VIIRS Sea-Surface Temperatures: pathways for improvements

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Focus of studies

- Cloud screening algorithms
  - machine learning ensemble algorithms and boosting
- Improving and evaluating algorithm performance a higher viewing angles
  - Response versus scan angle corrections
- Sensor and algorithm performance evaluations
  - Analysis of global fields and matchups with in situ data from IQUAM.

Cloud mask

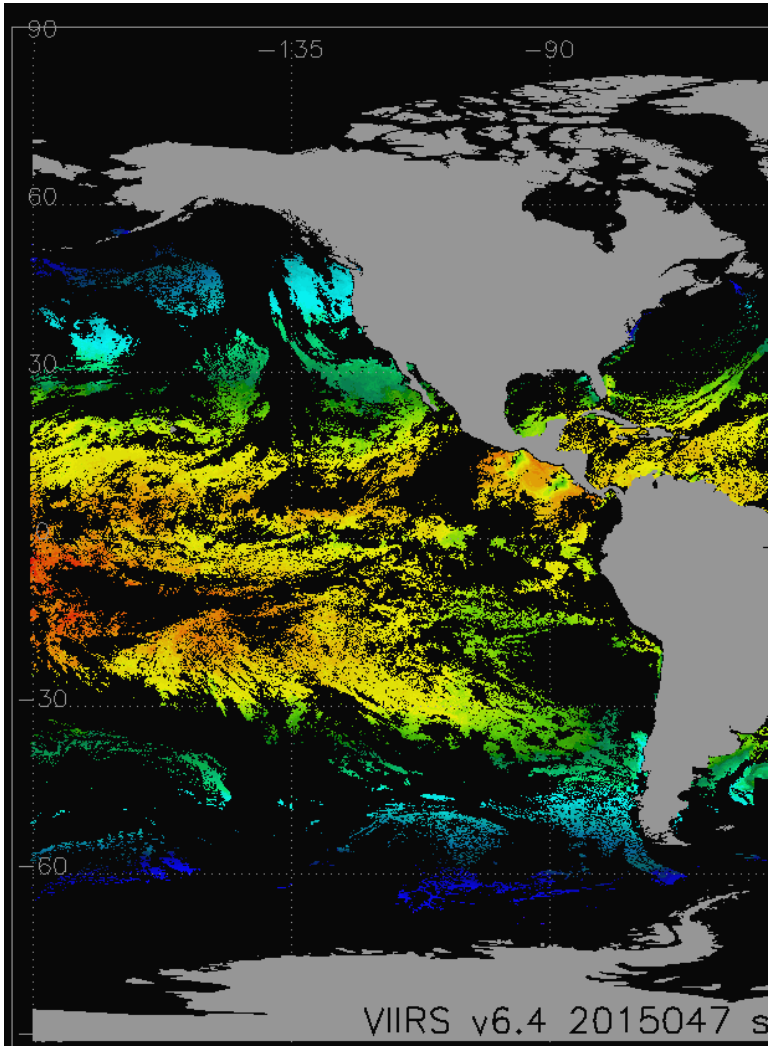
- IR algorithms are only accurate in cloud free and atmospherically "clean" pixels

- Decision Tree misclassification errors.
  - Sensitivity versus specificity
  - Good classified as bad and bad classified as good.

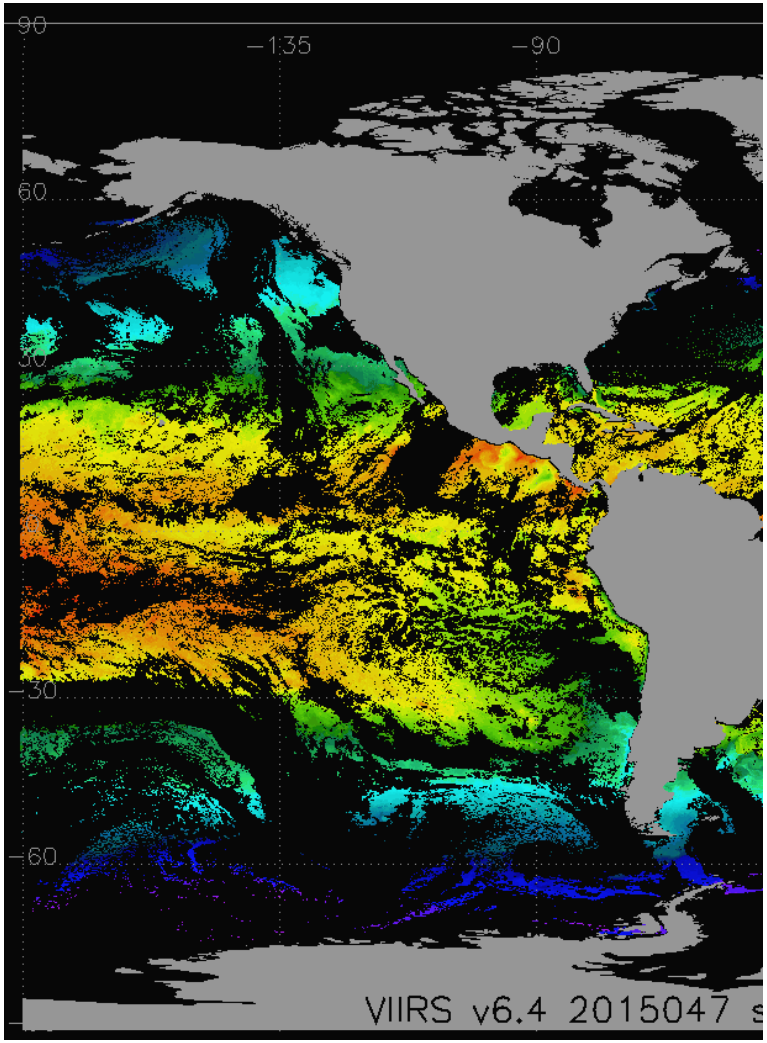
- Differences in ability to detect clouds between day and night can impact sampling/binning of higher level products.
  - Differences in gap free fraction

- Ensemble classification methods to improve misclassification errors using boosting and alternating decision trees (ADTree)

Cloud free night versus day classifiers



night



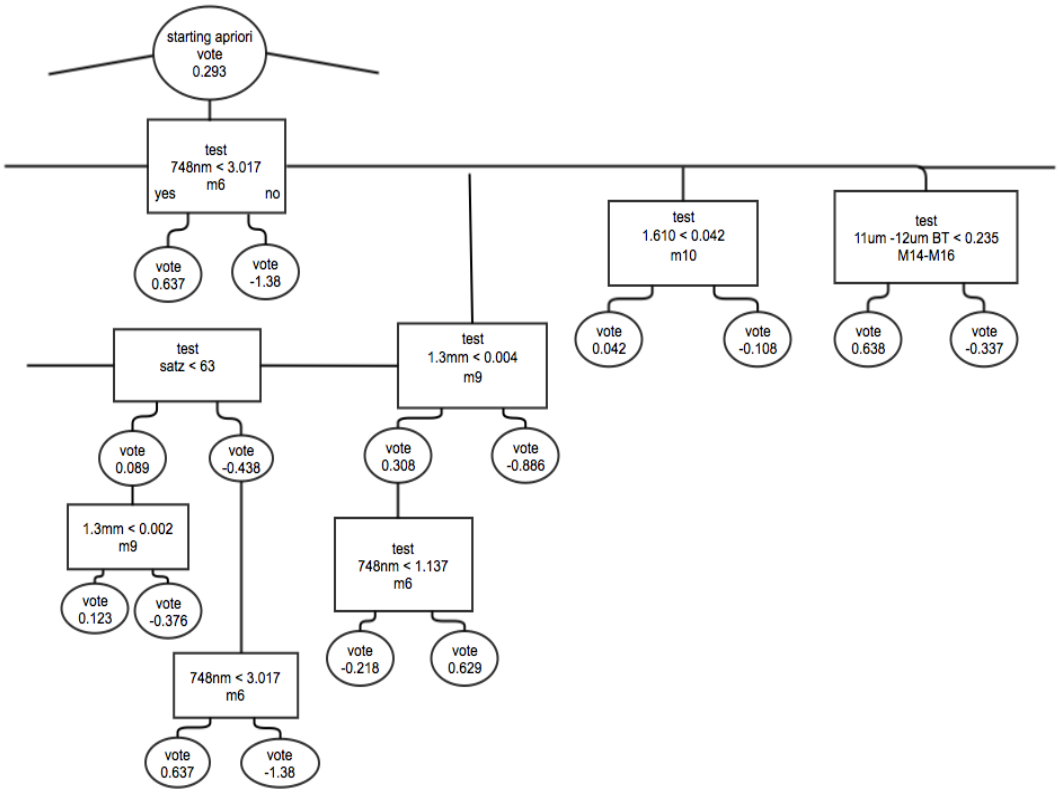
day

Ensemble machine learning for pixel cloud classification

- Alternating decision trees combine the simplicity of single decision trees and the power of boosting
  - Highly accurate
  - Relatively small size easy to interpret and code
  - Provides a measure of prediction confidence
- Boosting turns weak learners collectively into strong classifiers
  - repeat reweighing of training examples to focus on problematic/misclassified pixels

Branch of SST ADTree cloud classifier

(crowd sourcing classification with the help of experts)



Classification is based on sum of community vote across all tree stumps and branches.

A positive sum is classified as good/clear and a negative is bad/cloud. The absolute magnitude of the sum provides an estimate of the confidence in the classification.

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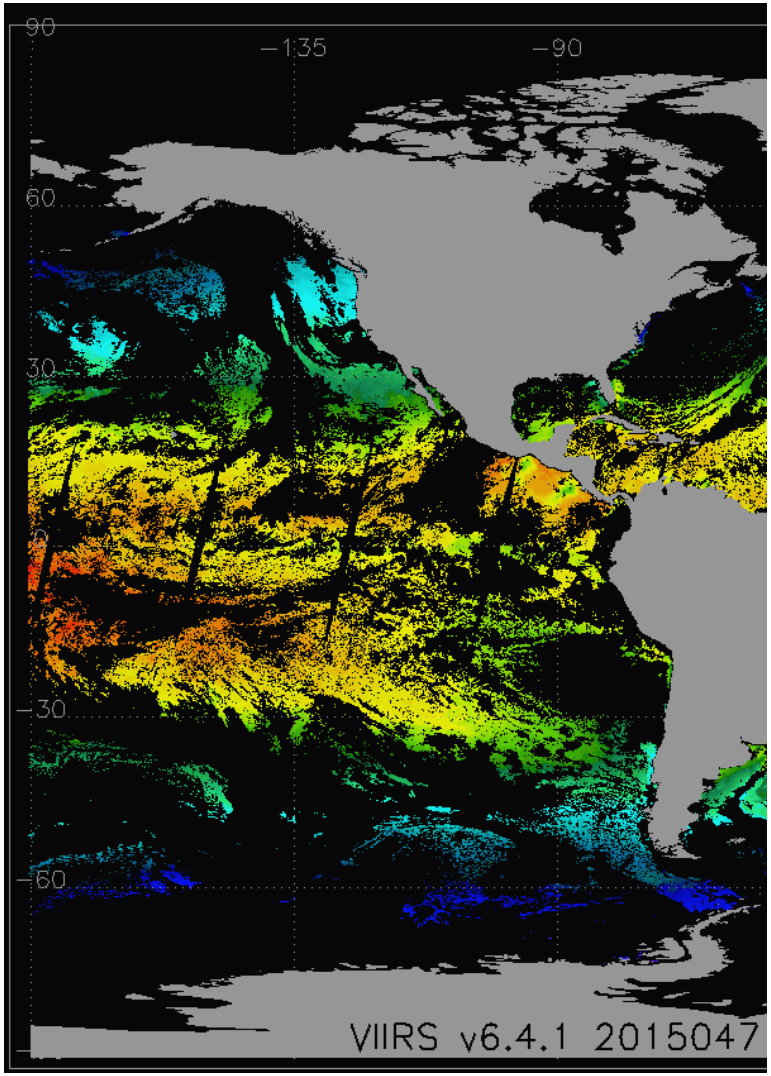
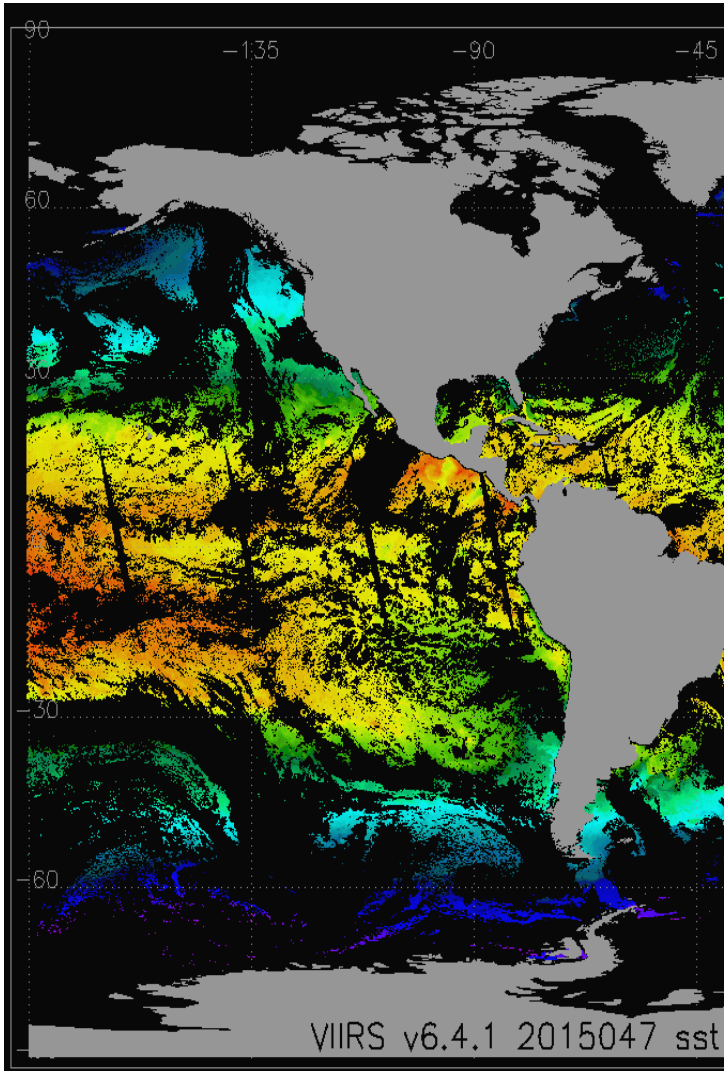
Night ADTree lower misclassification

Night Decision Tree:
misclassified
0.20
sensitivity
0 .69
Specificity
0.81

Night ADTree:
misclassified
0.099
sensitivity
0 .80
Specificity
0.90

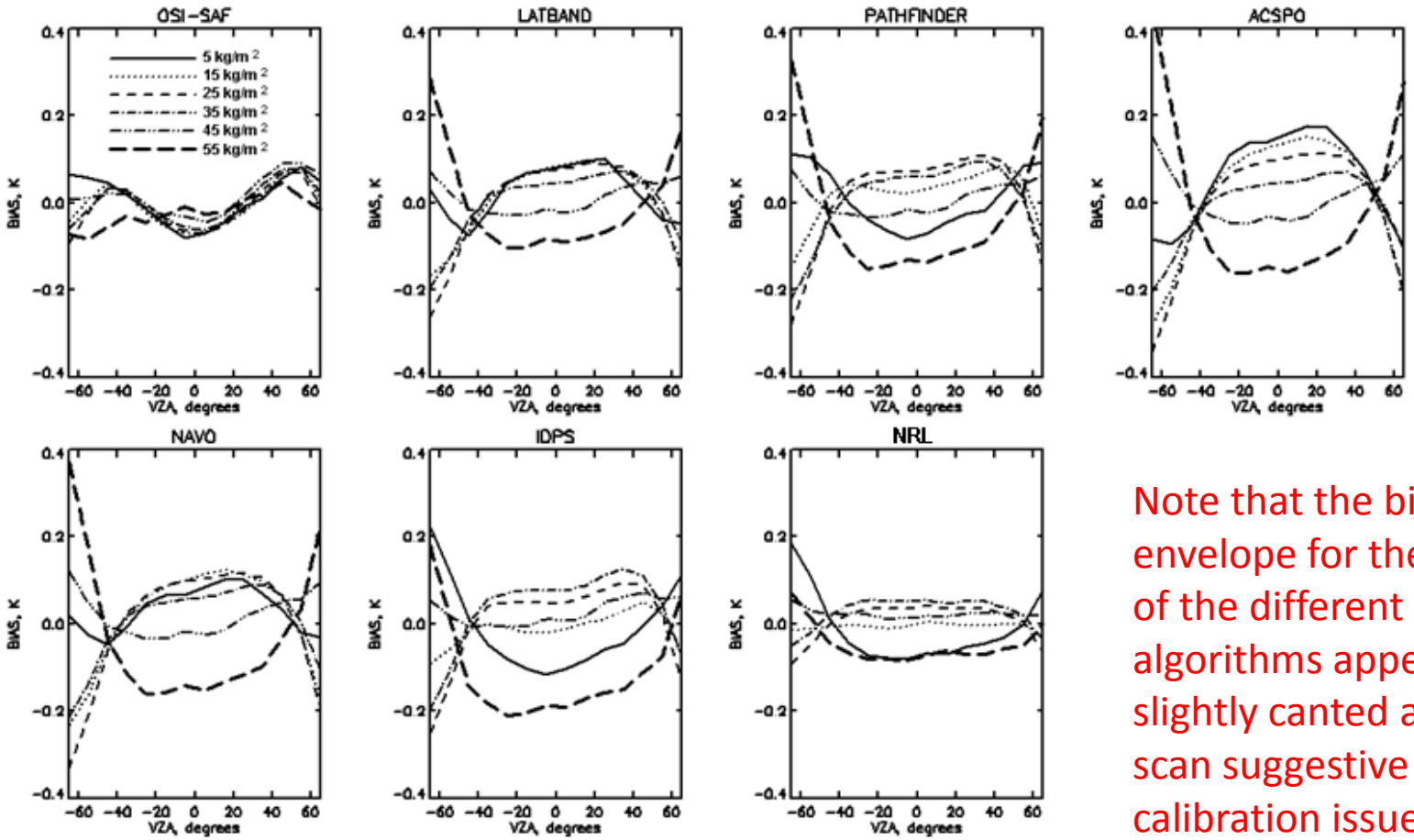


night



day

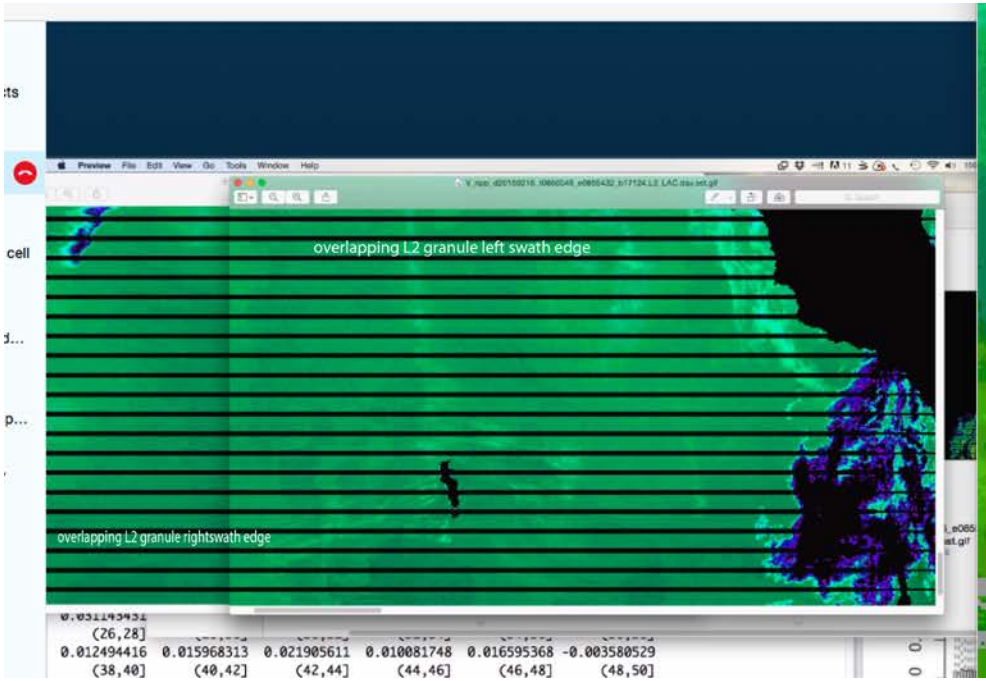
Algorithms for Improving accuracy at high scan angles

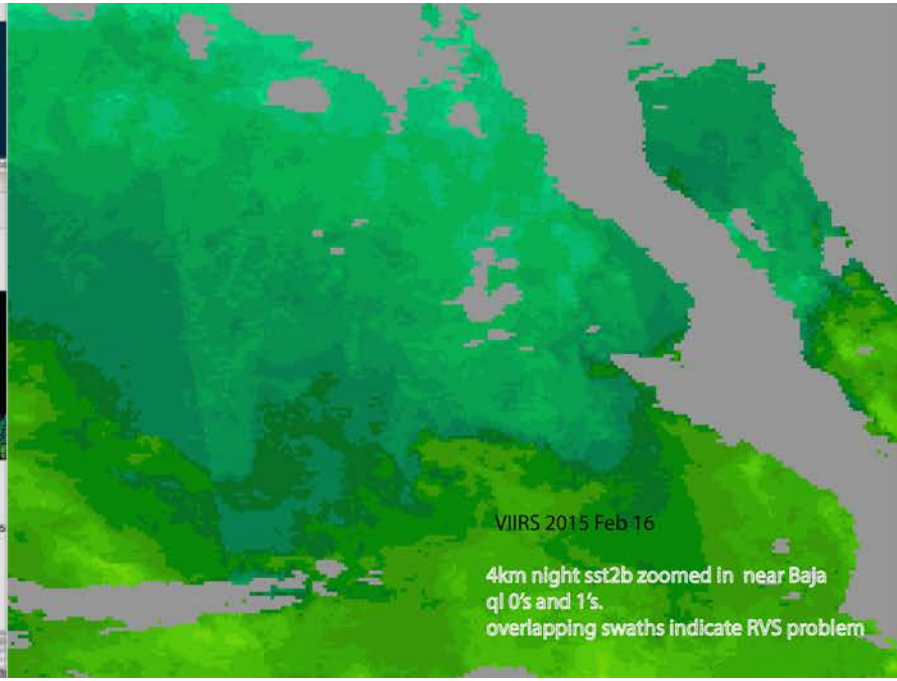


Note that the bias envelope for the majority of the different algorithms appear slightly canted across the scan suggestive of an RVS calibration issue

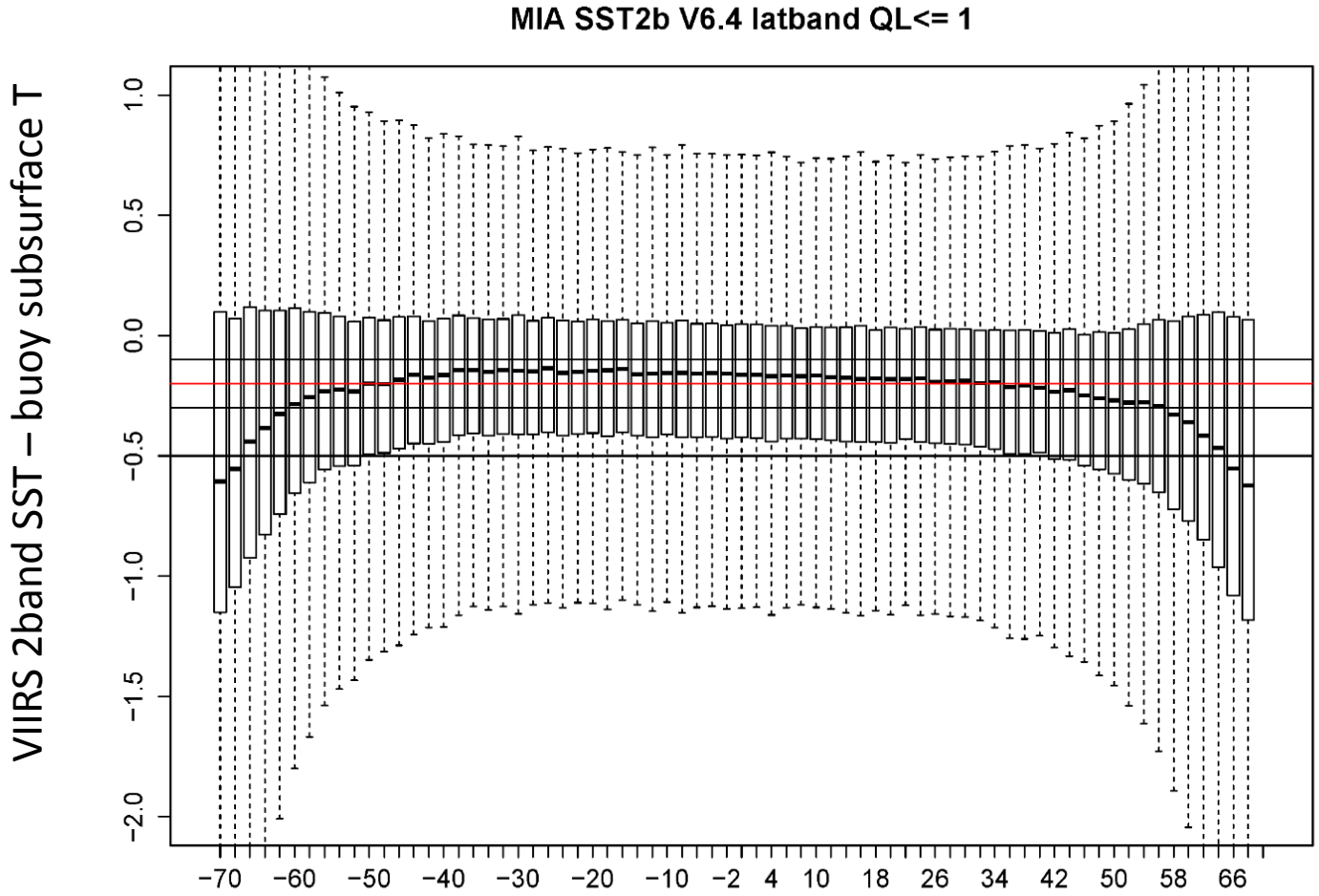
Figure from: Petrenko et al. 2014 JGR JPSS SST Algorithms for VIIRS

VIIRS wide swath algorithms RVS issue at 10-12µm?





SST uncertainties as f(satellite zenith angle). QL=0,1



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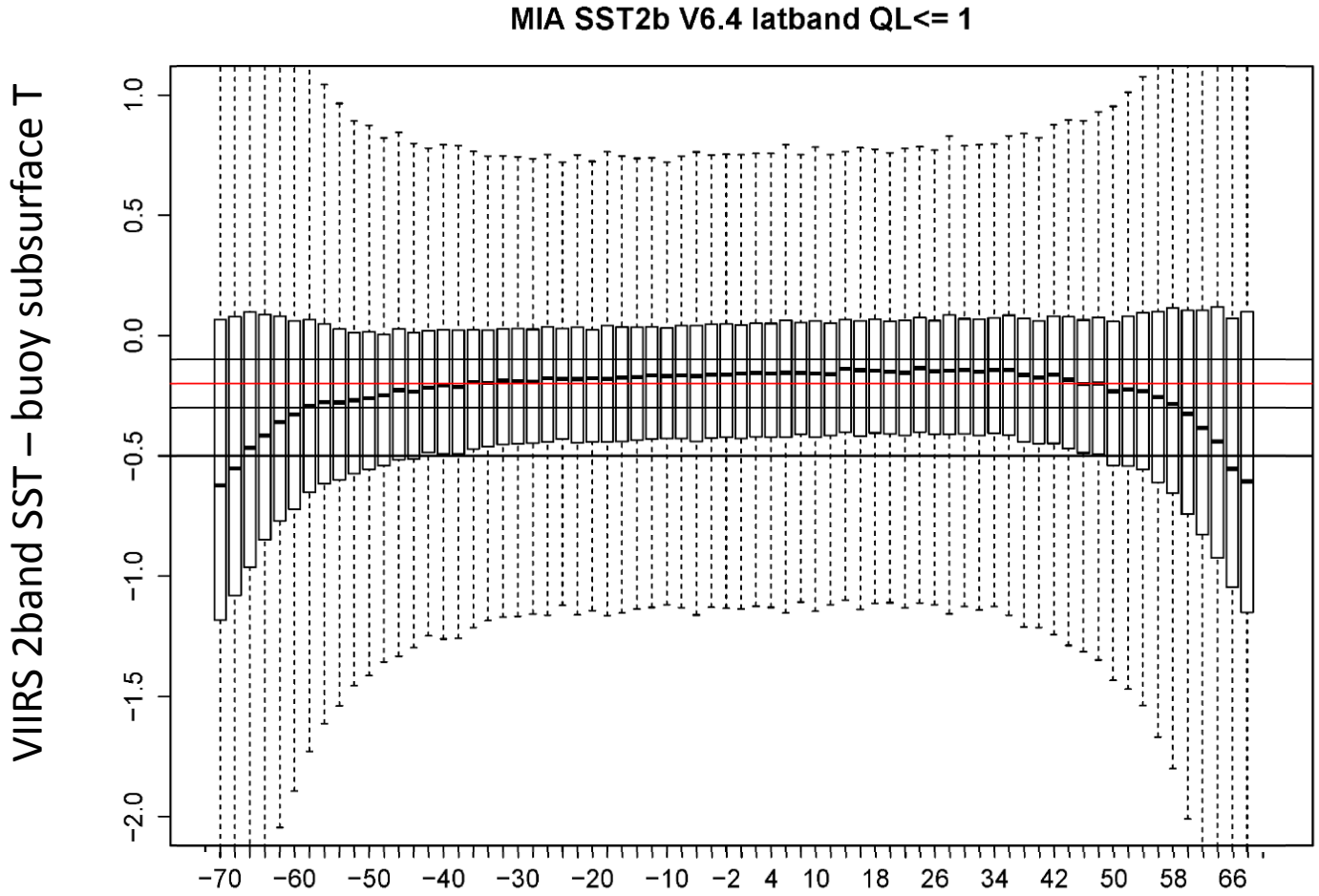
SST uncertainties as f(satellite zenith angle). QL=0,1



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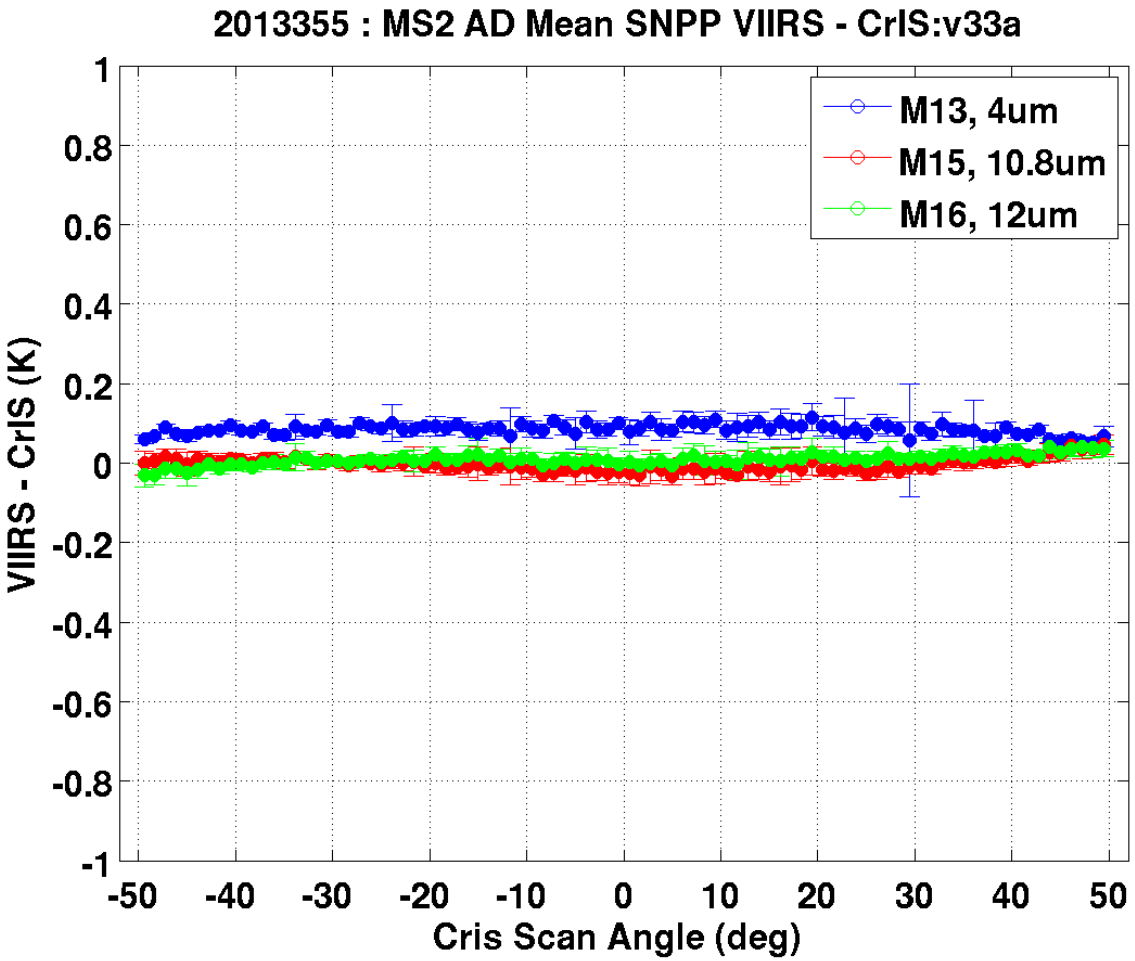
VIIRS *vs* CrIS



Provided by Chris Moeller

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Algorithm innovations

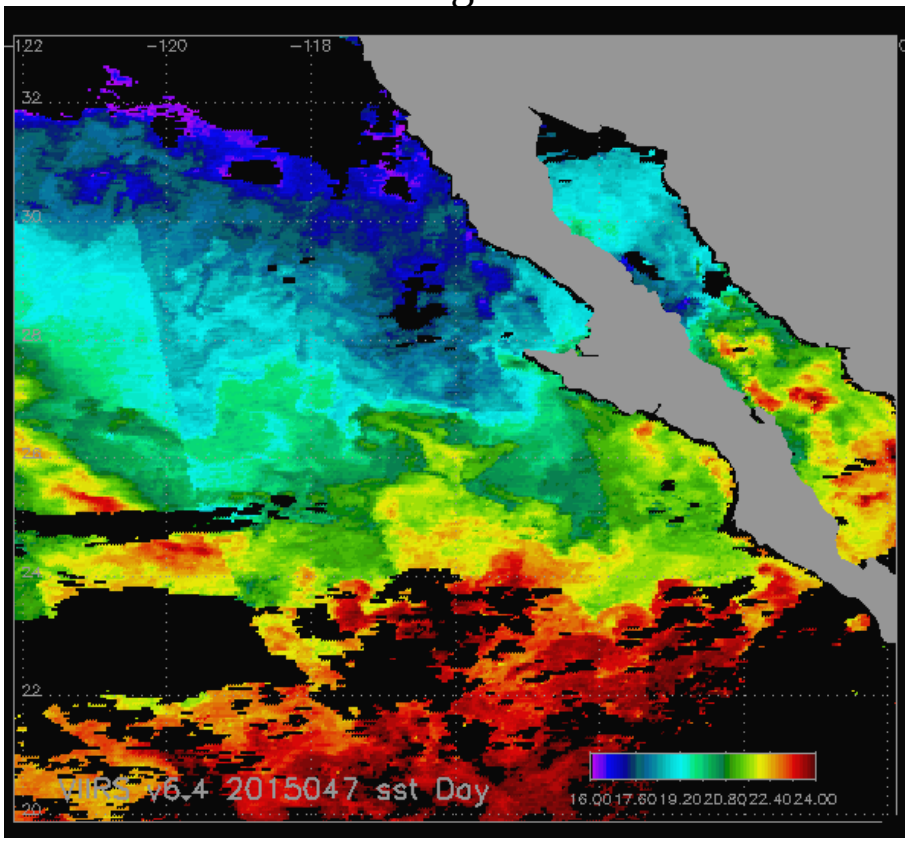
Objective to extend retrievals towards edge of VIIRS swaths and corrected for any RVS artifacts

$$
\begin{aligned}
SST_{sat} = a_0 &+ \\
& a_1 T_{11} + \\
& a_2 (T_{11} - T_{12}) T_{sfc} + \\
& a_3 (\sec(\theta) - 1)(T_{11\mu m} - T_{12\mu m}) + \\
& a_5(\theta) + \\
& a_6(\theta^2)
\end{aligned}
$$

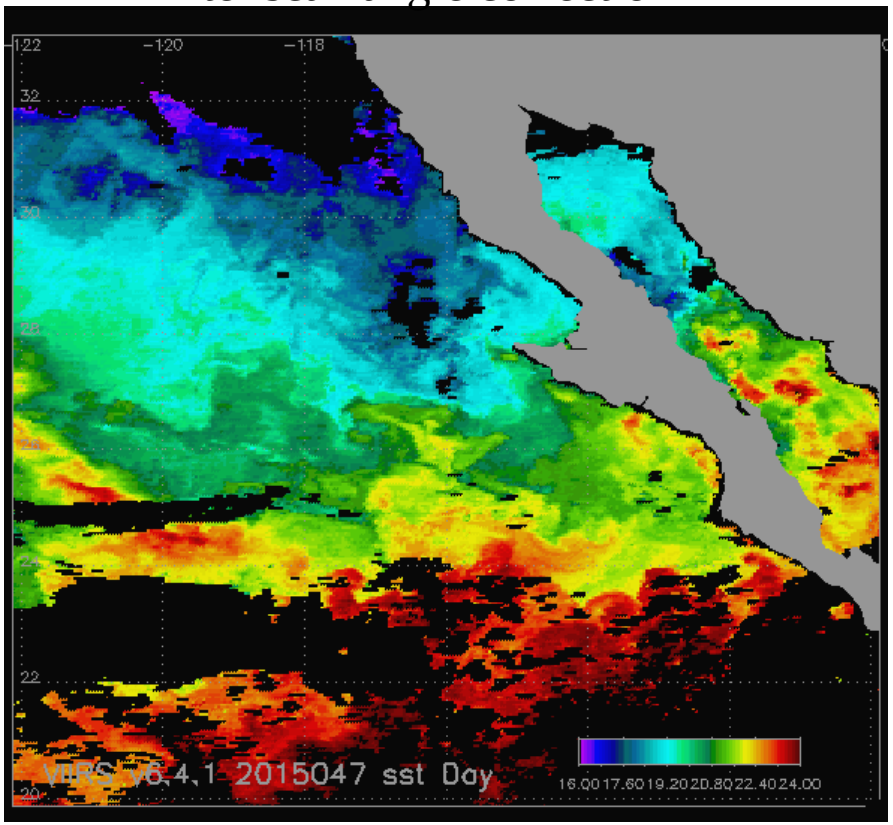
VIIRS Day SST Feb 16 2015

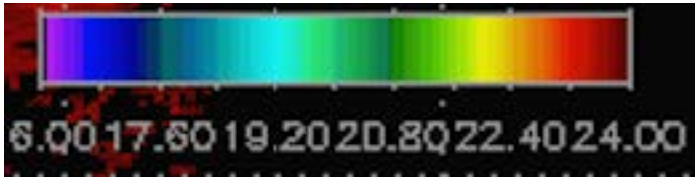
4km map image

Before scan angle correction



After scan angle correction





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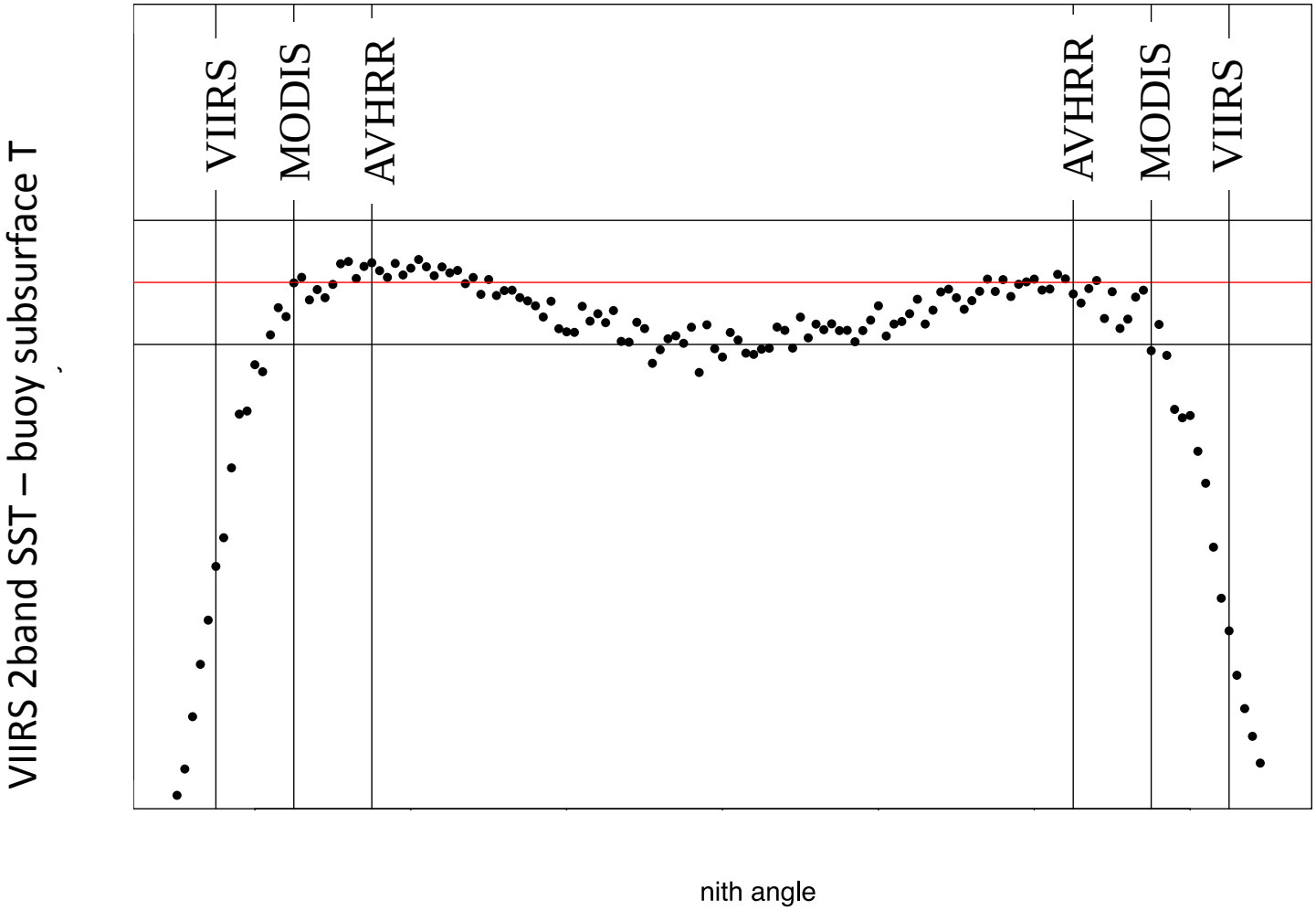
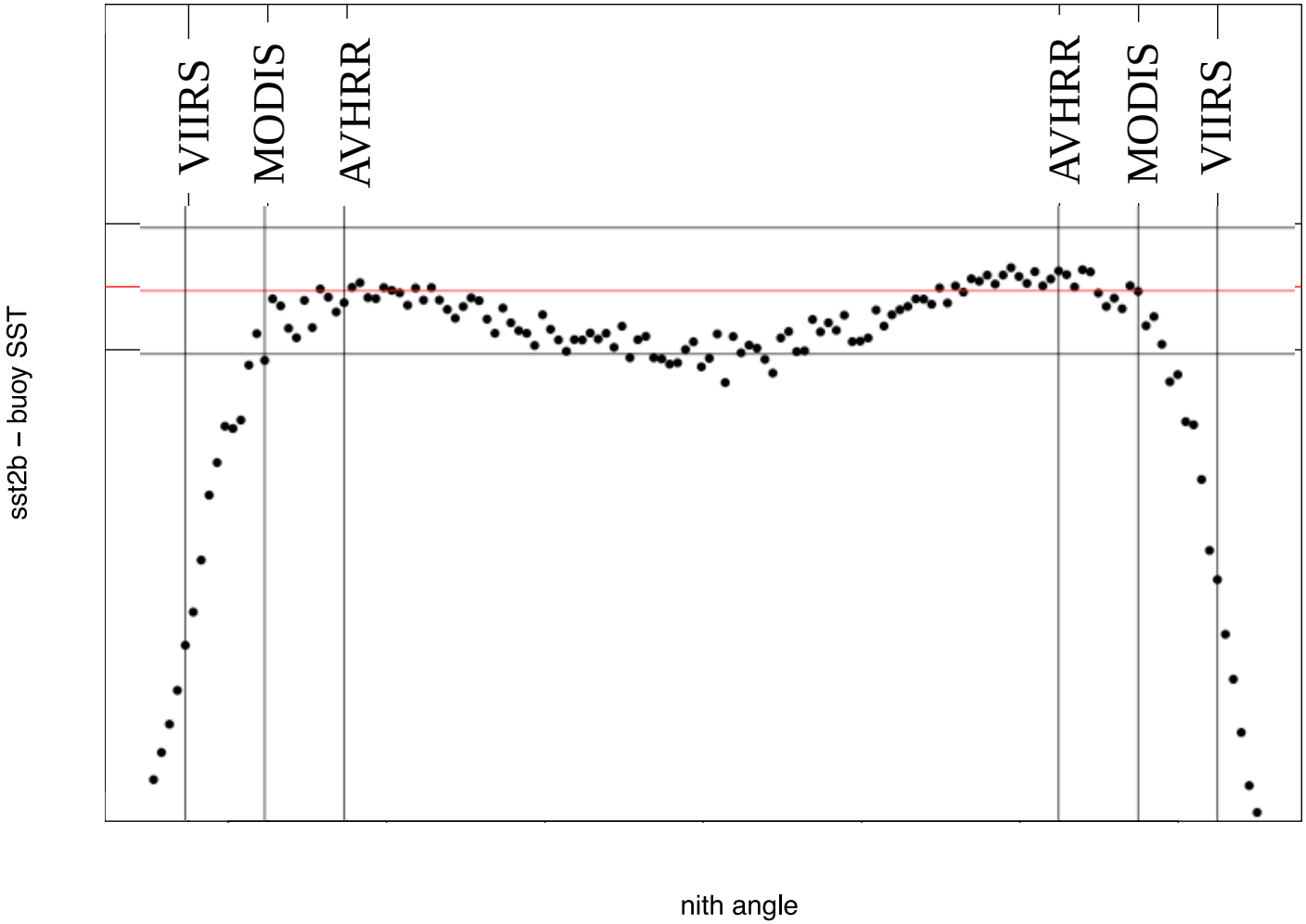
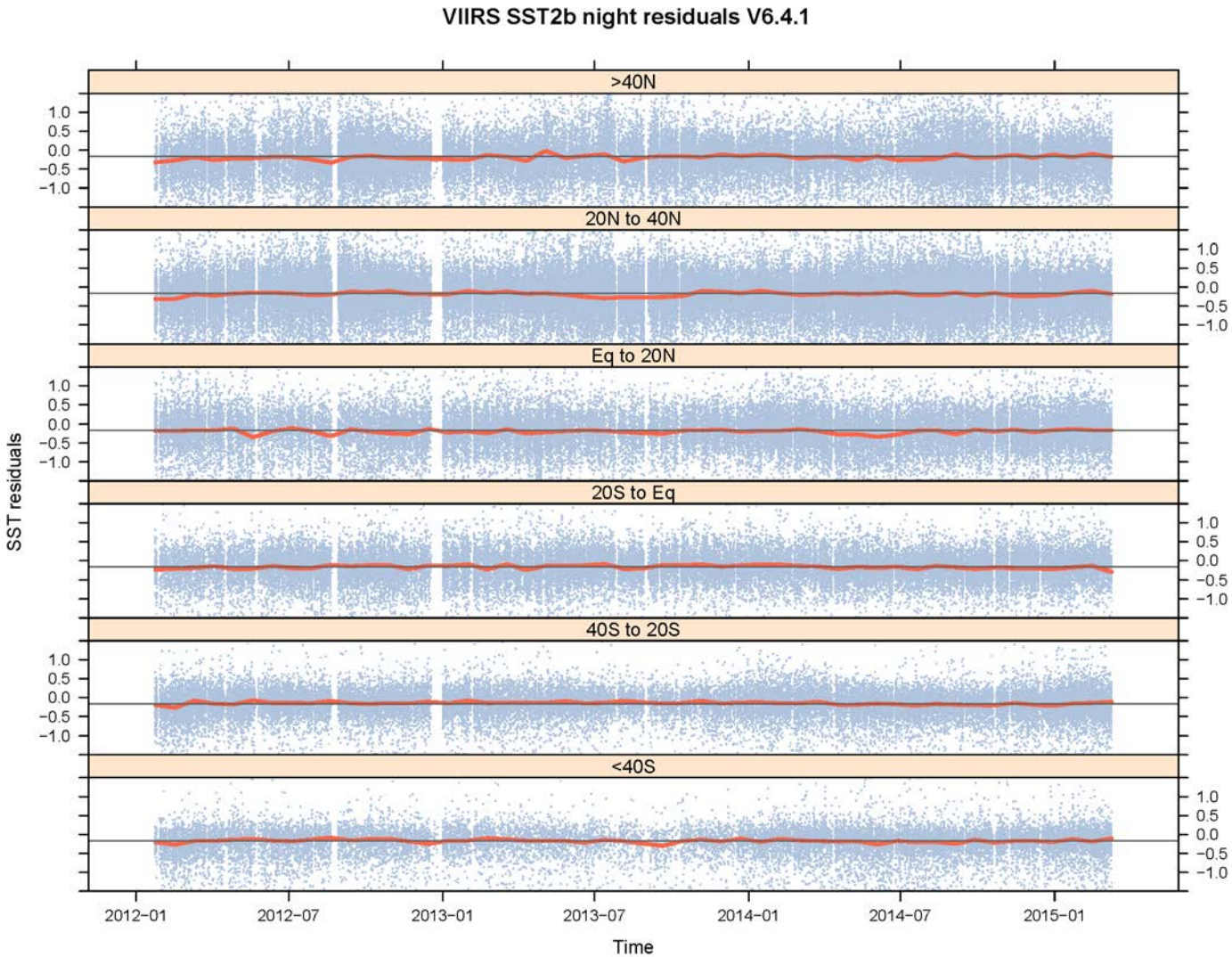

VIIRS 2band SST – buoy subsurface T
VIIRS
MODIS
AVHRR
AVHRR
MODIS
VIIRS
nith angle


VIIRS
MODIS
AVHRR
AVHRR
MODIS
VIIRS
sst2b – buoy SST
nith angle

VIIRS SST matchups with Miami improvements



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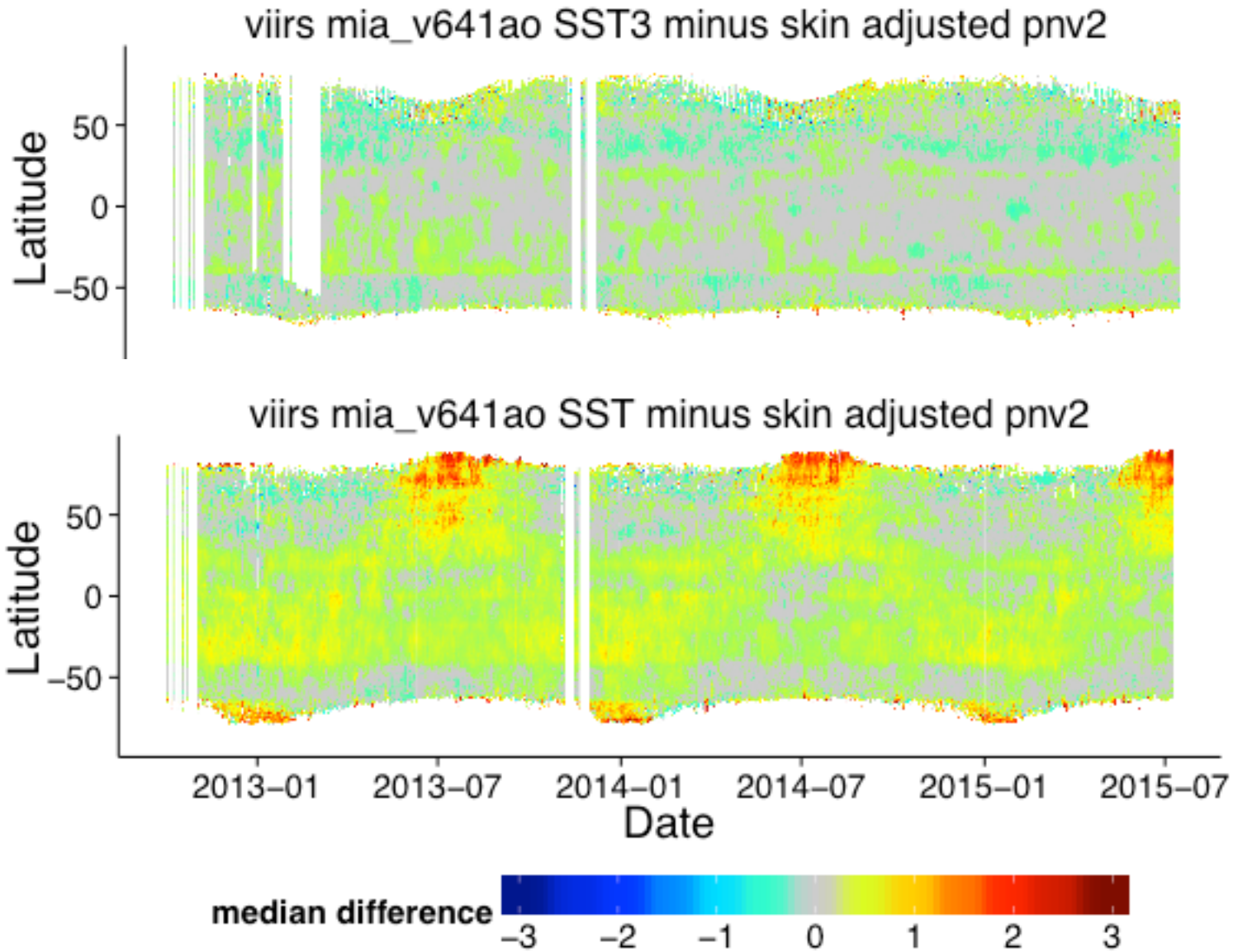
Difference relative to daily Reynolds SST 0.25°

Night

day



Summary

- Cloud screening and quality of SST can be improved by the use of ensemble machine learning classification methods and provide classification confidence estimates

- The VIIRS sensor has a small scan angle artifact in both the 11 and 12um channels which is magnified by the channel difference terms in the SST algorithms

- Analysis of global fields and matchups with in situ data indicate that VIIRS SST performance and stability is very good but there are paths for operational SST product improvement.

Thank you.