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**JPSS Electronic Signature Page**

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# ABSTRACT

This is the Algorithm Theoretical Basis Document (ATBD) for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Visible/Infrared Imager/Radiometer Suite (VIIRS) Land Surface Temperature (LST) algorithm for retrieval of the LST Environmental Data Record (EDR).

The VIIRS LST algorithms are based on physical regression methods to retrieve skin LST. They use brightness temperatures sensed by VIIRS Infrared (IR) channels. The VIIRS baseline LST algorithm is a two band thermal split window algorithm that is based on one equation for each land cover type. A dual split window algorithm that is based on four thermal brightness temperature bands is also available and may be optionally selected to supersede the baseline two band split window algorithm under the most optimum retrieval conditions (i.e., not affected by sun-glint). These algorithms do not require emissivity information.

The atmospheric correction, the complexity of land surface types, and the sensor performance limit the accuracy of satellite LST measurements. The VIIRS LST algorithm requires 2.5 K measurement accuracy and 1.4 K measurement precision. The VIIRS two-band split window and four-band dual split window algorithms (Land cover approach) will likely meet the accuracy requirement for all the land cover types, but may probably miss the 1.4 K precision requirement for some land types.

The validation of LST is limited by the availability of *in situ* observations. The VIIRS LST is defined as the skin temperatures of the uppermost layer of the land surface, while *in situ* observations are usually shelter temperatures. Reliable observed or analyzed skin temperatures will be a critical factor in validating the VIIRS LST retrieval.

# 2.0 EXPERIMENT OVERVIEW

## 2.1 OBJECTIVES OF LAND SURFACE TEMPERATURE RETRIEVALS

Land surface temperatures play an important role in land-surface processes on a regional as well as on a global scale. They are of fundamental importance to the net radiation budget at the Earth’s surface and to monitoring the state of crops. LST is a good indicator of both the greenhouse effect and the energy flux between the atmosphere and the ground (Mannstein, 1987; Sellers *et al*., 1988). Satellite-derived LST assimilates to climate, mesoscale and land surface models to estimate the sensible heat flux and latent heat flux from the Earth’s surface. Satellite-based LST measurement has not been used operationally in regional weather forecasting and climate prediction due to large uncertainties. However they have the potential to provide LST information over vast remote regions such as deserts.

The accuracy of satellite LST measurement is primarily limited by the complexity of land surface types, the atmospheric correction, and sensor performance. The published satellite multichannel LST algorithm permits global LST retrievals within 3 to 4 K measurement accuracy (Becker and Li, 1990; Dozier and Wan, 1994; Li and Becker, 1993).

The overall scientific objective of the VIIRS LST retrieval is to provide improved measurements of global and regional LST fields. The VIIRS LST EDR requires a 2.5 K measurement accuracy and 1.4 K measurement precision.

## 3.1 PROCESSING OUTLINE

The coefficients for the regression equations will be obtained using MODTRAN and a global database through our simulation processes. Figure 3 depicts the processing concept for LST retrievals. In the VIIRS baseline dual split window algorithm, one equation is developed for each of the 17 IGBP land cover types for operational use (Figure 3; Table 2).

### Mathematical Description of the Algorithm

Based on the previous section’s discussion of the physics of the problem, the mathematical descriptions of the algorithm can be simply stated.

#### *Baseline Split Window Algorithm:*

The baseline LST algorithm two band split window (11 and 12 μm) algorithm. Regression coefficients are required for each of the 17 IGBP surface types.

 (14)

#### *Optional Dual Split Window Algorithm:*

VIIRS dual split window day/night LST algorithm establishes one equation to each surface type by using 4 VIIRS bands (10.8, 12, 3.75, and 4.005 μm), and it added a solar zenith angle correction during the daytime:

Daytime:

 (15)

Nighttime:

 (16)

Where *i* is the index of the 17 International Geosphere Biosphere Program (IGBP) surface types (Table 2) produced by the VIIRS Surface Type EDR, θ is the satellite zenith angle and is ψ the solar zenith angle. The two band split window algorithm is used for all sunglint affected pixels.