CIRA FINAL REPORT 2001-2010

COOPERATIVE INSTITUTE FOR RESEARCH IN THE ATMOSPHERE

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INTRODUCTION

This report describes research funded in collaboration with NOAA's cooperative agreement and the CIRA Joint Institute contract period July 1, 2001 through June 30, 2010.

The report is meant to be an overview of the reporting period. Complete reports for each contract year can be found at the following links on the CIRA web page:

2001-2002: http://www.cira.colostate.edu/publications/annual_report/cira_annual_report_fy01-02.pdf
2002-2003: http://www.cira.colostate.edu/publications/annual_report/cira_annual_report_fy02-03.pdf
2003-2004: http://www.cira.colostate.edu/publications/annual_report/cira_annual_report_fy03-04.pdf
2004-2005: http://www.cira.colostate.edu/publications/annual_report/cira_annual_report_fy04-05.pdf
2005-2006: http://www.cira.colostate.edu/publications/annual_report/cira_annual_report_fy05-06.pdf
2006-2007: http://www.cira.colostate.edu/publications/annual_report/cira_annual_report_fy06-07.pdf
2007-2008: http://www.cira.colostate.edu/publications/annual_report/cira_annual_report_fy07-08.pdf
2008-2009: http://www.cira.colostate.edu/publications/annual_report/cira_annual_report_fy08-09.pdf
2009-2010: http://www.cira.colostate.edu/publications/annual_report/cira_annual_report_fy09-10.pdf

For further general information on CIRA, please contact our web site: http://www.cira.colostate.edu/ . CIRA management will be happy to provide any additional information or clarifications that may be needed.

Graeme L. Stephens
Director

EXECUTIVE SUMMARY
CIRA Research Highlights by Funding Year

July 1, 2001 – June 30, 2002

Atmospheric Model Evaluation

- In April of 2002, a 20km, 50-level version of the RUC was integrated into operation at NCEP. This new RUC version (RUC-20) incorporates a variety of new data sources, including GPS cloud-top pressure, precipitable water, boundary-layer profilers and RASS. The physics package used in the forecast engine was also significantly enhanced to improve convective parameterization and cloud microphysics. The existing soil model was enhanced to include a 2-layer snow model and high-resolution land-use/soil type and topography data.

- An optimized configuration of the LAPS hot-start forecast system, coupled with the non-hydrostatic MM5 forecast model, was developed and tested. The configuration utilizes a triple-nested domain, with the domains having a grid spacing of 10 km, 3.3 km, and 1.1 km. This configuration has been installed on a Linux cluster coupled to the local data assimilation and forecast system at the western space launch range located at Vandenberg AFB, CA. A similar configuration is being tested for the eastern range (Kennedy Space Center).

- The WRF Standard Initialization package was significantly enhanced to better process various datasets required for the initialization of the WRF land surface packages. New, modular horizontal interpolation routines were added as library functions to better interpolate these types of fields, which must be handled differently based on the model's representation of land or water surface types. Additionally, significant effort was put forth to accommodate the latest version of the WRF mass-based vertical coordinate using the Runge-Kutta dynamic core.

- Real-time runs of the WRF model using the LAPS diabatic initialization were set up on the FSL high-performance computing system for the IHOP campaign, and CIRA scientists will be analyzing these forecasts in follow-on research collaborations related to IHOP and WRF development.

- Development of an operational ensemble forecast system, including several diverse regional forecast models such as NCEP's Eta and RSM, FSL's RUC, and NSSL's MM5, began this past year. The resultant ensemble forecast products are expected to improve the overall model prediction.

Cloud Physics

- Stratus cloud drizzle retrieval using the first three moments of the Doppler spectra to obtain drizzle properties from a 3-parameter log-normal model of the drizzle droplet distribution was initiated. Measurement data from the FIRE Artic Clouds Experiments, the North Slope of Alaska cloud radar, and a cloud radar on the NOAA research vessel Ron Brown will provide the Doppler spectra.

- Some earlier non-drizzle results have been published in refereed journals. One showed the results of comparisons between in-situ FSSP measurements and radar retrievals of stratus cloud effective radius. Another article was from retrievals of stratus cloud properties determined during SHEBA. A third article involving radar observations of clouds has been submitted to a refereed journal.

CloudSat

- CloudSat is a NASA ESSP mission scheduled for launch in April 2004. The mission includes two significant features: A cloud imaging 94GHz radar, and a formation flying aspect unlike other satellite missions.

- CIRA was selected as the Data Processing Center for CloudSat in 2000. As the DPC for CloudSat, CIRA will be responsible for creating all of the standard products as defined by NASA and the Principal Investigator, Professor Graeme Stephens. In addition, the DPC is responsible for the dissemination of CloudSat data to the PI, Science Teams, and the general science community. In effect, the DPC acts as a NASA DAAC for the duration of the mission (2 years) and, only after the mission is completed, will the data be transferred to the Langley DAAC for archive and subsequent dissemination.

- The last years activities include:

    - Successfully passed the Critical Design Review
    - Implementation of development software unique to CIRA and recognized by NASA as highly innovative
    - Reintroduction of the Calipso data stream. This means CloudSat is the only satellite mission whose core products require another satellite.

Earthstation & Infrastructure

- The CIRA Infrastructure grew by 15% overall. Many systems were upgraded to Pentium 4 technology with additional memory and hard drive space. An additional local area network subnet was added to accommodate the growth. A new 1TB mass storage was brought online for general research. The modeling cluster was expanded to 24 Pentium-4 nodes. CIRA's local network was upgraded as necessary and a firewall was added for additional security. CIRA's storage archive continues to be a reliable source now using both DLT tapes and DVD disks.

- The CIRA satellite earthstation continued to provide global coverage ingesting and archiving over 60GB/day. CIRA also acted as the primary collection site for NOAA's GOES-11 science test.

Educational Outreach

- The GLOBE program initiated in 1995 achieved several major milestones in 2002. The Program has now expanded to over 12,000 schools in 98 partner countries, with 20,000 teachers having attended GLOBE workshops and GLOBE students having reported data from 8 million measurements worldwide. Science protocols have also expanded to now include Atmosphere/Climate, Hydrology, Soil, Land Cover/Biology, Phenology, as well as several special observations such as hummingbird behavior, budburst, and lilac phenology.

- Performance of the FX-Net system during the 2002 Winter Olympics in Salt Lake City was a resounding success. Application of this system in support of fire weather prediction is being explored.

Mesoscale Studies

- In a collaborative effort with RPN and UCLA to ascertain the appropriate large-scale forcing that should be included in the hyperbolic system, the relative contributions of the various physical parameterizations included in a typical operational weather prediction model to the large-scale forecast accuracy were determined. In agreement with the theory of the periodic updating of hyperbolic systems with multiple timescales, the periodic insertion of wind data alone provides mid-latitude initial conditions for the winds essentially identical to those of the operational assimilation system. Results from the collaborative manuscript (Gravel et al., 2002) were presented at the Canadian CMOS meeting in May.

- A well-posed, open boundary multiscale ocean model is being developed for ONR. A simple and computationally efficient model has been developed to demonstrate the accuracy and stability of the open boundary treatment. Preliminary results from this model have shown the feasibility of this approach. Theoretical work on a remaining issue in multiscale atmospheric dynamics will be conducted. The feasibility of accurate and stable open boundary conditions for a model based on the well-posed reduced system for oceanography will be completed during the coming year.

- Collaborative research on the improvement and testing of the QNH mesoscale model continued this past year. Comparative studies were conducted between the parallelized and serial versions of the QNH model. Additional sensitivity studies were conducted with the 10km version of the model, primarily involving QPF predictions. Effort began to produce daily runs of a 10km version of the mass-coordinate WRF model. The height-coordinate WRF model will be modified using a stretch coordinate.

- GPS tomography package to handle the GPS operational data set available at Japan Tsukuba dense GPS network was prepared. Compared with the software developed at the Japan MRI, the numerical results obtained from the FSL-developed tomography package were acceptable. Based upon the discussions at the Kyoto GPS workshop, FSL, MRI, and the University of Kyoto formed a collaboration to conduct future GPS tomography research on theoretical and operational experiments.

- Manuscript entitled “Impact of Formulation of Cost Function and Constraints on Three-Dimensional Variational Data Assimilation” (Xie et al., 2002) now in print for the Monthly Weather Review appears to contradict several operational 3DVAR implementations. Intent is to develop a new 3DVAR system based upon this theory. This system, which differs from the WRF 3DVAR in many respects, could be used as a research tool for comparing current 3DVAR analysis techniques.

Technology Transfer

- The WFO-Advanced forecast system was originally implemented on Hewlett Packard (HP) hardware, using the Hewlett Packard Unix (HPUX) operating system. The Linux operating system has been identified as an attractive replacement for HPUX; research and testing effort was initiated to determine the optimum transition from HPUX to Linux.

- Collaboration continued on the web dissemination component of LDAD known as the Internet-based Emergency Management Decision Support (EMDS) system. It is a web-based applet/application for use by a small number of state and local government users and/or a large number of public Internet users. The EMDS disseminates all types of weather data, including high-resolution weather analysis/forecast/model grids, radial radar grids, observations, quality control information and textual forecasts in a multi-modal GUI to a variety of users. It also allows the local and state government agencies to integrate weather information from the National Weather Service with their GIS data sets to create a personalized Decision Support System. The full deployment of EMDS at all WFOs was a major accomplishment for the year.

- The PACE effort comprised of two separate investigative projects—the FX-Connect and the TMU projects—is examining innovative software and data products to help minimize adverse weather disruptions to air traffic operations over the US. Aviation data sets and forecast products specifically tailored for the ARTCC air traffic weather forecasting environment are being prototyped, along with investigation into the utilization of collaborative weather forecasting techniques.

- Development continued on a directive-based model parallelization software suite called the Scalable Modeling System (SMS) that is used in the parallelization of weather and ocean models. The SMS parallel version of the Regional Ocean Modeling System at PMEL is being used to examine inter-annual to decadal variability in circulation and hydrography in the Coastal Gulf of Alaska region. One version of the SMS-parallelized Princeton Ocean Model is being used by NASA/Goddard to investigate century-scale variability in the North Atlantic and Arctic Oceans.

- Capabilities of different satellite sensors (DMSP, MODIS, AVHRR) in detecting fires were evaluated. A prototype application for a website posting daily maps of fire detections on a regional basis (S.E. Asia) by multiple sensors was developed. A particle dispersion model developed by NOAA (HYSPLIT) is incorporated into the website mapping, along with weather forecast data, to predict the trajectory and concentration of smoke from the fires. Analysis of aerial photography for calibration of DMSP nighttime lights data was also conducted, and images were produced for estimating percentage of development in the U.S. and the resulting effects on carbon cycling.

July 1, 2002 – June 30, 2003

Global and Regional Climate Dynamics

- Continued participation in the Global Air-ocean IN-situ System (GAINS) support included several demonstration test flights this past year. GAINS is a long-duration stratospheric platform, instrumented for environmental sensing through a combination of dropsondes, XBTs, and chemistry, particulate, in-situ, and remote sensors.

Mesoscale and Local Area Forecasting and Evaluation

- The results of the collaborative work with Canada's RPN and UCLA to ascertain the appropriate large-scale forcing that should be included in the hyperbolic system was incorporated into the Canadian operational global assimilation system and model. The reduction in the error relative to in-situ surface pressure and upper air data over North America can be seen on the Canadian website: www.msc-smc.ec.gc.ca/cmc/index_e.html

- The use of well posed and stable open boundary conditions for the multiscale system for oceanography has been demonstrated to be capable of recreating the flow in a limited area of a global basin similar to the atmospheric case. The multiscale system for the ocean appropriately reduces to the incompressible Navier-Stokes equations for smaller scales of motion and variants of the multiscale system are being used in a number of physical applications.

- Several new research collaborations on mesoscale studies were initiated this past year. One involved the analysis and modeling of bores detected during the IHOP field experiment during May – July 2003. Another effort involved the development of a new convective parameterization based on ensemble representation of convective closures combined with data assimilation techniques and climatological analysis. A third project is designed to assess how accurately the land surface schemes in atmospheric models can simulate runoffs and to identify and begin work on the research tasks necessary for operational hydrologic forecast capabilities to be fully integrated within atmospheric systems.

- A benchmark-testing package for evaluating various GPS tomography techniques was developed and distributed to various attendees at the GPS Meteorology Conference hosted by the Japan MRI this past January. Based on new results from associated 3DVAR research, a more general version of the GPS tomography software has been developed.

- The successful implementation of an integrated weather system, involving LAPS and a diabatically initialized MM5, at Vandenberg AFB (with Cape Canaveral to follow) leveraged government "off-the-shelf" technology to maintain an effective upgrade path between civilian and military weather agencies. Local data ingest (via AWIPS/LDAD), national and local data display (via AWIPS D2D), data assimilation (via LAPS), and NWP (via hot-started MM5) will provide a unique capability to enhance pre-and post-launch space vehicle launches and range safety operations.

- In support of the US Fire Consortia for Advanced Modeling of Meteorology and Smoke, CIRA researchers created one 12-km western US and two 4-km Rocky Mountain and Southwest region windows of LAPS and MM5 forecast runs on the iJet supercomputer to provide experimental real-time fields. Collaborating with the US Forest Service Rocky Mountain Research Station, the team created web displays of several fire weather indices, PBL mean wind, and an interactive point forecast.

- In perhaps the first quasi-operational implementation of the new WRF model and the first NWS-sanctioned local modeling effort, CIRA researchers participated in the Coastal Storms Initiative to perform a proof-of-concept for local data assimilation and NWP within a NWS Forecast Office (Jacksonville). With the first use of satellite and radar data for real-time WRF initialization, early results are promising.

Applications of Satellite Observations

- CIRA has installed a Data Processing and Error Analysis System (DPEAS) at NESDIS/OSDPD. This 8-node PC system is processing AMSU data and is demonstrating the use of PC to perform real-time satellite data processing for significantly lower cost than conventional methods.

- Began the analysis, using cross-sensor method of land microwave emissivity. This is the beginning of the validation of the NESDIS Microwave Land Emissivity Model (MEM).

- Developed a CD-ROM of over 60,000 IR images of Atlantic and Eastern Northern Pacific tropical storms. These data are being used for tropical storm research such as improvements in the Dvorak intensity estimation algorithm.

- Our development work on the CloudSat Data Processing Center has been recognized by NASA as an outstanding portion of the CloudSat mission. The significance of this to NOAA is that CIRA is building a prototype data system that has several unique attributes that could be incorporated in future NOAA/NESDIS mission support systems:

    - It ingests several different satellite platforms (the A-train) that includes AIRES, MODIS, Calypso, and CloudSat to build specific products.
    - It will provide not only CloudSat data to the science community, but the correlative data from these other sensor platforms, surface validation data, and analysis grids subsetted for the location and time of CloudSat overpasses.

Numerical Modeling

- In May of 2003, the CIRA RUC team participated in replacing the analysis scheme used in the operational 20km RUC (OI) at NCEP with a 3D variational method. Use of the 3DVAR package allows more efficient integration of additional observation data.

- An optimized configuration of the LAPS hot-start forecast system, coupled with the non-hydrostatic MM5 forecast model, was developed, tested and implemented operationally at Vandenberg AFB, CA. The configuration utilizes a triple-nested domain, with the domains having a grid spacing of 10 km, 3.3 km, and 1.1 km. This configuration has been installed on a Linux cluster coupled to the local data assimilation and forecast system at the western space launch facility. A similar configuration is being tested for the eastern range (Cape Canaveral).

- The WRF Standard Initialization package was significantly enhanced to better process various datasets required for the initialization of the WRF land surface packages. Additional flexibility was added to allow users to more easily use separate input datasets for the initial, lateral, and lower boundary conditions. Gridded fields that are on non-isobaric surfaces can also now be ingested. Mercator and Lambert FORTRAN map projection routines were simplified and standardized.

- Case study reruns of LAPS analyses and forecasts for the IHOP campaign have been performed for RAMS initialization. More detailed studies (high resolution of 50- or 100-m) are planned to investigate the interaction of surface heterogeneities and the LLJ.

- An experimental 10km WRF is being run over the TAQ (New England Temperature and Air Quality Program) domain and a 20km WRF is being run over the CONUS domain. The TAQ project incorporates a number of special observations, including boundary layer profilers, GPS precipitable water, radar reflectivity and Mesonet observations into a nested (10-km nest) model running out to 48 hours four times per day.

- Development of an operational ensemble forecast system, including several diverse regional forecast models such as NCEP's Eta and RSM, FSL's RUC, and NSSL's MM5, continued this past year. Each model is expected to provide five ensemble members. Thus far, an ensemble forecast system for the RUC has been developed and put into operation.

Cloud Physics

- During the past year, an algorithm for retrieving stratus cloud droplet liquid water flux due to gravitational settling using cloud radar reflectivities was developed. By computing the divergence of the flux, the cloud heating and cooling due to gravitational settling of cloud droplets can be estimated and compared with the calculated radiative cooling and heating.

Education, Training, and Outreach

- The GLOBE program initiated in 1995 continues to grow and now includes over 13,000 schools in 102 partner countries, with 23,000 teachers having attended GLOBE workshops and GLOBE students having reported data from 9.7 million measurements worldwide. Science protocols now include Atmosphere/Climate, Hydrology, Soil, Land Cover/Biology, Phenology, as well as several special observations such as hummingbird behavior, budburst, and lilac phenology.

- Our RAMM Team has conducted over 600 training sessions for over 11,000 students for the Virtual Institute for Satellite Integration Training. This program is a prototype for rapid technology transfer of University satellite research to the NWS operational field offices.

- Performance of the FX-Net system as an experimental fire weather forecaster workstation during the 2002 fire season was a resounding success. With the addition of a variety of new functionalities to the FX-Net client, including new fire weather products and new user-friendly tools, the system will support the National Interagency Fire Center and the Geographic Area Coordination Centers as an operational fire weather support platform during the 2003 fire season. FX-Net continues to support the AIRMAP Program, through the University of New Hampshire, that focuses on the long-term monitoring and forecasting of air quality parameters like nitrogen oxides, sulfur dioxide, carbon monoxide and low-level ozone.

- Conversion of the WFO-Advanced forecast system (core software for AWIPS) from Hewlett Packard Unix (HPUX) operating system to Linux has proceeded smoothly. The AWIPS radar data ingest capabilities were enhanced in anticipation of new radar volume scan strategies. Display of local lightning data was a significant addition to the workstation software in support of the space launch facilities at Vandenberg AFB and Cape Canaveral.

- Collaboration continued on the web dissemination component of LDAD known as the Internet-based Emergency Management Decision Support (EMDS) system. It is a web-based applet/application for use by a small number of state and local government users and/or a large number of public Internet users. During the past year, a surveillance capability within the EMDS was completed. The surveillance capability includes the ability to create derived grids and to monitor conditions within some distance of a point for the purpose of generating alerts if specified thresholds are exceeded.

- The PACE effort comprised of two separate investigative projects—the FX-Connect and the TMU projects—is examining innovative software and data products to help minimize adverse weather disruptions to air traffic operations over the US. Aviation data sets and forecast products specifically tailored for the ARTCC air traffic weather forecasting environment are being prototyped, along with investigation into the utilization of collaborative weather forecasting techniques. The initial phase of a four-phase project is designed to address the weather information needs of the TMU relating to the weather-related hazards of convection, icing, turbulence, and ceiling/visibility.

- The Advanced Computing group initiated an investigation into how grid technology can be utilized by the atmospheric and ocean research communities. The project's goal is to determine the feasibility of running a coupled model on the grid with one model, e.g., atmospheric, running on one machine and the other, e.g., ocean, running on a second machine at another facility.

- After successfully applying the wavelet transform data compression technique to satellite imagery, the wavelet compression technique, including a user-defined "precision control," was further modified to address 3-D gridded model fields. Early results with temperature fields indicate 2 to 6 times higher compression ratios compared to typical lossless codecs with the same precision requirements.

Societal and Economic Impacts

- Several research efforts in collaboration with the National Geophysical Data Center (NGDC) continued involving DMSP imagery, Geographical Information Systems (GIS) and other specialized remote sensing data manipulation and mapping techniques. These efforts included: 1) a project to show that coral reef bleaching can be detected with IKONOS satellite data using radiometric normalization of image pairs using difference-image processing techniques; 2) data processing of Landsat ETM imagery for use in analysis of accuracy of active fire detections in AVHRR, DMSP and MODIS in Southeast Asia, and burn scar from MODIS; 3) processing of nightly DMSP data for Madagascar for time period of August 2002 through December 2002, for mapping of fires; and 4) analysis of high-resolution aerial photography for calibration of DMSP nighttime lights data to produce images estimating percentage of impervious surfaces in the U.S as input to carbon cycling models.

- Joint collaboration with the National Renewable Energy Laboratory (NREL) is ongoing to investigate forecast methods to improve low-level wind prediction for wind energy production. The wind study uses model ensembles to estimate probability distributions of low-level wind forecasts to provide confidence levels in predicting wind-energy power generation.

Infrastructure

- CIRA's satellite earth station has successfully transitioned its real-time data collection to a DVD storage system. Designed by our in-house engineering staff, the system is collecting over 55 Gbytes of data each day. Unlike previous 8mm and digital linear tape systems we now have a verified data collection. Tapes are usually written to and the quality of the data on the tape is taken as an act of faith. Only subsequent reads of the data verify that the data actually was successfully transferred. Unfortunately each subsequent read on tape systems poses a threat to the data due to the possible scrapping of oxides from the tapes' surface. DVDs, using optical retrieval, suffer no damage from repeated reads, are random access, and during the 4 months of operation have saved CIRA over $19,000 in media costs.

- Besides the DVD systems, CIRA also converted all its critical mail, ftp, and data ingest storage systems to RAID technology. Although not a new technology, RAID systems in 2003 became available at low cost. We are now able to build redundant fault tolerant 1-terabyte storage systems for $3800 each.

July 1, 2003 – June 30, 2004

Global and Regional Climate Dynamics

- Collaborations continued on the development of computer software for the parallelization of atmospheric and oceanic weather and climate models through enhancements of both the WRF model and the Scalable Modeling System (SMS). Feasibility of combining geographically distributed computing resources into a single virtual resource was explored by creating and demonstrating a WRF/ROMS coupled model running simultaneously at FSL and PMEL.

- Feasibility of forecasting runoff using a non-hydrostatic multi-scale regional climate model down to scales that resolve individual valleys and massifs was examined. Set of three 5-year experiments using a high-resolution coupled atmosphere-land surface modeling system to simulate runoff in a hydrologic model was conducted.

- Our climate modeling efforts (Northwest Mexican Monsoon and Great Plains Precipitation) found that soil moisture anomalies had a greater impact than SST anomalies on monsoon circulations and precipitation.

- Developed a stochastic process that can reproduce a climatology of the observed abrupt shifting dynamics in the Great Lakes basin.

Mesoscale and Local Area Forecasting and Evaluation

- Several new research collaborations on mesoscale studies occurred during the past year. One involved the development of a new convective ensemble-based parameterization for the RUC. Another effort involved the analysis of bore dynamics during the IHOP 2002 field experiment. A third effort involved the development of a time-lagged ensemble forecast system based on various RUC forecasts initialized at different times. Another effort was begun to develop a wavelet-based diagnostic tool to better detect gravity waves and clear air turbulence.

- GPS tomography technique was tested using actual GPS data and the resulting water vapor analysis was compared with satellite water vapor imagery and sounding data obtained during IHOP with good results.

- First year of proof-of-concept testing of local data assimilation and NWP within a NWS Forecast Office produced favorable results. Satellite, radar, and other local data were used for real-time initialization the WRF model on a Linux cluster.

- Collaborations with the Boulder WFO on evaluations of an experimental infrasound system developed by ETL have begun. Cases of tornado events will be examined to determine the potential value of the new system to provide enhancement to radar in the detection of tornadoes.

- A specially configured mesoscale ensemble forecast system comprised of MM5 and WRF model runs was developed to support the Road Weather Maintenance Decision Support System (MDSS) for the FHA. LAPS analysis was used to initialize both WRF and MM5 to produce 48 runs per day out to 15 hours during the entire 2003/2004 winter. These forecast grids serve as input to provide forecast winter road conditions and recommended treatment options for road maintenance personnel.

- Support of the US Fire Consortia for Advanced Modeling of Meteorology and Smoke continued with enhanced fire weather products including a “Critical Fire Weather Index.” Plots of surface latent heat flux forecasts and solar radiation observations were created to help diagnose and improve surface relative humidity forecasts.

- SCAN (System for Convection Analysis and Nowcasting) developed by the NWS/MDL was ported into Taiwan Central Weather Bureau’s AWIPS-like weather forecasting workstation to better integrate weather surveillance radar data for short-term severe weather analyses and forecasts. Follow-on effort to

integrate MDL's Flash Flood Monitoring Program into AWIPS for hydrologic forecast and emergency management support was initiated.

- Successfully completed the first dual Doppler micro-scale wind/density/turbulence study in the Oklahoma City area.

Applications of Satellite Observations

- Several research efforts in collaboration with the National Geophysical Data Center continued involving DMSP imagery, GIS, and other specialized remote sensing data manipulation and mapping techniques. These efforts included: 1) a project to demonstrate that coral reef bleaching can be detected with IKONOS satellite imagery using radiometric normalization of image pairs using change detection techniques; 2) compilation of data for comparison of the capabilities of different instruments (DMSP, MODIS, VIRS) for fire detection; and 3) data processing and analysis to estimate the amount of impervious surface area (ISA) within the conterminous United States, using DMSP satellite data, U.S. Census Bureau TIGER roads data, high-resolution aerial photography, and Landsat TM classification data from USGS EROS Data Center. This project is part of NASA's Land Use Land Cover program, and the product is used as input to models for carbon cycling.

- Improved the dew point retrieval error statistics over the existing GOES sounder-only methodology and the NCEP first guess only method.

- Successfully implemented (at CIRA and NESDIS/OSDPD) a Total Precipitable Water product that combines AMSU and SSM/I sensor data from all the NOAA and DMSP satellites with these sensors.

- Created a GOES-IR-based wind field estimation method.

- A variational analysis system was applied to satellite wind data to produce a complete surface wind field. This method allows partial wind observations (such as wind speed obs with ambiguous direction) to be assimilated.

- Began simulation studies in support of NPOESS sensor risk reduction. Demonstrated a method for combining a numerical cloud model with an observational operator to produce synthetic NPOESS imagery.

- Validated AMSU temperature retrievals under cloudy and precipitating conditions in a hurricane system.

- Validated the GOES Aerosol and Smoke Product (GASP) output and applied it to large scale air pollution events over the US mid-Atlantic region.

- Developed a new ice cover mapping system that combines AVHRR and GOES. Current studies are looking at potential snow depth algorithm improvements.

Cloud Physics

- Retrieval of liquid water flux and drizzle properties from stratus clouds were developed and refined using millimeter cloud radar, along with Doppler lidar and wind profiler mounted on a ship.

- Series of eddy resolving simulations (ERS), and large eddy simulations (LES) of smoke-cloud interactions were performed to demonstrate the relative importance of various factors responsible for cloud suppression in the biomass burning regions of Amazonia.

Numerical Modeling

- A special configuration of the LAPS "hot-start" forecast system implemented operationally at Vandenberg AFB, CA last year was installed at Cape Canaveral this past year. This involves a triple-nested version of the MM5 model diabatically initialized with LAPS. Convective instabilities at the finer 1.1 km inner grid spacing were corrected that have resulted in improved QPF forecast fields.

- The WRF Standard Initialization (SI) was significantly improved, including support for the incorporation of the NCEP Nonhydrostatic Mesoscale Model (NMM) core. Capability to set up and initialize nested WRF domains was also implemented.

- Completed the development of our Regional Atmospheric Modeling and Data Assimilation System (RAMDAS).

- Developed a Southern Hemisphere tropical cyclone model now installed at the Joint Typhoon Warning Center.

- Completed the development of an ensemble method for determining the error covariance matrix for model and forecast errors.

- Applied ensemble data assimilation and model error method to NASA's GEOS column precipitation model.

Education, Training, and Outreach

- GLOBE Systems team comprised of 10 CIRA researchers successfully transferred their operation from the NOAA/FSL facility to the UCAR Foothills Lab campus with no impact to the Program's worldwide users now located in 106 countries. There are now more than 11 million observations in the GLOBE database collected by students in over 15,000 schools since the Program's inception in 1995.

- The PACE effort comprised of two separate investigative projects—TMU and FX-Connect—made significant progress this past year. The effort is driven by the need for innovative software tools and data products to minimize adverse weather disruptions in air traffic operations. For phase I of the TMU project, a prototype Tactical Convective Hazards Product was prototyped and enhanced. The FXC Volcanic Ash Coordination Tool project is a response to the needs of collaborating agencies in generating consistent Volcanic Ash Advisories. The initial release of the FXC VACT systems, including the delivery and installation of both hardware and software, along with major enhancements.

- During the 2003 fire season, FX-Net server systems were installed in four of the NWS Regional HQs offices (Western, Southern, Alaska, and Pacific). At one point during a very active wildfire season, 32 Incident Meteorologists in the field deployed by the Western Region were using FX-Net as their primary forecasting system.

- A new version of the wavelet data compression was applied to the FX-Net system to more efficiently compress satellite and model grid images, and to reduce the file encoding and decoding time. This new version of FX-Net was fielded at the National Interagency Fire Center, at the Western and Southern NWS Regional HQs offices, and for university clients and NOAA researchers.

- Latest version of the Air Quality FX-Net was deployed to researchers involved in the AIRMAP Program over New England. Additional air quality observation data were also added to the FX-Net ingest and display capability during 2003.

- With the conversion of AWIPS from an HPUX to a Linux operating system, new technologies for implementation on Linux platforms were explored to address the ever-increasing amount of data. An Advanced Linux Prototype System was formulated focusing on employment of new network and database technologies.

- A specialized version of the Display-3D (D3D) interface for AWIPS was implemented for display of 3D lightning data at Cape Canaveral.

- Novel visualization of global weather phenomena and in-the-round visualization of other planets and moons in our solar system were developed for the Science on a Sphere display platform.

- Ported a new Wavelet-based compression algorithm to UNIX, Linux, and Win2000 operating systems. This system was targeted to uplink satellite data to NOAA's P-3 aircraft for hurricane surveillance and penetration.

- The Virtual Institute for Satellite Integration Training (VISIT) has issued over 12,000 training certificates.

Societal and Economic Impacts

- Several research efforts in collaboration with the National Geophysical Data Center continued involving DMSP imagery, GIS, and other specialized remote sensing data manipulation and mapping techniques. These efforts included: 1) a project to demonstrate that coral reef bleaching can be detected with IKONOS satellite imagery using radiometric normalization of image pairs using change detection techniques; 2) compilation of data for comparison of the capabilities of different instruments (DMSP, MODIS, VIRS) for fire detection; and 3) data processing and analysis to estimate the amount of impervious surface area (ISA) within the conterminous United States, using DMSP satellite data, U.S. Census Bureau TIGER roads data, high resolution aerial photography, and Landsat TM classification data from USGS EROS Data Center. This project is part of NASA's Land Use Land Cover program, and the product is used as input to models for carbon cycling. Ultimately, this information will be used with many other data in the global warming debate.

- Joint collaboration with the National Renewable Energy Laboratory (NREL) continued to support applications of the RUC model in wind energy planning. Effort is now concentrated in application of ensemble forecasting methods to produce probability distribution functions for potential wind energy production, detection of nocturnal low-level jet, and improved near-surface wind forecasts through variation in surface roughness.

- Improved the AHPS information delivery by applying social science perspective to web page user interface.

Infrastructure

- Our Data Systems Group at FSL designed and developed new software to streamline the acquisition and processing of data. This new software was created using Object Oriented methods to reduce maintenance and to allow for the generic handling of data types thereby shortening the development time for decoders and translators by an order of magnitude.

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Global and Regional Climate Dynamics

- Modeling studies have been completed on GCM sensitivities to cloud feedback, specifically shallow convection. The model sCAM has been used with several tropical data sets taken during BOMEX, ASTEX, and DYCOMS I and II. Year-long simulations have revealed several biases in the NCAR Community Atmosphere Model (CAM) including: anomalous precipitation patterns associated with the Asian Monsoon. The bottom line will be improved parameterizations in these climate models for precipitation and convection.

- GCM (CAM2) biases are being evaluated using HIRS and ISCCP data sets. Discovered biases are being investigated using the model's energy and water budgets.

- CIRA has made great progress in using redundant ISCCP data to shed light on the dataset's accuracy of cloud cover.

- Comprehensive model sensitivity studies have been performed on North American drought, floods and El Nino seasons using the monsoon convection as a telecommunication mechanism between monsoonal surges in Northern Mexico and convection in the central U.S.

- CIRA has had many carbon cycle research starts in the last 6 months. Although too early to report results, the exceptional growth in CIRA's carbon research is noteworthy in itself.

- A prototype NOAA computational grid has been developed as part of an effort to explore the feasibility of combining geographically distributed computing resources into a single virtual resource (a computational grid). It includes processors located at the Forecast Systems Laboratory in Boulder, Colorado, the Geophysical Fluid Dynamics Laboratory in Princeton, New Jersey, and the Pacific Marine Environmental Laboratory in Seattle, Washington. A rudimentary grid-scheduler was developed to allow users to submit jobs from nodes anywhere on the grid. The coupling of atmospheric and oceanic models across the TeraGrid for climate applications is in progress.

- Regional climate simulations were performed for June 2004 with the WRF model to study the effects of soil moisture on precipitation and to compare results obtained with different convective parameterizations and with explicitly resolved convection. Convection is parameterized in simulations on a 20-km resolution grid and cloud-resolving simulations are performed on a 1.7-km resolution grid. A preliminary comparison of modeled precipitation with a .25 degree resolution CPC analysis is presented. A more comprehensive comparison with stage 4 data is planned.

- Initial in-situ versus satellite measurement comparisons have been performed to see how representative the cloud observatory will be at Eureka, Canada where a cloud radar, radiometer and other instruments for cloud monitoring are being sited. This data will be used for input to climate models and for observing climate changes in the Arctic.

Mesoscale and Local Area Forecasting and Evaluation

- The Range Standardization and Automation (RSA) project was upgraded to a whole new set of IBM hardware and a new operating system (Advanced Server 2.0). This project is aimed at providing high-resolution analyses and forecasts to support space center activities at Cape Canaveral and Vandenberg AFB. Utilizing LAPS and the MM5 mesomodel, the RSA system creates high-resolution analysis and forecast products that support operations from the next few minutes to 24 hours in advance. The product set merges with the NOAA and USAF product streams for display on AWIPS. CIRA's efforts combined with those of other team members led to FSL and the LAPS branch being recognized with the 2005 NOAA Technology Transfer Award.

- Various diagnostic tools were developed to investigate the interaction between gravity waves and turbulence. A theoretical framework of gravity wave polarization and associated diagnostic methods was also developed. Using the wavelet-based cross-spectral method, spectral results in physical space were localized to see how gravity wave polarization is related to the generation of turbulence.

- Research into time-lagged ensemble forecast and modeling using RUC forecasts as a set of ensemble members continued. A multi-variable linear regression scheme was developed. This scheme uses past observational data to train each time-lagged ensemble members and provides optimal weights for these forecasts. Ensemble forecasts using these optimal weights showed significant improved forecast skills in the short-range.

- A method to improve ensemble-based forecasts of maximum daily 1-hr and 8-hr averaged ozone concentrations was developed and evaluated. The method minimizes least-square error of ensemble forecasts by assigning weights for its members. Investigation showed that the magnitude of a weight does not necessarily correspond to the quality of the ensemble member. Maximum benefit in performance of the ensemble is achieved when weights are calculated daily, suggesting in a certain way the value of persistence as a forecasting tool.

- First year of proof-of-concept testing of local data assimilation and NWP within a NWS Forecast Office produced favorable results. Satellite, radar, and other local data were used for real-time initialization of the WRF model on a Linux cluster.

- Additional enhancements were implemented for the specially configured mesoscale ensemble forecast system comprised of MM5 and WRF model runs developed to support the Road Weather Maintenance Decision Support System (MDSS) for the FHA. New domain and products improve the input that provides forecast winter road conditions and recommended treatment options for road maintenance personnel.

- Support to U.S. Forest Service operations continued with LAPS analyses running on IJET, as well as a recent transfer to the newer cluster called EJET. The large western U.S. domain was increased in resolution from 18km down to 6km. We will be revisiting the possibility of parallelization of the analyses to help restore the radar feed.

- LAPS researchers participated in the Developmental Testbed Center's (DTC) winter experiment of testing high-resolution (5 km) CONUS scale models (NMM and ARW, two versions of the WRF model) for winter forecasting. The experiment was called the DTC Winter Forecast Experiment (DWFE), and the involvement included subjective assessment of the forecasts with a paper presented at the AMS conference on Numerical Weather Prediction and Weather Analysis and Forecasting in August 2005.

- Efforts continued to adapt the MDL-developed *System for Convection Analysis and Nowcasting* (SCAN) software to KMA's *Forecaster Analysis System* (FAS), an AWIPS-like, weather forecast workstation. Using the C- and S- band data from the various KMA radar data collection platforms, a real-time radar data processing system was created to generate the required SCAN radar products: Vertically Integrated Liquid (VIL), Composite Reflectivity (CZ), and Storm Track and Identification (STI).

- Display of the upstream contributing area (area of rainfall runoff) and downstream flow path (potential Flash Flood track) from an arbitrary large scale (small) FFMP watershed was added to the Flash Flood Monitoring Program (FFMP). This display improves the NWS forecaster's comprehension of the hydrologic processes and impact features involved in flash flood forecasting.

- The MicroMet model is well under development. MicroMet will serve to couple high- resolution hydrological and land use models with lower resolution (15-40 km) mesoscale models. Three conference papers and two publications are currently under review.

- CIRA has completed a toxic dispersion transport model. The unique feature of this model is that it’s for streams and rivers. Using CSU’s CASC2D hydrological model as a starting point, this model simulates the erosion, deposition, chemical leaching, and solubility of many toxic materials and their transport and dilution downstream in the face of rain and flood events.

- Our work with the DoD on soil moisture is converging with NOAA’s activities. We are currently finishing up a soil moisture data assimilation system that uses WindSat 6 Ghz radiometer data as well as satellite IR and SSMI data. The 6 GHz channel provides deeper penetration and the modeling aspect should allow soil moisture analysis deeper than any sensor data can hope to achieve without a modeling component. The Backus-Gilbert work reported in the Satellite Applications section is a key element of this work.

- Research on Ensemble assimilation and prediction techniques is well underway as part of several research efforts and next year's report will show significant results.

Applications of Satellite Observations

- A breadboard etalon spectrometer and prototype analysis algorithm was developed to measure CO2 remotely. This project, closely linked to the NASA OCO mission is an early development effort that could lead to a NOAA operational mission for the measurement of CO2 sources and sinks at very high resolution.

- GOES-N Post Launch Test website online. http://rammb.cira.colostate.edu/projects/goes_n/

- Improved statistical hurricane intensity forecasts developed. SHIPS improved by using satellite data and analysis shows eastern Pacific intensities improved significantly.

- The Tropical Cyclone Formation product was successfully transferred from CIRA to OSDPD.

- A cross sensor blended total precipitation product (SSMI and AMSU) has been developed and delivered to OSDPD.

- An improved AMSU-based tropical intensity and wind structure estimation algorithm using a tropical cyclone dataset 5 times larger than previously available is now being run routinely at CIRA.

- A two dimensional Backus-Gilbert filter as been developed for general use to any satellite sensor and specifically for the WindSat data. This technology is critical to all passive microwave data utility within the modeling community. These data must be screened for RFI prior to model assimilation to be of any use over land.

- GOES-R Risk reduction activities included generation of synthetic HES images from simulated data. CAPE and TPW products were generated from the synthetic HES images. CIRA also generated synthetic sounder soundings with variable vertical footprints of the CONUS region. Information content studies, tropical cyclone products, severe weather applications, and prototype fog, smoke, and volcanic ash products were also investigated.

- Completed an NPOESS utility study on how these new data could be used in severe weather modeling and forecasting. As part of this process, a new Operational Operator was developed for the VIIRS 11.02, 12.3, and 13.3 micron channels. Synthetic VIRRS data was generated during this research.

- QuickSCAT data has been used to measure Gulf (Baja) surges as part of CIRA's multi-faceted work on the North American Monsoon Experiment.

- Quality assessment of the Cloud Top Height product (CTOP) created by the FAA AWRP Oceanic Weather Product Development Team was conducted. The assessment provided an intercomparison-based analysis of CTOP with an operational cloud top height product. This analysis marked the first use of remote sensing data for verification of aviation weather products in the context of the AWTT process. Based strongly on the results of the CIRA analysis, the FAA technical reviewers decided to make the CTOP product available to operational organizations on an experimental basis.

Cloud Physics

- Series of eddy resolving simulations (ERS) and large eddy simulations (LES) of smoke cloud interactions were performed to demonstrate the relative importance of various factors responsible for cloud suppression in the biomass burning regions of Amazonia. The vertical distribution of smoke aerosol in the convective boundary layer was found to be crucial to determining whether cloudiness is reduced or

increased. The study also pointed out the importance of coupling aerosol radiative properties and a surface soil and vegetation model to the microphysical-dynamical model. Under polluted conditions (associated, e.g., with biomass burning smoke), the surface flux response to the aerosol may be the single most important factor in cloud reduction.

- CIRA has analyzed uncertainty estimates of aerosol direct forcing of climate through stratocumulus cloud processing.

- A major finding in the comparison of VIRS IR rain estimates to TRMM measurements was found. Results indicate the Iris hypothesis is not supported by the data. No trend indicating changes in precipitation efficiency was found in the 18-month period of study.

Numerical Modeling

- CIRA has used NESDIS' Microwave Land Emissivity Model (MEM) and a 1DVAR vertical model to validate and create an AMSU-B antenna pattern that has resulted in a 10-15% bias error improvement to the upper-water vapor profiles. (These biases are in MEM so the discovery of these biases will affect all users of this model's output).

- A 1DVAR global emissivity retrieval system is currently being prepared for technology transition to NESDIS.

- Dr. Tomislava Vukicevic was awarded a Fulbright award for her work on 4DDA research. Her work on assimilation of GOES infrared radiances in the presence of clouds is proving that in increased constraints posed by these radiance values and their more frequent updates to mesoscale models improves forecast accuracy.

- Developed a model describing the uptake of water vapor by inorganic and organic particles. This work is critical in the future accuracy of remote sensing of CCNs because of how CCNs' radiative properties vary as they take on water.

- During the past year, support of the RUC development continued, both at NCEP and at FSL. A new version of the operational RUC was implemented at NCEP on 28 June 2005, with increased horizontal resolution, down to 13km, several new data sources, and improved surface, precipitation and cloud forecasts. The RUC was also used extensively for data impact studies, most recently evaluating wind profilers, lidar and ACARS moisture observations.

- To support the Developmental Testbed Center's desires to make a series of forecasts using WRF/NMMV1 for the DTC Winter Forecast Experiment (DWFE) using the latest physics incorporated into V2, the V2 physics package was merged into V1. With the use of available supporting software packages such as the SI and post-processing developed for V1, the DWFE was a total success.

- CIRA scientists collaborated on the design and development of a prototype WRF Portal—a Java-based GUI front end for running WRF. The design incorporates a mySQL database, Java application, and communication protocols between the client side application, WRF Portal, and server side workflow manager/job scheduler.

Education, Training, and Outreach

- The GLOBE Systems Team comprised of 8 CIRA researchers continued to provide website, database, and data acquisition support to the Program's worldwide users now located in 109 countries. There are now more than 13 million observations in the GLOBE database collected by students in over 16,000 schools since the Program's inception in 1995. The Program received the Goldman Sachs Foundation Prize for Excellence in international education (media and technology category) in November 2004.

- Science on a Sphere™ was installed this past year in its first permanent science museum location at the Nauticus Museum in Norfolk, VA. SOS continues in use at the Science Fiction Museum in Seattle. A full set of Jupiter's Galilean satellites is now available for display. Photo-mosaics of several Saturnian satellites were updated by reprojecting and overlaying recently taken Cassini flyby images. Maps of five Uranian satellites were added as well as one for Neptune. Some image processing was performed to add a high-resolution Voyager mosaic to a pre-existing map of Neptune's moon Triton.

- The PACE effort comprised of two separate investigative projects—TMU and FX-Connect—made significant progress this past year. The effort is driven by the need for innovative software tools and data products to minimize adverse weather disruptions in air traffic operations. The FXC Volcanic Ash Coordination Tool project is a response to the needs of collaborating agencies in generating consistent Volcanic Ash Advisories. A successful test based on a simulated volcanic eruption in the North Pacific was conducted in May 2005. The participating agencies were FSL, the Alaska Aviation Weather Unit, Alaska Volcano Observatory, and the Anchorage Center Weather Service Unit. The test enabled the participants to exercise the FXC VACT system in a simulated operational situation, familiarize users with VACT capabilities, and develop collaboration strategies and protocols for operations.

- The latest version of the FX-Net Client was installed at the Bureau of Land Management's (BLM's) Federal Test Center in Lakewood, Colorado. The system passed the rigorous network and security tests administered at the Test Center, and was certified for use by the 11 Geographical Area Coordination Centers (GACCs), the NIFC, the National Forest Service and the Ag Outlook Board. BLM users at these locations provide long-range fire predictions, daily fire indexes, and drought outlook products for various BLM websites and for operational use by fire weather forecasters. Specialized maps were added to the FX-Net system for these specialized users.

- A new version of the Wavelet Compression code was added to the system, providing higher resolution satellite imagery and improved product retrieval response. New datasets were added via the use of the MADIS system as well as locally generated, high-resolution model output.

- The core FX-Net system was used to build the servers for specialized air quality users. Additional datasets such as the EPA's AIRNOW real-time air quality observational data, the NOAA/EPA air quality forecast model data (CMAQ), and experimental air quality forecast models, such as FSL's WRF/Chem model were included in this new system.

- The successful implementation of Valid Time Event Codes (VTEC) in warning and advisory products for severe weather and flooding continues to be one of the most important near term goals of the NWS. During this past year, CIRA researchers helped the NWS successfully implement VTEC for severe convective warnings and some marine warnings.

- The AWIPS Linux Prototype System (ALPS) development effort began during FY04/05 exploring how the AWIPS system can be redesigned to support the longer term needs of the NWS and possibly other NOAA agencies. The focus this past year has been on distributed data and on an improved interface for user developed applications.

- Satellite utility and educational efforts have been very active. Coordination with WMO on the role of satellite meteorology, investigations of improved spatial, temporal, and spectral data, Costa Rica training, and training sessions at the AMS Satellite Conference in 2005 have been conducted or are underway.

- The SHyMet training course, a collaboration between CIRA and CIMMS to develop a distance learning course on satellite hydrology and meteorology, is well underway. Currently NWS SOS's feedback is being incorporated into the program.

- The VISIT program has fulfilled all goals identified in 1998. This accomplishment has been validated from feedback from VISIT participants and students. 15,000 training certificates have been awarded and 15

teletraining courses have been developed. More and more NOAA offices are using VISIT training as travel funds for training continue to shrink.

- In close collaboration with CIRES' NOAA Western Water Assessment, analysis of three Colorado watersheds is being modeled for drought risk assessment.

Societal and Economic Impacts

- Professor Cochrane has developed an econometric model that models weather-induced natural disasters and their economic impacts. The model also computes the inter-segment impacts of these disasters. This accounts for such things as a local economy actually being stimulated by post-disaster building activity, government sector activities, and many other cross sector economic couplings.

- AHPS Regional Excellence Award received by Central Region for Climate Services Division's work on improving delivery of hydrological products. CIRA's sociological work (Dr. Deo) was critical to the improved understanding of customer needs, clear message generation, and the optimization of the process via workshops, focus groups, and prototype designs.

- Joint collaboration with the National Renewable Energy Laboratory (NREL) continued to support applications of the RUC model in wind energy planning. Effort is now concentrated in application of ensemble forecasting methods to produce probability distribution functions for potential wind energy production, detection of nocturnal low-level jet, and improved near-surface wind forecasts through variation in surface roughness.

Infrastructure

- Currently installing NOAAPort (Linux version) at CIRA to support R&D for AWIPS.

- Completed an intercomparison study of Judd Communications and Campbell Scientific sonic snow depth sensors (for ASOS measurement).

- The inventory of Tropical Cyclone IR imagery has grown to 336 storms in the 1995-2004 timeframe with 93,700 images to assist storm track, intensification and general research efforts.

- Delivered a new IT computer system based on DPEAS to OSDPD that saved them approximately $7M compared to standard IT systems for the processing of multi-platform data. If scaled to the 55 NPOESS EDRs, the savings would be approximately $385,000,000.

- Completed an ORA IT invited Infrastructure Study Group list of recommendations (Drs Kidder and Jones). As part of this multi-institutional review, ORA is expected to reorient their IT services and science project management.

- CIRA built its first 64-bit Linux cluster. Moving from 32 to 64-bit architecture was prompted by our modelers who needed additional addressable memory (RAM) to perform simulations over larger domains (larger grid arrays). The immediate outcome of this improved infrastructure was the ability to model three major meteorological events (severe weather, lake effect snow, and Hurricane Lili).

- The CloudSat Data Processing Center (DPC) was completed (hardware and software) during this period. CIRA DPC personnel are now awaiting the expected 29 Sept 2005 launch. The DPC's functions include data ingest from the USAF satellite earth station network, archive, production of standard products, distribution of products to the CloudSat science team members, and outreach to the broader science community. Please view the DPC website for the latest CloudSat updates. For product information http://cloudsat.atmos.colostate.edu/data/data.html and for the DPC http://www.cloudsat.cira.colostate.edu/

- CIRA has developed a DVD-based storage solution. This system has several attributes worth consideration:
    - A low-cost method of storing real-time satellite (and any other data source) data.
    - A system that can be reconfigured to store a new data source in minutes.
    - Unlike all tape storage media, the DVDs are verified at the time of writing. We know we have the data actually on the DVD. In the case of burn errors or a bad DVD, the system rejects the DVD platter and burns another one.
    - The system also sorts data by source and writes a full description of the data on the media. Self documenting. There is no human transcription error possible.
- Our Data Systems Group at FSL continued their research into the design and development for new and modified datasets. Use of Object Data System (ODS) applications and methods has expanded as legacy translators and product generation methods are replaced by the new techniques including OO software development for point data. CIRA researchers in DSG continued to collaborate with FSL scientists and developers to assemble and maintain a state-of-the-art meteorological data center. Data acquired, decoded and processed by DSG have been vital to the success of MADIS, RTVS, and FSL's X-window workstation (FX-Net). Additionally, data delivery systems developed for DTC, DWFE and RUC have also been vital to their success.

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Global and Regional Climate Dynamics

- We are developing a physically-based micrometeorological model (MicroMet) that will serve as an interface between current course-resolution meteorological models and the fine-resolution hydrological and ecological models. The preliminary version is completed.
- Performed the first climate sensitivity experiment using a GCM with explicit representation of clouds.
- Created the longest RCM summer climatology to date for the contiguous US and Mexico using RAMS which effectively produced a down-scaled NCEP-NCAR reanalysis in this region. One of the insights of this analysis was that the time varying SST modes in the Pacific affect the onset of the North American Monsoon System.
- Developed and tested a method for extrapolating surface-layer CO2 measurements at flux towers to atmospheric mixed-layer values under convection conditions.
- Developed several methods for estimating continental carbon budgets from CO2 mixing ration observations.
- Found that CO2 variations are predominantly driven by horizontal advection rather than changes in vertical mixing and can be well modeled.
- Identified smoke aerosols as having two different effects on cumulus development: absorption and local heating by biomass burning aerosols as it modifies atmospheric stability and the dynamical feedback of absorbing aerosols as they block solar radiation causing surface heat fluxes to fall.

- Our North American Monsoon (NAM) to Soil Moisture study has demonstrated the sensitivity of the NAM to soil moisture, SSTs and vegetation.

- Completed a multiscale variability study of the flow during NAME. QuickScat data was used to study Gulf surges.

- A preliminary plan for a network of global Unmanned Aerial System (UAS) observations has been designed and tested against past observations. Twelve ground stations for UAS operations have been selected using archived hourly surface observations to screen the stations for optimal conditions for takeoff of the UAS. The flight paths and routing of the UAS between fixed observational points have been screened for reliability of the network using reanalysis data. In addition to the global network of UAS, a concept of operations for an intensive UAS program over the Arctic to study climate change is under development.

- Six animated demonstrations from three different climate models have been created for Science on a Sphere™ (SOS) using model output from the fourth IPCC results. Three animations display surface temperature changes from the year 1870 to 2200; two animations show sea ice and ocean temperatures/currents; one additional animation shows precipitation changes.

- Project entitled Regional Transport Analysis for Carbon Cycle Inversions was initiated this past year to provide influence functions for selected CO_2 measurement towers in North America. Portion of this effort will be to provide Rapid Update Cycle (RUC) analyses as input to a Lagrangian model to calculate backward trajectories of particles reaching these observation sites. The winds obtained from the analyses are adjusted to conserve mass with a minimization technique with constraints using a Lagrangian multiplier. During the past year, data sets of hourly meteorological analyses generated by the RUC assimilation system on the 13-km grid over North America were obtained. Sub-setting software to extract only the transport fields from these analyses was developed and tested, and the CSU Lagrangian Particle Dispersion Model (LPDM) was adapted to read the 13-km RUC fields. The ability to calculate adjoint, or backward-in-time, transport influence functions for specified sampling stations has been verified to quantify the sensitivity of each observation at NOAA sampling towers to unit surface fluxes of CO2 or other trace gases at all points upstream in the RUC domain.

- Regional climate simulations were performed for June 2004 with the WRF model to study the effects of soil moisture on precipitation and to compare results obtained with different convective parameterizations and with explicitly resolved convection. Convection was parameterized in simulations on a 20-km resolution grid and cloud resolving simulations were performed on a 1.7-km resolution grid. The default parameterization of convection is an ensemble of closures based on varying assumptions. Turbulence is parameterized with a 2.5-order closure, and a land surface model by Smirnova et al. was used. Initial conditions for the atmospheric and the land surface models were obtained from the RUC analysis. Differences in hourly characteristics of precipitation in different simulations were obtained and some results of this effort were presented at the Conference on Applied Climatology in Ljubljana, Slovenia in September 2006.

- A one-year comparison is made of mean monthly values of cloud fraction and cloud optical depth over Barrow, Alaska between 35 GHz radar-based retrievals, the TOVS Pathfinder Path-P product, the AVHRR APP-X product, and a MODIS-based cloud retrieval product from the CERES-Team. The data sets represent largely disparate spatial and temporal scales; however, for this research effort, the focus is to provide a preliminary analysis of how the mean monthly values derived from these different data sets compare and to determine how they can best be used separately, and in combination, to provide reliable estimates of long-term trends of changing cloud properties.

Mesoscale and Local Area Forecasting and Evaluation

- Developed correction algorithms for the Judd and Campbell snow depth sensors that improved their error to +/-0.4 inches for 6-hour averages and to within 0.23 inches absolute error.

- Developed a special version of JTWC's Statistical Typhoon Intensity Prediction Scheme STIPS tool which included AOML's tropical cyclone heat potential TCHP. The average intensity forecast error improvement was significant.

- A webpage of landfall probabilities for 2004-5 hurricanes is at http://rammb.cira.colostate.edu/projects/tc_wind_prob. This was done in association with improved error statistics, and included in TPC's training sessions. The new probability program will provide a quantitative measure of the risk of various wind thresholds, and will likely lead to a number of new operational products in the immediate future that will be distributed to the public.

- Completed the AMSU algorithm for the estimation of tropical cyclone maximum winds and wind structure. The fully operational version was implemented in June 2006 at NCEP/NCO, NTWC and NHC in Miami.

- In the "Stratocumulus Role in Modification of Pollution Plume Transported to the North American Continent" study, we successfully identified the smoke plumes documented by Wotawa and Trainer. No false positives were made; and, based on the success of this study, the method was applied to the historical database to develop estimates of annual frequency of occurrence of transport of smoke from wild fires to the eastern and southeastern US. These ranged from 5 to 15% of the aerosol samples being influenced by long-range transport of smoke.

- In support of an operational evaluation of the second version of the Graphical Turbulence Guidance product (GTG-2) produced by the FAA's Turbulence Product Development Team, the CIRA team designed and developed a verification data processing system for turbulence forecasts. The system produces statistical plots and graphical displays, which are available via a powerful web interface, using reports of turbulence from aircraft pilots as observations. NOAA collaborators intend to use the system as the primary verification tool in the upcoming formal assessment. In addition, CIRA researchers continue to deploy upgrades and new verification capabilities to an RTVS configuration at the NWS Headquarters in Silver Spring, MD. The transfer provides the NWS, through the system housed at the Telecommunications Gateway Operations Center, with the ability to perform long-term quality assessments of operational aviation weather products issued from the NWS Aviation Weather Center. This capability, a significant upgrade, aligns very well with the recently elevated NOAA priorities regarding performance evaluation of weather forecasts.

- The Developmental Testbed Center (DTC) Winter Forecast Experiment (DWFE) was run from 15 Jan to 31 Mar 2005 as a test of two 5-km numerical models with explicit convection run on the continental United States (CONUS) scale. One of the models was run out of ESRL/GSD, and the other at NCAR (the location of the DTC), with one run of each per day, out to 48 h over the CONUS scale. This was the first time that these perspective models of the future were run in real-time on such a large scale. CIRA researchers participated in the DWFE by providing subjective assessment of the forecasts of the high-resolution NMM and ARW versions of the WRF model for winter forecasting. Papers were presented at the AMS conference on Numerical Weather Prediction and Weather Analysis and Forecasting in August 2005. One of the unique products that was output from the DWFE models was model-simulated radar reflectivity, which allowed for a better depiction of the structures within winter storms, as well as a direct comparison of the model output with observations in real-time.

  To aid in evaluation of the model output, graphical representations of model output parameters were generated for 30-day study periods in each of the four seasons. The scripts used to generate the images, as well as the website for access and display, were created through modification of those used in the DTC Winter Forecast Experiment (DWFE) from FY05. Capabilities of the website were expanded to include display of images from the RUC-13 and the ability to compare WRF ARW-and NMM-based images in a side-by-side or tiled fashion. Numerical modelers and other meteorolgists were able to use the images to easily locate anomalies and closely scrutinize differences in the ARW and NMM cores and make definitive determination as to the most accurate choice for ultimate inplementation. The web-site may be viewed by pointing to http://bolas.fsl.noaa.gov/mab/wrfrr .

- Two major new advances were made in the suite of modeling capabilities at GSD. First, the NCEP WRF model, NMM, was modified to permit Local Analysis and Prediction System (LAPS) diabatic initialization. This required modifying initialization codes of the WRF source. This modified code has been run in real-time over the Colorado region, and it has been shared with the NWS/SOOs. Second, multiple mesoscale models (WRF-ARW, WRF-NMM, MM5, RAMS) have been pulled together in order to generate ensemble forecasts. Scripts were written to ensure that each model is run in real time and initialized with LAPS diabatic initialization. Probabilistic output is generated by combining the forecasts from this group of models and by including past forecasts. Ensemble forecasts have been generated in real-time and displayed on AWIPS for the NWS Boulder office.

- A full evaluation of ensemble forecasts produced in support of the Hydrometeorological Testbed has been conducted, and the results have been formed into an ensemble composition that will be run in real-time and distributed to Monterrey WFO, Reno WFO, and Sacramento WFO during next year's Hydrometeorological Testbed field project (Dec 2006 - Mar 2007).

- TAMDAR data is currently being evaluated at ESRL/GSD and elsewhere for quality, utility for forecasting various types of weather, and impact on numerical weather prediction model forecasts (via the RUC model). CIRA researchers at GSD have been involved in all of these aspects of the TAMDAR assessment. An extension of the Great Lakes Fleet Experiment into FY06 allowed for further analysis of the impact of TAMDAR observations on RUC model forecasts. Examination of errors in temperature, relative humidity and winds for model runs with and without TAMDAR data show improvement (i.e., smaller errors) in these parameters for the TAMDAR-inclusive model runs for the Midwest United States.

Applications of Satellite Observations

- Completed the WMO/TD No. 1267 “Implementation Plan for Evolution of Space and Surface-based sub-systems of the GOS”. The plan is part of an effort to improve the utilization and future development of satellite-based weather observations.

- Developed a hurricane/cyclone surface wind field estimate from a combined GOES imagery, microwave, and model assimilation. The development of the components of the satellite tropical cyclone wind algorithm is complete. Real-time analysis is on schedule for the operational centers and evolution.

- Code for generating the three-dimensional wind field for Polar Regions from temperature profiles derived from AMSU radiance has been completed.

- Conducted numerous impact studies in support of GOES-R NPOESS and specific sensor technologies on weather forecasting systems. This included a study of AMSR-E and AMSU hurricane measurements. AMSU cloudy radiance assimilation showed large positive impacts on upper level wind divergence. AMSR-E cloudy radiance improved lower level wind circulation.

- VIIRS proxy data is being collected from MODIS to develop new maximum intensity algorithms for hurricanes.

- Synthetic HES imagery has been produced in support of GOES-R risk reduction using AIRS data as a proxy.

- Demonstrated that significant NOAA MEM bias errors exist on the order of 5-10%.

    - Identified AMSU-B Antenna Pattern Correction errors. After correction, the result was a 10-15% improvement in bias error for upper-water vapor profiles.
    - The demonstration allowed NESDIS/ORA to request the operationalization of the MSPPS microwave emissivity products already developed.

- Several new products have been developed under the GIMPAP project including

- a new cloud-top temperature differencing product that measures increases in temperature above the tropopause likely due to water vapor absorption above the clouds. These rare increases are associated with severe thunderstorms.
- A new Oklahoma centered fire hotspot image loop using the 3.9 micron channel for wild fire detection was produced.
- Confirmed CIMSS detection of a thermal foldover of certain GOES pixels when detecting fires (sources>342 deg C)

Cloud Physics

- In our studies of Secondary organic aerosols (SOA) it has been determined that properties of aerosol populations (number concentrations, size distributions) and accuracy of the CCN instruments are most crucial for CCN closure, whereas detailed knowledge of the aerosol composition plays only a minor role.

- The role of smoke aerosol in modifying the microphysics and dynamics of cumulus cloud fields in biomass burning regions such as Brazil was investigated. We have identified two primary reasons for the absence of clouds in heavy smoke regimes. The first is related to absorption and local heating by biomass burning aerosol and its modification of atmospheric stability. The second is based on a dynamical feedback due to the absorbing aerosol, and follows from the fact that heavy aerosol cools the earth's surface by blocking incoming solar radiation. The reduction in net surface radiation results in a commensurate reduction in surface fluxes, which suppresses convection and cloud formation.

Numerical Modeling

- The ensemble work has demonstrated that the MLEF method is better during the first few days of a forecast period. Additionally it improves the 48-hour forecast more than the 6-hour demonstrating the benefit of ensembles in creating balanced initial conditions.

- A visible radiative transfer model and its adjoint have been developed. This new model is 5 times faster than the previously used DISORT model. This code has been transferred to JCSDA.

- CIRA researchers developed a Java application called WRF Portal that configures, runs, and monitors the runs of WRF-NMM and WRF-ARW models on a variety of computers. WRF Portal also supports 2D visualization and it includes a module called Domain Wizard that enables the easy selection and localization of domains (and replaces the legacy WRFSI GUI application). Refer to the www.wrfportal.org website for additional information.

- The journal article on "An hourly assimilation – forecast cycle: The RUC" by S. Benjamin, D. Devenyi, S. Weygandt, K. Brundage, J. Brown, G. Grell, D. Kim, B. Schwartz, T. Smirnova, T. L. Smith, *Mon. Wea. Rev.,* 132, 495-518 (Feb 2004) was recognized a 2005 OAR Outstanding Scientific Paper. This paper describes the analysis system utilized within the Rapid Update Cycle (RUC) and discusses some issues associated with high-frequency data assimilation cycling. The RUC assimilation/model system ingests a wide variety of meteorological observations each hour (a frequency much higher than is generally done) and produces short-range (up to 12-h) gridded weather forecasts. Significance: RUC analyses and short-range forecasts (initialized from the analyses) are used extensively within the aviation and severe weather communities as well as by National Weather Service forecasters. As such, the RUC forecast system is a vital component of the NOAA mission to provide weather information to society and to support a safe and efficient transportation system.

- A time-phased, multi-model ensemble forecast system was successfully developed. This system has now been adopted by NOAA/OAR and applied to the OAR's hydrometeorological testbed (HMT) field experiment in the American River Basin of California. It has also been made as a forecast product on NOAA/GSD's AWIPS. Coupled with the Local Analysis and Prediction System, this time-phased, multi-model ensemble forecast system is very useful for short-range Quantitative Precipitation Forecast (QPF) and Probabilistic QPF (PQPF).

- The WRF model was used to conduct idealized simulation of interaction among upper-level jet, gravity waves, and turbulence. During the past year, a PV inversion package was successfully developed, and this PV inversion package was used to simulate an upper-level jet and generation of gravity waves associated with this jet.

Education, Training, and Outreach

- The NOAAPort data ingest system and AWIPS-linked components are now functional and will be used in the next year to make improvements in the AWIPS' current NWSFO minimal satellite data capabilities. Using standard AWIPS configurations to port technology into NWS operations will greatly improve their acceptance of CIRA's training topics.

- A SHyMet funded Satellite Meteorology and Applications course has been developed for NWS interns. CIRA developed three of the learning modules: Orientation, GOES Imaging and Sounding including area coverage, resolution, and frequency, Satellite Applications to Tropical Cyclones, and revisions to Cyclogenesis-Analysis utilizing satellite imagery,

- The VISIT program has awarded over 16,000 training certificates and has received very positive student feedback.

- GLOBE Systems team comprised of 8 CIRA researchers continued to provide website, database, and data acquisition support to the Program's worldwide users now located in 109 countries. There are now more than 15 million observations in the GLOBE database collected by students in over 18,000 schools since the Program's inception in 1995. Visit the GLOBE website at www.globe.gov.

- During the past year, a major release of the FX-Collaborate (FXC) Volcanic Ash Coordination Tool (VACT) software, version 2.30 was implemented and the new system provided support of volcanic eruptions for the Anchorage VAAC. The FXC VACT was used in operations during the eruptions of Mt. Augustine and for four other events along the Aleutian chain and the Kamchatka peninsula. Refer to http://www-ad.fsl.noaa.gov/asdad/projects/vact/ for additional information on the project.

- Research was completed on National Convective Weather Forecast (NCWF2) product integration into the AWIPS FXC Traffic Management Unit (TMU) 2.30 system and the TMU Website was upgraded to handle the NCWF2 Graphics used in Fort Worth. SID and STAR map backgrounds were created for the Dallas-Ft Worth airspace. The TCHP animation page was redesigned and the TMU home page was redesigned to fit the display. Version 2.2 of the TMU Website that contained the NCWF2 graphic products was released for evaluation.

- Science On a Sphere™ was installed at six new permanent public venues this past year—Nauticus National Maritime Museum in Norfolk, VA, Bishop Museum in Honolulu, HI, The Tech Museum in San Jose, CA, Science Museum of Minnesota in St. Paul, MN, NASA Goddard Space Center in Greenbelt, MD, and the Maryland Science Center in Baltimore, MD. A five-projector display architecture was implemented and demonstrated. This new projector arrangement reduces shadowing by viewers and eliminates Polar Regions where no data is displayed in our older four-projector arrangement. An enhanced software-based projector alignment method was developed, eliminating tedious mechanical projector alignment, while improving image registration. Finally, several new data visualizations were developed, along with enhancements to existing data sets.

- Significant changes to the basic FX-Net system were made in the past year. The system was upgraded to provide the latest version of the NOAAPort data and extended AWIPS data and file server functions. The system delivered to the NWS's IMET program, the National Interagency Fire Center GACC offices and NWS WSO users was based on AWIPS v. OB6—the most recent version of the fielded software and the latest version of Linux, Enterprise, v. 3.0. This new version of the FX-Net system was considered a major upgrade by the NWS regional offices in Western, Southern, Alaska and Pacific regions. New high-resolution forecast models and additional data sets were added to the system. Data added included the long range GFS model out to 380 hrs, the new high-resolution CONUS ETA model, RAWS data utilizing MADIS, and the planning process to add US Forest Service dispersion models was begun. Improved compression algorithms were added to the system. Wavelet Compression algorithm improvement included better memory management which improved display manipulation and product loading performance. It also improved satellite product fidelity.

- In support of AWIPS enhancement, several efforts and activities occurred during the past year including:
    - development of data access techniques for displaying Multi-sensor Precipitation Estimate (MPE) and NOAA/NESDIS sea surface temperature data
    - integration of the Graphical Forecast Editor (GFE)
    - evaluation of AWIPS workstation usage
    - investigation of new data delivery paradigm
    - investigation into using AWIPS to disseminate hazard event information

- The successful implementation of Valid Time Event Codes (VTEC) in warning and advisory products for severe weather and flooding continues to be one of the most important near-term goals of the NWS. During FY04/05, CIRA researchers helped the NWS successfully implement VTEC for severe convective warnings and some marine warnings. During FY05/06, CIRA researchers aided in the implementation of VTEC in many hydrologic (flood) warnings and advisories. Upgrading and maintaining the VTEC's capability within AWIPS continues to require substantial changes both to AWIPS warning generation software and the text workstation component of AWIPS.

- During the past year, the 3-year project to implement NWS MDL's SCAN on Korean Meteorological Administration's (KMA) Forecast Analysis Station (FAS) was successfully completed. Project completion was demonstrated by hosting 12 KMA weather forecasters to a training exercise at NOAA ESRL/GSD (formerly NOAA/FSL). Two full days of training were provided.

Societal and Economic Impacts

- Professor Cochrane has completed an econometric model that models weather-induced natural disasters and their economic impacts. The model also computes the inter-segment impacts of these disasters. This accounts for such things as a local economy actually being stimulated by post-disaster building activity, government sector activities, and many other cross-sector economic couplings.

- Conducted training workshops, focus groups, and developed new prototype designs for NWS's Central Region's hydrology warning web system. The improved interface design that is based on detailed customer interactions, and not just what IT can do, has received a NOAA Administrator's Award and is being actively considered by the Climate Services Division and the National Integrated Drought Information System (NIDIS) for their new information portal.

- For the first time NWS has incorporated US Census data into the development of its severe weather watches and warnings product development. Coupled with GIS data, the database will allow the emergency management community to know the demographic and socio-economic details of the areas under threat. This will allow for better evacuation, vulnerability, and threat assessments. This kind of information, for example, would have immediately shown that the Ninth Ward in New Orleans needed buses for evacuation since most did not have cars.

- Joint collaboration with the National Renewable Energy Laboratory (NREL) continued to support applications of the RUC model in wind energy planning. Effort is now concentrated in application of ensemble forecasting methods to produce probability distribution functions for potential wind energy production, detection of nocturnal low-level jet, and improved near-surface wind forecasts through variation in surface roughness.

- Seven air quality models were run to provide forecasts of surface ozone concentrations over the eastern U.S. and southern Canada. Accuracy of these forecasts was assessed against hourly ozone measurements at over 350 locations. The ensemble of these air quality models was used to issue deterministic and probabilistic forecasts of maximum daily 8-hr and 1-hr averaged ozone concentrations. The economic value of forecasts, which is calculated using Richardson's cost-loss decision model was evaluated for both deterministic and probabilistic cases. Results indicated that deterministic forecasts obtained with the ensemble of models provide a greater benefit to decision-makers than forecasts issued with individual models. Probabilistic forecasts demonstrated similar advantages over the deterministic forecasts.

- In FY06, FX-Net clients were distributed to state and local air quality forecasters across the country. The specialized data sets included in the system provide air quality information for the areas of the CONUS experiencing the most serious air quality issues. Using this system, forecasters are able to visualize forecast weather patterns that affect air quality in their area, and to overlay real-time EPA observations and analysis to verify their forecasting techniques. The forecasters report that the system saves them time when preparing forecasts as they have all atmospheric and chemical data integrated into one system.

- FX-Collaborate (FXC) is currently being implemented and/or evaluated for the *Geo-targeted Alerting System (GTAS)* sponsored by NOAA and the Department of Homeland Security. The objective of the project is to develop a prototype public notification system to be used by NOAA and the DHS operations centers in the event of a biological, chemical or radiological release in the National Capital Region. The key system components of the GTAS system are FXC and the HYSPLIT dispersion model. The concept is to use FXC as the technology for controlling the execution of the HYSPLIT model, collaborating between the offices, and for creating the alert information that is sent to the selected vendor for notifying the public. During the past year, the HYSPLIT model was installed on the FXC session controller and software developed to convert the output of the model into a format that is usable by FXC. The FXC code was modified to allow easy customization of the FXC user interface to generate the appropriate control parameters and to view the dispersion model output. Also, the format of the alert information message (XML) was defined and tested with two different vendors using secure https communications.

Infrastructure

- CIRA's satellite storage now exceeds 100TBytes. This includes all GOES/GVAR data, GMS, CloudSat, and parts of AVHRR and GMS.

- We are nearing completion of the migration of our 8mm and DLT data to DVDs. We have also completed a major database indexing system that makes finding and exploring our holdings easier for the scientists.

- The CloudSat Data Processing Center (DPC) is now fully functional with the launch of CloudSat on 28 April 2006. We were able to distribute the first light imagery in a matter of days after the launch.

- Our NOAAPort installation is complete.

- Successfully demonstrated DPEAS software within NESDIS/OSDPD on their PC network. This technology has maximized GRID technology in their offices with a savings of $600K and the creation of over $7M in benefits due to increased computer throughput.

- Our CIRA researchers in the Data Systems Group at GSD continued to collaborate with GSD scientists and developers to assemble and maintain a state-of-the-art meteorological data center. They continued their research into the design and development for new and modified datasets. Use of Object Data System (ODS) applications and methods continue to expand as legacy translators and product generation methods are replaced by new, more flexible techniques. Design and development continued toward creating an automated "archive search" system. This will facilitate the retrieval of data sets for use by researchers studying interesting weather events. Data acquired, decoded and processed by DSG have been vital to the success of projects and programs such as MADIS, RTVS, and FSL's X-window workstation (FX-Net). Additionally, data delivery systems developed for the programs such as DTC and RUC have also been vital to their success. Development of new metadata handling techniques is ongoing. This facilitates the use of real-time and archived data sets.

July 1, 2006 – June 30, 2007

Global and Regional Climate Dynamics

- A report on the potential for the use of UAS for Arctic observations was written to support the development of an Arctic UAS Testbed. The report detailed the feasibility of using Eielson AFB for ground operations and launch/recovery of UAS, as well as the capabilities of existing UAS and Autonomous Underwater Vehicles (AUV) and instrumentation suitable for use on these vehicles.

- Six Science on a Sphere® demonstrations illustrating the fourth IPCC model results have been refined and completed. The demonstrations show the changes in surface temperature and sea ice cover in the A1B scenario from the NCAR CCSM, Hadley, and GFDL climate models.

- During the past year, regional climate simulations were performed for the summer months of 2004 and 2005 with the WRF model to study the effects of soil moisture on precipitation and to compare results obtained with different convective parameterizations and with explicitly resolved convection. Results indicate that the quality of the lateral boundary conditions had a large effect on the simulations in the high resolution domain (1.667 km). Examination of the behavior of different convective closures with ensemble members of the Grell-Devenyi parameterization yielded several interesting results.

- Progress was made on the CSU-ESRL/GMD collaboration entitled Regional Transport Analysis for Carbon Cycle Inversions to provide influence functions for selected CO_2 towers in North America. This past year, work was started on parameterization of convective transport (cloud venting) in the CSU Lagrangian Particle Dispersion Model (LPDM) linked to the RUC. LPDM simulations were performed and influence functions derived for 30 towers (existing and planned) for all longer periods with available RUC fields in the period from March 2005 to May 2006.

- The first climate sensitivity experiment conducted using a GCM with explicit representation of clouds was conducted by Prof. Randall.

- Created the longest RCM summer climatology to date for the contiguous U.S. and Mexico. This was accomplished by dynamically downscaling the NCEP-NCAR global reanalysis for the period 1950-2002.

- Prof. Denning's group has developed and tested a method for extrapolating surface-layer measurements of CO_2 at flux towers to atmospheric mixed-layer values under convective conditions. As a result of this and other work, they have produced a dramatic reduction in the uncertainty in the annual net North American CO_2 flux and its interannual variations as compared to current publications.

Mesoscale and Local Area Forecasting and Evaluation

- In February 2007, the Federal government members of the VACT development team were awarded the 2006 US Department of Commerce Bronze Medal "for developing the Volcanic Ash Collaboration Tool, a

new tool which provides collaborative forecasting capabilities during volcanic eruptions and is essential to preventing volcanic ash damage to lives and property." CIRA researchers were integral to the success of this project and the lead CIRA engineer was recognized with the Colorado State University Distinguished Administrative Professional Award.

- CIRA researchers continued to investigate and implement new ways to deploy upgrades and new verification capabilities to a Real-Time Verification System (RTVS) configuration to the NWS Headquarters in Silver Spring, MD. The transfer provides the NWS, through the system housed at the Telecommunications Gateway Operations Center, with the ability to perform long-term quality assessments of operational aviation weather products issued from the NWS Aviation Weather Center.

- Dr Knaff is preparing the Annular Hurricane Eyewall Index (AHI) for operational use for this year's hurricane season. This product will be used to forecast hurricane intensification.

- Further testing and development was done on a global LAPS analysis called "GLAPS". LAPS software was updated so it can localize and display domains using a cylindrical equidistant (lat/lon) projection that can allow full coverage over the globe (unlike the gaps near the poles in the previously used Mercator projection). Analyses of (unbalanced) 3-D state variables on a 21-km cylindrical grid are now being generated. GLAPS localization output on an experimental 15km grid has been fed to the FIM model development team that they are in turn interpolating to provide topography and related static grids. GLAPS topography images are also being provided for import into Google Earth applications.

- The success of the GSD efforts during the 2005-2006 Hydrometeorological Testbed (HMT) winter field campaign to provide a single, high-resolution NWP forecast for the forecasters in the NWS weather forecast and river forecast offices led to the group's efforts to examine whether ensemble methods could improve guidance of probability of precipitation and precipitation amount. This led to an ensemble NWP model forecasts being implemented for the 2006-2007 winter field campaign for the American River Basin in northern California. The ensemble consisted of three configurations of the WRF-ARW and one configuration of the WRF-NMM. The forecast domain was identical to the one used during the 2005-2006 field campaign, i.e., 3-km grid point spacing over a domain of 450-km X 450-km. Collaboration with HMT participants at the National Severe Storms Laboratory led to the coupling of WRF model precipitation forecasts with a hydrological model. This appears to be a promising application of WRF ensemble data.

- To support Fire Weather applications, a new 500-m resolution LAPS analysis over a domain mainly in Boulder County was created. This is envisioned to be relocatable in support of fire fighting operations, particularly with high-resolution wind fields. The analysis utilizes a downscaled RUC background together with the latest observational data. Graphics plots were developed to potentially display surface winds generated by the balance package thus showing terrain effects more accurately. A web interface was developed that allows the end user to automatically move a fire analysis/forecast domain so that the system can quickly respond to evolving fire situations.

- During the past year, TAMDAR data continued to be taken from ~50 commercial aircraft servicing both large and a number of much smaller airports from the Midwest to the lower Mississippi Valley. Using the Rapid Update Cycle (RUC) model, the long-term evaluation of TAMDAR impact continued using identical versions of the RUC model run with and without TAMDAR. Both objective and subjective evaluation of the model output has shown that TAMDAR does, indeed, have a positive impact on RUC forecasts of wind, temperature, humidity, and precipitation. Demonstration of the utility of the TAMDAR soundings for forecasting convection and other weather problems also continued this past year.

- One of the crucial issues related to variational data assimilation is how to determine background statistical error covariances. A method to construct background error covariances using time-phased ensemble forecasts was developed this past year that appears to possess many advantageous features over traditional methods. It is able to show clear mesoscale structures relevant to weather situations and possesses a flow-dependent property.

- The time-phased multi-model ensemble system developed last year using the LAPS hourly data assimilation system was further refined and applied in various forecast and field experiments such as the NOAA Hydrometeorological Testbed campaign. The time-phased multi-model ensemble forecast appears to show better skill than each deterministic forecast.

- An NCAR AN display system (CIDD) was installed at the Fort Worth-Dallas WFO. This allows forecasters to review the several types of AN products (real -time and forecast) that are available within the system. The benefit to the NWS is an improved situational awareness--thus improving NWS forecasts. In preparation for an operational evaluation, significant software improvements were made during the past year in Data Management, Data Display, Forecaster Interaction (boundary and polygon editing), and Data Dissemination.

- Evaluated Ocean Heat Content (OHC) data into the current Tropical Cyclone Intensity Forecast Model (TCHP). The new STIPS intensity model has improved intensity forecasts by ~2% and has been incorporated into NRLMRY models to support JTWC. Fundamental to this process has been CIRA's prototype production of OHC maps since October 2006.

Applications of Satellite Observations

Cloud Physics

- A synchronized data set of pertinent cloud and aerosol microphysical properties at a temporal resolution of 20s was created based on the experimental set-up at Point Reyes, CA during 2005. Aerosol fields measured at coarser temporal resolution have been interpolated to 20s recognizing that aerosol temporal changes are much slower than cloud temporal changes. Although the various measures of aerosol effects on cloud microphysics are consistent, they were demonstrated to likely be too low.

- Comparisons were performed of the statistical properties of Large Eddy Simulations (LES) with aircraft observations of non-precipitating, warm cumulus clouds observed in the vicinity of Houston, TX during the Gulf of Mexico Atmospheric Composition and Climate Study (GoMACCS). Comparisons have focused on the statistical properties of a set of dynamical and thermodynamical variables. For all variables, good agreement between the simulated and observed clouds was achieved. These comparisons, together with the excellent agreement between observed and simulated cloud size distributions, suggest that the LES is able to successfully generate the cumulus cloud populations that were present during GoMACCS.

- Developed code based on "atmospheric rivers" where water fluxes can be computed for wind fields under geostrophic, linear, or nonlinear balance conditions. Research that improves the balance approximations is also showing improved accuracy in the derived winds.

- Currently transitioning the CIRA Wind Regime Cloud Climatology application and database to the AWIPS environment. This system output is being used for VISIT training and within NWS' Weather Event Simulator for case studies.

- Synthetic GOES-R ABI imagery was produced for three weather events to simulate Mesoscale scenarios using the CSU RAMS model cloud physics modules to test prototype algorithms for ABI. Additionally idealized fire hot spots were generated for fire spotter algorithm development. Tropical cyclone proxy data and intensity estimation algorithms were produced for 12 named storms.

- GIMPAP activities at CIRA have included: 1) Tropical Web page has been released for public use; 2) The Mesoscale Convective System (MCS) Index is running in real time and being validated using GOES IR imagery; 3) Winter Weather Atovs analysis; 4) Fog Fires and Volcanic Ash/Dust Product development; 5) Cloud Climatologies for Regional Training Centers in Central America; and 6) Inter-satellite calibration/validation comparisons (GOES 12/13).

- deAlwis designed a fully-automated calibration/validation system for NOAA 16,17 and 18 which was able to recover records that had been discarded in the heritage system.

- Developed numerous GOES-R proxy data sets including a16 band ABI simulation from SEVIRI data.

- Louis Grasso and Manajit Sengupta received the CIRA Research Initiative Award for their work on the GOES-R risk reduction project.

Numerical Modeling

- CIRA researchers have been an integral part of the team that has brought the ESRL Finite-volume Icosaheral Model (FIM) code to a level of maturity where the model will soon begin retrospective testing. Specifically, they have been directly involved in adding GFS physics to FIM. Using the Scalable Modeling System (SMS), the output of FIM was tuned and enabled to occur in parallel to the computations thus hiding the cost of the output and speeding up FIM by 30% so that now FIM scales from 120 processors to 240 processors by a factor of 1.95X which is an efficiency of 98%.

- CIRA researchers also developed the Icosahedral grid generation for FIM. Several efficient algorithms such as k-d tree and 2D space filling curve have been developed or adapted. An efficient grid generator for an Icosahedral grid was implemented. The new software reduces the computation time from hours to minutes thereby making it possible to generate the grid “on the fly.”

- As part of the Terrain Rotor Experiment (TREX) project, graphic products including potential temperature, relative humidity, dewpoint, wind, and vertical velocity for five pressure levels; wind, omega, potential temperature, and relative humidity for six height levels; and wind, omega, turbulent kinetic energy, Richardson number, Scorer parameter, Na/U and Nh/U (which describe the atmospheric response to orographic gravity waves) for vertical cross sections were automatically generated following runs of the WRF Rapid Refresh ARW and NMM models running over a 2 km X 2 km domain with 50 vertical levels in the vicinity of the Sierra Nevada mountain range. The products are made available for viewing and comparison on a web page (http://www-frd.fsl.noaa.gov/mab/trex/). To examine how the model runs performed, aircraft data from the HIAPER (High-performance Instrumented Airborne Platform for Environmental Research), the BAe-146 (British Aerospace), and the National Center for Atmospheric Research King Air were also collected to be used for comparison with the resultant model forecasts.

- CIRA researchers developed a Java application called WRF Domain Wizard that is the GUI for the new WRF Preprocessing System (WPS). WRF Domain Wizard enables users to choose a region of the Earth to be their domain, re-project that region in a variety of map projections, create nests using the nest editor, and run the three WPS programs. Two new features are currently being added: a vertical level editor, and visualization module that enables users to visualize the NetCDF output.

- Developed a state-of-the-art, physically based micrometeorological model (MicroMet) that can serve as an interface between the course-resolution Mesoscale atmospheric models and fine-resolution hydrological and ecological models. This model development included collaboration with NOAA/FSL.

- A new real-time objective method for selection of a optimal ensemble configuration for rainfall forecasting has been developed by Dr. Isidora Jankov and colleagues.

- The Maximum Likelihood Ensemble Filter (MLEF) used as the front end to the NCEP Global Forecasting System (GFS) was developed and tested using a 5-day data period in January 2004. Preliminary results suggest the MLEF is producing correct statistical results without noticeable outliers. 100 ensemble members were used. Significantly this system is currently the only Ensemble Data Assimilation algorithm not based on statistical sampling.

- A new SHIPS model has been developed to evaluate vertical shear tropical storms that improves statistical intensity forecast models. A parallel version of SHIPS with this new shear predictor and GFS vortex predictor was implemented in real time beginning in September 2006.

- A visible radiative transfer mode (SHDOMPPDA) l and its adjoint were developed and compared the DISORT and is 5 times faster. This model has been incorporated into RAMDAS in support of JCSDA activities.

Education, Training, and Outreach

- GLOBE technology team comprised of six CIRA researchers successfully designed and released the new GLOBE Web site this past year. With the selection by NSF and NASA of the four Earth System Science Programs (ESSPs)—Seasons and Biomes, Carbon Cycle, From Local to Extreme Environments (FLEXE), and Watershed Dynamics—plans are to provide improved data visualization and analysis tools for student collaboration on projects and better support for student research projects including tools, content, and data portals for the ESSPs. The international GLOBE network has grown to include representatives from 109 participating countries and 135 U.S. Partners coordinating GLOBE activities that are integrated into their local and regional communities. Due to their efforts, there are more than 40,000 GLOBE-trained teachers representing over 20,000 schools around the world. GLOBE students have contributed more than 16 million measurements to the GLOBE database for use in their inquiry-based science projects.

- Significant changes to the basic FX-Net system were made in the past year, including an upgrade to provide the latest version of the NOAAPort data and extended AWIPS data and file server functions. The system delivered to the NWS' IMET program, the National Interagency Fire Center GACC offices, and NWS WSO users was based on AWIPS v. OB6. A new version of the FX-Net Client (v.5.0) is also scheduled for release at the end of July 2007 that will include the addition of significant new data analysis and display tools. In April 2007, two CIRA members of the FX-Net development team were awarded a Certificate of Recognition by the Director of the National Weather Service. The award was: "In recognition of . . . leadership to ensure operational excellence via innovative development and maintenance of critical software for our IMETS."

- Over 18,000 training certificates have been awarded by the VISIT training program.

- Enhancements to the Gridded FX-Net Forecaster Workstation included the addition of data 'Pull' capability to the Compression Relay Management System (CRMS) that allows users to individually retrieve products and observations that are not automatically distributed via the CRMS LDM data distribution. AWIPS software was also upgraded to v. OB6.

- The wavelet compression software for the gridded FX-Net also underwent significant improvement. A new encoder and decoder pair were developed that improves efficiency of both computation and memory usage. These improvements allow faster retrieval of 2D and 3D data sets when using the Gridded FX-Net D2D client. A new grid compression scheme was also developed to allow more flexible encoding and decoding of super large datasets. This improvement allows users to retrieve a single layer of a 3D data set (gridded model data) instead of retrieving the entire data set. As the data are compressed one layer at a time, data sets are distributed and displayed faster.

- Science on a Sphere® (SOS) was installed at seven new permanent public venues—Great Lakes Maritime Heritage Center in Alpena, MI, Imiloa Astronomy Center in Hilo, HI, James Madison University in Harrisonburg, VA, McWane Science Center in Birmingham, AL, Fiske Planetarium in Boulder, CO, Orlando Science Center in Orlando FL, and Museum of Science and Industry in Chicago IL. Enhancements to the program software this past year included: 1) a new display mode that allows direct display of sequences of images in equatorial cylindrical equidistant (ECE) map projection; 2) addition of the display of MPEG-4 encoded files that reduce storage requirements and increases animation rates; 3) addition of a picture-in-a-picture (PIP) capability that allows introductory slides or related still images to be

overlaid on the underlying SOS imagery; and 4) the development of additional new data visualizations of meteorological and climate model data.

- CIRA researchers have initiated investigations into Service Oriented Architecture (SOA) concepts with focus on experimenting with the standards for web access to geospatial data that the Open Geospatial Consortium (OGC) is developing. CIRA participated in the development of a "One-NOAA" prototype software that displays a variety of data from NOAA organizations on Google Earth as well as SOS. Weather, oceans, fisheries, satellite and coastal services data were included.

- The AWIPS Linux Prototype System (ALPS) has provided a platform for evaluating new operational concepts, including remote access to forecast models for the HMT (Hydrometeorological Testbed). Using the plug in interface, ALPS also provided the ideal tool for demonstrating an advanced drawing capability desired by the NWS for some time, i.e., describing a warning area by a polygon that encompasses the hazardous weather area instead of only the traditional description by counties (CWA). The AWIPS WarnGen program was modified to include the polygon, storm centroid, and the direction of motion.

- Dr. Purdom lectured at APSATS, a high profile training event in Melbourne Australia, to students on satellite data utilization. Topics included: spectral bands and their application, severe weather and heavy rainfall, and satellite capabilities and use of the Virtual Laboratory.

- CoCoRaHS has grown to 20 states and over 4500 climate observations. This citizen-science project is now a nationally-recognized outreach program for which Nolan Doesken has received a NOAA Environmental Hero Award.

- The first SHyMet Intern course was offered to NOAA individuals and others. NOAA has begun tracking the course with their e-Learning Management System. 113 NOAA/NWS employees have participated; 50% of these have completed the Intern course.

Societal and Economic Impacts

- The objective of the FX-Collaborate (FXC) project is to develop an interactive display system that allows forecasters / users at different locations to collaborate in real-time on a forecast for a particular weather or weather-dependent event. FXC is currently being implemented and or evaluated for several outside projects and organizations. One significant application in particular, Geo-targeted Alerting System (GTAS), involves the development of a prototype public notification system to be used by NOAA and the DHS operations centers in the event of a biological, chemical or radiological release in the National Capital Region. This year's effort focused on improving the output from the HYSPLIT model and enhancing the system functions. In collaboration with other GSD staff, the input weather model for HYSPLIT was shifted to NAM12 since it provided better temporal and spatial resolution. Also, the HYSPLIT control parameters were adjusted to provide a better representation of the plume.

- Dr Deo's work on product improvement and customer fitness using Census data for severe weather watches and warnings received a Regional Excellence Award in Oct 2006.

Infrastructure

- Our Data Systems Group at ESRL/GSD continued to design and develop new software to streamline the acquisition and processing of data. "Object Data System" technique was applied to develop a new martime data decoder to replace legacy software. Other decoders and translators underwent significant updates. Data acquisition and processing affecting virtually all GSD projects—from Nexrad and satellite observations to profiler and mesonet data—were developed or enhanced.

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Global and Regional Climate Dynamics

- Code for the generation of synthetic UAS observations were ported to the ESRL/GSD supercomputer system. A method of converting the synthetic UAS observations for ingest into the Gridpoint Statistical Interpolation was developed and testing of the assimilation of the synthetic data into the GSI is currently underway. Evaluations of the Nature Run for the Pacific UAS testbed OSSE (Rossby waves) and Arctic Testbed OSSE were performed.

- Interpolation routines were developed that generate Flow-following Icosahedral Model (FIM) output on a 0.5 degree latitude and longitude grid. These output fields can be plotted using standard contouring packages and compared against other global models such as the Global Forecast System (GFS) model. Currently, a cylindrical equidistant projection is used; however, other projections are being investigated. A website for display of FIM model output has been created and has some preliminary products available for perusal with 3-hourly forecasts going out to 7 days (http://fim.noaa.gov/fimgfs). The website is currently being enhanced to include more output products, GFS model output, and FIM-GFS difference fields.

- A modeling system was developed based on WRF that can be used to perform seasonal to decadal regional simulations of climate. The system will be used to test the utility of downscaling seasonal forecasts from the Climate Forecast System for use in western water management decisions.

- A state-of-the-art, physically-based micrometeorological model (MicroMet) was developed that can serve as an interface between coarse-resolution atmospheric models and fine-resolution hydrological and ecological models. This model is expected to lead to improved local weather and hydrological forecasts.

- GIMPAP plans for the Cheyenne and Eureka NWS forecast offices were developed to produce satellite cloud climatologies. The climatologies were stratified by marine layer depth for the Eureka case. Other examples of completed transitioned work in the project include: improve hurricane intensity forecast models-provided to NWS and fog and volcanic ash detection techniques provided to NESDIS operations.

- GOES-West ISCCP Sector Processing Center- Data collection and quality control for ISCCP. These data were compared with observations from the recently-launched CloudSat and CALIPSO satellites with ISCCP products. CloudSat and CALIPSO data were matched with MODIS data from the Aqua satellite to investigate how well the channels on which ISCCP is predicated sense clouds and cloud layers.

- The purpose of IPCC Studies for Climate Observations research is to examine the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (FAR) from Working Group 1 and make recommendations on priorities for Scientific Data Stewardship of Climate Data Records (CDRs). The involvement of young scientists in this report is also an objective. A major early result of this study was the rescue of 15 months of SSM/T-2 (a passive microwave moisture sounding instrument) data from 1993-1994 to add to NCDC's satellite climate data record archive. The first data exist from late 1991 onwards, but NCDC's archive began in July 1994.

- Monsoon Flow and its Variability during NAME: Observations and Models improve our understanding of the North American Monsoon and its variability on multiple spatial and temporal scales. This research, based on data collected during the 2004 North American Monsoon Experiment (NAME), has provided new insight into the dynamics of Gulf of California surges. The most prominent surge (13-14 July 2004) was found to consist of two stages: A shallow, bore-like disturbance that traveled rapidly (20-25 m s-1) up the Gulf, followed by a Kelvin wave-like disturbance characterized by a deeper layer of sharp cooling and strong moisture transport research on monsoon surges. Peter Rogers, who joined the NWS Phoenix office after completing his M.S. degree at CSU, has collaborated with the Tucson and Phoenix NWS offices for forecasting monsoon surges and associated rainfall.

- Richard Johnson, Atmospheric Science Department Head and Fellow of CIRA, was appointed Chair of the Expert Team on Severe Monsoon Weather, of the WMO/CAS Working Group on Tropical Meteorology

- Collaborative Research: Norwegian-United States International Polar Year (IPY) Scientific Traverse: Climate Variability and Glaciology in East Antarctica: The core of this project involves scientific investigations along two overland traverses in East Antarctica: one going from the Norwegian Troll Station (72º S, 2º E) to the United States South Pole Station (90º S, 0º E) in 2007-2008; and a return traverse starting at South Pole Station and ending at Troll Station by a different route in 2008-2009. The results of this investigation will add to understanding of climate variability in East Antarctica and its contribution to global sea level change. The project includes extensive outreach to the general public both in Scandinavia and North America through the press, television, science museums, children's literature, and websites. Active knowledge sharing and collaboration between pioneers in Antarctic glaciology from Norway and the U.S., with the international group of scientists and students involved in this project, provide a unique opportunity to explore the changes that half a century have made in climate proxies from East Antarctica, scientific tools, and the culture and people of science.

Mesoscale and Local Area Forecasting and Evaluation

- Delivered a new Monte Carlo wind probability estimate to NHC with a 600% improvement in speed estimation. This code was also modified to provide all of the input needed for the wind speed probability table program. This inclusion of GPCE information allows modification of the track probability distributions, which has a significant impact of wind speed probability distribution. The partitioning of the probability distributions into along- and cross-track components is being run at NHC in parallel with the older code for operational verification.

- Added Tropical Cyclone Heat Potential (TCHP) as a predictor to the Statistical Typhoon Intensity Prediction System (STIPS) model. Up to 2.7 percent improvement was made in the subsequent STIPS forecast hour interval forecasts. This research, which uses satellite altimeter data, will help improve the intensity forecasts for hurricanes that have the potential to rapidly weaken or intensify.

- Development and Evaluation of GOES and POES Products for Tropical Cyclone and Precipitation Analysis has three goals/products: (1) the development and operational implementation of an Advanced Microwave Sounding Unit (AMSU) –based global tropical cyclone intensity algorithm, (2) the development and operational implementation of an objective satellite-based tropical cyclone formation prediction for the Atlantic, eastern N. Pacific and the western N. Pacific, and (3) improvements of the already operational NOAA/NESDIS Hydro-Estimator product using cloud resolving numerical modeling. Goals 1 and 3 were completed last year. The pre-operational phase of the new Tropical Cyclone Formation Probability (TCFP) product was successfully completed during this report period. During this phase a new TCFP product, with an updated algorithm and an extended domain that covers the Atlantic, eastern N. Pacific and the western N. Pacific, was run experimentally at CIRA and displayed in real-time on the following website http://rammb.cira.colostate.edu/projects/gparm/index.asp.

- NOAA Bronze Medal, Mark DeMaria, Antonio Irving, Nancy Merckle, John A. Knaff: For the development and operational implementation of the Tropical Cyclone Formation product that quantitatively predicts storm formation probability.

- The Terrain-induced Rotor Experiment (T-REX) project is a testbed for high resolution, nonhydrostatic weather models in order to provide accurate guidance in complex environments. The test area for T-REX is in the vicinity of the Sierra Nevada Mountain Range. Graphical products of extensive model parameters were made available for viewing and comparison on a web page (http://www-frd.fsl.noaa.gov/mab/trex/) following runs of two separate WRF models: Advanced Research WRF (ARW) and National Mesoscale Model (NMM). Both of these models used a 2 km X 2 km domain with 50 vertical levels.

- A formal assessment to the Aviation Weather Technology Transfer (AWTT) Technical Review Committee (TRC) was provided in support of the operational transition of the Forecast Icing Potential (FIP) product developed by the FAA's Icing Research Team. Attributes of the forecast that were evaluated include icing probability, icing severity, and supercooled large drops (SLD). Findings indicated that FIP showed significant value as a supplement to the AIRMET; and, primarily basing their decision on the study, the TRC formally approved the use of FIP in FAA operations.

- Collaborations with the RTVS group to create and demonstrate a verification framework to support processing of meteorological quality information within NextGen. Critical to the effort is the ability to effectively integrate information from the air traffic planning process. CIRA researchers successfully implemented a proof-of-concept to evaluate and demonstrate the new ideas. This approach proved valuable to the operational community; as a result, work continues on enhancing the capability and integrating the system into the NextGen development.

- CIRA scientists have been an integral part of an on-going Hydrometeorological Testbed (HMT) project that represents a cooperative effort between NWS WFOs in Sacramento and Monterey and the Reno WFO in Nevada, the NOAA California-Nevada River Forecast Center in Sacramento, and the NOAA National Centers for Environmental Prediction (NCEP) Heavy Precipitation Branch. The collaboration focuses on the detailed analysis of the WRF-ARW model with various microphysics and its performance in cases of atmospheric river events. The evaluation consisted of comparisons of the flow and cloud structure against observations from experimental radars deployed for the HMT project.

- A collaboration between the Hazardous Weather Testbed and Hydrometeorological Testbed was established. CIRA researchers participated in an initial brainstorming session to determine how the two testbeds can work together to accomplish common goals. A primary developmental priority that was identified was the need to advance the use of high-resolution forecasts so that they could be used in an adaptable manner. A pilot test is now underway in which a mesoscale model ensemble forecast is being used to provide initial and boundary conditions to produce a cloud-scale model ensemble forecast.

- Collaboration with AOML to run a LAPS analysis for Hurricane Dennis from 2005, including the use of specially-derived radar observations. This is a proof of concept for using LAPS to initialize the WRF model with current tropical cyclone information to help improve forecasts. The LAPS web interface was improved to be able to plot the densely-packed special observations that support the analysis of tropical storms

- The TAMDAR (Tropospheric AMDAR (Aircraft Meteorological Data Relay)) program underwent a significant milestone when the NWS agreed to purchase the TAMDAR data from the Midwest and mid-CONUS that had been part of the TAMDAR Great Lakes Field Experiment. The objective and subjective evaluation efforts by ESRL/GSD, CIRA, and some NWS WFOs (particularly WFO Green Bay, Wisconsin) were crucial to establishing the usefulness and reliability of the data input that went into the NWS decision.

- Graphics and a website (http://rapidrefresh.noaa.gov) were generated for the Rapid Refresh (RR) model, which is an upgrade to the RUC model that includes assimilation of radar reflectivity, TAMDAR observations, enhanced convection and enhanced land-surface radiation. The RR remains at 13 km resolution; however, the domain covers all of North America rather than just the Continental U.S.

- Analyses using spectral, multi-order structure functions, and multi-fractal methods were conducted to study gravity waves and turbulence interactions in the upper troposphere. A series of WRF model simulations of gravity wave generation, propagation, and dissipation in a baroclinic atmospheric condition were also conducted. These analyses further revealed scale interactions and energy cascade between mesoscale gravity waves and turbulence.

- Over the last few years, development of time-lagged, multi-model ensemble systems and ensemble-based data assimilation systems have been applied to various projects and experiments including QPF,

PQPF, and QPE studies. During the past year, a method to construct mesoscale background error covariance was developed for a data assimilation system and global precipitation verification studies using various satellite data and the GFS global atmospheric forecast model.

Applications of Satellite Observations

- Code was developed to compute the location of Atmospheric Rivers. Water vapor fluxes in these rivers are computed for wind fields assuming geostrophic, linear, or nonlinear balance conditions. The analysis revealed problems with ATOVS data and the research is now using AMSU-A/B data instead.

- The Advanced Environmental Satellite Research Program has formed the basis for an international coordination to evolve the Global Earth Observing System (GEOS). Additionally, these coordination efforts, through participation in high-level international committees and WMO groups, are leading to the improved use of space based earth observing data.

- GOES-R ABI analysis and simulated radiance fields were developed as proxy data for Mesoscale weather and hazard events using high-quality simulations of radiance. ABI radiances for one hurricane event and several fire proxy datasets and model fields of "ground truth" were created.

- The blended TPW and TPW anomaly products have been made available to more users. Both the blended GPS-AMSU-SSM/I TPW product and the anomaly product are available on the web (http://amsu.cira.colostate.edu/GPSTPW) and on the McIDAS Server (ULY/AMSU.27 and 28) and are scheduled for AWIPS Operational Build 9.

- Creation of cloud and microwave emissivity verification tools for use in the CRTM has just begun. Delivered the CSU MWLSM v1.0 to the JCSDA for subsequent insertion in the operational CRTM. CloudSat data sets have been matched to the WRF-3DVar data assimilation case studies for future verification work. This work leverages DoD sponsored work with JCSDA support for NOAA's mutual benefit.

- Development of a multi-platform satellite tropical cyclone wind analysis system. The system combines measurements from a number of satellite platforms to estimate the surface wind fields of tropical cyclones. Two important contributions to tropical cyclone wind field outside of the eyewall region of the storm come from the AMSU instrument and from QuikSCAT. Considerable effort was made to determine the error characteristics of these two wind instruments, and a method was developed to convert the AMSU winds (which are representative of winds above the boundary layer) to the surface. NOAA may view this work as a tool for justifying public investment in science initiatives. Having data available from advanced sensors will allow researchers to develop products for the forecaster to utilize in severe weather situations. It will also allow for preparation of training materials to train the forecaster to use the products. This will in turn lead to better weather/hazard forecasts for the public.

- Produced an updated and quality-controlled archive of SSM/I antenna temperature data in Wentz and TDR formats from DMSP F08, F10, F11, F13, F14, and F15 for the period July 1987 through the present. Developed software for the processing of both the Wentz and TDR formats. Developed a technique for intercalibrating the SSM/I brightness temperatures with TRMM TMI in order to produce a consistent multi-sensor climate data record. Currently working with the intercalibration working group within the NASA Precipitation Measurement Mission (PMM) science team to refine this approach. Received certificate of appreciation from the director of NOAA's National Climatic Data Center for providing a comprehensive archive of SSM/I data and associated documentation.

- Satellite-derived wind measurements are most valuable over the oceanic regions where fewer conventional observations exist. This lack of observational data extends over all latitudes, from the tropics to the Polar Regions. The polar winds project involves collaborations with other agencies including the National Environmental Satellite, Data, and Information Service's Office of Research and Applications

(NESDIS/ORA), and the Cooperative Institute for Meteorological Satellite Studies (CIMSS) located at the University of Wisconsin – Madison

- Evaluation of GOES-13 Imager and Sounder during NOAA's Science Test: Collection and Analysis of Data Science Test indicates that the GOES-13 instruments (Imager and Sounder) are less noisy than previous GOES. On the other hand, the potential reduction in striping (to be achieved through increasing the Imager scan-mirror dwell time on the blackbody from 0.2 sec to 2 sec) has not been realized. Improvements were noted in both the navigation and registration of GOES-13 imagery. Frame-to-frame registration of the imagery appears to be improved as well.

- To assess the utility of NPOESS instruments for tropical cyclone applications, proxy data from currently available satellites and synthetic data from mesoscale and radiative transfer models are being used. AIRS/AMSU retrievals (proxy for ATMS/CrIS) from the AIRS Science Team were collected in the environment of 11 tropical cyclones. In situ soundings from the NOAA Gulfstream Jet were also available as ground truth. The VIIRS proxy dataset was used to study the impact of resolution on the Dvorak intensity estimation technique. A method to estimate tropical cyclone wind structure from temperature and moisture retrievals was also evaluated. This algorithm is now being run in real time using AMSU temperature retrievals for all tropical cyclones around the globe. The retrievals are now available to forecasters at the National Hurricane Center in Miami and the Joint Typhoon Warning Center in Honolulu via the following web page: http://rammb.cira.colostate.edu/products/tc_realtime/.

- POES-GOES Blended Hydro-Meteorological Products builds upon earlier NOAA Product Services Development Initiative (PSDI) work at CIRA to deliver operational algorithms for blended total precipitable water (TPW) into AWIPS Operational Build 9, targeted for early 2009. The merged TPW and accompanying TPW anomaly products developed at CIRA currently use inputs from four different types of sensors (AMSU, SSM/I, GPS, and GOES Sounder) along with climatology data to create near real-time blended moisture products. The websites hosting these demonstrations, http://amsu.cira.colostate.edu and http://amsu.cira.colostate.edu/gpstpw, are routinely accessed by NWS forecasters. The demand to make these products fully operational has spurred this technology transition effort.

- WindSat RTM Intercomparisons: Microwave Land Surface Model (MWLSM/CSU) fields were compared to Conical Microwave Imager Sounder Model (CM/AER). The study found that the MWLSM is, in fact, a generalized research version of the NPOESS CM model code. Results are very similar between systems if MWLSM parameters are adjusted to match the CM parameter assumptions (details are found in Rapp et al., 2006):
    - Absolute brightness temperature differences < 3K.
    - Normalized sensitivities < 0.5 K.
    - Forward RTM models are in good agreement, primary focus should be observational validation of the underlying RTM theory using WindSat data (part of Rapp MS Thesis topic).The MWLSM gives physically expected results
    - Most sensitive to soil moisture.
    - Sensitive to vegetation and roughness effects.
    - Soil moisture ranges are similar to expected soil moisture ranges.

- Research & Development for GOES-R Risk Reduction: This project developed algorithms for data assimilation using the Weather Research and Forecasting (WRF) model and the Maximum Likelihood Ensemble Filter (MLEF). The impact of covariance localization (based on employing local sub domains) on the information measures was examined. A simulated GOES-R Product Web using ABI-equivalent MSG data was developed (see http://rammb.cira.colostate.edu/products/goes-r/). Currently the page shows experimental products developed for fog/stratus discrimination and blowing dust, as well as a GOES-11 version of the blowing dust product that uses the same split-window difference still available with GOES-10 (West). The development of the GOES-R proxy tropical cyclone database for Dvorak intensity estimation studies was completed. About 400 IR images from AVHRR and MODIS were collected from 11 tropical cyclones from 2002-2005 at 1 km resolution. These were remapped to 2 and 4 km resolution and companion GOES imagery was obtained. These data will be used to develop new tropical cyclone intensity algorithms for GOES-R as part of the Algorithm Working Group project.

Applied Cloud Physics

- A synchronized data set of pertinent cloud and aerosol microphysical properties at a temporal resolution of 20s was created based on the experimental set-up at Point Reyes, CA during 2005. Aerosol fields measured at coarser temporal resolution have been interpolated to 20s, recognizing that the temporal changes in aerosol are much slower than those of clouds . Although the various measures of aerosol effects on cloud microphysics are consistent, they were demonstrated to likely be too low. Radiative transfer modeling also demonstrated that uncertainties in these measures will translate to large uncertainties in radiative forcing estimates.

- Comparisons were performed between the statistical properties of Large Eddy Simulations (LES) and aircraft observations of non-precipitating, warm cumulus clouds that were observed in the vicinity of Houston, TX during the Gulf of Mexico Atmospheric Composition and Climate Study (GoMACCS). Comparisons have focused on the statistical properties of a set of dynamical and thermodynamical variables. For all variables, good agreement between the simulated and observed clouds was found. These comparisons, together with the excellent agreement found between observed and simulated cloud size distributions, suggest that the LES is able to successfully generate the cumulus cloud populations that were present during GoMACCS.

- CloudSat has completed its nominal 22-month mission and has been approved for a 3-year, on-orbit mission extension. CIRA's Data Processing Center has received several NASA awards for excellence in its support of the science teams who are pushing the boundaries of our understanding of cloud physics, morphology, layering, and interactive role in the climate system.

Air Quality and Visibility

- Investigation of SMOKE Aerosol-Cloud-Radiation and Surface Interactions using Large Eddy Simulations: this project examines aerosol-cloud interactions between clouds, aerosols, radiation, surface fluxes and boundary layer processes in warm convective clouds in the Houston area. Comparisons of the statistical properties of Large Eddy Simulations (LES) with aircraft observations were done for non-precipitating, warm cumulus clouds observed in the vicinity of Houston, TX during the Gulf of Mexico Atmospheric Composition and Climate Study (GoMACCS).

- Processing of organic aerosols by heterogeneous and multiphase processes: Particulate organic carbon has been shown to be an important component of the global aerosol system, and yet its physical and chemical sources are poorly understood. The long-term objective of this project is to improve the representation of the properties and formation processes of organic aerosols in chemical and climate models, including their role in aerosol indirect forcing. Ervens et al., (2008) is a collaborative work on aqueous phase modeling of SOA formation. Our modeling studies have shown that SOA yields from isoprene (i) depend strongly on the initial volatile organic carbon (VOC)/NOx ratio resulting in 42% > Yc > 0.4% over the atmospherically-relevant range of 0.25 < VOC/NOx < 100; (ii) increase with increasing cloud-contact time (iii) are less affected by cloud liquid water content, pH, and droplet number. The uncertainty associated with gas/particle-partitioning of semivolatile organics introduces a relative error Yc□of -50% ≤ < +100 %. The reported yields can be applied to air quality and climate models as is done with SOA formed on/in concentrated aerosol particles (SOAaer). The paper by Ervens et al., (2008) has been selected as 'Editor's Highlight' by the editor of Geophysical Research Letters. In addition, it has been mentioned on 'Science Daily' ("Cloud Chemistry Concocts Aerosols").

- CIRA has headed efforts to improve WRF-Chem forecasts with data assimilation using the Gridpoint Statistical Interpolation (GSI). One effort concentrated on the development of background error covariances for ozone and its implementation in the GSI. The assimilation cycle was also implemented for WRF-Chem (NMM version). The results of data assimilation of surface ozone observations with WRF-Chem NMM and GSI have been evaluated over a period of three weeks in August 2006.

Numerical Modeling

- CIRA researchers have been an integral part of the team that has brought the ESRL Finite-volume Icosahedral Model (FIM) code to its current level of maturity where the global model produces daily weather forecasts. They improved the software engineering processes used during FIM development by creating source code repositories, developing an automated test suite for FIM, and implementing a lightweight software engineering process tailored to FIM requirements. With the new process, test suite, and repositories in place, FIM software engineering practices are now on a par with other major production NWP and climate codes such as CCSM and WRF. CIRA scientists also refactored upper levels of FIM software to allow interoperability with NCEP's NEMS architecture implemented via the Earth System Modeling Framework. They created a prototype FIM ESMF component and are implementing the functional details to permit coupling of FIM physics and dynamics within the NEMS architecture. CIRA researchers also assisted GSD scientists to incorporate aspects of WRF-CHEM into FIM.

- Impact of fundamental assumptions of probabilistic data assimilation/ensemble forecasting: Conditional mode vs. conditional mean explores the possibility for NOAA operational use of ensemble assimilation/ prediction system. This implies the assimilation of NCEP operational observations (including satellite radiances), and the use of NCEP Global Forecasting System (GFS) spectral model, at resolution T126. The NCEP operational observations are accessed using NCEP infrastructure, i.e. using the forward component of the operational Grid-point Statistical Interpolation (GSI) system. The prototype ensemble data assimilation (EnsDA) system has been developed and tested. The EnsDA system generally outperforms the operational GSI (3D-Var) system. In terms of the root-mean-squared errors, the results are especially improved at upper levels of the troposphere.

- Ensemble Data Assimilation of Precipitation Observations: CIRA has developed the basic version of the data assimilation algorithm and tested it in assimilation of the real satellite precipitation observations (TRMM and SSM/I data). In particular, we developed and evaluated a smoother, the Maximum Likelihood Ensemble Smoother (MLES), which was especially useful for assimilation of precipitation data. The data assimilation algorithm is installed on the NASA Columbia computer and made available to the NASA GPM research. The results indicate positive impact of assimilation of precipitation data, especially in producing dynamically balanced precipitation analyses (e.g., precipitation analyses in agreement).

- CIRA-NCAR/MMM WRF-Var Collaboration Work Plan: CIRA determined several new methods for the WRF-Var preconditioner and determined that the WRF-Var Empirical Orthogonal Functions (EOFs) were hindering the use of the Zupanski preconditioner methods which are used successfully in the CIRA 4DVAR data assimilation system. Several alternate recommendations were presented to NCAR for consideration.

- CIRA delivered to NCAR new WRF-Var codes that allow the insertion of satellite microwave emissivities into the WRF-Var framework. This also includes the addition of a new satellite data interpolation scheme to handle missing satellite field-of-views.

- Implementation and Evaluation of an Improved Mellor-Yamada level-3 Turbulence Closure in WRF: The scheme evaluated positively against LES and was successfully used in modeling of radiation fog. The potential benefit to WRF from this enhancement is considered as high, especially in conditions when phase changes in the boundary layer occur. The scheme has been implemented in WRF and is being evaluated. Meetings with NCAR staff are planned to discuss results.

Education, Training, and Outreach

- CIRA has upgraded all software on the AWIPS data server, AWIPS workstation, and WES workstation. An experimental workstation has been configured to assist the transition of RAMMB products to AWIPS. We have also developed a Coastal Effects WES training course. All of these efforts are intended to augment the minimal satellite data set in the current AWIPS configuration with techniques developed by RAMMB/CIRA.

- CoCoRaHS is a community outreach effort to educate the public about climatology and weather, with an emphasis on the collection of precipitation data. CoCoRaHS celebrated its 10th anniversary as a network in 31 states, with 4 more states being added in 2008. Over 5,000 volunteers are reporting precipitation daily and 5,000 more have contributed occasionally. Many educational programs and web-based tutorials have been used in conjunction with NWS' SKYWARN spotter training. Observational activities have focused on precipitation which has formed a basis for collaboration with many organizations at the local and state level. CoCoRaHS provides high density data critical to meteorological and hydrological climate records. It works as a low cost gap filler for NOAA's COOP program. This program's lead and PI, Nolan Doesken, was a recipient of the NOAA 2007 Environmental Hero award

- The AutoNowcast prototype is up and running at the Fort Worth WFO. CIRA consulted and prepared the installation packages and did trouble-shooting for communications problems during the installation.

- The Next Generation GLOBE (NGG) plan was approved in September 2005 by NASA and NSF. In response, the GLOBE Program Office (GPO) has aligned its major areas of work to achieve GLOBE's vision of being a worldwide community of students, teachers, scientists, and citizens working together to better understand, sustain, and improve Earth's environment at local, regional, and global scales. In 2008, GPO's attention is shifting towards providing a more collaborative space to promote student research around various themes such as climate change and sustainability.

- The overall objective of the Satellite Hydrology and Meteorology (SHyMet) program is to develop and deliver a comprehensive distance-learning course on satellite hydrology and meteorology. This is being done in close collaboration with experts from CIRA, the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin-Madison, the Cooperative Program for Operational Meteorology, Education and Training (COMET) in Boulder, Colorado, the National Weather Service (NWS) Training Center (NWSTC) in Kansas City, Missouri, and the NWS Warning Decision Training Branch (WDTB) in Norman, Oklahoma. The SHyMet Intern course was offered online. It consisted of 9 modules, accessible via the following website: (http://rammb.cira.colostate.edu/training/shymet/intern_topics.asp). For NOAA individuals, the course was set up for tracking through the e-Learning Management System (LMS). For non-NOAA individuals, the course was offered through online modules and was tracked at CIRA. Statistics for April 2007 – March 2008 (compared to entire period April 2006 – March 2008). Thirty-seven new NOAA/NWS employees/participants have registered at CIRA (144 total for period April 2006 – March 2008). Seven of the new NOAA/NWS individuals have completed SHyMet Intern Course (60 total for period April 2006 – March 2008). Eight non-NOAA participants have registered at CIRA (National Environmental Satellite, Data, and Information Service / Satellite Applications Branch (NESDIS/SAB) contractors, and Korean Meteorological Service) (22 total for period April 2006 – March 2008).

- Support of the Virtual Institute for Satellite Integration Training (VISIT): Based on extensive feedback from participants, the VISIT program has fulfilled the original goal identified in 1998. The number of topics addressed and participating students have increased appreciably. A typical monthly training calendar now contains about 15 teletraining sessions over a wide variety of topics. To date, over 18,000 training certificates have been awarded.

- In April 2008, CIRA researchers released a beta version of a Java application called WRF Portal, a graphical user interface (GUI) to WRF-NMM and WRF-ARW. WRF Portal now runs on most computer systems. It supports 2D visualization and includes WRF Domain Wizard as a built-in software component. WRF Domain Wizard enables users to choose a region of the Earth to be their domain, re-project that region in a variety of map projections, create nests using the nest editor, and run the three WRF Preprocessing System Programs. Two new features added to the Domain Wizard include a vertical level editor and visualization module that enables users to visualize the NetCDF output. See www.wrfportal.org

- Aviation-specific enhancements regarding icing, turbulence, convection, ceiling, and visibility were successfully integrated into AWIPS versions being prepared for field deployment in 2008. For the first time, NWS Center Weather Service Units will be able to use the AWIPS Remote Display (ARD) to view aviation weather products and map backgrounds for use in their aviation forecasting and briefings to the FAA's Traffic Management Units (TMU). These products give visual references to affected airspace that words alone sometimes do not capture.

- Support continued on a web interface recently developed that allows an end user (e.g. Redzone Inc.) to automatically move a fire analysis/forecast domain to permit quick response to evolving fire situations. The LAPS analysis runs at 500m resolution and utilizes a downscaled RUC background together with the latest observational data. The relocatable 500-m resolution forecast downscales the latest NAM run into the future.

- FIM and GFS global model forecast displays on Science On a Sphere™ (SOS) were updated with additional fields and improved color tables. For example, a display that overlays precipitable water with surface pressure is useful for tracking tropical cyclones. The dataset for Mercury was updated based on recent data from the MESSENGER spacecraft as well as Earth-based radar information. A new map of Io from the USGS is also now available for SOS. Updated planetary satellite maps were constructed for several of Saturn's moons, including Dione, Tethys, Enceladus, and Iapetus.

- A GLOBE technology team comprised of 5 CIRA researchers successfully designed and released the new GLOBE website in June 2007. The new website continues to receive improvements based on the principles of being more user-friendly and better supporting collaborative student research projects, including projects related to the Earth System Science Projects (ESSPs), and local and regional projects. Future development will include content and tools specifically designed for students based on pedagogical principles (in addition to sections for teachers, partners, scientists, etc.). The international GLOBE network has grown to include representatives from 110 participating countries and 138 U.S. Partners coordinating GLOBE activities that are integrated into their local and regional communities. Due to their efforts, there are more than 40,000 GLOBE-trained teachers representing over 20,000 schools around the world. GLOBE students have contributed more than 18 million measurements to the GLOBE database for use in their inquiry-based science projects.

- CIRA made significant changes to the basic FX-Net system in the past year, including an upgrade to provide the latest version of the NOAAPort data and extended AWIPS data and file server functions. A new version of the FX-Net Client (v.5.1) includes the addition of significant new data analysis and display tools.

- Enhancements to the Gridded FX-Net Forecaster Workstation included a new capability to compress grid data sets with irregular boundaries, such as potential temperature fields. The newly designed algorithm and implemented encoding/ decoding software provide good compression performance at the expense of minimum additional computation.

- Science on a Sphere™ (SOS) was installed at four new permanent public venues—NOAA's National Severe Storms Laboratory, Norman, OK; Ocean Explorium, New Bedford, MA; Clark Planetarium, Salt Lake City, UT; and Lawrence Hall of Science, Berkeley, CA—increasing to 20 the number of sites where SOS is in operational use. Model output data from the FIM global meteorological model were rendered for display on SOS. Existing GFS model output was visually enhanced and new and improved planetary data sets were developed.

- CIRA researchers continued their participation in the evaluation of AWIPS II. The objective is to provide an independent verification and validation of the proposed next version of AWIPS, which is built upon a Services Oriented Architecture (SOA) paradigm. Work was completed on developing metrics for the new AWIPS which will serve as a benchmark for evaluating the performance of the future AWIPS II.

- As part of the AWIPS Evolution—Web Service Development project, CIRA researchers participated in several efforts including: 1) development of prototype software for the distributed retrieval and processing of ensemble model data; 2) development of prototype web service software using OGC standards; and 3) development of modules for the Earth Information Services prototype that includes data retrieval from new sensors, analysis module, and work-flow module.

- CIRA researchers contributed to a number of changes made to the AWIPS workstation including the ability to view dual polarized radar data. This capability provides significant additional information for estimating the amount of precipitation present in a radar echo, identifying the presence of hail, and discerning ground clutter from real hydrometeor data.

- The ALPS (Advanced Linux Prototype System) provides an ideal platform for prototyping new capabilities. CIRA researchers demonstrated and tested many new features using the ALPS system, including the ability to create graphics in KMZ format and display them on GoogleEarth (TM). Also, the FIM (Flow-Following Finite-volume Icosahedral Model) was integrated and displayed for the entire globe on the ALPS "movable" scale. This same data can be exported and displayed on Science On a Sphere ™ (SOS).

- A "gridded data server" feature on ALPS was implemented to improve the speed with which an ALPS workstation user can view remotely located forecast model grids. This innovation made it possible for selected West Coast offices participating in the HMT (Hydrometeorological Testbed) to access very high resolution model data generated at GSD in Boulder in real time.

- An NCAR AutoNowcaster display system (Configurable Interactive Data Display--CIDD) was installed at the Fort Worth-Dallas WFO. This allows FAA Central Weather Service Unit (CWSU) forecasters to review the several types of AN products (real-time and forecast) that are available within the system. In preparation for an operational evaluation, significant software improvements were made during the past year in Data Management, Data Display, Forecaster Interaction (boundary and polygon editing), and Data Dissemination. The significance of this achievement goes beyond providing improved severe weather situational awareness for the CWSU forecasters with operational products to assist in regional air traffic control, but that this guidance is now being served using input data provided by NWS forecasters using AWIPS.

Societal and Economic Impacts

- The objective of the FX-Collaborate (FXC) project is to develop an interactive display system that allows forecasters/users at different locations to collaborate in real time on a forecast for a particular weather or weather-dependent event. FXC is currently being implemented and/or evaluated for several outside projects and organizations. One significant application in particular, Geo-targeted Alerting System (GTAS), involves the development of a prototype public notification system to be used by NOAA and the DHS Operations Centers in the event of a biological, chemical or radiological release in the National Capital Region. The emphasis this year changed from building and installing prototype systems to developing a deployment strategy. Thus, much of this year's work consisted of coordinating with NOAA HQ and DHS staff on defining the future expansion of GTAS. Several demonstrations of the system were given to DHS staff in Washington and to other visitors in Boulder. CIRA started coordination with Lawrence Livermore National Laboratory, developers of the NRAC dispersion model, to define the interface between GTAS and NRAC. NRAC is currently being used by DHS and several other government agencies instead of the HYSPLIT model now running on GTAS.

- Applied social science connected to the Advance Hydrologic Automated Prediction System (AHAPS) has improved the effective distribution of water resources information through improved organization of dissemination web-based tools. These advanced approaches were presented at the Weather And Society Integrated Studies (WAS*IS) program workshop.

- Sociological research in collaboration with NIDIS improved its web portal for the Dec 07 completion. Initial public comment was favorable. This approach can provide a template for a similar approach in severe weather product utility analysis beyond just economic analysis.

Infrastructure

- The CIRA Data Systems Group at ESRL/GSD continued to design and develop new software to streamline the acquisition and processing of data. An "Object Data System" technique was applied to develop a new maritime data decoder to replace legacy software. Other decoders and translators underwent significant updates. Data acquisition and processing affecting virtually all GSD projects—from Nexrad surface radar and environmental satellite observations to profiler and mesonet data—were developed or enhanced.

July 1 2008 - June 30, 2009

Global and Regional Climate Dynamics

- As part of an NSF-funded research collaboration entitled 'Norwegian-United States IPY Scientific Traverse: Climate Variability and Glaciology in East Antarctica', scientific investigations along two overland traverses in East Antarctica—one going from the Norwegian Troll Station (72º S, 2º E) to the United States South Pole Station (90º S, 0º E) in 2007-2008 and a return traverse starting at South Pole Station and ending at Troll Station by a different route in 2008-2009—were executed as scheduled. Analyses of the snow data collected during the traverse are in progress to understand snow accumulation and spatial variability across the East Antarctic Ice Sheet. The results of this investigation will add to understanding of climate variability in East Antarctica and its contribution to global sea level change.

- As part of an NSF-sponsored IPY collaborative research, a prototype international network for measuring Arctic winter precipitation and snow cover (Snow-Net) was initiated. Both snowfall and snow on the ground are changing, yet we are in a poor position to monitor this change partly because winter precipitation and snow on the ground are currently monitored by two separate systems. At 5 key Arctic sites we are augmenting existing meteorological and snow measuring instrumentation with solid-state snow pillows, heated plate precipitation sensors, snow fences (to capture the wind-blown flux), and eddy correlation towers for computation of sublimation. Several times a winter, ground surveys of snow cover depth, water equivalent, and other properties are conducted at these sites using tools that allow rapid collection of extensive data. These are augmented with aerial photography and airborne remote sensing from inexpensive platforms to visualize drift and deposition patterns. The combined suite of instruments and measurements is designed to allow us to close the winter water balance at each site, for the first time balancing the precipitation with measured accumulation. Field instruments were installed during 2007 and measurements were made during winter 2007-2008 and 2008-2009.

- Current information and knowledge related to snow tends to be compartmentalized by discipline, dispersed throughout the literature, and rarely inclusive. A synthesis is needed now more than ever because both the duration and the nature of the arctic snowpack are changing. We take a comprehensive approach to snow that will produce a better understanding of how changing snow conditions will affect the Arctic System. Our terrestrial snow work completes the suite of synthesis studies on the Arctic System undertaken in the first phase of the SASS Program by combining with an existing study of snow on sea ice, thereby producing a full system-wide assessment of snow impacts. The synthesis is organized into five tasks designed to provide answers to several pressing snow-related questions: 1) collect pan-Arctic datasets, 2) merge tools and models to simulate Arctic snow-related features, 3) produce spatially distributed time-evolving distributions of snow properties and characteristics for the terrestrial pan-Arctic System, 4) from these distributions develop a set of integrated indices and derived products that capture the essential snow-related impacts, and 5) use the impact indices to better understand the Arctic System.

- The long-term research objective of determining the regulatory mechanism for sub-seasonal precipitation variability in the east Pacific warm pool during Northern Hemisphere summer has been met. Predicting sub-seasonal precipitation variability in the east Pacific is crucial for predicting periods of enhanced tropical cyclone formation not only over the east Pacific, but also over the Gulf of Mexico and Caribbean Sea. Such basic understanding may also lead to improved parameterization in our climate models. It was shown that 1) bursts of Atlantic tropical cyclone activity are preceded by the propagation of MJO-induced Kelvin waves from the Pacific into the Atlantic; 2) Rossby wave propagation is the dominant means by which ENSO affects Atlantic hurricanes; 3) sub-seasonal SST variability in the east Pacific warm pool is much greater than once suspected, possibly playing an important role in forcing convection that affects the predictability of the North American monsoon region; 4) an ocean model with a dynamical mixed layer is necessary to capture realistic subseasonal SST variability in the east Pacific warm pool, and surface latent and shortwave radiation fluxes appear to be at the root of intra-seasonal SST variability in the east Pacific; and 5) several climate models exhibit a strong sensitivity of tropical intra-seasonal variability to wind-induced surface heat exchange, suggesting that surface flux forcing may be a key underlying mechanism of the MJO.

- As part of the effort to simulate and analyze the interaction between aerosols and clouds, precipitation and the radiation budget, the Town Energy Budget (TEB) urban model was coupled to the newest version of RAMS for a domain over the Gulf of Mexico and Houston. The Landsat Thematic Mapper ™ National Land Cover Data (NLCD) corresponding to 2001, along with two additional datasets (1992 and 2006) were processed and the NLCD land use categories were converted into the RAMS land use categories. These datasets were used for the initialization of the two finest grids of series the numerical simulations. We focused on a convective storm triggered by the sea-breeze circulation (Aug 24, 2001) and performed two series of sensitivity experiments with the different land use data sets and considering aerosol sources linked to the urban sub-grid urban fraction.

- Since 1983, CIRA has served as the International Satellite Cloud Climatology Project (ISCCP) processing center for GOES-West data. GOES data (currently GOES-11 data) are received from our ground station, converted into ISCCP B1 and B2 formats, and delivered to the Goddard Institute for Space Studies for processing into the ISCCP products and to the National Climatic Data Center (NCDC) for archiving. We also provide calibration sectors (small samples of GOES-11 and GOES-12 data) for comparison with observations from polar-orbiting satellites. Our current objective is to transition this ISCCP processing from a research setting (CIRA) into an operational setting (NCDC). Our processing code has been transferred to NCDC and we are working with NCDC personnel to implement the processing there and to quality check and compare the NCDC-produced files with the files produced at CIRA.

Mesoscale and Local Area Forecasting and Evaluation

- CIRA researchers supported the assessment of global icing forecasts created for the World Meteorological Organization's (WMO) World Area Forecast System (WAFS). Primarily intended for trans-oceanic operational flight planning, the global forecast grids provide information about potential icing at five flight levels. With very few observations of icing in the domains of interest to the operational planners, the CIRA team developed an icing diagnostic based on CloudSat cloud classification data and a global temperature analysis from the GFS model. The algorithm was developed and tuned in the CONUS domain, using the relatively rich icing observation data. Then, the global forecasts were verified in the areas of concern for operational planning.

- As the centerpiece of weather information in NextGen, the 4-D Data Cube will contain verification information about the forecasts utilized by the air traffic management algorithms. A new approach is necessary to create verification software sufficient for the NextGen operational setting, a complex, service-oriented architecture (SOA) comprised of weather and air traffic management components. In response to this need, CIRA researchers design and test configurations of the integration layer, a primary component supporting flexible, complex queries of the verification statistics. Building on an initial proof-of-concept from the previous year, the team expanded the Network-Enabled Verification Service (NEVS) capability to provide verification information about the FAA's experimental convective forecast, the Collaborative Storm Prediction Algorithm (CoSPA), during the 2009 convective season.

- One of the recent activities included an application of a theoretical approach recently published in Monthly Weather Review on model output from a complete system for numerical weather prediction (WRF-ARW model). The technique consists of first diagnosing the performance of the forecast ensemble which is based on explicit use of the analysis uncertainties, and then optimizing the ensemble forecast using results of the diagnosis. The technique includes explicit evaluation of probabilities which are associated with the Gaussian stochastic representation of both the analysis and forecast. It combines the technique for evaluating the analysis error covariance that was first presented in the Ensemble Transform data assimilation method developed by Bishop et al in 2001 and the standard Monte Carlo approach for computing samples from the known Gaussian distribution. Results from this study have been recently presented at the Weather Analysis and Forecasting conference in Omaha.

- As part of the Hydrometeorological Testbed (HMT) team, CIRA led an effort to test a newly developed observations-based forecast model verification tool by a group of PSD scientists for atmospheric rivers and their impacts on coastal orographic precipitation enhancement. The tool focuses on water vapor flux as a major determinant of orographic precipitation. The water vapor transport is estimated by using wind profilers and GPS-met (Integrated Water Vapor) IWV data.

- A website for display of FIM model output was created and has currently has 24 products available for perusal with 3-hourly forecasts going out to 7 days (http://fim.noaa.gov/fimgfs). GFS model forecast plots are also available as are FIM-GFS difference plots, and plots from the two models can also be viewed side-by-side. Several different projections are also now available including: CONUS, Africa, the Arctic, West Atlantic, West Pacific, Europe, and the Southern Hemisphere. Additionally, the web site features the ability to loop any of these fields throughout the forecast periods. The Texas Advanced Computing Center (TACC) granted access to their 60,000 processor supercomputer for running the FIM at a higher resolution level, with grid points at about 15 km spacing. Separate web pages were created for FIM output from the TACC runs. Hurricane tracking software was used on the FIM output, providing FIM-produced forecasts of projected hurricane paths.

- In support of the Joint Hurricane Testbed, improvements to the Monte Carlo (MC) method for estimating the probability of occurrence of 34, 50 and 64 kt winds utilizing the uncertainty in the track, intensity and wind structure forecasts were implemented this past year. One effort involved the refinement of the MC wind probability estimates by making the underlying track error distributions a function of the forecast uncertainty. The current MC model uses basin-wide error statistics but recent research has shown that the spread of track forecasts from various models can provide information about the expected track error. A real-time tool to quantitatively estimate the track forecast uncertainty (the Goerss Predicted Consensus Error, GPCE) was incorporated into the MC model. Results showed that the GPCE version of the probability model improved the skill as measured by both a Brier Score and a threat score.

- For the Tropical Cyclone Forecast Product project, the NCEP/TPC operational SHIPS intensity model was updated prior to the 2008 hurricane season, where data from the 2007 season was added and the model coefficients re-derived. Methods have been developed to estimate the complex principal components (CPC) in a real-time manner to be used as potential predictors for the Rapid Intensification Index (RII) and SHIPS. Work continues with AOML and TPC on RII modifications and with operational transition issues. GOES predictors have been tested in the Atlantic and East Pacific versions of the RII. In both basins, the GOES predictors significantly improve the ability to anticipate rapid intensification events.

- For the Cloud and Microwave Emissivity Verification Tools for Use within the Common Radiative Transfer Model (CRTM) project, CIRA-developed software, including the CSU microwave land surface model documentation and codes, were delivered to JCSDA for integration into the CRTM. Our WRF-3DVAR use of the microwave emissivities has shown substantial improvement over the deserts of the Middle East, which represents a substantial bias improvement over the CRTM estimates.

- The Development of an Improved Climate Rainfall Dataset from SSM/I project involves the development of specific rainfall databases and procedures to produce rainfall products from TMI and AMSR-E. Significant progress has been made and we are on schedule to produce a complete climate rainfall dataset from SSM/I for the period from 1987 through the present using version 2008 of the GPROF retrieval algorithm by the end of the project. Initial results from the new retrieval algorithm indicate significant improvements in ocean rainfall estimates that will provide a much improved dataset for climate research applications.

- A study using the new CloudSat/CALIPSO dataset in the Arctic was conducted to examine the vertical structure of clouds and the generation of eddy available potential energy. The relationship between the vertical structure of clouds and radiation changes at the surface was quantified.

- A number of satellite networks (including dawn/dusk and other sun-synchronous orbits) were examined and the total flux constraint provided per satellite was found to not depend strongly on the orientation of a sun synchronous orbit (local time of ascending node) -- even dawn/dusk orbits provide much information, despite the high solar zenith angles and long atmospheric paths that affect their measurements. A fleet of four appropriately spaced sun-synchronous satellites with measurements similar to those planned for the Orbiting Carbon Observatory (OCO) could potentially improve surface CO_2 flux estimates by 50-60% where our current understanding is worst. This work is of interest not only for understanding the functioning of the global carbon cycle (and its implication for predicting future levels of global warming), but also for use in monitoring compliance with international CO_2 emissions treaties.

- Surface observations over northwestern Mexico during NAME have been used to document the diurnal cycle of the surface flow during July and August 2004. Comparison of the observed flows with the special NAME North American Regional Reanalysis (NARR) reveals significant deficiencies in the NARR's ability to properly represent the sea and land breeze circulations. In another finding of this study, the diurnal cycle of convection over the Sierra Madre Occidental (SMO) in northern Mexico was determined to be unique in comparison to other mountainous regions of the tropics and subtropics. Early morning low clouds and insolation characteristics on the western slope of the SMO delay the development of upslope flow and deep convection there to the afternoon and evening.

Applications of Satellite Observations

- CloudSat launched on April 28th, 2006 and the CIRA CloudSat Data Processing Center (DPC) has been fully operational since the first CloudSat data were downlinked on May 20th 2006. Since that date, the CloudSat data downlink system has collected 99.9% of the available data, and the CIRA CloudSat Data Processing Center has processed 100% of the available input data to Level 2 products.

- Because of the success of the baseline 22-month CloudSat mission, NASA has extended the mission for an additional 3 years, including support of the CIRA CloudSat DPC. The CloudSat DPC is also responsible for maintaining an archive of the CloudSat data products and the distribution of products to the science community. As of December 31st, 2008, the data distribution system has provided data to over 712 users/groups in 50 different countries. The DPC was given a requirement to provide Level 0 and Level 1 products within 30 days of the receipt of data. We are currently generating both products, and displaying a geo-located browse image of the CPR science data within 2 minutes. This quick turnaround of data and the generation of the "quicklook images" was identified as one of two NASA "Firsts" for this mission. (The other being the accomplishment of formation flying.) A second mission requirement calls for CIRA to maintain 60 days of on-line raw data and data product storage. The DPC has maintained on-line data storage from the beginning of the mission with over 2 ½ years of data on-line as of the end of this past calendar year.

- CIRA participates in the GOES-R 'Satellite Proving Ground' where simulated GOES-R products for advanced instruments such as the Advanced Baseline Imagery (ABI) and the Geostationary Lightning Mapper (GLM) are demonstrated at NWS Weather Forecast Offices (WFOs) on their AWIPS display systems. This past year, the first prototype PG products were migrated into AWIPS at the WFO Boulder and WFO Cheyenne. One of the goals of the Proving Ground project is to leverage existing capabilities

within CIRA to provide training and experience directly to NWS forecasters on the new capabilities of these instruments to maximize the utility of GOES-R.

- CIRA develops GOES-R proxy data for mesoscale weather and hazard events using a sophisticated cloud model and accurate radiative transfer modeling. Under the GOES-R Risk Reduction project, CIRA has developed the capability to produce radiance fields for GOES-R Advanced Baseline Imager (ABI) bands using the CSU RAMS Mesoscale forecast model output. The procedure has been successfully applied to develop synthetic imagery for different types of mesoscale weather events like lake effect snow, severe weather, and hurricanes. This past year, focus was on the creation of ABI radiances for different fire proxy datasets along with the model fields for "ground truth". The goal of these studies is to provide a variety of simulated fire hot spot scenarios along with synthetic GOES-R ABI imagery to support the development of ABI fire retrieval algorithms. The synthetic imagery is also being used for ABI fire detection uncertainty studies.

- CIRA-produced blended AMSU, SSM/I, and GPS Total Precipitable Water Vapor (TPW) product and the Percent of Normal TPW product are now being produced operationally at NESDIS (OSDPD) and to be part of AWIPS Operational Build 9, which means that the two products are available NWS-wide on AWIPS. NOAA 18, NOAA 19, and MetOp-A data are now also being added into the TPW products.

Air Quality and Visibility

- An initiative to improve WRF-Chem forecasts with data assimilation using the Gridpoint Statistical Interpolation (GSI, Purser et al., 2003a and b) is under way. Some results of this work are described in a journal paper on assimilation of surface observations of ozone and PM2.5 that has been accepted by the Quarterly Journal of the Royal Meteorological Society subject to revisions. The experiment demonstrated that assimilation of ozone and PM2.5 could lead to much improved forecasts of concentrations of these species in terms of standard statistical measures. A positive impact of assimilation is observed in forecasts at least out to 24 hours. The result for ozone is encouraging, especially since it is a volatile species dependent on the presence of precursors and sunlight. Improvement in the forecasting skill of PM2.5 concentrations with assimilation was expected. First, PM2.5 is much less reactive than ozone and the impact of assimilation should have longer-term effects. Second, PM2.5 forecasts generally show large errors in terms of basic statistics and their correction via assimilation should be substantial.

- One of the goals of a NASA sponsored project in support of the Clean Air Act and the National Ambient Air Quality Standards (NAAQS) is to improve air quality decision support system through the integration of satellite data with ground-based, modeled, and emissions data. CIRA is pursuing capabilities enhancement of the Visibility Information Exchange Web System (VIEWS) and its associated Technical Support System (TSS) through the integration of NASA satellite data products relevant to air quality and visibility with surface-based monitor data, air quality model output, and advanced analysis tools for intercomparing and interpreting the data. During the past year, a number of satellite data products for air quality, meteorology and land use/land cover were acquired in collaboration with the Joint Center for Earth Systems Technology for multiple years (2006-8) from OMI and MODIS Terra and MODIS Aqua, and loaded into VIEWS-TSS. A prototype visualization tool for satellite data products was implemented in VIEWS, along with many other improved tools for browsing existing data. Metadata were also added for satellite data and browsing of data catalogs was improved

- Recent work has focused on analyzing results from two large field campaigns comprising the Rocky Mountain Airborne Nitrogen and Sulfur (RoMANS) study conducted in spring and summer 2006 to characterize spatial and temporal patterns in nitrogen and sulfur species concentrations and to evaluate dominant pathways for nitrogen deposition within Rocky Mountain National Park (RMNP). Effort has also focused on developing new methods for improved measurements of ammonia and organic nitrogen. Measurements revealed that reactive nitrogen concentrations were much higher, on average, to the east of RMNP than to the west. This was true both for oxidized and reduced forms of nitrogen. Reduced nitrogen, in the form of ammonia plus particulate ammonium, was highest in NE Colorado. The discovery that organic nitrogen and ammonia are important contributors to total N deposition in RMNP is important, given that routine concentration and deposition network measurements do not include these species.

- Another project—an extension of previous efforts to characterize transport and deposition of airborne nitrogen and sulfur in Rocky Mountain National Park described above—includes objectives to study airborne concentrations and deposition throughout a full annual cycle in order to evaluate seasonal trends in pollutant concentrations, transport patterns and deposition fluxes as well as the addition of new methods for continuous measurement of trace oxidized nitrogen species in the gas phase. A field project in RMNP was begun in November 2008 and will run through fall 2009. Daily or higher time resolution measurements are being made of fine particle composition, particle size distributions, concentrations of key trace gases (esp. NH_3, HNO_3, NO_x, and NO_y), and wet deposition fluxes of inorganic ions, organic nitrogen and organic carbon.

- The Technical Support System (TSS) is an extended suite of analysis and planning tools designed to help planners develop long-term emissions control strategies for achieving natural visibility conditions in class I areas by 2064. The TSS is intended to provide state and tribal governments in the Western Regional Air Partnership's (WRAP) region with the emissions, modeling, and monitored air quality data and analysis tools necessary for the completion of their State and Tribal Implementation Plans. To achieve these objectives, the TSS consolidates the data resources of the Visibility Information Exchange Web System (VIEWS) and the WRAP's Emissions Data Management System (EDMS), Regional Modeling Center (RMC), and Fire Emissions Tracking System (FETS) into an online suite of data access, visualization, and analysis tools on the TSS website together with the technical information and guidance to apply these data and tools to state, local, and regional air quality planning. The TSS project team at CIRA currently collaborates with several other organizations to design and develop the technical infrastructure for the TSS. Launch of the first production version of the TSS website was completed, along with the integration of monitored, modeling, and emissions data for the baseline planning period of 2000-2004 and the integration of emissions modeling projections for 2018. Implementation of website usage and tracking system has also been completed.

Numerical Modeling

- Baseline calibration experiments UAS OSSE project have been performed for two 7-week periods using archived observations for six different data-denial types: RAOB, Aircraft, AMSU-A, AIRS, and GOES. Synthetic observations from the Nature Run are now available, and calibration data denial runs for the synthetic observations are now underway. A 'Quick'-OSSE has begun in support of the hurricane UAS testbed. The purpose of the Quick-OSSE is to provide initial guidance for UAS flight paths and instrumentation by performing ad hoc, uncalibrated OSSE experiments using regional forecasting models. Code has been written and tested to generate synthetic UAS observations for dropsondes, in situ measurements, balloons, and SFMR using nested moving regional model output.

- CIRA researchers continue to play an integral part of the team that is preparing FIM for planned operational implementation. CIRA researchers have upgraded FIM to meet NEMS interoperability standards for "Phase I: Incorporation of the FIM into the NEMS D&T code" as specified in the NCEP-GSD LoA for transitioning FIM into operations.

- CIRA researchers organized, debugged, parallelized and optimized the NIM code. Optimizations included rewriting the matrix solving section which decreased the entire code serial runtime from 700 seconds to 108 seconds. Parallelizations were done with SMS. SMS was extensively refactored to simplify implementations and remove functionality that is no longer required. The new "SMS-LITE" has 55,000 fewer lines of source code and is even easier to port and maintain and yet contains all the new unstructured grid functionality.

- In collaboration with the ESRL Director and the GSD Project Manager, CIRA researchers investigated the feasibility of using Graphical Processing Units (GPUs) and the IBM cell processors for increasing the performance of weather codes, specifically the NIM code. Experiments on FIM subroutines have shown that, compared to the state-of-the-art CPUs, a 20X speedup is possible.

- Observed radiative fluxes from an airborne radiometer and fluxes simulated based on model output were compared to evaluate the ability of our model to represent the radiative effects of the aerosol-cloud system. A three-dimensional radiative transfer models was applied to our simulated cloud fields and compared to aircraft observations. Results show good statistical agreement between modeled and measured irradiance provided both cloud and aerosol are included in the calculations. A paper showing the importance of properly simulating both the aerosol, cloud, radiative fluxes has been published in *Geophysical Research Letters* (Schmidt et al., 2009).

- Simulations of aerosol-cloud interactions in trade cumuli (RICO) to assess the sensitivity of cloud macrophysical, dynamical, and radiative properties to aerosol changes at a range of model resolutions were also performed. This includes feedbacks among precipitation, entrainment and turbulent mixing. A paper describing the effect of aerosol on trade cumulus cloud morphology has been accepted for publication in the *Journal of Geophysical Research* (Jiang et al. 2009).

- A state-of-the-art, physically based, micrometeorological model (MicroMet) that can serve as an interface between the relatively coarse-resolution atmospheric models and fine-resolution hydrological and ecological models was developed. Several papers have been published summarizing its performance. This will lay the groundwork for substantial improvements to existing hydrologic and ecologic models. This need is particularly acute in the western mountain States where topographic variations lead to significant variations in winter snow precipitation, snow-depth distribution, spring snowmelt, and runoff rates (e.g., changes of over 500% across distances of a few 100 m for some variables). This, in turn, will lead to increased accuracy of operational weather, hydrologic, and water-resource forecasts.

- One of the primary goals of a collaboration with NASA and the University of California sponsored by the Global Precipitation Measurement Mission program is to develop an ensemble data assimilation system to downscale satellite precipitation observations and to produce high-resolution dynamic precipitation analysis for hydrological applications. During this past year, the MLEF algorithm was interfaced with the GSI forward operators and a capability for assimilation of precipitation sensitive satellite radiances was developed. Data assimilation experiments were performed with AMR-E and TMI radiances for a tropical cyclone case in fine spatial resolution (3 km grid distance in the inner nest). The experimental results indicated positive impact of data assimilation on the analysis and forecast of the cyclone intensity and location and the associated cloud microphysical variables and precipitation.

- In an effort to improve bulk microphysical parameterizations of non-convective precipitation processes by radar data assimilation, model performance was first evaluated relative to radar observations and model errors diagnosed to determine an optimal measure of distance from these observations to use in the data assimilation. The study was started with model verification on examples of IHOP (International H2O Project) cases because of readily available data archives of rich observational coverage and diversity of summer storm systems. The simulations were performed with Advanced Research WRF (ARW) community model with 4-km horizontal grid spacing and 51 vertical levels and three available microphysics options. The three different microphysical schemes used were Lin, WSM6 and Schultz. Model evaluation by global diagnostics such as reflectivity histograms, 3D contingency tables and standard skill scores in the radar reflectivity space as well as comparison of 2D cross-sections of the reflectivity fields between the model and LAPS analysis have been computed.

Education, Training, and Outreach

- CIRA/GLOBE technology team provided support for the GLOBE Learning Expedition (GLE) and Annual Conference which took place 22-27 June 2008 in Cape Town, South Africa and brought together over 500 students, teachers, scientists, partners and guests from 51 countries. The GLE provided opportunities for students to present their research to an international audience, participate in field studies led by master teachers, and build networks for future collaborative activities. Automated web content uploading for various categories of pages (GLOBE Stars, News and Events, ESSP pages: Seasons and Biomes, Carbon Cycle, Watershed Dynamics, and From Local to Extreme Environments) on the GLOBE website was also implemented recently as part of the migration to a Content Management System.

- During the last few months of 2008 and continuing through the beginning of 2009, the GLOBE Technology Team worked closely with one of the four NSF projects, FLEXE, to develop and deliver an online, collaborative application designed to encourage learning and facilitate teacher evaluation. The application included, among its many activities, a student report writer tool, along with a system that allows students to peer review each other's work, and finally revise their original report based on the reviews they received. The application provided ways for students to interact with scientists in learning more about the project-specific research topics.

- CIRA researchers released WRF Portal to the modeling community and continued to extend and improve the software. The new version of WRF, 3.x, is supported and visualization was extended to support both NetCDF and GRIB (version 1 and 2) files. Workflow management was extended to support PBS, SGE, and LSF with both the internal and external workflow managers. The portal was also generalized to provide support for running the FIM model and CIRA researchers ran complex FIM workflows at TACC (Texas Advanced Computing Center) in support of a GSD-led hurricane tracking experiment.

- CIRA researchers adapted WRF Domain Wizard to support the latest features of WPS (WRF Preprocessing System) 3.0 and added a non-linear vertical grid stretcher. CIRA researchers also collaborated with LEAD (Linked Environments for Atmospheric Discovery) researchers to produce a version of WRF Domain Wizard for LEAD.

- CIRA researchers have begun collaboration on the NNEW project to design and implement a suite of performance and latency tests for OGC web services (WFS and WCS) and associated database/website. CIRA researchers also created web services for searching and retrieving ESRL GFS meteorological data, as well as an ESRL intranet website for doing so (http://intranet.fsl.noaa.gov/data-locator/).

- Tests were conducted with the GME global atmospheric model running in Korea to see if it can be displayed using SOS. With our earthquake animation, locally gathered data from the Taiwan CWB has been integrated with the global database from USGS to give greater earthquake accuracy over Taiwan. A new animation of the "Blue Marble" image with nighttime lights was created. An animation showing the establishment of GLOBE schools around the world over the past 14 years was also created.

- CIRA staff worked on setting up a quasi real-time animation from the STEREO pair of satellites orbiting the sun to show more than half the solar disk in extreme ultraviolet light. This involves adapting our reprojection software so it can work with the spacecraft images provided by Goddard Space Flight Center. An algorithm was developed to use persistence imagery to fill in the part of the sun that has rotated out of view. Work is continuing on improving the reliability of the animation.

- The map of Mercury was updated with improved use of older Mariner imagery along with improved navigation of the newer images from Messenger. The map of Saturn's moon Mimas was reworked with improved navigation information for the individual images. The Enceladus map now has color imagery more widely used, as well as improved navigation in the vicinity of the South Pole. Some new Cassini imagery was added to the Tethys map. The map of Saturn's satellite Rhea was updated with new imagery from a February Cassini flyby. Maps were updated for Titan and Iapetus using the latest available Cassini spacecraft imagery. The map of Iapetus is slated to be used in a paper in "Science" magazine.

- Even though the ultimate all-hazards system is not a complete reality, the development team has been very successful in providing key elements to the users. Significant changes to the basic FX-Net system were made in the past year. The system was upgraded to provide the latest version of the NOAAPort data and extended AWIPS data and file server functions. The system delivered to the NWS's IMET program, the National Interagency Fire Center GACC offices, and NWS WSO users' was based the latest version of the AWIPS software, v. 8.3. The operating system as upgraded to RedHat Linux Enterprise v. 4.0. This makes the FX-Net servers completely up to date with the NWS WFO AWIPS systems.

- The new version of the FX-Net Client (v.5.2) was released in March 2009. This version of the client includes the addition of significant new data analysis and display tools. Significant research effort was expended adding the high resolution topography maps. Multiple tools and processes were evaluated in order to provide these hi-res map backgrounds and ensure that the overlaid data sets were geophysically accurate.

- The FX-Net team is working on AWIPS II thin client capability evaluations and standing up an AWIPSII Client. The evaluations will result in reports to the NWS AWIPS II program office regarding the AWIPS II existing thin client capability, the gaps in the architecture that need to be addressed to allow a fully functional AWIPS II thin client. The team is also working on transitioning the version control (Subversion) and client build systems (Install Shield) into an integrated system.

- In order to take full advantage of the forecast grids available on the AWIPS II client systems in each GACC office, a tool was developed to allow users to extract a very specific set of surface grids. The Grid Extraction Tool, Web Interfaced (GETWI) allows users to export grids in various formats to enable the data to be used as input to fire potential algorithms and to create graphical fire potential products for the GACC web pages.

- SOS was installed at 16 new permanent public venues, including our first international sites in Korea, Taiwan, Mexico, and France. Our real-time data distribution to existing SOS sites was enhanced with the addition of global model data, a global earthquake visualization, and a new view of the sun from NASA's stereo sun mission. A new remote presence capability called SphereCasting was developed, which allows a presenter to control multiple remote SOS systems across the Internet, with an accompanying video webcast.

- As part of the NNEW project, CIRA developers implemented a THREDDS data server in order to serve up, in real time, several local weather modes to assist collaborating agencies within NNEW for input into their flight paths. THREDDS implements a web coverage service (WCS) as a mechanism for providing data to clients on request. CIRA researchers also developed a JMBL prototype server to serve up MADIS datasets to a JMBL client. The Joint METOC Broker Language (JMBL) defines a web based interface for accessing meteorological and oceanographic data.

- CIRA developers in collaboration with the GSD Information Systems Branch worked on a major transition effort to transfer MADIS to operations. This work involved porting over 15 years worth of code to the new hardware at NCEP, updating outdated software, setting up web access to the data, writing documentation as well as adding new data providers.

- Faster processors and other technological advances have made it possible to routinely create forecast grid ensembles with a large number of members. CIRA researchers have been working with other GSD staff in exploring innovative ways to process and display ensemble data. As part of this activity, CIRA has developed software to store NCEP grids from the Short Range Ensemble Forecasts (SREF) and Global Ensemble Forecast System (GEFS) into the ALPS database and to implement creative approaches to interactively display this data on the ALPS workstation.

- Major changes have been made to the initial GTAS prototype that was deployed to the FEMA offices in the Washington, D.C. area. The ability to display GIS (Geographic Information System) shapefiles has been enhanced significantly to allow the overlay of GIS data, labeling of shapes with specific attributes, disclosing more data as the user zooms in on a particular area, and shapefile layers being aware of shapes in other layers. An updated version of the HYSPLIT dispersion model has been installed and a new interface for the GTAS client defined that allows chemical information to be specified. The first prototype systems were installed at the NWS Southern Region Headquarter in Fort Worth, Texas and the adjacent weather forecast office and Emergency Operations Center.

- The AutoNowcast (ANC) prototype is up and running at the FWD WFO and has been for several years now. This year, an updated package was delivered to the WFO to streamline the tools used by the

forecasters to insert boundaries and polygons as well as support the new operational version of AWIPS (OB9.0). In addition the software was installed on all workstations within the office so that any of the forecasters could use the ANC tools as opposed to just the short term forecaster. The complete ANC system also is now running on NWS' hardware at MDL rather than at NCAR.

- Effort has begun to map a strategy for Debris Flow Support to provide precipitation gage data from the WFO Hydro Database, which has been specifically requested by USGS researchers. Suggestions have been made on adding Quantitative Precipitation Estimates (QPE) and Quantitative Precipitation Forecast (QPF) data sets to allow USGS Debris Flow models to develop a 'forecast' capability to their existing post-event analysis models. To support the USGS's ability in their analysis of storms which cause Debris Flows, a prototype application was developed to deliver near real-time data using data available from internet accessible databases. This was provided as a quick, partial implementation of the prototype to be installed at LOX (Oxnard) and SGX (San Diego) WFOs.

- CIRA participated in the WMO sponsored Regional Training Course on the Use of Environmental Satellite Data in Meteorological Applications for RA III and RA IV that was held for Spanish speaking countries in Argentina, 22 September – 3 October, 2008. The Argentina National Space Agency CONEA hosted the event at the Gulich Institute in the Space Center facility CETT in Cordoba Province. CIRA prepared and delivered lectures focused on the status of GOES/POES, Introduction to Multispectral and Hyperspectral satellite data, VISITview training, and a demo on McIDAS software.

- The Satellite Hydrology and Meteorology (SHyMet) Intern course was offered online. It consisted of 9 modules, including introduction to GOES and POES satellite imagery and data, GOES sounder and high density wind products, and satellite application for severe weather and tropical cyclones. For NOAA individuals, the course was set up for tracking through the e-Learning Management System (LMS). For non-NOAA individuals, the course was offered through online modules and was tracked at CIRA. CIRA also produced 5 modules—Dvorak, cloud climatology, GOES-R, aviation hazards, and volcanic ash hazards—for the SHyMet Forecasters course.

- During the past year, the VISIT team at CIRA developed two new teletraining sessions on "An Overview of Tropical Cyclone Track Guidance Models used by NHC" and "An Overview of Tropical Cyclone Intensity Guidance Models used by NHC". The VISIT team at CIRA also assisted in the development of two new audio / video playback version training modules covering "ASCAT Winds" and "AWIPS OB9 Blended TPW Products".

July 1, 2009 – June 30, 2010

- The NOAA/NESDIS Regional and Mesoscale Meteorology Branch (RAMMB) at CIRA continued its many Geostationary Operational Environmental Satellite (GOES) research activities which consider both current and future members of this constellation. RAMMB co-led the GOES-14 Science Test to prepare this new system for operational support. New products are being developed for the next generation GOES systems (starting with GOES-R) with emphasis on severe weather and tropical cyclone forecasting. Some of these products are being demonstrated in real time for the National Weather Service (NWS) using proxy data generated from model simulations or research-grade satellite sensors. RAMMB also began new research to improve tropical cyclone forecasts as part of the NOAA Hurricane Forecast Improvement Project (HFIP) and continues to develop new applications for the National Hurricane Center (NHC) through participation in the Joint Hurricane Testbed (JHT). Two members of RAMMB (Drs. Mark DeMaria and John Knaff) were awarded the NOAA Bronze Medal for their roles in developing, implementing, and conducting outreach for new National Hurricane Center Tropical Cyclone Surface Wind Speed Probability products.

- CIRA's participation in the GOES-R Satellite Proving Ground project is providing a new way to interface with operational end-users of satellite applications. The Proving Ground establishes a direct connection

to the Advanced Weather Information Processing System (AWIPS) data display systems used in NWS Weather Forecast Offices (WFOs), and a potential conduit to all WFOs. Among the products currently being demonstrated is a new Orographic Rain Index (ORI) tool which couples satellite-retrieved total precipitable water (TPW) information with model-predicted wind fields and high-resolution surface topography for the purpose of highlighting regions where the terrain may enhance precipitation and increase the risk of flash flooding. ORI has been used by the Hydrometeorological Prediction Center (HPC) to monitor land-falling Pacific storms along the U.S. West Coast this past Fall and Winter and was highlighted in several weather discussions issued to the Western Region. A strong cross-linkage between the Proving Ground and an independent research program established between CIRA and the Naval Research Laboratory has enabled the leveraging of selected applications from the *NexSat* (www.nrlmry.navy.mil/NEXSAT) program.

- Collaborations with the Global Systems Division (GSD), the Chemical Sciences Division (CSD), the Physical Sciences Division (PSD), and the Global Monitoring Division (GMD) of the NOAA Earth System Research Lab (ESRL) in Boulder continued at an unprecedented level this past year. CIRA researchers were immersed in every branch and virtually every project in GSD, including project leadership and integral support involving the FAA and NWS NextGen, NNEW, and NEVS aviation program; meteorological workstation development, including the AWIPS II—Extended project, FX-NET, and GTAS; high performance computing; and the design, development and implementation of various regional and global weather and climate models, including the RUC, HRRR, FIM, and NIM as well as UAS OSSE investigations. Under education and outreach, the SOS architecture was enhanced to run on one computer instead of five and the system was installed at 10 new sites this past year, as well as the highly publicized centerpiece of the US State Department's US Center at the COP-15 Climate Conference in Copenhagen.

- Vital collaborations involving the other ESRL divisions continued with collaborations on clouds, aerosol, and precipitation interactions (with CSD), atmospheric rivers and their impacts on coastal orographic precipitation enhancement (with PSD), and carbon assimilation and OSSE research (with GMD). New endeavors in Boulder also included collaboration with NESDIS/NGDC and the Space Weather Prediction Center on the Joint Polar Satellite System's Space Environment Monitor (SEM) sensor algorithm development, as well as a partnership with the NWS Meteorological Development Lab and USGS on convective nowcasting and debris flow prediction.

- The multi-disciplinary Center for Geosciences and Atmospheric Research (CG/AR) is beginning its 25th year of research on environmental issues. This Department of Defense oriented program plans to welcome several new faculty and graduate students into its activities in 2010. As another example of how CIRA is able to leverage complementary research activities, CG/AR research includes examination of data from the NASA CloudSat mission to determine our ability to extend such high vertical (but limited horizontal) resolution information into the surrounding region—a technique bearing direct relevance to the NWS NextGen aviation program in terms of improved model evaluation of cloud forecasts.

- Over the past year the CIRA group working with the National Parks Service (NPS) continued its research on air quality issues in national parks. They successfully completed the Rocky Mountain Atmospheric Nitrogen and Sulfur Study (RoMANS) that examined the causes of excess nitrogen deposition in Rocky Mountain National Park. The results are being used to support and develop nitrogen deposition mitigation strategies. Over the coming year, we will begin exploring ways in which new NOAA and National Renewable Energy Laboratory (NREL) related research at CIRA in renewable energy (solar) may leverage the wealth of *in situ* data being collected regularly by the ongoing NPS programs.

- The CloudSat mission (launched 28 April 2006) continues to enjoy strong support from NASA Headquarters, having successfully gone through its latest senior review process with a recommendation to extend mission funding through 2012. The CloudSat program, with its Data Processing Center running operationally at CIRA on behalf of NASA, has facilitated multiple research activities including both NOAA and DoD-related efforts. In early December 2009, the CloudSat spacecraft experienced a serious battery anomaly which threatened to spell the demise of the mission. Scientists at JPL, Ball Aerospace, and

CIRA worked on a remedy to the complicated issues surrounding this anomaly, and the radar was turned back on to operational mode successfully in mid-January 2010.

- The NASA Orbiting Carbon Observatory (OCO) mission was cut short when it failed to reach orbit in February 2009. This dealt a heavy blow as the main algorithm development activities were led by CIRA, and satellite-based atmospheric carbon research was an important element of CIRA's re-competition proposal to NOAA. The research program was quickly reconfigured to utilize the Japanese GOSAT satellite. It was announced recently that OCO will be given a new start with a target launch in early 2013. CIRA will continue to operate as a major contributor to this important and exciting mission that is designed to measure atmospheric CO2 and track its sources and sinks, and in the process presenting new avenues for collaboration with NOAA CarbonTracker activities at ESRL.

- The 2009/2010 Annual Report is broken into several chapters which represent the NOAA-defined themes of this Cooperative Institute. In our *Satellite Algorithm Development, Training and Education* theme, we describe ongoing efforts in developing applications for the current constellation of GOES sensors as well as risk-reduction for the future GOES-R satellite program, work related to estimating tropical cyclone formation probability and the cost-savings of improved track forecasting, and contributions to the VISIT and SHyMET satellite training programs.

- Our *Regional to Global-Scale Modeling Systems* theme includes research to improve our understanding of the magnitude of aerosol indirect effects, work with the Joint Hurricane Testbed to develop Monte-Carlo based models for probabilistic forecasting of maximum sustained wind speeds, and progress with high performance computing required to run global forecast models at increasingly higher spatial resolution.

- Our *Data Assimilation* theme showcases developments connected to the Hydrometeorological Testbed (HMT) program in wind profiler and GPS integrated water vapor data ingest, the use of wideband radar, balloon soundings, and Unmanned Aircraft Systems (UAS) in hurricane forecast model initialization, and the production of situation-dependent error information from Ensemble Kalman Filter data assimilation coupled to the Hurricane Weather Research Forecast (HWRF) model.

- Included in our *Climate-Weather Processes* theme are studies on the complex interactions between smoke and clouds as modeled via Large Eddy Simulations (LES), the development of a long-term rainfall data set from Special Sensor Microwave/Imager (SSM/I) data, and a critical assessment of the Intergovernmental Panel on Climate Change (IPCC) fourth assessment to ensure full integration of available resources, proper prioritization and physical consistency of key climate data records.

- Highlighted in CIRA's *Data Distribution* theme is work with the National Weather Service (NWS) Meteorological Development Lab for flash flood monitoring and migration of Autonowcaster to operations for improved situational awareness, multiple efforts toward improving aviation forecast verification systems, preparations for the next-generation AWIPS-II interface, the Meteorological Assimilation Data Ingest System (MADIS) transition to NWS operations, and development of a novel drought early warning system. In addition to these major themes, CIRA engages in multiple education and outreach activities and strives to link weather, water, and climate research to societal impacts.

- Interspersed among these major research themes are important contributions from CIRA's NESDIS postdoctoral program in data distribution, assimilation, and satellite algorithm development. Located in Camp Springs, MD, and integrated closely with NOAA technical contacts at STAR, these scientists are immersed in research ranging from refinements to the Community Radiative Transfer Model (CRTM), satellite-based sea surface temperature (SST) algorithm development, techniques for monitoring and quality control of long term SST records, and ocean color algorithm development for global climate and coastal/in-land water ecosystem monitoring. We are extremely proud of this program and its direct positive impacts to NOAA research needs.

AWARDS

July 1, 2001- June 30, 2002

CIRA Research Initiative Award

Gerald Browning for inspiring mentorship, contributions to the NOAA Forecast Modeling Lab, advanced modeling efforts and pioneering work in numerical modeling

NOAA RAMM Team Members of the Hurricane Mitch Reconstruction Project: **Bernie Connell, Hiro Gosden, Dave Watson** for essential support on the GOES rainfall auto estimator, coordination of training, and installation of a GOES satellite receiving station and network stations throughout Central America,.

Jim Frimel for technical leadership, commitment, productivity and dedication vital to the recent success of the FAA TMU Project.

July 1, 2002 – June 30, 2003

Thomas Vonder Haar - Election to the National Academy of Engineering

Stan Kidder - NOAA's Atmospheric Research and Applications Division Trainer of the Year Award

Shripad Deo - NOAA National Weather Service Certificate of Recognition for Phase II of the AHPS and IFP WFO Web Structure

Ali Zimmerman, Maureen Murray & Lisa Gifford - NOAA's Forecast Systems Laboratory 2002 Annual Web Award

Ali Zimmerman - NOAA Forecast Systems Laboratory Employee of the Month – September 2002

Jim Frimel - NOAA's Forecast Systems Laboratory Employee of the Month – March 2003

Mark DeMaria, Debra Molenar, et al (CIRA Affiliated Scientists) - Department of Commerce Bronze Medal Award for Superior Federal Service for Implementation of a Critical Satellite Receiving Station in Central America as Part of the Hurricane Mitch Reconstruction Project

A. Scott Denning (CIRA Colleague) - Colorado State University Monfort Professor Award

Richard Johnson (CIRA Colleague) - National Science Foundation Special Creativity Award

Graeme Stephens (CIRA Colleague) - Fellow of the American Geophysical Union

Dave Watson, Bernadette Connell and Hiro Gosden - 2002 CIRA Research Initiative Award for Essential Support on the GOES Rainfall Auto Estimator. Coordination of Training, and Installation of GOES Satellite Receiving Station and Network Stations throughout Central America as Part of the Hurricane Mitch Reconstruction Project

Gerald Browning - 2002 CIRA Research Initiative Award for Inspiring Mentorship, Contributions to the NOAA Forecast Modeling Lab, Advanced Modeling Efforts and Pioneering Work in Numerical Modeling

Jim Frimel - 2002 CIRA Research Initiative Award for Technical Leadership, Commitment, Productivity and Dedication Vital to the Recent Success of the FAA TMU Project

Roger Ames, Shawn McClure, Shuxin Yin and Bret Schichtel - 2003 CIRA Research Initiative Award as VIEWS Team Members for Being Among CSU's Most Productive and Innovative Scientists and for Bringing Attention to the Cutting-edge Research on Which They Have Been Working

Cliff Matsumoto - 2003 CIRA Research Initiative Award Acknowledging His Contributions to the Overall Research Environment at CIRA and Special Activities to Foster New Research With CIRA's Partners

Chris MacDermaid, Leslie Ewy, Paul Hamer, Bob Lipschutz, Glen Pankow, Richard Ryan and Amenda Stanley - 2003 CIRA Research Initiative Award as Members of the ITS Data Systems Group for Being Among CSU's Most Productive and Innovative Scientists

July 1, 2003 – June 30, 2004

Shripad D. Deo - Advanced Hydrologic Prediction Service was recognized with NOAA Administrator's Award in May 2004.

Richard H. Johnson (Colleague) - NSF Creativity Award

John Knaff - 2004 NOAA David Johnson Award in recognition of his tropical cyclone intensity work

Guch, et al (2004) - Best of Session Award– Collaborative Computing at NOAATECH 2004.

Postdoc - Kinkade - Interim NOAA/NESDIS Ocean Color Science Team Leader 2003-04.

V, Chandrasekaran (Colleague) - Elected to fellow of IEEE - Geo Sciences and Remote Sensing.

Michael Hiatt - CIRA 2004 Research Initiative Award. The infrastructure was recognized for excellence in the November 2003 NOAA 5-Year Review Report.

GLOBE Team: Travis Andersen, Matt Hansen, Mike Leon, Karen Milberger, Maureen Murray, Dave Salisbury, Mike Turpin, and Ali Zimmerman – CIRA 2004 Research Initiative Award for consistently demonstrated exceptional initiative throughout its involvement with the GLOBE Program.

July 1, 2004 – June 30, 2005

Michael Hiatt, CIRA Research Infrastructure Group Manager - 2004 CIRA Research Initiative Award

GLOBE support group: Travis Anderson, Matt Hansen, Mike Leon, Karen Milberger, Maureen Murray, Dave Salisbury, Mike Turpin, and Ali Zimmerman - 2004 CIRA Research Initiative Award

GLOBE Program - The Goldman Sachs Foundation Prize for Excellence in International Education

Cliff Matsumoto and Kevin Micke - recognized as AP Stars by the Colorado State University Administrative Professional Council.

NOAA/FSL's Aviation Division (including Jim Frimel, Lisa Gifford and Young Chun) - The National Weather Association's Aviation Meteorology Award for enhancements in the area of aviation services.

The federal researchers supporting the Range Standardization and Augmentation (RSA) project were nominated for a DOC Technology Transfer Award. Unfortunately, CIRA Research Associate **Steve Albers** was not eligible to be nominated since he is not a federal employee. However, Lab Chief John McGinley made clear that Steve's key contributions to RSA were part of the reason this nomination was possible.

Michael Barna, Kristi Gebhart, William Malm, and Bret Schichtel (CIRA Federal Affiliates) - National Park Service STAR award for performance substantially exceeding job requirements in August 2004.

G.R. McMeeking, Herbert Riehl Award for M.S. level student journal publication. U.S. National Park Service-Field Studies of Aerosol Properties Relevant to Air Quality and Visibility in National Parks (Reporting Period (1 July 2004- 30 June 2005).

Sher Schranz and Jebb Stewart - FSL Team Members of the Month

Kevin Brundage - recognized with the 2004 FSL "Best Web Tool" Award for his Product Inventory Generator (PIG) script program for the RUC web page.

Shripad Deo's Project: Applied Research in Support of Implementation of National Weather Service Advanced Hydrologic Prediction Services in Central Region was recognized with the Regional Excellence Award for Collaborative Efforts with Climate Services Division (August 2004).

David Randall (CIRA Principal Investigator) - CSU's Scholarship Impact Award for 2005.

July 1, 2005 – June 30, 2006

Steve Albers – CIRA Research Initiative Award for helping to create the Precision Airdrop System (PADS) in response to a request from the U.S. Army's Natick Soldier Systems Center and the U.S. Air Force Mobility Command.

Don Reinke – CIRA Research Initiative Award for his tremendous contributions to the CloudSat Data Processing Center, related projects and managerial accomplishments.

Jebb Stewart was designated as FSL's Team Member of the Month for July 2005. He received this recognition for outstanding efforts in furthering the FX-Net technology and projects.

Graeme Stephens (a long-time CIRA collaborator and CIRA Fellow) - named a University Distinguished Professor in April 2005 by CSU President Larry Edward Penley.

Tomislava Vukicevic - selected as a Fulbright Scholar to teach at the University of Beograd in Serbia and Montenegro. The Fullbright program is sponsored by the U.S. Department of State.

Jeff Smith and Glen Pankow - recognized for their innovative achievements in web technology and applications with the 2005 ESRL/GSD Web Awards: Jeff Smith - Aviation Branch, Advanced Computing Section, WRF Portal, Best New Site and Glen Pankow – Information and Technology Services, Data Systems Section, GRIB Data Viewer, Best Internal Use.

Sonia Kreidenweis (CIRA Fellow and Professor of Atmospheric Science) - received the Outstanding Professor Award for 2005 in the Department of Atmospheric Science, CSU.

Graeme Stephens (CIRA Fellow and Professor of Atmospheric Science at CSU) - named a Fellow by the American Association for the Advancement of Science (AAAS) for his numerous contributions to research in atmospheric radiation and the use of remote sensing in climate studies.

Mark DeMaria (NESDIS/RAMM Branch leader at CIRA and CSU Department of Atmospheric Science graduate) received the NOAA Silver Medal for collaborative effort to improve the operational intensity forecast tool known as the Statistical Hurricane Intensity Prediction Scheme (SHIPS).

Gerald Browning – In recognition of extremely high-quality research contributions to CIRA, the title of Research Scientist Emeritus was granted to him. This marks the first time CIRA has awarded this prestigious designation to one of its employees.

Sean Madine, Missy Petty, Nick Matheson and Dale Betterton (The Real Time Verification System – Next Generation Development Group - received the March 2006 GSD Team Members of the Month Award.

Dave Randall (Professor of Atmospheric Science and a CIRA collaborator) awarded the CSU Scholarship Impact Award for 2005.

July 1, 2006 – June 30, 2007

Mike Biere - GSD Team Member of the Month – June 2007 for superb efforts in furthering the SOS mission

Kevin Brundage – CIRA Research Initiative Award for his significant participation on the NOAA Research and Development High Performance Computing System Procurement as well as his continuing superior performance on collaborative research with NOAA/RDTL GSD's Assimilation and Modeling Branch.

Louie Grasso and Manajit Sengupta – CIRA Research Initiative Award for their outstanding work on the GOES-R Project.

Dr. Shripad Deo - Regional Excellence Award for research to help the NWS communicate with the public more clearly and effectively.

Nolan Doesken - The NOAA 2007 Environmental Hero Award Nolan Doesken (one of ten recipients) for organizing a network of citizen volunteers to measure and report precipitation from their homes following a flash flood that killed five people in Fort Collins, Colorado in 1997

Jim Frimel - Distinguished Administrative Professional Award for his key leadership of several high visibility research projects, including the FAA- and NWS-sponsored Volcanic Ash Coordination Tool project that recently received the 2006 NOAA Bronze Medal.

Don Reinke - Distinguished Administrative Professional Award for his exceptional performance as Leader of the CloudSat Data Processing activity since 2001.

Richard Johnson (CIRA PI) **-** finished a 3-year term on the NAME Science Working Group and was selected to serve on the CPPA Science Panel.

Evan Polster - GSD Team Member of the Month – December 2006

Sher Schranz and Jebb Stewart - Honored for the FX-Net Project at the annual NWS Incident Meteorologist (IMET) Workshop in Boise, Idaho

Jeff Smith – Recognized for the Best New Site at the NOAA/Global Systems Division (GSD) Christmas event

Mark Govett and Jeff Smith - 2007 AMS Poster Award – Use of WRF Portal to Support the Developmental Testbed Center

Tracy Smith – 2006 Department of Commerce Gold Medal Award. Although only Federal employees are eligible for this award, she was a key member of the team that successfully demonstrated new applications for GPS meteorology that are essential to NOAA's Integrated Earth Observing System/Global Earth Observing System of Systems.

Tracy Smith (coauthor) - 2005 OAR Outstanding Scientific Paper Award

Tom Vonder Haar - elected Chairman of the Interdisciplinary Section of the National Academy of Engineering

Kenneth Eis, Phil Partain, Dale Reinke, Donald Reinke, and Laura Sample (SDPC Team) - NASA Honor Award for exceptional contributions to the CloudSat mission in the design, development and implementation of the CloudSat Data Processing System.

July 1, 2007 – June 30, 2008

Nikki Privé - August 2007 ESRL/GSD Team Member of the Month

Leigh Cheatwood-Harris- November 2007 GSD Team Member of the Month

Sean Madine - December 2007 GSD Team Member of the Month

Don Hillger - April 2008 Group Achievement Award presented to the GOES-N Series Team by the National Aeronautics and Space Administration (NASA)

Chris MacDermaid - May 2008 GSD Team Member of the Month

Jebb Stewart - CIRA Research Initiative Award for the system design and technical leadership necessary in the development of enabling technology for the Gridded FX-Net system. .

Glen Liston – CIRA Research Initiative Award for his innovative blowing snow model. His modeling suite represents a tremendous advance forward in the field.

Tom Vonder Haar, Doug Fox (Senior Research Scientist emeritus) and **Graeme Stephens** (CIRA Director-Select) - Nobel Peace Prize Shared by CIRA Researchers who worked with the Intergovernmental Panel on Climate Change, which shared the Nobel Peace Prize announced Oct. 12, 2007.

Ken Knapp, Mark DeMaria, Antonio Irving, Nancy Merckle, **John A. Knaff** (**Andrea Schumacher** and **Bernadette Connell** were also contributors) - 2007 NOAA Bronze Award

Stan Kidder - CIRA Scientist Among Authors of Book Celebrating 50 Years of Earth Observations from Space (**Tom Vonder Haar** helped manage the book project as a member of the Board on Atmospheric Sciences and Climate)

Bob Lipschutz (Coordination of Team Activities), **Paul Hamer, Patrick Hildreth, Chris MacDermaid, Tom Henderson, Richard Ryan, Jacques Middlecoff, Ning Wang, Steve Albers, Mike Biere, Jebb Stewart, Tom Kent, Kevin Brundage and Brian Jamison –** GSD Certificate of Appreciation for their contributions to the integrated demonstration of GSD global modeling (Flow-following finite-volume Icosahedral Model – FIM), supercomputing, data management, and information systems efforts for Mary Glackin during her visit to ESRL on March 6.

Graeme Stephens and Phil Partain - NASA Honor Award**.** Graeme Stephens received an Exceptional Public Service Medal for his exceptional scientific leadership of the CloudSat Project and for his visionary promotion of combined active and passive measurements for atmospheric science. Phil Partain received an Exceptional Public Service Medal for his unique contributions to the CloudSat mission.

Graeme Stephens (CIRA Director-select**) –** International Radiation Commission Gold Medal

July 1, 2008 - June 30, 2009

Tracy Smith, **Stan Benjamin**, **Seth Gutman**, and **Susan Sahm** - 2008 OAR Outstanding Scientific Paper Award

Paul Hamer – 2008 CIRA Research Initiative Award for being instrumental in developing and supporting the Object Data System (ODS) software architecture that underlies the success of the Central Facility data system of the NOAA ESRL Global Systems Division (GSD).

Andrea Schumacher – 2008 CIRA Research Initiative Award for working as part of a NESDIS team on the development and transition of a new operational NESDIS product for estimating the probability of tropical cyclone formation.

Jeff Smith – 2008 CIRA Research Initiative Award for significantly impacting the Global Systems Division in respect to web applications, web services, and java programming.

Brian Jamison - 2008 GSD Web Award ("Webbie") Winner

William Malm (CIRA NPS Partner) - 2008 Thomas W. Zosel Outstanding Individual Achievement Award **-** In recognition for being the leading scientist behind the visibility protection provisions of the Clean Air Act.

William Malm (CIRA NPS Partner) - 2008 National Park Service Director's Award for Excellence in Natural Resource Research

William Malm (CIRA NPS Partner) - Air & Waste Management Association's Frank A. Chambers Excellence in Air Pollution Control Award

Jim Ramer - January 2009 GSD Team Member of the Month

Tom Hendersen - February 2009 GSD Team Member of the Month

Kevin Brundage - June 2009 GSD Team Member of the Month

Mark DeMaria (NOAA/NESDIS/RAMM Branch) - The Richard H. Hagemeyer Award

Michael Hiatt - 2009 CSU Distinguished Administrative Professional Award

Don Reinke - NASA Exceptional Public Service Medal for leadership and tireless efforts on behalf of the CIRA CloudSat Data Processing Center

Linn Barrett - 2009 CIRA Research and Service Initiative Award for outstanding performance, dedication to the people of CIRA in successfully managing the complex Human Resources function and contributions to the administrative team

Jacques Middlecoff – 2009 CIRA Research and Service Initiative Award for outstanding performance as an integral part of the development of GSD's state-of-the-art global weather and climate predication model

Sher Schranz – 2009 CIRA Research and Service Initiative Award for outstanding leadership of researchers and software developers in the design, development, testing, deployment and operational support for the FX-Net, Gridded FX-Net and Fire Weather Projects

Ning Wang – 2009 CIRA Research and Service Initiative Award for outstanding performance as an integral part of the development of GSD's state-of-the-art global weather and climate prediction model

Frank Kelly (Former CSU/ATS Student) - Named NWS Director - Alaska Region

Steve Koch (CIRA Fellow and Council Member) - Named Fellow of AMS

Robert Maddox (Former CIRA Ph.D. Student) – Recipient of The Cleveland Abbe Award

Tom Peterson (Award Winning ATS Alumnus and Former CIRA-supported Student) Has Several Accomplishments:

NOAA Administrator's Award "for outstanding leadership in and dedication to developing U.S. CCSP Synthesis & Assessment Products integrating climate research for decision support," with Harold E. Brooks, Roger Pulwarty, Ronald J. Stouffer, Thomas L. Delworth, Robert S. Webb, Douglas Marcy, Robb Wright, Neil Christerson, Adrienne Sutton, Thomas Knutson and Kent Laborde.

United States Department of Commerce Gold Medal Award for Scientific/Engineering Achievement "for improving the understanding of observed climate change and causes by showing that global average atmospheric warming is similar to surface warming" with Thomas R. Karl, Christopher D. Miller, Venkatachalam Ramaswamy, John R. Lanzante, Dian J. Seidel, Russell S. Vose and Richard William Reynolds.

United States Department of Commerce Bronze Medal Award for Superior Federal Service "for developing research-quality radiosonde atmospheric temperature datasets for reliably monitoring climate variations and change," with Imke Durre, Melissa Free, John Lanzante, Jay Lawrimore, and Dian Seidel, 2007.

United States Department of Commerce Bronze Medal Award for Superior Federal Service "for innovative research which led to the production of a unique blended (satellite and ground based) global surface temperature data set," with Alan Basist, Norm Grody and Claude Williams, 2001.

United States Department of Commerce Bronze Medal Award for Superior Federal Service in 1996 "for developing revolutionary new climatological baseline data sets and statistical techniques that reveal accurate long-term climatic trends," with David Easterling.

Jim Purdom (CIRA Retiree) - Awarded Cosmonautics Federation of Russia Yuri Gagarin Medal

July 1, 2009 - June 30, 2010

Dan Lindsey – NRL Alan Berman Research Publication Award as co-author on the paper "Stratospheric Impact of the Chisholm Pyrocumulonimbus Eruption: Part 1. Earth-viewing Satellite Perspective," by M. Fromm (NRL), et al

Randy Collander and Tom Kent – August 2009 GSD Team Member of the Month - as part of a team for their work on MADIS: The Meteorological Assimilation Data Ingest System.

Glen Liston - U.S.-Norway Research Collaborations Strengthened - Dr. Glen Liston and scientists at CIRA/Colorado State University have been developing regional climate modeling tools to simulate the evolution and changes occurring within Arctic systems. These tools include atmospheric models, hydrologic models, ecosystem models, and data assimilation models.

Darren Van Cleave (CIRA Student), Honored at the AMS Numerical Weather Prediction Conference - Tied for first place in Category 4 with his poster "Relating Snowfall Patterns Over the Central and Eastern US to Infrared Imagery of Extratropical Cyclone Comma Heads."

Mark DeMaria, John Knaff, Alison Krautkramer, Chris Lauer, Chris Sisko, Richard Knabb, Chris Juckins, Timothy Schott **,** Michelle Mainelli **,** Edward Rappaport - NOAA Bronze Medal Award. Two of CIRA's on-site NOAA collaborators (and CSU alums) were recently honored with the 2009 NOAA Bronze Medal. Also, three staff members from our Boulder CIRA team were celebrated as collaborators on Bronze-Medal winning teams - **Isidora Jankov, Kevin Brundage** and **Bob Lipschutz.**

Stan Kidder and Tom Vonder Haar - Reflections on 50 years of Earth Observation - Featured in *Science* Magazine

Scott O'Donnell and Ken Sperow (CIRA) as well as Steve Olson, Curt Neidhart (OST/PPD), Chris Adams, and Mamoudou Ba. - AutoNowcaster Team Wins Recognition of Excellence -- January 2010

Ning Wang - NOAA/GSD Team Member of the Month – October 2009

Gavin Roy - NSF Fellowship. Prof. Tom Vonder Haar, CIRA's Director Emeritus, is pleased to announce that one of his upcoming graduate advisees in the Department of Atmospheric Science has won an NSF Fellowship award.

SEMINARS

July 1, 2001 – June 30, 2002

- July 1, 2001 – June 30, 2002, B. Motta, D. Bikos, J. Weaver, B. Zajac, R. Zehr, D. Lindsey (CIRA). Over 150 VISIT teletraining sessions delivered to NWS Offices.
- July 2, 2001, D. McKague. Development and Application of a Probability Distribution Retrieval Scheme to the Remote Sensing of Clouds and Precipitation.
- July 3, 2001, B. Motta, D. Hillger. COMET Executive Board Teleconference Briefing on RAMM Team's Involvement in Training Activities at COMET and With the VISIT Project.
- July 11, 27 & August 3, 2001, J. Weaver. Presentations on Spotter Training and Safety Aspects of Severe Weather.
- July 11-13, 2001, J. Weaver. Unusual Consequences of Natural Disasters and the Fort Collins Flood of July 28, 1997.
- July 12, 2001, B. Motta. Teleconference Presentation of Internet- Delivered Audio in Combination with Interactive RAMSDIS Online and VISIT View.
- July 13, 2001. L. Grasso, Observations of a Severe Left Moving Thunderstorm.
- July 16-20, 2001, J. Weaver, J. Knaff. Multiple Presentations Discussing Hurricane and Severe Weather at the Colorado State University Kids in College Program.
- July 17, 2001, J. Adegoke (CIRA/South Dakota). Modeling the Impact of Irrigation on Midsummer Surface Energy Budget and the CBL in the U.S. High Plains.
- July 17, 2001, M. DeMaria. Status of the NESDIS Contribution to the Hurricane Mitch Reconstruction Project
- July 21-25, 2001, H. Gosden. Training on RAMSDIS Workstations in Nicaragua, Guatemala, and Costa Rica
- July 25, 2001, M. DeMaria. Current Status and Future Capabilities for Hurricane Rainfall Forecasting.
- July 25-27, 2001, J. Weaver, D. Hillger, D. Bikos, B. Motta, J. Dostalek. Presentations on Radiative Transfer Modeling and on Severe Thunderstorm Efforts at CIRA
- July 29 – August 2, 2001, B. Motta. Use of Satellite Imagery in Forecasting and Modeling
- July 29 – August 2, 2001, J. Dostalek. Left-moving Thunderstorms in a High Plains, Weakly-sheared Environment.
- August 1, 2001, M. DeMaria. Briefing on the NESDIS Contribution to the Hurricane Mitch Reconstruction Project.
- August 1, 2001, R. Edson (Anteon Corp./Univ. of Guam). Recent Findings in the Operational Use of Microwave Data as Related to Tropical Cyclone Forecasting.
- August 13, 2001, M. DeMaria. Tropical Cyclone Applications of GOES and POES Data.
- August 15, 2001, M. DeMaria, L. Grasso. An Overview of the Progress on the Model Development.
- August 17, 2001, H. Borton (Caribbean Inst. Of Meteor. And Hydro). Overview of the Activities and Responsibilities of CIMH.
- September 13, 2001, R. Dargaville (NCAR). Inter-annual Variability in Atmospheric Transport: Implications from Carbon Cycle Studies.
- September 19, 2001, J. Weaver. The Problem of Trying to Pull Order from Chaos During and After a Natural Disaster.
- September 25, 2001, E. Kalnay (Univ. of Maryland). Low Dimensionality in Atmospheric Dynamics: Application to Data Assimilation.
- October 3, 2001, L. Grasso. Using a Radiative Transfer Model to Simulate GOES-8 CH4 of a Simulated Thunderstorm.
- October 3, 2001, J. Weaver. Using Satellite Data in the Warning Decision Making Process.
- October 4, 2001, B. Zajac. Lightning Meteorology 1: Electrification and Lightning Activity by Storm Scale.
- October 4, 2001, B. Mapes (NOAA/CIRES). Lessons Learnt from Nested-Grid Simulations Over the Tropical Americas
- October 12, 2001, B. Connell. Satellite Meteorology.
- October 12, 2001, J. Weaver, B. Zajac. Thunderstorm Electrification.

- October 15-18, 2001, M. DeMaria. Validation of an Advanced Microwave Sounder Unit (AMSU) Tropical Cyclone Intensity and Size Estimation Algorithm
- October 15-18, 2001, D. Hillger. Principal Component Image of MODIS for Volcanic Ash and Simulation of GOES-M 5-Band Imager Using MODIS Data
- October 15-18, 2001, B. Motta. Recent Training and Results from the Virtual Institute for Satellite Integration Training (VISIT)
- October 15-18, 2001, R. Zehr. Tropical Cyclone Surface Wind Analysis Using Satellite Sensors.
- October 15-18, 2001, B. Connell. The Use of Mesoscale Climatologies for Monitoring and Forecasting Weather in Costa Rica.
- October 15-18, 2001, C. Combs. Wind Regime Cloud Cover Composites of Convective Development Over the Wakefield, VA Region
- October 15-18, 2001, D. Bikos. Observations of a Severe Supercell Thunderstorm on July 24, 2000 Using GOES-11 Sounder and Imagery
- October 16-24, 2001, H. Gosden. RAMSDIS Training in Panama and Belize
- October 17-19, 2001, V. Castro. RAMSDIS Training in Panama.
- October 18, 2001, C. Deser (NOAA/CIRES). On the Persistence of Sea Surface Temperature Anomalies in Midlatitudes.
- October 25, 2001, W. Lyons (FMA Research, Inc.). (Still More) Creatures in the Mesospheric Zoo.
- November 1, 2001, J. Curtis (Wyoming State Climatologist). Climate Change and Metadata Resources Available in Wyoming.
- November 6, 2001, M. DeMaria, W. Gray. USWRP Congressional Briefings on Hurricanes at Landfall.
- November 6-8, 2001, B. Motta. Model Initialization Issues and Related Topics.
- November 8, 2001, J. Fleming (Colby College). Carbon Dioxide and Climate: Ideas and Apprehensions on Decadal to Centennial Time Scales.
- November 15, 2001, J. Hawkins (Naval Research Lab, CA). Tropical Cyclone Structure Vis Multiple Passive Microwave Satellite Sensors.
- November 15, 2001, P. Miller (NOAA FSL). MADIS – Meteorological Assimilation Data Ingest System.
- November 15, 2001, D. Thompson. What is the Arctic Oscillation and Why Do We Care?
- November 16, 2001, M. DeMaria. The Current Status and Future Plans of the NOAA GOES and POES Satellites.
- November 19, 2001, J. Kossin. Daily Hurricane Variability Inferred from GOES Infrared Imagery.
- November 26-27, 2001, M. DeMaria. Development and Use of Statistical Models Based on Best Track Data.
- November 28, 2001, J. Kossin. Daily Hurricane Variability Inferred from GOES Infrared Imagery.
- December 4-7, 2001, B. Connell, R. Alfaro. Satellite Meteorology Workshop.
- December 5, 2001, J. Jimenez (CA Inst. Of Tech.). Bringing New Eyes Into the Problem: Developing and Applying Advanced Instrumentation for Atmospheric Chemistry Research.
- December 6, 2001, R. Carbone (NCAR). Inferences of Predictability Associated with Warm Season Precipitation.
- December 12, 2001, J. Weaver. Using Satellite Data in the Warning Decision Making Process.
- December 12, 2001, C. Walcek (SUNY Albany). Improved Numerical Advection in Atmospheric Models.
- December 13, 2001, B. Zajac. Utilizing Lightning Data.
- December 14, 2001, C. Anderson (CSU, Computer Science). An Introduction to Artificial Neural Networks.
- January 13-18, 2002, B. Motta. VISIT Integrated Sensor Training: Using AWIPS Satellite Products and Capabilities.
- January 13-18, 2002, B. Zajac. Lightning Meteorology 1: An Introductory Course on Forecasting with Lightning Data and an Overview of Lightning Training from NWS/VISIT.
- January 24, 2002, Y. Xie (NOAA/FSL/CIRA). Impact of Formulation of Cost Function and Constraints on Three-Dimensional Variational Data Assimilation.
- January 31, 2002, A. Kasahara (NCAR). The Role of the Horizontal Component of the Coriolis Vector in Nonhydrostatic Atmospheric Models.
- February 5, 2002, B. Lipscomb (Los Alamos NL). Incremental Remapping: A New Transport Scheme for Climate Models

- February 7, 2002, K. Wolter (CDC/NOAA). Regionalization of Precipitation Patterns Over Colorado and the Interior Southwest.
- February 14, 2002, T. Shepherd (Univ. of Toronto). What Have We Learned From the Canadian Middle Atmosphere Modeling Project?
- February 18, 2002, S. Solomon (NOAA). The Coldest March: Insights Into Scott's Fatal Antarctic Expedition.
- February 19, 2002, D. Barker (MMM Division/NCAR). The Development of a 3DVAR Assimilation Capability for the WRF Model.
- February 26, 2002, Y. Want (Univ. of Hawaii). Vortex Rossby Waves and Tropical Cyclone Structure and Intensity Changes in a Full Physics Model
- February 28, 2002, J. Gille (NCAR). The MOPITT Experiment: Determining the Global Patterns of CO in the Troposphere.
- March 7, 2002, D. Collins (Texas A&M). Recent Advances and Remaining Challenges in Aerosol Radiative Closure.
- March 11-15, 2002, J. Knaff. An Update on Joint Hurricane Testbed (JHT) Projects at CIRA and CIMMS and New Operational Tools to Produce Five-Day Tropical Cyclone Intensity Forecasts.
- March 13-14, 2002, J. Weaver. GOES RSO Imagery in the Warning Decision Making Process.
- March 19, 2002, M. DeMaria. Satellite Data Assimilation Experience and Interests at CIRA.
- March 21-26, 2002, D. Watson. Training for RAMSDIS/McIDAS-NT and VISIT in Germany.
- March 21, 2002, K. Gurney. Towards Robust Regional Estimates of CO_2 Sources and Sinks Using Atmospheric Transfer Models.
- March 26, 2002, M. Shapiro (NOAA/OAR). The Hemisphere Observing System Research and Predictability Experiment (THORpex).
- March 28, 2002, Z. Toth (NOAA/NCEP/EMC). Ensemble Forecasting and Targeted Observations at NCEP.
- April 4, 2002, D. Edwards (NCAR). The Terra/MOPITT Mission: Technique, Validation and Early Results.
- April 5, 2002, J. Corwin (Pacific Northwest National Lab). Quantitative Single Particle Studies Applied to Field Aerosol Chemistry and Apportionment.
- April 11, 2002, H. Warner (NCCR Switzerland). North Atlantic-European Climate 1500-2000 AD: Reconstruction and Diagnosis of State Variables, Modes, and Extremes.
- April 12, 2002, M. DeMaria. Summary of RAMM Team Activities.
- April 18, 2002, J. Marwitz (Univ. of Wyoming). Melting Effects in Winter Storms.
- April 19, 2002, D. Hillger. Noise Reduction by Principal Components Truncation and Image Re-transformation: An Important Aspect of PC Compression.
- April 29, 2002, D. Molenar, D. Hillger. Presentations on Satellite Image Products and Display Systems.
- April 29 – May 3, 2002, M. DeMaria. The Use of GOES Imagery in Statistical Hurricane Intensity Prediction.
- April 29 – May 3, 2002, J. Demuth. An Evaluation of CIMSS and CIRA AMSU Tropical Cyclone Intensity Estimation Algorithms.
- April 29 – May 3, 200s, J. Knaff. What Are Annual Hurricanes? And Examining the Eight-Day Evolution of Upper Level Winds in Hurricane Floyd.
- April 29 – May 3, 2002, R. Zehr. Vertical Wind Shear Characteristics With Atlantic Hurricanes During 2001.
- May 2, 2002, J. Weaver. Using Satellite Data in the Warning Decision Making Process.
- May 8, 2002, M. DeMaria. Summary of the NESDIS Contribution to the Hurricane Mitch Reconstruction Project.
- May 14, 2002, D. Zupanski. Model Error Optimization Using Advanced Data Assimilation Systems.
- May 20 – 24, 2002, J. Knaff. Newly Developed Tropical Cyclone Intensity Forecast Algorithms and CIRA's AMSU-derived Tropical Cyclone Intensity and Wind Radii Estimation Algorithms.
- May 28, 2002, M. DeMaria. Summary of Significant Weather from the GOES-West-Asia-Pacific Satellite Applications Training Course (APSAT).
- May 31, 2002, M. DeMaria. Weather and Tropical Cyclones.
- June 3, 2002, M. DeMaria. Coastal and Inland Effects of Tropical Cyclones.

- June 6, 2002, I Solheim. An Introduction to IDL.
- June 24 – 28, 2002, J. Weaver, M. DeMaria, J. Dostalek. Hurricanes and Their Impacts – Emergency Response to Various Weather-related Disasters at Colorado State University's Kids College Program.
- June 27, 2002, W.K. Tao. Mesoscale Convective Systems During SCSMEX: Simulations With a Regional Climate Model and a Cloud-resolving Model.

July 1, 2002 – June 30, 2003

- July 1, 2002 – June 30, 2003, D. Bikos, D. Lindsey, J. Weaver, R. Zehr. 3446 Students participated in 183 VISIT teletraining sessions delivered to NWS Offices, et al.
- July 9, 2002, M. DeMaria. Forty Years of Progress in Atlantic Hurricane Forecasting: 1962-2002.
- July 16, 2002, S. Gravel (RPN Canada). The Relative Contribution of Forcing Components and Data Sources to the Large-scale Forecast Accuracy of an Operational Model.
- July 24, 2002, N. Nichols (Met Office UK). Assimilation of Data Into an Ocean Model with Systematic Errors Near the Equator.
- August 8, 12 – 16, 2002, D. Lindsey. Lightning Meteorology II: An Advanced Course on Forecasting With Lightning Data.
- August 14 – 16, 2002, M. DeMaria, J. Knaff, D. Hillger. RAMM Team Research Plans, Pingree Retreat.
- August 23, 2002, T. Dunkerton (Northwest Research Associates). Monsoon and Hurricane Regimes in Angular Momentum-conserving Circulations.
- September 5, 2002, R. Pielke. Climate as n Integrated Earth System Research Issue – Challenges and Opportunities.
- September 12, 2002, B. Mapes (NOAA/CIRES). Strides, Steps and Stumbles in the Annual March.
- September 19, 2002, S. Matrosov (NOAA/ETL). Quantitative Measurements of Rain With X-band Radars.
- September 26, 2002, B. Randel (NCAR). Variability of the Tropical Tropopause Region.
- September 27, 2002, M. McIntyre (Cambridge University UK). Local Mass Conservation and Velocity Splitting in PV-conserving Balanced Models.
- October 3, 2002, D. Stevens (Lawrence Livermore). An Analysis of Some Very Computationally Intensive Simulations: Effects of Domain Size and Numerical Resolution on the Simulation of Shallow Cumulus Clouds.
- October 7, 2002, E. Zipser (Univ. of Utah). Global Distribution of Intense Convection.
- October 10, 2002, M. Zupanski. Challenge of Mesoscale Data Assimilation: Four-dimensional Variational Data Assimilation and Beyond.
- October 15, 2002, P. Rayner (CSIRO Atmospheric Research). Inferring Carbon Sources Using Passive NIR Satellite Measurements.
- October 17, 2002, J. Hurrell (NCAR). On the Limitations of Prescribing Sea Surface Temperatures in Atmospheric General Circulation Model Experiments.
- October 17, 2002, J. Knaff. Current and Future Tropical Cyclone Projects at CIRA/NESDIS: An Update and Outlook.
- October 23, 2002, M. DeMaria, J. Knaff, D. Bikos, D. Lindsey, J. Demuth, J. Weaver. Overview of RAMM Team Research and Training to the U.S. Air Force Academy Senior Cadets.
- October 24, 2002, N. Doesken. The Drought of 2002 in Colorado.
- October 28, 2002, H. Barker (Meteorological Service of Canada). Purification of Radiative Transfer Calculations in GCMs.
- October 31, 2002, P. Arkin (University of Maryland). Analyses of Large-scale Precipitation: Methods and Applications.
- November 5, 2002, C. Combs, M. DeMaria. Overview of RAMM Team Research and Cloud Climatologies Produced at CIRA.
- November 7, 2002, S. Mikaloff (NOAA). Constraining Methane Flux Estimates Using Atmospheric Observations of Methane and 13C/12C in Methane.
- November 13, 2002, M. DeMaria. Tropical Cyclones.
- November 14, 2002, B. Connell. Use of Operational Satellite Data in Central America to Support Disaster Management.

- November 21, 2002, RAMM Team Staff. Project Overviews Presented to Fran Holt, Director NESDIS/ORA/CoRP.
- November 22, 2002, L. Cucurull (NCAR). The Use of the Global Positioning System in Numerical Weather Prediction Models.
- November 29 – December 13, 2002, J. Knaff. AMSU-based Tropical Cyclone Intensity and Structure Estimates from CIRA/NESDIS.
- January 10, 2003, J. Weaver. VISIT Satellite Training for NWS Forecasters, Part I – Distant Learning Operations Course.
- January 14, 2003, H. Dijkstra (Utrecht University). Stability of the Global Ocean Circulation.
- January 31, 2003, J. Weaver. VISIT Satellite Training for NWS Forecasters, Part II – Distant Learning Operations Course.
- February 6, 2003, R. Meroney (Civil Eng.). Fire Whirls, Fire Tornadoes and Fire Storms: History, Physics, Fluid Modeling and CFD.
- February 7, 2003, J. Weaver. VISIT Satellite Training for NWS Forecasters, Part III – Distant Learning Operations Course.
- February 9-13, 2003, M. DeMaria. 50 Years of Progress in Operational Forecasting of Atlantic Tropical Cyclones.
- February 9-13, 2003, M. DeMaria, J. Knaff. Improvements in Real-time Statistical Tropical Cyclone Intensity Forecasts Using Satellite Data.
- February 9-13, 2003, D. Hillger. A Simple GOES Skim Temperature Product.
- February 9-13, 2003, C. Combs, M. DeMaria. Examining High Wind Events Using Satellite Cloud Cover Composites Over the Cheyenne, WY Region.
- February 9-13, 2003, J. Knaff, R. Zehr, M. DeMaria. A Demonstration of Real-time Transmission and Display of GOES Imagery Aboard the NOAA P-3 Aircraft During the 2002 Hurricane Season.
- February 9-13, 2003, D. Lindsey, J. Weaver, M. DeMaria. VISITview – Connecting Instructions With Operational Forecasters.
- February 18, 2003, Y. Rudich (Weizmann Institute of Science). The Multifaceted Role of Dust in Affecting Cloud Properties and Rain Formation.
- February 20, 2003, M. Nicholls. Why Should You Care About Compression Waves?
- February 26, 2003, T. Hamil (NOAA/CIRES). Generating Initial Conditions for Ensemble Forecasts with Analysis-error Covariance Singular Vectors.
- February 26, 2003, D. Hillger. Volunteer Role as Webmaster for the USMA Website Hosted by CSU.
- February 27, 2003, February 27, 2003, G. Browning (NOAA/FSL/CIRA). The Bounded Derivative Theory: Recent Discoveries and Developments in the Geosciences.
- February 28, 2003, J. Weaver. VISIT Satellite Training for NWS Forecasters, Part IV – Distance Learning Operations Course.
- March 4, 2003, J. Weaver. Missionary Ridge Fire-spawned Tornadoes.
- March 6, 2003, S. Denning. Carbon-climate Interaction as a First-order Source of Uncertainty in Future Climate.
- March 10-15, 2003, M. DeMaria. A Monte Carlo Method for Estimating Surface Wind Speed Probabilities.
- March 10-15, 2003, R. Zehr, M. DeMaria, J. Knaff, K. Bessho. Tropical Cyclone Surface Wind Analysis Using Satellite Data – Dvorak, Microwave, Scatterometer and Cloud Motion Winds.
- March 10-15, 2003, M. DeMaria, J. Demuth, J. Knaff. Recently Developed Operational and Experimental Tropical Cyclone Intensity and Structure Guidance for the Western North Pacific.
- March 18, 2003, N. Wang, R. Brummer (CIRA/NOAA). Wavelet Transform-based Data Compression and Its Application to Multi-dimensional Gridded Data Sets.
- March 20, 2003, D. Vimont (University of WA). Is the El Nino/South Oscillation Initiated by the Mid-latitude Atmosphere?
- March 27, 2003, B. Collins (NCAR). Atmospheric Response to Natural and Anthropogenic Aerosols.
- April 3, 2003, M. Zupanski. What is Probabilistic Data Assimilation, and Why Do We Care?
- April 8, 2003, N. Wang, R. Brummer (CIRA/NOAA). Wavelet Transform-based Data Compression and Its Application to Multi-dimensional Gridded Data Sets.
- April 8, 2003, M. DeMaria. Use of Satellite Observations in Tropical Cyclone Forecasting.
- April 9, 2003, J. Weaver, D. Bikos. Mesoanalysis Using GOES SO Imagery – VISIT Session

- April 10, 2003, M. Alexander (NOAA). The Atmospheric Response to Arctic Sea and Ice Anomalies.
- April 17, 2003, S. Rafkin (SRI Boulder). Mesoscale Modeling of Mars' Atmosphere.
- April 17, 2003, B. Connell. GOES and the Characteristics of Its Channels.
- April 21, 2003, K. Troy (Australian Bureau of Meteorology Melbourne). The Influence of Sheer on Tropical Cyclone Genesis in the Australian Bureau of Meteorology's Limited Area Prediction System (LAPS).
- April 22, 2003, M. DeMaria. Estimating Tropical Cyclone Wind Probabilities.
- April 24, 2003, T. Lang. Understanding the Spatial and Temporal Variability of Precipitation in the Central Himalayas.
- April 29, 2003, P. Sellers (NASA). STS-112, Building the International Space Station: A Global Perspective.
- May 8, 2003, C. Deser (NCAR). Decadal Climate Variability Over the Pacific: What the Instrumental Records Tell Us.
- May 19-21, 2003, M. DeMaria. Tropical Cyclone Applications of Hyperspectral Data.
- May 30, 2003, J. Kossin (University of Wisconsin-Mad). Recent Advances in Tropical Cyclone Intensity Estimation Using GOES-IR Imagery.
- June 17, 2003, G. Gayno (USAF AFWA). An Overview of AFWA and the USAF AGRMET Land Surface Modeling System.
- June 27, 2003, P. Rayner (CSIRO). Carbon Cycle Data Assimilation.

July 1, 2003 – June 30, 2004

- July 8, 2003. P. Haertel (CIRES/NOAA). On the Dynamics of 2-Day Equatorial Disturbances
- July 10, 2003, P. Artaxo (Univ. of San Paulo). Aerosols and Cloud Interactions in Amazonia: Results From the LBA/SMOCC Experiment
- August 1, 2003, C. Golaz (NRL).Improvements and Simplifications to a PDF-Based Boundary layer Closure
- September 4, 2003, J. Hurrell (NCAR). Tropical Forcing of North Atlantic Climate Change
- September 11, 2003, G. Grell (NOAA/FSL). A Next Generation Air Quality Prediction Model Based on WRF
- September 17, 2003, K.V. Ooyama (NOAA/AOML). Historical Aspects of Tropical Cyclone Research
- September 18, 2003, G. Bryan (NCAR). Cloud Resolving Modeling and Interpretation of Midlatitude Squall Line Systems
- September 23, 2003, M. Sengupta. The Importance of Accurate Liquid Water Path for Surface Radiation
- September 25, 2003, B. Geerts (Univ. of WY). Classification and Characterization of Tropical Precipitation Based on High-Resolution Airborne Vertical-Incidence Radar
- October 2, 2003, W.W. Tung (NCAR MMM). Interaction Between Tropical Convection and Large Scale Equatorial Waves
- October 8, 2003, J.M. Chen (Univ. of Toronto). Deriving Large-Area Carbon Fluxes from Air CO2 Concentration Measurements at a Boreal Site
- October 9, 2003, B. Huebert (Univ. of Hawaii). ACE-Asia and AMMA: What Do and Don't We Know About the Impacts of Dust and Black Carbon
- October 14, 2003, L. Grasso. GOES-R Risk Reduction Activities at CIRA
- October 16, 2003, M. DeMaria. Improvements in Deterministic and Probabilistic Hurricane Intensity Forecasts
- October 22, 2003, J. Lin (Harvard Univ.). Constraining Sources and Sinks of Carbon at the Regional Scale with Aircraft Observations
- October 23, 2003, S. Rizvi (NCAR MMM). Recent Developments in Data Assimilation at NCAR
- October 28, 2003, C. Lu (NOAA/FSL/CIRA). NOAA/FSL's RUC Short-Range Ensemble Forecast System
- October 30, 2003, T. Vukicevic. 3D Clouds from Satellite Observations
- October 31, 2003,. T. Nguyen, T. Tien (Hanoi, Vietnam). A Numerical Study in Heavy Rainfall Causing Severe Flash Flood: Does Finer-grid-induced Airlfow Affect Rainfall?
- November 2, 2003, C. Jakob (BMRC). Cloud Regimes in the Tropical Western Pacific and Their Radiative Characteristics

- November 6, 2003, A.Kellie (NCAR). Computing for the Atmospheric Science NCAR
- November 11, 2003, B. Ruston. Characteristics of Summertime Microwave Land Emissivity.
- November 13, 2003, S. Nesbitt (CSU/ATS.) Radar, Rainfall and Lighting Characteristics of Tropical Rainfall Systems According to TRMM
- December 2, 2003, M. Barna. Simulating the Formation and Transport of Surface Aerosol for the BRAVO Study
- December 4, 2003,J. Klemp (NCAR). Development and Evaluation of the WRF Model for Convection Resolving NWP
- January 20, 2004,H. Gerber (Gerber Scientific). Holes and Entrainment in Stratocumulus
- January 22, 2004, D. Ren (Univ. of Oklahoma, Sarkeys Energy Center). Hydrauliclift and Its Implication on Soil Moisture Simulation
- January 22, 2004, C. Stroud (NCAR ASP). Predicting the Physico-Chemical Properties of Secondary Organic Aerosol Derived from the Photo-Oxidation of Toluene/NOx Mixtures
- January 27, 2004, D. Hillger. Metric Transition in the United States: Where We Are, and Where We Are Headed
- January 29, 2004, D. Zupanski. Model Error Estimation in the Framework of Ensemble Data Assimilation
- February 5, 2004, K. Davis (PSU). Multi-scale Observations of the Terrestrial Carbon Cycle: Progress, Puzzles and Motivation
- February 12, 2004, S. Solomon (NOAA). Climate Change: A Review For Everyone
- February 17, 2004, T. Kampe (Ball Aerospace). Earth Remote Sensing at Ball Aerospace
- February 19, 2004, S. Koch (NOAA FSL. Structure and Dynamics of Atmospheric Solutions During IHOP
- February 26, 2004, W. Robinson (Univ. of Illinois). Negative Viscosity Redux: Jets, Annular Variability, and Eddy Generation
- March 1, 2004, A. Jacobson (Los Alamos National Lab.) Real-Time Monitoring of Severe Convection Using Radio-Frequency Sensors on Satellites
- March 4, 2004, N. Gruber (UCLA). The Oceanic Sink for Anthropogenic CO2
- March 8, 2004, A. Tompkins (ECMWF). Organization of Tropical Deep Convection: The Ubiquitous Role of Coldpools
- March 10, 2004, C.C. Wu (National Taiwan Univ.). Some Research Highlights on the Tropical Cyclone Dynamics and the Typhoon-Ocean-Biogeochemistry Interaction
- March 11, 2004, R. Fovell (UCLA). Discrete Propagation of Midlatitude Squall Lines
- March 25, 2004, H. Owada (Japan Meteorological Agency). Assimilation of Geostationary Satellite Data for Cloud Analysis at JMA
- March 25, 2004, M. Baldwin (NRA, Bellevue, WA). How Are Weather and Climate Affected by Stratospheric Variability?
- April 1, 2004, K. Moore (NCAR). Chemical Composition of Ultrafine Atmospheric Aerosol
- April 2, 2004, C. Landsea (NOAA/AOML/HRD). The Atlantic Hurricane Database Re-analysis Project - Results for 1851 to 1910 and 1992's Hurricane Andrew
- April 8, 2004, H. Dijkstra. Physics of Multidecadal Variability in the North Atlantic
- April 14, 2004, N.T.K. Oanh (Asian Inst. Of Tech.). Preliminary Findings of the Asian Air Pollution Research Network: PM Levels, Composition and Source Apportionment in the Bangkok Metropolitan Region
- April 15, 2004, B. Stevens (UCLA.). Scaling Laws for Shallow Moist Convection
- April 20, 2004, K. Zeller, N. Nikolov (USDA Forest Service). Mesoscale Modeling and Forecasting Support at the Rocky Mountain Center
- April 27, 2004, L. Bonaventura (Max Planck Inst. for Meteorology). The ICON Project: Modeling Strategies and Preliminary Results
- May 5, 2004, W. Berg (CSU/ATS). The Status of Satellite-Based Climate Rainfall Observations
- May 6, 2004, J. Seinfeld (California Institute of Technology). Secondary Organic Aerosol
- May 14, 2004, J. Beven (NCEP). The TPC/NHC Hurricane Tracking and Forecast Process
- May 17, 2004, W. Skirving (CIRA, NOAA/NESDIS). Coral Bleaching From Space: The Use of NOAA Environmental Satellite Data to Monitor Bleaching Conditions
- May 21, 2004, L. Ji (CIRA/USGS, South Dakota). Comparison of MODIS and AVHRR 16-Day Normalized Difference Vegetation Index Composite Data

- June 3, 2004, Y.P. Wang (CSIRO Atmospheric Research, Australia). Seasonal Variation of Maximal Photosynthetic Rates of Different Forest Canopies as Inferred from FLUXNET Dataset Using Nonlinear Inversion.
- June 21, 2004, R. Wood (Hadley Centre for Climate Prediction and Research, UK). Modeling Past and Future Climate Changes in the Ocean.
- June 22, 2004. G.G. Campbell (CIRA). ISCCP Clouds View Angle Dependence and the Long-term Trend.

July 1, 2004 – June 30, 2005

- July 27, 2004, E. Raschke (Univ. of Hamburg). Radiation Budget of the Atmosphere from ISCCP Products.
- August 5, 2004, E. Raschke (Univ. of Hamburg). Climate and Society.
- August 19, 2004, B. Johnson (ERDC). Watershed Water Quality and Contaminant Development Activities Ongoing at the Environmental Laboratory ERDC.
- September 2, 2004, H.V. Storch (GKSS, Germany). The Utility of Long-Term Reconstruction with Regional Climate Models.
- September 16, 2004, H. Rolston III (CSU). Using Water Naturally.
- September 28, 2004, M. Rodriguez (Univ. of CA, Irvine). Air Pollution Simulation Modeling: Global and Urban Scale Issues.
- September 30, 2004, B. Cotton. Aerosols, Clouds, and Precipitation.
- October 4, 2004, J. Staehelin (ETH, Zurich). The Puzzle of Long-Term Tropospheric Ozone Trends – a Phenomenological Analysis.
- October 8, 2004, G. Campbell. The Space Elevator.
- October 13, 2004, A. Majda (NY Univ.). A New Multi-Scale Model for the Madden-Julian Oscillation.
- October 14, 2004, D. Chelton (Oregon State Univ.). The Influence of Sea Surface Temperature on Surface Wind Fields in the ECMWF and NCEP Models.
- October 20, 2004, C. Johnson (NCAR). Information Content of Observations in 4D-Var.
- October 21, 2004, J. Weiss (Univ. of CO). Vortex Dynamics in Geophysical Turbulence.
- October 27, 2004, H. Miura (Japan). Development of a Global Cloud Resolving Model on a Spherical Hexagonal-Pentagonal Geodesic Grid.
- October 28, 2004, B. Mapes (NOAA). Mesoscale Wind Divergence Profiles in Tropical Convection.
- November 2, 2004, G. Stephens. On the Retrieval of Cloud and Precipitation Properties from Space.
- November 4, 2004, J. Kuettner (NCAR). How the Lee Wave Was Discovered (and other Scientific Gliding Adventures).
- November 10, 2004, L. Uccellini (NCEP). NCEP Update.
- November 18, 2004, T. Zhang (NSIDC/CIRES). Inferring Climatic Change Signals from Geothermal Gradients: Promises and Problems.
- November 30, 2004, J. Purdom. Applications and Implications of the Next Generation Meteorological Satellite Imagers and Sounders.
- December 2, 2004, A.R. Albayrak (CSU). Sigma Point Filters.
- December 7, 2004, T. Strawa (NASA). Aerosols in the Looking Glass.
- December 9, 2004, T. Vukicevic. From Information to Knowledge: Data Assimilation in Atmospheric Sciences.
- December 14, 2004, C. Davis (NCAR). How Does Vertical Wind Shear Affect Hurricane Formation?
- December 15, 2004, R. Leffler. Going … Going … Gone? Earth's Melting Tropical Glaciers.
- January 20, 2005, B. Schichtel. Cause of Haze at Big Bend National Park, Texas – Results from the BRAVO Study.
- January 27, 2005, B. Conzemius (CSU). The Dynamics of Sheared Convective Boundary layer Entrainment as Reproduced by Large Eddy Simulations.
- February 10, 2005, J. Alexander (CRA, Boulder). The Gravity Wave Response to Observed Fine-Scale Latent Heating Structure.
- February 15, 2005, Z. J. Luo. Characterization of the Upper-Tropospheric Temperature, Moisture, and Cloud Biases of a Global Climate Model Using Satellite Observations.

- February 17, 2005, D. Neelin (UCLA). Pathways of Tropical Rainfall Impacts by Teleconnections, Greenhouse Gases and Aerosols.
- February 22, 2005, R. Morss (NCAR). Meteorological Observations for Science and Society: An Interdisciplinary Approach to Observing Network Design.
- February 24, 2005, D. Whitley (CSU). The Temperature Inverse Problem, Optimization, and No Free Lunch.
- March 3, 2005, V. Larson (Univ. of WI, Milwaukee). Some Thoughts on Cloud Parameterization.
- March 9, 2005, D. Estep (CSU). Fast and Reliable Methods for Determining the Evolution of Uncertain Parameters in Differential Equations.
- March 10, 2005, T. Takemura (NASA/GSFC). Simulation of the Climate Response to Aerosol Effects with an Aerosol Transport-Radiation Model.
- March 24, 2005, R. Wakimoto (UCLA). Understanding the Generation of High Winds Associated With Bow Echoes.
- March 25, 2005, L. Grasso. Synthetic GOESR-ABI/HES Imagery.
- March 31, 2005, R. Salmon (Scripps). A General Method for Conserving Quantities Related to Potential Vorticity in Numerical Models.
- April 5, 2005, G. Dittberner (NOAA/NESDIS/OSD). Advanced Technologies for Future Environmental Satellite Systems.
- April 7, 2005, C. Williams (NOAA/ETL). Radar Profilers Used in Multi-Sensor Hydraulic Campaigns.
- April 11, 2005, P. Naughtin (Australia). Australia and Related Topics.
- April 14, 2005, J. Peel (CSU). The Health Effects of Ambient Air Pollution: An Epidemiologic Perspective.
- April 21, 2005, G. Rottman (CU). Solar Radiation and its Effect on our Atmosphere and Climate.
- April 25, 2005, A. Powell, Jr. (NOAA/NESDIS/ORA). In Search of the Sun-Earth Connection.
- May 5, 2005, A. Arakawa (UCLA). From Cyclone-Resolving to Cloud-Resolving GCMs: A Historical Prospective.
- May 24, 2005, M. Zupanski. The Maximum Likelihood Ensemble Filter (MLEF).
- May 24, 2005, M. Kim (NASA GSFC/GEST). Microwave Remote Sensing of Snowfall.
- May 26, 2005, A. Comrie (Univ. of AZ). Meteorologically Adjusted Urban Air Quality Trends in the Southwestern United States.
- June 8, 2005, J. Steppeler (GWS, Germany). Numerical Developments for the Nonhydrostatic Model LM.
- June 8, 2005, D. Mitchell (DRI, Nevada). Radiative Transfer Methods in a Cloudy Atmosphere.
- June 20, 2005, W. Frank (Penn State Univ.). Tropical Waves and Cyclogenesis.
- June 23, 2005, B. Ruston (NRL). A 1DVAR Preprocessor for Assimilation of Infrared and Microwave Window Channels Over Land.
- June 29, 2005, M. Bell (Leeds Univ.). Micro-Modeling of the Dispersion of Automotive Pollutants and Kerbside Exposures.

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- August 26, 2005, T. Nakajima (Univ. of Tokyo). A Study of Aerosol Climate Effects Using Model and Satellite Remote Sensing.
- September 15, 2005, D. Atlas (NASA). Contrails to Cirrus – Morphology, Microphysics, and Radiative Properties.
- September 22, 2005, K. Gurney. Global Carbon Sources and Sinks: Estimates and Links to Climate Variability from the Inverse Approach.
- September 29, 2005, G. Holland (NCAR). Tropical Cyclone Genesis as a Scale Interaction Process.
- October 6, 2005, E. Holland (NCAR).
- October 11, 2005, H. Xiang-Yu Huang (NCAR). The Weather Research and Forecasting Model Based 4-dimensional Variational Data Assimilation System.
- October 13, 2005, H. Cochrane. Valuing Improvements in Weather and Climate Forecasts: Retro and Prospective Views.
- October 27, 2005, Q. Li (JPL). Trapping of Deep Convective Pollution by Upper Level Anticyclones: Implications for Global Climate.

- October 28, 2005, O. Popovicheva (Moscow St. Univ.). General Physico-Chemical Properties of Aircraft Engine and Laboratory-Made Soots: Some Atmosphere Implications.
- November 9, 2005, S. Nigam (Univ. of Maryland). Hydroclimate Variability over the Great Plains in Observations, Reanalyses and Model Simulations.
- November 10, 2005, K. Shell (NCAR ASP). Climate Sensitivity to Airborne Mineral Dust in a Simple Model.
- November 17, 2005, R. Bleck (NOAA/NASA/GISS). Putting Models to Use: Simulation of Oceanic CO2 Sequestration.
- November 18, 2005, M. Cai (Florida St. Univ.). 40-70 Day Meridional Propagation of Global Circulation Anomalies.
- November 22, 2005, H. von Storch (GKSS). Hockeysticks, The Tragedy of the Commons and Sustainability of Climate Science.
- December 6, 2005, T. Lee (NRL). NPOESS Satellite Training Online Through COMET.
- December 13, 2005, X. Wang (ESRL). A Comparison of Hybrid Ensemble Transform Kalman Filter-3DVAR and Ensemble Square-Root Filter Analysis Schemes.
- January 19, 2006, F. Stratmann (Leipzig). LACIS: New Facility for Cloud Studies at the Institute for Tropospheric Research, Leipzig.
- January 23, 2006, T. Nakajima (Univ. of Tokyo). Atmospheric particles Observed by ADEOS2 Global Imager.
- January 26, 2006, P.W. Chan (Hong Kong Observatory). Windshear and Turbulence at the Hong Kong International Airport – Observation, Warning and Modeling.
- January 26, 2006, O. Liechti (A&K, Switzerland). Meteorological Flight Plans for Soaring and Their Verification.
- February 9, 2006, R. Cohen (Berkeley ASC). Atmospheric Nitrogen Oxides: Observational Challenges to Conventional Wisdom.
- February 22, 2006, J. Brown (ESRL). WRF from a NOAA-Boulder Perspective: Physics and Core Comparisons.
- February 23, 2006, R. Martin (Dalhousie Univ.). Interpretation of Satellite Observations of Tropospheric Aerosols and Trace Gasses.
- March 7, 2006, J. Hand. Individual Particle Analysis of Biomass Burning Aerosols from Young and Aged Smoke.
- March 9, 2006, R. Korty (CIT). The Eocene Paradox.
- March 24, 2006, R. Anthes (UCAR). GPE Radio Occultation Sounding of Earth's Atmosphere – Recent Results and the COSMIC Program.
- April 12, 2006, G. Brasseur (NCAR). The Response of the Upper and Middle Atmosphere to Solar Variability and Anthropogenic Perturbations.
- April 13, 2006, D. Vimont (Univ. of WI). Mid-latitude Influences on Tropical Pacific Climate Variability.
- April 20, 2006, O. Pauluis (NYU). Water Vapor and the Maintenance of the Atmospheric Circulation.
- April 25, 2006, I. Jankov. The Role of Physical Schemes Interactions on Warm Season Rainfall Forecasts.
- April 27, 2006, D. Wesley (UCAR/COMET). Mechanisms for Extreme Snowfall Variations in the Front Range Heavy Snowstorm of 17-20 March 2003, and a few other Winter Front Range Forecast Issues.
- May 1, 2006, J. Hack (NCAR). Modeling the Climate System Across Scaled.
- May 1, 2006, S. Kusselson (NOAA, NESDIS, OSDPD). NOAA/NESDIS/Satellite Analysis Branch Collaboration with CIRA/CSU.
- May 4, 2006, W. Rossow (NASA GISS). Evaluating and Testing Model Representations of Cloud-Climate Relations.
- May 11, 2006, J. Steppleler (German Weather Service). Developments Concerning a Next Generation Model.
- May 19, 2006, G. Goodge (NCDC). The Climate Reference Network (CRN): What Is It? Where Is It? And, What Can It Do For Me?
- June 8, 2006, E. Raschke (ZMAW, Germany). Some Controversial Results on the Radiative Forcing of Our Climate System as Extracted from Model Results for the AMIP-2 and IPCC-FAR and for the Radiation Climatologies of the ISCCP-FD and GEWEX-SRB.

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- June 16, 2006, J. Tilley (Univ. of North Dakota). Recent Army-Related Atmospheric Research at the University of North Dakota.
- June 20, 2006, Z. Levin (Tel Aviv University, Israel). On the Effects of Dust and Air Pollution on Clouds and Precipitation.
- July 17, 2006, H.F. de Campos Velho (INPE/LAC, Brazil). Turbulence Parameterization Based on the Taylor's Approach.
- July 18, 2006, H.F. de Campos Velho (INPE/LAC, Brazil). Inverse Problems in Geosciences.
- July 26, 2006, S. Fletcher. Lognormal Data Assimilation: Motivation, Theory and the Application to Satellite Data Assimilation.
- August 18, 2006, C. Jakob (BMRC, Australia). A Cloudy View of Tropical Climate – Cloud Regimes, Diabatic Heating and Circulation Systems.
- September 7, 2006, H. Schmidt (Germany). The Response of the Middle Atmosphere to Solar Cycle Forcing.
- September 11, 2006, J. Corbett (Univ. of Delaware). Moving Freight Transport Onto the High Road; Achieving Air Quality Goals Despite Growing Trade and Mobility Needs.
- September 12, 2006, S. Kempler (NASA/GSFC). A-Train Data Depot: Integrating and Visualizing Atmospheric Measurements Along the A-Train Tracks.
- September 14, 2006, D. Randall. Counting the Clouds.
- September 28, 2006, T. Ellis, M. Masarik and M. Smith. Our Department's New Radiosonde System – Overview and Launch Demonstration.
- October 12, 2006, M. Barth (NCAR). Convective-Scale Cloud Chemistry Simulations of a Thunderstorm.
- October 19, 2006, C. Franzke (NCAR). A Hidden Markov Model Perspective on Regimes and Metastability in Atmospheric Flows.
- October 26, 2006, R. Johnson. Fifty Years of Progress in Tropical Meteorology: A Personal View.
- November 2, 2006, G. Stephens. CloudSat: Early Highlights, Applications and Science.
- November 9, 2006, R. Dickinson (Georgia Tech). Analyzing the 3D Scattering from a Spherical Bush.
- November 16, 2006, D. Campbell (U.S. Geological Survey). Blazing a Trail in Rocky Mountain National Park: Application of Monitoring and Research on Nitrogen Deposition to Air and Water Quality Policy.
- November 29, 2006, T. Bond (Univ. of Illinois). Energy Shakes Hands with the Climate System: An Engineer's View.
- November 30, 2006, B. Otto-Bliesner (NCAR). Simulating Past Abrupt Climate Changes and Ocean-Atmosphere Responses to Freshwater Events in the North Atlantic.
- December 7, 2006, J. Hansen. Writing the History of CSU – Again!
- January 25, 2007, P. Silvia (Utah State). The Chemistry of Atmospheric particle Formation in Cache Valley, UT, and Implications for Other Rapidly Urbanizing Areas in the West.
- February 1, 2007, D. Crisp (NASA JPL). Measuring Atmospheric CO2 from Space: The NASA Orbiting Carbon Observatory Mission.
- February 6, 2007, Y. Noh. Snowfall Retrievals Over Land Using High Frequency Microwave Satellite Data.
- February 8, 2007, P. Thornton (NCAR). Effects of Carbon-Nitrogen Cycle Coupling on Climate-Carbon Cycle Dynamics.
- February 14, 2007, B. Weatherhead (NOAA/CIRES). Detecting Trends in Environmental Data. What Can We Control?
- February 15, 2007, D. Henze (Cal Tech). Exploring and Exploiting the Coupling of Sulfate Aerosol with Gas-Phase Precursors Using the Adjoint of a Global Chemical Transport Model.
- February 22, 2007, T. Ito. Why Is It So Hard to Explain the Glacial pCO2?
- March 1, 2007, L. Ott (NASA GSFC). A Comparison of Convection and Convective Transport in Single-Column and Cloud-Resolving Models.
- March 6, 2007, T. Lakhankar. Soil Moisture Retrieval from Microwave Remote Sensing Data.
- March 6, 2007, D. Lilly (Univ. of Oklahoma). Defining, Predicting and Verifying Convective Mixed Layers.
- March 8, 2007, K. Caldeira (Carnegie Institute). Ocean Acidification.
- March 19, 2007, G. Dalu (INRC, Italy). The West African Monsoon and its Impact on the Mediterranean.

- March 22, 2007, J. Marshall (MIT). GFD Experiments in Climate and Paleoclimate.
- April 2, 2007, D. Frierson (Univ. of Chicago). Tropical Circulations in a Hierarchy of Atmospheric Models.
- April 5, 2007, S. Bordini (UCLA). Monsoons as Regime Transitions of a Hadley Cell in an Idealized Aquaplanet GCM.
- April 13, 2007, C. Moore (NPS NST). National Park Service Night Sky Team.
- April 16, 2007, T. Birner (Univ. of Toronto). The Thermal Structure of the Extratropical Tropopause.
- April 19, 2007, V. Larson (Univ. of Wisconsin). Figuring Out Why Your Model is Wrong.
- April 24, 2007, K. Fuller (Univ. of Alabama). Absorption of Light by Airborne Particulate Matter.
- April 26, 2007, E. Maloney (Oregon State Univ.). The Madden-Julien Oscillation in a General Circulation Model and Observations.
- April 30, 2007, A. Shamsheyeva and P. Gabriel. Machine Learning, Classification and Support Vector Machines.
- May 2, 2007, P. Gabriel. On the Retrieval of Optical and Microphysical Properties of 3D Clouds.
- June 2, 2007, E. Ray (NOAA OAR MASC). Impacts of Tropical Cyclones on the Upper Troposphere.

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- July 10, 2007, N. Prive`. Towards an Observing System Simulation Experiment (OSSE) for Atmospheric Measurements from Unmanned Aircraft Systems (UAS).
- July 20, 2007, P. Stephens. New Developments in Monte Carlo Model as Applied to OCO Spectroscopy.
- July 25, 2007, M. Pagowski (ESRL/GSD). Behaviour of the Weather Research and Forecasting (WRF) Model Boundary Layer and Surface Parameterizations in One-Dimensional Simulations during the BAMEX Field Campaign.
- August 13, 2007, S.Y. Hong (Yonsei University, Korea). The Yonsei University Research Model System (YOURS).
- August 16, 2007, E. Gerber (Columbia University). Timescales of the NAO and Annular Modes: Tropospheric Feedbacks and Stratospheric Coupling.
- August 23, 2007, M. Sapiano (CICS). A New Global Analysis of Precipitation.
- August 30, 2007, A. Butler, L. Ciasto, T. Ellis, L. Van Roekel and T. Ito (CSU ATS). Understanding Ocean General Circulation using the CSU Spin Tank.
- September 13, 2007, W. Schubert (CSU ATS). Some Aspects of the Inner Core Structure of Hurricanes.
- September 20, 2007, T. Chase (CU). Modeling and Predicting Three Asian Monsoon Systems.
- September 25, 2007, G. Liston. International Polar Year (IPY): Barrenlands Snow-Measurement Expedition.
- September 26, 2007, S. Bony-Lena (LMD/IPSL, Paris). Cloud Radiative Feedbacks and Their Role in the Climate System: Progress, Questions and Prospects.
- October 4, 2007, B. Cotton (CSU ATS). Aerosol Influences on Clouds and Precipitation.
- October 8, 2007, L. Illari (MIT). Weather in a Tank.
- October 10, 2007, R. Klein (Potsdam Institute). Multiple Scales in the Atmosphere: Anelastic Approximation for Dry and Moist Flows.
- October 10, 2007, G. Holland (NCAR). A Revised Hurricane Pressure-Wind Model.
- October 16, 2007, P. McMurry (University of Minnesota). New Particle Formation and Growth Rates in the Atmosphere.
- October 17, 2007, J. Shukla (George Mason University). Dynamical Seasonal Prediction: Model Fidelity vs. Predictability.
- October 25, 2007, B. Medeiros (UCLA). Can Aquaplanets Predict a GCM's Climate Sensitivity?
- November 1, 2007, N. Lovenduski (CSU ATS). Enhanced CO2 Outgassing in the Southern Ocean from a Positive Phase of the Southern Annular Mode.
- November 8, 2007, K. Steffen (CIRES). Changes in the Arctic Ice Cover: Greenland Ice Sheet and Surrounding Oceans.
- November 14, 2007, T. Schneider (NOAA ESRL). An Overview of the NOAA Hydrometeorological Testbed (HMT).
- November 15, 2007, J. Randerson (UC Irvine). Contrasting Climate Effects of Fire in Boreal and Tropical Regions.

- November 28, 2007, C. MacDermaid, J. Smith and P. Hamer (ESRL/GSD). Use of Google Earth at ESRL/GSD.
- November 29, 2007, C. Boxe (JPL). Surface Chemistry and Physics: Implications for Terrestrial Polar Science and Planetary Science.
- December 3, 2007, J. Yano (Paris). Large-Scale Tropical Atmospheric Dynamics: Waves or Balance?
- December 6, 2007, M. DeMaria (NOAA). Dynamic and Thermodynamic Controls on Tropical Cyclone Intensity Change.
- December 11, 2007, C. Wieninmyer (NCAR). Estimating Emissions from Vegetation for Air Quality Modeling: Methods and Challenges.
- January 16, 2008, H. Brix (IGPP UCLA). Seasonal, Interannual and Decadal Variability in the Biogeochemistry of Mode Waters.
- January 31, 2008, J. Snider (University of Wyoming). Clouds: Their Effect on Aerosol and Vice-Versa.
- February 7, 2008, D. Neelin (UCLA). Rethinking Convective Quasi-Equilibrium.
- February 14, 2008, T. Li (NASA NPL). Lidar Observed Interannual Variability in the Middle Atmospheric Temperature
- February 22, 2008, C. Holloway (UCLA). Constraints on Tropical Convection: What Can We Learn from Vertical Temperature and Moisture Structures?
- February 25, 2008, H. Okamoto (CAOS). Study of Ice Cloud Microphysics using Radar and Lidar Observations.
- February 26, 2008, S. Shimizu (NIED, Japan). Structure and Formation Mechanism on 24 May 2000 Supercell-like Storm Developing in a Moist Environment over the Kanto Plain in Japan.
- February 28, 2008, M. Betsill (CSU). An Overview of the Policy Landscape for Dealing with Climate Change.
- March 6, 2008, S. Denning (CSU ATS). A Stool with Three Legs: Sources of Uncertainty in the Climate of the 21st Century.
- March 11, 2008, E. Raschke (University of Hamburg, Germany). Effects of Ancillary Data on Cloud and Radiation Products in the ISCCP and SRB Projects.
- March 13, 2008, G. Bryan (NCAR MMM). Gravity Currents in a Deep Anelastic Atmosphere.
- March 24, 2008, S. Van Den Heever (CSU ATS). The Impacts of the Cold Pool and Gust Front on Convective Storms.
- March 27, 2008, D. Chelton (Oregon State University). Observations and Modeling of Sea Surface Temperature Influence on Surface Winds and the Troposphere.
- March 27, 2008, V. Grubisic (Desert Research Institute). Terrain-Induced Rotor Experiment: New Insights into Lee Waves and Atmospheric Rotors.
- April 1, 2008, B. Fox-Kemp (CIRES). Submesoscales and Mixed Layer Eddies.
- April 3, 2008, D. Gochis (NCAR). Multiscale Observations and Modeling of Land-Atmosphere Interactions.
- April 10, 2008, S. Madronich (NCAR ACD). Atmospheric Chemistry In and Near a Megacity: The 2006 Mexico City MILAGRO Field Campaigns.
- April 15, 2008, A. Sorooshian (CA Institute of Technology). Aerosol Composition and Hygroscopicity Studies: Instrument Development/Characterization, Ambient and Laboratory Measurements, and Modeling.
- April 17, 2008, P. Sellers (NASA). What It's Like to go Into Space.
- April 28, 2008, K. Barsanti (NCAR ASP). Representing Secondary Organic Aerosols: From New Particle Formation to Absorptive Partitioning.
- May 1, 2008, H. Miura (JAMSTEC). A Study on the Madden-Julian Oscillation Using a Global Cloud-Resolving Model.
- May 9, 2008, E. Gruntfest (University of Colorado, Colorado Springs). Weather and Society * Integrated Studies (WAS*IS).
- May 19, 2008, H. Cochrane. The Regional Economic Impact of Disaster: A Rapid Assessment Tool.
- June 13, 2008, S. Vutukuru (University of California, Irvine). Secondary Aerosol Formation in the Atmosphere: Model Development and Applications.
- June 20, 2008, C. Zhang (University of Miami). Bimodal Variability of Tropical Diabatic Heating.

- June 27, 2008. G. Liston (CSU/CIRA). International Polar Year, South Pole/Antarctica Research Expedition.
- June 27, 2008. Y. Zhang (North Carolina State University). Development and Application of the Weather Research and Forecasting Model with Chemistry (WRF/Chem): From Urban Pollution to Regional/Global Climate Change.

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- August 8, 2008, Y.N. Takayabu (Univ. of Tokyo). Dynamical and Thermodynamical Controls on Tropical and Subtropical Convective Activity Inferred from Three Dimensional Latent Heating Distributions with TRMM SLH Beta-Version data.
- August 8, 2008, S. Shige (Osaka Prefecture Univ., Japan). Spectral Retrieval of Latent Heating Profiles from TRMM PR Data: Comparisons of Lookup Tables from Two and Three Dimensional Simulations.
- August 21, 2008, S. Vannitsem (Institut Royal Meteorologique de Belgique, Belgium). Dynamical Properties of Model Output Statistics (MOS): The Impact of Initial Condition and Model Errors.
- August 21, 2008, A. Carrassi (Institut Royal Meteorologique de Belgique, Belgium). Model Error and Sequential Data Assimilation: A Deterministic Formulation.
- August 28, 2008, T. Karl (NCAR). Volatile and Semivolatile Organic Compounds in the Atmosphere.
- September 4, 2008, A. White (NOAA/ESRL/PSD). Improving Observations of Coastal Storms.
- September 11, 2008, S. Birkel (Univ. of Maine). Climatic Implications of the Mechanical Collapse of the Laurentide Ice Sheet.
- September 17, 2008, J. Edwards, L. Cheatwood, B. Motta (CIRA & NOAA/ESRL/GSD). AWIPS II (Version T08).
- September 18, 2008, D. Noone (CIRES). Water Vapor Pathways and Cycling Rates Deduced from Global Water Isotope Measurements.
- September 18, 2008, G. Liston (CIRA). From Coast to Pole: A Research Expedition Traversing Antarctica.
- September 25, 2008, A. Robinson (Carnegie Mellon Univ.). Source Appointment of Organic Aerosols: The Molecular Marker Approach.
- October 2, 2008, S. Solomon (NOAA/ESRL/CSD). Linkages Between Ozone Depletion and Climate Change: Evolution of the Science and Connections to Public Policy.
- October 3, 2008, T. Matsui (GEST UMBC & NASA GSFC). On the Development of Multi-Scale Cumulus Ensemble Models with Satellite Radiance Observations and Multi-Sensor Satellite Simulators.
- October 9, 2008, G. McKinley (Univ. of WI – Madison). The Changing North Atlantic Carbon Cycle: 1992-2006.
- October 16, 2008, C. Thorncroft (SUNY). A Multiscale Analysis of the West African Monsoon.
- October 16, 2008, D. Nolan (Univ. of Miami). Environmental Controls of Tropical Cyclone Formation as Seen in High Resolution Simulations.
- October 23, 2008, C. Deser (NCAR). Atmospheric Circulation Trends, 1950-2000: The Relative Roles of Sea Surface Temperature Forcing and Direct Atmospheric Radiative Forcing.
- October 30, 2008, W. Cotton (CSU). Weather and Climate Engineering.
- November 4, 2008, R. Levy (NASA/GSFC). Retrieving Global Aerosol Properties from MODIS: The Challenge of the Climate Data Record.
- November 6, 2008, G. Kiladis (NOAA). Multiscale Organization of Equatorial Waves.
- November 13, 2008, S. Denning (CSU). Earth's "Carbon Cycle" is Key to NASA's Earth Science Program.
- November 19, 2008, D. Birkenheuer (NOAA/ESRL/GSD). Use of GPS Data at ESRL GSD to Further the Advance of GOES Radiometric Quality and Utility.
- November 19, 2008, D. Thompson (CSU). The Ozone Hole and Climate Change.
- November 20, 2008, M. Hernandez (CU). Characterization of Bioaerosols from Non-Point Sources.
- November 21, 2008, K. Lapina (MTU). Assessing the Impact of Boreal Wildfires on 03 and 03 Precursors Using Observations at the Pico Mountain Observatory.
- December 4, 2008, L. Dilling (CIRES). Communicating About Climate Changes: Moving Beyond the Myths toward More Effective Strategies for Societal Engagement.

- December 11, 2008, A. Heymsfield (NCAR). Microphysics of Maritime Tropical Convective Updrafts at Temperatures from -20 to -60C and the Role of Dust.
- January 22, 2009, J. Flemming (Colby College). Fixing the Sky: Does Geo-Engineering Have a History?
- January 29, 2009, D. de Haan (Univ. of San Diego). Irreversible Aerosol-Forming Reactions of Volatile Dicarbonyl and Amine Compounds.
- January 30, 2009, D. Schecter (NRA, WA). Hurricane Formation in Diabatic Turbulence.
- February 5, 2009, J. Overpeck (Univ. of AZ). A Paleoclimatic Perspective on Future Sea Level Rise and Drought: It Could Get Worse Than We Think.
- February 12, 2009, T. Bertram (Univ. of WA). Constraints on Tropospheric Ozone Production: From Aircraft Observations to in situ Heterogeneous Kinetics
- February 19, 2009, A. Eldering (JPL). Insights into Tropospheric Chemistry: New Results Utilizing EOS TES.
- February 26, 2009, W. Washington (NCAR). 20th and 21st Century Climate Change: Computer Modeling, Societal Impacts and Environmental Justice.
- March 5, 2009, G. Vallis (Princeton). Meridional Energy Transport in the Coupled Atmosphere-Ocean System.
- March 12, 2009, M. Holland (NCAR). Perennial Arctic Sea Ice: Here Today, Gone Tomorrow?
- March 18, 2009, D. Lindsey (NOAA/NESDIS/RAMMB). Wildfire-induced Thunderstorms: Observations and Possible Climate Impacts.
- March 25, 2009, J. Marsham (NCAR). Recent Observations from CSIP and IHOP of Cold Pool Outflows, Bores and Waves from Deep Convection and Subsequent Initiation.
- March 26, 2009, T. Birner (CSU). Stratospheric Severe Weather: The Dynamics of Sudden Stratospheric Warmings.
- March 30, 2009, M. Evans (Leeds Univ.). Two Short Stories about the Marine Boundary Layer.
- April 2, 2009, D. Waliser (JPL/Cal Tech). Cloud Ice: A Climate Model Challenge with Signs and Expectations of Progress.
- April 9, 2009, B. Randel (NCAR). The Asian Monsoon Anticyclone, Pollution Near the Tropopause and Transport to the Stratosphere.
- April 16, 2009, J. Shaman (OSU). The ENSO-North African-Asian Jet Teleconnection: Dynamics and Implications.
- April 23, 2009, B. Kahn (JPL). A-train Studies of Temperature and Water Vapor Variance Scaling and Upper Tropospheric Relative Humidity Distributions.
- April 30, 2009, A. Gettelman (NCAR). Simulating the Past, Present and Future of the Tropical Tropopause Layer.

July 1, 2009 – June 30, 2010

- July 16, 2009, M. Cai (Florida State Univ.). Dynamical Polar Warming Amplification and a New Climate Feedback Analysis Framework.
- July 24, 2009, A. Sorooshian (CIRA). Where on Earth does Aerosol Reduce Precipitation?
- July 30, 2009, W. Sun (Purdue Univ.). One Dimensional Snow-Land Surface Model and its Application.
- August 6, 2009, A. Jonko (Oregon State Univ.). Effects of CO2 Forcing Magnitude on Climate Feedbacks.
- August 19, 2009, A. Betts (NSSL). Idealized Model for Changes in Equilibrium Temperature and Boundary Layer Cloud Over Land in a Doubled CO2 Climate.
- August 27, 2009, A. Heidinger (NOAA/NESDIS). NOAA Cloud Product Algorithm Development for the Next Generation GOES-R and NPOESS Satellite Observing Systems.
- September 3, 2009, M. Glantz (Univ. of Colorado). Our War with Climate.
- September 10, 2009, J. Calderazzo & S.E. Campbell (Colorado State Univ.). 100 Views of Climate Change.
- September 17, 2009, T. Scambos (National Snow and Ice Data Center). Arctic Sea Ice Decline.
- September 24, 2009, B. Mapes (Univ. of Miami). Studying the MJO and Tropical Waves through Data Assimilations.

- October 8, 2009, W. Gray (Colorado State Univ.). A Look Back at the Changes in Meteorology (Atmospheric Science) Since the Early 1950's.
- October 15, 2009, P. Durkee (Naval Post Graduate School). Multispectral Aerosol Optical Depth Retrievals from High-Resolution Satellite Imagery.
- October 30, 2009, E. Tziperman (Harvard). Dinosaur Forecast: Clouds, and Other Lessons from Past Warm Climates.
- November 2, 2009, B. Ruston (Naval Research Lab). Expected Impacts of NPOESS Sensors on NWP.
- November 5, 2009, G. Frost (NOAA). Evaluation of U.S. NOx Emissions with Satellite-Based Observations and Model Simulations.
- November 12, 2009, J. Weiss (UC Boulder). Nonequilibrium Statistical Mechanics and Climate Variability.
- November 19, 2009, E. Greene (Colorado Avalanche Information Center). Understanding Avalanches: A Theoretical Framework and Practical Approach.
- November 30, 2009, J. Sun (NCAR). Radar Data Assimilation for High-Resolution Models: Recent Activities at NCAR.
- December 3, 2009, M. Weisman (NCAR). The 8 May 2009 "Super Derecho": A Land-Hurricane?
- December 10, 2009, T. Birner (Colorado State Univ.). Stratospheric Circulation Impact on Composition and Structure of the Tropopause Region.
- January 13, 2010, T. Mathewson (BLM). Fire Weather Predictive Services.
- January 28, 2010, D. Estep (Univ. of Miami). Adjoint-Fueled Advances in Error Estimation for Multiscale, Multiphysics Problems.
- February 4, 2010, R. Wood (Univ. of Washington). The Sensitivity of Precipitation in Low Clouds to Aerosol Perturbations.
- February 8, 2010, C. Fletcher (Univ. of Toronto). Linear Interference Effects on Tropical-Extratropical Teleconnections.
- February 11, 2010, K. Venayagamoorthy (Colorado State Univ.). Probing the Physics of Environmental Flows Using Numerical Simulations.
- February 18, 2010, A. Clement (Univ. of Miami). Low-Level Clouds and Climate Change.
- February 24, 2010, D. Zupanski (CIRA). Applications of Data Assimilation Methodologies in Wind Power Forecasting.
- February 25, 2010, G. Feingold (NOAA ESRL). Aerosol Effects on Clouds and Precipitation: Buffered States, Runaway States, and Self-Organization.
- March 4, 2010, S. Lovejoy (McGill Univ.). The Time-Space Cascade Structure of the Atmosphere and its Numerical Models.
- March 18, 2010, S. Otsuka (Kyoto Univ.). Numerical Experiments on Thin Moist Layers in the Tropical Midtroposphere.
- March 25, 2010. G. Stephens (CSU/CIRA). The Water Cycle, Moist Processes and Climate Change: What Might Be Predictable, Where Challenges Lie and What We Glean from New Earth Observations.
- April 1, 2010. Mark Jury (Univ. Puerto Rico). Caribbean Climate, Weather Variability and Interactions.
- April 8, 2010. Hugh Coe (Univ. of Manchester). Aerosol Properties and Processes Across Europe and Their Impacts: A Multi-aircraft Study During EUCAARI
- April 15, 2010. Gerald Meehl (NCAR). Weather Extremes in a Changing Climate.
- April 21, 2010. Adrian Sandu (Virginia Tech). Computational Tools for Chemical Data Assimilation
- April 29, 2010. Zhiming Kuang (Harvard). Large-scale Convectively Coupled Tropical Transients.
- May 21, 2010. Martin Setvak (Czech Hydrometeorological Institute). Satellite Observations of Convective Storms at the CHMI
- May 28, 2010. C. Balaji (Indian Institute of Technology). Retrieval Algorithms for the Megha-Tropiques Mission
- June 24, 2010. Lance Bosart (SUNY Albany) Late Season Tropical Cyclogenesis in the Western Caribbean Sea and Gulf of Mexico: Tropical Cyclone Ida (2009)

NOAA-FUNDED PROJECTS

July 1, 2001 – June 30, 2002

- A Comparison of Rooftop and Standard Ground-based Temperature
- A Multisensor Satellite Study of Upper Tropospheric Water Vapor and Clouds
- A Satellite-derived Cloud Climatology for the Mid-Atlantic States
- Advanced Environmental Satellite Research
- Air-Sea Interaction Remote Sensing Processes
- Applied Research in Support of Implementation of National Weather Service's Advanced Hydrologic Prediction Services in Central Region
- Atmospheric Analysis & Dynamical Modeling Over the TOGA/COARE Region
- Atmospheric CO_2 Inversion Intercomparison Project (TransCom 3)
- CIRA Activities and Participation in DMSP Satellite Data Processing
- CIRA Activities and Participation in the GOES I-M Product Assurance Plan
- CIRA Activities in the U.S. Weather Research Program
- Convective and Boundary Layer Processes in the Vicinity of the South China Sea During the Onset of the East Asian Monsoon
- Coupling Between Monsoon Convection and Subtropical Highs in the PACS Region on Subseasonal to Interannual Time Scales
- Developing a Mesoscale Observing Network Over the North Atlantic Continent and Adjacent Ocean Areas to Support the Next Generation Numerical Weather Prediction Models
- Development and Implementation of a Statistical Typhoon Intensity Prediction Scheme for the Western North Pacific
- Development of Advanced Applications Products Using AMSU Data
- Development of a Forward Model for Hurricane Initialization
- Development of a Virtual Laboratory Web Server for International Satellite Meteorology Training
- Effective Communication and Utilization of National Weather Service Critical Hydrometeorological Information
- Enhanced Communications at CIRA: Upgrade of the CIRA Computer Laboratory
- Enhancement of Satellite Data Processing and Analysis Capabilities in Central America
- Environmental Applications Research
- Examination of Linkages Between the Northwest Mexican Monsoon and Great Plains Precipitation
- Funds for the Cooperative Institute for Research Program
- GOES –I/M Product Assurance and Advanced Product Development for Demonstration Project for Satellite Meteorology Applications Focused Regional Meteorological Training Centers in Costa Rica and Barbados
- GOES-I/M Product Assurance and Advanced Product Development for Support of the Virtual Institute for Satellite Integration Training (VISIT)
- Impact Assessment of Measurements of CO2 from Space, Including CRLS and HIRS/(A)MSU
- Impact of Clouds on Nitrogen Species and Ozone in the NARE Boundary Layer
- Impact of Interactive Vegetation of Predictions of American Monsoons
- Influence of the Tropical Western Pacific on Climate Dynamics
- Information Content of Visible and Infrared Radiance Data: Toward Definition of New Generation Geostationary Imagers
- Interactions of the Monsoons and Anticyclones in the Coupled Atmosphere-Ocean System
- International Satellite Cloud Climatology Project Sector Processing Center for GOES
- Modeled Aerosol Optical Properties from Measurement-based Mixtures of Chemical Species: Assessing the Impacts of Particle Morphology and Absorption
- Monitor and Modeling Isotropic Exchange Between the Atmosphere and the Terrestrial Biosphere
- NESDIS/CIRA Postdoctoral Program
- Parameterizing Subgrid-scale Snow-cover Heterogeneities for Use in Regional and Global Climate Models

- Satellite Data Reception and Analysis Support
- Sensitivity of Cloud Resolving Simulations of Convective Precipitation and Cloudiness to Various Methods of Soil Initialization and Evaluation of Convective Parameterizations
- Simulations of the Interaction Between Deep Convection and the Ocean Mixed Layer During TOGA COARE
- Stochastic Modeling and Simulation of the Great Lakes Net Basin Supplies
- Study of Large-scale Motions, Boundary-layer Processes and Convective Parameterizations Using TOGA-COARE Data
- Technological Transfer and Validation of the CIRA Scheme for the Tropical Rainfall Potential (TRAP) Technique
- Temperature, Precipitation and Wind Continuity With ASOS
- Theoretical and Observational Analysis of Mesoscale Vorticity and Wind Structure in Hurricanes
- The Response of North American Monsoon to Boundary and Regional Forcing Mechanisms as Simulated by CLIMRAMS
- The Role of Stratocumulus Clouds in Modifying Pollution Plumes Transported to the North American Continent

July 1, 2002 – June 30, 2003

- A Comparison of Rooftop & Standard Ground-based Temperature Measurements
- A Satellite Hydro-Meteorology (SHyMet) Training & Education Proposal
- Activities & Participation in DMSP Satellite Data Processing & Analysis
- Advanced Environmental Satellite Research Support
- Advanced High-Performance Computing (includes SMS and Grid)
- Air-Sea Interaction Remote Sensing Processes
- Applied Research in Support of Implementation of National Weather Services
- Atmospheric Tracer Transport Inversion Intercomparison (TransCom 3)
- Aviation-Related Research (includes PACE, ADDS, and RTVS)
- CASES 99
- CIRA Activities in the U.S, Weather Research Program
- CIRA Activities & Participation in DMSP Satellite Data Processing & Analysis
- CIRA Activities & Participation in National Geophysical Data Center Data Repository, Processing & Management
- CIRA Activities and Participation in the GOES I-M Product Assurance Plan
- CIRA's Cross-Sensor Products for Improved Weather Analysis & Forecasting
- Coupling Between Monsoon Convection & Subtropical Highs in the PACS Region on Subseasonal to Interannual Time Scales
- Developing a Mesoscale Observing Network over the North Atlantic Continent and Adjacent Ocean Areas
- Development & Evaluation of GOES and POES Products for Tropical Cyclone and Precipitation Analysis
- Development of a Forward Model for Hurricane Initialization
- Development of a Virtual Laboratory Web Server for International Satellite Meteorology Training
- Development of Efficient Satellite Data Compression Techniques: Transmission of GOES Imagery to the NOAA WP-3D Aircraft
- Enhanced Communications at CIRA for the Development of Real-time Evaluation of Advanced Microwave Sounder
- Enhancement of Satellite Data Processing & Analysis Capabilities in Central America
- Environmental Applications Research
- Evaluation and Verification of Aviation Impact Variables
- Examination of the Linkages between the Northwest Mexican Monsoon & Great Plains Precipitation
- Experimental Forecast Facility
- Funds for the Cooperative Institute for Research Program

- FX-Net Project (includes TAQ and NIFC prototypes)
- GAINS
- Getting Ready for NOAA's Advanced Remote Sensing Programs: A Satellite Hydrometeorology (SHYMET) Training and Education Proposal
- GLOBE
- GPS Tomography
- Harnessing the Spare Computing Power of Desktop PCs for Improved Satellite Data Processing and Technology Transition
- Impact Assessment of Measurements of CO_2 from Space, Including Cr1S & HIRS/(A) MSU
- Impact of Interactive Vegetation on Predictions of North American Monsoons
- Interactions of the Monsoons & Anticyclones in the Coupled Atmosphere-Ocean System
- International Satellite Cloud Climatology Project Sector Processing Center for GOES
- LAPS Enhancements
- Local Data Acquisition and Dissemination (LDAD) Project
- Mesoscale Modeling Research
- Monitoring & Modeling Isotopic Exchange between the Atmosphere & the Terrestrial Biosphere
- NESDIS Postdoctoral Program
- Parameterizing Subgrid-Scale Snow Cover Heterogeneities for Use in Regional & Global Climate Models
- Precipitation Monitoring & Modeling Isotopic Exchange between the Atmosphere & the Terrestrial Biosphere
- Predictability in Well-Posed Regional Mesoscale Models
- Radar Remote Sensing of Marine and Continental Stratus Clouds
- Rapid Update Cycle (RUC) Model Development
- Research to Improve Tropical Cyclone Intensity Analyses and Predictions Using Satellite Data
- Satellite Data & Analysis Equipment & Support for Research Activities
- Severe Weather Research
- Short-Range Ensemble Forecast System Development
- Social Science Research Support for Implementing Advanced Hydrologic Prediction Service of NOAA's National Weather Service
- Stochastic Modeling & Simulation of the Great Lakes Net Basin Supplies
- Support of the Virtual Institute for Satellite Integration Training
- Technological Transfer & Validation of the CIRA Scheme for the Tropical Rainfall Potential Technique
- The Response of North American Monsoon to Boundary and Regional Forcing Mechanisms as Simulated by CLIMRAMS
- The Role of Stratocumulus Clouds in Modifying Pollution Plumes Transported to North American Continent
- Theoretical Methods in 3DVAR and 4DVAR Data Assimilation
- U.S. Weather Research Program Joint Grants Program Severe Weather Research
- Validation of NESDIS Microwave Land Emmissivity Model
- Variability & Trends in Global Precipitation
- Wavelet Transform Data Compression Research
- WFO-Advanced (AWIPS) Project
- WFO-Advanced Workstation 3-D Display Development
- WRF Model Development

July 1, 2003 – June 30, 2004

- Advanced Environmental Research Support
- An Evaluation of Ultrasonic Snow Depth Sensors for Estimating 6- and 24-Hour Snowfall Totals
- Applied Research in Support of Implementation of National Weather Service Advance Hydrologic Prediction Services in Central Region
- Atmospheric CO_2 Inversion Intercomparison Project
- Carbon Dioxide Measurements From an Airborne Spectrometer in Support of Operational Temperature Soundings and the Study of the Carbon Cycle
- CIRA Activities and Participation in DMSP Satellite Data Processing and Analysis
- CIRA Activities and Participation in the GOES I-M Product Assurance Plan (GIMPAP)
- Climate Process Team on Low-latitude Cloud Feedbacks on Climate Sensitivity
- Continued Investigation of the North American Monsoon Sensitivity to Boundary and Regional Forcing with a Focus on Land-Atmosphere Interaction
- Coupling Between Monsoon Convection and Subtropical Highs in the PACS Region on Subseasonal to Interannual Time Scales
- Cross-sensor Products for Improved Weather Analysis and Forecasting
- Development and Evaluation of GOES and POES Products for Tropical Cyclone and Precipitation Analysis
- Development of a Multi-platform Satellite Tropical Cyclone Wind Analysis System
- Development of Efficient Satellite Data Compression Techniques: Transmission of GOES Imagery to the NOAA WP-3D Aircraft
- Enhanced Communications at CIRA for the Development of Real-time Evaluation of AMSU Tropical Cyclone Products
- Environmental Applications Research
- Examination of Linkages Between the Northwest Mexican Monsoon and Great Plains Precipitation
- Getting Ready for NOAA's Advanced Remote Sensing Programs: A Satellite Hydrometeorology Training and Education Proposal
- Global Microwave Surface Emissivity Error Analysis
- Harness the Spare Computing Power of Desktop PCs for Improved Satellite Data Processing and Technology Transition
- Impact of Interactive Vegetation on Predictions of North American Monsoons
- Improvement in Deterministic and Probabilistic Tropical Cyclone Surface Wind Predictions
- Interactions of the Monsoon and Anticyclones in the Coupled Atmosphere-Ocean System
- International Satellite Cloud Climatology Project Sector Processing and Analysis
- NESDIS Postdoctoral Program
- Polarimetric Radar Observations of Precipitation: Measurements, Analysis and Modeling
- Radar Remote Sensing Processes and Investigation of Smoke Aerosol Cloud Interactions Using Large Eddy Simulations
- Research & Development for GOES-R Risk Reduction
- Severe Weather and Tropical Cyclone Product Development for NPOESS Preparatory Project
- Stochastic Modeling and Simulation of the Great Lakes Net Basin Supplies
- Support of the Virtual Institute for Satellite Integration Training (VISIT)
- Task I: Funds for the Cooperative Institute for Research in the Atmosphere
- The CIRES-NOAA Western Water Assessment—Providing Increased Focus on the Crucial Agricultural Sector
- The Role of Stratocumulus Clouds in Modifying Pollution Plumes Transported to North American Continent
- Variability and Trends in Global Precipitation
- Weather Satellite Data and Analysis Equipment and Support for Research Activities

July 1, 2004 – June 30, 2005

- A High Resolution Meteorological Distribution Model for Atmospheric, Hydrologic, and Ecologic Applications
- Advanced Environmental Satellite Research Support
- Advanced Weather (AWIPS) Support for Satellite Hydrometeorology (SHYMET) and VISIT Training and Education
- An Evaluation of Ultrasonic Snow Depth Sensors for Estimating 6- and 24-Hour Snowfall Totals
- Analyses and Diagnostic Studies from SMN Radar and Related Data in Support of NAME
- Analysis and Interpretation of Census Data
- Applied Research in Support of Implementation of National Weather Service Advance Hydrologic Prediction Services in Central Region
- Atmospheric CO_2 Inversion Intercomparison Project (TransCom3)
- Carbon Dioxide Measurements from an Airborne Spectrometer in Support of Operational Temperature Sounds and the Study of the Carbon Cycle
- CIRA Activities and Participation in the GOES I-M Product Assurance Plan
- Climate Process Team on Low-latitude Cloud Feedbacks on Climate Sensitivity
- Continued Investigation of the N.A. Monsoon Sensitivity to Boundary and Regional Forcing
- Coupling Between Monsoon Convection and Subtropical Highs in the PACS Region
- Cross-sensor Products for Improved Weather Analysis and Forecasting
- Data Fusion to Determine North American Sources and Sinks of Carbon Dioxide at High Spatial and Temporal Resolution
- Development and Evaluation of GOES and POES Products for Tropical Cyclone and Precipitation Analysis
- Development of a Multi-platform Satellite Tropical Cyclone Wind Analysis System
- Development of an Annular Hurricane Eyewall Index for Tropical Cyclone Intensity Forecasting
- Development of Three-dimensional Polar Wind Retrieval Techniques Using the Advanced Microwave Sounder Unit
- Environmental Applications Research
- Funds for the Cooperative Institute for Research in the Atmosphere
- Getting Ready for NOAA's Advanced Remote Sensing Programs: A Satellite Hydrometeorology Training and Education Proposal
- Global Microwave Surface Emissivity Error Analysis
- Impact of Fundamental Assumptions of Probabilistic Data Assimilation/Ensemble Forecasting: Conditional Mode vs. Conditional Mean
- Improvement in Deterministic and Probabilistic Tropical Cyclone Surface Wind Predictions
- Interactions of the Monsoon and Anticyclones in the Coupled Atmosphere-Ocean System
- International Satellite Cloud Climatology Project Sector Processing and Analysis
- Investigation of Smoke Cloud-Aerosol Interactions Using Large Eddy Simulations
- Maximizing the Usefulness of Grid Technology on NOAA Office PCs
- NESDIS Postdoctoral Program
- ORA IT Infrastructure of the Future
- Proposal on Efficient All-weather (Cloudy and Clear) Observational Operator for Satellite Radiance Data Assimilation
- Radar Remote Sensing Processes and Investigation of Smoke Aerosol Cloud Interactions Using Large Eddy Simulations
- Research and Development for GOES-R Risk Reduction
- Science Stewardship of Thematic Climate Data Records: A Pilot Study With Global Water Vapor
- Sensitivity of the North American Monsoon to Soil Moisture and Vegetation
- Severe Weather and Tropical Cyclone Product Development for NPOESS Preparatory Project
- Ship-based Radar, Sounding, and Flux Observations in Support of NAME
- Study of Gulf Surges Using QuickSCAT and NAME Observations
- Support of the Virtual Institute for Satellite Integration Training (VISIT)

- The CIRES-NOAA Western Water Assessment—Providing Increased Focus on the Crucial Agricultural Sector
- The Role of Africa in Terrestrial Carbon Exchange and Atmospheric CO_2: Reducing Regional and Global Carbon Cycle Uncertainty
- The Role of Stratocumulus Clouds in Modifying Pollution Plumes Transported to North American Continent
- Variability and Trends in Global Precipitation
- Weather Satellite Data and Analysis Equipment and Support for Research Activities

July 1, 2005 – June 30, 2006

- A High Resolution Meteorological Distribution Model for Atmospheric, Hydrologic, and Ecologic Applications
- Advanced Environmental Satellite Research Support
- Advanced Hydrological Prediction Service
- Advanced Weather (AWIPS) Support for Satellite Hydrometeorology (SHYMET) and VISIT Training and Education
- An Evaluation of Ultrasonic Snow Depth Sensors for Estimating 6- and 24-Hour Snowfall Totals
- Analyses and Diagnostic Studies from SMN Radar and Related Data in Support of NAME
- Analysis of Clouds, Radiation and Aerosols from Surface Measurements and Modeling Studies
- Analysis of Simulated Radiance Fields for GOES-R ABI Bands for Mesoscale Weather and Hazard Events
- Applications of Satellite Altimetry Data to Statistical and Simplified Dynamical Tropical Cyclone Intensity Forecast Models
- Atmospheric CO_2 Inversion Intercomparison Project (TransCom3)
- CIRA Activities and Participation in the GOES I-M Product Assurance Plan
- CIRA Research Collaboration with the NOAA Geophysical Data Center (NGDC) for Support of the National Geodetic Survey CORS Project
- Climate Process Team on Low-latitude Cloud Feedbacks on Climate Sensitivity
- Continued Development of Tropical Cyclone Wind Probability Products
- Continued Investigation of the N.A. Monsoon Sensitivity to Boundary and Regional Forcing With a Focus on Land-Atmosphere Interaction
- Data Fusion to Determine North American Sources and Sinks of Carbon Dioxide at High Spatial and Temporal Resolution
- Development and Evaluation of GOES and POES Products for Tropical Cyclone and Precipitation Analysis
- Development of a Multi-platform Satellite Tropical Cyclone Wind Analysis System
- Development of an Annular Hurricane Eyewall Index for Tropical Cyclone Intensity Forecasting
- Development of Three-dimensional Polar Wind Retrieval Techniques Using the Advanced Microwave Sounder Unit
- Documenting Historical Climate Network Stations in Colorado
- Environmental Applications Research
- EPIC ITCZ Radar Data
- Expansion of CIRA Research Collaboration with the NWS Meteorological Development Lab
- Funds for the Cooperative Institute for Research, Task I
- Getting Ready for NOAA's Advanced Remote Sensing Programs: A Satellite Hydrometeorology Training and Education Proposal
- Global Microwave Emissivity Error Analysis
- GOES West ISCCP Sector Processing Center
- Impact of Fundamental Assumptions of Probabilistic Data Assimilation/Ensemble Forecasting: Conditional Mode vs. Conditional Mean
- Improved Statistical Intensity Forecast Models

- Incorporation of Census Data in Severe Weather Watches and Warnings
- Interactions of the Monsoon and Anticyclones in the Coupled Atmosphere-Ocean System
- Investigation of Smoke Cloud-Aerosol Interactions Using Large Eddy Simulations
- Maximizing the Usefulness of Grid Technology on NOAA Office PCs
- MicroRad'06: Microwave Radiometry and Remote Sensing Specialist Meeting
- NESDIS Postdoctoral Program
- NPOESS Applications to Tropical Cyclone Analysis and Forecasting
- ORA IT Infrastructure of the Future
- Pilot Program to Improve Satellite System Utilization Through Education, Training and Outreach
- Processing of Organic Aerosols by Heterogeneous and Multiphase Processes
- Proposal on Efficient All-weather (Cloudy and Clear) Observational Operator for Satellite Radiance Data Assimilation
- Radar Remote Sensing Processes
- Regional Transport Analysis for Carbon Cycle Inversions
- Research and Development for GOES-R Risk Reduction
- Satellite Data Reception and Analysis Support
- Science Stewardship of Thematic Climate Data Records: A Pilot Study With Global Water Vapor
- Sensitivity of the North American Monsoon to Soil Moisture and Vegetation
- Ship-based Radar, Sounding, and Flux Observations in Support of NAME-2004
- Study of Gulf Surges Using QuickSCAT and NAME Observations
- Support of the Virtual Institute for Satellite Integration Training (VISIT)
- The Role of Africa in Terrestrial Carbon Exchange and Atmospheric CO_2: Reducing Regional and Global Carbon Cycle Uncertainty
- The Role of Stratocumulus Clouds in Modifying Pollution Plumes Transported to North American Continent
- Ultrasonic Depth Sensors for NWS Snow Measurements in the U.S.: Evaluation of Operational Readiness

July 1, 2006 – June 30, 2007

- A High Resolution Meteorological Distribution Model for Atmospheric, Hydrologic, and Ecologic Applications
- A Satellite Analysis of Atmospheric Rivers
- Advanced Environmental Satellite Research Support
- Advanced Weather (AWIPS) Support for Satellite Hydrometeorology (SHYMET) and VISIT Training and Education
- Analyses and Diagnostic Studies from SMN Radar and Related Data in Support of NAME
- Analysis of Clouds, Radiation and Aerosols from Surface Measurements and Modeling Studies
- Analysis of Simulated Radiance Fields for GOES-R ABI Bands for Mesoscale Weather and Hazard Events
- Applications of Satellite Altimetry Data to Statistical and Simplified Dynamical Tropical Cyclone Intensity Forecast Models
- CIRA Activities and Participation in the GOES I-M Product Assurance Plan
- Climate Process Team on Low-latitude Cloud Feedbacks on Climate Sensitivity
- Cloud and Microwave Emissivity Verification Tools for Use Within the CRTM
- CoCoRaHS: The Community Collaborative Rain, Hal and Snow Network—Enhancing Environmental Literacy Through Participation in Climate Monitoring and Research
- Continued Development of Tropical Cyclone Wind Probability Products
- Continued Investigation of the N.A. Monsoon Sensitivity to Boundary and Regional Forcing With a Focus on Land-Atmosphere Interaction
- Data Fusion to Determine North American Sources and Sinks of Carbon Dioxide at High Spatial and Temporal Resolution

- Development and Evaluation of GOES and POES Products for Tropical Cyclone and Precipitation Analysis
- Development of an Annular Hurricane Eyewall Index for Tropical Cyclone Intensity Forecasting
- Development of Three-dimensional Polar Wind Retrieval Techniques Using the Advanced Microwave Sounder Unit
- Environmental Applications Research
- EPIC ITCZ Radar Data
- Evaluation of GOES-13 Imager and Sounder During NOAA's Science Test: Collection and Analysis of Data
- Expansion of CIRA Research Collaboration with the NWS Meteorological Development Lab
- Funds for the Cooperative Institute for Research, Task I
- Getting Ready for NOAA's Advanced Remote Sensing Programs: A Satellite Hydrometeorology Training and Education Proposal
- GOES West ISCCP Sector Processing Center
- Impact of Fundamental Assumptions of Probabilistic Data Assimilation/Ensemble Forecasting: Conditional Mode vs. Conditional Mean
- Improved Statistical Intensity Forecast Models
- Incorporation of Census Data in Severe Weather Watches and Warnings
- Investigation of Smoke Cloud-Aerosol Interactions Using Large Eddy Simulations
- NESDIS Postdoctoral Program
- NPOESS Applications to Tropical Cyclone Analysis and Forecasting
- Processing of Organic Aerosols by Heterogeneous and Multiphase Processes
- Proposal on Efficient All-weather (Cloudy and Clear) Observational Operator for Satellite Radiance Data Assimilation
- Research and Development for GOES-R Risk Reduction
- Regional Transport Analysis for Carbon Cycle Inversions
- Satellite Data Reception and Analysis Support
- Sensitivity of the North American Monsoon to Soil Moisture and Vegetation
- Ship-based Radar, Sounding, and Flux Observations in Support of NAME-2004
- Study of Gulf Surges Using QuickSCAT and NAME Observations
- Support of the Virtual Institute for Satellite Integration Training (VISIT)
- The Role of Africa in Terrestrial Carbon Exchange and Atmospheric CO_2: Reducing Regional and Global Carbon Cycle Uncertainty
- Ultrasonic Depth Sensors for NWS Snow Measurements in the U.S.: Evaluation of Operational Readiness

July 1, 2007 – June 30, 2008

- A High Resolution Meteorological Distribution Model for Atmospheric, Hydrologic, and Ecologic Applications
- A Satellite Analysis of Atmospheric Rivers
- Advanced Environmental Satellite Research Support
- Advanced Hydrologic Prediction Service
- Advanced Weather (AWIPS) Support for Satellite Hydro-Meteorology (SHyMet) and Virtual Institute for Satellite Integration Training (VISIT) Training and Education
- An Improved Wind Probability Estimation Program
- Analyses and Diagnostic Studies from SMN Radar and Related Data in Support of NAME
- Analysis of Clouds, Radiation and Aerosols from Surface Measurements And Modeling Studies
- Analysis of Simulated Radiance Fields for GOES-R ABI Bands for Mesoscale Weather and Hazard Events
- Applications of Satellite Altimetry Data to Statistical and Simplified Dynamical Tropical Cyclone Intensity Forecast Models

- Blended AMSU, SSM/I, and GPS Total Precipitable Water Products
- CIRA Activities and Participation in the GOES I-M Product Assurance Plan
- Cloud and Microwave Emissivity Verification Tools for Use Within the CRTM
- CoCoRaHS: The Community Collaborative Rain, Hail and Snow Network—Enhancing Environmental Literacy Through Participation in Climate Monitoring and Research
- Collaborative Research with NIDIS for Their Web Portal
- Continuation of CIRA Research Collaboration with the NWS Meteorological Development Lab
- Continued Development of Tropical Cyclone Wind Probability Products
- Continued Investigation of the N.A. Monsoon Sensitivity to Boundary and Regional Forcing With a Focus on Land-Atmosphere Interaction
- Development and Evaluation of GOES and POES Products for Tropical Cyclone and Precipitation Analysis
- Development of a Multi-platform Satellite Tropical Cyclone Wind Analysis System
- Development of a Polar Satellite Processing System for Research And Training
- Development of an Improved Climate Rainfall Dataset from SSM/I
- Development of Three-Dimensional Polar Wind Retrieval Techniques Using the Advanced Microwave Sounder Unit
- Environmental Applications Research
- Evaluation of GOES -13 Imager and Sounder During NOAA's Science Test: Collection and Analysis of Data
- Expansion of CIRA Research Collaboration with the NWS Meteorological Development Lab
- Funds for the Cooperative Institute for Research, Task 1
- Getting Ready for NOAA's Advanced Remote Sensing Programs: A Satellite Hydro-meteorology (SHyMet) Training and Education Proposal
- GOES West ISCCP Sector Processing Center
- Impact of Fundamental Assumptions of Probabilistic Data Assimilation/Ensemble Forecasting: Conditional Mode vs. Conditional Mean
- Investigation of Smoke Aerosol-cloud Interactions Using Large Eddy Simulations
- IPCC Studies for Climate Observations
- Monsoon Flow and Its Variability During NAME: Observations and Models
- NESDIS Postdoctoral Program
- NPOESS Applications to Tropical Cyclone Analysis and Forecasting
- POES-GOES Blended Hydrometeorological Products
- Processing of Organic Aerosols by Heterogeneous and Multiphase Processes
- Proposal on Efficient All-Weather (Cloudy and Clear) Observational Operator for Satellite Radiance Data Assimilation
- Regional Transport Analysis for Carbon Cycle Inversions
- Research & Development for GOES-R Risk Reduction
- Sensitivity of the North American Monsoon to Soil Moisture and Vegetation
- Ship-based Observations of Precipitation Convection and Environmental Conditions in Support of NAME-2004
- Simulation and Analysis of the Interaction Between Aerosols and Clouds, Precipitation and the Radiation Budget Over the Gulf of Mexico And Houston
- Social Verification of Tornado Warnings; How Can We Improve Response to Warnings?
- Study of the Direct and Indirect Effects of Aerosol on Climate
- Support of the Virtual Institute for Satellite Integration Training (VISIT)
- The Role of Africa in Terrestrial Carbon Exchange and Atmospheric CO_2: Reducing Regional and Global Carbon Cycle Uncertainty
- Ultrasonic Depth Sensors for NWS Snow Measurements in the U.S.: Evaluation of Operational Readiness
- Weather Satellite Data and Analysis Equipment and Support for Research Activities

July 1, 2008 – June 30, 2009

- A GOES-R Proving Ground for National Weather Service Forecaster Readiness
- A High Resolution Meteorological Distribution Model for Atmospheric, Hydrologic, and Ecologic Applications
- Advanced Environmental Satellite Research Support
- Advanced Verification Techniques for the Hurricane Weather Research and Forecast (HWRF) Model
- An Improved Wind Probability Estimation Program
- Analysis of Clouds, Radiation and Aerosols from Surface Measurements And Modeling Studies
- Analysis of Simulated Radiance Fields for GOES-R ABI Bands for Mesoscale Weather and Hazard Events
- Applications of Satellite Altimetry Data to Statistical and Simplified Dynamical Tropical Cyclone Intensity Forecast Models
- Blended AMSU, SSM/I, and GPS Total Precipitable Water Products
- CIRA Activities and Participation in the GOES I-M Product Assurance Plan
- Cloud and Microwave Emissivity Verification Tools for Use Within the CRTM
- CoCoRaHS: The Community Collaborative Rain, Hail and Snow Network—Enhancing Environmental Literacy Through Participation in Climate Monitoring and Research
- Continuation of CIRA Research Collaboration with the NWS Meteorological Development Lab
- Data Fusion to Determine North American Sources and Sinks of Carbon Dioxide at High Spatial and Temporal Resolution from 2004 to 2008
- Development and Evaluation of GOES and POES Products for Tropical
- Cyclone and Precipitation Analysis
- Development of a Polar Satellite Processing System for Research and Training
- Development of an Improved Climate Rainfall Dataset from SSM/I
- Environmental Applications Research
- Evaluation of Hurricane Mitigation Hypotheses Through an Interactive Program of Observational Analyses and Numerical Simulation
- Expansion of CIRA Research Collaboration with the NWS Meteorological Development Lab
- Funds for the Cooperative Institute for Research, Task 1
- Further Expansion of CIRA Research Collaboration with the NWS Meteorological Development Lab
- Getting Ready for NOAA's Advanced Remote Sensing Programs: A Satellite Hydro-meteorology (SHyMet) Training and Education Proposal
- Investigation of Aerosol-Cloud-Radiation and Surface Flux Interactions Using Large Eddy Simulations
- IPCC Studies for Climate Observations
- Monsoon Flow and Its Variability During NAME: Observations and Models
- NESDIS Postdoctoral Program
- POES-GOES Blended Hydrometeorological Products
- Research & Development for GOES-R Risk Reduction
- Satellite Analysis of the Influence of the Gulf Stream on the Troposphere: Convective Response
- Simulation and Analysis of the Interaction Between Aerosols and Clouds, Precipitation and the Radiation Budget Over the Gulf of Mexico And Houston
- Support of the Virtual Institute for Satellite Integration Training (VISIT)
- Transitioning ISCCP GOES-West Processing from CIRA to NCDC
- Validation of Satellite-based Thermodynamic Retrievals in the Tropics
- Weather Satellite Data and Analysis Equipment and Support for Research Activities

July 1, 2009 – June 30, 2010

- A GOES-R Proving Ground for National Weather Service Forecaster Readiness
- Advanced Environmental Satellite Research Support
- Analysis of Clouds, Radiation and Aerosols from Surface Measurements And Modeling Studies

- Analysis of Simulated Radiance Fields for GOES-R ABI Bands for Mesoscale Weather and Hazard Events
- Applications of Satellite Altimetry Data to Statistical and Simplified Dynamical Tropical Cyclone Intensity Forecast Models
- CIRA Activities and Participation in the GOES I-M Product Assurance Plan
- CIRA Research Collaboration with the NOAA/NESDIS NGDC for the NPOESS SEM Sensor
- CoCoRaHS: The Community Collaborative Rain, Hail and Snow Network—Enhancing Environmental Literacy Through Participation in Climate Monitoring and Research
- Continuation of the CIRA Research Collaboration with the NWS Meteorological Development Lab
- Development and Evaluation of GOES and POES Products for Tropical Cyclone and Precipitation Analysis
- Development of a Polar Satellite Processing System for Research And Training
- Development of an Improved Climate Rainfall Dataset from SSM/I
- Ensemble Data Assimilation for Hurricane Forecasting
- Environmental Applications Research
- Evaluation of Hurricane Mitigation Hypotheses Through an Interactive Program of Observational Analyses and Numerical Simulation
- Further Expansion of CIRA Research Collaboration with the NWS
- Getting Ready for NOAA's Advanced Remote Sensing Programs: A Satellite Hydro-meteorology (SHyMet) Training and Education Proposal
- Global Tropical Cyclone Formation Probabilities
- Investigation of Smoke Aerosol-cloud Interactions Using Large Eddy Simulations
- IPCC Studies for Climate Observations
- Joint Hurricane Testbed – An Improved Wind Probability Estimation Program
- Monsoon Flow and Its Variability During NAME: Observations and Models
- NESDIS Postdoc Yong Chen
- NESDIS Postdoc Prasanjit Dash
- NESDIS Postdoc Xing Ming Liang
- NESDIS Postdoc Wei Shi
- NESDIS Postdoc Feng Xu
- POES-GOES Blended Hydrometeorological Products
- Research & Development for GOES-R Risk Reduction
- Satellite Analysis of the Influence of the Gulf Stream on the Troposphere: Convective Response
- Simulation and Analysis of the Interaction Between Aerosols and Clouds, Precipitation and the Radiation Budget Over the Gulf of Mexico and Houston
- Support of the Virtual Institute for Satellite Integration Training (VISIT)
- Task I – A Cooperative Institute to Investigate Satellite Applications for Regional/Global-Scale Forecasts
- The Role of the Colorado Climate Center in a Meaningful Drought Early Warning System for the Upper Colorado Basin
- Transitioning ISCCP GOES-West Processing from CIRA to NCDC
- Tropical Cyclone Model Diagnostics and Product Development
- Validation of Satellite-based Thermodynamic Retrievals in the Tropics
- Weather Satellite Data and Analysis Equipment and Support for Research Activities

CIRA PUBLICATIONS 2001 - 2010

Institute Lead Author

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Peer Reviewed				29	70	42	46	37	24
Non-peer Reviewed				82	128	40	6	58	6

NOAA Lead Author

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Peer Reviewed	18	20	21	20	14	30	26	21	17
Non-peer Reviewed	51	73	32	48	52	91	2	34	0

Other Lead Author

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Peer Reviewed	53	77	78	40	25	71	80	35	31
Non-peer Reviewed	46	108	44	53	46	64	5	49	5

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