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An Improved Mean Annual Ice Surface Temperature distribution for the Ross Ice Shelf, Antarctica using Satelite Thermal Images

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Ice surface temperature is an important boundary condition for modelling ice shelf flow. Glen's flow law relates the strain rate and the stress via the rate factor, a strongly temperature dependent parameter. Together with the ocean temperature and the temperature depth function, ice surface temperature is required for a realistic treatment of ice flow in simulations. However, the spatial variation of ice surface temperature on ice shelves can be large. Past estimates have often used the shallow firn temperature (10m temperatures) as a proxy for mean surface temperature, or annual means from automatic weather stations (AWS). These data are spatially sparse relative to the variations seen in satellite thermal-band images. Here, we attempt to improve the spatial detal of the mean surface temperature map of the Ross Ice Shelf (RIS) by combining satellite thermal images with the 10m and AWS data.

We use the polar pathfinder 5km AVHRR data set, available at NSIDC. Surface temperature data in combination with a new cloud mask has been used to select only clear sky data for the later processing. For each pixel a sinusodial seasonal temperature change has been fitted to the clear-sky data. The determination of the mean annual temperature with this technique avoids a under- or over-representation of seasons, since cloud cover might be so extensive that big temporal gaps might occur.

A comparison of the produced AVHRR mean annual surface temperature distribution with the mean annual temperature at the positions of six operating AWS on the RIS and 10m temperatures from the RIGGS program has been performed. Both, AWS and

10m temperatures are significantly larger than the clear-sky AVHRR data, by several degrees Celsius. We attribute this to the formation of a strong near-surface inversion under clear sky conditions. We discuss several approaches for blending the AVHRR-derived spatial detail with AWS and 10m temperature values.

The AVHRR Polar Pathfinder 1km temperature algorithm appears to be within 1.5C of the true skin temperature as measured in situ over sea ice during the Aurora Australis 2003 'ARISE' cruise. Furthermore, inversions of up to 10C were observed to occur within an hour under clear sky conditions. This may explain the difference between AWS temperatures measured at 2m height and AVHRR skin temperatures.