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Surface Temperature Over High Latitudes, Derived From Passive Microwaves

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Surface temperature is an important climatic parameter, as it governs the energy transfers between the ground and the atmosphere. It plays a key role in the establishment of the local condition, as for example the moisture content of the soil, or its state (liquid or frozen). It is also well recognized as an indicator of climate variability, related to large climate oscillations (NAO, El Niño/La Niña) or to the global warming trend. Its survey is particularly important, evenmore over Northern High Latitudes, due to the presence of the permafrost, a frozen soil. Recent surveys have highlighted the thawing of those areas, leading to a decrease of the global repartition of the permafrost since a few decades. An accurate characterization of these Northern surface is highly recommended to discuss the evolution of this soil and its impact on the hydrology and the surface energy budget. Surface temperature is a key parameter of interest for these studies. Moreover climate models need such a data to simulate the evolution of parameters, as reanalysis data seem to be sometimes biased.
In-situ measurements over the High Latitudes are sparse, resulting in insufficient datasets for a global study. Remote sensing allows to monitor surface “skin” temperature over large areas, but retrieving long term time series of surface temperature and its link with the permafrost evolution remains still a great challenge from space observations. Passive microwaves from SMMR (Scanning Multichannel Microwave Radiometer) and SSM/I (Special Sensor Microwave Imager) give a 25 years time series of data with a 25 km x 25 km resolution, from 1978 to 2002. This database has a great potential for climate studies. Passive microwaves present the advantages to be independent of cloud cover (opposed to thermal sensors). The repeat orbit of the satellite allow us to deal with at least 1 data every other day (for SMMR sensor),

twice a day for the best case (Northern part with the SSMI sensors). This results in an adequate database to reach our objectives.

We propose here a method to derive the surface temperature (temperature of the first centimeters of the surface) from brightness temperatures (satellite data) from 19 and 37 GHz, both vertically and horizontally polarized. With the additionnal ERA40 reanalysis air temperature, we developped a technique to simulate the hourly variation of surface temperature. A special care is also taken to avoid the presence on the ground of snow or frozen water, as those surface conditions are a limit to the surface temperature retrieval.

We compare our results to 2 datasets from meteorological measurements from Baker Lake's and La Tuque's station. The comparisons show a good concordance between our results and the meteorological data, which allow us to be very confident with our method. Results are integrated over a full summer to get a map of positive degree-days which is a good indicator of the permafrost extent.