GOES-16 ABI Aerosol Detection Product

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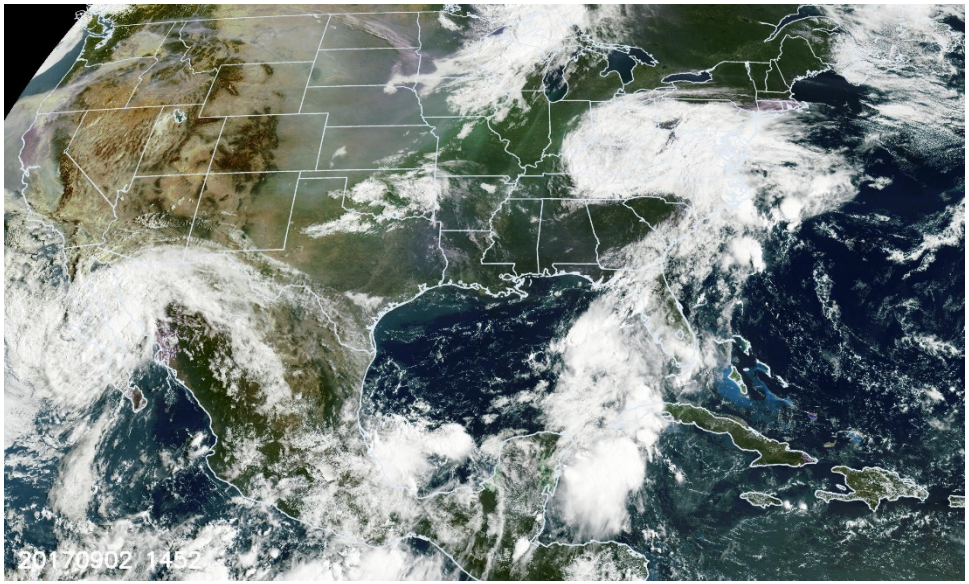
IMSG

GOES-16 ABI Aerosol Detection Product

- Identify the presence of aerosol in the atmosphere and classify it as dust or smoke.
  - Required accuracy: 80% for dust; 70% for smoke

	GOES-R ABI
Spatial	2 km
Temporal	15 min
Coverage	Regional

  - Qualitative imagery product
- Useful applications: operational air quality forecasting; aerosol data assimilation in numerical models



GOES-16 ABI Synthetic RedGreenBlue Image

GOES-16 ABI Smoke Detection over Land

$$R_{2.25\mu m} \times 100 < 20$$

$$R_{0.64\mu m} \times 100 > (6 + R_{2.25\mu m} \times 100)$$

$$R_1 \geq 0.85$$

$$R_2 \geq 1.0$$

$$\sigma_{R_{0.64\mu m}} \leq 0.04$$

$$R_1 = \frac{R_{0.47\mu m}}{R_{0.64\mu m}}, \qquad R_2 = \frac{R_{0.86\mu m}}{R_{0.64\mu m}}$$

- Smoke is transparent at 2.25 µm and bright at 0.64 µm
- Reflectance ratios allow smoke/clear sky discrimination
- Spatial variability test minimizes mis-identification of cloud as smoke

GOES-16 ABI Dust Detection over Land

Thin dust detection

$$BT_{11\mu m} - BT_{12\mu m} \le -0.2K$$

$$BT_{3.9\mu m} - BT_{11\mu m} \ge 15K$$

$$R_{1.38\mu m} < 0.035$$

$$\text{if } BT_{3.9\mu m} - BT_{11\mu m} \ge 20K \text{ then dust}$$

$$\text{if } (MNDVI < 0.08) \,\&\, (Rat_2 > 0.005) \text{ then dust}$$

$$NDVI = \frac{R_{0.86\mu m} - R_{0.64\mu m}}{R_{0.86\mu m} + R_{0.64\mu m}} \qquad MNDVI = \frac{NDVI^2}{R_{0.64\mu m}^2}$$

$$Rat_1 = \frac{R_{0.64\mu m} - R_{0.47\mu m}}{R_{0.64\mu m} + R_{0.47\mu m}} \qquad Rat_2 = \frac{Rat_1^2}{R_{0.47\mu m}^2}$$

Thick Dust detection

$$BT_{11\mu m} - BT_{12\mu m} \le -0.5K$$

$$BT_{3.9\mu m} - BT_{11\mu m} \ge 25K$$

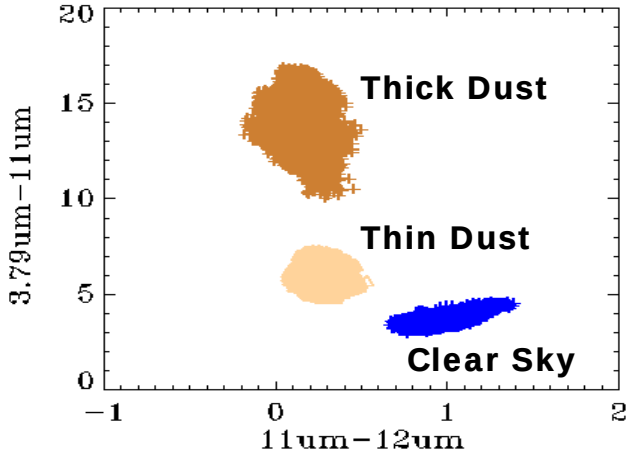
$$R_{1.38\mu m} < 0.055$$

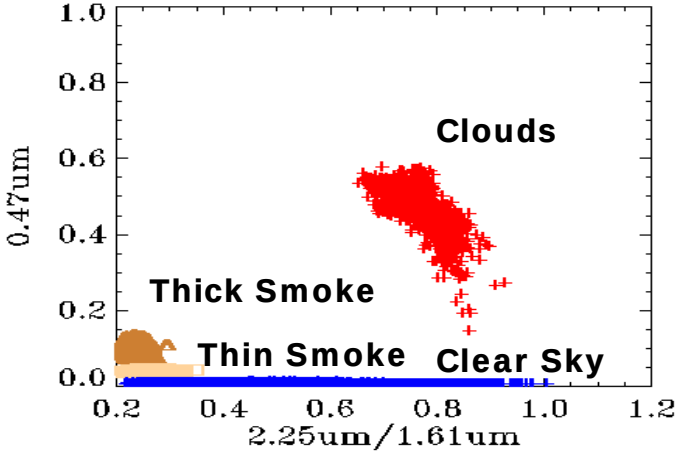
$$\text{if } MNDVI < 0.2 \text{ then dust}$$

- Dust absorbs more at 11 μm than at 12 μm
- Spatial variability test minimizes mis-identification of smoke as cloud
- Cirrus test

Aerosol Detection Spectral Tests

For illustration purpose, scenes with dust, smoke, clouds, and clear sky over Ocean were manually chosen





Algorithm takes advantage of spectrally varying absorption and scattering of dust, smoke, clouds, and surface

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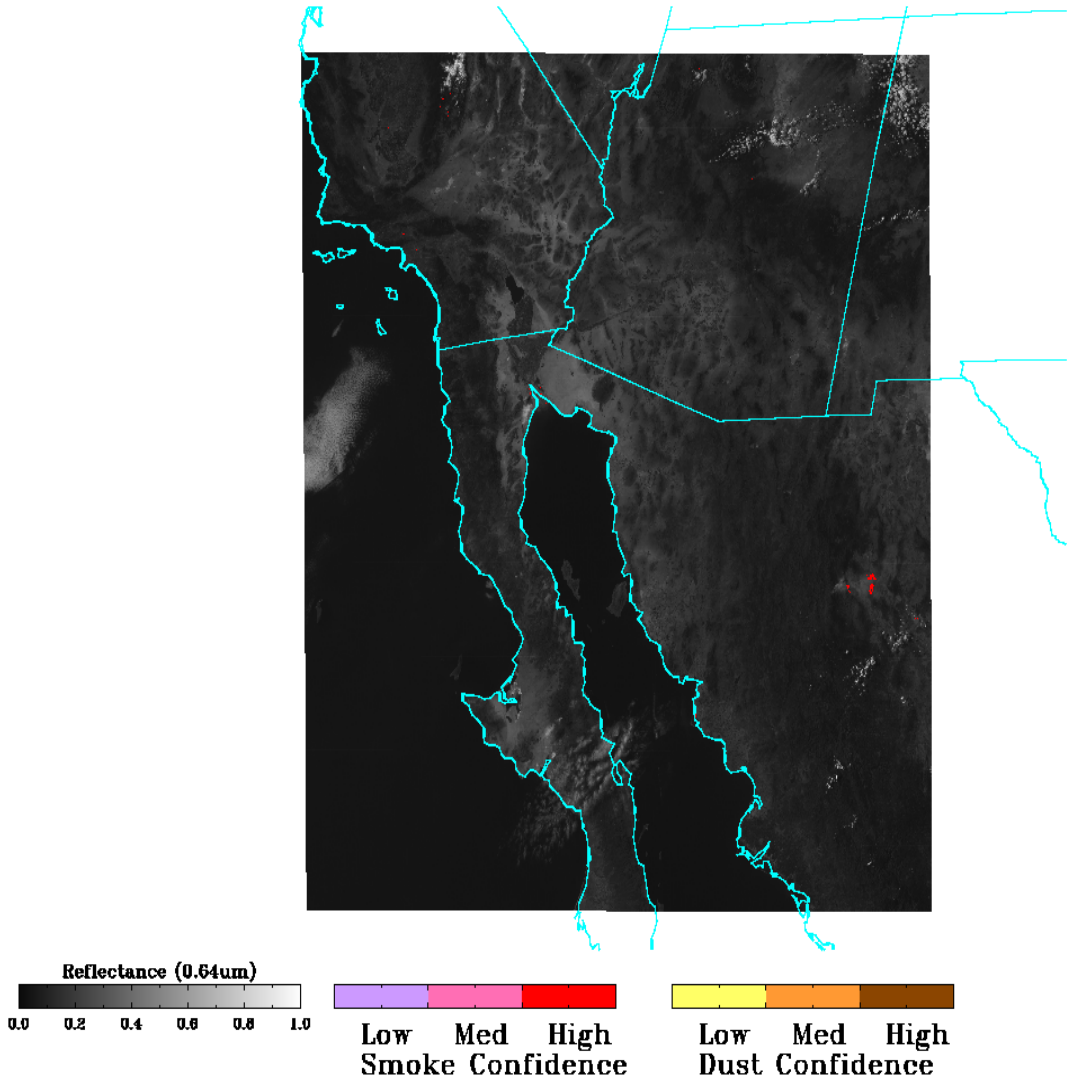
Mesoscale Mode



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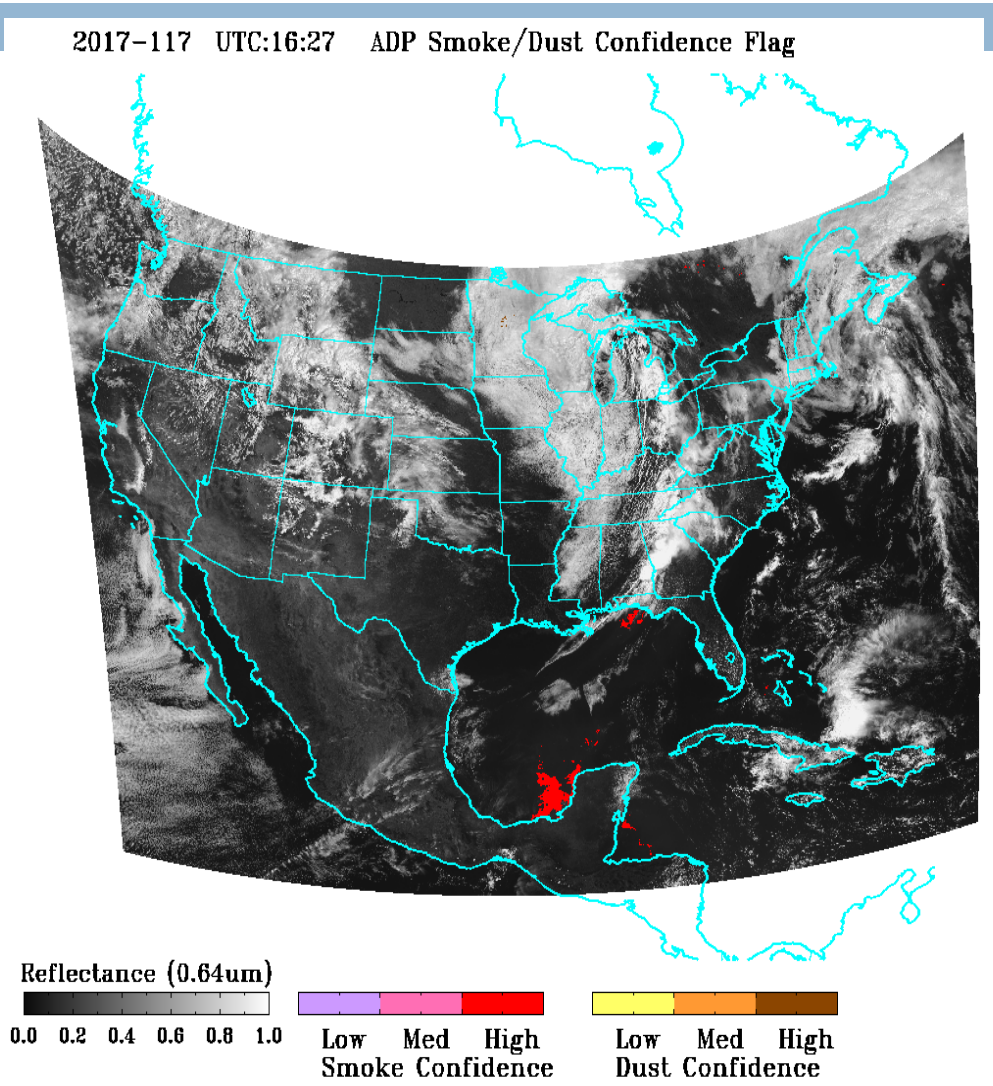
CONUS Mode



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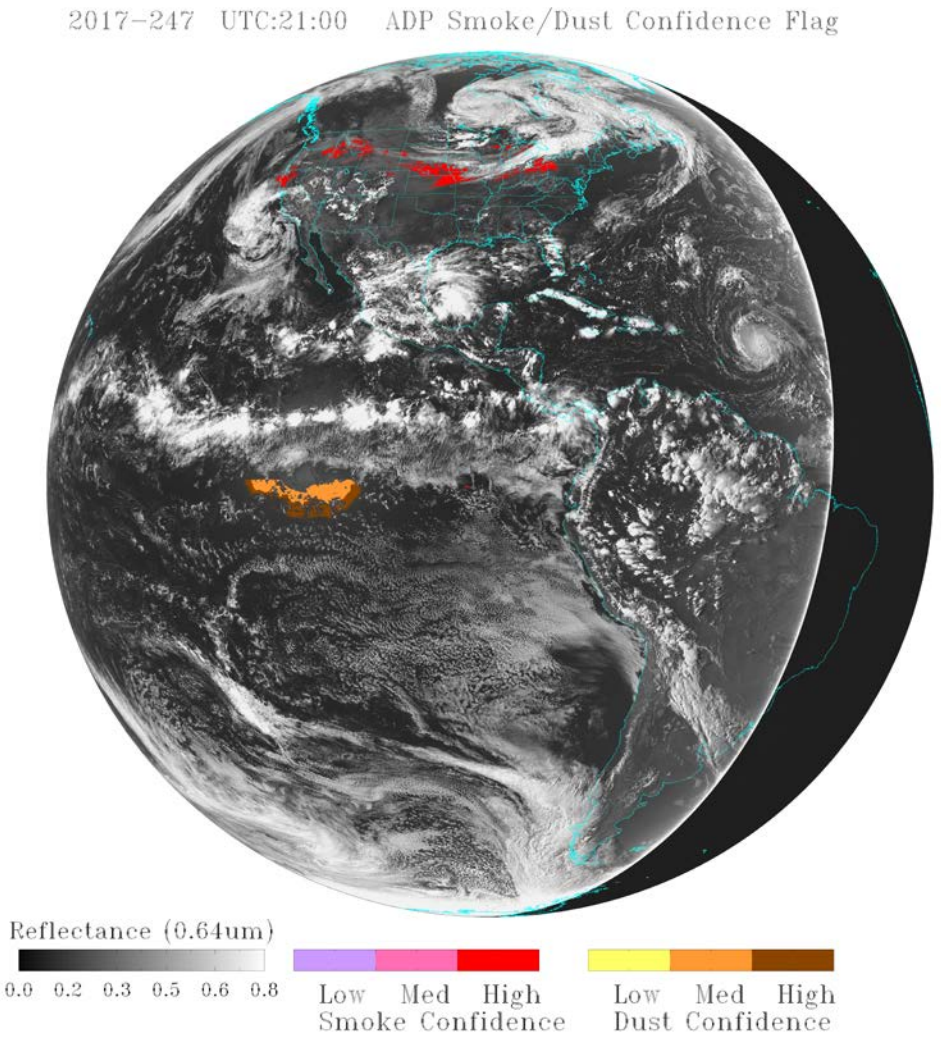
Full Disk Mode



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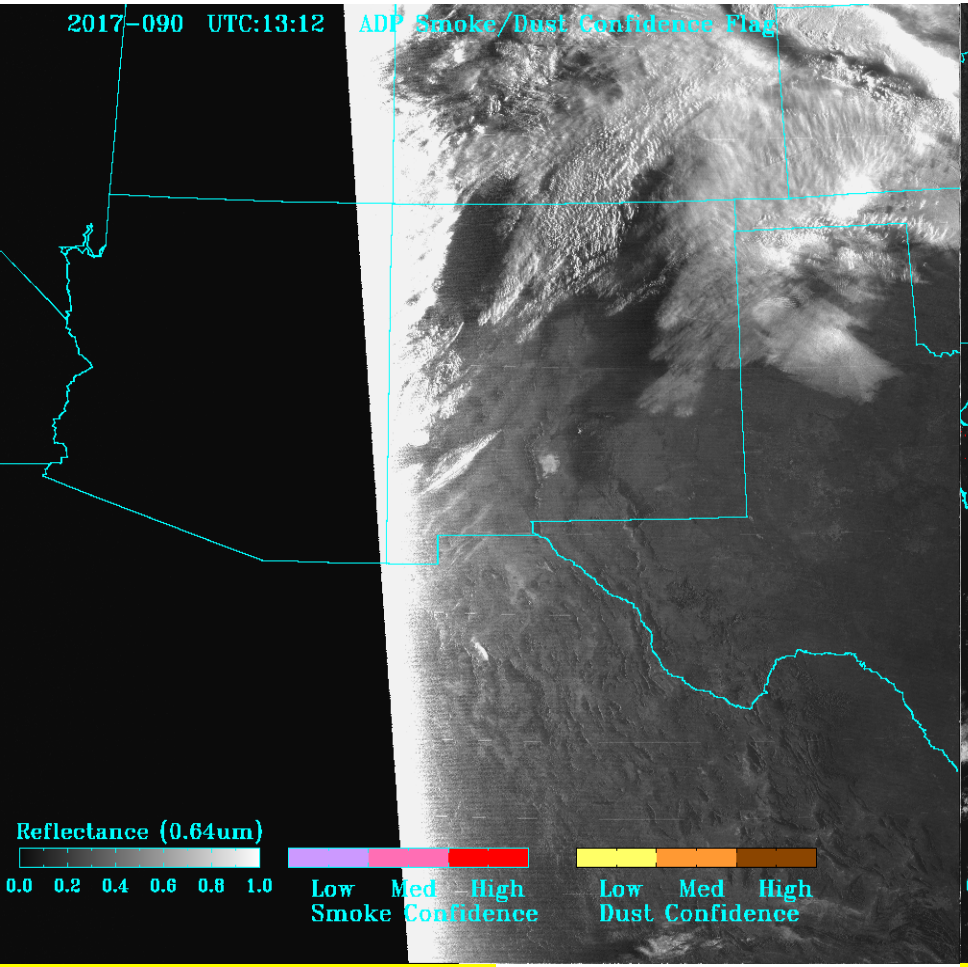
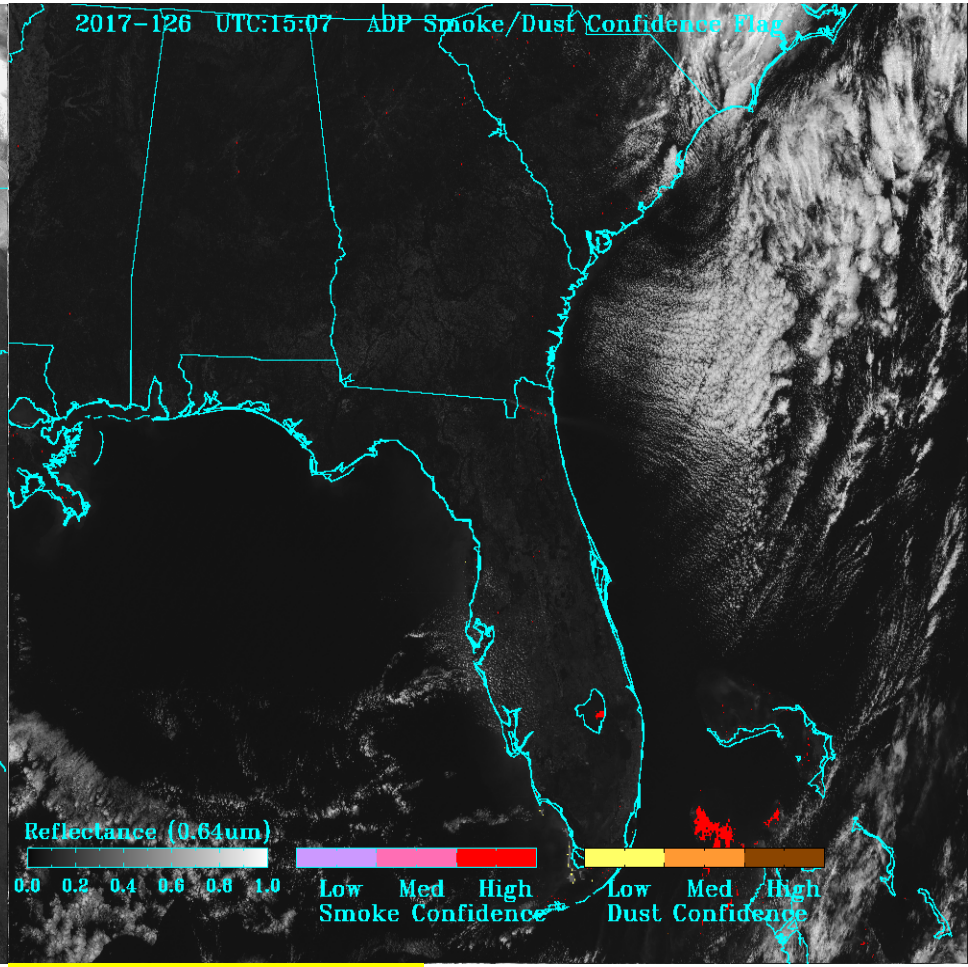


March 31, 2017



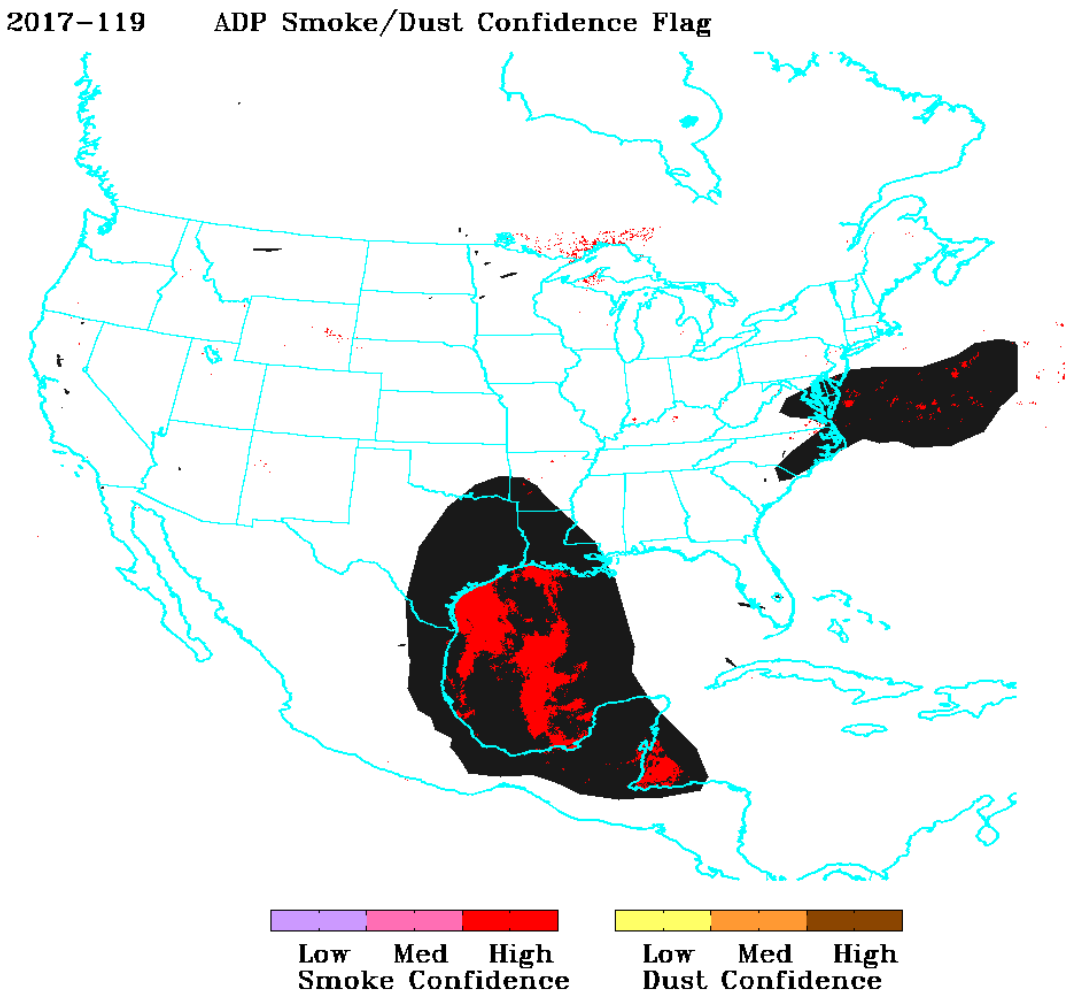
May 6, 2017

GOES-16 ABI Aerosol Detection Product Validation

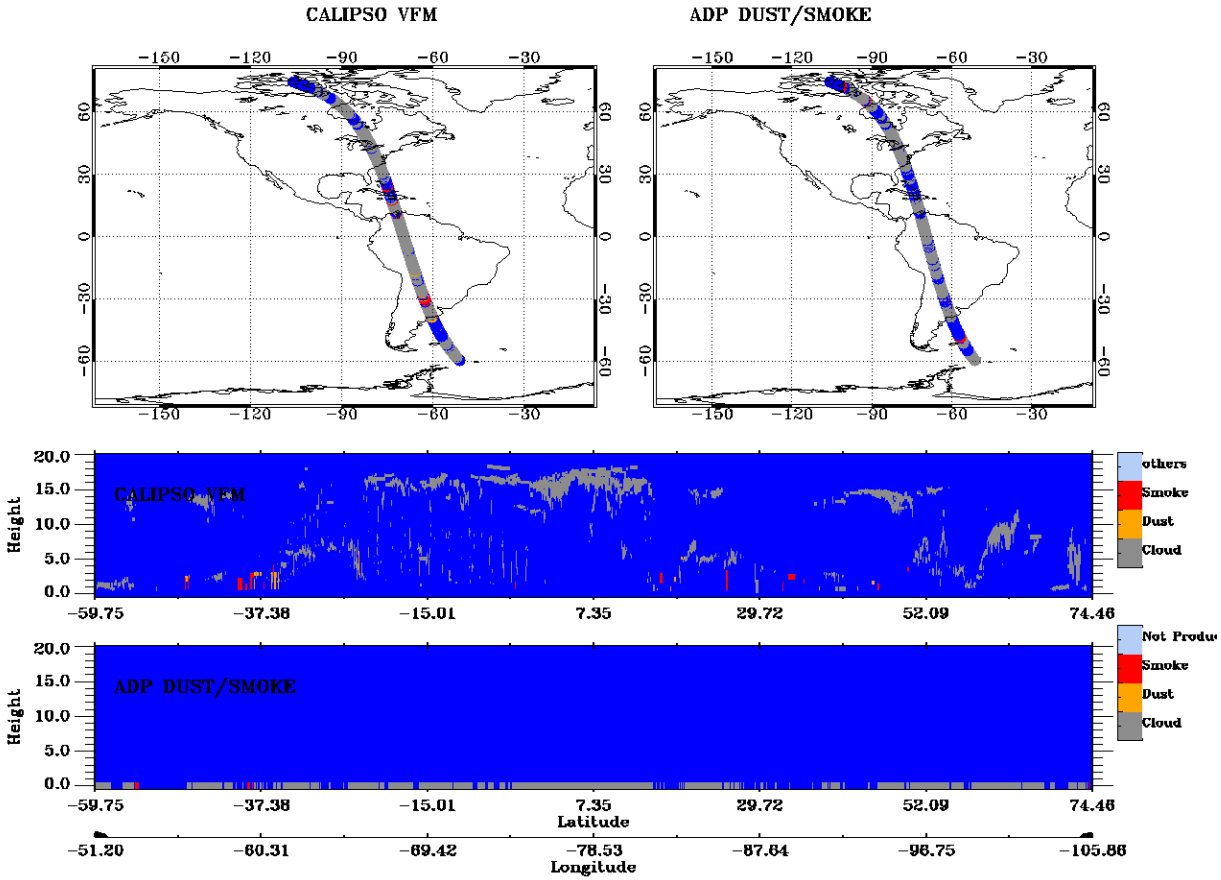
- Primary validation is to compare to other correlative measurements
  - CALIPSO
    - Space-borne LIDAR which provides aerosol classification
  - AERONET
    - Ground based aerosol instrument that provides particle size information which is used to classify aerosol observations into dust/smoke/haze
  - Hazard Mapping System
    - Human analysis of smoke plume

Three metrics are computed: Accuracy, Probability of Correct Detection, Probability of False Detection

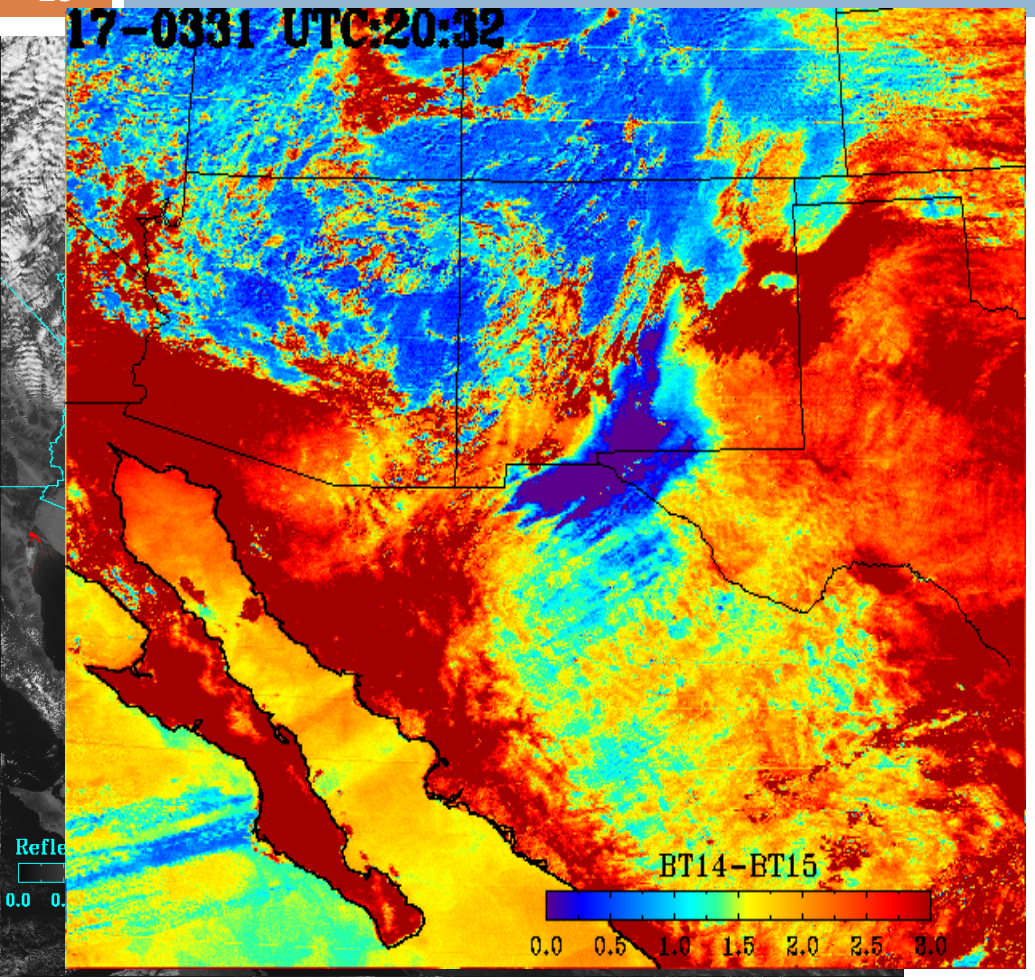
GOES-16 ABI ADP vs. HMS

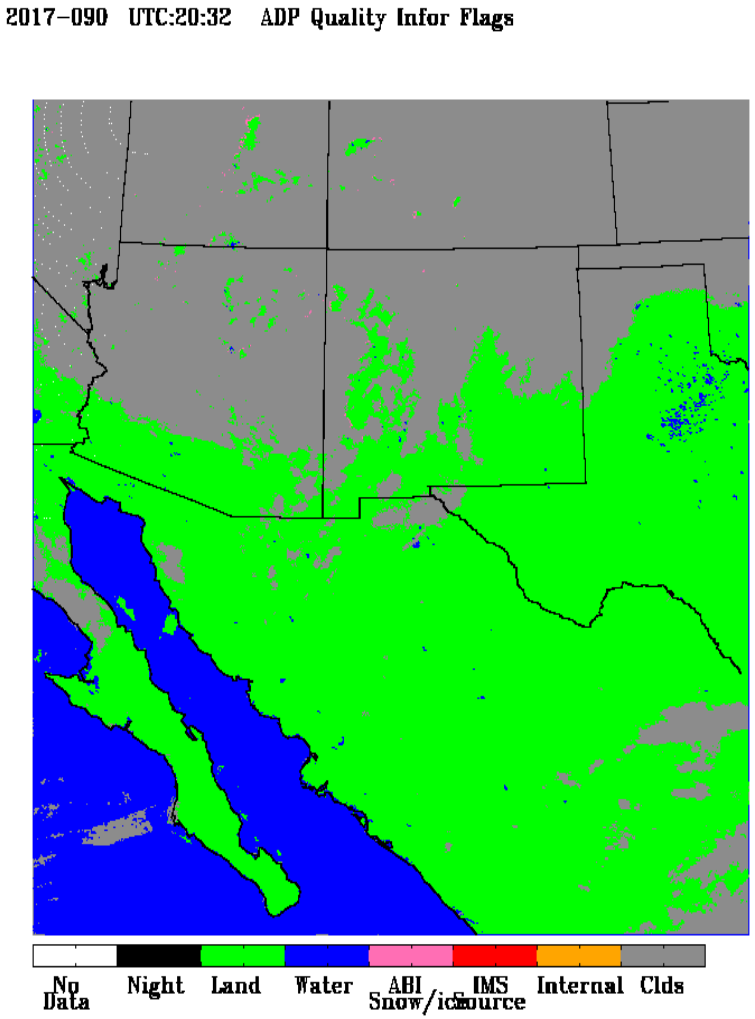


GOES-16 ABI ADP vs. CALIPSO



Data Artifacts





Validation Summary

- Validation against RGB, DUST RGB and Natural color imagery shows GOES-16 Aerosol Detection Product (ADP) product is capturing the events.

- Validation metrics improve after calibration update
  - GOES-16 vs. HMS shows improvement
  - Matchups with CALIPSO, AERONET, and CATS need to be stratified (before/after calibration update) to analyze improvements in performance. Not enough matchups to do this analysis as of this review

- Aerosol team is planning to tune ADP threshold tests to improve product performance
  - Angle dependent thresholds
  - Improved cloud mask
  - ABI specific thresholds (*current thresholds are based on MODIS*)

Beta Maturity

- GOES-16 at a checkout position of 89°W. Will move to East (75°W) position later this year;
- Algorithm relies on various spectral and spatial variability tests
  - Based on MODIS. Need updates
  - No prior experience with similar capabilities from a geostationary orbit
    - Need to look at actual ABI data, understand the time of the day retrieval issues, and tune thresholds we put in for various tests

Beta Maturity ⇨ Provisional

Level 1b data must be provisional and calibration must be up to date and accurate

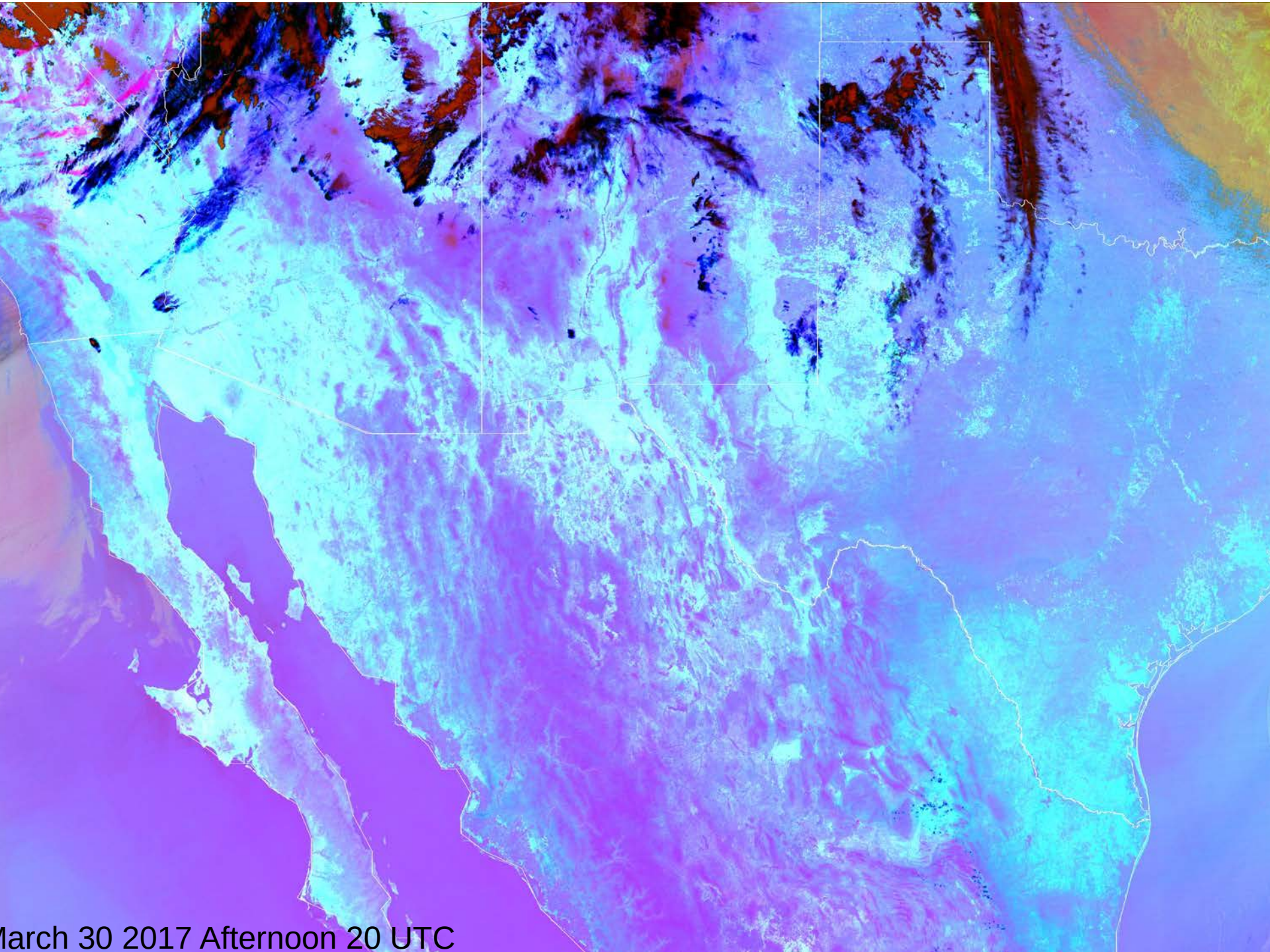
Cloud mask, snow/ice mask must be provisional

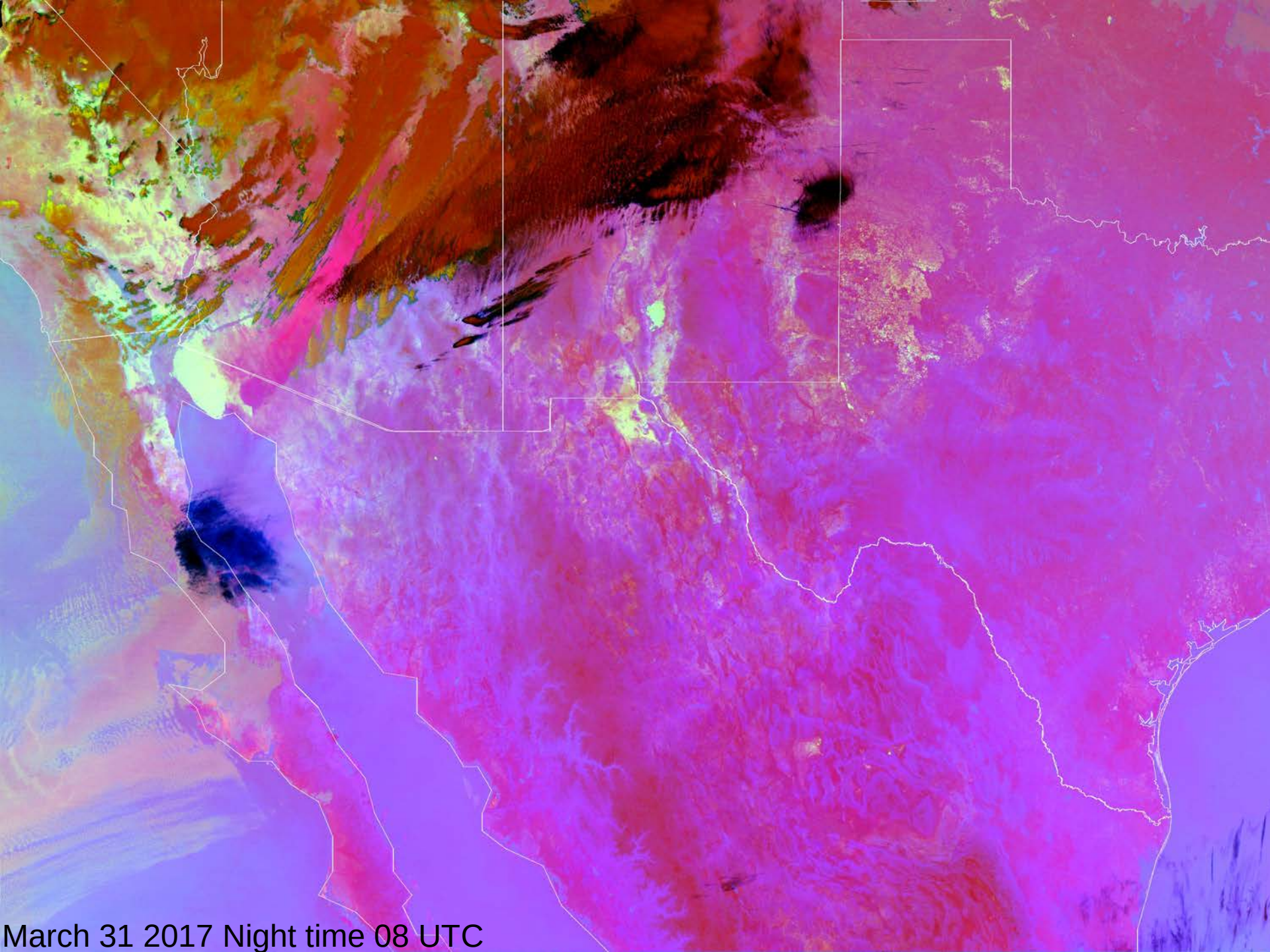
A local archive of collocated L1, L2, and PQI over AERONET sites will be analyzed to revise:

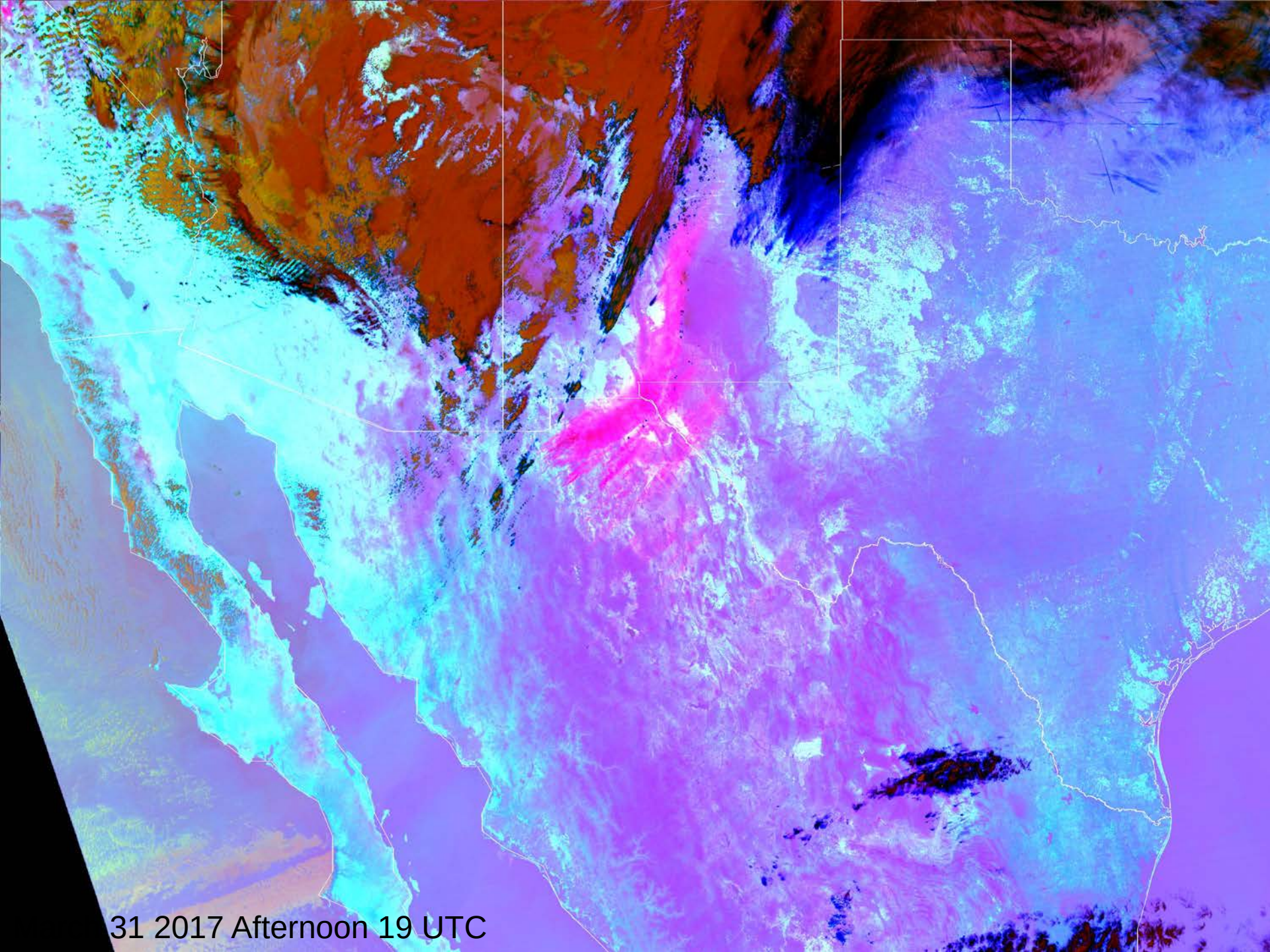
- Thresholds used for various spectral tests. *Baseline algorithm consists of values based on MODIS*
- Develop and apply view geometry dependent thresholds for various tests to improve detection and minimize false detections

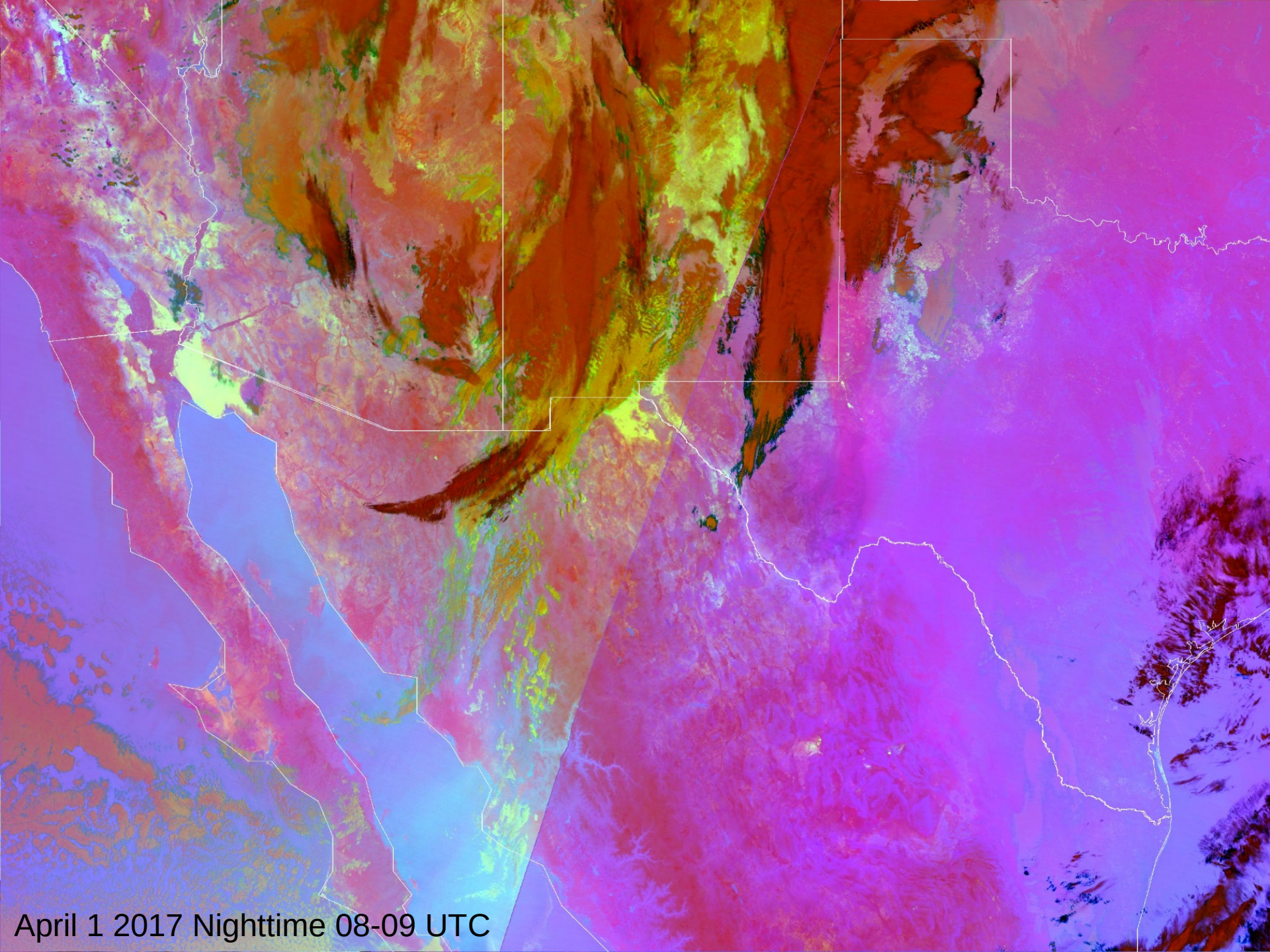
- Understand product performance as a function of
  - Over land vs. ocean
  - Time of the day
  - Land surface type
- Initial feedback from operational forecasters

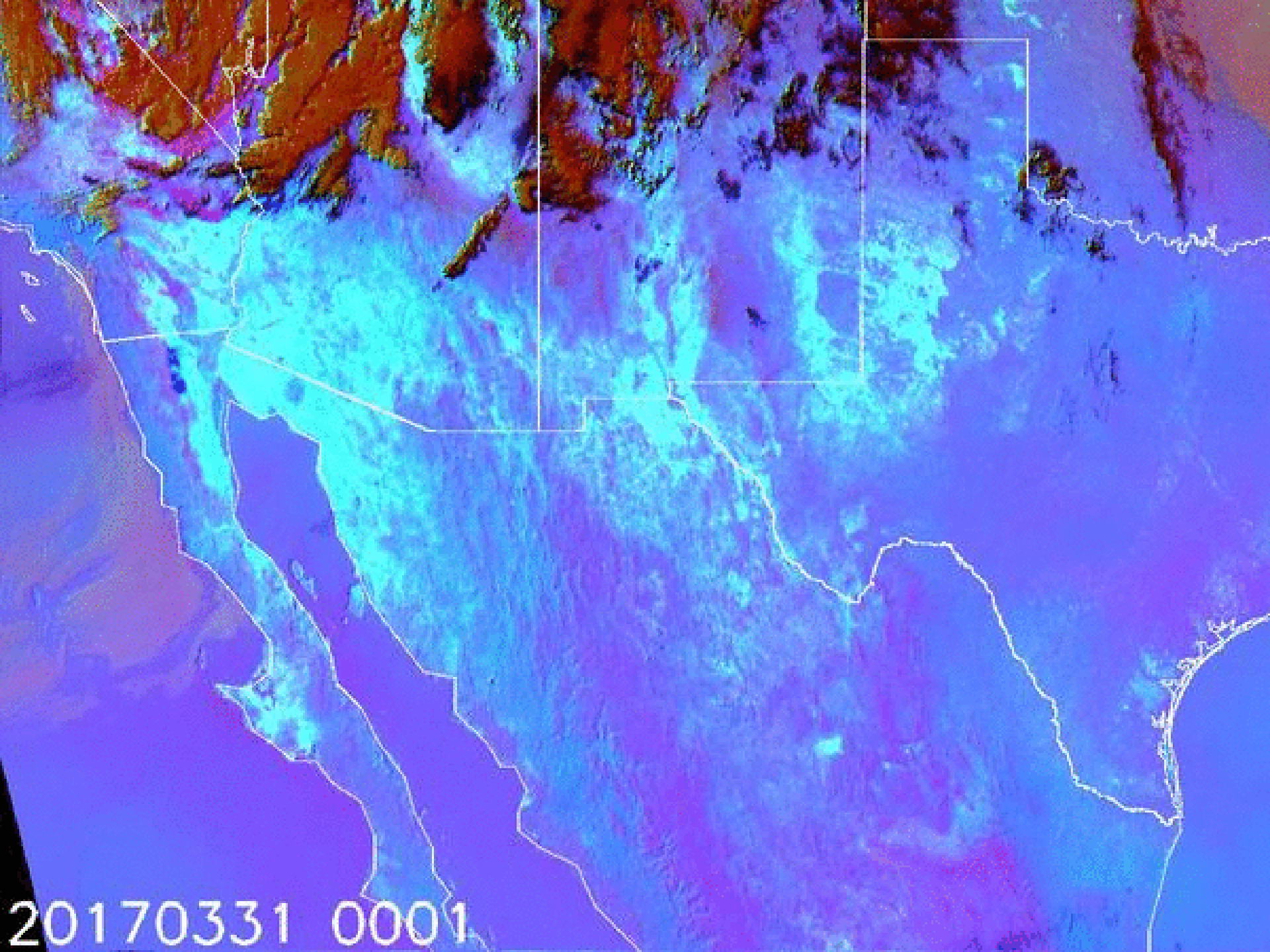
Geo vs. Leo
(Dust Case)


March 30 2017 Afternoon 20 UTC


March 31 2017 Night time 08 UTC


31 2017 Afternoon 19 UTC


April 1 2017 Nighttime 08-09 UTC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