Current Usage and Future Prospects of Multispectral (RGB) Satellite Imagery in Support of NWS Forecast Offices and National Centers

Andrew Molthan, Kevin Fuell, John Knaff, and Thomas Lee

1NASA Short-term Prediction Research and Transition (SPoRT) Center, NASA MSFC, Huntsville, Alabama, 2University of Alabama Huntsville/SPoRT, Huntsville, Alabama
3NOAA/NESDIS Regional and Mesoscale Meteorology Branch, Ft. Collins, Colorado, 4Naval Research Laboratory, Monterey, California

What is an RGB Composite Image?
- Current and future satellite instruments provide remote sensing at a variety of wavelengths.
- RGB composite images assign individual wavelengths or channel differences to the intensities of the red, green, and blue components of a pixel color.
- Each red, green, and blue color intensity is related to physical properties within the final composite image.
- Final color assignments are summarized to the related characteristics of image pixels.
- Products may simply the interpretation of data from multiple bands by displaying information in a single image.

Product Examples and Usage
- Several products are being disseminated for test and evaluation by NOAA/NWS field offices and National Centers as part of NOAA’s GOES-R and Joint Polar Satellite System (JPSS) Proving Grounds.
- SPoRT has partnered with the Naval Research Laboratory in Monterey, CA to transition popular passive microwave composites to N-AWIPS for use at the National Hurricane Center and the Hydrodynamics Prediction Center.
- SPoRT and CIRA, and NRL have facilitated the use and evaluation of RGB products at a variety of NWS forecast offices and National Centers.
- Table 3 provides a list of RGB products that have been developed by these groups and disseminated to end users for a variety of applications.

Current Products and Usage
- Collaborations between SPoRT, CIRA, and NRL have facilitated the use and evaluation of RGB products at a variety of NWS forecast offices and National Centers.
- Partnerships are being established for test and evaluation by NOAA/NWS field offices and National Centers as part of NOAA’s GOES-R and Joint Polar Satellite System (JPSS) Proving Grounds.
- Table 3 provides a list of RGB products that have been developed by these groups and disseminated to end users for a variety of applications.

Future Directions and Opportunities
- The examples provided here demonstrate that multispectral (RGB) composite image analysis may offer some new applications using current satellite observations and those expected from future instruments such as GOES-R and JPSS.
- However, current decision support systems such as AWIPS, AWIPS II, and N-AWIPS lack capabilities to display imagery at the full color depth. AWIPS and AWIPS II are currently limited to 256 colors, whereas N-AWIPS is limited to 96 colors. 24-bit imagery assigns 8-bit colors to three values, resulting in 2^24 possible colors.
- New capabilities will need to be developed for the AWIPS II environment to support RGB image analysis and manipulation.
- These capabilities likely include, but may not be limited to the following:
  - Shader language or other color palette capabilities to display the full 24-bit color resulting from the R, G, B triplet at each pixel.
  - The ability to load pre-defined RGB composites as a "product baseline", in addition to the forecaster or analyst being able to make minor adjustments as needed to enhance specific features.
  - Other image enhancement techniques that are beneficial to single-channel or channel-difference imagery, such as histogram equalization or multiple segments of linear stretching.
  - Opportunities to expand to 32-bit imagery that incorporates an alpha channel or transparency layer to blend quantitative information or cloud textures provided by high resolution visible or infrared data.

Data Dissemination Strategies
- As new satellites are launched and come online, they provide a tremendous increase in data volume distributed to operational centers in addition to continued increases in model output and availability of additional radar products.
- Some, but not all satellite platforms or channels are included as baseline products. Some RGB products may require the inclusion of an additional band, or several bands, that are outside of the baseline.
- In terms of efficient data distribution, there are several options that can be discussed and debated, ranging from dissemination of all required (missing) bands and production of the final product at the forecaster workstation to construction of products by a provider and shipment of a single file. Some options are outlined below.

Table 3. List of RGB products that have been developed by these groups and disseminated to end users for a variety of applications.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Purpose</th>
<th>Example</th>
<th>Benefits</th>
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<tbody>
<tr>
<td>MODIS/VIIRS</td>
<td>True Color, Air Mass, Fog/Low Cloud</td>
<td>Example of the MODIS/VIIRS air mass product used to identify hot, dry air associated with a midlatitude heat wave over the Southern Plains, versus monsoon flow and moisture into Arizona and New Mexico. Example produced by the National Weather Service forecast office in Albuquerque, NM.</td>
<td>Enables detection of air mass differences in model output and availability of additional radar products.</td>
</tr>
<tr>
<td>Meteosat</td>
<td>Dust RGB</td>
<td>Example of the EUMETSAT &quot;Dust&quot; RGB developed from MODIS channels with application over the southwestern United States.</td>
<td>Enables detection of particulate matter differences in model output and availability of additional radar products.</td>
</tr>
<tr>
<td>GOES</td>
<td>Night Band RGB</td>
<td>Example of the MODIS/VIIRS night band RGB developed for the MODIS/VIIRS instrument suite.</td>
<td>Enables detection of differences in moonlight during nighttime conditions.</td>
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Figure 1. Example of MODIS/VIIRS air mass product used to examine the midlatitude transition of Tropical Storm Nadine. Colors emphasize the possible intrusion of dry air and upper levels (reds) near the core, in addition to interactions with a midlatitude front over the northern Gulf of Mexico. Example produced by Michael Hayes and John Knaff at NWS/SPoRT. | Enables detection of air mass differences in model output and availability of additional radar products. |

Figure 2. Example of Naval Research Laboratory passive microwave brightness temperature composites over the southwestern United States. Here, left panel shows areas as a white color, used to identify areas that are possible extreme rain potential. Center panel shows the areas of most rain potential over the southern United States. Right panel shows the areas of most rain potential over the southwestern United States. | Enables detection of differences in rain potential differences in model output and availability of additional radar products. |

Figure 3. Example of the MODIS/VIIRS air mass product used to examine the midlatitude transition of Tropical Storm Nadine. Colors emphasize the possible intrusion of dry air and upper levels (reds) near the core, in addition to interactions with a midlatitude front over the northern Gulf of Mexico. Example produced by Michael Hayes and John Knaff at NWS/SPoRT. | Enables detection of air mass differences in model output and availability of additional radar products. |

Figure 4. Example of the MODIS/VIIRS night Band RGB developed for the MODIS/VIIRS instrument suite. | Enables detection of differences in moonlight during nighttime conditions. |

Figure 5. Example of Naval Research Laboratory passive microwave brightness temperature composites over the southwestern United States. Here, left panel shows areas as a white color, used to identify areas that are possible extreme rain potential. Center panel shows the areas of most rain potential over the southern United States. Right panel shows the areas of most rain potential over the southwestern United States. | Enables detection of differences in rain potential differences in model output and availability of additional radar products. |

Figure 6. Example of Naval Research Laboratory passive microwave brightness temperature composites provided by NRL, for use with the day-night band and infrared bands for temperature band of infrared. Example shows cloud and snow are visible due to reflected moonlight. The storm track for Erika as an example of how N-AWIPS can be used to examine the midlatitude transition of Tropical Storm Nadine. | Enables detection of differences in rain potential differences in model output and availability of additional radar products. |

Figure 7. Example of Naval Research Laboratory passive microwave brightness temperature composites over the southwestern United States. Here, left panel shows areas as a white color, used to identify areas that are possible extreme rain potential. Center panel shows the areas of most rain potential over the southern United States. Right panel shows the areas of most rain potential over the southwestern United States. | Enables detection of differences in rain potential differences in model output and availability of additional radar products. |

Andrew Molthan - andrew.molthan@nasa.gov