

Final project report

<i>Project ID</i>	2004/6.07
<i>Title</i>	Physico-chemical characterization of Antarctic aerosol and removal processes
<i>Principal investigator</i>	Prof. Franco Prodi
<i>Institution</i>	ISAC-CNR
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<i>Duration</i>	3 years
<i>Assigned funding</i>	240.000,00 Euro

Activities and results

The research activities were focused on two aspects: the evaluation of particle deposition velocity and size distribution in the remote site of the Nanseen Ice Sheet; the characterisation of samples of snow collected at Terra Nova Bay and at the remote site of Nansen to identify the mechanisms of scavenging of aerosols.

Activities involved significant work in Italy for definition and laboratory testing of the sampling probes for ultrafine aerosols at Nansen; realization of the pneumatic and electronics interfaces for real time measurement system of aerosol, which has been positioned in the remote station of the Nansen Ice Sheet (NIS); laboratory tests of the acquired equipment, and in particular the system DMA and CPC for ultrafine aerosol size classification. Laboratory tests for the calculation of losses, depending on the size distribution of particles, inside the sampling lines.

The measurement campaign was performed during the XXII Italian Expedition.

The analysis of snow samples obtained at Terra Nova Bay allowed to obtain significant results despite the limited number of samples. Specifically:

- The concentrations of sea salts (derived from Na^+ ion concentrations) show a significant contribution to the overall concentration of ions examined, and this in agreement with data reported in previous publications, on the coastal areas of Antarctica.
- The ratio between soluble inorganic ions and Na^+ indicates that the nucleation process is important in the process of aerosol scavenging. It is possible to identify a contribution of thermal and diffusion foretic forces on scavenging.
- Sulphates not of marine origin (nss-SO_4^{2-}), derived from oxidation of dimethyl sulphide (DMS) in marine waters generated by the activities of plankton species, contribute to total sulphate in a proportion ranging from 60 to 73%. In samples of snow are also present soluble organic compounds: acetate, formate, pyruvate, oxalate and MSA.
- The association of the chemical composition of samples of snow with the shape of crystals, inferred from the replicates and from SEM examination, shows high concentrations of Na^+ and Cl^- ions in crystals relatively small (order of tens of micron), and concentrations lower in larger crystals (hundred of micron).
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The analysis of real time measurements of fine and ultrafine particles at the remote site in Nanseen Ice Sheet allowed to obtain significant results regarding the characteristics of aerosol and its dry deposition velocity. Specifically:

- It was analyzed the effect of limited time response of the condensation particle counter (CPC) for the assessment of the deposition rate by developing an appropriate correction technique based on digital filtering of data.
- The analysis of particle size distribution, albeit with limited statistics, showed the presence of two

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modes, one centered around 15-20 nm and one (with more weight) centered around 60-70 nm . The first mode (nanoparticles) appears to have more weight at low wind speed while the second mode is dominant at high wind speed characterised by the most relevant values of deposition velocity (on average about 1 mm/s).

- The data were analyzed, with the eddy correlation technique, for the evaluation of deposition of ultrafine particles on the Ice Sheet Nansen. The dry deposition was, on average 0.47 mm/s. The results indicate that higher deposition velocity are observed at high wind velocity.
 - Results indicate an almost linear correlation between the deposition velocity V_d and the friction velocity u^* . This could be the base of a parameterisation of V_d using the adimensional ratio V_d/u^* .
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Products

A – papers in scientific magazines

1. Prodi Franco, F., Belosi, G. Santachiara, D. Contini, L. Di Matteo, F. Grasso, "Chemical composition and shape of snow crystals in Antarctica", *Il Nuovo Cimento*, Vol. 31 C, N. 2, pp. 157-173, 2008.
2. Contini D., Donateo A., Belosi F., Grasso F.M., Santachiara G., Prodi F. Deposition velocity of ultrafine particles measured with eddy-correlation method over Nansen Ice Sheet (Antarctica). *Journal of Geophysical Research*, 115, D16202, 2010.
3. Belosi F., Contini D., Donateo A., Santachiara G. and Prodi F. *Aerosol size distribution at Nansen Ice Sheet Antarctica*. Submitted to *Tellus B*, 2011.

B – book chapters

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C - proceedings of international conferences

1. Prodi F., F. Belosi, L. Di Matteo, G. Santachiara, R. Udasti, F. Grasso, "Snow chemical composition in Antarctica and ice crystal shape", European Aerosol Conference 2008, Thessaloniki 24-29 August, 2008
2. Donateo A., Contini D., Belosi F., Grasso F. M., Santachiara G., Prodi F., 2009. *Measurements of concentrations and deposition velocity of ultrafine aerosol over the Nansen Ice Sheet (Antarctica)*. European Aerosol Conference (EAC 2009).

D – proceedings of national meetings and conferences

1. Prodi F., G. Santachiara, L. Di Matteo, F. Belosi, F. Grasso, R. Udasti. *Composizione chimica e forma di cristalli di neve in Antartide*, 3 Convegno Nazionale sul Particolato Atmosferico, Bari, 6-8 ottobre, 2008.
2. Donateo A., Contini D., Belosi F., Grasso F.M., Prodi F. *Concentrazione e flussi verticali turbolenti di nano particelle sul Nansen Ice Sheet (Antartide)*. Abstract per il XCIV Congresso Nazionale Società Italiana di Fisica. Genova, 21 -27 Settembre 2008. Atti del Convegno. p. 139.
3. Donateo A., Contini D., Belosi F., Prodi F. *Valutazione dell'effetto della risposta temporale dei sensori sulla misura dei flussi verticali turbolenti con la tecnica di eddy correlation su Nansen Ice Sheet (Antartide)*. Abstract XCV Congresso Nazionale Società Italiana di Fisica, 28 Settembre – 3 Ottobre 2009, Bari, p. 208.

E – thematic maps

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F – patents, prototypes and data bases

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G – exhibits, organization of conferences, editing and similar

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

1. Research fellowship: *Analisi di misure meteorologiche e di particolato atmosferico in tempo reale nello strato limite*. Assigned to Dr. Antonio Donateo. Activities performed at the Lecce Branch of Istituto di Scienze dell'Atmosfera e del Clima (ISAC-CNR).
 2. *Applicazione dello scattering ottico degli aerosol alla qualità dell'aria* Assigned to Dr. Lorenza DiMatteo. Activities performed at the Bologna Branch of Istituto di Scienze dell'Atmosfera e del Clima (ISAC-CNR).
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Research units

Unità Operativa 1:

Prof. Franco Prodi (Coordinatore), Direttore ISAC-CNR
Dr. Franco Belosi, Primo Tecnologo ISAC-CNR
Ing. Gianni Santachiara, Collaboratore scientifico ISAC-CNR
Dr. Marcello Tercon, Collaboratore tecnico ISAC-CNR
Dr. Stefania Travaini, Collaboratore Università di Ferrara
Dr. Lorenza DiMatteo, Assegnista di ricerca ISAC-CNR

Unità Operativa 2:

Dr. Daniele Contini (Coordinatore), Ricercatore ISAC-CNR
Dr. Paolo Martano, Ricercatore ISAC-CNR
Dr. Daniela Cava, Ricercatore ISAC-CNR
Dr. Mauro Tagliazucca, primo ricercatore ISAC-CNR
Dr. Antonio Donateo, Assegnista di ricerca ISAC-CNR
Sig. Fabio Massimo Grasso, CTER ISAC-CNR