Surface Ozone Differences Between Appledore Island and Thompson Farm: Local-Scale vs. Synoptic Scale

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Introduction

During the New England Air Quality Study (NEAQS) 2002, the surface ozone observation network included stations at Thompson Farm (TF), Appledore Island (AI), and Appalachian Lee Trough (ALT). The sites were separated by 10–30 km apart, yet the differences in the ozone measured at the two sites could be as low as 5 ppbv or as high as 50 ppbv. This study focuses on meteorological processes that contribute to the ozone differences at the two sites, particularly during the afternoon hours.

Sea Breeze

4 Aug

- Appalachian Lee Trough formed in the afternoon (Fig. 4).
- Sea breeze played a similar role as on Aug 3. During sea breeze period in Appledore Island, CO concentrations consistently above 200 ppbv.
- Southerly component winds.
- Transport of pollutants from Boston area toward AI.
- CO concentrations consistently above 200 ppbv.
- Southerly-component winds.
- Mechanism for long-range transport.

5 Aug

- Appalachian Lee Trough.
- Dynamic features along the east coast such as the sea breeze were important part of the meteorological feature (Fig. 7).
- Ozone profiles: reservoir of ozone in the southeast of the New Hampshire coast available for advection to both sites (Fig. 3). 

Ozone forecast results

3 Aug

- WRF-Chem predicted ozone over the New England area.
- Sea breeze front forming near the New England coast (Fig. 3).
- TF and AI in two different air masses.

- Appalachian Island:
  - East of the stationary front.
  - Southerly component winds.
  - CO concentrations above 200 ppbv.
  - Significant increase in ozone in TF and ALT.

- Appledore Island:
  - East of the stationary front.
  - Southerly component winds.
  - CO concentrations above 200 ppbv.
  - Significant increase in ozone in TF and ALT.

- Post-frontal flow:
  - Cold front passage before midnight (LST) of 6 Aug (Fig. 3).
  - Large-scale northerly flow over New England.
  - NO emissions lowered the CO and ozone at both the TF and AI sites.

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Fig. 1: Map showing locations of measurement sites for NEAQS (courtesy of Allen White ETU).

Fig. 2: Synoptic weather map for 1800 UTC (1300 LST), 3 Aug. 2002.

Fig. 3: Conceptual model of transport of pollution inland by the sea breeze (Graphics by Robert Banta and Al.Romero).

Fig. 4: Signal-to-noise ratio (SNR) for two 915-MHz radar wind profilers. A=Appledore Island.

Fig. 5: Conceptual model of transport of pollution inland by the sea breeze (Graphics by Robert Banta and Al.Romero).