Colorado State University  
Center for Geosciences/Atmospheric Research (CG/AR)  
Quarterly Report No. 27  
by T. H. Vonder Haar and Collaborators  

Reporting period: October 1 – December 31, 2012  
Cooperative Agreement #W911NF-06-2-0015  

Overview

Having entered a second, no-cost extension period at the end of April, the Center for Geosciences/Atmospheric Research at Colorado State University continued research this quarter under two research themes: Hydrometeorology; and Clouds, Icing and Aerosols (with, of course, the cross-cutting theme Technology Transfer and Interactions).

In this quarter, three CG/AR-supported graduate students successfully defended their research and respective thesis and dissertations. News came of the publication of a referred paper in July and another in September.

CG/AR research highlights this quarter include further development and testing of a parameter estimation method for the Equilibrium Moisture from Topography (EMT) model (for use in downscaling soil moisture patterns) by Mr. Werbylo within Prof. Niemann’s group. The performance of the EMT model and EOF method were compared. A portion of the work was presented on a poster at the 2012 AGU Fall Meeting. Within the Cloud, Icing, and Aerosols Effects theme, the work involving vertical structure profiles of precipitable water for use with cloud base prediction continued with cloud liquid water profiles being created. A journal paper of this effort is in preparation.

Ms. Loretta Wilson,  
Program Assistant to CG/AR

For more information on the DoD Center for Geosciences/Atmospheric Research at Colorado State University, please access our web page at http://www.cira.colostate.edu/research/dod/geosci.php
Colorado State University  
Center for Geosciences/Atmospheric Research  
Scientific Interactions May 2006 to Present

- Sonia Kreidenweis and Kelley Johnson with Doug Westphal, Piotr Flatau, and Marcin Witek (NRL/Monterey)
- Tom Vonder Haar and others with Mr. Robert Brown (ARL)
- Tom Vonder Haar and CG/AR researchers with Dr. James Cogan (ARL)
- Milija Zupanski and others with Jeff Tilley (UND)
- Andy Jones and Cindy Combs with Gary McWilliams (ARL) and Li Li (NRL)
- Steven Fletcher with Carolyn Reynolds (NRL), Dale Barker (NCAR), Brian Ancell (Univ. Washington), Ron Errico and others (NASA Goddard), and international colleagues
- Stan Kidder with Arlin Krueger (Univ. Maryland-Baltimore County)
- Steven Fletcher with Clarke Amerault (NRL)
- Andy Jones, Laura Fowler, Steven Fletcher, Manajit Sengupta, Scott Longmore, Tarendra Lakhankar, and Curtis Seaman with Dale Barker, Hans Huang, Qingnong Xiao, Jenny Sun, and Zhiquan Liu
- Large and small group interactions at the Annual Review, held at CSU/Fort Collins, including:
  Tom Vonder Haar, Ken Eis, Loretta Wilson, et al. with DoD Review Panel and invited attendees  
  Adam Kankiewicz with Pam Clark (ARL) and Ted Tsui (NRL)  
  Stan Kidder and Jeff Jorgeson (ERDC)  
  John Forsythe with Ted Tsui (NRL)  
  Pierre Julien and James Halgren with Jeff Jorgeson (ERDC)  
  Sonia Kreidenweis with Ron Pinnick (ARL)
- Steven Fletcher with Profs. Nancy Nichols and Alan O’Neil (Data Assimilation Research Centre, UK)
- Steven Fletcher with Dr. Amos Lawless (Department of Mathematics at the University of Reading) and Dr. Eric Andersson (ECMWF)
- Tom Vonder Haar with Patricia Phoebus, Joe Turk, Jerry Schmidt, Nancy Baker and Craig Bishop (NRL)
- Tom Vonder Haar with Philip Durkee (NPS)
- Mahmood Azimi with Mike Mungiole, Alan Wetmore, John Noble, Pam Clark, Sandra Collier and Dave Marlin (ARL)
- Curtis Seaman with Nancy Baker and others (NRL)
- Andy Jones and Steve Fletcher with Dale Barker (NCAR); Dennis Garvey, Jim Cogan, Alan Wetmore (ARL); Tim Nobis (AFWA)
- Yoo-Jeong Noh and Curtis Seaman with David Hudak (Environment Canada)
- CG/AR researchers and graduate students with James Cogan (ARL/WSMR)
- Steve Miller and Andy Jones with Michael Wynne (Secretary of the Air Force)
- Andy Jones with Gary McWilliams (ARL)
- Andy Jones with Dr. Ye Hong (Aerospace)
- Andy Jones with Mr. John Eylander (AFWA)
- Andy Jones with Dr. White (NOAA/ESRL)
- Andy Jones and Steven Fletcher with Bob Dumais (ARL)
- Andy Jones with Gary McWilliams (ARL)
- Andy Jones with Dr. Tom Greenwald (Univ. Wisconsin)
- Michael Coleman with Rick Shirkey (ARL)
- Andy Jones with Brian Skahill and Mike Follum (ERDC/CHL)
- Andy Jones and Adam Carheden with Rick Shirkey
- John Forsythe and Eric Guillot with Bob Dumais (ARL-White Sands Missile Range)
- John Forsythe with Lt. Col Vincent Rees (AFWA)
- Andy Jones with James Cogan (ARL)
- Andy Jones with Gary McWilliams (ARL), George Mason (ERDC), Jim Cogan (ARL) and Dr. Li (NRL)
- Stan Kidder with Prof. Phil Durkee (NPGS)
- Sonia Kreidenweis with Prof. Cathy Cahill (Univ. Alaska-Fairbanks)
- Andy Jones with John Eylander (AFWA)
- Andy Jones with Susan Frankenstein (CRREL)
- Sam Atwood with Pam Clark and others (ARL)
- Andy Jones with John Eylander (AFWA)
- Prof. Jeff Niemann with George Mason (GSL/ERDC)
- Yoo-Jeong Noh with Peter Rodriguez (Environment Canada)
- Yoo-Jeong Noh with Dr. G. Liu (Florida State University)
- Andy Jones, Tom Vonder Haar, Stan Kidder, Sonia Kreidenweis and Sam Atwood, Steve Reising, John Forsythe, Loretta Wilson with Dr. James Cogan (ARL), 3-day visit to CG/AR
- Sonia Kreidenweis with Prof. Cathy Cahill (Univ. Alaska-Fairbanks)
- Sonia Kreidenweis with Dr. Jeff Reid (NRL-Monterey)
- Andy Jones with Dr. Rick Shirkey (ARL)
- Sam Atwood at NRL-Monterey (hosted by Dr. Jeff Reid)
- Andy Jones, Sue van den Heever and Rob Seigel with Dr. Robert Haehnel (Army Cold Regions Research and Engineering Laboratory)
- Prof. Steve Reising with Dr. David Turner (NOAA National Severe Storms Laboratory)
- Andy Jones and Stan Kidder with Dr. Jeffrey Cetola and Mr. Steve Rugg (AFWA)
- Andy Jones with Mr. Gary McWilliams (ARL) and Mr. John Eylander (ERDC/CRREL)
- Andy Jones with Dr. Jeffrey Cetola (AFWA) and other DoD partners
- Prof. Tom Vonder Haar with Pamela Clark and James Cogan (ARL)
- Prof. Tom Vonder Haar with colleagues at NRL/Monterey
Research Theme: Hydrometeorology

Administrative

We are pleased to report that James Halgren (Pierre Julien, advisor) completed the requirements for the Doctor of Philosophy degree during this Fall semester, submitting his dissertation to the Graduate School. The research of this student was supported entirely by the DoD Center for Geosciences/Atmospheric Research.

Research activity and/or results

Prof. Jeffrey Niemann and Kevin Werbylo

During this quarter the EOF method was analyzed under conditions of spatially-limited data. Locations of observed soil moisture to be used in the development of regression relationships used in the EOF method were selected using (1) a random sampling method or (2) a stratified random sampling method based on the combination of the 10 terrain attributes considered in the EOF method. Similar to the EMT model, strategically selecting locations from which to calibrate the EOF method produces better performance than random sampling when the number of locations is small, whereas randomly selecting locations from which to calibrate the EOF method produces better performance when the number of locations is large. Although the threshold number of locations where random sampling overtakes strategic sampling in model performance is fluid between catchments it ranges from roughly 50 to 120 samples. This threshold is probably dependent on a number of variables including the level of influence of topography on the soil moisture pattern, the stability of the soil moisture pattern over time, and the variation of the mean soil moisture between dates. It can also be concluded that the EOF method performs better when the true spatial mean of the catchment is used in the method as opposed to the mean of only the sampled points. This is consistent with results when using the EMT model under similar conditions.

The next step in analyzing the EOF method under conditions of spatially-limited data will be to assess model performance when a combination of random and strategic samples are used to calibrate the regression relationships used in the model. In the end, we expect to see similar results as the EMT model, where the combination approach of sampling in space outperforms conventional random and stratified sampling. In addition, the EOF method will be assessed when data is limited temporally. The computer codes are already written to perform these analyses, so generating the results should not take a great deal of time during the next quarter.

Also during this past quarter, the performance of the EMT model and EOF method were compared when an equal number of randomly selected locations from each of the three test catchments were used to calibrate each method. The number of samples randomly selected at each of the catchments ranged from less than 10 to more than 200, with increments of about 10 to 20 samples. In general, the EMT model outperformed the EOF method when the number of samples in space was small, but the EOF method outperformed the EMT model when the number of samples in space was large. The threshold where the performance of the EOF method overtakes that of the EMT model is catchment dependent but was shown to range from roughly 40 to 100 samples. This suggests that although the EOF method has a greater maximum performance it is more dependent on large datasets than the EMT model.
A portion of the above work was presented on a poster at the 2012 AGU Fall Meeting. The focus of this presentation was the ability of the developed stratified sampling method to capture the spatial variability of the soil moisture pattern as compared to a simple random sampling method. As was mentioned above, we proposed that the stratified sampling technique captures the variability better than a random sampling technique when the number of observations in space is limited.

**Travel**

Kevin Werbylo traveled to the AGU Fall Meeting, held December 2-5 in San Francisco, California (funding was provided by another source).

**Equipment/systems status**

Nothing to report this period.
Research Theme: Clouds, Icing, and Aerosols Effects

Administrative

None this period.

Research activity and/or results

John Forsythe and Dr. John Haynes
This period continued developments in support of the paper entitled “Estimating Three-Dimensional Cloud Structure via Statistically Blended Satellite Observations.” Dr. Haynes contributed to several figures of the draft paper; specifically worked on the science and methodology used to generate the plots of sigma, the variance of cloud base height as a function of range for various cloud types, as well as normalized cloud water content profiles. New figures showing retrieved cloud 3D structure were created from the technique. A journal paper for Journal of Applied Meteorology and Climatology is being prepared. The figure below shows two synthesized cloud base cross sections across a typhoon.

Example of 3D cloud-field generation for Super Typhoon Choi-Wan, 0353 UTC 15 Sep 2009. (a) The MODIS cloud classification; the CloudSat ground track is shown by the purple line, and north is indicated by the arrow. (b) The MODIS visible image. The vertical extent of the uppermost cloud layer only is shown, as measured by CloudSat. Dashed lines are at 2-km intervals up to 10 km. The colors on the cross section correspond to the MODIS cloud type at cloud top from (a). (c),(d) The uppermost cloud layer is reconstructed along a line (brown) at two different oblique angles to the CloudSat track, respectively.
Work continues on using the retrieved base and top to distribute the MODIS 2-D cloud liquid water path results into 3D profiles, away from the CloudSat track.

**Travel**

Prof. Tom Vonder Haar was an invited guest to the dedication ceremony of the Marine Meteorology Center of the Naval Research Laboratory in Monterey, CA on October 12. He met with colleagues concerning current and ongoing collaborative research.

Tom Vonder Haar also traveled to attend the Fall Meeting of the American Geophysical Union in San Francisco, CA, December 2-6.

**Equipment/systems status**

Nothing to report.
Research Theme: Environmental Modeling and Assimilation

Administrative

None this period.

Research activity and/or results

There was no reportable research activity during this quarter.

Travel

None this period.

Equipment/systems status

Nothing to report this period.
Research Theme: Urban and Boundary Layer Environment

**Administrative**

None this period.

**Research activity and/or results**

There was no reportable research activity during this quarter.

**Travel**

None this period.

**Equipment/systems status**

Nothing to report this period.
Research Theme: Remote Sensing of Battlespace Parameters

**Administrative**

None this period.

**Research activity and/or results**

There was no reportable research activity during this quarter, however, we are pleased to report that Lance VandeBoogart (Tom Vonder Haar, advisor) successfully defended his masters thesis on October 18, and Robert Seigel (Sue van den Heever, advisor) successfully defended his Ph.D. dissertation on October 26. The research work of both these graduate students was supported almost entirely by the DoD Center for Geosciences/Atmospheric Research.

**Travel**

None this period.

**Equipment/systems status**

Nothing to report this period.
Research Theme: Technology Transition and Interactions

Publications

The paper “Simulated Density Currents beneath Embedded Stratified Layers” by Rob Seigel and Sue van den Heever was published in the July issue of JAS.

The thesis research of Geoffrey Krall (defended November 1, 2010) was published in September in Tropical Cyclone Research and Review with additional effort by Prof. William Cotton and Gustavo Carrio (Department of Atmospheric Science).

Presentations

### Appendix 1

#### CG/AR Researchers under Cooperative Agreement W911NF-06-2-0015

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Appendix 2
Publications

(The following were supported under CG/AR Cooperative Agreement W911NF-06-2-0015. Readers may also want to review the publications list from the previous Cooperative Agreements, DAAD19-02-2-0005, DAAD19-01-2-0018 and DAAL01-98-2-0078.)


Fletcher, S.J., and M. Zupanski, 2007: An alternative to bias correction in retrievals and direct radiances assimilation. Pre-print CD-ROM, 11th Symposium on Integrated Observing and
Assimilation Systems for the Atmosphere, Oceans, and Land Surface (IOAS-AOLS), January 13-19, San Antonio, TX (AMS).


Information Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, January 14-18, San Antonio, TX (AMS).


Symposium on Recent Developments in Atmospheric Applications of Radar and Lidar at the 88th AMS Annual Meeting, January 20-24, New Orleans, LA (poster).


