VALIDATION FOR GOES-R AND NPOESS LAND SURFACE TEMPERATURE PRODUCTS: ANALYZING DIFFERENCE BETWEEN SATELLITE AND IN SITU MEASUREMENTS

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1. INTRODUCTION

Validation of satellite derived land surface temperature (LST) products has never been straight forward or simple.. A high resolution climate data record (CDR) of global LST will soon become available after decades of infrared remote sensing of the Earth surface through a variety of satellite programs. Each of the satellite programs has produced an environmental data record (EDR) of LST for a few years[1][2], which makes it possible to monitor long-term variation of global LST distribution. However, usefulness of such LST EDRs is limited until they are well validated and calibrated. Traditionally, validation of satellite LST products is performed by comparing the LSTs derived from satellite data to the LSTs estimated from ground *in situ* measurements[3][4]. Because of small scale variation feature of the LST over most land surfaces, the satellite derived LSTs may have significant difference to the *in situ* LSTs, which makes the LST validation process very hard. Both the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and the Geostationary Operational Environmental Satellite R series (GOES-R) programs have produced a validation plan for validating and calibrating the LST products derived from each satellite sensor.. In this paper we present the approach and some preliminary results we obtained for the NPOESS LST validation.

2. METHOD

There are a number of issues in satellite LST validation using the ground in *situ data*: 1) thermal heterogeneity of land surface, 2) lack of accurate emissivity information, 3) temporal difference between the satellite data and *in situ* data, 4) limitation of high quality *in si*tu data, 5) undetected cloud contamination in satellite data, 6) angular anisotropy of land surface emissivity and temperature. All the above difficulties must be considered for a reliable satellite LST validation process. In particular, the thermally heterogeneous feature over satellite pixel area (e.g., ~ 1 km) must be considered in the comparison of the satellite LSTs to the *in situ* LSTs since the latter are usually collected over significant smaller and more homogeneous area (e.g., ~0.01 km). For estimating the LST difference between the satellite and in situ data, we construct synthetic moderate resolution satellite pixels using corresponding high resolution satellite data. Area of the high resolution satellite pixels is about the size of the in situ measurements. The LSTs measured from the synthetic pixels are compared to the LSTs estimated from the moderate resolution pixels for illustrating and analyzing the differences. A statistical model of the *in situ* LST correction can be generated for the validation process, for each ground station.

3. DATA AND RESULTS

Six SURFRAD ground stations were selected as the source of *in situ* LST data. One year of MODIS data over the ground stations were collected; some of corresponding ASTER data was used for generating the synthetic pixels of MODIS data. The original goal of this work is to validate VIIRS LST product, which is now studied using MODIS data as proxy. Figure 1 illustrates how the synthetic data is composed.

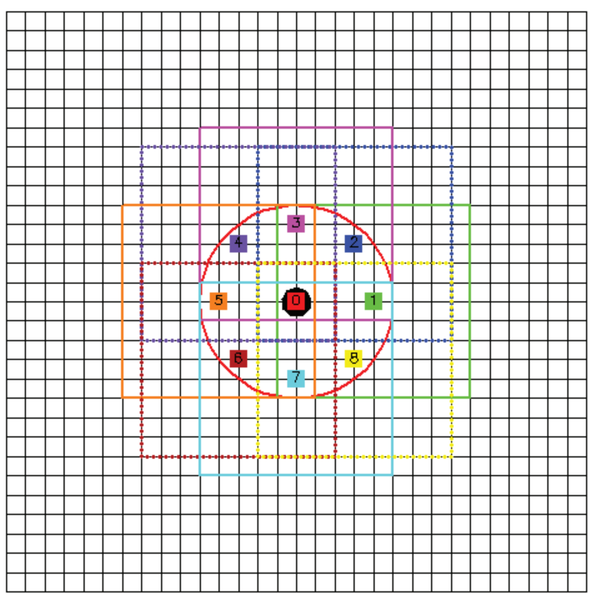

Figure 1. *Pixels synthesized from fine-resolution (90m) ASTER TIR pixels. Each synthetic pixel has the target ground site enclosed, but the distance between the ground site and the center of synthetic pixel varies, which mimics the possible navigation uncertainties in MODIS pixels.. Nevertheless, the distance of every synthetic pixel center from the ground site is within the pixel size (1Km). Different colors are used for the 9*

synthetic pixels, and the center of each pixel is marked with a small numbered square of the same corresponding color. The numbers on the squares are the pixel IDs used in the relevant analysis.

The LSTs estimated from SURFRAD site measurements were compared to the LSTs estimated from the ASTER pixel data at the station and the LSTs estimated from the synthetic pixel for analyzing the differences.

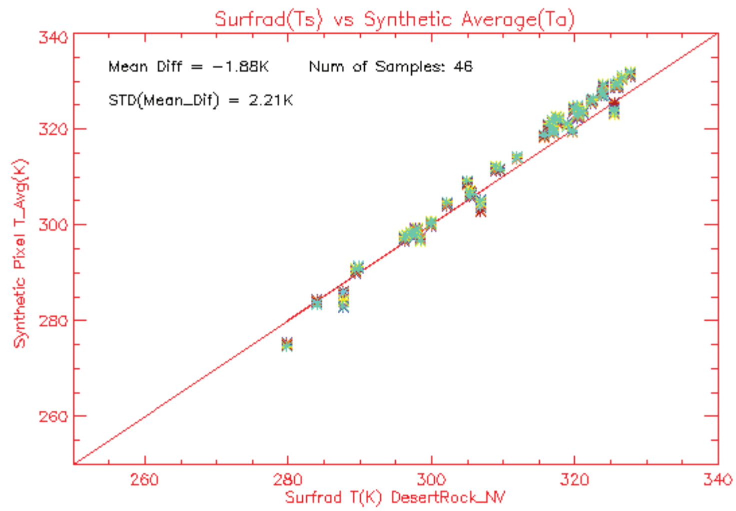

Figure 2. *Comparison of synthetic pixel average temperature with the ground site temperature. Note that different colors are used for the 9 different synthetic pixels as shown in Figure 1.*

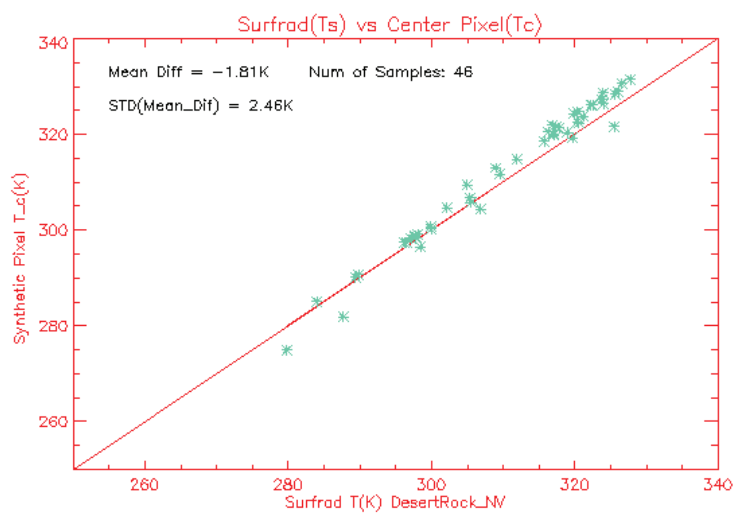

Figure 3. *Same as Figure 2, but for the central ASTER pixel which is the nearest to the ground site.*

Figures 2 to 4 show the comparison results for the SURFRAD site at Desert Rock, Nevada. For this particular site it is shown that the surface variations within the satellite pixel do not have significance impact to the validation process. This is simply because the land surface at Desert Rock is pretty homogeneous. Note that these are just preliminary results. More data processing for other SURFRAD sites will be performed.

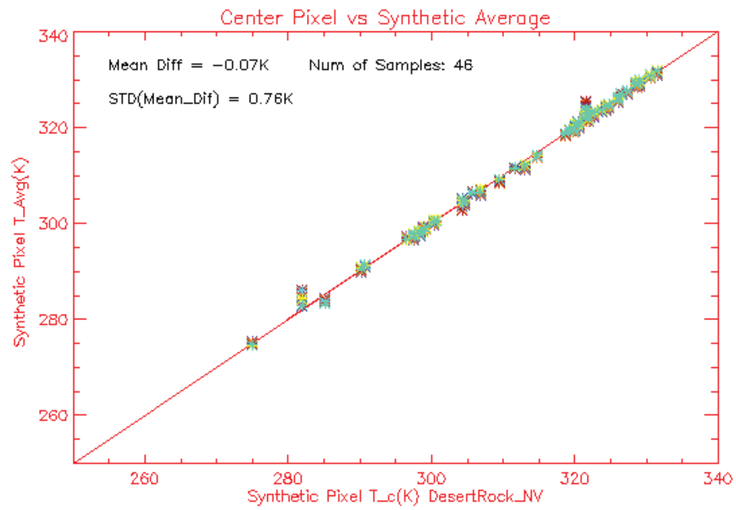

Figure 4. *Comparison of synthetic pixel average temperature with the central ASTER pixel.*

4. SUMMARY

In satellite LST validation process we simulate moderate resolution satellite LSTs, which are to be validated, using corresponding high resolution satellite data. Geolocation of the simulated data are over six SURFRAD ground stations so that the LSTs estimated from the SURFRAD data can be used for comparison to the satellite data. Difference between LSTs of the satellite synthetic pixel and LSTs of the ground measurement can be modeled, which will be applied for the satellite LST validation and calibration.

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