Geophysical Research Abstracts
Vol. 15, EGU2013-2240, 2013
EGU General Assembly 2013

Towards a protocol for validating satellite-based Land Surface Temperature: Theoretical considerations

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Land Surface Temperature (LST) and emissivity are important parameters for environmental monitoring and earth system modelling. LST has been observed from space for several decades using a wide variety of satellite instruments with different characteristics, including both platforms in low-earth orbit and in geostationary orbit. This includes for example the series of Advanced Very High Resolution Radiometers (AVHRR) delivering a continuous thermal infrared (TIR) data stream since the early 1980s, the series of Along-Track Scanning Radiometers (ATSR) providing TIR data since 1991, and the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments onboard NASA's Terra and Aqua platforms, providing data since the year 2000. In addition, the Spinning Enhanced Visible and Infrared Imager (SEVIRI) onboard of the geostationary Meteosat satellites is now providing LST at unprecedented sub-hour frequency. The data record provided by such instruments is extremely valuable for a wide variety of applications, including climate change, land/atmosphere feedbacks, fire monitoring, modelling, land cover change, geology, crop- and water management. All of these applications, however, require a rigorous validation of the data in order to assess the product quality and the associated uncertainty.

Here we report on recent work towards developing a protocol for validation of satellite-based Land Surface Temperature products. Four main validation categories are distinguished within the protocol: A) Comparison with in situ observations, B) Radiance-based validation, C) Inter-comparison with similar LST products, and D) Time-series analysis. Each category is further subdivided into several quality classes, which approximately reflect the validation accuracy that can be achieved by the different approaches, as well as the complexity involved with each method. Advice on best practices is given for methodology common to all categories. For each validation category, recommendations are further given with respect to specific methodology that has proven to be valuable for each approach. Selection criteria used for distinguishing the accuracy classes are established for each category and examples for the various categories and classes are provided. While the four validation categories introduced in the protocol exhibit varying levels of complexity and differ in terms of their resource demands, they are generally quite complementary, and a comprehensive LST validation will ideally entail certain elements from all four of them. The suggested validation protocol is a first attempt to provide a standardized framework for structuring the various LST validation approaches and will be further modified based on experiences and feedback from the LST validation community.