The potential of satellite derived surface state to empirically estimate pan-arctic ground temperature at specific depths and the essential role of in-situ data

Christine Kroisleitner¹, Annett Bartsch¹, Birgitt Heim², and Mareike Wiezorek²
¹b.geos GmbH, Korneuburg, Austria (christine.kroisleitner@bgeos.com)
²Alfred Wegener Institute; Potsdam, Germany

Surface state information, derived from ASCAT microwave sensors (C-band scatterometer), were empirically linked to in-situ arctic ground temperature measurements. The resulting FT2T-regressionmodel was established using the sum of days of year frozen and in-situ mean annual ground temperatures, both at specific depths and years. Regionally, the model showed the best results in Scandinavia and northern Russia with less than 1°C difference to the in-situ data. Overall, the results were valid for most depths and regions, with a slight tendency for underestimation of the ground temperatures on the Eurasian continent (about -1°C) and an overestimation on the American continent up to 2 °C. The most northern parts of Greenland, the Canadian High Arctic Islands and Alaska, however, showed a high positive bias of more than 10°C. Reasons for this overshooting include the limited amount of measurements in those regions, the oceanic influence and possibly snow cover effects.

Due to the inaccessibility of many arctic regions, in-situ data availability is still sparse and if available not harmonized. We used the currently revised annual ground temperature dataset from CCI+ Permafrost, which combines in-situ data from the GTNP-database, RosHydroMet and additional regional arctic ground temperature datasets (e.g. Nordicana). The resulting determination coefficients of the FT2T-model showed 55% explained variance at shallow borehole-depths below 80cm and decrease with depth to around 25% at 20 meters. This suggests that the sum of frozen days of year delivers better result at shallow depths in the active layer than at the actual permafrost table. The RMSE showed a dependency on the spread of measurement stations considered in the model calibration step. The more input regions we could use, the larger the RMSE got due to the increase of variability in the input data. Inevitably, it’s the in-situ information which enables the translation between ground temperatures and microwave backscatter and thus it fundamentally affects the accuracy of the result.