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Towards consistent Land Surface Temperature products from multiple satellite instruments: Validation Results from WACMOS-ET

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Land surface temperature (LST) is an important parameter for a wide variety of earth surface processes and in particular for evapotranspiration. The ESA-funded project WACMOS-ET aims at advancing the development of evapotranspiration estimates at global and regional scales using various earth observations products. As part of this project, LST is computed globally using a consistent retrieval algorithm for satellite data from both low-earth orbit and geostationary instruments. These instruments include the Advanced Along-Track Scanning Radiometer (AATSR), the Spinning Enhanced Visible and Infrared Imager (SEVIRI), the Geostationary Operational Environmental Satellite (GOES), and the Multi-functional Transport Satellites (MTSAT).

In order to evaluate the quality of the resulting LST products, a comprehensive global validation study was carried out. The validation was performed by comparing satellite-derived LST against a) in situ observations acquired at stations located in various land cover types and b) the independent observations of the well-validated MOD11 LST product, which is generated from data acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) satellite instrument onboard of the Terra platform.

A direct comparison of AATSR-derived LST against in situ observations indicated a mean nighttime bias of 0.3 °C and a mean daytime bias of 1.4 °C. The standard deviations were found to be 1.3 °C and 2.5 °C, respectively. The root mean squared error (RMSE) as a measure of overall product accuracy was found to be 1.4 °C and 3.2 °C for nighttime and daytime data, respectively. LST derived from AATSR was found to be negatively affected by insufficient cloud masking during nighttime observations. However, the WACMOS-ET AATSR product was found to provide slightly more accurate retrievals than those of the GlobTemperature AATSR product when the same cloud mask is used. No suitable in situ sites were available for validating MTSAT LST but inter-comparisons with MODIS and AATSR LST showed a good correspondence. LST retrievals from GOES-E showed a good agreement with the ground-based in situ observations. The average bias over seven stations was found to be 0.37 °C for daytime data and as low as 0.21 °C for nighttime data. The standard deviations were found to be 2.9 °C and 2.4 °C, respectively. The RMSE for daytime data was 3.2 °C and for nighttime data 2.6 °C.

Overall, the LST retrievals evaluated here show good to very good performance within the limits of what is currently achievable for LST products. The study indicates that applying a consistent retrieval algorithm for multiple instruments is feasible and provides promising results. The results from this study can be seen as an important first step towards producing merged LST products with high spatial and temporal resolution by combining data from both geostationary and low-earth orbit instruments.