Final project report

Project ID Title	2004/2.02 Trace gases and optical properties of aerosol at Baia Terra Nova and Dome-C (DO3meCO2)
Principal investigator	Dr. Paolo Bonasoni
Institution	ISAC-CNR
Email	<i>p.bonasoni@isac.cnr.it</i>
Duration	3 years
Assigned funding	90.000,00 Euro

Activities and results

In the framework of this project, continuous measurements of O₃ and CO₂ concentrations, meteorological parameters and longwave and shortwave radiation fluxes have been conducted at the Campo Icaro (MZS-IC) clean air facility at Terra Nova Bay/MZS. This experimental activity allowed to investigate the summer variability of CO_2 and O_3 during five summer experimental campaigns from November 2001 to February 2006. By adopting a specific screening methodology for selecting "background" conditions, we defined that the summer average background O₃ values ranged from 18.3 ± 4.7 ppbv (summer 2005 – 2006) to $21.3 \pm$ 4.0 ppbv (summer 2003 – 2004). Background CO₂ concentrations showed an average growth rate of 2.12 ppmv/year, ranging from 369.28 ± 0.18 ppmv (summer 2001 - 2002) to 377.76 ± 0.26 ppmv (summer 2005-2006). As shown by the analysis of local wind direction and by 3D back-trajectory calculations, the highest CO_2 and O_3 values were recorded in correspondence to air masses flowing from the interior of the Antarctic continent. These results possibly provide indirect evidence of the role played by photochemical NOx emissions from the Antarctic snowpack during the summer season, as well as indicating that transport from the interior of the continent has an important influence in Antarctic coastal areas. The in-situ measurements of solar radiation permitted to define and investigate the typical diurnal variations of the SW and LW, radiation components. This permits to investigate the radiative effects of clouds at MZS-IC. On average, during the five summer campaigns, these effects ranged from -72.6 W/m² to -83.7 W/m². Starting from December 2005, continuous surface O₃ measurements were started at Dome-C (these

measurements are still running). A specifically designed experimental set-up permitted to characterize 4-year of O_3 observations: December 2005 – December 2009. The surface O_3 concentration showed an average value of 29.2 ± 5.5 ppbv. The seasonal O_3 behaviour was characterized by a winter maximum (32.1 ± 2.8 ppbv) with a secondary maximum during summer (29.5 ± 2.1 ppbv). As pointed out by the analysis of O_3 values in function of the local meteorology, the presence of local sources for O_3 during summer were probably related with snow-pack photo-denitrification processes resulting in NO_x release and O_3 production. The analysis of the synoptic-scale atmospheric circulation by means of 3D back-trajectory calculations, permitted to evaluate that also for Dome-C, on average the highest O_3 concentrations were recorded in connection with air-masses originating over the eastern Antarctic Plateau, indicating that this area can represent a source region for surface O_3 at Dome-C, particularly during summer.

At Dome-C, 17 in-flask air samplings have been carried out during the period 2007-2008. This permitted to infer a first evaluation of the typical levels of climate-altering halogentaed gases in this Antarctic region.

Products

A – papers in scientific magazines

- Cristofanelli, P., Bonasoni, P., Calzolari, F., Bonafè, U., Lanconelli, C., Lupi, A., Trivellone, G., Vitale, V. and Petkov, B., 2008. Analysis of near-surface ozone variations in Terra Nova Bay, Antarctica. Antarctic Science, 20 (4), 415-421.
- Cristofanelli, P., F. Calzolari, U. Bonafè, C. Lanconelli, A. Lupi, M. Busetto, V. Vitale, T. Colombo and P. Bonasoni, 2011. i5-year analysis of background carbon dioxide and ozone variations during summer seasons at the "M. Zucchelli" station (Antarctica), under review on Tellus-B.

B – book chapters

C - proceedings of international conferences

- Calzolari, F., P. Bonasoni, V. Vitale, F. Evangelisti, U. Bonafè, G. Trivellone, A. Lupi and P. Cristofanelli, Tropospheric ozone measurements at Terra Nova Bay (Antarctica). Proceedings of the Quadrennial ozone symposium, 860-861, Ed. C.S. Zerefos, pp. 1246. 2004
- Cristofanelli, P.; Bonasoni, P.; Calzolari, F.; Lanconelli, C.; Lupi, A.; Vitale, V.; Agnoletto, A. Tropospheric ozone variations at Terra Nova Bay coastal station and Dome Concordia high altitude station (Antarctica). Geophysical Research Abstracts, Vol. 8, 08583, 2006
- Cristofanelli, P.; Bonasoni, P.; Bonafe', U.; Calzolari, F.; Duchi, R.; Lanconelli, C.; Lupi, A.; Vitale, V.; Colombo, T.: 5-year analysis of background surface ozone and carbon dioxide variations during summer seasons at Terra Nova Bay (Antarctica). Geophysical Research Abstracts, Vol. 12, EGU2010-11579, 2010.

D – proceedings of national meetings and conferences

 Cristofanelli, P., Agnoletto, L., Busetto, M., Calzolai F., Maione, M., Marinoni, A., Bonafè, U., and P. Bonasoni. Surface ozone measurements at Dome Concordia: preliminary results. SIF Conference Proceedings, Vol. 97, "Italian Research on Antarctic Atmosphere", M. Colacino and C. Rafanelli (Ed.), pp. 57-68, 2009.

E – thematic maps

--

F – patents, prototypes and data bases

- 1. Surface O₃ concentrations at MZS-IC summer campaigns (2001/2002-2005/2006) DATABASE
- 2. Surface CO₂ concentrations at MZS-IC summer campaigns (2001/2002-2005/2006) DATABASE
- 3. Meteorological parameters at MZS-IC summer campaigns (2001/2002-2005/2006) DATABASE
- 4. HYSPLIT three-dimensional back-trajectories at MZS-IC summer campaigns (2001/2002-2005/2006) DATABASE
- 5. LW and SW radiation fluxes at MZS-IC summer campaigns (2004/2005-2005/2006) DATABASE
- 6. Surface O₃ concentrations at Dome-C (December 2005 December 2009) - DATABASE
- 7. HYSPLIT three-dimensional back-trajectories at Dome-C (December 2005 December 2009) - DATABASE

G - exhibits, organization of conferences, editing and similar

1. P. Bonasoni. Misure di concentrazione di gas in traccia e delle caratteristiche ottiche delle particelle di aerosol a baia Terra Nova e Dome C. Antartide. Un Osservatorio naturale per comprendere la terra. PNRA.

H - formation (PhD thesis, research fellowships, etc.)

Research units

Reaserch Unit 1: MOR-BON

Paolo Bonasoni, Ricercatore P.I. Paolo Cristofanelli, Ricercatore Vito Vitale, Ricercatore Angelo Lupi, Assegnista Tiziano Colombo, Aeronautica Militare Ubaldo Bonafe, Super STER Francescopiero Calzolari, Super STER

ISAC-CNR ISAC-CNR ISAC-CNR ISAC-CNR UGM-AM Roma ISAC-CNR ISAC-CNR

Date: 19 October 2010

Notes

Due to a significant decrease of the requested financial supports, the measurements of CO_2 at Dome-C and of aerosol properties at MZS and Dome-C were not implemented.