NPP VIIRS Land Surface Temperature EDR validation using NOAA's observation networks

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Introduction

NOAA will soon use the new Visible Infrared Imager Radiometer Suite (VIIRS) on the Joint Polar Satellite System (JPSS) as its primary polar-orbiting satellite imager. Employing a near real-time processing system, NOAA will generate a series of Environmental Data Records (EDRs) from VIIRS data. For example, the VIIRS Land Surface Temperature (LST) EDR will estimate the surface skin temperature over all global land areas and provide key information for monitoring Earth surface energy and water fluxes. Because both VIIRS and its processing algorithms are new, NOAA is conducting a rigorous calibration and validation program to understand and improve product quality. This work presents a new validation methodology to estimate the quantitative uncertainty in the LST EDR, and contribute to improving the retrieval algorithm. It employs a physically-based approach to scaling up point LST measurements currently made operationally at many field and weather stations around the world. The scaling method consists of the merging information collected at different spatial resolutions within a land surface model to fully characterize large area (km x km scale) satellite products. The approach can be used to explore scaling issues over terrestrial surfaces spanning a large range of climate regimes and land cover types, including forests and mixed vegetated areas. Ultimately, this validation approach should lead to an accurate and continuously-assessed VIIRS LST products suitable to support weather forecast, hydrological applications, or climate studies. It is readily adaptable to other moderate resolution satellite systems.

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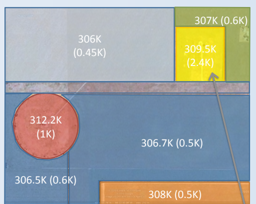
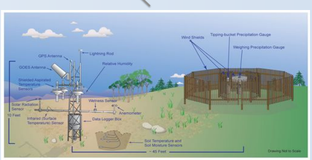
Problematic



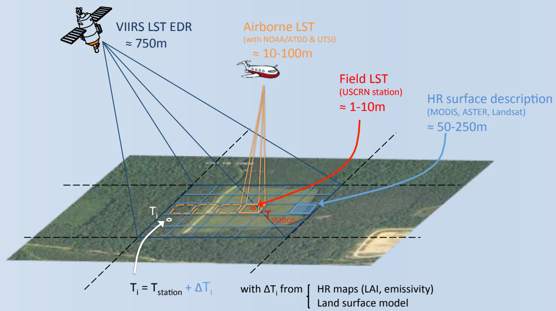
How to compare satellite data at moderate resolution and field measurements due to spatial variability of the LST around a station?

Here, distribution of LST within a 1km² area derived from ASTER (90m resolution) data over Champaign, IL . Mean and STD are represented for each cover type.

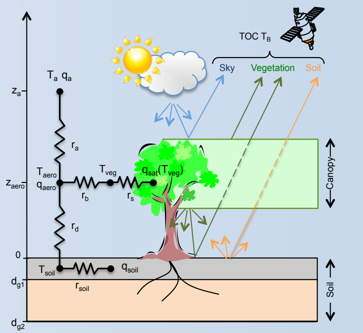
US Climate Reference Network (CRN) stations are used for routine EDR validation.



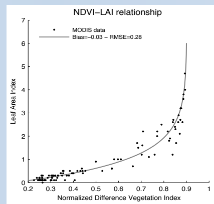
Scaling methodology

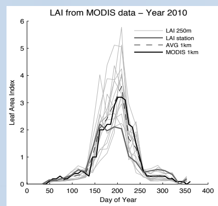


1. Calibration of the SETHYS land surface model using ground observations: determination of the optimal set of internal model parameters that allows the model to describe the observed *in situ* LST.
2. Representation of the LST spatial distribution within a satellite footprint using the model with biophysical properties of land covers surrounding the station – here LAI at 250m resolution
3. Calculation of the LST value at satellite resolution from a weighted mean of n radiative contributions.



Schematic representation of the SETHYS land surface. The incoming long wave radiation, and the simulated soil and canopy temperatures are used to simulate the directional Top of Canopy (TOC) brightness temperature (T_B).

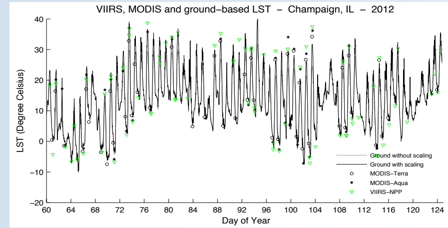




Relationship between NDVI and LAI MODIS standard-products at 1 km resolution – for Champaign, IL. The relationship at 1km is applied to high-resolution NDVI data to derive LAI values at 250m. The averaged value of the 16 sub-pixels and MODIS LAI standard-product at 1 km are consistent.

Results

Land Surface Temperature measured by VIIRS (green triangles), by MODIS (black circles and stars), by a USCRN ground station (gray line), and assessed using the upscaling methodology (black line) over an agricultural landscape near Champaign, IL. VIIRS and MODIS agree better with scaled-up field data than with non-scaled field observations.



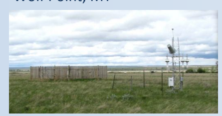
Champaign, IL

(40.05N, 88.37W)

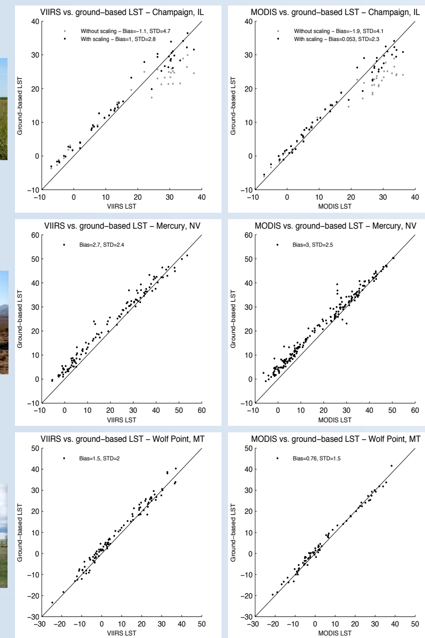
Mercury, NV

(36.62N, 116.02W)

Wolf Point, MT



(48.31N, 105.1W)



VIIRS LST validation results over three validation sites. Bias and Precision specifications of VIIRS LST are 1.5K and 2.5K.