Overview of Multi-Sensor Research and Applications at NASA SPoRT

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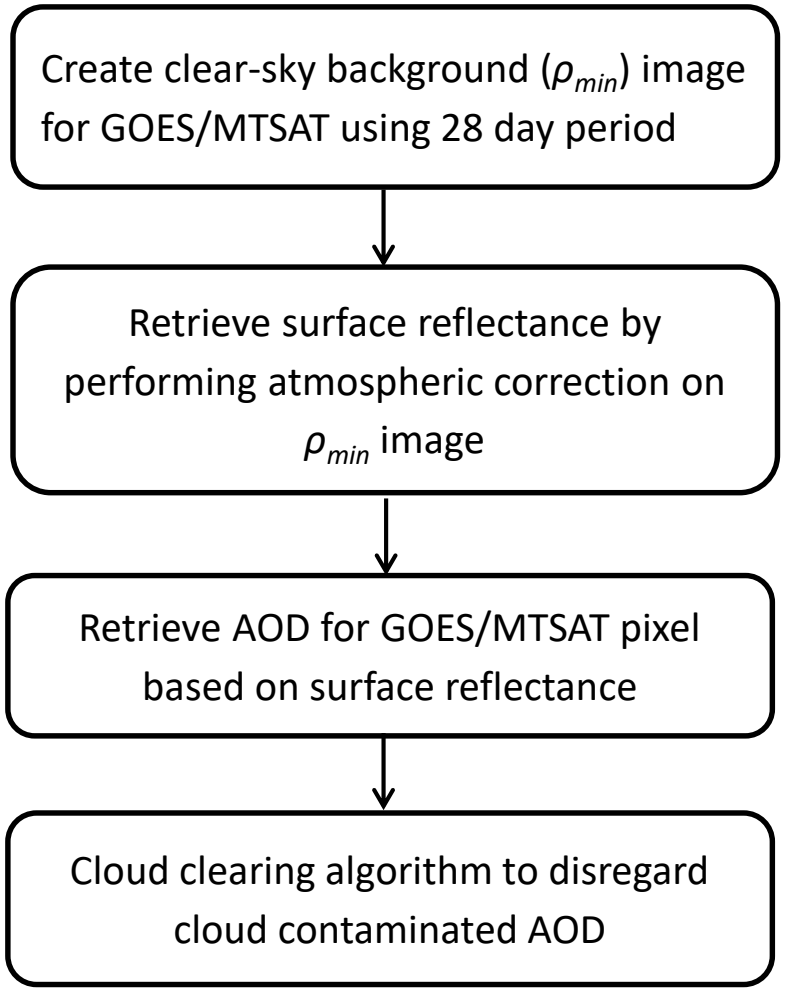
Previous Development of AOD Composite Product

Naeger et al. (2016)



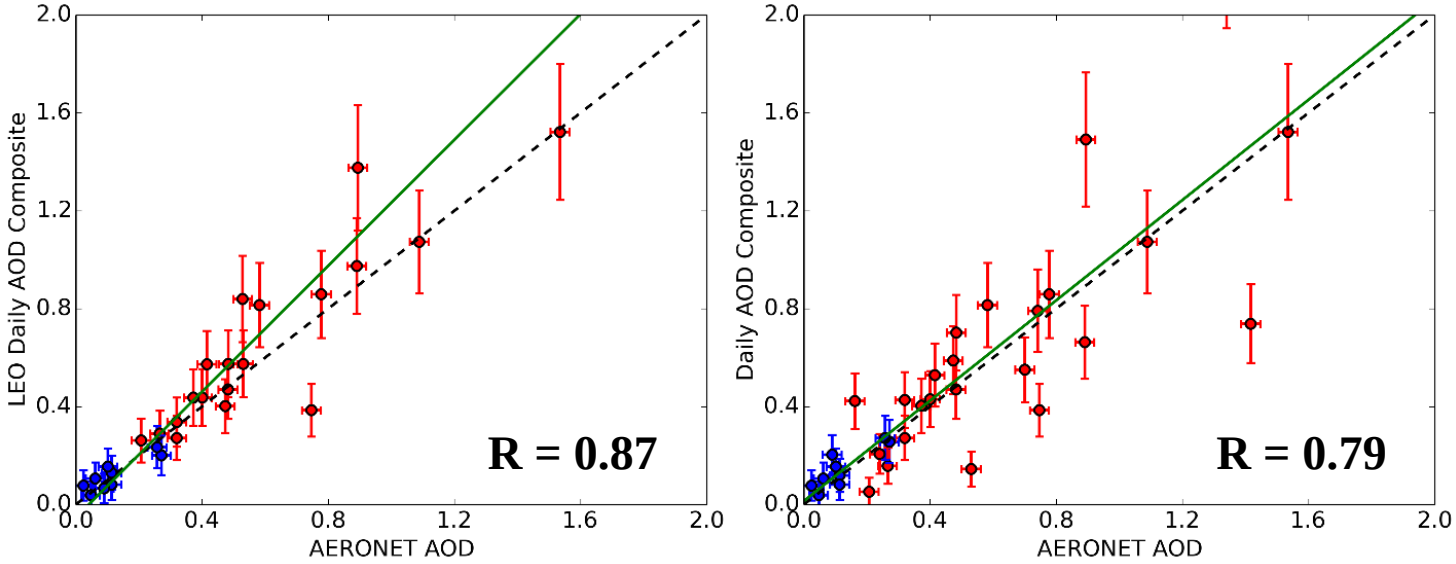
Four major steps involved in the GOES and MTSAT AOD retrieval algorithms.

- Product merged aerosol retrievals from LEO and GEO satellite sensors (including MODIS, VIIRS, MTSAT, and GOES-15).
  - MODIS and VIIRS AOD were acquired from LANCE-MODIS and NOAA CLASS systems, respectively.
  - We developed our own retrieval algorithms for the GEO sensors based on the raw satellite data.
- Previous GEO AOD retrieval was based on a rather simplified algorithm based on past geostationary sensors (e.g., GOES-15, MTSAT).
  - Cloud masking technique based on limited number of channels (5)
  - Use of only two aerosol models (i.e., continental and dust) based on predefined aerosol properties in 6SV RTM
  - Surface reflectance was defined by 2nd lowest reflectance over a 28-day period for each hour
- Goal of product is to provide end users with a comprehensive tool to monitor and track aerosols that can aid in forecasting and air quality applications.

Previous Development of AOD Composite Product

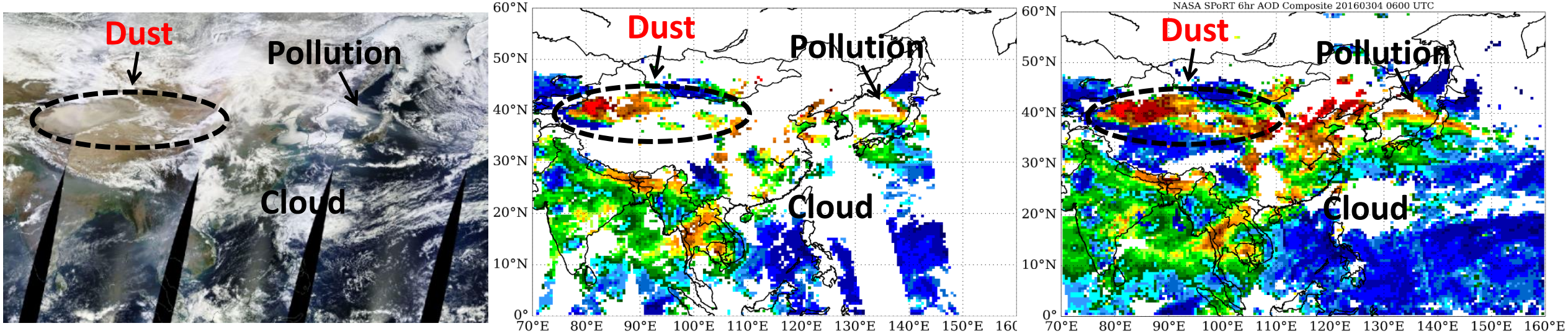
Naeger et al. (2016)

- GEO helped fill gaps in the LEO AOD coverage as the high temporal resolution allowed for an increase in cloud-free retrievals
- GEO retrievals showed adequate performance over Asia and U.S., but as expected contributed to larger errors in the AOD Composite product.

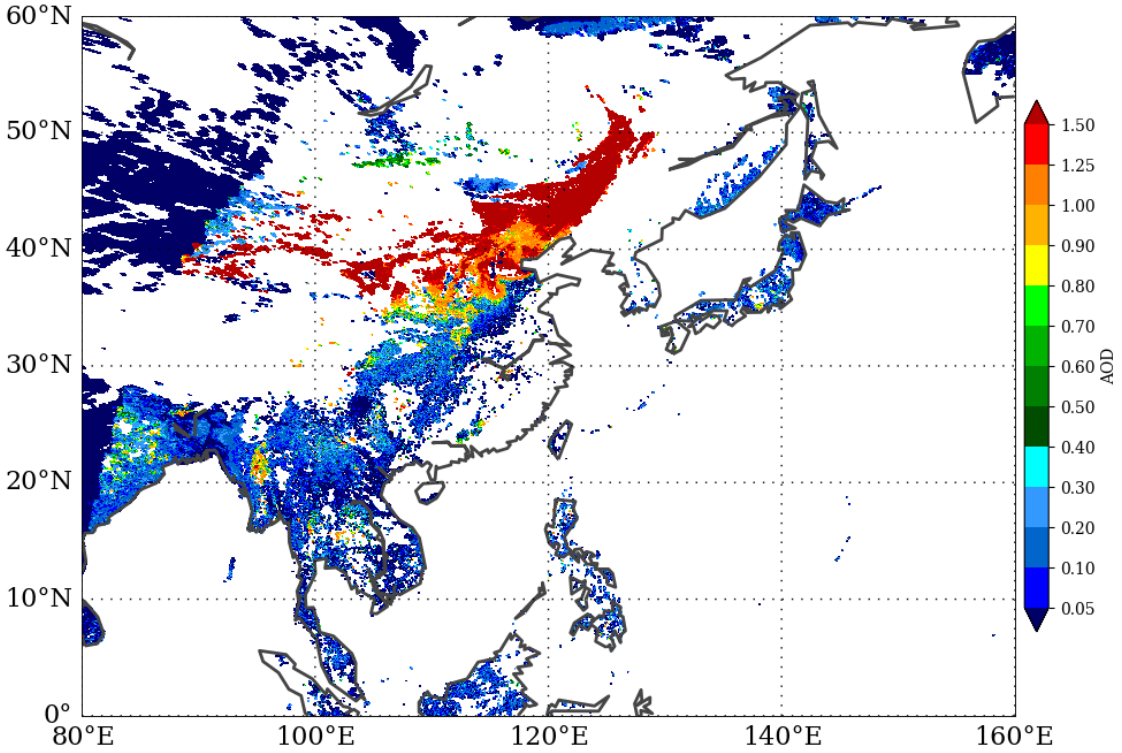


(Top) AOD retrieval validation conducted during March 2014 for AERONET sites over Asia (red) and U.S. (blue)

(Bottom) 6-hr AOD composite with only LEO (middle) vs LEO and GEO AOD composite (right) for 4 March 2016



Recent Developments of AOD Composite Product



AHI AOD retrievals valid for 4 May 2017 at 0600 UTC

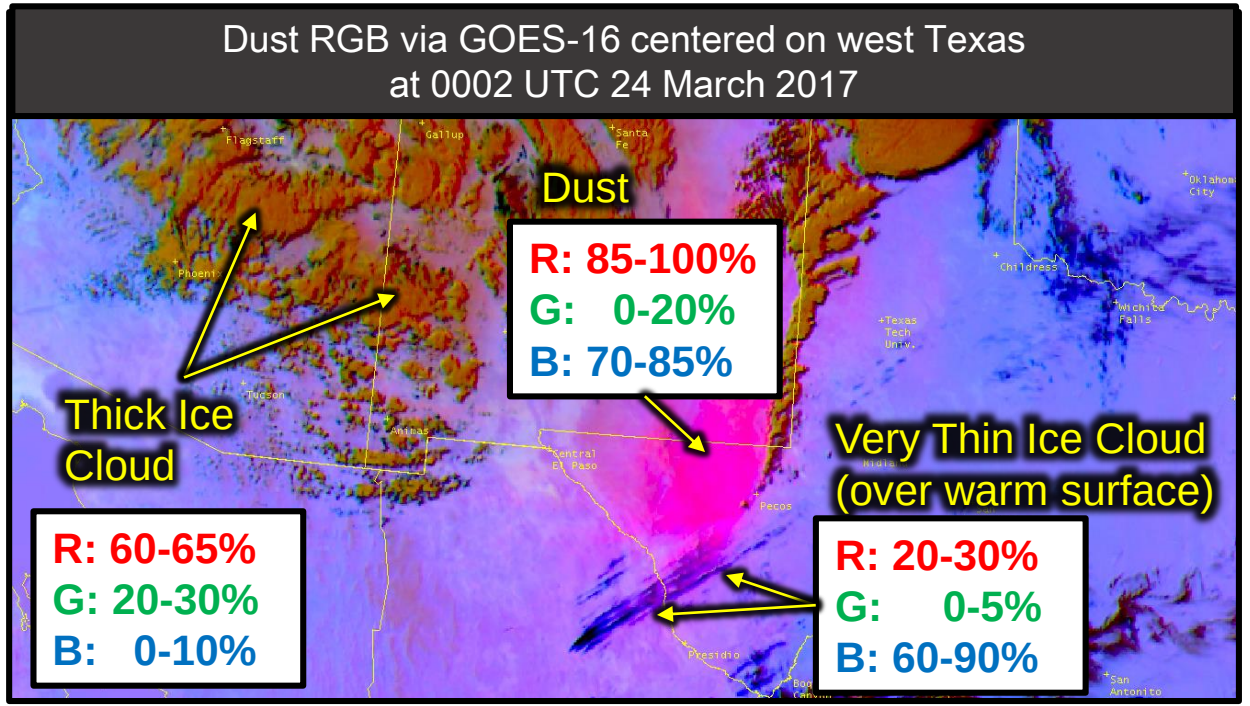
- Complete overhaul of the previous GEO retrieval algorithm to account for drastic improvement in new generation of geostationary sensors.
- Processed AERONET data throughout AHI FOV to update aerosol models within the retrieval algorithm
- Used both ‘supervised’ and ‘unsupervised’ methods to choose most appropriate aerosol models for the region
- Updated surface reflectance retrieval based on conducting 6SV RTM calculations on AHI and AERONET matchups
- Refined cloud masking technique using additional channels available from AHI

Dust RGB Recipe & Product Basics

Color	Band/Band Diff. (μm)	Physically relates to…	Small contribution to pixel indicates…	Large contribution to pixel indicates…
Red	12.3-10.3	Optical depth/cloud thickness	Thin clouds	**Thick clouds, dust plume**
Green	11.2-8.4	Particle phase	Ice and particles of uniform shape (dust)	**Water particles or thin cirrus over deserts**
Blue	10.3	Surface temperature	Cold surface	**Warm surface**

Dust RGB Product

- 12.3 μm is semi-transparent to dust
  - ➢ large red intensity compared to clouds
- "Warm" dust at low levels
  - ➢ large blue intensity
- Dust plume resulting color: **magenta**
- Dust RGB valid day and night (*benefit over typical use of visible or true color imagery to analyze dust plumes*)



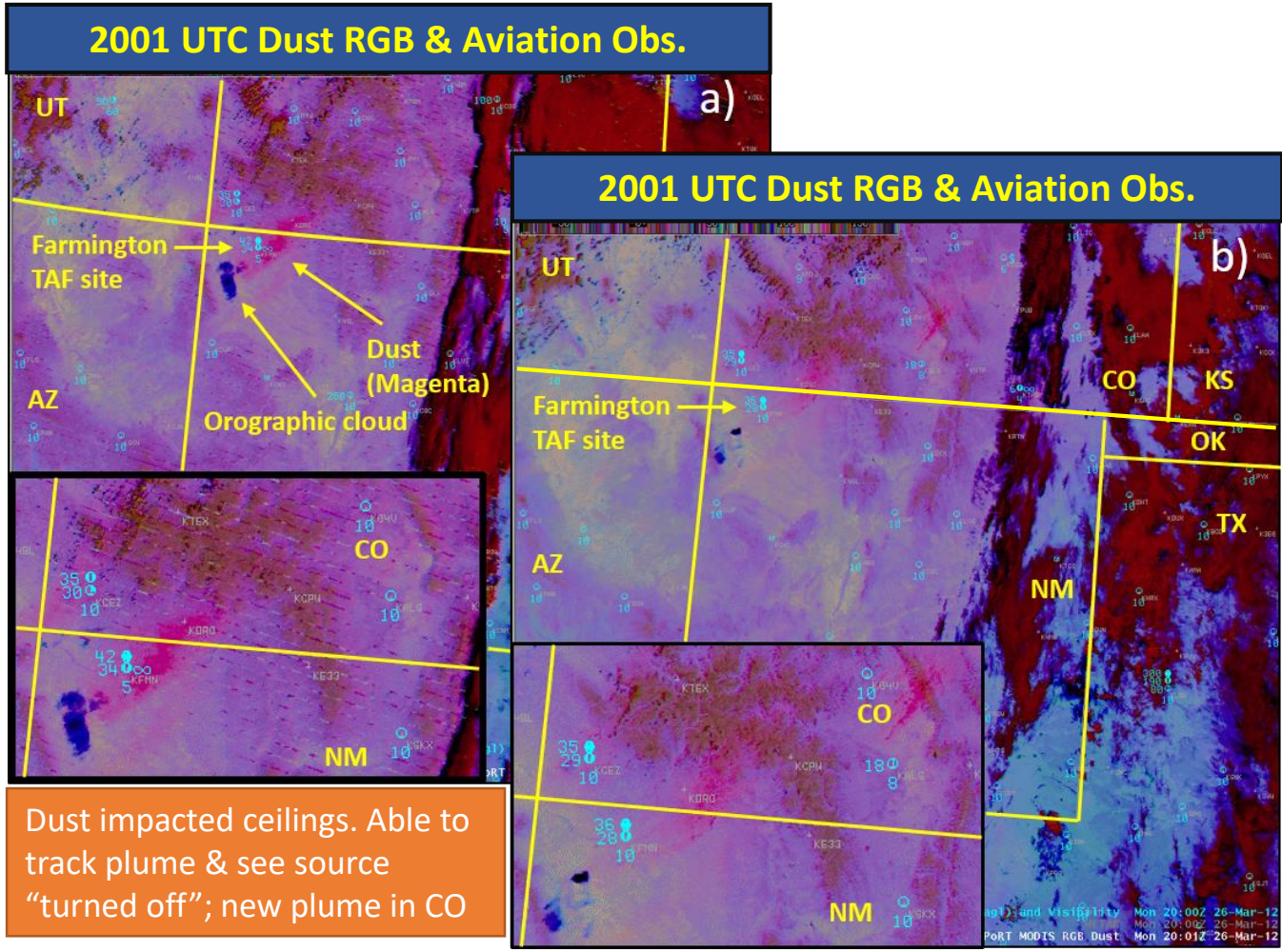
Forecast Issue and Hypothesis

Challenge: Detection and Analysis of Blowing Dust for Aviation & Public

- Impact to ceiling and visibility criteria at airports
- Reduced visibility along roadways
- Difficult to detect in satellite imagery when clouds present/mixed
- Dust color similar to dry land surface in True Color imagery
- Can not track plume at night

Hypothesis:
EUMETSAT Dust RGB via MODIS/VIIRS increases forecast lead times via greater efficiency in analysis both day and night

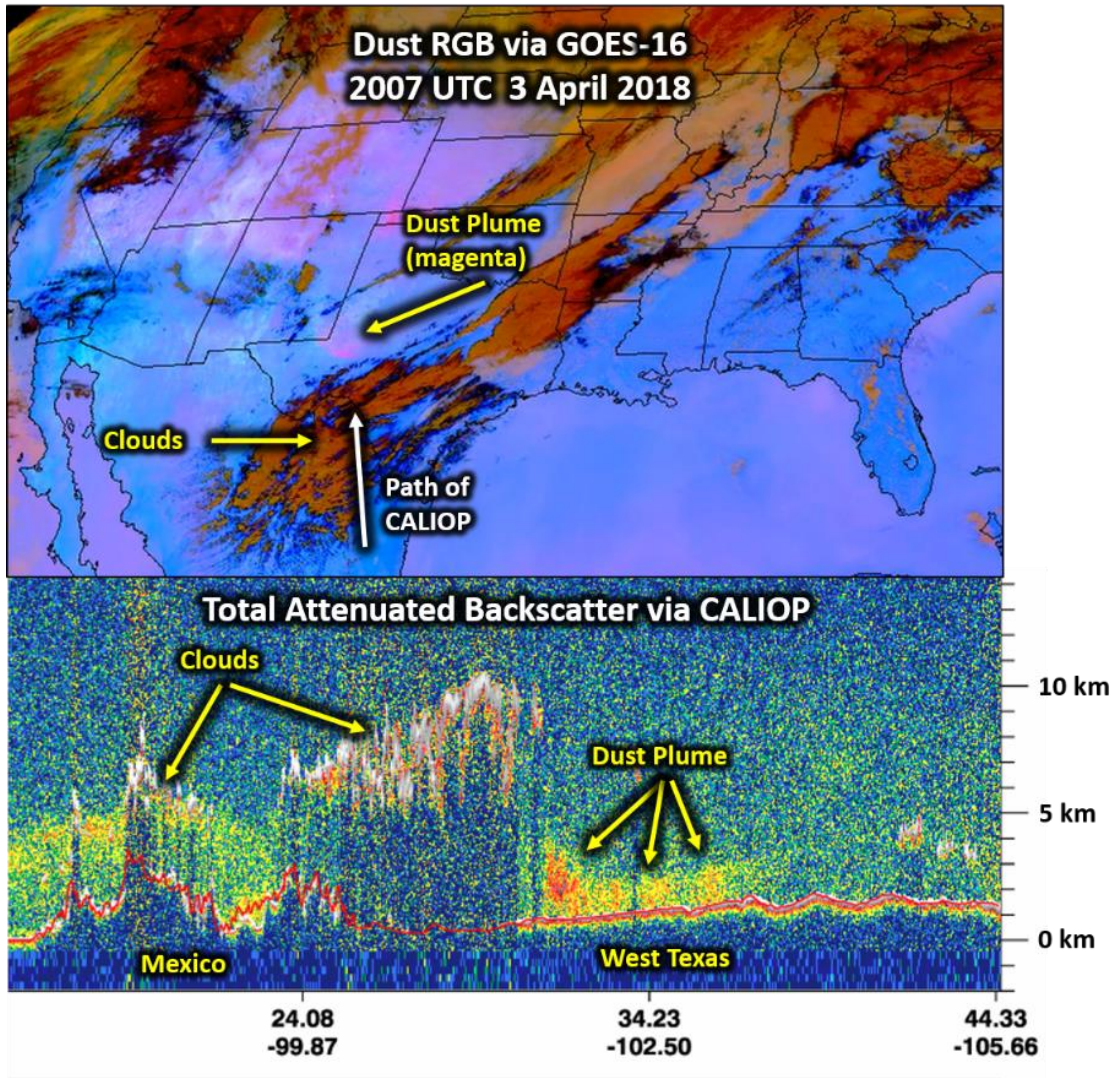
MODIS/VIIRS Dust RGB prior to GOES



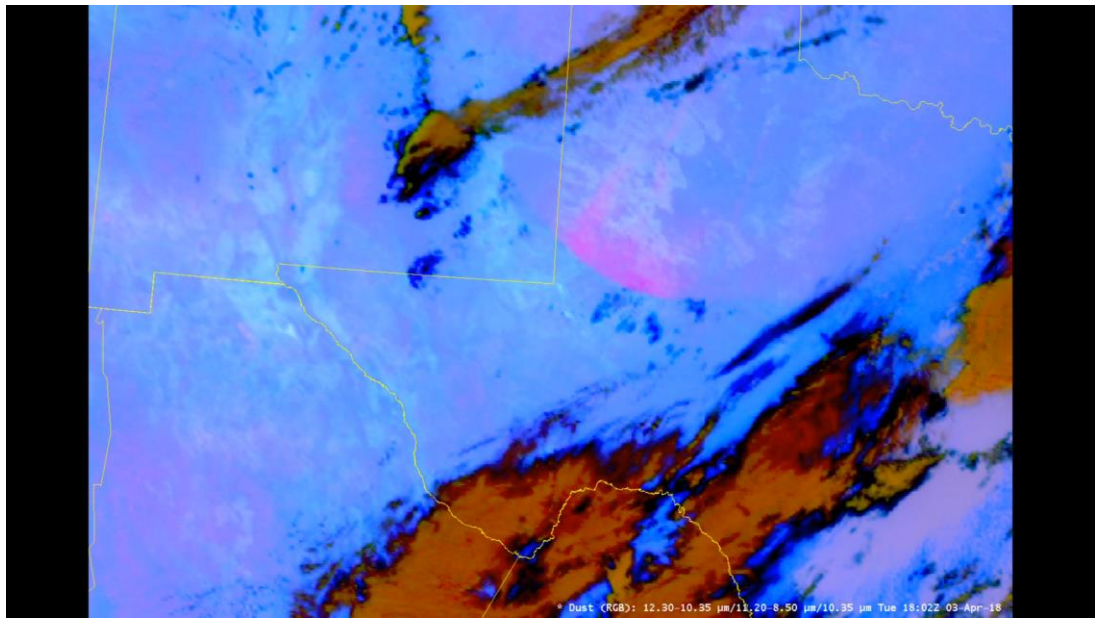
Dust impacted ceilings. Able to track plume & see source "turned off"; new plume in CO

Figure 4 from Fuell et. al. 2016

Dust RGB via GOES-16 / ABI: User Assessment



Dust RGB via GOES-16; 03 Apr. 2018



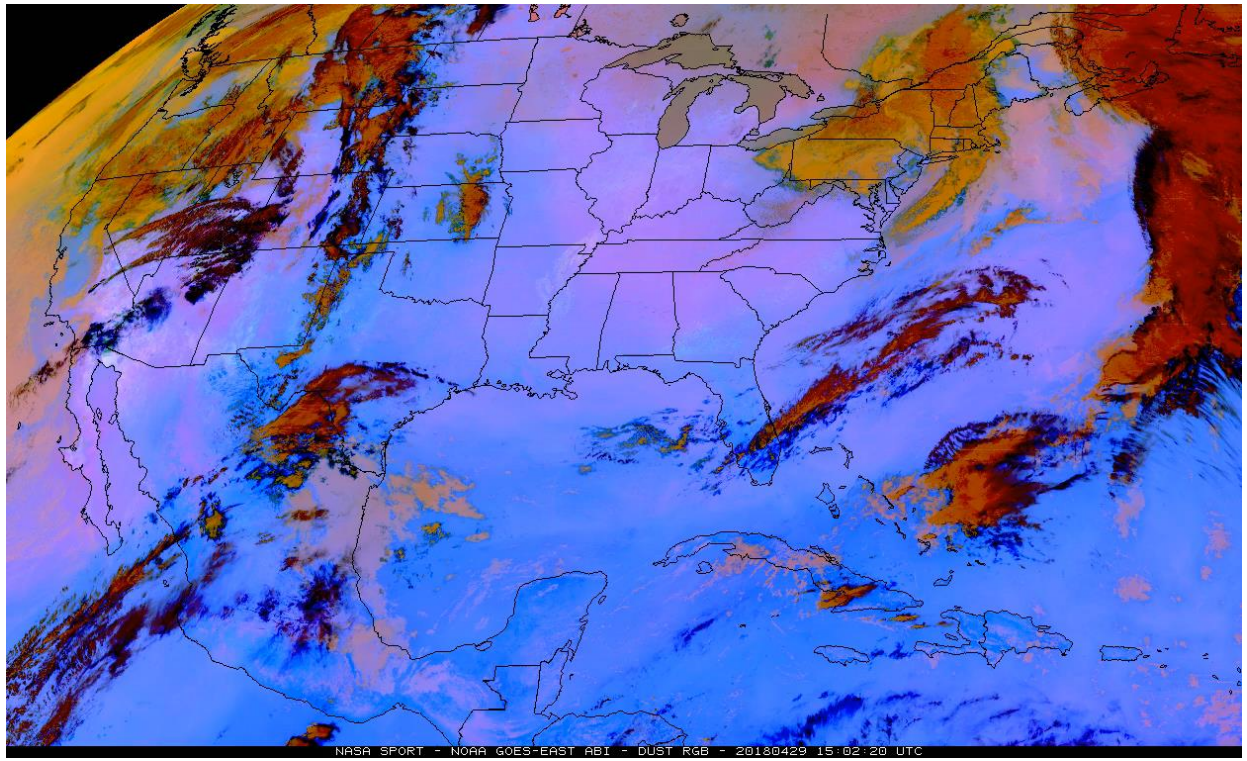
Forecaster at ZAB (i.e. CWSU) sent feedback indicating Dust RGB caused collaboration between WFO Midland and AWC resulting in issuing a Center Weather Advisory at 1945Z for IFR visibility in widespread BLDU.

Highway Incident/Closure: Nebraska 4/29/18

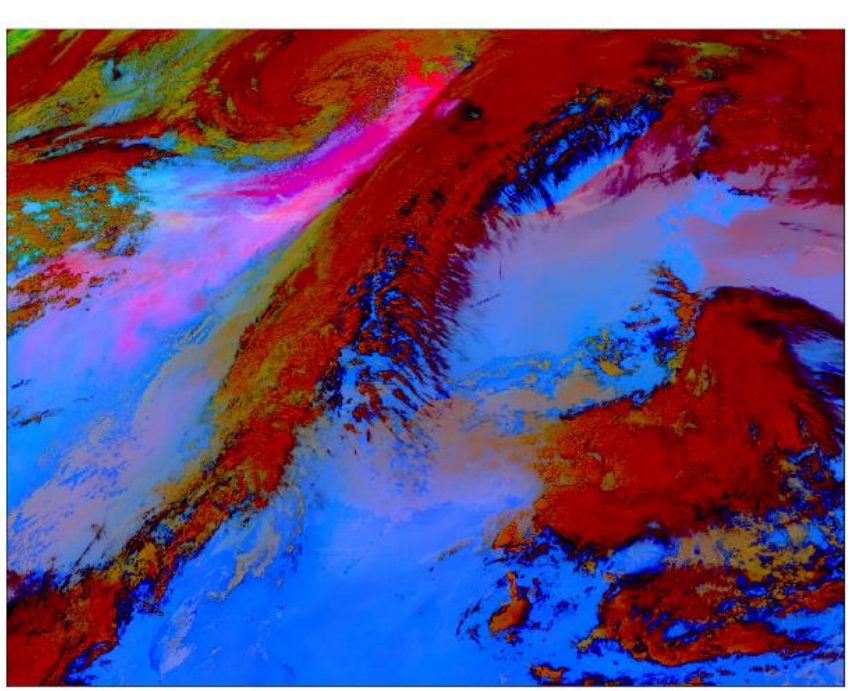
Dust RGB Limitations

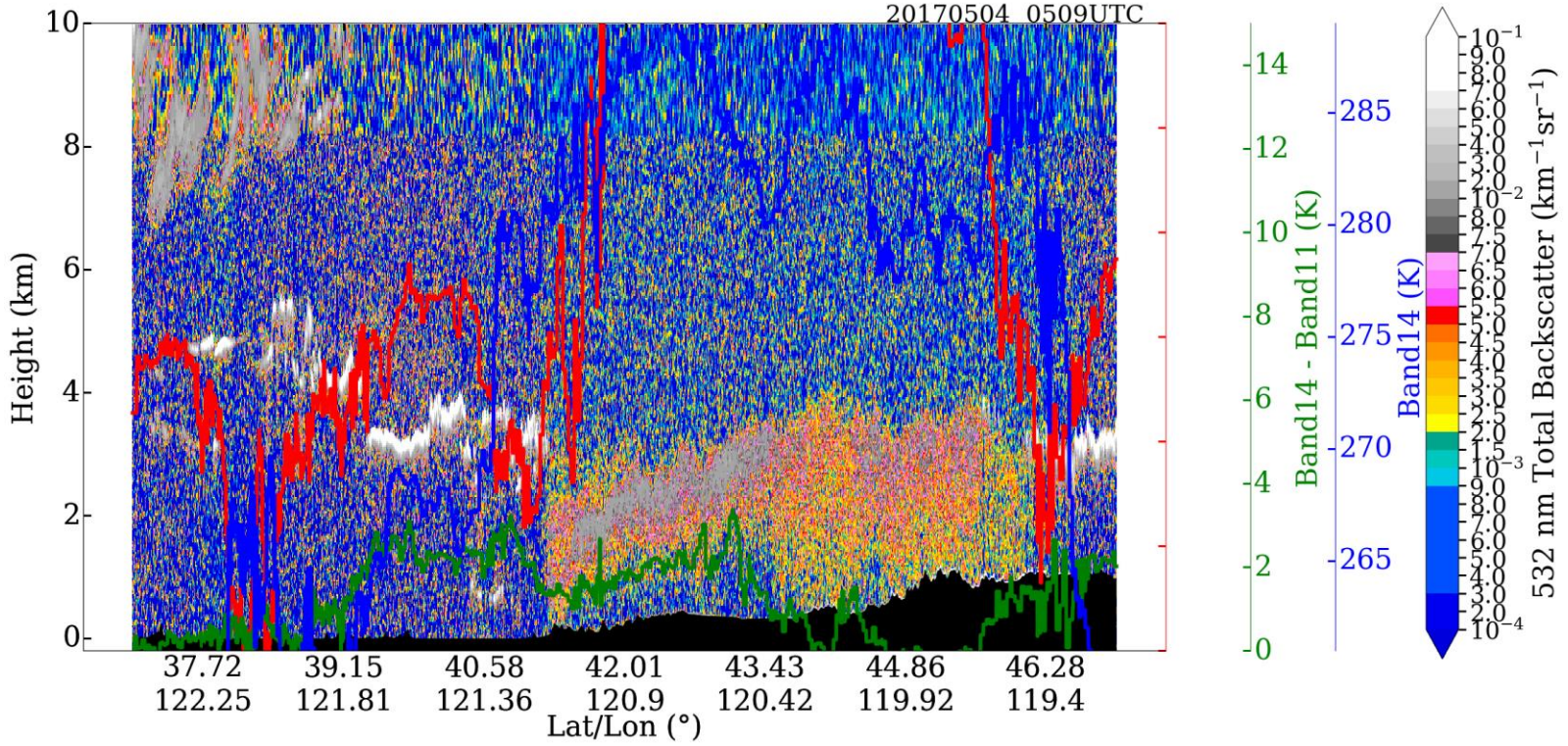
- Very shallow dust event
- Clouds at High/Mid-levels block view
- AOD product could potentially help identify these “missed” events

Dust RGB via GOES-16: 29 Apr 2018 from 1500 – 0400 UTC



CALIOP and variations in channels/differences





- CALIOP and/or CATS active lidar measurements can help validate the dust RGB product

Summary and Future Work

- Implementing significant refinements in GEO AOD retrieval algorithms with current focus on AHI, which will be completed in the next couple months
- The AHI algorithm will be adapted to GOES in order to provide total coverage of aerosols from Asia to CONUS
- Validate and potentially improve the dust RGB capabilities by utilizing active lidar sensors
- Merge the dust RGB and AOD Composite products for improving the ability of detecting and monitoring near surface and low-level dust plumes