Multispectral Application Development for Himawari-8 AHI

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Session 2: Himawari-8, related status and application
S02-4

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1 CIRA Connecting Models and Observations
2,3 NOAA NESDIS STAR
4 CIMSS
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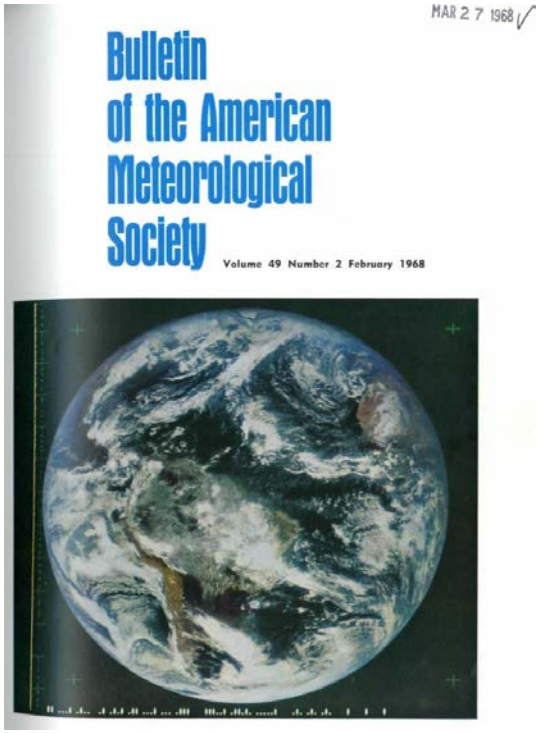
Outline

- Background—NOAA's GOES-R Proving Ground (PG)
- Selected PG applications from Suomi-NPP VIIRS
- Transitioning to AHI:
  - Selected AHI RGB Applications
  - True Color and "Hybrid Green"
  - *GeoColor* Blended Imagery
  - Lofted Dust
- Conclusions



NASA ATS-3 (1967)
The last geostationary satellite to offer a true color imaging capability.

NOAA's GOES-R Proving Ground

Vision:

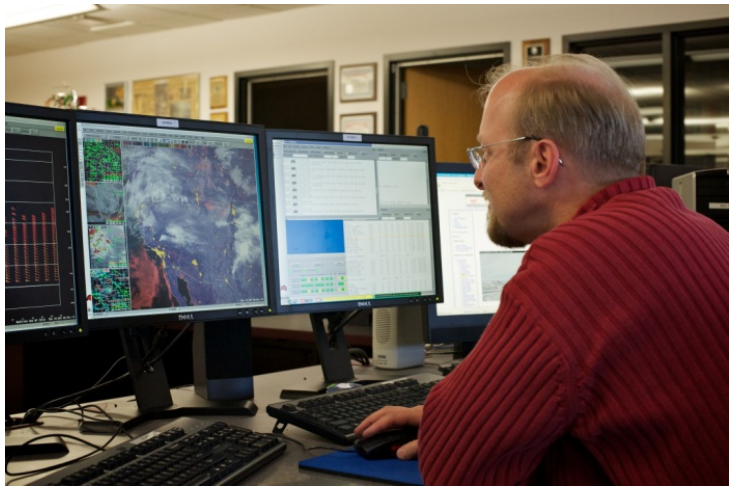
- Bridge the gap between researchers and forecasters

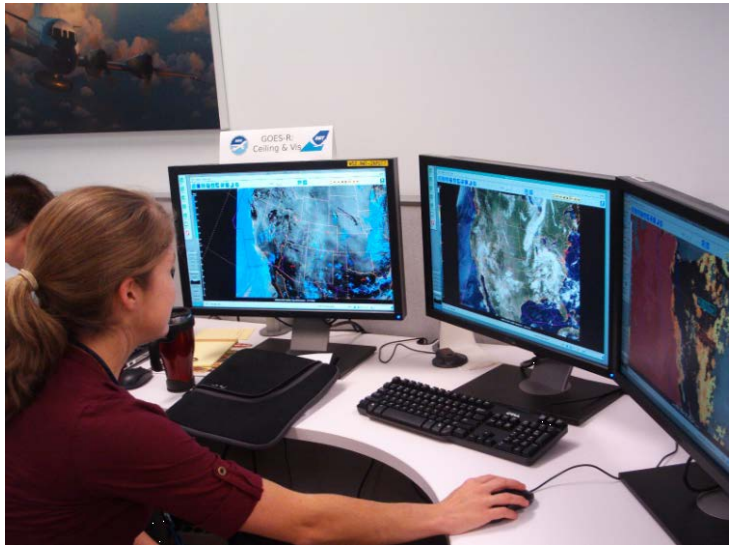
Objectives:

- Day-1 readiness and maximum utilization of the GOES-R observing system
- A conduit for research satellite products to be hosted on operational display systems

Approach:

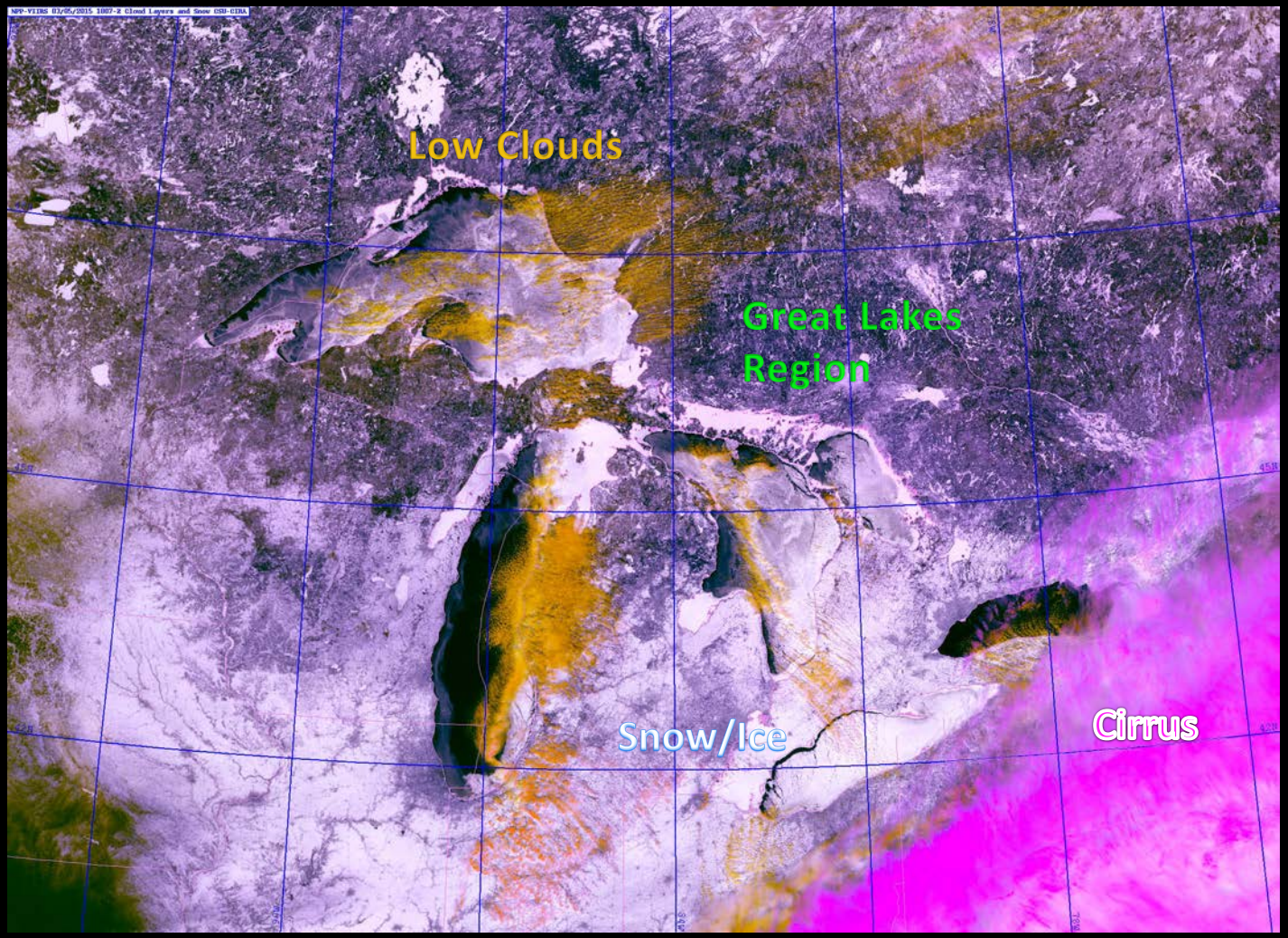
- Use proxy data to anticipate future GOES-R Advanced Baseline Imager capabilities
- Demonstrate ABI-caliber products/techniques in the operational environment
- Engage in 2-way dialogue to enable research-to-operations-to-research (R2O2R) development



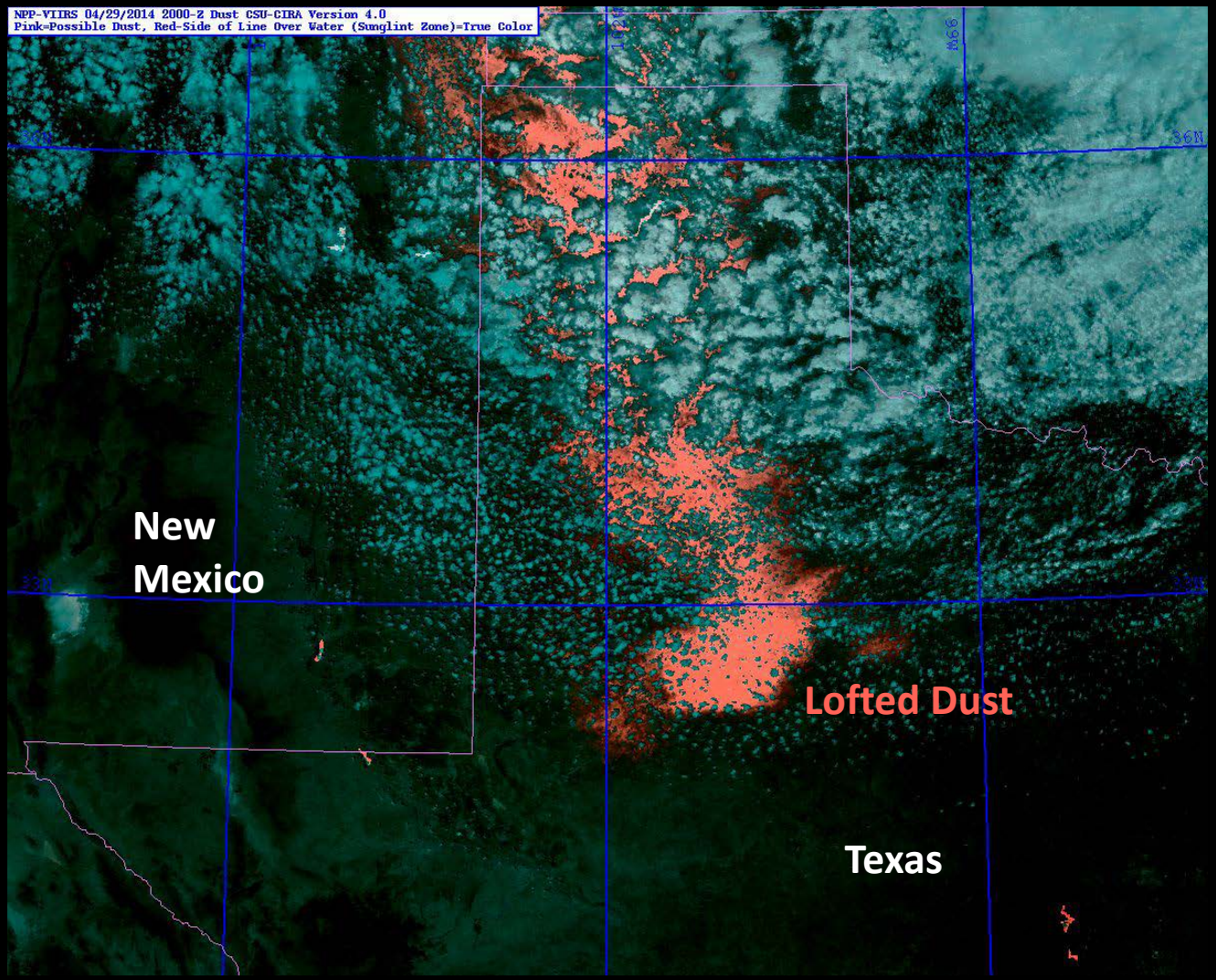


→ **Himawari-8 AHI provides closest proxy to GOES-R ABI**

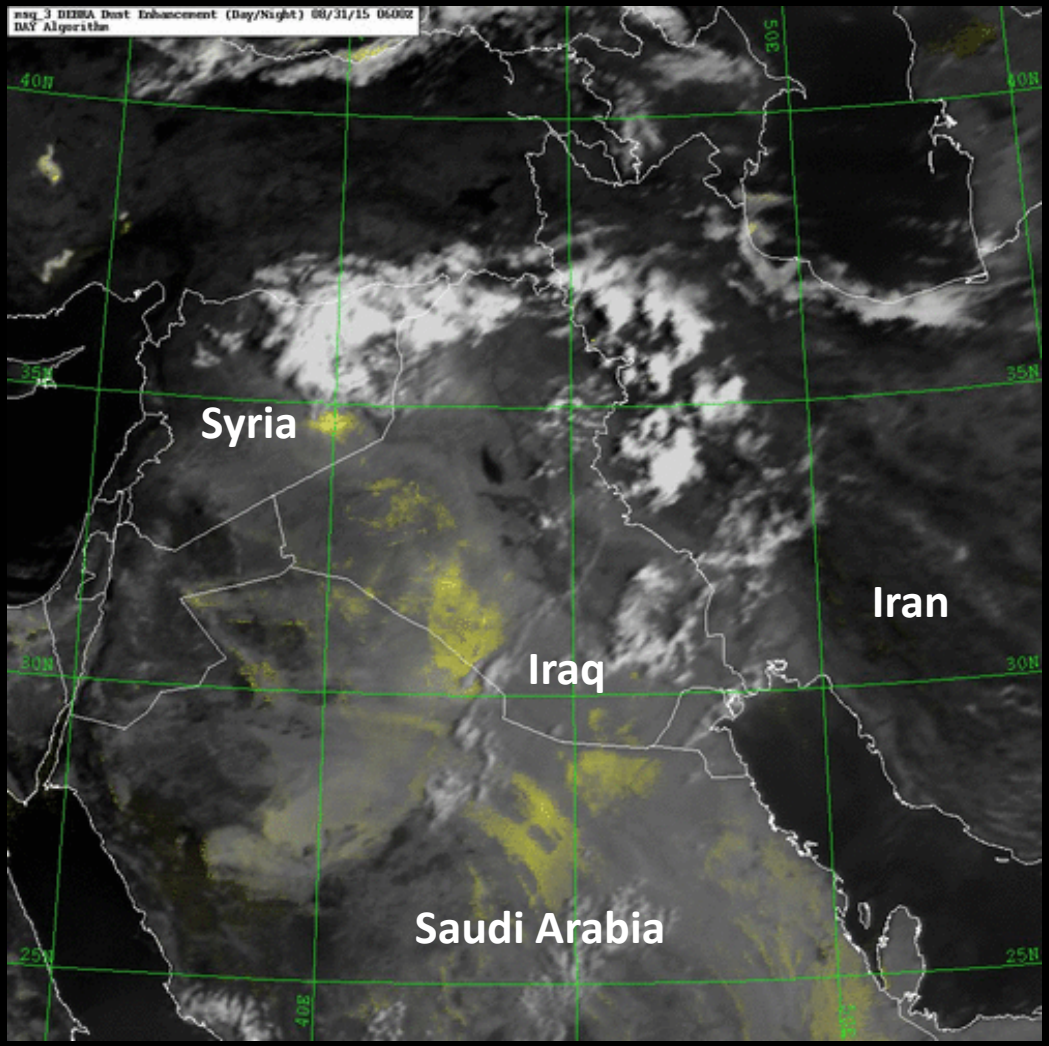
Proving Ground Demonstrations: MODIS/VIIRS Cloud/Snow



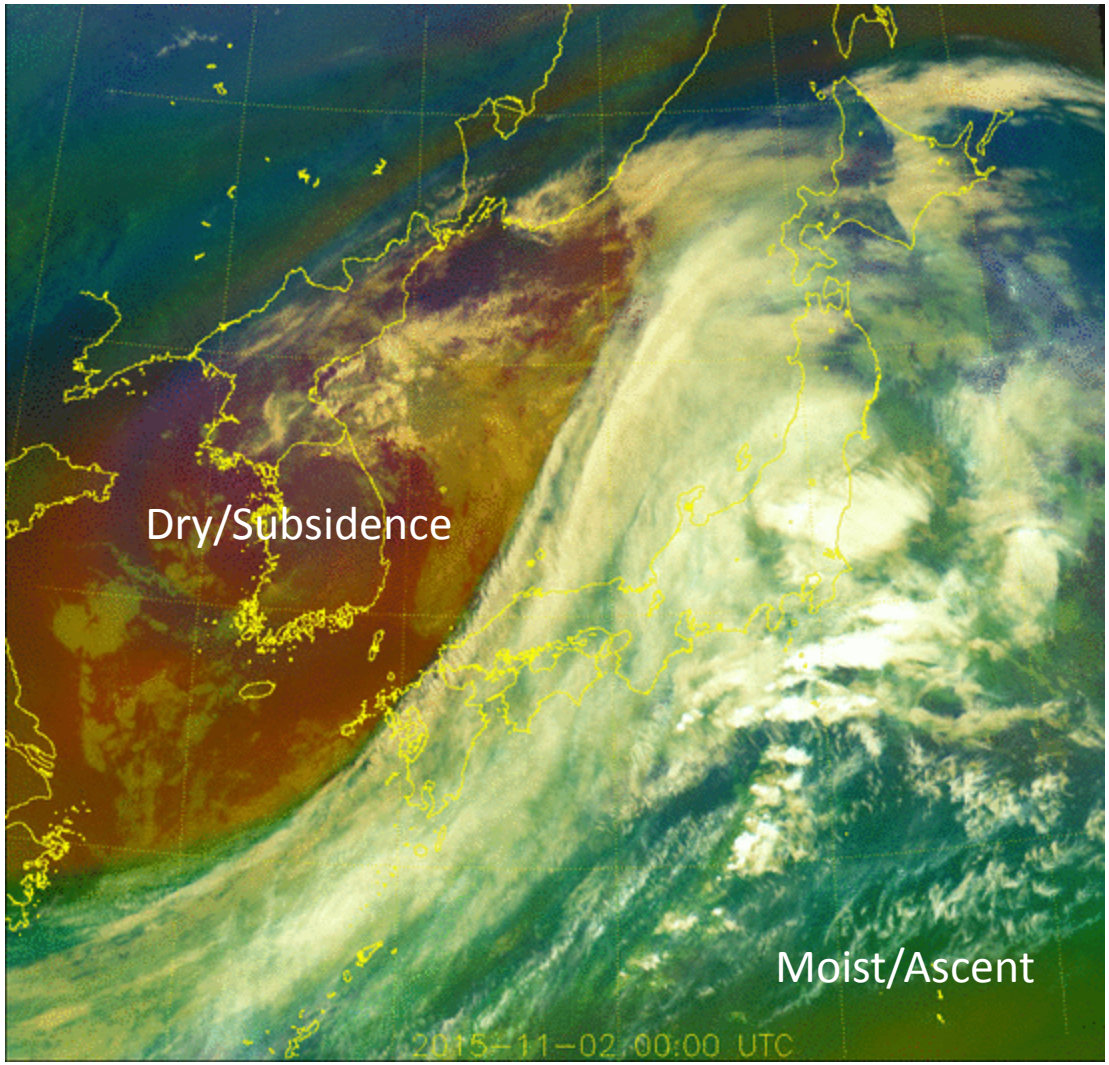
Proving Ground Demonstrations: MODIS/VIIRS Blue-Light Dust



Proving Ground Applications: MSG ‘DEBRA’ Dust Mask



AHI Airmass RGB (EUMETSAT)



A frontal system passes over Japan
0000-0750 UTC 2 November 2015

Band 8 (6.2 µm) BLUE

Band 12-13 (9.6 - 10.3 µm) GREEN

Band 8-10 (6.2 – 7.3 µm) RED

- Colors are dependent on temperature, water vapor and ozone

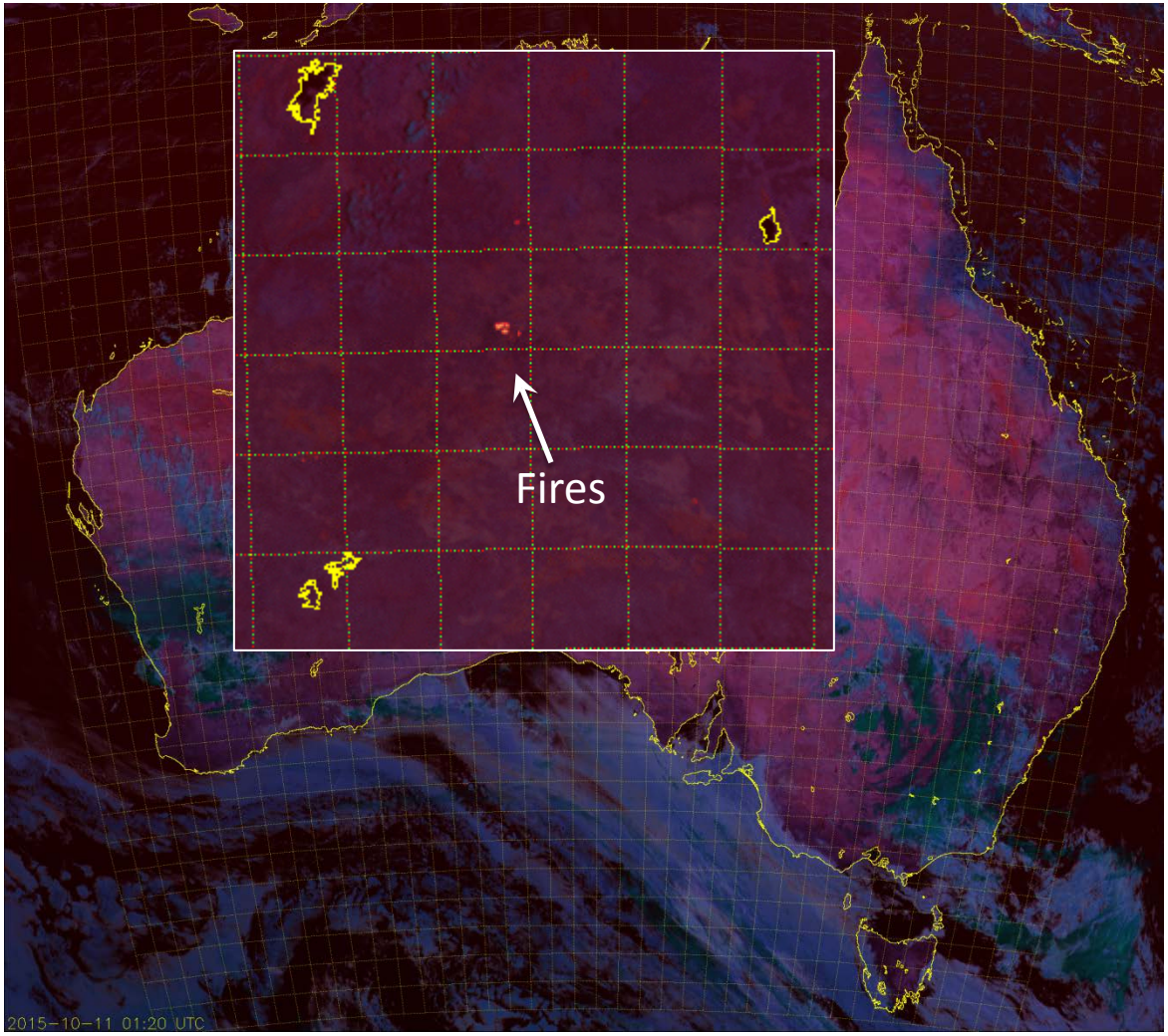
- Warm, moist (tropical): green
- Warm, dry: **orange**

- Cold, dry (polar): purple
- Cold, moist: **blue**

- Low tropopause height/strong subsidence: **red**

- Warm land surface: **black**
- Cold clouds: white

AHI Fire Temperature RGB



Bush land fires detected in Australia
2340-0800 UTC 11 October 2015

Band 5 (1.6 µm) BLUE

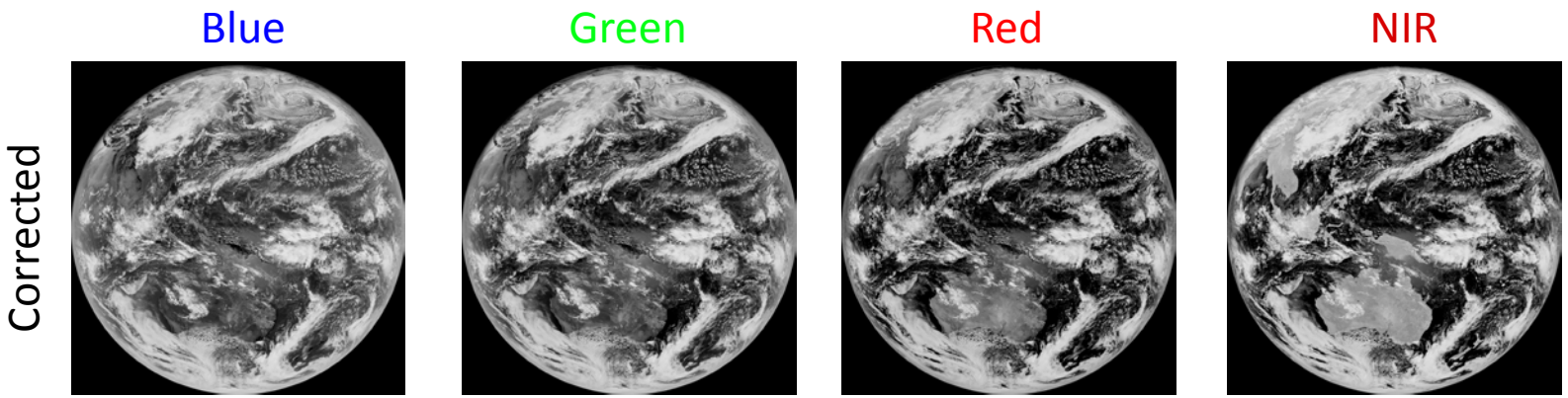
Band 6 (2.3 µm) GREEN

Band 7 (3.9 µm) RED

- Relatively cool/small fires only detected at 3.9 µm appear red
- Warmer/larger fires detected in both 3.9 µm and 2.25 µm appear yellow
- Very large/hot fires detected in all three bands and appear white
- Liquid clouds: blue
- Ice clouds: dark green

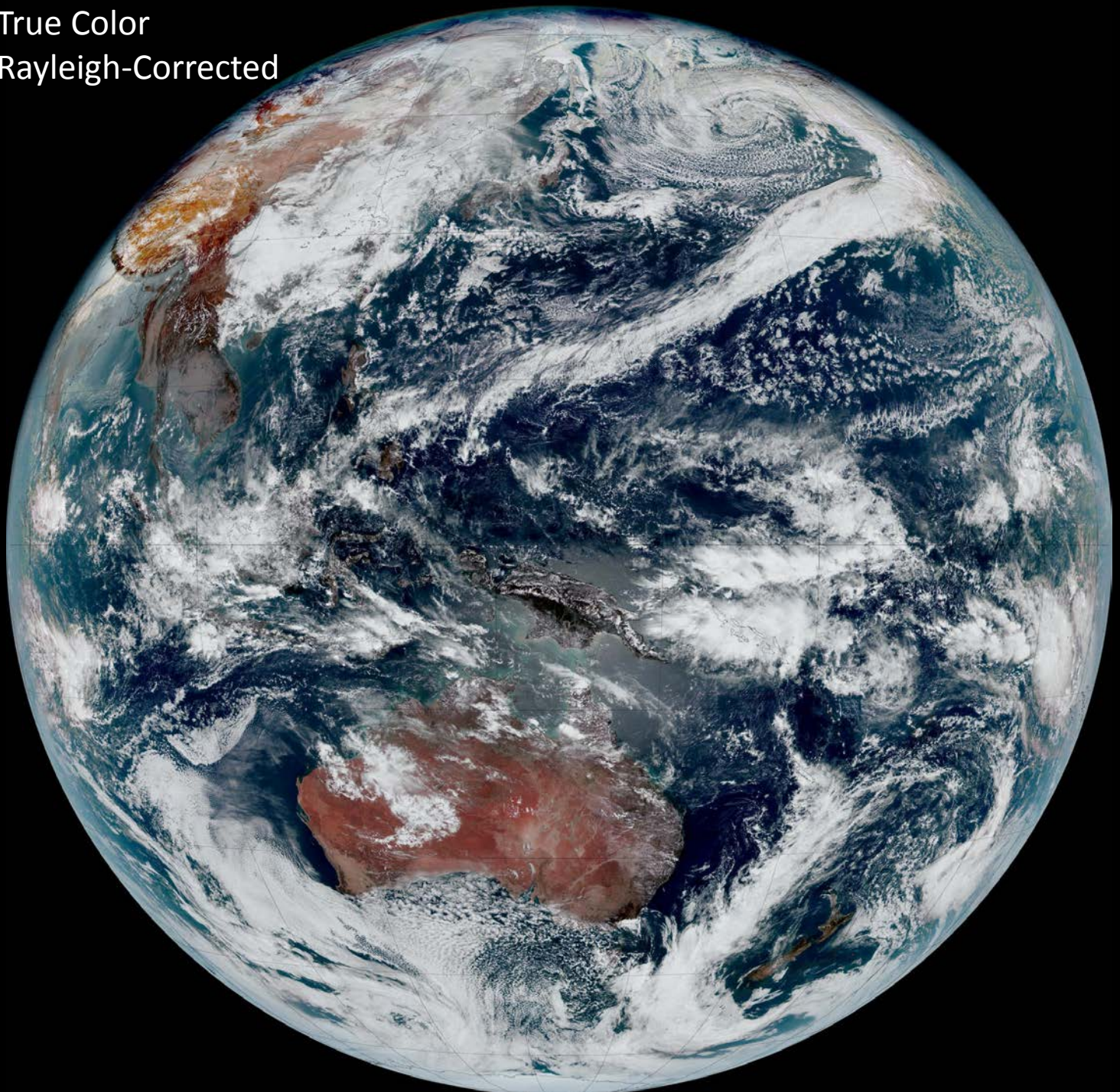
AHI True Color: Rayleigh Corrections

- Molecular scatter of sunlight by the gaseous atmosphere is significant, particularly in the blue-band
- Adapted atmospheric correction software, applied previously to SeaWiFS/MODIS/VIIRS sensors, to AHI bands
- Corrections are a function of solar & satellite geometry

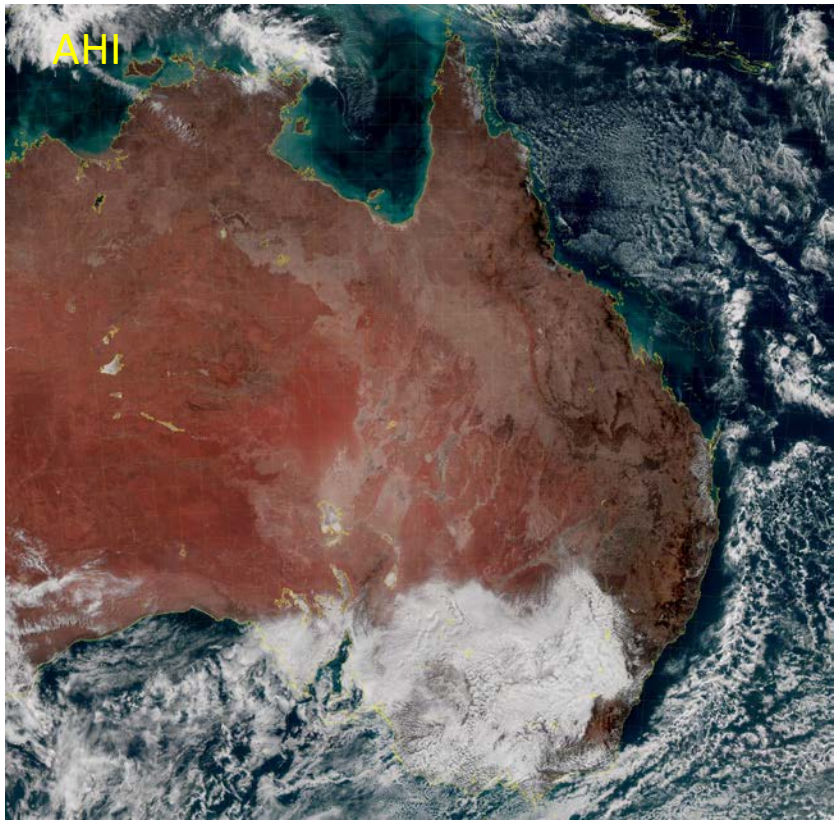


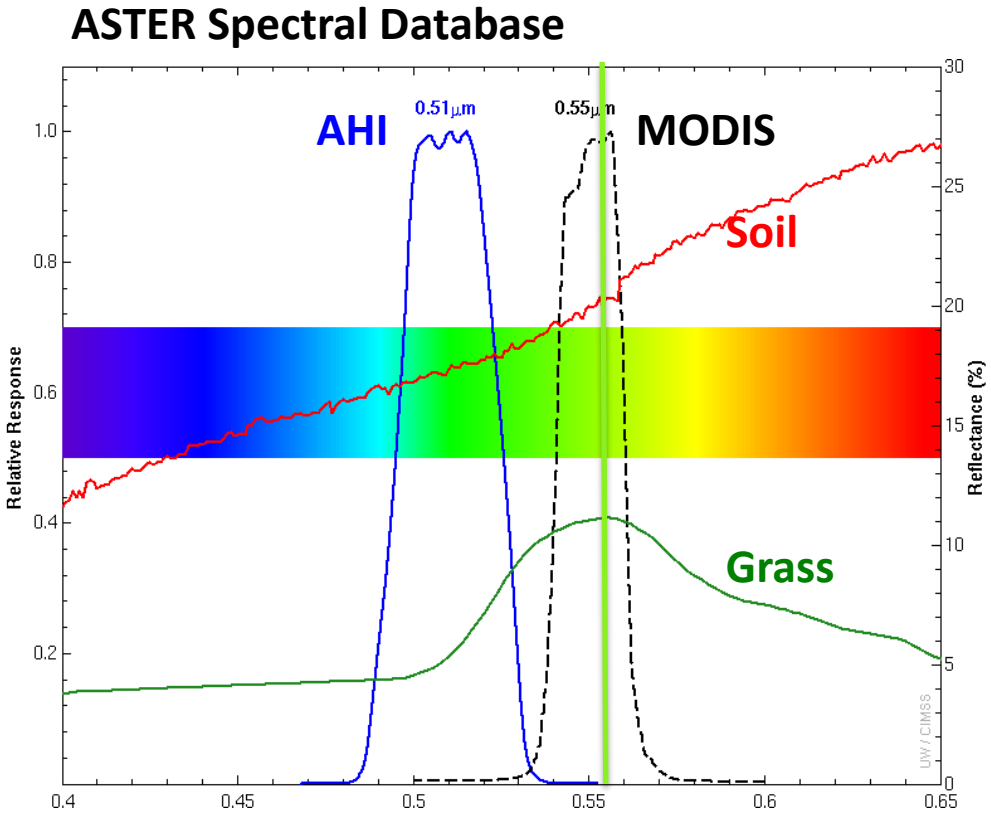
→ *These atmospheric corrections are a critical step in attaining high-quality true color imagery*

True Color
Rayleigh-Corrected



Inconsistency with MODIS/VIIRS





- Comparisons of AHI true color imagery to VIIRS & MODIS showed vegetation too brown, deserts too red
- The 510 nm AHI band misses the 555 nm chlorophyll signal, and mineral soils are more absorbing.(MODIS/VIIRS both use 555 nm)

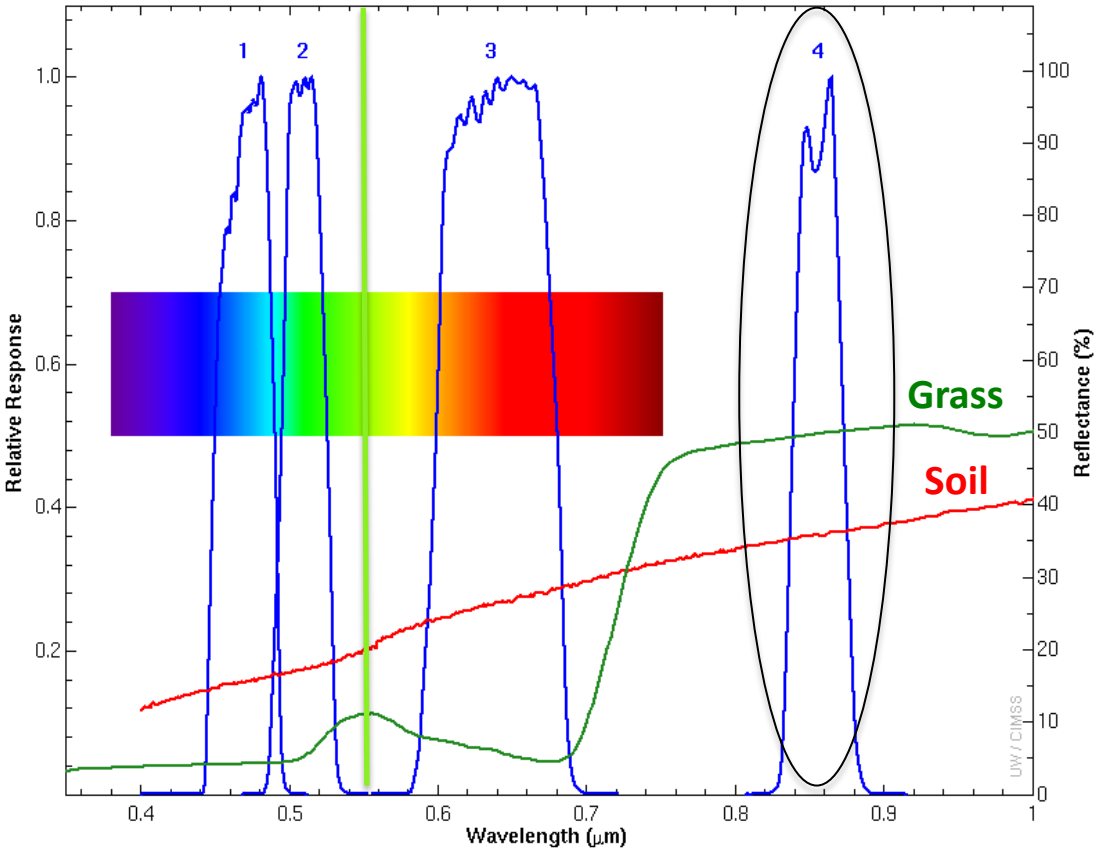
Proposing a '*Hybrid Green*' Band

- Blend 510 nm green band with vegetation-sensitive 856 nm band to produce a 'hybrid green' band (G_H):

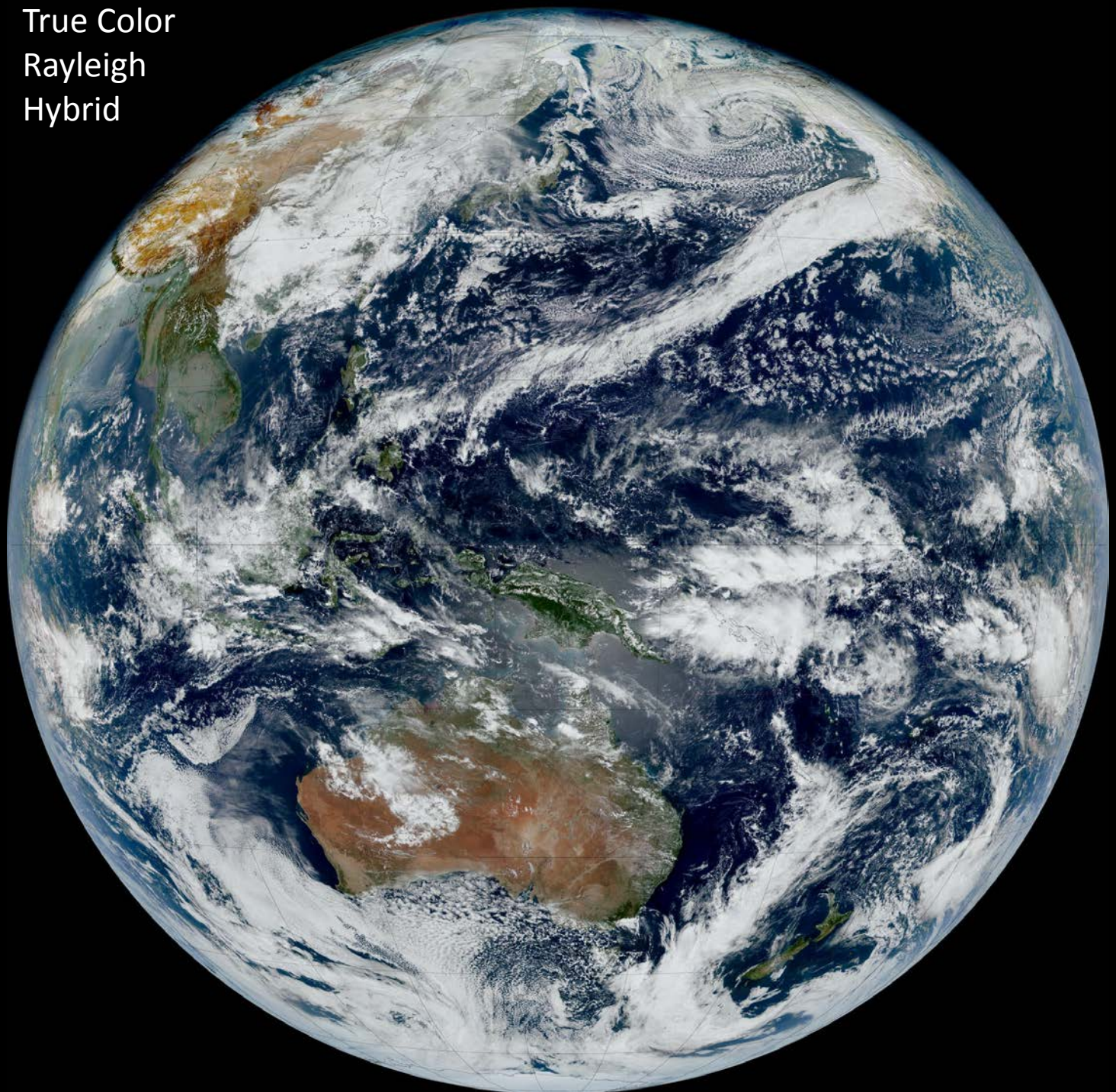
G_H = F * R_510 + (1-F) * R_856

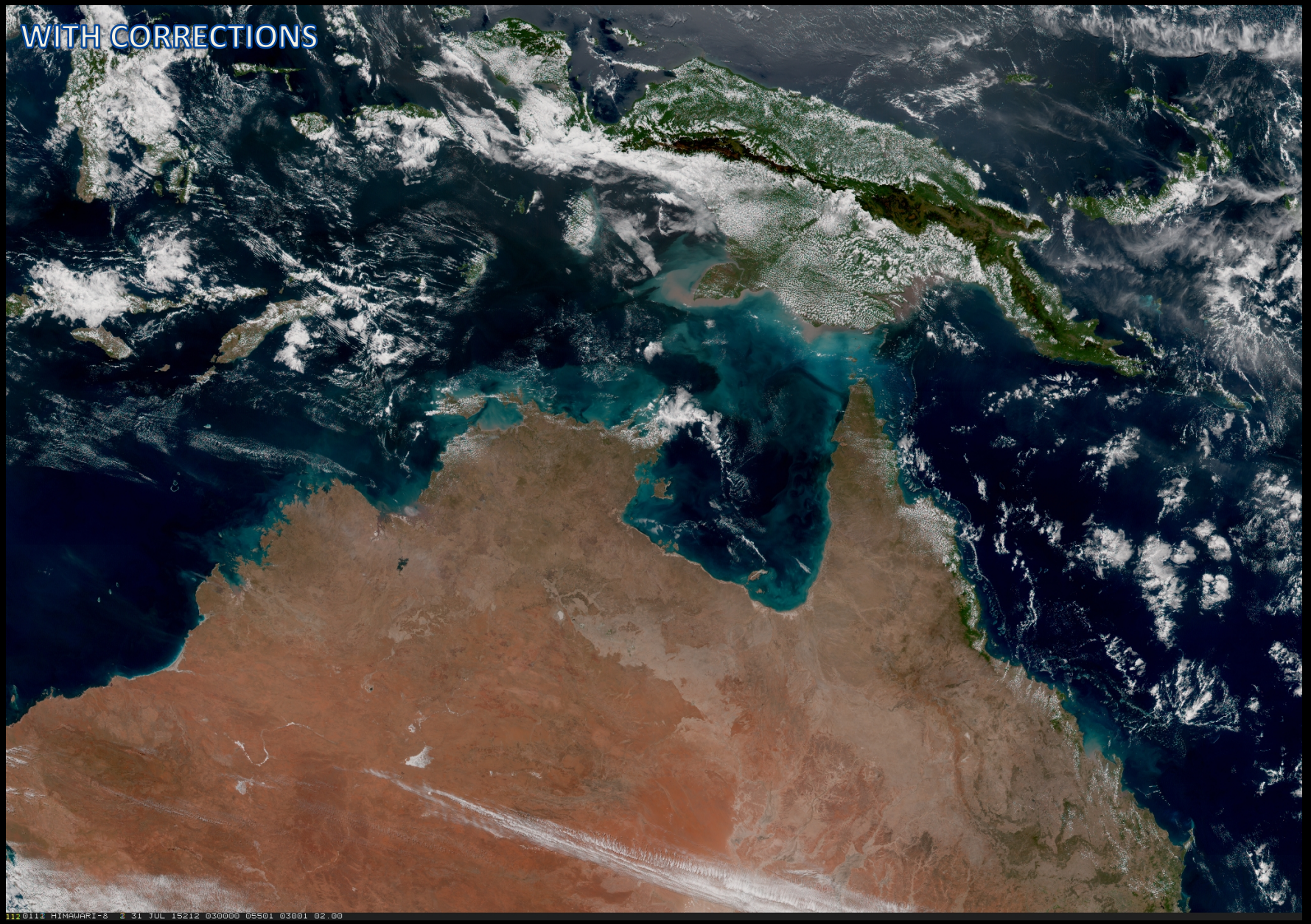
~ 0.93 (experimental)

- Provides enhancement to green vegetation and mineral soils (e.g., deserts).
- Minimal impact to other features of the scene (clouds, ocean, and shallow-water coloration)

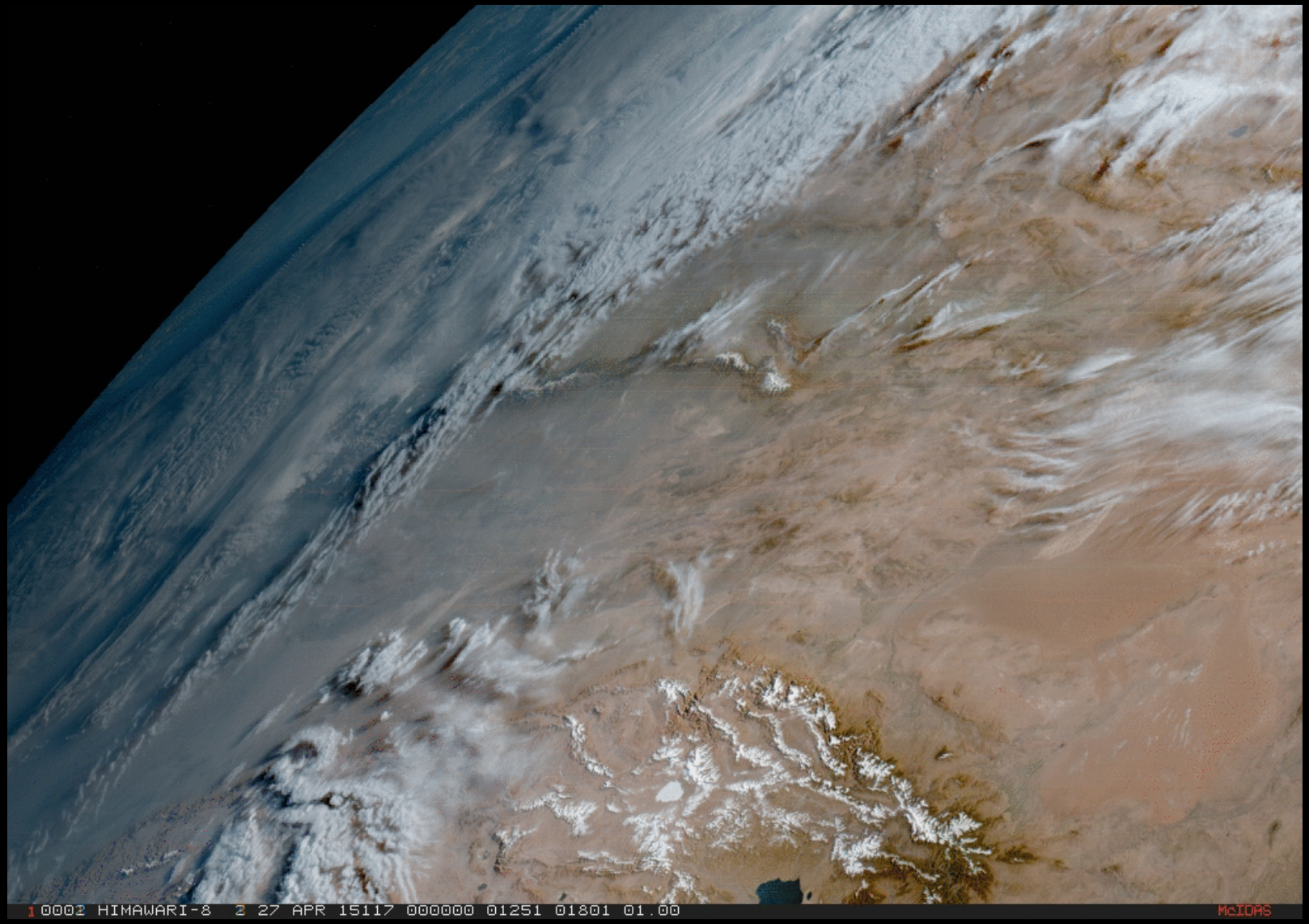


→ **AHI Band 4 (856 nm) provides a 'boost' to the 510 nm vegetation and soil reflectance…**


True Color
Rayleigh
Hybrid

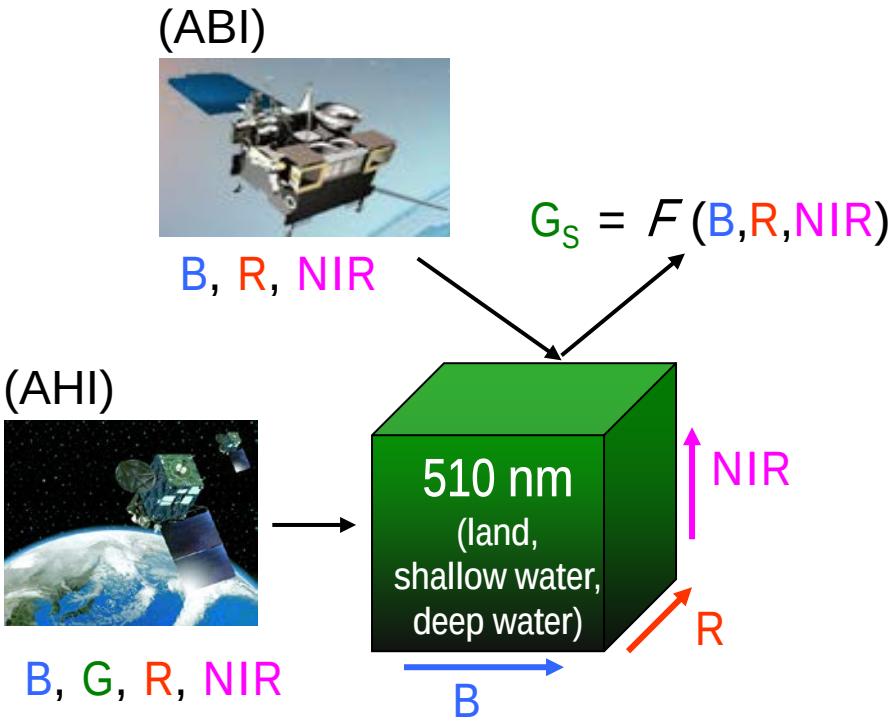

WITH CORRECTIONS
112 0112 HIMAWARI-8 2 31 JUL 15212 030000 05501 03001 02.00

Hybrid Green True Color Examples



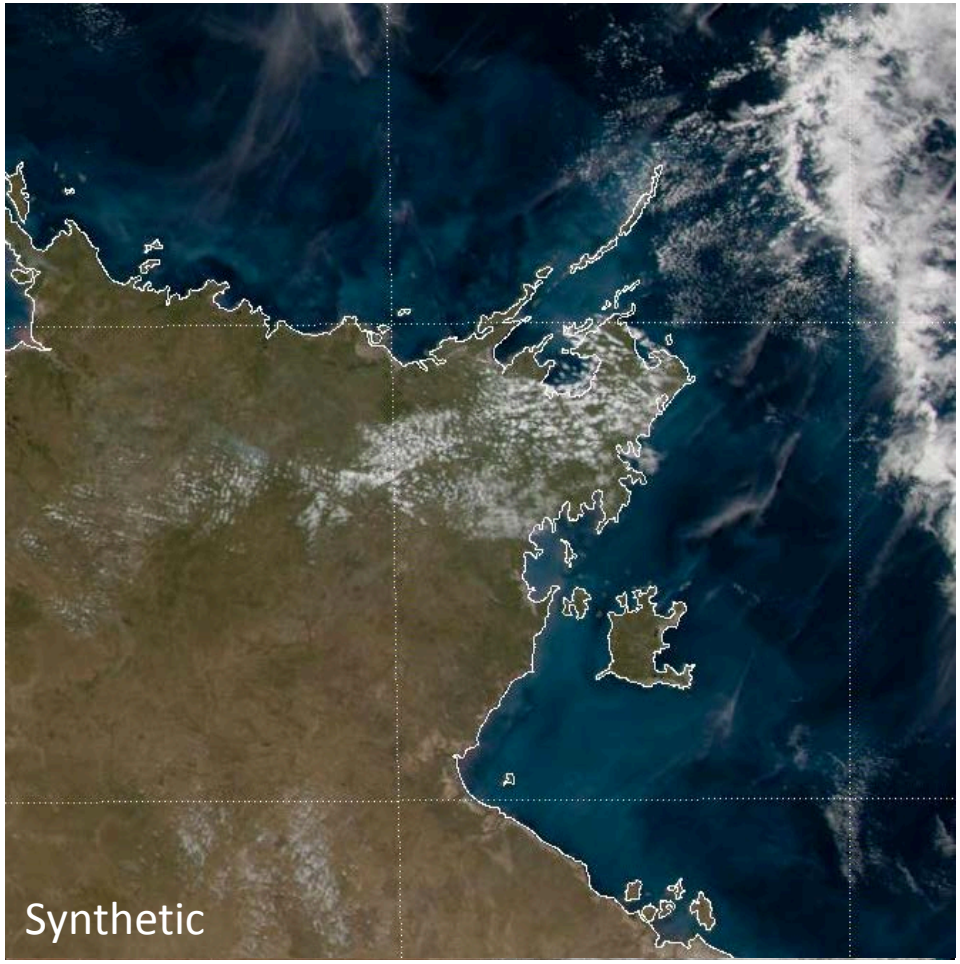
A Synthetic Green Band for ABI

GOES-R ABI has no green band—we must approximate it via correlations with other available bands. → We are using Himawari-8 AHI for this development.



For GOES-R ABI, we will first construct G_S (510 nm), then compute $G_{H,S}$ via:

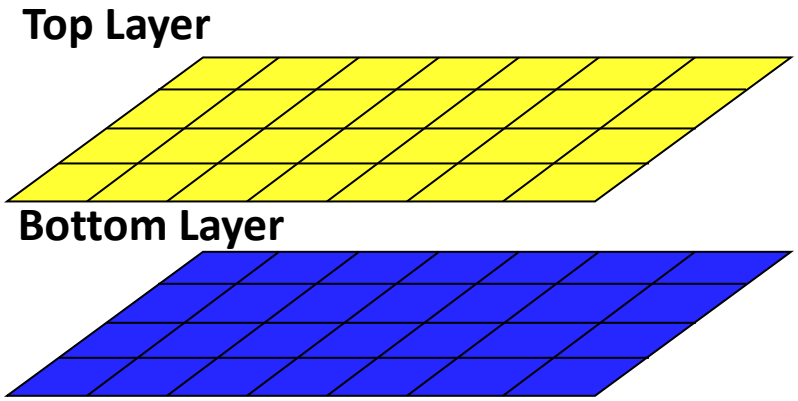
$$G_{H,S} = F*G_S + (1-F)*R_{856} \quad , F = 0.93$$



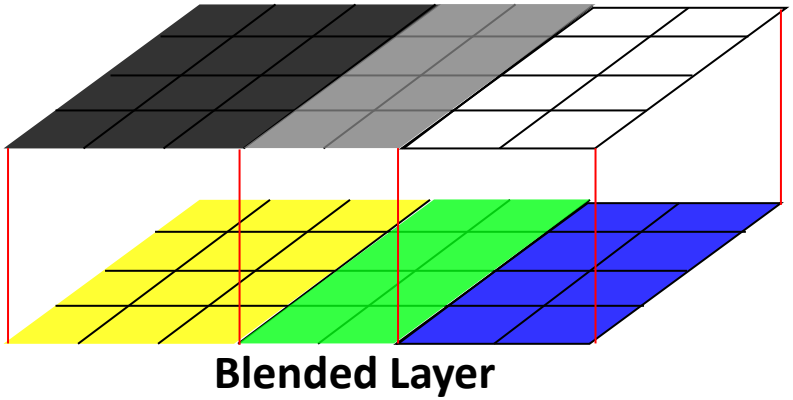
Miller, S. D., C. Schmidt, T. Schmit, and D. Hillger, 2012, *Int. J. Rem. Sens.*, **33**(13), 3999-4028.

Merging Layers of Information
The *GeoColor* Concept

Layers of Information (2 layer example)

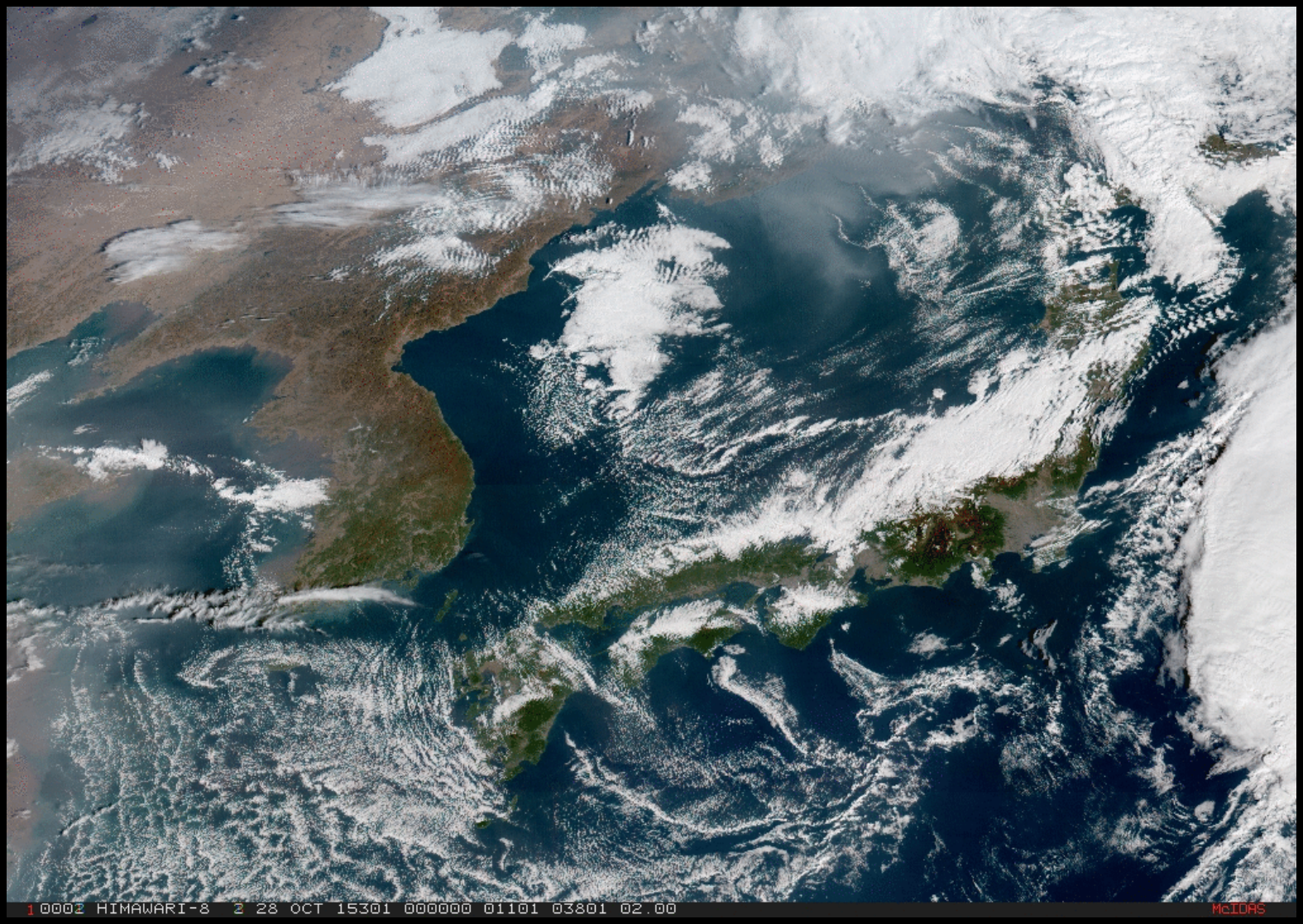


Spatial Opacity Rules for Top Layer (Black= Opaque, White=Transparent)



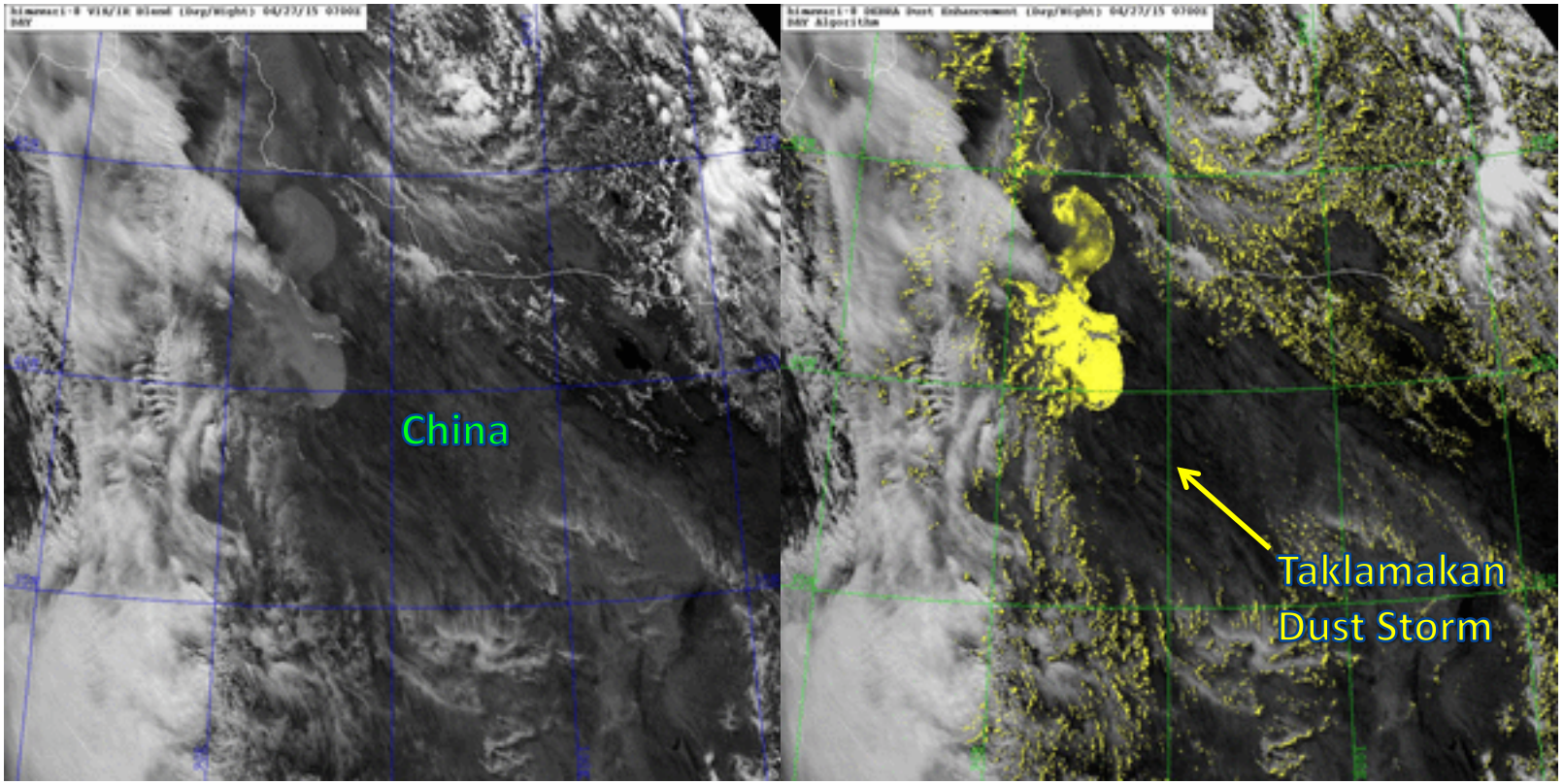
- Each layer of information has an associated opacity field that is defined at the pixel level.
- A separate blend is done for each color gun (R/G/B).
- Concept can be extended to "N-dimensional blending," allowing for ***simultaneous display of multiple layers***.

AHI GeoColor (Provisional)



Future Layers: AHI "DEBRA" Dust Mask (Provisional)

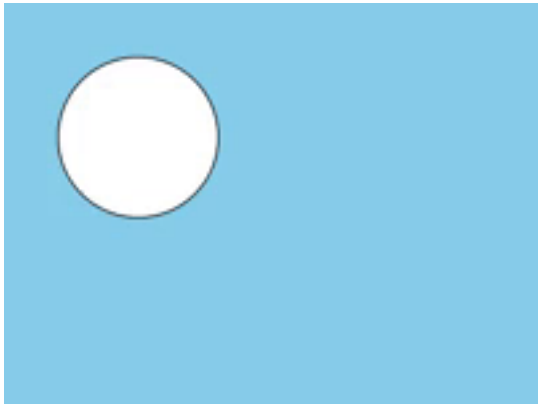
Visible **Dust Enhancement**



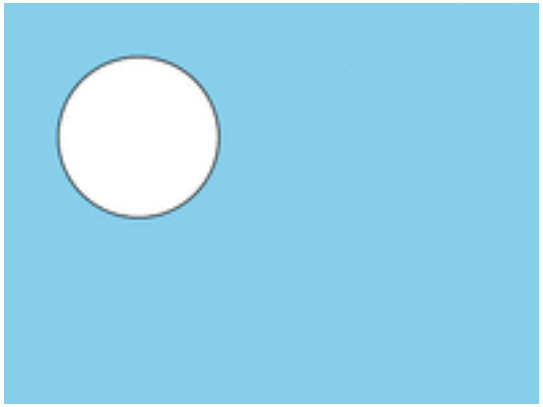
→ *In early development for AHI, DEBRA is a confidence factor that could readily be used as another layer in GeoColor...*

Optical Flow Image Filtering

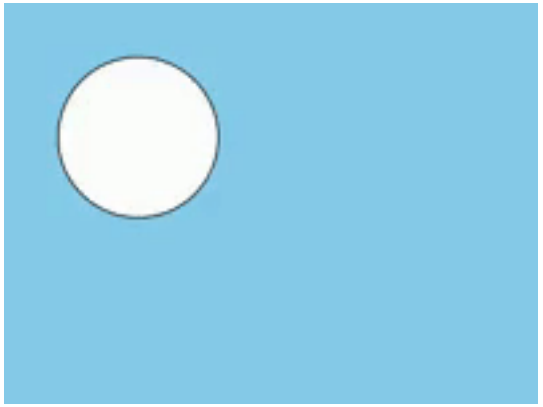
Sequential

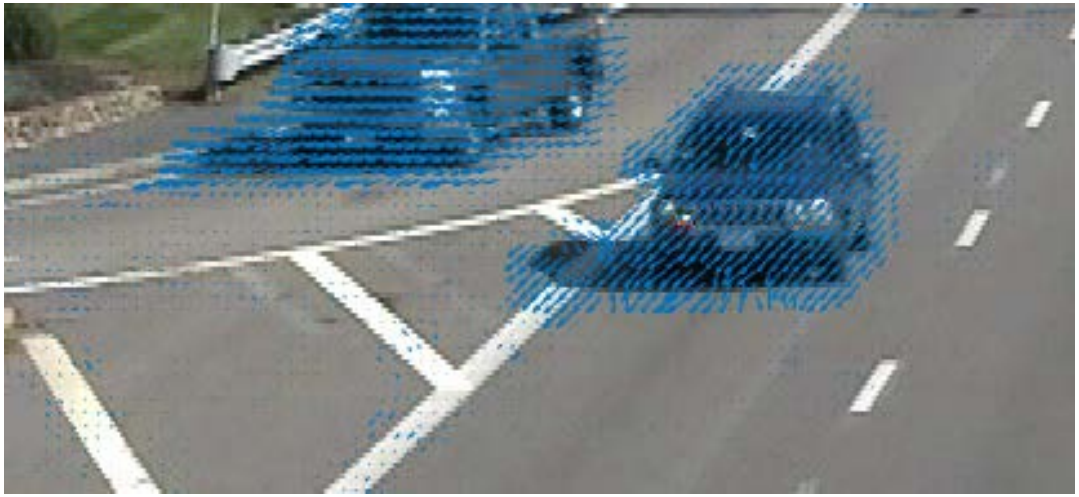


Basic Fading



Optical Flow Filtering

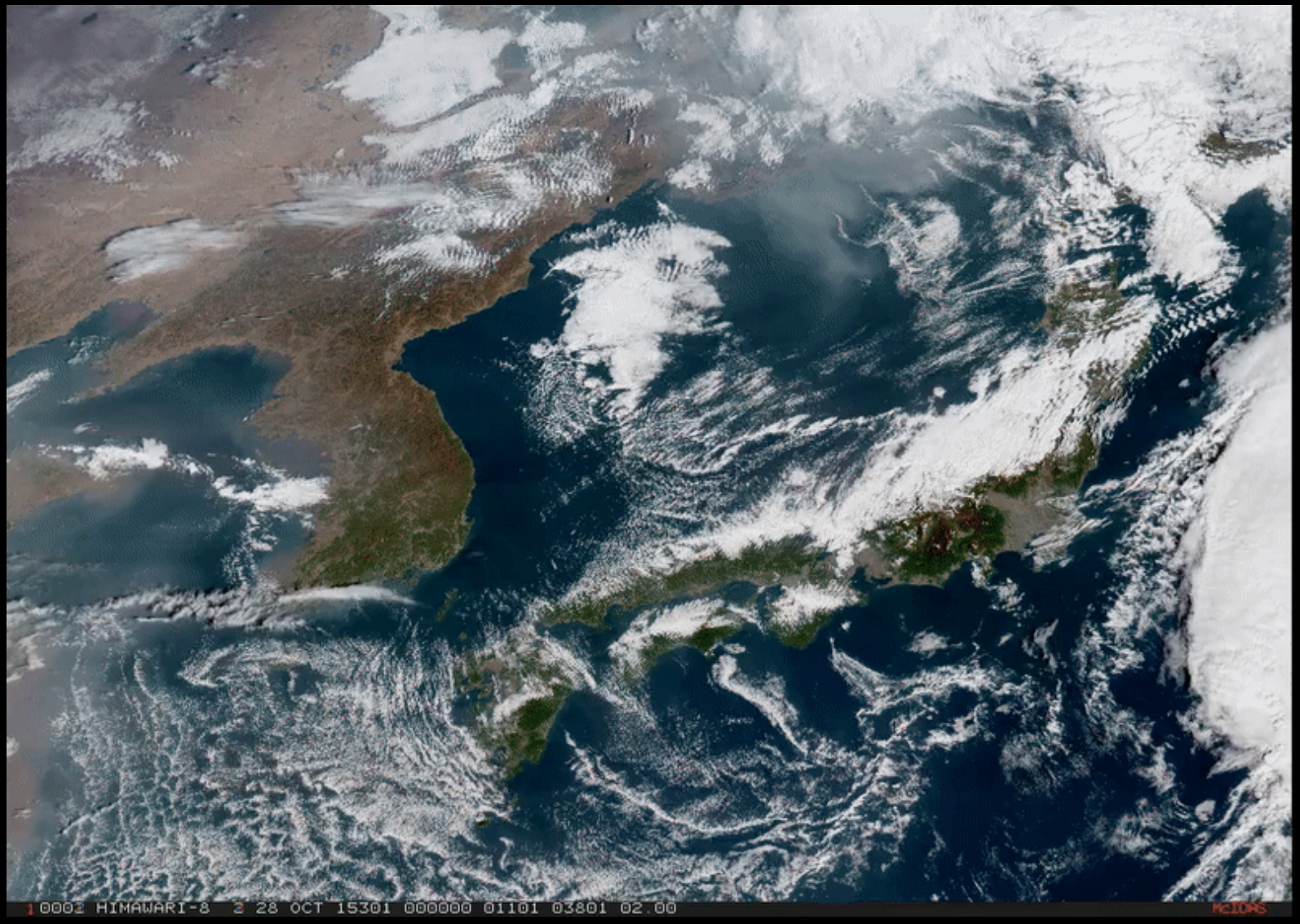




We are collaborating with computer scientist Dan Delany to apply the Farnebäck dense optical flow algorithm to geostationary imagery.

Farnebäck, G., 2003: Two-frame motion estimation based on polynomial expansion. Proc. 13th Scandinavian Conf. on Image Anal., 363-370.

AHI GeoColor (Optical Flow)



Conclusions

- Himawari-8 AHI provides a first opportunity to apply multispectral MODIS/VIIRS imagery algorithms to geostationary satellite data.
- AHI provides the best-available surrogate to GOES-R ABI for Proving Ground demonstrations.
- Development of AHI products will facilitate rapid transition of similar products to ABI.
- CIRA is collaborating closely with JMA to help users realize the full potential of AHI capabilities.

ありがとう

Thanks!