Pico mountain in the Azores Islands provides an ideal location for studies of the central N. Atlantic lower free troposphere. The PICO-NARE station has operated there since summer 2001. Here, we present key findings from summertime measurements, during 2001-2004.

Main Findings: Anthropogenic and biomass fire emissions dominate variations in CO and have major impacts on O₃, nitrogen oxides, non-methane hydrocarbons (NMHCs) and black carbon.

2. STATION OVERVIEW
The PICO-NARE station is located at 2225 m asl in the Portuguese Azores Islands. Fig. 1 shows the location and example flow pathways bringing clean marine air, N. American pollution, and subarctic air potentially containing boreal fire emissions. Measurements at the station include: CO (2001-present), O₃ (2001, 2003-present), NO, NO₂, and NOₓ (2002-2005), black carbon (2001-present), and NMHCs (2004-present). The station was recently shut down for the first time, for the 2005-06 winter season. Pending new funding, it will reopen in spring 2006 with new measurements of aerosol size distribution, CO, and CO₂, and resumption of NO, and NOₓ measurements.

3. IMPACTS OF DISTANT BOREAL FIRES ARE LARGE
Major fires in Alaska and western Canada repeatedly impacted our station during summer 2004. Extreme enhancements of CO, O₃, NO, NOₓ, BC, and NMHCs (not shown) occurred during these periods.[Fig. 4]

- d[O₃]/d[CO] was similar to some previous reports for well-aged forest fire plumes, although in some cases O₃ production was suppressed, especially in the most concentrated part of the plume.[Fig. 5a].
- [NOₓ]/[CO] was a significant fraction in the estimated NOₓ/CO emission ratio [2] and only moderately smaller than previous measurements much closer to fires.[Fig 5b].

4. SIGNIFICANT IMPACTS OF N. AMERICAN ANTHROPOGENIC EMISSIONS
Enhancements of CO, BC, NOₓ, NO₃, and NMHCs levels above background also occur during flow from the U.S.[Fig. 8]. Most of these events travel in the lower FT in a route governed by the Azores-Bermuda High and transient northerly lows.[11], and typically have a photospheric age of 5-10 days as indicated by the "NMHC clock".[Fig. 9] and backwards trajectories (not shown).

5. CONCLUSIONS AND FINAL REMARKS
• Large boreal wildfires in 2002-2004 strongly impacted atmospheric composition over the central North Atlantic lower FT, and dominated the interannual variability of CO, O₃, and aerosol BC over 2001-2004. The frequency distribution of O₃ shifted toward higher levels, suggesting significant impacts on the summertime O₃ background over the region.
• Nitrogen oxides levels during fire-impacted periods were very high for such a remote region, suggesting significant continuing O₃ production in these well-aged boreal fire plumes.

*This deserves further study since little is known about the impact of boreal wildfires on the O₃ levels in the Northern Hemisphere. Boreal wildfire activity is expected to increase in the future due to an increase in temperatures resulting from global warming.*

• O₃ enhancements during U.S. outflow transported to the site over 5-10 days were significantly higher than those reported from previous observations near North America.

*Further work is needed to determine whether this indicates larger O₃ impacts from U.S. emissions than currently estimated.*

The PICO-NARE station has been proved to be a valuable platform for observations of the regional background and of U.S. and boreal fire impacts. It is also impacted by European and African emissions, although less frequently.

*Additional climate-relevant measurements (CO₂, aerosols, and CCN) are planned beginning in 2006 (pending new support). Future PICO-NARE CO₂ and O₃ observations will be incorporated into the NOAA-CMDL record.*

*The Portuguese Met. Inst. and the Regional Government of the Azores are making significant progress toward converting the station into a permanent GAW observatory in 2008.*

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