Coastal Boundary Layer Influence on Pollutant Transport in New England

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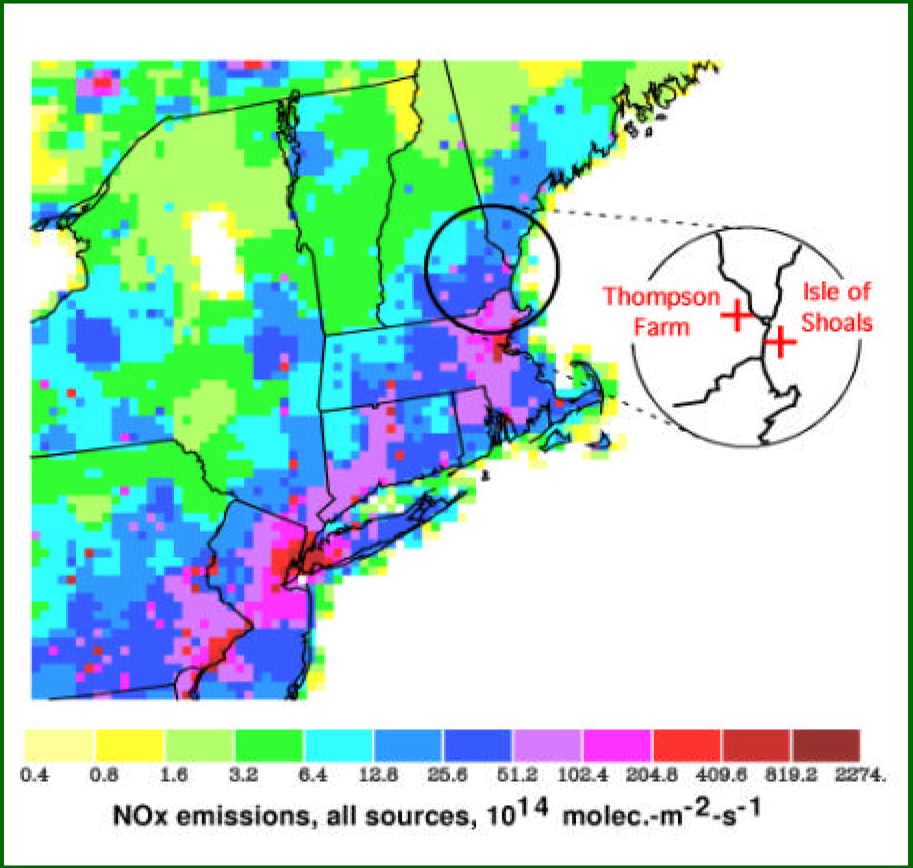
Coastal Boundary Layer Influence on Pollutant Transport

- Where does pollution in northern New England come from?
- Strongest pollution episodes involve overwater transport
- Information from profilers, surface sites, *Ronald H. Brown,* COAMPS



Model description – COAMPS

- Four domains at 67.5, 22.5, 7.5, 2.5 km grid spacing, one-way nesting
- 40 vertical levels, 13 below 1 km, lowest levels 1 and 5 m
- Tracer released at lowest 3 levels in Boston, no deposition
- Model results compared with measurements to ensure consistency

How is overwater transport different?

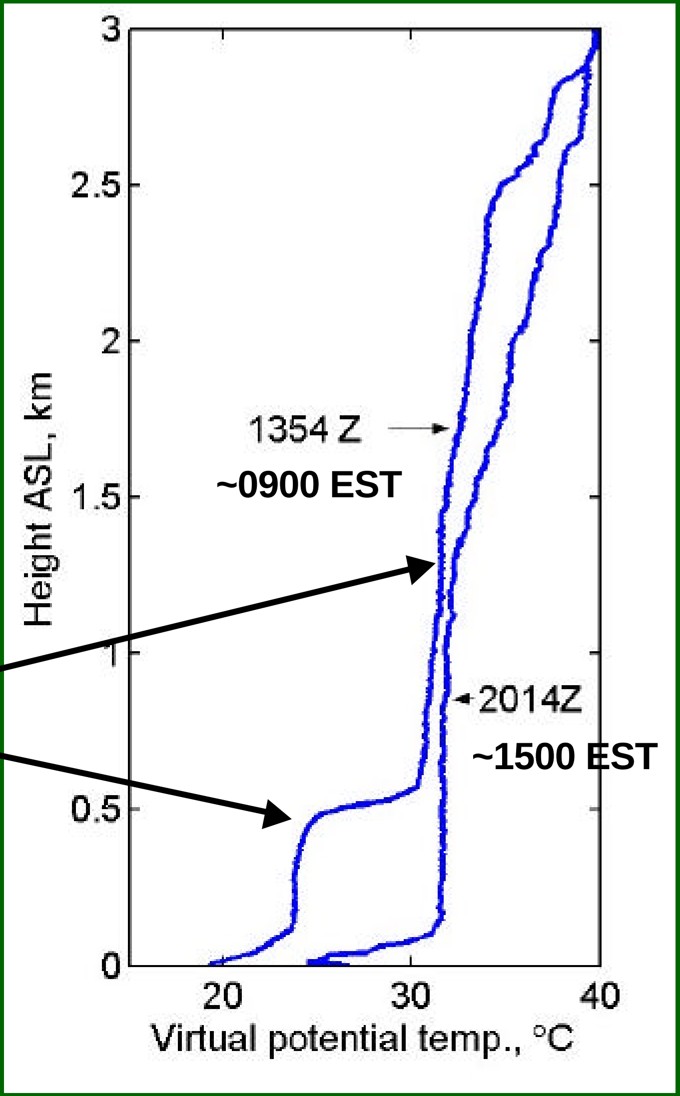
- Vertical mixing is reduced (but not eliminated)
  - Dilution is reduced
  - Differential advection increases (plume shearing)
- Deposition of ozone and most precursors is reduced
  - No leaf surfaces
- Local emissions are reduced
  - No fresh input for reactions
- Wind speeds increase
- Pollutants can be transported long distances without major losses

Two episodes

- 22-23 July
  - Large-scale transport dominant
  - Affects inland Maine on 22nd and downeast on 23rd
- 11-14 August
  - Sea breeze a factor
  - Affects New Hampshire and Maine
- All episodes had (non-stagnant) SW flow near and offshore

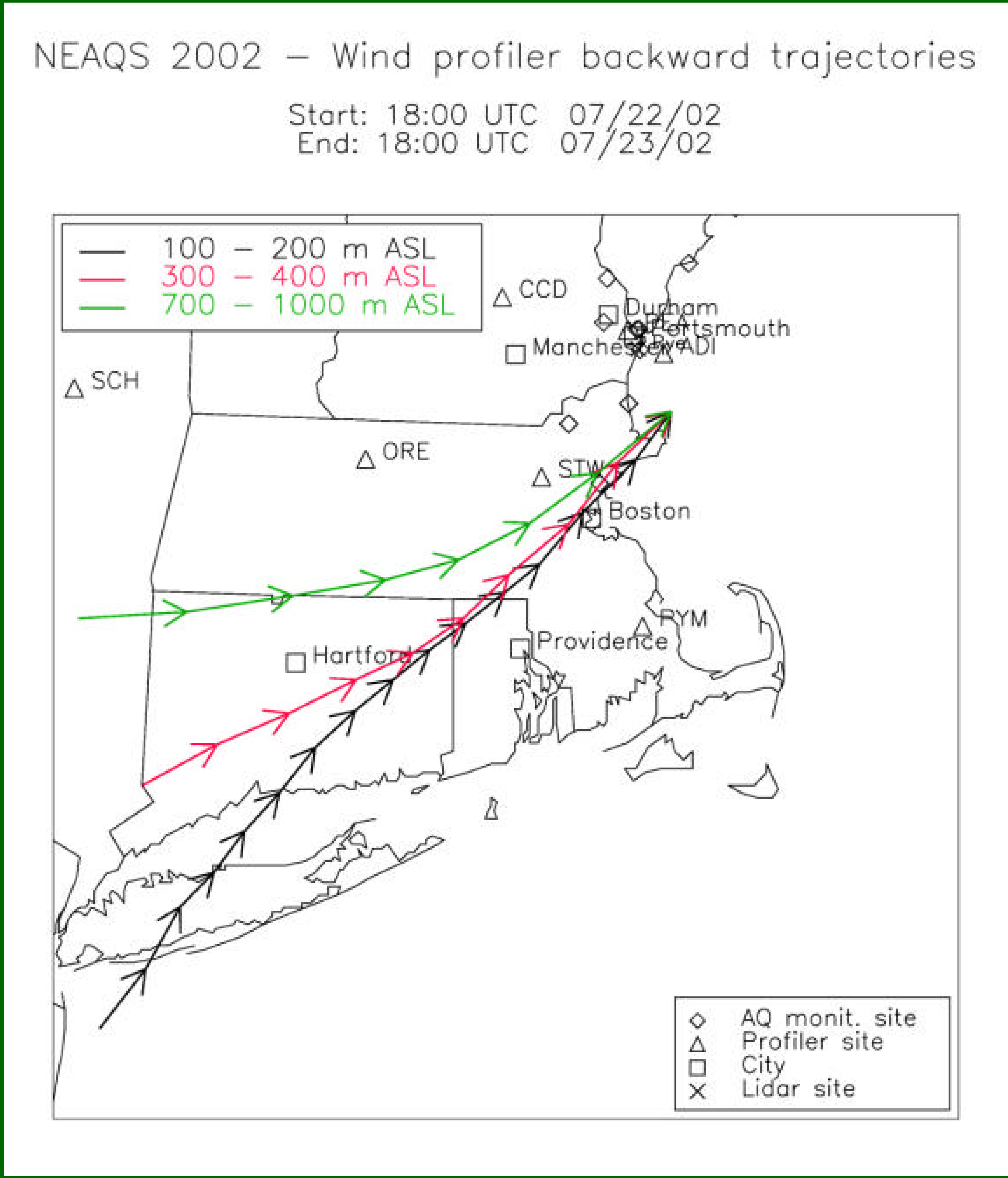
22 July soundings from RHB

- Temps over land warmer than over water throughout episode
- Statically stable layer over water, must be turbulent to show cooling
- Shear-driven or advected turbulence?
- Note depth of mixed layer from land



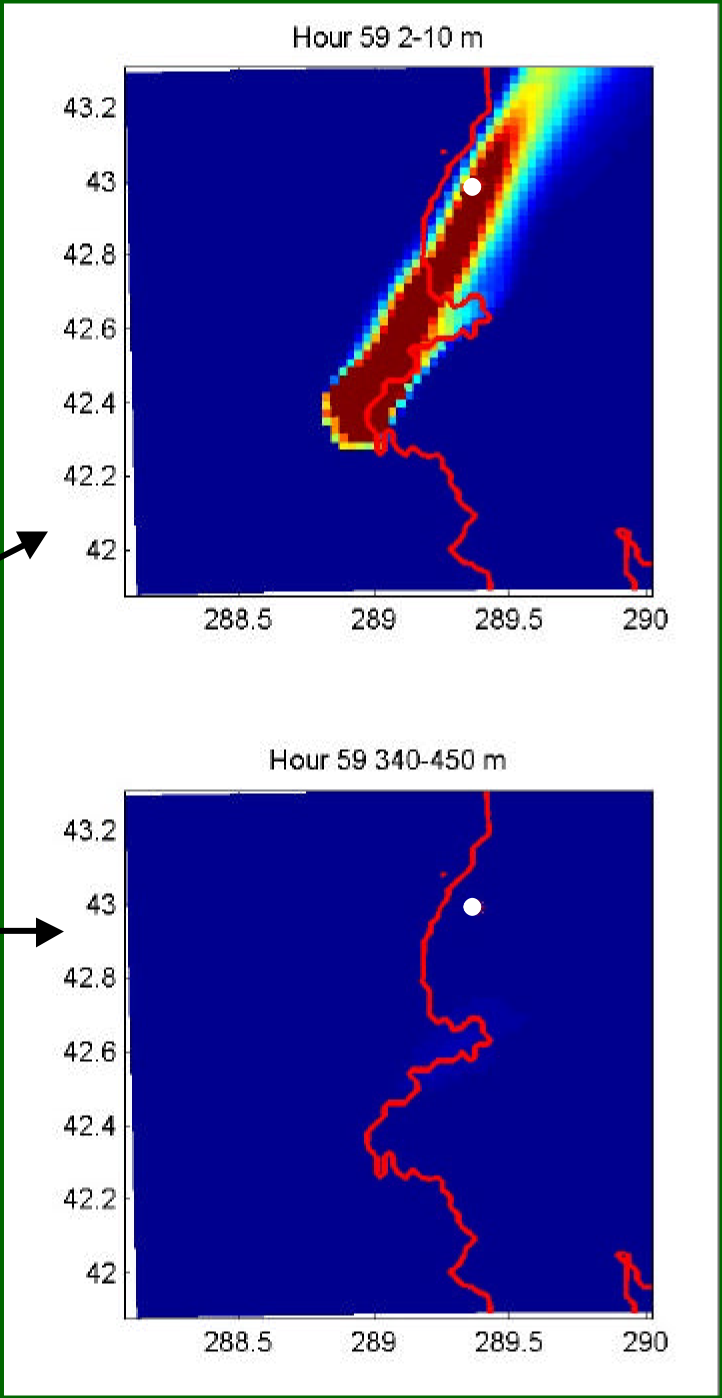
23 July
profiler trajectories

- Approx. 2 hour transport time from Boston to ship position off Cape Ann
- New York City ~24 hours upwind



23 July modeled plume

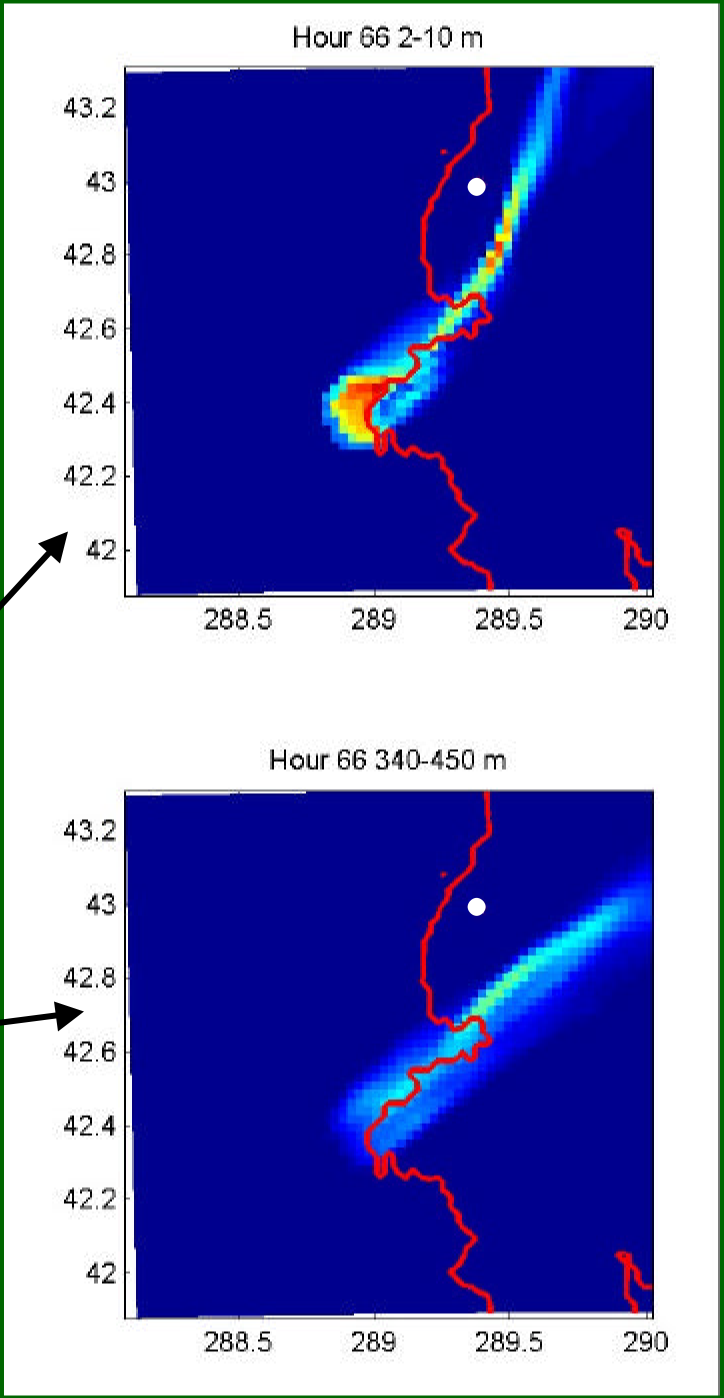
- Modeled Boston tracer concentration
- Early morning, 1100 UTC = 0600 EST
- Top view
- Near-surface and mid-level



23 July modeled plume

- Modeled Boston tracer concentration
- Midday,

  1800 UTC = 1300 EST
- Near-surface concentrations lower than at night because plume is deeper
- Upper level concentration is closer to that in lower level
- Plume location changes with height

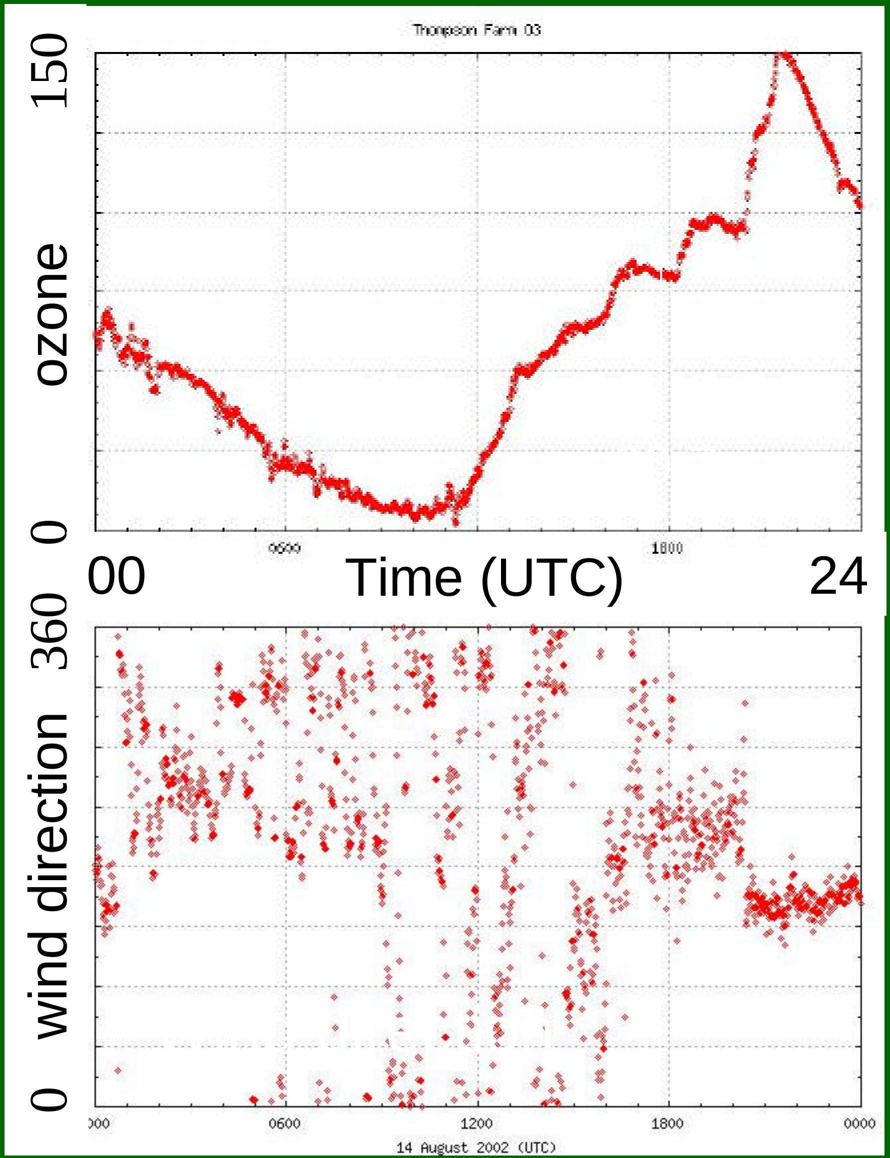


11-14 August

- Strongest episode of 2002
- Prolonged (really 10-19 August)
- Thompson Farm peak O_3 comparable to Isles of Shoals
- Winds light but still net >2 m/s above 100 m AGL
- Sea breeze carried strongest O_3 inland
- Operational models did not capture mesoscale processes
- Stronger ozone aloft at Acadia National Park

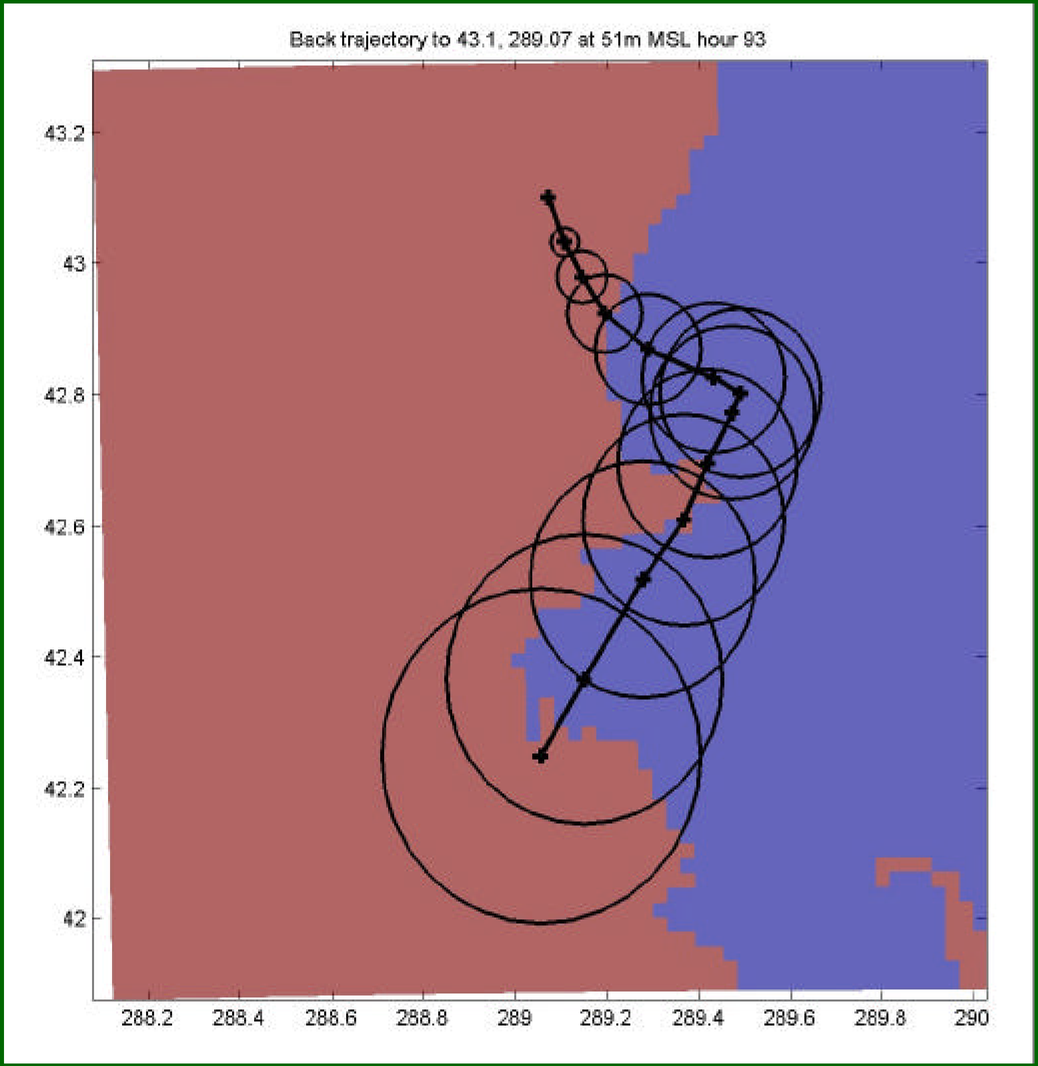
14 August ozone & wind at TF

- Clear signature of sea breeze carrying polluted air to Thompson Farm
- CO, NOy, particles show same pattern
- Also on 11th and 12th but not so clear on 13th



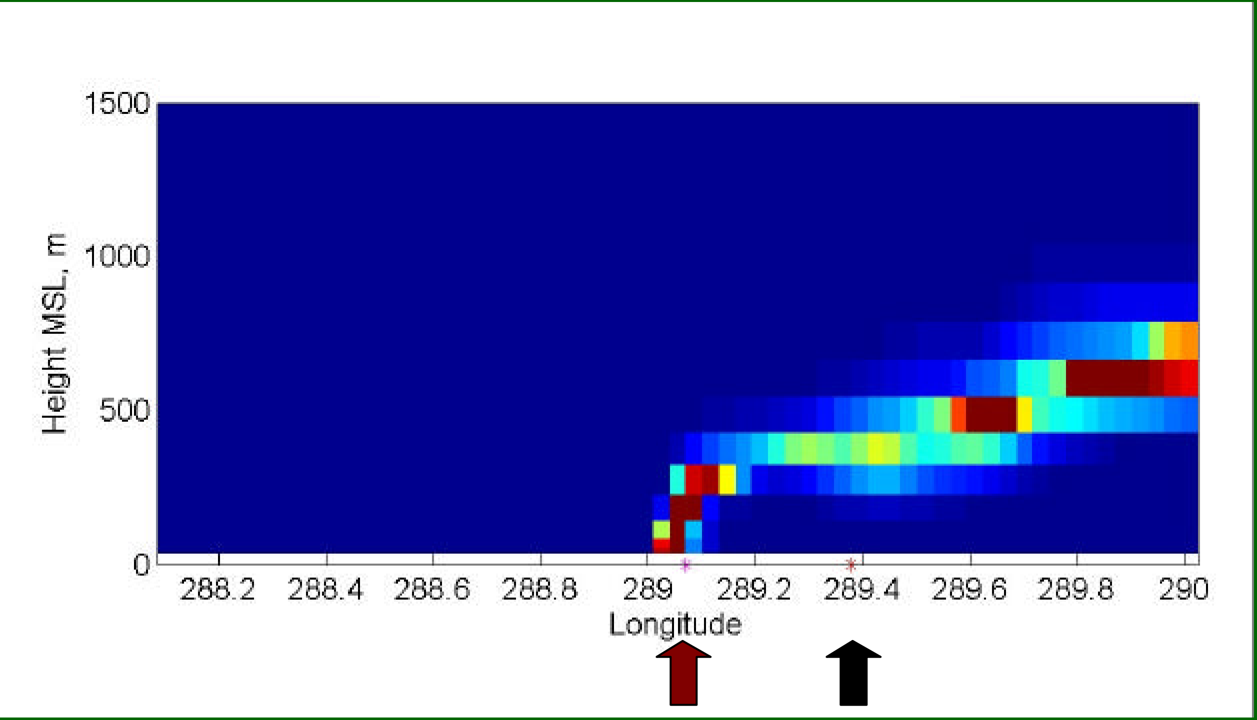
14 August modeled trajectories

- 2100 UTC 14 August (O_3 peak at Thompson Farm)
- To Thompson Farm
- Surface (~50 m)
- Note shift due to sea breeze



14 August modeled plume

- Polluted air carried onshore by sea breeze
- Elevated pollution layer left offshore
- 2300 UTC = 1800 EST
- Longitude slice of Boston tracer at latitude of Thompson Farm
- Side view from south



Summary

- Most-polluted air came over water to NH and ME
- Direct, same-day transport from Boston is most important, NYC et al. also contribute
- Primary transport to the surface was at the surface
- Pollutants emitted at night are transported in shallow layers at the surface
- Daytime emissions are mixed more deeply and transported in plumes with complex 4D structure
- These are transport events, not local production / stagnation events
- Modeling with tracer allows easier visualization of transport

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