GROUND-BASED L-BAND EMISSION MEASUREMENTS AT DOME-C ANTARCTICA : DOMEX-2 A CONTRIBUTION TO SMOS CALIBRATION

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1. INTRODUCTION

In recent years there is growing interest, on the part of the remote sensing community, in using the Antarctic area for calibrating and validating data of the low-frequency satellite-borne microwave radiometers. In particular, the East Antarctic Plateau appears to be suited for this purpose. The reason of this interest lies in the size, structure, spatial homogeneity and thermal stability of this area. The roughness is limited with respect to other Antarctic area and the temperature of the firn below 10 m remains constant during the years [1]. This is particularly interesting for low-frequency microwave radiometers since, due to the low extinction of dry snow, the upper ice sheet layer is almost transparent and the brightness temperature variability is therefore extremely small. Moreover, the Italian-French base of Concordia, which operates all year round, guarantees the availability of ancillary data, such as atmospheric parameters and snow temperature at different depths, which are necessary for the analysis and the interpretation of microwave data.

A first pilot experiment, called DOMEX-1 [2], was carried out in 2004-2005 Antarctic campaign and demonstrated the brightness temperature stability at monthly scale. In preparation for the November 2009 launch of the ESA's SMOS satellite, a second experiment called DOMEX-2 was started in the Austral summer 2009 [3]. The main scientific objectives of this activity are to provide independent microwave data for SMOS satellite calibration monitoring. In particular, the objectives were to acquire: a continuous calibrated time series of microwave (L-band) and thermal Infrared (8-14micron) emission over an entire Austral annual cycle; a long time-series of snow measurements; and relevant local atmospheric measurements from the local weather station.

Nevertheless, a more detailed analysis is necessary in order to identify an area sufficiently large with respect to the satellite field of view, and which exhibits a stable microwave emission value.
In order to further investigate this aspect, C-band microwave radiometric data collected by the AMSR-E sensor (on board on the AQUA satellite) in the period 2002- 2008 were analyzed. In this paper the results obtained from DOMEX-2 experiment, as well as the results of satellite analysis, were presented and discussed. Comparison to SMOS data will be also presented (if these data will be available).

2. THE DOMEX-2 EXPERIMENT

The Italian–French base of DOME-C is located on the polar plateau of East Antarctica at 75°06’06’’S latitude, 123°23’42’’E longitude, and with an altitude of 3280 m a.s.l. The average air temperature there throughout the year is -50.8° C (-30° C in summer and -60° C in winter). The annual (solid) precipitation is of the order of 2-10 mm (snow water equivalent): which at a typical mean surface density of 300 kg/m3 is equal to an annual accumulation of about 3.7 cm/yr. The location of the Dome-C base was originally selected for glaciological purposes, since 3,000 meters of layered ice, have a great potential for long time paleo-climatic reconstruction [4]. However, it is now a reference station for astronomical, seismological and atmospheric research, and satellite calibration and validation and many experimental campaigns have been carried out in and are planned on this site.
DOMEX-2 experiment consists in an L-band and an infrared (8-14 μm) radiometers (RADOMEX) installed at Concordia base in a protected box on an observation tower at a height of 13 m respect to the ice sheet. Data are collected continuously (24/24 h) over an entire Austral annual cycle, starting from December 2008 at different incidence angles within the 30°- 130° range with respect to nadir. Snow measurements (including snow stratigraphy, density, grains size and shape), as well as meteorological data, are also collected during the experiment. The instrument is remotely controlled to the station form the tower using LAN cable, data are daily transferred in Europe on a daily basis using satellite connection. The RADOMEX perfectly worked up to June 2009 when an unpredictable power failure compromised the performance of the instrument for the second part of the year. Data collected by the instrument were calibrated and thermally compensated. The obtained results showed that the first period of observation was characterized by a very stable period (from the beginning of the experiment to the end of the year). The signal then slightly increased, and became quite noisy (up to mid of February). From mid February to the end of May, the signal was very stable. The reason for the temperature trends and the fluctuations during the first period of the experiment (December-mid of January) will be better investigated in the forthcoming months. From

the analysis of the stable period (end of January – mid of May) we observed that the measured Tb signal was very stable. As an example the pre-calibrated data collected at 42° of incidence angle showed a mean value of 204.89 K and 175.43 K in V and H polarization respectively, and a standard deviation of 0.34 K and 0.9 K. Data collected in the campaign will be presented in this paper.

3. SATELLITE DATA ANALYSIS

Passive data collected by the AMSR-E sensor (onboard on the AQUA satellite) were obtained from the National Snow and Ice Data Center (NSIDC). AMSR-E was chosen because it is the only space-borne instrument that includes the C-band radiometer, which is the available frequency closest to the L-band. Therefore, it is expected that the results obtained by using this frequency where the most suitable to infer the electromagnetic properties of the East Antarctic Plateau at L-band. The AMSR-E 10 GHz channel was also used to verify the results obtained at C-band. AMSR-E data were acquired from 2002 to 2008. Anyway, only data from April 2003 were analyzed since earlier images present somewhat errors. Due to the location of the area (i.e. near to South Pole) a huge number of AMSR-E images containing the area surrounding Concordia station have been acquired (more than 15000). It is important to note that the analysis of the brightness temperature was computed for the V polarization only because the H one is much more sensitive to the snow layering [5]. This fact makes the Tb at H pol more "noisier" than the Tb at V pol, anyway the results of the study obtained by using the vertical polarization can be assumed valid also for the horizontal one since the two polarizations are highly correlated [5]. In order to carry out the spatial and temporal analysis, six orbits were considered and eventually three were selected, which completely cover the region of interest (about 1000 x 1000 Km^2). For each time series, data have been geo-located and co-registered with a DEM in order to relate the spatial variations with the surface characteristics. The study was carried out in two different steps. In the first, a temporal analysis was performed on the Tb images, in order to select those areas which have the most stable brightness temperature. The second step was devoted to analyze the spatial features of the microwave radiation in order to find the most homogeneous regions. For this analysis, two statistical methods (Getis analysis, and Modified Average Deviation) were applied and finally two areas, which are suitable as candidate for SMOS external calibration, were individuated. These areas exhibited a very stable brightness temperature both in space and time with a temporal and spatial Tb standard deviation lower than 0.5 K. From an operational point of view we can suggest to monitoring these area at the very beginning of the SMOS commissioning phase: if the spatial homogeneity is confirmed also at L-band, these areas could be used for calibration monitoring purposes. Validation will be performed in the next months as real SMOS data become available.

4. REFERENCES

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