Air Quality Forecasting Applications of GOES-16 ABI Data

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AC-VC-14

May 4, 2018

Air Quality Forecasting in the U.S.

- **State, local, and tribal government agencies** issue air quality forecasts to protect the public from the adverse health effects of **criteria pollutants**
  - NOAA (NWS) does <u>not</u> issue air quality forecasts, but does provide support (numerical air quality model guidance)
- Forecasts typically issued by mid-afternoon (~3 PM), valid for the **next day**
  - Allows for lead time to communicate with public, local governments, businesses, schools
  - Available on state and local websites and AirNow national website (http://www.airnow.gov/)
- Communicated using the color-coded **Air Quality Index (AQI)**

Good	0 to 50
Moderate	51 to 100
Unhealthy for Sensitive Groups	101 to 150
Unhealthy	151 to 200
Very Unhealthy	201 to 300
Hazardous	301 to 500

Today's AQI Forecast
Wednesday, May 02, 2018

Generated: 2018-05-02 14:22:53Z
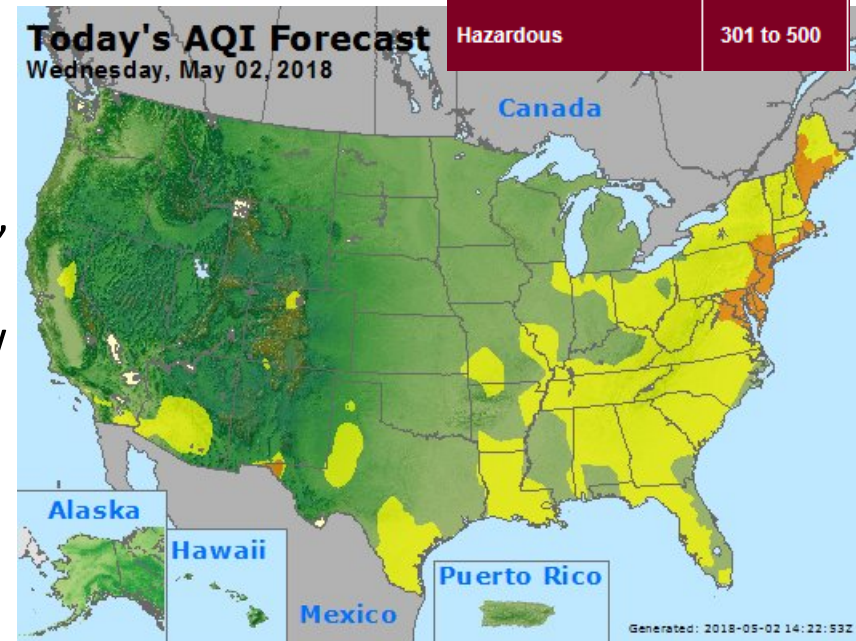
Air Quality Alerts

- O_3, $PM_{2.5}$, PM_{10} are the most commonly forecasted pollutants in the U.S.
- **Air Quality Alert (AQA)** issued to public on days when forecast for pollutant exceeds **National Ambient Air Quality Standard (NAAQS)**
- In practice, this translates to a **Code Orange, Red, Purple, or Maroon** forecast on the AQI scale
- Public warned to take action to limit their exposure to pollutants
- AQA forecasts are the **most important** ones to get correct!!

NWS Forecast Office Philadelphia/Mt Holly
Weather.gov > Mount Holly, NJ

Current Hazards   Current Conditions   Radar   Forecasts   Rivers and Lakes   Climate and Past

Click a location below for detailed forecast.

Watches, Warnings & Advisories

Zoom Out

Marine Weather Statement
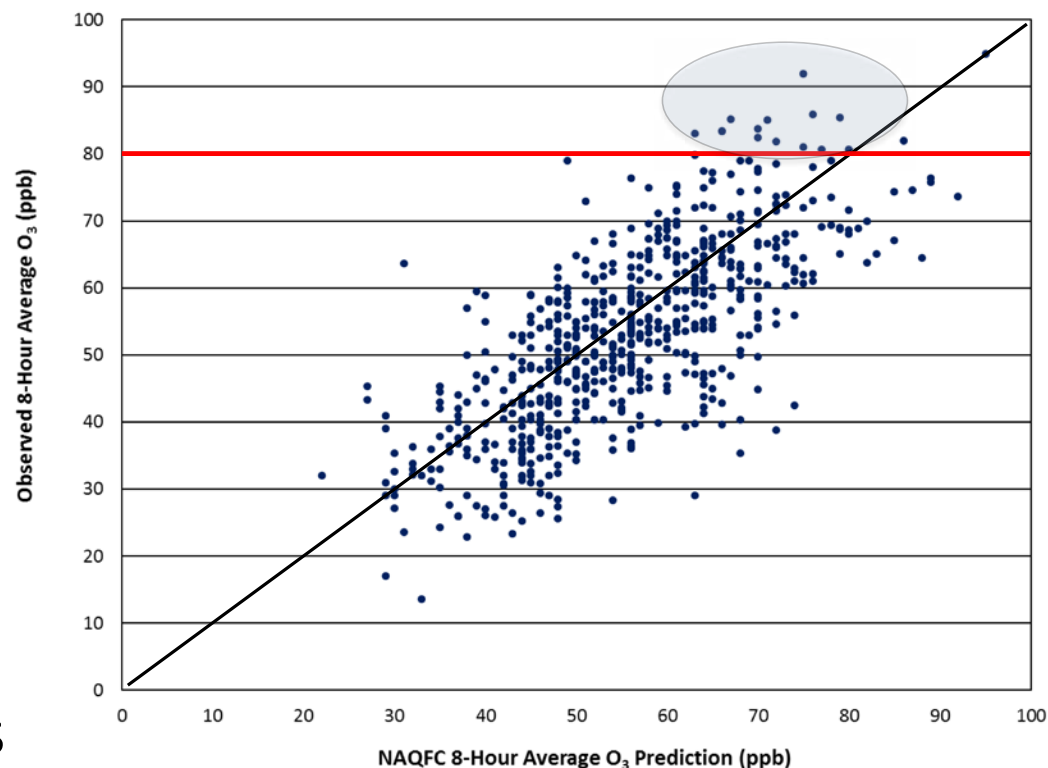
Air Quality Alert
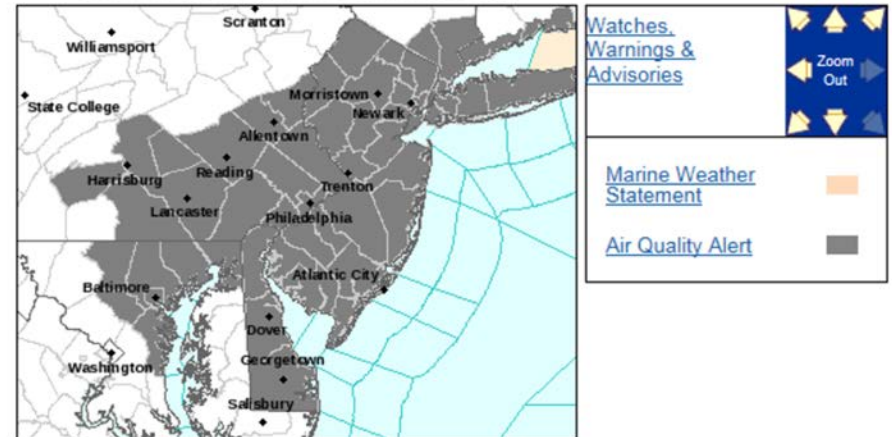
Wildfire Emissions Plumes and Blowing Dust

- Emissions plumes from large wildfires contain:
  - Primary $PM_{2.5}$ and PM_{10} (smoke aerosols)
  - Nitrogen oxides (NO_x) and volatile organic compounds (VOCs): precursors for secondary formation of O_3 and $PM_{2.5}$
- Wildfire emissions plumes can be lofted above the boundary layer and remain relatively intact while traveling long distances, often 100s of km
  - If the wildfire plume mixes to the surface downwind, it can **substantially** increase local O_3 and $PM_{2.5}$
  - Wildfires are becoming larger, more intense, and more frequent
- Blowing dust affects PM_{10} and $PM_{2.5}$ air quality (dust aerosols)
  - Primarily in arid regions, like the Southwestern U.S. (local sources)
  - Transported Saharan dust periodically affects the Atlantic and Gulf coasts

# Forecasting the Impacts of Wildfires and Blowing Dust

- Our typical air quality forecasting methods are not much help with wildfire plumes and blowing dust
  - They are uncommon events, so **climatology** doesn't work
  - **Persistence** will always miss the onset day of a fire- or dust-influenced event, but it can help with subsequent days (if it's a multi-day event)
  - **Numerical air quality models** tend to under-predict because they don't account for wildfire emissions or dust transported from outside of the CONUS

Example: Philadelphia, PA metro area, 2013-2017
NAQFC under-predicts O_3 on days influenced by fires

Observed 8-Hour Average O_3 (ppb)

NAQFC 8-Hour Average O_3 Prediction (ppb)

Fort McMurray Fire Smoke Plume, May 7, 2016

NAQFC (left) under-predicted PM$_{2.5}$ in Midwest associated with smoke from Ft McMurray fire
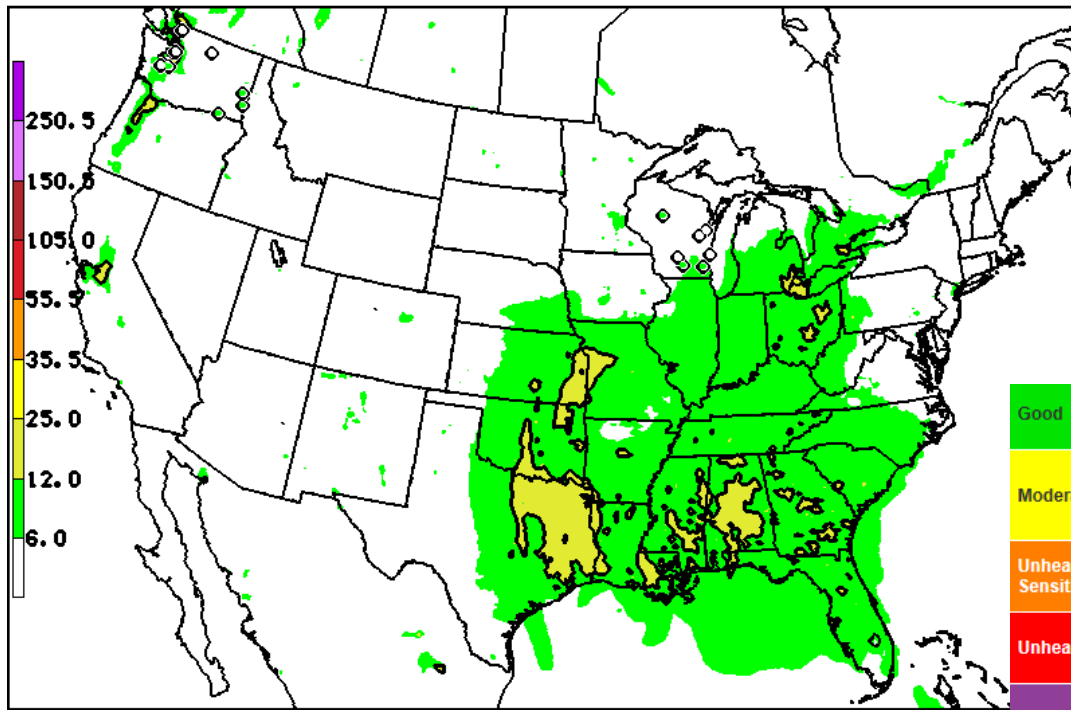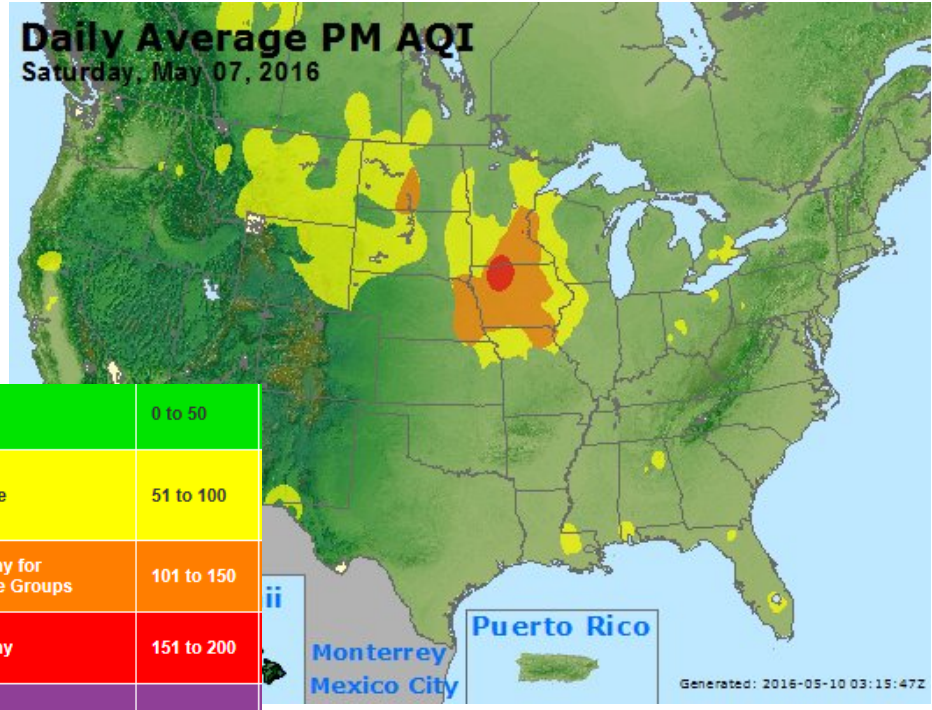
Satellite Aerosol Products

- Air quality forecasters turn to **aerosol satellite products** to help track wildfire emissions plumes and blowing dust
  - **Aerosol optical depth (AOD):** quantitative measure of aerosols
  - **Smoke/dust mask:** qualitative measure of aerosols
  - **Dust color imagery (dust RGB):** locations, movement of blowing dust
  - **GeoColor/true color (RGB):** locations, movement of smoke and dust
- Historically, satellite aerosol data had **limited usefulness for operations**
  - Polar-orbiting satellites: low temporal resolution
    - Observations not available in time for early-afternoon forecasting deadlines
  - Previous generation GOES: low spectral resolution
    - No high-accuracy, multi-channel aerosol products

VIIRS RGB and Smoke Mask 20180430
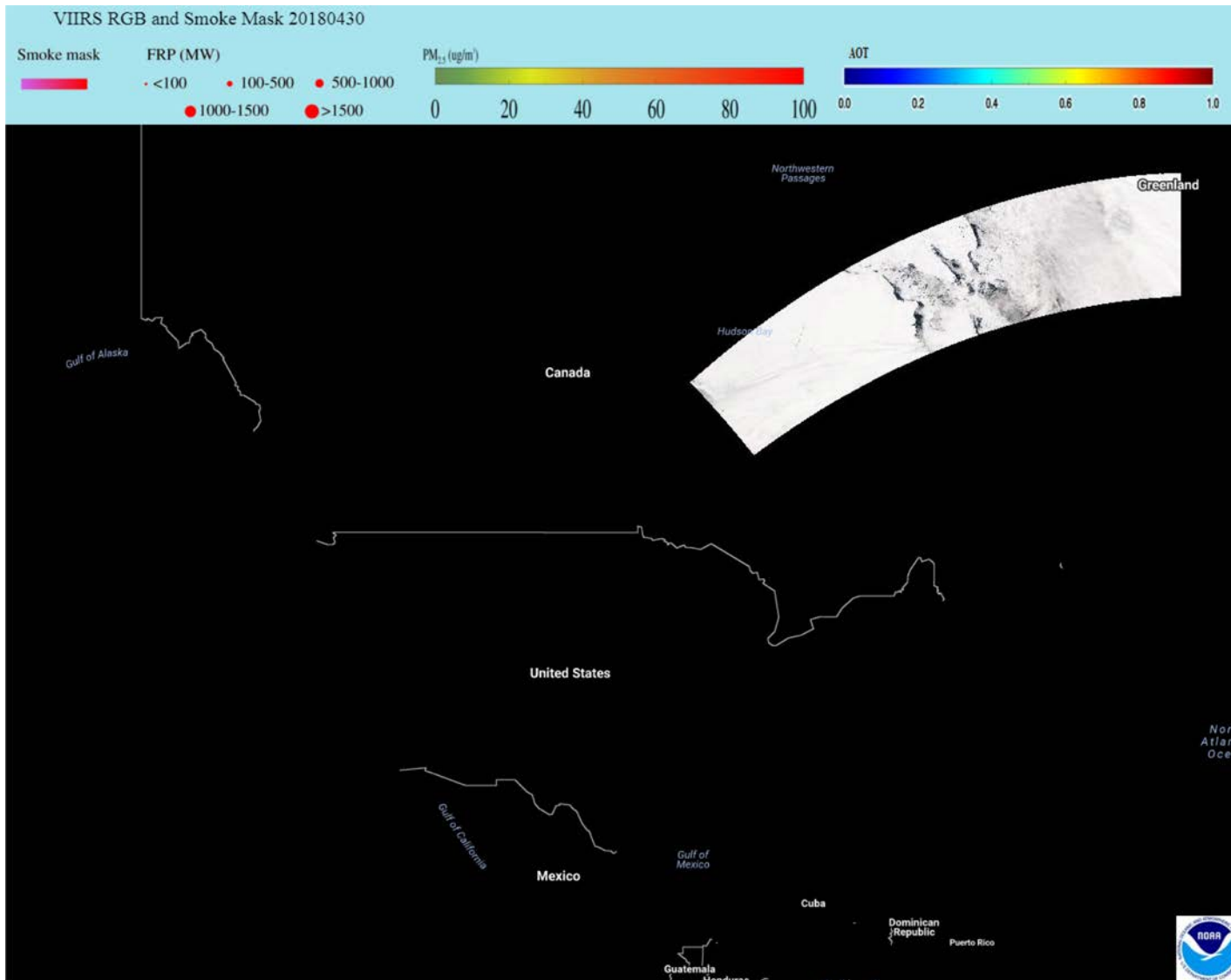
Example: VIIRS Data

- This is the extent of the VIIRS RGB and AOD available by my forecast deadline (~2 pm)
- Shobha did all she could to increase the latency, but observations are available too late in the afternoon
- VIIRS data are more useful for **post-analysis**

# Advanced Baseline Imager on GOES-R Satellites

- **Advanced Baseline Imager (ABI)** on GOES-16 (GOES-East) and GOES-17 (soon to be GOES-West) is revolutionizing the forecasting of air quality associated with fires and dust

- ABI has **16 spectral bands** vs. 5 on previous GOES imager
  - New products!
  - Higher accuracy and spatial resolution!

- **Faster scan rate** compared to previous GOES imager
  - More frequent observations!
  - Routine CONUS and full disk views!

- **Only 20 min latency!**

ABI GeoColor: Dust Storm in Southwest U.S., April 12, 2018

1800-2350 UTC
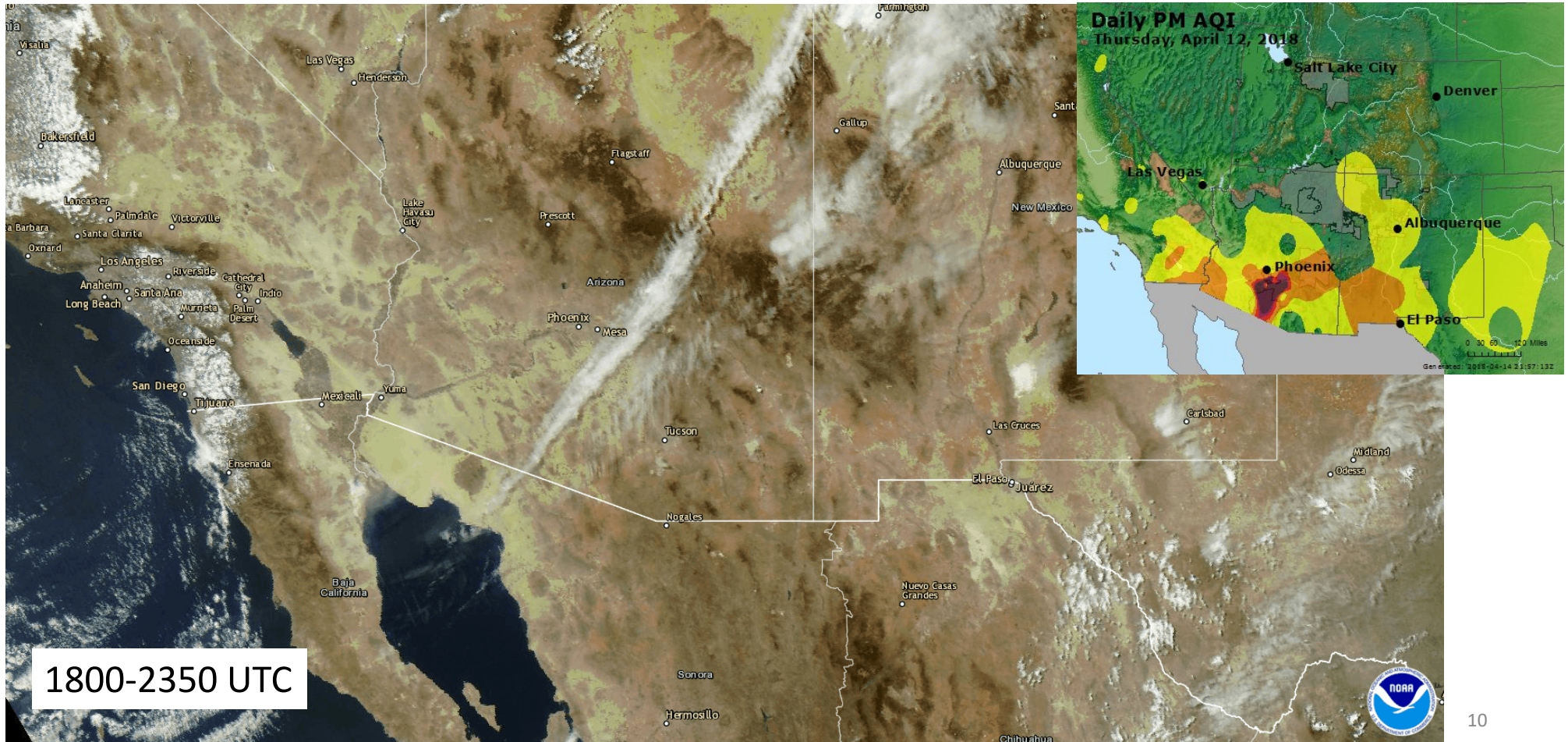
ABI Dust RGB: Dust Storm in Southwest U.S., April 12, 2018

1800-2350 UTC
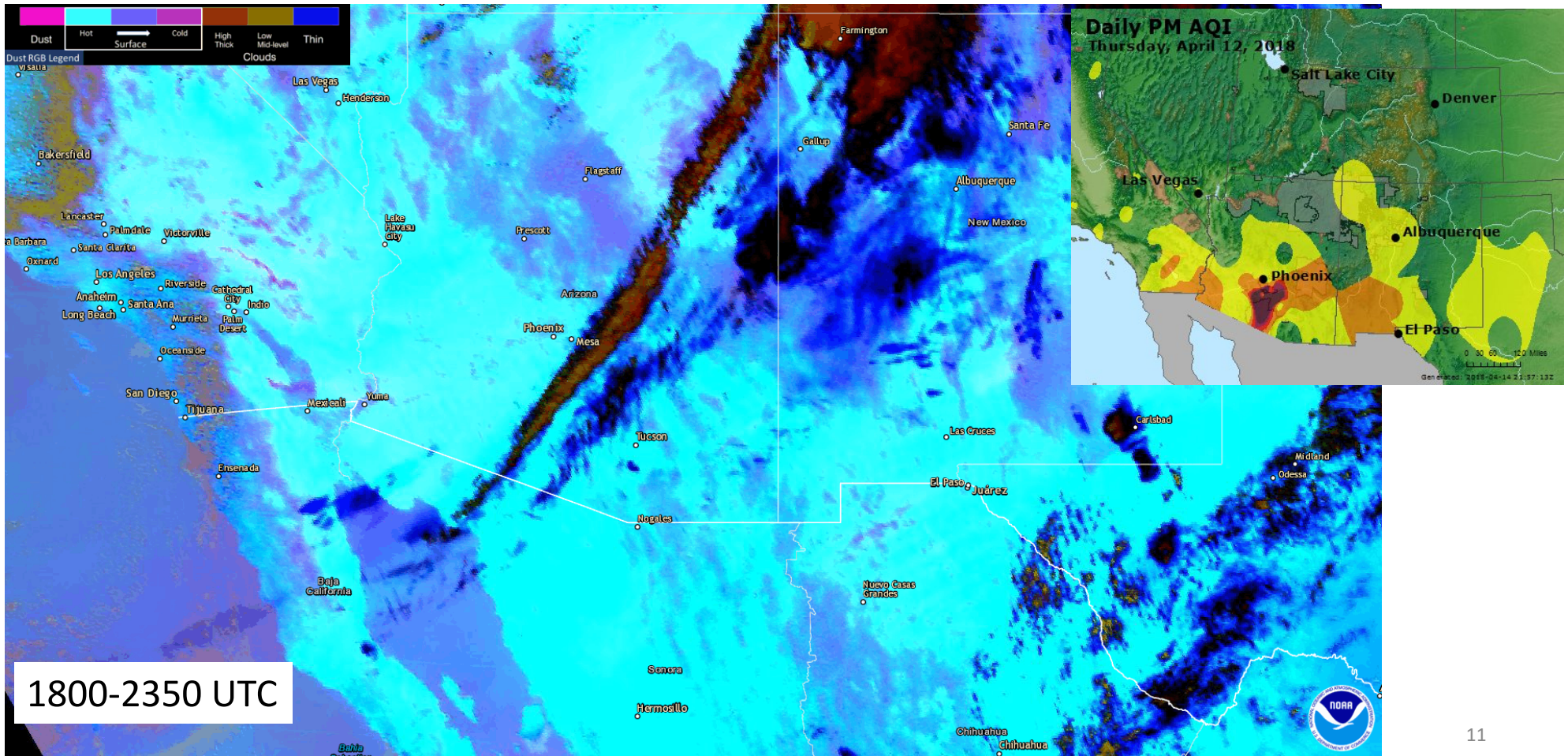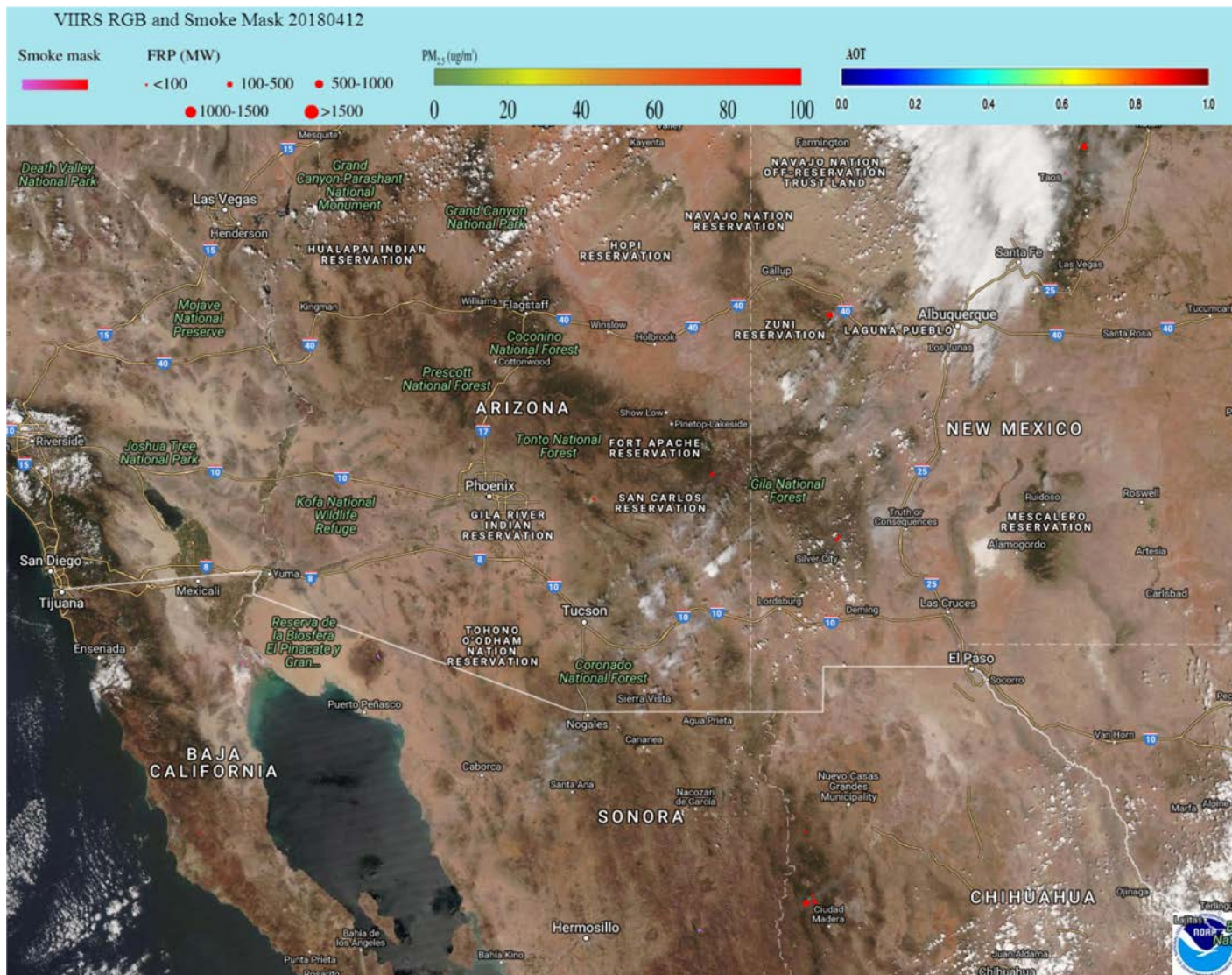
VIIRS RGB

- Most of the event occurred **after** the VIIRS observation!

- So forecasters couldn't use polar-orbiting satellite data to detect and track blowing dust associated with this event!
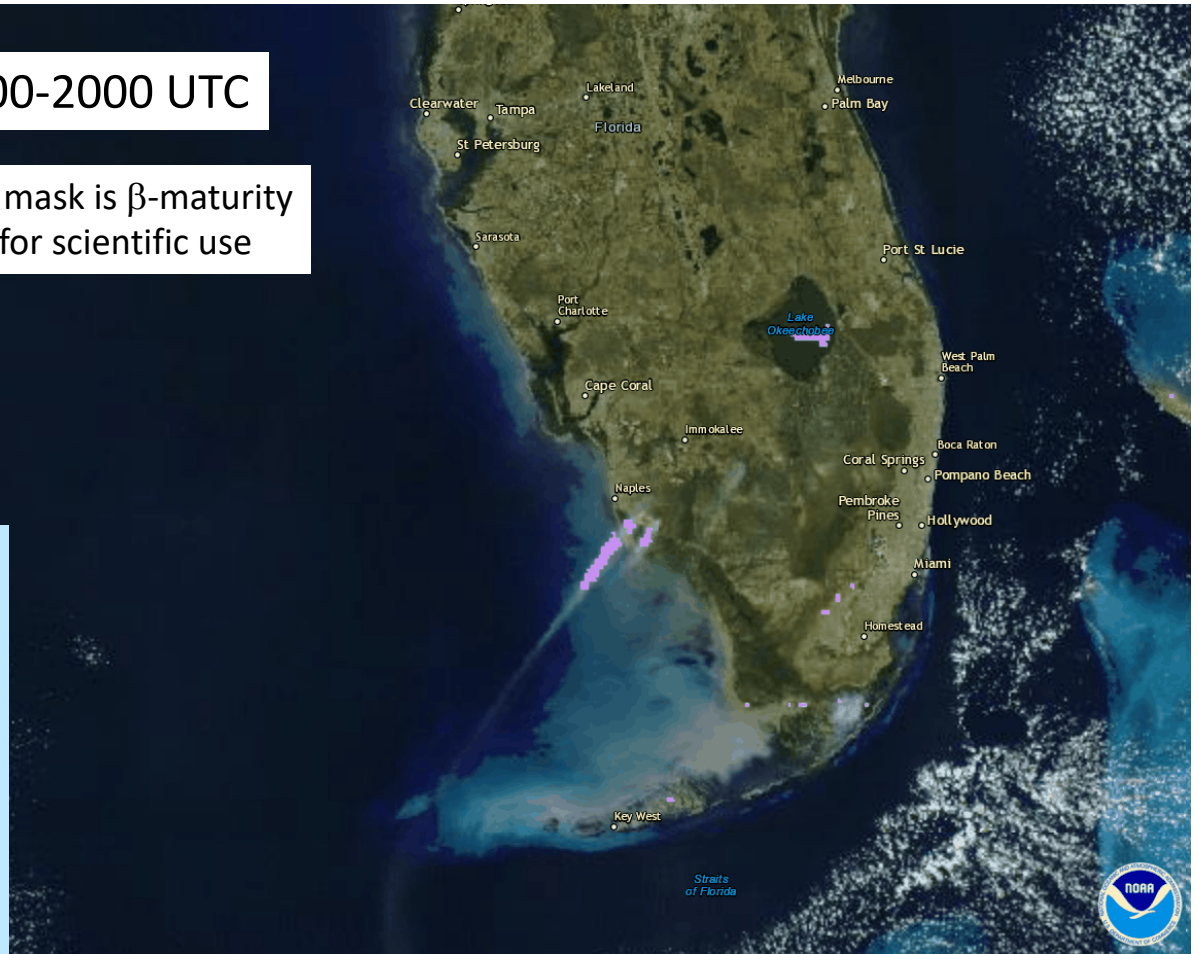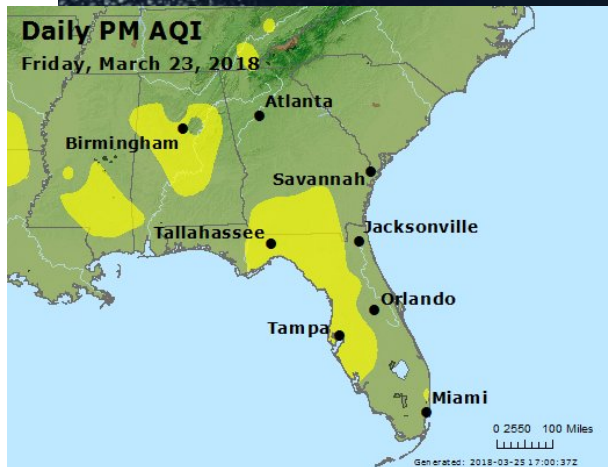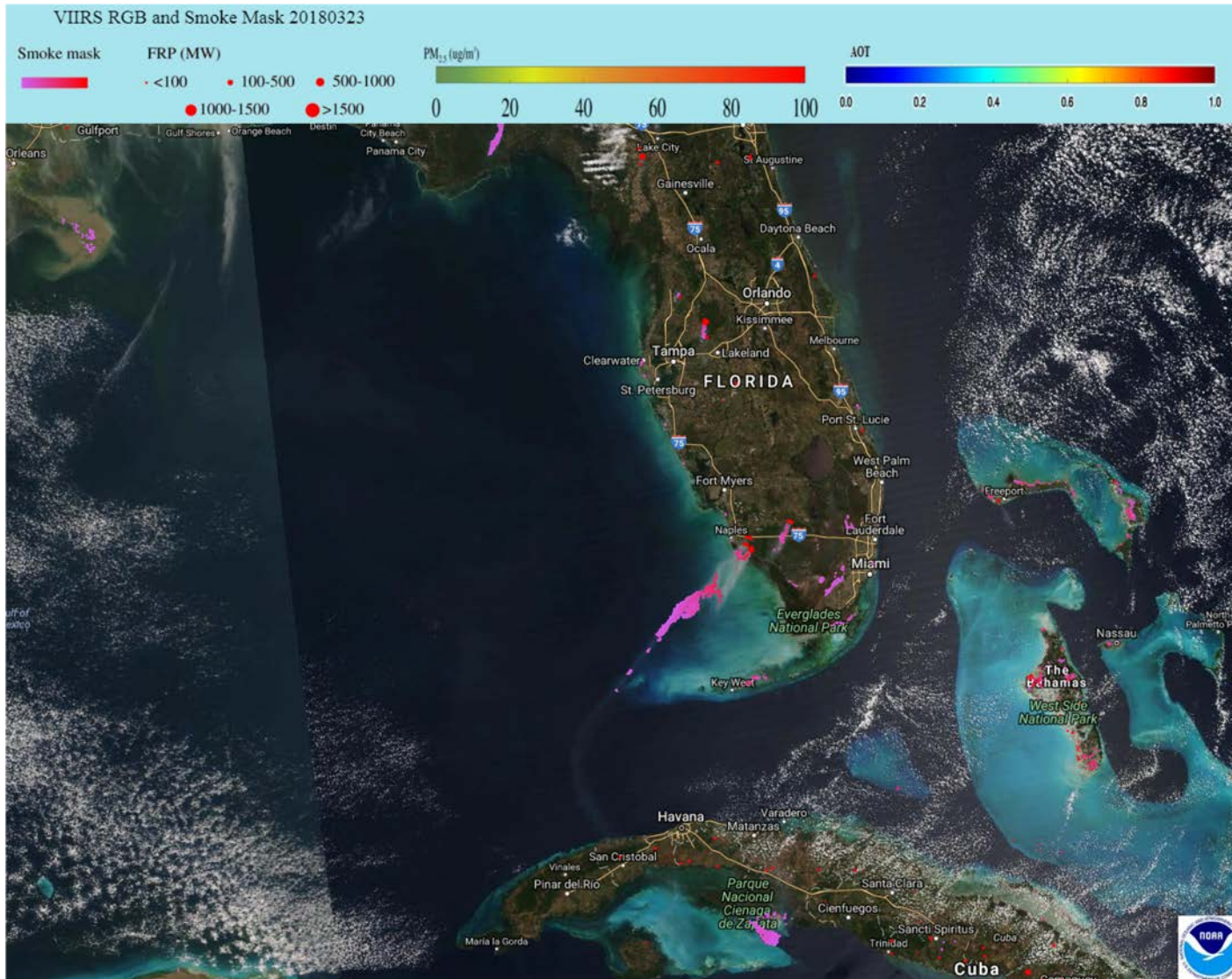
ABI Smoke Mask: Local Fires in Florida, March 23, 2018

1600-2000 UTC

Smoke mask is β-maturity
Not for scientific use

VIIRS RGB and Smoke Mask 20180323

VIIRS RGB and Smoke Mask

- VIIRS captured the smoke event, but it is only a snapshot

- Doesn't show the evolution or growth of the plume like the ABI can!

- And VIIRS was not available in time to inform the forecast!

New NOAA *AerosolWatch* Website
Access to Near Real-Time ABI and VIIRS Aerosol Imagery for Operational Users
https://www.star.nesdis.noaa.gov/smcd/spb/aq/AerosolWatch/

Plans for 2018

- 2018 ozone season in the Mid-Atlantic is underway; runs May 1 Sept 30
- Pilot study to use ABI **AOD, smoke mask, and GeoColor** to track transport of plumes from wildfires
  - Fires cause many of the highest magnitude and most widespread (geographically) O_3 events in the Mid-Atlantic
  - But AOD and smoke/dust mask currently β**-maturity**
  - Waiting for provisional maturity products, anticipated soon (June 2018)
  - Fully validated products expected **Fall 2018**
- GOES-17 currently in its check-out orbit at 89.5 °W
  - Will become GOES-West later this year (~200 days after launch)
  - Lots of fires in Western U.S., Canada!

Acknowledgements

- Support for air quality forecasts:
  - Pennsylvania Department of Environmental Protection
  - Delaware Department of Natural Resources and Environmental Control

- Support for NOAA aerosol products and *AerosolWatch*:
  - Shobha Kondragunta, Hai Zhang, and the NOAA aerosol Cal/Val team
  - NOAA JPSS and GOES-R programs
    - Air Quality Proving Ground
    - Fire and Smoke Initiative