

# Land Surface Temperature Production for GOES-R and JPSS Missions

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## Introduction

Land surface temperature (LST) measurement is important for understanding climate change, modeling the hydrological and biogeochemical cycles, and is a prime candidate parameter for Numerical Weather Prediction assimilation models. Development of land surface temperature Environmental Data Record (EDR) for the U.S. Geostationary Operational Environmental Satellite (GOES) R series (GOES-R) satellite mission and the Joint Polar-orbiting Satellite System mission is one of the major tasks of the land product team at Satellite Meteorology and Climatology Division (SMCD), center for SaTellite Applications and Research center (STAR). The LST algorithm for GOES-R mission has been developed based on an emissivity explicit, split window linear regression approach, while the LST product for JPSS S-NPP mission is based on a surface-type dependent, split window regression algorithm. Pre-launch evaluation of the GOES-R LST algorithm using real satellite (proxy) data, as well as simulation data, indicates that it will be a stable and high quality product when high quality surface emissivity data at the thermal infrared band is available. Post-launch monitoring and validation works show that quality of the JPSS S-NPP LST product is equivalent to the NASA MODIS LST product. However, it may be greatly impacted by quality of the VIIRS surface type data. The first validated version of the JPSS S-NPP LST product readiness has been reviewed in December 2014; shall be operationally available March 2015.

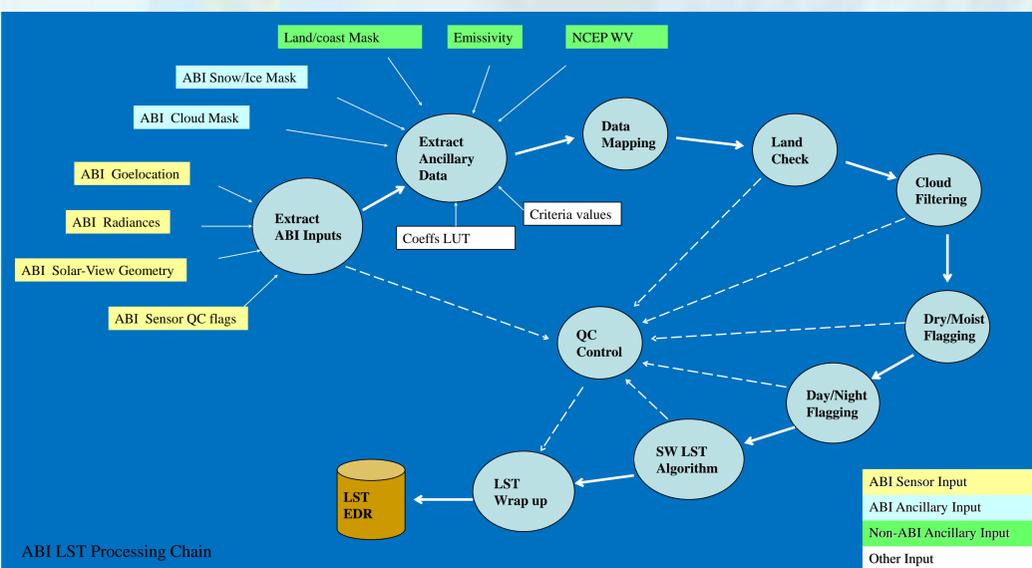
## GOES-R LST Production

### GOES-R ABI LST Algorithm and Process Chain

A split-window, emissivity-explicit regression algorithm is implemented for the GOES-R/ABI land surface temperature,  $T_s$ , production:

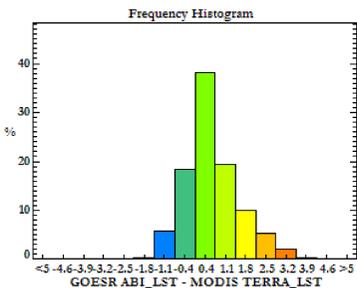
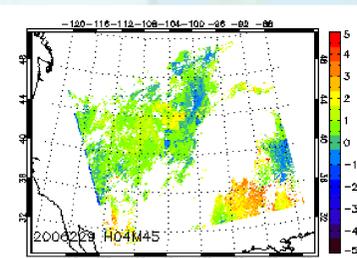
$$T_s = a_0 + a_1 T_{11} + a_2 (T_{11} - T_{12}) + a_3 \varepsilon + a_4 (T_{11} - T_{12}) (\sec\theta - 1)$$

where  $a_k$  are algorithm coefficients,  $\theta$  is view zenith angle;  $T_{11}$  and  $T_{12}$  represent the ABI sensed brightness temperatures at 11 and 12 micron channels (the split-window).

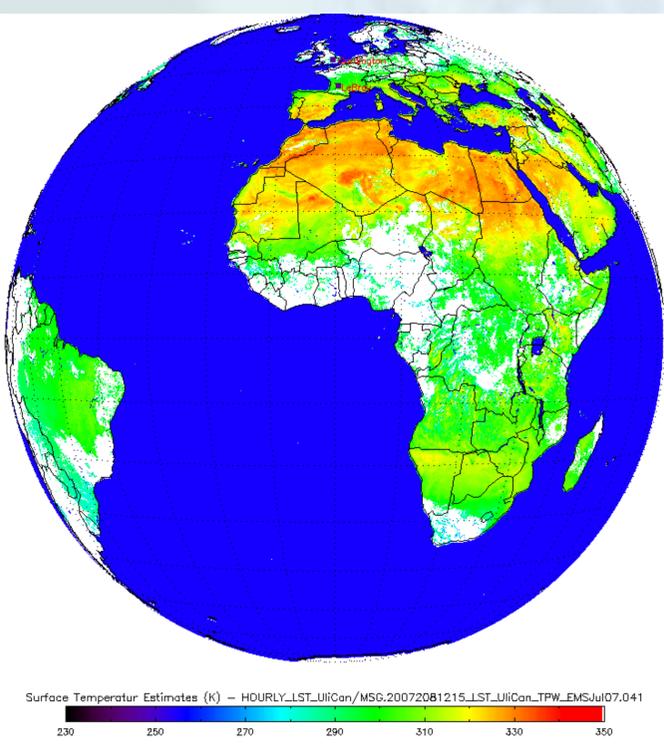


## Evaluations using proxy data

ABI LST Map using SEVIRI data as a proxy (right), and evaluation results using MODIS as proxy (bottom).



Validation sample: Image and histogram plot of LST difference between the proxy GOES-R LST and the MODIS LST. The data is sampled from MODIS Terra, on August 17, 2006.



## JPSS S-NPP LST Production

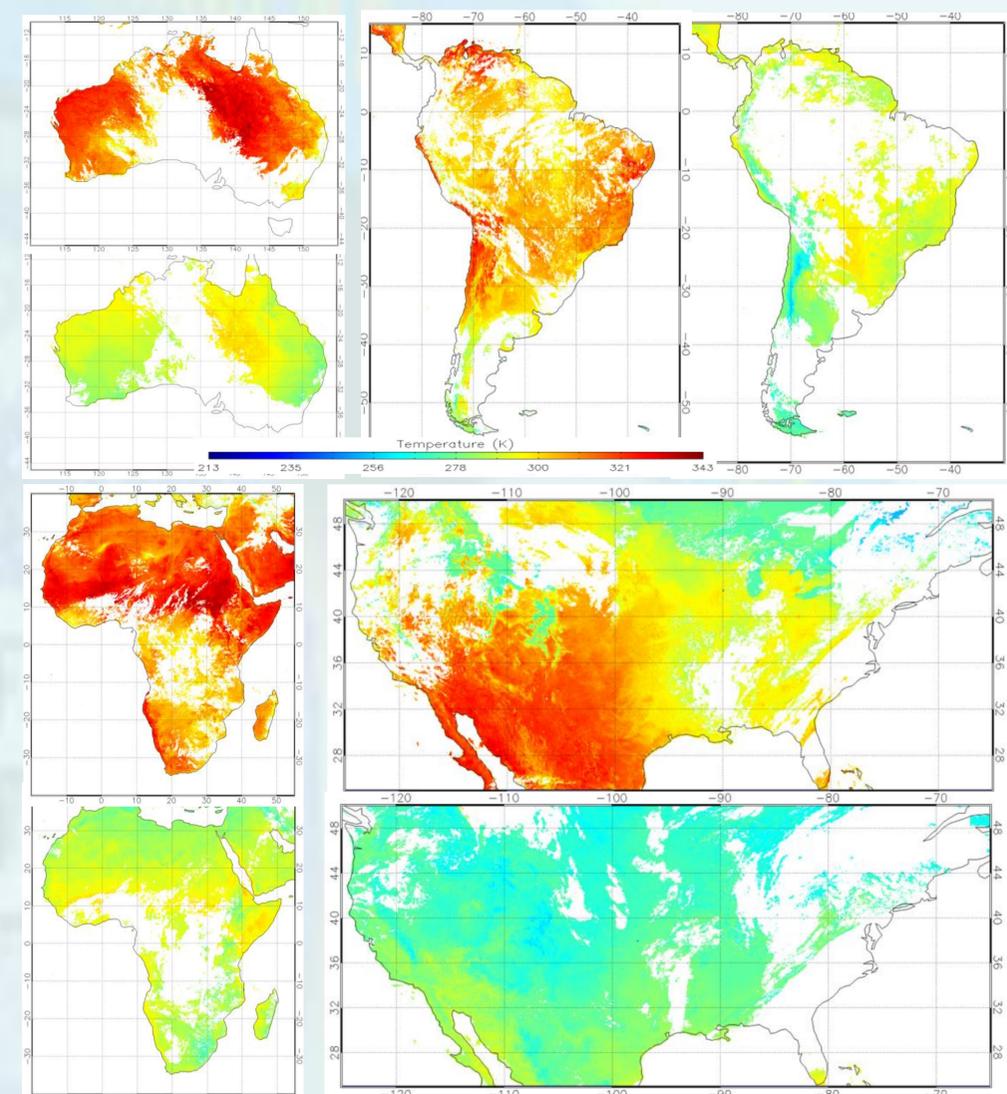
### JPSS S-NPP LST Algorithm

A split-window regression algorithm is running for the JPSS/VIIRS land surface temperature,  $T_s$ , production:

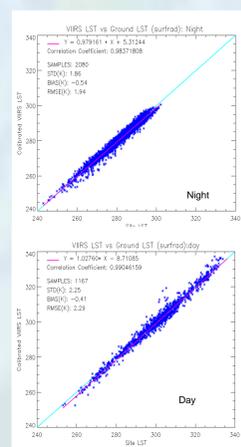
$$T_s = a_{0,i} + a_{1,i} T_{11} + a_{2,i} (T_{11} - T_{12}) + a_{3,i} (\sec\theta - 1) + a_{4,i} (T_{11} - T_{12})^2$$

where  $a_{k,i}$  are algorithm coefficients;  $i$  indicates 17 IGBP surface types;  $\theta$  is view zenith angle.  $T_{11}$  and  $T_{12}$  represent the VIIRS sensed brightness temperatures at 11 and 12 micron channels (the split-window).

### Sample VIIRS LST Maps



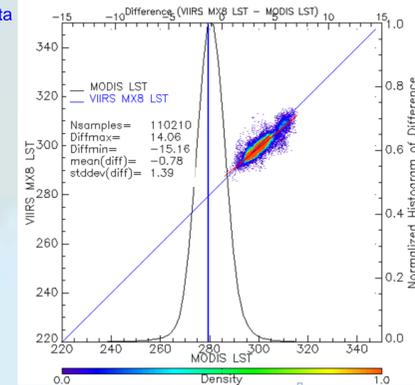
## Evaluations



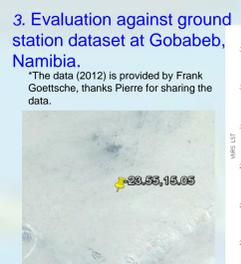
### 1. Evaluation against SURFRAD Station data

Surface type	Day/ Night	data num	Provisional Bias	Provisional STD	Beta Bias	Beta STD
Deciduous Broadleaf Forest	day	4	-0.67	0.80	0.31	3.10
	night	11	-0.13	1.60	-0.13	1.60
Closed Shrub lands	day	37	-0.81	1.77	-1.16	1.77
	night	57	-1.37	0.80	-2.48	0.63
Open Shrub lands	day	277	-0.1	1.90	0.67	1.90
	night	327	-0.88	0.79	-2.38	0.79
Woody Savannas	day	46	-1.09	2.39	-0.34	2.81
	night	81	1.38	1.35	1.38	1.35
Grasslands	day	172	-0.38	1.90	1.11	2.36
	night	500	-0.35	1.41	-0.35	1.41
Croplands	day	266	0.14	2.95	0.35	3.54
	night	558	-0.21	1.58	-0.21	1.58
Cropland/Natural Veg Mosaics	day	208	-0.83	1.98	0.13	2.15
	night	459	0.47	1.94	0.47	1.94
Snow/ice	day	97	-1.16	1.67	-1.95	1.70
	night	87	-1.17	0.88	-2.67	0.88
Barren	day	60	0.72	1.68	0.12	2.10
	night	87	-1.17	0.88	-2.67	0.88

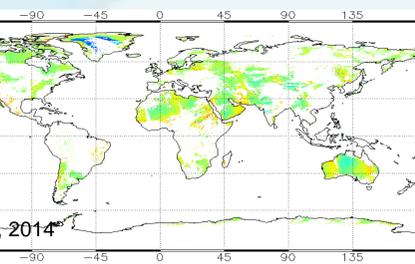
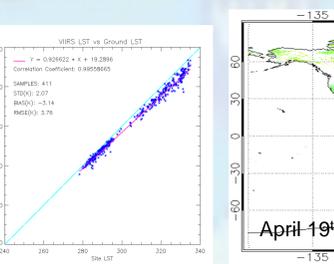
SURFRAD LST over 6 sites covering the time period from Feb. 2012 to December 2013



2. Evaluation against MODIS LST data (above: Granule comparison; bottom right: Global comparison)



3. Evaluation against ground station dataset at Gobabeb, Namibia



## Summary

- An explicit split-window algorithm has been applied for the GOES-R ABI LST measurement.
- The algorithm package has been developed and implemented in the mission's ground system.
- The U.S. SURFRAD station measurement is applied for evaluation of the GOES-R ABI LST data.
- Simulation and proxy satellite data have been used for the pre-launch validation; the requirement is met.
- A validation and monitoring tool is in development.
- The Japanese Himawari-8 satellite data will be used for the pre-launch evaluation.

- Overall, S-NPP/VIIRS LST quality meets the Mission's requirement, based on the in-situ LST measurements from the U.S. SURFRAD stations during the period from Feb. 2012 to Aug. 2014.
- Quality of S-NPP/VIIRS LSTs and MODIS LSTs are similar, based on the comparisons of over 100 VIIRS/MODIS simultaneous nadir observation scenes.
- The S-NPP/VIIRS LST production is stable, based on STAR weekly LST monitoring.
- Impact of sensor noise is ignorable; impacts of ST misclassification and cloud contamination are significant.
- Validated V1 version of the VIIRS LST product will be available March 2015.