A comparison of satellite, modeled, and in situ land surface temperatures: global analysis for selected months in 2003

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Land surface skin temperature (LST) is the physical temperature of the Earth's land surface. In contrast to the oceans, land surfaces are highly variable in space and have low heat capacity and limited moisture. As a consequence, when exposed to solar flux variations, LSTs exhibit strong diurnal to seasonal variations (modulated by surface properties like vegetation density and soil moisture), acting as a key variable governing land-atmosphere interactions. Energy exchanges at the land-surface boundary are largely controlled by the difference between the LST and the surface air temperature, the air and the surface reacting with different time and space scales to external forcing while still being complexly interconnected. Estimates of the LST diurnal cycle can also yield relevant information about the soil moisture via an estimate of the thermal inertia.

In order to foster dialogue between the research and user communities on the retrieval and use of LST products, the "International Workshop on the Retrieval and Use of Land Surface Temperature: Bridging the Gaps"[1] was held at NOAA National Climatic Data Center (NCDC), Asheville, on April 2008, co-sponsored by the GEWEX Radiation Panel and NCDC, in partnership with NASA. One of the outcomes of the meeting was the realization that there was a need to better assess the accuracy of selected LST products, especially over arid and semi-arid areas where errors can be large due to improper characterization of surface emissivity and the large amplitude of the diurnal cycle. Towards this objective, Paris Observatory and AER have started an inter-comparison of different remote sensing, model and in situ LST products, at the global scale, to assess level of agreement of the data and to investigate the causes for disagreement (e.g., cloud mask, calibration issues, atmospheric correction, observing angles, different LST definitions between observed and model estimates, etc). This exercise is not completed, but some examples of preliminary results for a comparison of three remote sensing estimates (ISCCP [*Rossow and Schiffer*(1999)], MODIS [*Wan*(2008)], and AIRS [*Aumann et al.*(2001)]) and one model output (GMAO[2]) for January and July 1993 are given in Figures 1 and 2. The differences between the products at some regions and times can be significant (e.g. see the large day differences between ISCCP and the other estimates over arid areas in Figure 1). The same LST estimates are also compared with in situ measurements from several stations archived at the CEOP data center [3]. Preliminary results are presented in Figure 3, showing also relatively large differences, but the results need to be further evaluated due to the difficulties of comparing point measurements with satellite footprints or model cells covering much larger areas.

It is believed that a detailed analysis of the differences between present LST products from observations and models can contribute to a significant improvement in the products, to a better understanding between the observation and modeling communities, and to help build confidence in the LST estimates from a wide community of potential users.

Acknowledgments. All data producers are kindly acknowledged by making their estimates available and by being available for discussions concerning their products.

[1]http://www.joss.ucar.edu/joss_psg/meetings/Meetings_2008/Bridging_the_Gaps
[2]http://gmao.gsfc.nasa.gov/
[3]http://monsoon.t.u-tokyo.ac.jp/ceop2/

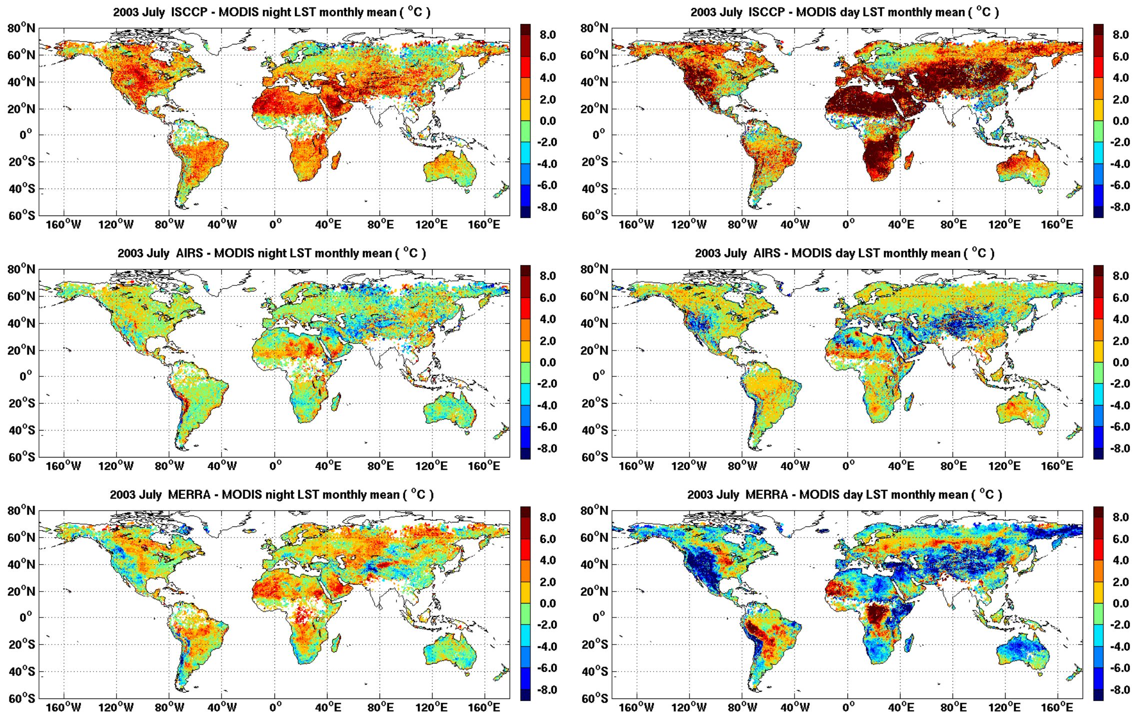

Figure 1: Example of night (left) and day (right) LST differences for July 2003. The compared products are the LST daily estimates from ISCCP (Dx, resolution of 30 km − 3 hours), MODIS (L3−v004, 5km − 2 daily overpasses), and AIRS (L3−v005, 1^o x 1^o − 2 daily overpasses), and model outputs from GMAO (CEOP contribution, $1/2^o$ x $2/3^o$ − 1 hour, referred here as MERRA). All the satellite and model products were linearly interpolated in time to the MODIS local time overpasses (∼1.30 am night−time, 1.30 pm. day−time) and in space to a $1/4^o$ x $1/4^o$ equal area grid (∼25 x 25 km^2 at the equator). Only clear−sky estimates (cloud flag from MODIS) have been compared. The differences are given with respect to MODIS.

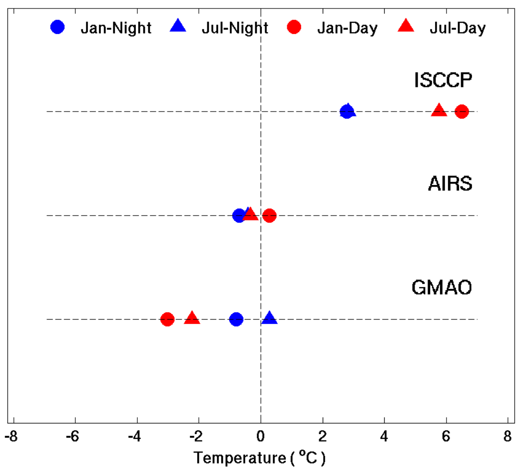

Figure 2: Example of LST differences between selected products (see Figure 1 for description of products): night (blue) and day (red) ISCCP, AIRS, and GMAO monthly differences with respect to MODIS for January (circles) and July (triangles) 2003.

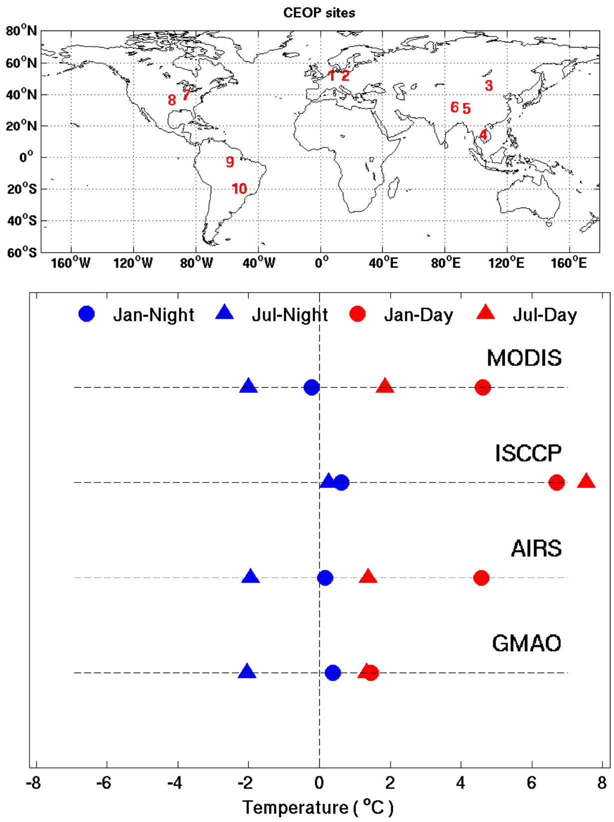

Figure 3: Example of LST differences between selected products (see Figure 1 for description of products) and in−situ measurements from several stations archived at the CEOP data center (point measurements − 1/2 hour). Matches with the global products were identified based on a 1/2 hour time window and a 1/6° x 1/6° box (∼15x15 km^2) around the station location (top). Bottom: night (blue) and day (red) MODIS, ISCCP, AIRS, and GMAO monthly LST differences with respect to the CEOP data for January (circles) and July (triangles) 2003.

References

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[*Rossow and Schiffer*(1999)] Rossow, W., and R. Schiffer, Advances in understanding clouds from ISCCP, *Bull. Amer. Meteor. Soc.*, *80*(11), 2261–2287, 1999.

[*Wan*(2008)] Wan, Z., New refinements and validation of the MODIS Land-Surface Temperature/Emissivity products, *Remote Sens. Envir.*, *112(1)*, 10.1016/j.rse.2006.06.026, 2008.