Using VIIRS Land Surface Temperature to Evaluate NCEP North American Mesoscale Model (NAM) Forecast

Zhuo Wang (University of Maryland)

Yunyue Yu (NOAA/NESDIS/STAR)
Peng Yu (University of Maryland)
Yuling Liu (University of Maryland)
Michael Ek (NOAA/NCEP/EMC)
Yihua Wu (I. M. System Groups, Inc.)

November 13, 2014
1. Introduction

2. Data Processing Method

3. Comparison results between VIIRS LST and NAM 6-hr data, as well as NAM hourly forecast data

4. Summary
Introduction

Purpose:
To promote the use of satellite Land Surface Temperature (LST) product in the models, and investigate the difference between the model and satellite data, and try to understand how such difference can be helpful to model and satellite product.

Available Predicted Surface Temperature from NCEP models:
NAM (North American Mesoscale Model) over CONUS (4km, 12km)

North American Land Data Assimilation System (NLDAS):
0.125°, hourly, January 1, 1979 – present

Satellite retrieved LST from VIIRS:
Granule based VIIRS LST (750 m at nadir)

Case study: March 2012, NAM 4km LST
1. Temporal match: use linear interpolation between two closest time to get the corresponding NAM data at VIIRS granule time

2. Spatial match: convert both VIIRS and NAM data to 0.05° grid.

3. Use aggregation to get new VIIRS LST for 0.05° lat/lon grid, i.e., averaged all VIIRS pixels falling in the 0.05° grid to represent the value of new 0.05° grid.

For surface type, use the dominant type to represent that grid.

Only high quality data are used in the comparison.
6 Hour Analysis Data: Daily mean LST difference (NAM–VIIRS) in March 2012

Day

Night
1 Hour Forecast Data: Daily mean LST difference (NAM–VIIRS) in March 2012, f00

Day

Night
Monthly mean LST difference versus IGBP surface type (6Hr) (NAM–VIIRS)

<table>
<thead>
<tr>
<th>Surface Type</th>
<th>Day</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed Forest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EBF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closed Shrubland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DNF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open Shrubland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DBF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woody Savanna</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Savanna</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grasslands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent Wetlands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegeration Mosaic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snow and Ice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barren or Sparse vegtation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Bodies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Monthly mean LST difference versus IGBP surface type (1Hr, f00) (NAM–VIIRS)

Day

Night

17. Water Bodies
Linear Interpolation for NAM Land Surface Temperature (6Hr, 1Hr)

- e.g., satellite view
  - time = 19.5Hr

Linear interpolation is more reasonable using 1hr NAM data.
Model Performance 1° Spatial Map for 6-Hour Analysis
Model Performance 1° Spatial Map for Hourly Forecast (f00)

Day
NAM–VIIRS

Night

Std

Samples
Distribution of VIIRS LST and NAM Hourly Forecast (Night)

VIIRS LST

NAM

Std

NAM–VIIRS

Surface Type
Match-up between Satellite View Time and NAM Hourly Forecast Time

Satellite View Time (night)
Hr=8 UTC, dt = 8

Satellite View Time (day)
Hr=21 UTC, dt = 21

dt = Satellite View Time – Forecast Starting Time
(how far away from the start time in each forecast cycle)
Monthly Mean Comparison vs. Satellite & Forecast Time Difference
NAM data used in Comparison for [16 –18Hr]
NAM data used in Comparison for [18 –22Hr]
NAM data used in Comparison for [20–21Hr]
Surface Type Map: 4 Regions for Model-Satellite Data Comparison

Reg 1: IGBP 10
Reg 2: IGBP 7
Reg 3: IGBP 4
Reg 4: IGBP 14
Reg1: IGBP10

(0.2°)

March 11

Night

Day

Monthly
Reg1: IGBP10

(1°)

March 11

Monthly

Day

Night
Reg1: IGBP10

(2°)

Day

Night

March 11

Monthly
Reg2: IGBP7 (1°)

Day

Night

March 14

Monthly
Reg3: IGBP4

\(1^\circ\)

Day

March 11

Night

Monthly
Reg4: IGBP14

(1°)

Day

Night

March 13

Monthly
Table 1. The monthly mean difference and standard deviation of VIIRS and NAM LST over 4 regions for day and night time (NAM − VIIRS)

<table>
<thead>
<tr>
<th>Day</th>
<th>Monthly</th>
<th>Night</th>
<th>Monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Δ LST</td>
<td>STD</td>
<td>Samples</td>
</tr>
<tr>
<td>Reg1 (1°)</td>
<td>− 2.810</td>
<td>2.611</td>
<td>4029</td>
</tr>
<tr>
<td>Reg2 (1°)</td>
<td>− 8.367</td>
<td>3.972</td>
<td>3680</td>
</tr>
<tr>
<td>Reg3 (1°)</td>
<td>1.804</td>
<td>2.539</td>
<td>3307</td>
</tr>
<tr>
<td>Reg4 (1°)</td>
<td>− 1.877</td>
<td>2.173</td>
<td>3172</td>
</tr>
</tbody>
</table>
March 14, 2012

The large LST Difference in Reg2 (open Shrubland) on March 14 is not Related to snow

Large LST difference in high latitude may caused by snow.
Summary

• The patterns of NAM and VIIRS LST are consistent. The VIIRS LST variation is larger than NAM LST.

• NAM and VIIRS LST difference has zonal (dominant) and meridional distribution, which reflects the geographic features. The NAM-VIIRS LST difference does not show the time dependent feature.

• The 1° statistic map indicates that western region has larger bias than eastern region. The difference (including bias and std) between NAM and VIIRS LST at night is smaller than that during the daytime.

• The comparison results depend on surface type. e.g., the difference over open shrubland is larger than that over grassland and cropland. Snow is also related to large LST difference.

• 4 forecast cycle provides similar comparison results.