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

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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

Data Processing Method

- 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







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

Day





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



- 1. ENF 5. Mixed Forest
- 2. EBF 6. Closed Shrubland
- 3. DNF 7. Open Shrubland
- 4. DBF 8. Woody Savanna
- 9. Savanna
- 10. Grasslands
- 11. Permanent Wetlands
- 12. Croplands

- 13. Urban and Built-up
- 14. Vegeration Mosaic
- 15. Snow and Ice
- 16. Barren or Sparse vegtation
- 17. Water Bodies

Monthly mean LST difference versus IGBP surface type (1Hr, f00) (NAM–VIIRS)



- 1. ENF 5. Mixed Forest
- 2. EBF 6. Closed Shrubland
- 3. DNF 7. Open Shrubland
- 4. DBF 8. Woody Savanna
- 9. Savanna
- 10. Grasslands
- 11. Permanent Wetlands
- 12. Croplands

- 13. Urban and Built-up
- 14. Vegeration Mosaic
- 15. Snow and Ice
- 16. Barren or Sparse vegtation

15

80

100

17. Water Bodies

Linear Interpolation for NAM Land Surface Temperature (6Hr, 1Hr)



Model Performance 1° Spatial Map for 6-Hour Analysis





Samples



2850

4275

-120

1425.

Bias_201203_1deg_6Hr_day

-120









Night

Model Performance 1° Spatial Map for Hourly Forecast (f00)





Samples



-120

1425.

2850

4275

Bias_201203_1deg_f00_day

-120







13.5



4.5



Night

Distribution of VIIRS LST and NAM Hourly Forecast (Day)

VIIRS LST

Std











NAM LST STD f00(doy)

15

10



1 2 3 4 5 8 7 8 9 10 11 12 13 14 15 16 17

NAM

Surface Type

Distribution of VIIRS LST and NAM Hourly Forecast (Night)



Std















1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

NAM

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



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

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

| Day | Monthly | | | Night | Monthly | | |
|-----------|---------|-------|---------|-----------|--------------|-------|---------|
| | ∆ LST | STD | Samples | | Δ LST | STD | Samples |
| Reg1 (1°) | - 2.810 | 2.611 | 4029 | Reg1 (1°) | - 0.268 | 1.318 | 1873 |
| Reg2 (1°) | - 8.367 | 3.972 | 3680 | Reg2 (1°) | - 3.251 | 2.633 | 4429 |
| Reg3 (1°) | 1.804 | 2.539 | 3307 | Reg3 (1°) | 0.823 | 0.806 | 3210 |
| Reg4 (1°) | – 1.877 | 2.173 | 3172 | Reg4 (1°) | 0.805 | 1.024 | 3907 |

Snow and Ice Chart from U.S. National / Naval Ice Center

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.

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.