

Final project report

<i>Project ID</i>	2004/5.2
<i>Title</i>	Surface mass balance of Dome C and Talos Dome drainage area (SURFMASS)
<i>Principal investigator</i>	Massimo Frezzotti
<i>Institution</i>	ENEA
<i>Email</i>	massimo.frezzotti@enea.it
<i>Duration</i>	3 years
<i>Assigned funding</i>	420.000,00 Euro

Activities and results

Snow accumulation is one of most direct climate change indicator and has important implications for ice sheet mass balance and palaeoclimatic reconstruction from ice cores. The extreme environmental conditions and remote location of Antarctica have long inhibited the systematic study of its climate and snow accumulation processes (Eisen et al., 2008; Remy and Frezzotti, 2006; Mayewski et al., 2005). Measurement of blowing snow in Antarctica is very difficult and limited and data are only available for a few sites. Blowing snow transport and erosion data detected by instruments, snow radar profiles, firn cores, stakes and satellite images were acquired in East Antarctica (Frezzotti et al., 2005, 2007; Magand et al., 2007; Scarchilli et al., 2010). Our result point out that in the convergence slope/coastal areas of Antarctica, a large fraction of snow is continuously eroded and exported by wind to the atmosphere and into the ocean. Wind-driven processes are fundamental components of surface mass balance. Spatial variations in accumulation are well correlated with surface slope changes along the prevalent wind direction (Frezzotti et al., 2007; in preparation). Extensive presence of ablation surface (blue ice and wind crust) upwind and downwind of the measurement site suggest that the combine processes of blowing snow sublimation and snow transport remove up to 50% of the precipitation in the coastal and slope convergence area (Frezzotti et al., 2007; Scarchilli et al., 2010). These phenomena represent a major negative effect on the snow accumulation and, till now, they are not sufficiently taken into account in studies and simulation of surface mass balance. The observed wind-driven ablation explains the inconsistency between atmospheric model precipitation and measured snow accumulation value (Frezzotti et al., 2007; Magand et al., 2007). Temporal variability of accumulation over the last two centuries shows no significant increase in accumulation in Dome C and Talos Dome drainage area (Frezzotti et al., 2007; Monaghan et al., 2006; Strassmeier et al., 2007; Urbini et al., 2008). Observations of time/source variability of precipitation (Scarchilli et al., in preparation) and of redistribution/sublimation process are studied (Frezzotti et al., 2005; 2007) for improving the climate and meteorological models and for studying post-depositional losses of chemical species by re-emission (Becagli et al., 2005; Benassai et al., 2005) and snow metamorphism (Macelloni et al., 2006, 2007). Research on Talos Dome area aimed to determine the spatial relationship between precipitation isotopic composition and local temperature (Masson-Delmotte et al., 2008), to improve our understanding of the factor that control the chemistry of snow and ice core records (Becagli et al., 2005, 2009; Benassai et al., 2005; Bertler et al., 2005; Morganti et al., 2007; Sala et al., 2008; Traversi et al., 2007), and find the best location to extract an undisturbed ice core down to the bedrock (Urbini et al., 2006).

Products

A – papers in scientific magazines

1. Becagli S., Castellano E., Cerri O., Curran M., Frezzotti M., Marino F., Moranti A., Proposito M., Severi M., Traversi R., Udisti R. (2009) Methanesulphonic acid (MSA) stratigraphy from a Talos Dome ice core as a tool in depicting sea ice changes and southern atmospheric circulation over the previous 140 years. *Atmospheric Environment*, 43, 1051–1058

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2. Becagli S., M. Proposito, S. Benassai, R. Gragnani, O. Magand, R. Traversi and R. Udisti (2005). Spatial distribution of biogenic sulphur compounds (MSA, nssSO₄²⁻) in the northern Victoria Land - Dome C- Wilkes Land area (East Antarctica). *Ann. Glaciol.* Vol. 41, 23-31.
3. Benassai S., S. Becagli, R. Gragnani, O. Magand, M. Proposito, I. Fattori, R. Traversi and R. Udisti (2005). Sea spray deposition in Antarctic coastal and plateau areas from ITASE traverses. *Ann. Glaciol.*, Vol. 41, 32-40.
4. Bertler N., Mayweski P., Aristarain A., Barrett P., Becagli S., Bernardo R., Bo S., Cunde X., Curran M., Qin Dahe, Dixon D., Ferron F., Fischer H., Frey M., Frezzotti M., Fundel F., Genthon C., Gragnani R., Hamilton G., Handley M., Hong S., Isaksson E., Jiancheng K., Jiawen R., Kamiyama K., Kanamori S., Kärkäs E., Karlöf L., Kaspari S., Kreuz K., Kurbatov A., Meyerson E., Ming Y., Mingjun Z., Motoyama H., Mulvaney R., Oerter H., Osterberg E., Proposito M., Pyne A., Ruth U., Simoes J., Smith B., Sneed S., Teinilä K., Traufetter F., Udisti R., Virkkula A., Watanabe O., Williamson B., Winther G., Yuansheng L. Wolff E., Zhongqin L., Zielinski A. (2005). Snow chemistry across Antarctica. *Ann. Glaciol.*, vol.41, 167-179.
5. Eisen O., M. Frezzotti M., C. Genthon, E. Isaksson, O. Magand, M. van den Broeke, D. A. Dixon, A. Ekaykin, P. Holmlund, T. Kameda, L. Karlöf, S. Kaspari, V. Y. Lipenkov, H. Oerter, S. Takahashi, D.G. Vaughan (2008) Ground-based measurements of spatial and temporal variability of snow accumulation in East Antarctica *Reviews of Geophysics*, *Rev. Geophys.*, 46, 1-39, RG2001, doi:10.1029/2006RG000218.
6. 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. (2005). Spatial and temporal variability of snow accumulation in East Antarctica from traverse data. *J. Glaciol.*, 51(172), 113-124.
7. Frezzotti M., Urbini S., Proposito M., Scarchilli C., Gandolfi S. (2007). Spatial and temporal variability of surface mass balance near Talos Dome, East Antarctica. *J. Geoph. Res.*, VOL. 112, F02032, doi:10.1029/2006JF000638, 2007.
8. Macelloni G., Brogioni M., Pampaloni P., Cagnati A. e Drinkwater M. (2006). DOMEX 2004: An experimental Campaign at Dome C (Antarctica) for the calibration of Spaceborne Low-Frequency Microwave Radiometers *IEEE Transactions on Geoscience and Remote Sensing*, Vol.44, No.10, 2642-2653
9. Macelloni G., Brogioni M., Pampaloni P. and A. Cagnati (2007). Multifrequency Microwave Emission From the Dome C Area on the East Antarctic Plateau: Temporal and Spatial Variability *IEEE Transactions on Geoscience and Remote Sensing*, Vol.45 No. 7, 2029-2039.
10. Magand, O, Genthon, C., Fily, M., Krinner, G., Picard, G., Frezzotti, M., Ekaykin, A.A. (2007). An up-to-date quality-controlled surface mass balance data set for the 90 –180 E Antarctica sector and 1950–2005 period *J. Geoph. Res.*, 2006JD007691 VOL. 112, D12106, doi:10.1029/2006JD007691, 2007.
11. Masson-Delmotte V., S. Hou, A. Ekaykin, J. Jouzel, A. Aristarain, R. T. Bernardo, D. Bromwich, O. Cattani, M. Delmotte, S. Falourd, M. Frezzotti, H. Gallée, L. Genoni, E. Isaksson, A. Landais, M.M. Helsen, G. Hoffmann, J. Lopez, V. Morgan, H. Motoyama, D. Noone, H. Oerter, J.R. Petit, A. Royer, R. Uemura, G.A. Schmidt, E. Schlosser, J.C. Simões, E. Steig, B. Stenni, M. Stievenard, M.R. van den Broeke, R.S.W. van de Wal, W.J. van de Berg, F. Vimeux, J.W.C. White (2008) A review of Antarctic surface snow isotopic composition: observations, atmospheric circulation and isotopic modelling. *J. Climate*, 21, 3359-3387.
12. Mayewski, PA, Frezzotti, M, Bertler N., Van Ommen T., Hamilton G., Jacka T.H., Welch B., Frey M., Dahe, Qin, Jiawen R., Simões J., Fily M., Oerter H., Nishio F., Isaksson E., Mulvaney R., Holmund P. Lipenkov V., Goodwin I. (2005). [The International Trans-Antarctic Scientific Expedition \(ITASE\): an overview](#). *Annals of Glaciology*, vol. 41, 180-185.
13. Monaghan A.J., Bromwich D.H., Fogt R.L., Wang SH, Mayewski PA, Dixon DA, Ekaykin A., Frezzotti M., Goodwin I., Isaksson E., Kaspari SD, Morgan VI, Oerter H., Van Ommen T., Van der Veen CJ, Wen J. (2006). Insignificant Change in Antarctic Snowfall Since the International Geophysical Year, *Science*, 313, 827-831.
14. Morganti A., S. Becagli, E. Castellano, M. Severi, R. Traversi & R. Udisti (2007). An improved flow analysis-ion chromatography method for determination of cationic and anionic species at trace levels in Antarctic ice cores. *Anal. Chim. Acta*, 603, 190-198.
15. Remy, F. and Frezzotti, M. (2006). Antarctica ice sheet mass balance. *Comptes Rendus Geoscience* 338: 1084-1097.
16. Sala M., B. Delmonte, M. Frezzotti, M. Proposito, C. Scarchilli, V. Maggi, G. Artioli, M. Dapiaggi, F. Marino, P.C. Ricci, G. De Giudici (2008) Evidence of calcium carbonates in coastal (Talos Dome and Ross Sea area) East Antarctica snow and firn: environmental and climatic implications. *Earth and Planetary Science Letters*, 271, 1-4, 43-52.
17. Scarchilli C., Frezzotti M., Grigioni P., De Silvestri L., Agnoletto L., Dolci S. (2010) Extraordinary blowing snow transport events in East Antarctica, *Climate Dynamics*, Vol 33, DOI 10.1007/s00382-009-0601-0
18. Scarchilli C., Frezzotti M., Ruti P., (submitted) Snow precipitation at Talos Dome core site in East Antarctica: provenance, seasonality and blocking factor. *Climate Dynamics*
19. Severi M., S. Becagli, E. Castellano, A. Morganti, R. Traversi, R. Udisti. 30 years of snow deposition at Talos Dome (Northern Victoria Land, East Antarctica): chemical profiles and climatic implication. *Microchemical Journal*, 2009, 92 (1), 15-20.
20. Strassmeier K.G., K. Agabi, L. Agnoletto, A. Allan, M. I. Andersen, W. Ansorge, F. Bortoletto, R. Briguglio, J.-T. Buey, S. Castellini, V. Coudé du Foresto, L. Damé, H. J. Deeg, C. Eiroa, G. Durand, D. Fappani, M. Frezzotti, T. Granzer, A. Gröschke, H. J. Karcher, R. Lenzen, A. Mancini, C. Montanari, A. Mora, A. Pierre, O. Pirnay, F. Roncella, F.-X. Schmider, I. Steele, J.W. V. Storey, N. F. H. Tothill, T. Travouillon, L. Vittuari, and M. Weber (2007). Telescope and instrument robotization at Dome C *Astron. Nachr. / AN* 328, No. 6, 451 – 474 (2007) /

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DOI 10.1002/asna.200710780.

21. Traversi R., S. Becagli, E. Castellano, V. Maggi, A. Moranti, M. Severi, R. Udisti (2007). Ultra-sensitive continuous flow analysis (CFA) determination of calcium in ice core at ppt level. *Analytica Chimica Acta*, Vol. 594, Issue 2, Pages 219-225.
22. Urbini S., Cafarella L., Zirizzotti A., Bianchi C., Tabacco I., Frezzotti M. (2006). Location of a new ice core site at Talos Dome (East Antarctica). *Annals of Geophysics*, 49 (4/5), 1133-1138.
23. Urbini S., Frezzotti M., Gandolfi S., Vincent C., Scarchilli C., Vittuari L., Fily M. (2008) Historical behaviour of Dome C and Talos Dome (East Antarctica) as investigated by snow accumulation and ice velocity measurements. *Global and Planetary Change*. Vol 60/3-4 pp 576-588 DOI: 10.1016/j.gloplacha.2007.08.002

B – book chapters

1. Baroni C., A. Biasini, G. H. Denton, M. Frezzotti, P. Grigioni, M. Meneghel, G. Orombelli, M.C. Salvatore, A. M. Della Vedova, L. Vittuari. (2005). MOUNT MELBOURNE QUADRANGLE, VICTORIA LAND, ANTARCTICA 1:250,000. MAP INSERTED IN FLUCTUATIONS OF GLACIER 1995-2000 (VOL VIII) A contribution to the Global Terrestrial Network for Glacier (GTN-G) as a part of the Global Terrestrial/Climate Observing System (GTOS/GCOS), the division of Early Warning and Assessment and the Global Environment Outlook as a part of the United Nations Environment Programme (DEWA and GEO, UNEP), and the International Hydrological Programme (IHP, UNESCO) IUGG(CCS)-UNEP-UNESCO 2005.
2. Baroni C., Frezzotti M., Cimbelli A., Tabacco E., Orombelli G., Salvatore M.C., Biasini A., Vittuari L. (2005). Antarctic Geomorphological And Glaciological 1:250000 Map Series RELIEF INLET QUADRANGLE (VICTORIA LAND). MAP INSERTED IN FLUCTUATIONS OF GLACIER 1995-2000 (VOL VIII) A contribution to the Global Terrestrial Network for Glacier (GTN-G) as a part of the Global Terrestrial/Climate Observing System (GTOS/GCOS), the division of Early Warning and Assessment and the Global Environment Outlook as a part of the United Nations Environment Programme (DEWA and GEO, UNEP), and the International Hydrological Programme (IHP, UNESCO) IUGG(CCS)-UNEP-UNESCO 2005.
3. Frezzotti M., M.C. Salvatore, L. Vittuari, P. Grigioni, L. De Silvestri. (2005). NORTHERN FOOTHILLS AND INEXPRESSIBLE ISLAND AREA, VICTORIA LAND, ANTARCTICA 1:50,000. MAP INSERTED IN FLUCTUATIONS OF GLACIER 1995-2000 (VOL VIII) A contribution to the Global Terrestrial Network for Glacier (GTN-G) as a part of the Global Terrestrial/Climate Observing System (GTOS/GCOS), the division of Early Warning and Assessment and the Global Environment Outlook as a part of the United Nations Environment Programme (DEWA and GEO, UNEP), and the International Hydrological Programme (IHP, UNESCO).
4. Frezzotti M. (2007) Mega-dunes. In B. Riffenburgh Ed., "Encyclopedia of the Antarctic", Taylor and Francis Group, New York (NY), 2007, Vol. 2, 639-640.
5. Frezzotti M. (2007) Surface feature. In B. Riffenburgh Ed., "Encyclopedia of the Antarctic", Taylor and Francis Group, New York (NY), 2007, Vol. 2, 972-973.

C - proceedings of international conferences

1. Dixon D., M. Frezzotti, E. Isaksson and T. Meloth (2009) Recent change in the climate and atmospheric chemistry over Antarctica, *PAGES News*. Vol.17, No 1, 36.

D – proceedings of national meetings and conferences

1. Becagli S., R. Traversi, E. Castellano, M. Severi, M. Proposito, M. Frezzotti, B. Delmonte & R. Udisti (2008) Sea ice extent reconstruction in the last 150yr by biogenic compounds stratigraphy at Talos Dome. *Terra Antarctica Reports*. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21, 2005. vol. 14, pp. 61-68 ISSN: 1723-7211
2. Bitelli G., Frezzotti M., Gusella L., Mancini F., Pino I. (2005) Analisi multitemporale di immagini satellitari per la determinazione del campo superficiale di velocità di ice-streams in Antartide. *Bollettino SIFET*, N 1. 125-136
3. Cagnati A., R., Dicasillati, E. Salviatti, R. Udisti (2008) Snow crystal observations at Dome C, Antarctica. *Terra Antarctica Reports*. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21 No. 14, 147-150. ISSN: 1723-7211
4. Cagnati A., G. Macelloni, E. Salviatti, M. Valt (2008) Snow Surface characteristics at Dome C, Antarctica *Terra Antarctica Reports*. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21, No. 14, 151-154. ISSN: 1723-7211
5. Frezzotti M., M. Proposito, S. Urbini & S. Gandolfi (2008) Snow Accumulation in the Talos Dome Area: Preliminary Results. *Terra Antarctica Reports*. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21, 2005. vol. 14, pp. 21-25 ISSN: 1723-7211.
6. Gandolfi S., Gusella L., Milano M., Vittuari L. (2008). Precise Point Positioning, an alternative approach for GPS data processing in Antarctica, *Terra Antarctica Reports*. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21, 14, pp. 27 – 30. ISSN: 1723-7211
7. Genoni L., B. Stenni, M. Proposito, O. Flora, M. Braida & M. Frezzotti (2008) A record of d¹⁸O variations from a near coastal site between Oates Coast and Talos Dome (East Antarctica). *Terra Antarctica Reports*. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21, 2005. vol. 14, pp. 159-162 ISSN: 1723-7211

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8. Macelloni G., A. Cagnati, M. Brogioni, P. Pampaloni, M. Drinkwater (2008) Low Frequency Microwave Emission of the Antarctic Plateau: Domex 2004, an Experimental Campaign for the Calibration of Space-Borne Radiometers Terra Antartica Reports. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21, No. 14, 163-168. ISSN: 1723-7211
9. Morganti A., S. Becagli, E. Castellano, M. Severi, R. Traversi & R. Udisti (2008) Chemical markers variability at Talos Dome: preliminary survey in support of the in progress deep drilling. Terra Antartica Reports. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21, No. 14, 97-106. ISSN: 1723-7211
10. Proposito M. & M. Frezzotti (2008) Preliminary glacio-chemical analysis of gv5 and GV7 Firn Cores Collected along the Oates Coast-Talos Dome Transect. Terra Antartica Reports. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21, 2005. vol. 14, pp. 111 - 116 ISSN: 1723-7211
11. Sala M., B. Delmonte, M. Proposito, V. Maggi, M. Frezzotti (2008) Evidence for particle dissolution in shallow firn core samples from Northern Victoria Land. Terra Antartica Reports. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21. vol. 14, pp. 117-122 ISSN: 1723-7211
12. Scarchilli C., M. Frezzotti, G. Didonfrancesco, M. Valt, S. Urbini, L. De Silvestri, S. Dolci, A. Iaccarino, P. Grigioni (2008) Precipitation and sublimation processes impact on snow accumulation: first result. Terra Antartica Reports. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21, 2005. vol. 14, pp. 47-50 ISSN: 1723-7211
13. Urbini S., M. Frezzotti, S. Gandolfi, L. Vittuari. (2008). Talos Dome migration: preliminary result. Terra Antartica Reports. CONGA - Convegno Nazionale di Glaciologia in Antartide. Milano. Ottobre 19-21, 2005. vol. 14, pp. 51 - 54 ISSN: 1723-7211

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

1. Convegno Nazionale di Glaciologia Antartica (CONGA 05), Milano (Italy), 19-21 Ottobre 2005

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

Post Doc fellowships

1. Proposito Marco "*Studi sul comportamento del clima attraverso indagini sperimentali e modelli di circolazione atmosferica in Antartide*", 2003-2007
2. Scarchilli Claudio Studio dell'origine delle aree sorgente e delle traiettorie delle precipitazioni nevose nell'area di Dome C", 2006-200

PhD theses

1. Debbie Biscaro dottoranda "Cambiamento dei fronti di ghiaccio galleggiante e "comportamento" degli iceberg nel tratto di costa compreso tra l'Isola di Ross e Porpois Bay". XX Ciclo, Dottorato in Scienze Polari, Univ. Siena
2. Genoni Laura PhD Thesis "Studio geochimico isotopico per la stima del bilancio di massa nel bacino di drenaggio di Dome C (Antartide orientale) come contributo alle variazioni del livello marino". XX Ciclo, Dottorato in Scienze Ambientali, ambiente fisico e costiero, Univ. Trieste
3. Pino Ivano PhD Thesis: "Monitoring Ice Velocity Field in Victoria Land (Antarctica) using cross-correlation techniques on satellite images" XX Ciclo, Dottorato in Scienze Geodetiche e Topografiche, Università di Bologna
4. Proposito Marco PhD Thesis "Studio della variabilità delle precipitazioni nevose negli ultimi due secoli attraverso la stratigrafia chimica ed il riconoscimento di marker vulcanici in Antartide" XVI Ciclo, Dottorato in Scienze Polari, Univ. Siena
5. Scarchilli Claudio PhD Thesis "Characterization of accumulation and sublimation processes over the Antarctic continent" XIX Ciclo, Dottorato in Scienze Polari, Univ. Siena

Research units

Massimo Frezzotti (ENEA, Roma), Silvia Becagli (Univ. Firenze), Anselmo Cagnati (ARPA, Arabba), Barbara Stenni (Univ. Trieste), Achille Zirizzotti (INGV, Roma), Luca Vittuari (Univ. Bologna)

Date:

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Notes