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Validation of the MODIS “clear-sky” surface temperature of the Greenland Ice Sheet

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Surface temperatures on the Greenland Ice Sheet have been studied on the ground, using automatic weather station (AWS) data from the Greenland-Climote Network (GC-Net), and from analysis of satellite sensor data. Using Advanced Very High Frequency Radiometer (AVHRR) weekly surface temperature maps, warming of the surface of the Greenland Ice Sheet has been documented from 1981 to present. We extend and refine this record using higher-resolution Moderate-Resolution Imaging Spectroradiometer (MODIS) data from March 2000 to the present. To permit changes to be observed over time, we are developing a well-characterized monthly climate-data record (CDR) of the “clear-sky” surface temperature of the Greenland Ice Sheet using data from both the Terra and Aqua satellites. We use the MODIS ice-surface temperature (IST) algorithm. Validation of the CDR consists of several facets: 1) comparisons between the Terra and Aqua IST maps; 2) comparisons between ISTs and in-situ measurements; 3) comparisons between ISTs and AWS data; and 4) comparisons of ISTs with surface temperatures derived from other satellite instruments such as the Thermal Emission and Reflection Radiometer. In this work, we focus on 1) and 2) above.

First we provide comparisons between Terra and Aqua swath-based ISTs at approximately 14:00 Local Solar Time, reprojected to 12.5 km polar stereographic cells. Results show good correspondence when Terra and Aqua data were acquired within 2 hrs of each other. For example, for a cell centered over Summit Camp (72.58°N, 38.5°W), the average agreement between Terra and Aqua ISTs is 0.74 K (February 2003), 0.47 K (April 2003), 0.7 K (August 2003) and 0.96 K (October 2003) with the Terra ISTs being generally lower than the Aqua ISTs. More precise comparisons will be calculated using pixel data at the swath level, and correspondence between Terra and Aqua IST is expected to be closer. (Because of cloud cover and other considerations, only a few common cloud-free swaths are typically available for each month for comparison.)

Additionally, previous work comparing land-surface temperatures (LSTs) from the standard MODIS LST product and in-situ surface-temperature data at Summit Camp on the Greenland Ice Sheet show that Terra MODIS LSTs are about 3 K lower than in-situ temperatures at Summit Camp, during the winter of 2008-09. This work will be repeated using both Terra and Aqua IST pixel data (in place of LST data).

In conclusion, we demonstrate that the uncertainties in the CDR will be well characterized as we work through the various facets of its validation.