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Satellite estimates of the Antarctic heat

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Different methods have been applied in recent years to quantify the thermal structure and most specific the geothermal heat flux over Antarctica. Due to the limited amount of direct measurements, estimates are often derived from modelling of satellite data or seismological models, or based on a combination of these. Here, we present results from the ESA Support to Science Elements GOCE+Antarctica and CryoSMOS.

An interesting, novel and complimentary observation to the estimates mainly derived on geophysical data reflecting the Solid Earth, is the geothermal heat flux as established as by-product of the analysis of data from the SMOS (Soil Moisture and Ocean Salinity) satellite mission. In the CryoSMOS study, it was shown that the L-band brightness temperature (TB) observations by SMOS over Antarctica could mainly be attributed to the ice-sheet temperature profile variability. An error assessment showed that the geothermal heat flux, as resulting from the inversion against the ice temperature profiles from SMOS, is in the range of $\pm$20 mW m-2. Even though the range is within the uncertainties of the input model, the difference is huge with respect to its implications on ice-sheet conditions.

We compare these results to a 3D lithospheric model based on the integration of satellite gradient gravity data and seismological models as established in the GOCE+Antarcttica study. For a profile running from the Transantarctic Mountains to the interior of East Antarctica differences of $\sim$10 km in crustal thickness estimates are observed. Such a huge difference has strong implications for the characteristics of the crust itself and the underlying mantle in terms of density, temperature and composition. To isostatically compensate the differences in Moho depth, the composition and thermal thickness of the lithospheric mantle is adjusted. In both cases, the observables are equally well explained, but the models significantly differ in the heat flow for the coastal region (differences >20 mW m-2).

The different satellite derived estimates differ significantly from heat-flow estimates based on magnetic satellite data and we discuss how to reconcile the different observations by modelling the crustal thermal properties.