Surface melt magnitude retrieval over Ross Ice Shelf, Antarctica using coupled MODIS optical and thermal satellite measurements during the 2002-03 melt season

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Ice shelf stability is of crucial importance in the Antarctic because shelves serve as buttresses to glacial ice advancing from the Antarctic Ice Sheet. Surface melt has been increasing over recent years, especially over the Antarctic Peninsula, contributing to disintegration of shelves such as Larsen. Unfortunately, we are not realistically able to quantify surface snowmelt from ground-based methods because there is sparse coverage in automatic weather stations. Satellite based assessments of melt from passive microwave systems are limited in that they only provide an indication of melt occurrence and have coarse resolution. Though this is useful in tracking the duration of melt, melt amount of magnitude is still unknown. Coupled optical/thermal surface measurements from MODIS were calibrated by estimates of liquid water fraction (LWF) in the upper 1cm of the firn derived from a one-dimensional thermal snowmelt model (SNTHERM). SNTHERM was forced by hourly meteorological data from automatic weather station data at reference sites spanning a range of melt conditions across the Ross Ice Shelf during a particularly intense melt season. Melt intensities or LWF were derived for satellite composite periods covering the Antarctic summer months at a 4km resolution over the entire Ross Ice Shelf, ranging from 0-2% LWF in early December to areas along the coast with upwards of 10% LWF during the time of peak surface melt. Spatial and temporal variations in the amount of surface melt are seen to be related to both katabatic wind strength and wind shifts due to the progression of cyclones along the circumpolar vortex. A future application of surface melt mapping using this empirical retrieval model is to determine melt magnitude over other Antarctic Ice Shelves, such as Larsen, where surface melt has been well documented in contributing to the disintegration of the ice shelf.