

Final project report

Project ID: 2003/6.07
Title: Characterization of aerosol-induced climatic effects in polar regions: an assimilation and analysis of multi-spectral sun-photometer data from the POLAR-AOD network

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Duration: 2 years
Assigned funding: € 115.000,00

Activities and results

Among the factors influencing the Earth's energy balance, climate forcing induced by aerosols is acknowledged as having one of the largest uncertainties. As a consequence of peculiar conditions in the polar regions (high surface albedo, low solar elevation) aerosols of different chemical composition cause complicated and rather significant regional climatic effects which can modify considerably the overall albedo of the surface-atmosphere system. Despite the important role that aerosols play in modulating the radiation budget of the Polar regions, our knowledge of their physical and radiative properties, horizontal and vertical distributions and temporal variability remain still inadequate.

The POLAR-AOD project aims to characterize the means, variability and trends of the climate-forcing properties of aerosols in Polar Regions. In 2006 it was designated as International Polar Year (IPY) Project # 171. Measurements at Arctic and Antarctic stations are carried out with the logistical and financial support of established national programs, while archiving, data management, inter calibration and coordination of other activities are developed mainly in Italy at ISAC and ISTI CNR Institutes. Italian activity include also measurements at the coastal station Mario Zucchelli (MZS). Activities involve numerous cooperative institutes, including more than 40 research groups from 23 countries.

Activities performed along these years moved along three lines:

1 - determination of trends in the last 30 years, based on the critical analysis of historical data. A review paper summarizing the results were published on JGR in 2007.

2 - Establish a data archive of spectral sun-photometer measurements, in-situ measurements and derived radiative parameters of aerosols observed in the Polar atmosphere. A web page was realized (<http://polaroad.isti.cnr.it:8080/PolarAOD/>) and is actually under reconstruction in a new format (<http://polaroad.isti.cnr.it:8080/Polar/>). In the web page uploading and downloading functions were activate to allow creation of an archive. In this archive are flowing data collected during intercomparison campaign as well as the historical data. A forum to fast and simply link the community of experts and not was activated (<http://polaroad.isti.cnr.it/forum>).

3 - Organize and carry out intercomparison campaigns (an important task for any network). The first field campaign was performed during 2006 (March 25 to April 5 - before IPY operational period). The campaign was carried out at Ny Alesund (78°56' N, 11°52' E, 40m m.s.l.), hosted by the Japanese Rabben, German Koldway and Italian Dirigibile Italia, Stations. The objective was to inter-compare sun-photometers of different design that are used operationally at a number of Arctic and Antarctic stations. Ten research groups representing nine countries participated to this campaign. A second field campaign is in progress at the Izaña Atmospheric Observatory, located at 2365 m altitude along the slope of the Teide volcano in the Tenerife Island (Canarian Archipelago).

Products

A – papers in scientific magazines

1. C. Tomasi, V. Vitale, A. Cacciari, A. Lupi, A. Pellegrini and 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*, Vol. **71**, pp. 139-169.
2. C. Di Carmine, M. Campanelli, T. Nakajima, C. Tomasi and V. Vitale, 2005: Retrievals of Antarctic aerosol characteristics using a Sun-sky radiometer during the 2001-2002 austral summer campaign, *Journal of Geophysical Research*, Vol. **110**, D13202, doi:10.1029/2004JD005280.
3. C. Tomasi, V. Vitale, B. Petkov, A. Lupi and A. Cacciari, 2005: Improved algorithm for calculations of Rayleigh-scattering optical depth in standard atmospheres, *Applied Optics*, Vol. **44**, pp. 3320-3341.
4. C. Tomasi, B. Petkov, E. Benedetti, V. Vitale, A. Pellegrini, G. Dargaud, L. De Silvestri, P. Grigioni, E. Fossat, W. L. Roth, L. Valenziano, 2006: Characterization of the atmospheric temperature and moisture conditions above Dome C (Antarctica) during austral summer and fall months, *Journal of Geophysical Research*, Vol. **111**, D20305, doi: 10.1029/2005JD006976.
5. C. Tomasi, V. Vitale, A. Lupi, C. Di Carmine, M. Campanelli, A. Herber, R. Treffeisen, R. S. Stone, E. Andrews, S. Sharma, V. Radionov, W. von Hoyningen-Huene, K. Stebel, G. H. Hansen, C. L. Myhre, C. Wehrli, V. Aaltonen, H. Lihavainen, A. Virkkula, R. Hillamo, J. Ström, C. Toledano, V. Cachorro, P. Ortiz, A. de Frutos, S. Blindheim, M. Frioud, M. Gausa, T. Zielinski, T. Petelski and T. Yamanouchi, 2007: Aerosols in polar regions: A historical overview based on optical depth and in situ observations. *Journal of Geophysical Research*, Vol. **112**, D16205, doi:10.1029/2007JD008432, 2007.
6. M. Campanelli, V. E. Leal, C. Tomasi, T. Nakajima, V. Malvestuto and J. A. Martinez-Lozano, 2007: Application of the SKYRAD improved Langley plot method for the in situ calibration of CIMEL sun-sky photometers, *Applied Optics*, Vol. **46**, 2688-2702.
7. C. Tomasi, B. Petkov, E. Benedetti, L. Valenziano, A. Lupi, V. Vitale and U. Bonafè, 2008: A Refined Calibration Procedure of Two-channel Sun-Photometers to Measure Atmospheric Precipitable Water at Various Antarctic Sites, *Journal of Atmospheric and Oceanic Technology*, Vol. **25**, No. 2, February 2008, 213-229.

B – book chapters

1. Lupi, C. Lanconelli, M. Mazzola, V. Vitale, C. Tomasi, 2007. Effetti radiativi diretti indotti dagli aerosol presso le stazioni MZS e Dome C in Antartide. In *Clima e Cambiamenti Climatici, le attività di ricerca del CNR* (a cura di B. Carli, G. Cavarretta, M. Colacino, S. Fuzzi), Consiglio Nazionale delle Ricerche, ISBN 978-88-8080-075-0, pp. 327-330.

C - proceedings of international conferences

1. C. Tomasi, V. Vitale, W. von Hoyningen-Huene, M. Campanelli, A. Lupi, F. Barnaba, A. Cacciari, T. Nakajima, G. Gobbi and B. Olivieri, 2004: *Determining Direct Aerosol-Induced Radiative Forcing Through Experiments and Closure Studies*, Invited paper at the World Climate Change Conference, 2003, September 29–October 3, Moscow, Russia, 12 pp.
2. V. Vitale, C. Tomasi, T. Yamanouchi, A. Herber and R.S. Stone, 2007, *The polar aerosol depth measurement network project* (POAR-AOD-IPY) Proceedings of the International Symposium Asian Collaboration in IPY 2007-2008, 1st March 2007, Tokyo, pp. 222-225.
3. M. Shiobara (NIPR), R. Stone (NOAA/U. Colorado), A. Herber (AWI), V. Vitale, C. Tomasi (ISAC), and Polar-AOD Campaign participants, *The First Polar-AOD Radiometer Inter-comparison Experiment at Ny-Alesund in the Arctic: Preliminary Result and Validation Analysis*, 29th Symposium on Polar Meteorology and Glaciology, 20-21 November 2006, NIPR, Tokyo, comunicazione orale, abstract 2 pp. pubblicato sui Proceedings del Convegno.
4. Andreas Herber, Claudio Tomasi, V. Vitale, Robert S. Stone, Takashi Yamanouchi, 2007, *The Polar Aerosol Optical Depth Measurement Network Project (POLAR-AOD-IPY)*, 2nd Ny-Ålesund – Pallas - Sodankylä Atmospheric Research workshop, Ny Alesund, 16-18 April 2007,
5. V. Vitale, Robert S. Stone, C. Tomasi, A. Herber, *The Polar Aerosol Optical Depth Measurement Network Project (POLAR-AOD-IPY)*, Global Environmental Change: The Role of the Arctic 13-17 October 2007, Nynäshamn, Sweden

D – proceedings of national meetings and conferences

1. Lupi, C. Lanconelli, M. Mazzola, B. Petkov, C. di Carmine, V. Vitale and C. Tomasi, *Direct Radiative forcing induced by aerosol particles in Antarctica*, XI Workshop Fisica e Chimica dell'Atmosfera Antartica, Roma, 10-12 Aprile 2007, SIF Conference Proceedings, in press.

E – thematic maps

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F – patents, prototypes and data bases

Programma Nazionale di Ricerche in Antartide (PNRA)

1. POLAR-AOD web page and archive old <http://polar.aod.isti.cnr.it:8080/PolarAOD/>
new format <http://polar.aod.isti.cnr.it:8080/Polar/>
2. POLAR-AOD forum <http://polar.aod.isti.cnr.it/forum>

G – exhibits, organization of conferences, editing and similar

1. 1st POLAR-AOD workshop October, 27-29, 2003 Bologna, Italy
2. 1st Inter-comparison campaign March 25, April 5, 2006 Ny Alesund, Svalbard
3. 2nd POLAR-AOD Workshop April, 4-5, 2006 Ny Alesund Svalbard
4. 2nd Inter-comparison campaign October, 6-20, 2008 Izaña Observatory, Tenerife, Spain
5. 3rd POLAR-AOD Workshop October, 6-20, 2008 Izaña Observatory, Tenerife, Spain

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

1. 2003-2006 Dottorato di Ricerca in Scienze Polari, Scuola di Dottorato di Ricerca in Scienze Polari XVIII Ciclo, *Valutazione degli effetti radiativi diretti delle particelle di aerosol in alcune regioni del Continente Antartico*, Università degli Studi di Siena, SIENA.

Research units

Unità operativa 1: COL-TOM

Coordinatore:

Claudio Tomasi, Dirigente di Ricerca Associato, ISAC-CNR,
Vito Vitale, Primo Ricercatore, ISAC-CNR,
Stefano Marani, Incaricato di Ricerca, ISAC-CNR,
Angelo Lupi, Dottorando, Uni Siena, ISAC-CNR,
Christian Lanconelli, Assegnista, ISAC-CNR,
Monica Campanelli, Assegnista, ISAC-CNR,
Ubaldo Bonafè, Tecnico STER, ISAC-CNR,
Giuliano Trivellone, Tecnico CTER, ISAC-CNR,
Francescopiero Calzolari, Tecnico, ISAC-CNR.

Unità Operativa 2: COL-OVI

Coordinatore:

Ovidio Salvetti, Primo Ricercatore CNR, ISTI-CNR,
Maria Grazia Di Bono, Assegnista, ISTI-CNR,
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Note