1. INTRODUCTION

We present measurements of CO, O₃, aerosol Black Carbon (BC) made over the central North Atlantic lower Free Troposphere (FT) during the summers of 2001-2004 along with measurements of nitrogen oxides (NOₓ and NO₃) made during the summer of 2004 (ICARTT period) and non-methane hydrocarbons (NMHCs) made during the winter of 2004-2005.

Main Findings: Anthropogenic and boreal wildfire emissions dominate impacts on CO, NOₓ, NO₃, NO₅, BC, and NMHCs over the North Atlantic lower FT during summer seasons.

2. STATION OVERVIEW

The PICO-NARE station is located in the Azores Islands, Portugal (2225 m asl), which is an ideal location for sampling North American pollution, forest fire emissions, and clean marine background air [Fig. 1].

Free Tropospheric Air Sampling?

The station altitude is well into the FT in all seasons [Figs. 2-3]. However, marine boundary layer (MBL) air occasionally reaches the station due to daytime buoyant uplift (periods of weak winds) and mechanically driven updraft [1] (periods of strong winds) [Figs. 3-4].

3. IMPACTS OF URBAN AND ANTHROPOGENIC EMISSIONS

Enhancements of CO, O₃, 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 photochemical age of 5-10 days as indicated by the "NMHC clock" [Fig. 9] and backward trajectories (not shown).

Evidence of Increased O₃ Export from the U.S.

In 2001, few fires were observed and nearly all periods of elevated CO and O₃ occurred during outflow. The O₃/CO₃ slope during these periods was unexpectedly higher than those reported previously over the North Atlantic region, even after accounting for CO loss and for declining North American CO emissions [Fig. 10] [12]. This suggests an additional significant amount of O₃ to air reaching Pico in 2001, relative to air near North America in the early 1990s.

5. CONCLUSIONS AND FINAL REMARKS

- Large boreal wildfires in 2002-2004 strongly impacted the air quality over the central North Atlantic lower FT, and dominate, interannual variability of CO₂ and summertime BC over 2001-2004. The frequency distribution of O₃ shifted toward higher levels, suggesting impacts on the summertime O₃ background over the region.
- Nitrogen oxides levels during fire-impacted periods were extremely high for such a remote region (e.g., NOₓ > 150 pptv), suggesting that significant additional NOₓ production must have occurred in these well-aged boreal fires 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 climate change [15].
- O₃ enhancements during U.S. outflow transported to the site over 5-10 days were significantly higher than those reported from previous observations.
- Further work is needed to determine whether this indicates larger O₃ impacts from U.S. emissions that simulated by Global Chemical Transport Models.
- The PICO-NARE station has been proved to be a valuable platform for observations of the regional background and U.S. and boreal fires impacts. It is also important for observations by European and African emissions, although less frequently.
- Additional climate-relevant measurements (CO₂, aerosols, and CCN) are planned beginning in 2006 (support pending). PICO-NARE CO₂ and O₃ observations will be incorporated into the NOAA-CAML network.
- We are working to convert the station into a permanent, Portuguese GAW observatory over the next ~3 years.

REFERENCES


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