

Overview of Air Quality Forecasting

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What Do We Forecast?

- Domain-wide peak 8-hour average ozone (O_3).
- Daily (midnight to midnight) average peak fine particles ($PM_{2.5}$).
- Some locations forecast other pollutants and future NO_2 forecasts are likely.
- Forecasts are verified at the state/local government network of monitors. These monitor networks vary in density.

Where Do We Forecast?

- Typically on the metropolitan scale – a city and its surrounding suburbs and exurbs.
- Some forecasts are statewide (e.g., Delaware) but most forecasts are for specific cities or for geographic portions of a state.
- 47 states and the District of Columbia issue daily air quality forecasts.

Who Does the Forecasting?

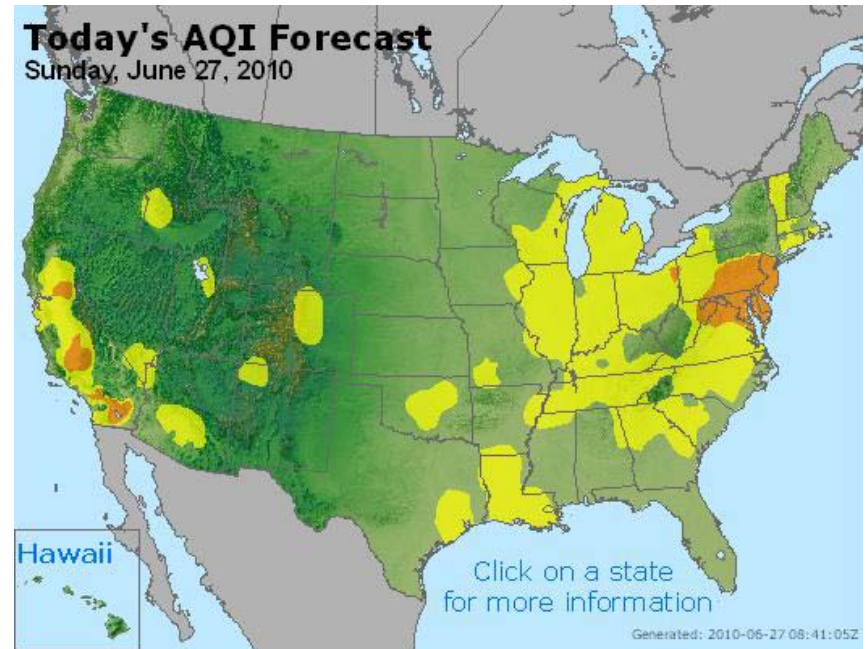
- Air quality forecasting is the responsibility of state, local or tribal governments.
- NOAA and EPA provide key services:
 - Ozone numerical forecast model:
www.weather.gov/aq
 - Data/forecast clearinghouse: AirNowTech and AirNow (www.airnow.gov).
- But, NOAA and EPA do not prepare air quality forecasts. This has important implications.

When Do We Forecast?

- Most forecasts are issued ~ 2 pm local time, but, for a variety of reasons, some locations forecast earlier in the day.
- The forecasts are valid for the following day.
- Some locations also issue morning updates to forecasts.
- In order to be useful for forecast preparation, data must be in “usable” form by roughly 1-1:30 pm local time.

Forecasts Appear in a Variety of Venues

The screenshot shows the National Weather Service website for Philadelphia/Mount Holly. The page features a navigation menu with options like 'Local forecast by City, St or zip code', 'Current Hazards', 'Current Conditions', 'Radar Imagery', and 'Forecasts'. A 'Quick Glimpse at the Weather' section displays a map of the Philadelphia area with a legend for 'Excessive Heat Warning', 'Air Quality Alert', 'Hazardous Weather Outlook', and 'Short Term Forecast'. The legend indicates that the Philadelphia area is currently under an 'Air Quality Alert' (yellow shading).



www.airnow.gov

Air Quality Alerts are carried on the NWS warning network

Air Quality Forecasting Basics

- Pollutant concentrations are a function of local and regional scale emissions of pollutant precursors. Day to day variations in pollutant concentrations, however, are primarily a function of transport and weather conditions.
- O_3 and, to a lesser extent, $PM_{2.5}$ are secondary pollutants but their precursors are not well observed and are quite difficult to predict using numerical or statistical models.

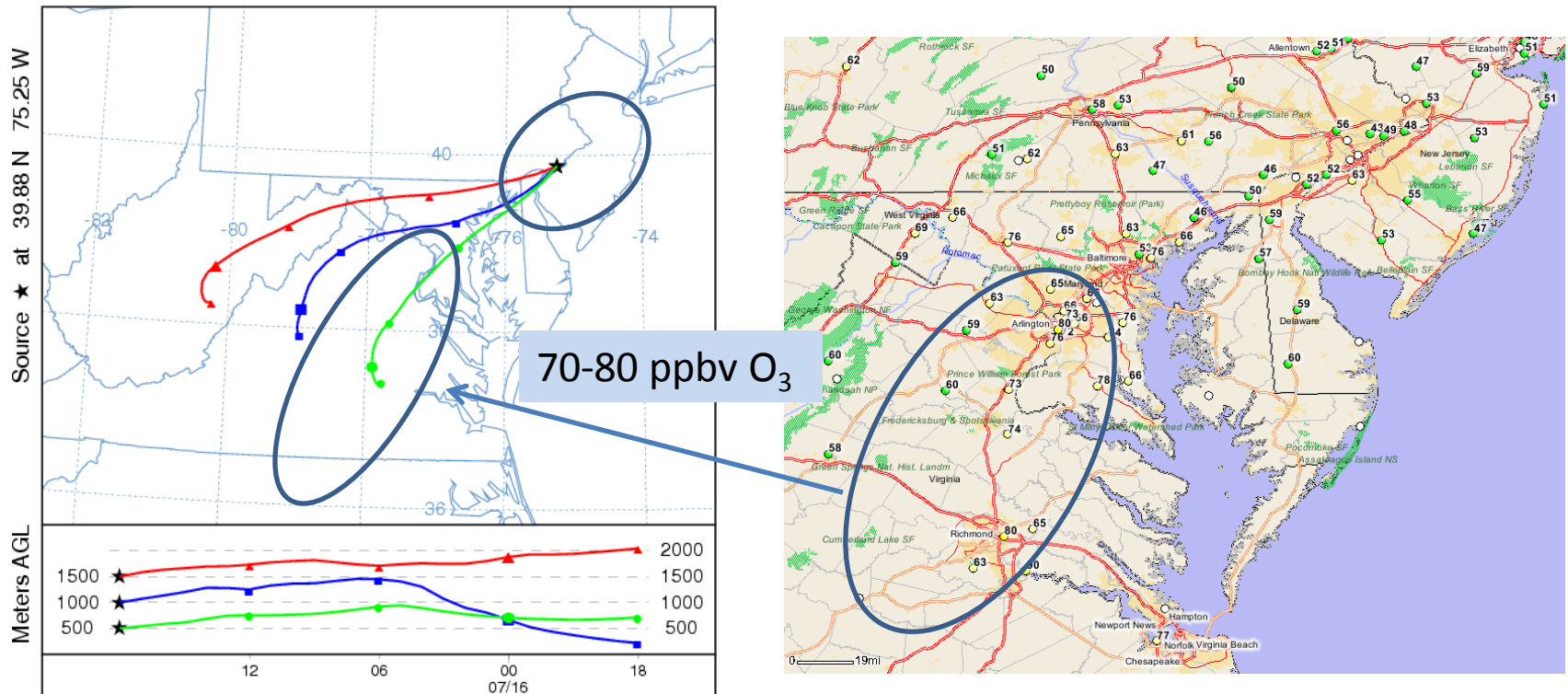
Variables of Interest for Air Quality Forecasts

- Sunlight (O_3)
 - Cloud type, optical depth and duration
- Temperature and Moisture (O_3 and $PM_{2.5}$)
 - Lowest 2-3 km
- Depth of planetary boundary layer (O_3 and $PM_{2.5}$)
- Wind direction/speed (O_3 and $PM_{2.5}$)
- Upwind air mass characteristics (O_3 and $PM_{2.5}$)
 - Transport within the “residual layer”
- Convection (summer season) (O_3)

Example: July 16, 2010

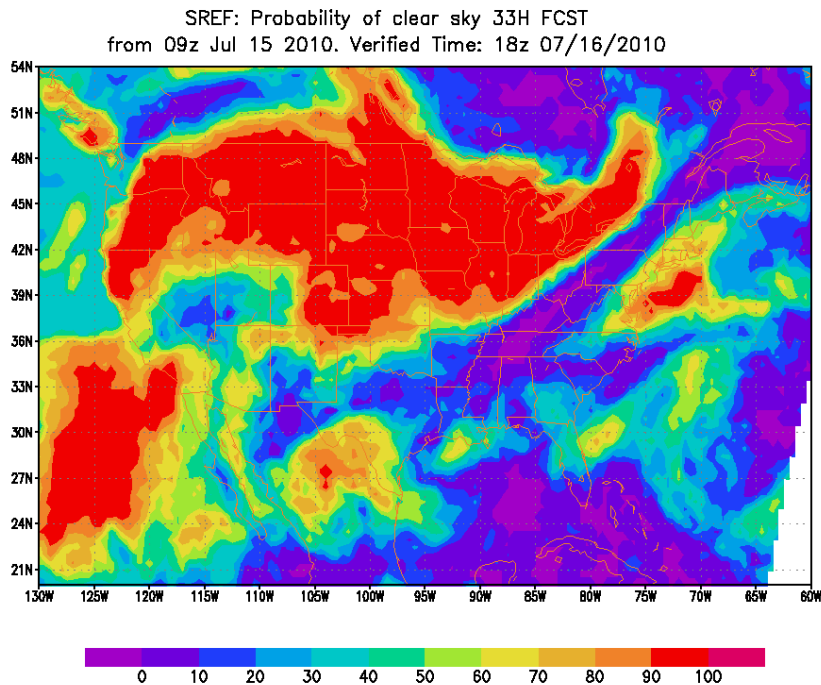
Transport of Pollutants (Ozone)

NOAA HYSPLIT MODEL
Backward trajectories ending at 1800 UTC 16 Jul 10
00 UTC 15 Jul NAM Forecast Initialization

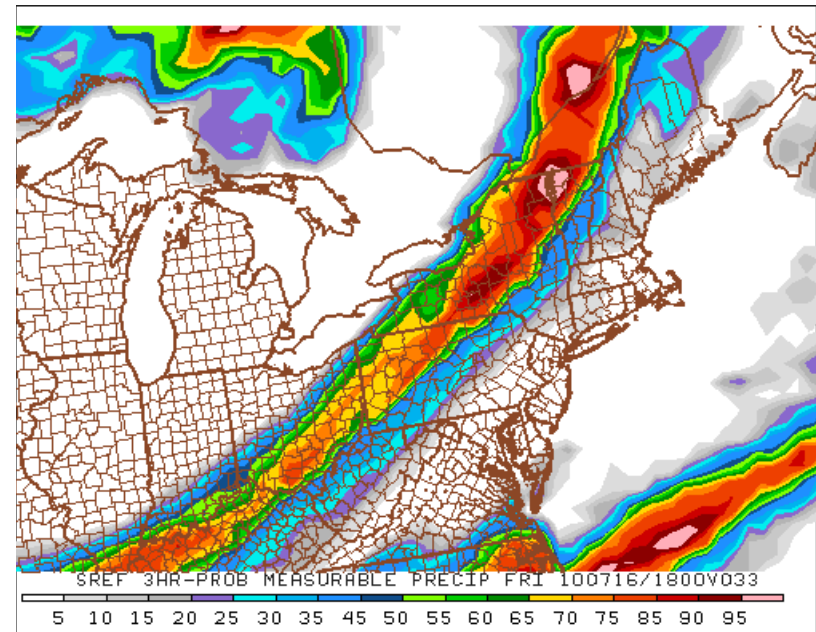


Back trajectory model (NOAA ARL HYSPLIT, left) is used to predict source region of incoming air. Current observations (EPA AirNowTech, right) are used to determine air mass characteristics.

Example: July 16, 2010 Clouds and Convection



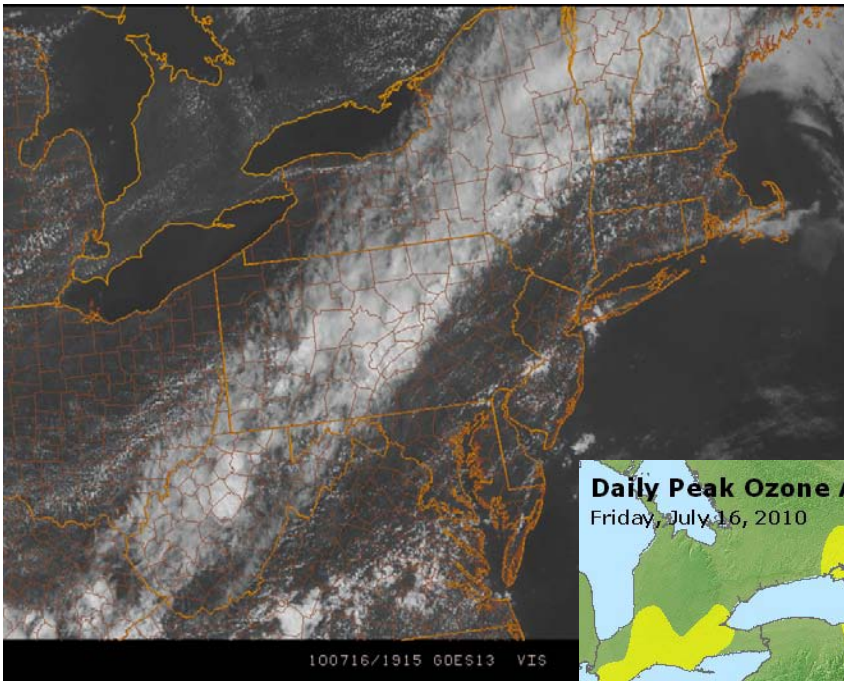
Short range weather model ensemble
(SREF) probability of clear skies at 1800
UTC on July 16.



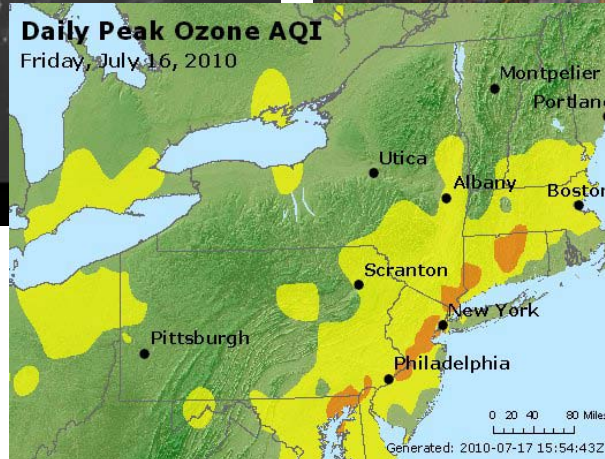
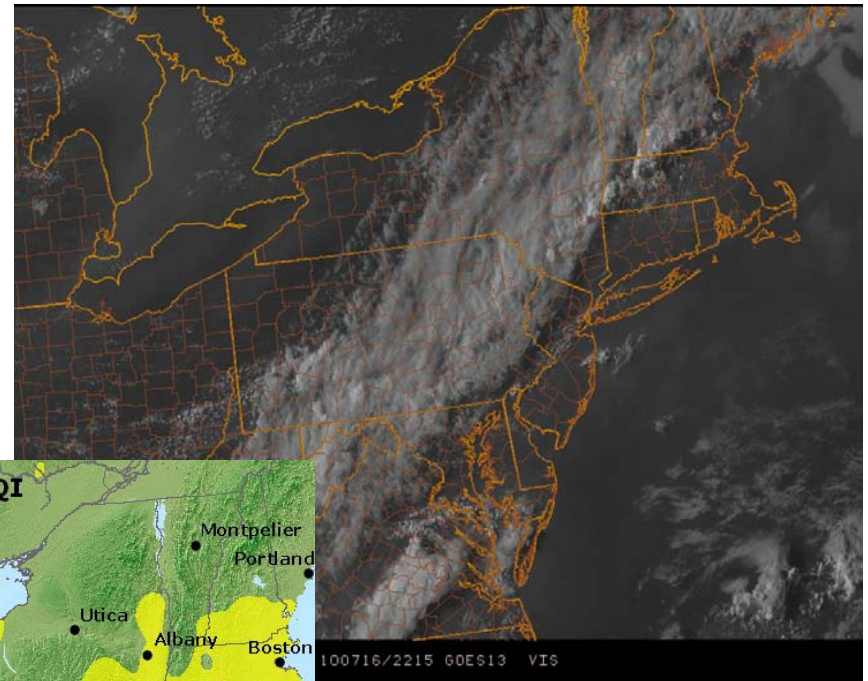
Short range ensemble model forecast
of probability of precipitation at 1800
UTC on July 16.

Example: July 16, 2010 Observed Cloud Cover

GOES Visible, 1915 UTC



GOES Visible, 2215 UTC



Transport Can Be Large Scale: Quebec Wildfires, 2002

July 6, 2002

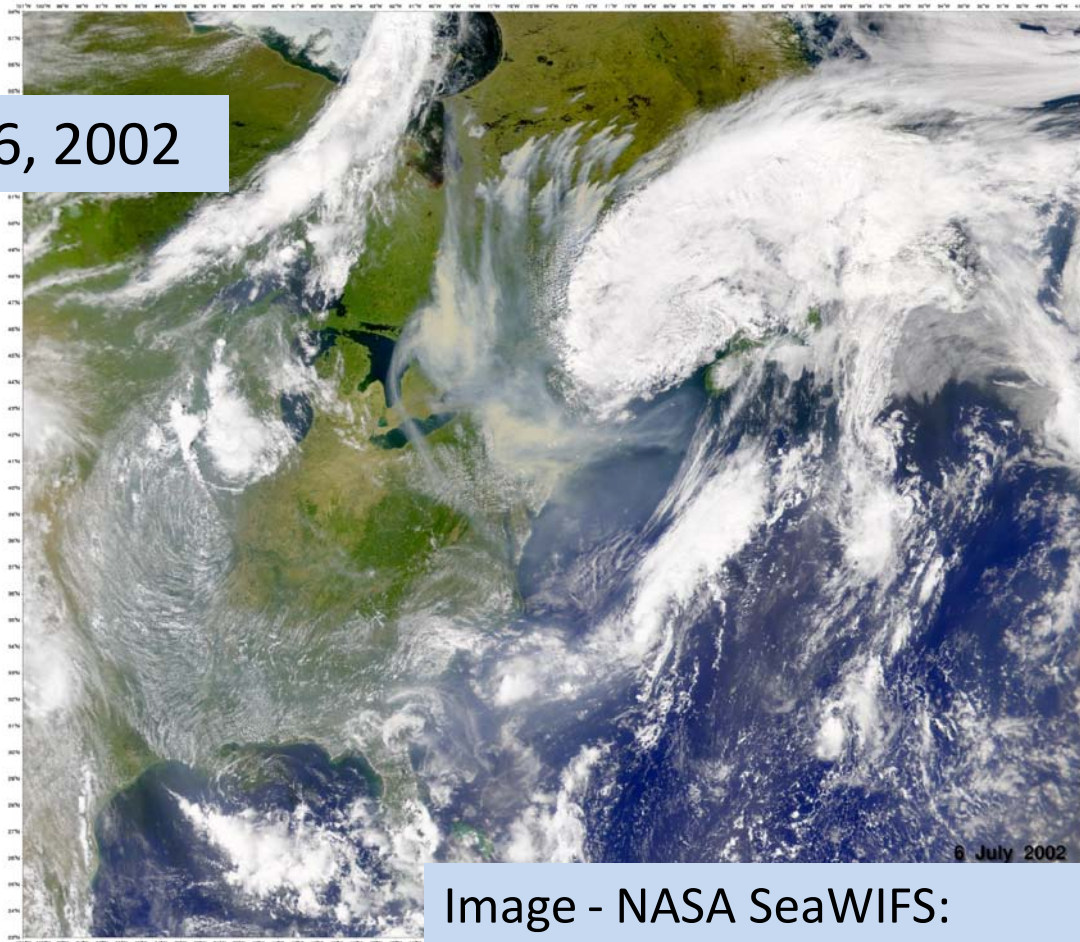
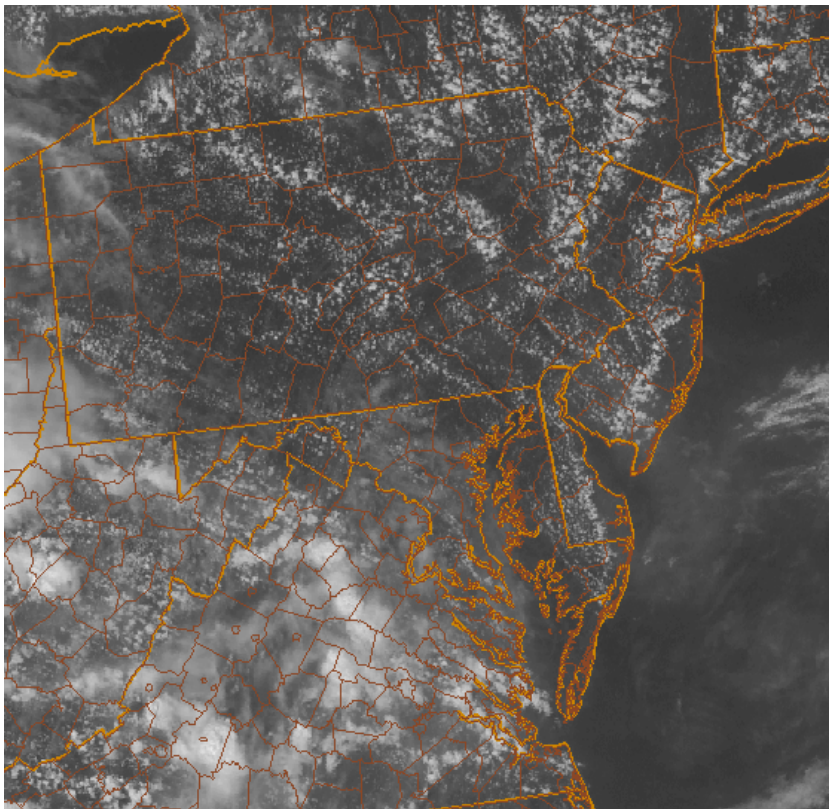


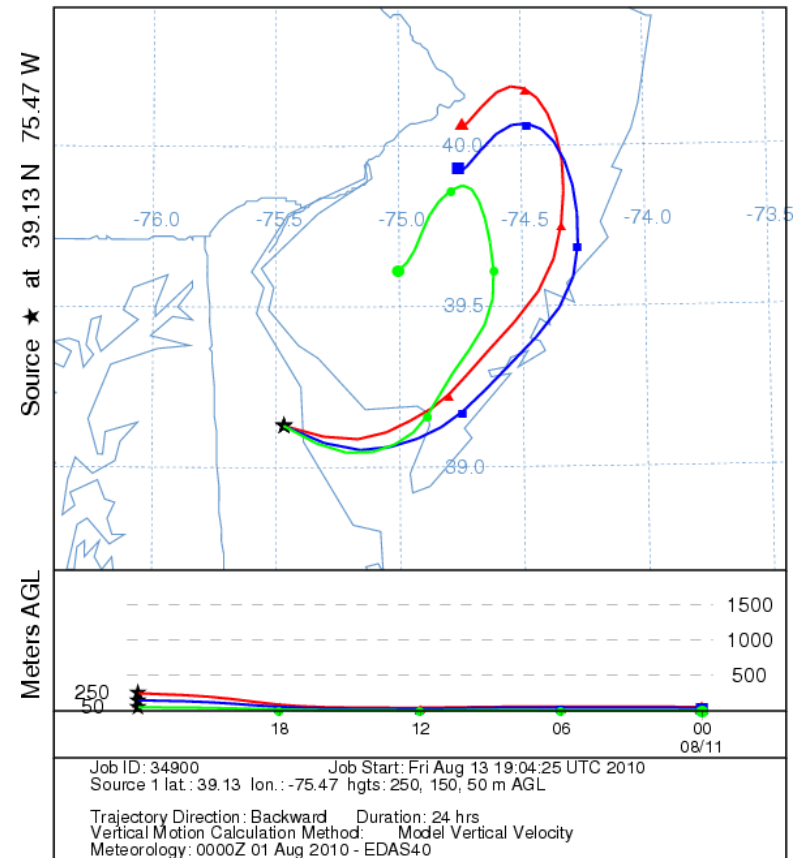
Image - NASA SeaWiFS:
<http://seawifs.gsfc.nasa.gov/SEAWIFS.html>

Transport Can Be Very Small Scale

August 11, 2010

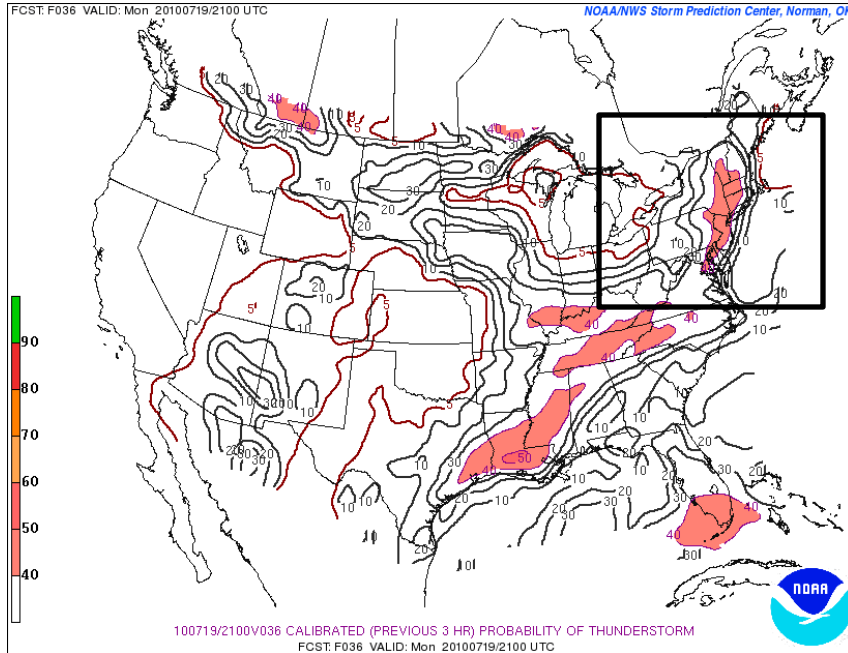


NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 12 Aug 10
EDAS Meteorological Data

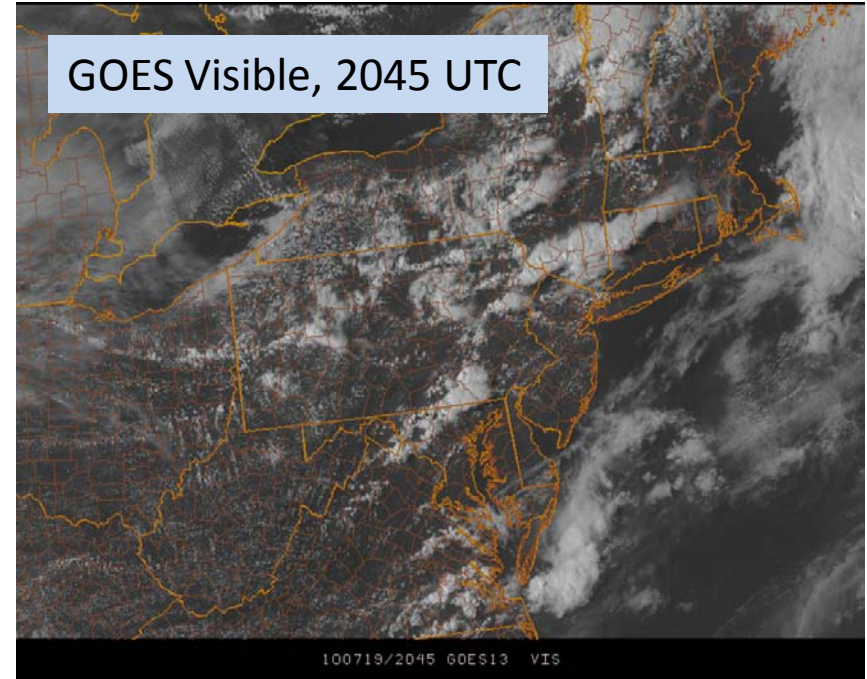


Thunderstorms Can Quickly Alter Air Quality

July 19, 2010



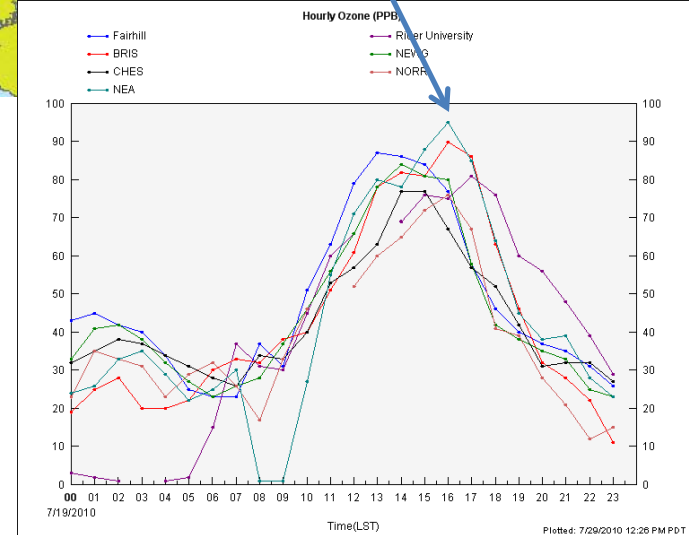
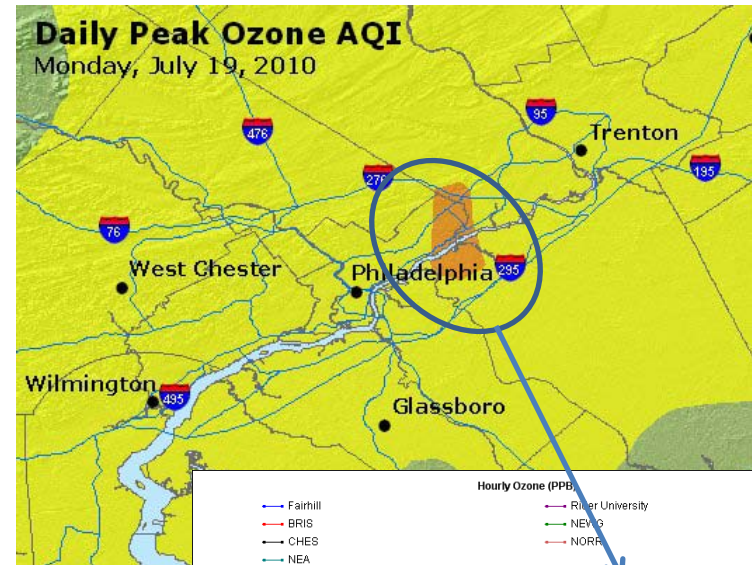
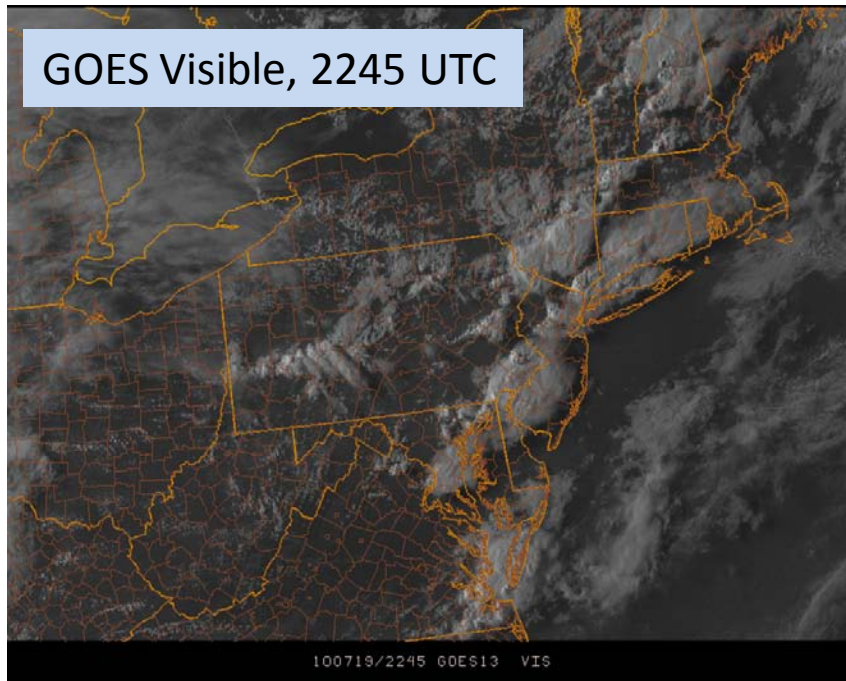
Thunderstorm probability forecast (SREF),
for 2100 UTC, July 19



Thunderstorms form at 2100 UTC but
just a bit further west and are slower to
reach Philadelphia

Thunderstorms Arrive an Hour Too Late

July 19, 2010



Summary

- Air quality forecasting is carried out on the state/local level with support from NWS and EPA.
- The utility of forecast tools are constrained by forecast deadlines (early afternoon).
- Variations in daily air quality depend primarily on local weather conditions as well as regional and local transport of pollutants and precursors.