W O R L D   M E T E O R O L O G I C A L   O R G A N I Z A T I O N

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RGB DEVELOPERS AND USERS WORKSHOP

Hosted by CIRA, NOAA, EUMETSAT, and WMO

18-20 OCTOBER 2022

Fort Collins, Colorado, USA

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EXECUTIVE SUMMARY

The Fourth RGB[1] Developers and Users Workshop was hosted by CIRA, NOAA, EUMETSAT, and WMO on 18-20 October 2022 in Fort Collins, Colorado at CIRA. The last RGB Experts and Developers Workshop occurred in Tokyo, Japan, November 2017. Since that time, NOAA NWS forecasters have adopted the use of Red/Green/Blue (RGB) displays from the GOES-16/17 ABI in addition to VIIRS and other platforms, and international colleagues continue to develop new RGBs from instruments such as the Himawari AHI and learn new RGB applications from various platforms. The primary goal of this workshop was to share knowledge on RGB applications and to prepare for the upcoming MTG FCI and EPS-SG Metimage instruments. The event had 35 in-person and 34 virtual participants from all six WMO Regions and was organized in cooperation with the WMO-CGMS Virtual Laboratory on Education and Training in Satellite Meteorology (VLab).

The objectives of the workshop were:

- Review and document RGB composite standards with the measurement capabilities of new-generation imager
- Share use cases and lessons learned of RGBs using new-generation imagers
- Demonstrate the value of RGBs in applications (alongside products, NWP)
- Compile guidance documents
- Compile demonstration and training material

Participants of the workshop agreed on Immediate Recommendations:

1. The WMO SSU to consider creating a WMO RGB working group to address ideas and issues brought up in the workshop.
2. Rename the “Day Land Cloud Fire RGB” to the “Day Fire RGB” and rename the “Natural Color RGB” to “Day Land Cloud RGB”.
3. Conduct the in-person RGB Workshop every two years.
4. Organize RGB recipe information into categories. The first framework drafted during the workshop is shown in section 4.1.
5. Develop content for web pages and training to encourage coordination and collaboration among RGB developers, trainers, and users. We expect to utilize the WMO SSU, the WMO Education and Training Programme, and the WMO-CGMS VLab.

See additional recommendations in section 4.2.

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[1] RGB (Red-Green-Blue) satellite products (or composites) refer to satellite imagery with the information content of multiple spectral channels mapped against an RGB colour scheme, for optimized visualization while at the same time preserving pattern and texture of atmospheric (e.g., cloud) and surface features, as well as continuity over time.

0. INTRODUCTION

The three-day workshop, jointly organized by CIRA, NOAA, EUMETSAT, and WMO, opened at 09:00 on 18 October 2023 at CIRA in Fort Collins, Colorado, USA. It was the fourth in a series of RGB-related community events after 2007, 2012, and 2017[2], all of which resulted in agreed RGB composite standards used in operations, training, and research. Since that time, NOAA NWS forecasters have adopted the use of RGB displays from the GOES-16/17 ABI in addition to VIIRS and other platforms, and international colleagues continue to develop new RGBs from instruments such as the Himawari AHI and learn new RGB applications from various platforms. The primary goal of this workshop was to share knowledge on RGB applications and to prepare for the upcoming MTG FCI and EPS-SG Metimage instruments. The event had 35 in-person and 34 virtual participants from all six WMO Regions (see list of participants in Annex I and the agenda in Annex II). It was organized in liaison with the WMO-CGMS Virtual Laboratory for Training and Education Training in Satellite Meteorology (VLab).

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[2] information and final reports from the meetings can be found on the following WMO Space Program Community web page: https://community.wmo.int/en/rgb-workshop

In his opening remarks, Dan Lindsey, the NOAA/NESDIS GOES-R Program Scientist, welcomed in-person attendees especially those that have travelled long distances from 11 countries to be in Fort Collins. He also recognized online participants that are joining in from multiple time zones. We are pleased to have representation from all six WMO Regional Associations for this RGB workshop. Next, Steve Miller, Director of CIRA, welcomed everyone to the newest building on the CSU Foothills Campus. One of CIRA's goals is to connect satellite observations with models. In the context of this meeting, it is also important to connect observations to human interpretation. The RGBs can provide both qualitative and quantitative information. He encouraged everyone to enjoy the Colorado Fall weather and to have a productive meeting.

Next, Bernie Connell, CIRA Training Lead and a WMO-CGMS VLab Co-Chair welcomed participants and shared a video on the CSU Land Acknowledgment. "The statement recognizes the long history of Native peoples and nations that lived and stewarded the land where the university now resides. The land acknowledgment statement also maintains the connection Native people and nations still have to this land." https://landacknowledgment.colostate.edu/ Bernie also emphasized that the main purpose of a workshop is to exchange ideas and we should strive for openness, and for everyone to contribute.

Mark Higgins from EUMETSAT reminded the group that Meteosat Second Generation (MSG) -1 was retired this past year. The launch of that satellite in 2002 and the use of the SEVERI sensor was the beginning of the RGB popularity for their users and for this workshop. He pointed out that the global community has been open to RGB usage and to sharing recipes and information to other satellites, AHI, ABI, AMI and soon for FCI. He looks forward to learning and sharing during the next 3 days of the workshop. Next, Heikki Pohjola, the Science Officer from the WMO Space System and Utilization Division stressed the importance of the workshop to review existing RGB standards. Keep in mind that less developed countries often have limited access to data and RGBs may be a valuable tool for them to use. He looks forward to the group building on the knowledge from previous workshops and providing an updated user guide for the community.

In-person and virtual attendees introduced themselves, where they were from and what they do. The list of attendees is attached as Annex I and the agenda in Annex II.

Presentations and background documents are available on the meeting website hosted by CIRA: https://www.cira.colostate.edu/conferences/rgb_workshop/

1. RGBS FROM NEW GENERATION GEO IMAGERS

1.1 NWS Operational RGB Usage in the Northern Plains of the U.S. - Carl Jones (NWS, Grand Forks, ND, USA)

Carl Jones presented results from a usage survey (73 participants) as well as forecast challenge areas in which RGBs have been useful. These areas include blowing snow during the day, melting snow, distinguishing fog and low stratus at night, convective initiation (night and day), identifying air masses, and detecting fires, smoke, and blowing dust.

Questions and comments in the discussion focused on:

1) software limitations that may change a regional RGB recipe and associated documentation, for example the Day Snow Fog RGB used in AWIPS in the USA;
2) the benefits and limitations of the user adjusting the ranges of the RGBs to assist in detecting the feature of interest and in particular desirable local tuning;
3) the use of the Day Cloud Type versus Day Cloud Phase RGBs;
4) creating training that captures user expertise to modify or use pre-set RGB ranges to use in real-time applications.

1.2 User Support Activities for RGB Composites and the Plan of Himawari-9 - Taro Handa (JMA)

Dan Lindsey expressed deep appreciate to JMA for allowing the USA access to Himawari-8 data prior to the launch of GOES R/16 and for sending Taro Handa to this RGB workshop. Mr. Handa (JMA) provided the current status of Himawari satellites, the wide range of users, Himawari Request Service, a comparison of Himawari-8 and -9, and the current plan for transitioning the role of operational satellite to Himawari-9. User support activities at JMA were discussed, including training events and quick reference guides for RGB composite imagery.

The JMA webpage for Himawari RGB Quick Guides was shown, scroll down the page to see a link for Himawari RGB Quick Guides "by-purpose":

The JMA Meteorological Satellite Center Technical Note "Introduction to RGB composite imagery by Himawari-8" (A. Shimizu, OCT 2020) is also available for reference.

JMA promotes the use of SATAID (SATellite Animation and Interactive Diagnosis), a sophisticated display software used to visualize meteorological information in multiple spatial and temporal dimensions, which assists forecasters to analyze and continually monitor weather parameters and phenomena for better meteorological services. A very interesting example was presented from the eruption of Fukutoku-Okanoba in August 2021. There was a significant amount of pumice that was ejected and needed to be tracked for many months for marine safety and for island safety cleanup upon landfall on various islands.

JMA will host the virtual 12th Asia Oceania Meteorological Satellite Users' Conference (AOMSUC-12) next month, 11-18 November 2022.

Questions and comments in the discussion focused on:

1) For the noted differences in bands between Himawari 8 & 9 and the adjusting of the RGBs to still represent the 'original' colors of the features, at what point do we accept the changes and adjust the training. We saw a little of this with ABI and may see more with FCI, so this is an important consideration for all.
2) With the Korean satellite GEO-KOMPSAT and Himawari close in position, are the benefits of 3-Dimensionsal usage of the imagery being realized, particularly for cloud height?

1.3 Planned RGBs using MTG/FCI – Ivan Smiljanic (EUMETSAT)

Ivan Smiljanic (EUMETSAT) discussed the benefits of the METEOSAT Third Generation (MTG) Flexible Combined Imager (FCI) and the expected advancements to RGB composite imagery. This includes plans for RGBs that were previously not possible with the SEVIRI instrument, ideas for new RGBs with specific forecasting challenges in mind, and improvements to the standard set of RGBs due to higher spatial and temporal resolution. We particularly look forward to observing the high 1 km spatial resolution imagery in the IR (3.8 and 10.5 um). Example imagery was shown throughout for better detection of aerosols, sea spray, dust and smoke, particularly over water. There is more to learn about what is termed 'ocean color'. Both the color and the shape of the feature are important!

New with FCI: True Colour RGB, Cloud Phase RGB, Cloud Type RGB, Fire Temperature RGB
Aspirational products: Low Level moisture, Fire RGBs
Improved: Dust RGBs, 24hr and Night Microphysics (more detailed features)

Questions and comments in the discussion focused on:

1) Should we have RGBs that are very good at one thing? Like blowing snow or low-level moisture for example?
2) Or should we just go crazy with the colors; can the forecasters understand what is going on?
3) For the product usage, does it depend on the scene context and what the application is? There were multiple responses of yes. In some cases, contextual information is needed to assess the situation and in other cases, the user wants to isolate and highlight the feature.
4) How do we better address the RGBs for usage in the tropics, mid, and high latitudes?

2. NEW RGBS BASED ON NEWLY-AVAILABLE CHANNELS IN GEO

2.1 RGB Usage at the NWS Ocean Prediction Center - Michael Folmer (NWS/OPC)

Michael Folmer (NWS/OPC) discussed the use of RGB products in NWS Ocean Prediction Center operations. Examples provide insight into how satellite imagery is incorporated into surface analysis, storm-force versus hurricane-force diagnostics, extratropical and tropical transitions, fog analysis, marine convection, and dust diagnostics.

Questions and comments in the discussion focused on:

1) The Airmass RGB was featured in the examples. Is the 9.6 um band crucial to identify the features that are being tracked?
2) Is the Airmass RGB providing an overlay of water vapor features on top of features caught in the infrared?

2.2 RGB Research at NASA/SPoRT - Emily Berndt (NASA/SPoRT)

Emily Berndt (NASA/SPoRT) discussed RGB research and training activities at NASA/SPoRT. This included the development of interactive modules, quick guides, and quick briefs, and involvement in the assessment of several products. Limb-corrections and intercalibration have been tested to account for the impact of high viewing angles and differing spectral characteristics. This has led to improvements across several RGBs. Ongoing research involves applying machine learning to RGBs for feature detection. Their dust assessment for Nighttime Microphysics RGB, Dust RGB, Day Cloud Phase Distinction RGB indicate that early proxies and training for new capabilities is extremely important.
Questions: At what point do we let machine learning and AI take the reins? A forecaster with expertise can adapt to do a mental intercalibration. AI can be very useful in helping tease out answers to questions on the frequency and extent of events, reinforce expertise, and aid in training entry level forecasters.

2.3 RGB Perspective from a Forecaster-Turned-Researcher - Bill Line (NOAA/NESDIS)

As a former forecaster and now researcher, Bill Line (NOAA/NESDIS) shared his perspective on RGBs, including current use of RGBs in NWS Weather Forecast Offices and the value they provide to forecasting over previously used products. Example imagery was shown for several applications. Plans for new multispectral imagery products were shared along with a discussion of RGB recipe modifications by users and the reasoning behind them.

RGBs routinely used: Day Cloud Phase Distinction (DCPD) RGB, Nighttime Microphysics RGB, GeoColor
RGBs for situational use: VIS/IR sandwich, Dust RGB
New/future multispectral imagery products: sea spray, blowing snow, RGBs with Geostationary Lightning Mapper (GLM), other combinations with GLM, combined day/night RGBs, etc.
Applications: general cloud analysis, convective initiation, snow squall, frost, hail swaths, storm top analysis, blowing dust detection, matchup of RGBs with level 2 quantitative products.

2.4 Color Vision Deficiency and Interpreting Satellite RGBs - Katie Crandall Vigil (CIWRO & NWS Training Center)

Katie Crandall Vigil (CIWRO & NWS Training Center) described color vision deficiencies and the forecasting challenges that may arise when using RGBs. Color vision deficiency is an inability to see certain shades of colors and there are various forms of color vision deficiency, both of which can be present to individuals on a spectrum. The outcomes of the recent Operations Proving Ground Evaluation were discussed, such as use of a color blindness simulator, color blind apps for phones, color glasses, The discussion also included feedback on user preferences and when characteristic information in an RGB may be difficult to decipher for a subset of forecasters. Next steps include creating a working group to identify RGBs requiring a modified option for users with color vision deficiency.

2.5 RGB Related Training Materials of EUMeTrain & Comparison of RGB Recipes - Maria Putsay (EUMeTrain, Hungary

Maria Putsay (EUMeTrain, Hungary) provided an overview of RGB training materials available on the EUMeTrain webpage, including training modules, webcasts, case studies, quick guides and RGB colour guides. A new RGB Tool developed to help analyze the components in an RBG image displayed on a webpage was demonstrated. (from eumetrain.org select "All resources", "Download RGB Colour Tool") Comparison of the various RGB recipes for different sensors suggests a need for standardization in how RGBs are presented. In particular, there was confusion on the definition of the gamma value and the way the ranges of the various components are presented. The effect of the background on color appearance and the role of the sensitivity of the human eye in RGB development were also discussed. A list of the RGBs used across the globe was presented and is further discussed during the day 3 morning session. The list is attached as Annex III.

2.6 Fire Detection RGBs and others under development - Curtis Seaman (CIRA)

Curtis Seaman (CIRA) discussed the value of satellite imagery in fire detection applications. The Day Land Cloud Fire RGB (also known as the Natural Fire Color RGB) and Fire Temperature RGB were introduced and compared to other products for fire detection information. Advantages can be seen in identifying hotspots, smoke, and burn scars, as well as other features that may impact forecasting (e.g. frontal passage changing the direction of fire travel).

His goal in developing RGBs is to maximize information in an image by improving the scaling to reveal new features.

2.7 Application of RGB Composite Imagery in the Asia / Pacific Ocean Region - Bodo Zeschke (Australia BoM, virtual), and Rion Salman (BMKG, in-person)

In the first part of this joint presentation, Bodo Zeschke (Australia, BMTC) looked at the popularity of various RGB composites and their impact across the Asia / Pacific Ocean region. The eruption of the Hunga Tonga-Hunga Ha'apai volcano was an example of how RGBs have been adapted to local case studies. Archived case studies utilizing RGB composite data are located on the Australian VLab CoE Regional Focus Group webpages. A quick guide for teaching the "mechanics" of RGB composites is also available. During the second part of the presentation, Rion Salman (Indonesia, BMKG) discussed the Day Cloud Phase Distinction RGB, including the main applications, recipe, and color interpretation guidance. A convective initiation example demonstrated how the RGB is used in tropical regions in comparison to other products.

2.8 RGB Usage in Africa

Lee-ann Simpson (COMET, South Africa) presented RGB usage and forecasting challenges across different regions in Africa, with examples from Niger, Morocco, Kenya, and South Africa. Satellite imagery and RGBs for forecasting is very important, with each region having particular physical and topographical needs. Common applications include monitoring convection, tracking air mass/weather systems, and dust detection.

Essential RGBs are ones that give information on cloud top temperature, cloud development and decay. Integration of RGB with other data sources (satellite products, precipitation, lightning, radar) is crucial. What are the training needs and what can we do to improve RGB utilization?

Day Natural Colors (easy to interpret) ideal for identifying convection
Day Microphysics RGB and Nighttime Microphysics RGB are used for identifying fog and low cloud
Convective Storms RGB
Air Mass RGB for approaching mid-latitude systems
Dust RGB

Discussion topics:
Strengths and limitations of EUMETCast Africa and comparison with other GEONETCAST systems. Tailoring RGBs for tropics vs mid-latitudes and how they are represented and labelled – a good topics for the open space discussions.

3. OPEN SPACE

The Open Space session that occurred on Day 2 of the workshop amounted to a series of participant-chosen topic breakout sessions, where a subset of the participants discussed and brainstormed ideas. These discussions were only available for in-person attendees and were not recorded. Instead, a note-taker was chosen for each one, and the resulting notes are summarized below. Following the breakouts, the summaries and take-home points were presented to the full group by the session leads (noted in parentheses next to the topics below), and recommendations were agreed upon. This is documented in Section 3 below.

3.1 Standardizing Tropical RGBs and Warm Rain Detection (Jose G.)

Challenge: How to generate an RGB that helps with warm rain processes.
There are 2 options:
a) Non cirrus case (no blocking by high clouds)
-Explore the effects of particle size, microphysics and optical thickness of clouds.
-Explore cooling and warming rates in low and mid-tropospheric clouds.
-Consider orography and effects on the cooling rates of clouds.
-Consider winds, especially where there is orography (onshore, upslope).
-Consider using artificial intelligence/machine learning to find a recipe.
-Consider precipitable water.
b) Cirrus case (blocking from high clouds)
-Consider incorporating Microwave (total precipitable water (TPW) and Advected Layer Precipitable Water (ALPW). Look at what is done in the Ensemble Tropical Rainfall Potential (eTRaP) project (https://www.ssd.noaa.gov/PS/TROP/etrap.html).
-Consider winds, especially enhancement when onshore/upslope.
-Consider satellite-derived stability indices; in Africa they use them together with TPW.

Recommendation - Developers are invited to explore RGBs suitable for warm rain processes. These may use AI/ML or microwave. This is also a theme in training RGBs in tropical regions

3.2 Polar Satellite RGB Visualization (Emily B. and Bozena L.)

Recommendation: To encourage use of RGBs derived from polar-orbiting satellites:

- Continue to develop limb correction and intercalibration approaches for both polar and geostationary sensors to improve data utilizations especially in the high latitudes whether data are integrated (GEO & LEO) or available independently per sensor.
- data latency and timeliness are key to use of polar-orbiting satellites and should be considered in training
- development of an alert for users to know when data for polar-orbiting satellites are available
- there is a need for a visualization platform for users to easily view and access polar-derived RGBs.

3.3 Multi-purpose Naming Conventions for RGBs

Recommendations:

- Rename the Day Land Cloud Fire RGB to the Day Fire RGB (USA/NOAA)
- Rename the Natural Color RGB to the Day Land Cloud RGB (EUMETSAT to match the USA). This will likely be a phased process that will be adopted over time with the acceptance of imagery from the new FCI sensor.

3.4 Recipe Standardization (1/gamma, etc) (Jose G.)

Recommendations for:

I. Presenting RGB Recipes

- Replace "Min-Max" label with "Range". Min and Max can be confusing if the scale is reversed. I.e. [30C .. -20C] is reversed
- Replace word "inverted" with "reversed". Inverted could be confused with 1/x. Include the word "reverse" on an additional column as a header, and indicate with a "check" if the scale is reversed. Place it immediately to the right of the "range", before the units. There were discussions on the possibility of this being confusing due to the double negation, but majority voted for keep the "reverse" term to reinstate that the scale is reversed. *(from the 3rd day discussion – a) if reversed is indicated as an 'r' it could be confused with reflected component 'r' which is used by some organizations. b) the use of whether the numbers were already reversed or needed to be reversed was again brought up as a significant concern)* (Note – This needs further discussion)
- Decimal places: Use one decimal.
- Reflectance units: Always use percentages.
- Temperature units: Use °C for quick guides. Developers can have °K. (Note – This needs further discussion although it may be related to either the background research information or the satellite operator documentation))
- If someone implements Zenith angle correction in an RGB this needs to be specified in the channel/component - otherwise we assume not corrected

II. How to convey the Gamma parameter/correction (Note – This topic needs further discussion.

- Include the format of the equation on the header (so it is explicitly stated whether the value included will be used as x or 1/x)
- Limit the value to 2 decimal places

Note: Based on the discussion on the third day, it was apparent that there was disagreement on how to present various types of information, in particular the range, inverted/reversed, and the gamma value. Keep in mind that the overall goal is clarity for users who program the RGBs and users who interpret the RGBs.

3.5 Downscaling (Dan L.)

Hama would like to get as high a resolution as possible for fog detection at night. We discussed that downscaling requires at least one of the channels in the recipe to be at a higher resolution than the other. For FCI and the nighttime microphysics, all of the input bands for the fulldisk (MTG-I1) will be at 2 km. For MTG-I2, the 3.9 and 10.5 bands will be available at 1 km, which is only available for the rapid scan sector which only includes Europe and far north Africa.

In the EUMETSAT Africa Product User Guide (PUG) document, we found mention that a 1x1 km nighttime microphysics RGB will be provided to Africa users. We are sceptical that the information is accurat**e. Ivan and Mark will check it.**

We also speculate that the Day Microphysics RGB from SEVIRI may be a good candidate for upscaling if the HRV band is substituted for the 0.8 band. However, the microphysics information (phase and particle size) is provided through the 3.9 um band, which is currently at 3 km resolution. We wonder that upscaling would be very useful although worth a try.

3.6 Training - new ideas, repository, etc (Kevin T. and Jose G.)

- Start with providing foundational/basic information of imagers and reflectance from atmospheric windows.
- Provide a hands-on exercise for a case study and show the individual components of the RGB.
- Create a central repository for training materials.
- Apply AI/ML to objectively identify features on a pixel level for the RGBs. Would need a very large dataset with lots of training data sets and would benefit from International collaboration.
- Present the RGB with the bands/components that make up the RGB.
- There are many lists and guides for RGBs, although forecasters often approach them from a problem based format. Provide training by topic.
- A satellite applications course would be very helpful, something similar to the United States Weather Service Radar Applications Course (RAC). RAC already uses satellite data, but might need a dedicated course
- Use a multi-tiered training approach with the lowest level being the individual bands, then working our way up to more complex applications and products.
- Include options and tools for people with color deficiencies.

3.7 Color Bars for Users (Ty H.)

- People have different perspectives on what color should account for. Example: Cloud tops are high up in the atmosphere at say 27,000 ft. The color red is related to higher values, so let's make it red. But, others see it as the temperature at the cloud top is very cold and blue is related to cold, so let's make it blue.
- How do certain colors become the decided color for an RGB? Should there be a specific group that does this?
- Sometimes there are qualitative values (example: airmass) where a continuous color scheme is used. Some of the colors are hard to determine.
- Can training about color tables be made to enhance forecasters' perspectives?
- Continue to explore single channel overlays to highlight information

3.8 AWIPS / GFE - Derive Sky grids from Satellite

This is a local staff effort to develop a tool to import satellite imagery directly into the sky cover forecasting parameter in the USA NWS forecasting process

3.9 Validating RGBs and Testbeds and Proving Grounds for RGBs (Emily B.)

A monthly meetings of experts (3T Forum) is run by Ivan Smiljanic. Email Ivan if you are interested and he will add you to the list.

THE RGB test bed is a good idea (differences in Europe vs US); the biggest problem is the visualization. The ´3T Forum´ is a small scale testbed.

In creating new RGBs, which approach is better? ´Bottom up´ or ´Top down´, ie do users ask for new RGBs to be developed/validated or do developers provide a new RGB for an identified gap? Reaching groups that will try them is important.

NESDIS/STAR Imagery team could play a role.

Designate a repository for sharing useful and user vetted RGBs.

Provide a community blog where people can contribute examples.

It is important to note that if the RGB is useful and comfortable to use, it will be more readily accepted. Validated RGBs may be out there but are too complex for users to use.

Note: Develop RGB readiness levels using the test bed process as a template. Gather evidence of use that includes strengths and weaknesses, and cite that in the readiness document.
Encourage collaboration between testbeds.

3.10 Satellite app, GIS format, VDS (Visual Display Systems) RGBs (Jose G.)

Requests:
For SLIDER:
- Fix the latitude longitude grids when zooming in to 1 km on the fulldisk domain.
- Develop a new method for downloading imagery so:
    a) Individual png images can be retrieved in a zipped file
    b)The file name includes the timestamp (YYYYMMDDHH:MM)
- Consider speeding up the latency
- Set the default of images to 4, instead of 12 (bandwidth)
- Consider including Precipitable Water Products
- Consider including other key products widely used in Latin America and the Southern US (Galvez-Davison Index?)
- Consider adding other RGBs that are commonly used in Himawari and Meteosat regions (to be discussed with nations)
- When going into the archived data, avoid loading images before defining the complete selection.
- Consider adding specific RGBs for specific sectors on the RAMSDIS website, outside of Slider (e.g. https://rammb.cira.colostate.edu/ramsdis/online/rmtc.asp), which are faster to load and occupy less storage space. Example: Blowing snow RGB for a new domain in Southern South America. No need to include it in SLIDER Full Disk as it would not be applicable to most locations. Also, revisit why the archive in this particular website is not 4 weeks anymore?
-Morocco has developed a platform to ingest Meteosat data quickly. Might be good to talk to them.
- We need a repository for visualization techniques, code, formats (other than netCDF) such as GIS friendly formats

3.11 Multi-dataset RGBs (e.g., satellite, NWP, etc) (Bill L.)

- Idea of a LPW RGB
- Include L2 products as component of RGB (TPW, Cloud products, AOD)
- RGB with GLM. IR+FED+MFA was tested in HWT in 2019, but did not gain traction. Bill created FED/MFA RGB but this has not been tested. Idea of RGB that combines FED and GLM-QC variable.
- NWP and RGBs. Ideal method is to view available RGBs with NWP overlays. DCPD RGB + NWP SFC Vorticity, NightMicro RGB + NWP LL Moisture Layer, True Color Imagery + HRRR Smoke (semi-trans).
- Discussed using NWP field as a RGB component, but realized issues/roadblocks (resolution differences - spatial and temporal, some NWP variables would be difficult to assign bounds)

Note: integration could be helpful … in the future will see outcome from testbeds and cases - good ideas to pursue …

3.12 Himawari-9 RGB Adjustments (Dan L.)

- The Spectral Response Functions (SRFs) are different between AHIs

- We suggest that JMA check the Night Microphysics, Day Microphysics, and Fire Temperature RGB to see how much those differ (since they use the 3.9 band) between H-8 and H-9

- In Taro's example, the H-9 version of Day Convection may actually be better than the H-8 version due to better cloud contrast, but a more careful look is needed

- Action for Taro: provide more examples to Rion and Bodo before we can recommend for sure if adjustments to the RGB recipes are needed

Recommendation: Continue to explore when and where RGB comparison matters for different spectral characteristics

3.13 Color deficiencies, sharing niche RGBs (Bill L.)

- Best option (when possible) may be to start with a first guess "CVD friendly" RGB, and trian the user to make slight adjustments to a point that works best for them, since CVD is a spectrum. For example, this would be possible to do in AWIPS.

- Taking tests for people for color vision deficiencies?
- Give a good first guess of whether this change in colors helps? If this is not meeting your needs how can we change the RGB?
- Color deficiency goes into the broader category of image interpretation?
- Understand what the science is telling them (forecasters). Color deficiency people rely on more of the science than the color of the RGB.
- Adjust the contrast of RGB help?
- The background of imagery can be affected with color deficiency.
- Involve culture for color? Other cultures perceive colors differently.
- Forecasters are worried that they will be judged for having color deficiency.
- Different RGBs for different products (dust, ice, fog, cloud type)? Example: dust is a pinkish color right now, but a light yellow is easier to see for some people.
- RGBs can sometimes be overwhelming for forecasters. Result in them just using the simple ABI channels.
- RGB test beds made to adopt main RGBs with some minor alternatives.
- Include options and tools for color deficiency people.
- Include color deficiency shift in the recipe document

3.14 Standards for True Color (Dan L.)

- The group recommends that any RGB applying the red to red, green to green, and blue to blue (including approximations/adjustments and Rayleigh correction to any of these) be referred to as "True Color RGB"

- EUMETSAT will attempt to phase out use of the term Natural Color RGB and adopt the term Day Land Cloud RGB

- NOAA and CIRA recommend applying a green component adjustment to the 0.51 band, by bringing in information from additional channels (0.8 µm. 0.55 µm and 0.4 µm).

3.15 Rise of AI/ML in Satellite Forecasting (Emily B.)

Many want to learn how other organizations use AI/ML products. The US is moving towards probabilistic forecasting and Artificial Intelligence / Machine Learning could help with that.

How to make training datasets
- Forecasters/experts circle or click on pixels to identify features
- Computer vision could help with this
- Human interpretation is key

Ideas for ML/AI
- Training applications: ML for language translation during synchronous events and translation of existing training to other languages.
- Blowing snow: tackle with self-organizing maps - take chunks of image and have forecasters answer yes/now for blowing snow. Pattern and colors unique in the image.
- Blowing snow may be a good project to have a student or intern, paired with a researcher and forecaster, help with training dataset creation.
- Warm rain processes are challenging. Suggest incorporating NWP and MW due to challenges with IR temperature associations with precipitable water for low cloud and cirrus/mulit-layer cloud issues.
- AI/ML for creating RGBs. 16 channels- all possible combinations. Let machine do the math to find the best combo or thresholds. Latin America task force to see if someone wants to take up the idea of RGB recipes or optimizing best channel combinations.
- Operations Proving Ground (OPG) did a mesoanalysis experiment – circle a place where CI will occur, or severe conditions (i.e., Severe Thunderstorm Warning or Tornado Warning). We should seek to obtain a training dataset to apply AI/ML for CI based on this RGB.
- Fire hot spot and alerts based on Fire Temp RGB –hot spot is lost in the background at times, especially with brush fires, fires in early stages, etc. Could you also send alerts to the forecaster similar to what is done with the NWS in alerting on a Tornado Vortex Signature?

3.16 Niche application support: Warm rain, blowing snow, ci, fire (Emily B. and Connor N.)

AI/ML could be useful for translating training to other languages, creating RGB recipes to find optimal bands or thresholds, addressing niche applications (e.g., blowing snow, warm rain, convective initiation, or fire hot spots), as well as address RGB interpretation limitations (e.g., dust at night).

Recommendation: AI/ML could be useful for translating training to other languages, creating RGB recipes to find optimal bands or thresholds, addressing niche applications (e.g., blowing snow, warm rain, convective initiation, or fire hot spots), as well as address RGB interpretation limitations (e.g., dust at night).

Might want to set up a satellite ML/AI working group (get researchers and operations at the same table) to address these niche topics and share best practices.

3.17 New things on FCI, especially the 0.91 band (Ivan S.)

Channel promising for:
- Dry line identification in general

- o Sea breeze
- o Gust fronts (dry pools of cold air), moisture in the dry regions (Middle East)
- o Convection nowcasting
- o Fog forecasting/nowcasting
- o Thin dust detection ('darker background' below)
- o 'return of WV' cases (pull of moisture from Gulf of Mexico)
- o Smoke likely less detected

What was done already:

- o HP Roesli and Ivan did a couple of cases, have RGB suggestions based on NIR0.9 (with or without SMT ratio (0.8/0.9 µm channels)
- o Curtis Seaman looked into some cases with MODIS
- o CIRA did a nice radiative transfer case for NIR0.91 channel (animation without clouds)

What can we do:

- o Check if 1km (vs 2km for BTD12-10 µm) would be very beneficial
- o Check if UVN (Sentinel-4) sounder could help with validation
- o Check the angle dependence of 0.904 channel (MODIS)
- o Think about further scientific questions we can answer

3.18 RGB Workshop frequency and WMO webpage (Bernie C.)

Recommendation on the RGB Workshop Frequency: Meet every two years: Personnel, technology, and user adaptations change rapidly necessitating interaction more frequently than every 5 years. Mark Higgins offered Germany as the location for the next workshop in October 2024.

- Webpage: Recommend a landing page hosted on the WMO Space program pages to provide visibility. It should include an introduction of what RGBS are, their usage, links to agencies, previous RGB workshop reports, and other relevant information.
  Note: After the workshop, the SSU pointed us to the RGB Workshop webpage on the community web pages that they maintain https://community.wmo.int/en/rgb-workshop. This report will be posted there.
- Content (to be determined, initial suggestions follow) to be put on Moodle Pages or linked in the Global Campus Library or both:
  Course content (topic, basic, advanced, expert)
  Existing quick guides, tools, publications, cases, modules, etc.

Considerations: Who will oversee the web pages and the moodle resources - volunteers?

Who makes the decisions on what content to include?

Recommendation to WMO SSU:

To consider creating a WMO RGB working group to address these and other issues brought up in the workshop.

3.19 RGB v/s HSL RGBs (Carl J.)

Jordan Gerth has worked with different color space techniques to create multi spectral imagery. He even had a presentation to illustrate and describe the different color spaces and examples of imagery in each.

He highlighted HCL/HSV may be superior in highlighting certain aspects (convection as an example) compared to RGB approach, by way of focusing on a particular desired feature and/or helping with color vision deficiency. (Note: HSL (for hue, saturation, lightness) and HSV (for hue, saturation, value are alternative representations of the RGB color model.)

Color space techniques other than RGB are confusing. There is fear of further confusion by users, and such would hinder use of potential products.

It is possible to transform HSV/HCL into RGB space within AWIPS (and probably other imagery software). Potentially easily done, but needs exploring if it is worth the effort.

Good candidates for HCL/HSV multispectral applications would be anything involving thin aerosols that have weak signals (thin smoke, sea spray, blowing snow, blowing dust).

4. REVIEW OF RGB STANDARDS

4.1 RGB Naming, Standardization, Recommendations for Variants of the RGB Composite Standards

This session of the 2022 RGB Developers and Users Workshop began with a brief introduction by Ivan Smiljanic and Maria Putsay. Prior to the workshop, Maria gathered information on the RGBs used by various organizations across the globe and compiled them into RGB_recipes_4_RGBworkshop_v2-Oct2022.docx. This document is in Annex III_a. Maria also organized the RGBs to compare what recipes are used by organizations and provided this information in RGB_recipes_comparison _4_RGBWorkshop_v2-Oct2022.docx. This document is in Annex III_b. Mark Higgins then joined Ivan and Maria to develop a framework to organize the RGBs. The group discussion helped to identify recipe similarities and variations and determine consistent naming for the RGBs commonly used by the global community. It was noted that there will be variations across satellites and sensors. The framework will provide the starting point for reorganizing the document provided by Maria and for the organization of materials on a new webpage for users and operational agencies to easily reference the information.

There was consensus among the group on the following RGB categories. Current naming conventions were reviewed and most were designated acceptable. The RGBs names that need additional discussion are noted. As noted in the previous paragraph, it is expected that there will be tuning of the RGB components to fit the satellite and sensors, region, and in some cases, the season. How to represent the tuning is a topic that needs further discussion.

Water Vapour:

a. AirMass RGB
    i. Variant I: AirMass RGB tuned for Tropical Convection or Overshooting Top for Tropical Convection. (This needs additional discussion as to the appropriate name and what channels it includes.)
b. Differential Water Vapour RGB
c. Simple Water Vapour RGB (This needs additional discussion on the name.)

24-hour Microphysics:

d. 24-hour Microphysics RGB
    i. Variant I: Dust RGB
    ii. Variant II: Ash RGB (This needs further discuss on including a Volcanic Emissions category. Can an RGB be listed more than once under different categories?)

Day Cloud Properties:

e. Day Microphysics RGB
f. Day Cloud Phase Distinction RGB (Note JMA calls this Cloud Phase Distinction)
    i. Variant I: Day Cloud Type (This needs additional discussion on what constitutes a variation and what constitutes a standard.) Additionally, the distinction

between these two look alike RGBs may be challenging for training. Until formal evaluation, should this go in an Annex?)

g. Day Cloud Phase RGB (from JMA)
h. Day Land Cloud RGB

Night Cloud Properties:

i. Night Microphysics RGB

High Resolution Imagery:

j. HRV Clouds {note the NOAA Day Cloud Convection uses the 0.64 km “high res” VIS with the 10.3 um. Are these similar enough and do we need to agree on a name?}
k. HRV Fog

{**Volcanic Emissions:** as a category to be discussed further}

l. SO2 RGB (For future discussion a proposal to rename this to Volcanic Emissions RGB since it can detect both SO2 and ash)
    i. SO2 variant from JMA
m. {Ash RGB (propose to include it here as well as in the 24-hour microphysics variant)}

Fire/Hot Spot Detection:

n. Fire Temperature RGB
o. Day Fire RGB (renamed from Day Land Cloud Fire RGB)

Convection:

p. Convection or Severe Storms RGB (Needs further discussion on which name to use.)
q. Day Cloud Convection {note 1: this was mentioned under High Resolution Imagery above: the NOAA Day Cloud Convection uses our 0.64 km “high res” VIS with the 10.3 um – so are these similar enough and do we need to agree on a name? note 2: as with other RGBs, this fits under more than one category and needs a discussion on how best to handle that}

Snow

r. Day Snow-Fog RGB
s. Others could go here too: Day Cloud Phase Distinction RGB
t. Snow RGB (EUM – VIS0.8/NIR1.6/IR3.9r)

Overshooting Tops: (potential new category to be discussed)

u. Day Deep Clouds (JMA)
v. Airmass RGB adapted for the tropics (This is another example of a potential RGB being included under two topics)

Multi-dataset:

w. Multi-dataset RGBs (not the typical RGBs): for example Geocolor. (Needs further discussion on how and where to represent.)

Color Vision Deficiency:

x. Airmass variant for color vision deficiency (Is there a name for this?)
y. Color Vision Deficiency (CVD) Dust RGB

The group reiterated that this list provides a framework to start the next iteration. It is not complete. Additional discussion on what constitutes a standard is needed. Is evaluation important? What type of documentation is sufficient? Is “we are using it because another satellite operator uses it” sufficient justification for a standard? Is “the satellite operator has it in their display system” sufficient justification to become a standard when no evaluation has been conducted?

4.2 Open Space Debriefs and Conclusions/Recommendations

In this session of the 2022 RGB Developers and Users Workshop the group rejoins to debrief on topics covered during the smaller Open Space sessions on Day 2 and the recommendations that evolved from those discussions. Topics include RGB recipe standardization, naming conventions, training aspects, validation and proving grounds, satellite applications, and many others.

Recommendation from 3.1 - Developers are invited to explore RGBs suitable for warm rain processes.

Recommendations from 3.2 - To encourage use of RGBs derived from polar-orbiting satellites, particularly in high latitudes, satellite operators and developers are encouraged to:

- Continue to explore when and where limb correction and intercalibration is appropriate to enhance the science and application from both polar and geostationary satellites.
- Develop or enhance visualization platforms for users to easily view and access polar-derived RGBs.
- Development an alert for users to know when data for polar-orbiting satellites become available

Recommendations from 3.3:

- USA will rename the Day Land Cloud Fire RGB to Day Fire RGB
- EUMETSAT will rename Natural Color RGB to Day Land Cloud RGB (matching US). This will likely be a phased process adopted over time following the acceptance of new imagery from the new FCI sensor.

Recommendation from 3.4:

- Presenting RGB Recipes (in a quick guide or in satellite operator documentation): Use one decimal place; use percentages for reflectance units; if a Zenith angle correction has been implemented, this needs to be specified in the channel/component.
- The position on units needs to be clarified. Researchers are likely to use degrees Kelvin in research papers. There is a need for further discussion for the purpose of quick guides and satellite operator documentation. For consistency, can degrees Centigrade be agreed upon for quick guides?
- There was much discussion on range, inverted/reversed, and how to convey the Gamma parameter/correction. There was disagreement on how to present various types of information. The overall goal is reference standards with the information presented consistently. It is outside the scope of this group to write program code standards. We do want the standards reflected in the quick guides. Mark commented that this discussion has occurred previously and will likely occur 10+ years from now. As we reorganize the recipe documentation, keep the information in it consistent across all satellite platforms. Quick guides may be more challenging when a display platform deviates from the documented recipe. The 3 topics (range, reversed, gamma representation) need to be revisited.

Recommendation from 3.16 (see 3.15 & 3.16 info)

- Explore the use of Artificial Intelligence/Machine Learning for translating training to other languages, creating RGB recipes to find optimal bands or thresholds, and addressing niche applications (e.g., blowing snow, warm rain, convective initiation, or fire hot spots), as well as address RGB interpretation limitations (e.g., dust at night).

Recommendation from 4.18:

- Conduct the RGB Workshop every two years. The personnel, technology, and user adaptations change rapidly necessitating interaction more frequently than every 5 years. Mark Higgins offered Germany as the location for the next workshop in October 2024.

Recommendation to WMO SSU from 4.18:

- The WMO Space program to host a 'landing' page on their webpages to provide visibility. It should include an introduction of what RGBS are, their usage, links to agencies, previous RGB workshop reports, and other relevant information.
  Note: After the workshop, the SSU pointed us to the RGB Workshop webpage on the community web pages that they maintain https://community.wmo.int/en/rgb-workshop. This report will be posted there.
- The WMO SSU to consider creating a WMO RGB working group to address ideas and issues brought up in the workshop.

5. TRAINING TOPICS

5.1 Data Access, RGB Creation, and Sharing of Resources for Translation

Marcial Garbanzo (UCR) and Diego Souza (INPE) discuss the results of the 2022 WMO RA III and RA IV Survey on the use of satellite data, the importance of data access for training on RGBs, and training approaches for RGB creation. The need for the translation of resources to native languages (e.g. Spanish, Portuguese) is also addressed. Software and visualization examples are shown and onclude how they are used on meteorological service webpages.

5.2 RGB Training Successes, Challenges, and Various Inclusive Approaches

This session of the 2022 RGB Developers and Users Workshop was a discussion around training experiences across the WMO regions. Training approaches that have enhanced the understanding of RGBs were shared, including starting at a base level with the physics, encouraging case studies and collaborative exercises, comparing RGBs and their components for a specific application, and the use of quick guides as reference material. Training challenges are also addressed, including time limitations and accommodating an audience with varying levels of expertise.

5.3 Planning for an Image Interpretation Event Week

This session of the 2022 RGB Developers and Users Workshop was an open discussion for brainstorming ideas on the format and topics to be covered in a future Image Interpretation Event Week. A projected timeline was mapped out:
Planning stage (6-8 months out)
Virtual event with a website for coordination
One focused topic/phenomena for a 1-2 hour session
Include an introduction to RGBs (satellite 101 type content)

5.4 Weather Briefing for RFG Sessions & Discussion

José Gálvez led a weather briefing to demonstrate RGB usage during a typical monthly session for the Regional Focus Group of the Americas and Caribbean. General topics include climate indices, atmospheric patterns and current weather using satellite imagery, and recent weather events. Following the weather briefing, the discussion turned to products displayed on SLIDER and other sites, the benefits of these informal sessions, who participates over time and their impacts, and how to encourage participation and new attendees.

6. CLOSING REMARKS

Dan Lindsey thanked CIRA technical and administrative staff for their superb efforts to ensure that the workshop ran smoothly: room setup, computer, webinar, and webpage support, and keeping us happy with snacks, beverages, and lunches. Both he and Mark Higgins mentioned that we made many connections and have a great list of recommendations. We are very appreciative of all who attended both in-person and online. Your contributions are valuable, and we look forward to continued collaborations and discussions.

ANNEXES I, II, IIIa, and IIIb

ANNEX I - PARTICIPATION

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ANNEX II

RGB Developers and Users Workshop Agenda

Co-Hosted by CIRA, NOAA, EUMETSAT, and WMO at CIRA in Fort Collins, Colorado, USA
October 18th – 20th, 2022

Day 1: 18 October 2022

Local Time	UTC	Topic	Speaker(s)
08:00 - 09:00	14:00 - 15:00	Convene/Set up/Light Breakfast at CIRA	
09:00 - 09:30	15:00 - 15:30	Welcome/Opening Remarks	Steve Miller (CIRA), Dan Lindsey (NOAA), Heikki Pohjola (WMO, virtual), Mark Higgins (EUMETSAT), Bernie Connell (CIRA)

Section 1 - RGBs from New Generation GEO Imagers

09:30 - 10:00	15:30 - 16:00	NWS Operational RGB Usage in the Northern Plains of the U.S.	Carl Jones (NWS, Grand Forks, ND)
10:00 - 10:15	16:00 - 16:15	Q&A and Discussion	All
10:15 - 10:30	16:15 - 16:30	Break	
10:30 - 11:00	16:30 - 17:00	RGB Usage from AHI by JMA	Taro Handa (JMA)
11:00 - 11:15	17:00 - 17:15	Q&A and Discussion	All
11:15 - 11:45	17:15 - 17:45	Planned RGBs using MTG/FCI	Ivan Smiljanic (EUMETSAT)
11:45 - 12:00	17:45 - 18:00	Q&A and Discussion	All
12:00 - 01:00	18:00 - 19:00	Lunch (catered at CIRA)	

Section 2 - RGB Operational Use and RGB Research

01:00 - 01:20	19:00 - 19:20	RGB Usage at the NWS Ocean Prediction Center + Q&A	Michael Folmer (NWS/OPC)
01:20 - 01:40	19:20 - 19:40	RGB Research at NASA/SPoRT + Q&A	Emily Berndt (NASA/SPoRT)
01:40 - 02:00	19:40 - 20:00	RGB Perspective from a forecaster-turned-researcher + Q&A	Bill Line (NOAA/NESDIS)
02:00 - 02:30	20:00 - 20:30	Break	
02:30 - 02:50	20:30 - 20:50	RGB user color challenges + Q&A	Katie Crandall Vigil (CIWRO &NWS Training Center)
02:50 - 03:10	20:50 - 21:10	EUMeTrain RGB activities + Q&A	Mária Putsay (EUMeTrain/Hungary)
03:10 - 03:30	21:10 - 21:30	Fire Detection RGBs and others under development + Q&A	Curtis Seaman (CIRA)
03:30 - 04:00	21:30 - 22:00	Break	
04:00 - 04:30	22:00 - 22:30	RGB Usage in Australia and Indonesia	Bodo Zeschke (Australia BOM, virtual), and Rion Salman (BMKG, in-person)
04:30 - 04:45	22:30 - 22:45	Q&A and Discussion	All
04:45 - 05:00	22:45 - 23:00	Session wrap-up	All

Day 2: 19 October 2022

Local Time	UTC	Topic	Speaker(s)
08:00 - 09:00	14:00 - 15:00	Light Breakfast at CIRA	

Section 2 - RGB Operational Use and RGB Research (continued)

09:00 - 09:30	15:00 - 15:30	RGB Usage in Africa	Lee-ann Simpson (COMET and previously SAWS, virtual)
09:30 - 09:45	15:30 - 15:45	Q&A and Discussion	All

RGB Developers and Users Workshop Agenda (continued)

Section 3 - Open Space

09:45 - 10:30	15:45 - 16:30	Open Space Agenda Building: description and selection of groups	Mark Higgins (EUMETSAT), all
10:30 - 11:00	16:30 - 17:00	Break	
11:00 - 12:30	17:00 - 18:30	Open Space Sessions (two - 45 minute sessions)	Various
12:30 - 01:30	18:30 - 19:30	Lunch (catered at CIRA)	
01:30 - 03:00	19:30 - 21:00	Open Space Sessions (two - 45 minute sessions)	Various
03:00 - 03:30	21:00 - 21:30	Picture & Break	
03:30 - 05:00	21:30 - 23:00	Open Space Sessions (two - 45 minute sessions)	Various
05:00 - 05:15	22:45 - 23:00	Session wrap-up	All

Open space description:

Open space is a structured process to enable wide-ranging dialogues, driven by the topics that we care about the most. The day will have a number of 45-minute sessions that run in parallel. We will build the detailed agenda at the beginning of the day. The agenda building will account for the issues that require more time, and for any clashes.
To prepare for the open space, think about the topics that you want to get the most from in the meeting. You may want to bring one or two slides that describe the challenge.
Each session will write their notes in a shared document.
At the end of the activity, we will condense our discussions along the following themes:

- Adjustment and extension of existing RGB standards
- Regional and seasonal variants of RGB composites
- Proposals for new RGB standards
- Naming conventions
- Best Practices

Day 3: 20 October 2022 Local Time	UTC	Topic	Speaker(s)
08:00 - 09:00	14:00 - 15:00	Light Breakfast at CIRA	

Section 4 - Review of RGB Standards

09:00 - 09:45	15:00 - 15:45	Open Space Debriefs and Conclusions	Mark Higgins (EUMETSAT), leads
09:45 - 10:30	15:45 - 16:30	RGB Naming, Standardization, Recommendations for variants of the RGB Composite Standards	Discussion led by Ivan Smiljanic (EUMETSAT)
10:30 - 11:00	16:30 - 17:00	Break	
11:00 - 12:00	17:00 - 18:00	RGB Naming, Standardization, Recommendations for variants of the RGB Composite Standards (continued)	Discussion led by Ivan Smiljanic (EUMETSAT)
12:00 - 01:00	18:00 - 19:00	Lunch (catered at CIRA)	

Section 5 - Training Topics

01:00 - 01:30	19:00 - 19:30	Data access, RGB creation, and sharing of resources for translation	Marcial Garbanzo (UCR, in-person) and Diego Souza (INPE, virtual)
01:30 - 02:00	19:30 - 20:00	RGB Training successes, challenges and various inclusive approaches	We anticipate contributions from each WMO Region
02:00 - 02:30	20:00 - 20:30	Break	
02:30 - 03:30	20:30 - 21:30	Planning for an Image Interpretation Event Week	Trainers
03:30 - 04:00	21:20 - 22:00	Live Weather Briefing	Jose Galvez demonstrating RGB usage and consecutive translation for a RFG session

Section 6 - Concluding Discussion

04:00 - 04:30	22:00 - 22:30	Review of Recommendations & Wrap-up	All

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RGB_recipes_4_RGBworkshop_v2-Oct2022.docx

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SEVIRI RGB recipes

Airmass RGB (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.2 – WV7.3	-25	0	K	1
Green	IR9.7 – IR10.8	-40	+5	K	1
Blue	WV6.2 inverted	243	208	K	1

Airmass RGB – for tropics (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.2 – IR10.8	-25	+5	K	1
Green	IR9.7 – IR10.8	-30	+25	K	1
Blue	WV6.2 inverted	243	190	K	1

Dust RGB (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 – IR10.8	-4	+2	K	1.0
Green	IR10.8 – IR8.7	0	+15	K	2.5
Blue	IR10.8	261	289	K	1.0

24-hour Microphysics RGB (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 – IR10.8	-4	+2	K	1.0
Green	IR10.8 – IR8.7	0	+6	K	1.2
Blue	IR10.8	248	303	K	1.0

Ash RGB (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 - IR10.8	-4	+2	K	1
Green	IR10.8 – IR8.7	-4	+5	K	1
Blue	IR10.8	243	303	K	1

Day Microphysics RGB (EUMETSAT recipe)

Colour beam	Channel	Range			Gamma
Red	VIS0.8	0	100	%	1.0
Green	IR3.9refl	0	60	%	2.5
Blue	IR10.8	203	323	K	1.0

Convection RGB or Severe Storms RGB (EUMETSAT recipe)

Colour beam	Channel difference	Range			Gamma
Red	WV6.2 – WV7.3	-35	+5	K	1
Green	IR3.9 – IR10.8	-5	+60	K	0.5
Blue	NIR1.6 – VIS0.6	-75	+25	%	1

Convection or Severe Storms RGB – for tropics (EUMETSAT recipe)

Colour beam	Channel difference	Range			Gamma
Red	WV6.2 – WV7.3	-35	+5	K	1
Green	IR3.9 – IR10.8	-5	+75	K	0.33
Blue	NIR1.6 – VIS0.6	-75	+25	%	1

Snow RGB (EUMETSAT recipe)

Colour beam	Channel	Range			Gamma
Red	VIS0.8	0	100	%	1.7
Green	NIR1.6	0	70	%	1.7
Blue	IR3.9refl	0	30	%	1.7

Natural Colours RGB (EUMETSAT recipe)

Colour beam	Channel	Range			Gamma
Red	NIR1.6	0	100	%	1
Green	VIS0.8	0	100	%	1
Blue	VIS0.6	0	100	%	1

HRV Clouds RGB (EUMETSAT recipe)

Colour beam	Channel	Range			Gamma
Red	HRV	0	100	%	1
Green	HRV	0	100	%	1
Blue	IR10.8 inverted	323	203	K	1

HRV Fog RGB (EUMETSAT recipe)

Colour beam	Channel	Range			Gamma
Red	NIR1.6	0	70	%	1
Green	HRV	0	100	%	1
Blue	HRV	0	100	%	1

Night Microphysics RGB (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 – IR10.8	-4	+2	K	1
Green	IR10.8 – IR3.9	0	+10	K	1
Blue	IR10.8	243	293	K	1

Night Microphysics RGB – for tropics (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 – IR10.8	-4	+2	K	1
Green	IR10.8 – IR3.9	0	+5	K	1
Blue	IR10.8	273	300	K	1

FCI proxy RGBs

Cloud Phase RGB (EUMETSAT recipe)

Colour beam	Channel	Range			Gamma
Red	NIR1.61	0	50	%	1
Green	NIR2.25	0	50	%	1
Blue	VIS0.67	0	100	%	1

Cloud Type RGB (Andrew Heidinger's recipe)

Colour beam	Channel	Range			Gamma
Red	NIR1.38	0	10	%	1.5
Green	VIS0.67	0	80	%	0.75
Blue	NIR1.61	0	80	%	1

Fire Temperature RGB (VIIRS recipe)

Colour beam	Channel	Range			Gamma
Red	IR3.7	273	333	K	0.4
Green	NIR2.25	0	100	%	1
Blue	NIR1.6	0	75	%	1

Moisture RGB

This FCI proxy RGB is under construction. It will use the new NIR0.9 channel. It is tested using MODIS data. Recipe will be fixed when FCI data will be available.

True Colour RGB

This FCI proxy RGB is under construction. It will use the new VIS0.4 and VIS0.5 channels. The algorithm will be similar to the method how CIRA creates the True Colour RGB from AHI data.

ABI RGB recipes

Airmass RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	WV6.2 - WV7.3	-26.2	+0.6	K	1
Green	IR9.6 – IR10.3	-43.2	+6.7	K	1
Blue	WV6.2 inverted	243.9	208.5	K	1

Dust RGB (based on CIRA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.3 – IR10.3	-6.7	+2.6	K	1.0
Green	IR11.2 – IR8.4	-0.5	+20	K	2.5
Blue	IR10.3	261.2	288.7	K	1.0

SO2 RGB (based on CIRA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.9 – WV7.3	-4.0	+2.0	K	1.0
Green	IR10.3 – IR8.4	-4.0	+5.0	K	1.0
Blue	IR10.3	243	303	K	1.0

Ash RGB (based on CIRA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.3 – IR10.3	-6.7	+2.6	K	1.0
Green	IR11.2 – IR8.4	-6.0	+6.3	K	1.0
Blue	IR10.3	243.6	302.4	K	1.0

Fire Temperature RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR3.9	273	333	K	0.4
Green	NIR2.2	0	100	%	1
Blue	NIR1.6	0	75	%	1

Simple Water Vapour RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR10.3 inverted	279.0	202.3	K	10
Green	WV6.2 inverted	242.7	214.7	K	5.5
Blue	WV7.3 inverted	261.0	245.1	K	5.5

Differential Water Vapour RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	WV6.2 – WV7.3	-30.0	3.0	K	3.5
Green	WV7.3 inverted	278.2	213.2	K	2.5
Blue	WV6.2 inverted	243.9	208.5	K	2.5

Night Microphysics RGB (based on CIRA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.3 - IR10.3	-6.7	+2.6	K	1.0
Green	IR10.3 – IR3.9	-3.1	+5.2	K	1.0
Blue	IR10.3	243.55	292.65	K	1.0

Day Cloud Type RGB (based on CIMSS quick guide)

Colour beam	Channel	Range			Gamma
Red	NIR1.37	0	10	%	1.5
Green	VIS0.64	0	78	%	1
Blue	NIR1.6	0	59	%	1

Day Land Cloud RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	NIR1.6	0	97.5	%	1.0
Green	NIR0.86	0	108.6	%	1.0
Blue	VIS0.64	0	100	%	1.0

This RGB corresponds to SEVIRI Natural Colour RGB.

Day Convection RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	WV6.2 - WV7.3	-35	+5	K	1
Green	IR3.9 – IR10.3	-5	60	K	0.5
Blue	NIR1.6 - VIS0.64	-75	25	%	1

Day Cloud Convection RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	VIS0.64	0	100	%	1.7
Green	VIS0.64	0	100	%	1.7
Blue	IR10.3 inverted	323	203	K	1.0

Day Cloud Phase Distinction RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR10.3 inverted	280.7	219.6	K	1.0
Green	VIS0.64	0	78	%	1.0
Blue	NIR1.6	1	59	%	1.0

Day Snow-Fog RGB (based on CIRA quick guide)

Colour beam	**Channel (difference)**	**Range**			**Gamma**
Red	**NIR0.86**	**0**	**100**	**%**	**1.7**
Green	**NIR1.6**	**0**	**70**	**%**	**1.7**
Blue	**IR3.9 – IR10.3**	**0**	**30**	**K**	**1.7**

Similar to SEVIRI Snow RGB, but in the blue colour beam the (IR3.9 – IR10.3) is used instead of IR3.9refl

ABI Day Land Cloud Fire RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR2.2	0	100	%	1
Green	NIR0.86	0	100	%	1
Blue	VIS0.64	0	100	%	1

ABI True Colour RGB

The algorithm of this RGB is more complex, see
https://journals.ametsoc.org/jtech/article/37/3/429/345394/GeoColor-A-Blending-Technique-for-Satellite

AHI RGB recipes

Airmass RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.2 – WV7.3	-25.8	0	K	1.0
Green	IR9.6 – IR10.4	-41.5	+4.3	K	1.0
Blue	WV6.2 inverted	242.6	208.0	K	1.0

Dust RGB (based on JMA quick guide, variant 1)

Colour beam	**Channel (difference)**	**Range**			**Gamma**
Red	**IR12.4 –IR10.4**	**-7.5**	**+3**	**K**	**1.0**
Green	**IR11.2 – IR8.6**	**-0.5**	**+15.0**	**K**	**2.2**
Blue	**IR10.4**	**261.5**	**289.2**	**K**	**1.0**

Dust RGB (based on JMA quick guide, variant 2)

Colour beam	**Channel (difference)**	**Range**			**Gamma**
Red	**IR12.4 – IR10.4**	**-7.5**	**+3**	**K**	**1.0**
Green	**IR10.4 – IR8.6**	**0.9**	**+12.5**	**K**	**2.5**
Blue	**IR10.4**	**261.5**	**289.2**	**K**	**1.0**

Some examples of the JMA quick guide was created with this variant

24-hour Microphysics RGB (based on JMA quick guide, variant1)

Colour beam	**Channel (difference)**	**Range**			**Gamma**
Red	**IR12.4 – IR10.4**	**-7.5**	**+3**	**K**	**1.0**
Green	**IR10.4 - IR8.6**	**0.8**	**+5.8**	**K**	**1.3**
Blue	**IR10.4**	**248.6**	**303.2**	**K**	**1.0**

24-hour Microphysics RGB (based on JMA quick guide, variant2)

Colour beam	**Channel (difference)**	**Range**			**Gamma**
Red	**IR12.4 – IR10.4**	**-7.5**	**+3**	**K**	**1.0**
Green	**IR11.2 - IR8.6**	**-0.4**	**+6.1**	**K**	**1.1**
Blue	**IR10.4**	**248.6**	**303.2**	**K**	**1.0**

Some examples of the JMA quick guide was created with this variant

Ash RGB (based on JMA quick guide, variant1)

Colour beam	**Channel (difference)**	**Range**			**Gamma**
Red	**IR12.4 - IR10.4**	**-7.5**	**+3**	**K**	**1.0**
Green	**IR10.4 - IR8.6**	**-1.6**	**+4.9**	**K**	**1.2**
Blue	**IR10.4**	**243.6**	**303.2**	**K**	**1.0**

Ash RGB (based on JMA quick guide, variant2)

Colour beam	**Channel (difference)**	**Range**			**Gamma**
Red	**IR12.4 - IR10.4**	**-7.5**	**+3**	**K**	**1.0**
Green	**IR11.2 - IR8.6**	**-5.9**	**+5.1**	**K**	**0.85**
Blue	**IR10.4**	**243.6**	**303.2**	**K**	**1.0**

Some examples of the JMA quick guide was created with this variant

SO2 RGB (based on JMA quick guide, variant1)

Colour beam	**Channel (difference)**	**Range**			**Gamma**
Red	**WV6.9 – WV7.3**	**-5.0**	**6.0**	**K**	**1.0**
Green	**IR10.4 – IR8.6**	**-1.6**	**4.9**	**K**	**1.2**
Blue	**IR10.4**	**243.6**	**303.2**	**K**	**1.0**

The CIRA quick guide recipe use this channel difference in the green colour beam.

SO2 RGB (based on JMA quick guide, variant2)

Colour beam	**Channel (difference)**	**Range**			**Gamma**
Red	**WV6.9 – WV7.3**	**-5.0**	**6.0**	**K**	**1.0**
Green	**IR11.2 – IR8.6**	**-5.9**	**5.1**	**K**	**0.85**
Blue	**IR10.4**	**243.6**	**303.2**	**K**	**1.0**

Some examples of the JMA quick guide was created with this variant

Simple Water Vapour RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	IR10.4 inverted	279.0	202.3	K	10.0
Green	WV6.2 inverted	242.7	214.7	K	5.5
Blue	WV7.3 inverted	261.0	245.1	K	5.5

Differential Water Vapour RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.2 - WV7.3	-30.0	3.0	K	3.5
Green	WV7.3 inverted	278.2	213.2	K	2.5
Blue	WV6.2 inverted	243.9	208.5	K	2.5

Fire Temperature RGB (based on JMA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR3.9	273.0	350	K	1.0
Green	NIR2.3	0	50	%	1.0
Blue	NIR1.6	0	50	%	1.0

The background is brighter than in the CIRA tunings. The fire is less eye-catching.

Night Microphysics RGB (based on JMA quick guide)

Colour beam	**Channel (difference)**	**Range**			**Gamma**
Red	**IR12.4 – IR10.4**	**-7.5**	**+3**	**K**	**1.0**
Green	**IR10.4 – IR3.9**	**-2.9**	**+7**	**K**	**1.0**
Blue	**IR10.4**	**243.7**	**293.2**	**K**	**1.0**

Day Cloud Phase RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	NIR1.6	0	50	%	1.0
Green	NIR2.3	0	50	%	1.0
Blue	VIS0.64	0	100	%	1.0

Cloud Phase Distinction RGB (based on JMA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR10.4 inverted	280.7	219.6	K	1.0
Green	VIS0.64	0	85	%	1.0
Blue	NIR1.6	1	50	%	1.0

Day Convective Storms RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	**WV6.2 - WV7.3**	**-36.0**	**5**	**K**	**1.0**
Green	**IR3.9 - IR10.4**	**-1.0**	**61.0**	**K**	**0.5**
Blue	**NIR1.6 - VIS0.64**	**-80**	**26**	**%**	**0.95**

Natural Colours RGB (based on JMA quick guide)

Colour beam	Channel	Range			Gamma
Red	NIR1.6	0	99	%	1
Green	NIR0.86	0	102	%	0.95
Blue	VIS0.64	0	100	%	1

Day Microphysics RGB (based on JMA quick guide)

Colour beam	Channel	Range			Gamma
Red	NIR0.86	0	102	%	0.95
Green	IR3.9refl	2	82	%	2.6
Blue	IR10.4	203.5	303.2	K	1.0

Day Snow-Fog RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	**NIR0.86**	**0**	**102**	**%**	**1.6**
Green	**NIR1.6**	**0**	**68**	**%**	**1.7**
Blue	**IR3.9 refl**	**2**	**45**	**%**	**1.95**

Natural Fire Colours RGB (based on JMA quick guide)

Colour beam	Channel	Range			Gamma
Red	NIR2.3	0	100	%	1
Green	NIR0.86	0	100	%	1
Blue	VIS0.64	0	100	%	1

Day Deep Clouds RGB (based on JMA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR6.2 – IR10.4	-35	5	K	1
Green	VIS0.64	70	100	%	1
Blue	IR10.4	243.6	292.6	K	1

AHI True Colour RGB

The algorithm of this RGB is more complex, see
https://journals.ametsoc.org/bams/article/97/10/1803/69646/A-Sight-for-Sore-Eyes-The-Return-of-True-Color-to

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Comparison of RGB recipes tuned for different satellite sensors

Comparison of Airmass RGB recipes

SEVIRI Airmass RGB (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.2 – WV7.3	-25	0	K	1
Green	IR9.7 – IR10.8	-40	+5	K	1
Blue	WV6.2 inverted	243	208	K	1

ABI Airmass RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	WV6.2 - WV7.3	-26.2	+0.6	K	1
Green	IR9.6 – IR10.3	-43.2	+6.7	K	1
Blue	WV6.2 inverted	243.9	208.5	K	1

AHI Airmass RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.2 – WV7.3	-25.8	0	K	1.0
Green	IR9.6 – IR10.4	-41.5	+4.3	K	1.0
Blue	WV6.2 inverted	242.6	208.0	K	1.0

Comparison of 24-hour Microphysics RGB recipes

SEVIRI 24-hour Microphysics RGB (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 – IR10.8	-4	+2	K	1.0
Green	IR10.8 – IR8.7	0	+6	K	1.2
Blue	IR10.8	248	303	K	1.0

24-hour Microphysics RGB (based on JMA quick guide, variant1)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.4 – IR10.4	-7.5	+3	K	1.0
Green	IR10.4 - IR8.6	0.8	+5.8	K	1.3
Blue	IR10.4	248.6	303.2	K	1.0

24-hour Microphysics RGB (based on JMA quick guide, variant2)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.4 – IR10.4	-7.5	+3	K	1.0
Green	IR11.2 - IR8.6	-0.4	+6.1	K	1.1
Blue	IR10.4	248.6	303.2	K	1.0

Some examples of the JMA quick guide was created with this variant

Comparison of Dust RGB recipes

SEVIRI Dust RGB (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 – IR10.8	-4	+2	K	1.0
Green	IR10.8 – IR8.7	0	+15	K	2.5
Blue	IR10.8	261	289	K	1.0

ABI Dust RGB (based on CIRA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.3 – IR10.3	-6.7	+2.6	K	1.0
Green	IR11.2 – IR8.4	-0.5	+20	K	2.5
Blue	IR10.3	261.2	288.7	K	1.0

AHI Dust RGB (based on JMA quick guide, variant 1)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.4 –IR10.4	-7.5	+3	K	1.0
Green	IR11.2 – IR8.6	-0.5	+15.0	K	2.2
Blue	IR10.4	261.5	289.2	K	1.0

AHI Dust RGB (based on JMA quick guide, variant 2)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.4 – IR10.4	-7.5	+3	K	1.0
Green	IR10.4 – IR8.6	0.9	+12.5	K	2.5
Blue	IR10.4	261.5	289.2	K	1.0

Some examples of the JMA quick guide was created with this variant

Comparison of SO2 RGB recipes

ABI SO2 RGB (based on CIRA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.9 – WV7.3	-4.0	+2.0	K	1.0
Green	IR10.3 – IR8.4	-4.0	+5.0	K	1.0
Blue	IR10.3	243	303	K	1.0

SO2 RGB (based on JMA quick guide, variant1)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.9 – WV7.3	-5.0	6.0	K	1.0
Green	IR10.4 – IR8.6	-1.6	4.9	K	1.2
Blue	IR10.4	243.6	303.2	K	1.0

SO2 RGB (based on JMA quick guide, variant2)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.9 – WV7.3	-5.0	6.0	K	1.0
Green	IR11.2 – IR8.6	-5.9	5.1	K	0.85
Blue	IR10.4	243.6	303.2	K	1.0

Some examples of the JMA quick guide was created with this variant

Comparison of Ash RGB recipes

SEVIRI Ash RGB

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 - IR10.8	-4	+2	K	1
Green	IR10.8 – IR8.7	-4	+5	K	1
Blue	IR10.8	243	303	K	1

Ash RGB (based on CIRA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.3 – IR10.3	-6.7	+2.6	K	1.0
Green	IR11.2 – IR8.4	-6.0	+6.3	K	1.0
Blue	IR10.3	243.6	302.4	K	1.0

Ash RGB (based on JMA quick guide, variant1)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.4 - IR10.4	-7.5	+3	K	1.0
Green	IR10.4 - IR8.6	-1.6	+4.9	K	1.2
Blue	IR10.4	243.6	303.2	K	1.0

Ash RGB (based on JMA quick guide, variant2)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.4 - IR10.4	-7.5	+3	K	1.0
Green	IR11.2 - IR8.6	-5.9	+5.1	K	0.85
Blue	IR10.4	243.6	303.2	K	1.0

Some examples of the JMA quick guide was created with this variant

Comparison of Simple Water Vapour RGB recipes

ABI Simple Water Vapour RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR10.3 inverted	279.0	202.3	K	10.0
Green	WV6.2 inverted	242.7	214.7	K	5.5
Blue	WV7.3 inverted	261.0	245.1	K	5.5

AHI Simple Water Vapour RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	IR10.4 inverted	279.0	202.3	K	10.0
Green	WV6.2 inverted	242.7	214.7	K	5.5
Blue	WV7.3 inverted	261.0	245.1	K	5.5

Comparison of Differential Water Vapour RGB recipes

ABI Differential Water Vapour RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	WV6.2 - WV7.3	-30.0	3.0	K	3.5
Green	WV7.3 inverted	278.2	213.2	K	2.5
Blue	WV6.2 inverted	243.9	208.5	K	2.5

AHI Differential Water Vapour RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.2 - WV7.3	-30.0	3.0	K	3.5
Green	WV7.3 inverted	278.2	213.2	K	2.5
Blue	WV6.2 inverted	243.9	208.5	K	2.5

Comparison of Fire Temperature RGB recipes

FCI-proxy Fire Temperature RGB (VIIRS recipe)

Colour beam	Channel	Range			Gamma
Red	IR3.7	273	333	K	0.4
Green	NIR2.25	0	100	%	1
Blue	NIR1.6	0	75	%	1

ABI Fire Temperature RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR3.9	273	333	K	0.4
Green	NIR2.2	0	100	%	1
Blue	NIR1.6	0	75	%	1

AHI Fire Temperature RGB (based on JMA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR3.9	273.0	350	K	1.0
Green	NIR2.3	0	50	%	1.0
Blue	NIR1.6	0	50	%	1.0

The background is brighter than in the CIRA tunings. The fire is less eye-catching.

Comparison of Night Microphysics RGB recipes

SEVIRI Night Microphysics RGB (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 – IR10.8	-4	+2	K	1
Green	IR10.8 – IR3.9	0	+10	K	1
Blue	IR10.8	243	293	K	1

ABI Night Microphysics RGB (based on CIRA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.3 - IR10.3	-6.7	+2.6	K	1.0
Green	IR10.3 – IR3.9	-3.1	+5.2	K	1.0
Blue	IR10.3	243.55	292.65	K	1.0

AHI Night Microphysics RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.4 – IR10.4	-7.5	+3	K	1.0
Green	IR10.4 – IR3.9	-2.9	+7	K	1.0
Blue	IR10.4	243.7	293.2	K	1.0

Comparison of Day Cloud Phase Distinction RGB recipes

Day Cloud Phase Distinction RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR10.3 inverted	280.7	219.6	K	1.0
Green	VIS0.64	0	78	%	1.0
Blue	NIR1.6	1	59	%	1.0

Cloud Phase Distinction RGB (based on JMA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR10.4 inverted	280.7	219.6	K	1.0
Green	VIS0.64	0	85	%	1.0
Blue	NIR1.6	1	50	%	1.0

Comparison of Cloud Type RGB recipes

FCI proxy Cloud Type RGB (Andrew Heidinger's recipe)

Colour beam	Channel	Range			Gamma
Red	NIR1.37	0	10	%	1.5
Green	VIS0.64	0	80	%	0.75
Blue	NIR1.6	0	80	%	1

ABI Day Cloud Type RGB (based on CIMSS quick guide)

Colour beam	Channel	Range			Gamma
Red	NIR1.37	0	10	%	1.5
Green	VIS0.64	0	78	%	1
Blue	NIR1.6	0	59	%	1

Comparison of Day Microphysics RGB recipes

SEVIRI Day Microphysics RGB

Colour beam	Channel	Range			Gamma
Red	VIS0.8	0	100	%	1.0
Green	IR3.9refl	0	60	%	2.5
Blue	IR10.8	203	323	K	1.0

AHI Day Microphysics RGB (based on JMA quick guide)

Colour beam	Channel	Range			Gamma
Red	NIR0.86	0	102	%	0.95
Green	IR3.9refl	2	82	%	2.6
Blue	IR10.4	203.5	303.2	K	1.0

Comparison of Day Natural Colour RGB recipes

SEVIRI Natural Colour RGB (EUMETSAT recipe)

Colour beam	Channel	Range			Gamma
Red	NIR1.6	0	100	%	1
Green	NIR0.86	0	100	%	1
Blue	VIS0.64	0	100	%	1

ABI Day Land Cloud RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	NIR1.6	0	97.5	%	1.0
Green	NIR0.86	0	108.6	%	1.0
Blue	VIS0.64	0	100	%	1.0

This RGB corresponds to Natural Colour RGB.

AHI Natural Colours RGB (based on JMA quick guide)

Colour beam	Channel	Range			Gamma
Red	NIR1.6	0	99	%	1
Green	NIR0.86	0	102	%	0.95
Blue	VIS0.64	0	100	%	1

HRV Fog RGB (EUMETSAT recipe)

Colour beam	Channel	Range			Gamma
Red	NIR1.6	0	70	%	1
Green	HRV	0	100	%	1
Blue	HRV	0	100	%	1

Comparison of Day Convection RGB recipes

SEVIRI Convection RGB or Severe Storms RGB (EUMETSAT recipe)

Colour beam	Channel difference	Range			Gamma
Red	WV6.2 – WV7.3	-35	+5	K	1
Green	IR3.9 – IR10.8	-5	+60	K	0.5
Blue	NIR1.6 – VIS0.6	-75	+25	%	1

ABI Day Convection RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	WV6.2 - WV7.3	-35	+5	K	1
Green	IR3.9 – IR10.3	-5	60	K	0.5
Blue	NIR1.6 - VIS0.64	-75	25	%	1

AHI Day Convective Storms RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.2 - WV7.3	-36.0	5	K	1.0
Green	IR3.9 - IR10.4	-1.0	61.0	K	0.5
Blue	NIR1.6 - VIS0.64	-80	26	%	0.95

Comparison of Day Cloud Convection RGB recipes

SEVIRI HRV Clouds RGB (EUMETSAT recipe)

Colour beam	Channel	Range			Gamma
Red	HRV	0	100	%	1
Green	HRV	0	100	%	1
Blue	IR10.8 inverted	323	203	K	1

Day Cloud Convection RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	VIS0.64	0	100	%	1.7
Green	VIS0.64	0	100	%	1.7
Blue	IR10.3 inverted	323	203	K	1.0

Comparison of Day Cloud Phase RGB recipes

FCI proxy Cloud Phase RGB (EUMETSAT recipe)

Colour beam	Channel (difference)	Range			Gamma
Red	NIR1.6	0	50	%	1.0
Green	NIR2.3	0	50	%	1.0
Blue	VIS0.64	0	100	%	1.0

Day Cloud Phase RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	NIR1.6	0	50	%	1.0
Green	NIR2.3	0	50	%	1.0
Blue	VIS0.64	0	100	%	1.0

Comparison of Snow RGB recipes

SEVIRI Snow RGB (EUMETSAT recipe)

Colour beam	Channel	Range			Gamma
Red	VIS0.8	0	100	%	1.7
Green	NIR1.6	0	70	%	1.7
Blue	IR3.9refl	0	30	%	1.7

ABI Day Snow-Fog RGB (based on CIRA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	NIR0.86	0	100	%	1.7
Green	NIR1.6	0	70	%	1.7
Blue	IR3.9 – IR10.3	0	30	K	1.7

Similar to SEVIRI Snow RGB, but in the blue colour beam the (IR3.9 – IR10.3) is used instead of IR3.9refl

AHI Day Snow-Fog RGB (based on JMA quick guide)

Colour beam	Channel (difference)	Range			Gamma
Red	NIR0.86	0	102	%	1.6
Green	NIR1.6	0	68	%	1.7
Blue	IR3.9 refl	2	45	%	1.95

Comparison of Natural Fire Colour RGB recipes

ABI Day Land Cloud Fire RGB (based on CIRA quick guide)

Colour beam	Channel	Range			Gamma
Red	IR2.2	0	100	%	1
Green	NIR0.86	0	100	%	1
Blue	VIS0.64	0	100	%	1

Natural Fire Colours RGB (based on JMA quick guide)

Colour beam	Channel	Range			Gamma
Red	NIR2.3	0	100	%	1
Green	NIR0.86	0	100	%	1
Blue	VIS0.64	0	100	%	1