



Satellite Research and Application Development at CI RA

Steven D. Miller

Cooperative Institute for Research in the Atmosphere

NOAA/NESDIS CoRP Science Symposium

18 July 2016



Colorado State University, Ft. Collins CO (68)



Earth Systems Research Lab, Boulder CO (45)

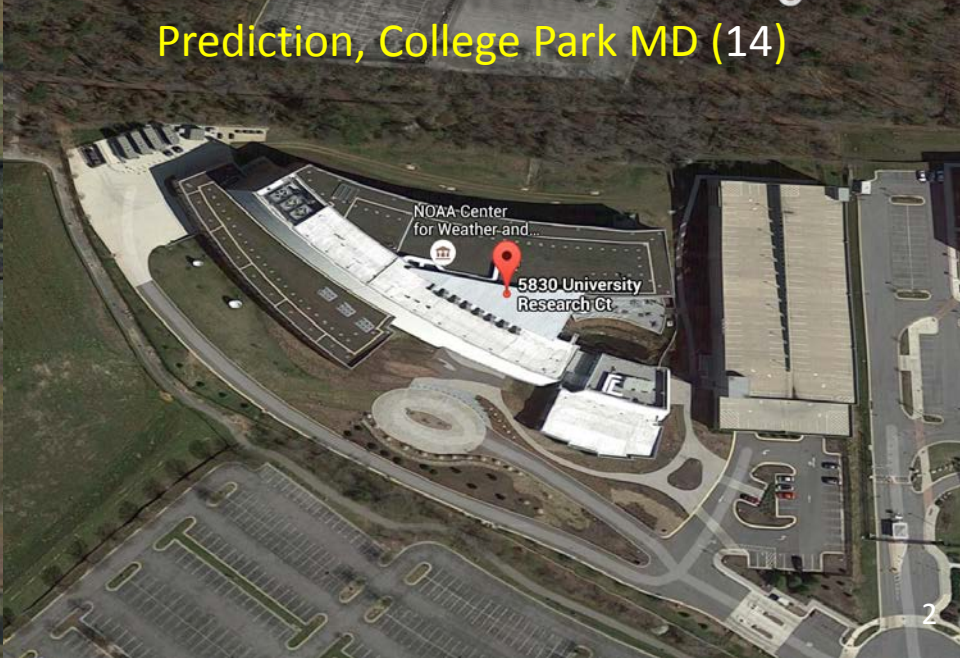


Connecting Models and Observations

Aviation Weather Center, Kansas City MO (12)



NOAA Center for Weather and Climate Prediction, College Park MD (14)



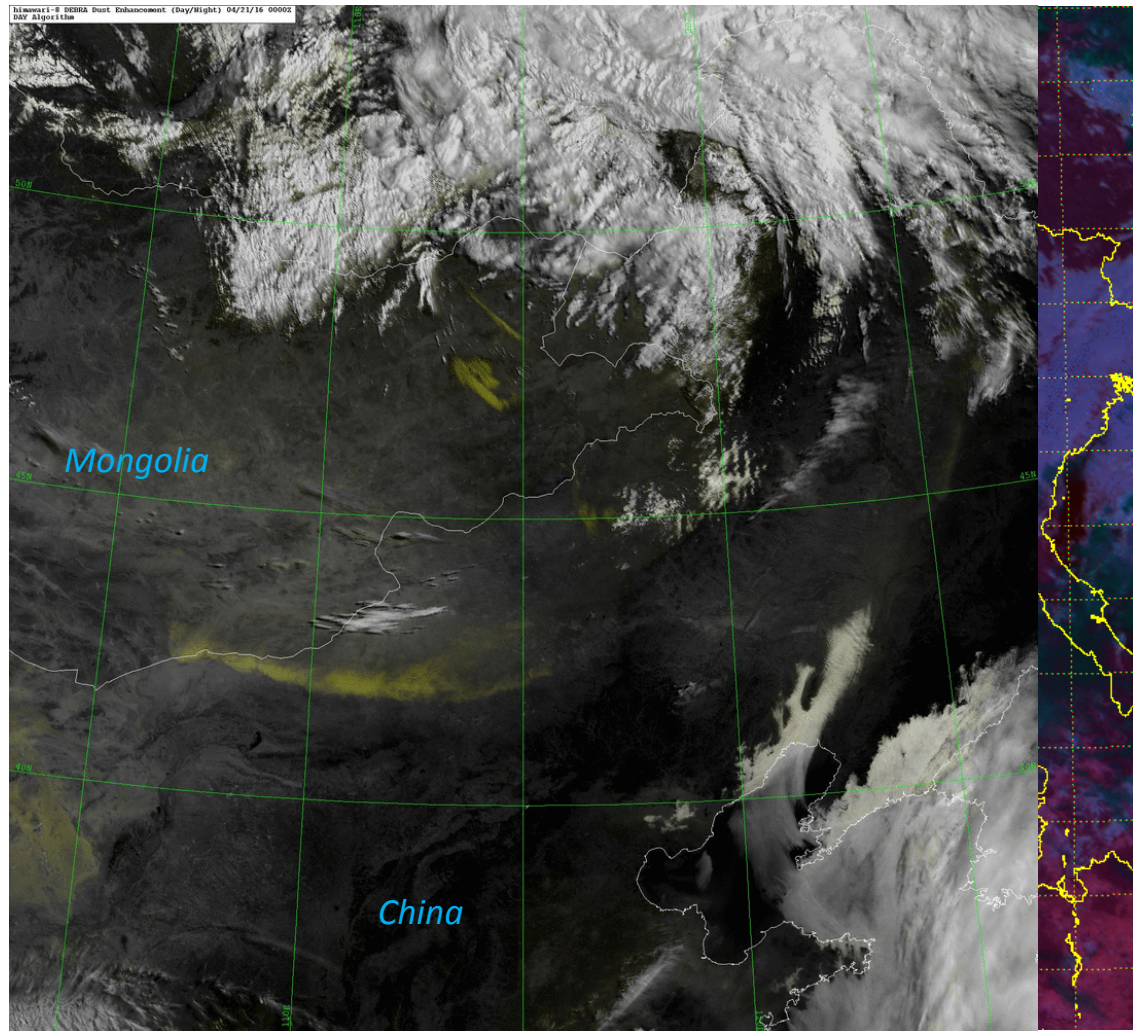
Satellite Research at CIRA

- **Instrument Check-Out: Calibration/Validation**
Evaluate on-orbit performance of operational satellite data and products
 - **Current Satellite Systems: Operational Algorithm Development**
Exploiting satellite data for hazards and other user-defined needs
 - **Future Satellite Systems: Algorithm Working Groups and Risk Reduction**
Designing improved operational algorithms, high-risk/high-reward applications
 - **Training on Meteorological Satellite Data/Products**
Regionally-dependent forecaster needs (domestic and international)
 - **Data Assimilation Research**
New observational operators, assimilation techniques, for improved analyses
 - **Proving Ground Demonstrations**
A “Research to Operations to Research” (R2O2R) framework for user engagement
- *Selected examples to follow*

Preparing for GOES-R ABI

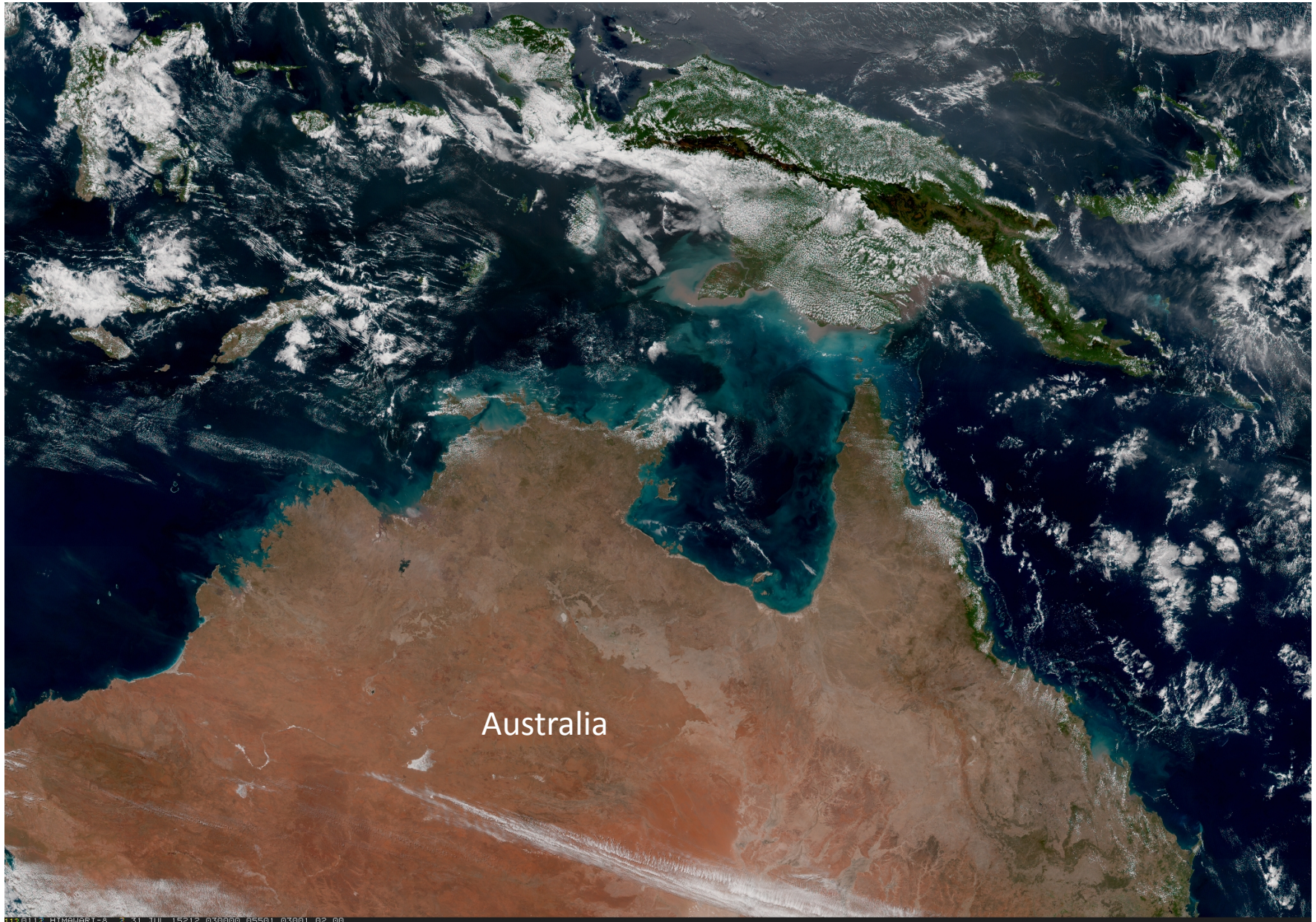
- Himawari-8 is used to demonstrate the multispectral capabilities of GOES-R:
- **True Color** identifies smoke, smog, volcanic ash, dust
- **Geocolor** combines True Color during the day with a **Low Cloud/Fog** detection product at night (pink)
- **Natural Color** identifies snow, ice and cloud phase (NIR reflectance)
- **Fire Temperature RGB** highlights fire location and intensity.
- **RGB Airmass** is used for airmass characterization, cyclone development
- **DEBRA** dust enhancement combines conventional dust detection tests with clear-sky background information to suppress false alarms.

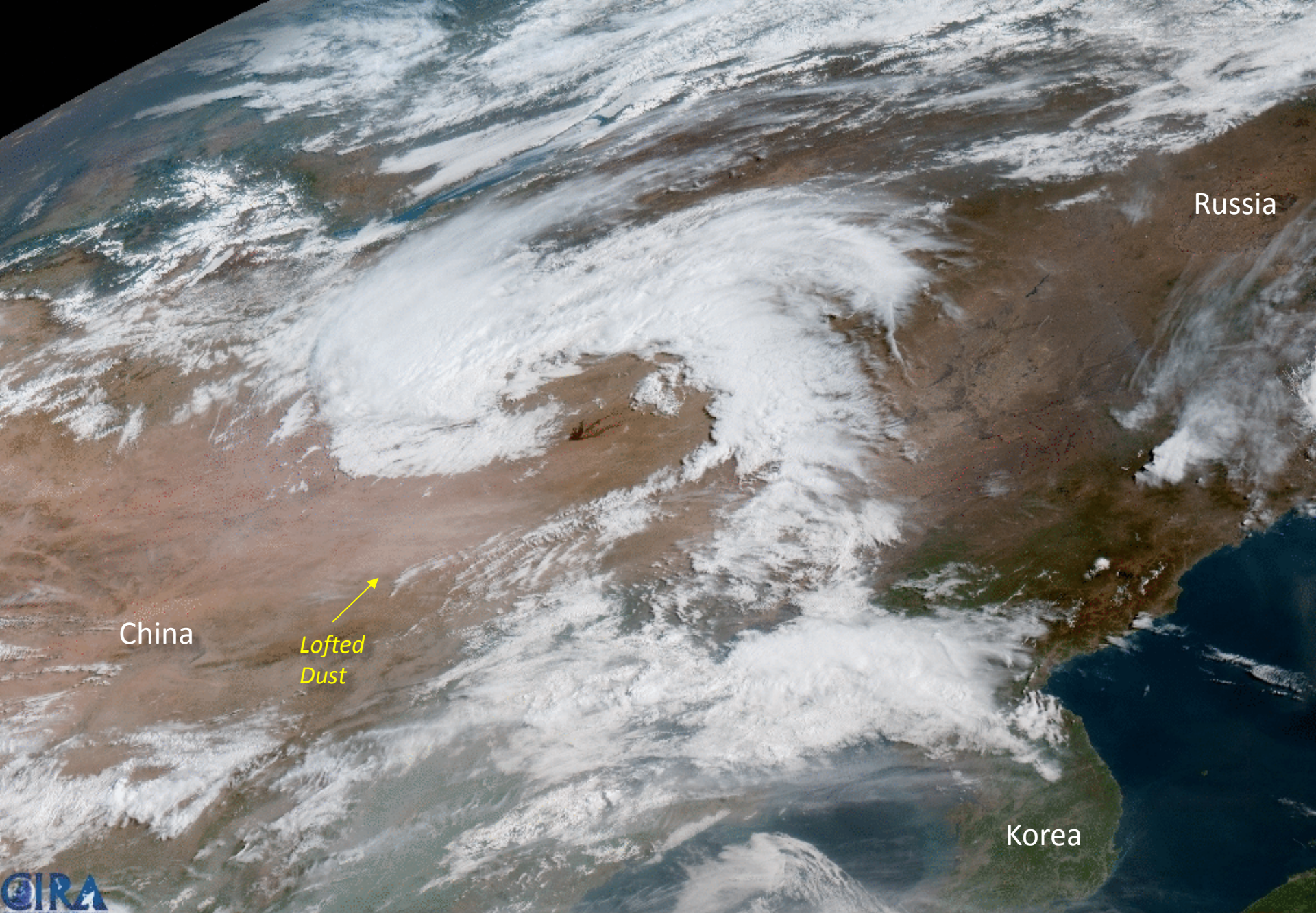
→ These and other products will be adapted to ABI following the launch of GOES-R (scheduled 4 November 2016)



<http://rammb.cira.colostate.edu/ramsdisk/online/himawari-8.asp>
http://rammb.cira.colostate.edu/ramsdisk/online/loop_of_the_day/

Making AHI True Color Imagery





China

Russia

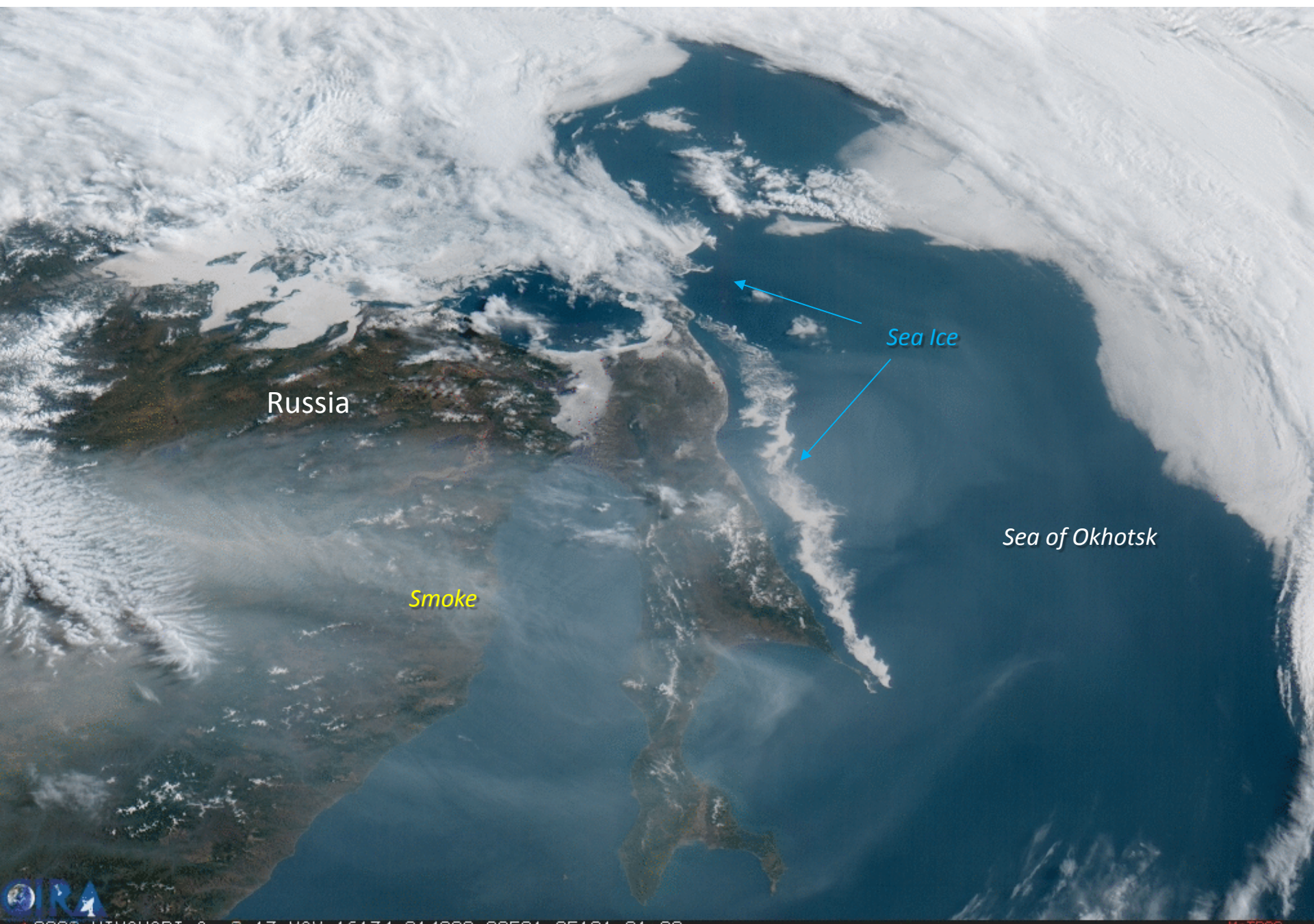
Lofted
Dust

Korea



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McIDAS



Russia

Sea Ice

Sea of Okhotsk

Smoke

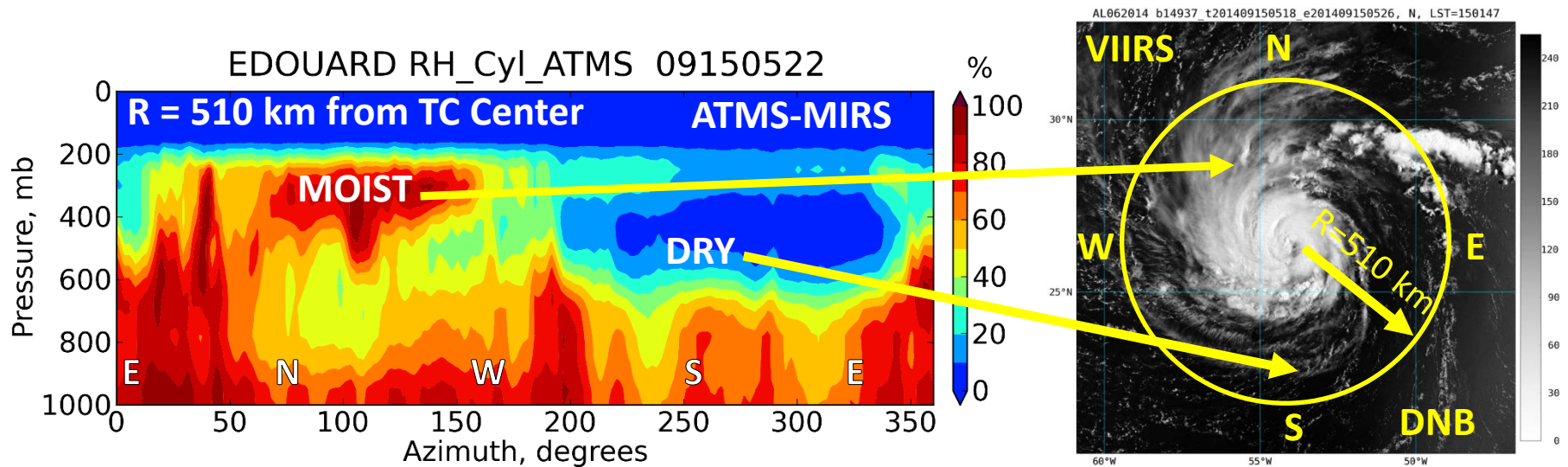


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McIDAS

Diagnosing Tropical Cyclone Structure

- Detecting dry-air intrusion → important for TC intensity changes.
- Use integrated moisture flux in the Rapid Intensification Index (RII)



G. Chirokova, R. DeMaria, J. Knaff (NOAA/NESDIS), M. DeMaria (NHC) Sponsor: JPSS-PGRR

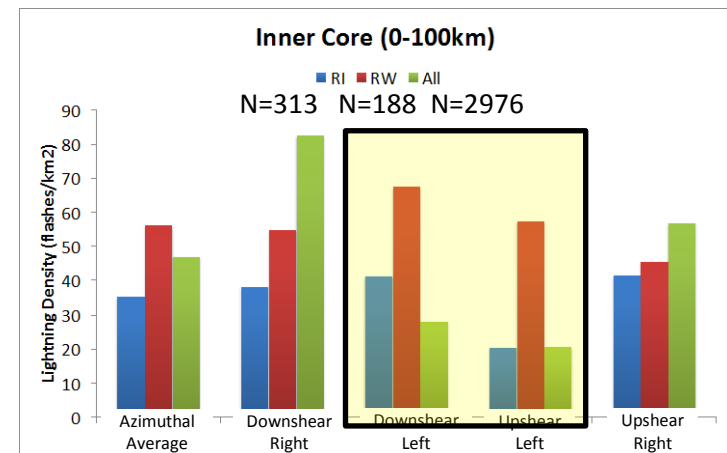
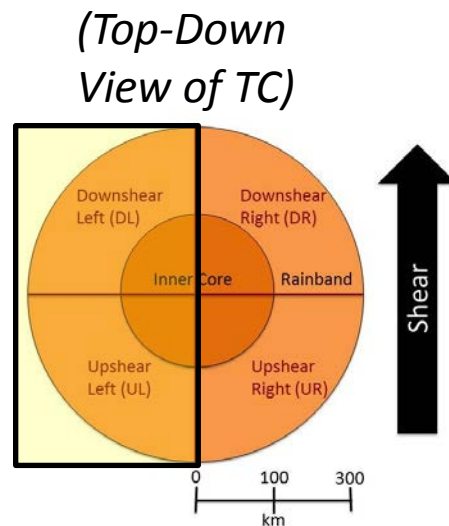
- Near-real time TC-centered VIIRS Visible, IR, and DNB Imagery used for eye detection and center-fixing

RAMMB-CIRA TC Real Time Page:

http://rammb.cira.colostate.edu/products/tc_realtime/index.asp

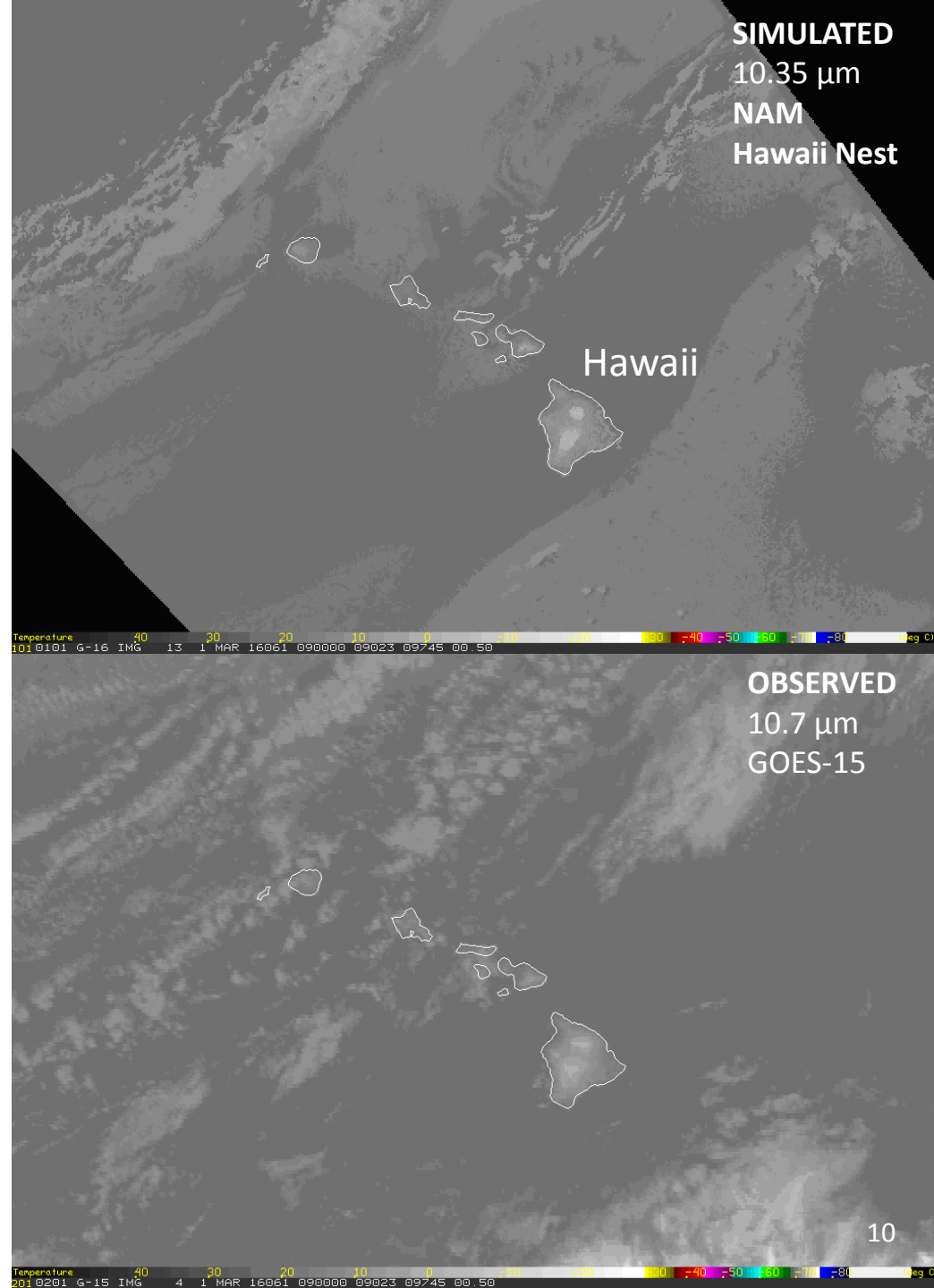
Total Lightning for Tropical Cyclone Genesis and Intensity Forecasting

- In anticipation of GOES-R Lightning Mapper (GLM), we are developing total lightning predictors for operational TC rapid intensification and genesis products
- Using Earth Networks and World Wide Lightning Location Network as proxy data
- Rapid intensification cases → less inner core lightning
- Rapid weakening cases → more inner core lightning
- Strongest signal in left-of-shear quadrants of the storm

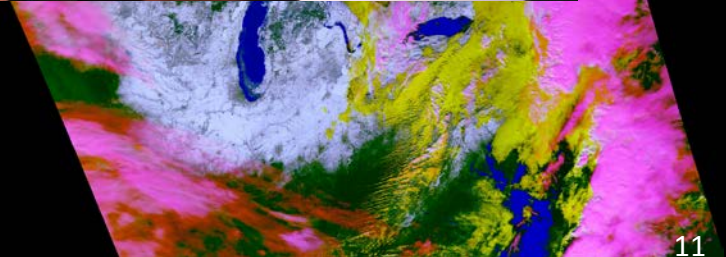
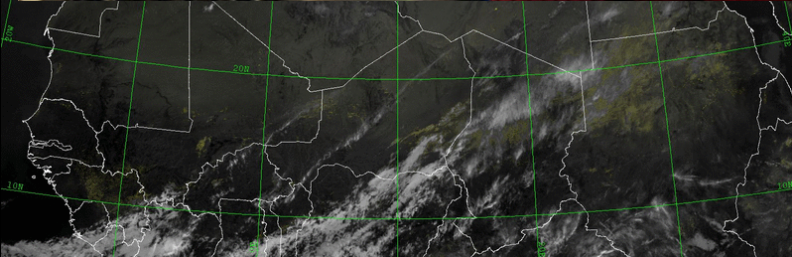
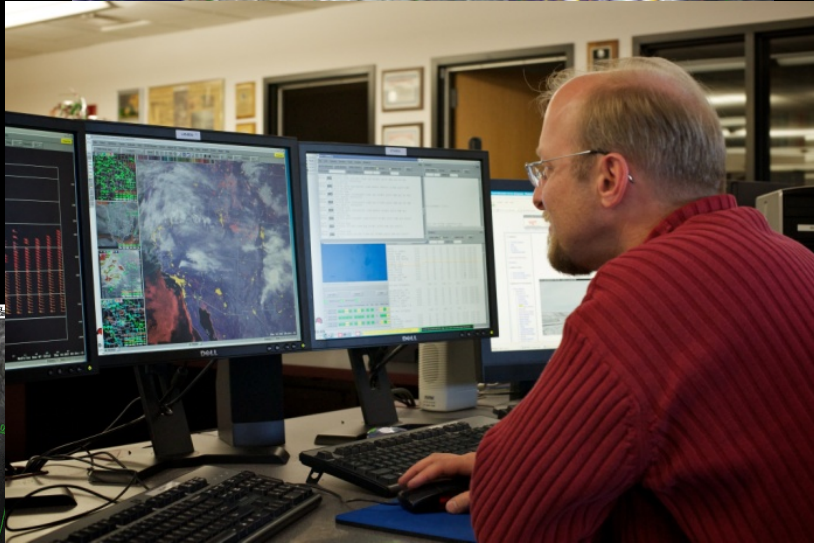
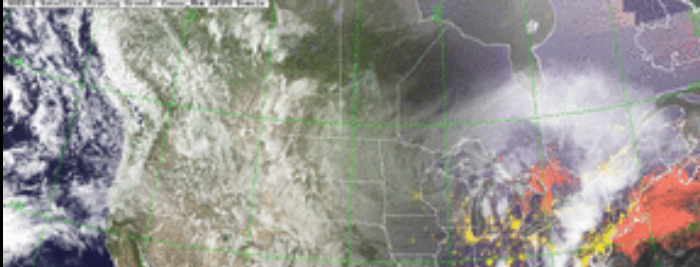


Synthetic Satellite Imagery

- Forward radiative transfer calculations used to transform model fields into equivalent satellite observations.
- Facilitates one-to-one comparisons and assessment of model's skill for the current meteorological situation.
- Provides a form of predictive satellite imagery—very popular with NWS forecasters.
- Synthetic imagery also being used in the assessment of CRTM handling of cloud microphysics.

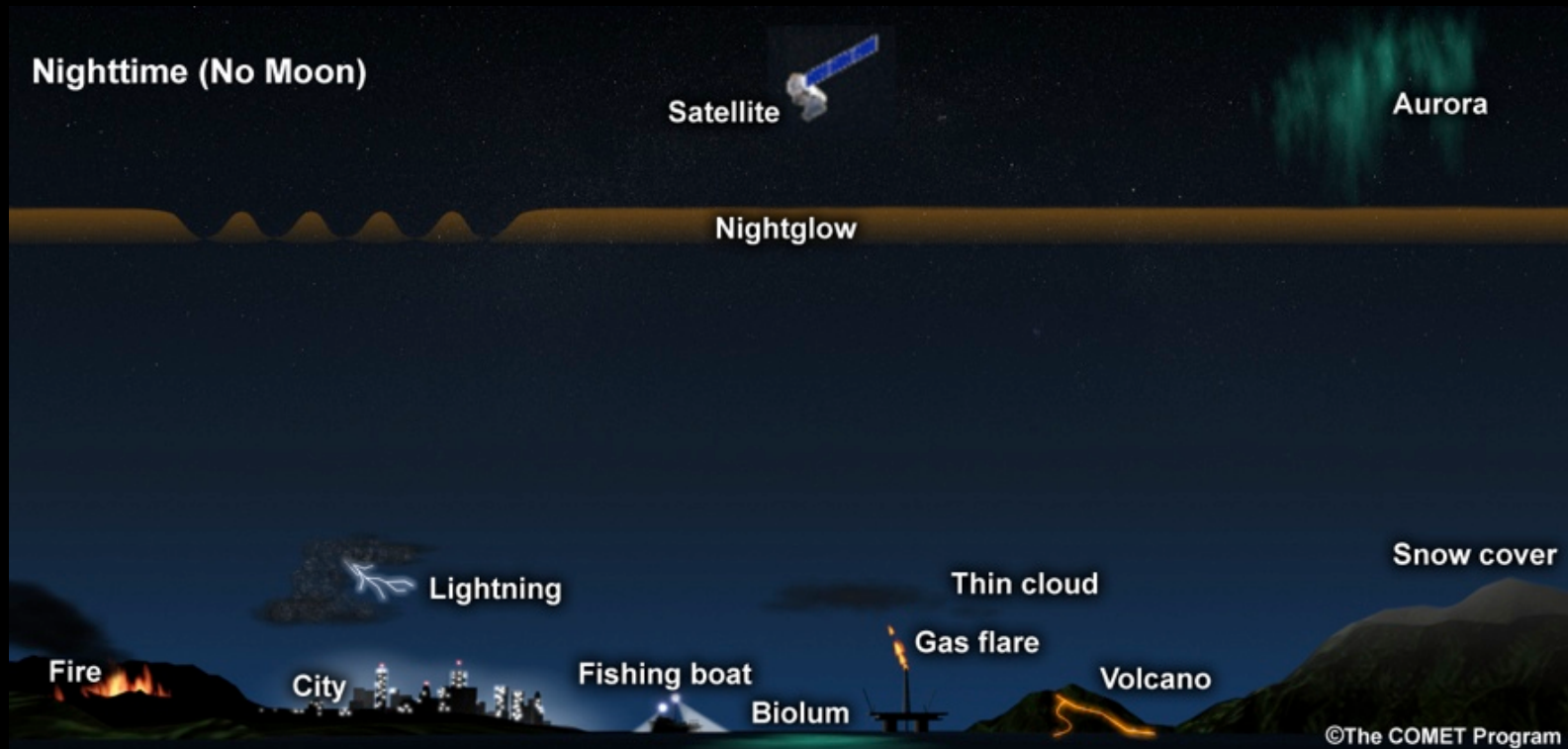


Connecting with the Forecasters: *'Proving Ground'* Demonstrations





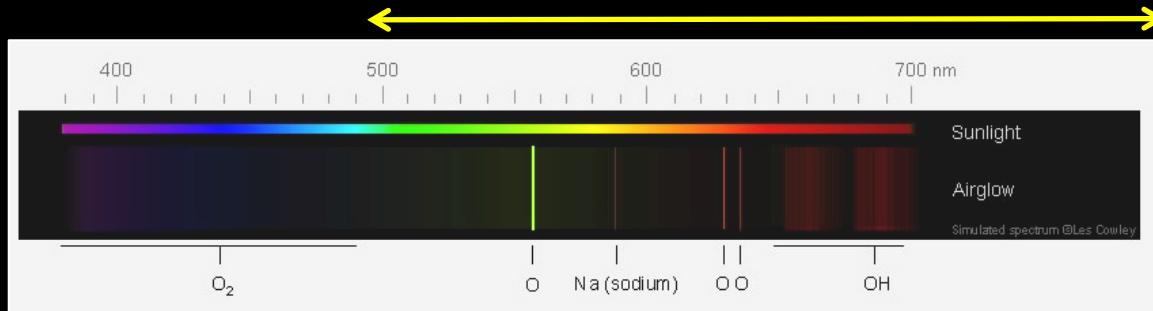
Casting Light on the Night with the VIIRS Day/Night Band



Miller et al., *Remote Sens.* 2013, **5**, 6717-6766; doi:10.3390/rs5126717

Airglow Sensitivity

Day/Night Band Spectral Response (0.5 – 0.9 μm)

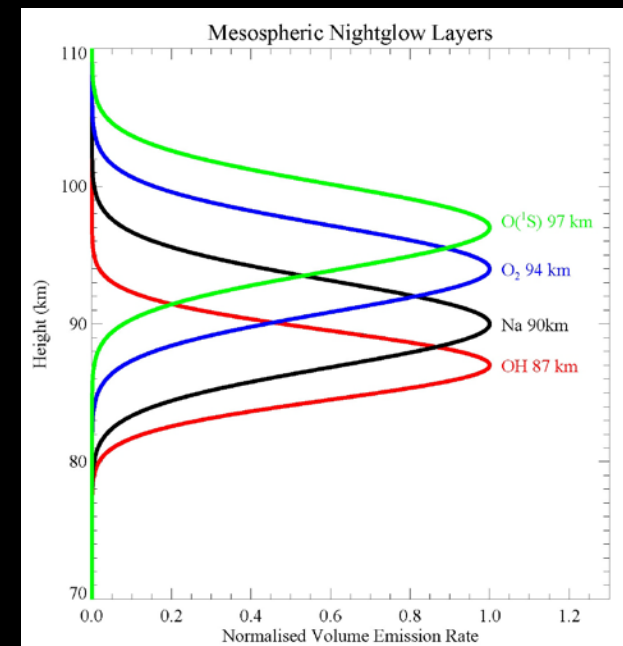
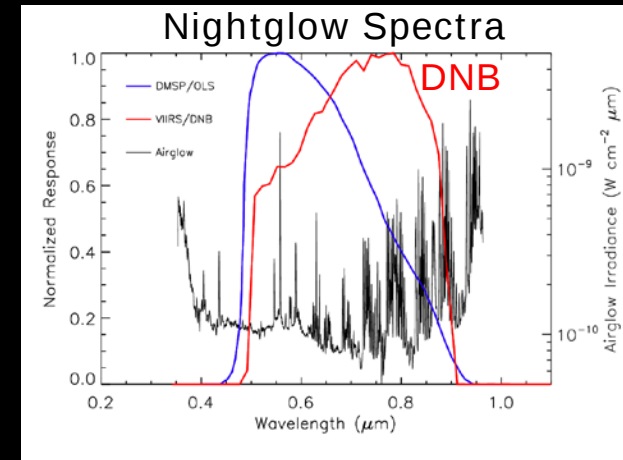


<http://www.atoptics.co.uk/highsky/airglow2.htm>

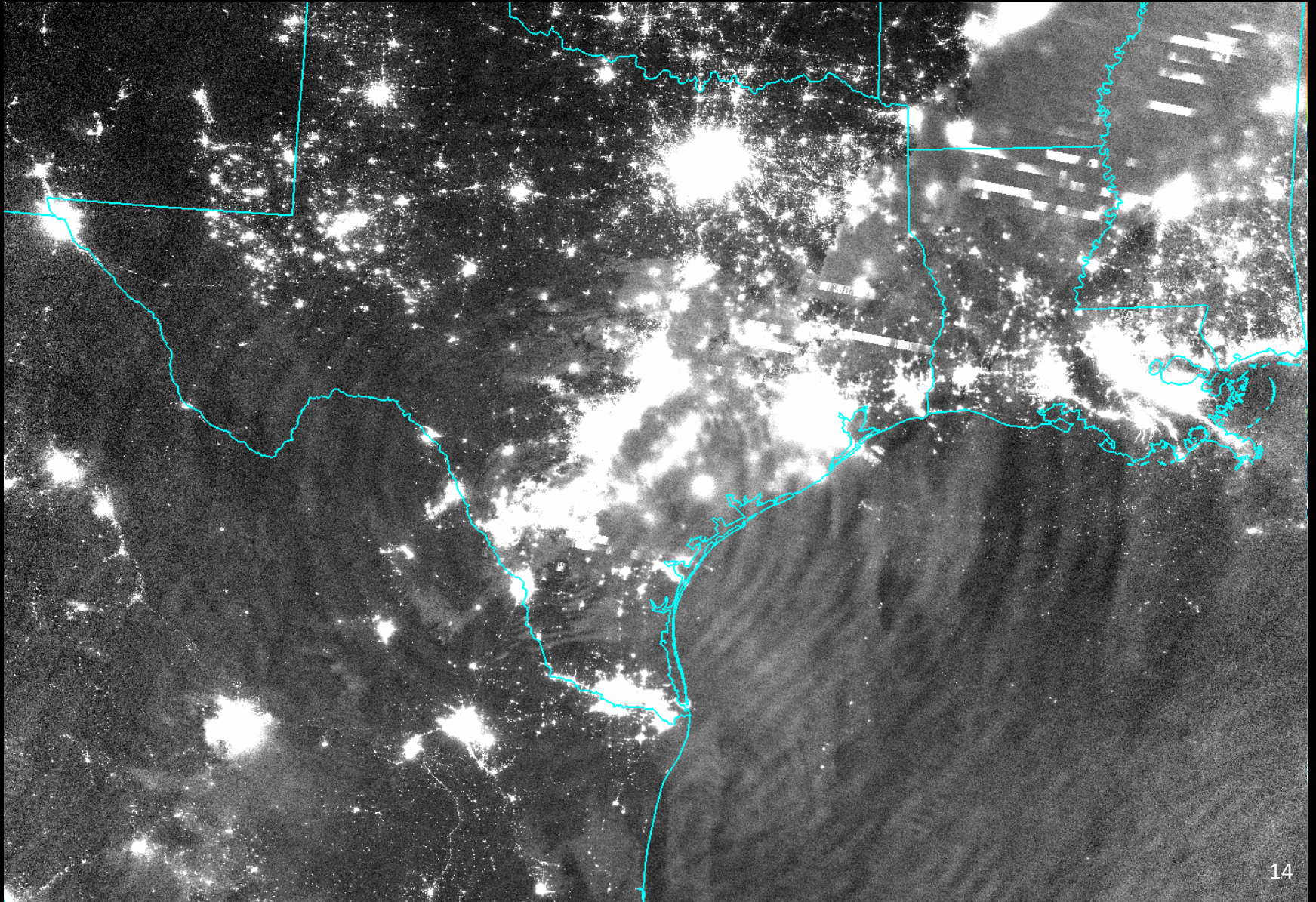
Airglow: Chemiluminescence related to relaxation or recombination of atoms and molecules that have been excited or photo-dissociated by solar ultraviolet radiation. Occurs globally. Photochemical processes at night are referred to as *Nightglow*.

- blue – molecular oxygen, ~ 95 km
- green – atomic oxygen, 90 – 100 km
- yellow/orange – atomic sodium, ~ 92 km
- red – atomic oxygen, 150 – 300 km
- red and near IR range – hydroxyl radicals (OH), 85 – 90 km

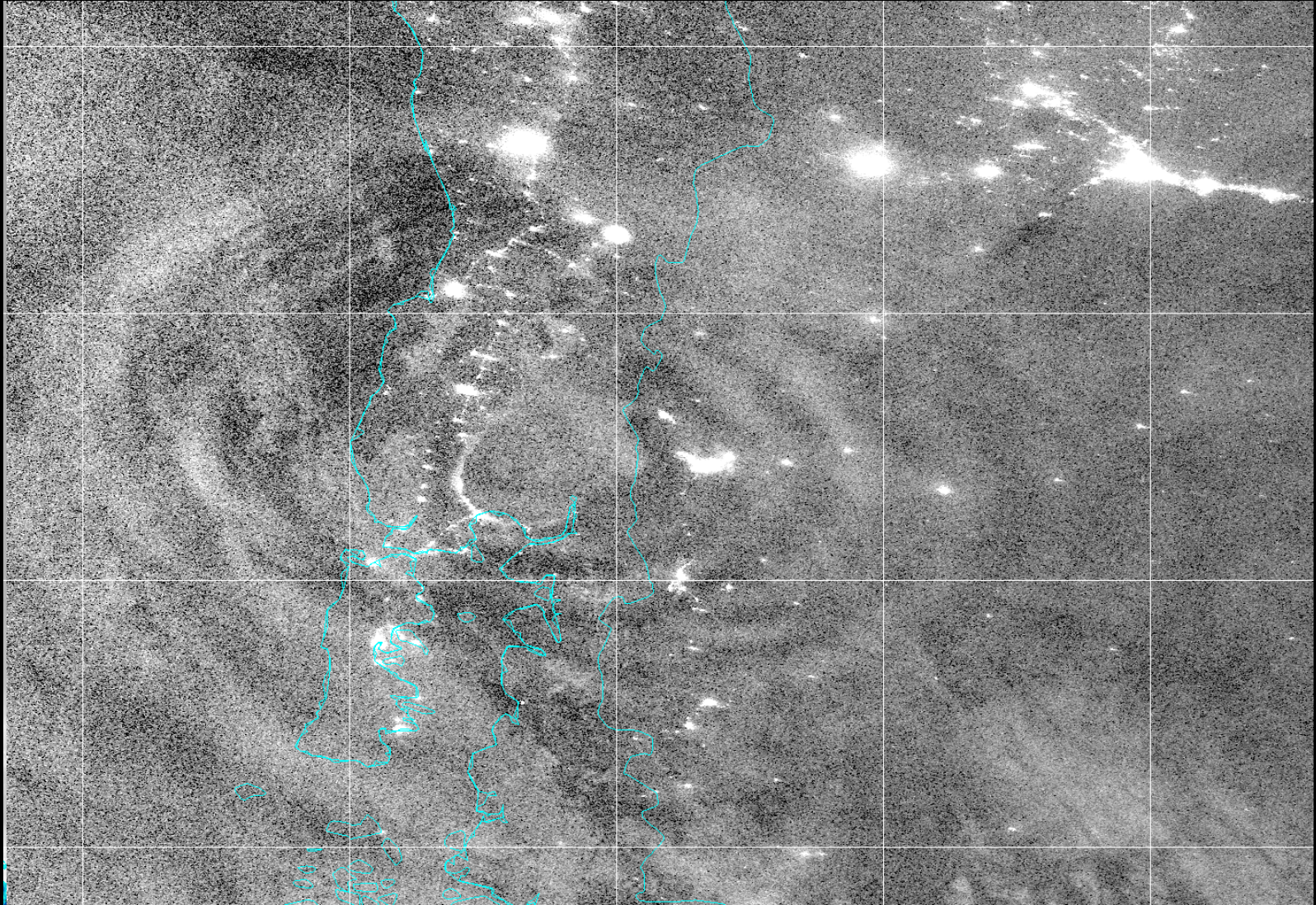
The Day/Night Band senses contributions from all these signals within its broad spectral response, with strongest emissions coming from OH^* (excited hydroxyls) near 87 km.



Waves in the Nightglow



Calbuco Volcano Eruption, Chile

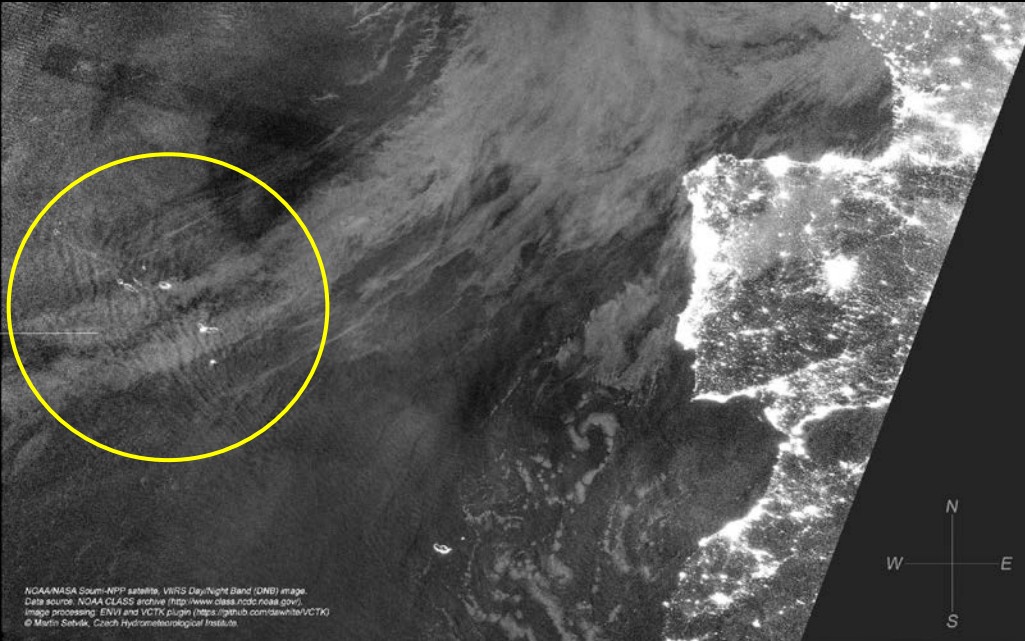


→ *This is the first satellite documentation of a night glow gravity associated with a volcanic eruption!*

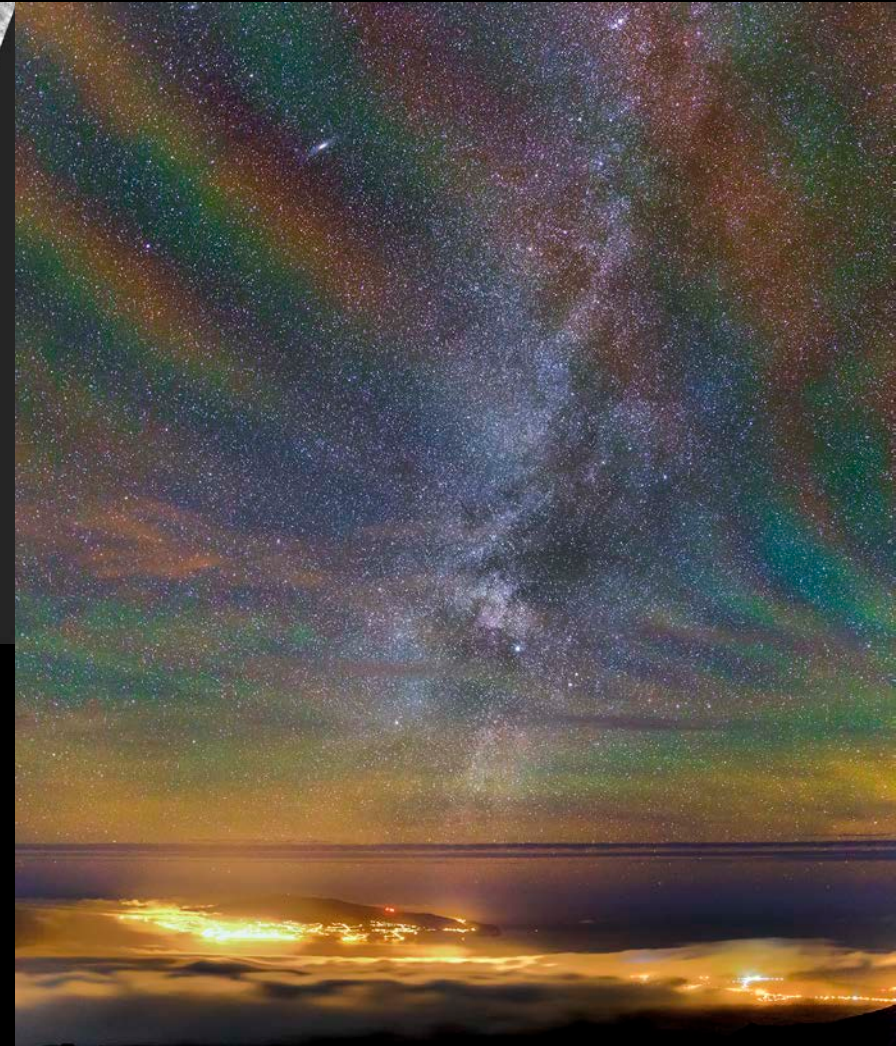
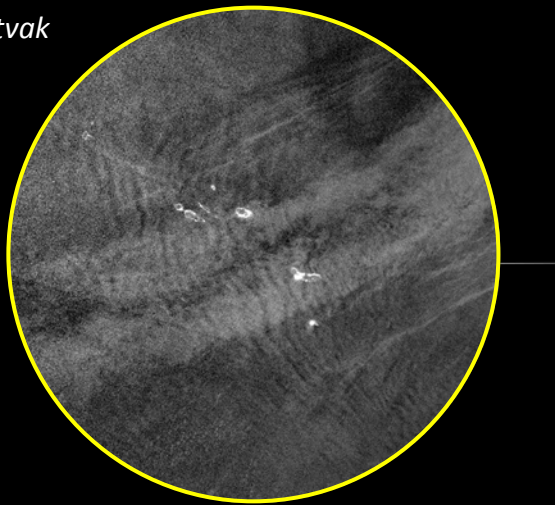
Pico Island, Azores

Suomi NPP VIIRS Day/Night Band: 16 March 2016, 0305 UTC

Surface Photo: 16 March 2016, 0343 UTC



Courtesy Martin Setvak



Central Azimuth $\sim 307^\circ$

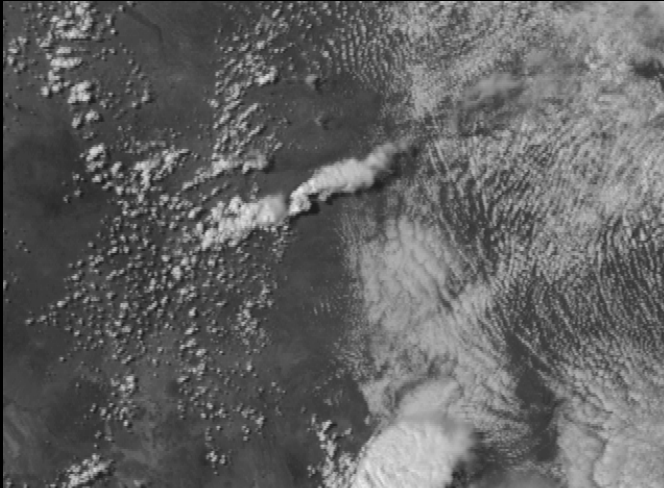
Courtesy Miguel Claro

Closing Thoughts

- NOAA Cooperative Institutes (CI's) link academia to operational users through applied research and development. Science → Societal Benefit.
- Each CI has a theme. At CIRA, we strive to connect models with observations, with a focus on satellite remote sensing and data fusion.
- The CoRP Symposium is an opportunity to hear from leaders in our field, get a pulse on the latest CI initiatives, and make connections with young scientists who are helping to define our future capabilities and research directions.
- We hope you enjoy the Symposium, and thanks for participating!

Proving Ground Demonstrations

Storm Prediction Center / Hazardous Weather Testbed

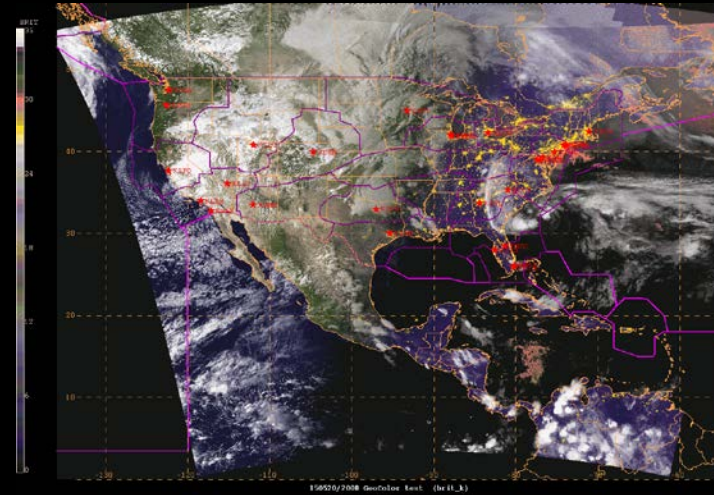


Super Rapid Scan Operations for GOES-R (SRSOR) over western TX of 1-min visible imagery from 19 April 2016. CIRA/RAMMB supports the SPC and HWT with this image when available.

The utility of geostationary imagery at high latitudes is on display in this Himawari image “way out on the limb”. Loop depicts the Pavlof eruption in Aleutian chain on 28 March 2016. GOES-R will have even better coverage over the Alaska Region.



Aviation Weather Center



Model data overlaid on a GeoColor image for a specially developed domain for the AWC. The purple boxes are aviation forecast zones.

High Latitude / Alaska Region

