Where Does Our Air Pollution Come From and What Do We Need To Do To Fix It?

A Simplified Conceptual Description

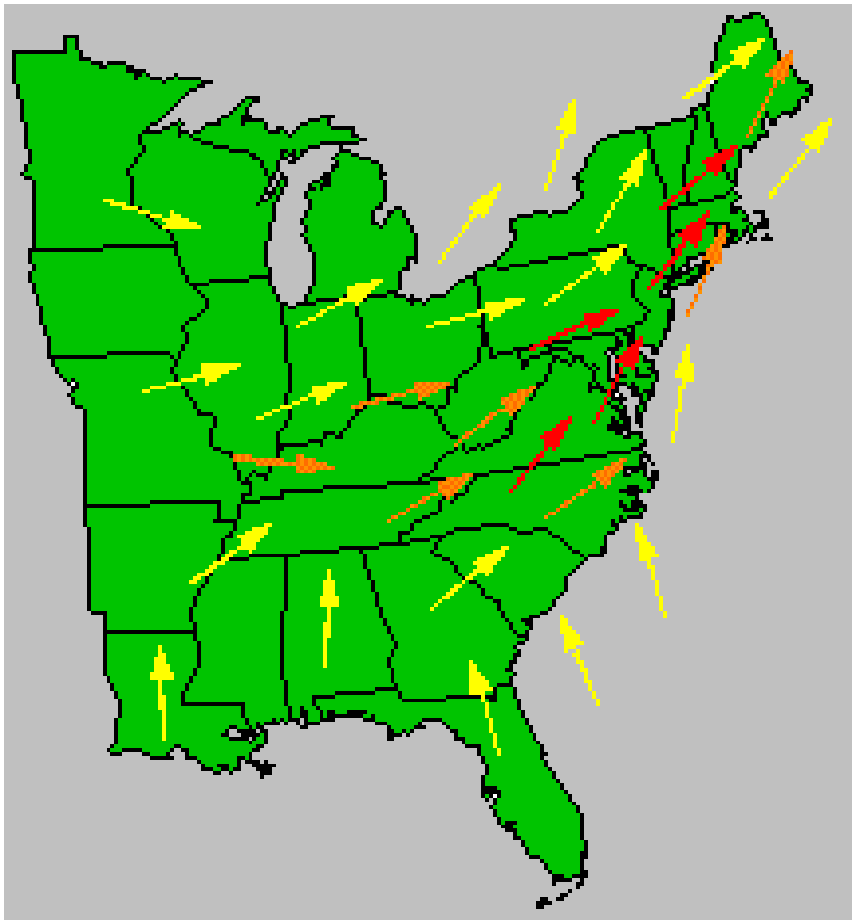
OZONE TRANSPORT COMMISSION

OTC Annual Meeting

June 7, 2005

Topics Covered

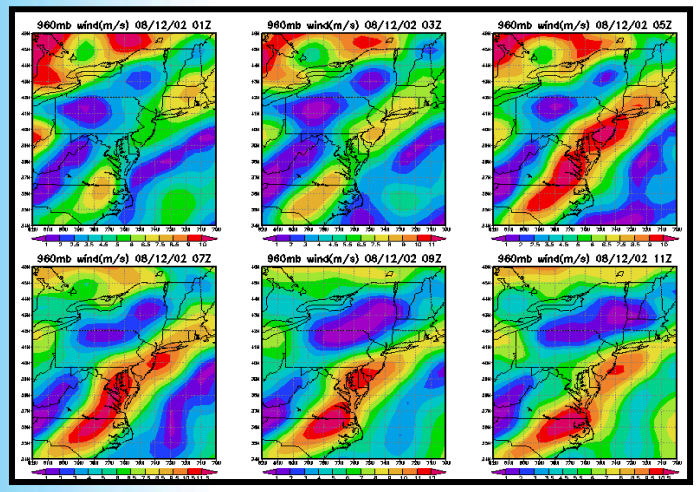
- Primer on transport
- How do OTC strategies address the different components of our air pollution problem
  - Local strategies
  - Regional power plant controls
  - Level-the-playing field initiatives



The Conceptual Description

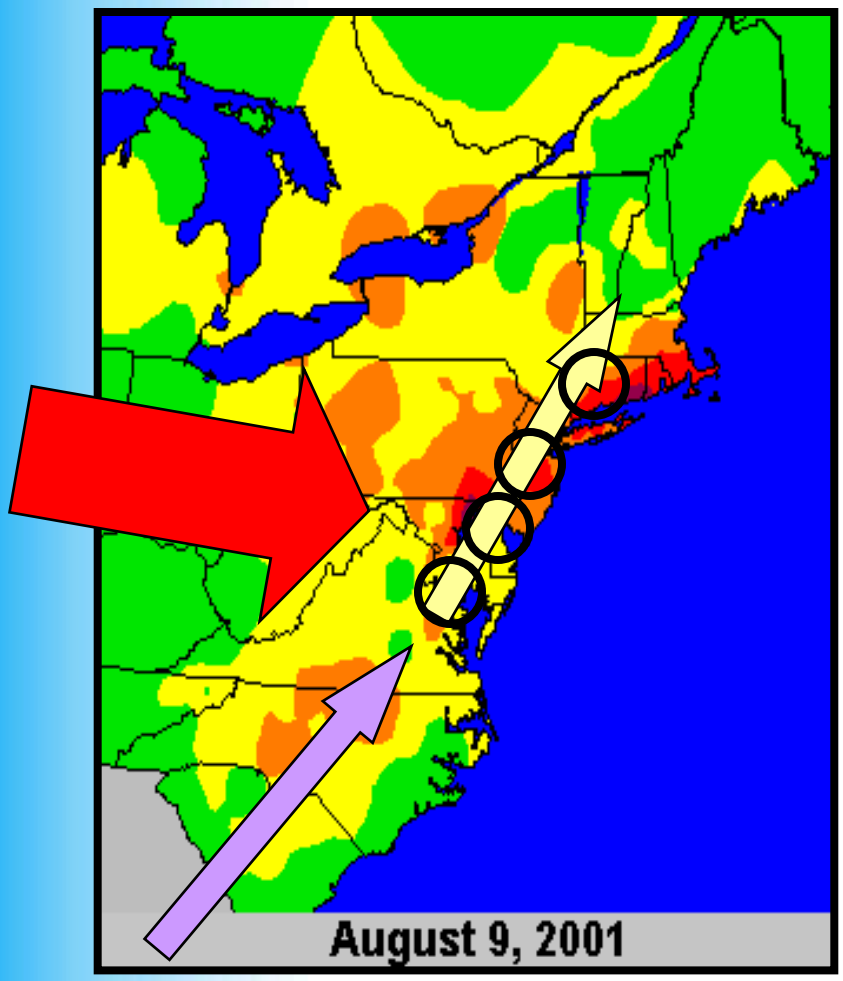
- Or … Where does our air pollution come from?
- Developed based upon 20 years of science
- Presented multiple times over the past year
- Much Thanks to:
  - UMD
  - NH, CT, ME, VA
  - NESCAUM
  - MARAMA
  - OTC

Blending Science and Policy



- Air pollution is complicated!!!
- This presentation boils down years of technical work and hundreds of technical papers into simple conclusions about the most important things that need to be done to clean up the the air in the OTR.
- Many details and nuances are left out
- There is however, considerable support from the scientific community that the conclusions reached in this presentation are

Where Does Our Air Pollution Come From?

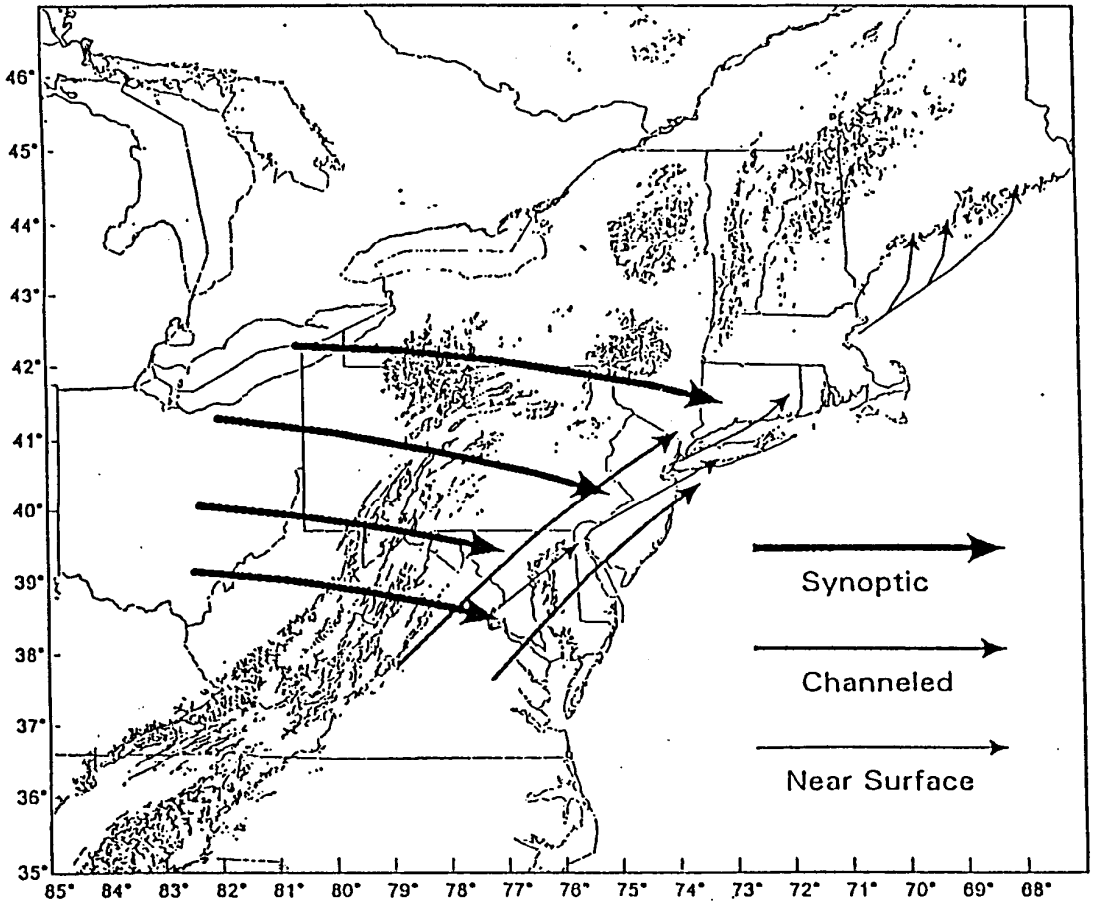


Four Distinct Parts

- Local emissions in Nonattainment Areas (NAAs)
- Three types of transport
  - Short range
    - "Ground level" transport
    - VA to MD to PA to NJ to NY to MA to NH.
  - Long range (synoptic scale)
    - "Aloft" transport
    - 100s of miles
    - Generally from W or NW
  - Low Level Night-Time Jets
    - "Aloft" transport at night
    - 100s of miles
    - SW to NE along the Atlantic

Different Types of Transport

Not Really a New Concept

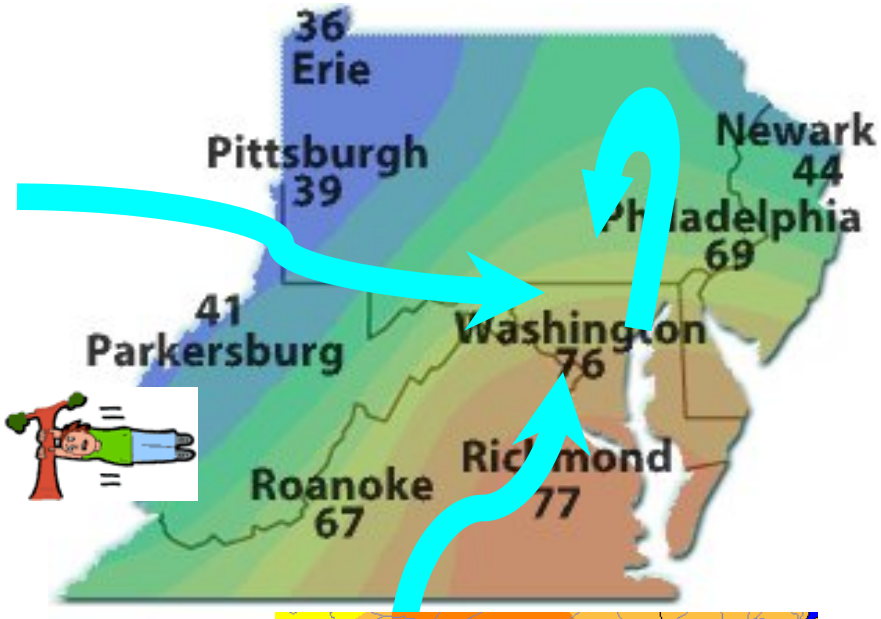


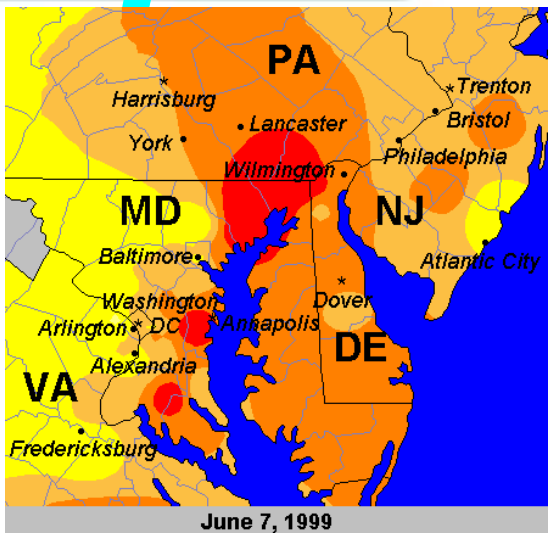
Transport Regimes Observed During NARSTO-Northeast

1998

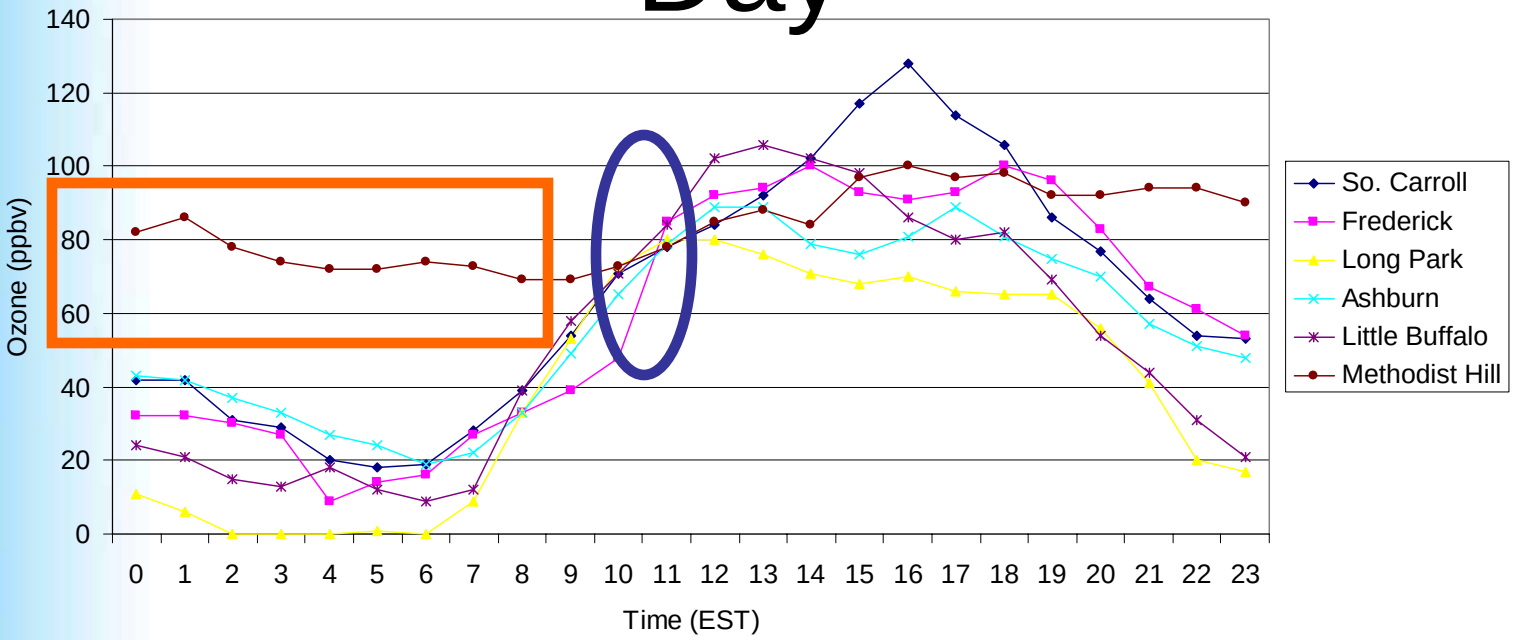
How Much Is Transport?

- Changes from day to day as the weather changes
- However … On our worst days we use airplanes to routinely measure ozone at 80 to 110 parts per billion (ppb) floating into the OTR from the West and South
  - Standard is 85 ppb
- Best guess … something like
  - 30 to 40 percent long range (westerly) transport
  - 10 to 20 percent short range transport
  - 10 to 20 percent Low Level Jet (LLJ) transport
  - 10 to 20 percent local





The Phases of a Bad Ozone Day

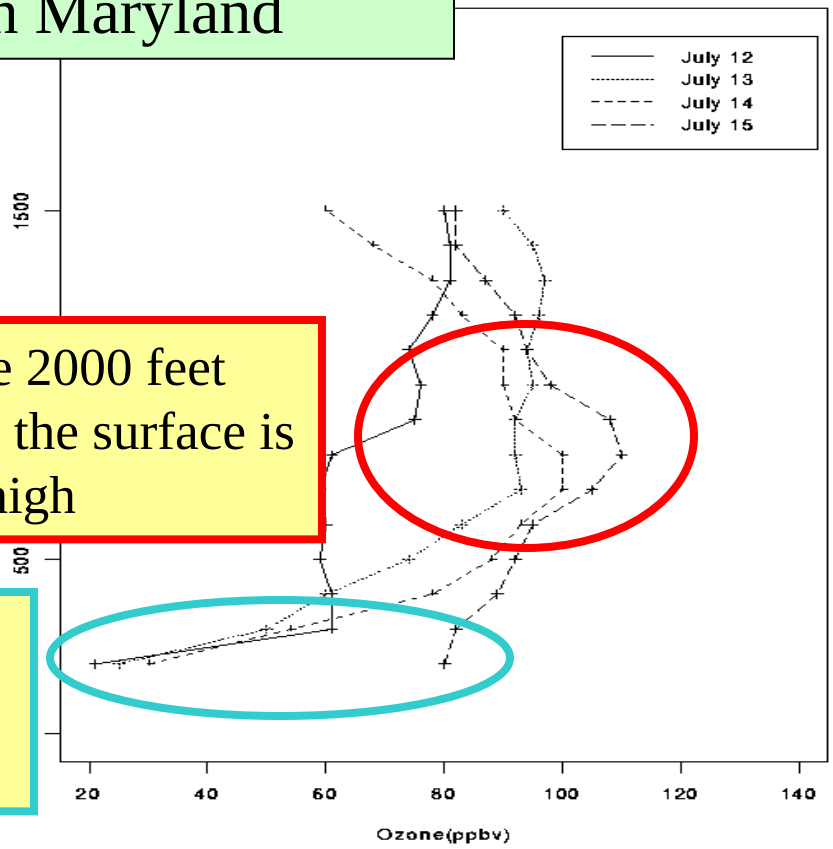


Three Stages of a Severe Regional Ozone Event

- **Up to around 10 - The "elevated reservoir"**
- **10 to 12 – Inversion breaks – the "regional" signal**
- **Afternoon – Local and regional pollution combine**

The Elevated Ozone Reservoir

Early Morning Ozone in Maryland



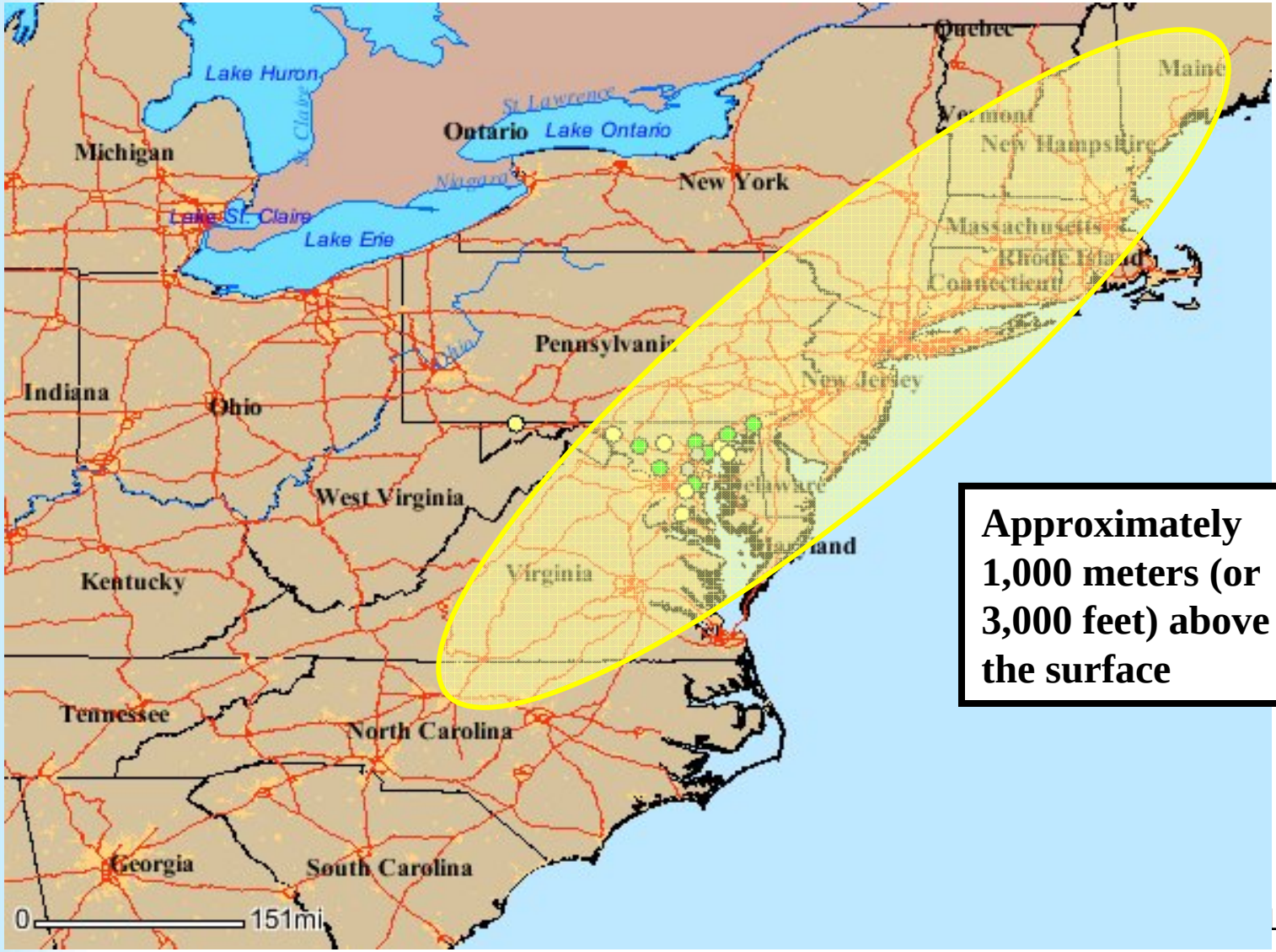
Ozone 2000 feet above the surface is very high

Surface ozone is very low

- On most bad ozone days, before any new ozone has been formed, a large reservoir of ozone and ozone precursors sits above the OTR waiting to mix down.
- Ozone levels in the reservoir can reach 80 to 100 ppb

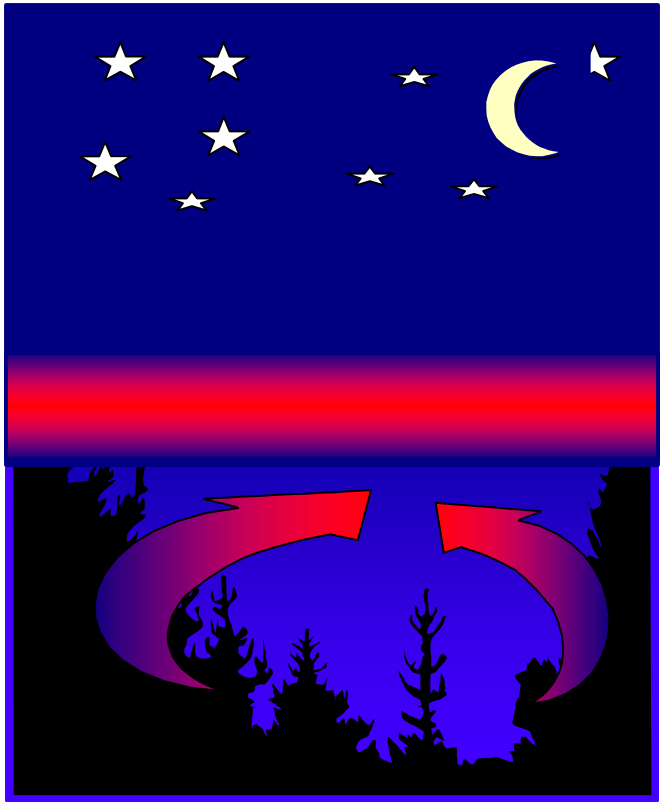
Maryland Data

How Big is the Reservoir?

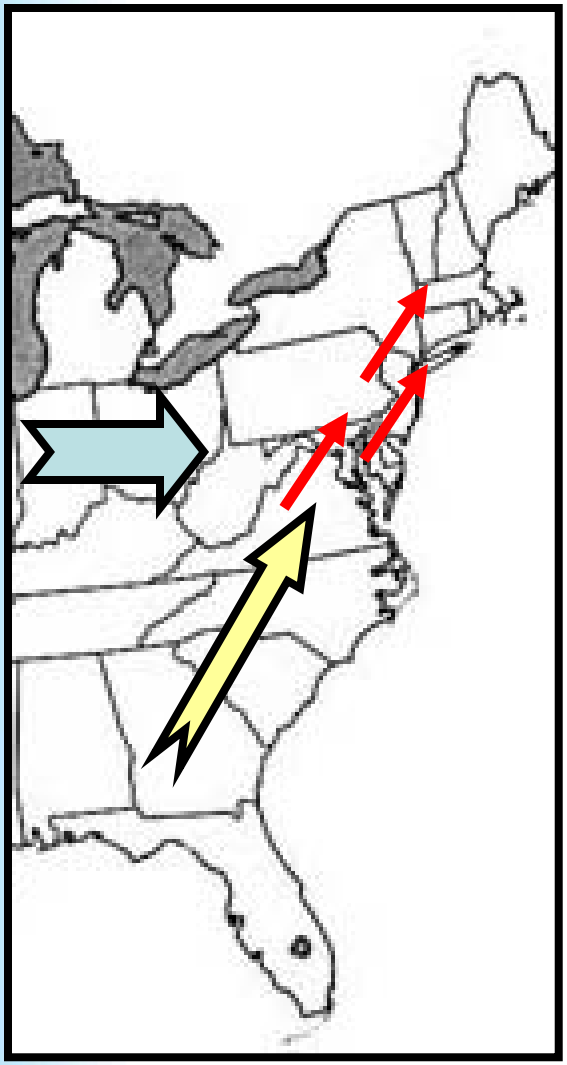


What Creates the Reservoir?

- At night the earth cools and a “nocturnal inversion” is created several hundred meters above the surface
- Ozone, created earlier in the day is trapped above the inversion and moved to the north by night-time jets.
- Ozone below the inversion drops to very low levels.

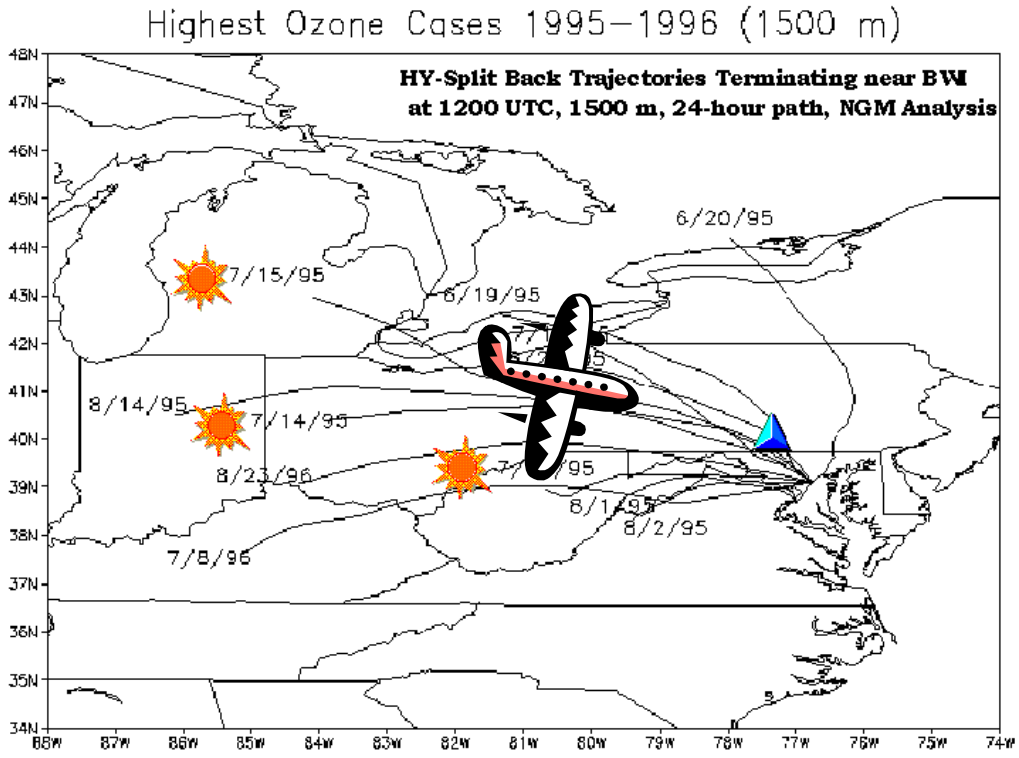


Filling the Reservoir



- What's over MD on Tuesday started off in Ohio and North Carolina on Monday.
  - MD's pollution soup floats to New Jersey and New York
  - New York's pollution floats to New England
- Power plants, cars, trucks and other sources are all contributors to the elevated pollutant reservoir.
- Filled with ozone and ozone precursors.

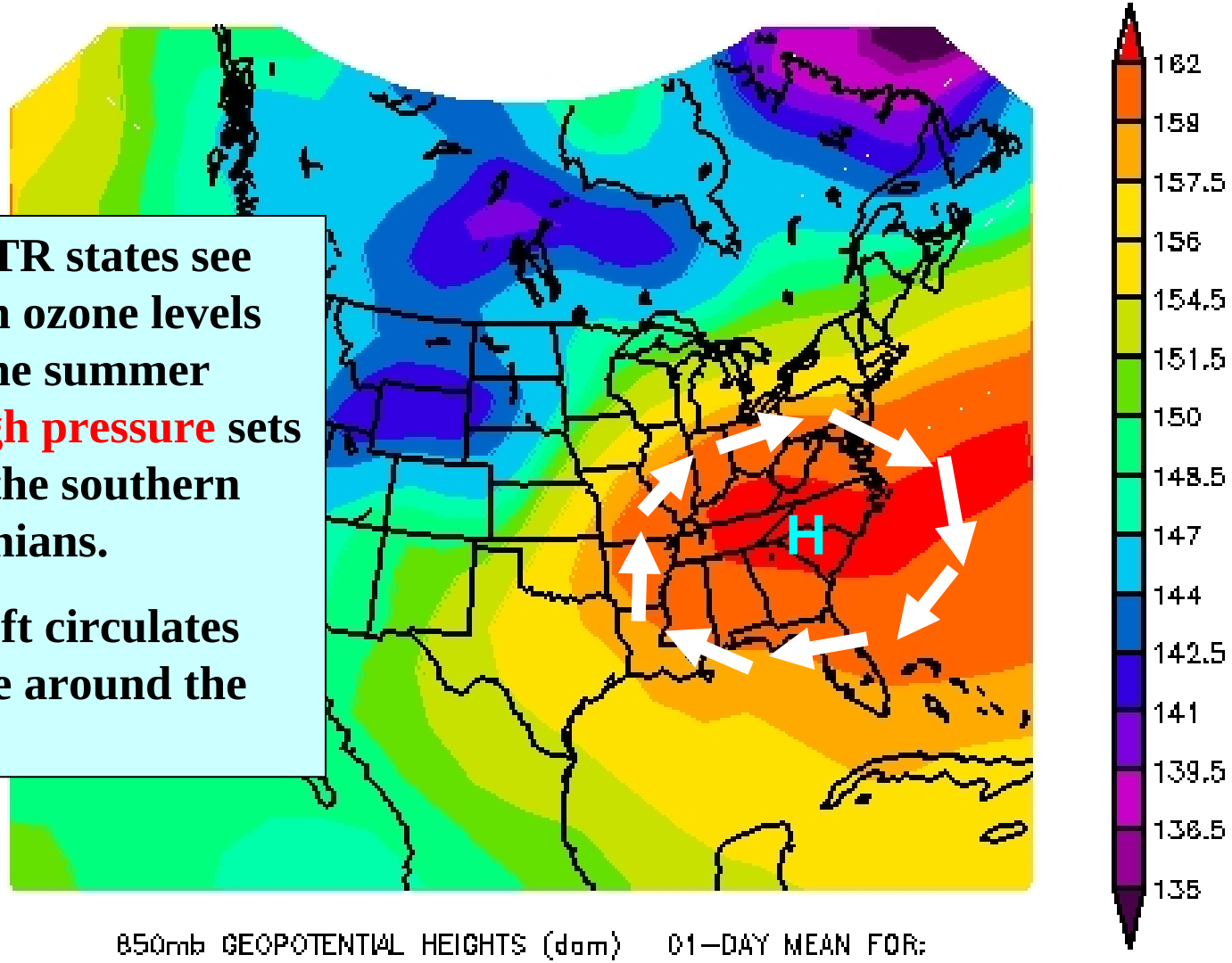
Westerly Transport



- On the worst ozone days “westerly transport” plays a significant role in creating high ozone.

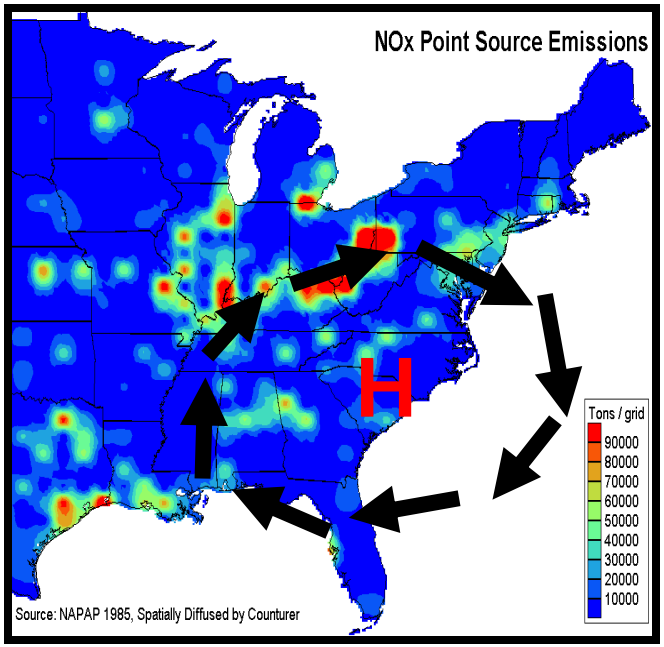
Classic Ozone Weather in the Mid-Atlantic

- **The OTR states see very high ozone levels during the summer when high pressure sets up over the southern Appalachians.**
- **Air aloft circulates clockwise around the High**

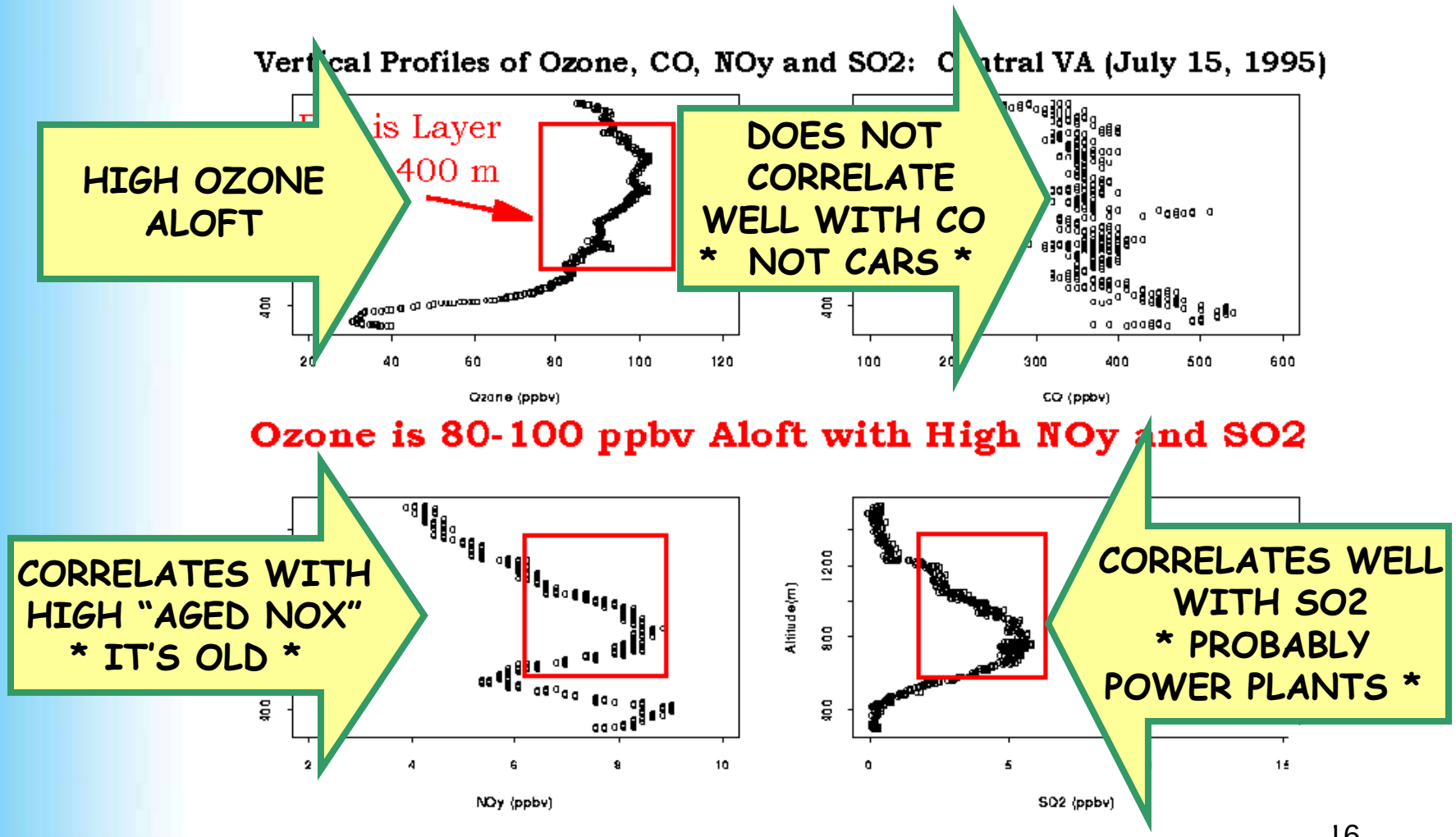


Power Plant Emissions

- Very large power plant emissions are concentrated along the Ohio River valley
- Again, air aloft circulates clockwise around the high



Westerly Transport – What Does the Data Tell us About Its Origin?

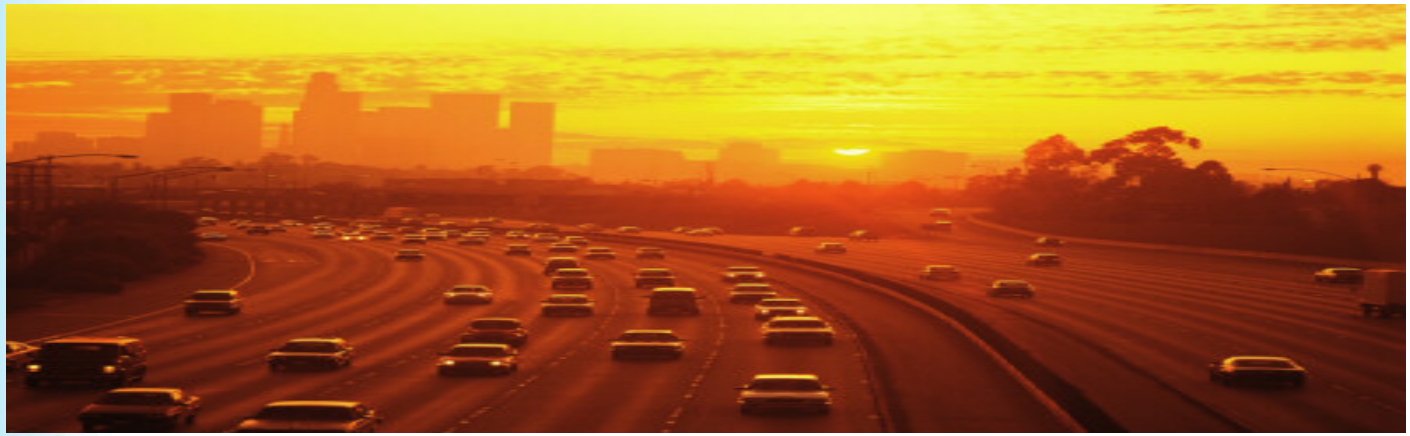


Low Level Jet

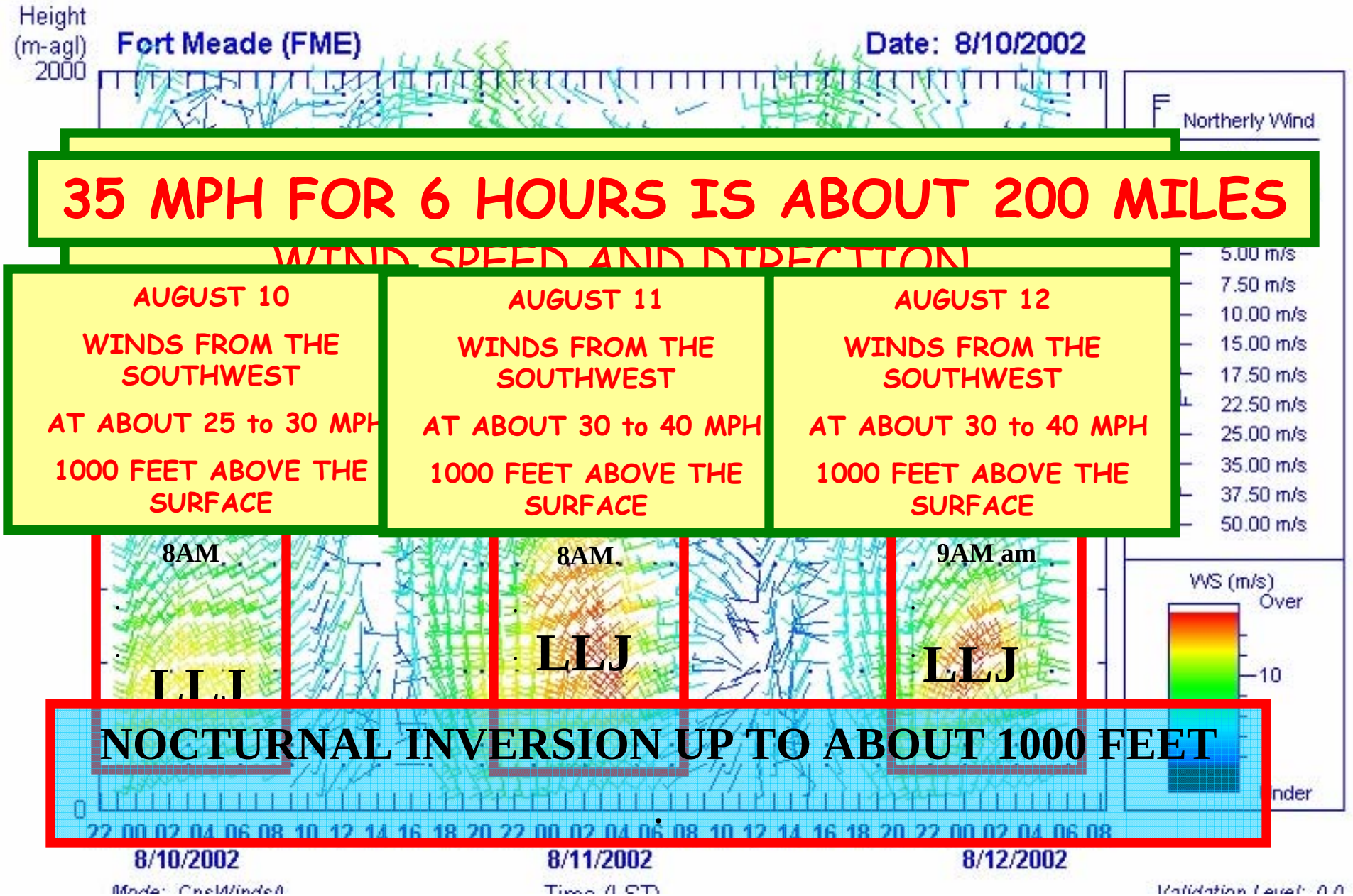
- Night time transport that moves air from NC to MD, MD to NJ, and northward
- The LLJ is funneled northward with the Appalachians on the west and the Atlantic on the east
- Wind speeds up to 40 miles per hour can move pollution hundreds of miles overnight
- Recent PSU/UMD findings
  - LLJ is routine not occasional
  - Almost always a 2 to 5 hr LLJ for MD Orange or Red days
  - Precursor transport – not just O3

How Much Ozone May be in the LLJ?

- Still analyzing this issue
- Theory and recent work by Penn State around Philadelphia (using laser technology called LIDAR) indicates that the low level jet can carry 80 to 90 ppb ozone.
- It's not just ozone but precursors too!

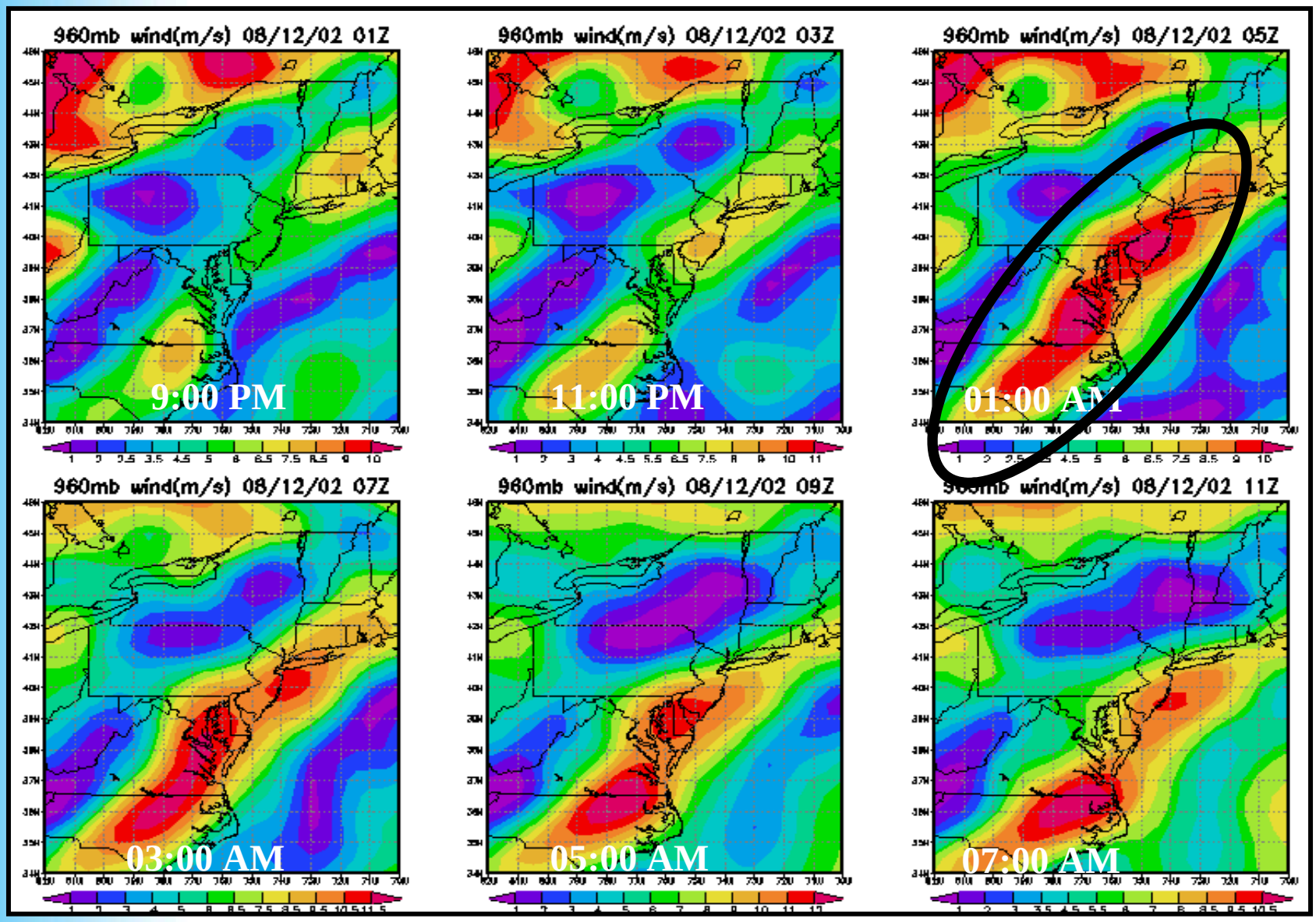


Low Level Jet Recorded Above Fort Meade Maryland



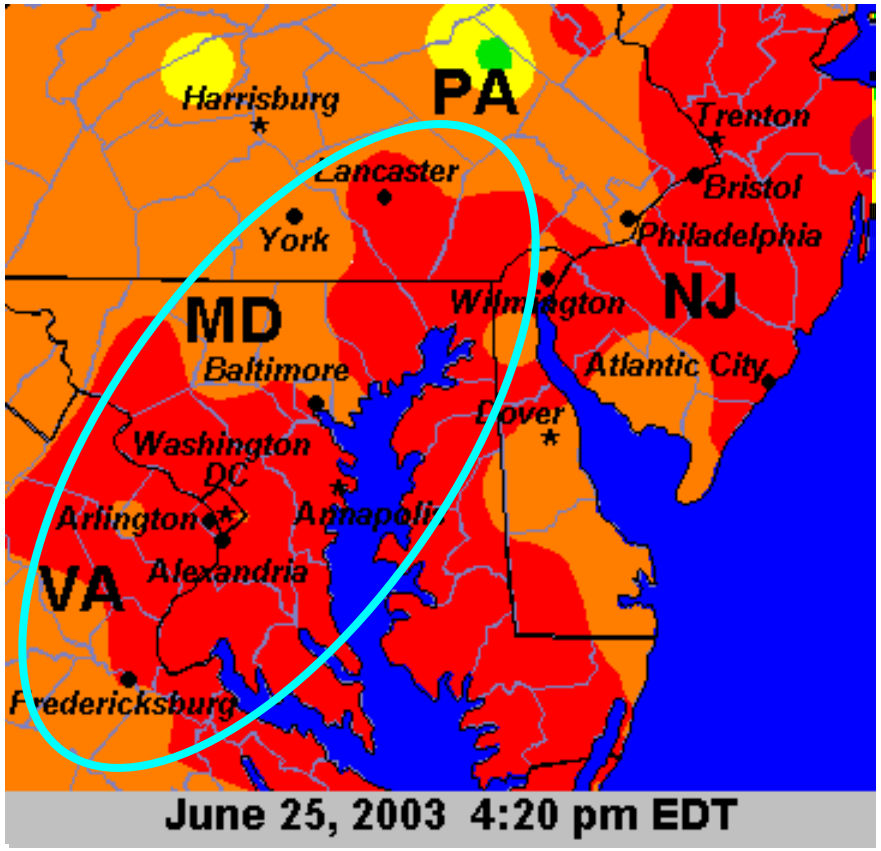
Meteorological Model Depiction of the LLJ

A Worst Case Scenario - High Wind Speeds In Red

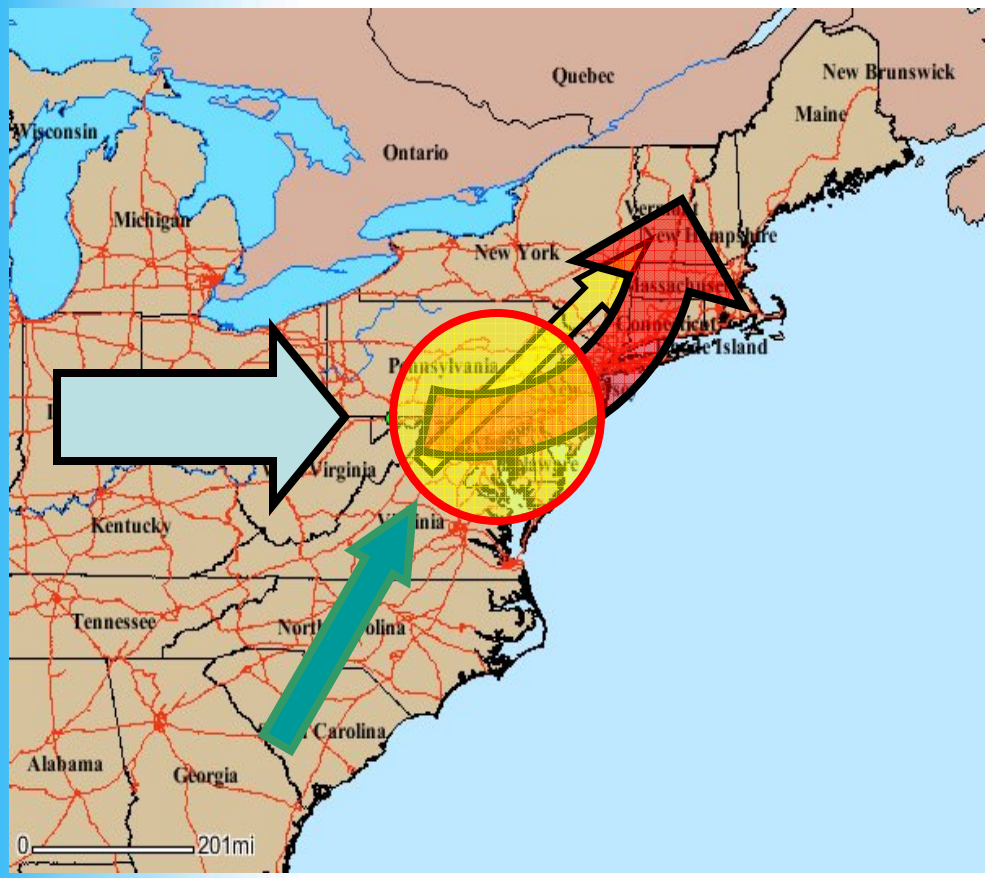


Short Range Transport

- Ground level (not aloft) transport
  - DC to Baltimore
  - Baltimore to Philly
  - Philly to NJ/NY, etc.
- Ground level winds can push pollution about 100 miles in a day
  - Ground level winds generally from southwest to the northeast
  - On some days, pollution can actually re-circulate back to the south from the north
  - Emissions from cars, area sources and stationary sources



The Transport “Crossroads”



- The Mid-Atlantic “Crossroads”
- Westerly, LLJ and local transport converge on the Mid-Atlantic area
- Jets, sea breezes, the lee-side trough and other coastal meteorology all turn pollution northward at the Mid-Atlantic crossroads

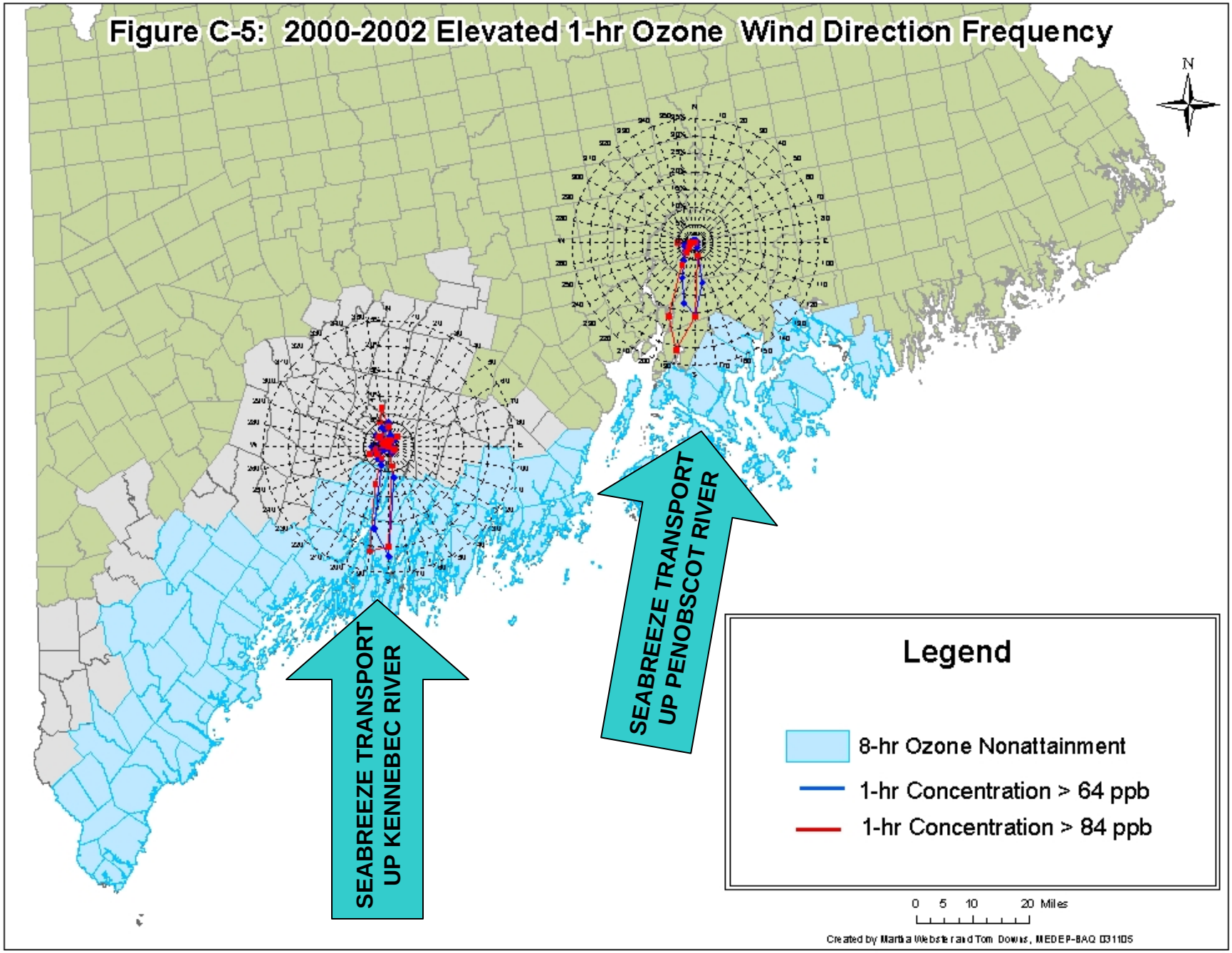
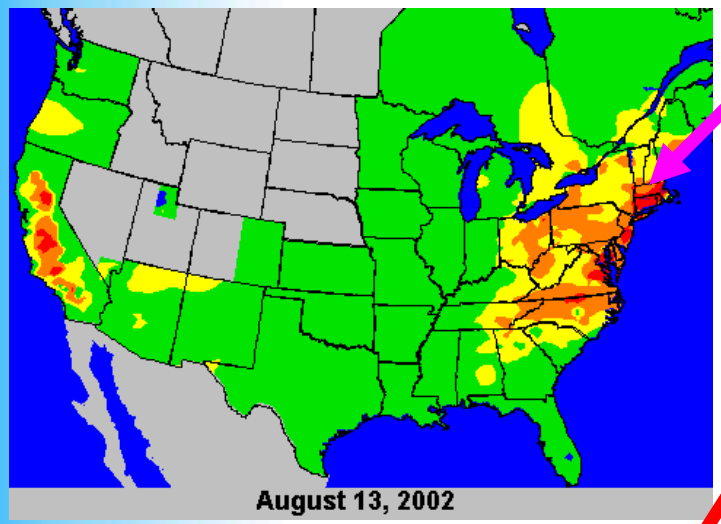


Figure C-5: 2000-2002 Elevated 1-hr Ozone Wind Direction Frequency
N
SEABREEZE TRANSPORT UP KENNEBEC RIVER
SEABREEZE TRANSPORT UP PENOBSCOT RIVER
Legend
8-hr Ozone Nonattainment
1-hr Concentration > 64 ppb
1-hr Concentration > 84 ppb
0 5 10 20 Miles
Created by Martha Webster and Tom Downs, MEDEP-BAQ 031105

A Worst Case Day in Connecticut

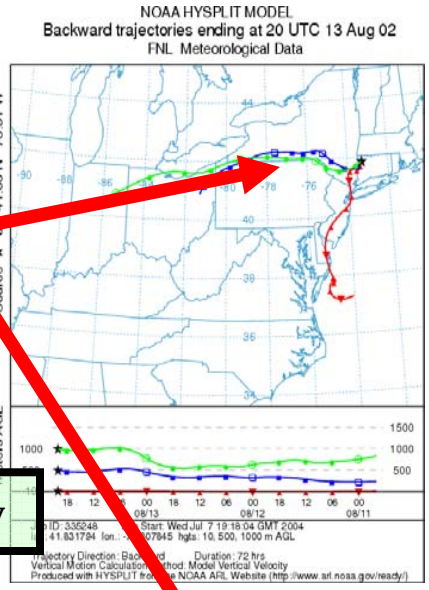


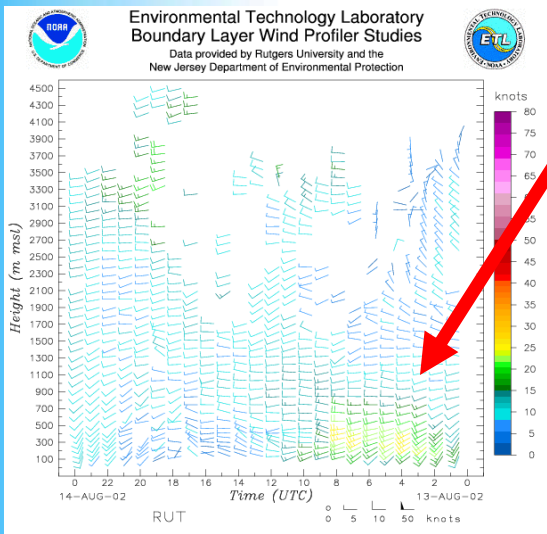
High Ozone

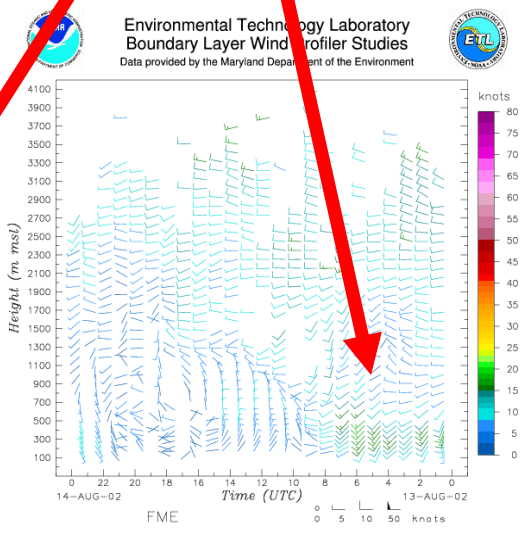
Westerly Transport

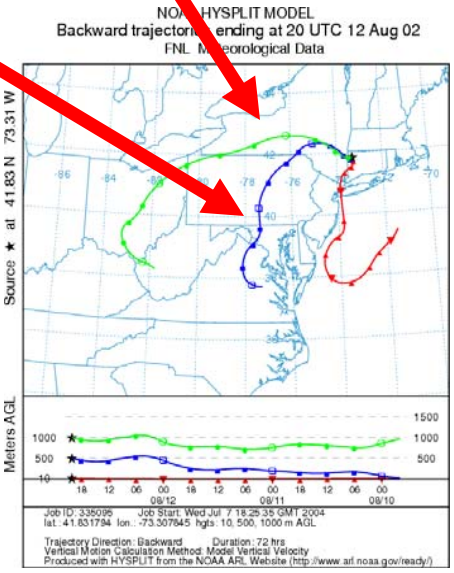
Low Level Jets

Coastal Meteorology









OTC Policies – Local Controls

- Still a significant need for more local - “inside the OTR” controls
  - Helps with Nonattainment Area control needs within the region
  - Helps reduce short range transport and LLJ transport within the OTR
- Additional OTC regional control efforts under review
  - Mobile source “corridor” strategy
  - Stationary source technology review/update
  - Area source initiatives
  - More in Committee reports
- Individual state initiatives
  - Multi-pollutant rules and legislation
  - Innovative state efforts
  - Voluntary measures

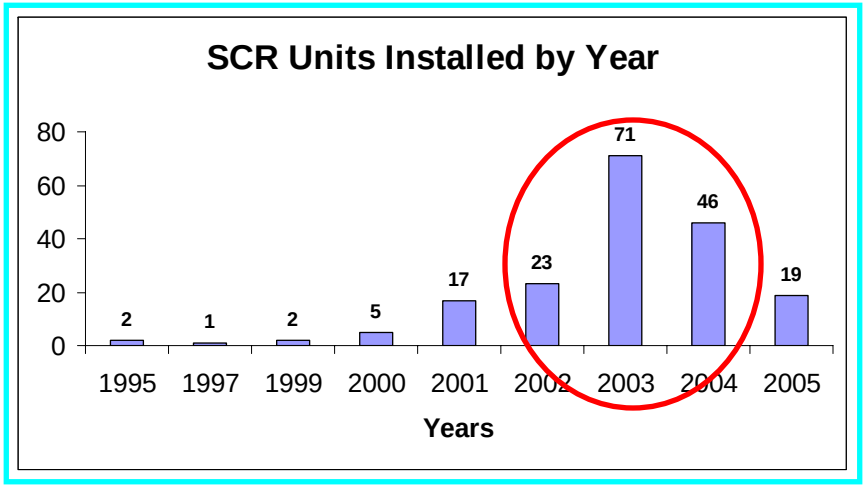
OTC Policies - Transport

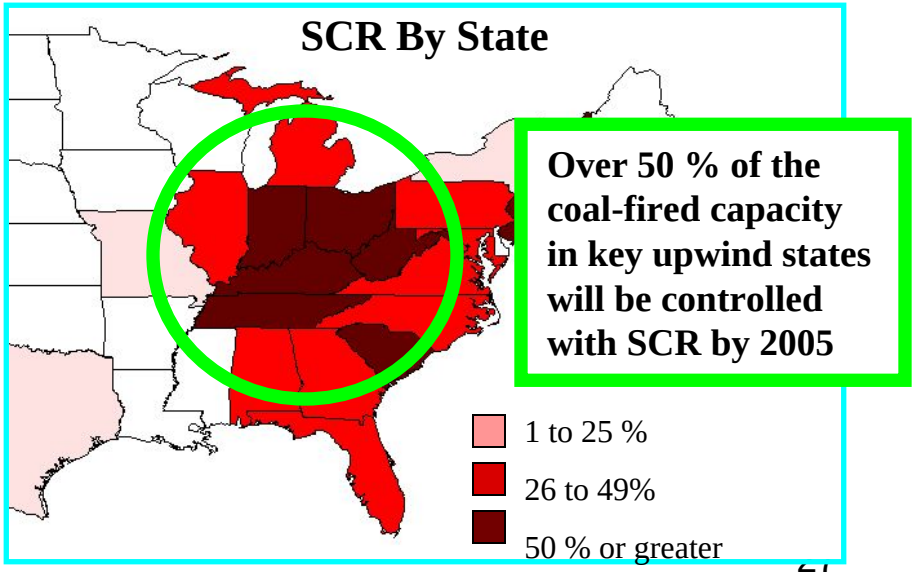
How do they address the different types of transport?

- Short Range Transport
  - Addressed by historical “inside the OTR” strategy and regional model rule development work
- Long Range Westerly Transport
  - Addressed by OTC NOx Budget, Program, the SIP Call and the OTC Multipollutant Position
- Low Level Night-Time Jet Transport
  - Just beginning to address this issue
    - Part of CAAAC effort pushing for more “regional” control programs through national

Beginning to Address Transport

- The NOx SIP Call is working
- Significant NOx reductions from regional power plants between 2002 and 2005
- Billions of dollars being invested in “Selective Catalytic Reduction” (SCR) technology to reduce power plant NOx emissions
- New tougher ozone and fine particle standards
  - More reductions needed





Next Steps

- Develop technical report on the conceptual model as part of OTC modeling effort
- Model “reality” check
- Use simplified conceptual description to guide strategy development
  - All source categories now under consideration
- Blend in fine particle and haze work now underway in states and MANEVU