

Final project report

Project ID: 2002/2.02
Title: Trace gases concentration and aerosol optical characteristics measurements at Terra Nova Bay station

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Duration: 2 years
Assigned funding: € 52.000,00

Activities and results

Project aimed to (i) collect information to assess direct effects of aerosols and clouds on the pattern of radiation fluxes (shortwave and longwave) at the surface (ii) obtain accurate measurements of CO₂ and ozone concentration at the surface, to monitor changes in atmospheric composition and investigate transport processes (horizontal, troposphere-stratosphere exchange) in the area of the Ross Sea. General objective was to create an observatory allowing to carry out monitor activities over a period of several years. In this perspective, experimental setup was designed and realized to be robust, reliable, easy to maintain and as much automatic as possible.

CO₂ and ozone concentration at the surface. Measures were located at the Atmospheric Physics Observatory of Icaro Camp, located on the coast 2 km southward of MZS station. Orography and local wind regime assured a negligibly influence of the relatively near station of MZS. Average concentrations of CO₂ during summer were 369.37 ± 0.22 ppmv in 2001 and 371.44 ± 0.25 in 2002. The growth rate of 2.1 ppmv/year, was greater than the mean value found at middle latitudes in the period 1983 to 2001 (1.6 ppmv/year), but in agreement with other Antarctic stations, indicating the existence in polar areas of large-scale phenomena influencing CO₂ concentration. Seasonal pattern was characterized by a slow decrease and a minimum in February. Elevated values of CO₂ concentration were found to be associated to air mass coming from N-W, while lower CO₂ concentrations were usually associated to advection from South. Ozone concentrations were characterized by summer average values of 20-22 ppbv with a SD of 4-5 ppbv. Seasonal trend of the monthly average show a grow until December and than a slowly decrease in January and February. Several episodes of ozone concentration enhancement were recorded, clearly indicating influence of advection and/or vertical exchange on ozone surface distribution in the coastal Ross Sea region.

Shortwave and longwave fluxes and effects of cloudiness. Measures of SW and LW radiation fluxes were performed regularly at Icaro Camp since 1999. Making use of Long and Ackerman algorithm, clear sky irradiances at noon were evaluated and found to vary from a minimum value of 1200 Wm⁻² to a maximum value of 1280 Wm⁻², with 95% confidence interval between 1220 and 1250 Wm⁻². These results clearly indicate that during summer the conditions of atmospheric transparency along the coast of the Ross Sea are stable and not influenced by changes in atmospheric composition. Annual mean cloud coverage during summer were found vary between 0.4 and 0.55 from one year to another, with SD around 0.4, indicating that strong cloudiness conditions are frequent over Terra Nova Bay during summer. Cloud type characterization made applying Duchon and O'Malley method showed that, on annual basis, cloud frequency of occurrence for all types ranges from about 10% to 15%, and clear sky conditions between 26% and 40%. Cumulus clouds were found most part associated with large cyclonic systems reaching coast of Antarctic continent from northern latitudes. Stratus cloudiness, on the contrary, appeared to be mainly linked to local weather conditions. An independent classification based on synop data collected over a period of 10 years provided average percentages for cirrus, cumulus, cumulus + Cirrus, Stratus and clear skies of $10\% \pm 1.9\%$, $16\% \pm 7.4\%$, $11\% \pm 6.4\%$, $40\% \pm 10.9\%$ and $27\% \pm 10.8\%$, respectively. For the period 2000-2003, the average total effect of cloudiness on the total net flow were found to be of -86 Wm⁻², -96 Wm⁻², -73 Wm⁻² and -96 Wm⁻², indicating that during summer the overall cloud forcing is negative and than clouds contribute to cooling the ABL. This result is closely related to the specific characteristics of Terra Nova Bay area during summer, in particular the low average surface albedo values.

Products

A – papers in scientific magazines

1. Colombo T., V. Vitale, F. Evangelisti, U. Bonafe', F. Calzolari, G. Trivellone, A. Lupi e P. Bonasoni, 2003: *Carbon dioxide and ozone measurements in Antarctica: a new station at the Italian base of Terra Nova Bay*, Rivista di Meteorologia Aeronautica, **Anno 63**, N. 1, pp. 21-26
2. Colombo T., V. Vitale, F. Evangelisti, U. Bonafe', F. Calzolari, G. Trivellone, A. Lupi e P. Bonasoni, 2004: *Further elaborations of trace gases concentration data recorded during the participation to the research activity in Antarctica by the Italian Air Force Meteorological Service are presented (XVII and XVIII Italian Expeditions)*. Rivista di Meteorologia Aeronautica, **Anno 64**, N. 4, pp. 11-20.
3. C. Tomasi, **V. Vitale**, A. Cacciari, A. Lupi, A. Pellegrini e P. Grigioni, 2004: Mean vertical profiles of temperature and absolute humidity from a twelve-year radiosounding data-set at Terra Nova Bay (Antarctica), Atmospheric Research, doi: 10.1016/j.atmosres.2004.03.009, Vol. 71, 139-169. Impact factor 1.786 / Cited half life 5.5

B – book chapters

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C - proceedings of international conferences

1. **Vitale V.**, 2001: *Plans for Picasso-Cena lidar calibration and validation activities at Dome C station*, Atti del Workshop Atmospheric Sciences at Dome C, Roma 20 aprile 2001, pp. 35-45.
2. F. Calzolari, P. Bonasoni, **V. Vitale**, F. Evangelisti, U. Bonafe', G. Trivellone, A. Lupi e P. Cristofanelli, 2004: *Tropospheric ozone measurements at Terra Nova Bay (Antarctica)*, Proceedings XX Quadrennial ozone symposium, Kos, Grecia, 1-8 giugno 2004. pp. 855-856.
3. U. Bonafe', F. Evangelisti, **V. Vitale**, P. Bonasoni, F. Calzolari, P. Cristofanelli e T. Colombo, 2004: *A new automatic dehumidification system for trace gas concentration measurements*, Proceedings XI SCALOP Symposium "Towards the International Polar Year and Beyond", Brema, Germania, 28 luglio 2004, Terra Nostra, helf 2004/5, 40-43.
4. U. Bonafe', F. Evangelisti, **V. Vitale**, F. Calzolari, V. Nanni, G. Trivellone, P. Bonasoni, 2004: *Wind-generator system applied to scientific instrumentation in remote Antarctic sites*, Proceedings XI SCALOP Symposium "Towards the International Polar Year and Beyond", Brema, Germania, 28 luglio 2004, Terra Nostra, helf 2004/5, 44-48.

D – proceedings of national meetings and conferences

1. Tomasi C., **V. Vitale**, A. Lupi, A. Cacciari e S. Marani, 2001: *Forcing radiativo indotto dalle particelle di aerosol in Antartide e misure di concentrazione di gas minori*, Global Change, Studi delle variazioni del Clima, degli Ecosistemi e delle Dimensioni Umane, Censimento delle Attività di Ricerca Nazionali e Partecipazione ai Programmi Internazionali IGBP, WCRP, IHDP, Workshop organizzato dalla Commissione Italiana IGBP, CNR, Roma, 27-29 Novembre 2000, pp. 155-156.
2. **V. Vitale**, P. Bonasoni, P. Cristofanelli, T. Colombo, F. Evangelisti, U. Bonafè, F. Calzolari, G. Trivellone e A. Lupi, 2004: *Continuous observations of CO₂ and O₃ at Terra Nova Bay (Antarctica) during the summer seasons 2001 and 2002*, Tenth Workshop Italian Research on Antarctic Atmosphere (M. Colacino Ed.), SIF Conference Proceedings, vol. 89, 127-139.
3. **V. Vitale**, C. Lanconelli, A. Lupi, M. Nardino, T. Georgiadis, F. Calzolari, F. Evangelisti, U. Bonafe', C. Tomasi e G. Trivellone, 2004: *Estimation of fractional sky cover, cloud type and cloud forcing effects at Terra Nova Bay from broadband radiation measurements*, Tenth Workshop Italian Research on Antarctic Atmosphere (M. Colacino Ed.), SIF Conference Proceedings, Vol. 89, 71-81.
4. Piervitali E., A. Damiani, E. Benedetti, M. Castorina, M. G. Di Bono, M. Martinelli, C. Rafanelli, O. Salvetti, M. Storini, L. Testa, **V. Vitale**, 2004: *S.I.R.I.A. – The Information System of Italian Research in Antartica*, Tenth Workshop Italian Research on Antarctic Atmosphere (M. Colacino Ed.), SIF Conference Proceedings, Vol. 89, 241-249

E – thematic maps

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Programma Nazionale di Ricerche in Antartide (PNRA)

F - patents, prototypes and data bases

1. sistema per la regolazione automatica del flusso di ingresso nell'inlet per diversi regimi di vento, basato sul principio delle retroazione.
2. software per la gestione automatica e continua del sistema di misura della CO₂, dell'ozono e di altre grandezze.
3. messa a punto di procedure per l'individuazione di episodi di intrusione di masse d'aria stratosferica.

G – exhibits, organization of conferences, editing and similar

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

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Research units

Vito Vitale, Ricercatore,	ISAC-CNR
Paolo Bonasoni, Ricercatore	ISAC-CNR
Tiziano Colombo, Ric. Areonautica Militare	UGM-Roma
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