Introduction

Emissivity is a key parameter for determining land surface temperature (LST) from thermal remote sensed data. NOAA LST team at STAR is developing a new emissivity product that enhances LST product of JPSS and GOES-R missions as well as to support forecasting models. It is proposed to combine historic emissivity product (ASTER GED mean emissivity and MODIS LSE product) and VIIRS near-real-time vegetation and snow observations for a dynamic emissivity production. Global gridded LSE product including VIIRS and ABI split window channels as well as a 8-13.5um broadband was generated each day at 0.009 degree resolution. The new product could well depict the seasonal variation of surface emissivity. In order to evaluate the LSE product, a series of evaluation efforts were performed, both in-situ and VIIRS near-real-time vegetation and snow observations for a dynamic emissivity production. Global gridded LSE product provides pixel-by-pixel theoretical uncertainty estimation and stores in the quality flag, more than 99.9% pixels have uncertainty within 1.5%.

LSE product and uncertainty

- Principal algorithm: Vegetation Cover Method
- A. Using mean background (bare soil and snow ice) emissivity from over 9 years ASTER & MOIDS LSE Products.
- B. Accounting for the dynamic change by VIIRS Near-Real-Time green vegetation fraction and snow fraction data.
- Main features:
  - A. D&I product with global coverage at 0.009 degree grid.
  - B. Including 5 bands: VIIRS and ABI split window channels and 8-15um broadband.
  - C. Pixel by pixel quality flag, grouping LSE uncertainty into four level and vast majority with an error of less than 1.5%.

LSE evaluation

- Bare sites in-situ emissivity evaluation

- Time series evaluation over vegetation area

Incorporating LSE into LST retrieval

- Incorporating LSE product into the emissivity-explicit split-window algorithm to implement VIIRS LST retrieval.
- Evaluate the LST accuracy via long-term (From February 2012 to June 2015) observations at 7 sites of SURFRAD
- Evaluate the quality of the LSE product through VIIRS LST results.

NOAA/STAR Enterprise Algorithm for VIIRS: 

\[ T = C + A_{M15} + A_{M16} + A_{C14} + A_{C15} + A_{E}(T_{M15} - T_{M16}) + A_{N}\Delta c \]

<table>
<thead>
<tr>
<th>Matchup Number</th>
<th>Bondville</th>
<th>Boulder</th>
<th>Desert Rock</th>
<th>Fort Peck</th>
<th>Goodwin Creek</th>
<th>Penn State</th>
<th>Sioux Falls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias (K)</td>
<td>0.44</td>
<td>-0.42</td>
<td>-0.81</td>
<td>0.32</td>
<td>0.84</td>
<td>0.34</td>
<td>0.36</td>
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<tr>
<td>STD (K)</td>
<td>2.13</td>
<td>1.54</td>
<td>1.78</td>
<td>2.00</td>
<td>2.05</td>
<td>2.21</td>
<td>1.75</td>
</tr>
<tr>
<td>RMSE (K)</td>
<td>2.17</td>
<td>1.60</td>
<td>1.95</td>
<td>2.10</td>
<td>2.21</td>
<td>2.23</td>
<td>1.78</td>
</tr>
</tbody>
</table>

Summary

- LSE product provides pixel-by-pixel theoretical uncertainty estimation and stores in the quality flag, more than 99.9% pixels have uncertainty within 1.5%.
- Bare sites in-situ measurements have a good agreement with the product with less than 0.6% mean difference at narrow bands and 1.2% for broadband.
- Ex-situ results show product has pretty high accuracy at desert area, where the gap could be as small as 0.3% and 0.5% for narrow bands and broadband, respectively.
- This new product highly related to the vegetation and snow fraction, it works well at vegetated areas with a difference of less than 0.3% error over desert sites.
- A large amount of sand samples were collected from three big deserts in China: X (40.308°N, 108.6515°E), T (37.482°N, 104.974°E), W (39.720°N, 106.672°E), and emissivity were measured in laboratory (RADI, CAS) using a Nicolet i550 Fourier transform infrared spectroscopy. The validation results as demonstrated reveal a high accuracy of less than 0.3% error over desert sites.