L-BAND BRIGHTNESS TEMPERATURE VARIATIONS AT DOME C AND SNOW METAMORPHISM AT THE SURFACE

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1. INTRODUCTION

The Antarctic Plateau is a promising site to monitor microwave radiometers' drift, and to inter-calibrate microwave radiometers, especially 1.4 GHz (L-band) radiometers on board the Soil Moisture and Ocean Salinity (SMOS), and Aquarius/SAC-D missions. The Plateau is a thick ice cover, thermally stable in depth, with large dimensions, and relatively low heterogeneities. In addition, its high latitude location in the Southern Hemisphere enables frequent observations by polar-orbiting satellites, and no contaminations by radio frequency interference. At Dome C (75S, 123E), on the Antarctic Plateau, the substantial amount of in-situ snow measurements available allows us to interpret variations in space-borne microwave brightness temperature (TB) (e.g. Macelloni et al., 2007, 2013, Brucker et al., 2011, Champollion et al., 2013). However, to analyze the observations from the Aquarius radiometers, whose sensitivity is 0.15 K, the stability of the snow layers near the surface that are most susceptible to rapidly change needs to be precisely assessed. This study focuses on the spatial and temporal variations of the Aquarius TB over the Antarctic Plateau, and at Dome C in particular, to highlight the impact of snow surface metamorphism on the TB observations at L-band.

2. TB SPATIAL VARIATIONS OVER THE ANTARCTIC PLATEAU

Over East Antarctica, Aquarius TBs are the lowest over the highest elevations, and gradually increase toward the coast, where temperature and annual snow accumulation increase. The Aquarius TB standard deviation calculated over one year depends on the polarization, and the radiometer incidence angle. TB standard deviations are low over the Plateau (0.2 – 0.8 K), and increase up to ~1.2 K close to the coastal regions, where seasonal melt occurs. After excluding these coastal areas improper for radiometer calibration, the largest standard deviations are located in regions where snow megadunes, glaze (wind-induced near-zero surface accumulation), and wind-scour zones exist (Figure 1).

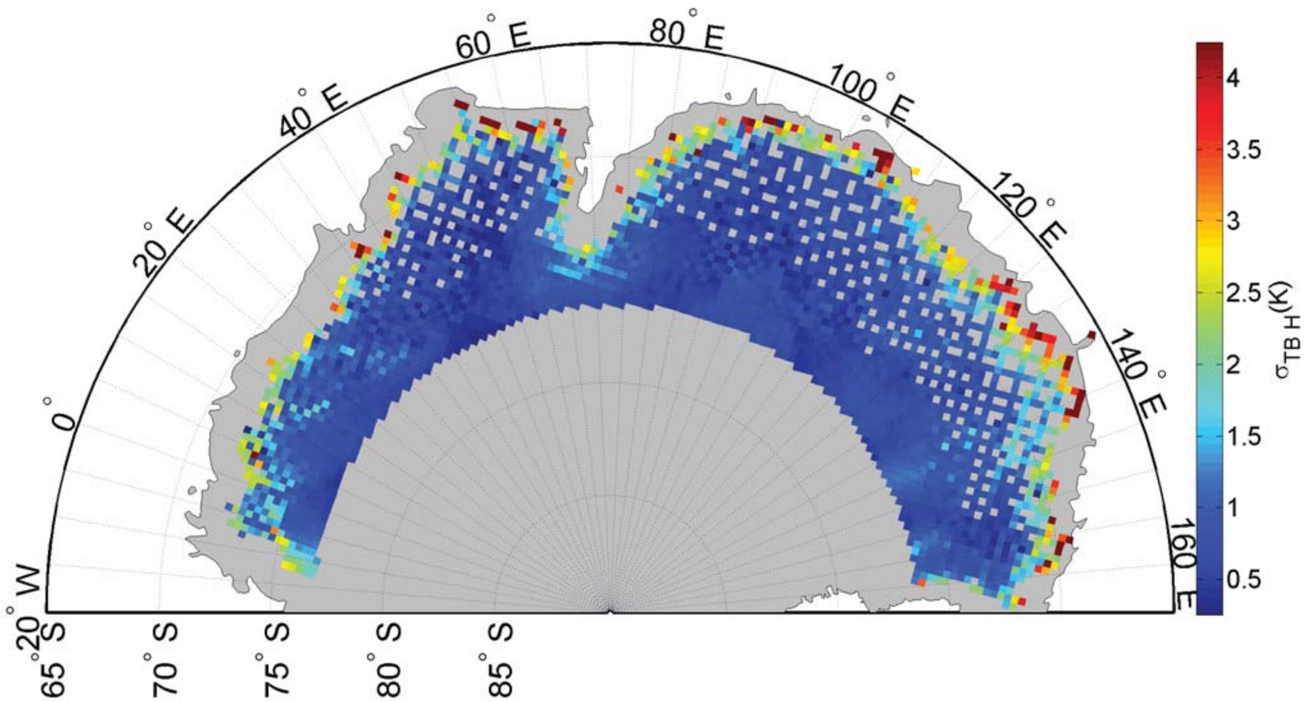

Figure 1: Map of Aquarius L-band TB standard deviation calculated using all 2012 valid observations from radiometer 3 (incidence angle 45.6°) at horizontal polarization over East Antarctica. Grid cells where melt events occurred since August 1, 2000 were masked.

3. TB TEMPORAL VARIATIONS AT DOME C

During the two-year period of Sept. 2011 – Sept. 2013, Aquarius TBs observed at Dome C are characterized by large summer-time variations, larger than 2 K at horizontal polarization. These variations are significant compared to the 0.15 K sensitivity of Aquarius' radiometers. To understand the source of these variations, two data sets were used. First, we compared Aquarius observations to a remote sensing grain index (GI) based on high-frequency (89 and 150 GHz), shallow-penetration TB channels. Variations in the Aquarius observations are synchronous with grain index changes (Figure 2). Second, Aquarius TB variations are compared to the presence of hoar crystals on the surface identified using surface-based near-infrared photographs. The largest and longest changes in TB correspond to period with hoar crystals on the surface.

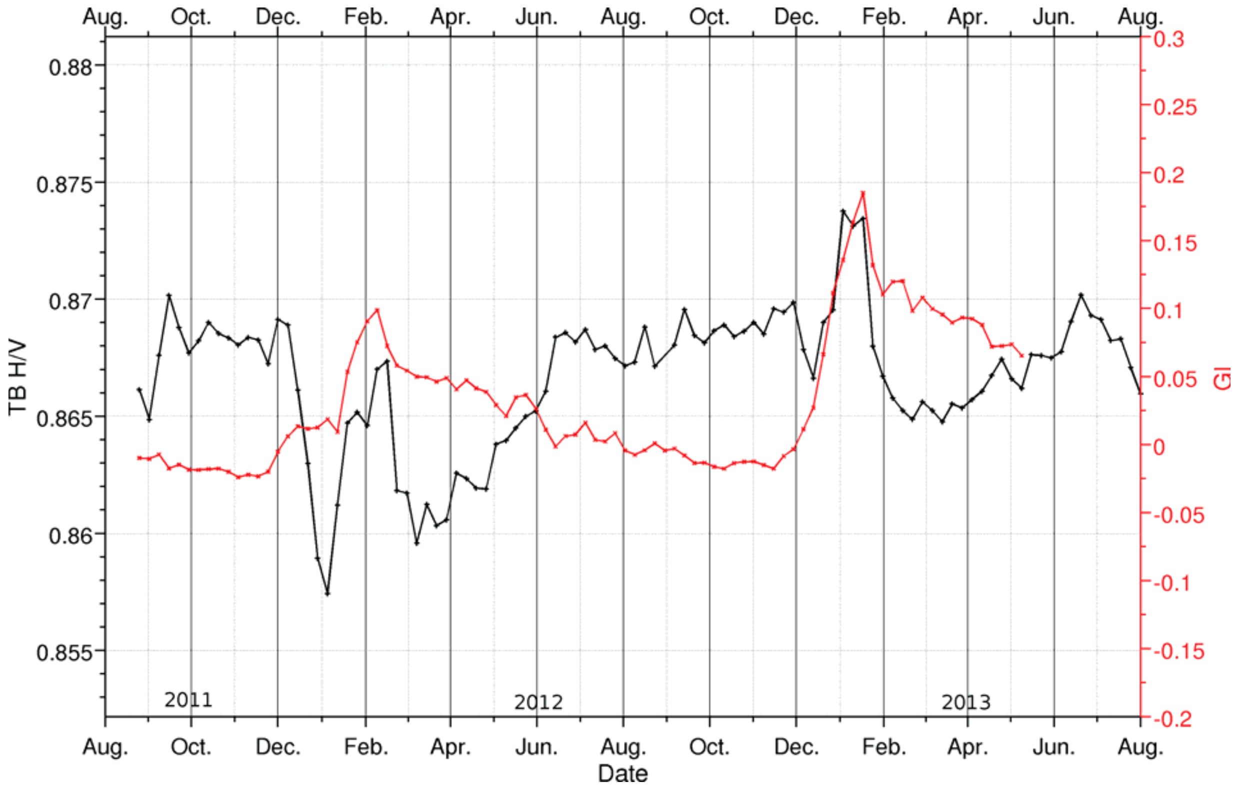

Figure 2: Time series of Aquarius TB ratio observed at horizontal (H) and vertical (V) polarizations (TB H/V) at Dome C by radiometer 3 (black). Time series of the remote sensing grain index (GI) based on AMSU-B high-frequency 89 and 150 GHz TBs only sensitive to the near surface (red).

4. CONCLUSION

Results show that Aquarius L-band TB variations are correlated to (1) a remote sensing grain index derived from AMSU-B high frequency observations, and (2) hoar crystal formation/disappearance on the surface observed by a surface-based near-infrared camera. Therefore, in spite of the deep penetration of the L-band radiation, evolutions of the snow properties at the surface, that usually change rapidly and irregularly, do influence L-band observations. Knowledge of the effects and periods of hoar crystal formation and disappearance on the ice sheet surface is crucial to monitor microwave radiometers' drift, and to inter-calibrate SMOS, Aquarius, and the forthcoming Soil Moisture Active/Passive (SMAP) L-band radiometers.

5. REFERENCES

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