

Final project report

Project ID: 2002/5.2
Title: *Mass Balance of Dome C drainage area*

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Duration: 2 years
Assigned funding: € 128.800,00

Activities and results

The project has contributed to reduce the uncertainties in the determination of components of the surface mass balance of the Dome C drainage area, to monitor and study the local glaciers of Victoria Land, and to provide information for a future deep ice core in Talos Dome area.

Spatial variability measurements show that wind-driven sublimation processes, controlled by the surface slope in the wind direction, have a huge impact (up to 85% of snow precipitation) on surface mass balance and are significant in terms of past, present and future surface mass balance evaluations. The spatial variability of surface mass balance at the kilometre scale is one order of magnitude higher than its temporal variability (20–30%) at the centennial time scale. Compared with our surface mass balance calculations, previous compilations generally over-estimate surface mass balance, up to 65% in some areas. The extensive presence (up to 30%) of glazed surface caused by a long hiatus in accumulation, with an accumulation rate of nil or slightly negative, has a significant impact on the surface mass balance of a wide area of the interior and coastal part of East Antarctica.

Snow accumulation rates and firn temperatures show warmer temperatures and higher accumulation values close to the ice divides extending from Talos Dome and Dome C to the Southern Ocean. The spatial pattern of data is linked with a katabatic-wind-source basin and moisture-source region. Remote sensing analysis and field observations have allowed the study of snow surface characteristic and megadune genesis (permanent and unusual feedback system between the cryosphere and atmosphere). Elevation variations of ice sheet surface using submerged velocity systems show a steady state condition along Terra Nova Bay-Dome C sector.

The study of chemical, isotopic and accumulation-rate variability allowed the identification of a distribution pattern which is controlled not only by altitude and distance from the sea, but also by the complex circulation of air masses in the study area. Moreover, we observed a decrease in concentration of aerosol components in the central portion of the Wilkes Land transect and in the southern portion of the Talos Dome transect; this decrease was linked to the higher stability of atmospheric pressure due to the channelling of katabatic winds.

The study of Strandline Glacier (Terra Nova Bay) has allowed the calculation of summer changes in thickness and in volume. This serves to identify and quantify the processes responsible for these variations and to understand the energy transfers at the glacier-air interface.

The Talos Dome survey has provided information for location of deep ice core TALDICE project. Talos Dome summit is situated above a sloped bedrock and internal layer of ice covered by about 1900 m of ice, whereas there is a relatively flat bedrock and internal layer 6 km away, along the southeast ice divide, where the bedrock is covered by 1550 m of ice. Data indicate that the stake closest to the summit moves south-southeast at a few cm a⁻¹. A preliminary age vs depth model for Talos Dome predicts that the ice 100 m above the bedrock may cover one glacial-interglacial period. A record of snow accumulation, isotopic temperature volcanic eruptions covering the last 800 years has been reported from a 90 m firn core drilled at Talos Dome. The results pointed out that Talos Dome has a good geochemical and paleoclimate record preserved in the ice, because the accumulation is higher there than at other domes in East Antarctica.

Activities and results

A – papers in scientific magazines

1. Baroni C., Frezzotti M., Salvatore M.C., Meneghel M., Tabacco I.E., Vittuari L., Bondesan A., Biasini A., Cimbelli A., and Orombelli G. (2004) Antarctic Geomorphological and Glaciological 1:250,000 map series. Mt. Murchison Quadrangle (northern Victoria Land). Explanatory notes. *Ann. Glaciol.* 39, 256-264.
2. Becagli S., S. Benassai, E. Castellano, O. Largiuni, A. Migliori, R. Traversi, O. Flora, R. Udisti. Chemical characterization of the last 250 years of snow deposition at Talos Dome (East Antarctica) (2004). *Intern. J. Environ. Anal. Chem.*, 84(6-7), 523-536.
3. Becagli S., Proposito M., Benassai S., Flora O., Genoni L., Gragnani R., Largiuni O., Pili S.L., Severi M., Stenni B., Traversi R., Udisti R., Frezzotti M. (2004) Chemical and isotopic snow variability in East Antarctica along the 2001/02 ITASE traverse. *Ann. Glaciol.* 39, 473-482.
4. Bianchi C., Cafarella L., De Michelis P., Forieri A., Frezzotti M., Tabacco I.E., Zirizzotti A. (2003). Radio Echo Sounding (RES) investigations at Talos Dome (East Antarctica): bedrock topography and ice thickness. *Ann. Geophys.*, 46 (6), 1265-1270.
5. Casacchia R., R. Salvatori, A. Cagnati, M. Valt, S. Gergo (2002). Field reflectance of snow/ice covers at Terra Nova Bay, Antarctica. *Int. J. Remote Sensing*, 4563-4667.
6. Diolaiuti G., C. Smiraglia, G. Vassena and M. Motta (2004). Dry-calving processes at the ice cliff of Strandline Glacier, northern Victoria land, Antarctica. *Ann. Glaciol.* 39, 201-208.
7. Folco L., Capra A., Chiappini M., Frezzotti M., Mellini M., Tabacco I.E. (2002). The Frontier Mountain meteorite trap (Antarctica). *Meteoritics & Planetary Science*, 37, 209-228.
8. Frezzotti M., Bitelli G., de Michelis P., Deponti A., Forieri A., Gandolfi S., Maggi V., Mancini F., Rémy F., Tabacco I.E., Urbini S., Vittuari L., Zirizzotti A. (2004). Geophysical survey at Talos Dome (East Antarctica): the search for a new deep-drilling site. *Ann. Glaciol.* 39, 423-432.
9. Frezzotti M. & Flora O. (2002). Ice dynamics and climatic surface parameters in East Antarctica from Terra Nova Bay to Talos Dome and Dome C: ITASE Italian Traverses. *Terra Antarctica* 9(1), 47-54.
10. Frezzotti M., Gandolfi S., La Marca F. and Urbini S. (2002) Snow dune and glazed surface in Antarctica: new field and remote sensing data. *Ann. Glaciol.* 34, 81-88.
11. Frezzotti M., Gandolfi S. and Urbini S. (2002). Snow megadune in Antarctica: sedimentary structure and genesis. *J. Geoph. Res.*, 107 (D18), 4344, doi:10.1029/2001JD000673, 1-12.
12. Frezzotti M. & Polizzi M. (2002) 50 years of ice front changes along Adélie and Clarie Coasts (East Antarctica). *Ann. Glaciol.* 34, 235-240.
13. Frezzotti M., Pourchet M., Flora O., Gandolfi S., Gay M., Urbini S., Vincent C., Becagli S., Gragnani R., Proposito M., Severi M., Traversi R., Udisti R., Fily M. (2004). New estimations of precipitation and surface sublimation in East Antarctica from snow accumulation measurements. *Climate Dynamics*, 23(7-8): 803-813 (DOI: 10.1007/s00382-004-0462-5).
14. Gay, M., M. Fily, C. Genthon, M. Frezzotti, H. Oerter, and J.G. Winther (2002). Snow grain size measurements in Antarctica, *J. Glaciol.*, 48(163), 527-535.
15. Goosse H., Masson-Delmotte V., Renssen H., Delmotte M., Fichefet T., Morgan V., van Ommen T., Khim B. K. & Stenni B (2004). A late medieval warm period in the Southern Ocean as a delayed response to external forcing? *Geophysic. Res. Lett.*, 31, L06203, doi: 10.1029/2003GL019140.
16. ISMASS Committee Abdalati W., I. Allison, F. Carsey, G. Casassa, M. Fily, M. Frezzotti, H.A. Fricker, C. Genthon, I. Goodwin, Z. Guo, G.S. Hamilton, R.C.A. Hindmarsh, C.L. Hulbe, T.H. Jacka, K.C. Jezek, R. Kwok, J. Li, U. Nixdorf, G. Paltridge, E. Rignot, C. Ritz, K. Satow, T.A. Scambos, C. Shuman, P. Skvarca, S. Takahashi, R.S.W. van de Wal, D.G. Vaughan, W.L. Wang, R.C. Warner, D.J. Wingham, N.W. Young, H.J. Zwally. (2004). Recommendations for the collection and synthesis of Antarctic Ice Sheet mass balance data. *Global and Planetary Change*, 42, 1 –15.
17. Largiuni O., E. Castellano, A. Migliori, R. Traversi, G. Piccardi, R. Udisti (2004). Preliminary study of HCHO spatial and temporal distribution from coastal to plateau areas in Antarctica. *Intern. J. Environ. Anal. Chem.*, 84(6-7), 537-549
18. Magand O., Frezzotti M., Pourchet M., Stenni B., Genoni L., Fily M. (2004). Climate variability along latitudinal and longitudinal transects in east Antarctica, *Ann. Glaciol.* 39, 351-358.
19. Motta L. and M. Motta (2004). Distribution and pattern of shallow melting at the local glacier of Terra Nova Bay (Antarctica) coast. *Ann. Glaciol.* 39, 483-489.
20. Pourchet M., Magand O., Frezzotti M., Ekaykin A. and J.-G. Winther (2003). Radionuclides deposition over Antarctica, *J. Environmental Radioactivity*, 68, 137-158.
21. Proposito M., Becagli S., Castellano E., Flora O., Gragnani R., Stenni B., Traversi R., Udisti R., and Frezzotti M. (2002). Chemical and isotopic snow variability along the 1998 ITASE traverse from Terra Nova Bay to Dome C (East-Antarctica), *Ann. Glaciol.*, 35, 187-194.

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22. Stenni B., Proposito M., Gragnani R., Flora O., Jouzel J., Falourd S. and Frezzotti M. (2002). Eight centuries of volcanic signal and climate change at Talos Dome (East Antarctica). *J. Geoph. Res.*, D9, 107, 10.1029/2000JD000317, 1-14.
23. Traversi R., Becagli S., Castellano E., Largiuni O., Migliori A., Severi M., Frezzotti M., Udisti R. (2004). Spatial and temporal distribution of environmental markers from coastal to plateau areas in Antarctica by firn core chemical analysis. *Intern.J. Environ. Anal. Chem.* Vol.84 (6-7),457-470.
24. Urbini S., Cafarella L., Zirizzotti A., Bianchi C., Tabacco I. E., Frezzotti M. (2006). Location of a new ice core site at Talos Dome (East Antarctica) *An. Geophys.*, Vol 49 N.4/5 1133-1138, (2006).
25. Vittuari L., Vincent C., Frezzotti M., Mancini F., Gandolfi S., Bitelli G., Capra A. (2004). Space geodesy as a tool for measuring ice surface velocity in the Dome C region and along ITASE traverse (East Antarctica). *Ann. Glaciol.* 39, 402-408.

B – book chapters

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C - proceedings of international conferences

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D – proceedings of national meetings and conferences

1. Becagli S., S. Benassai, E. Castellano, M. Severi, R. Traversi, R. Udisti (2004). Distribuzione spaziale di componenti chimici nelle deposizioni nevose del settore BTN-Dome C-DDU (Antartide). Parte I - composti dello S. X Convegno Nazionale "La contaminazione chimica in Antartide", Venezia (Italy), 10-11 giugno 2004. Conference Proceedings, pp. 205-217.
2. Becagli S., E. Castellano, M. Frezzotti, O. Largiuni, R. Traversi, R. Udisti (2002). Correlazioni tra i profili di marker biogenici in carote di firn e variazioni del ghiaccio marino nel mare di Ross (Antartide). Risultati preliminari. In: P. Cescon ed., PNRA - IX Convegno Nazionale "La contaminazione chimica in Antartide" – Proceedings. Viareggio (Italy), 23-24 Giugno 2002, pp. 184-197.
3. Becagli S., Frezzotti M., Gragnani R., Migliori M., Proposito M., Traversi R., & Udisti R. (2003). Variability of snow depositions along the 1998/99 ITASE traverse. Proceedings of the 4th Italian Meeting on Antarctic Glaciology Ed. Frezzotti M. & Maggi V. Terra Antartica Reports No 8, 43-48.
4. Benassai S., S. Becagli, E. Castellano, M. Innocenti, R. Traversi, R. Udisti. Distribuzione spaziale di componenti chimici nelle deposizioni nevose del settore BTN-Dome C-DDU (Antartide) (2004). X Convegno Nazionale "La contaminazione chimica in Antartide", Venezia (Italy), 10-11 giugno 2004. Conference Proceedings, pp. 218-230.
5. Diolaiuti G., C. Salvatore & C. Smiraglia (2003). First Attempt to Classify and Inventory Local or "Alpine" Glaciers in Northern Victoria Land (Antarctica). *Terra Antarctica Reports*, 9, 1-6.
6. Flora O., Genoni L., Stenni B., Proposito M. & Frezzotti M. (2003). Tritium activity variations along the ITASE TNB-DC traverse. Proceedings of the 4th Italian Meeting on Antarctic Glaciology Ed. Frezzotti M. & Maggi V. Terra Antarctica Reports No 8, 49-52.
7. Frezzotti M., Bitelli G., Gandolfi S., De Michelis P., Mancini F., Urbini S., Vittuari L., Zirizzotti A. (2003). Geophysical survey at Talos Dome (East Antarctica). Proceedings of the 4th Italian Meeting on Antarctic Glaciology Ed. Frezzotti M. & Maggi V. Terra Antarctica Reports No 8, 117-120.
8. Frezzotti M., Ceinini A., Gandolfi S., Giardini P., Flati D., Pourchet M., Quintavalla A., & Urbini S. (2003). Italian ITASE Traverse from D85 to M4. Proceedings of the 4th Italian Meeting on Antarctic Glaciology Ed. Frezzotti M. & Maggi V. Terra Antarctica Reports No 8, 53-56.
9. Frezzotti M. & Maggi V. (2003). Eds. Proceedings of the 4th Italian Meeting on Antarctic Glaciology, Terra Antarctica Reports No 8, 1-216.
10. Largiuni O., S. Becagli, M. Frezzotti, M. Severi, R. Traversi, R. Udisti. H₂O₂ and HCHO distribution in surface snow and firn from coastal areas to Dome C (Antarctica) (2002). In: "Italian Research on Antarctic Atmosphere" - M. Colacino ed., SIF - Bologna, 2002, 80, 253-262.
11. Mancini M. & Frezzotti M. (2003) Surface wind Field along IT-ITASE traverse (East Antarctica). Proceedings of the 4th Italian Meeting on Antarctic Glaciology Ed. Frezzotti M. & Maggi V. Terra Antarctica Reports No 8, 57-59.
12. Mancini M., Frezzotti M., Smiraglia C., Gragnani R., Zirizzotti A., Motta L., Pavan M. (2003) Mass Balance of Campbell Glacier (Northern Victoria Land, Antarctica). Proceedings of the 4th Italian Meeting on Antarctic Glaciology Ed. Frezzotti M. & Maggi V. Terra Antarctica Reports No 8, 11-14.
13. Motta M., G. Diolaiuti, C. Smiraglia & G. Vassena (2003) Mass Balance and Energy Balance Measurements at Strandline Glacier (Terra Nova Bay, Antarctica). Terra Antarctica Reports No 8.
14. Motta L. & M. Motta (2003) Penetration of radiation in Antarctic snow and ice Proceedings of the 4th Italian Meeting on Antarctic Glaciology Ed. Frezzotti M. & Maggi V. Terra Antarctica Reports No 8.
15. Proposito M., Gragnani R., Flora O., Genoni L. & Frezzotti M. (2003) Volcanic records at GPS1, GPS2, 31DPT and M2 stations along the 1998-99 ITASE traverse (East Antarctica). Proceedings of the 4th Italian Meeting on Antarctic Glaciology Ed. Frezzotti M. & Maggi V. Terra Antarctica Reports No 8, 60-66.
16. Proposito M., Gragnani R., Udisti R. & Frezzotti M. (2003) NssCl⁻, NO₃⁻ and MSA losses in M2 firn core, along the 1998-99 ITASE traverse from Terra Nova Bay to Dome C (East-Antarctica). Proceedings of the 4th Italian Meeting on Antarctic Glaciology Ed. Frezzotti M. & Maggi V. Terra Antarctica Reports No 8, 67-72.

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17. Salvatori R., R. Casacchia, A. Grignetti, M. Valt, A. Cagnati, P. Plini (2004) Cartografia delle coperture nevose nelle Svalbard Occidentali. Atti VIII Conferenza ASITA Roma 14-17 dicembre 2004, vol. II, 1795-1796.
18. Stenni B., Genoni L., Flora O., Udisti R., Becagli S., Largiuni O. & Frezzotti M. (2003). The chemical and isotopic signal in the ITASE TNB-DC traverse surface snow. Proceedings of the 4th Italian Meeting on Antarctic Glaciology Ed. Frezzotti M. & Maggi V. Terra Antartica Reports No 8, 73-76.
19. Udisti R., S. Becagli, S. Benassai, I. Fattori, O. Largiuni, R. Traversi. Nitrati in Northern Victoria Land (Antartide) (2002). In: P. Cescon ed., PNRA – IX Convegno Nazionale “La contaminazione chimica in Antartide” – Proceedings. Viareggio (Italy), 23-24 Giugno 2002, pp. 132-157.
20. Truzzi C., L. Lambertucci, A. Annibaldi, G. Gambini, S. Becagli, R. Traversi, R. Udisti, G. Scarponi (2002). Studi chemiometrici sulle nevi antartiche: identificazione delle fonti di aerosol mediante analisi delle componenti principali. In: P. Cescon ed., PNRA – IX Convegno Nazionale “La contaminazione chimica in Antartide” – Proceedings. Viareggio (Italy), 23-24 Giugno 2002, pp. 164-183.
21. Truzzi C., L. Lambertucci, A. Annibaldi, G. Gambini, S. Becagli, R. Traversi, R. Udisti, G. Scarponi (2003). Identification of sources of antarctic aerosol in Victoria Land by means of Principal Component Analysis of chemical data. Terra Antartica Reports, 2003, No. 8, 37-42.

E – thematic maps

1. Baroni C., Frezzotti M., Salvatore M.C., Meneghel M., Tabacco I.E., Vittuari L., Bondesan A., Biasini A., Cimbelli A., and Orombelli G. (2004) Antarctic Geomorphological and Glaciological 1:250,000 map series. Mt. Murchison Quadrangle (northern Victoria Land). MNA Siena.
2. Frezzotti M., Raffi R., Guarracino M. & Mancini M. (2002). Glaciological Map Of Matushevich Glacier Area (Oates Coast, East Antarctica). Terra Antartica Report, 7, 1-8.

F – patents, prototypes and data bases

1. Motta M., G. Diolaiuti, C. Smiraglia (2007) – Un esempio di bilancio di massa di ghiacciaio locale antartico: lo Strandline Glacier (Terra Vittoria Settentrionale). CD-ROM Proc. Careser 40, 30 giugno 2007, Cogolo di Peio.

G – exhibits, organization of conferences, editing and similar

1. 4^o Convegno Nazionale di glaciologia antartica (CONGA) Milano 25-26 giugno 2002.
2. Workshop EPICA-ITASE, Potsdam 18-20 September 2002
3. ISMASS Workshop on Antarctic Ice Sheet Mass Balance, Milano, August 24, 2003
4. 7th International Symposium on Antarctic Glaciology. Milano 25-29 August, 2003

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

Assegni di ricerca e Borsisti

- Castellano Emiliano
- Mancini Francesco
- Migliori Alessio
- Genoni Laura
- Sterzai Paolo
- Urbini Stefano

Dottorati in Scienze Polari

- Alessandro Forieri
- Marco Proposito

Research units

UO ORO-BIA.1

- Cesidio Bianchi
- Massimo Chiappini
- Enrico Zuccheretti
- Achille Zirizzotti
- Paola De Michelis
- Umberto Sciacca

UO ORO-CAS

- Casacchia Ruggero

Programma Nazionale di Ricerche in Antartide (PNRA)

- Salvatori Rosamaria
- Cagnati Anselmo
- Valt Mauro
- Zasso Renato
- Ghergo Stefano

UO ORO-COR

- Franco Coren
- Paolo Sterzai
- Roberto Vidmar
- Francesco Palmieri

UO ORO-BNC

- Motta Michele
- Motta Luigi
- Ajassa Roberto

UO ORO-SMI

- Smiraglia Claudio
- Diolaiuti Guglielmina
- Pavan Mauro
- Vassena Giorgio
- Valla Francois

UO ORO-TAB.1

- Tabacco Ezio Ignazio
- Forieri Alessandro
- Alessio della Vedova
- Urbini Stefano
- Lozej Alfredo
- Tartaglia Antonio
- Passerini Andrea
- Tosi Nicola

UO ORO-FRE

- Frezzotti Massimo
- Mancini Mauro
- La Marca Floriana
- Gragnani Roberto
- Proposito Marco
- De Cassan Maurizio

UO ORO-BIT

- Bitelli Gabriele
- Capra Alessandro
- Vittuari Luca
- Gandolfi Stefano
- Mancini Francesco
- Vassena Giorgio

UO ORO-BEC

- Silvia Beccagli
- Rita Traversi
- Emiliano Castellano
- Alessio Migliori

UO ORO-FLO.2

- Flora Onelio
- Salvi Gianguido
- Genoni Laura

Date: