

VIIRS Aerosol Case Study: An Air Quality Forecaster's Perspective

Amy K. Huff

**Department of Meteorology
Pennsylvania State University**

STAR JPSS Annual Science Team Meeting
August 27, 2015

PENNSSTATE



Operational Air Quality Forecasting

- State, local, and tribal agencies issue **air quality forecasts** to protect the public from the adverse health effects of criteria pollutants
 - 43 states plus Washington, DC
 - O_3 , $PM_{2.5}$, PM_{10} most commonly forecasted pollutants
 - Based on EPA's color coded Air Quality Index (AQI)
 - Air Quality Alert (AQA) issued when forecasted air quality is Code Orange or higher
 - Forecasts issued by mid-afternoon (~3 PM) for next day; some agencies do morning updates
 - Forecasts available on state and local websites and EPA's AirNow national website (<http://www.airnow.gov/>)



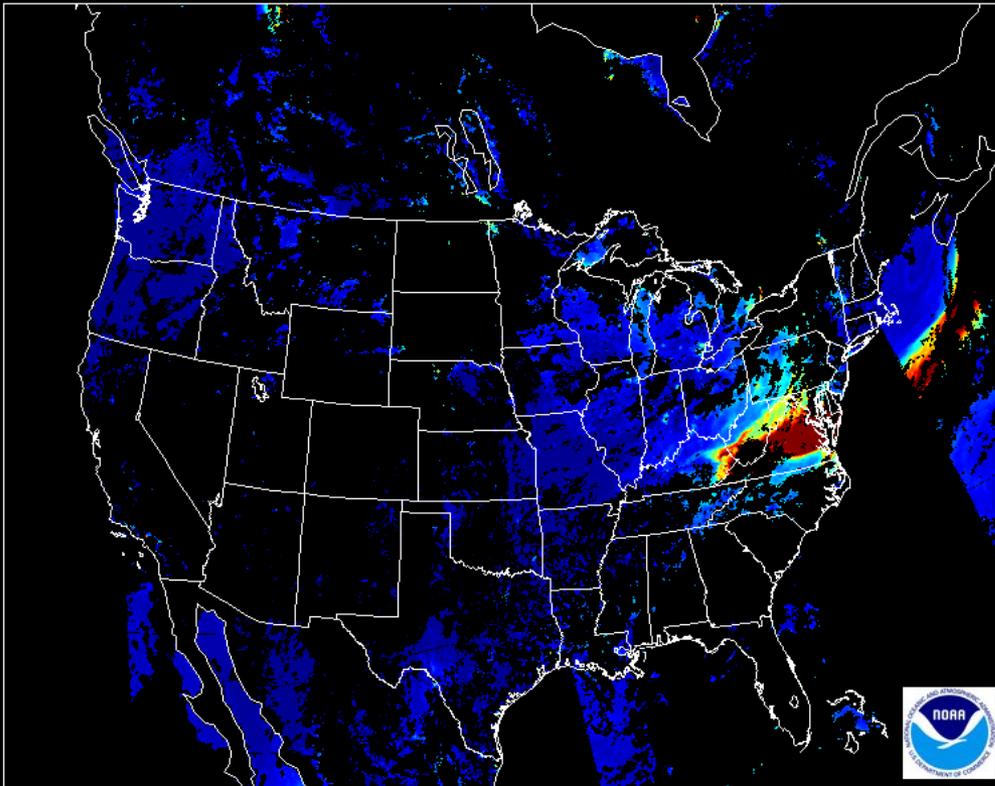
Smoke is a Major Issue for AQ Forecasts

- O_3 and $PM_{2.5}$ concentrations in the Mid-Atlantic region are a primarily function of:
 - Synoptic and mesoscale weather conditions
 - Emissions of pollutants ($PM_{2.5}$) and precursors (O_3 , $PM_{2.5}$)
 - Air mass transport (i.e., “dirty” air from upwind that is rich in pollutants and precursors)
- Smoke from **wildfires**, either local or transported, can have a significant impact on O_3 and $PM_{2.5}$
 - Most of the forecasting tools we use, including statistical and numerical models, do not include effects of smoke
 - So we rely heavily on **satellite aerosol products** to forecast the impacts of smoke!

Wildfire Smoke Case Study: June 11, 2015

- In early June, smoke from fires burning in central Canada was transported south and east into the US, impacting the northern Plains, Great Lakes, Ohio River Valley, and Mid-Atlantic regions
- When will smoke impact surface air quality in Mid-Atlantic?

VIIRS EDR 20150610

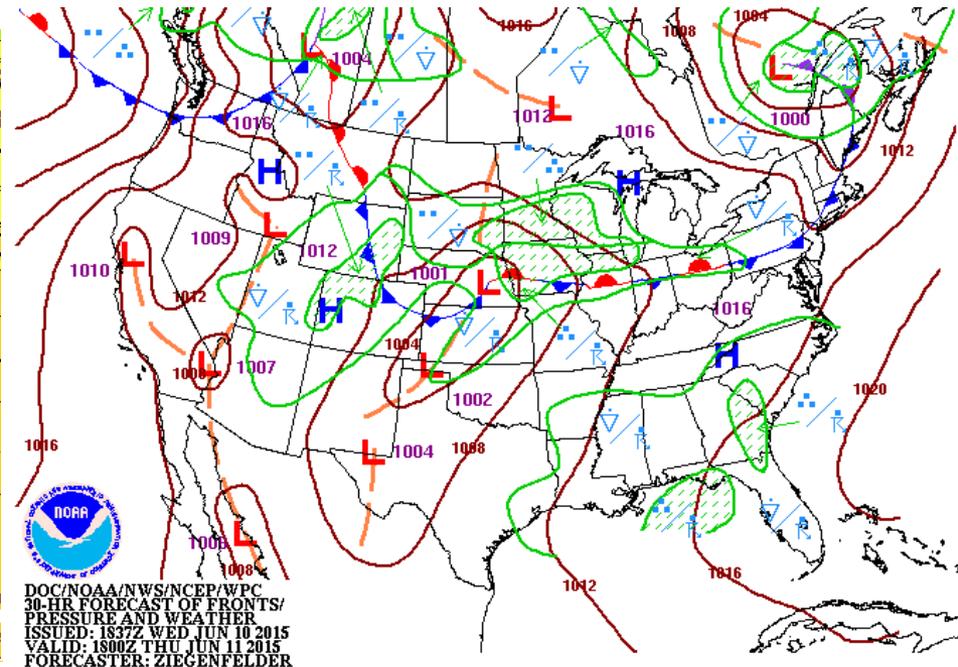
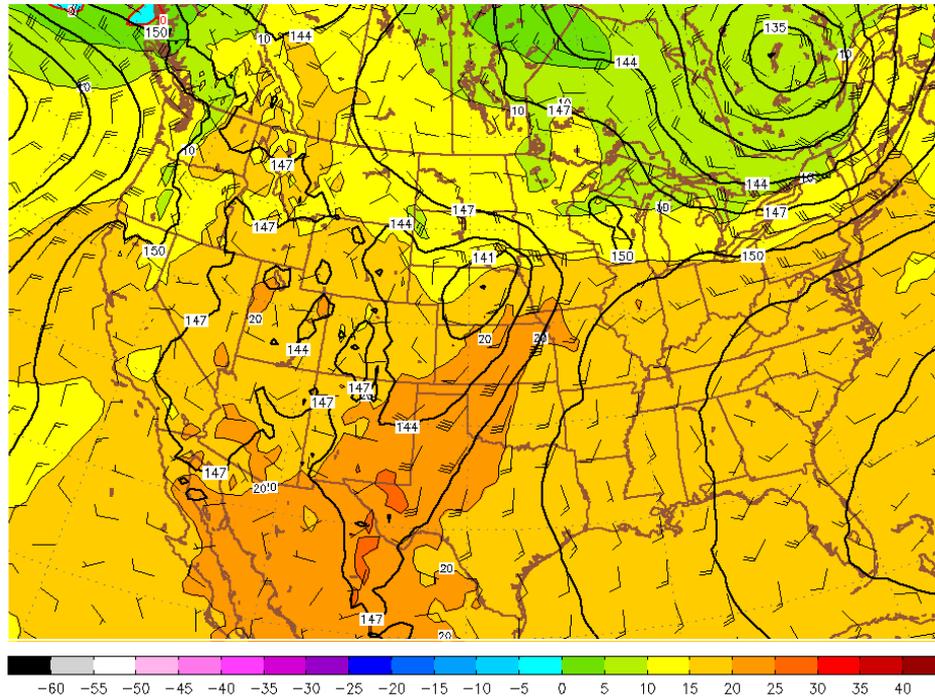


June 11 Weather Conducive for O₃ Formation

- A “ridge” of high pressure was centered over the Southeast US, with high pressure at the surface
 - Sunny skies, light surface winds, hot ($T_{\max} \geq 90^{\circ}\text{F}$) in Mid-Atlantic
- Weak “back door” cold front approaching in afternoon, but not expected to develop clouds/thunderstorms until evening

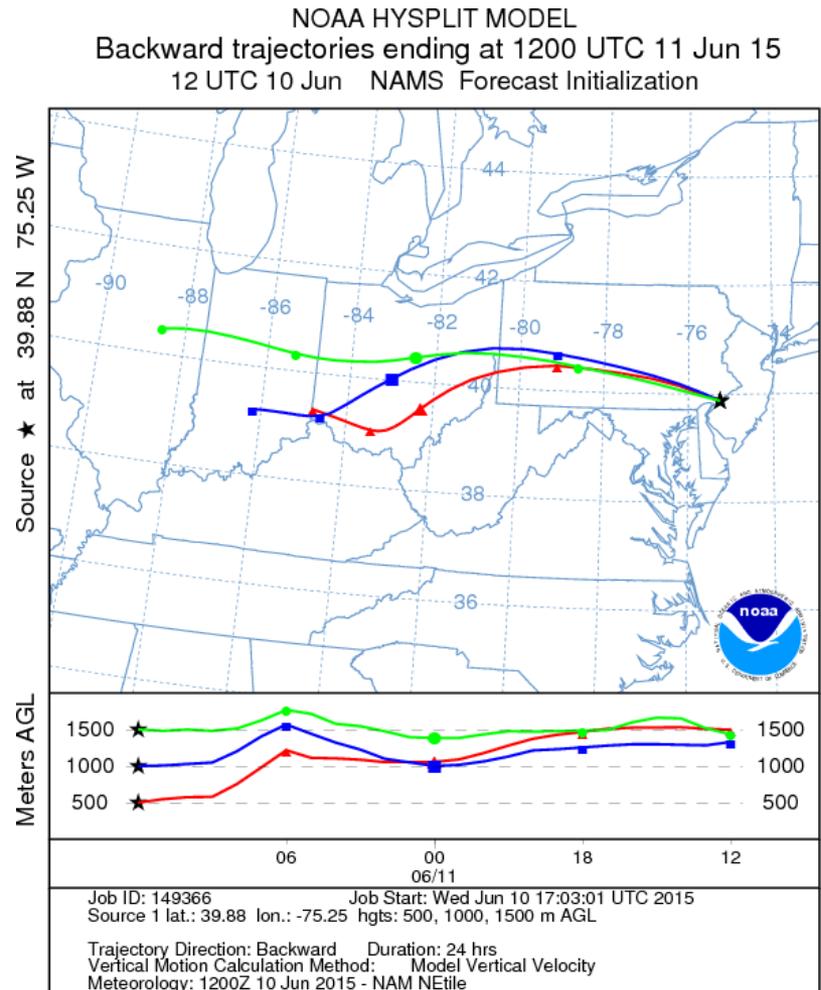
850 MB Height, Temperature, and Winds (knots)
30 hour forecast valid 12Z Thu 11 JUN 2015
GFS initialized 06Z Wed 10 JUN 2015

Pro.AccuWeather.c



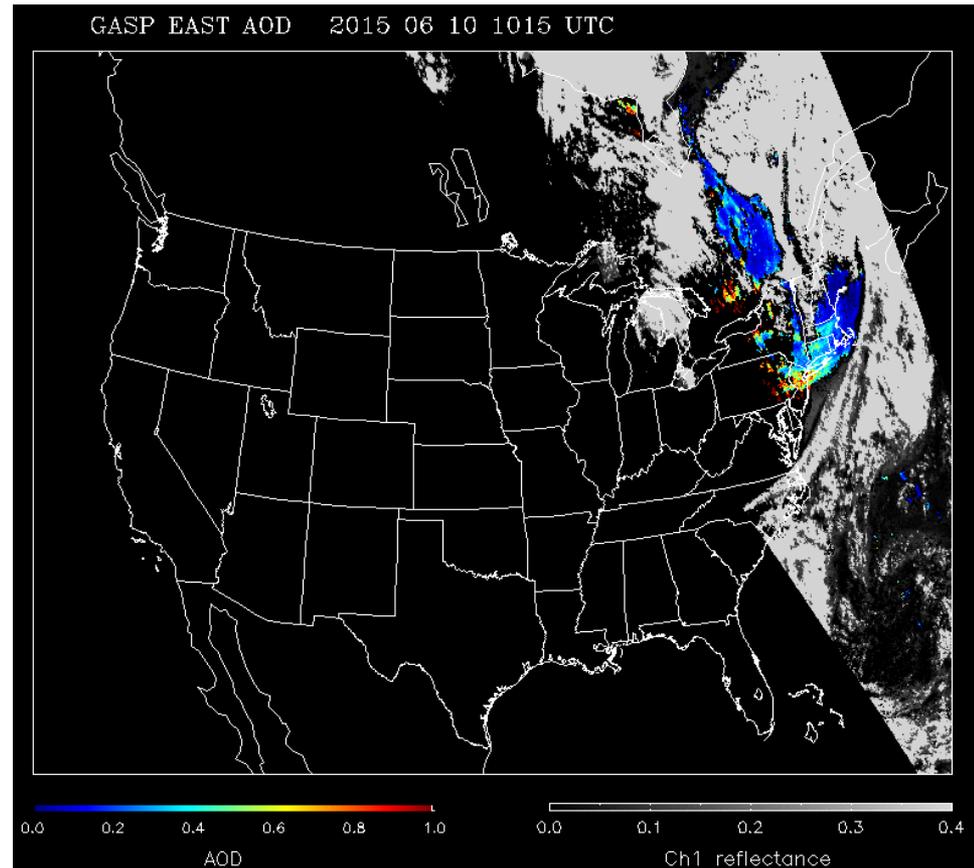
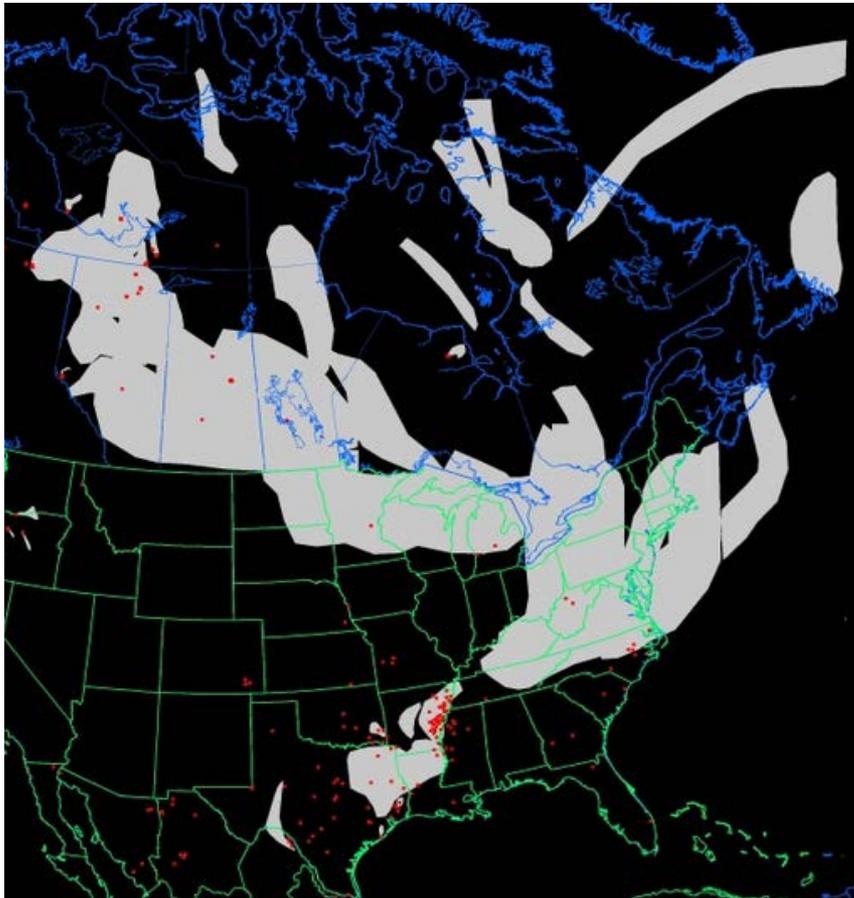
What is Impact of Transported Smoke?

- HYSPLIT backward air mass trajectory analysis shows air that will be in PHL morning of June 11 coming from IN/OH (ORV)
- Previous day (June 10), Code Orange O₃ and upper Code Yellow PM_{2.5} in ORV due to smoke



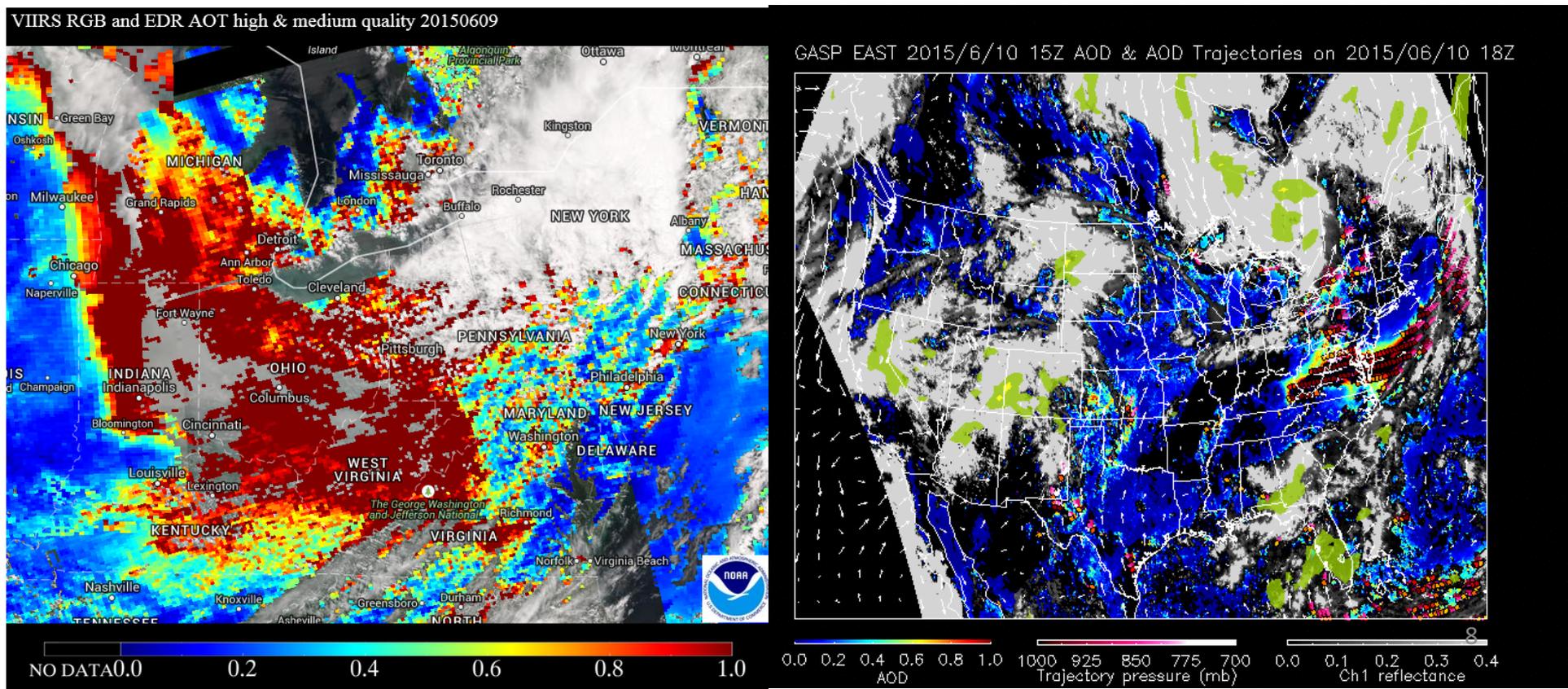
It's 1-2 PM June 10; Forecast for June 11 is Due 3 PM

- NOAA HMS analysis shows smoke over Mid-Atlantic on June 10; no substantial impact on surface AQ yet
- GASP shows thickest plume continuing to move east



Best Forecast Tool is IDEA Forward Trajectories

- Numerical air quality models don't include smoke in boundary conditions, so they can't help us
- Only way to determine impact of smoke is IDEA 48-hr aerosol forward trajectories; have to use GASP b/c VIIRS not available by forecast time
- VIIRS zoom-in from previous day (June 9) also helpful for seeing where thickest smoke plume is (gives idea of transport)



June 11: Forecasted and Observed Code Orange O₃

OBSERVED	PHL	Delaware
O ₃ (ppb)	92	94
PM _{2.5} (µg/m ³)	33.6	23.9

Customize Your Weather.gov

City, ST

Enter Your City, ST or ZIP Code

Remember Me

Get Weather

Privacy Policy

NWS Forecast Office Philadelphia/Mt Holly

Weather.gov > Mount Holly, NJ

Mount Holly, NJ
Weather Forecast Office

[Current Hazards](#) [Current Conditions](#) [Radar](#) [Forecasts](#) [Rivers and Lakes](#) [Climate and Past Weather](#) [Local Programs](#)

Click on the map below to zoom in.



[Watches, Warnings & Advisories](#)

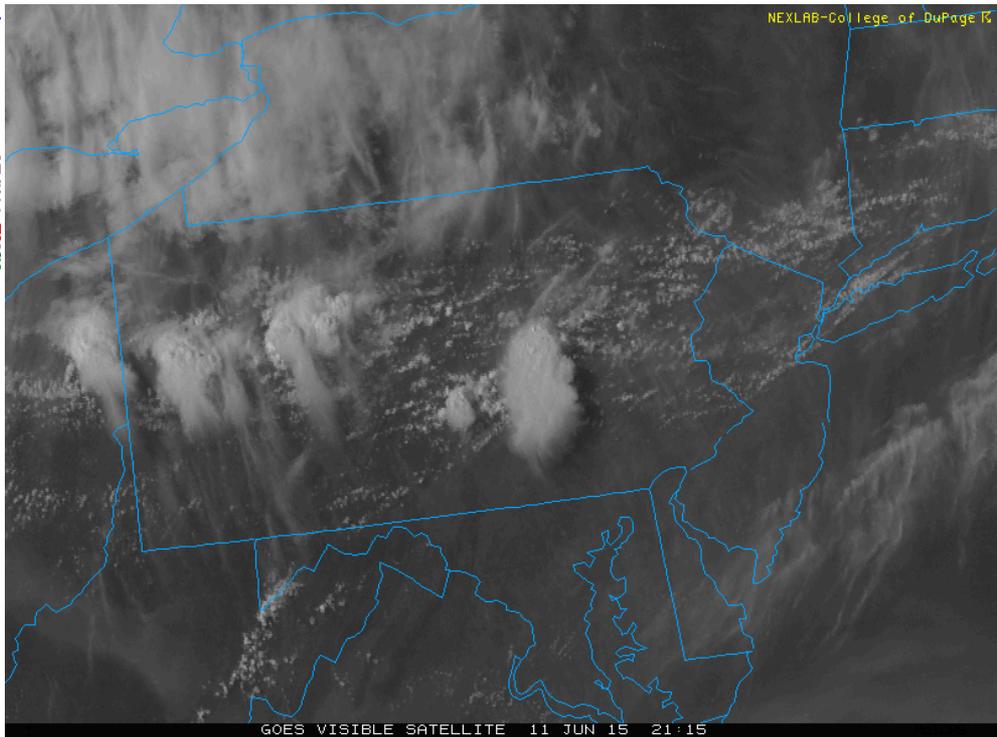
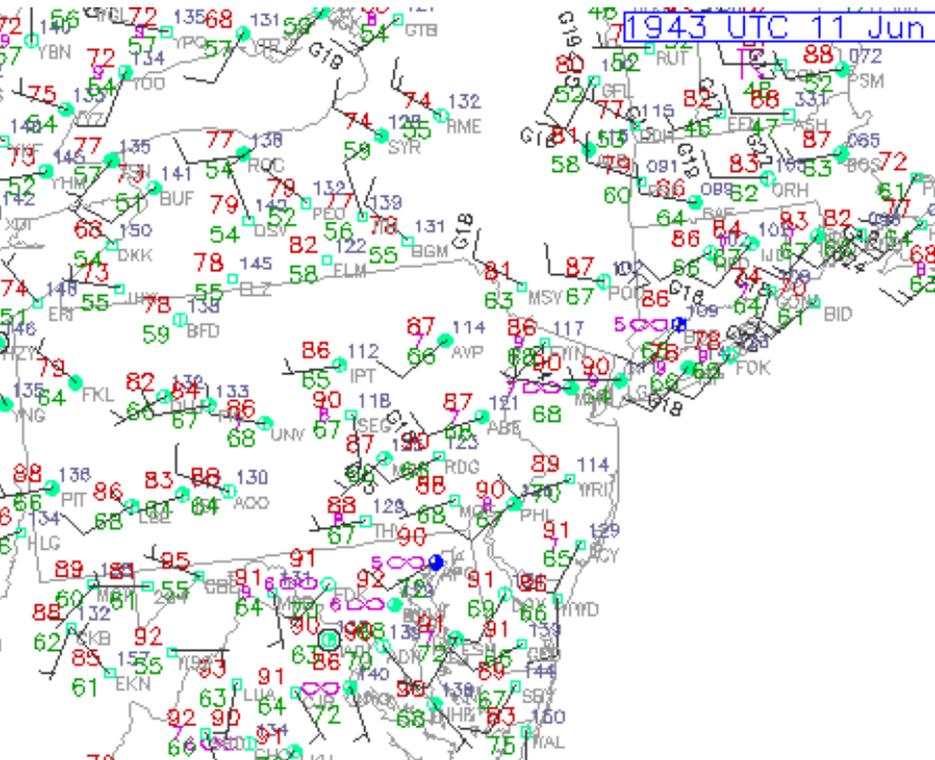
Small Craft Advisory

Air Quality Alert

Hazardous Weather Outlook



Last Map Update: Thu, Jun. 11, 2015 at 8:14:32 am EDT



GOES VISIBLE SATELLITE 11 JUN 15 21:15

Importance of VIIRS Aerosol Products for Air Quality Forecasting

- **VIIRS RGB and AOD** essential for identifying smoke plume transport upwind
 - Gives forecasters a heads-up when smoke may be heading toward our forecast area
 - Use in conjunction with surface PM_{2.5} measurements to determine when smoke is impacting surface air quality
 - Also useful for retrospective analysis/exceptional events
- **VIIRS zoom-in tool on IDEA** very helpful for identifying thickest parts of smoke plume
- **IDEA 48-hour aerosol trajectories critical tool** for identifying when smoke will reach surface in forecast area
 - Need to use GASP trajectories b/c VIIRS not available by 1-2 PM