

Toward all weather, long record, and real-time land surface temperature retrievals from microwave satellite observations

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The land surface temperature can be estimated from satellite passive microwave observations, with limited contamination from the clouds as compared to the infrared satellite retrievals. With $\sim 60\%$ cloud cover in average over the globe, there is a need for “all weather,” long record, and real-time estimates of land surface temperature (Ts) from microwaves. A simple yet accurate methodology is developed to derive the land surface temperature from microwave conical scanner observations, with the help of pre-calculated land surface microwave emissivities. The method is applied to the Special Sensor Microwave/Imagers (SSM/I) and the Earth observation satellite (EOS) Advanced Microwave Scanning Radiometer (AMSR-E) observations, regardless of the cloud cover. The SSM/I results are compared to infrared estimates from International Satellite Cloud Climatology Project (ISCCP) and from Advanced Along Track Scanning Radiometer (AATSR), under clear-sky conditions. Limited biases are observed (~ 0.5 K for both comparisons) with a root-mean-square difference (RMSD) of ~ 5 K, to be compared to the RMSE of ~ 3.5 K between ISCCP et AATSR. AMSR-E results are compared with the Moderate Resolution Imaging Spectroradiometer (MODIS) clear-sky estimates. As both instruments are on board the same satellite, this reduces the uncertainty associated to the observations match-up, resulting in a lower RMSD of ~ 4 K. The microwave Ts is compared to in situ Ts time series from a collection of ground stations over a large range of environments. For 22 stations available in the 2003-2004 period, SSM/I Ts agrees very well for stations in vegetated environments (down to RMSD of ~ 2.5 K for several stations), but the retrieval methodology encounters difficulties under cold conditions due to the large variability of snow and ice surface emissivities. For 10 stations in the year 2010, AMSR-E presents an all-station mean RMSD of ~ 4.0 K with respect to the ground Ts. Over the same stations, MODIS agrees better (RMSD of 2.4 K), but AMSR-E provides a larger number of Ts estimates by being able to measure under cloudy conditions, with an approximated ratio of 3 to 1 over the analysed stations. At many stations the RMSD of the AMSR-E clear and cloudy-sky are comparable, highlighting the ability of the microwave inversions to provide Ts under most atmospheric and surface conditions.