Inter-comparison of Land Surface Temperature Products from NPP/VIIRS and Aqua/MODIS Protocol, Limitations, and Validation Results

Biard J.C.[a,b], Guillevic P.C.[a,b], Hulley G.C.[c], and Privette J.L.[b]

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Introduction

The Visible Infrared Imager Radiometer Suite (VIIRS) on the Suomi National Polar-orbiting Partnership (NPP) satellite is NOAA's newest polar-orbiting imager. The Land Surface Temperature (LST) product from VIIRS estimates the surface skin temperature over land surfaces and provides key information for monitoring Earth surface energy and water balances. Part of the VIIRS LST calibration and validation process is checking the product against comparable products from other platforms and characterizing any differences.

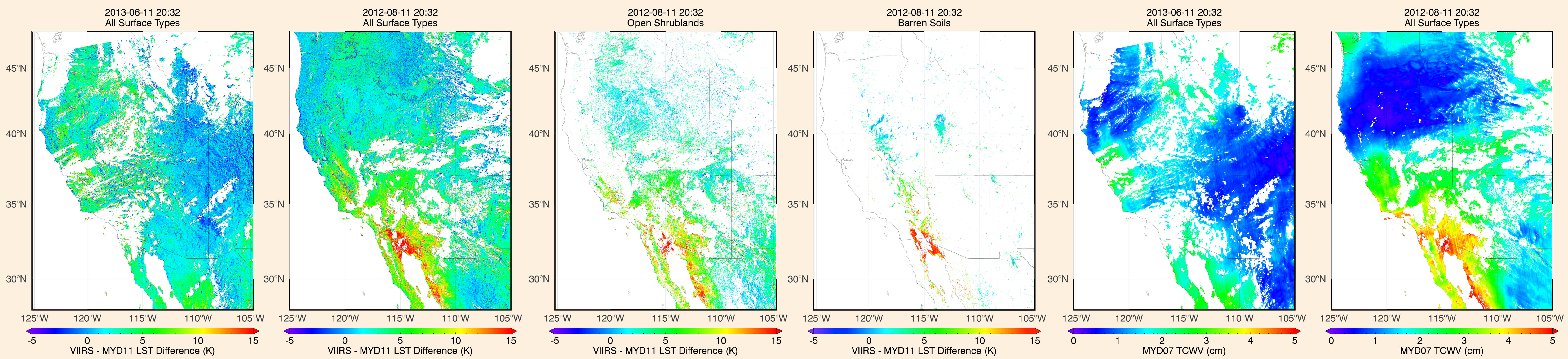
Results

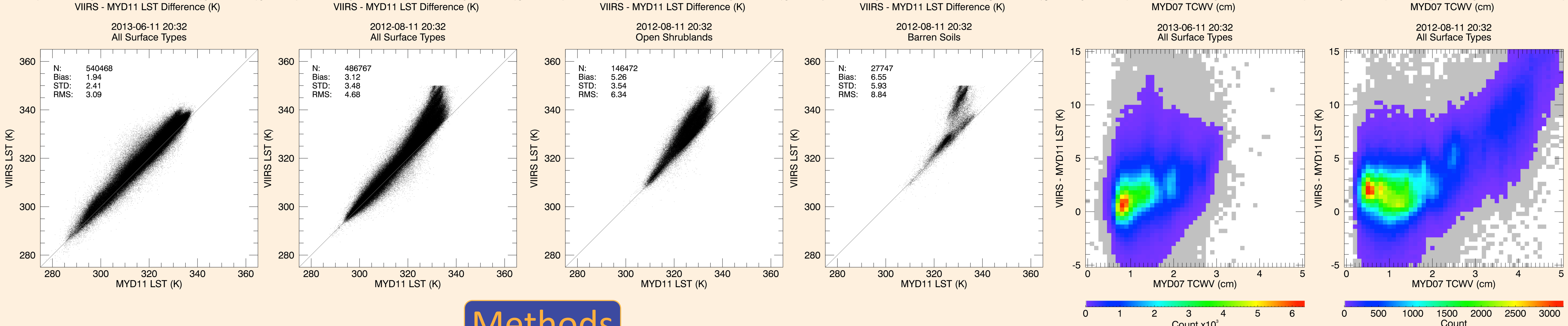
While the differences between the LST samples are relatively small and linear for most SNOs, some are large, complex, and temperature dependent. These anomalies are not seen when comparing top of atmosphere (TOA) brightness temperatures, which are the inputs to the LST algorithms. Two SNOs with comparable temperature distributions are shown here as an example.

Sub-setting the comparisons by surface type shows that the LST differences have strong spatial dependencies. They do not depend on temperature alone, as both good and bad agreement can be found for even the highest temperatures.

The MYD11 LST algorithm, unlike the VLSTO algorithm, is a function of near-surface air temperature and total column water vapor (TCWV). The MODIS MYD07 TCWV product is used in the MYD11 LST algorithm. This suggests two possible lines of investigation.

Analysis of the relationship between the LST differences and TCWV shows a strong, non-linear dependence between the two.





Methods

The VIIRS VLSTO LST and NASA's Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) MYD11 LST product were compared using data from near-simultaneous nadir overpasses (SNOs). Nearest neighbor VIIRS samples were matched to MODIS samples having the same surface type.

Affiliations:
[a] Cooperative Institute for Climate and Satellites (CICS) – NCSU, Asheville, NC, USA
[b] NOAA's National Climatic Data Center (NCDC), Asheville, NC, USA
[c] Jet Propulsion Laboratory (JPL), California Institute of Technology, Pasadena, CA, USA

Discussion

The daytime VLSTO split-window algorithm uses the equation

$$T_s = a_0 + a_1 T_{M15} + a_2 (T_{M15} - T_{M16}) + a_3(\sec\theta - 1) + a_4 (T_{M15} - T_{M16})^2$$

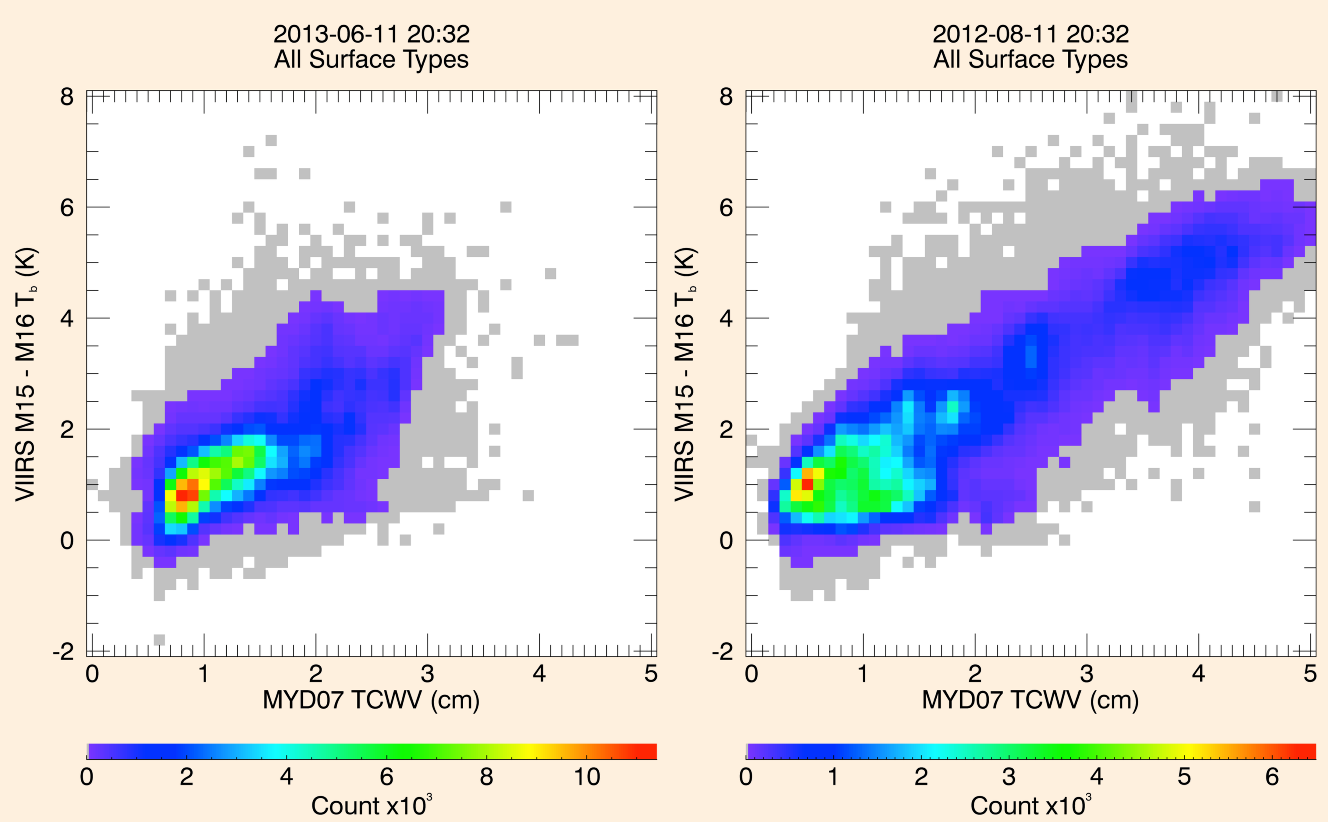
where T_{M15} and T_{M16} are the TOA brightness temperatures for the 11 and 12 µm VIIRS bands, θ is the viewing angle, and the coefficients a_n depend upon surface type.

The daytime MYD11 split-window algorithm uses the equation

$$T_s = \left(a_1 + a_2 \frac{1-\varepsilon}{\varepsilon} + a_3 \frac{\Delta\varepsilon}{\varepsilon^2}\right)\frac{T_{31}+T_{32}}{2} + \left(b_1 + b_2 \frac{1-\varepsilon}{\varepsilon} + b_3 \frac{\Delta\varepsilon}{\varepsilon^2}\right)(T_{31} - T_{32}) + c$$

where T_{31} and T_{32} are the TOA brightness temperatures for the 11 and 12 µm MODIS bands; the ε and Δε terms represent combinations of emissivities; and the coefficients a_n, b_n, and c depend on surface air temperature, TCWV, and viewing angle.

Analysis of the relationship between ($T_{M15} - T_{M16}$) and MYD07 TCWV indicates that there is a roughly linear relationship between the two quantities.



Conclusion

The current VIIRS LST algorithm is not well adapted to situations where there is a combination of high surface temperature and high water vapor content.