NOAA ROSES Semi-Annual Report

Reporting Period: September 2020 – February 2021 (1st report)

PI: Dr. Steven Miller
Co-PI(s):   Dr. Curtis Seaman

Project Title: Advanced Concepts Enabling Situational and Hazards Awareness
via Imagery (ACES-HAI)

Executive Summary

Scientists at CIRA have pioneered the exploitation of the GOES-R series Advance Baseline Imager (ABI) for value-added imagery applications. From design of a 'missing' green band that enables true color imagery, to novel fire temperature products credited with saving lives, to fusion with the GOES Lightning Mapper (GLM) in ways that are now widely emulated, to advanced techniques in Dynamic Enhancement Background Reduction (*DEBRA*) and the multi-dimensional blending technique that enables *GeoColor* imagery, CIRA's award-winning imagery. The objective of this project is to look for the vast array of additional and unexploited capabilities in the realm of imagery/product fusion. This project focuses on the development of novel and innovative approaches that tap into this potential, via a paradigm shift to the *GeoColor* application that pursues the following key, central objectives:

1. Signal encoding of lofted dust and a new short/mid-wave infrared ABI fire product
2. Propagating composite daytime snow cover information into the night
3. Integrating Proxy Vis to enable an advanced low-cloud description at night
4. Incorporating satellite-derived Level-2 products for imagery/product synergy
5. Enabling a 0.5 km, 1-min "mesobox-anywhere, on-demand" via spatial and temporal sharpening

Progress toward FY20 Milestones and Relevant Findings

Environmental features, isolated via physically-based algorithms, serve as either normalized modulators of localized parts of *GeoColor* (signal imprinting), or as embedded layers of information and are now being combined within CIRA's generalized framework of multi-dimensional blending technique. Spatial sharpening of day-side true color encodes red-band variance to the blue and synthetic green band, and temporal sharpening enlists optical flow to assign a dense vector field. The result is a new, information-rich display that can be customized and tailored to the needs of specific end-users.

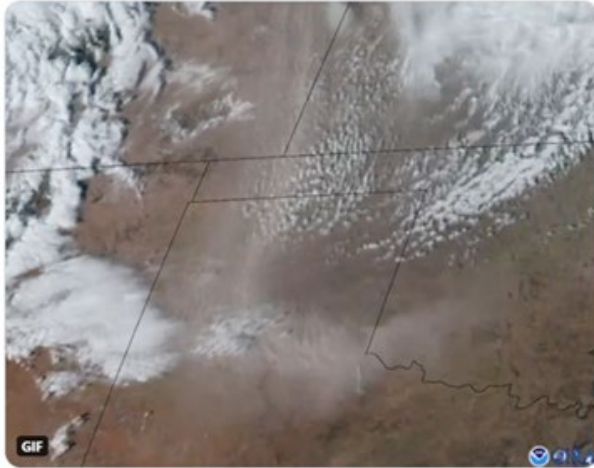Significant accomplishments are listed below:

1) Feature Imprinting Upon GeoColor:

Use of GeoColor imagery combined with DEBRA was used to depict major dust events over Texas Panhandle during December 2020 – February 2021. While this is not an example of the feature imprinting, but provides a conceptual view of the combined product, and offers a case study for development of the technique. We will approach this imprinting in two ways: i) a simple imprint of the 12-11 brightness temperature difference, and ii) a more sophisticated imprint of the DEBRA-Dust confidence factor. The two methods will be compared and contrasted on case studies such as this one.
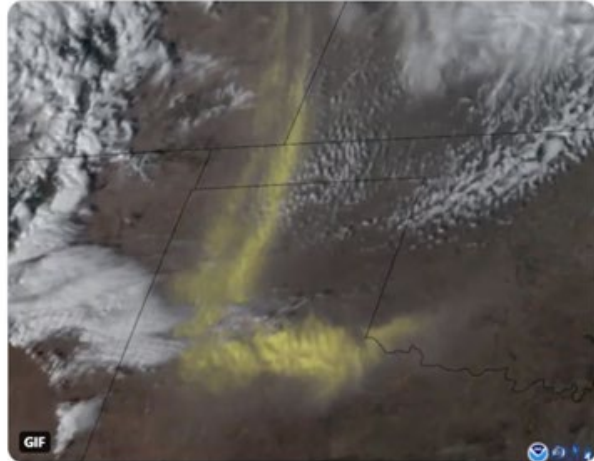
Figure 1: *Left: GeoColor imagery from 23 December 2020 showing a strong dust plume moving into the Texas Panhandle. Loop:* https://twitter.com/CIRA_CSU/status/1344024222587265024
Right: GeoColor with DEBRA overlay highlighting the dust plume in yellow.
Loop: https://twitter.com/CIRA_CSU/status/1344029675798945799

2) GOES-17 GeoColor with GLM Group Energy Density overlay now allows for linking wildfires to lightning strikes and can give an indication for intensification of Tropical Storms.

   A @NOAASatellites tweet of a GOES-16 GeoColor nighttime imagery loop of Hurricane Laura with GLM lightning overlay, posted on 26 August 202, ended up getting over 20,000 (!!!) shares from various news outlets, across Facebook and Twitter:

   https://twitter.com/NOAASatellites/status/1298593389978497025

   The GOES-R Program Office requested an extended imagery loop all the way through Laura's landfall.

3) Successful re-working the Meteosat Processing of *GeoColor* and DEBRA
   Re-working the processing for SLIDER of Meteosat *GeoColor* and DEBRA resulted in a significant reduction in processing time for both products (from 12-17 **minutes** down to 10-15 *seconds*). DEBRA is now running in near-real-time for both operational Meteosat satellites (8 and 11), and is being evaluated on a private SLIDER server before being made available to the public. The implementation of DEBRA on these satellites is particularly relevant from the standpoint of prolific dust generation over this region and the enhanced ability to track easterly African waves across the African continent via dust signatures—potentially enhancing forecasters' ability to gauge the longer-term (~2 week) outlook of TC activity in the Atlantic basin.
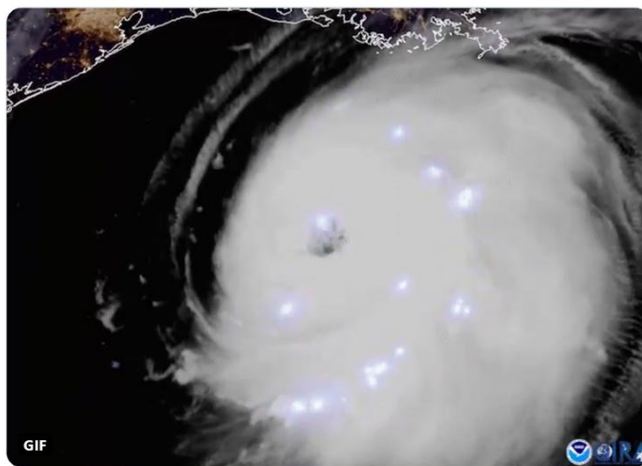
Figure 2 NOAA Satellite tweet on 26 August 2020.

A GeoColor - GLM Group Energy Density combo display was also used by TV news stations, like NBC, on 20 August 2020, in Al Roker's "*The Today Show*".

Figure 3: Al Roker, a regular user of CIRA/NOAA imagery products, displays CIRA's GeoColor product with GLM Group Energy Density overlay while talking about wildfires in California on the 20 August 2020 episode of NBC's The Today Show.

4) As part of ACES HAI, we will start to examine the potential of carrying daytime-observed snow field into the night-side imagery as a layer of information in *GeoColor*. This work will be conducted during the second half of Year 1. A pseudo code for this application has been developed, where a snow-layer will be aggregated from daytime NDDI information over an allowable range of solar zenith angles. The snow layer will then be inserted on the nighttime-side imagery between the surface and city lights layer (and below the low- and high- cloud layers) in the multi-dimensional blend. We will explore the usage of the CLAVR-x cloud mask as part of the filtering for the mask. YJ Noh has provided access and readers for this cloud mask.

5) Work began on integrating Proxy Vis with *GeoColor* to enable an advanced low-cloud description at night. At this time we have succeeded in reading and converting the proxy-visible layer into the *GeoColor* processing code, and will next examine the necessary scaling to optimize its display as an intermediate layer above the city lights and below the high-cloud layer.

6) Postdoc Peter Marinescu will be joining the ACES-HAI Team in June 2021, and will begin assisting in the integration of satellite and model fields into the *GeoColor* display. An initial thrust will be sea surface temperature fields, while Natalie Tourville is assisting in bringing across to CIRA.

ACES-HAI Product Dissemination:

- **GeoColor implementation at NESDIS**
  - GOES-16 and GOES-17 ABI GeoColor products are running in real-time at NESDIS
  - GOES-16 and GOES-17 ABI GeoColor imagery is available on the NESDIS GOES-East and on the NESDIS GOES-West Viewer websites:
    https://www.star.nesdis.noaa.gov/GOES/conus.php?sat=G16
    and https://www.star.nesdis.noaa.gov/GOES/conus.php?sat=G17

- **GOES-16 and GOES-17 ABI GeoColor products are running at NWS WFOs** (through the AWIPS LDM) and are also being used by the **National Centers (OPC, WPC, SPC, AWC, NHC).**

- ACES-HAI baseline products, especially **GeoColor** imagery, are regularly being used by the **GOES-R Program Office**

Additional Methods of Dissemination:

- **Training Sessions**
- Presentation at **scientific conferences** and **workshops (as listed below)**
- Posting on **twitter accounts** (especially on @CIRA_CSU, @NOAASatellites, @NWS)
- **Satellite blogs** using SLIDER imagery (https://satelliteliaisonblog.com/)
- **NOAA and CIRA Facebook pages** using SLIDER imagery (https://www.facebook.com/CIRACSU, https://www.facebook.com/NOAASatellites/)
- Use of **SLIDER imagery / imagery loops** by **NOAA Management** (https://rammb-slider.cira.colostate.edu/)
- **Publications (as listed below)**

CIRA/RAMMB Satellite Blogs:
https://rammb2.cira.colostate.edu/research/goes-r/proving_ground/blog/

Publications:

Miller, S. D., D. T. Lindsey, C. J. Seaman, and J. E. Solbrig, 2020: GeoColor: A Blending Technique for Satellite Imagery. *J. Atmos. Ocean. Tech.*, **37**(3), 429-448, https://doi.org/10.1175/JTECH-D-19-0134.1

Grasso, L. D., D. Bikos, J. Torres, J. F. Dostalek, T.-C. Wu, J. Forsythe, H. Q. Cronk, C. J. Seaman, S. D. Miller, E. Berndt, H. G. Weinman, and K. B. Kasper, 2021: Satellite Imagery and Products of the 16-17 February 2020 Saharan Air Layer Dust Event over the Eastern Atlantic: Impacts of Water Vapor on Dust Detection and Morphology. *Atmos. Meas. Tech.*, **14**, 1615–1634, 2021 https://doi.org/10.5194/amt-14-1615-2021

Presentations:

Miller, S. D, 2020: Night and Day: A New Era in Satellite Observations. *2020 Satellite Educators Association (SEA) Conference* (virtual due to COVID19 pandemic). 25 July 2020. Keynote Address. Main audience: K-16 Educators who are interested in ways to infuse new materials and energy into their Science/Technology/Engineering/Mathematics (STEM) curriculum.

Seaman, C. J., 2021: SLIDER: A website for displaying geostationary and polar-orbiting satellite data. *Australia Bureau of Meteorology WMO VLab Centre of Excellence Regional Focus Group Meeting.* Invited virtual oral presentation/training session. 20 October 2020 Recording available: http://www.virtuallab.bom.gov.au/index.php/download_file/view/1557/227/

Seaman, C. J., 2021: SLIDER: A website for displaying realtime, global satellite data at full resolution. *101st AMS Annual Meeting*. Virtual. 13 January 2021

Seaman, C. J., 2021: CIRA's SLIDER: A website for displaying realtime, global satellite data at full resolution. 2021 AMS GOES-R/JPSS Short Course. Virtual. 17-18 March 2021

Social Media:

Products developed under this ACES-HAI project are regularly being used by social media, twitter accounts, and by national and international news organizations.

Noteworthy newspaper publication with GeoColor imagery:

On 28 December 2020, New York Times' Michael Benson published an article on climate change titled "Watching the Earth Burn". The title page article came with a large full-disk GOES-16 GeoColor imagery loop and the article itself depicted 12 additional GeoColor images and imagery loops. https://www.nytimes.com/2020/12/28/opinion/climate-change-earth.html

Figure 4: New York Times title page on 28 December 2020.

Plans for Next Reporting Period

Work on all project milestones will continue during the second half of project year 1.