Frozen Surface Classification Scheme for ATMS and GMI

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Within the development of passive microwave precipitation retrieval techniques, and, in particular, of snowfall detection and retrieval techniques, the possibility to characterize the frozen background surface (snowcover and sea ice conditions) at the time of the overpass appears to be a relevant task. As demonstrated by many recent studies (e.g., Tabkiri et al., 2019, Ebtehaj and Kummerow 2017, Panegrossi et al., 2017), the microwave signal related to snowfall is strongly influenced by the surface conditions, and the response of the observed brightness temperatures to the presence and intensity of snowfall depends on complex interconnections between environmental conditions (surface temperature, water vapor content, snow water path, cloud depth, presence of supercooled droplets) and the different surface conditions (wet or dry snow cover, sea ice concentration and type, etc.). The use of surface classification climatological datasets results inadequate for the purpose because of the extreme variability of the frozen surface conditions. It is therefore necessary to be able to identify the background surface condition as close as possible (in space and time) to that of the observation. The conically scanning GPM Microwave Imager (GMI) and cross-track the Advanced Technology Microwave Sounder (ATMS) are the most advanced currently available microwave radiometers. They are both equipped with channels at several different frequencies that can be exploited both for the identification of the frozen surface conditions and for snowfall detection and retrieval at the time of the overpass over a precipitation event (i.e., Rysman et al., 2018). Moreover, they can be used to analyze the potentials of future radiometers with similar characteristics such as the EPS-SG Microwave Sounder (MWS) and Microwave Imager (MWI), which represent the future in terms of European operational radiometers that can be exploited for precipitation retrieval at all latitudes (including the Polar Regions). In the last years we have developed two frozen surface classification schemes based on the use of GMI and ATMS low frequency channels (from 10 GHz up to 36 GHz) and on ancillary near-surface temperature and columnar water vapor data (obtained from ECMWF global ERA5 reanalysis). The algorithm is able to identify 9 classes of soil including different type of snow and sea ice. The results of such classification have been compared with other products, such as the NASA-GPROF soil type classification, and with snowcover and sea ice global datasets (such as GMAS- Autosnow, and SNODAS from NOAA, and ECMWF ERA5). In particular, the comparison with SNODAS over Northern America region shows

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that the probability of detection of snow-covered surfaces varies between 86% - 98% (79%-95%) for GMI (ATMS) with a relatively small false alarm ratio (10%-30%). The analysis evidenced the main factors limiting the detection capability, such as the moisture content, the presence of orography, the snow cover beam filling and the snow depth.