COMPLEXO CLIMAAT – TERCEIRA – NARE PARA A MONITORIZAÇÃO DA COMPOSIÇÃO DA ATMOSFERA NA CAMADA LIMITE DO ATLÂNTICO NORTE

CLIMAAT-TERCEIRA-NARE COMPLEX TO MONITORING THE COMPOSITION OF THE MARINE BOUNDARY LAYER IN THE NORTH ATLANTIC

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SUMMARY

As a result of the partnership between the University of Azores, the Association for the Study of the Insular Environment through the Environment Observatory and the Meteorological Institute, during the 2004 summer it took place the beginning of the installation of the CLIMAAT – TERCEIRA – NARE (INTERREG IIIB - Projecto CLIMAAT – MAC 2.3/A3) platform. In this stage, it was also installed in the José Agostinho observatory, near the city of Angra do Heroísmo, several equipments to monitoring the atmospheric and sun irradiation. Near the coast, at the moment, and beside the meteorological common parameters, pressure, temperature, relative humidity, precipitation, wind direction and intensity some measurements of the black carbon and iron oxide aerosol absorption coefficients were also done. The results of this project should contribute to the study of the evolution and composition of the North Atlantic atmosphere, and in that matter to the study of the Global Changes, namely as a land platform of reference to remote sensing satellite systems. This platform is part of the Azores Global Atmosphere Monitoring Complex (AGAMC)

1. Introduction

The Azores Global Atmospheric Monitoring Complex (AGAMC) is a set of ground-based measurement stations for use in sampling the marine boundary layer (MBL) and free troposphere (FT) over the central North Atlantic Ocean. The stations include the free tropospheric PICO-NARE station, the remote MBL observatory Serreta station (INTERREG IIIb – Project CLIMAAT – MAC 2.3/A3), and two meteorological stations. These stations are available for use by collaborating researchers to the maximum extent possible given space and power availability.

2. The Azores as a Base for atmospheric studies

The Azores Islands (Fig. 1) have a long history as a base for atmospheric observations. Prior to the advent of satellite observations, they provided weather data critical to the accuracy of European weather forecasts. Today, they provide a unique base for studies of atmospheric chemistry in the central North Atlantic region. Although it is itself a region of low emissions, the central North Atlantic is surrounded by areas of concentrated anthropogenic emissions in North America and Europe (Fig. 2). Transport from those regions brings aged anthropogenic pollution, providing an opportunity for observation of the combined effects of emissions, transport, and transformation. It is also at times impacted by arctic and sub arctic outflow containing products of anthropogenic activities (e.g., arctic haze) and boreal fires, by transport from the south bringing tropical marine air, and by African dust storms.

Figure 1 – Azores archipelago.

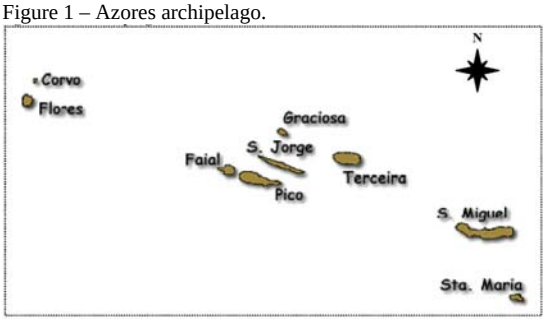
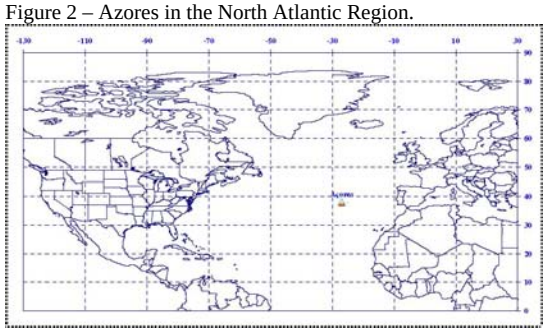


Figure 2 – Azores in the North Atlantic Region.



Atmospheric measurements in the central North Atlantic region are therefore highly desirable for studies of the large-scale impacts of anthropogenic emissions, for determining trends in background levels of greenhouse gases, aerosols, and other species, and for studies of the impacts that anthropogenic emissions and natural sources such as desert dust and boreal wildfires have on those background levels. Measurements in the free troposphere (FT) are particularly useful, because trace gas and particle lifetimes are longer in the FT than in the underlying marine boundary layer (MBL), leading to greater impacts from distant sources. In contrast, the composition of the MBL reflects a combination of long-range transport and upwind emissions (e.g., ship emissions) in the MBL, subsidence from or exchange with the overlying FT, and deposition and chemical destruction, which are enhanced in the MBL due to the presence of the ocean surface, high water concentrations, and enhanced sea-salt aerosol loadings.

In the entire central North Atlantic region, Pico mountain (Fig. 3), located on Pico island in the Azores Islands, provides the only possible base for ground-based free tropospheric measurements. It is therefore a valuable location for an atmospheric observatory. The PICO-NARE station was developed for this reason, and measurements made there since 2001 have demonstrated that the station is impacted by long-range transport of anthropogenic, boreal fire, and desert dust emissions and that the station is suitable for sampling the lower free troposphere [Honrath et al., 2004; Fialho et al., 2005 ; Tanner et al., 2005].

Figure 3 – View of the Pico Mountain.

Nearby measurements in the MBL provide a valuable complement to FT observations and an opportunity to study issues specifically related to the MBL, such as impacts of ship emissions, the importance of long-range transport in the MBL relative to that in the overlying FT, and the role of the MBL as a sink for atmospheric constituents. The Serreta MBL station, located on Terceira island in the Azores Islands, was developed to provide a base for MBL measurements at a location near the Pico station.

Furthermore, the three Azores station will provide a unique platform for sea level and mixed boundary layer reference measurements for satellite remote sensing observations (NASA and ESA). The Azores are the only site in the North Atlantic region that offer the opportunity for the operation of surface sites that can provide continuous ambient concentration and atmospheric column measurements which are of utmost importance for validation of satellite observations.

3. Station description

3.1 Pico station (38º28’15’’N, 28º24’14’’ W, 2225 m a.s.l.):

This remote mountaintop station was installed in 2001. It is located in the summit caldera of Pico mountain, an inactive volcano on Pico Island (Fig. 4).

Figure 4 – View of the Pico station at the caldera during 2004 mission.

The station samples free tropospheric air much of the time, and measurements made to date have demonstrated that it is suitable for frequent observation of aged North American pollution and boreal fire plumes, and occasional observation of African dust aerosol, and European anthropogenic emissions. The current station is limited in space and power availability, but the addition of small and low or moderate power instruments is possible and future expansion of power and space is planned.

The station infrastructure was installed and has been maintained by Michigan Technological University

(MTU) in the scope of NOAA- and NSF- funded research projects on the intercontinental transport and chemical transformation of pollution from source regions bordering the Atlantic Ocean. Current station measurements include black carbon aerosol, O3, NO/NO2/NOy, NMHC and CO and meteorological parameters (Fig. 5). All instrumentation is automated and is remotely accessed and controlled. Electrical power is supplied by a medium-voltage cable connection from a diesel generator (Fig. 6) located at lower altitude (~ 1200 m a.s.l.). The site is within a National Park and can be accessed via a ~ 5 km strenuous hiking trail or by helicopter (Portuguese Air Force).

Figure 5 – View of the inside of the station.

Figure 6 – Diesel generator.

3.2 Serreta station (38º46'30''N, 27º21'36''W 140 m a.s.l.):

This station is located on the western coast of Terceira Island, ~100 m meters from the coast line and close to the NOAA/CMDL Azores air flask long term monitoring sampling site (Fig. 7). The infrastructure was funded by INTERREG IIIb Project CLIMAAT – MAC 2.3/A3. The University of Azores is preparing the installation of continuous particle measurement (Black Carbon) and meteorological observations (wind, air temperature and relative humidity). Instrumentation will be operated in a stand alone fashion and recent and archived data will be accessible by internet. This site is accessible by car (~30 km from Angra do Heroísmo town). Space and power may be available for additional measurements at this station.

Figure 7 – View of the Serreta Station.

3.3 José Agostinho Observatory (38º39'36''N, 27º13'26'' W, 90 m a.s.l.):

This station is located on the south coast of Terceira Island on the outskirts of Angra do Heroísmo (Fig. 8) historical centre (UNESCO World Heritage site since 1983).

Figure 8 – View from the José Agostinho Observatory over the city of Angra do Heroísmo. BREWER MKII spectrometer (on the bottom) and of the sun tracker where several radiation sensors and one photometer where installed (on the top).

It is part of the Portuguese Institute of Meteorology (IM) operational network, providing regular meteorological observations since 1937. During the last 10 years other observational programmes were added (wet deposition, PM10 concentration, total ozone, SO_2 and UV spectral radiation) in the scope of WMO/GAW and EMEP programmes. Recently, a sun tracker was installed for automatic measurement of radiation and aerosol optical depth funded by INTERREG IIIb (Project CLIMAAT – MAC 2.3/A3).

3.4 Lajes upper air station (38º44'N, 27º04' W, 113 m a.s.l.):

Established in 1988, it is part of the GCOS Upper Air Network (GUAN) and operated by Portuguese Air Force (FAP) personnel. It is located in the Lajes airport facility at the east coast of Terceira Island. Two radio soundings are performed daily with a DigiCORA-MARWIN system (Vaisala). This facility has previously provided ozone soundings using MAST-BREWER sondes in the scope of national funded campaigns (ROCA 1999, 2001).

4. Station contacts

Primary coordination:

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5. References

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