

## Final project report

*Project ID:* 2003/6.4  
*Title:* *Study of heterogeneous nitrogen oxide chemistry on the snow surfaces*

*Principal investigator:* Antonietta Ianniello  
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*Duration:* 2 years  
*Assigned funding:* € 55.000,00

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### Activities and results

Findings of NO<sub>x</sub> production in snow interstitial air suggest that photochemical NO<sub>x</sub> production in or above snow surfaces is sufficient to alter the composition of the overlying atmosphere. Substantial amounts of HONO were also found in polar arctic atmospheres, possibly as intermediate. Simple calculations show that this species is responsible for the formation of OH radicals in the polar troposphere. This project is concerned with the mechanism of NO<sub>x</sub> and HONO releases. The current understanding points towards the absorption of some NO<sub>y</sub> species by aerosols in or above snow surfaces, the presence and subsequent reduction of nitrate in a surface phase followed by photochemical NO<sub>x</sub> release.

The measurements of gas species (HCl, HBr, HONO, HNO<sub>3</sub>, SO<sub>2</sub>, NO<sub>2</sub> and PAN) and their relative salts were carried out in the first year (2003) at Campo Icaro. Here two annular denuders systems were installed at two heights above the surface snow (low line at 50 cm and high line at 150 cm) to measure the concentration gradient of atmospheric compounds. The ion content of samples were analysed by an Ion Chromatograph in laboratories of the Antarctic Station. During the second year (2004) the activities were linked to that of Project 2004/6.2 by means of the ion chemical analysis, pH and conductivity of snow samples collected at Browning Pass. In this context, samples of snow and sea ice were collected at various distances from the coast.

Five species showed concentration gradients above the snow surfaces. The HCl, HBr and HNO<sub>3</sub> concentrations were significant higher in high line while NO<sub>2</sub> was higher in the low line. The particulate Br<sup>-</sup> showed a concentration gradient in the high line. This finding of NO<sub>2</sub> gradient in Antarctica is in agreement with previous results. It is also interesting to consider that HONO showed no gradient in our measurements. If we assume that the difference in concentrations between the two sampling heights is equal to the amount taken by the snow than our measures, it is showed that only 11.7% of emitted NO<sub>2</sub> is converted to HNO<sub>3</sub>. Bromine containing species are important for the ozone depletion in polar areas. Our measurements show that about 35% and 90% of gaseous and particulate bromine, respectively, may be taken by the snow. This indicates that bromine containing species are available for the reduction in the snow.

The chemical and physical composition of the snow surfaces were also determined to understand the HONO emissions from the snow. The snow precipitation was also examined during the measurement period. Thus, the influence of sea salt on the snow composition was studied because its deposition makes basic snow preventing atmospheric HONO emissions. The results show that the snow is mostly basic due to the dominant presence of sea salt composed primarily by sodium and chloride. Then nitrate in the snow is present as sodium nitrate (NaNO<sub>3</sub>), which does not allow the photolysis products to be emitted into the atmosphere.

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### Products

#### A – papers in scientific magazines

1. Ianniello, R. Sparapani, I. Allegrini, C. Vazzana, C. Mazziotti Gomez de Teran, M. Montagnoli, A. Fino, A. Felici (2003). Study of nitrogen containing compounds in the polar troposphere. *Annali di Chimica*, 93, 69.

## Programma Nazionale di Ricerche in Antartide (PNRA)

2. H. J. Beine, A. Amoroso, F. Dominé, M. D. King, M. Nardino, A. Ianniello, J. L. France (2006). Surprisingly small HONO emissions from snow surfaces at Browning Pass, Antarctica. *Atmospheric Chemistry and Physics*, 6, 2569.

### B – book chapters

1. Ianniello, I. Allegrini (2007). Determinazione delle specie gassose e particellari nella troposfera polare mediante i denuders di diffusione. *Clima e Cambiamenti Climatici – le attività di ricerca del CNR (CNR – Dipartimento Terra e Ambiente Editrice)*, 315.

### C - proceedings of international conferences

1. H. J. Beine, A. Amoroso, F. Dominé, A. Ianniello, T. Georgiadis, M. Nardino, M. King (2004). Fluxes of nitrous acid from snow surfaces in Antarctica. *Eos Trans. AGU*, 85(46), Fall Meet. San Francisco, CA, Suppl., Abstract A11B-0035.
2. H.J. Beine, A. Amoroso, A. Ianniello, F. Dominé, M. King, M. Nardino (2005). Surprisingly Small HONO Emissions Fluxes From Snow Surfaces at Browning Pass, Antarctica. *Eos Trans. AGU*, 85(52), Fall Meet. Suppl., A24A-04.

### D – proceedings of national meetings and conferences

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### 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. Assegno di ricerca su "Reattività diffusionale ed analisi di inquinanti atmosferici contenenti azoto" presso CNR - Istituto sull'Inquinamento Atmosferico.

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## Research units

### CNR-IIA: Responsabile Dott.ssa Antonietta Ianniello

Nome	Qualifica	Istituto
Antonietta Ianniello	Ricercatore	CNR-IIA
Harald J. Beine	Primo Ricercatore	CNR-IIA
Ivo Allegrini	Dir. Ricerca	CNR-IIA
Mauro Montagnoli	Tecnico	CNR-IIA

### CNR-ISAO: Responsabile Dott.ssa Marianna Nardino

Nome	Qualifica	Istituto
Teodoro Georgiadis	Primo Ricercatore	CNR-ISAO
Marianna Nardino	Ricercatore	CNR-ISAO
Ubaldo Bonafe'	Tecnico	CNR-ISAO
Francesco Calzolari	Tecnico	CNR-ISAO
Giuliano Trivellone	Tecnico	CNR-ISAO

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**Date:** 16 Ottobre 2008

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