S-NPP Land Surface Temperature Product: Accomplishments and Issues

Prepared by

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Basic of the VIIRS LST Product

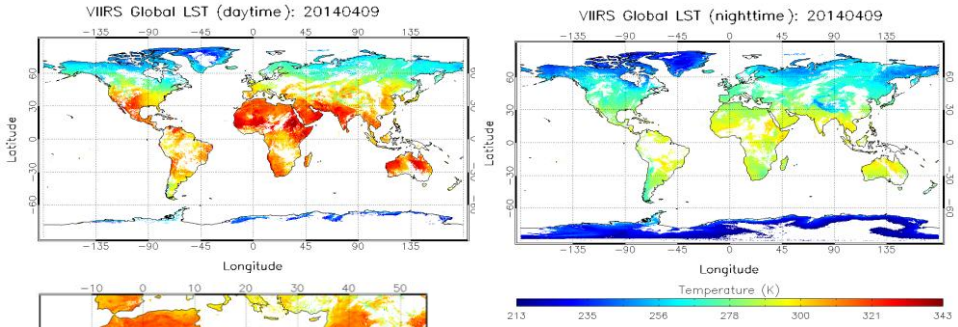
- VIIRS LST EDR provides effective land surface skin temperature value at the time of overpass
- VIIRS design allows for full (high) resolution LST measurements over global land covers, *under clear, probably clear and probably cloudy* conditions.
- Represents continuity with NASA EOS MODIS and NOAA POES AVHRR LST production, also with international missions such as (A)ATSR
- Product is expected to be used by weather forecasting models, Agriculture monitoring, drought prediction and monitoring, ecosystem monitoring; climate studies etc.

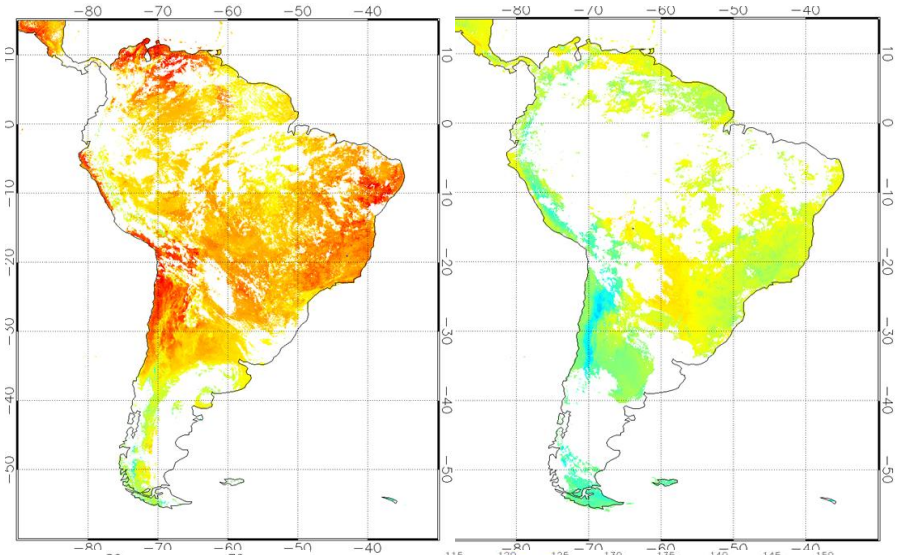
LST EDR Team Membership

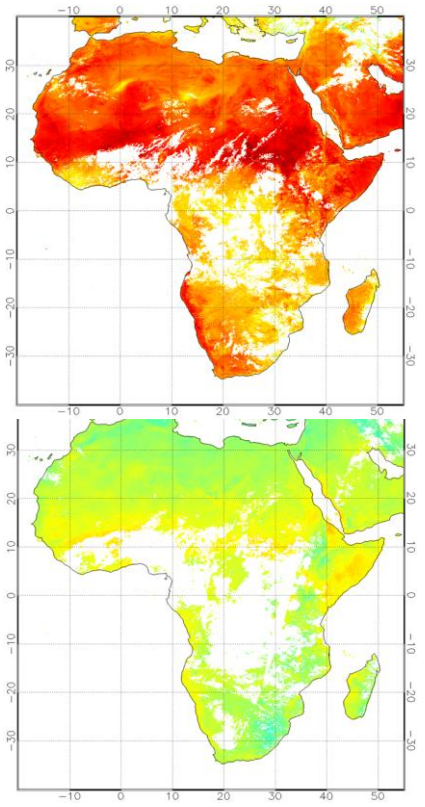
Project		Institute	Function
JPSS	Land Lead: Ivan Csiszar,	NOAA/NESDIS/SATR	Project Management
	EDR Lead: Yunyue YU	NOAA/NESDIS/SATR	Team management, algorithm development, validation
	Yuling Liu	UMD/CICS	algorithm development, validation
	Zhuo Wang	UMD/CICS	Simulation, algorithm improvement
	Peng Yu	UMD/CICS	algorithm improvement, product monitoring
	Youhua Tang	IMSG	STAR AIT support: code verification, delivery
	Mike Ek' team	NOAA/NWS/NCEP	User representative
	Leslie Belsma	JPSS/DPA	lgorithm Manager (JAM) for Land
NASA Land LPEATE			
	Robert Wolf' team	NASA/GSFC	Cal/Val support
NASA NPP Science Team			
	Miguel Roman	NSAS/GSFC	Cal/Val support
	Simon Hook	NASA/JPL	Cal/Val support

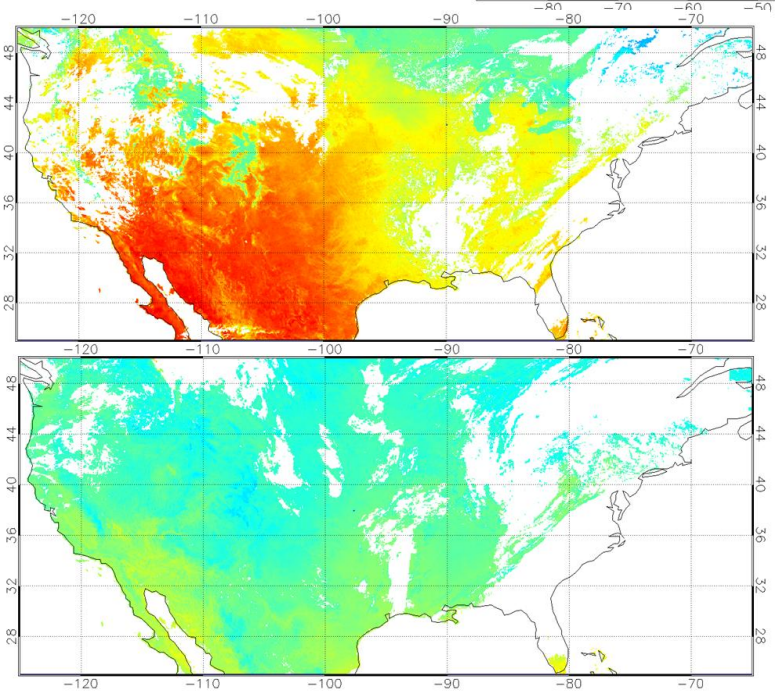
Accomplishments

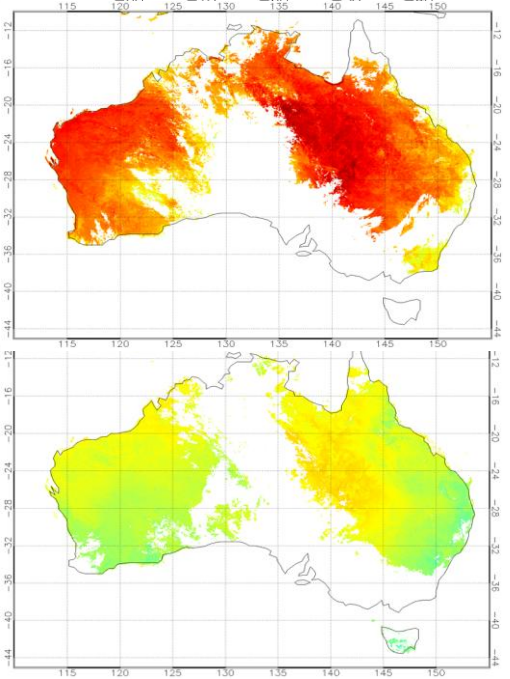
Provisional LST installed on IDPS



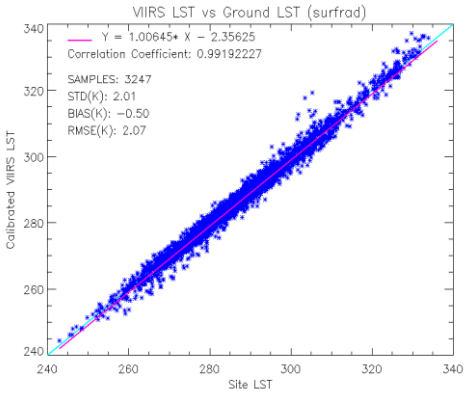


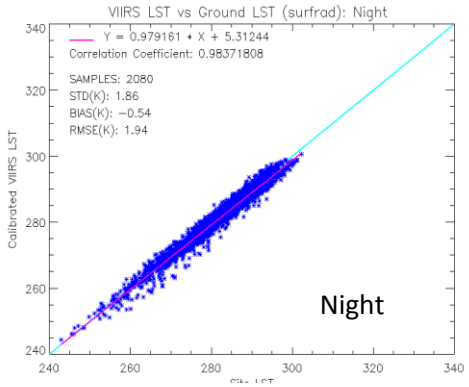


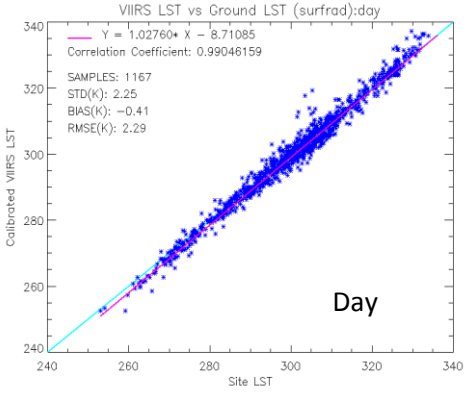




Accomplishments







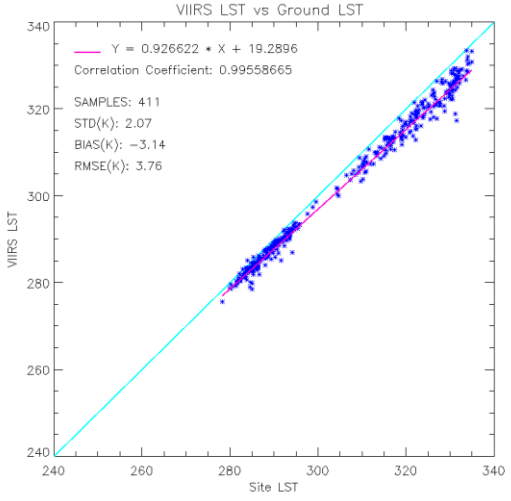
Evaluation against ground data

Surface type	Day/ Night	data num	Provisional		Beta	
			Bias	STD	Bias	STD
Deciduous Broadleaf Forest	day	4	-0.67	0.80	0.31	3.10
	night	11	-0.13	1.60	-0.13	1.60
Closed Shrub lands	day	37	-0.81	1.77	-1.16	1.77
	night	57	-1.37	0.80	-2.48	0.63
Open Shrub lands	day	277	-0.1	1.90	0.67	1.90
	night	327	-0.88	0.79	-2.38	0.79
Woody Savannas	day	46	-1.09	2.39	-0.34	2.81
	night	81	1.38	1.35	1.38	1.35
Grasslands	day	172	-0.38	1.90	1.11	2.36
	night	500	-0.35	1.41	-0.35	1.41
Croplands	day	266	0.14	2.95	2.39	3.54
	night	558	-0.21	1.58	-0.21	1.58
Cropland/Natural Veg Mosaics	day	208	-0.83	1.98	0.13	2.15
	night	459	0.47	1.94	0.47	1.94
Snow/ice	day	97	-1.16	1.67	-1.95	1.70
	night					
Barren	day	60	0.72	1.68	0.12	2.10
	night	87	-1.17	0.88	-2.67	0.88

SURFRAD LST over 6 sites covering the time period from Feb. 2012 to December 2013

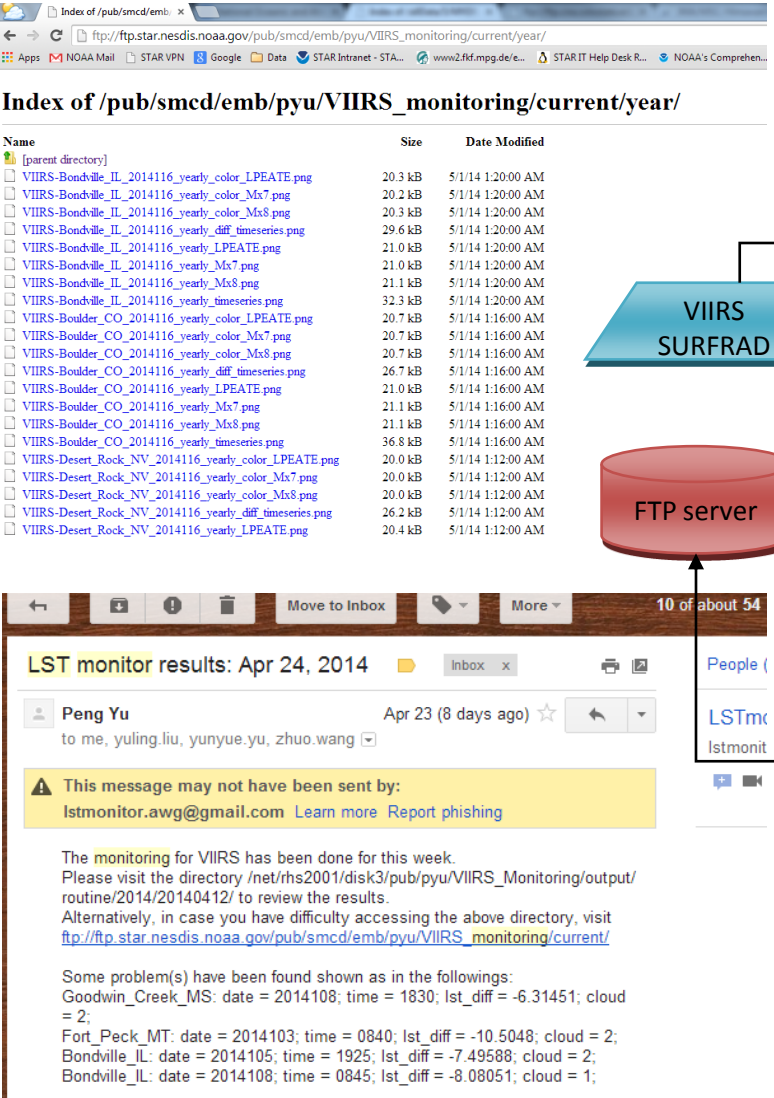
A ground dataset at Gobabeb in Namibia covering the time period of 2012.

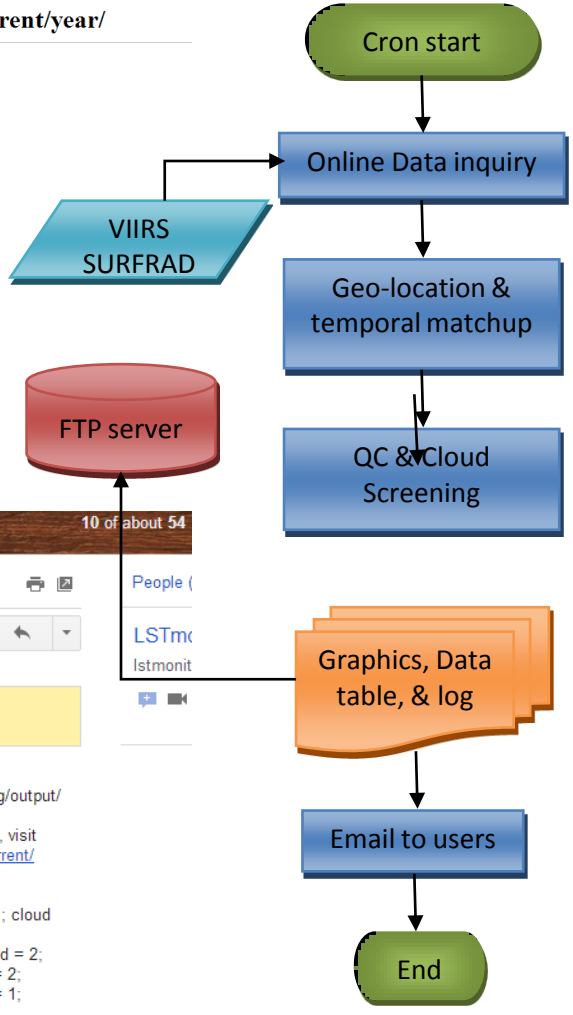
*The data is provided by Frank Goettsche, thanks Pierre for sharing the data.

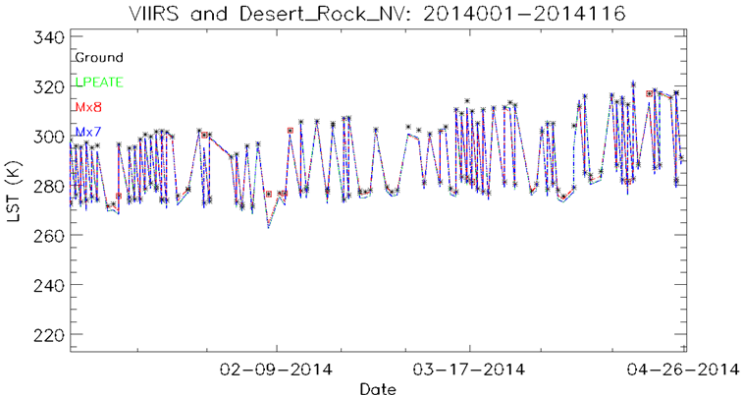


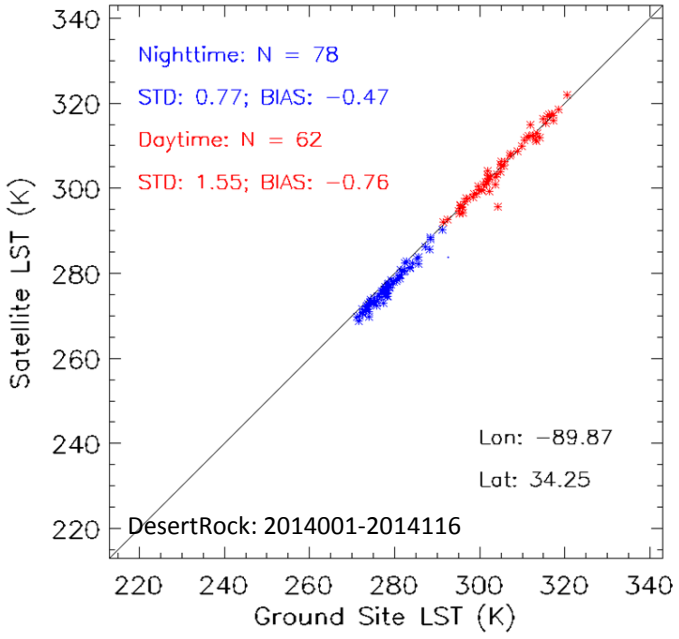
Accomplishments

A monitoring tool developed





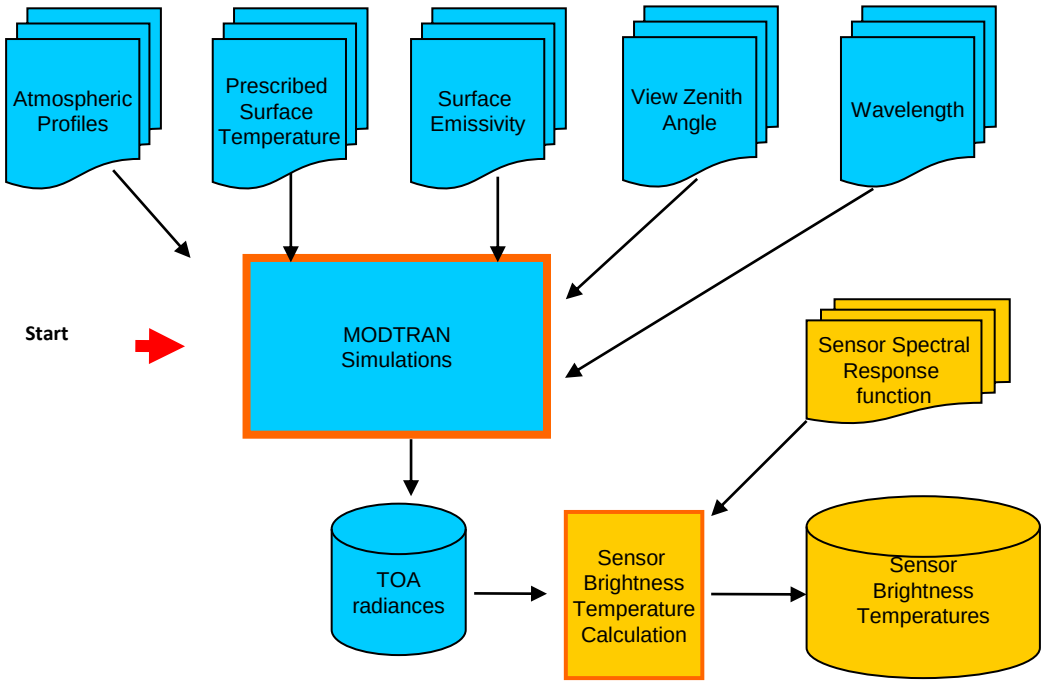




Accomplishments

A Comprehensive Simulation dataset generated

- 1,714,608 data pairs of land surface skin temperature and TOA infrared spectral radiance/brightness temperature, associated with satellite-solar geometry, surface emissivity, atmospheric profile, etc.



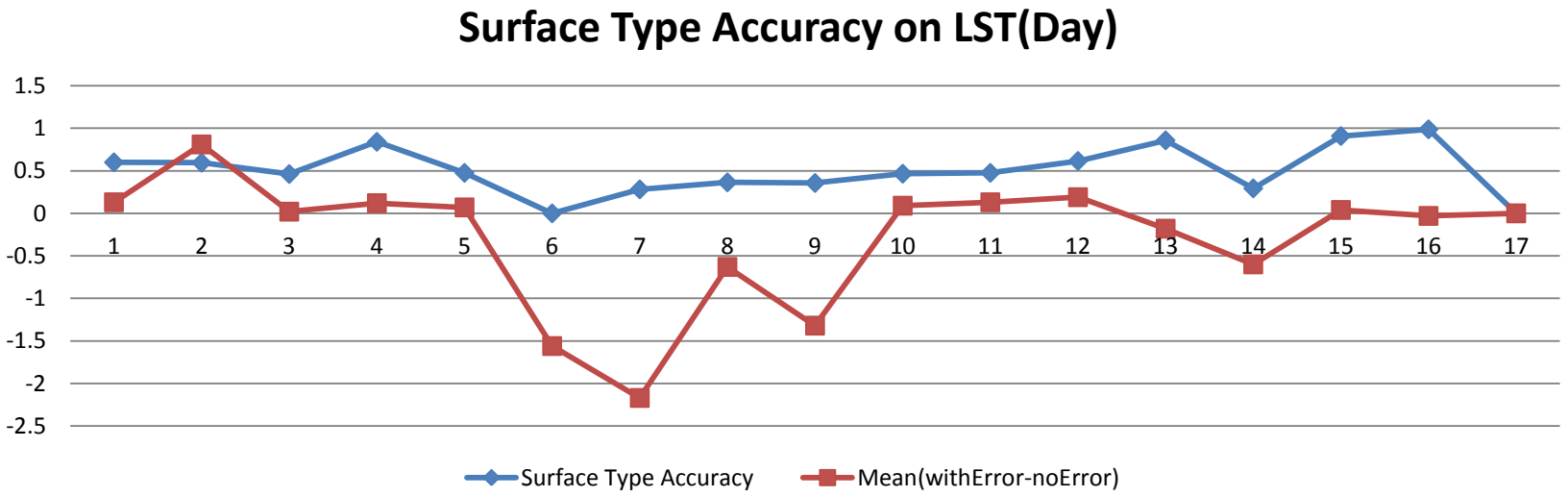
- 126 cloud-free atmospheric profiles, global distribution: 60 profiles for daytime and 66 profiles for nighttime.

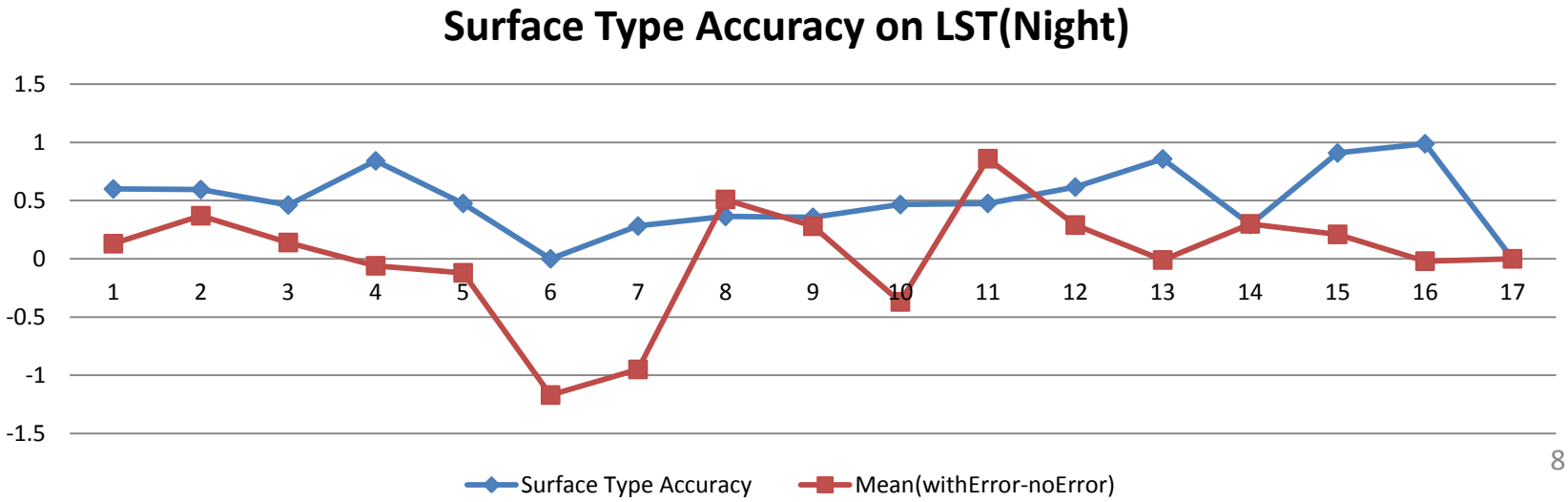
- A Gaussian distribution of ($T_S - T_{air}$) is prescribed for real surface temperature simulation.

- Infrared Spectral range : 3.4 –13 μm; surface emissivity range: [0.90-0.9999]; view zenith range: 0 - 70°

Issues -- Algorithm

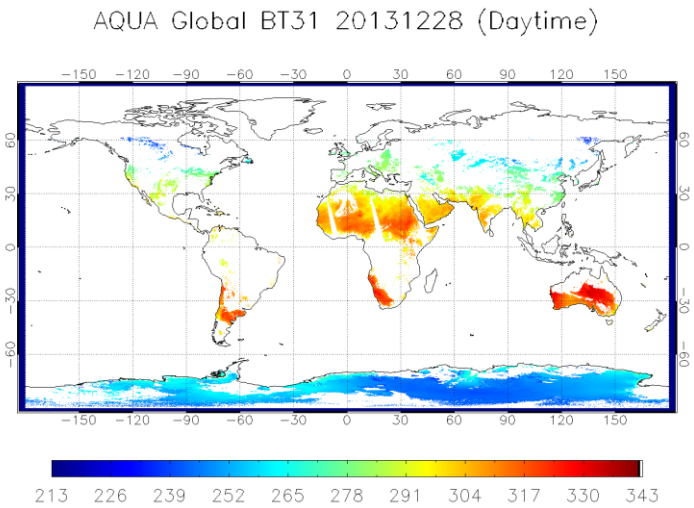
Impact of the Type EDR error

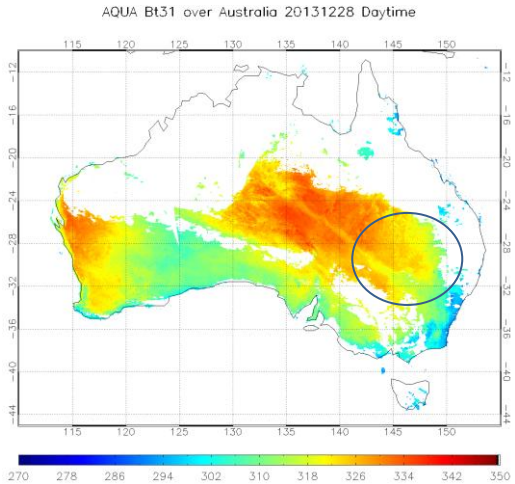


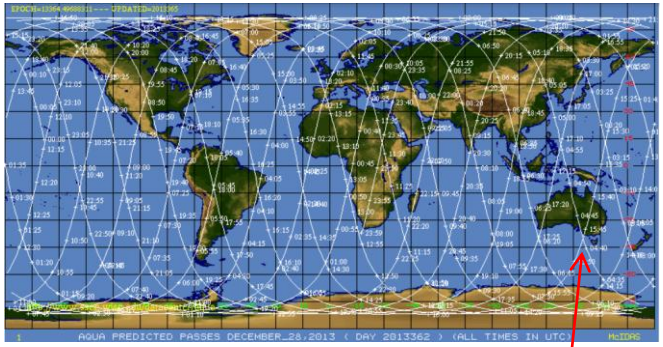


Issues – Validation

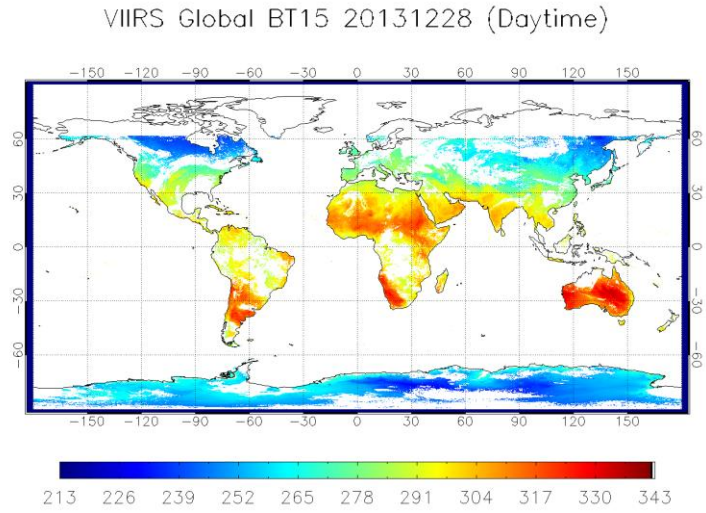
Impact of time difference in cross-satellite comparison

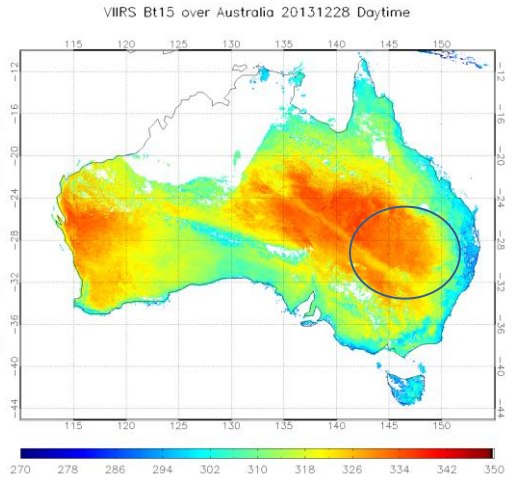


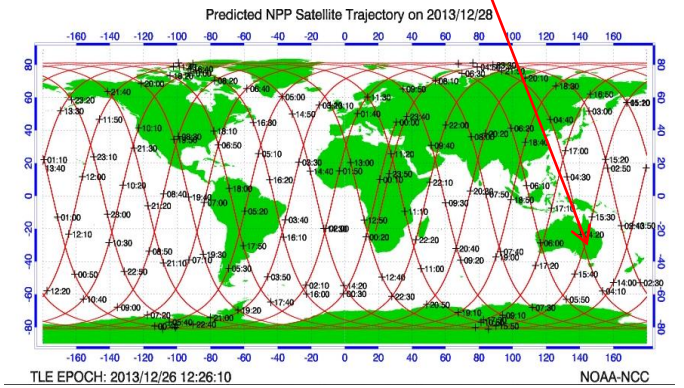




About 25 min difference between VIIRS and MODIS

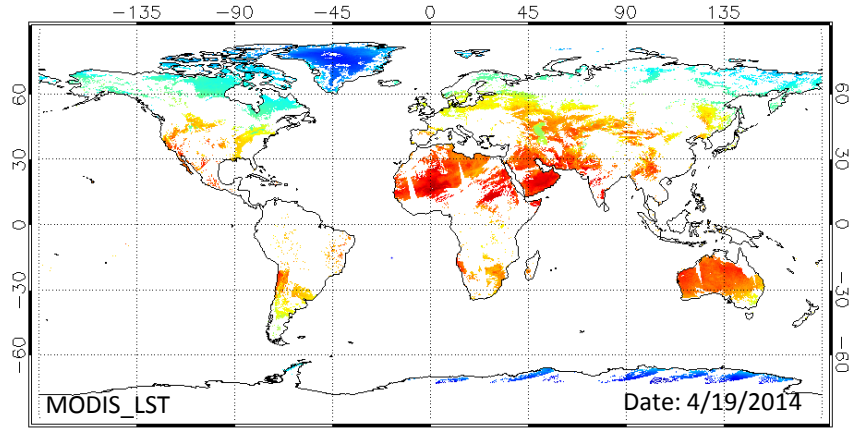


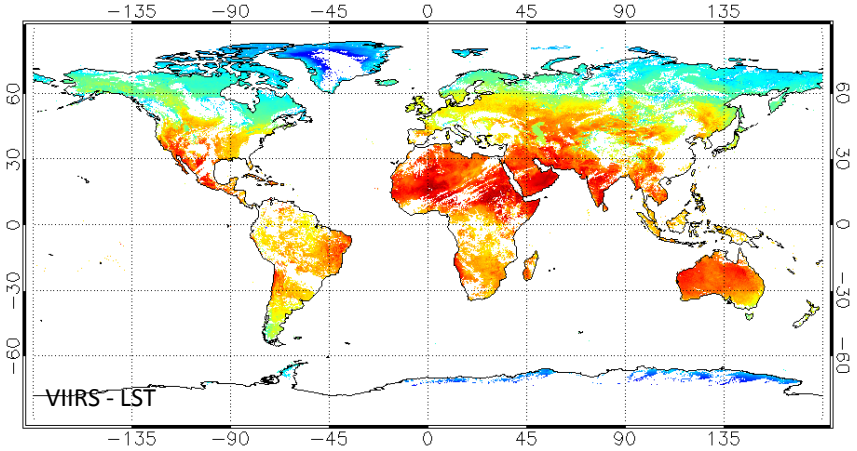


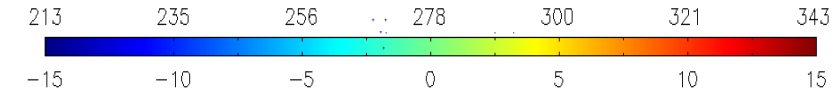


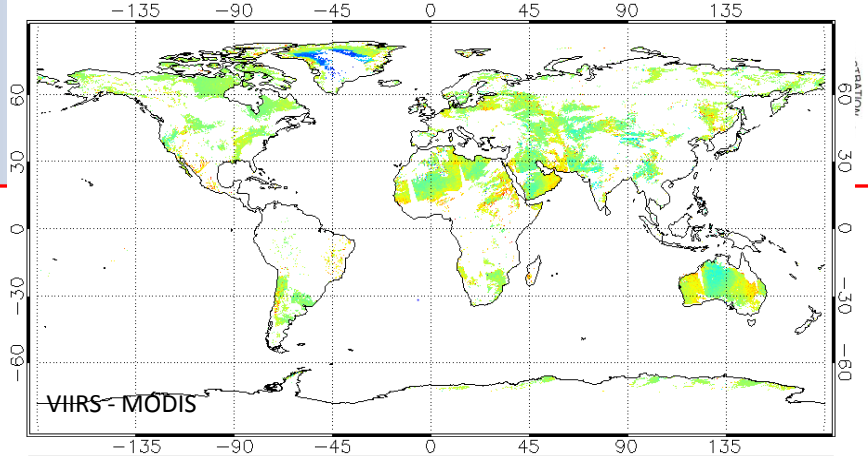
Issues – Validation

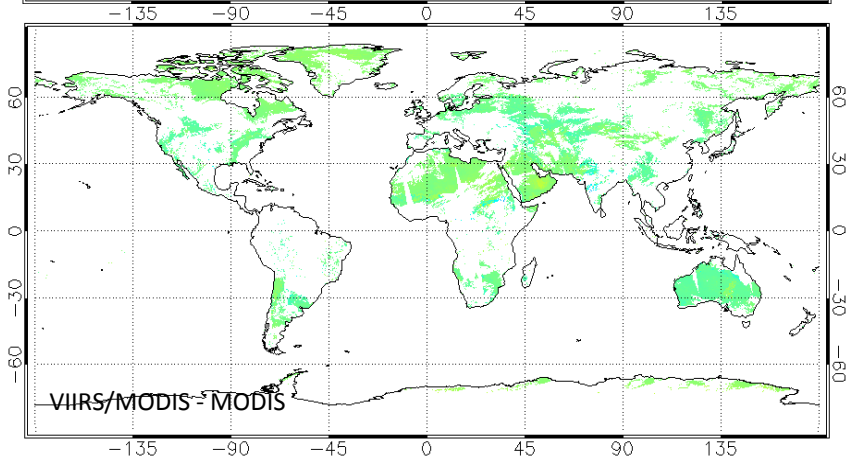
Cross-satellite comparison

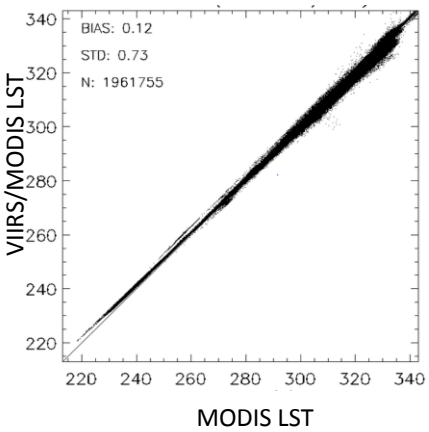










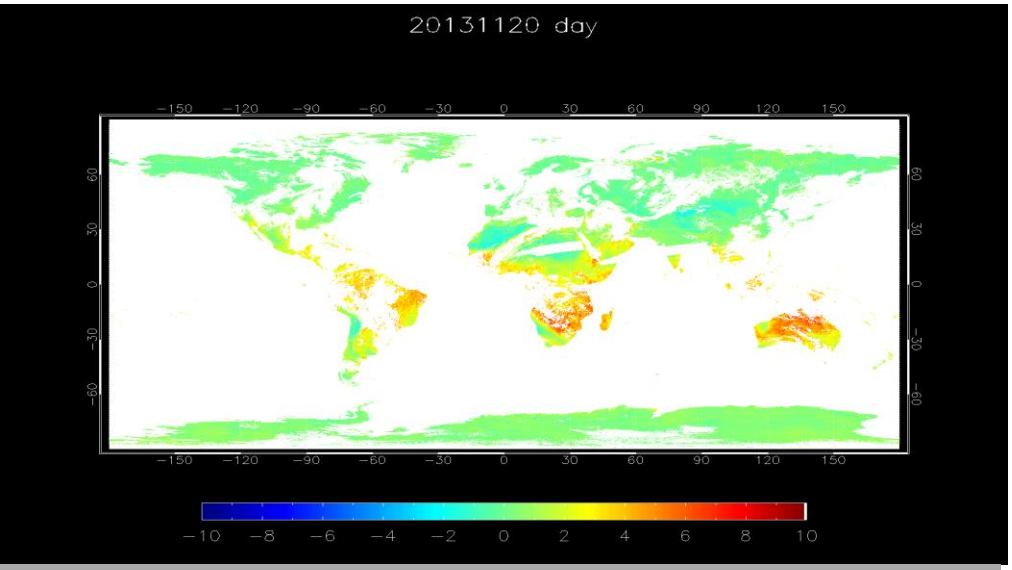


Cross-satellite LST comparison is used in VIIRS LST evaluation.

Caution: Time difference is a significant impact; granule level comparison is needed.

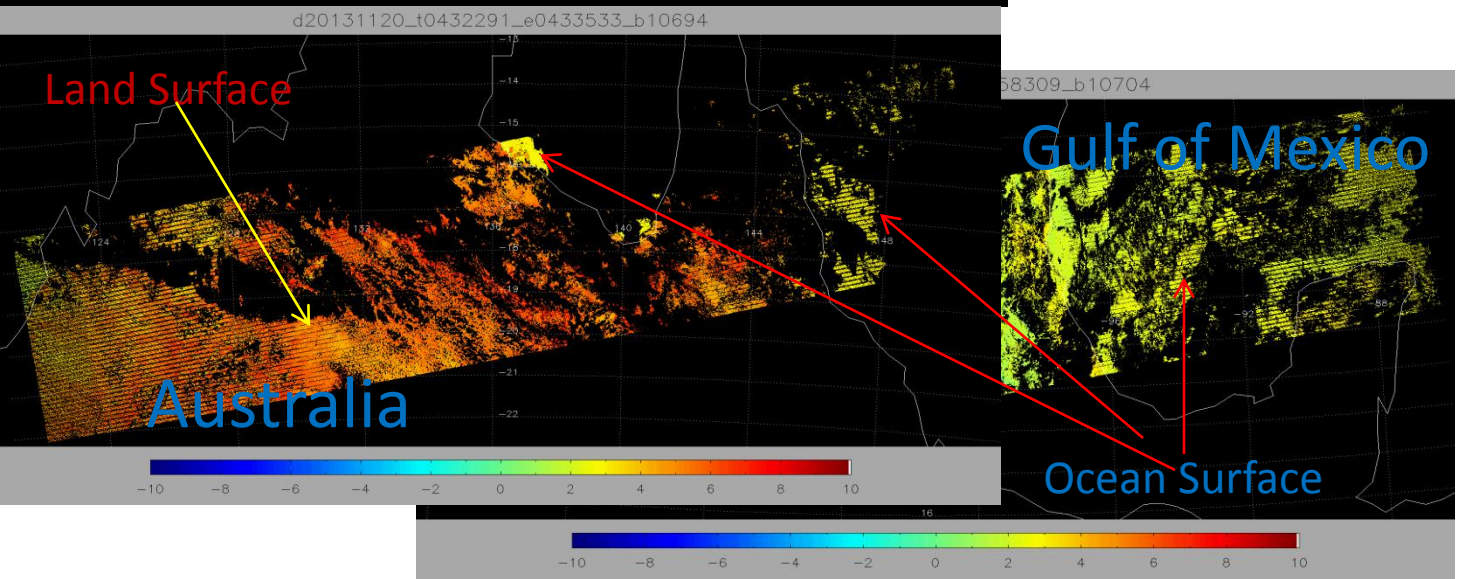
Issues -- Algorithm

BT difference correction



Split-window algorithm feature: brightness temperature difference at 11 and 12 μm is used for atmospheric correction. It is the SST heritage. However, the BT difference can be very different over land. Additional measure is needed.

BT difference at daytime

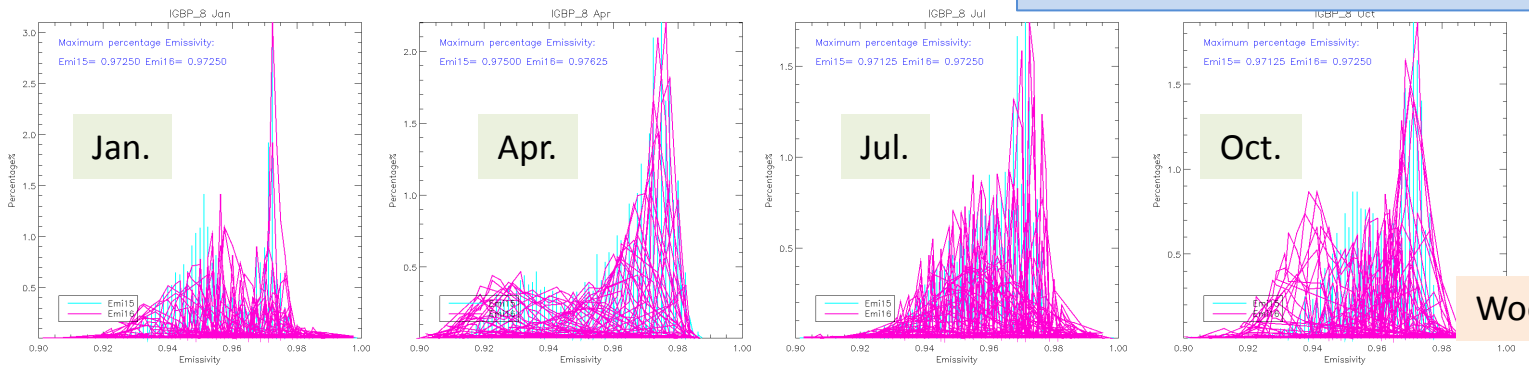


Left: Significant BT differences over land and sea water surface. The BT difference is much smaller over sea surface

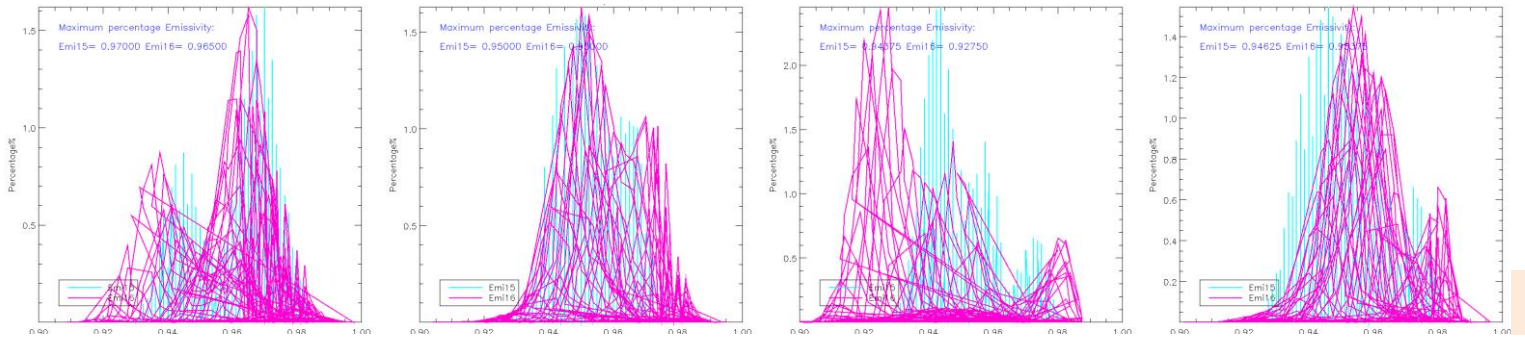
Issues -- Algorithm

Emissivity Impact to LST

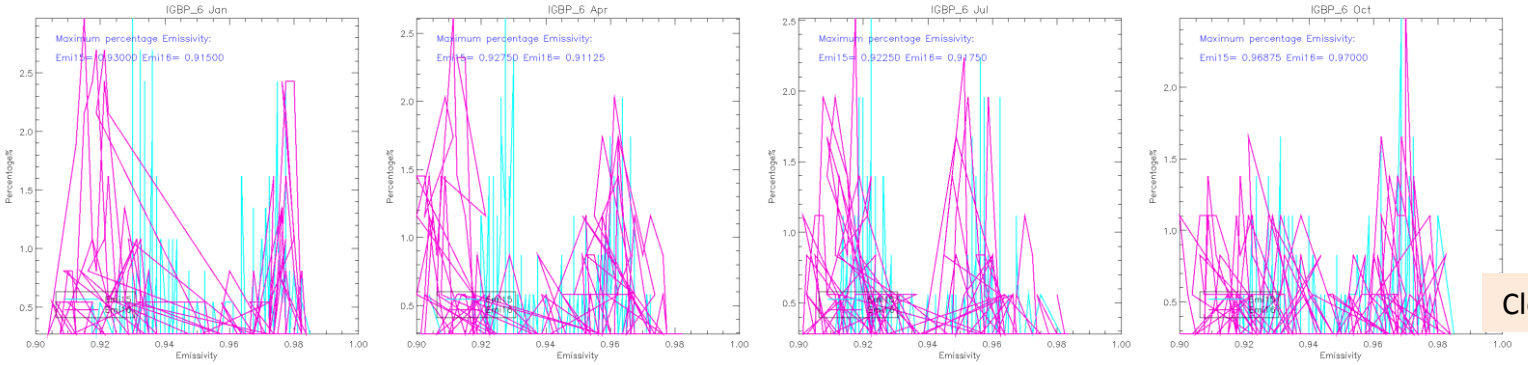
- *Considerable seasonal emissivity variation over some surface types*
- *Considerable emissivity variation within cover types*



Woody Savannas (2012)



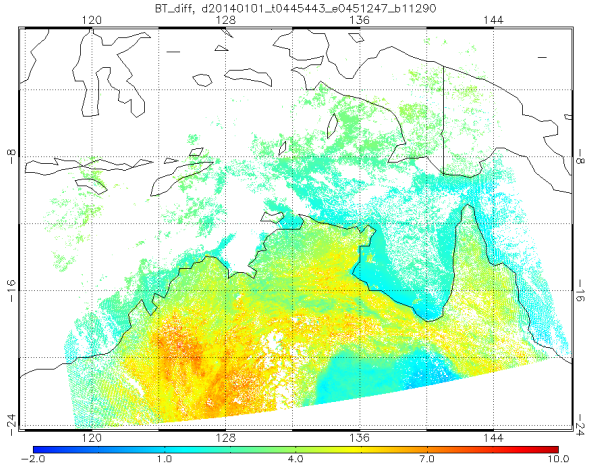
Grassland(2011)



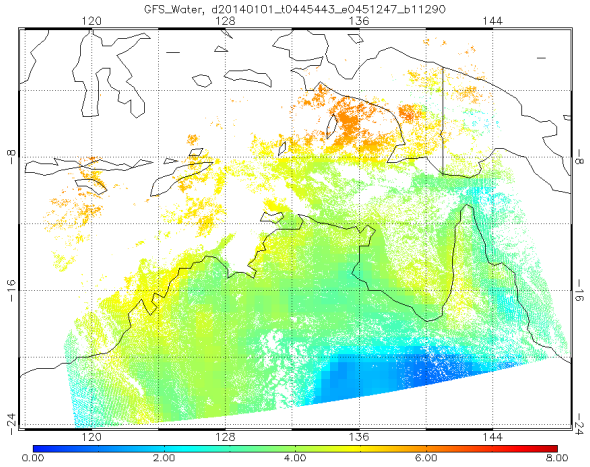
Closed Shrub lands (2012)

Issues -- Algorithm

Emissivity Impact to LST

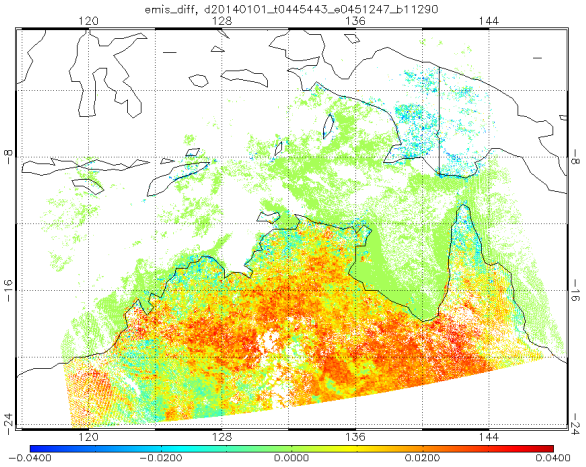


BT difference map for VIIRS granule d20140101_t0445443



GFS water vapor map

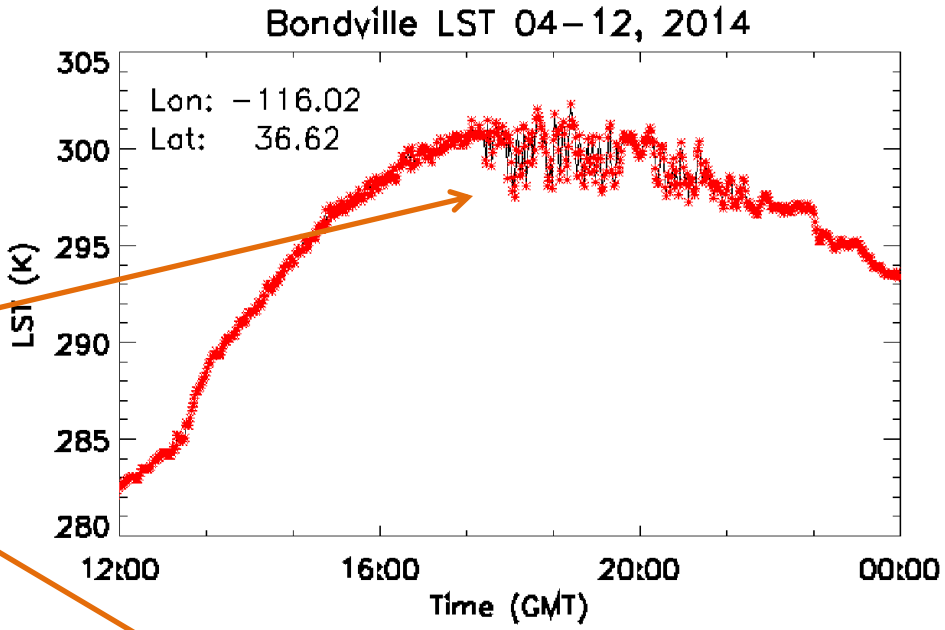
Emissivity difference map

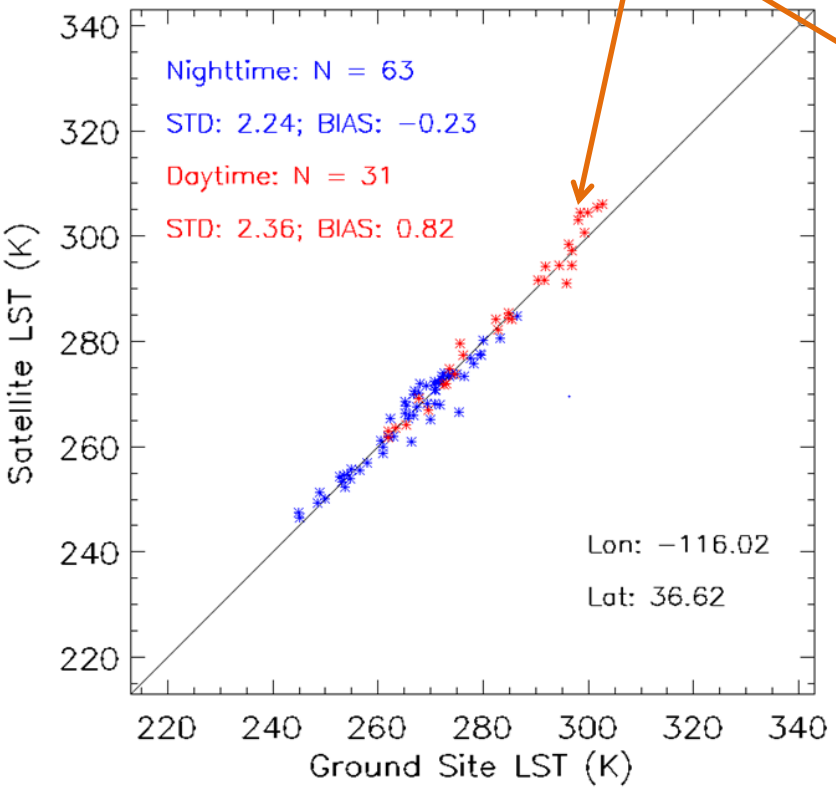


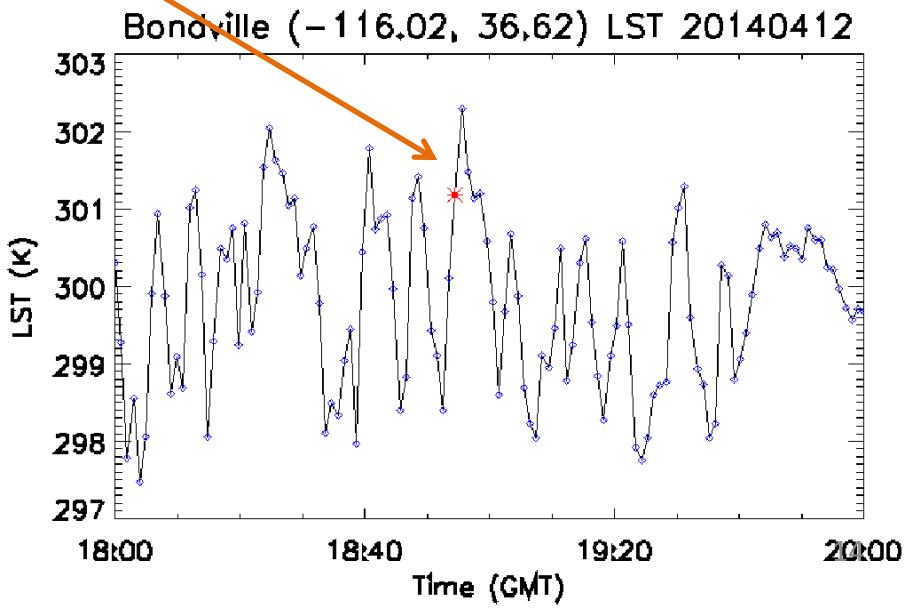
Issues -- Validation

Ground data fluctuation

The ground LST estimate can be fluctuated significantly, resulting big match-up uncertainty (~6K)







Summary

- Split Window LST(SWLST) is applied for VIIRS LST production
- Provisional release
  - Provisional version delivery done in 07/2013, in production in 10/2013
  - Errors found in 10/2013, switch back to beta in 11/2013
  - Provisional update delivery in 02/2014, in production in 04/2014
- Evaluation underway
  - Cross-satellite comparisons (MODIS LST product)
  - Ground data comparisons
    - Comparisons with SURFRAD LST estimates
    - Comparisons with individual field data
  - Radiance-base comparisons
  - Monitoring tool in use
- Issues found
  - Algorithm issues
    - significant impact from the Type EDR
    - Emissivity impact to LST (vs. to SST)
  - Validation issues
    - impact of time difference in cross-satellite comparison
    - Ground data quality, heterogeneity.

Future Works

- Algorithm Improvement
  - ✓ Emissivity explicit *vs.* implicit
  - ✓ Additional water vapor correction
  - ✓ Emissivity correction
- User Promotion
  - ✓ Enhance LST product usage in EMC assimilation/forecasting model
- Monitoring tool
  - ✓ Daily/weekly/monthly/year maps and graphics
- Validation methodology
  - ✓ Cross-satellite comparisons
  - ✓ evaluation against ground data
- International cooperation
  - ✓ NOAA-CMA bilateral program: land product validation subtask
  - ✓ US-Portugal bilateral program : remote sensing subtask
  - ✓ EUMETSAT Land SAF
  - ✓ International Land Surface Temperature and Emissivity Working Group

Thanks

and

Questions?