

Final project report

<i>Project ID</i>	2004/3.1
<i>Title</i>	Calibration and validation of optics and microwave remote sensing data in Antarctica
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<i>Duration</i>	3 years
<i>Assigned funding</i>	140000,00 Euro

Activities and results (max 3000 characters)

Satellite sensors are the most suitable tools for observing the temporal and spatial variations in extensive snow-covered areas such as Antarctica. On the other hand there is a growing interest in the remote sensing community in using part of the East Antarctic plateau for calibrating and validating data of satellite-borne microwave and optical radiometers. The main objective of this project was to obtain a microwave radiometer spectral measurement time-series at Dome C. This activity was supported by the European Space Agency (ESA) in the framework of the calibration and validation activities of the SMOS space mission. A new instrument composed by two microwave radiometers at L-band and C-band and an infrared radiometer was then developed. During the Antarctic Campaign 2004-2005 the instrument was installed on the tower of Concordia base and data were collected for around one month. The obtained results demonstrated that at C-band we observe a diurnal cycle amplitude of a few Kelvin. In contrast, the L-band data indicated extremely stable values with a standard deviation lower than 0.4K. During the same campaign observations of the snow parameters were carried out in different sites around Concordia station. Snowpack profiles were effected, according to the conventional method. A detailed analysis of the profiles pointed out the different mechanisms that affect the snow metamorphism of the first layers during the year. Besides the results of snow measurements emphasized the unique spatial uniformity of the physical characteristics of the area near the base. To better understand the evolution of the surface layers a model analysis was performed by means of the SNOWPACK model developed at SLF-Switzerland. Preliminary results showed a good ability of the model to simulate some parameters such as temperatures along the profile and the stratigraphic sequence, while some critical aspects related to the densification of fresh snow and settlements process have been highlighted. Then, some modifications to the modelling of fresh snow and snow transformation initial processes, have improved the performance of the model. On the basis of these results, we can confirm the spatial uniformity and temporal stability of the snow layers emitting low-frequency microwave radiation and then confirm the possibility of using the plateau as an extended calibration target. Moreover multi-frequency microwave satellite data were also analyzed. In particular it was developed a methodology to retrieve the snow temperature of snow at different depths with an error lower than 1° C, starting from microwave data. Lastly an electromagnetic model, able to simulate the microwave data, was implemented and validated by using satellite data. The analysis of the spectral behavior of snow, at the wavelength range of 350-2500nm, allows to derive information on the size and shape of surface snow crystals. These remote observations are directly correlated with measures of radiance recorded in the images taken from optical satellite sensors. Therefore, merging field and satellite data it is possible to produce thematic maps that describe the differences in the snow cover. This approach was successfully used to process Landsat TM and ASTER images of areas morphologically more complex than the Antarctic plateau where spatial distribution of different types of snow grains can be recognized. The results achieved highlighted that optical data can be an additional tool for the interpretation of microwave snow data.

Products

A – papers in scientific magazines

N. Parag, G. Heygster, T. Jackson, G. Macelloni, R. Bindlish, J. Notholt, *“Passive Polarimetric Microwave Signatures Observed over Antarctica”*, IEEE Transaction On Geoscience and Remote Sensing, - Volume: 48 , [Issue: 3](#), Part: 1 , Page(s): 1059 – 1075, 2010

M. Brogioni, G. Macelloni, E. Palchetti, S. Paloscia, P. Pampaloni, S. Pettinato, E. Santi, A. Cagnati, A. Crepaz, *“Monitoring Snow Characteristics with Ground Based Multifrequency Microwave Radiometry”*, IEEE Transaction On Geoscience and Remote Sensing, - Vol. 47, Issue 11, pp. 3643-3655 – Nov. 2009

A. Cagnati, G. Macelloni, E. Salvietti and M. Valt, *“Snow Surface Characteristics at Dome C, Antarctica”*, Terra Antarctica reports, vol.14, 2008

G. Macelloni, A. Cagnati, M. Brogioni, P. Pampaloni and M. Drinkwater, *“Low-frequency Microwave Emission of the Antarctic Plateau: DOMEX 04 an Experimental Campaign for the Calibration of Space-Borne Radiometers”*, Terra Antarctica reports, vol.14, 2008

G. Macelloni., M. Brogioni, P. Pampaloni, A. Cagnati, *“Multi-frequency Microwave Emission from the East Antarctic Plateau: Temporal and Spatial Variability”*, IEEE Trans. Geosci. Remote Sensing (Microrad 08, Special Issue), vol. 43, pp.2029-2039 –July, 2007.

G. Macelloni, M. Brogioni; P. Pampaloni; A. Cagnati, M.R. Drinkwater, *“DOMEX 2004: An Experimental Campaign at Dome-C Antarctica for the Calibration of Spaceborne Low-Frequency Microwave Radiometers”*, Geoscience and Remote Sensing, IEEE Transactions; vol. 44, Issue 10; Page(s):2642 - 2653 –Oct. 2006

C - proceedings of international conferences

G. Macelloni, M. Brogioni, A. Crepaz, M. Drinkwater and J. Zaccaria, *“DOMEX-2 : L-band Microwave Emission Measurements of the Antarctic Plateau”*, Proceedings of IEEE Geoscience and Remote Sensing Symposium, IGARSS 2009, Page(s): II-1016 - II-1019, 2009

S. Vey, S. Dolce, E. Checa, G. Macelloni, *“DOMEX-2 Thermal design, testing and commissioning in support to the SMOS mission”*, Proceedings of [39th International Conference on Environmental Systems \(ICES\)](#), , Doc. Number 2009-01-2375 , July 2009

G. Macelloni, M. Brogioni, S. Paloscia, P. Pampaloni, S. Pettinato, E. Santi, *“Spatial and Temporal Monitoring of the East-Antarctic Plateau using Passive Microwave Data”*, Geoscience and Remote Sensing Symposium, 2008. IGARSS 2008. IEEE International Volume 5, 7-11 July 2008 Page(s):V - 29 - V – 32

G. Macelloni, M. Brogioni, S. Paloscia, P. Pampaloni, S. Pettinato, E. Santi, *“Monitoring of Temporal and Spatial Variability of the East-Antarctic Plateau Using Passive Microwave Data”*, Microwave Radiometry and Remote Sensing of the Environment, 2008. MICRORAD 2008 11-14 March 2008 Page(s):1 – 4

Programma Nazionale di Ricerche in Antartide (PNRA)

G. Macelloni, M. Brogioni, S. Vey, *"Calibration of a Ground Based Radiometer for a One-Year Experiment in Antarctica: a Contribution to SMOS Calibration"*, Geoscience and Remote Sensing Symposium, 2007. IGARSS 2007. IEEE International 23-28 July 2007 Page(s):2423 – 2426

G. Macelloni, M. Brogioni, P. Pampaloni, *"An Experimental Campaign in Antarctica for the Calibration of Low-frequency Space-borne Radiometers"*, Geoscience and Remote Sensing Symposium, 2006. IGARSS 2006. IEEE International Conference on; July 31 2006-Aug. 4 2006 Page(s):3980 – 3983

M. Brogioni, G. Macelloni, P. Pampaloni, *"Temporal and Spatial Variability of Multi-frequency Microwave Emission from the East Antarctic Plateau"*, Geoscience and Remote Sensing Symposium, 2006. IGARSS 2006. IEEE International Conference on; July 31 2006-Aug. 4 2006 Page(s):3820 – 3823

G. Macelloni, P. Pampaloni, M. Brogioni, E. Santi, A. Cagnati, M. Drinkwater, *"DOMEX 2004: an Experimental Campaign at Dome-C Antarctica for the Calibration of Space-Borne Low-Frequency Microwave Radiometers"*; Geoscience and Remote Sensing Symposium, 2005. IGARSS '05. Proceedings. 2005 IEEE International; Volume 3, 25-29 July 2005 Page(s):1932 – 1935

G. Macelloni, P. Pampaloni, M. Brogioni, A. Cagnati, M. Drinkwater, *"DOMEX 2004: an Experimental Campaign at Dome-C Antarctica for the Calibration of Space-Borne Low-Frequency Microwave Radiometers"*, Proceeding of the URSI commission F Symposium, Barza d'ISPRA 20-21 April 2005, <http://ursi-f-2005.jrc.it/proceedings.htm>

G. Macelloni, P. Pampaloni, M. Tedesco, *"Microwave Emission from Antarctica and the Calibration of Low Frequency Space-Borne Radiometers"*; Geoscience and Remote Sensing Symposium, 2004. IGARSS '04. Proceedings. 2004 IEEE International; Volume 4, 20-24 Sept. 2004 Page(s):2462 - 2464 vol.4

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

Marco Brogioni –PhD – Modeling Microwave Emission from Snow Covered Soil –University of Pisa – 2005-2007

Research units

Unità Operativa IFAC-CNR:

Giovanni Macelloni (responsabile unità operativa, responsabile progetto)
Marco Brogioni
Simone Pettinato

Unità Operativa CVA-ARPAV:

Anselmo Cagnati (responsabile unità operativa)
Mauro Valt
Andrea Crepaz
Renato Zasso

Programma Nazionale di Ricerche in Antartide (PNRA)

Unità Operativa IIA-CNR:

Rosamaria Salvatori (responsabile unità operativa)
Ruggero Casacchia

Date: 2/25/2011

Notes