Ozone distribution in the horizontal and vertical – airborne ozone lidar

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Airborne $\text{O}_3$ Differential Absorption Lidar (DIAL)
Addressing ICARTT objectives

• Atmospheric transport and mixing processes; ‘New England’ scale
  – Individual urban plumes
  – Combined ‘continental outflow’ streams
  – Vertical transport processes

• NWP forecast model validation
  – Distribution, location, structure of $O_3$ emission cloud, *including vertical*
Individual city emission plume:
$O_3$ from NYC a.m. rush-hour emissions – 20 July 04

- Dimensions of emission plume, including depth
- Structure and layering
- Context for other line, point measurements; representativeness
- Model prediction (Flexpart; WRF-Chem similar)
Total column of species 1 for age class all
Simulation start 20040723 000000 Actual time 20040720 230000
Mean value 0.120E+02
Maximum value 0.165E+03
Minimum value 0.000E+00

MIXING RATIO OF NO2TRAC
CUSTOM CROSS SECTION FOR WEBPAGE BASED ON GFS ANALYSIS
ANALYSIS 20040723 000000 UTC ACTUAL 20040723 230000 UTC

Latitude [km]

NO2 ppbv
O$_3$ in NYC pollution plume

West – upwind

East - downwind
‘Amalgamated’ outflow stream

- Overall region of relatively higher $\text{O}_3$
  - 50-60 ppb stream, e.g., within…
  - 30-40 ppb ‘clean’ background
- Higher $\text{O}_3$ plumes embedded
  (could be 70-80 ppb or more)
- Agrees with NWP model picture
- Have seen a few times already
Map of ozone values – 17 July 04
Ozone cross sections – 17 July 04
Additional issues to be addressed

- Continental outflow during subtropical high stagnation, weak transport
- Role of small-scale features in vertical transport (sea breeze, terrain, nocturnal LLJ, etc.)
- Study mixed-layer depth (aerosol)
- Detailed evaluation of NWP forecasts
- Data set includes drop-wind-sonde profiles \([T(z), p(z), \text{humidity}(z), \text{winds}(z)]\)