JPSS-NPP Land Surface Temperature Product: Beta and Provisional release Status

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Introduction

The U.S. Joint Polar-orbiting Satellite System (**JPSS**) launched its first satellite, the Suomi NPP (**S-NPP**) satellite, in October 2011. Subsequent satellites of the JPSS mission are scheduled for launch in 2017 (J1 satellite) and in 2022 (J2 satellite). The Center for SaTellite Applications and Research (**STAR**) at the National Environmental Satellite Data and Information Service (**NESDIS**) of the U.S. National Oceanic and Atmospheric Administration (**NOAA**) is responsible for producing operational land surface environmental data record (**EDR**) products for the JPSS mission, including land surface temperature (**LST**). The LST production is based on the Visible Infrared Imager Radiometer Suite (**VIIRS**) sensor onboard the JPSS satellites. The NOAA LST EDR team at NOAA/NESDIS/STAR has performed intensive testing and evaluation on the VIIRS LST product since the S-NPP satellite launch.

Product Basics

- The VIIRS LST is a moderate band pixel-by-pixel determination of effective land surface skin temperature produced as EDR.
- The split-window algorithm is performed as baseline algorithm.
- Evaluations are performed through internal and external comparisons.
- The VIIRS LST production is under the JPSS level 1 requirement.
- NOAA/NESDIS/STAR is responsible for the JPSS LST development.

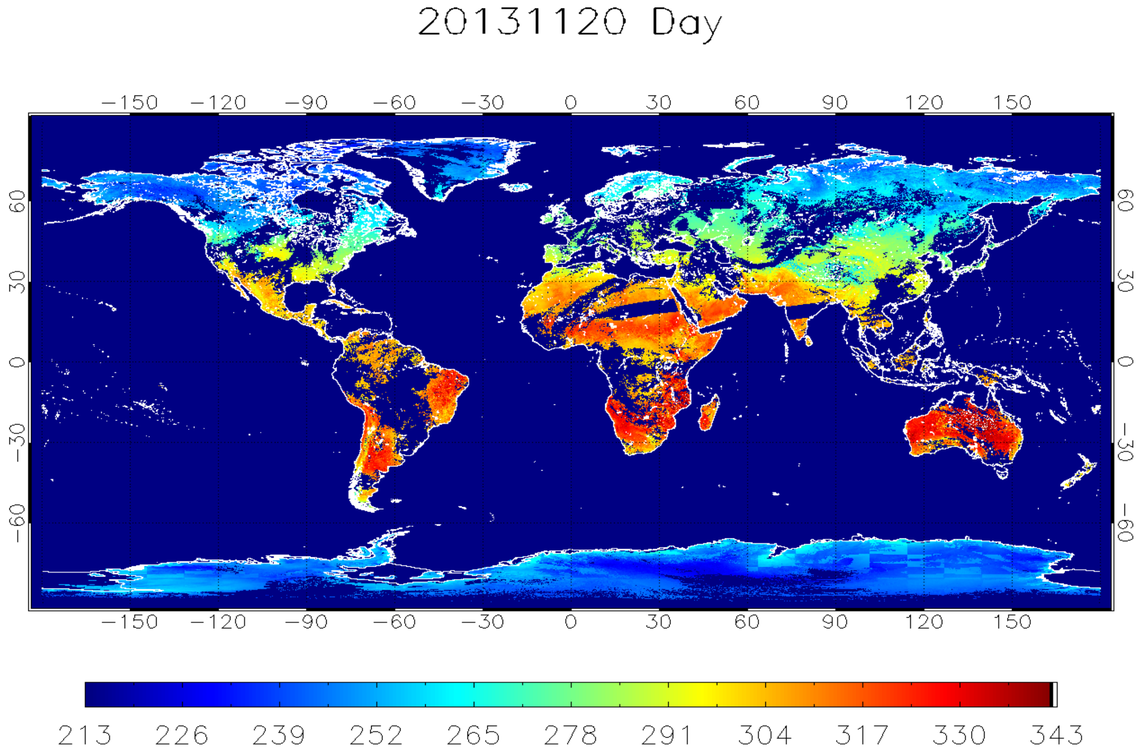
L1RD: Land Surface Temperature		
Attribute	Threshold	Objective
LST Applicable Conditions: Clear		
a. Horizontal Cell Size	4 km	1 km
Nadir	(800 m)	(500 m)
b. Mapping Uncertainty, 3 Sigma	1 Km at Nadir	1 km at Edge of Scan
c. Measurement Range	213 – 343 K	183 – 343 K
d. Measurement Precision (1 sigma)	2.5 K	1.5 K
e. Measurement Accuracy (bias)	1.4 K	0.8 K
f. Refresh	At least 90% coverage of the globe every 24 hours (monthly average)	

Algorithm

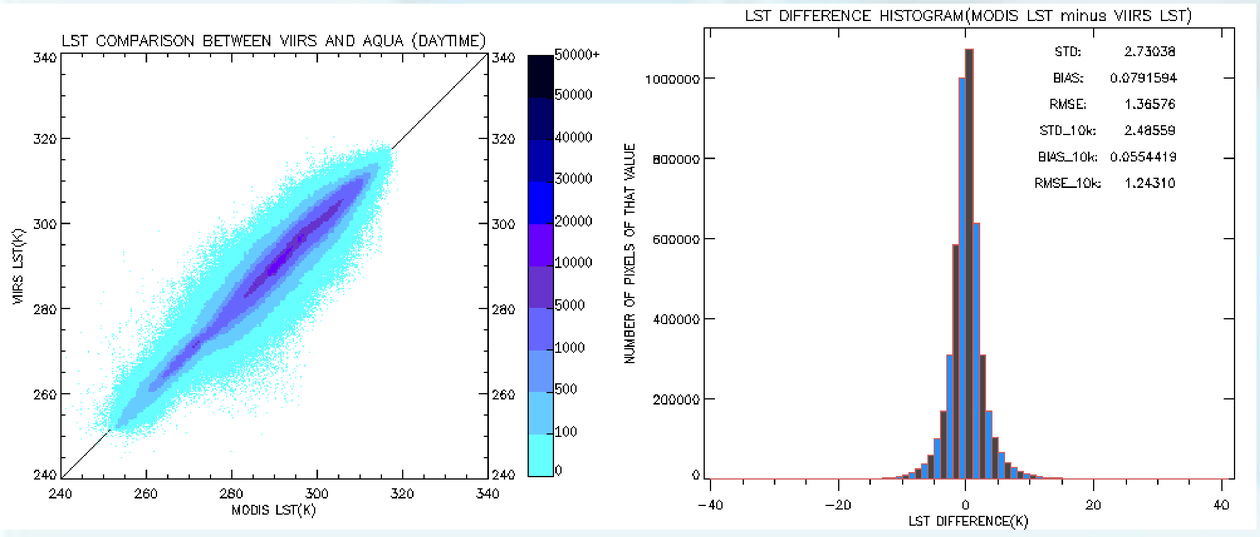
$$LST_i = a_0(i) + a_1(i)\,T_{11} + a_2(i)\,(T_{11} - T_{12}) + a_3(i)\,(\sec\theta - 1) + a_4(i)\,(T_{11} - T_{12})^2$$
$$i = 1,..,17$$

Note:
- i is the index of the 17 International Geosphere Biosphere Program (IGBP) surface types
- T_{11}, T_{12} are the brightness temperatures of the VIIRS 10.8 μm and 12 μm bands respectively
- θ and φ are the sensor and solar zenith angles respectively
- $a_j(i)$ are the regression coefficients for the jth IBGP surface type for daytime and nighttime LST retrievals respectively

LST Product and Validation

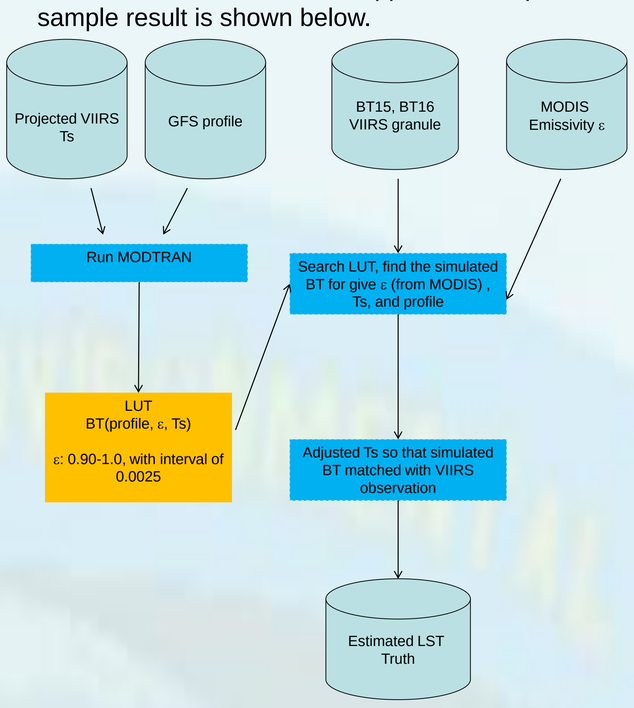


A global daytime composite map of the S-NPP LST, for the day of 20 Nov. 2013.

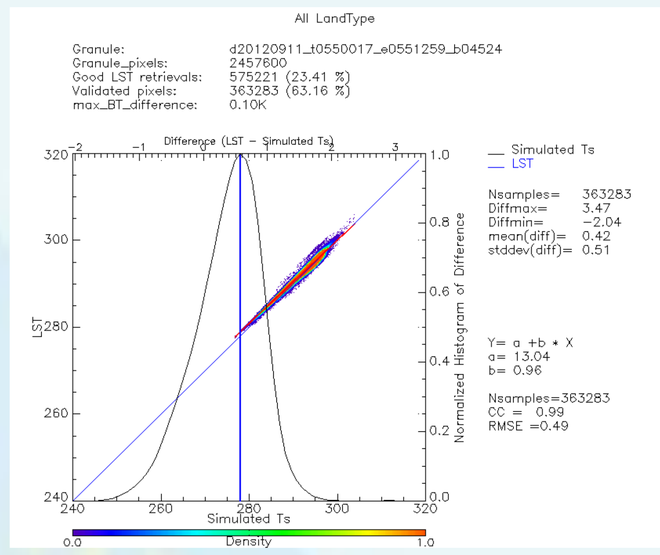


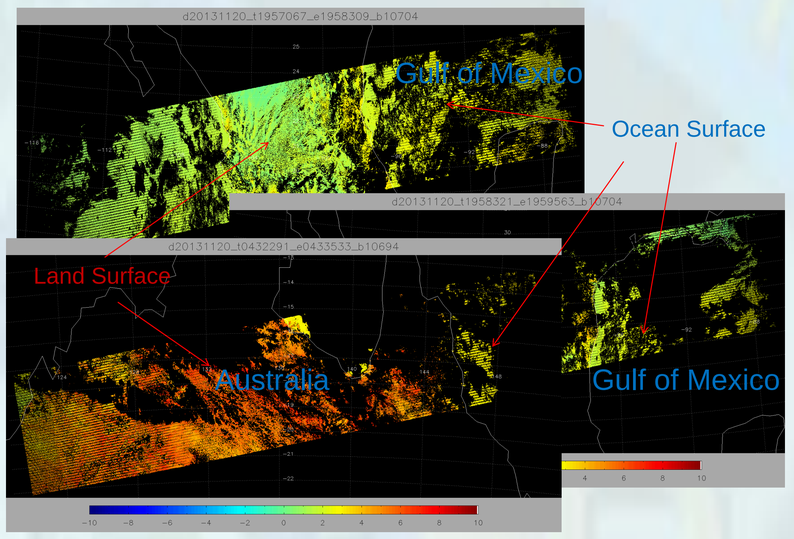
Beta version validation: *Daytime comparison between the VIIRS LST and AQUA LST. Scatter plots of the two LSTs are shown on the left; the color bar represents the density of LST pairs in each bin (0.5K). Histogram of the difference is shown on the right with the standard deviation (STD), bias and the root mean square error (RMSE); STD_10K, BIAS_10K and RMSE_10K represent results after removing those suspicious data in which the difference between the VIIRS LST and the MODIS LST is greater than 10K.*

A radiance-based validation approach is implemented at STAR. The processing flow chart and a sample result is shown below.

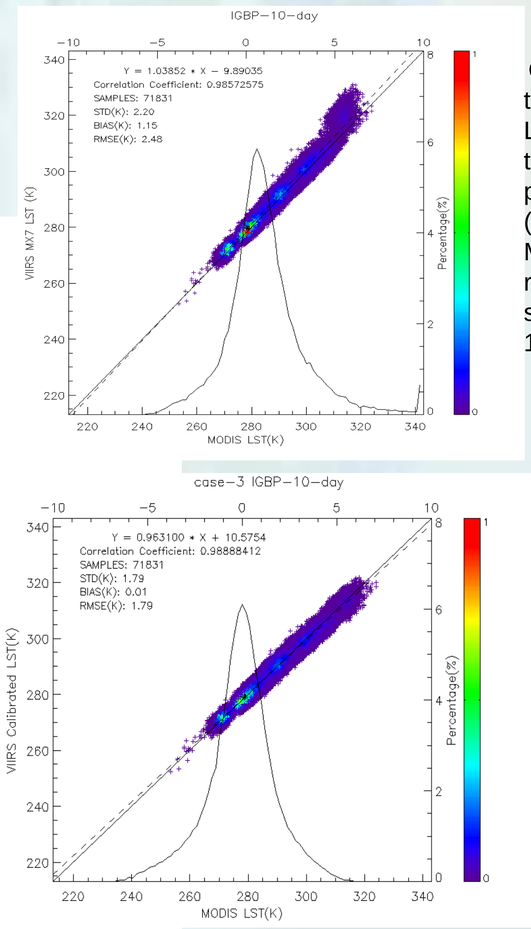


Left: Radiance-based approach; below: sample result

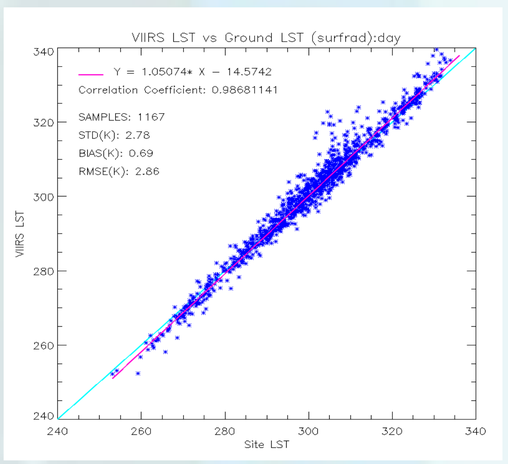




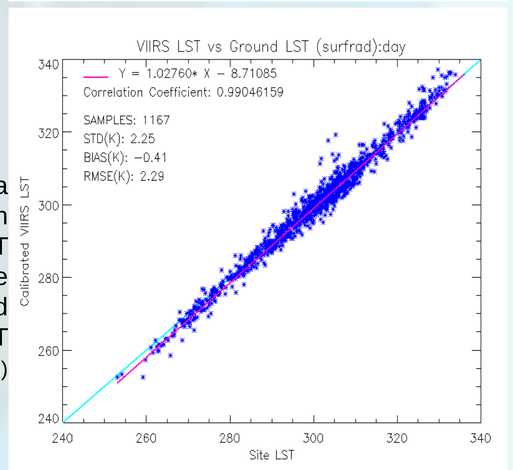
<u>Correction of the brightness temperature (**BT**) difference</u>:
In principal, the BT difference of the split-window channels is applied for atmospheric correction in the algorithm, assuming that the BT difference represents well the atmospheric absorption. However, over land surface the BT difference contains the surface spectral emission difference between the channels as well as the atmospheric absorption. Considering that the VIIRS LST algorithm is an emissivity implicit (coefficients surface type dependent) algorithm, calibration of the BT difference terms in the algorithm is needed.



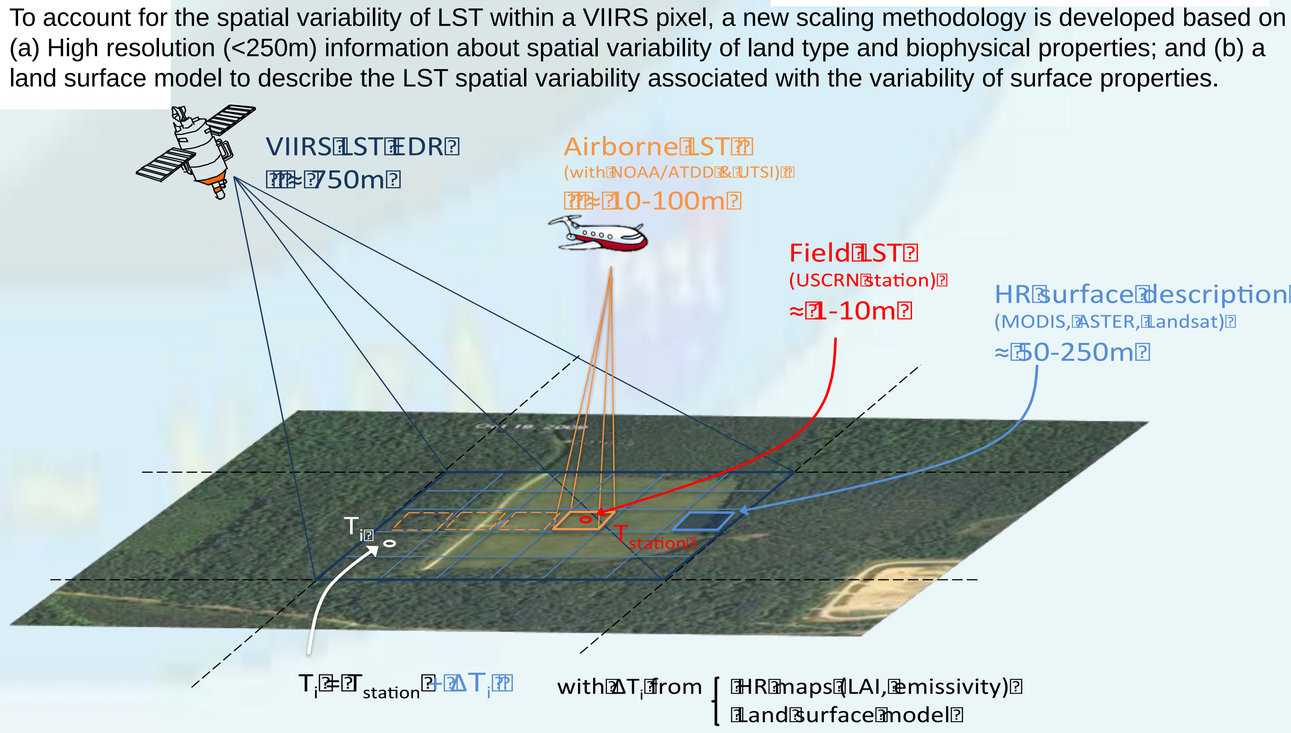
Comparisons of the VIIRS beta LST (top-left) and the calibrated provisional LST (bottom-left) with MODIS LST as reference. The sample IGBP type 10: Grasslands.



Ground data validation on VIIRS Beta LST (Top) and the calibrated Provisional LST (Bottom)



To account for the spatial variability of LST within a VIIRS pixel, a new scaling methodology is developed based on (a) High resolution (<250m) information about spatial variability of land type and biophysical properties; and (b) a land surface model to describe the LST spatial variability associated with the variability of surface properties.



Current Status

- Beta version of the LST has been in operations since December 2012.
- A provisional version was tested in November 2013; error of underestimation was found.
- A calibrated provisional version has been developed recently, and will be in operations soon.