Ground-based Measurements in the Azores Islands

Richard Honrath
Dept. of Civil & Environmental Engg.
Michigan Tech
April 23, 2003

Participants:
- Michigan Tech
- Univ. Azores: Paulo Fialho
- Univ. Colo.: Detlev Helmig

Funding:
- NOAA/OGP
- NSF-ATM
- Port. Sci. & Tech. Found.
Broad Scientific Objectives

1. Test understanding of chemical evolution of $\text{NO}_x$, CO, HCs, $\text{O}_3$, ca 3–10 days after emission.

(a) “Climatology” for evaluation of GCTM simulations; seasonal variations of $\text{NO}_x$, $\text{NO}_y$, NMHCs.
   - lower free troposphere;
   - marine boundary layer.

(b) Species-species relationships indicating broad emission/mixing/photochemistry relationships (CO-$\text{O}_3$, CO-$\text{NO}_y$, HC-HC).
   - cf. near-continent.
1. Test understanding of chemical evolution of NO\textsubscript{x}, CO, HCs, O\textsubscript{3}, ca 3–10 days after emission (continued).

(c) Presence or absence of net O\textsubscript{3} production in exported air.
- Impact of [NMHCs], [NO\textsubscript{x}] on in-situ production.
- Seasonal dependence (esp. winter, spring)
2. Quantify impact of North American and European emissions on key species over the central North Atlantic (CO, O\textsubscript{3}, NO\textsubscript{x,y}, NMHCs, black carbon aerosol).

(a) Mixing ratios (distributions by flow pathway); *cf.* levels in background MBL and FT air.

(b) Flux over Azores resulting from export.

Identification of source regions:

- Back-trajectories;
- NMHC tracers: marine, island biogenic, anthropogenic source regions, biogenic;
- Species-CO and species-NMHC correlations.
3. Evaluate specific processes.

(a) Ship emissions: impact on NO$_x$, O$_3$ in MBL.
(b) Comparative fate and impact of continental emissions transported within the MBL; within the FT.
(c) Frequencies and impacts of flow from North America, Europe; relative frequencies and impacts of alternative transport pathways.
4. Initiate long-term measurements for evaluation of medium- to long-term atmospheric change, as well as North American, European, and more distant emissions change;

- GAW stations operated by the Portuguese Meteorological Institute.
  - MBL station(s);
  - Pico (FT/MBL) station.
5. Be useful to ITCT/EXPORT/INTEX studies as a link between western and eastern N. Atlantic campaigns.
## Species and Measurement Periods

### Pico mountain

<table>
<thead>
<tr>
<th>Species</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>August 2001–spring 2005&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>O&lt;sub&gt;3&lt;/sub&gt;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Black carbon</td>
<td>&quot;</td>
</tr>
<tr>
<td>NO&lt;sub&gt;x,y&lt;/sub&gt;</td>
<td>August 2002–spring 2005 planned (funded –spring 2004)</td>
</tr>
<tr>
<td>NMHCs, selected oxy-HC</td>
<td>March 2004–spring 2005&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Met and J&lt;sub&gt;NO&lt;sub&gt;2&lt;/sub&gt;&lt;/sub&gt;</td>
<td>August 2001–spring 2005&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>Measurements may continue beyond spring 2005, hopefully under Portuguese Meteorological Institute operation.
Additional Azores measurements

- MBL station: Terceira island (paulo.fialho@angra.uac.pt)
  - early 2004–?
  - Black carbon (aethalometer), high-vol aerosol, $O_3$ (KI), ($CO_2$?), met parameters.

- Column $O_3$: Angra do Heroismo (Terceira Island).

- $O_3$ sondes: Lajes, Terceira Island.
  - Budgeted 1/week for 1 year. Willing to focus during ITCT, or to launch your sondes.

- Future plans: multiple MBL stations to observe non-island-affected air.
  - pending successful development by P. Fialho (Univ. Azores) and Portuguese Meteorological Institute

- Aeronet station (Horta, Faial Island)
PICO-NARE location
Pico mountain
PICO-NARE station on summit caldera
Exterior of the station
Local meteorology: MBL, FT

- Twice-daily soundings at Lajes, Terceira island.
- Upslope flow on some days.
  - 10–14 km to N, NW coast.
  - cf. Mauna Loa: \( \sim 62 \) km.

![Graphs showing potential temperature and water mixing ratio over altitude with station data for Lajes and Pico-Nare.](image-url)
Identification of MBL, FT

- Relative humidity.
- NO\textsubscript{x} levels and variability.
- Biogenic and marine NMHCs.
Transport pathways
Geometrically adjusted 10-day flow probability.

Winter

Spring

Summer

Fall
Samples of measurements to date

CO-O$_3$ relationship: 2001 vs 1993

Solid symbols: Pico, summer 2001;
Pink crosses: MBL, 1993 [Parrish et al., 1998].
Time series: Background/Transport; FT/MBL

Screening Method(s) = N day
Best type: alt alt choice = 1000.00  P choice = 850.00

Mon Feb 24 11:06:22 2003
Mon Feb 24 11:17:28 2003
Back-trajectory clusters by season and NAOI

Summer, Positive NAOI

Summer, Negative NAOI
Back-trajectory clusters by season and NAOI

Fall, Positive NAOI

Fall, Negative NAOI
Back-trajectory clusters by season and NAOI

Winter, Positive NAOI

1960-1999_pos_djf_6_cluster_new

Winter, Negative NAOI

1960-1999_neg_djf_6_cluster_new
Back-trajectory clusters by season and NAOI

Spring, Positive NAOI

Spring, Negative NAOI