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Scattering properties and signatures of Antarctic snow derived from multitemporal satellite radar and field data

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Radar backscattering from Antarctic snow shows high variability in dependence of imaging geometry, radar wavelength, and polarization. The azimuthal anisotropy is primarily caused by persistent katabatic winds and the resulting predominant pattern of sastrugi. Incidence angle dependence and magnitude of backscattering is related to snow morphology as a result of the vertical sequence of internal layers due to snow accumulation and subsequent snow metamorphism. We investigate the backscattering properties in X-Band in comparison to C- and L-Band between the coastal areas in Antarctica and the high-elevated plateau.

The analysis is based on ScanSAR data from Terra-SAR, Envisat, and ALOS in Dronning Maud Land and the western Ross Sea region. Most of the image data were acquired during the winter season, when the snow also in the percolation zone is frozen. As a reference for the interpretation of satellite data serve field data from snow pits and firn cores, such as accumulation, density profiles, layering, grain size, and hardness. Also available are ground penetrating radar (GPR) data. In Dronning Maud Land, field data are available along several traverse routes and measurement profiles between the German overwintering base Neumayer and the Kohnen Station. In the western Ross Sea Region field data were collected in November 2008 near Scott Base (New Zealand) within ESA's Cryosat Cal/Val program.

We apply a normalization procedure with respect to incidence and azimuth angle to the various data sources in order to generate normalized maps of the backscattering coefficient. Maps of backscattering coefficient and incidence angle dependence are used as input to a snow classification algorithm, which are interpreted along with the field data.

The most significant differences in the backscattering properties can be understood as a result of variations in penetration depth between the dry snow zone and percolation zone. In the dry snow zone backscattering variations in dependence of location and radar frequency are at least partly related to snow layers and annual snow accumulation. The complex pattern of snow classes reflects the high natural variability of snow properties in the investigation area. The results are used to identify areas with distinct radar signatures and are input for the validation of a numerical backscattering model.