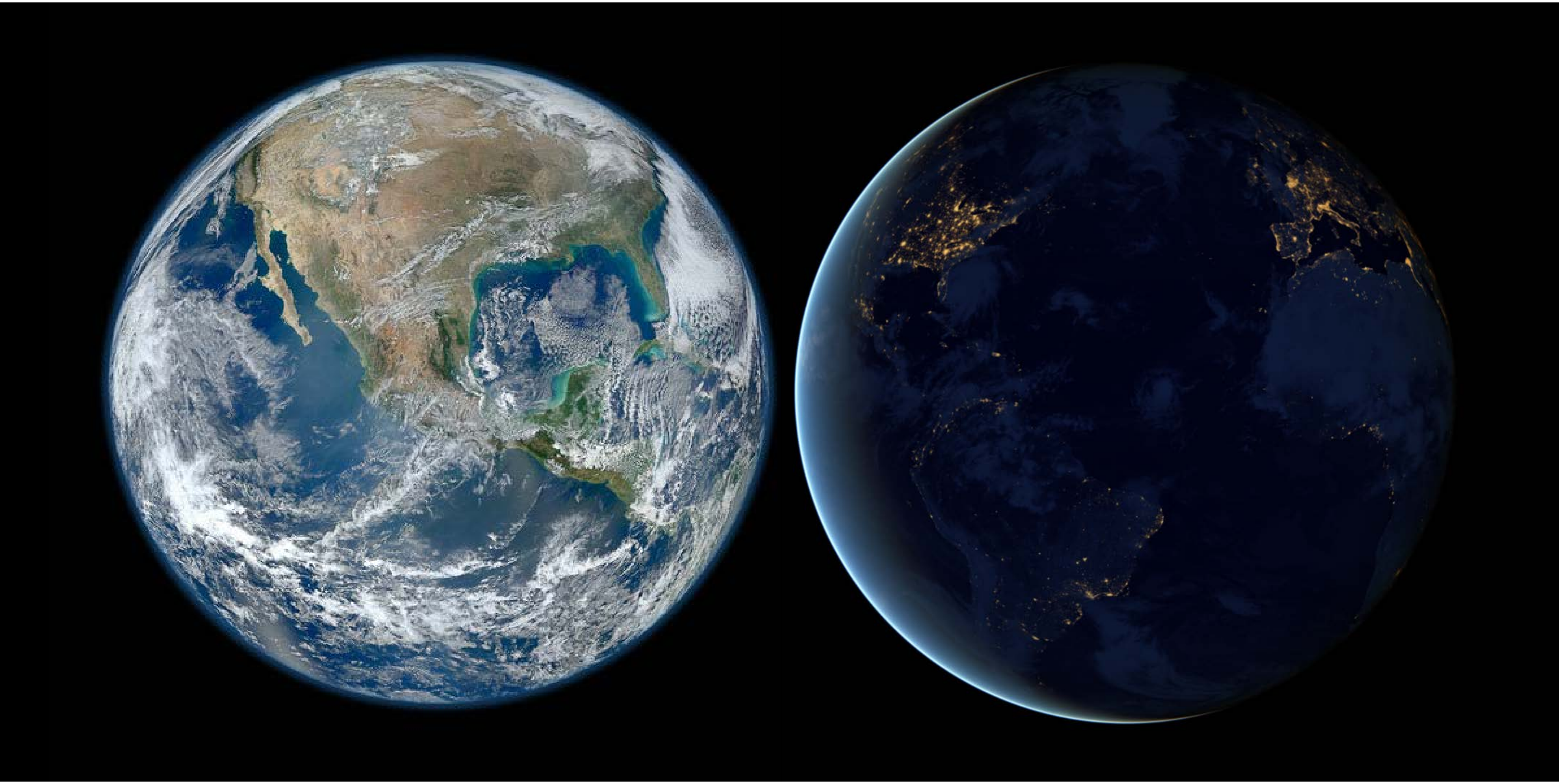
Use of Suomi-NPP Data for Global Land Change Science and Applications



Miguel O. Román, Zhuosen Wang, Eleanor Stokes, Donglian Sun, Wei Zheng, Virginia Kalb, Peter Ma, George Riggs, Dorothy Hall, Ivan Csiszar, and Karen Seto

NASA Goddard Space Flight Center

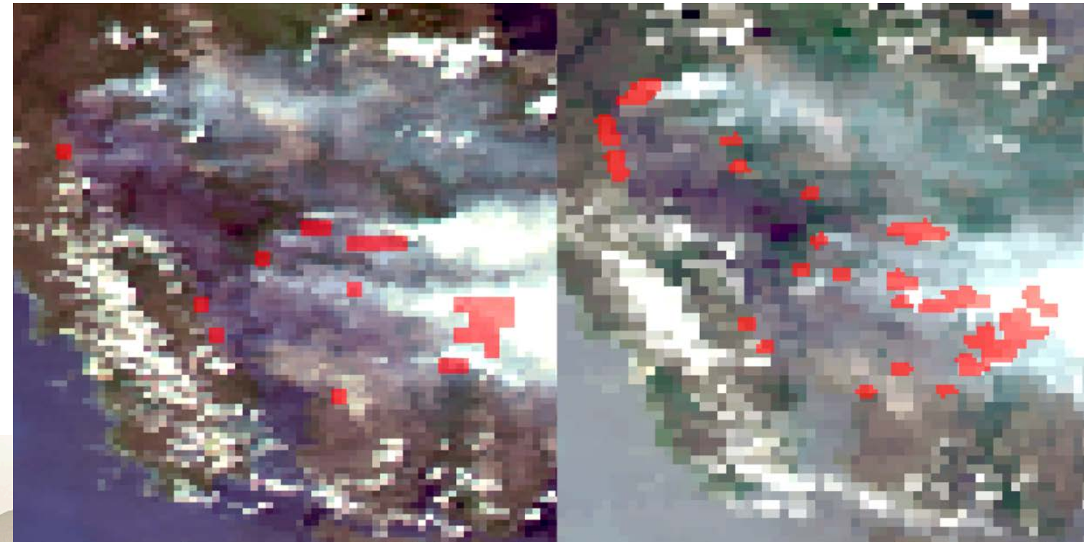
Yale University School of Forestry & Environmental Studies

George Mason University

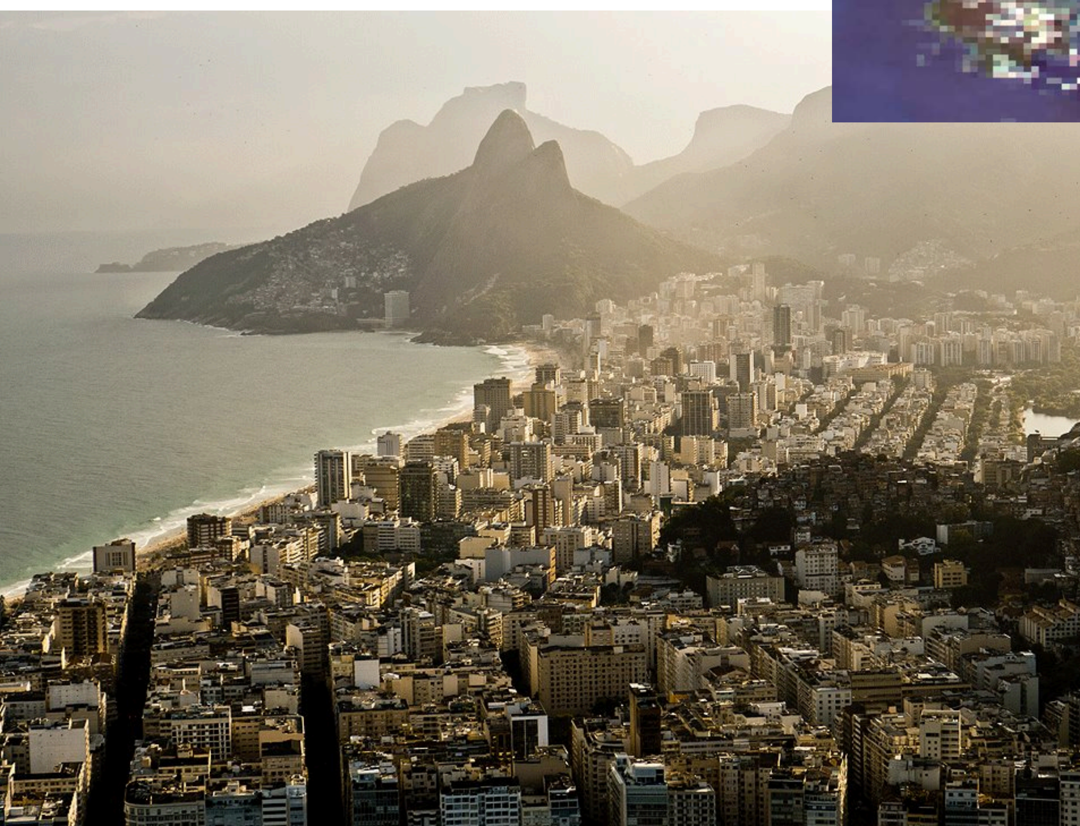
Research support provided by NASA's Disasters & LCLUC Program and the Office of the Chief Scientist

Some Unique Capabilities of Suomi-NPP

Improved fire detections (25% higher VIIRS fire counts than MODIS).



MODIS (left) and VIIRS (right) Fires in Tasmania
Credit: Peter Ma (NASA) & Wilfrid Schroeder (NOAA)

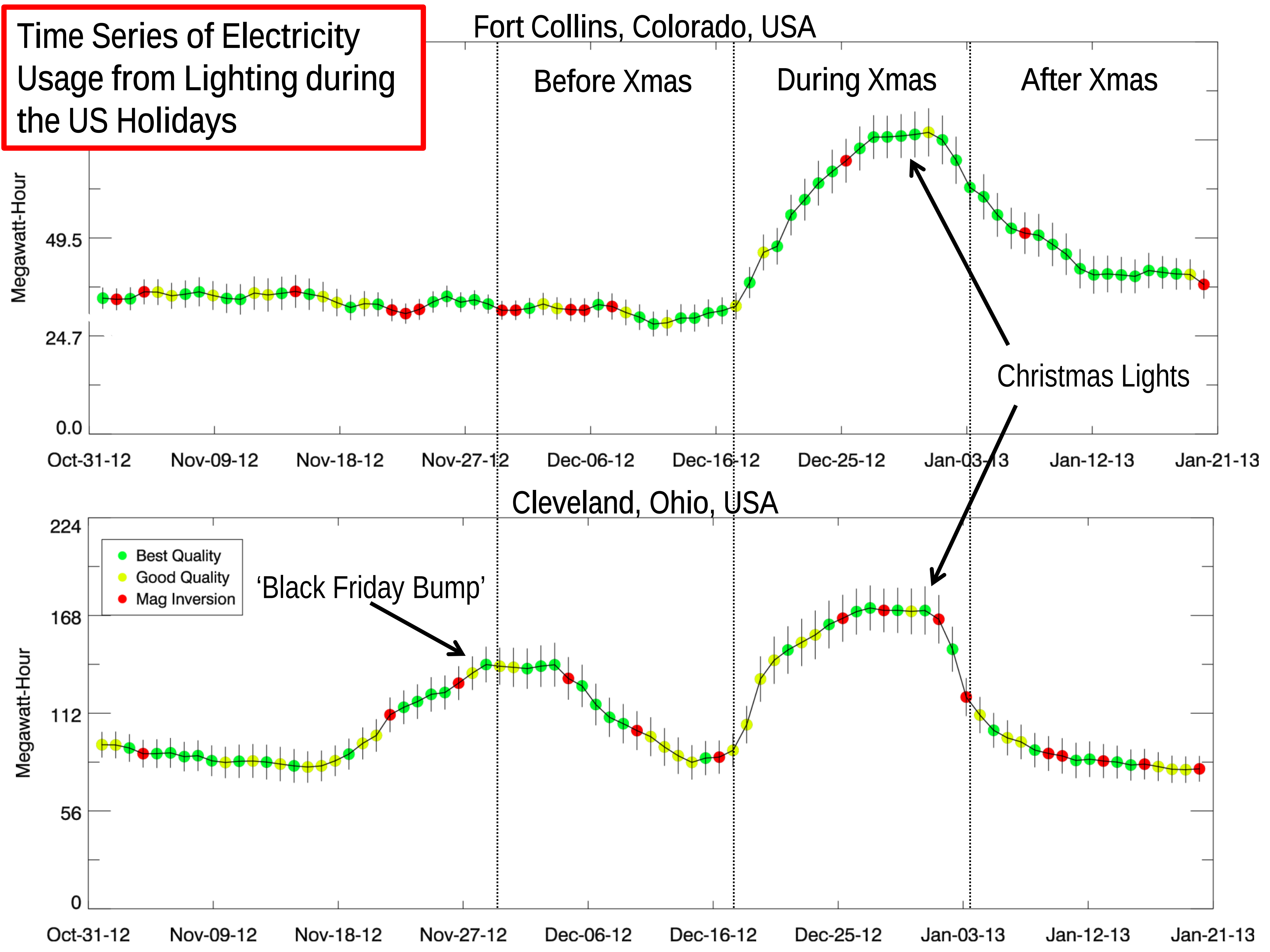


Measure a variety of phenomenon associated with human settlements.

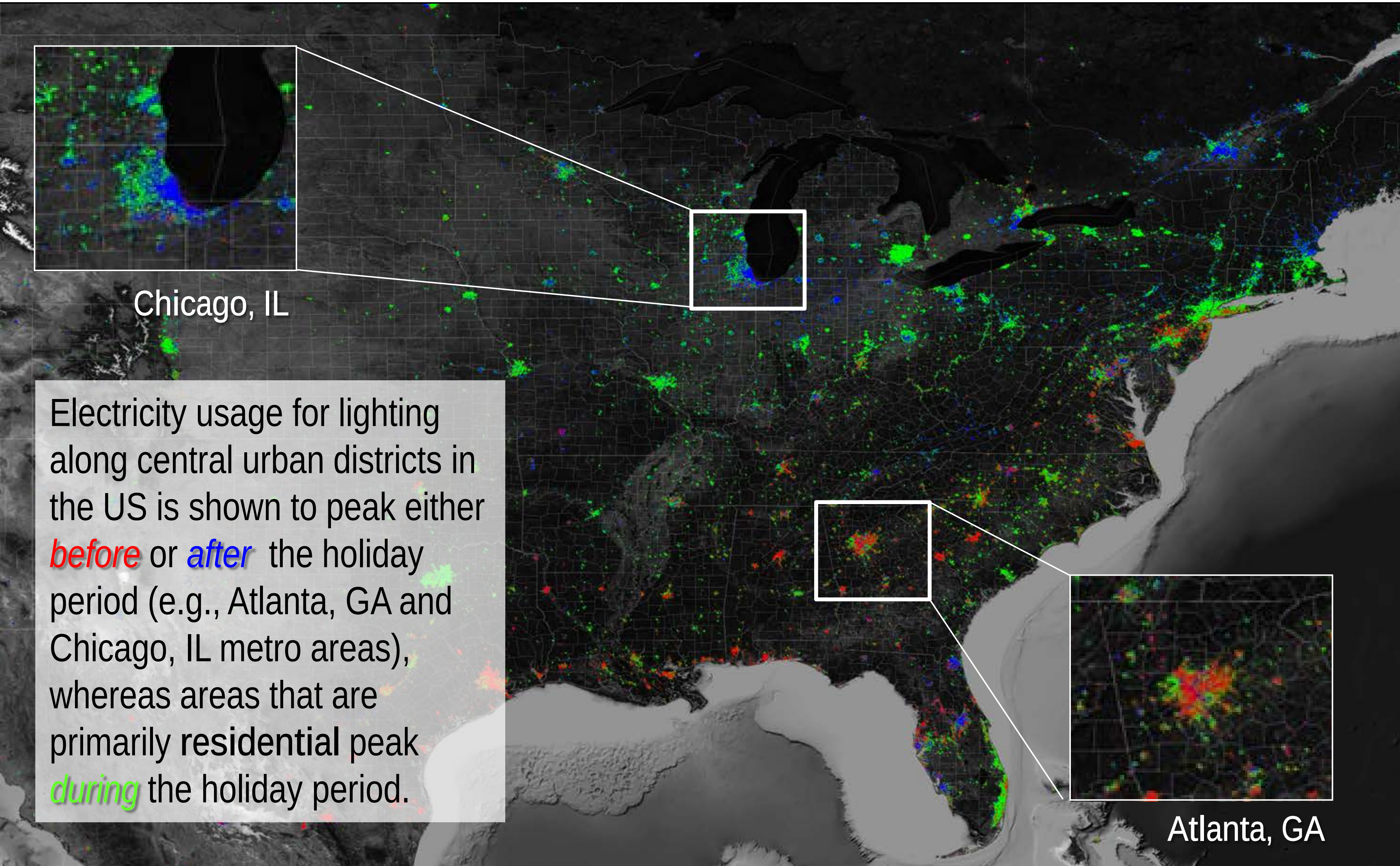
One apparent manifestation of energy use in human settlements is in the celebration of holidays.

During holidays, human activity patterns change. This in turn affects short-term patterns in energy consumption.

Román & Stokes (2014) submitted


Time Series of Electricity Usage from Lighting during the US Holidays
Fort Collins, Colorado, USA
Before Xmas
During Xmas
After Xmas
Megawatt-Hour
49.5
24.7
0.0
Christmas Lights
Oct-31-12
Nov-09-12
Nov-18-12
Nov-27-12
Dec-06-12
Dec-16-12
Dec-25-12
Jan-03-13
Jan-12-13
Jan-21-13
Cleveland, Ohio, USA
224
168
112
56
0
Best Quality
Good Quality
Mag Inversion
'Black Friday Bump'

Christmas Lights from Space!



Electricity usage for lighting along central urban districts in the US is shown to peak either *before* or *after* the holiday period (e.g., Atlanta, GA and Chicago, IL metro areas), whereas areas that are primarily **residential** peak *during* the holiday period.

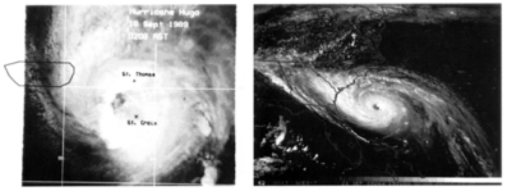
Before Festivity ■ During Festivity ■ After Festivity ■

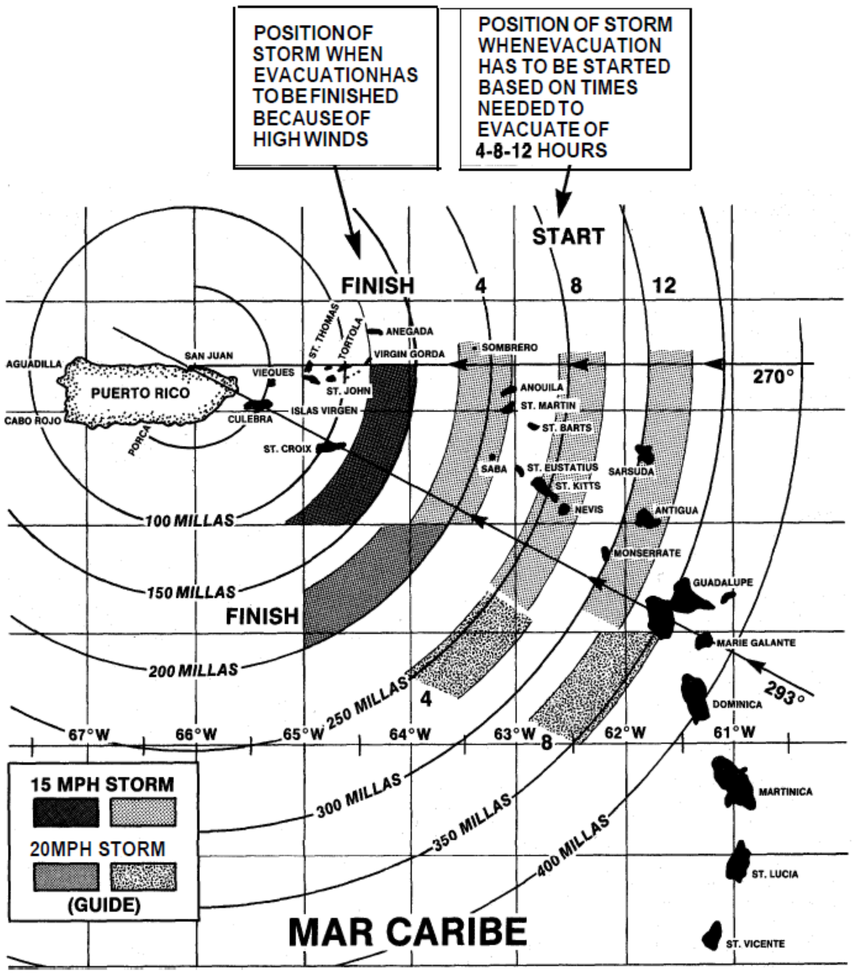
NASA Goddard Space Flight Center

Yale University School of Forestry & Environmental Studies

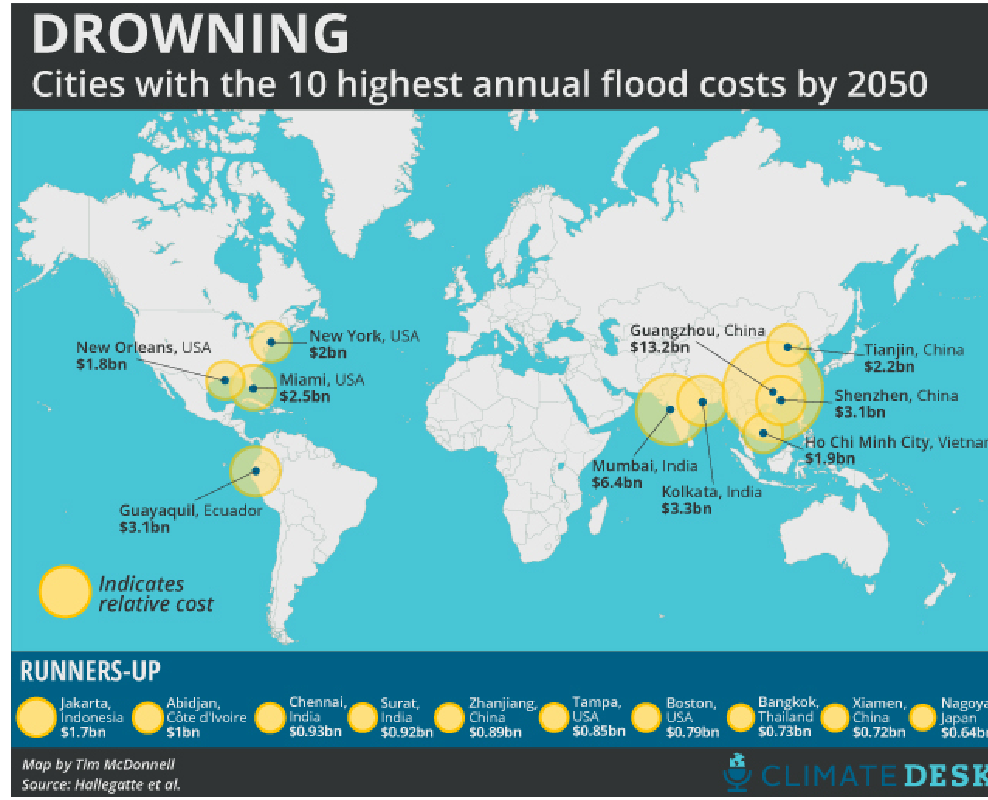
WHY HUMAN SETTLEMENTS?

Hurricane Hugo
September 10-22, 1989



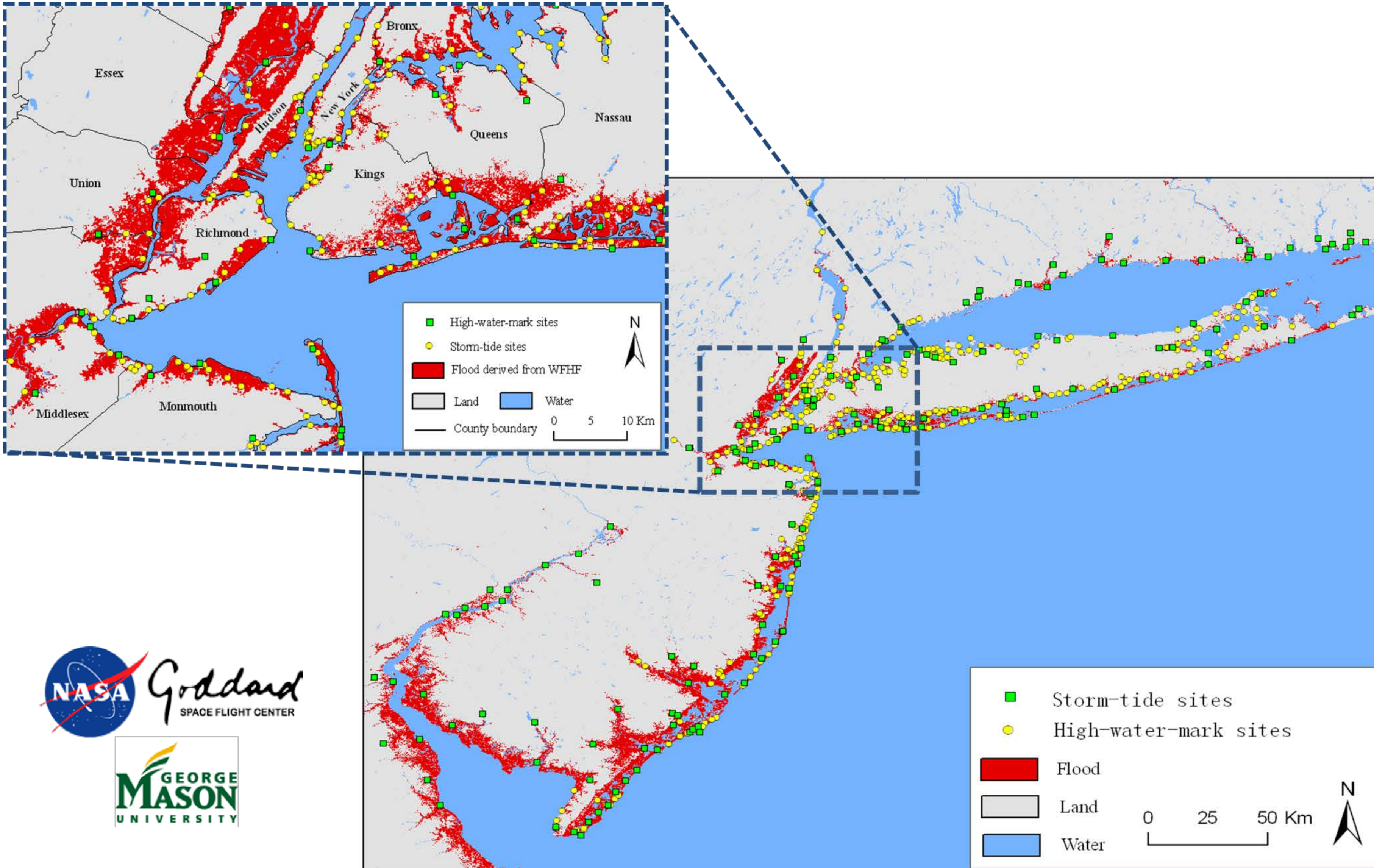


MUNICIPIO OF SAN JUAN



CITIES ARE AS VULNERABLE AS THEY ARE POWERFUL. Almost 50% of cities are already dealing with the effects of climate change, and nearly all are at risk. Over 90% of all urban areas are coastal, putting most cities on Earth at risk of flooding from rising sea levels and powerful storms.

Enhanced ATMS Flood Map of New York Metro Area After Hurricane Sandy



Refined product shows consistent inundated locations (PCT = 88%; R^2 = 0.94)

Zheng et al., 2014 (in preparation)

Towards Simultaneous Clear-Sky and Ocean Dynamics Analyses in the NOAA SST System

Irina Gladkova[1,2,3], Yury Kihai[1,2], Alexander Ignatov[1], Fazlul Shahriar[3,4], Karlis Mikelsons[1,2], Marouan Bouali[1,2], Boris Petrenko[1,2]

[1]NOAA/NESDIS/STAR,
[2]GST, Inc.,
[3]City College of New York, NOAA/CREST,
[4] Graduate Center of CUNY.

Motivation

- Customarily, clear-sky masks for ocean are independent of downstream ocean dynamics applications, such as
- detection of ocean thermal fronts, currents, cold upwelling, eddies, and monitoring of their evolution in time

- Ocean dynamics in satellite SST imagery is analyzed over clear sky pixels, only, and may be strongly affected by the quality of clear-sky scene detection

Quality of Clear-Sky Mask

Majority of current masking algorithms use thresholds. Liberal thresholds result in “cloud leakages”, whereas conservative settings lead to “false alarms”

Conservative SST mask is usually considered preferable, to minimize cloud leakages, at the expense of excluding a (presumably, relatively small) fraction of clear pixels, globally

Standard Quality Criteria:

- Minimal cloud leakages; and
- Large geographical coverage

What is the price?

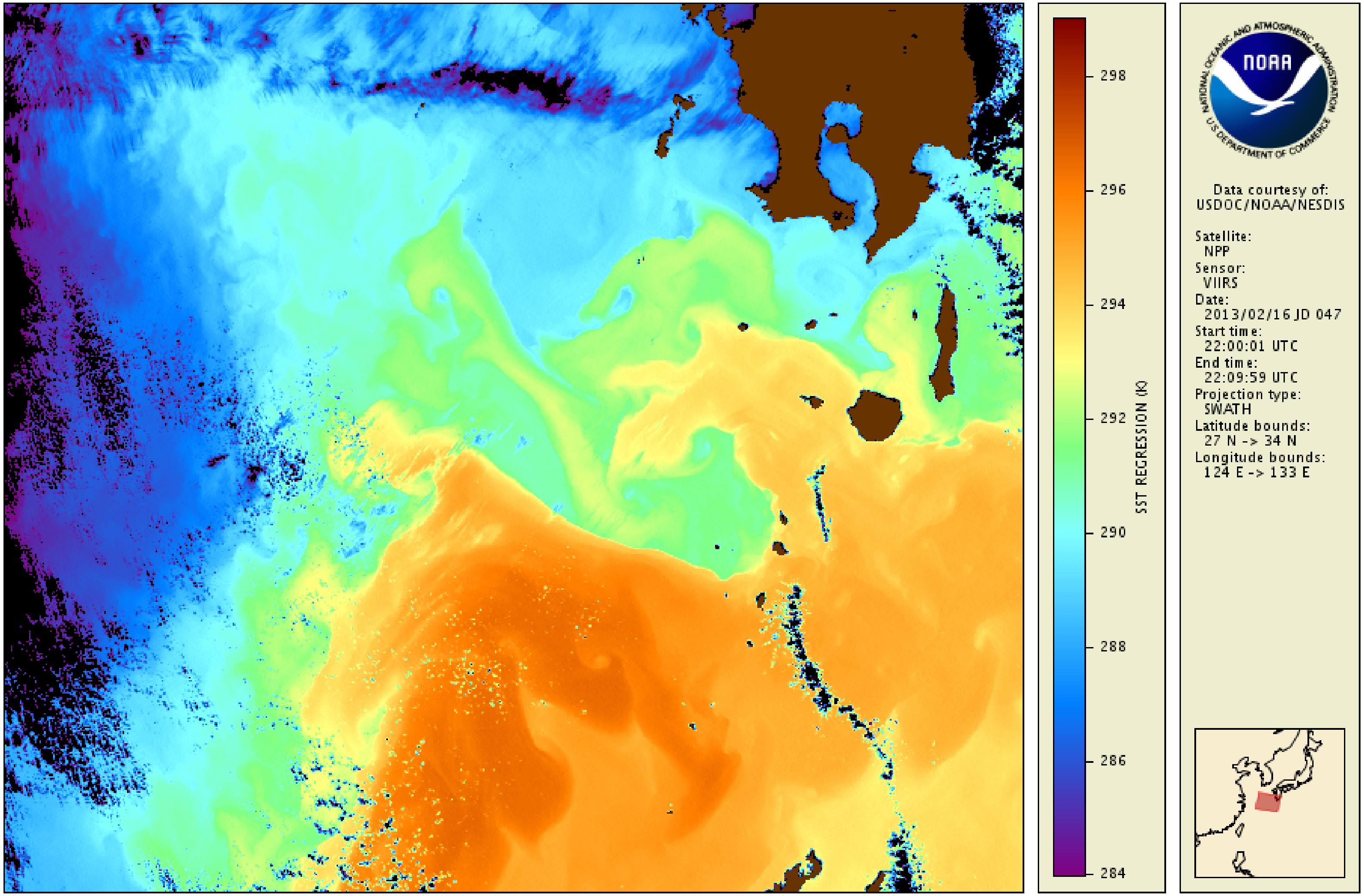
- The geographic distribution of “false alarms” is highly non-uniform
- “False alarms” are often persistent from pass to pass
- Misclassification mostly occurs in those ocean areas where SST is variable and/or significantly colder than surrounding waters and/or climatology
- It is those highly dynamic and coastal waters that are of most interest to the SST users for fishing, ship navigation, ocean dynamic modeling, climatology and marine biology studies

Objective of this Study

Open up interesting areas of the ocean by incorporating elements of ocean dynamics analysis in Clear-Sky Mask

- ❑ Initially, we want to reclassify (at least, some) “false alarms” back into clear-sky domain for SST users
- ❑ We do not address “cloud leakages”, at this stage of analysis
- ❑ This study makes use of VIIRS superior radiometric and imagery performance
- ❑ Eventually, we plan to extend the method to MODIS 1km, and AVHRR (1km FRAC, and 4km GAC) data

VIIRS SST


298
296
294
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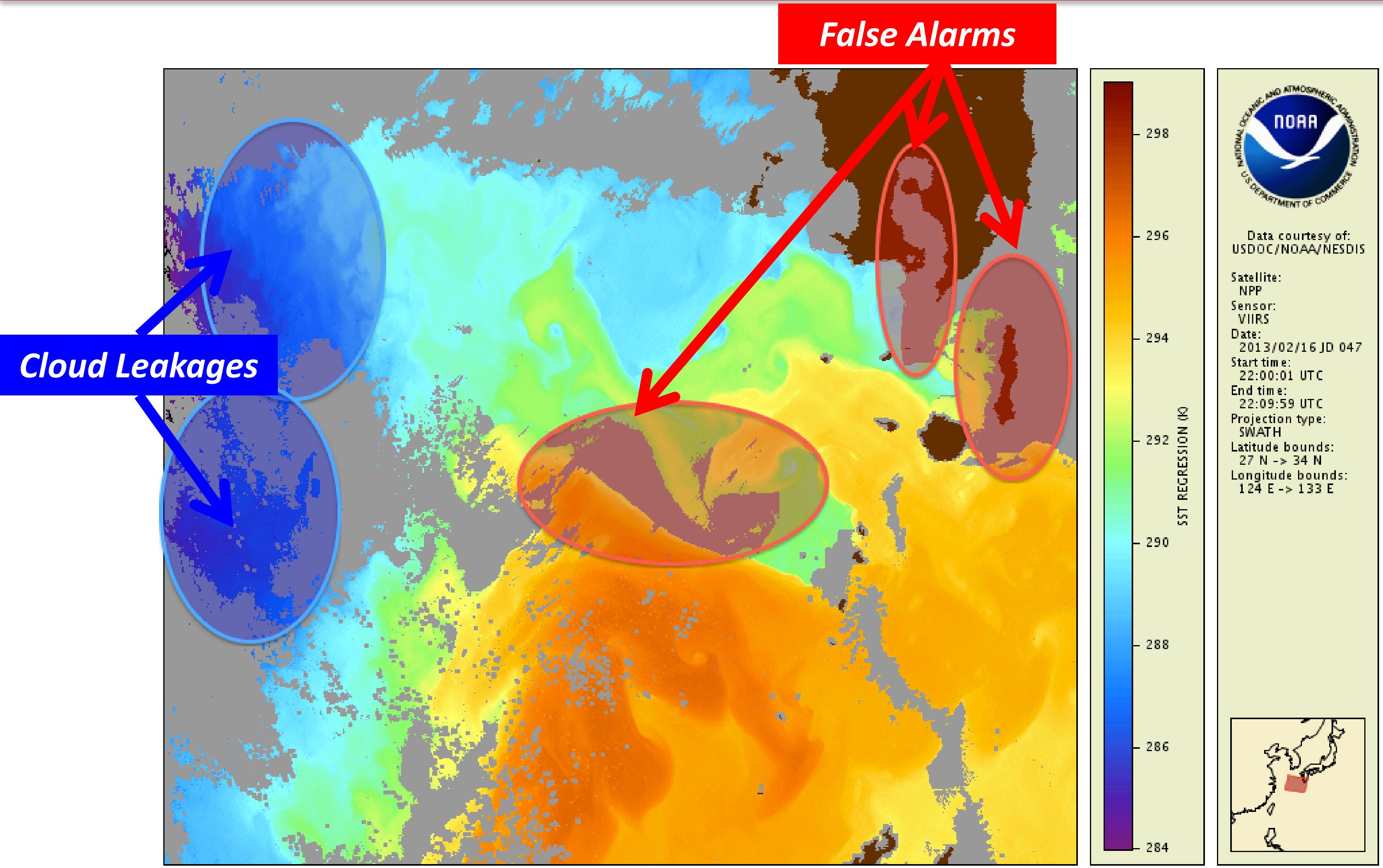
290
288
286
284
SST REGRESSION (K)
NOAA
Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2013/02/16 JD 047
Start time:
22:00:01 UTC
End time:
22:09:59 UTC
Projection type:
SWATH
Latitude bounds:
27 N -> 34 N
Longitude bounds:
124 E -> 133 E

ACSPO Clear Sky Mask



Typical False Alarms

Typical clear sky ocean regions misclassified by the ACSM

- Contiguous
- With well-defined boundaries
- Typically located in the vicinity of ocean thermal fronts

Existing image processing techniques

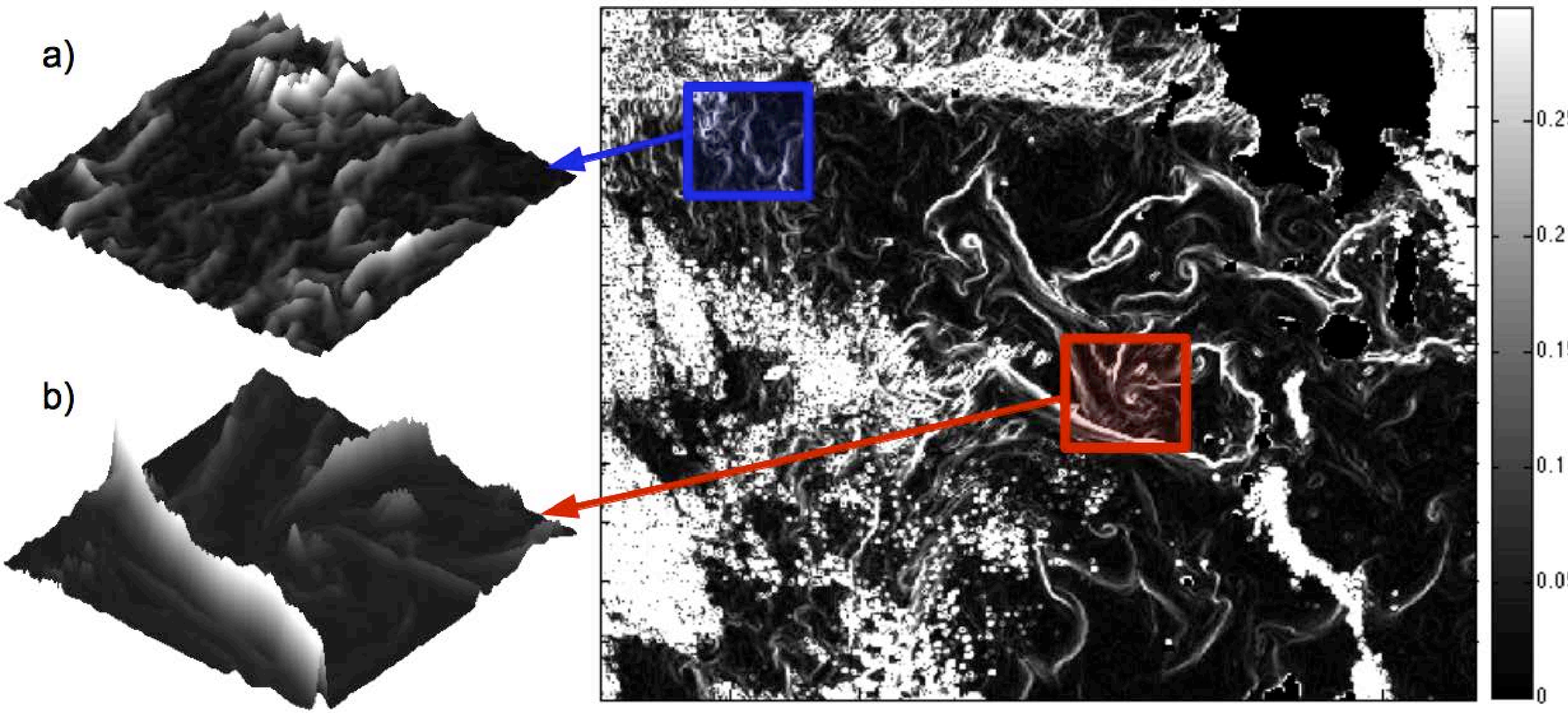
- Segmentation
- Morphological Procedures: erosion and dilation
- Thermal Front Detection

Human Perspective

- Human eye does not perceive absolute pixel values (i.e., SST values)
- Instead, it relies on local contrasts and ratios, which more directly correlate with gradients in an image
- Difference between ocean and cloud patterns is more pronounced in the SST gradient magnitude domain

Gradient Magnitude

Gradient magnitudes viewed as a terrain look like sharp ridges towering over flat valleys.



The Algorithm

Step 1: Identify Search Domain

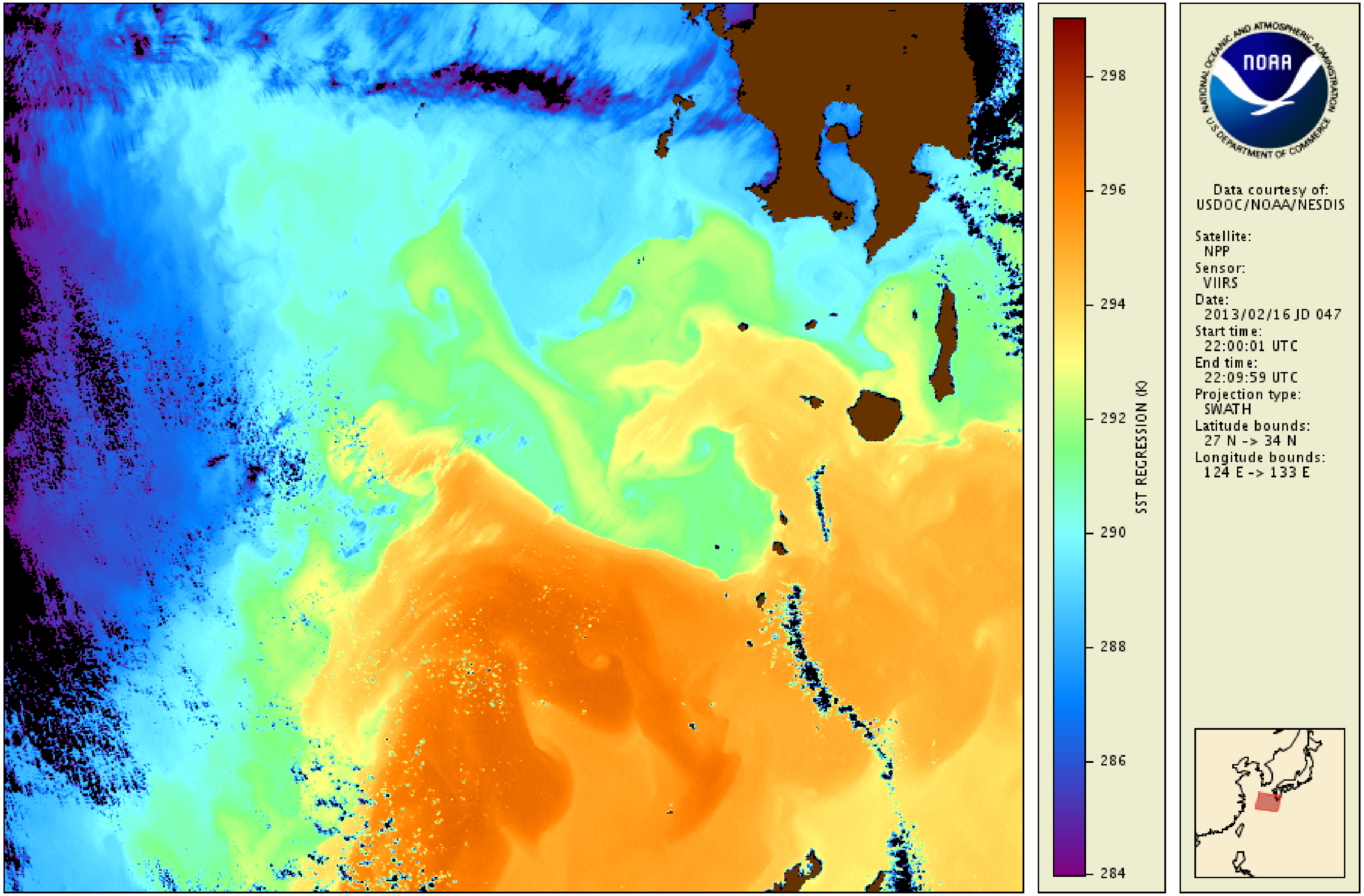
Step 2: Determine SST gradient ridges

Step 3: Determine spatially connected cold SST regions

Step 4: Discard SST segments found in Step 3 that do not border the ridges found in Step 2

Step 5: Statistical Test

VIIRS SST



298
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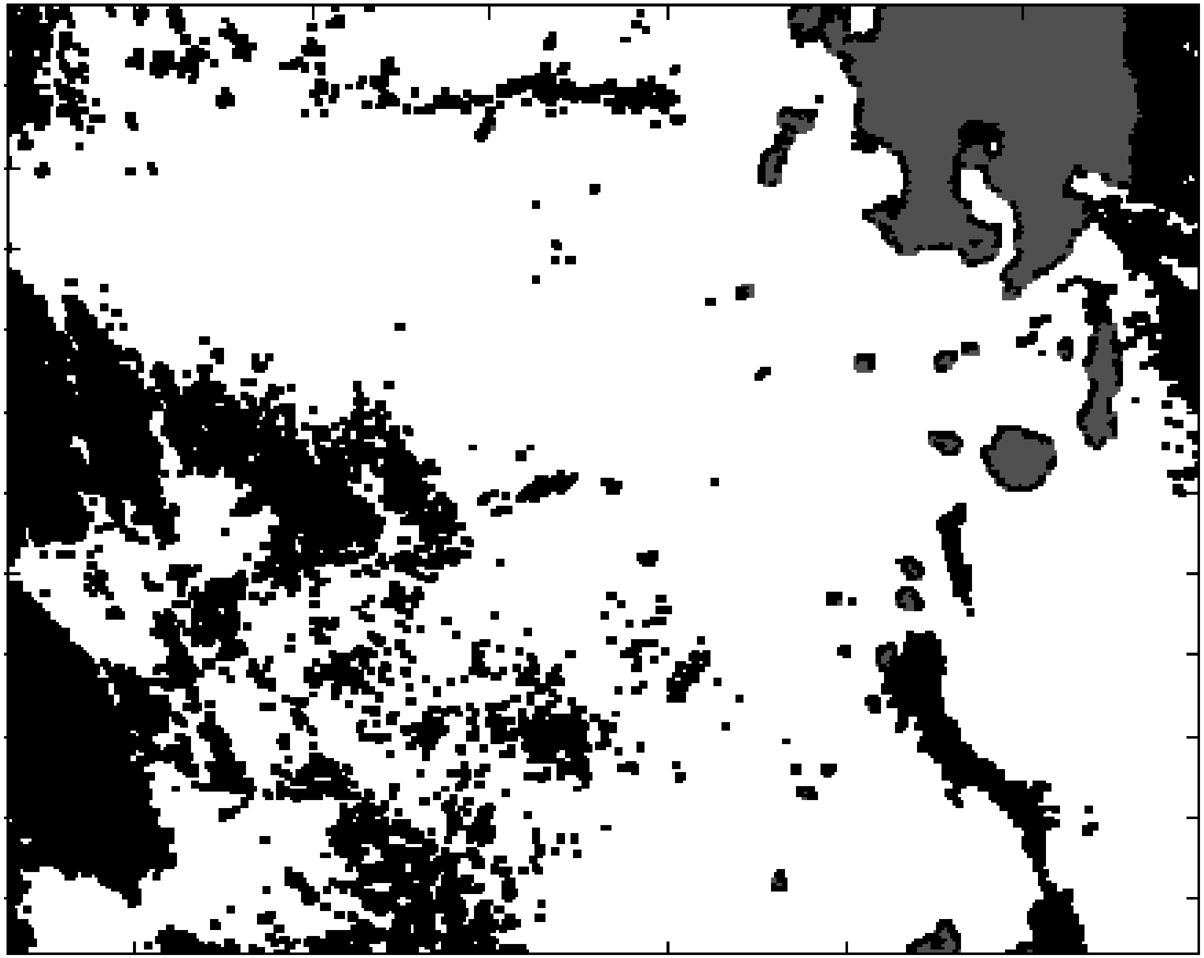
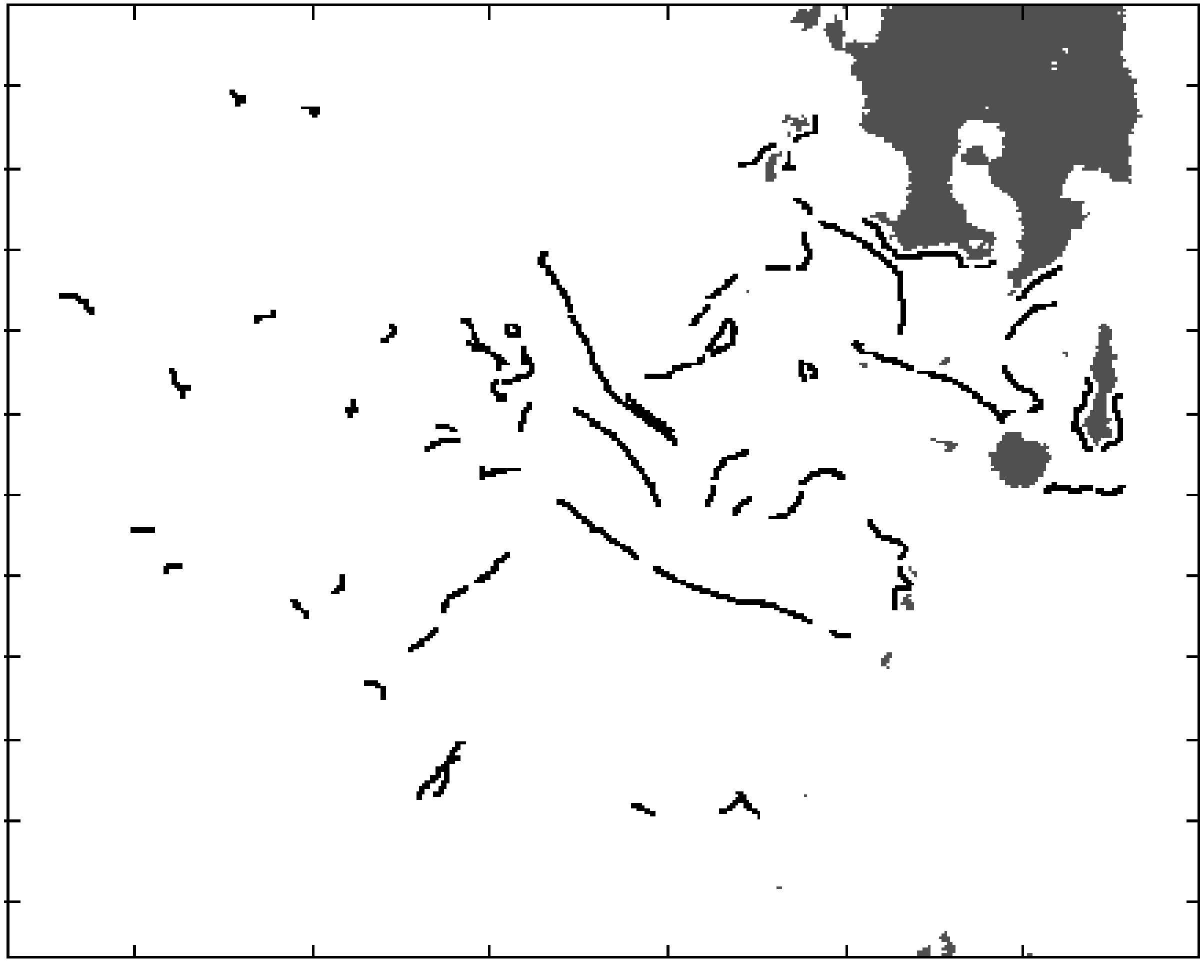
284
SST REGRESSION (K)
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
Data courtesy of:
USDOC/NOAA/NESDIS
Satellite:
NPP
Sensor:
VIIRS
Date:
2013/02/16 JD 047
Start time:
22:00:01 UTC
End time:
22:09:59 UTC
Projection type:
SWATH
Latitude bounds:
27 N -> 34 N
Longitude bounds:
124 E -> 133 E

Step1: Search Space



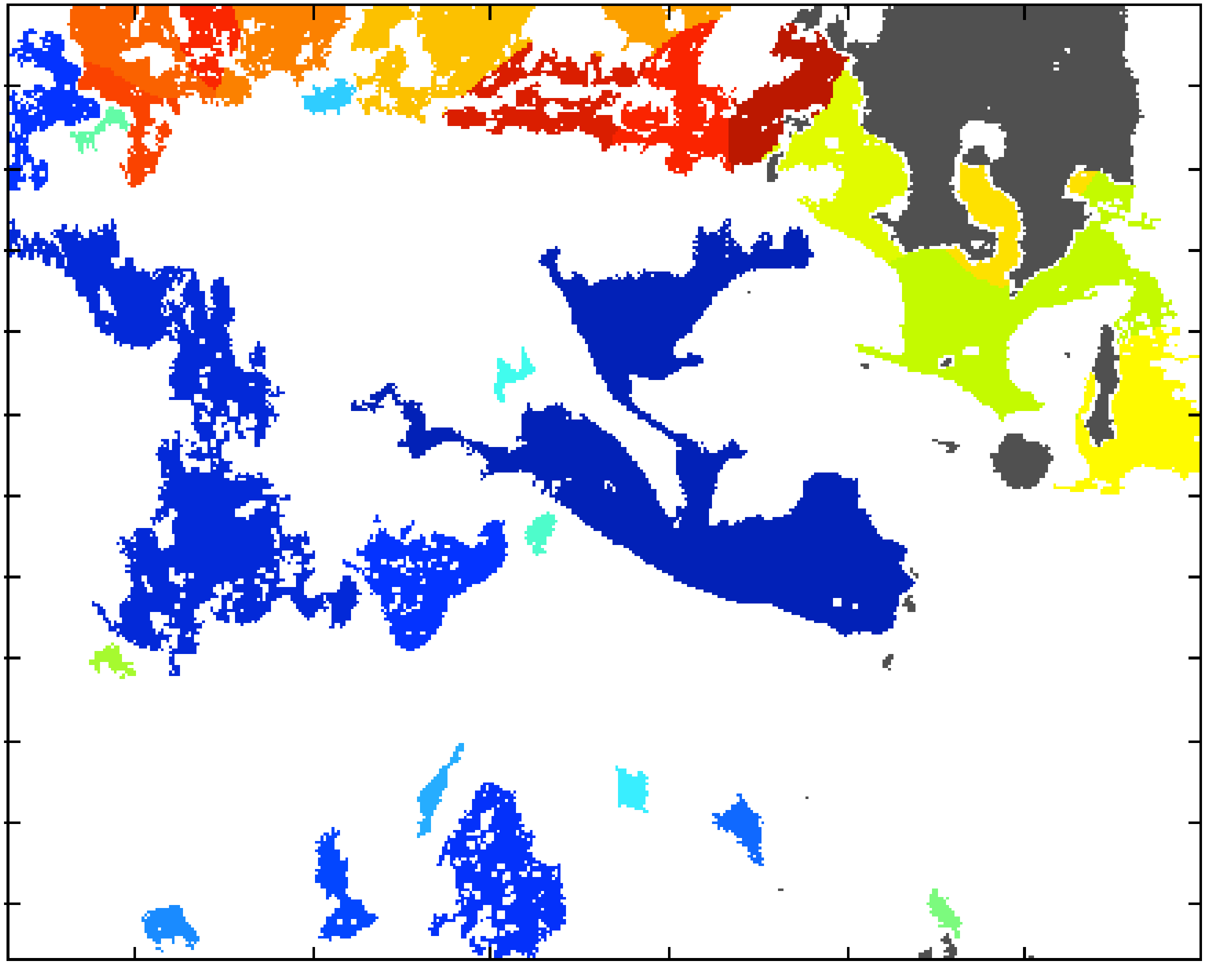
Narrow down search space, in the interest of processing time

Step 2: Gradient Ridges



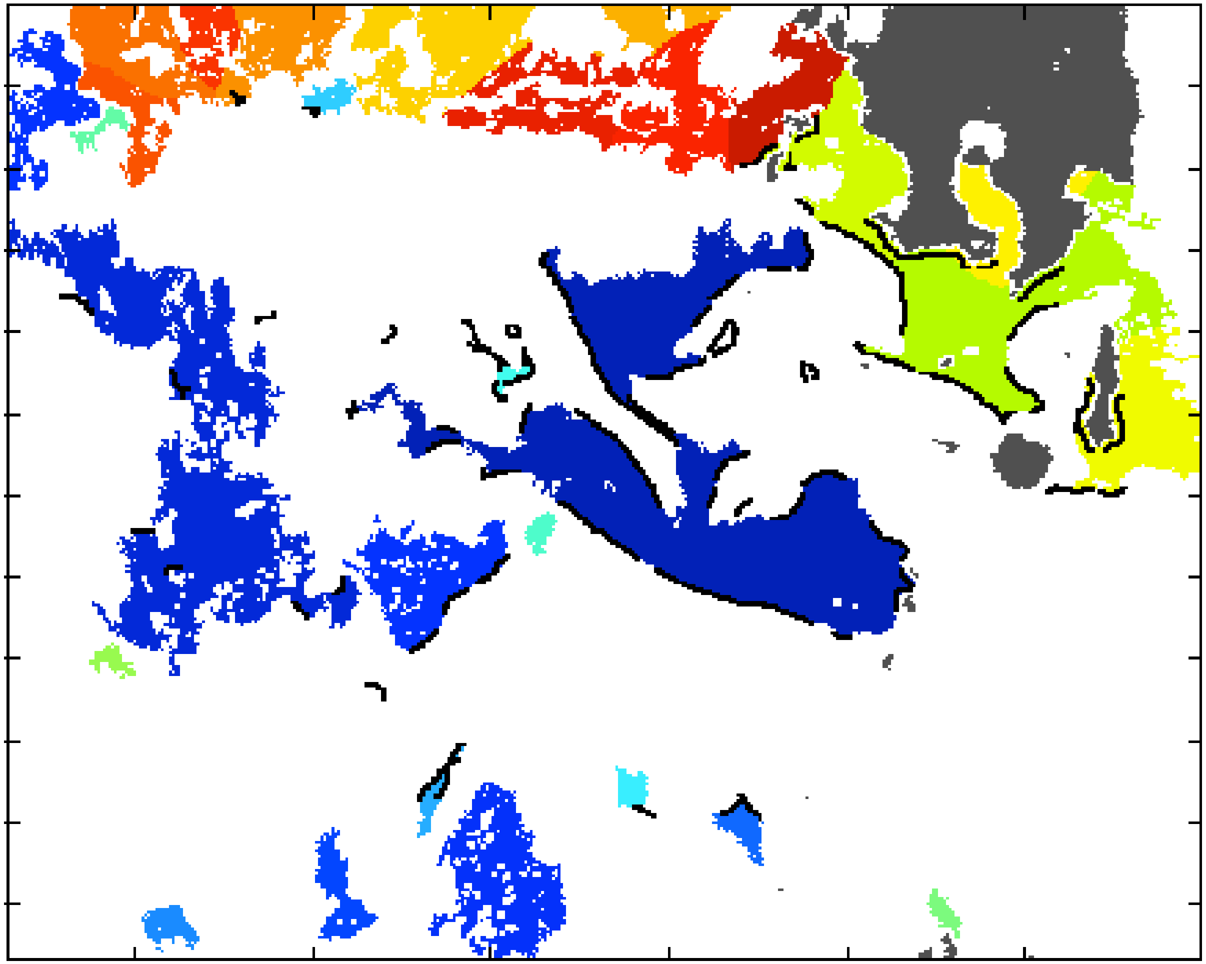
Determine contiguous portions of thermal fronts

Step 3: Segmentation



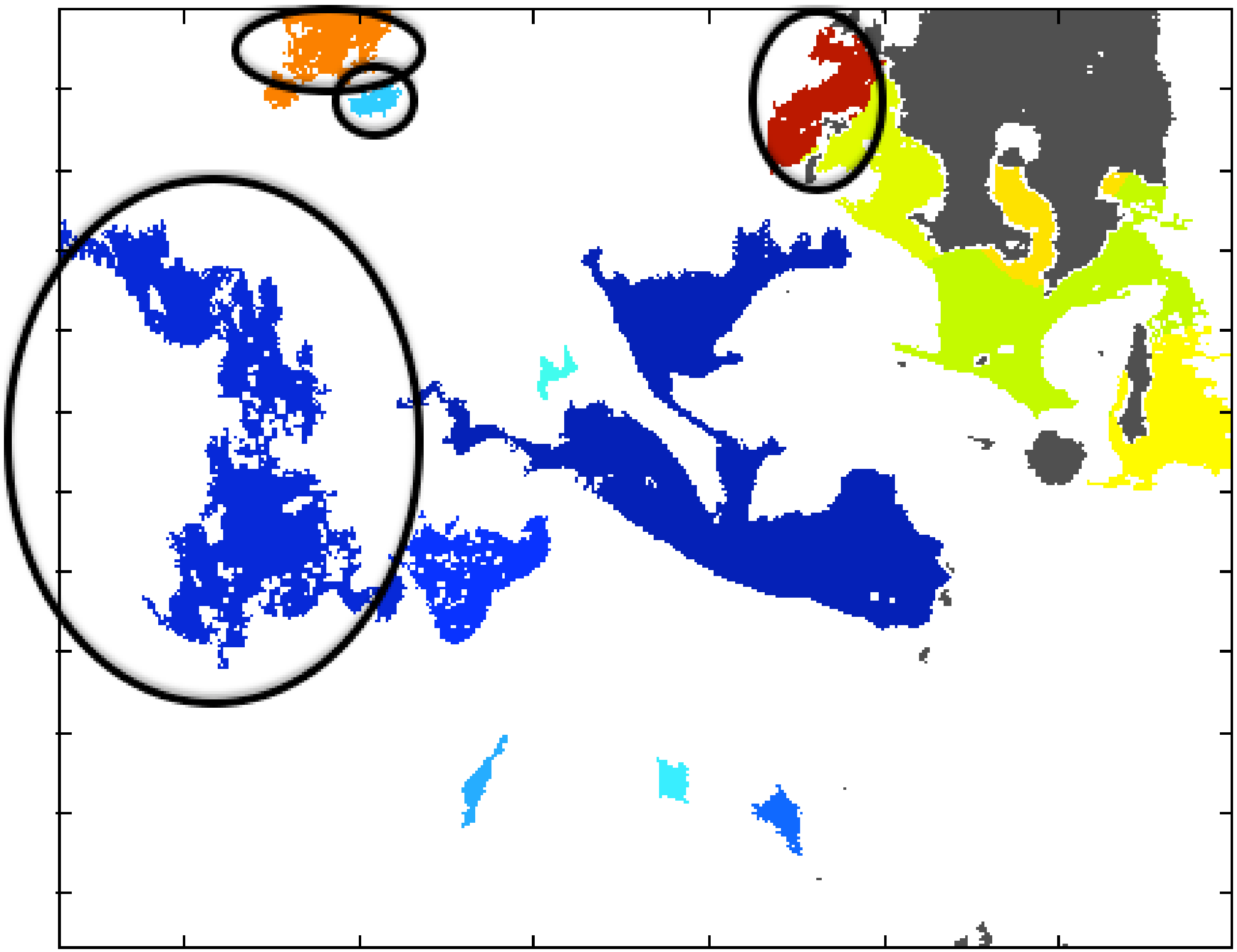
Find spatially connected regions with negative ΔSST

Step 4: Adjacency



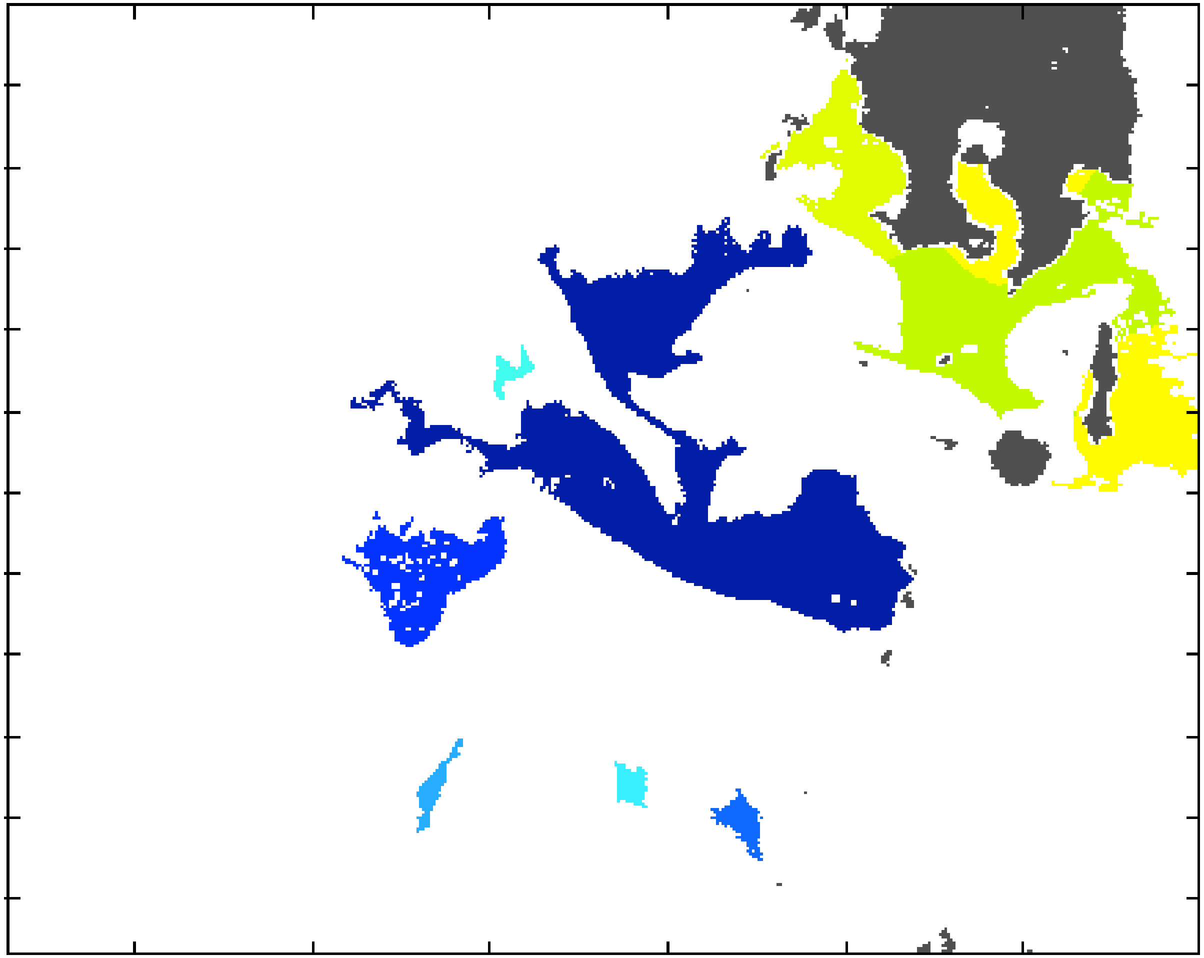
Keep Segments that have adjecent Ridges

Statistical Test



Keep segments which more statistically similar to ocean then cloud

Clear Sky Regions



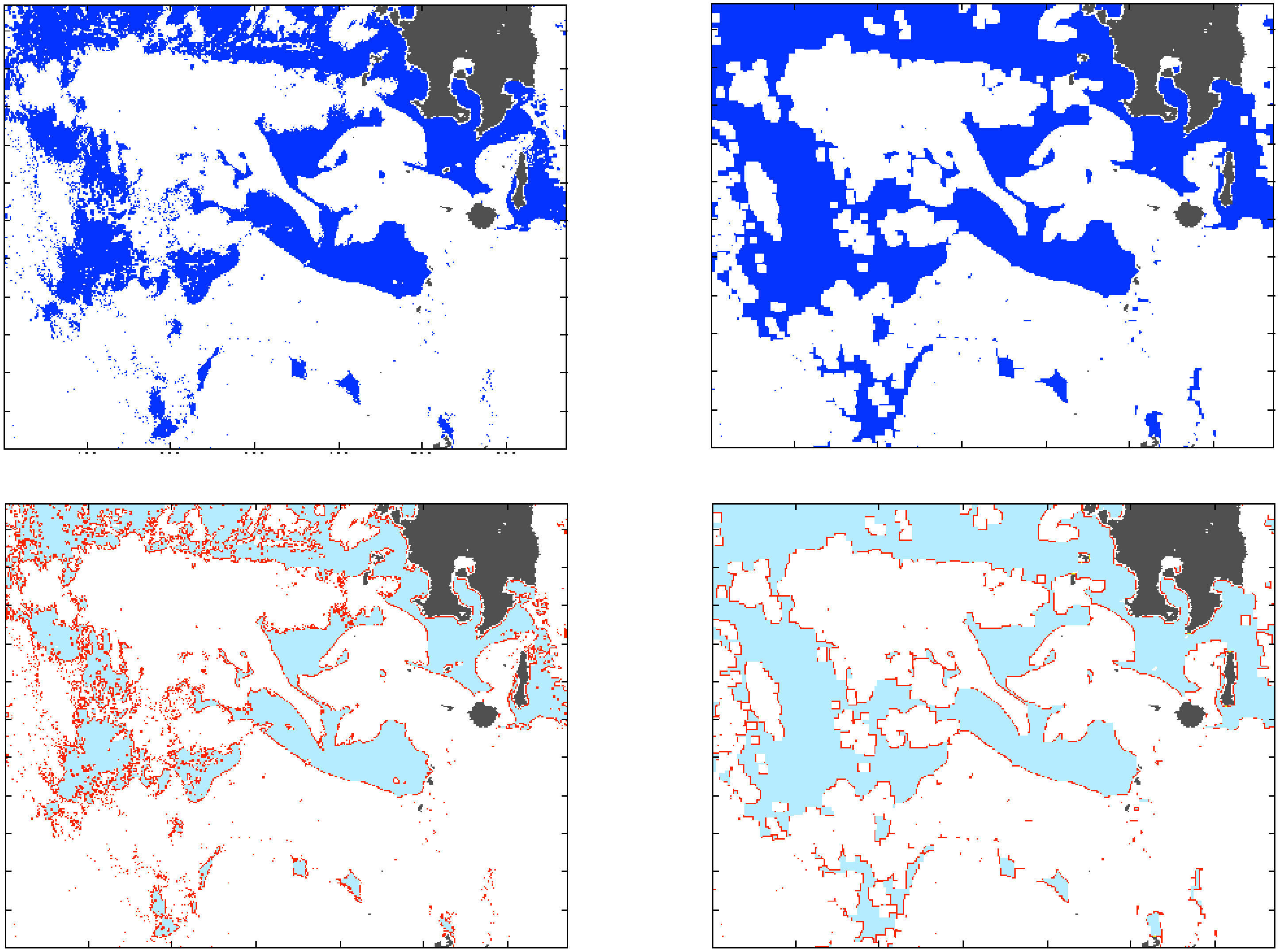
Restore identified "false alarms" back to SST domain

Detection of Gradient Ridges

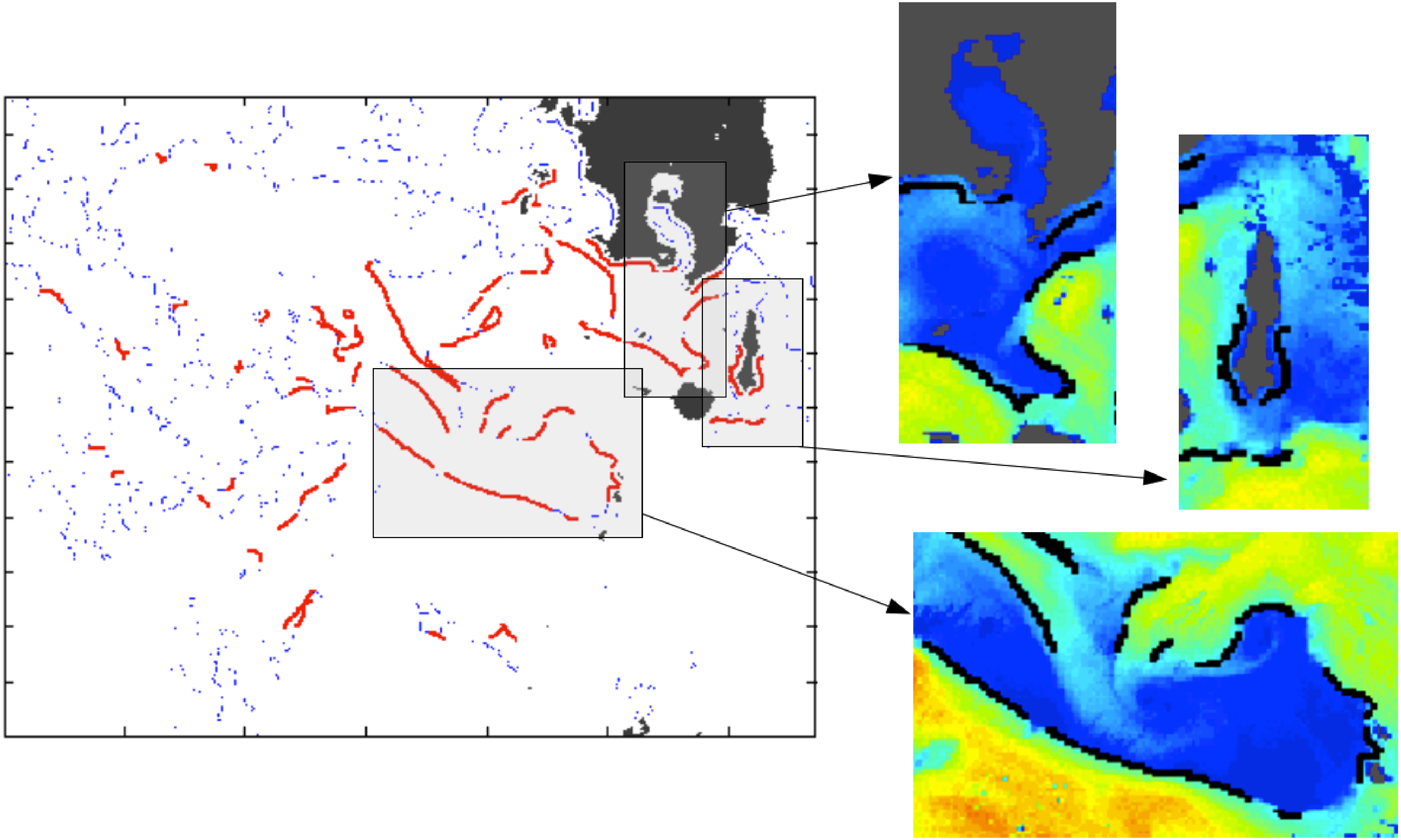
Existing Image Processing Tools:

- Thermal Front Detection
- Edge Detection
- Gradient Ridges and Valleys

Border Stability

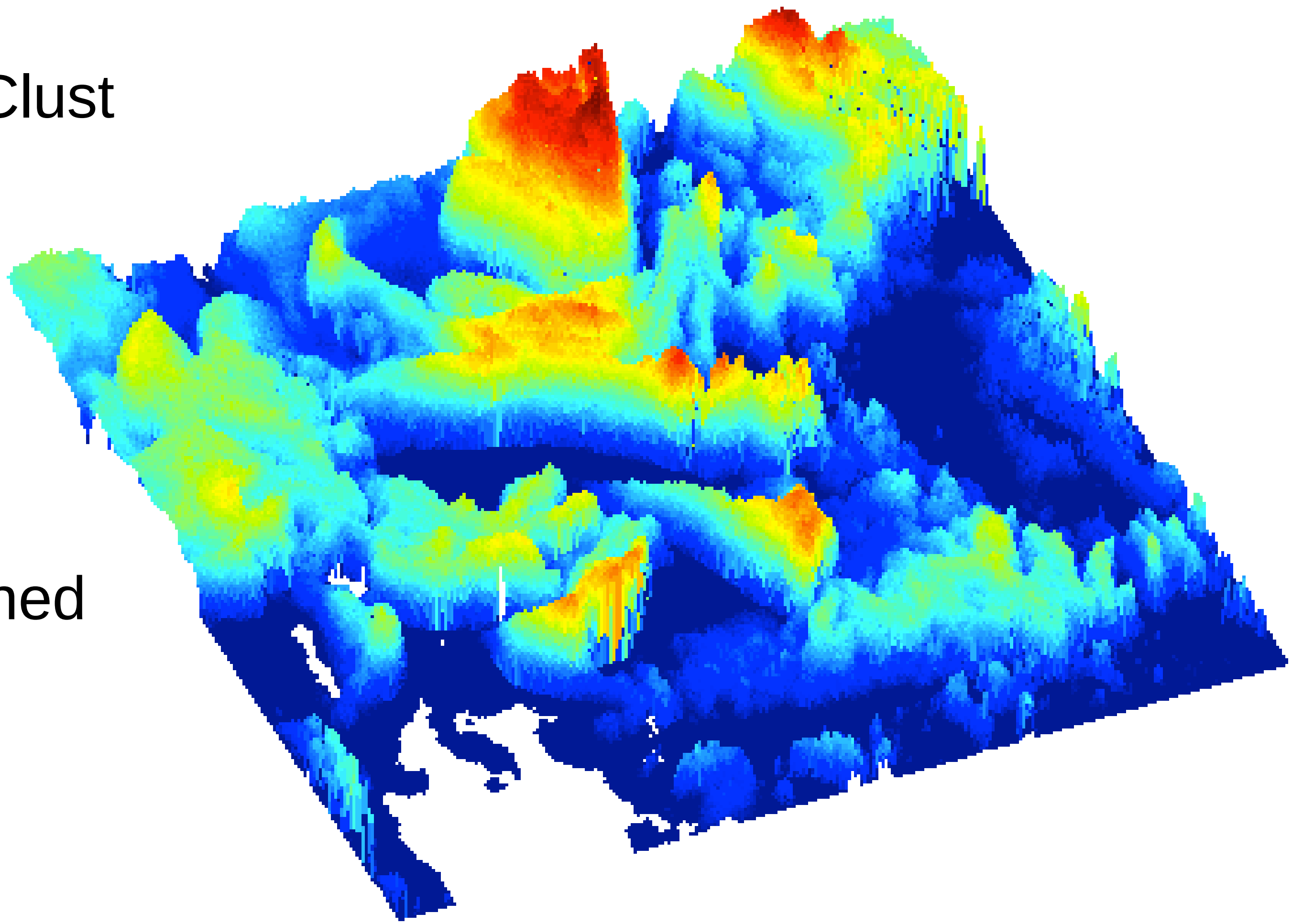


SST Gradient Ridges



Watershed Segmentation

- Segmentation/Clustering is a well studied field
- Many ways to perform segmentation
- We use watershed type applied to ΔSST



Steps of Segmentation

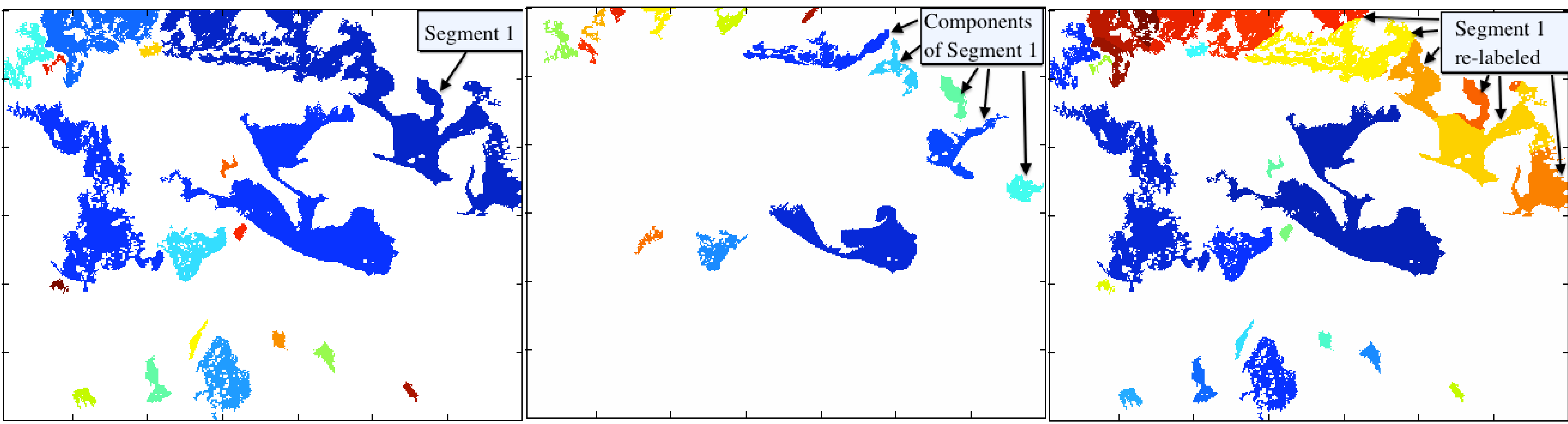
Segments obtained via iterative procedure:

Iter 0: Initial segments

Iter k: Lower the threshold level

Find new “catchment basins”

Re-label in case of split



Data Artifacts

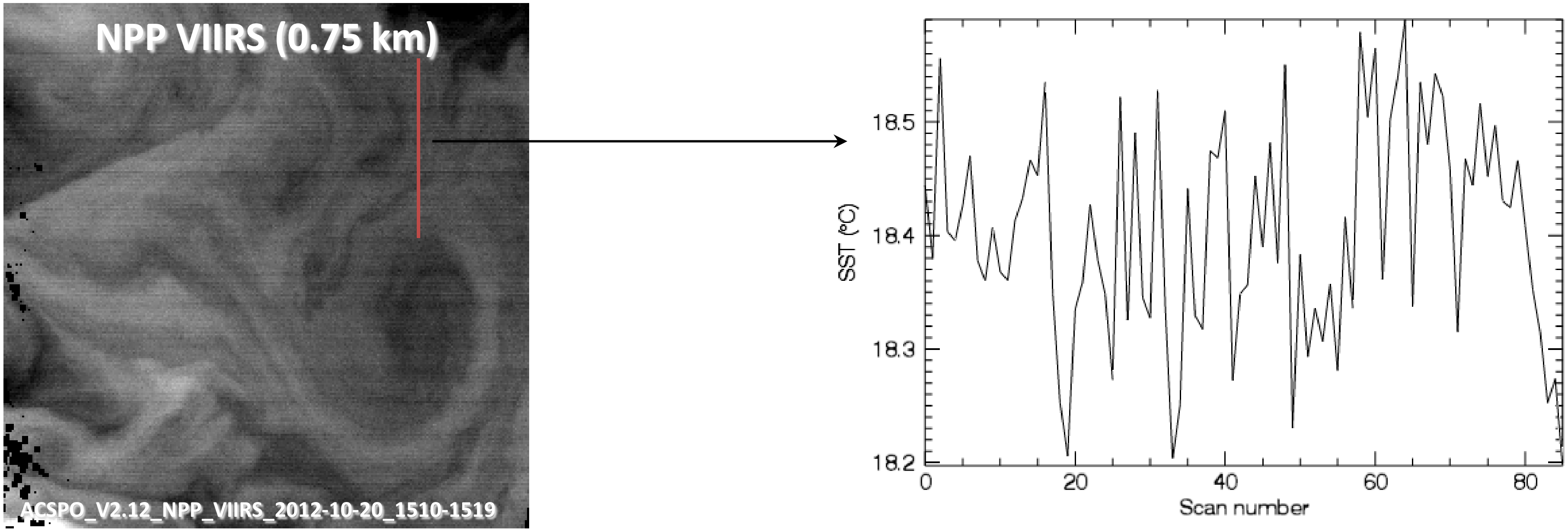
Pattern Recognition techniques assumes that the data is "clean" and free of artifacts. However, VIIRS is subject to:

- Striping
- Pixel deletion zone
- Bow-tie distortions

Destriping

- VIIRS brightness temperatures are subject to striping due to independent characterization of it’s 16 detectors and double-side mirror
- This leads to spatial discontinuities and severe artifacts in the SST gradient field rendering pattern recognition analysis unusable
- As a pre-processing step, VIIRS BT’s are destriped using STAR destriping code
- The code is currently finalized for operational implementation

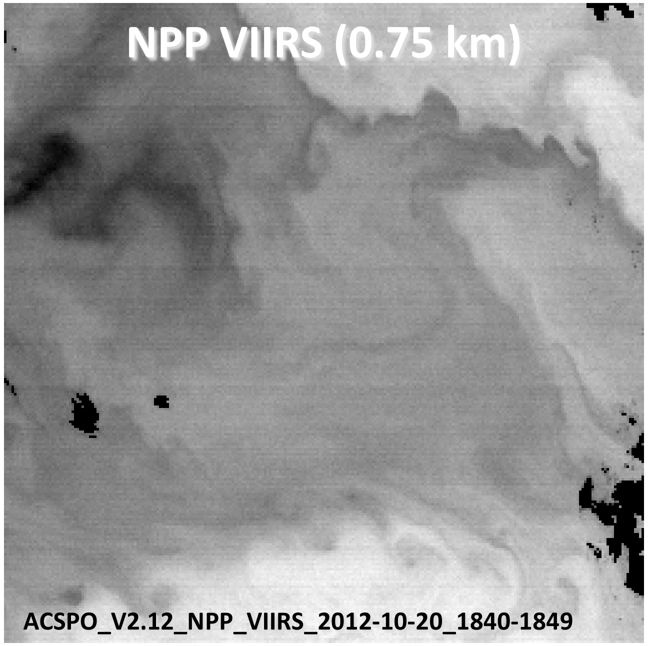
Accuracy of SST retrieval



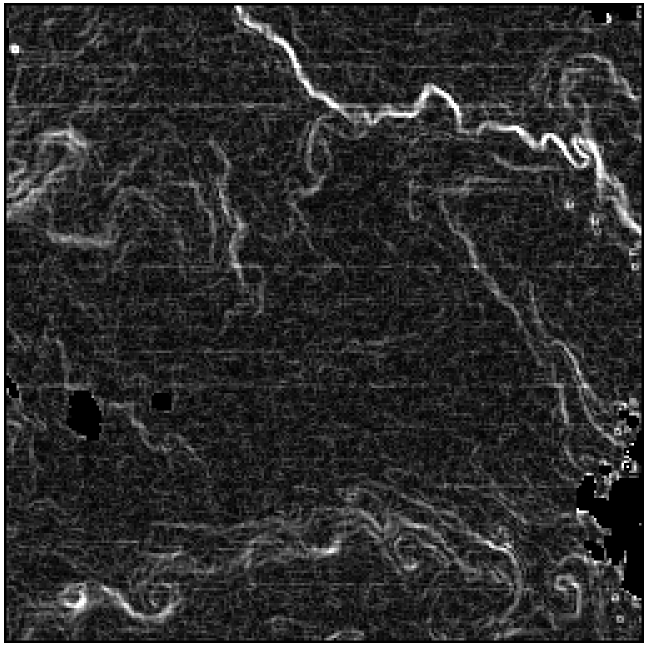
Stripe noise in level 1B or SDRs BTs

can lead to SST errors of up to ± 0.3K

SST Fronts

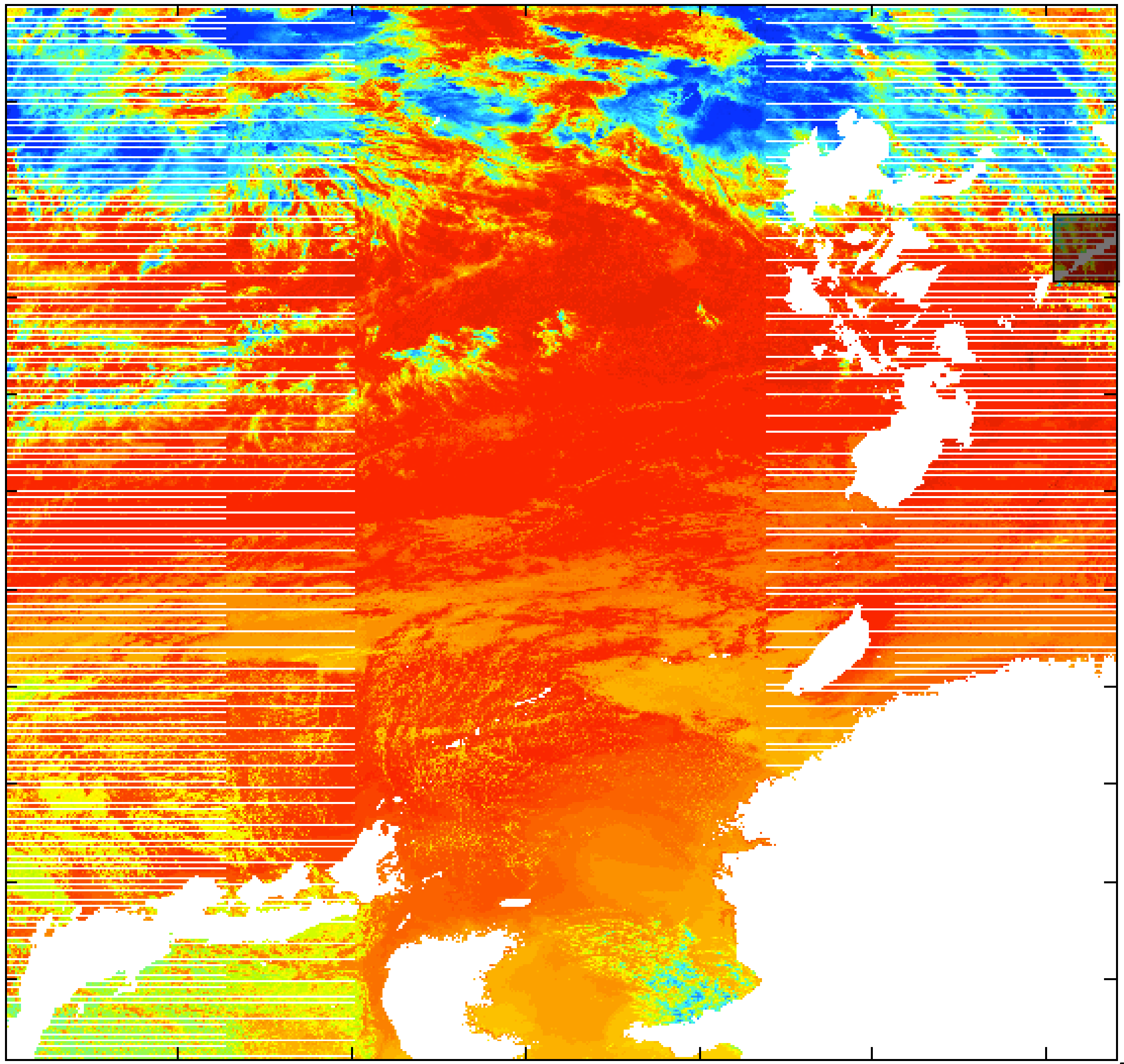


Sobel filter



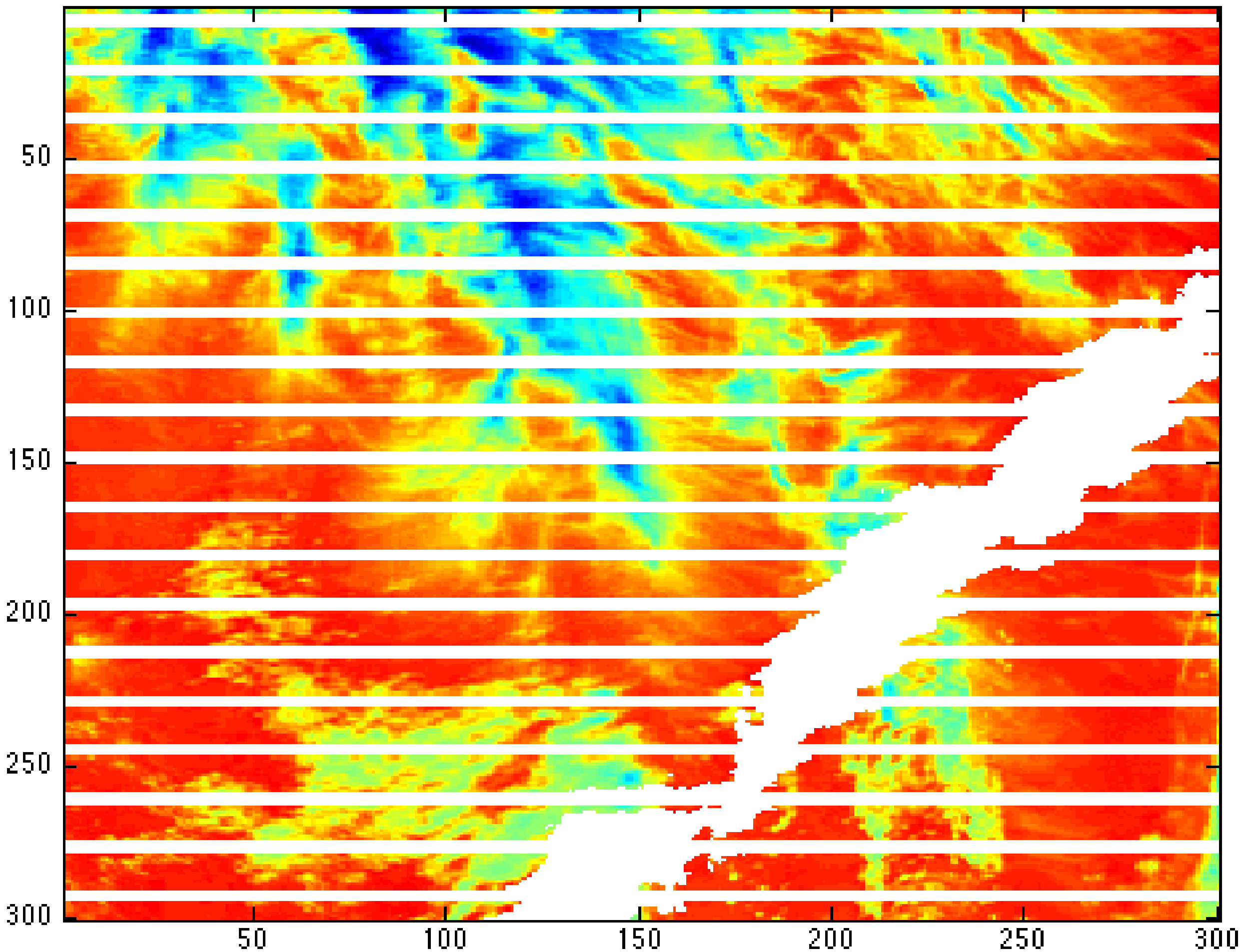
Striping introduces artificial structures and affects the analysis of thermal fronts (orientation, intensity and location)

Bow-tie area

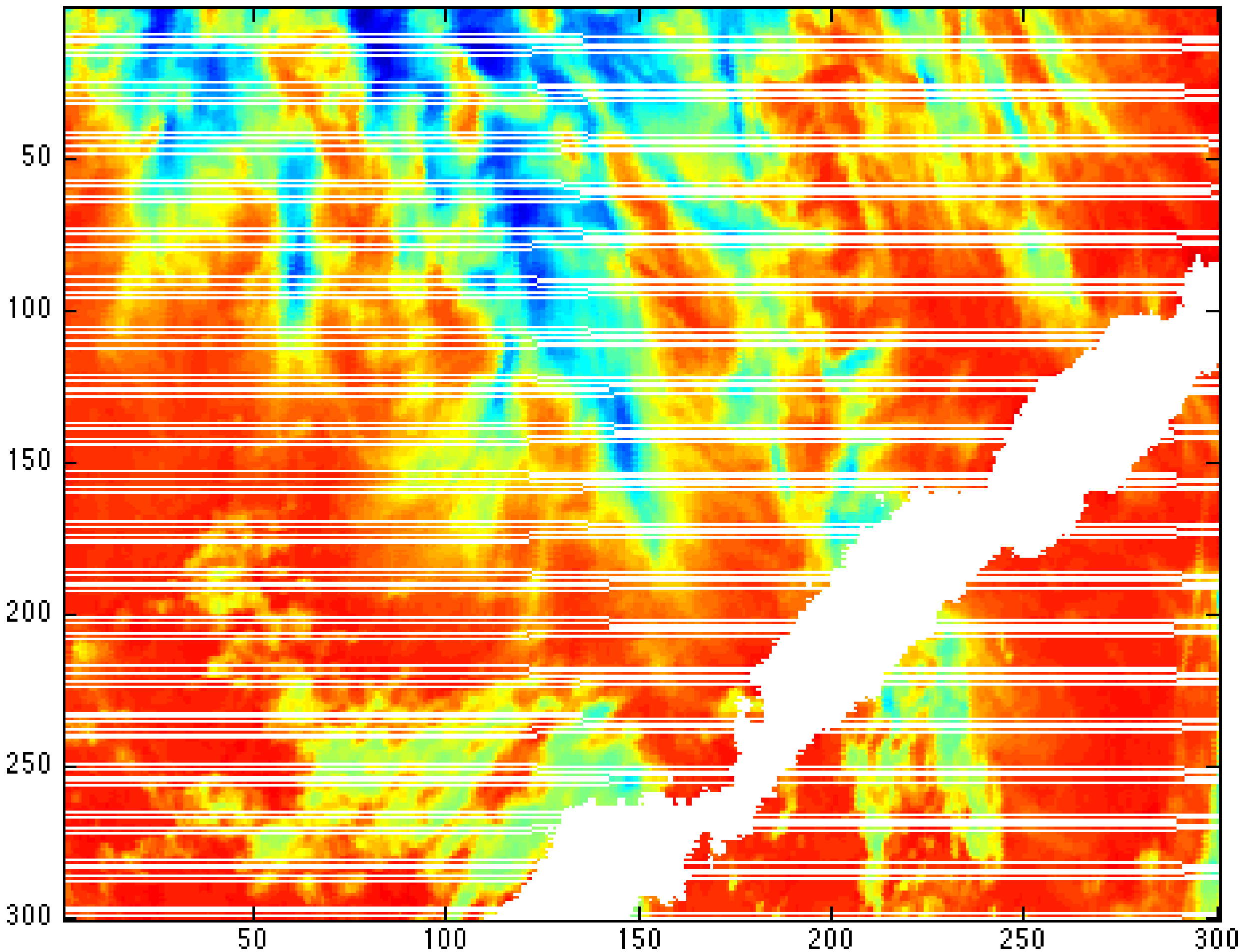


ACSPO_V2.20_NPP_VIIRS_2013-02-16_0430-0440_20130219.232756.nc

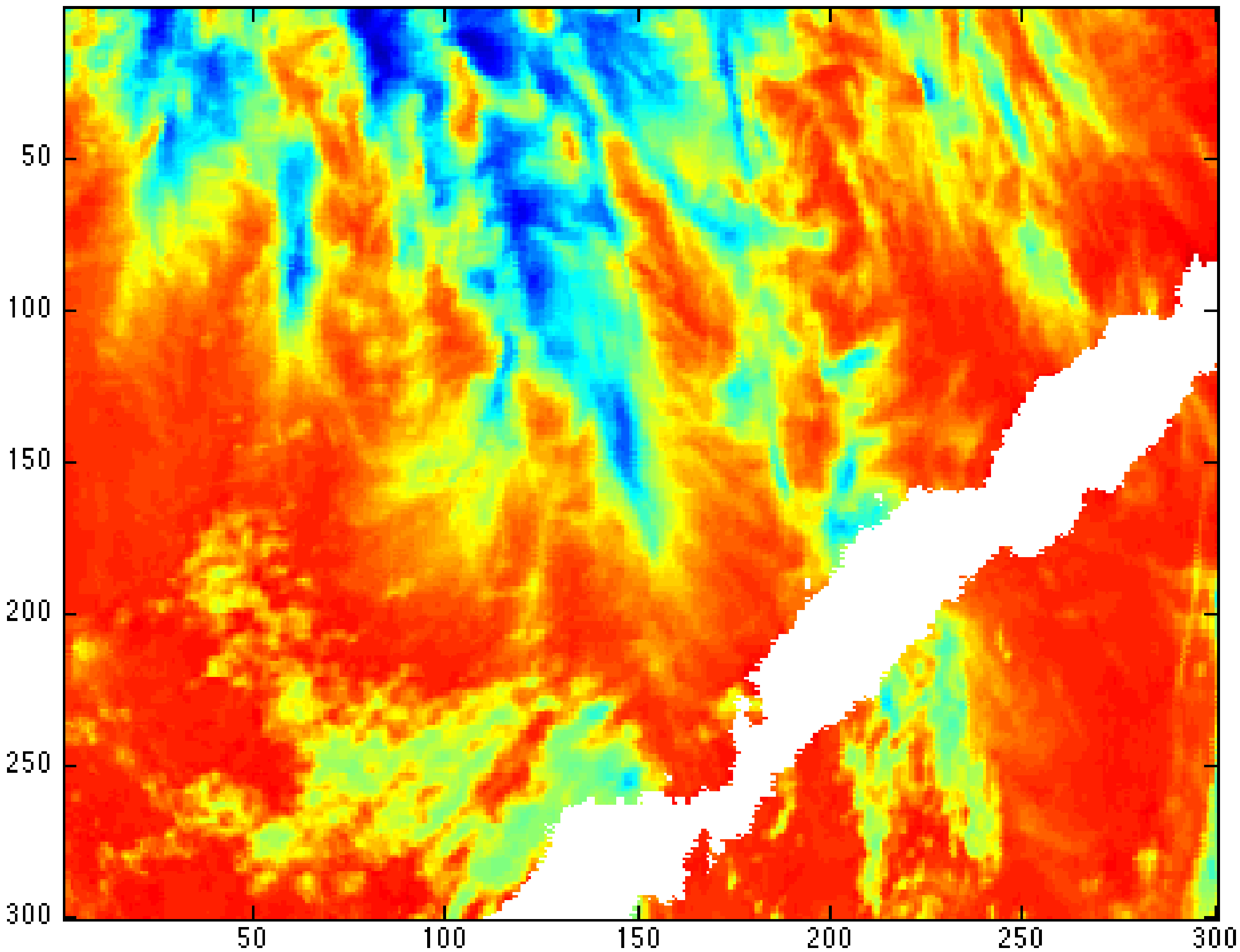
Original SST values



With Monotonic Latitudes



Resampled



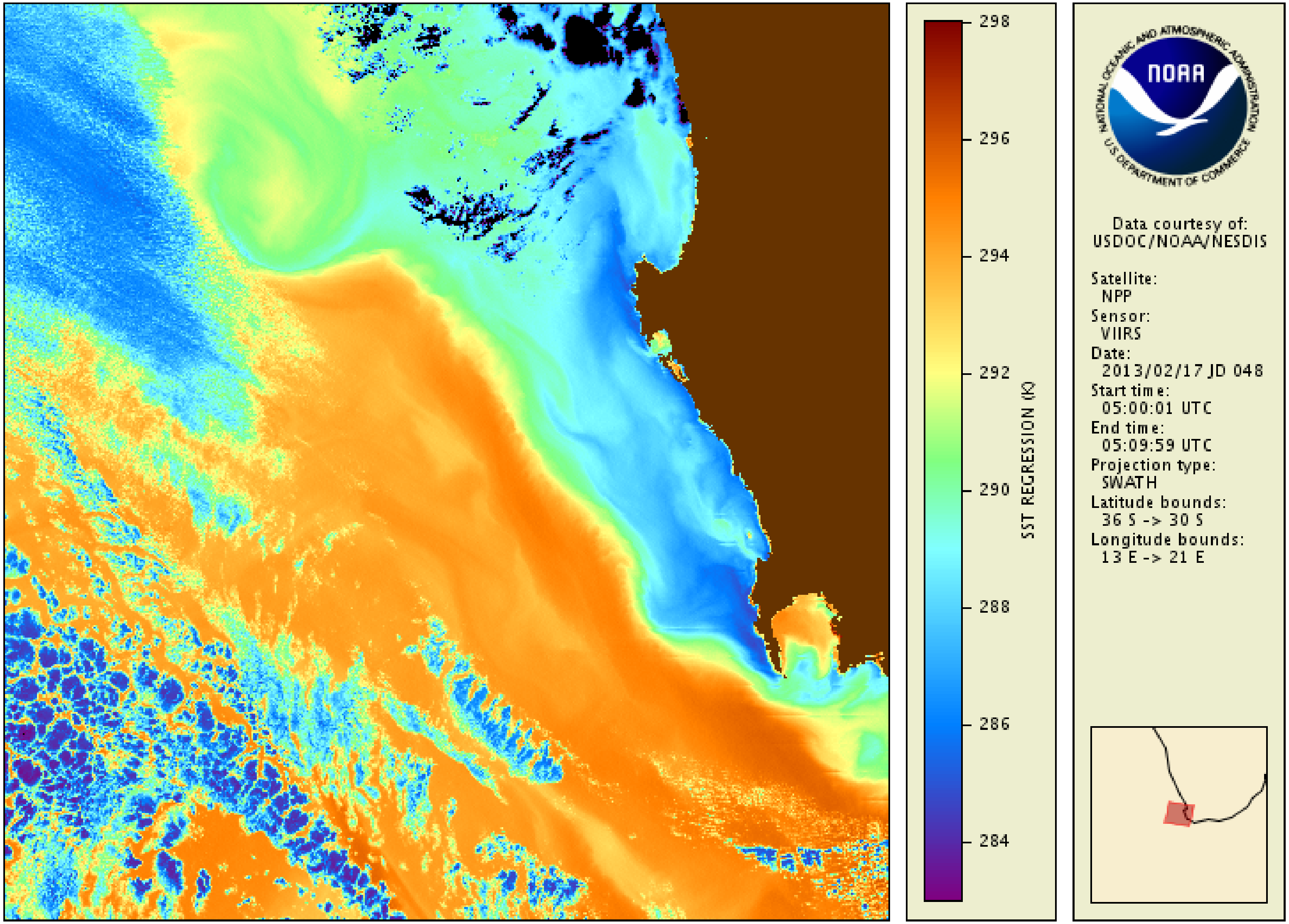
Potentials and Limitations

Considered 2 sets of VIIRS data:

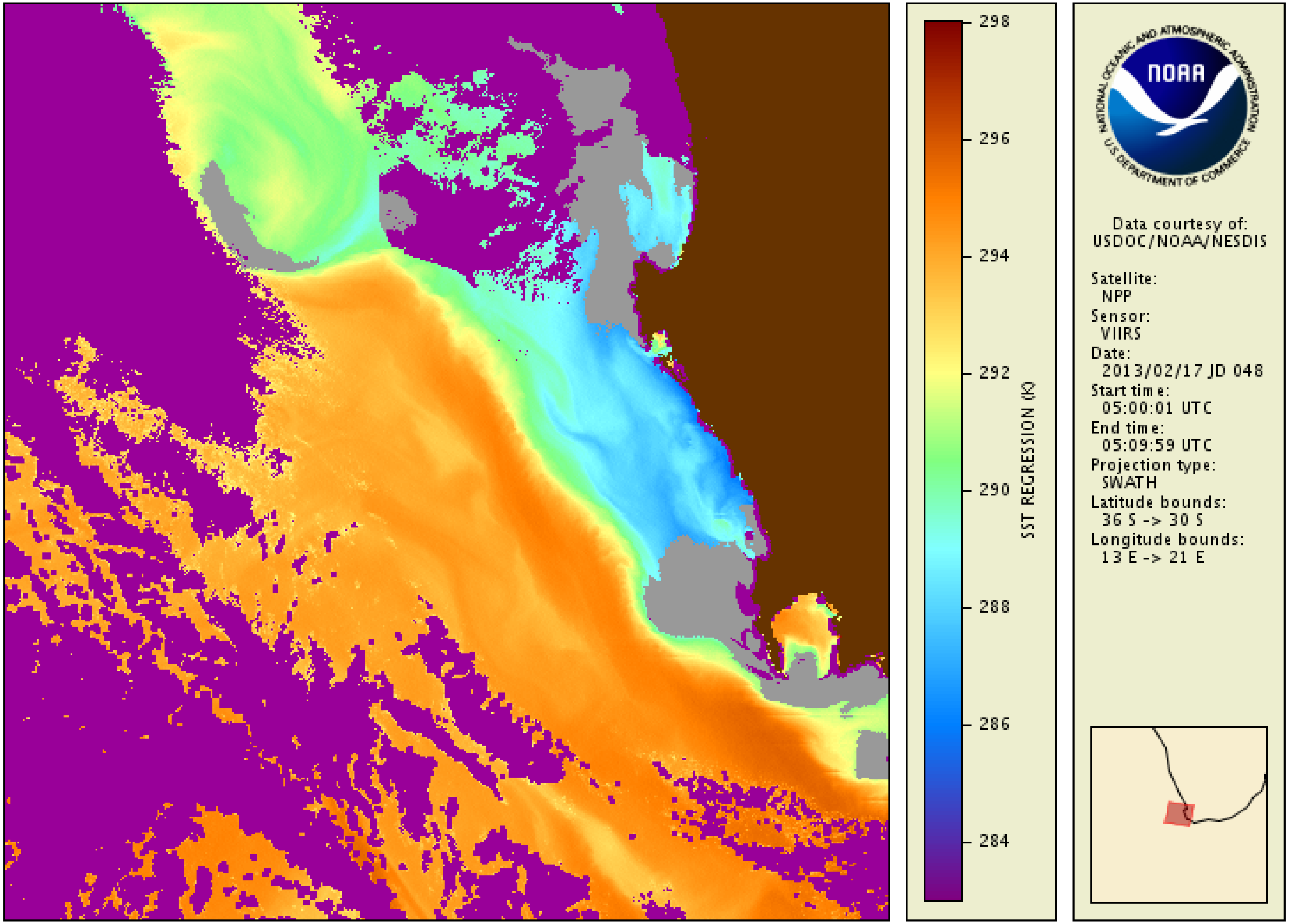
- 48 hand picked and cropped regions with typical clear sky misclassification
- 144 granules representing 1 day global observations

Results were visually inspected and analyzed;
Success rate is promising but more work is needed.

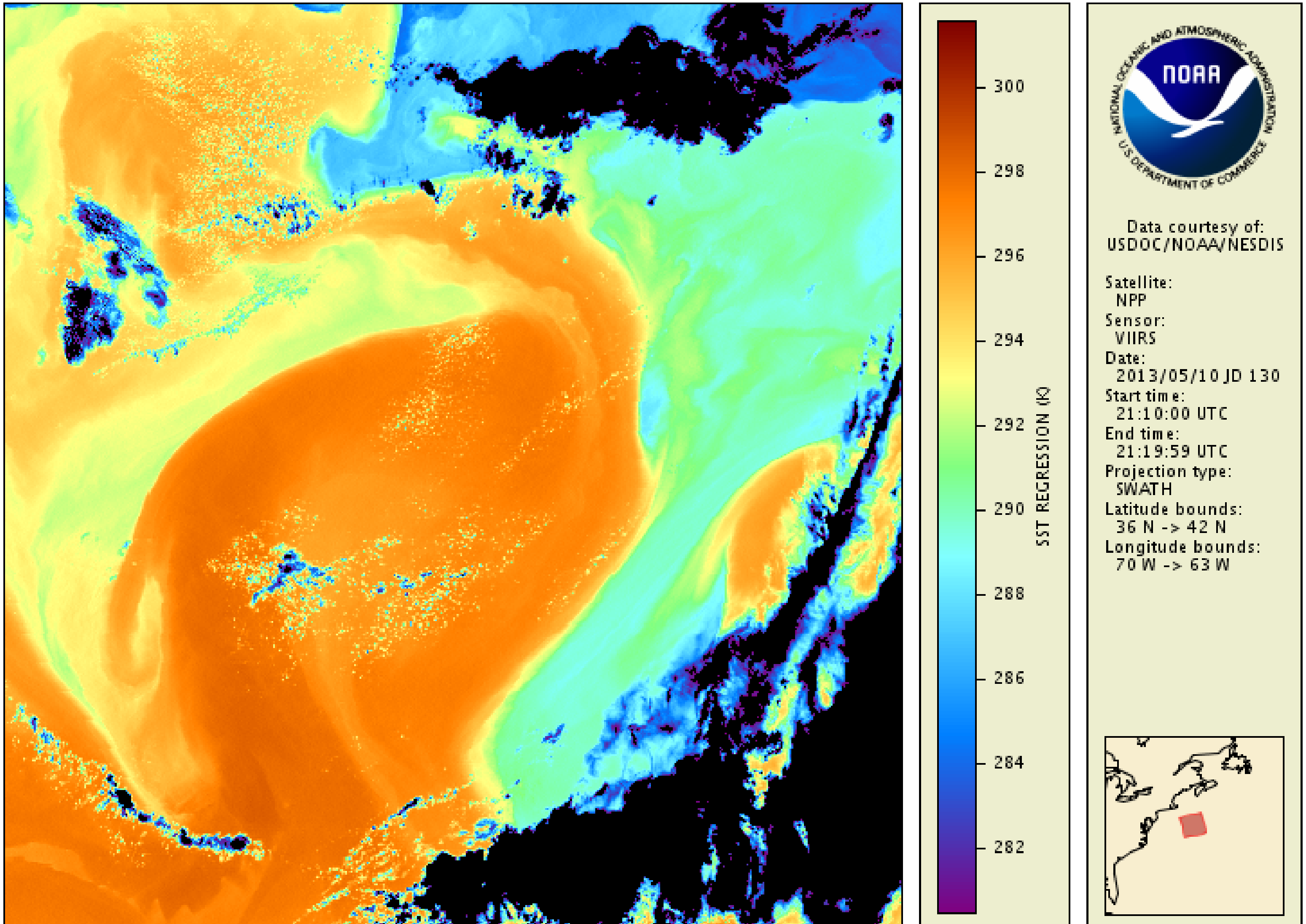
South Africa, 02/17/13 (night)



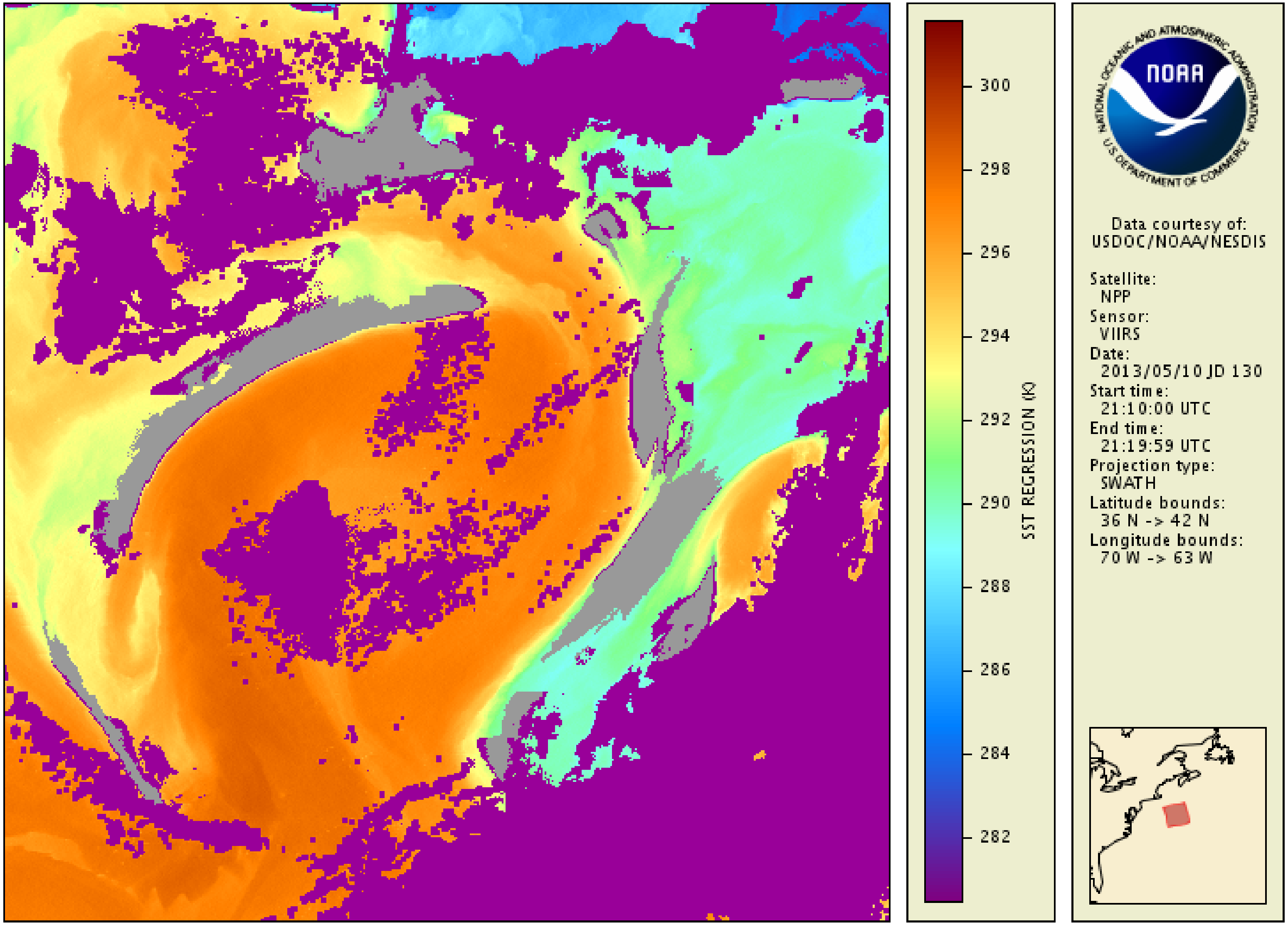
South Africa, 02/17/13 (night)



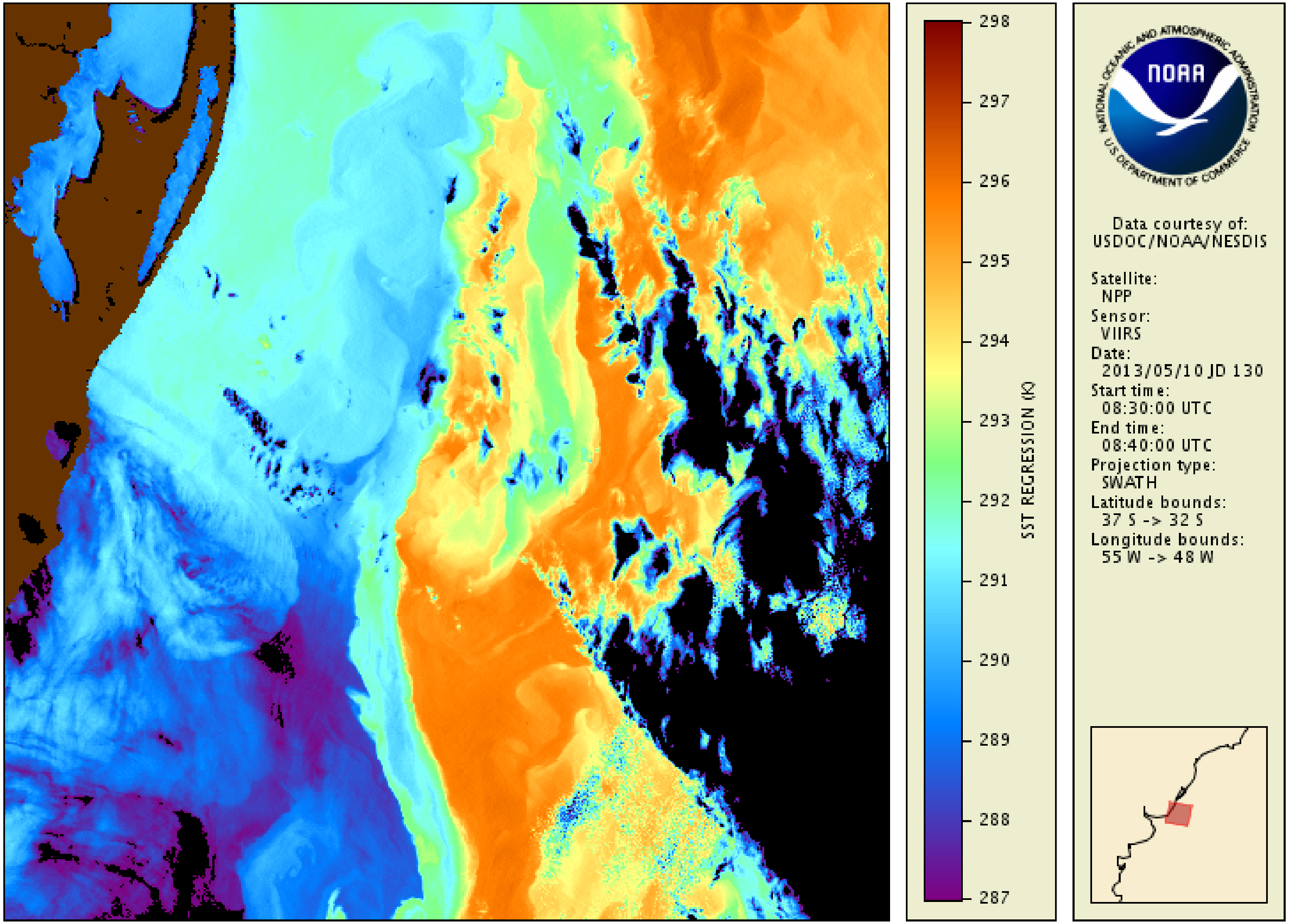
Gulf Stream, 05/10/13 (day)



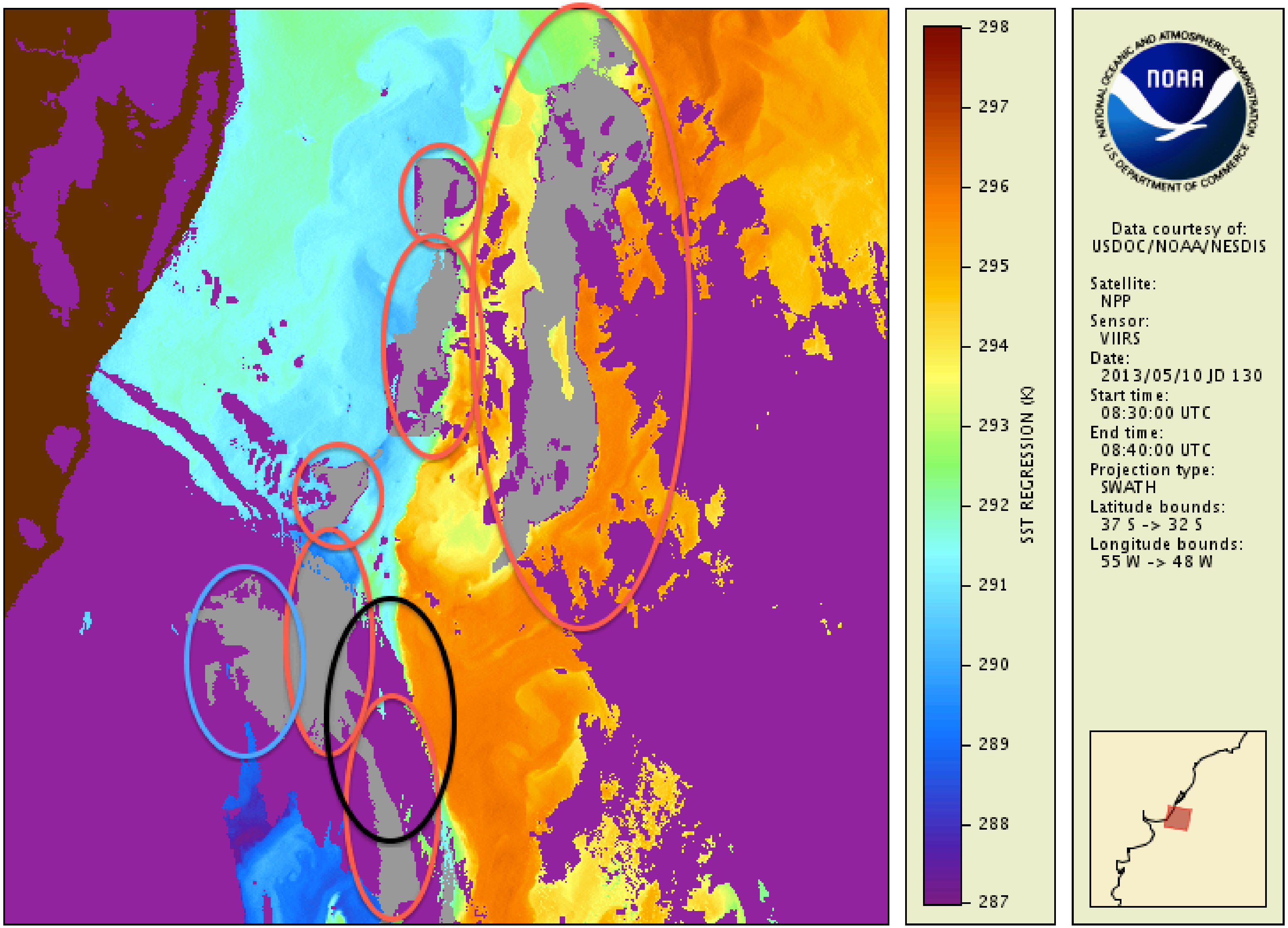
Gulf Stream, 05/10/13 (day)



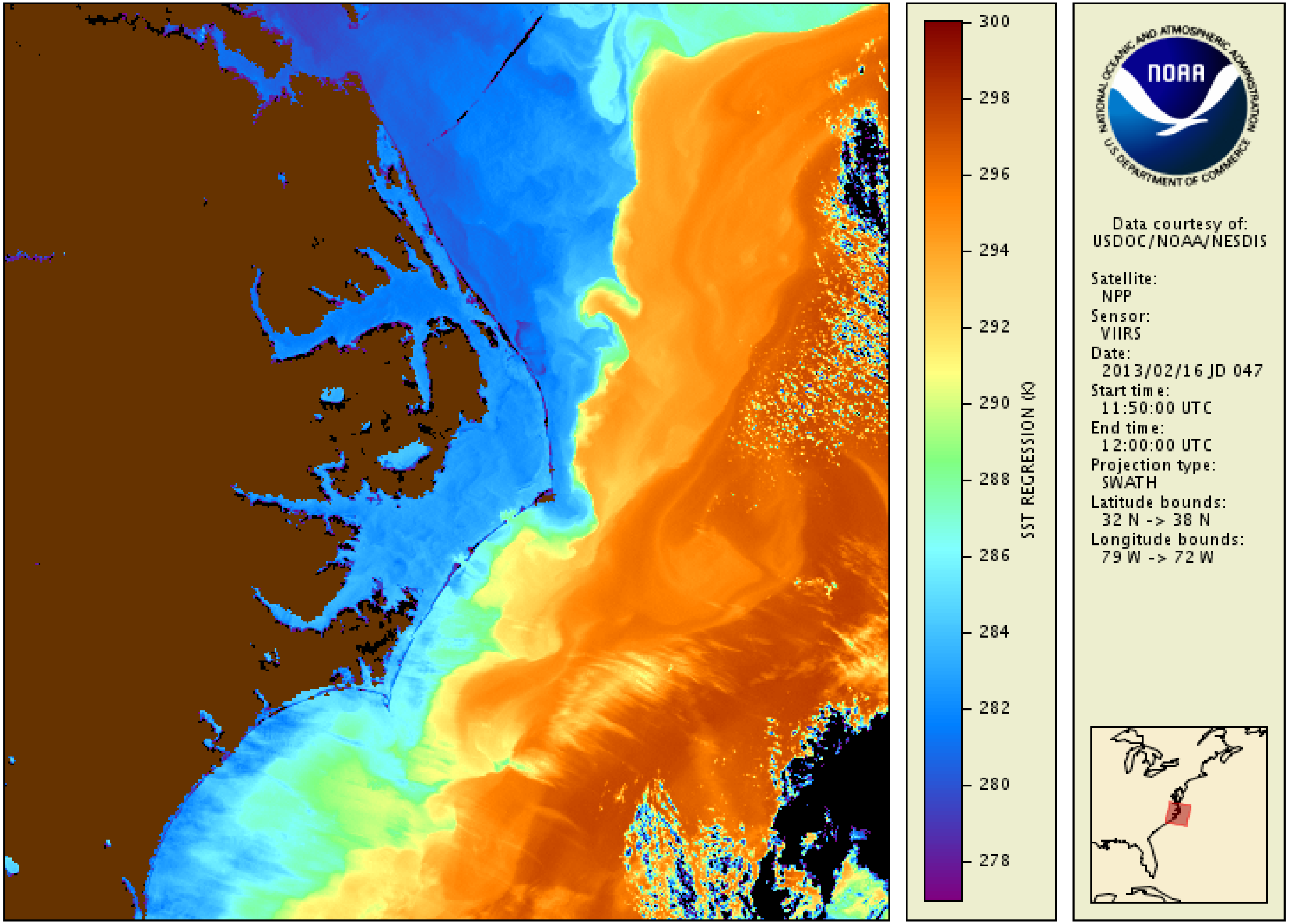
Uruguay, 05/05/13 (night)



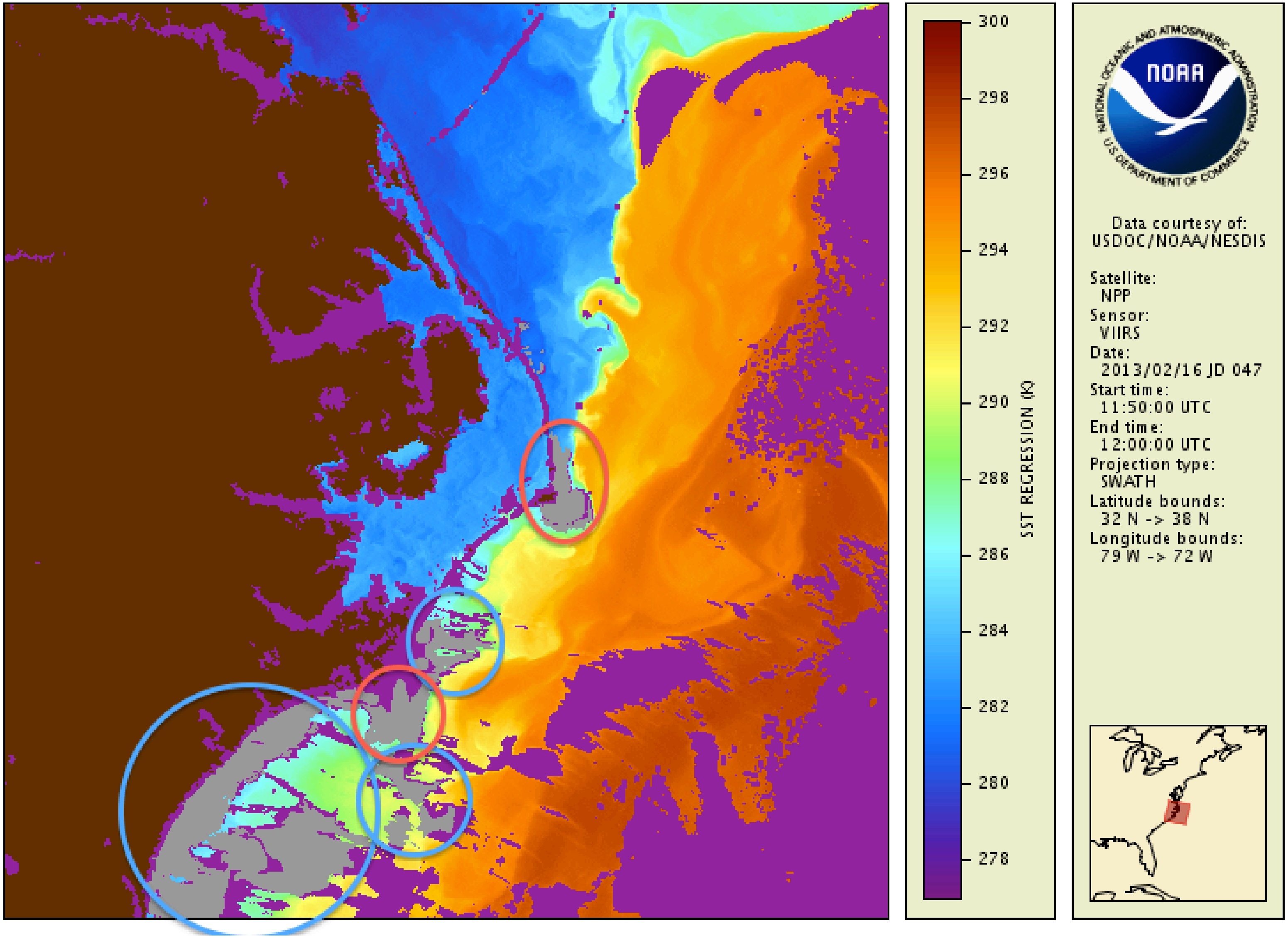
Uruguay, 05/05/13 (night)



Pamlico Sound, 02/16/13 (night)



Pamlico Sound, 02/16/13 (night)



Future Work

- The algorithm presented here was initially designed as a supplementary step to the existing ACSPO Clear-Sky Mask
- We will consider redesigning the current ACSM, based on the new pattern recognition principles
- It will be first implemented and extensively tested with the VIIRS SSTs, and later extended to also include AVHRR and MODIS data
- We will also consider generating an ocean front product at the stage of cloud masking, and outputting in the SST files, as an additional layer

NOAA Satellite and Information Service

National Environmental Satellite, Data, and Information Service

On Assimilation of ATMS and CrIS Data in HWRF

Fuzhong Weng[1], Xiaolei Zou[2], Lin Lin[3], Ellen Liang[3], Banglin Zhang[4] and Vijay Tallaparagada[4]

1. NOAA Center for Satellite Applications and Research
2. Florida State University
3. IMSG Group Inc.
4. NOAA Environmental Modeling Center

STAR JPSS Science Team Annual Meeting, May 12-16, 2014, College Park, ,MD, U.S.A.

Outline

- A Brief Description of Data Assimilation
- Improvements Made to HWRF System for Satellite DA
- Positive Impacts of ATMS DA on Hurricane Forecasts
- Mixed Impacts of CrIS DA on Hurricane Forecasts
- Preliminary Results Using 2014 Version of HWRF
- Summary, Current and Future Plan

Assimilation

$$J(\mathbf{x}) = \frac{1}{2}(\mathbf{x}-\mathbf{x}_b)^T \mathbf{B}^{-1}(\mathbf{x}-\mathbf{x}_b) + \frac{1}{2}(H(\mathbf{x})-\mathbf{y}^{obs})^T (\mathbf{O}+\mathbf{F})^{-1}(H(\mathbf{x})-\mathbf{y}^{obs})$$

$$J(\mathbf{x}_a) = \min_{\mathbf{x}} J(\mathbf{x}) \quad \forall \mathbf{x} \text{ near } \mathbf{x}_b$$

$\mathbf{x}$ – analysis variable

$\mathbf{x}_a$ – final analysis

$\mathbf{x}_b$ – background

$\mathbf{B}$ – background error covariance

$\mathbf{y}^{obs}$ – observations

$\mathbf{O}$ – observation error covariance

H – observation operator

$\mathbf{F}$ – forward model error covariance

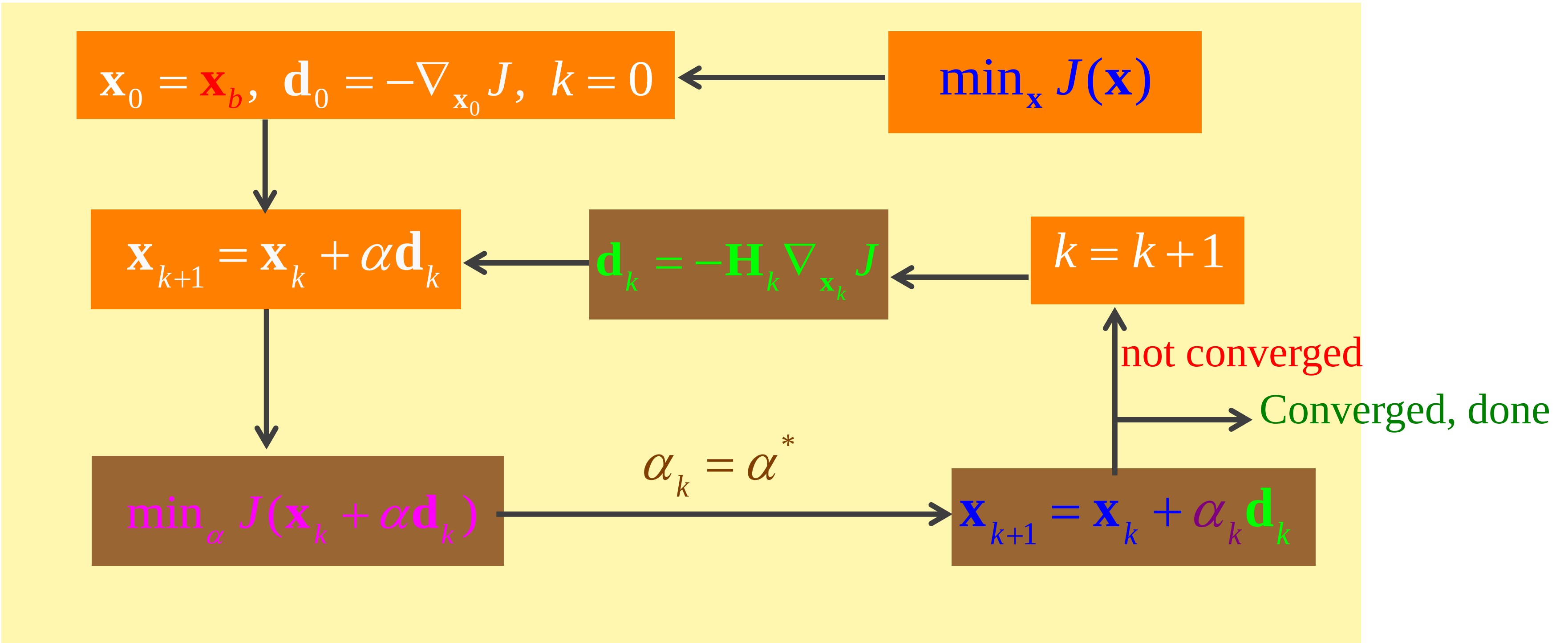
- NCEP GSI 3D-Var Data Assimilation System
- Hurricane Weather Research Forecast (HWRF) System

An Iteration Procedure of Assimilation

Starting from a background field $\mathbf{x}_0 = \mathbf{x}_b$, various minimization algorithms compute a sequence of solution

$$\{\mathbf{x}_k, k = 1, 2, \ldots\}$$

$\mathbf{x}_k$ approaches a local minimizer $\mathbf{x}^*$ of J. $\mathbf{x}^*$ is taken as the DA analysis.



$\mathbf{d}_k$ --- Search direction α_k --- Step size

Data for Data Assimilation

Three Key Components for Assimilation of Satellite Data:

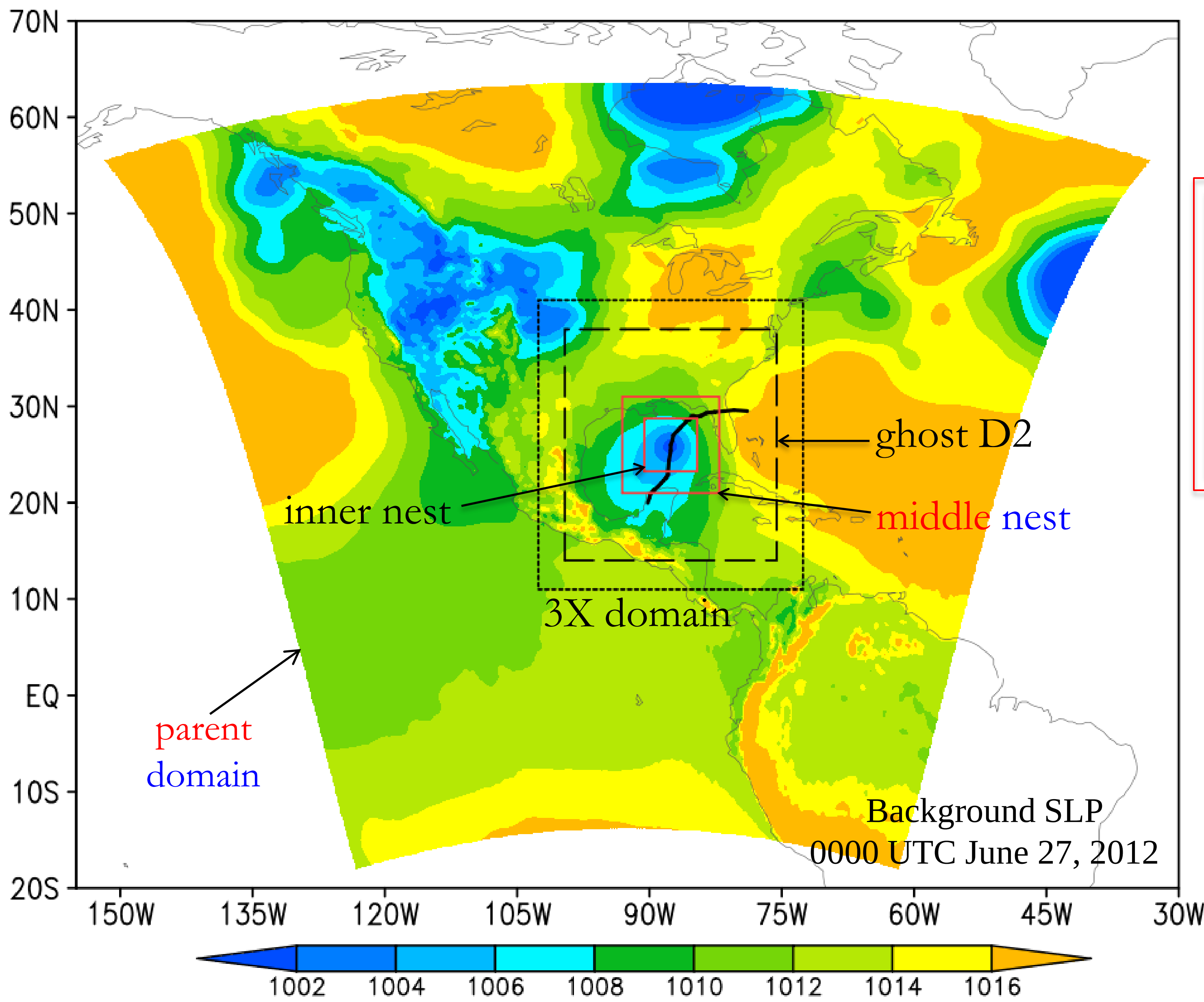
- ✓ **Bias Correction**
- ✓ **Quality Control**
- ✓ **Data Thinning**

- Instrument bias
- Air mass dependent bias
- Erroneous data
- RTM errors
- Spatially correlated data
- Spectrally correlated channels

2. Improvements to HWRF System for Satellite DA

- In 2011 and 2012 version of HWRF system, most of satellite data are not assimilated in HWRF analysis process due to mixed impacts on hurricane track and intensity forecasts
- Model top in 2011-2013 versions of HWRF is too low for assimilation of upper-level channels
- Cold start (background fields are not the HWRF 6-h forecasts
- Analyses show GSI quality controls for satellite water vapor sounding data are problematic (lots of bad data sneak into the analysis process)
- Bias correction schemes for satellite data developed for the global model applications have not been fully vetted for regional model applications

2012 HWRF Domain Sizes for Tropical Storm Debby



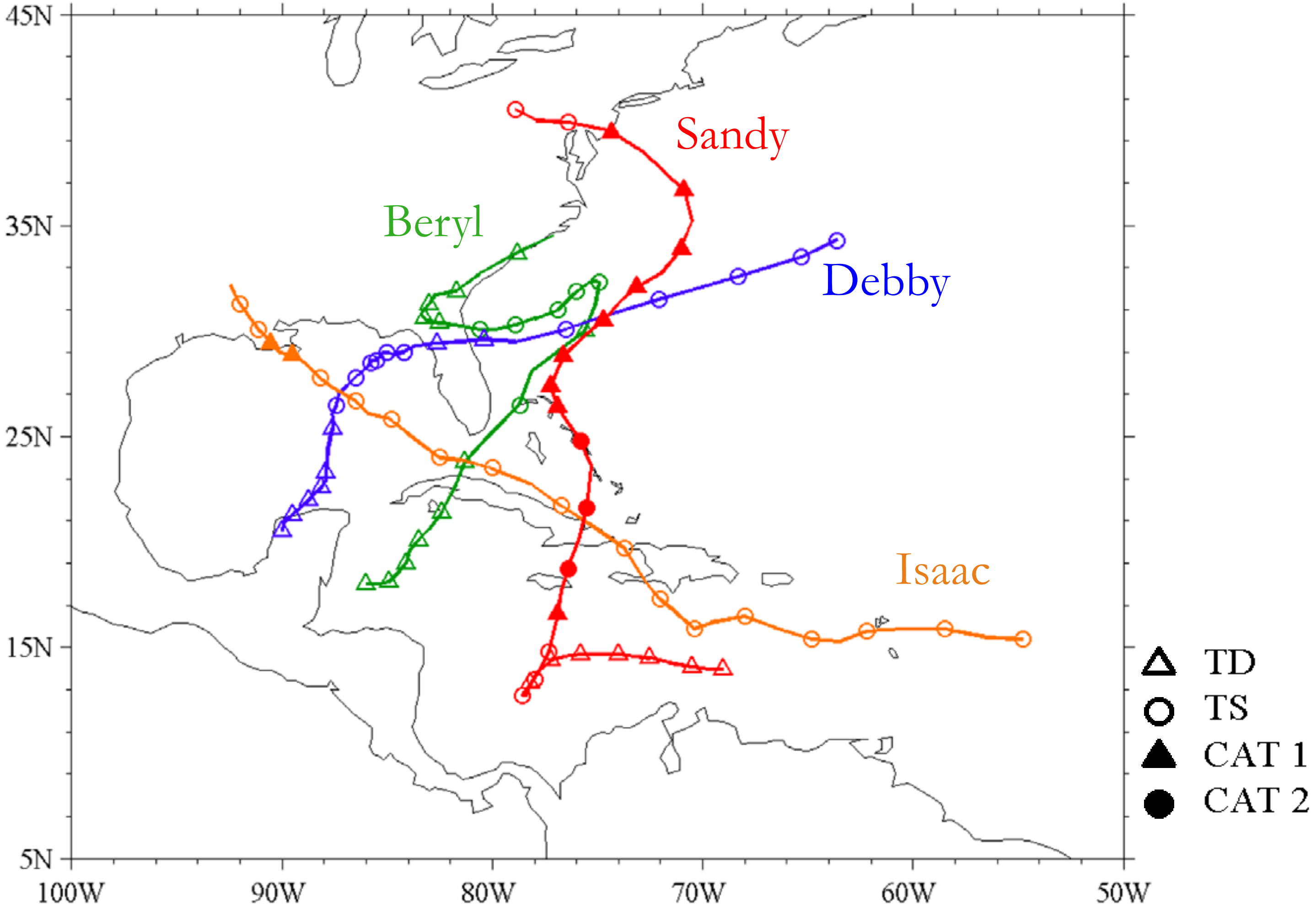
DA

2012 HWRF

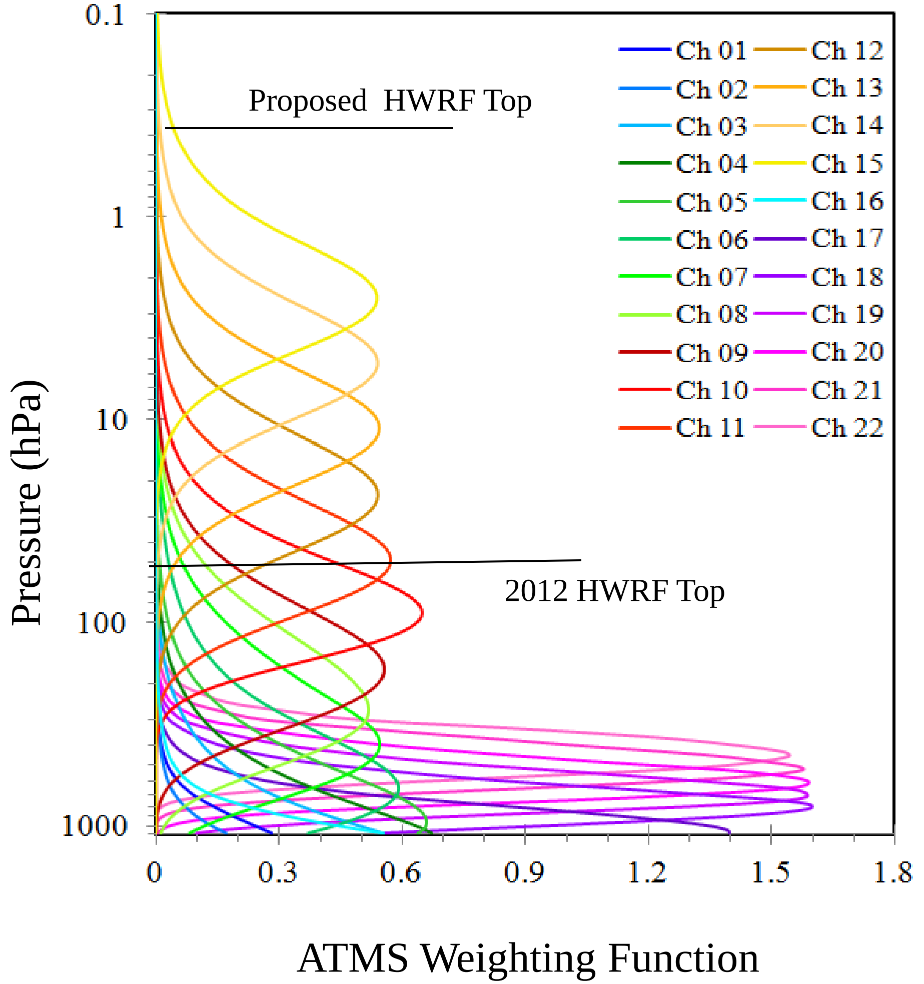
Parent domain
27 km, 750x750

Middle Nest
9 km, 238x150

The Best Tracks of Four 2012 Atlantic Landfall Hurricanes

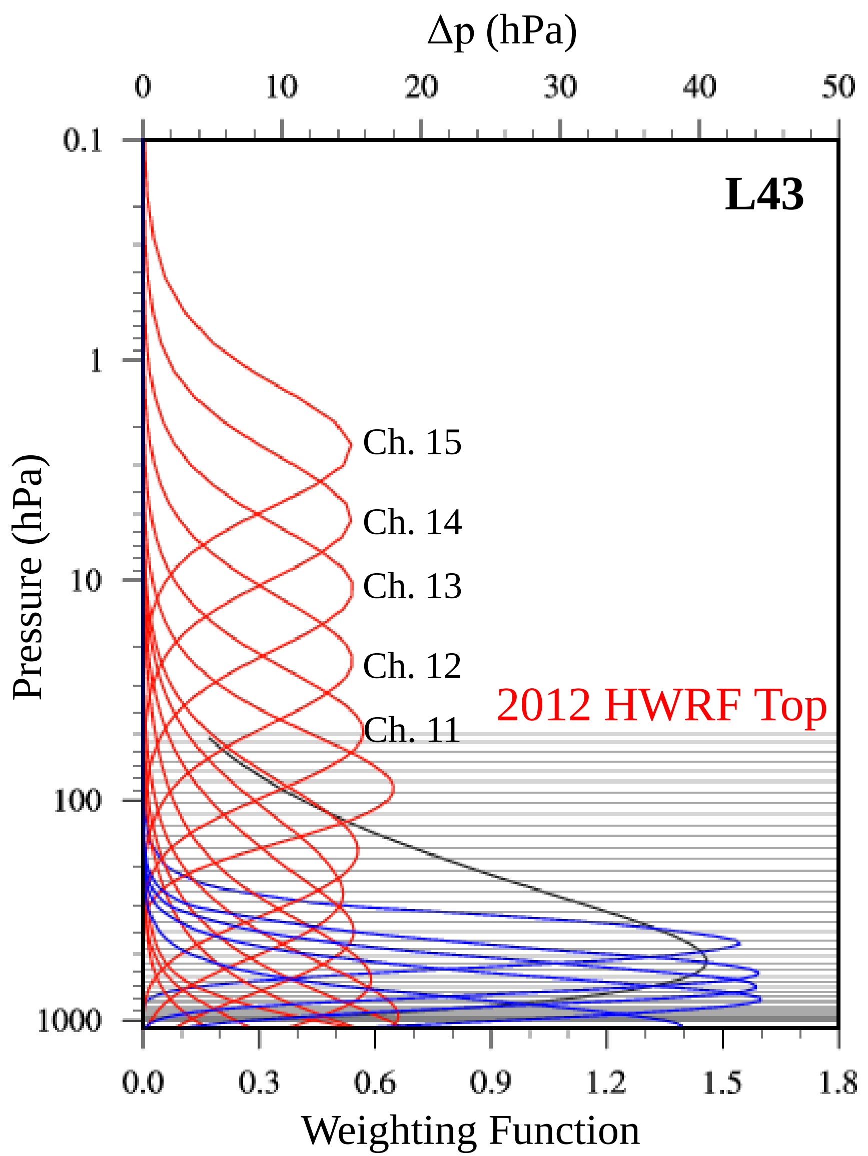


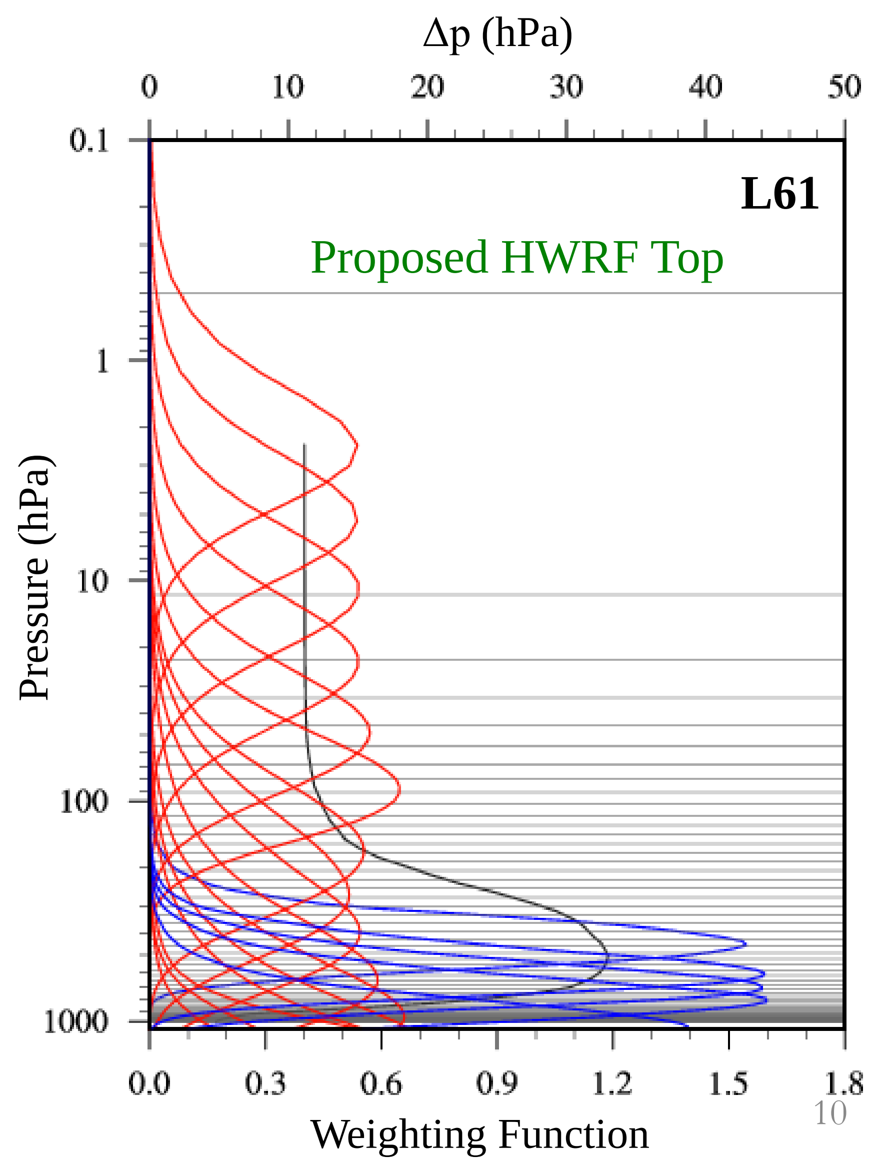
ATMS Weighting Functions



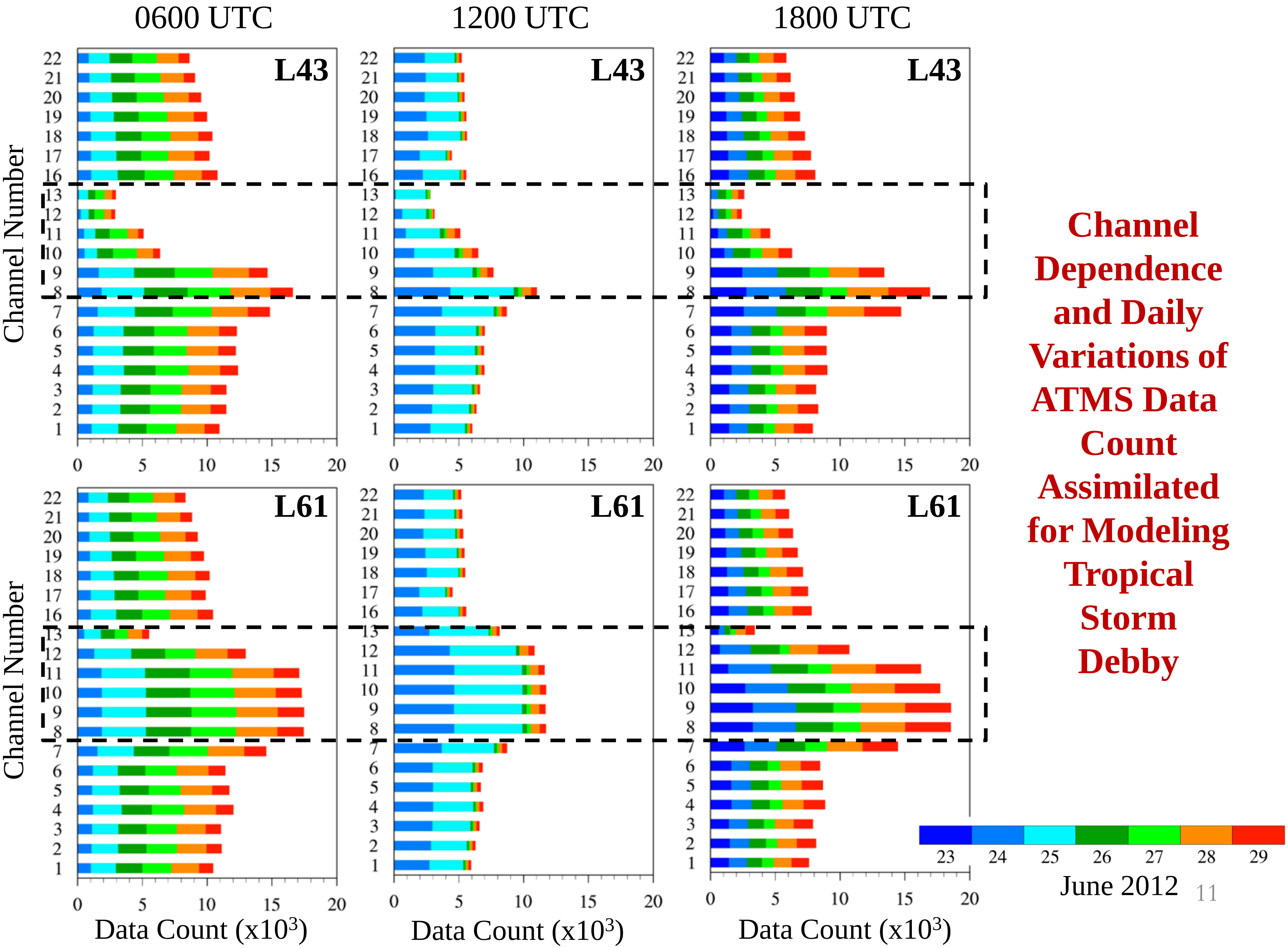
Our approach: Raise the model top to allow for more satellite data be assimilated into hurricane forecast model

Weighting Functions for ATMS Channels

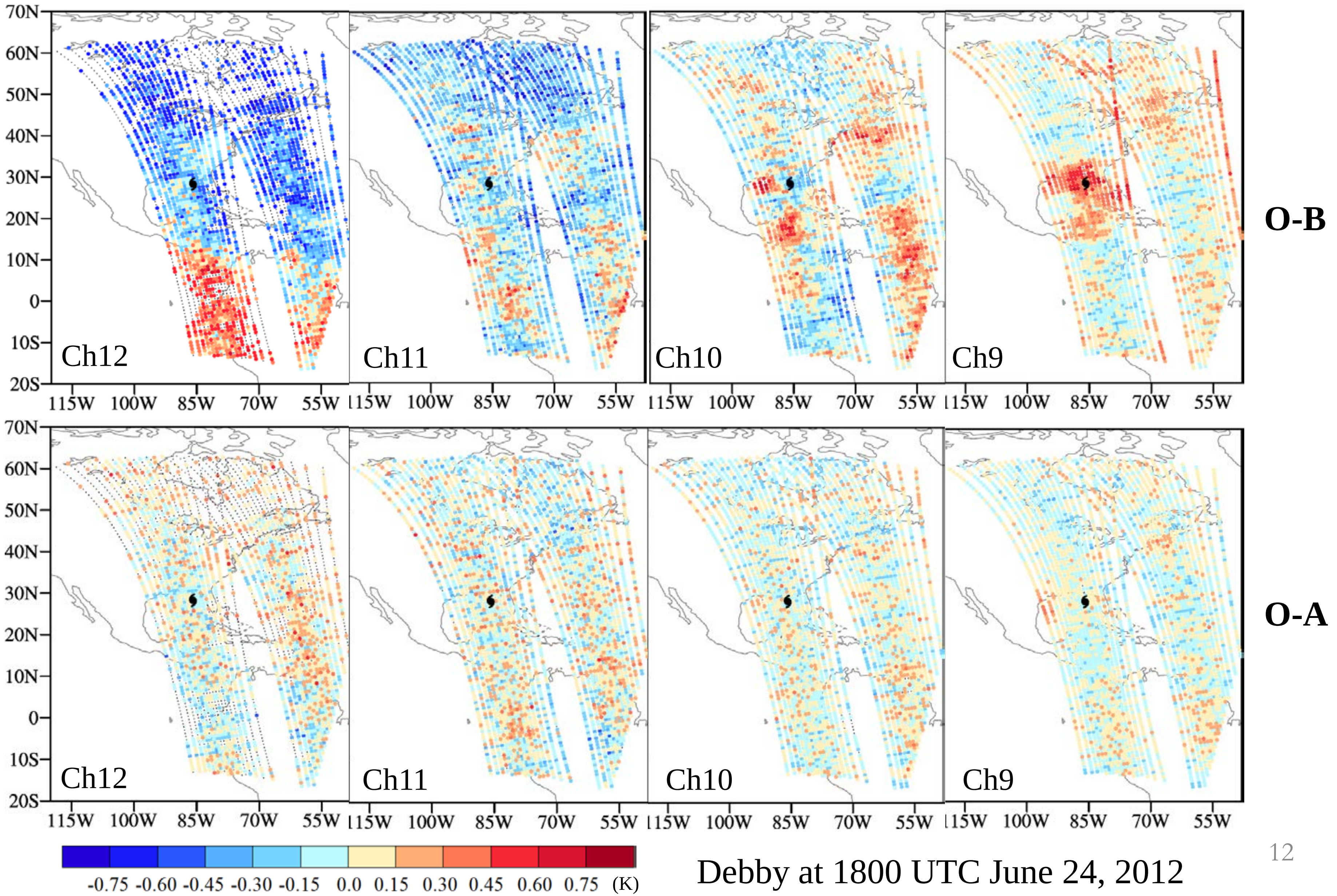




Channel Dependence and Daily Variations of ATMS Data Count Assimilated for Modeling Tropical Storm Debby

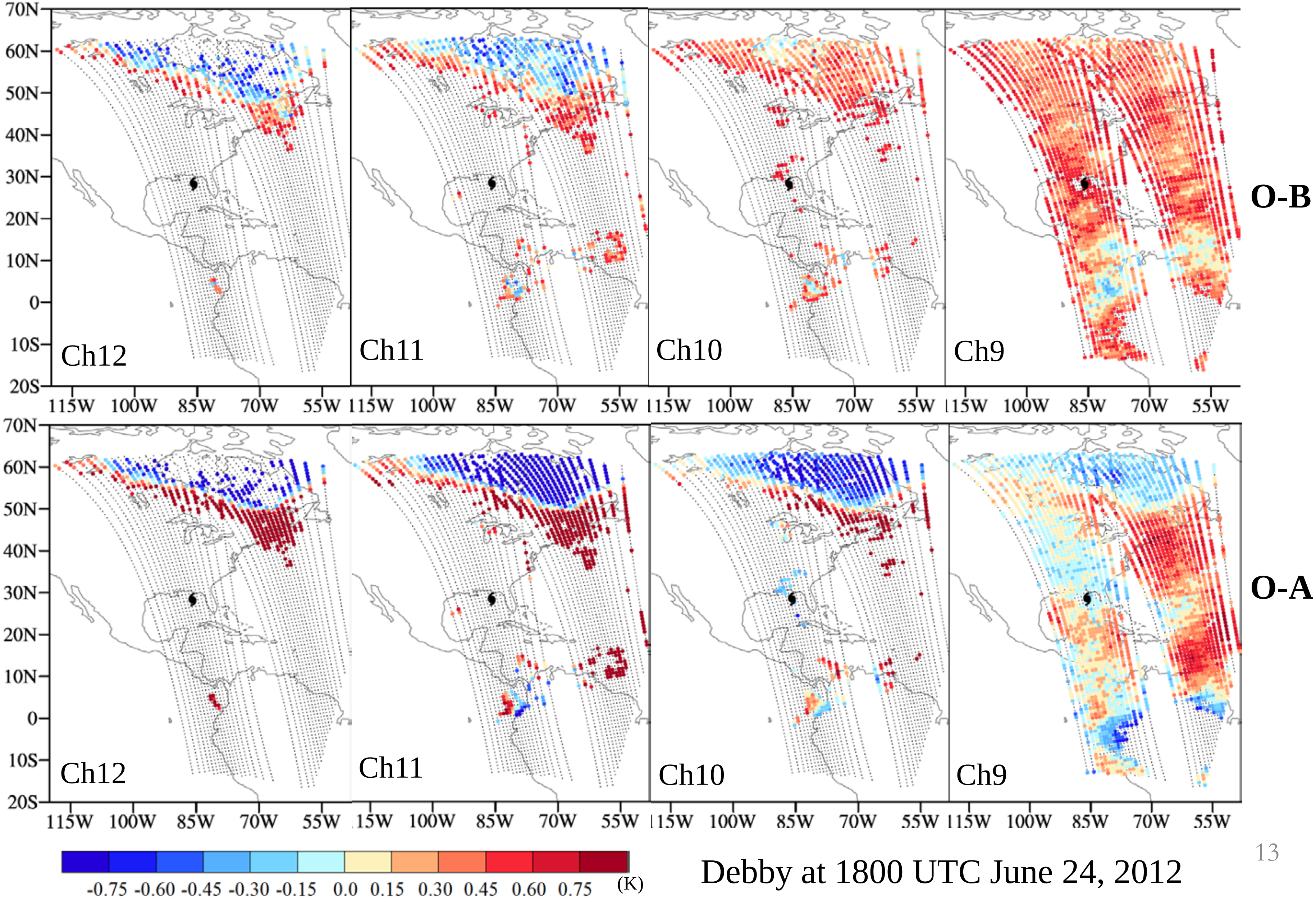


Convergence of ATMS Data Assimilation in L61



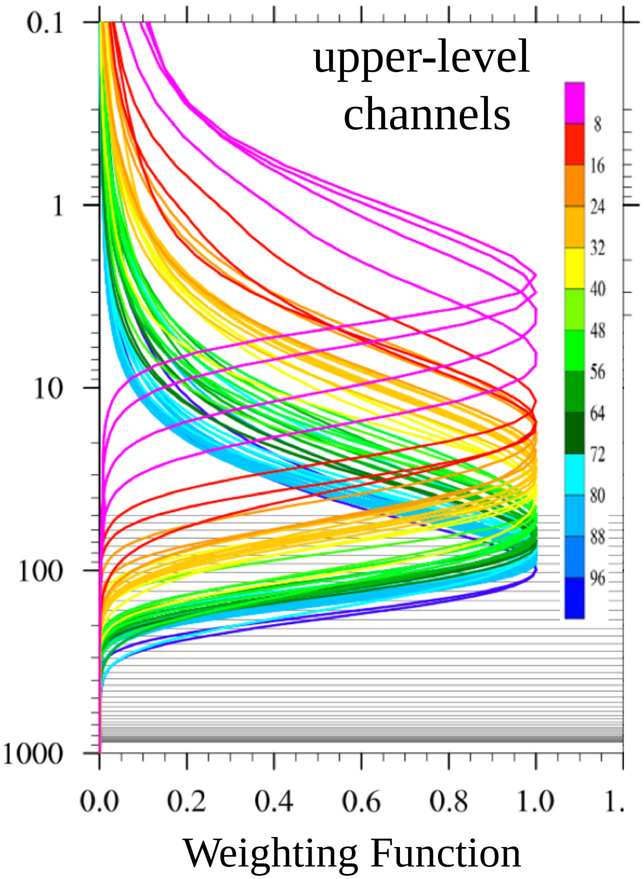
Debby at 1800 UTC June 24, 2012

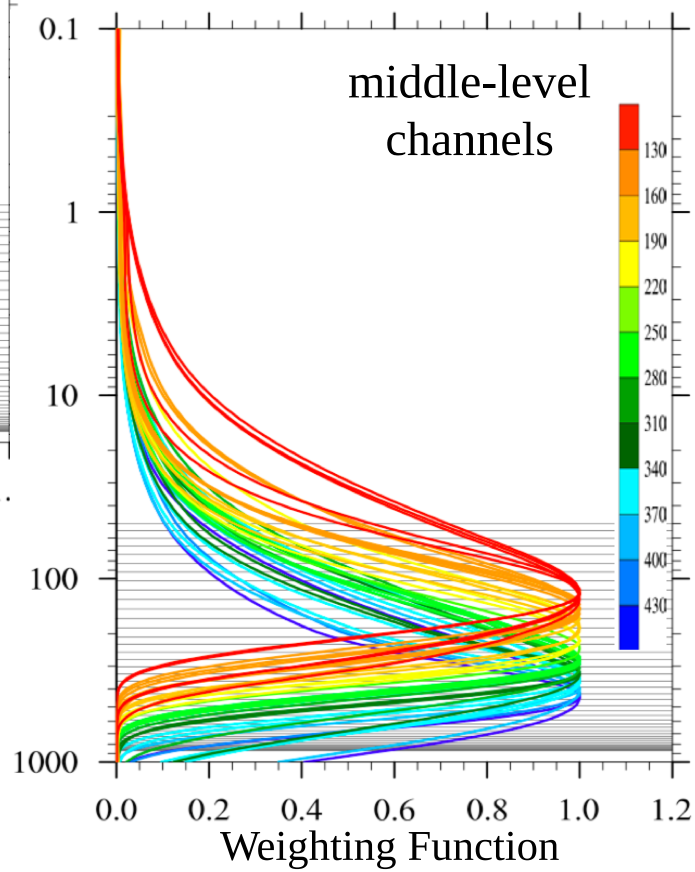
Convergence of ATMS Data Assimilation in L43

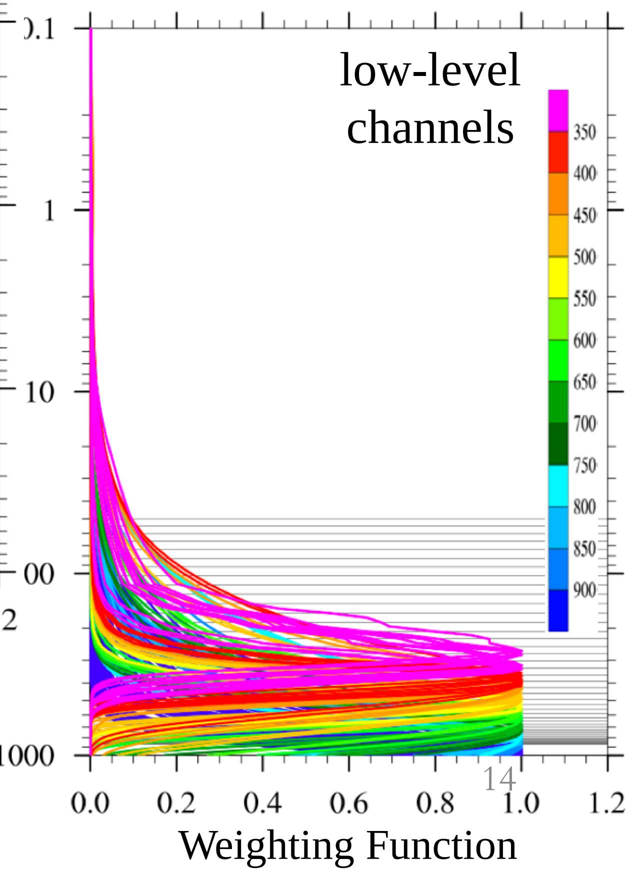


Debby at 1800 UTC June 24, 2012

AIRS Channels (281)

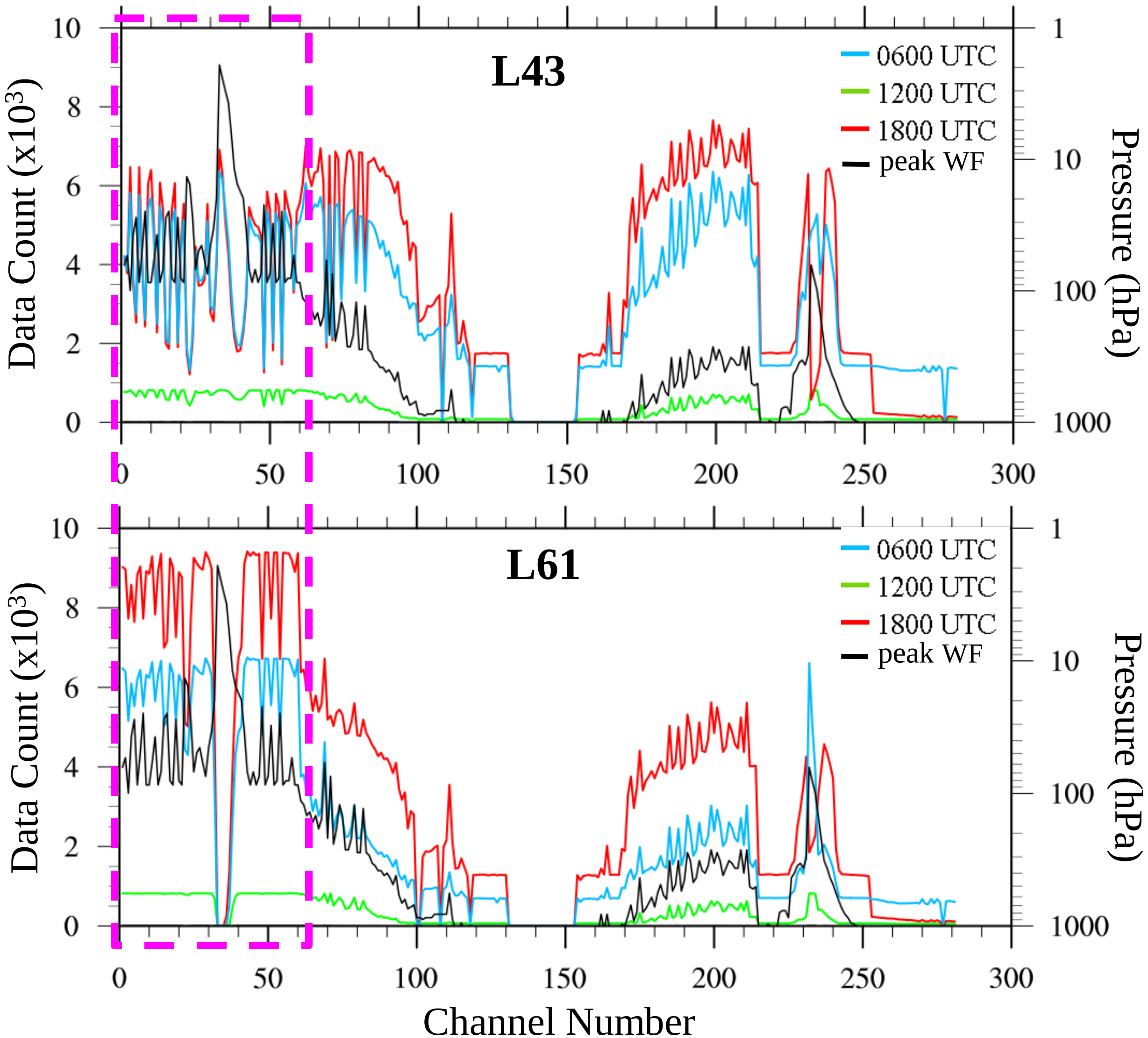






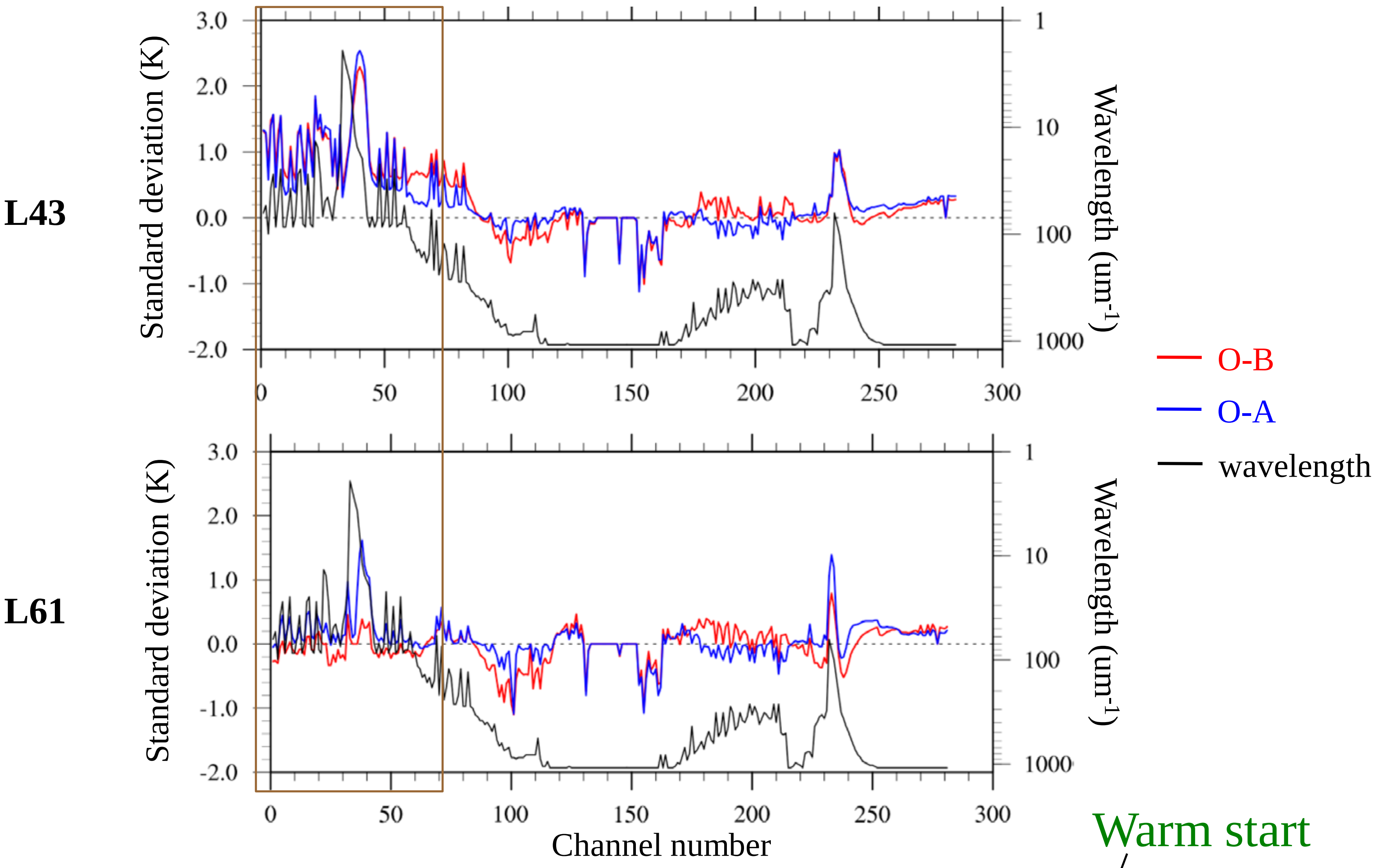
These 281 channels are selected for data assimilation in the GSI/HWRF system. The pressure at which WF reaches a maximum is indicated in color.

AIRS Channel Dependence of Data Count Assimilated During Tropical Storm Debby



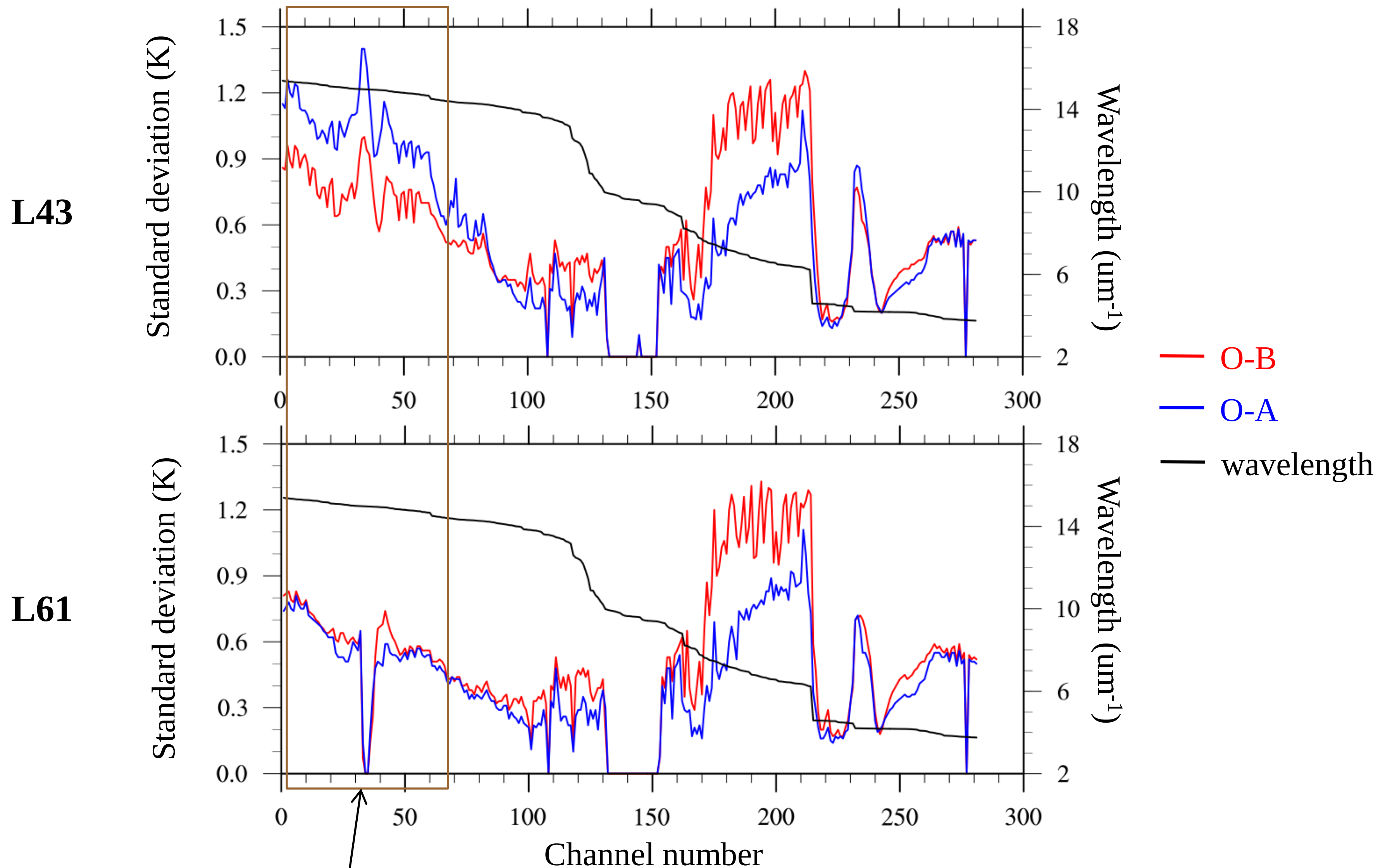
More upper-level channel data are assimilated in L61 with a higher model top (0.5 hPa) than L43 whose model top is located around 50 hPa.

Mean of O-B and O-A from AIRS Data Assimilation



Large positive biases are present in both O-B and O-A fields for many upper-level AIRS channels in L43 but not in L61. L43 background fields are different from L61.

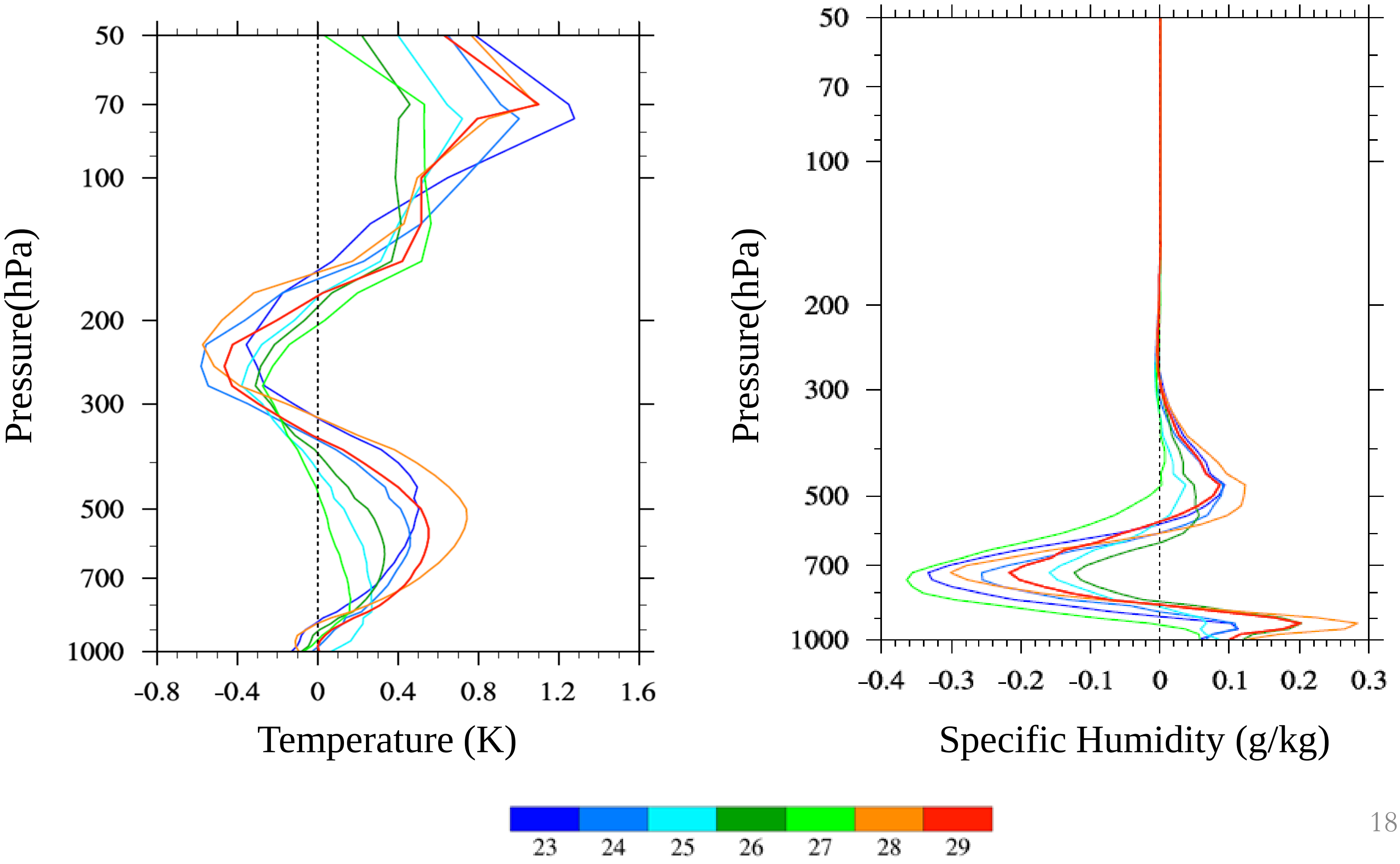
Standard Deviation of O-B and O-A from AIRS DA



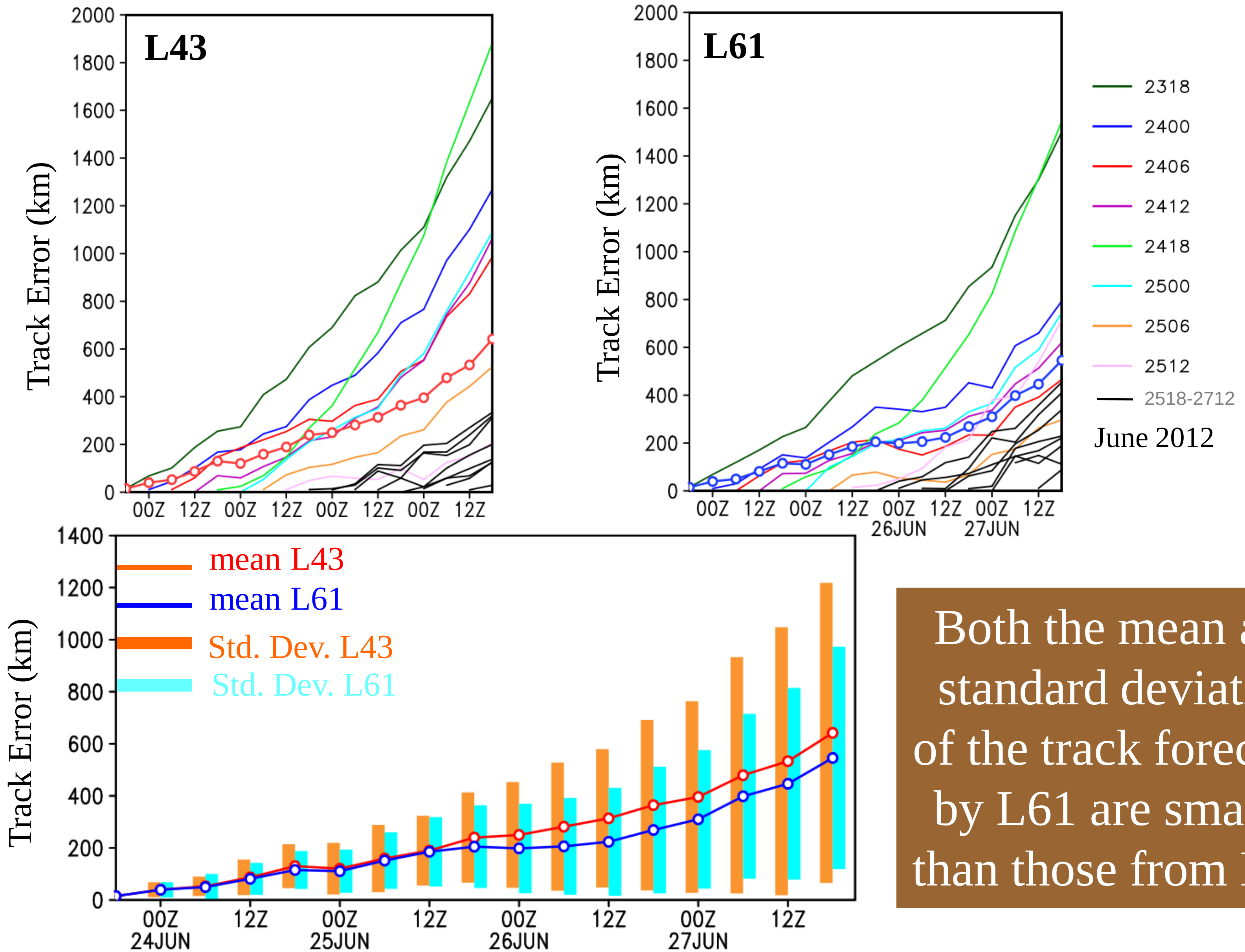
The standard deviation of O-A is greater than that of O-B for upper-level AIRS channels in L43.

Background Differences between L61 and L43 (L43 – L61)

1800 UTC from June 23 to June 29, 2012 after one-day DA cycle

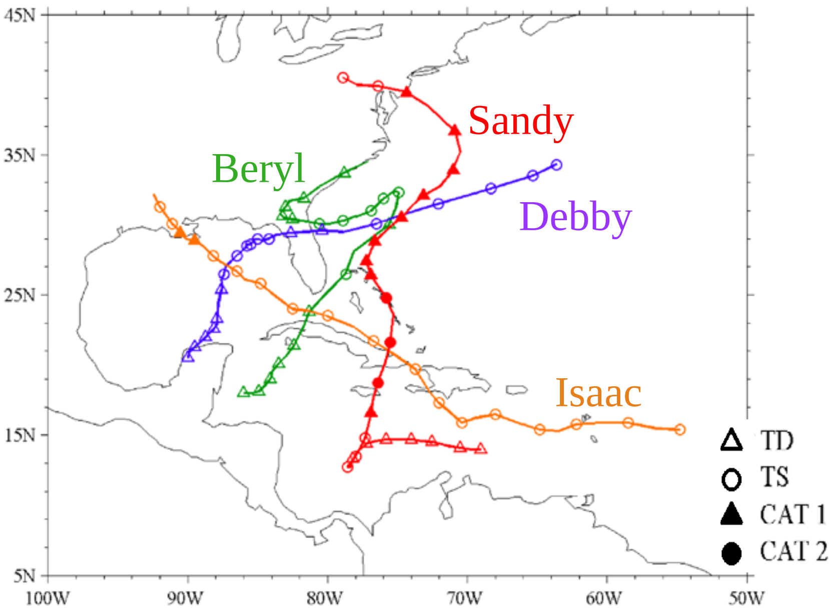


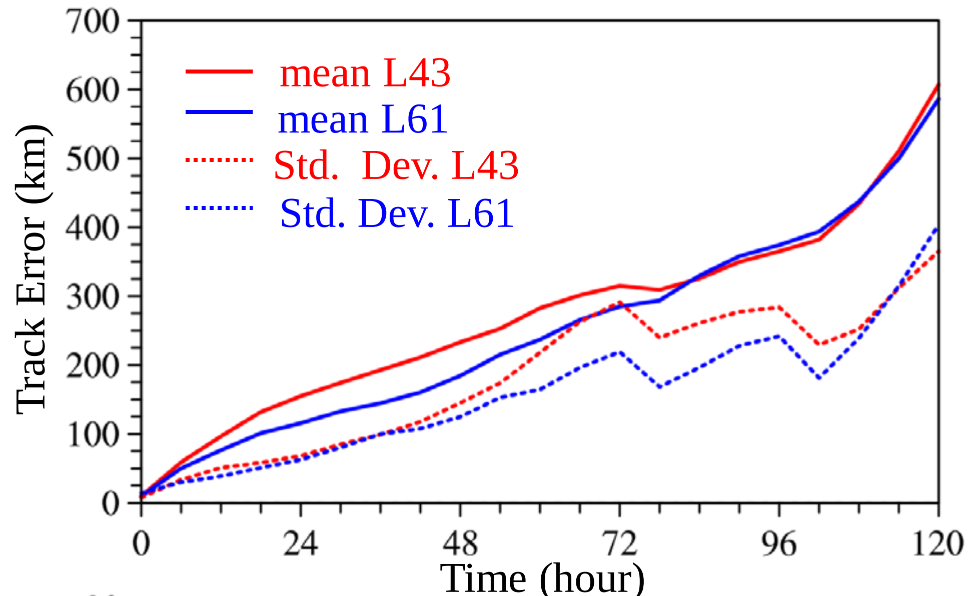
Track Forecasts for Tropical Storm Debby

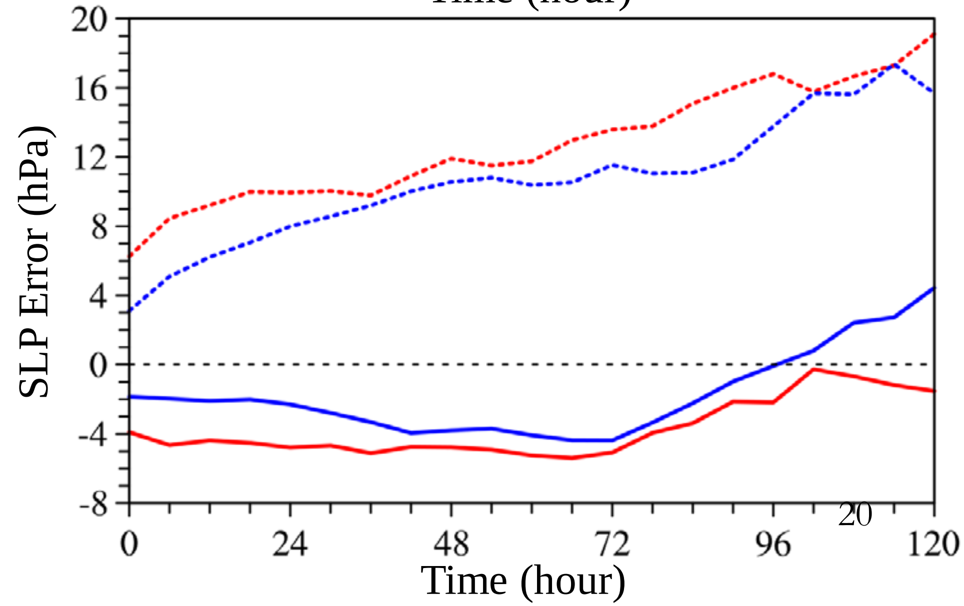


Both the mean and standard deviation of the track forecasts by L61 are smaller than those from L43.

Impacts of Model Top Altitude on Track and Intensity Forecasts for Four 2012 Atlantic Hurricanes







Biases and standard deviations for both track and intensity forecast errors are reduced by raising the model top of the HWRF system.

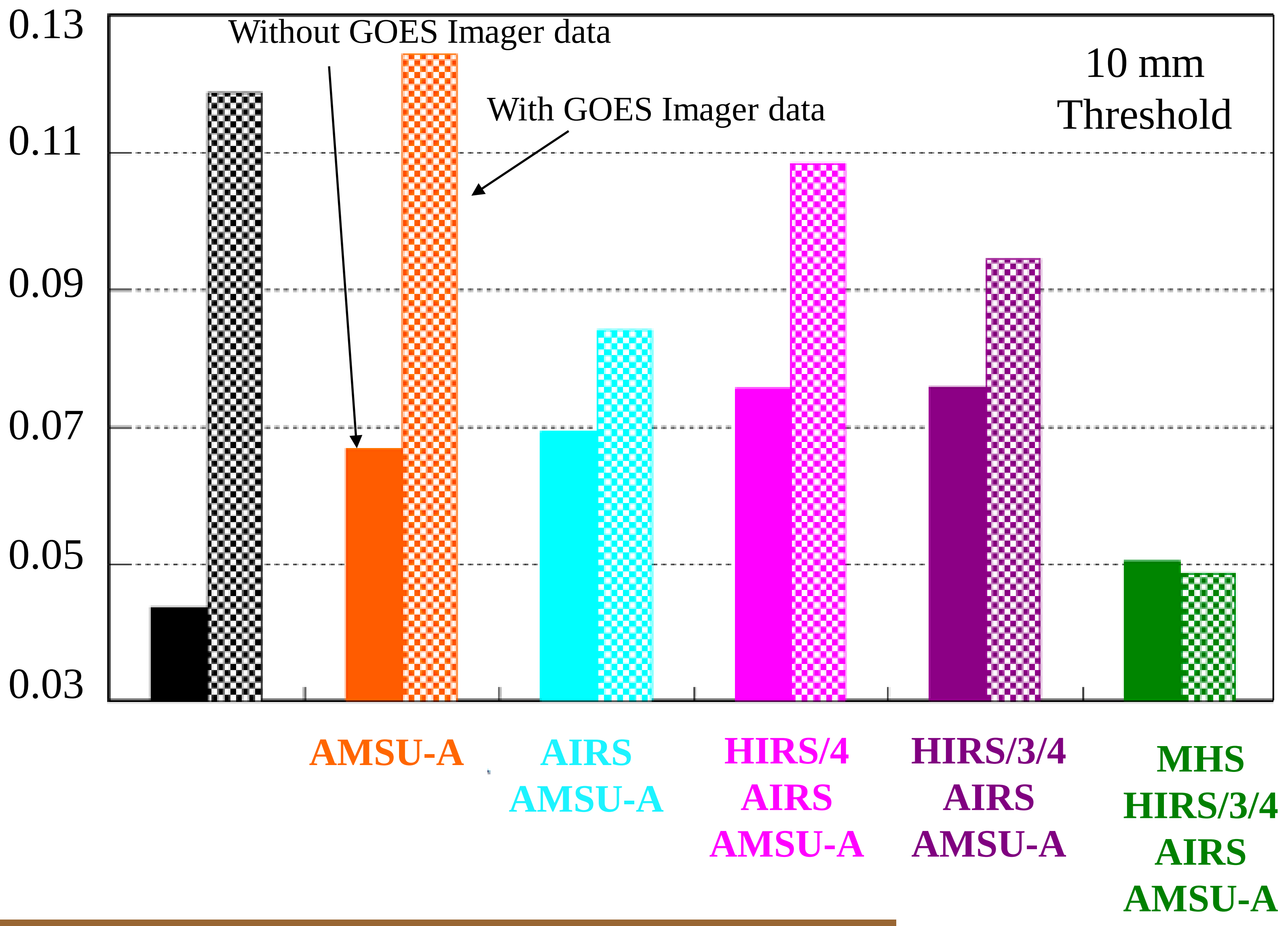
3. Positive Impacts of ATMS DA on Hurricane Forecasts

- Detrimental impacts of MHS DA on QPFs

- ATMS FOVs *T* and *q* channels are collocated, which makes the cloud detection much more effective

- Impacts of ATMS data assimilation are consistently positive. ATMS water vapor sounding channels contribute positively to hurricane forecasts due to improved QC

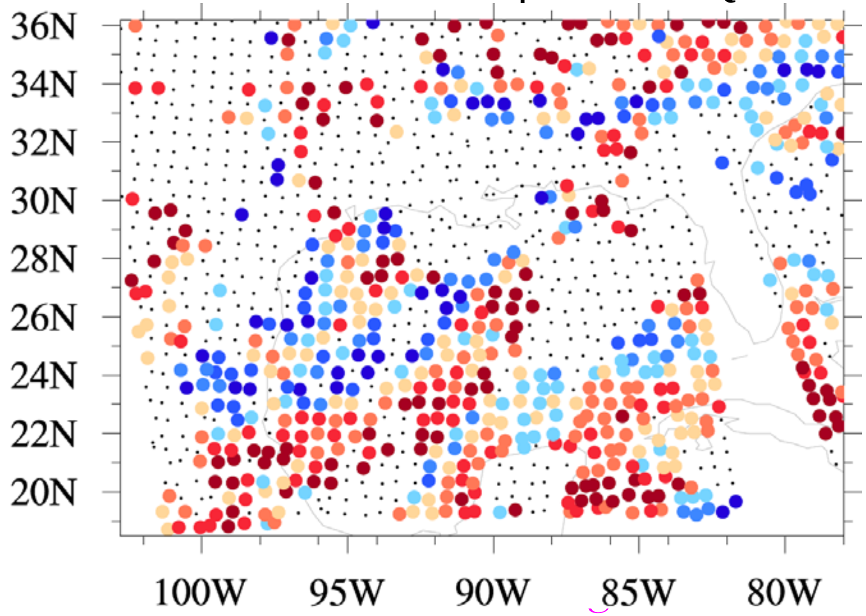
Threat Scores of 24-h Accumulative Rainfall



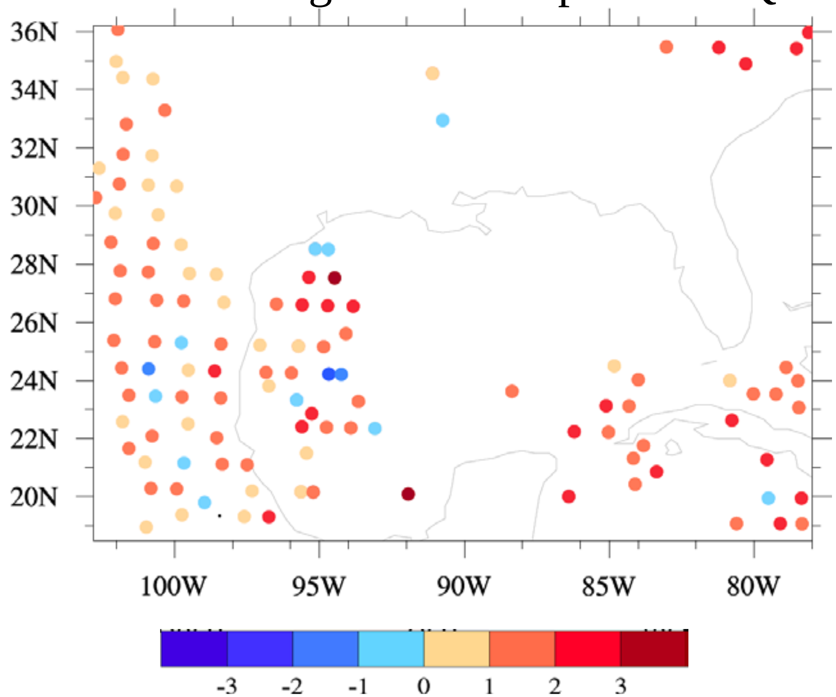
A detrimental impact of MHS DA on QPFs!

O-B Data Distribution of MHS Channel 3 at 1800 UTC 22 May 2008

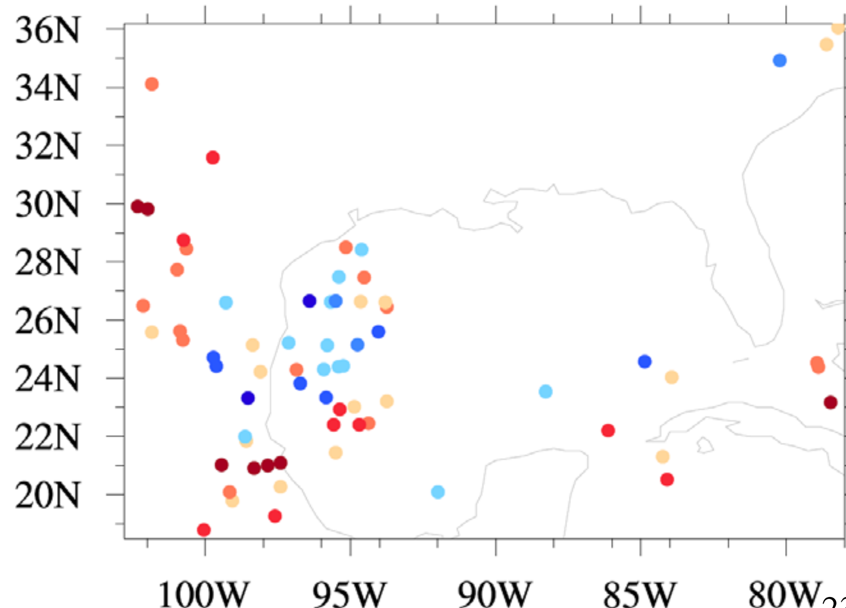
MHS data that pass GSI QC

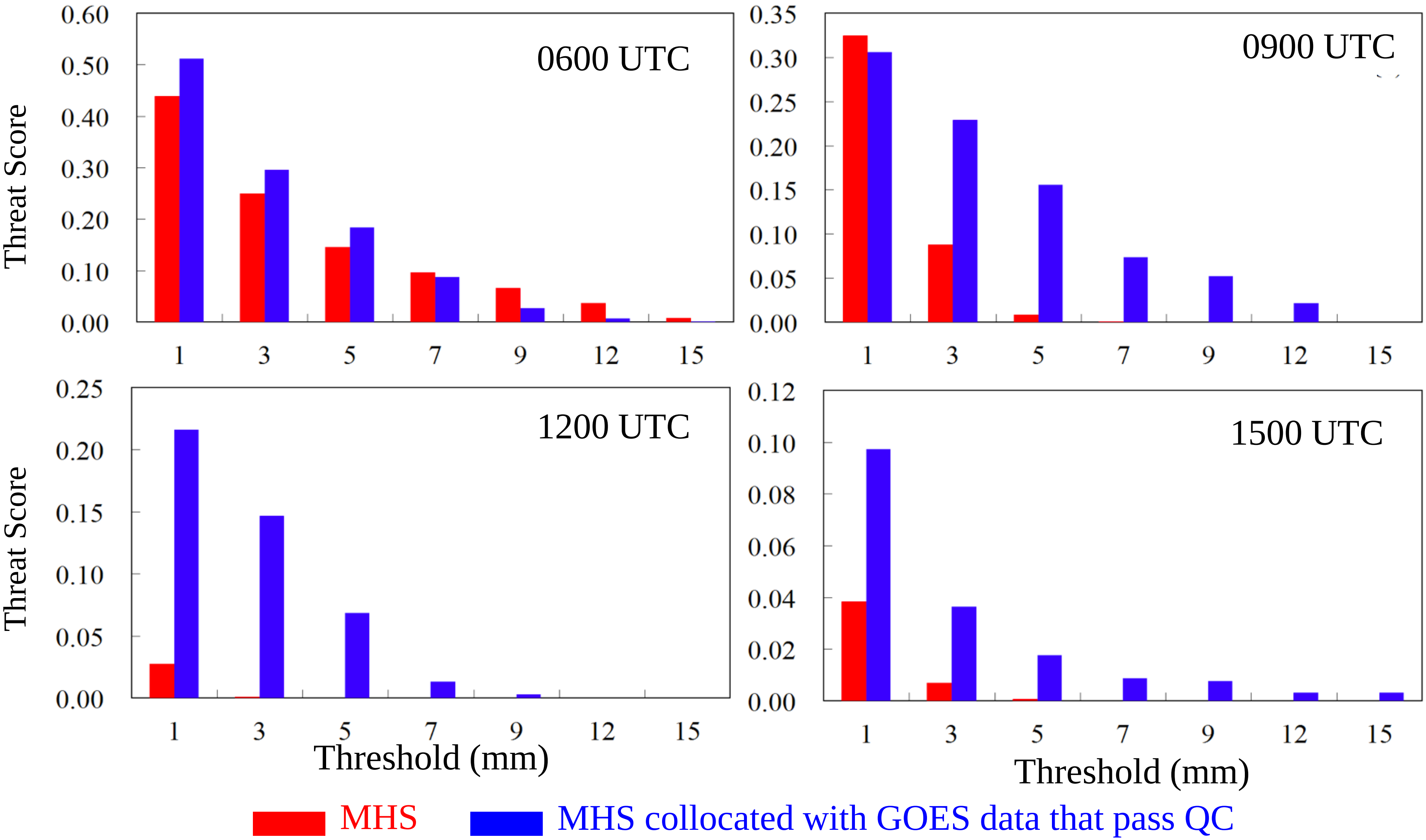


GOES imager data that pass GSI QC



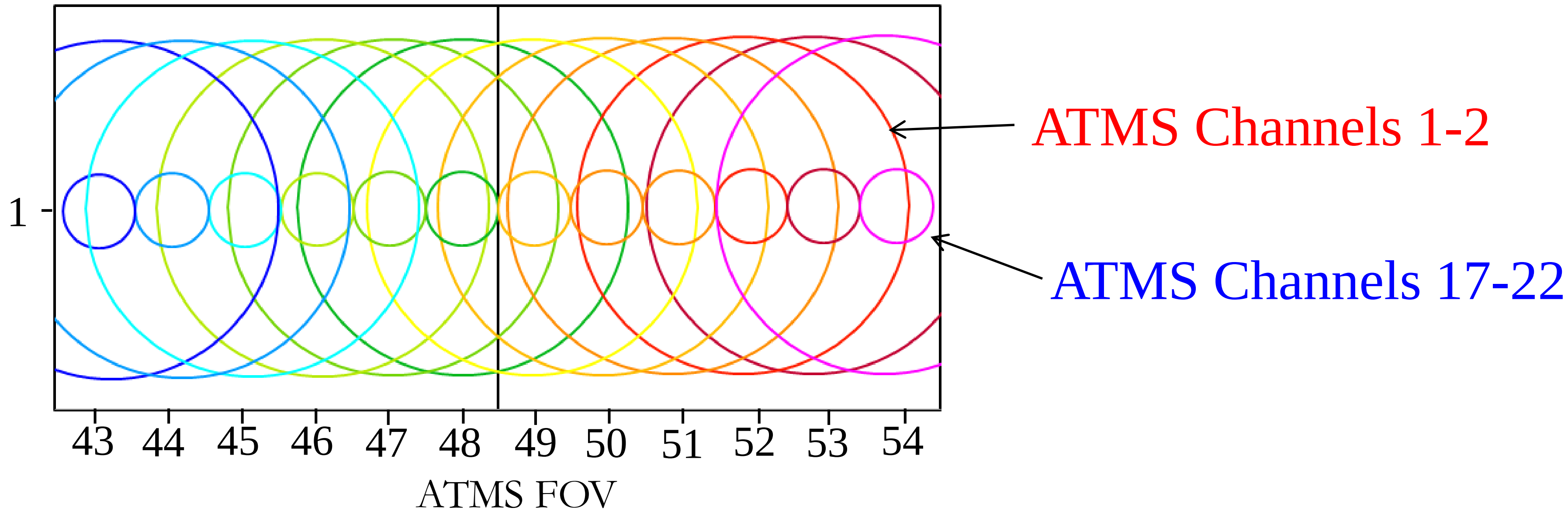
MHS data collocated with GOES imager data that pass GSI QC

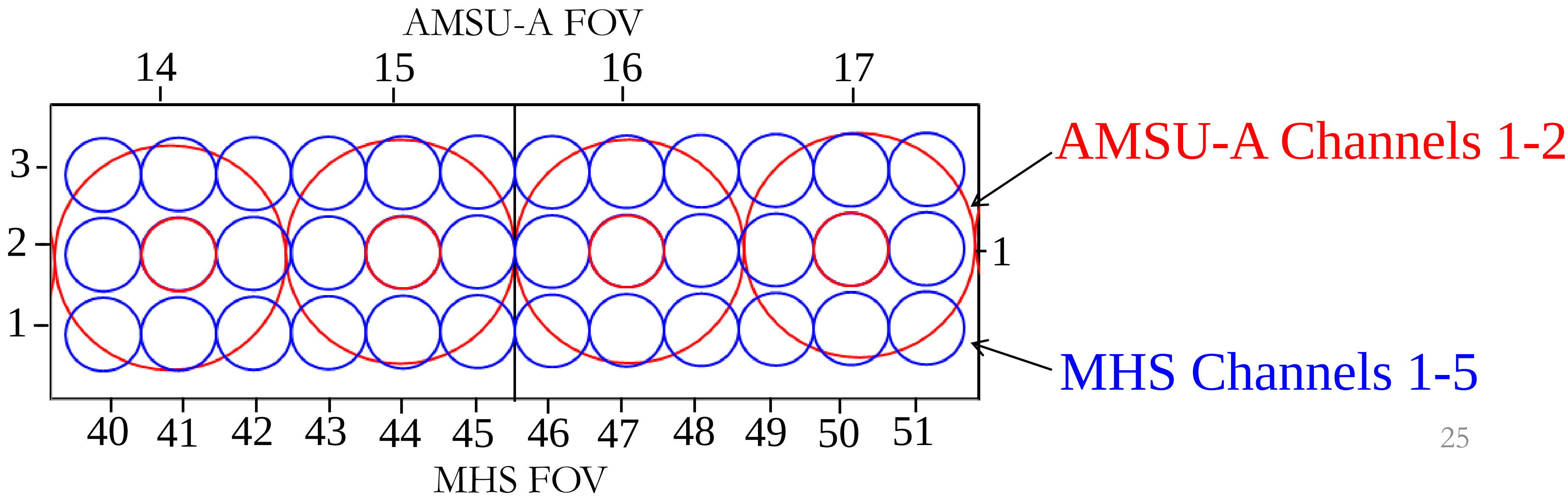




An elimination of MHS data over areas where GOES imager QC detects clouds improved the impact of MHS data assimilation on quantitative precipitation forecasts.

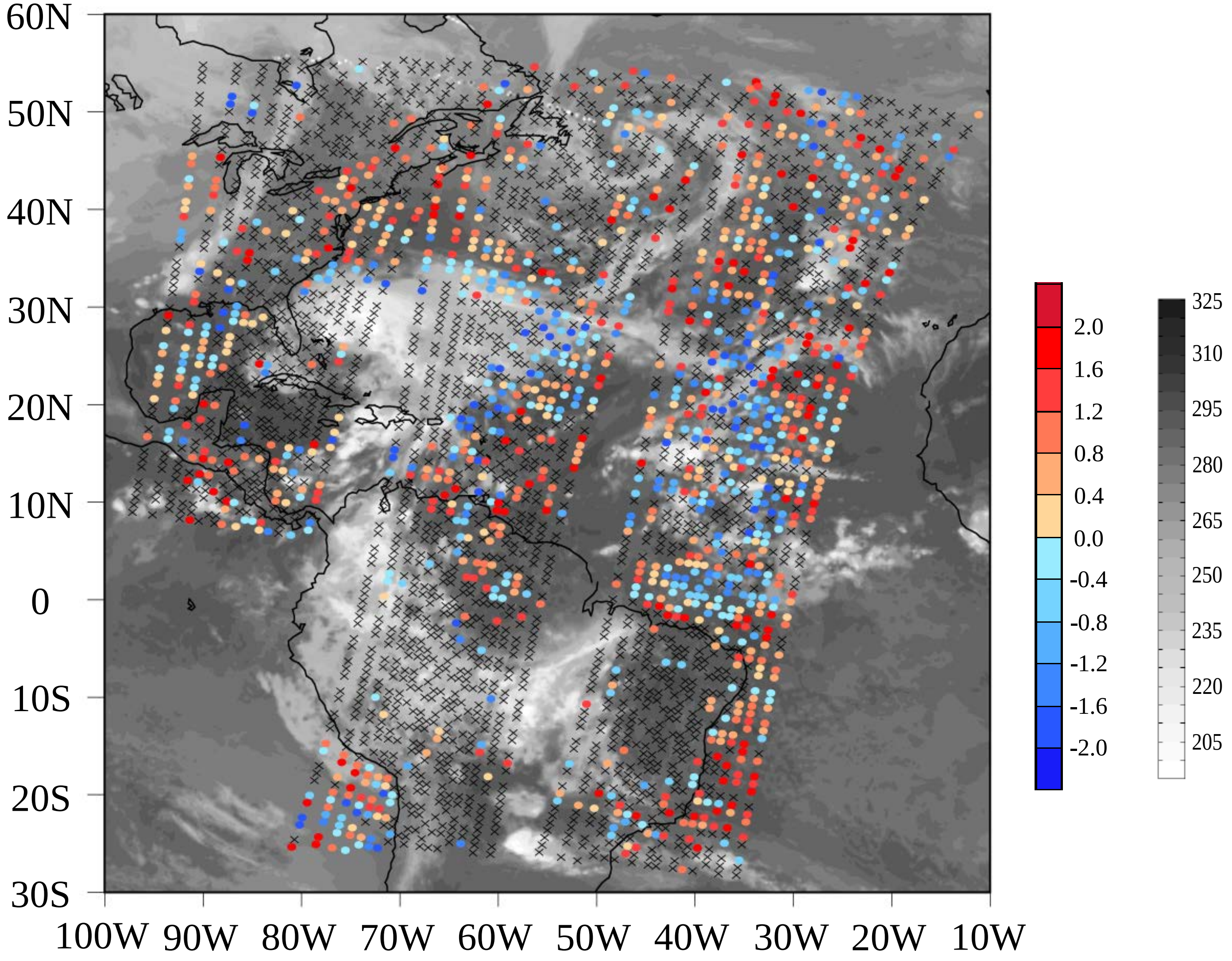
Comparison of FOV Distributions between ATMS and AMSU





ATMS Quality Control in HWRF/GSI

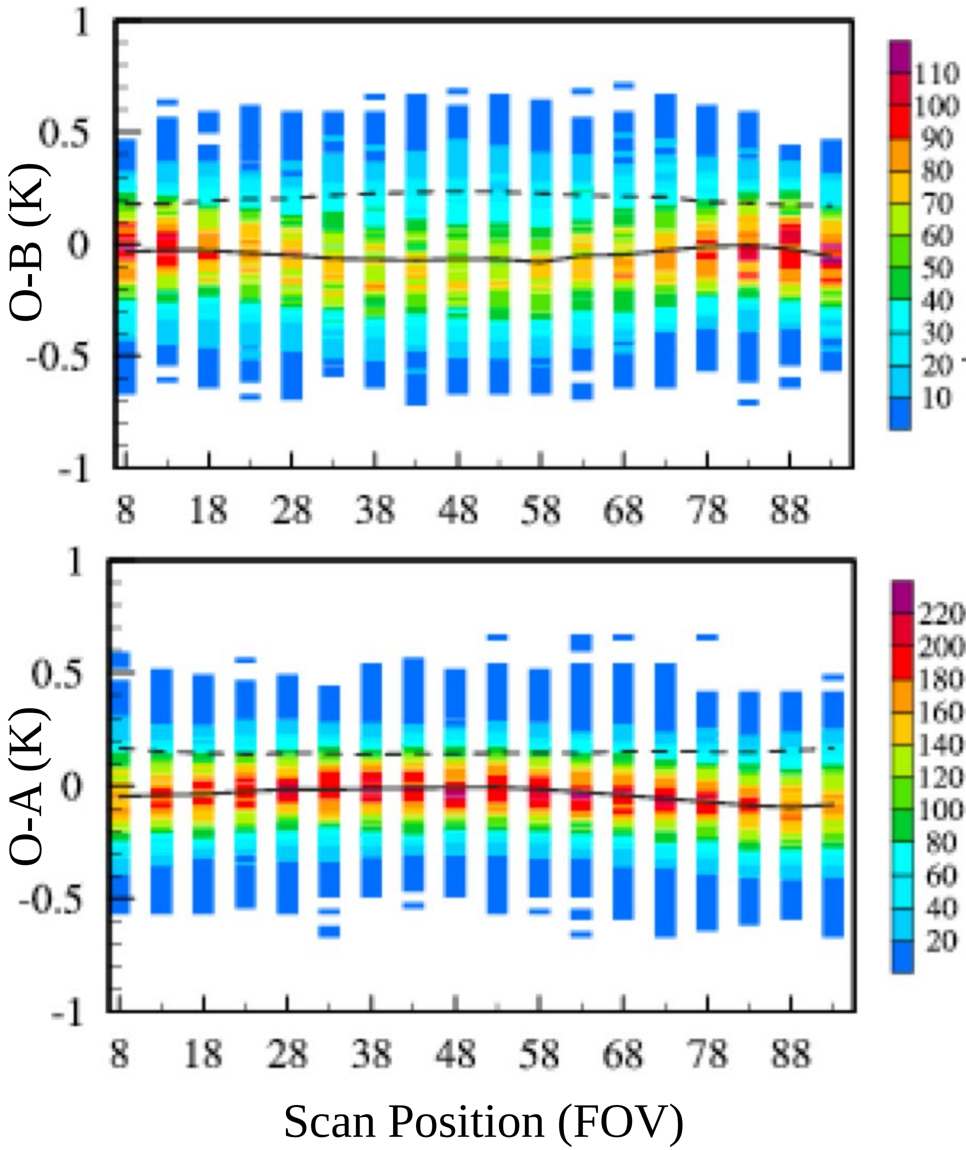
O-B
ATMS Ch19



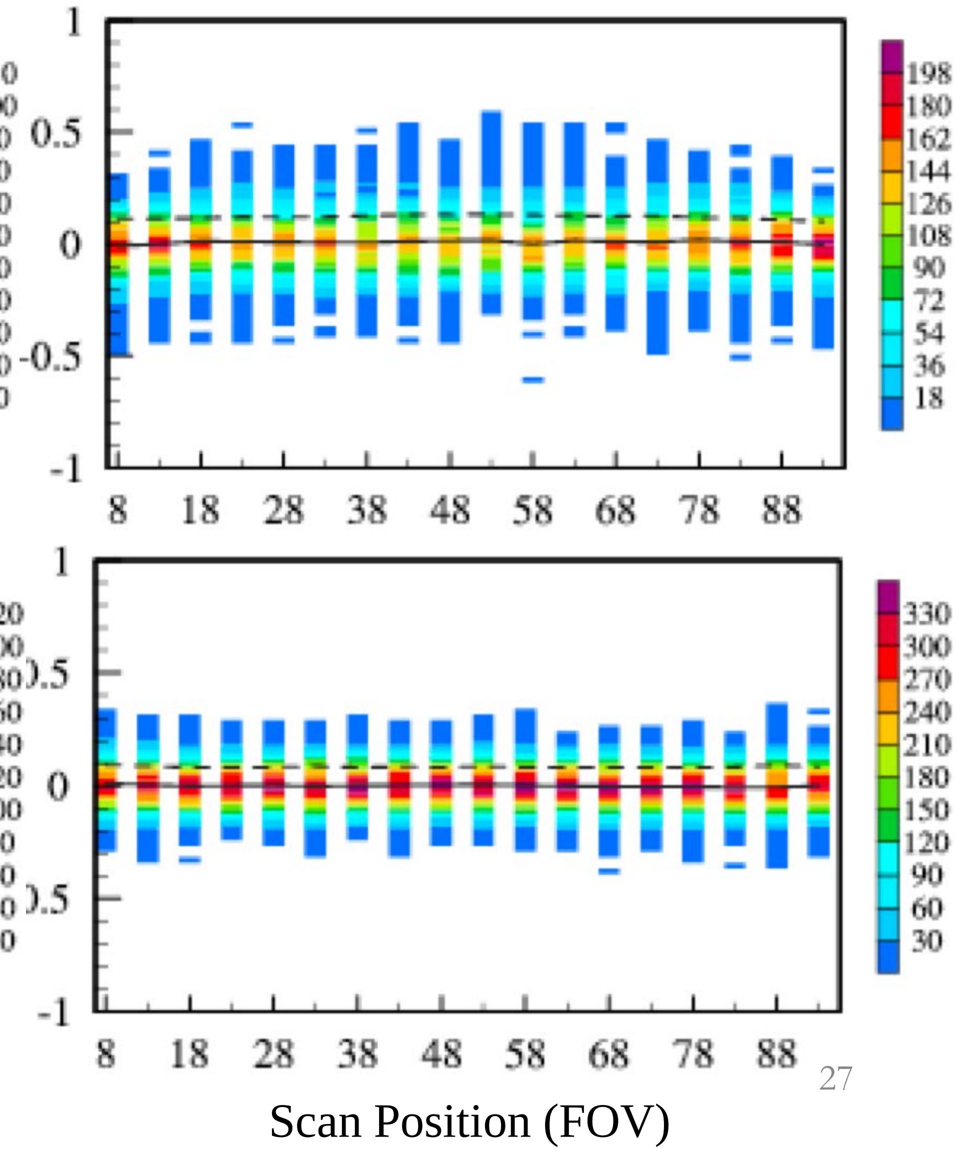
GSI QC performs well for ATMS water vapor sounding channels due to the use of more window channels (1, 2, 16, 17) for cloud detection

O-B and O-A Data Counts for Hurricane Isaac

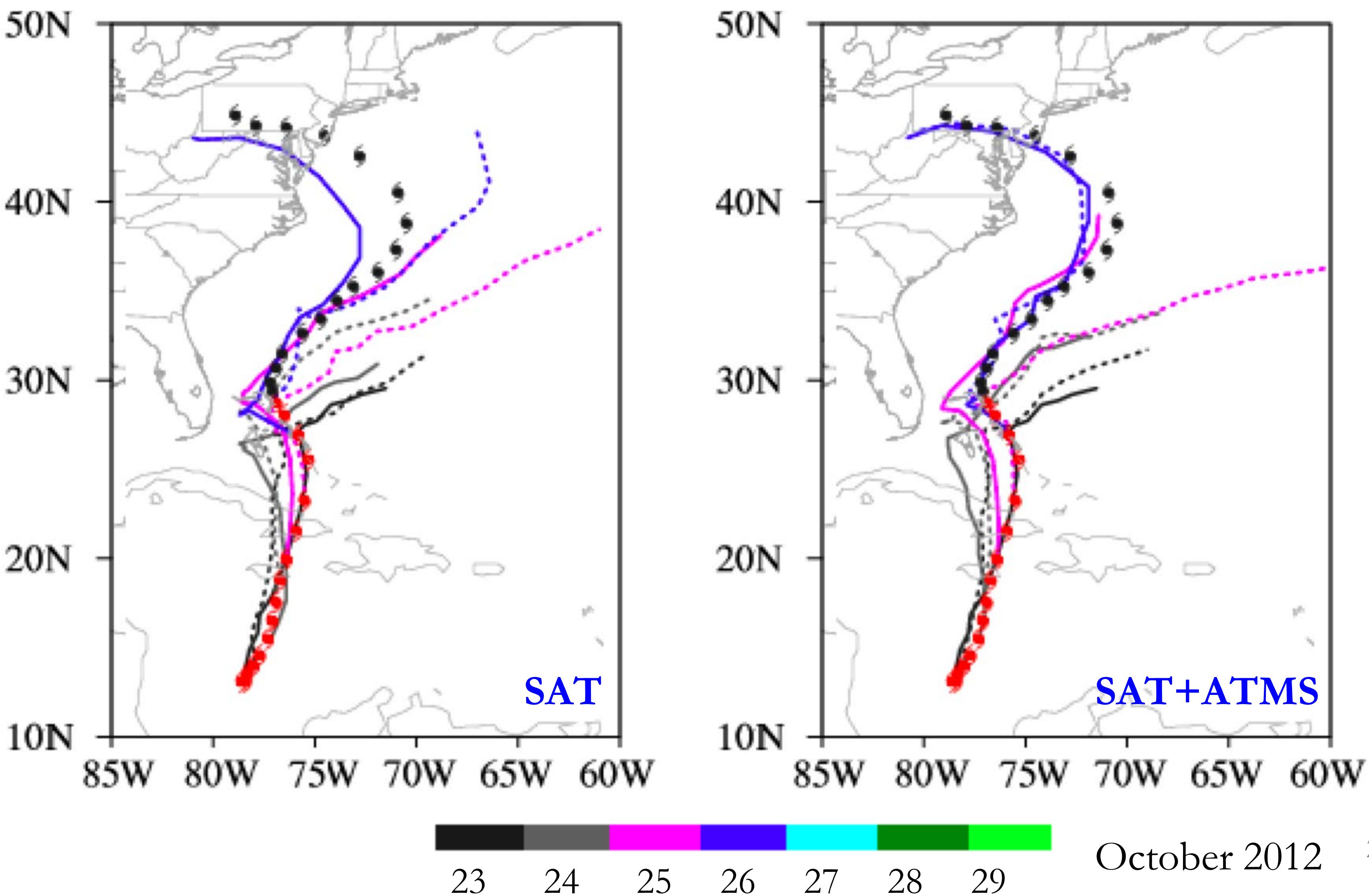
ATMS Channel 6



ATMS Channel 9

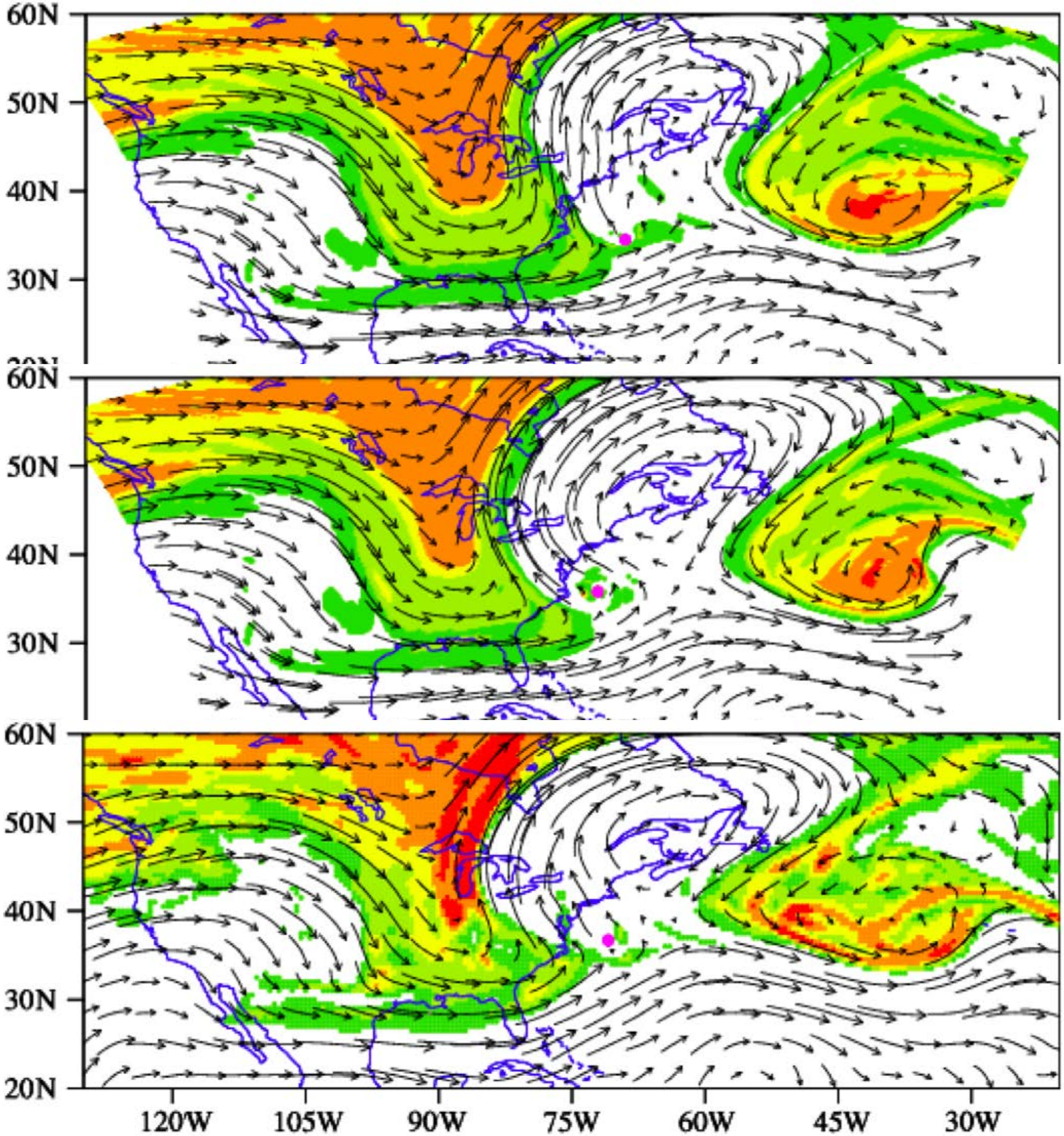


Impacts of ATMS Data Assimilation on Track Forecast of Hurricane Sandy



October 2012

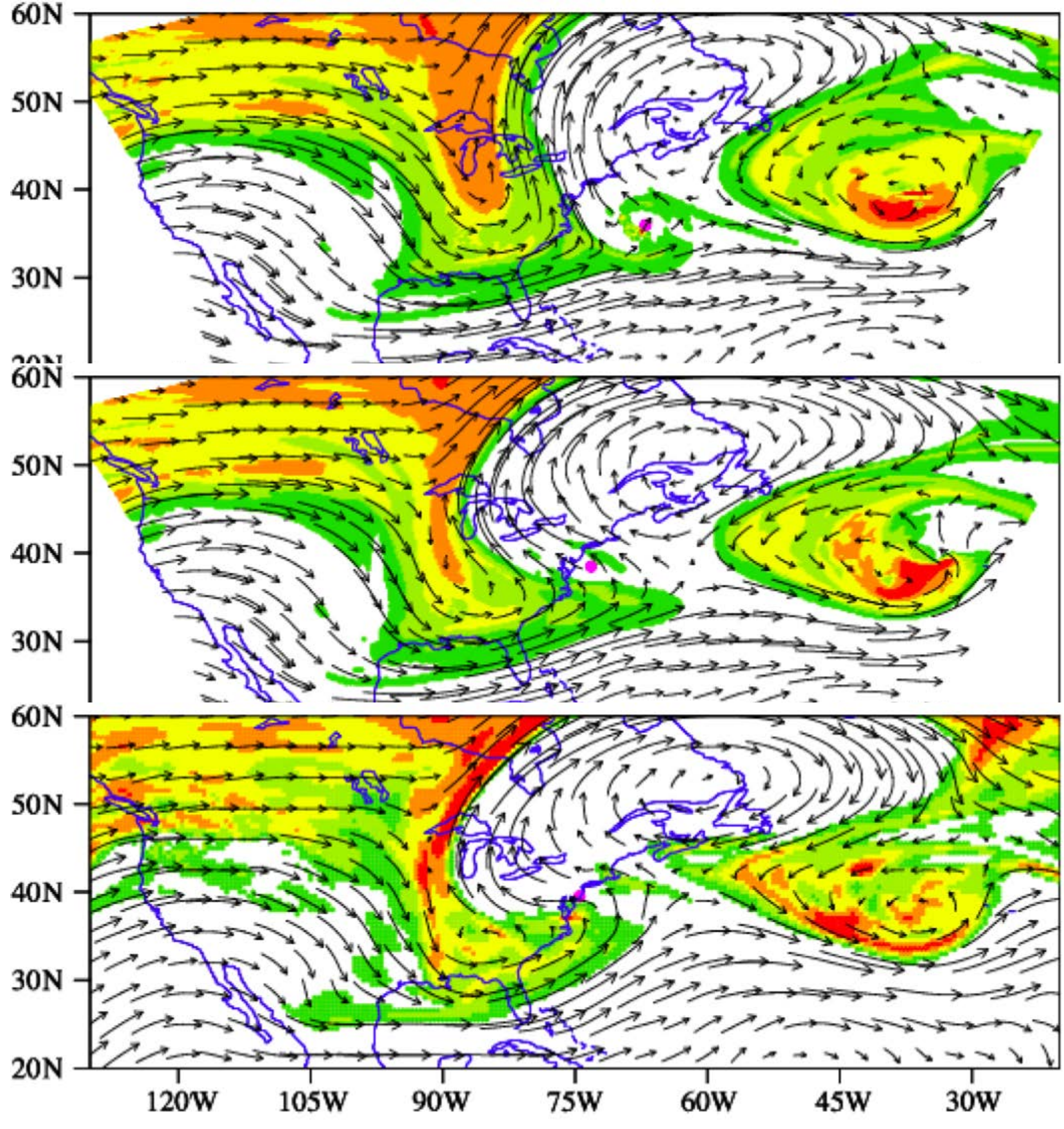
Hurricane Sandy (PV at 200 hPa)



72-h Forecast without ATMS

72-h Forecast with ATMS

NCEP GFS analysis 1200 UTC October 29



Hurricane Sandy (PV at 200 hPa)

84-h Forecast without ATMS

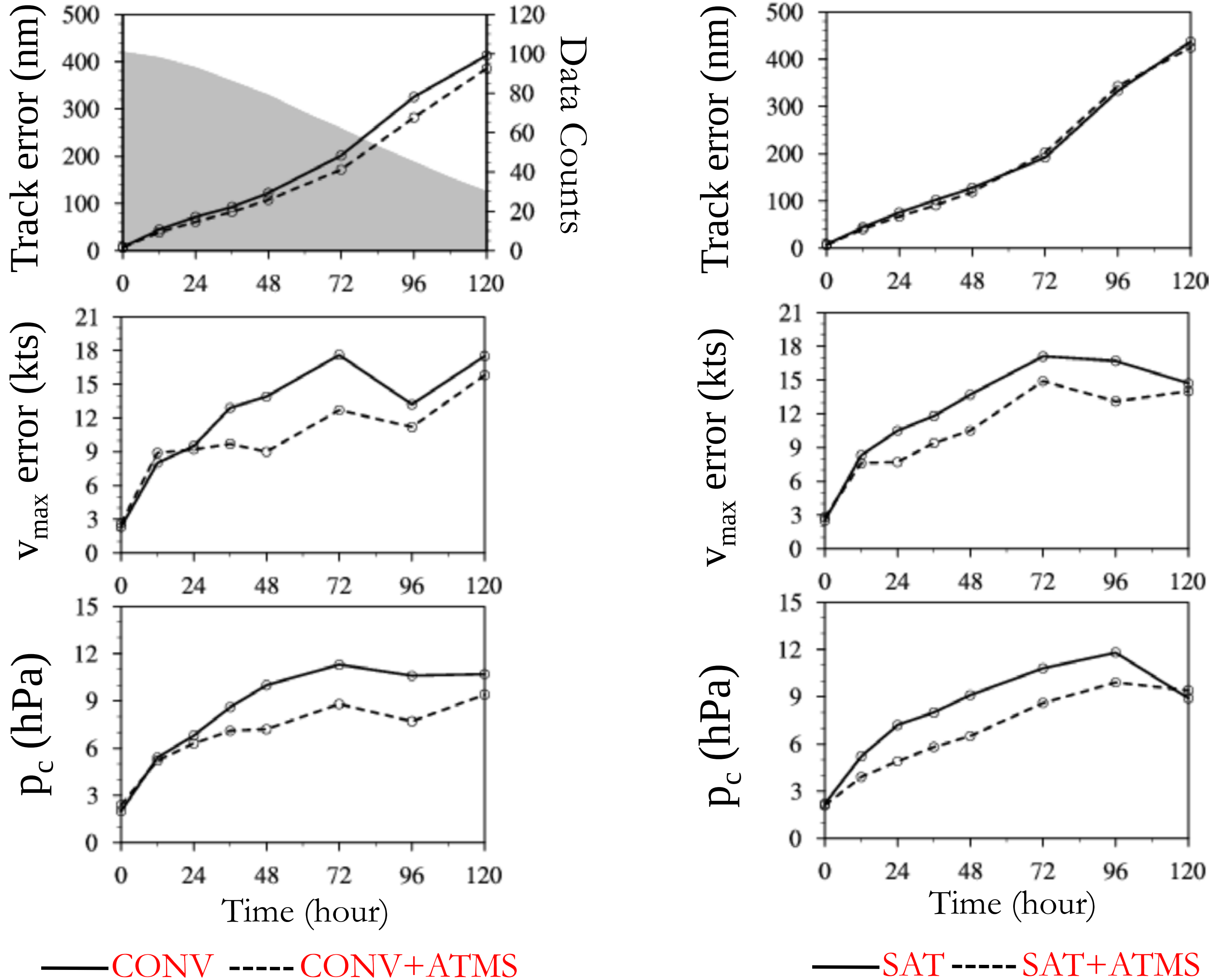
84-h Forecast with ATMS

NCEP GFS analysis

0000UTC October 30

Mean Forecast Errors for Four 2012 Atlantic Hurricanes

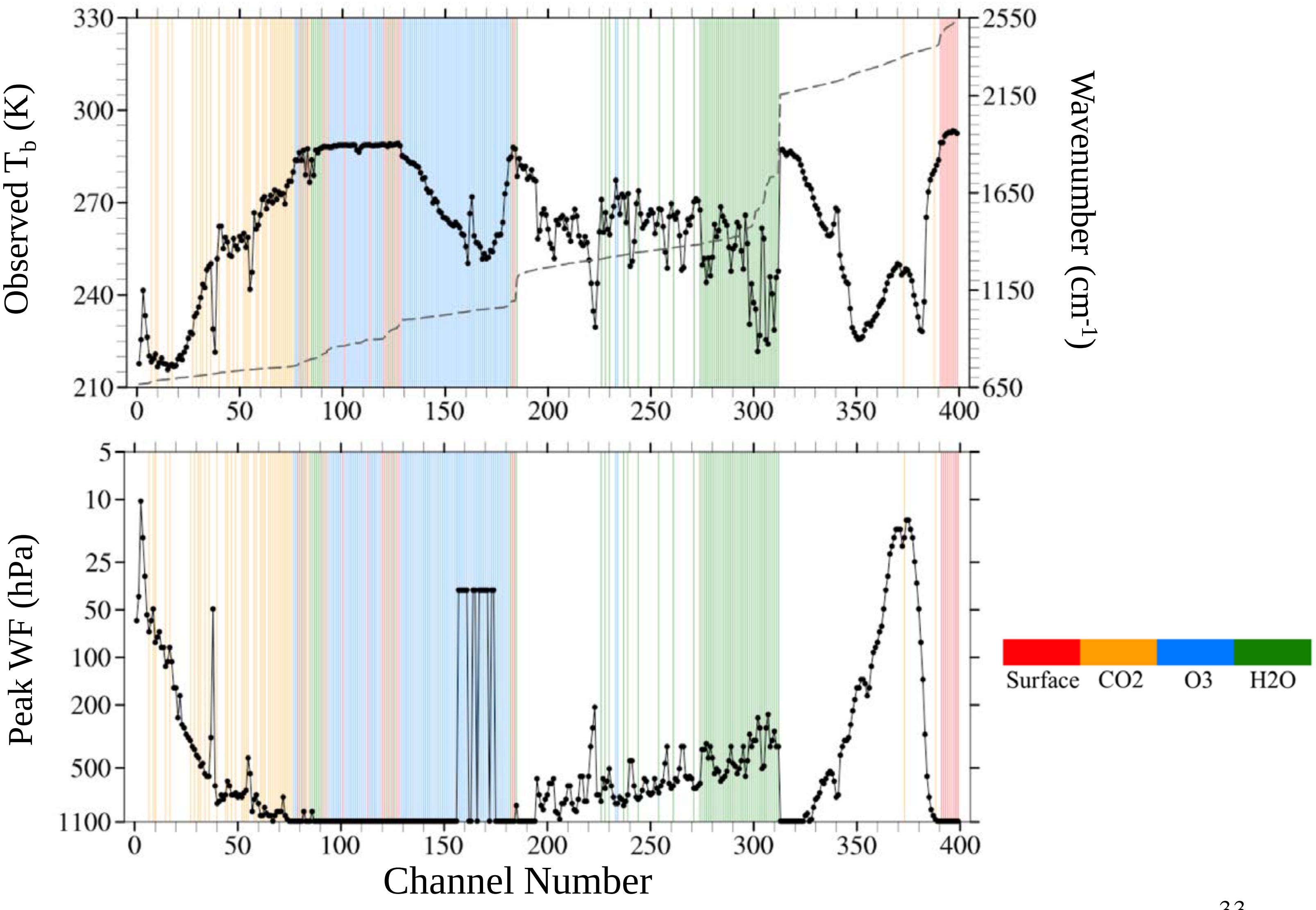
Impact of ATMS Data Assimilation



4. Mixed Impacts of CrIS DA on Hurricane Forecasts

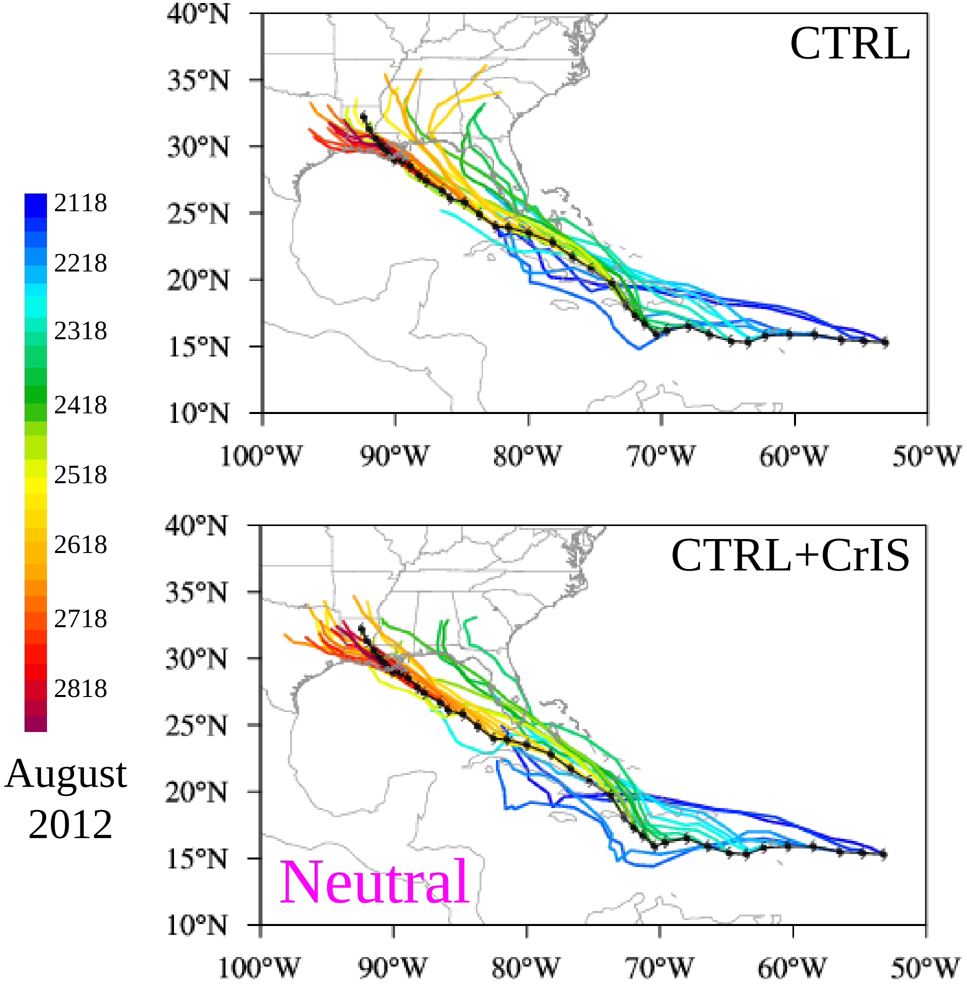
- Examples showing a mixed impact of CrIS DA on TC Forecasts
- Surface-sensitive shortwave channels (3.5-4.6 μm) are cleaner but not assimilated due to the lack of a correction of reflected reflected solar radiance over ocean at daytime
- Nonlocal Thermal Equilibrium emission at 4.3-μm CO_2 band can be as large as several degrees in Kelvin but is not corrected
- There exists a significant discrepancy between GSI calculated and VIRRS retrieved cloud top pressures except for ? cloud

399 CrIS Channels Assimilated in HWRF

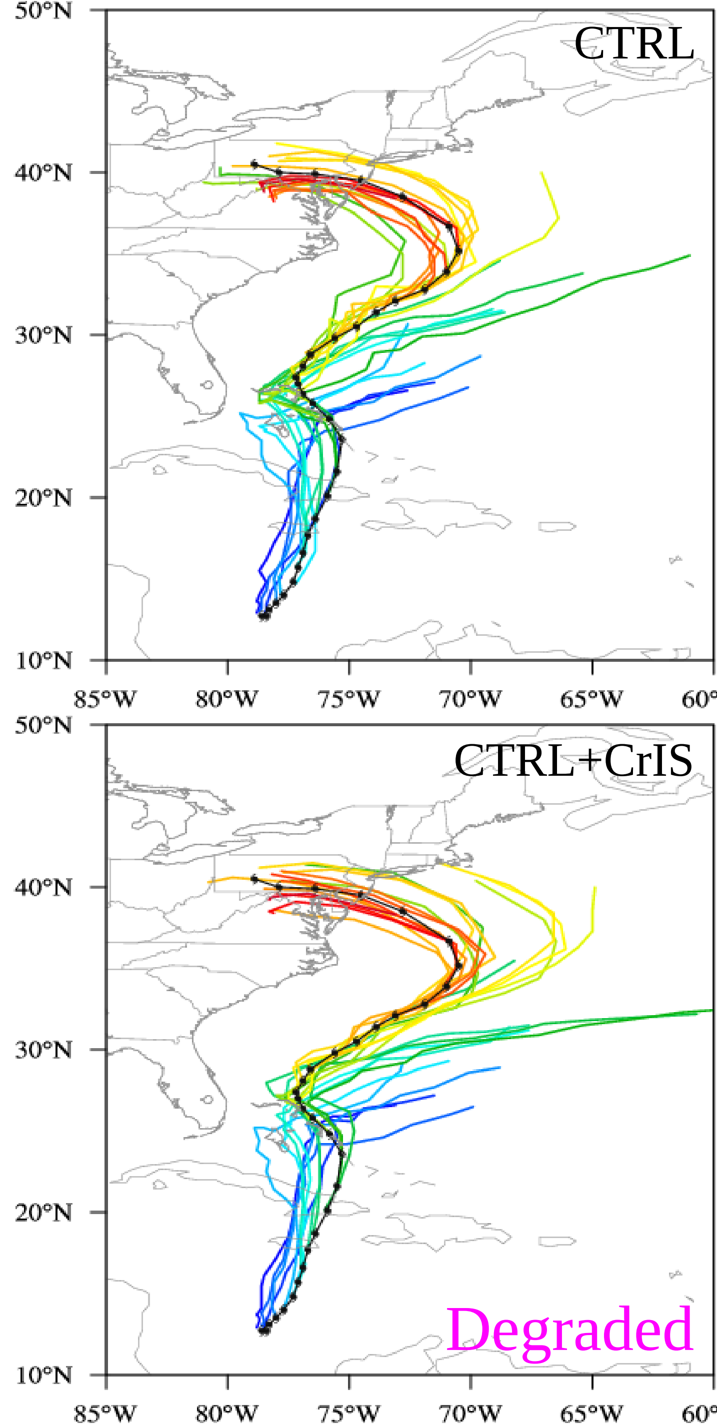


Mixed Impacts of CrIS DA on Track Forecasts

Isaac



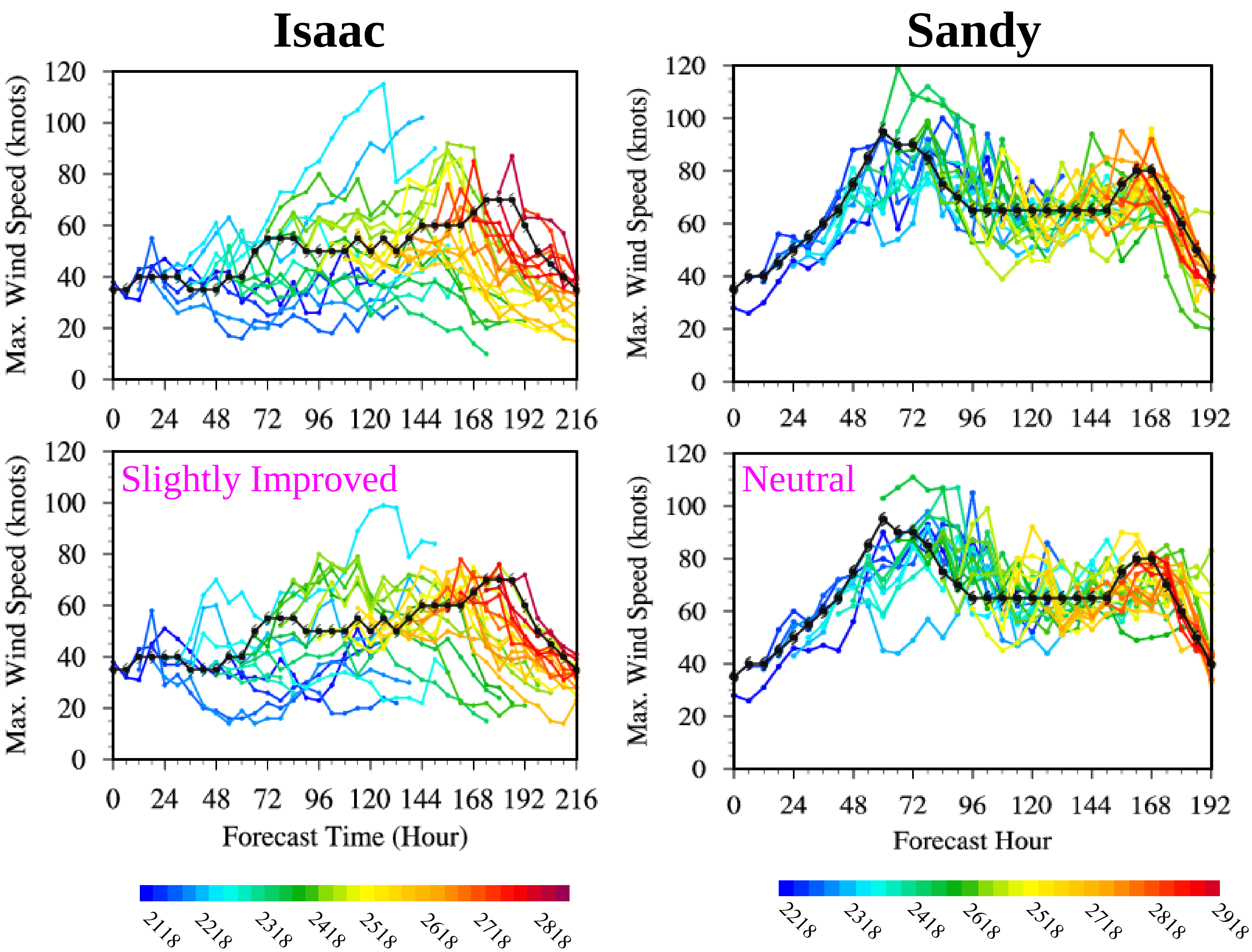
Sandy



Mixed Impacts of CrIS DA on Intensity Forecasts

CTRL

CTRL + CrIS



NLTE and Solar Reflection of Surface Infrared Shortwave Channels

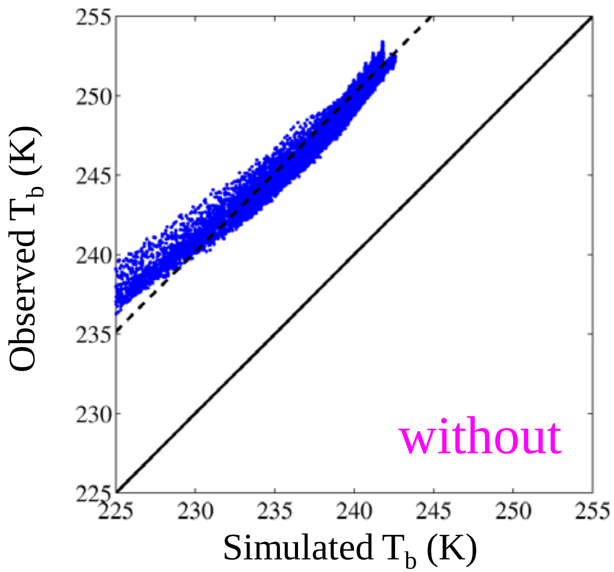
- Nonlocal Thermal Equilibrium (NLTE) emission at 4.3-μm CO_2 band can be as large as several degrees in Kelvin but is not considered in the current HWRF/GSI system
- Surface-sensitive shortwave channels (3.5-4.6 mm) are cleaner but not assimilated due to lack of a correction of reflected solar radiance at daytime in the current HWRF/GSI system

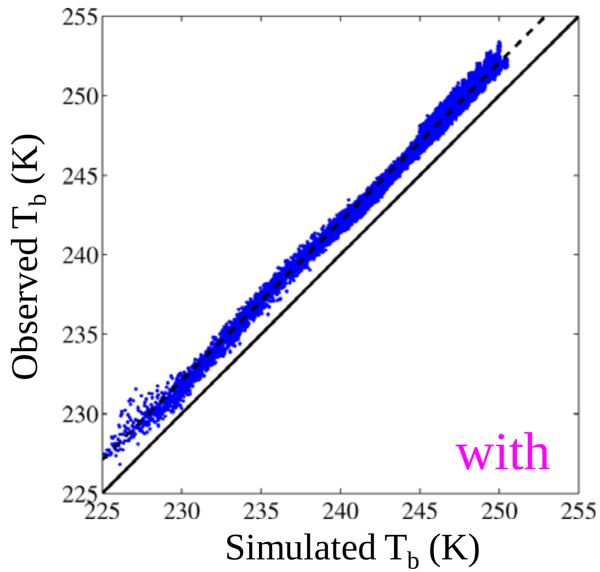
Shortwave infrared sea surface reflection and NLTE effects on CrIS data are assessed using a modified CRTM in which a bidirectional reflectance distribution function (BRDF) for the ocean surface and an NLTE radiance correction scheme developed for the hyperspectral sensors by Chen et al. (2013) are incorporated.

Chen Y., Y. Han, P.-V. Delst, and F. Weng, 2013: Assessment of shortwave infrared sea surface reflection and NLTE effects in CRTM using IASI data. *JTECH*, **30**, 2152-2160.

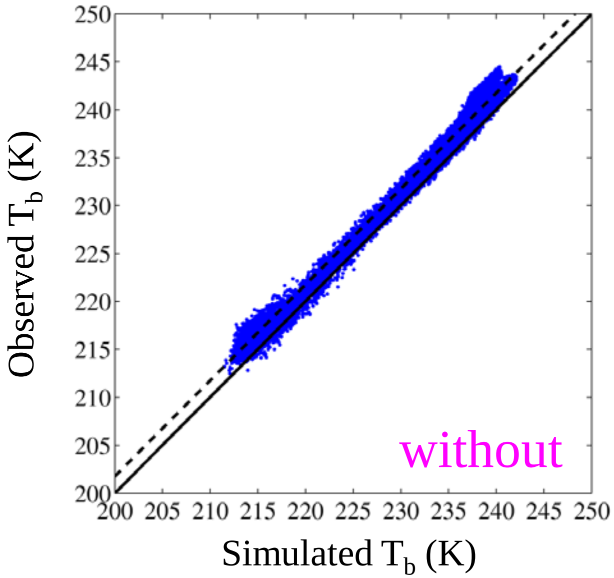
O-B Scatter Plots with and without NLTE Correction

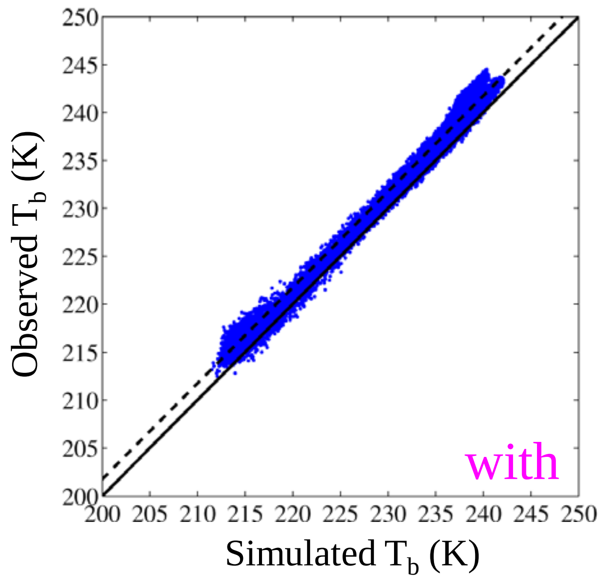
CrIS Channel 1217 (2330 cm^{-1}, 17 hPa)





Data over ocean
Ascending node
1800UTC 10/25/12

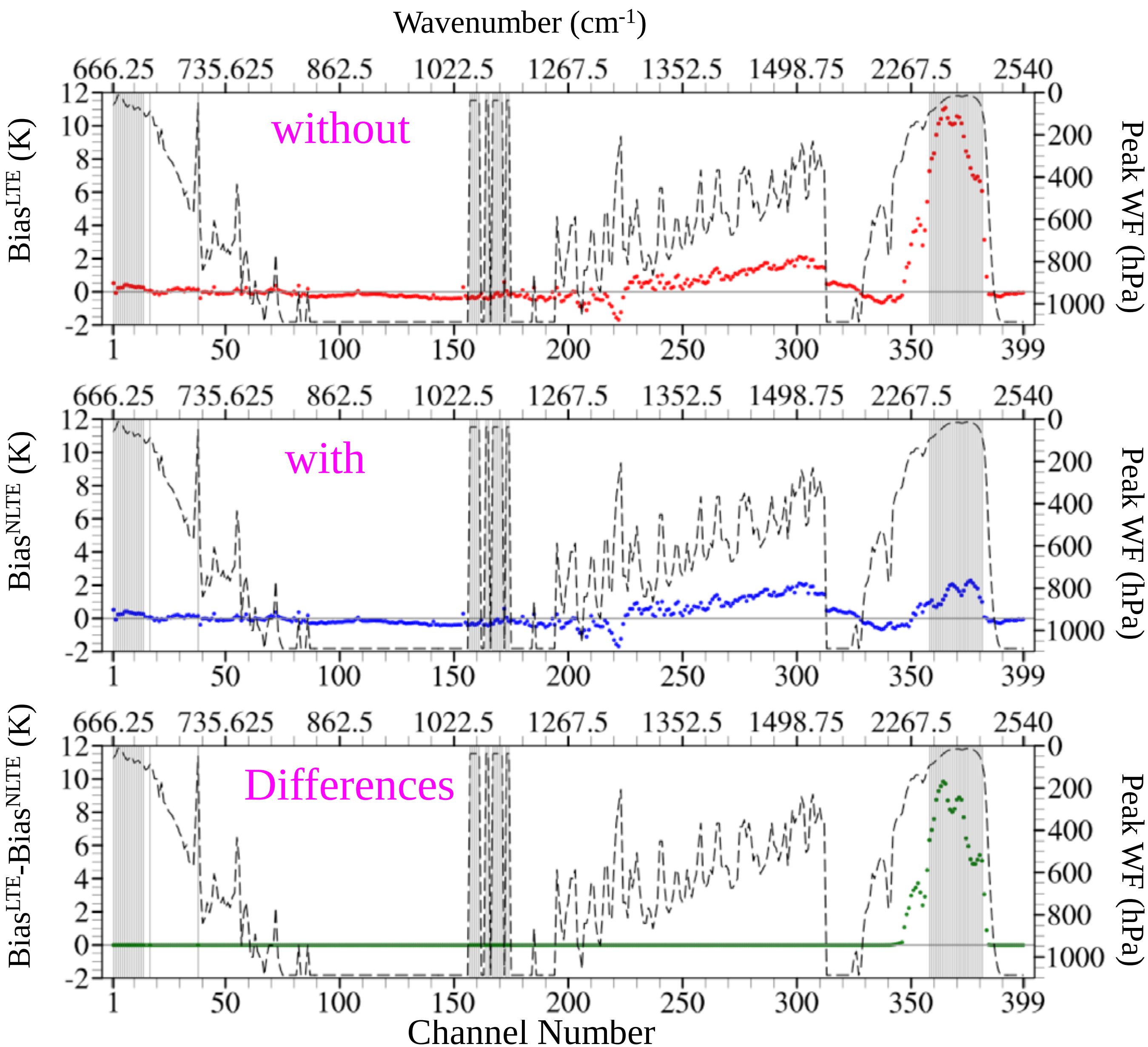




Same channel
Descending node
0600UTC 10/25/12

O-B Biases with and without NLTE Correction

Ascending node, clear-sky data over ocean at 1800UTC during 22-29 October 12



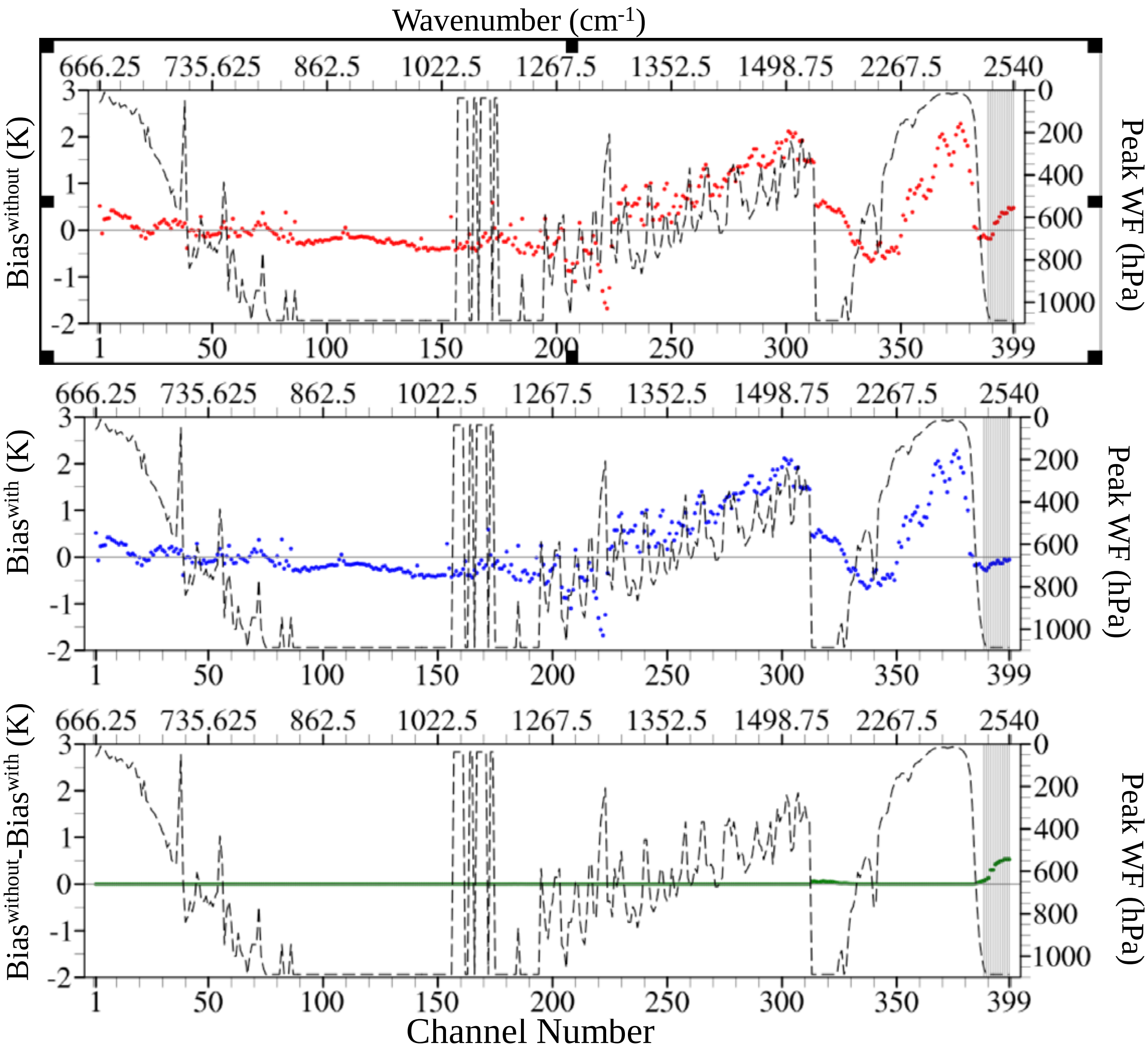
Biases are indicated by colored dots.

Pressure levels at which WF peaks are indicated by the black dashed line.

Channels with WF peaks higher than 100 hPa are indicated by the gray vertical lines.

O-B Biases with and without Solar Correction

Ascending node, clear-sky data over ocean at 1800UTC during 22-29 October 12



Biases are indicated by colored dots.

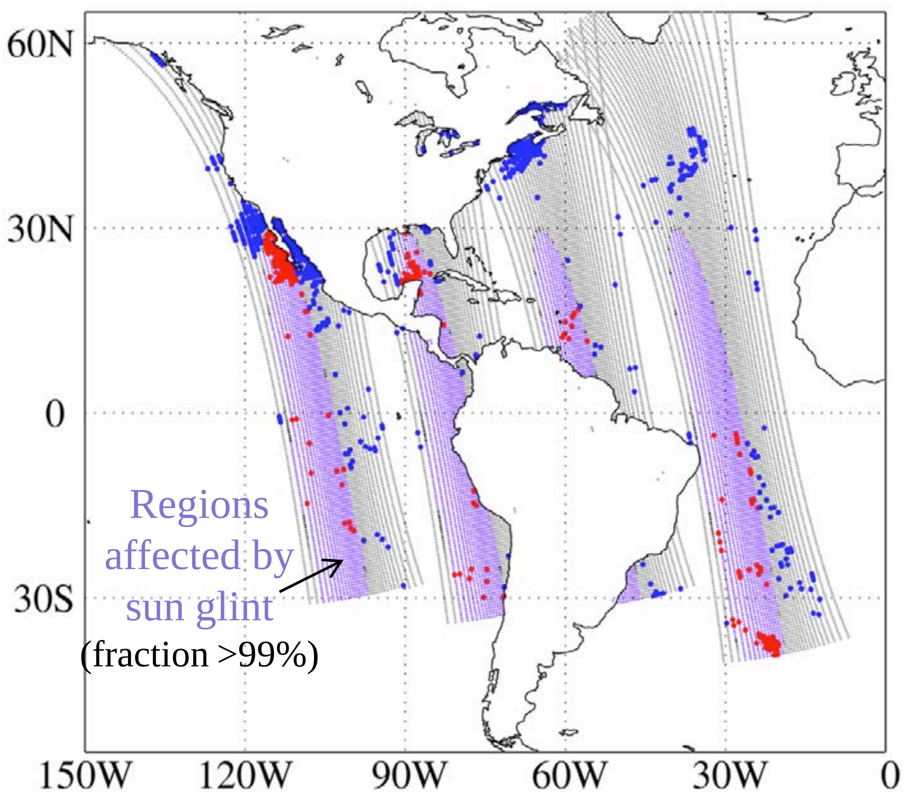
Pressure levels at which WF peaks are indicated by the black dashed line.

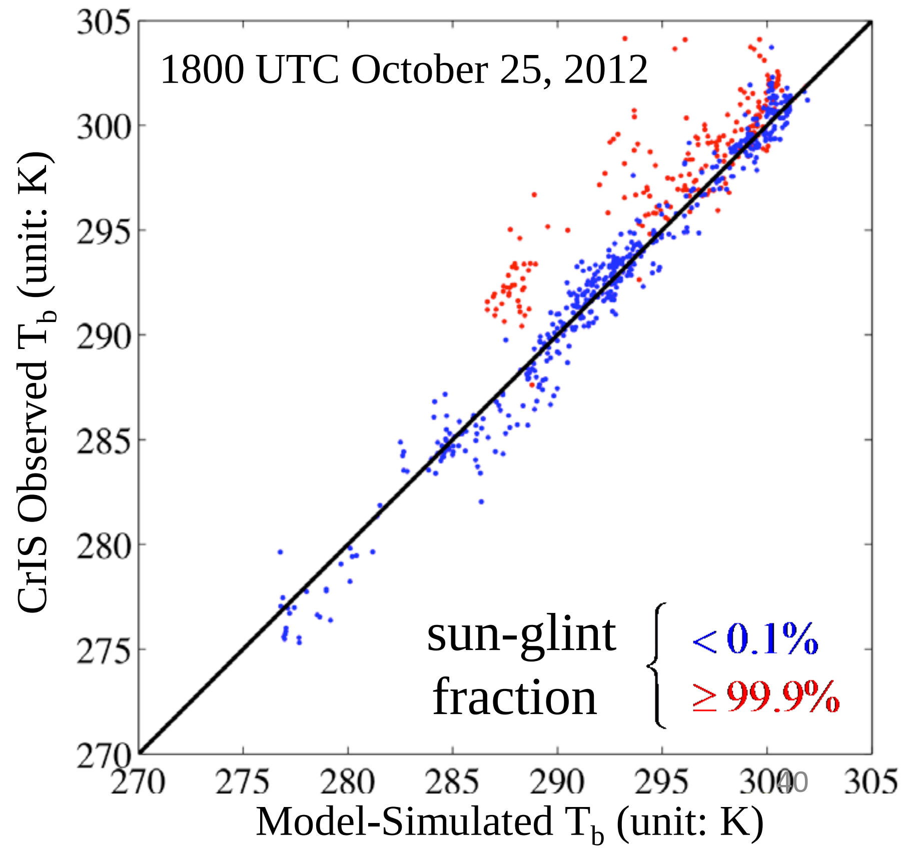
Channels with wavenumbers greater than 2400 μm are indicated by the gray vertical lines.

CrIS Quality Control Related to Sun Glint

Shortwave oceanic data during daytime could be affected by Sun glint. All data with wavenumbers being larger than 2400 cm^{-1} are removed in GSI. But, not all CrIS pixels are affected by sun glint!

CrIS Channel 1293 (2520.0 cm^{-1}) in Clear-Sky Conditions

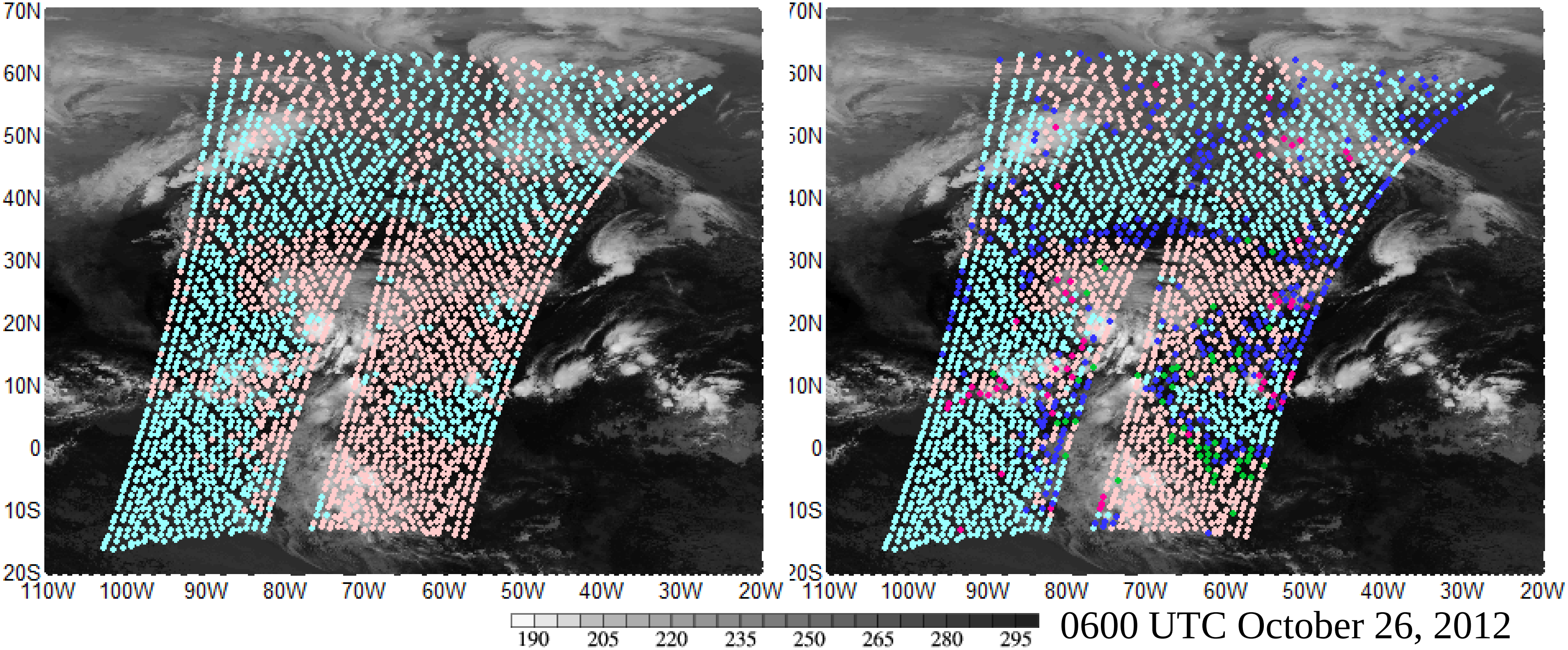




QC for CrIS Channel 80 (699cm^{-1}, 265 hPa)

Current GSI QC

Use VIIRS cloud detection

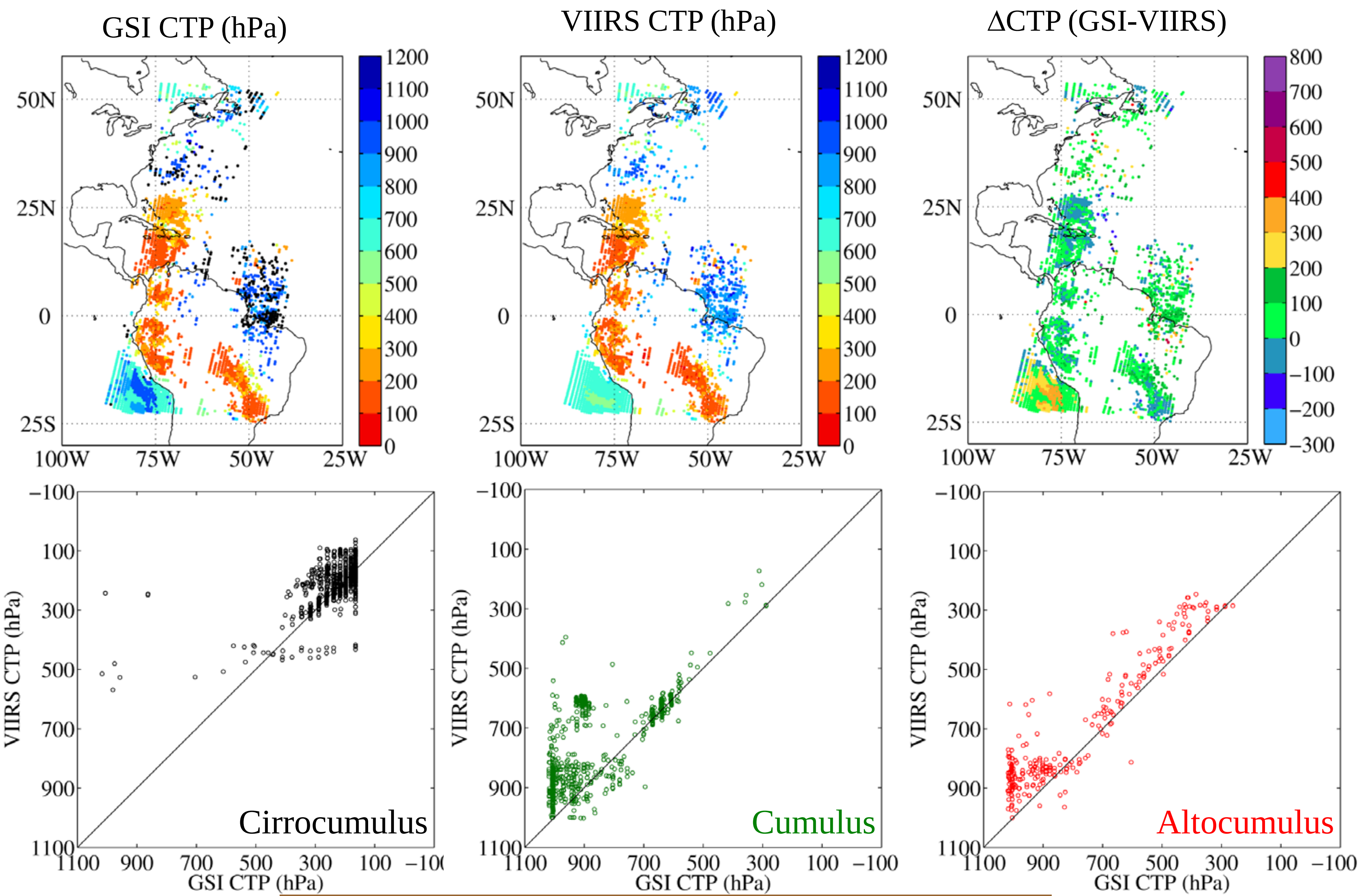


0600 UTC October 26, 2012

- pass all QC
- rejected by original cloud check
- rejected by gross check
- rejected by original cloud check by retained by new cloud check
- pass all QC but rejected by new cloud check
- rejected by old cloud detection, retained by new cloud check but rejected by gross check

VIRRS cloud detection suggests to retain more clear-sky data.

Cloud Top Pressure at 0600 UTC 24 October 2012



GSI cloud top is systematically lower than VIIRS cloud top.

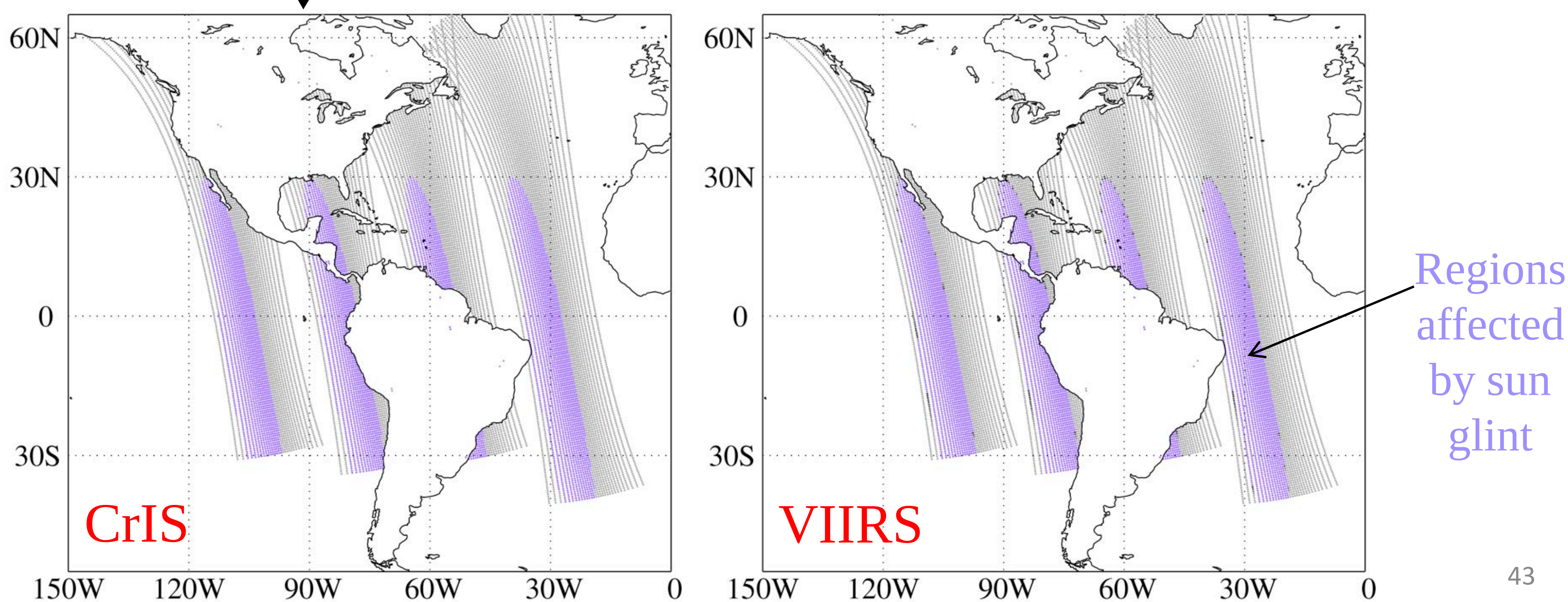
Modified Quality Control Related to Sun Glint

A CrIS pixel is affected by the sun-glint if sun glint angle satisfies

$$0 < \cos^{-1}\left\{\sin\theta_{sat}\sin\theta_{sol}\cos\left[180^{o} - (\phi_{sun} - \phi_{sun})\right] + \cos\theta_{sat}\cos\theta_{sun}\right\} < 36^{0}$$

θ_{sat} – satellite zenith angle $\quad$ θ_{sun} – solar zenith angle

ϕ_{sat} – satellite azimuth angle $\quad$ ϕ_{sun} – solar azimuth angle



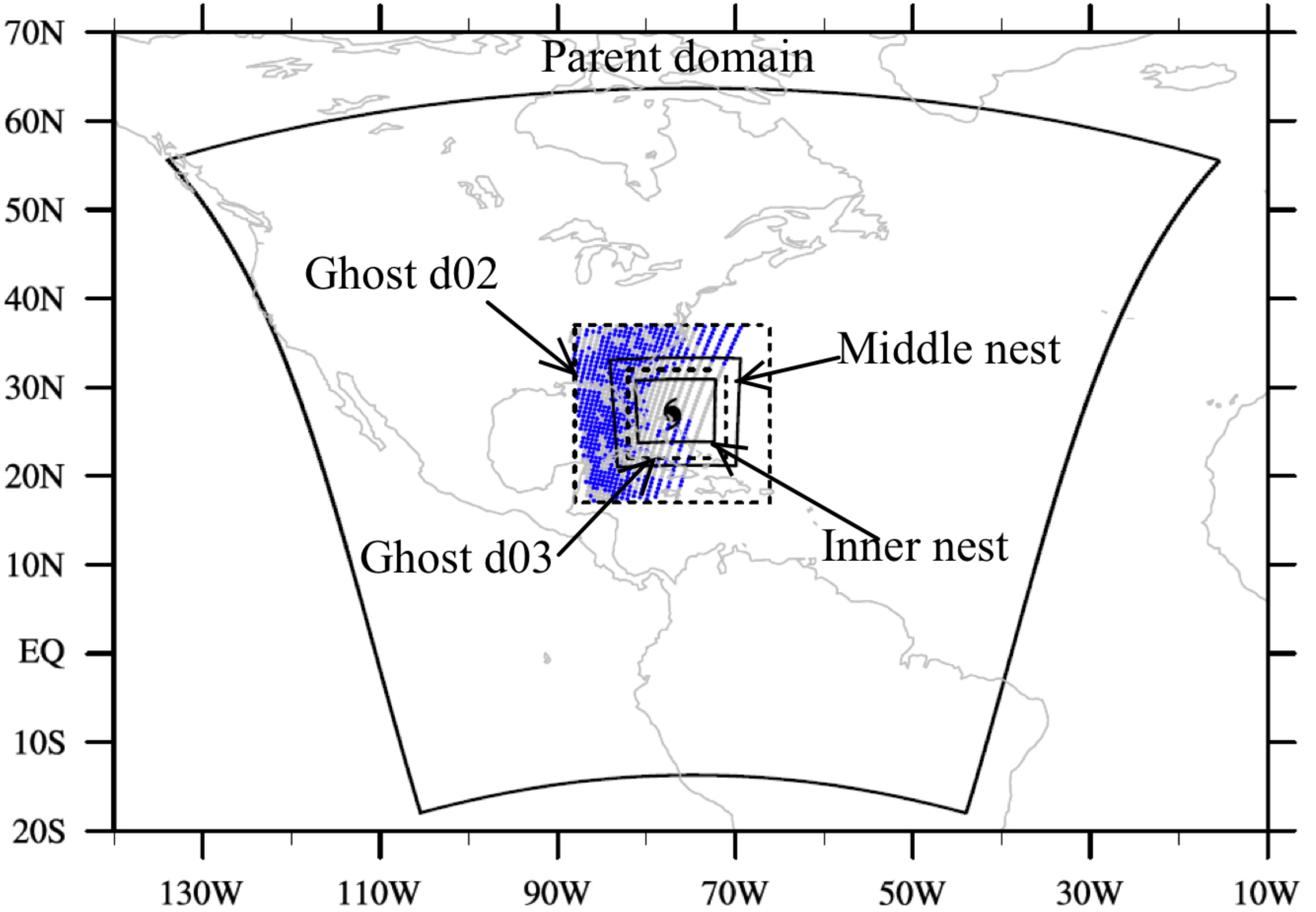
5. Preliminary Results Using 2014 Version of HWRF

- Major Upgrades to 2014 HWRF
  1. Higher model top (2 hPa) and more vertical levels (61)
  2. Satellite DA on middle ghost domain (9 km) and inner ghost nest (3 km)
  3. Improved vortex initialization
  4. DA cycling does not wait until a TC is named

- A Quick Look at 2014 HWRF Results for Hurricane Sandy

- Two Major Concerns
  - To little satellite data are assimilated into HWRF if satellite DA is carried out only within ghost domain (9 km) and inner nest (3 km)
  - Asymmetric components available from satellite retrieval products should be added to vortex initialization

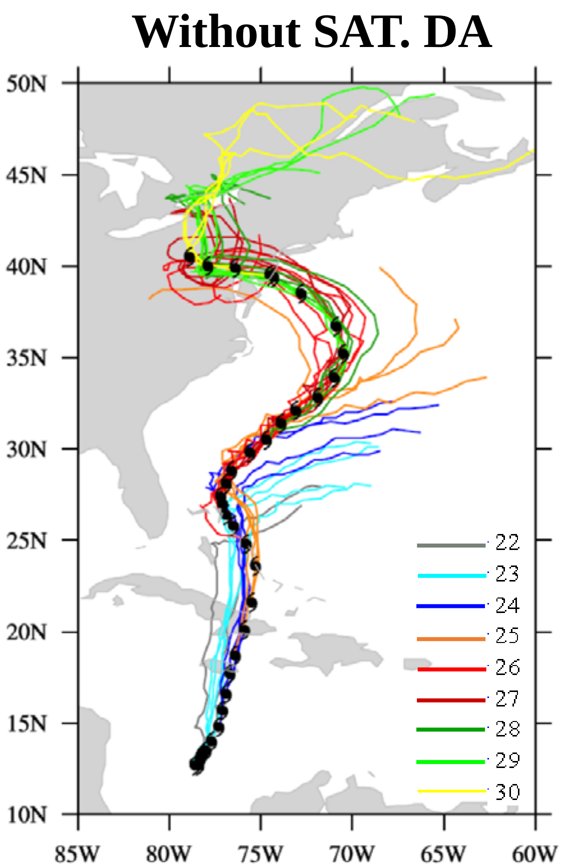
2014 HWRF Domain Setup

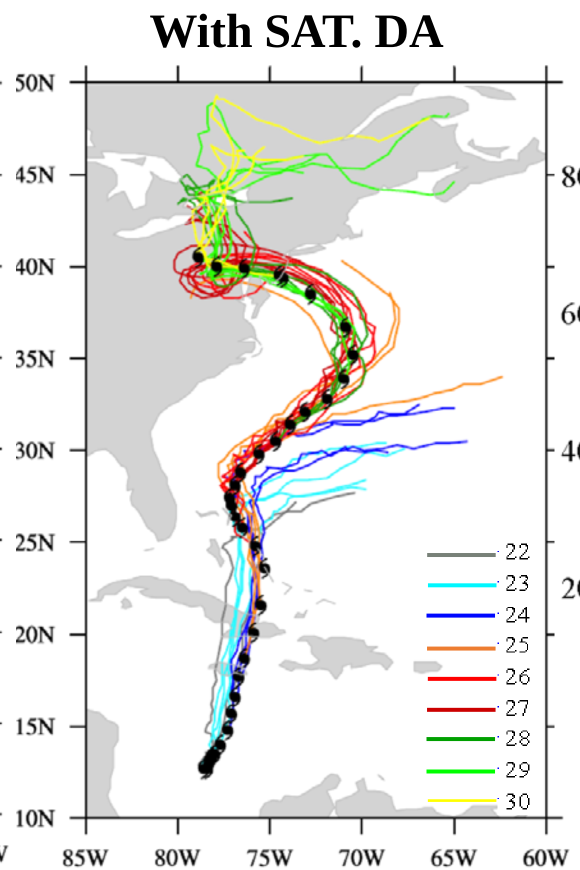


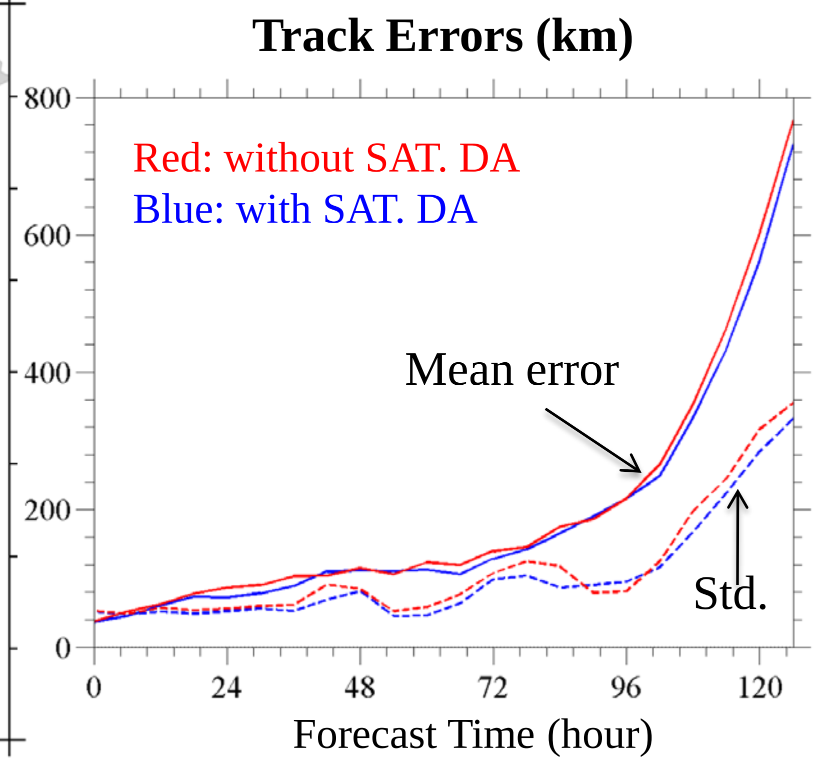
AMSU-A channel 4 data from MetOp-A assimilated in middle ghost domain at 1800 UTC October 26, 2012 are indicated in blue dots.

DA is carried out in both Ghost d02 (9 km) and Ghost d03 (3 km).

Sandy Track Forecasts by 2014 HWRF

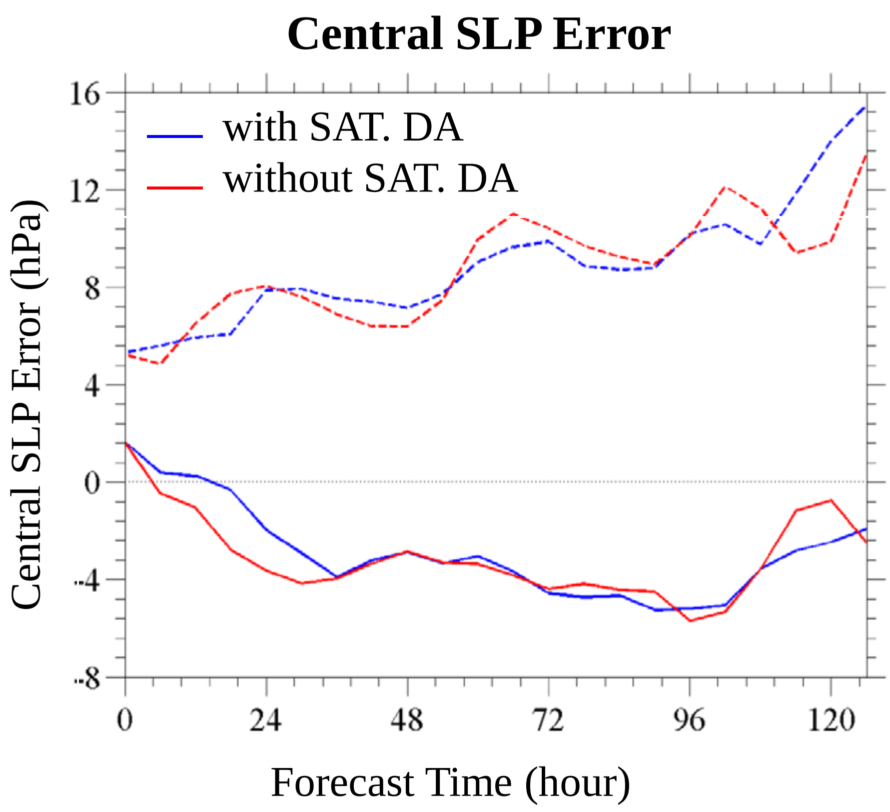


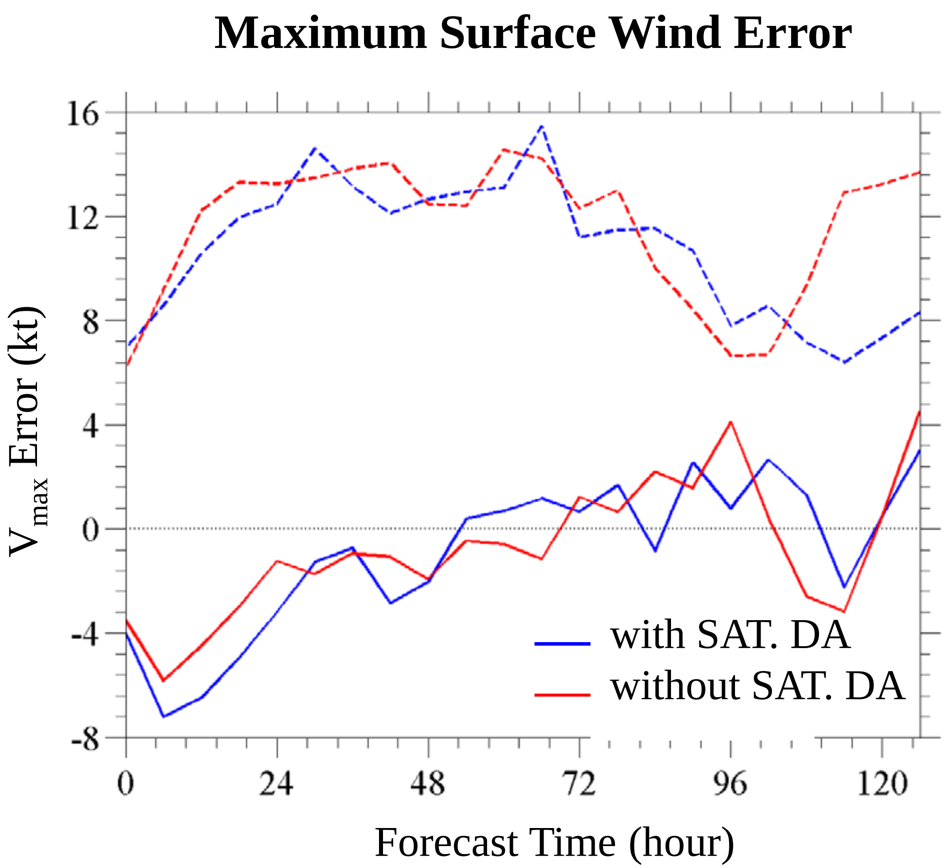




Satellite DA has a marginal positive impact on Sandy's track forecasts.

Sandy Intensity Forecasts with and without Satellite DA Using 2014 HWRF





Satellite DA has a marginal positive impact on Sandy intensity forecasts.

Summary and Conclusions

- The HWRF system was re-configured to have more vertical layers and a higher model top for more effective uses of upper-level satellite sounding data in HWRF, which enabled the HWRF model to generate an improved atmospheric steering flow and thus the movement of tropical cyclones

- A collocated FOV distribution between ATMS temperature and humidity channels makes the cloud detection more effective

- ATMS data assimilation in GSI/HWRF results in a consistent positive impact on the track and intensity forecasts of 2012 landfall hurricanes

- CrIS QC and cloud detection schemes are diagnosed and improved.

- Improvements in the GSI quality control for CrIS channels remain critical and challenging

More details can be found in

Zou, X., F. Weng, Q. Shi, B. Zhang, C. Wu and Z. Qin, 2013: Satellite data assimilation in NWP models. Part III: Impacts of model top on radiance assimilation in HWRF. *J. Atmos. Sci.*, (submitted)

Zou, X., F. Weng, B. Zhang, L. Lin, Z. Qin and V. Tallapragada, 2013: Impact of ATMS radiance data assimilation on hurricane track and intensity forecasts using HWRF. *J. Geophys. Res.*, **118**, 11,558-11,576.

Da C., X. Zou, X., F. Weng, B. Zhang and V. Tallapragada, 2014: Satellite data assimilation in NWP models. Part VI: Impact of CrIS radiance data on hurricane track and intensity forecasts using HWRF. *J. Atmos. Sci.*, (in preparation) .

Zou, X., Z. Qin and F. Weng, 2014: Two separate quality control approaches for MHS data assimilation over land and ocean. *J. Atmos. Sci.* (to be submitted)

Weng, F., X. Zou, X. Wang, S. Yang, and M. D. Goldberg, 2012: Introduction to Suomi NPP ATMS for NWP and tropical cyclone applications. *J. Geophy. Res.*, **117**, D19112, 14pp, doi:10.1029/2012JD018144.

2014 STAR JPSS Science Teams Annual Meeting

ATMS/CRIS SDR Team Leads

ATMS SDR Team

Major Accomplishments (1/3)

- **SNPP ATMS TDR and SDR products have been declared a validated maturity level**
  - Noises for SNPP are well characterized and meet much lower than specification
  - ATMS processing coefficient table (PCT) were updated with nominal values
  - Destriping algorithms are being developed for K/Ka/V-band only
  - Geolocation errors for all the channels are quantified and are smaller than specification
  - On-orbit absolute calibration was explored using GPS RO data, LBLRTM and ATMS SRF. The biases at the upper-air sounding channels are characterized
  - Remap SDR (RSDR) coefficients were optimally set and RSDR biases are assessed
  - ATMS SDR products are well documented through ATBD, user manuals, OAD, peer reviewed publications

Major Accomplishments (2/3)

- **JPSS-1 Prelaunch Activities**
  - Completed the CP Mid and CP High data analysis of J1 ATMS TVAC data
  - The analyses are conducted by four groups with consistent results
  - NEDT meets specification, except for channel 17
  - Calibration accuracy and nonlinearity are meeting the spec
  - Striping is less significant in V-band but more pronounced at WG bands. Some low frequency coherent noise at 10/20 Hz at mid temp; and 2, 4, and 5 Hz at low temp are shown (root-cause is to be investigated)

Major Accomplishments (3/3)

- **Advance in General SDR Sciences**
  - From 19th ITSC, NWP users including NWS, ECWMF and UKMET require ATMS destriping data (30-45 days) in BUFR format. ATMS team is responding to request but, the algorithm is being developed.
  - ATMS resampling algorithm is generalized to generate the TDR/SDR products at 2.2 degree and will be made available for National Hurricane Center storm monitoring
  - Advanced radiance transformation system (ARTS) is being developed for SNPP and J1 processing. The system will further enhance the products and correct the angle dependent errors.
  - A polarization correction term is developed and can be applied in TDR to SDR conversion to improve the calibration at the surface sensitive channels

Future Plan (1/3)

- **Refinements of SNPP ATMS TDR and SDR Products Quality**
  - Standardize the NEDT calculation algorithm
  - Provide timely updates on ATMS processing coefficient table (PCT)
  - Make the destriping algorithms operational at IDPS and ART systems
  - Update ATMS ATBD, user manuals, OAD

Future Plan (2/3)

- **Continue JPSS-1 Prelaunch Activities**
  - Complete the analysis of J1 ATMS TVAC data at low, mid and high temperatures
  - Generate the J1 PCT and deliver it for IDPS algorithm update
  - Develop the proxy data for ATMS J1 algorithm
  - Improve destriping algorithms for J1 ATMS WG band applications

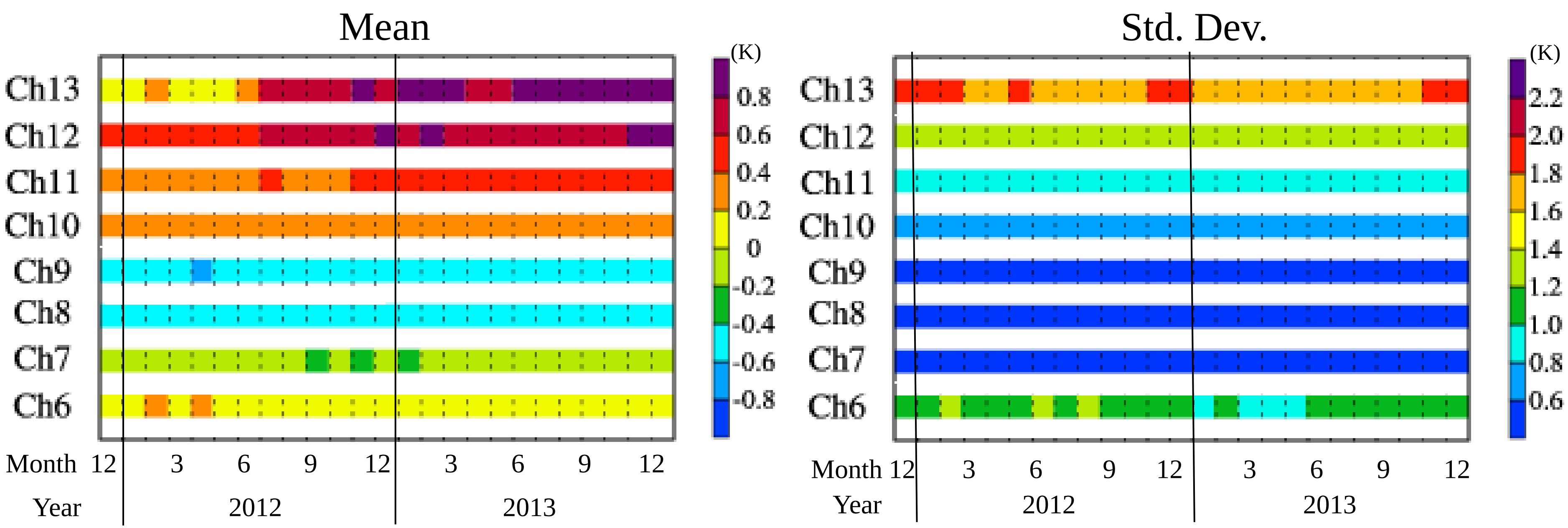
Future Plan (3/3)

- **Advanced SDR Sciences**
  - Generate SNPP ATMS destrping data (30-45 days) in BUFR format and deliver to NCEP NWP impact tests
  - Generalize ATMS resampling algorithm at 2.2 degree for Ka/K/V bands
  - Implement all the QC flags in Advanced radiance transformation system (ARTS) and make it ready for SNPP and J1 processing
  - Implement a polarization correction term from third Stokes component for the TDR to SDR conversion

Backslides

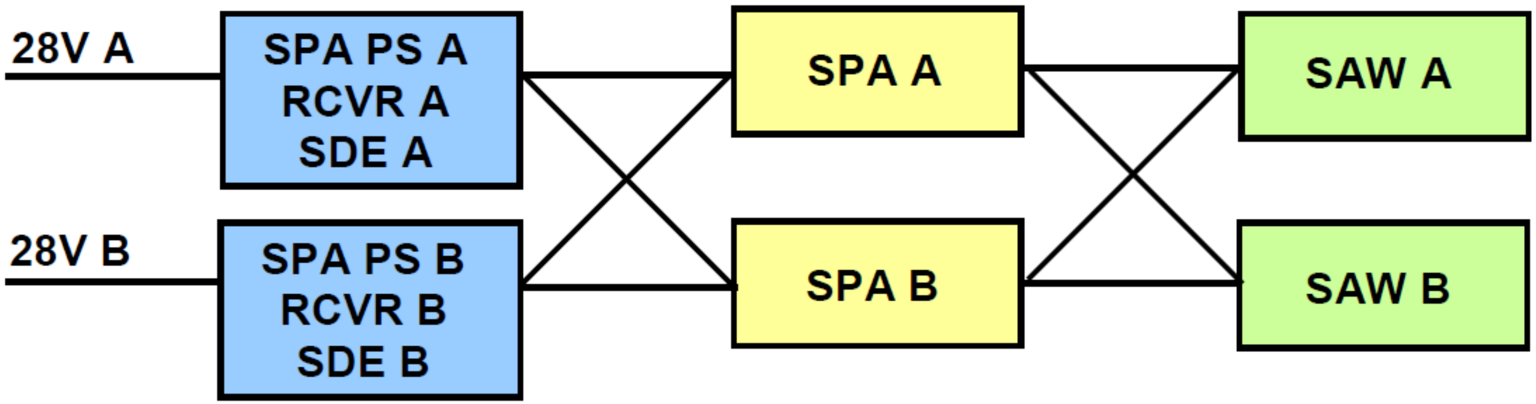
Monthly Mean of O-B^COSMIC

Clear-sky, over ocean, 60°S ~ 60°N, Dec. 10, 2011 ~ Dec. 31, 2013



Channels 6 to 11 show consistently stable mean O-B and standard deviation.

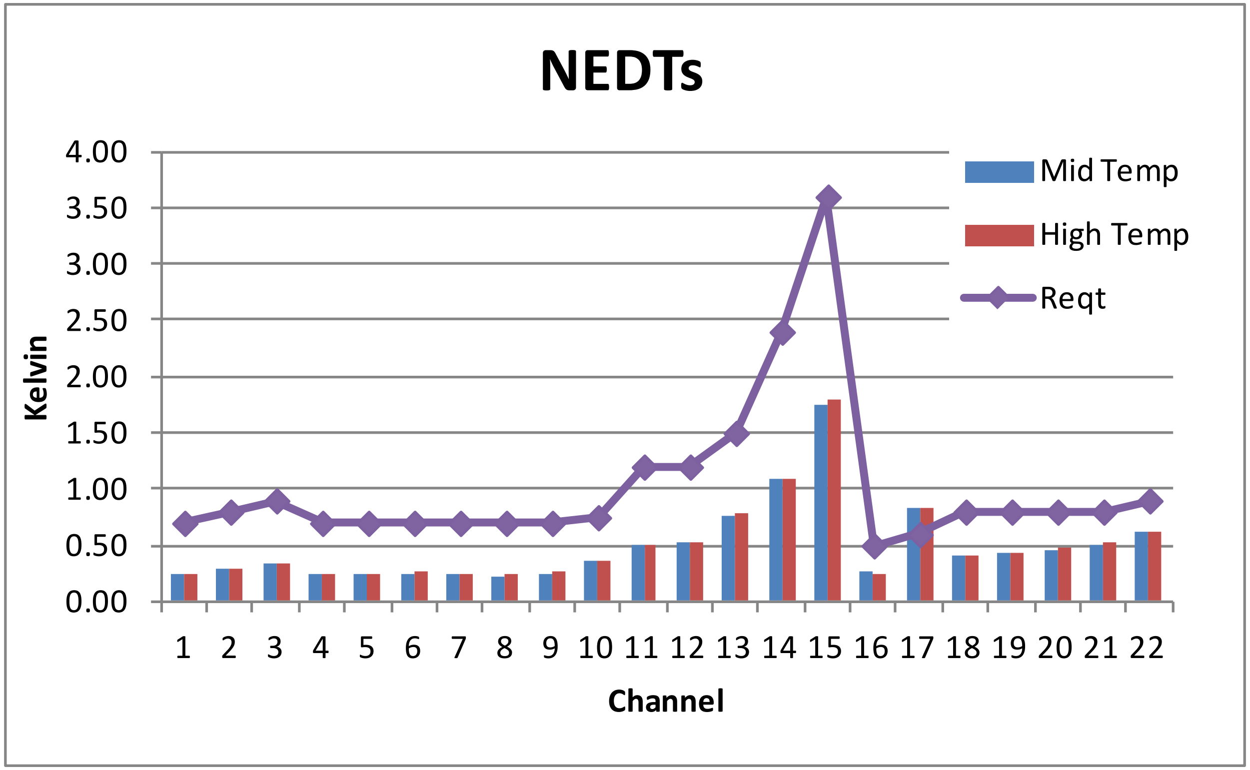
J1 ATMS TVAC Redundancy Configuration



CONFIG.	SPA PS	RECEIVER SELECT	SDE SELECT	SPA CROSS	SAW CROSS
1	A	REC A - PLO, CSO, GDO, RPS	SDE A	SPA A	SAW A
2					SAW B
3				SPA B	SAW B
4					SAW A
5	B	REC B - PLO, CSO, GDO, RPS	SDE B	SPA B	SAW B
6					SAW A
7				SPA A	SAW A
8					SAW B

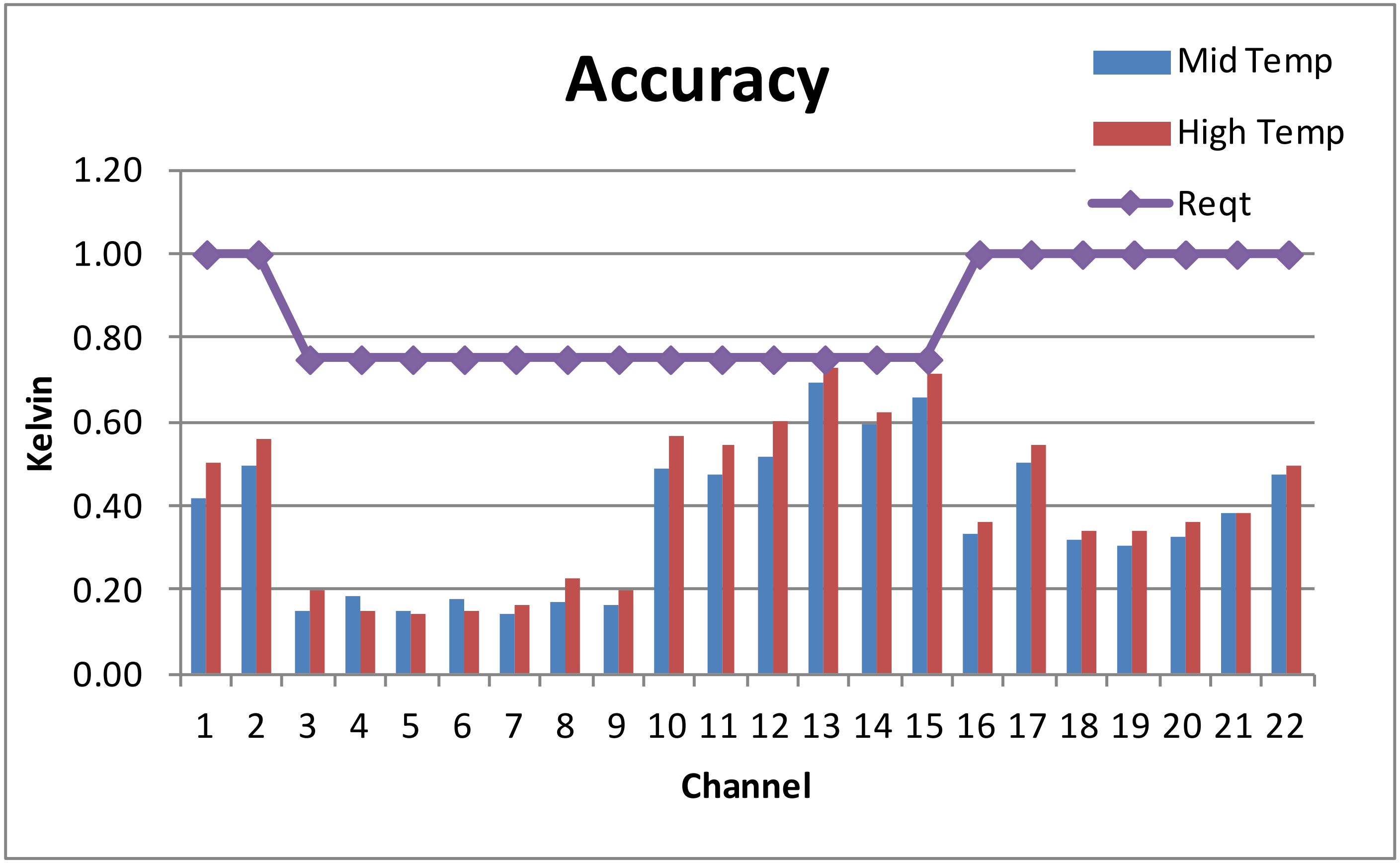
JPSS1 ATMS NEDT Performance

- Worst Case of 4 Redundancy Configurations
- Scene temperature at 300 K



- Waiver request will be submitted for Channel 17 NEDT
- All other channels compliant

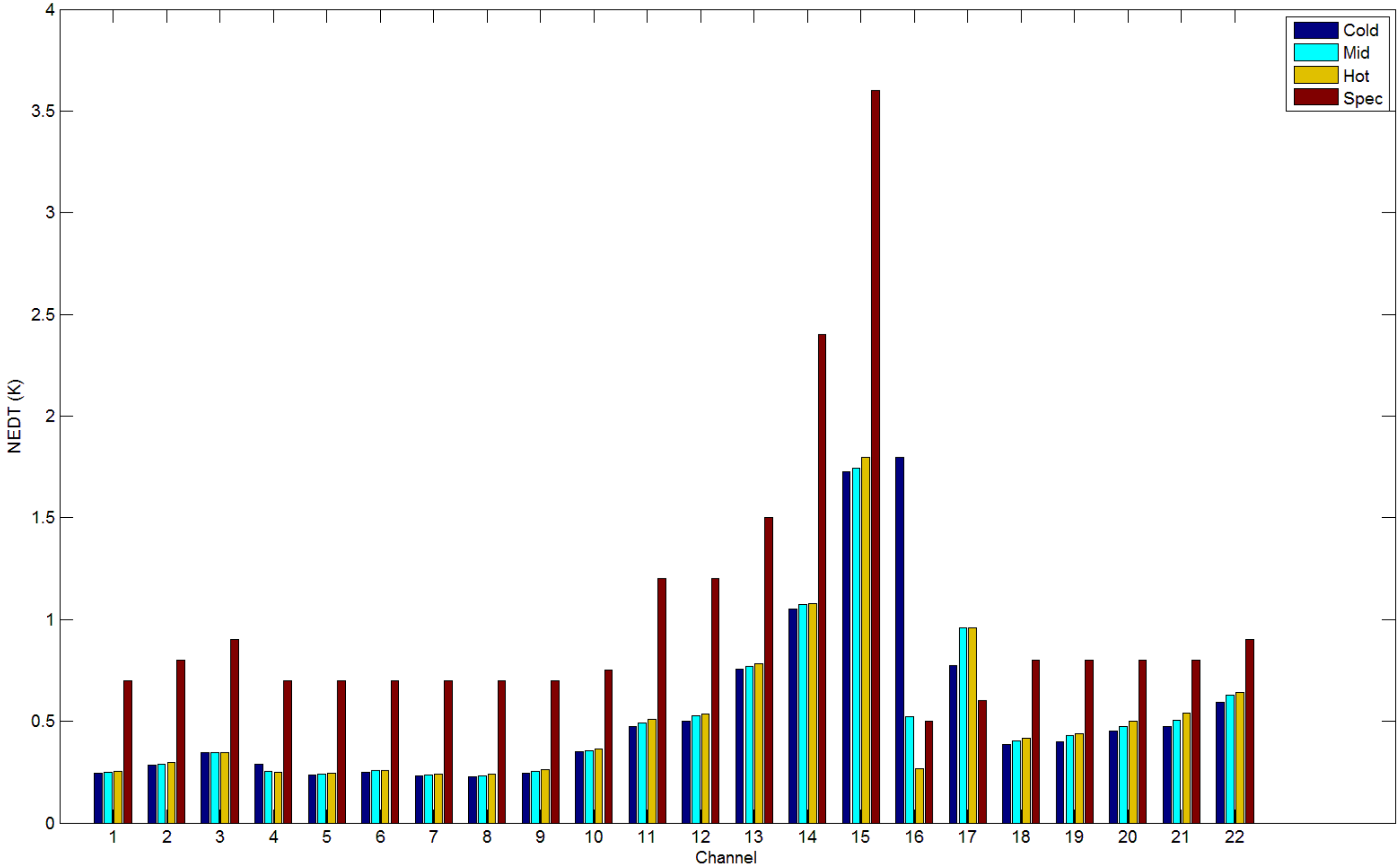
JPSS1 ATMS On-Orbit Accuracy



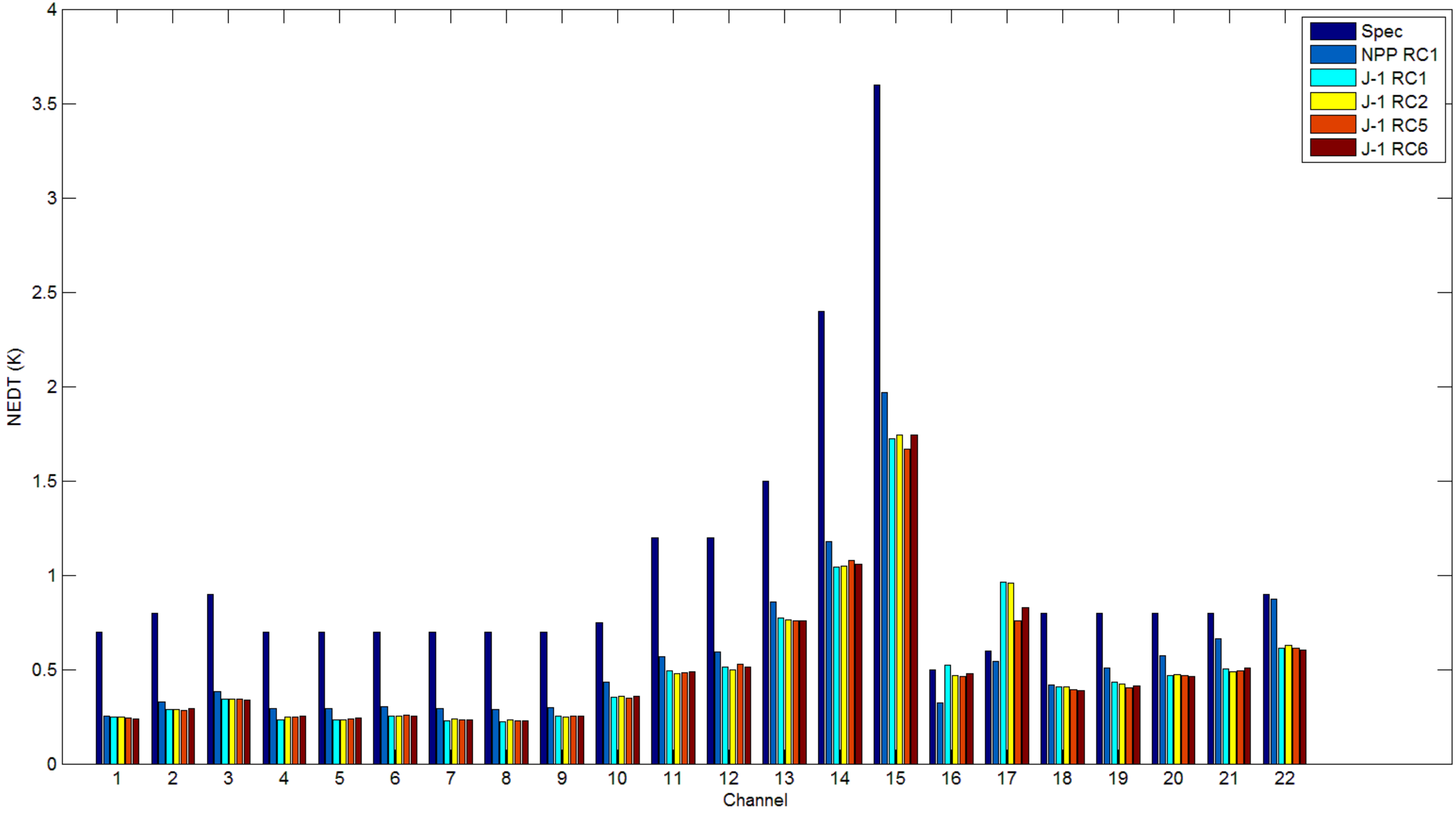
- Worst Case of 4 Redundancy Configurations
- All channels compliant

JPSS1 ATMS NEDT Performance

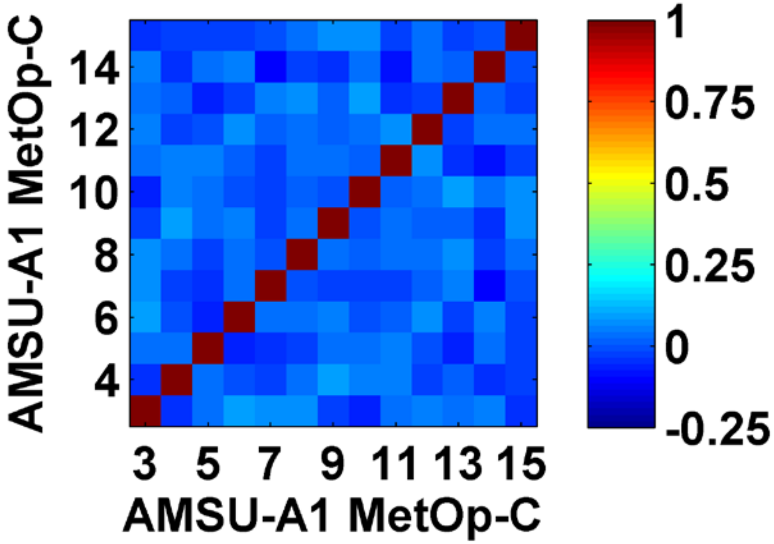
- Worst Case of 4 Redundancy Configurations
- Scene temperature interpolated to 300 K

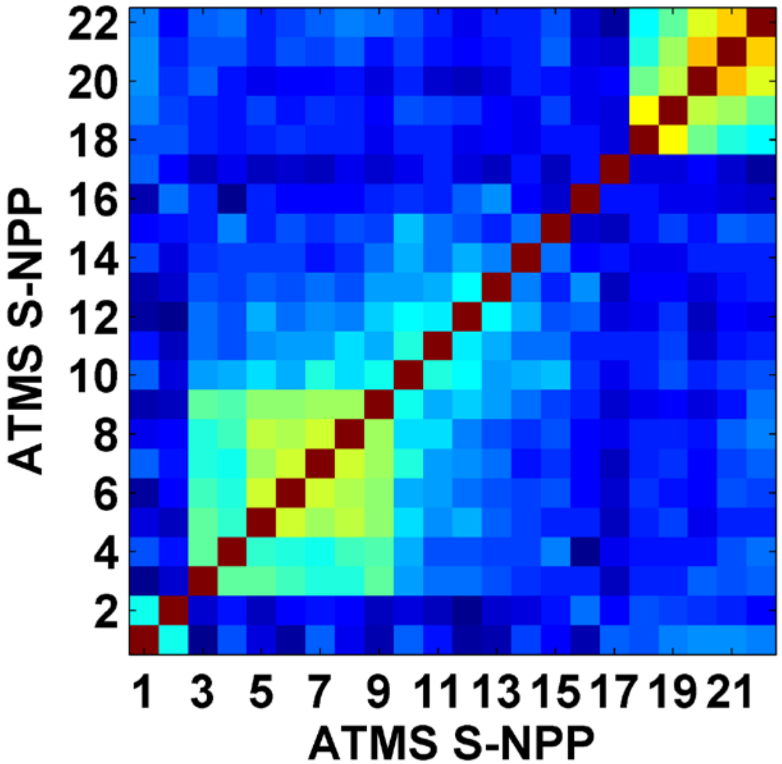


NEDT for J-1 and NPP at Mid Cold Plate Temp Interpolated to 300K



Inter-channel Correlation Coefficients

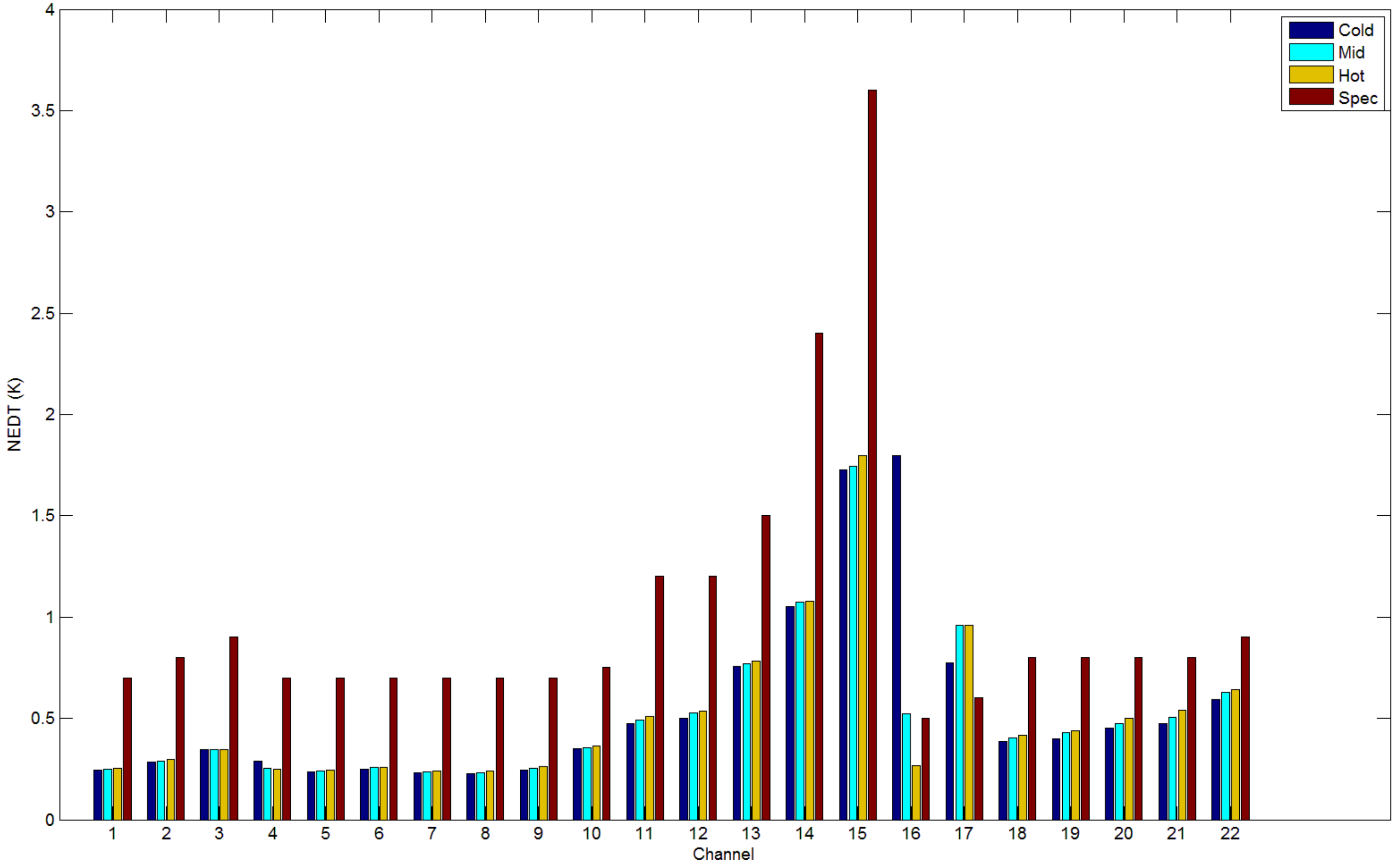




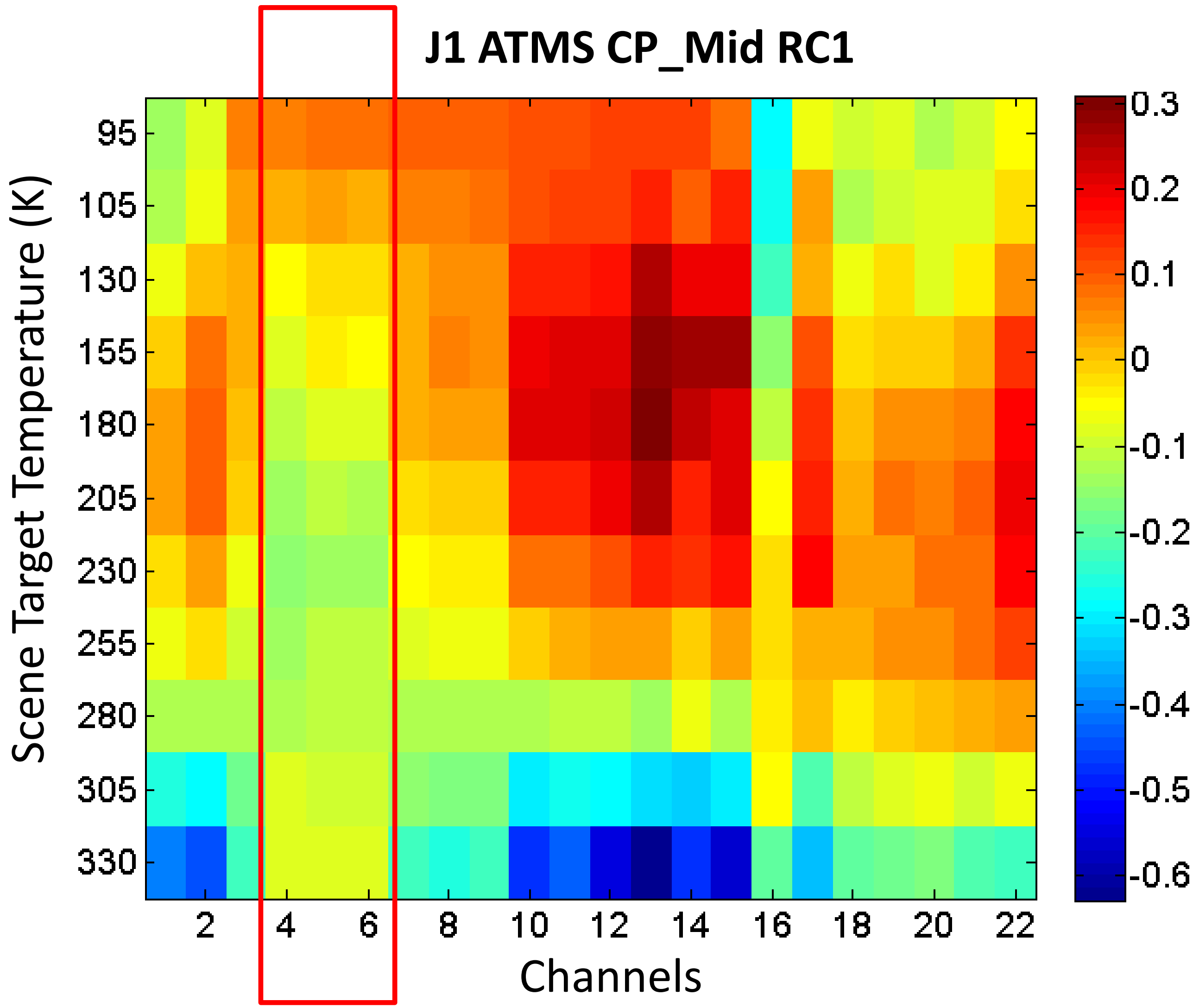
Correlation Coefficients of (left) AMSU-A1 and (right) ATMS Channel Gains.

JPSS1 ATMS NEDT Performance

- Worst Case of 4 Redundancy Configurations
- Scene temperature interpolated to 300 K

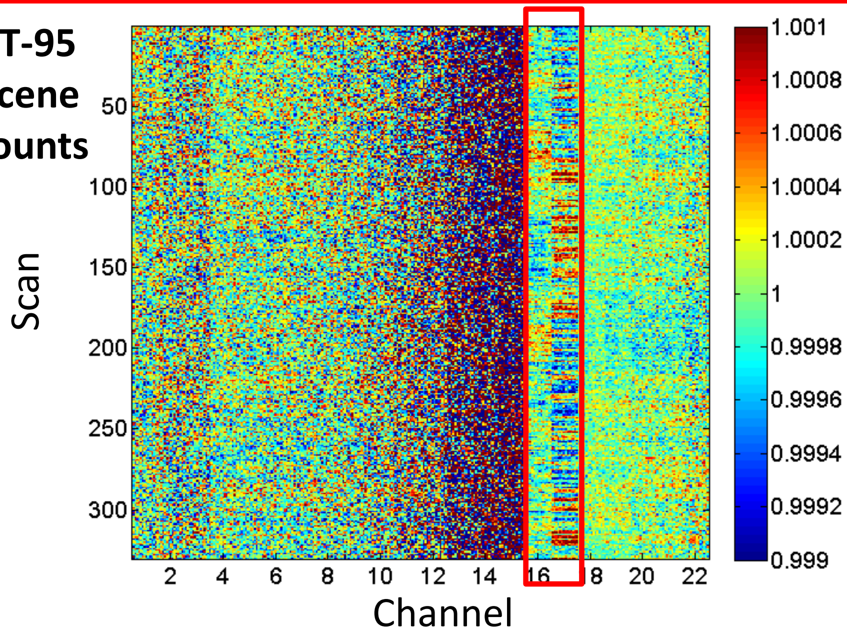


Radiometric Accuracy at CP_Mid RC1

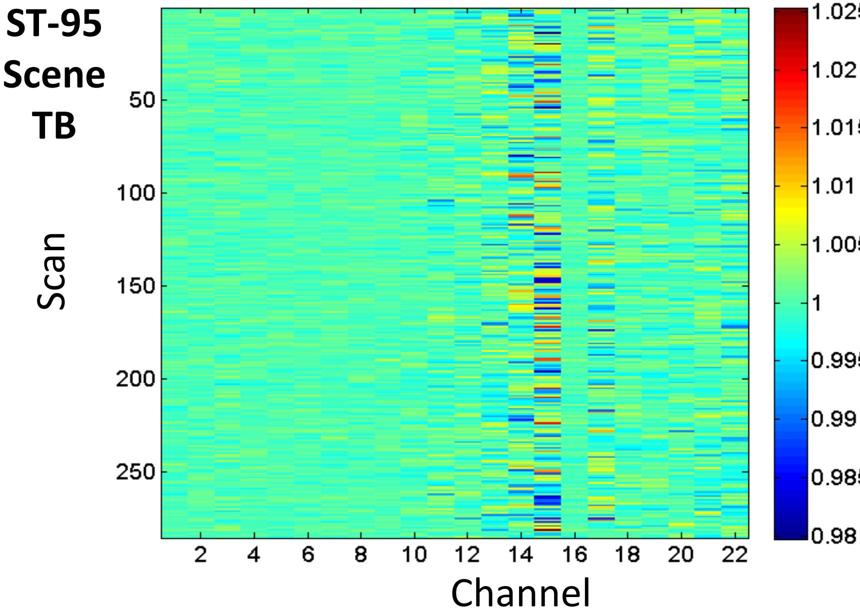


Striping in RC1 at CP_Mid ST-95 vs. ST-330

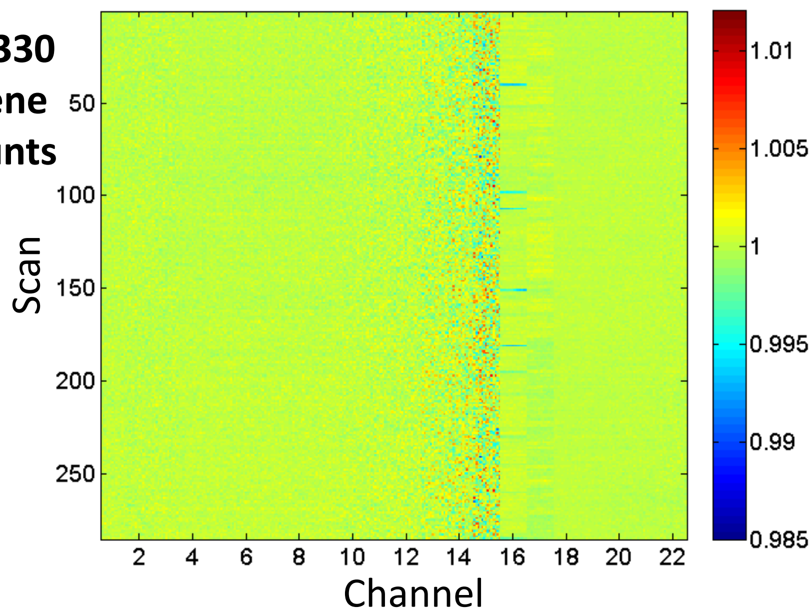
ST-95 Scene Counts



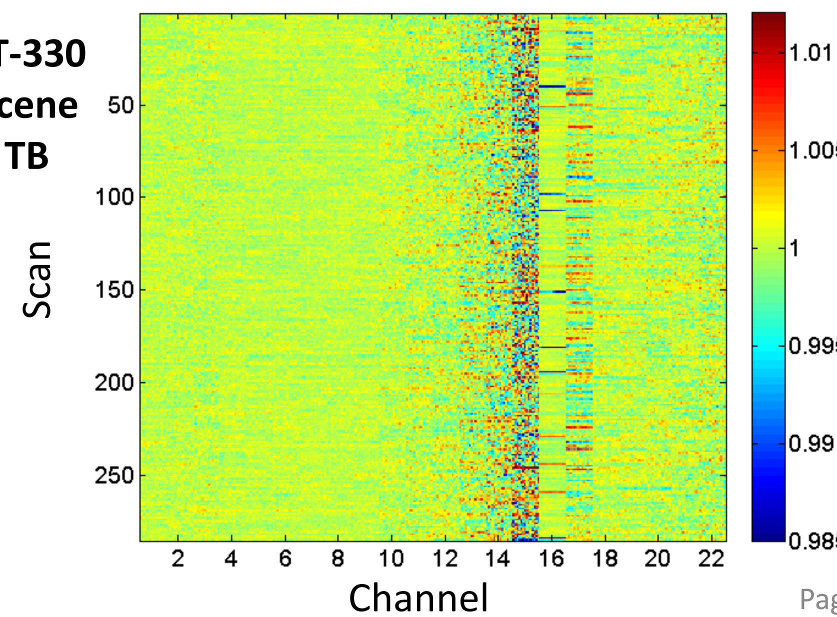
ST-95 Scene TB



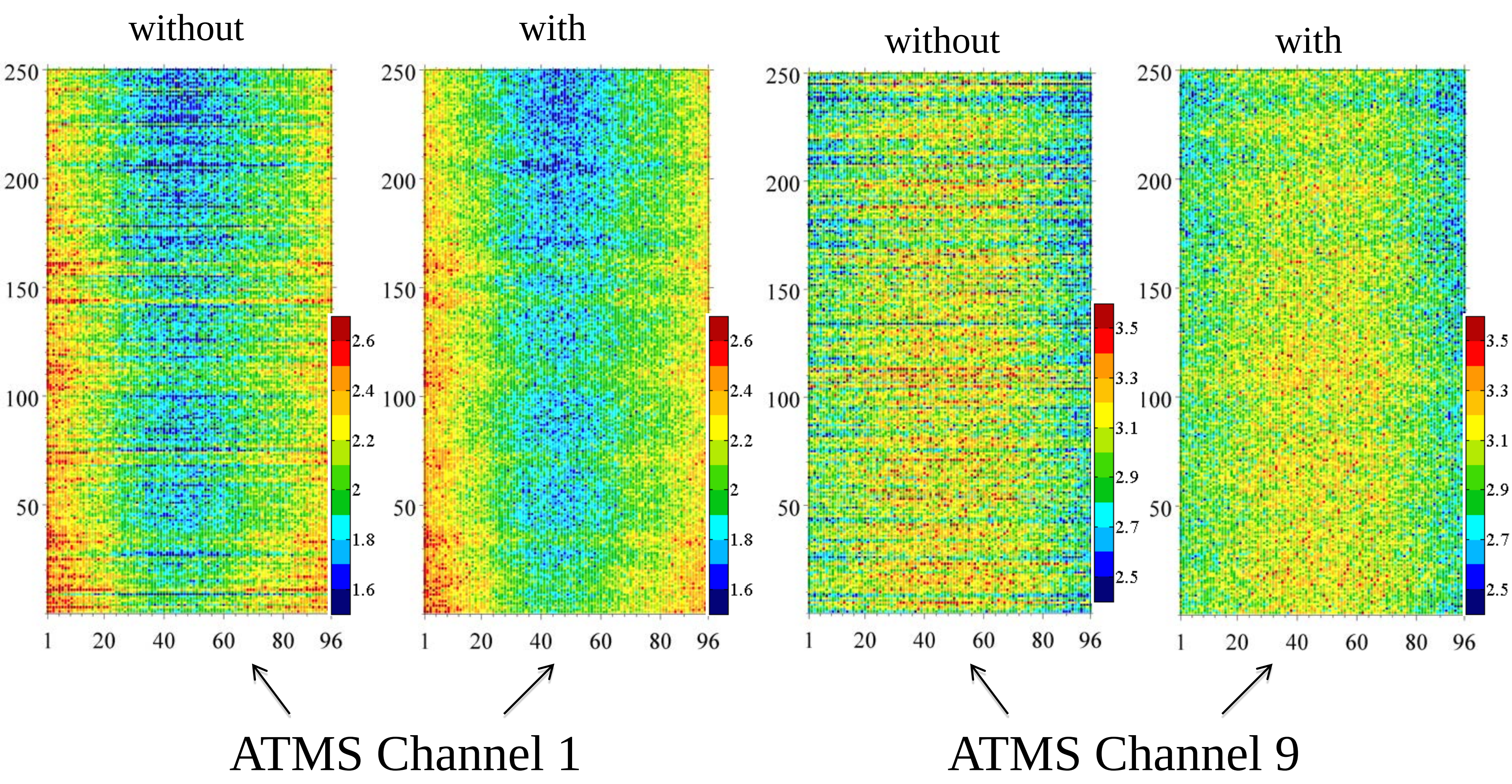
ST-330 Scene Counts



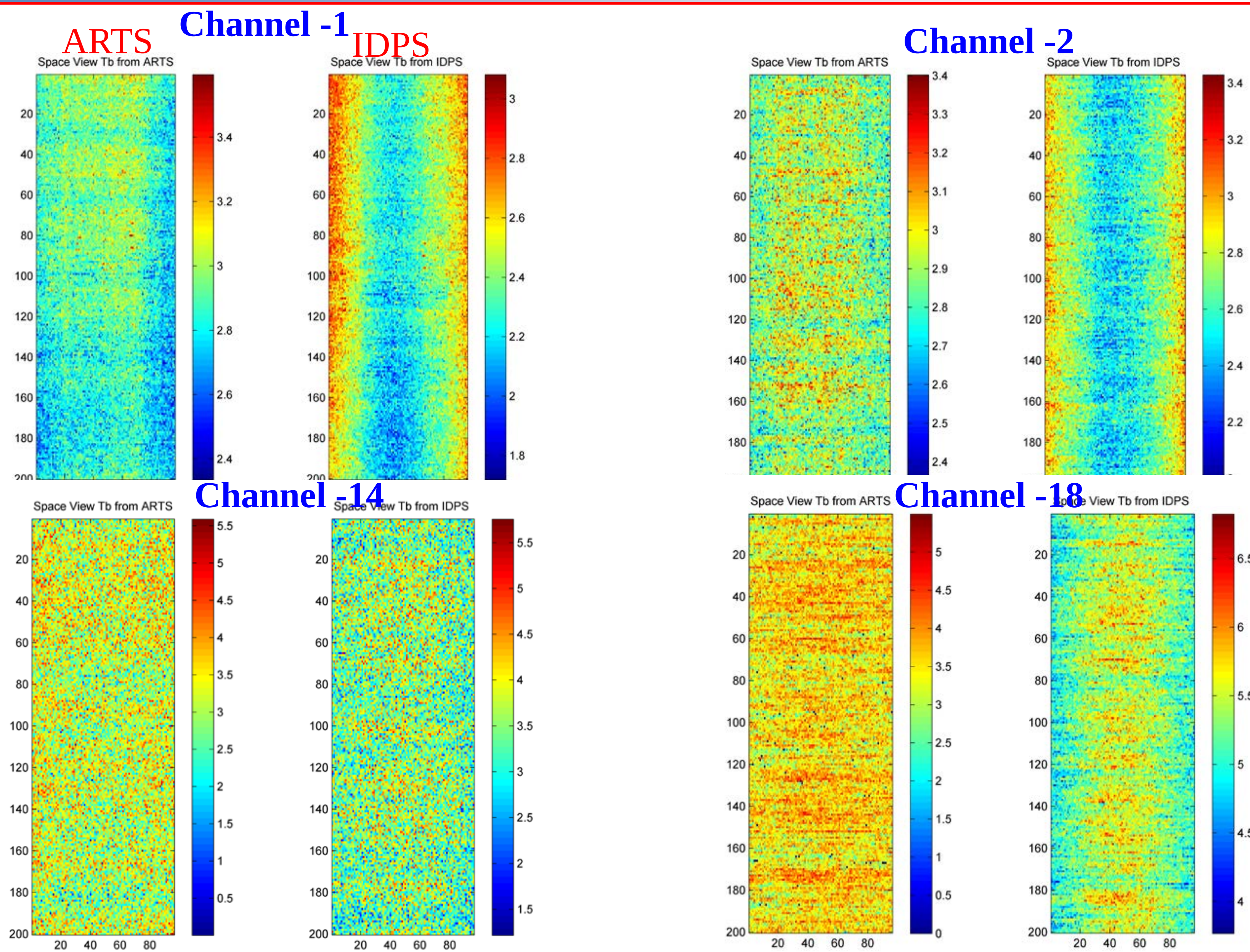
ST-330 Scene TB



Pitch-Over Maneuver Data with and without Optimal Filtering



Calibrated Space View Tb from ARTS



2014 STAR JPSS Science Teams Annual Meeting

ATMS/CRIS SDR Team Leads

Yong Han
CrIS SDR Team

May 16, 2014

Team Activities during This Annual Meeting

- Team Lead report
- ATM/CrIS SDR Breakout Session
  - 8 CrIS SDR presentations and discussions
- 1 hour CrIS SDR Team Discussion
  - J1 test schedule and status overview – Dave Johnson
  - CrIS SDR algorithm/software improvement discussions
- Team member side meetings - lots of discussions
- STAR CrIS SDR group side meetings with other CrIS SDR groups

Last Year's Major Accomplishments

- Successfully completed the CrIS SDR ICV process: achieved the Validated status for the S-NPP CrIS SDR product
- CrIS noise performance and accuracies of radiometric and spectral calibrations exceed specifications with large margins
- Rate of GOOD SDRs is better than 99.98%
- All significant DRs have been processed and issues addressed
- Good progress was made in improving calibration algorithms and software
- Preliminary analysis of the bench test data was performed and the results are within the expectation
- Preparation for the IDPS CrIS SDR code to handle full resolution RDRs was completed
- Program was made in generating a comprehensive proxy data set for J1 algorithm and code testing

Important Coming Events

- J1 SDR code and cal. LUTs delivery, Jan. 15, 2015
- S-NPP CrIS will be switched to full spectral resolution mode, Dec 2014
- J1 TVAC tests, June – Oct., 2014

Work Plan
(coming program year)

- SDR calibration algorithm/software improvements
  - Formulate the best radiometric and spectral calibration equation
  - Improve self-apodization correction algorithm
  - Optimize FIR filter and post calibration filter
  - New FCE correction module
  - Algorithm implementation and CMO computation efficiency improvement
- J1 pre-launch CalVal work
  - Test data analysis
  - Instrument performance evaluation
  - Deriving calibration coefficients (LUTs)
- Proxy data sets for J1 algorithm/code test
  - Data source: S-NPP data, J1 TVAC data and RT simulations
- Full spectral resolution work
  - Validate IDPS SDR product when S-NPP CrIS is switched to FSR mode in Dec, 2014
  - Prepare for FSR SDR offline processing

Summary of Algorithm Improvement Discussions during this Annual Meeting

- To meet the SDR software delivery date on Jan. 15, 2015, the team is organized to work in three areas in parallel: calibration algorithms, proxy data sets and software changes
- Algorithm improvements to remove ringing artifacts
  - Need to define truth spectra with channel response functions the user can simulate
  - Determine the best calibration equation through simulations and real data analysis (actions planned)
  - The team agreed to change CMO computation scheme (actions planned)
- Software work
  - Before the team’s decision on the algorithm changes, work will be done to modularize calibration code so that once the decision is reached, the algorithms can be quickly implemented into the software (actions planned)
  - Useful discussions with STAR AIT team and Raytheon team for code change collaborations

The following slides are more detailed summary of the results of CrIS SDR team activities during this annual meeting

Summary and Highlights

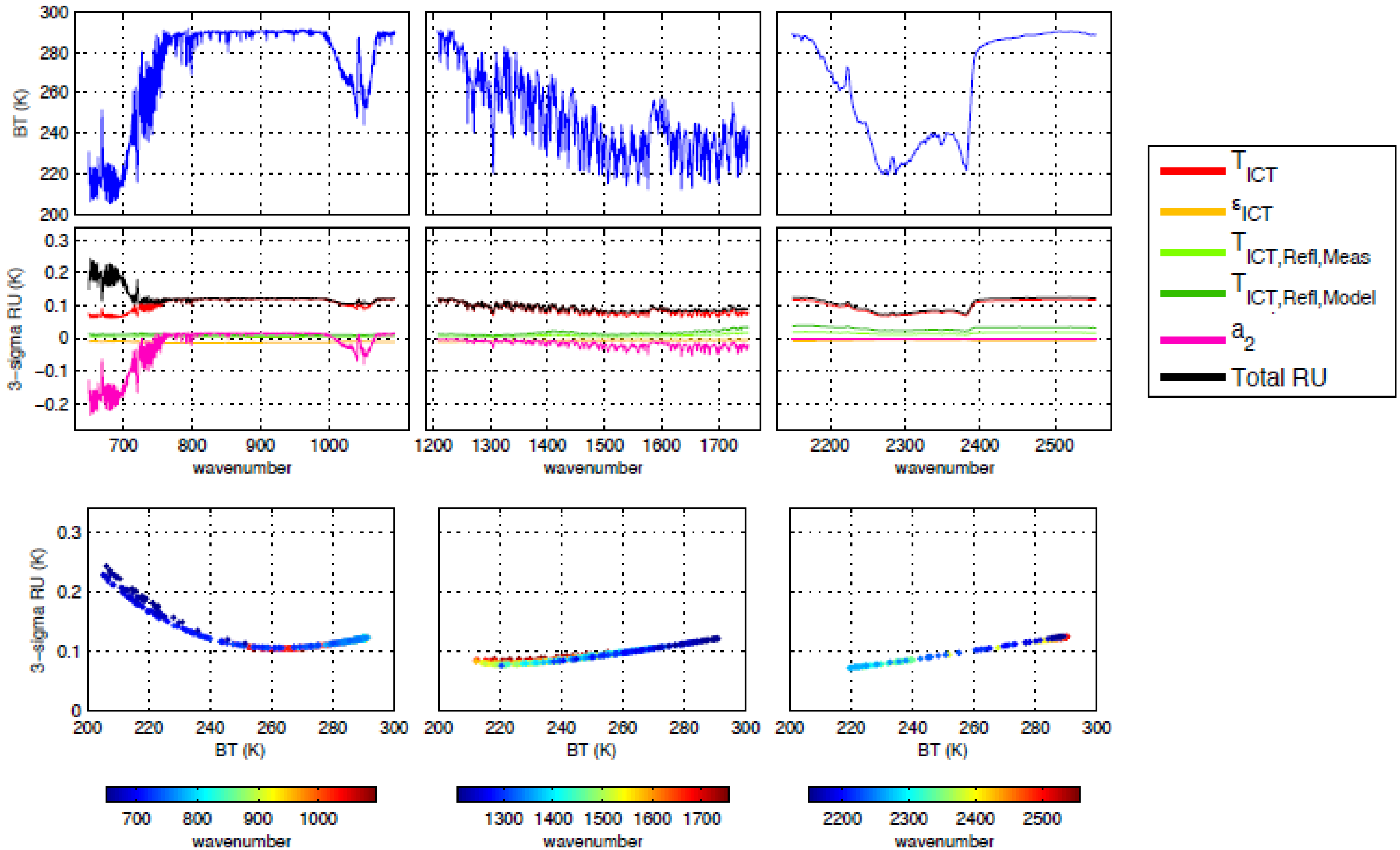
- There are 8 presentations from the CrIS SDR Cal/Val team
- Team activities focused on
  - Continue to improve S-NPP algorithm software performance and robustness (two updates since SDR review)
  - Continue to evaluate and characterize CrIS SDR data accuracy and stability
    - Radiometric calibration performance
    - Spectral calibration performance
  - Prepare for full resolution SDR generation
    - Baseline algorithm developed based on ADL version of the SNPP code
    - Evaluation of different calibration approaches
  - Assessment of full resolution SDR data quality by comparison with AIRs/IASI
    - Global comparison
    - SNOs
  - Support to JPSS-1 sensor testing and performance assessment
- Open discussion session of instrument test status and J-1 SDR algorithm development plan after the presentations

CrIS Radiometric Calibration

- Major contributors to CrIS Radiometric Uncertainty (RU):
  - ICT emissivity/reflectivity
  - ICT temperature (driver at 112mk for NPP)
  - Residual Nonlinearity (LW band more significant)
  - Polarization (not yet included due to lack of characterization, but estimated up to 50mk)
- Performance Issues: shortwave band biases
  - FOV2FOV comparison
  - Comparison with other instrument (IASI/AIRS?)
- J-1 RU expected to be similar to SNPP
- Recommended changes for future CrIS sensors:
  - Remove spectral gaps between LW-MW and MW-SW gaps
  - Smaller and more FOVs
- Discussion
  - Q: Are there any seasonal change in the RU ?
  - A: No changes are seen due to ICT

S-NPP CrIS, example 3-sigma RU estimates

For a typical warm, ~clear sky spectrum

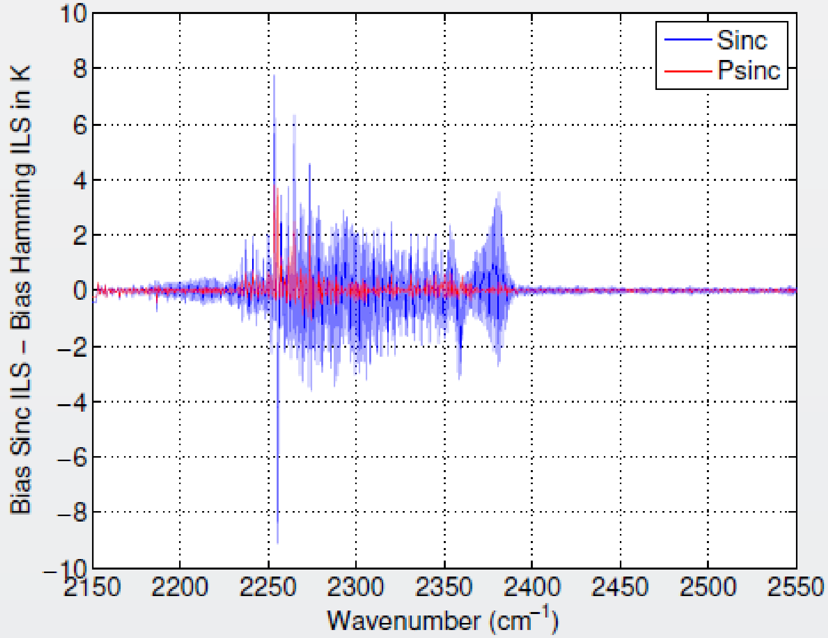


CrIS Spectral Calibration

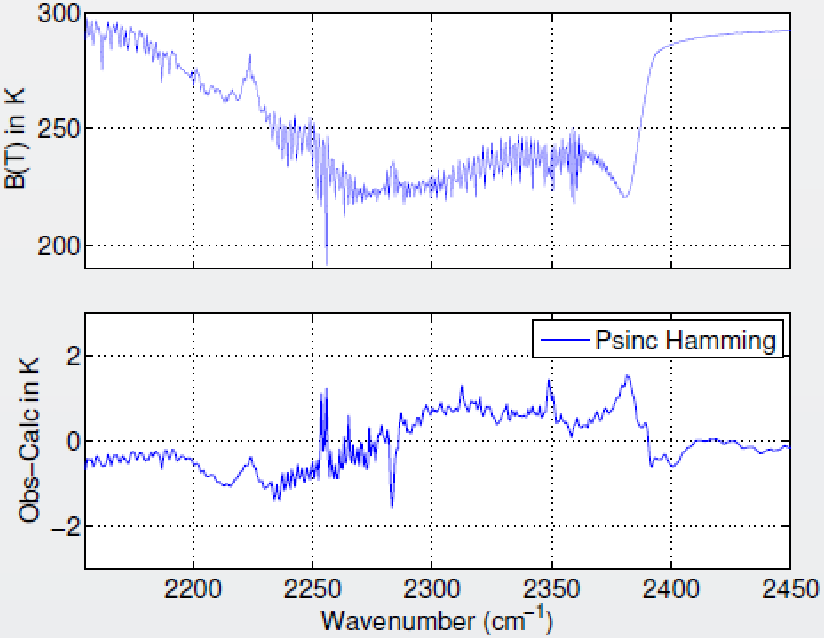
- Assessment of CrIS Spectral calibration
  - stable and accurate based on partially completed analysis
- Selection of ILS basis (Sinc vs Periodic Sinc)
  - Short-wave SDR ringing vastly improved for high-resolution; less significant for normal mode data
  - FOV-7 improvements needed for high-spectral resolution mode
- Comparison of CrIS high resolution mode data and AIRS SNOs
  - 0.1K agreement on a channel-by-channel basis
  - 0.2K ringing in AIRs data is due to lack of spectral calibration
- Discussion
  - Q : Is there a neon lamp drift?
  - A: Found a -0.07 ppm trend since the beginning of the mission (so very stable).

Sinc vs. Periodic Sinc

Bias Psinc/sinc - Bias Hamming
A clean metric for excess ringing



Observed - Computed (NWP)
Psinc apodized to Hamming



- This is a major improvement to the high-resolution short-wave data
- Periodic sinc mostly improves corner FOVS, where the self-apodization correction is largest, SA matrix is more poorly conditioned.
- Should help improve absolute spectral calibration once CrIS is in high-resolution mode

CrIS Calibration Equation

- Evaluated 11 different calibration approaches
- Order of CMO (self-apodization removal) has caused the most significant differences
- Spectral interpolation before or after radiometric calibration also makes a (small) difference
- Relative differences only, not absolute ranking of performance due to lack of truth (objective criteria)

Calibration options

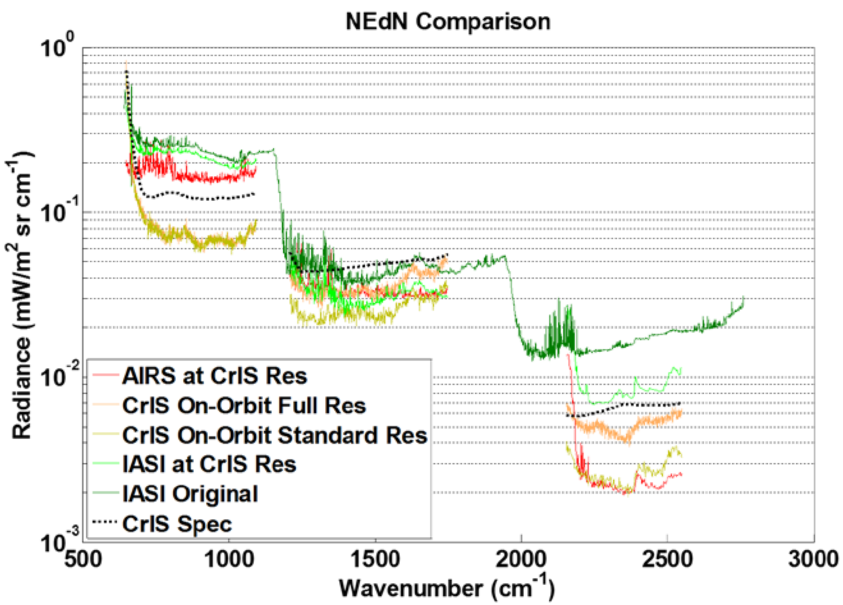
Item	Member	Calibration	CMO Principals	Calibration Order
1	IDPS	$N=(SA_u^{-1}\cdot F_{s\to u}\cdot f_{ATBD})\cdot\left\{\frac{S_E-S_{SP}}{S_{ICT}-S_{SP}}\cdot ICT(T,u_{sensor*(1+delta)})\right\}$	$SA_u^{-1}\cdot F_{s\to u}$	Calibration first, then CMO
2	ADL/CSPP	$N=(SA_u^{-1}\cdot F_{s\to u}\cdot f_{ATBD})\cdot\left\{\frac{S_E-S_{SP}}{S_{ICT}-S_{SP}}\cdot ICT(T,u_{sensor*(1+delta)})\right\}$		
3	Exelis (old)	$N=\left(SA_u^{-1}\cdot F_{s\to u}\cdot f_{ATBD}\right)\cdot\left\{\frac{S_E-S_{SP}}{S_{ICT}-S_{SP}}f_{BH}\cdot\left[SA_u^{-1}\cdot F_{s\to u}\right]^{-1}\cdot ICT(T,u_{sensor})\right\}$		
4	UMBC/UW** option A	$N=F_{s\to u}\cdot f\cdot SA_s^{-1}\cdot\left\{f\cdot\frac{FIR^{-1}\cdot(S_E-S_{SP})}{FIR^{-1}\cdot(S_{ICT}-S_{SP})}\cdot ICT(T,u_{sensor\_off\_axis})\right\}$	$F_{s\to u}\cdot SA_s^{-1}$	
5	CCAST Cal mode 1	$N=F_{s\to u}\cdot f\cdot SA_s^{-1}\cdot\left\{\frac{FIR^{-1}\cdot(S_E-S_{SP})}{FIR^{-1}\cdot(S_{ICT}-S_{SP})}\cdot ICT(T,u_{sensor\_off\_axis})\right\}$		
6	UMBC/UW** option B	$N=F_{s\to u}\cdot\left\{ICT(T,u_{sensor})\cdot f\cdot SA_s^{-1}\cdot\left\{f\cdot\frac{FIR^{-1}\cdot(S_E-S_{SP})}{FIR^{-1}\cdot(S_{ICT}-S_{SP})}\right\}\right\}$		
7	CCAST Cal mode 2	$N=F_{s\to u}\cdot f\cdot\left\{ICT(T,u_{sensor})\cdot SA_s^{-1}\cdot\left\{\mathrm{Re}\left[\frac{FIR^{-1}\cdot(S_E-S_{SP})}{FIR^{-1}\cdot(S_{ICT}-S_{SP})}\right]\right\}\right\}$		
8	LL(old)*	$N=\left\{\frac{M\cdot\left(FIR^{-1}\cdot(S_E-S_{SP})\right)}{M\cdot\left(FIR^{-1}\cdot(S_{ICT}-S_{SP})\right)}\right\}\cdot ICT(T,u_{user})$		CMO first, then Calibration
9	LL(new)	$N=\left\{\frac{F_{s\to u}\cdot SA_s^{-1}\cdot\left(FIR^{-1}\cdot(S_E-S_{SP})\right)}{F_{s\to u}\cdot SA_s^{-1}\cdot\left(FIR^{-1}\cdot(S_{ICT}-S_{SP})\right)}\right\}\cdot ICT(T,u_{user})$		
10	Proposed(1)	$N=F_{s\to u}\cdot f_{ATBD}\cdot\left\{\frac{SA_s^{-1}\cdot\left(FIR^{-1}\cdot(S_E-S_{SP})\right)}{SA_s^{-1}\cdot\left(FIR^{-1}\cdot(S_{ICT}-S_{SP})\right)}\cdot ICT(T,u_{sensor})\right\}$		
11	Proposed(2)	$N=ICT(T,u_{user})\cdot\left\{\frac{F_{s\to u}\cdot SA_s^{-1}\cdot f_{ATBD}\cdot\left(FIR^{-1}\cdot(S_E-S_{SP})\right)}{F_{s\to u}\cdot SA_s^{-1}\cdot f_{ATBD}\cdot\left(FIR^{-1}\cdot(S_{ICT}-S_{SP})\right)}\right\}$		
12	Exelis(new)	$N=\left\{\frac{(SA_u^{-1}\cdot F_{s\to u}\cdot(S_E-S_{SP}))}{(SA_u^{-1}\cdot F_{s\to u}\cdot(S_{ICT}-S_{SP}))}\right\}\cdot ICT(T,u_{user})$	$SA_u^{-1}\cdot F_{s\to u}$	

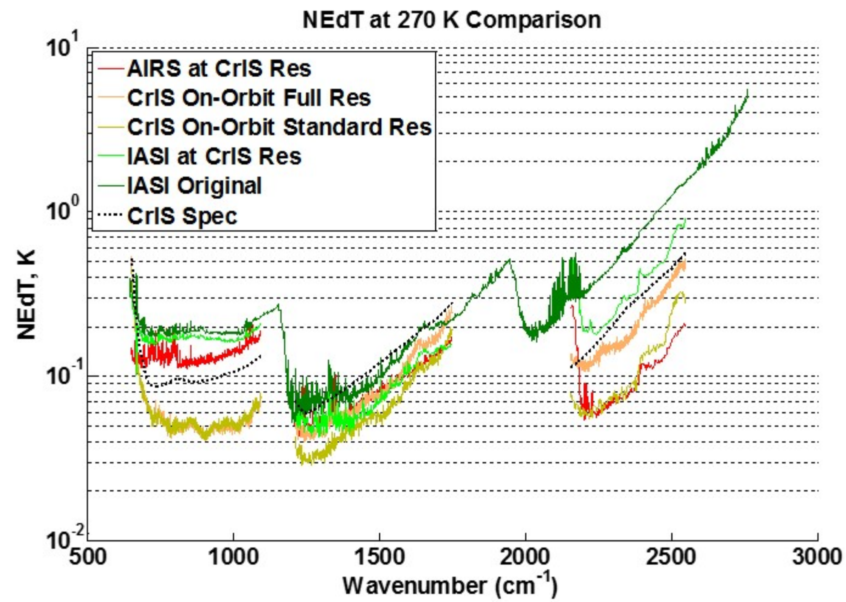
Ref

CrIS Noise Performance

- NEdN level meets mission requirements for both NPP and J1 instruments with a margin of typically 100% (except MWIR FOV 7 NPP instrument).
- The intrinsic detector noise randomly distributed in spectral domain dominates total instrument NEdN
  - Negligible contribution of correlated noise is observed.
- CrIS has comparable or smaller noise levels than AIRS and IASI heritage instruments (~2-3 times smaller in LWIR spectral band)
- NEdN has remained extremely stable during on-orbit operations. Only small seasonal, orbital and spatial NEdN variations (<10%) are observe on-orbit.
- Small anomaly (50%) in LWIR FOR1 NEdN was observed on July 07 and September 10 and 12,2013. Remains stable on slightly elevated level (<10%)
- Discussion
  - Q: What is the noise increase of LW FOV1 root cause?
  - A: Root cause is not known

NPP: NEdN and NEdT (at 270^0K) comparison with AIRS and IASI



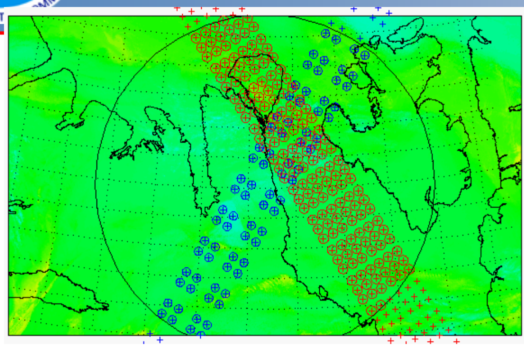


- NEdN is estimated from Earth scene radiances using SDL PCA approach (60 PCs retained)
- CrIS exhibits smaller noise level in LWIR (~x3) and SWIR (~x3) spectral bands than noise estimated from IASI observations reduced to CrIS spectral resolution
- As expected, CrIS full spectral resolution noise in MWIR and SWIR bands is higher by ~x1.4 and ~x2, respectively, as compared to the CrIS standard spectral resolution

Preparation of CrIS Full Resolution Processing

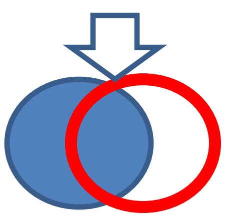
- Full resolution SDR algorithm is under development
  - Prototype code development is based on MX 8.3 and ADL 4.2
  - The prototype has now options for different calibration approaches (spectral cal/radiometric cal ordering)
- CrIS full resolution SDR radiometric uncertainty:
  - FOV-2-FOV radiometric differences are small, within ±0.3 K for all the channels
  - Double difference with IASI are within ±0.3K for most of channels
  - SNO results versus IASI show that agreement is very good for band 1 and band 2, but large BT differences in cold channels for band 3
- CrIS full resolution SDR spectral uncertainty:
  - Spectral shift relative to FOV5 are within 1 ppm
  - Absolute spectral shift relative to CRTM simulation are within 3 ppm
- Discussion
  - Q :With the acquisition of full resolution on NPP, will we drop FOV 7 ?
  - A: Yes FOV7 in the direct broadcast will drop as reported by DPE/DPA.
  - Q: SNO CrIS IASI difference in SW appears big?
  - A: yes it is somewhat high.
  - Q: Can the code perform a dynamic switch between low and full resolution?
  - A: No. the code needs to recompile in order to switch resolution.

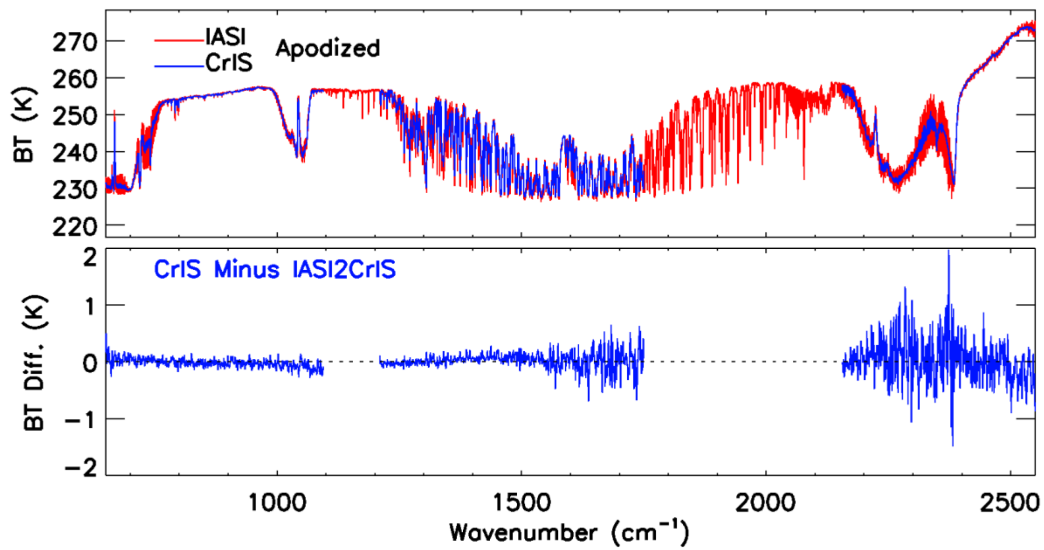
SNOs between CrIS and IASI

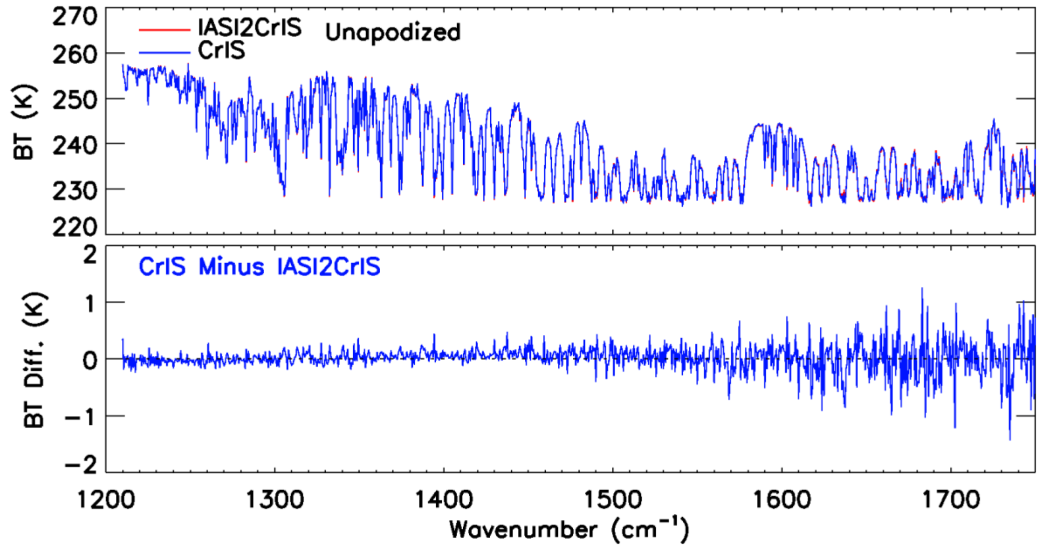


SNO Criteria

- Time difference: <= 120 seconds
- Pixel distance: <=(12+14)/4.0 km = 6.5 km
- Zenith angle difference: ABS(cos(a1)/cos(a2)-1) <= 0.01

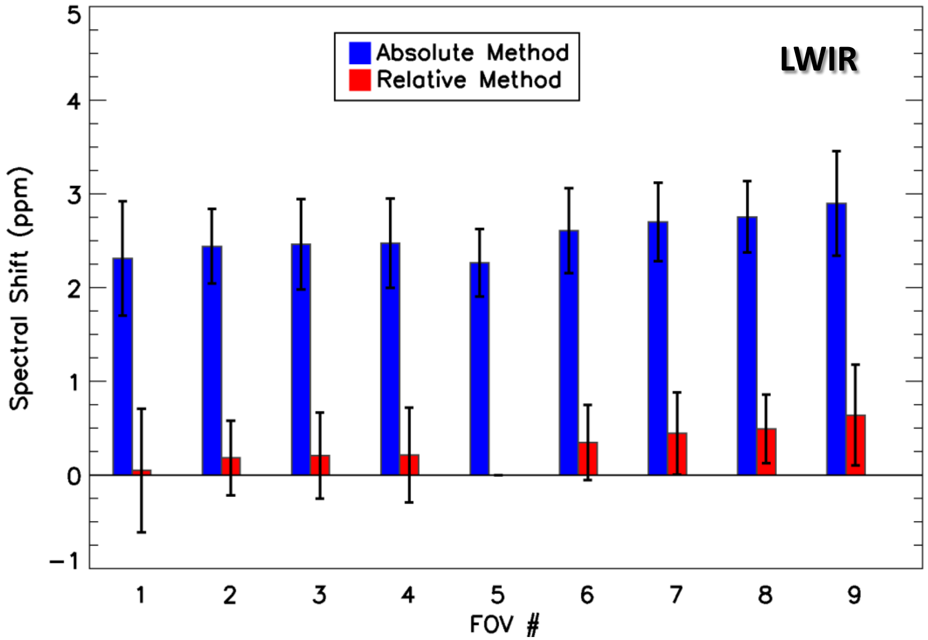


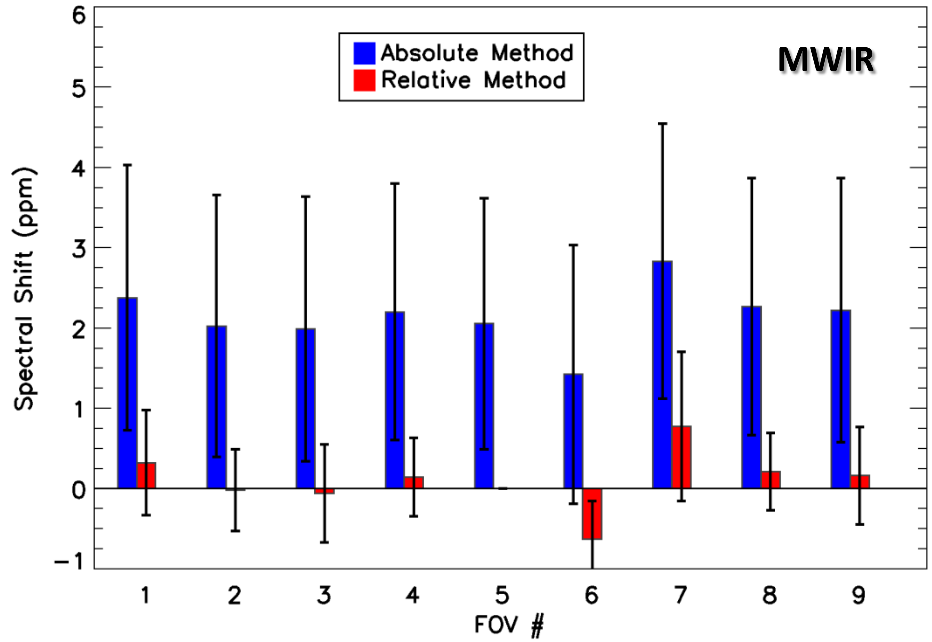


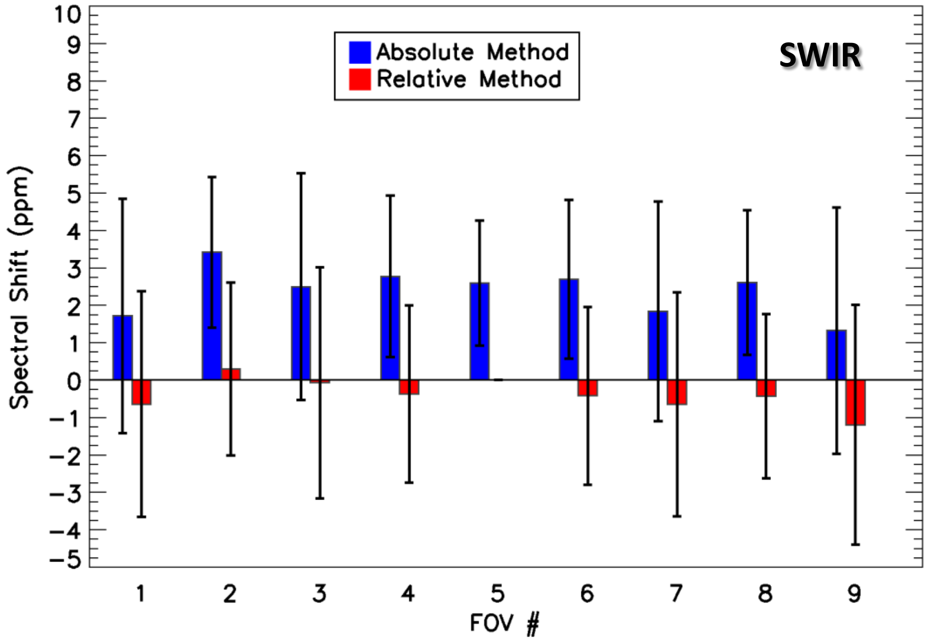


- SNO agreement is very good for band 1. Also good for band 2, but larger BT difference toward the end of band edge
- Large BT differences in cold channels for band 3

CrIS Spectral Uncertainty





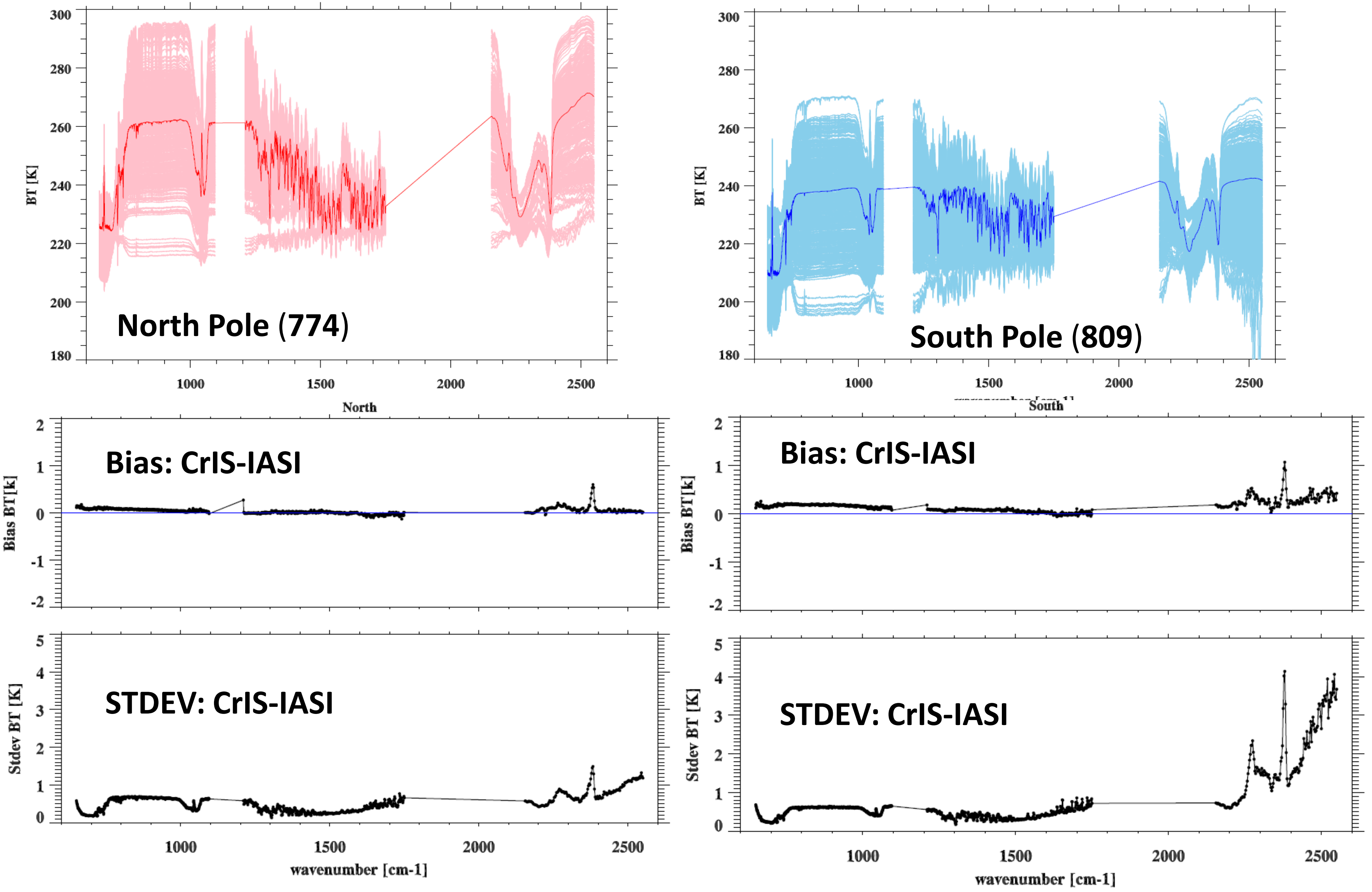


- Absolute cross-correlation method: between observations and CRTM simulations under clear sky over oceans to detect the spectral shift
- Relative method: observations from FOV 5 to other FOVs
- Frequency used: 710-760 cm^{-1} , 1340-1390 cm^{-1} , and 2310-2370 cm^{-1}
- **Spectral shift relative to FOV5 are within 1 ppm**
- **Absolute spectral shift relative to CRTM within 3 ppm**

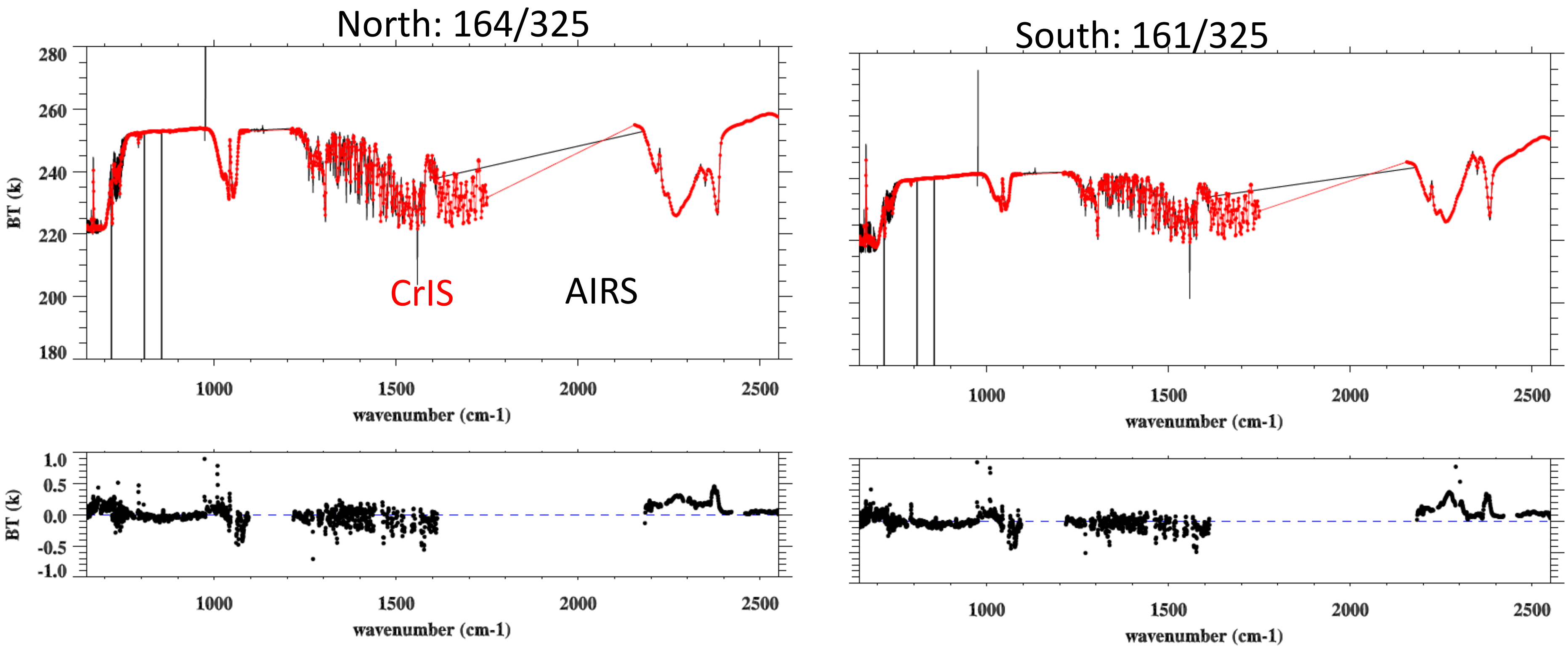
Towards Establishing a Reference Instrument

- Inter-comparison of CrIS with IASI/Metop-A, IASI-Metop-B, and AIRS have been made for one year's of SNO observations in 2013.
- CrIS vs. IASI
  - CrIS and IASI well agree each other at LWIR and MWIR bands with 0.1-0.2K differences
  - No apparent scene dependent bias
  - At SWIR band, a sharp increases can be clearly seen at spectral transition region. The reason is still under investigation.
- CrIS vs. AIRS
  - Resampling errors still remain when converting AIRS and CrIS onto common spectral grids.
  - CrIS and AIRS well agree each other at LWIR and MWIR bands within 0.4 K differences
  - At SWIR band, a sharp increases can be clearly seen at spectral transition region.
  - A weak seasonal variation can been seen for CrIS-AIRS at water vapor absorption region.
- Lessons learned for JPSS CrIS: Non-linearity play an important role for CrIS radiometric accuracy and should be carefully evaluated during the prelaunch test.
- Discussion:
  - Q What is the comparison between IASI A vs B (CrIS minus A or B)?
  - A: It shows a small difference, about 0.1 K.
  - C: We need to establish an absolute radiometric assessment.

CrIS versus IASI/MetOp-B



CrIS versus AIRS
Daily averaged SNO observations



Large spread could be due to the resampling uncertainties and AIRS band channels

Proxy dataset for Testing and Evaluating J1 CrIS SDR products

- There is a need to establish testing data for the algorithm due to software bugs, and missing observation among other reasons
- **We have so far collected 16 proxy datasets from SNPP CrIS trending/monitoring/debugging activitiesfor various tests:**
  - Functional test
  - Sensitivity test
  - Instrument anomaly
  - Engineering
  - Abnormal inputs
- **We have convenient tools to manipulate the dataset to create new cases for new requirement for J1**

NGAS Support for CrIS Cal/Val

- Twenty-seven DRs investigated, most related to SDR algorithm and data product quality issues, leading to eight CrIS SDR code update deliveries since launch
  - Two update deliveries since SDR validated maturity review to improve data anomaly handling
- Proposed an alternative spectral calibration approach to correct for sel-apodization and resample to user grid in one single step based on least square fit to the user desired (specified) ILS
  - Suggest to consider as an objective criterion when evaluating various viable approaches
- Use TVAC test data to evaluate different calibration approaches
- Discussion:
  - Q: Can CMO with LSE be available?
  - A: Yes, need to define laser wavelength

CrIS SDR Group Discussion

- J1 testing.
  - Window had leak. It has been resolved and now gives no tail end in LW. There is an obscuration cause by chip in the optics in FOV8.
  - RRTVAC (risk reduction) testing to check low frequency vibration due to communication gimbal.
  - Emi testing results are looking good. Current TVAC is from June to Oct 13 2014. This will include 8 thermal testing. Pre-ship review (PSR) is scheduled for the end of October. There is not enough time to do TVAC analysis (Oct 13) to be ready for the PSR. TVAC analysis should take about 2 months.
  - A request is made to have draft of sell-off memos (from D. Tobin).
- J-1 algorithm development.
  - Need to select the new algorithm (which candidate is the best) from a list of candidates
    - need to define the truth spectrum.
    - The selection of one of the 4 candidates will use simulation and also by looking at real data
  - Move CMO computation offline
    - It will be interpolated to the measured laser wavelength. (179 MB per laser wavelength). An advantage is to compute the CMO offline so we have visibility and there is no latency limitation. Also, we can select the best way to compute the CMO. As a disadvantage, if laser wavelength is way off the table range it would create an issue.
    - Also there is need to smooth the measured laser wavelength.
    - A suggestion is to interpolate the SA, then compute the inverse once per granule.
  - Need to address the non-cyclical effect s of the FIR application on-board the instrument.

Visible Infrared Imaging Radiometer Suite

VIIRS SDR Session Summary

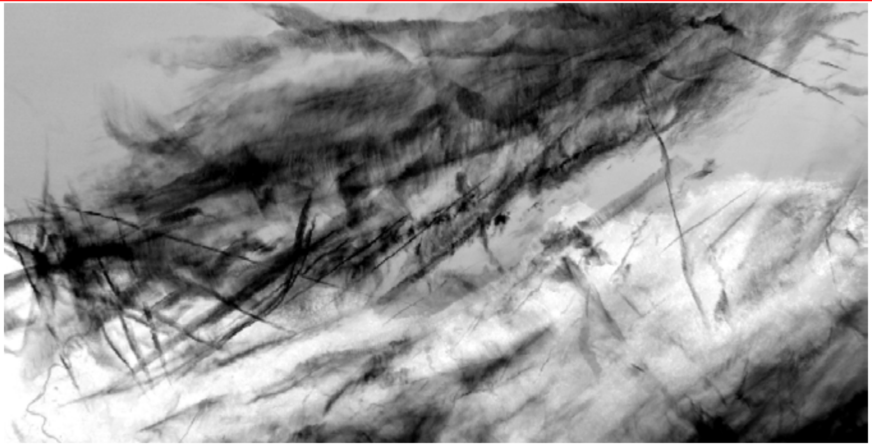
Changyong Cao
VIIRS SDR Team Lead

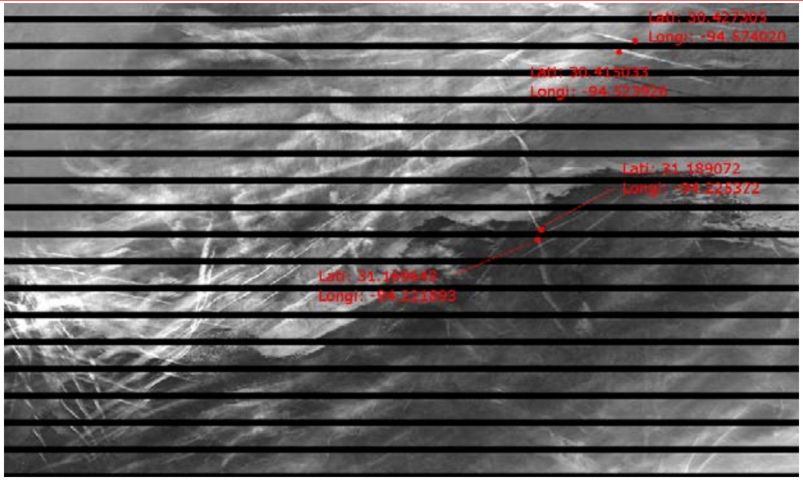
NOAA Center for Weather and Climate Prediction (NCWCP)
5830 University Research Park, College Park, Maryland
May 12-16, 2014

VIIRS SDR Session Summary

- Overall, the VIIRS instrument continues to perform well, meeting performance specifications
- TEB summary:
  - SST striping continues to be an issue that require further investigation. Effects due to detector vs. band average level RSR analyzed. Results show that M13 NEDT at blackboy is 0.04K while noise can be upto 0.15K due to striping, half of which due to band average RSR effects.
    - Action: Further test the striping effect due to RSR averaging in the algorithms.
    -
  - C0 adjustment can reduce the M15 bias but the benefit is marginal given the uncertainties with IASI/AIRS/CrIS consistency at low temperatures (Moeller)
  - “mis-alignments” between scans reported by SST in the bow-tie region. A quick analysis using contrails does confirm the effect (upto 5km displacement found between scans).
    - Action: Further investigation using ground linear featuresneeded because contrails are at much high altitudes.
- DNB summary:
  - Straylight correction works well according to users.
  - Improvements and changes in calibration need to be well documented and made available to the public on-line.
    - Action: Enhance the VIIRS Event Log database to keep track of all changes. Add commentary on anomalies to facilitate reanalysis. Currently the database covers a large number of events but not completely.

Alignment check using contrail (I4-I5)



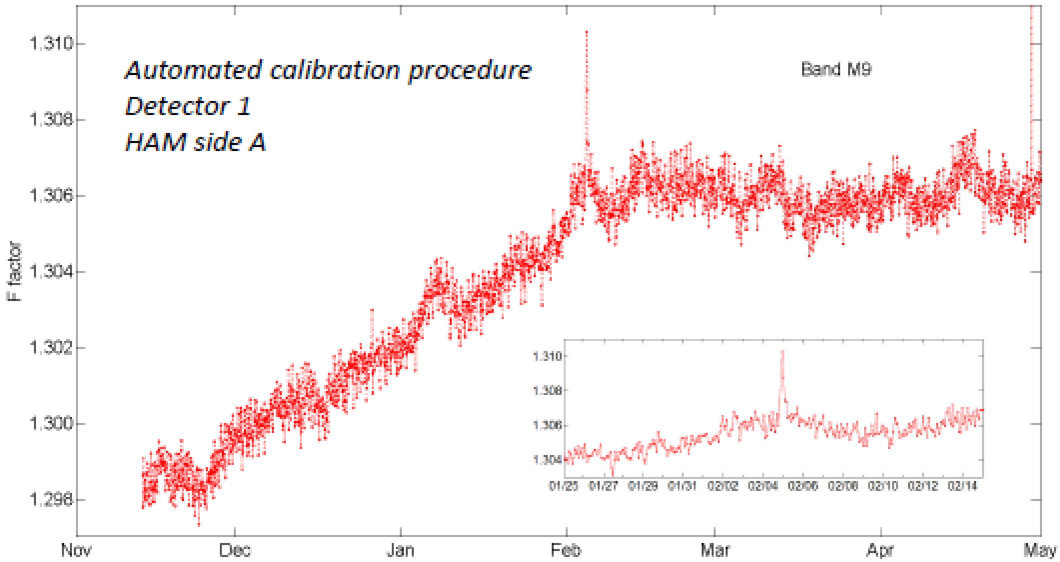


VIIRS SDR Session Summary

- RSB calibration
- H-factor discrepancies between the operational and other versions may cause problems in the F factor trends.
- Recent flattening in the F-factor trend requires further investigation
- Validations at vicarious sites, DCC, and comparisons with MODIS may confirm the discrepancies observed by ocean color groups
- Actions:
  - A) further investigate the root cause for the flattening trend in the F-factors
  - B) Prepare for early transition to RSB autocal to mitigate the recent calibration issues

- J1 Polarization issues
  - Good progress has been made in planning for additional prelaunch characterization, modeling, global observations using GOME, and ground based measurements
  - Uncertainty in the polarization phase is a concern (BG)
- Actions:
  - A) Provide feedback to NASA on the phase uncertainty concerns to see whether it can be improved for J1/J2
  - B) Endorse the current effort to support the polarization studies for J1 VIIRS

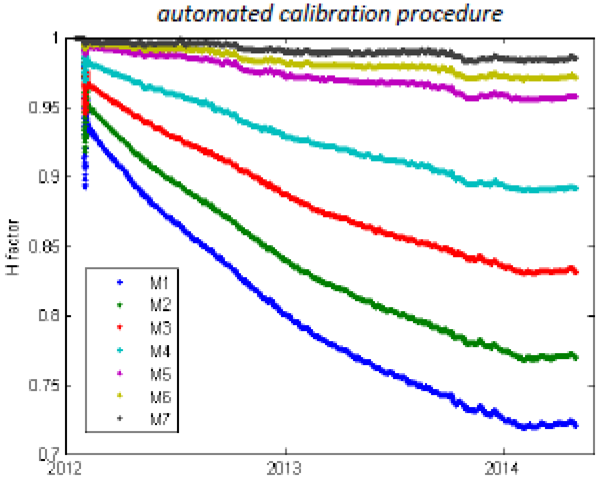
Calibration Trend Change

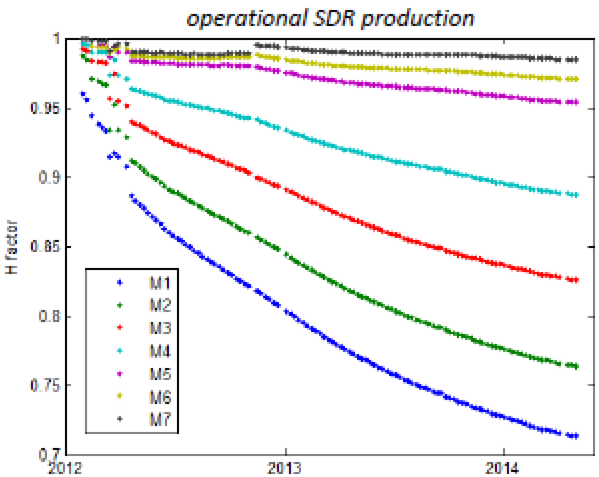


- On February 4, 2014, VIIRS single-board computer lockup anomaly occurred and lasted longer than one orbit
- Following recovery from the anomaly (marked by the spike in the M9 F factors: see the insert graph), the F factor trends have changed

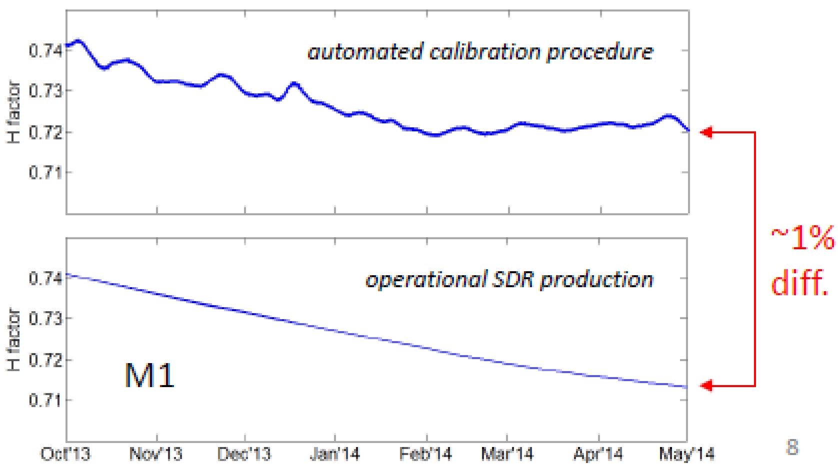
- Despite fluctuations in the calculated F factor values, it is clear that the F factors for the SWIR bands are no longer increasing due to the telescope throughput degradation (note that solar diffuser reflectance is assumed constant for the SWIR bands)
- The telescope degradation may have stopped if during the February 4 anomaly the telescope mirrors temperature increased enough to “bake out” water ice that after the UV photolysis was providing protons for the tungsten oxide color center formation 7

Solar Diffuser Degradation Trend

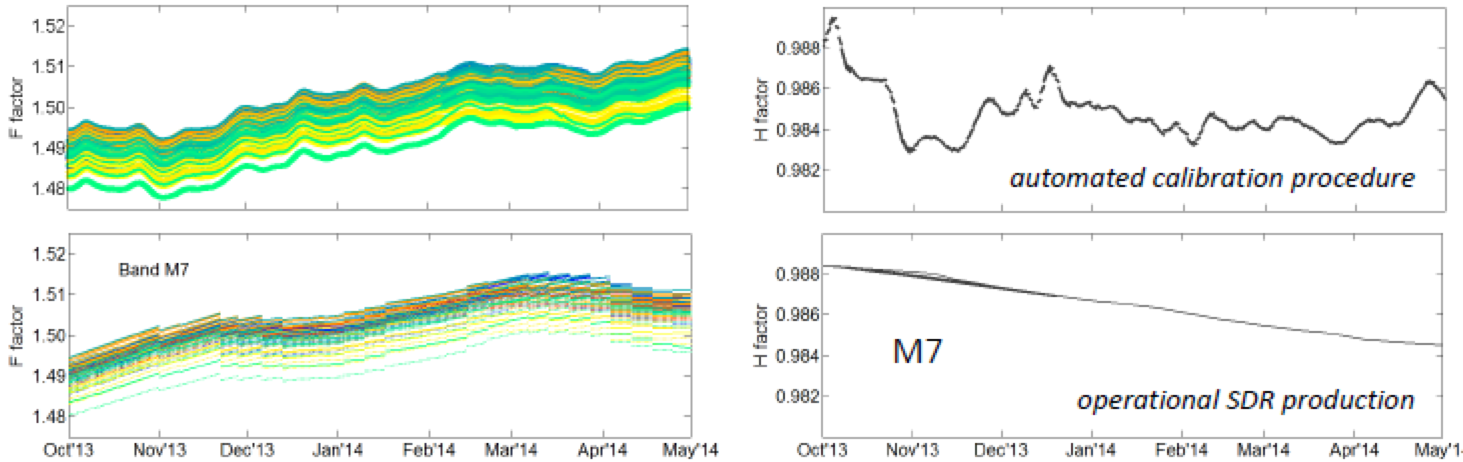


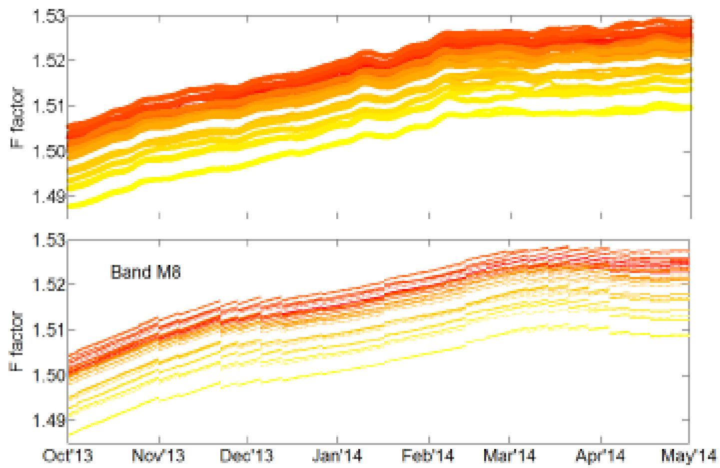


- When the solar diffuser monitoring data are analyzed with the automated calibration procedure, the reflectance degradation trend changes in February 2014: the decrease has diminished
- If during the February 4 anomaly the solar diffuser temperature increased above ~360 K, the hydrocarbons that cause the degradation may have been baked out (in vacuum)



Effects on Radiometric Calibration





- For the bands not corrected by the H factors (SWIR), the automated procedure calibration responded more timely to the calibration trend changes
- Additionally, for the bands corrected by the H factors, the automated procedure responded better to the changes in the solar diffuser degradation

JPSS STAR Science Team Annual Meeting
OMPS SDR Team Report

Xiangqian Wu
OMSP SDR Lead

May. 16, 2014

Major Events

- OMPS SDR Team Overview to Session 2 on Monday
- One-day dedicated Session 4c for the team. 20+ participants, including four of the five group leads attended in person. Several dialed in.
- Team meeting during the session.
- Side meeting on a technical issue for J1 upper code change
- Many attended Ozone EDR activities (Session 5e on Ozone EDR and Users' Breakout Sessions)

Overview

The Team Overview reviewed:

- Team member and primary roles
- Products and Users
- Requirements and Performance
- Accomplishments
- Algorithms Evaluation
- Future Plans for J1

Session 4c

- 12 presentations
  1. Solar calibration
  2. Dark and linearity calibration
  3. Wavelength registration
  4. Stray light correction
  5. Calibration in the region of NP-NM spectral overlap
  6. Accounting for solar activities in OMPS calibration
  7. Inter-calibration
  8. OMPS performance and monitoring
  9. LP SDR Science
  10. S-NPP and J1 CONOPS
  11. J1 OMPS pre-launch calibration status
  12. J1 SCDB analysis and conversion to LUT

Team Meeting

- Vision of team interaction: STAR expects to
  - Perform cal/val and adapt for IDPS
  - Collaborate with NASA broadly and indefinitely
  - Get advice from NGAS for as long as possible
  - Work with Raytheon and Aerospace as has been
- Lessons Learned from S-NPP:
  - Inflexible code, esp. CAL SDR
  - Update the DARK sooner
  - Evaluate stray light and update the correction sooner.
  - Wavelength registration may depend on temperature.
  - Dichroic transmittance may change after orbit.
  - Need offline science code.
  - Need tools to interrogate the RDR / SRD
  - Need tools and data to compare (GOME-2, SBUV/2, OMI, CRTM, MLS, …)
  - Need to access BATC documents
- New Challenges of J1:
  - Pre-processor
  - Spectral gaps
  - CAL RDR collection
  - CAL SDR improvements

TIM on LUT with Spectral Gaps

- Informal but informative discussion of
  - Importance to properly handle gaps
  - Current capability
  - Minimum requirements for J1
  - Ideal scenario for J1
  - Outlook of schedule
  - Options and cautions
  - Potential contributors and ways of collaboration

EDR Activities

- Benefited from users' perspective.

Summary

- Most comprehensive collection to document the progress.
  - This was the major goal and has been accomplished, thanks to the team members.
  - Will digest and archive.
- Team meeting to discuss the changing roles, lessons learned, new challenges.
- Precious opportunity to learn about the (indirect) users' perspective.
- TIM to focus on technical issue.
- Very productive overall.

2014 STAR JPSS Science Teams Annual Meeting

ICVS Team Lead Report

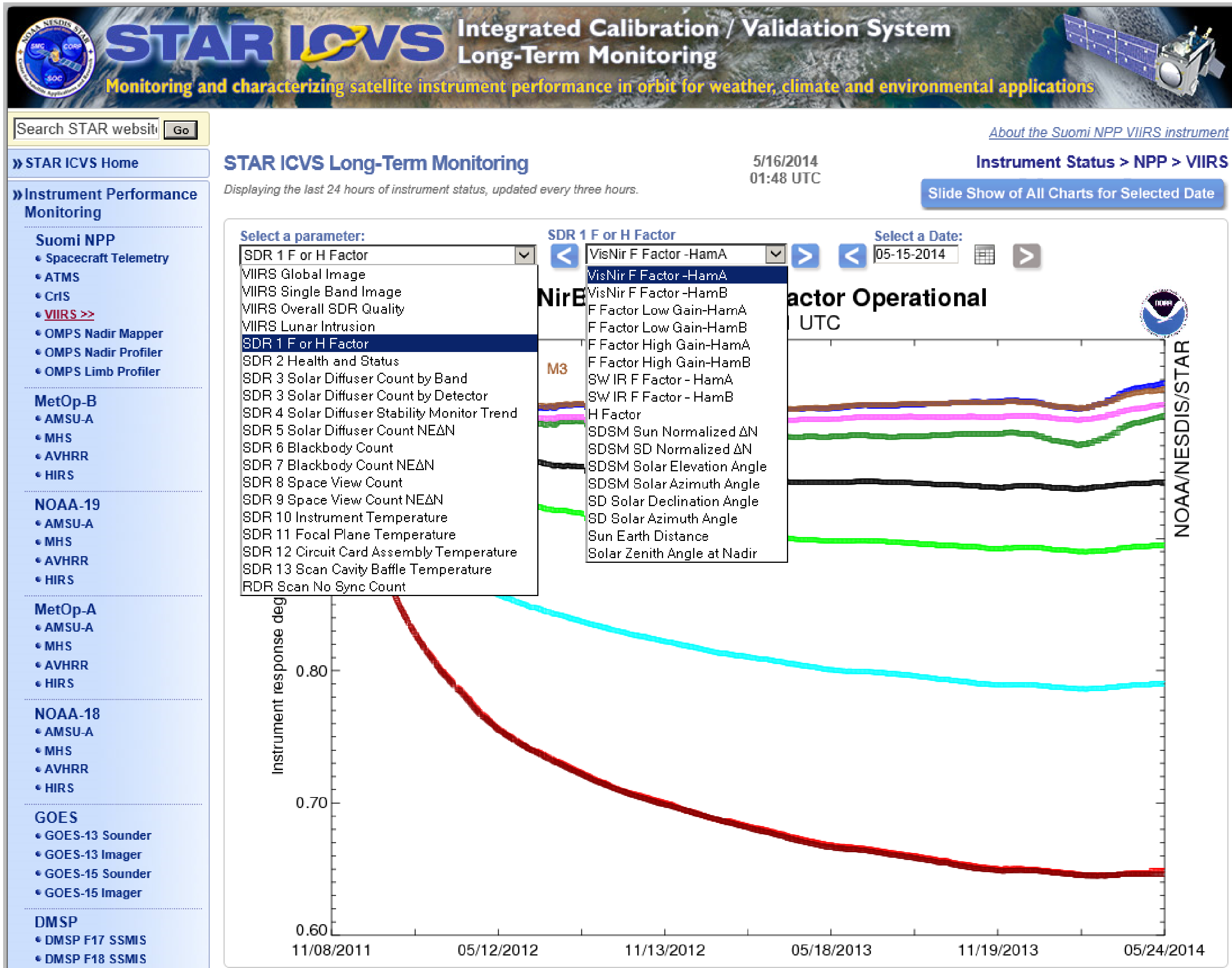
STAR ICVS Team

Major Accomplishments

- SNPP Spacecraft Level (Spacecraft health status and telemetry parameters)
  - 107 products
  - 2 customized text format data files
- Instrument Level (Health status and telemetry parameters) – 984 products
  - S-NPP (total 412 products)
    - ATMS – 92 products
    - CrIS – 46 products
    - VIIRS – 39 products
    - OMPS NM/NP/LP – 81/75/79 products
  - POES/MetOp (total 512 products)
    - AMSU/MHS – 380 products
    - AVHRR – 76 products
    - HIRS – 56 products
  - GOES Sounder/Imager – 60 products
- Calibration Level (Calibration target and performance parameters) – 1714 products
  - S-NPP (total 588 products)
    - ATMS – 92 products
    - CrIS – 170 products
    - VIIRS – 163 products
    - OMPS NM/NP/LP – 79/39/45 products
  - POES/MetOp (total 832 products)
    - AMSU/MHS – 352 products
    - AVHRR – 152 products
    - HIRS – 328 products
  - GOES Sounder/Imager – 294 products
- SDR Level (SDR images, quality flags, and bias characterization parameters) – 633 products
  - S-NPP (total 465 products)
    - ATMS – 108 products
    - CrIS – 213 products
    - VIIRS – 62 products
    - OMPS NM/NP/LP – 29/33/20 products
  - POES/MetOp (total 168 products)
    - AMSU/MHS – 132 products
    - AVHRR – 28 products
    - HIRS – 8 products
  - GOES Sounder/Imager

Total 3440 products from ICVS-LTM, 1574 for S-NPP

Major Accomplishments



Future Plan – ICVS-Lite Transition

- A lite version of ICVS will be transitioned to GRAVITE and serve as the operational S-NPP instrument and SDR data quality monitoring system
- GRAVITE (GV3) can provide more reliable support on S-NPP data stream and be operated in 24/7 mode
- STAR will keep the ownership of ICVS-Lite system and be responsible for system test, transition, maintenance, and upgrade services
- ICVS-Lite users can submit requests to add more parameters in the system

Future Plan – Generation of J1 Proxy Data

- J1 proxy data will be produced to evaluate the error handling capability of operational ground processing system
  - Functional test
    - Golden day data
  - Instrument/data anomaly will be provided using ICVS record
    - PRT inconsistency
    - Calibration count inconsistency
    - Calibration count out of range
    - Missing calibration or scene packets
    - Missing spacecraft diary packet
    - Missing scans
    - Maneuver flag setting
    - SDR data quality flag setting
    - Lunar intrusion

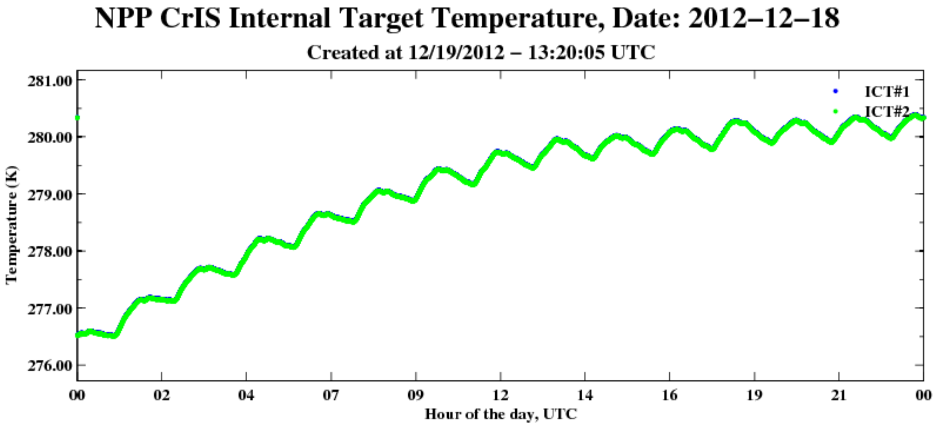
- STAR ICVS team will be working with each SDR team to generate and archive J1 proxy data for test.

S-NPP Anomaly for J1 Proxy Data

CrIS ICT temperature anomaly

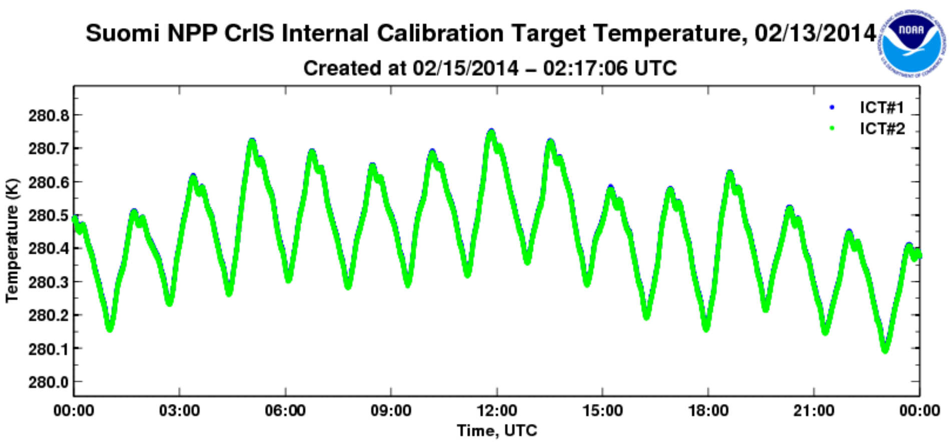
- ICT temperature quickly increased more than 4K on Dec 18, 2012 after CrIS was switched to safe mode, and the nominal daily variation is less than 0.8K

ICT anomaly

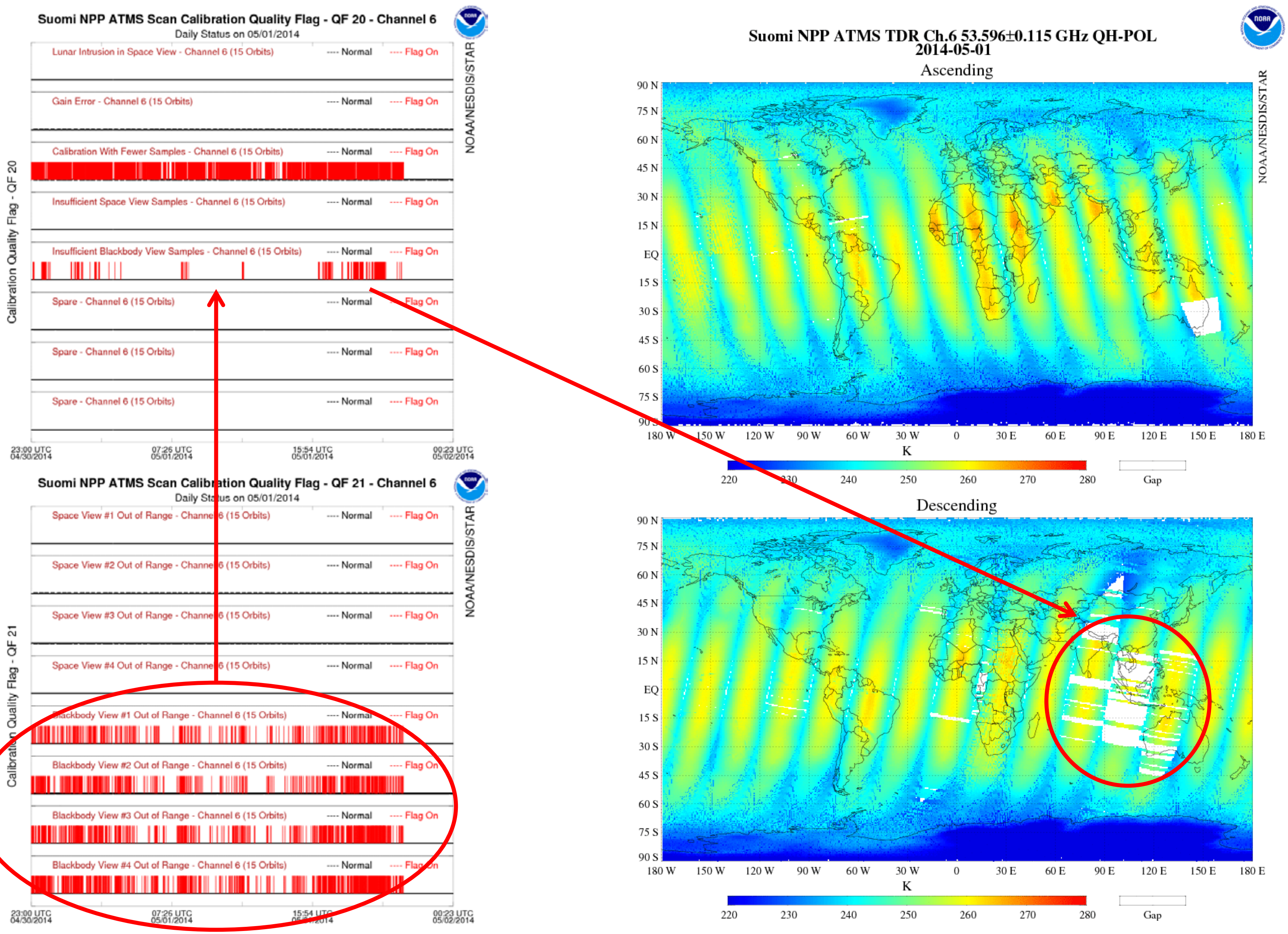


This case will be used to test the program response to dramatic ICT drifting. Some quality flags should be triggered.

Nominal ICT

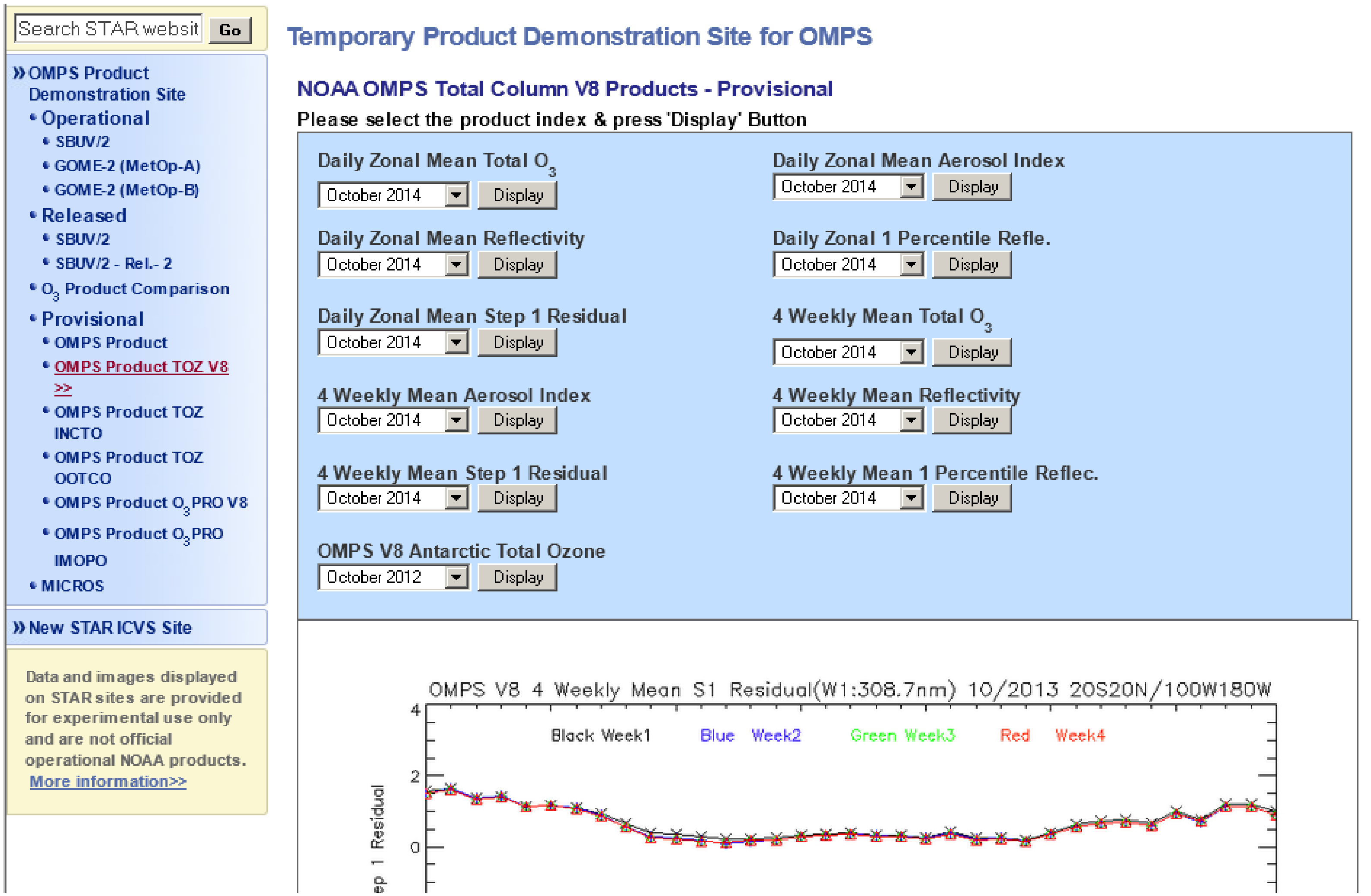


S-NPP Anomaly for J1 Proxy Data



Future Plan – EDR LTM Prototype

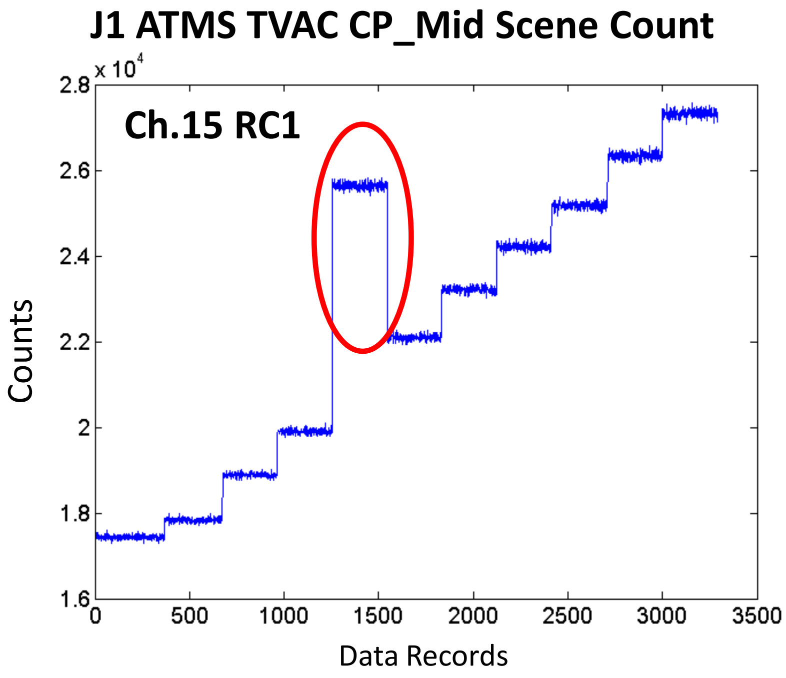
- STAR ICVS website hosts a number of ozone product monitoring web pages
- ICVS team will be working with STAR ozone EDR group to build a EDR LTM prototype in STAR ICVS

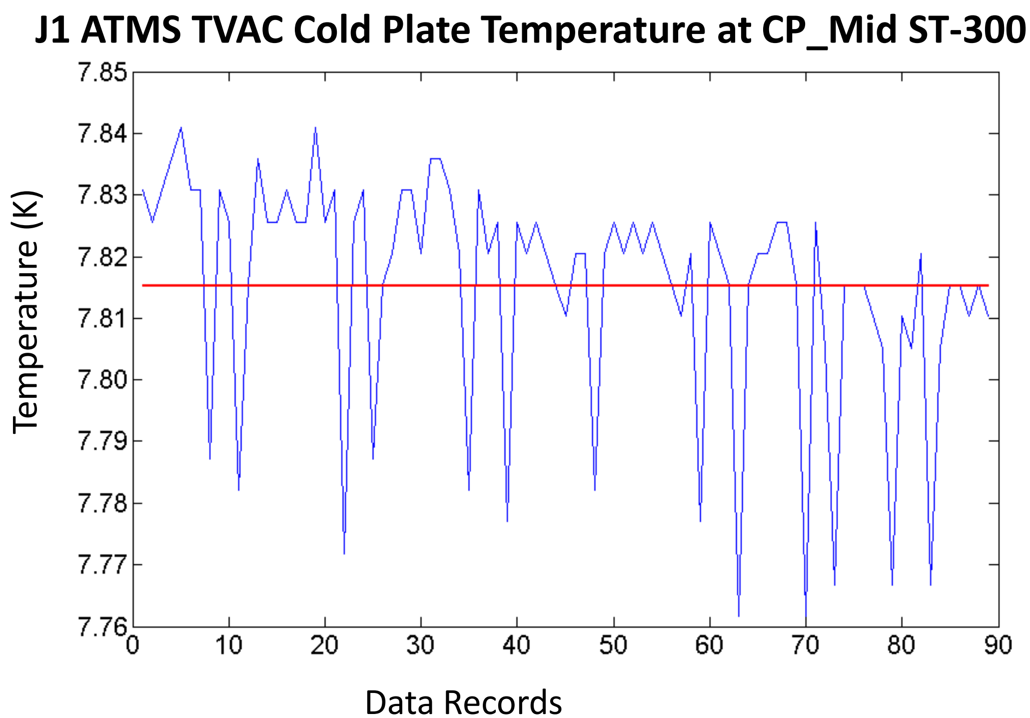


Future Plan – J1 TVAC Support

- STAR ICVS will be archiving J1 instrument thermal vacuum (TVAC) raw data

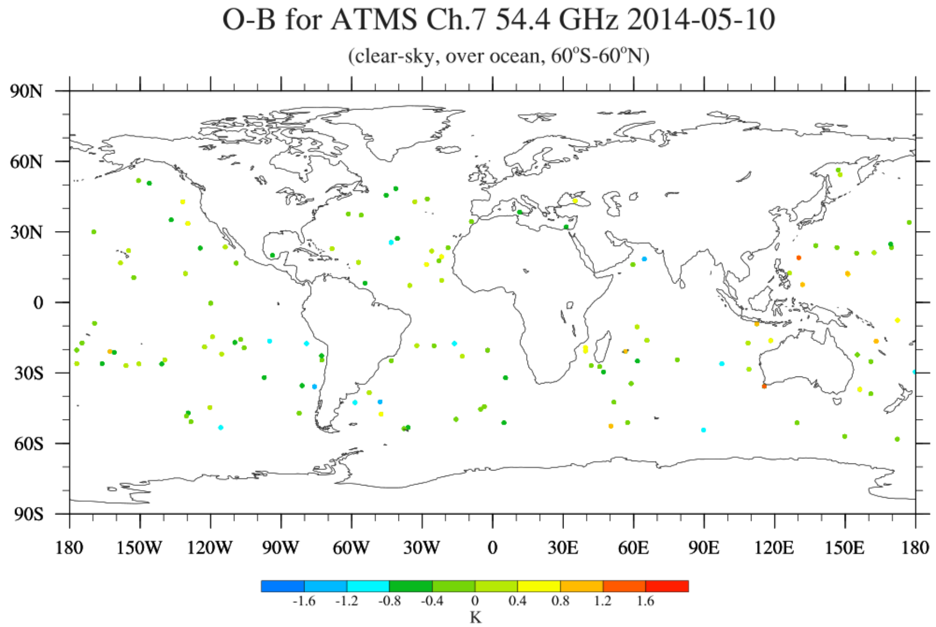
- ICVS team will be providing TVAC data decoding and key parameter trending monitoring service for each SDR team during TVAC test

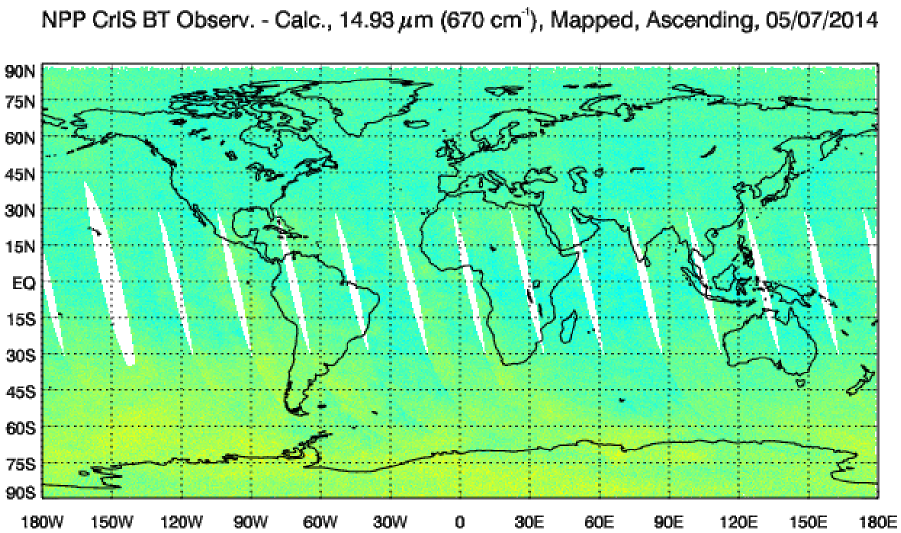




Future Plan – Improved SDR Bias Characterization

- Current SDR bias characterization package needs to be improved
  - Global RTM simulation is not stable
  - Lack of long-term trending products over different surface conditions or geophysical locations
  - RTM needs to be improved for more accurate simulations
- Reprocess S-NPP data to build SDR bias characterization LTM





JPSS STAR Science Team Annual Meeting

Aerosol EDR Team Report

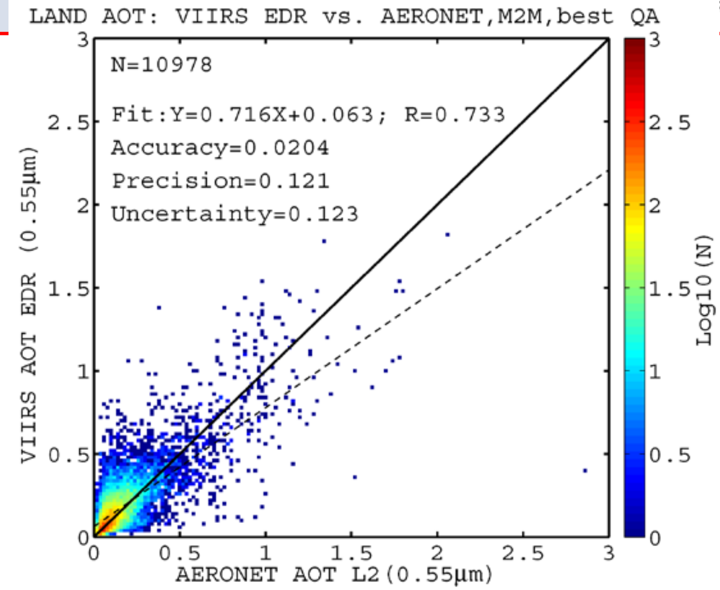
May 16, 2014

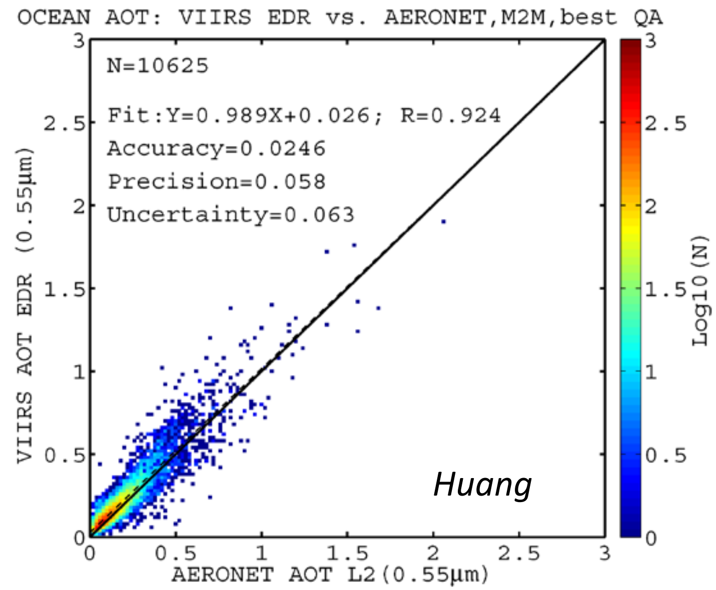
Report on the Atmosphere Breakout

- Eight aerosol presentations
  - Two on the quality of AOT and APSP
  - One on potential improvement of AOT retrieval over land
  - Two on alternative algorithms for AOT/APSP & SM
  - Three on assimilation of VIIRS aerosol products

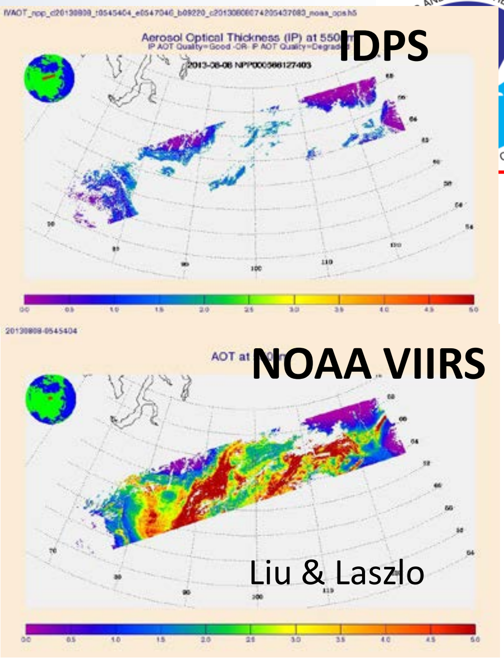
Quality of AOT and APSP

- Characterization used long-term records of independent satellite-derived and ground-observed aerosol data are used
  - MODIS Terra, MODIS Aqua, MISR, AERONET:
    - 01/23/2013-02/28/2014 (land) 05/02/2012-02/28/2014(ocean)
    - **Products meet JPSS L1 requirements** (except for AOT precision at high end over land; small sample. Also, using different matchup data all requirements are met!)
  - Maritime Aerosol Network (MAN): May 2, 2012 to February 28, 2014:
    - **AOT and APSP meet JPSS L1 requirements**
- **Evaluation effort/results meet validated maturity criteria**

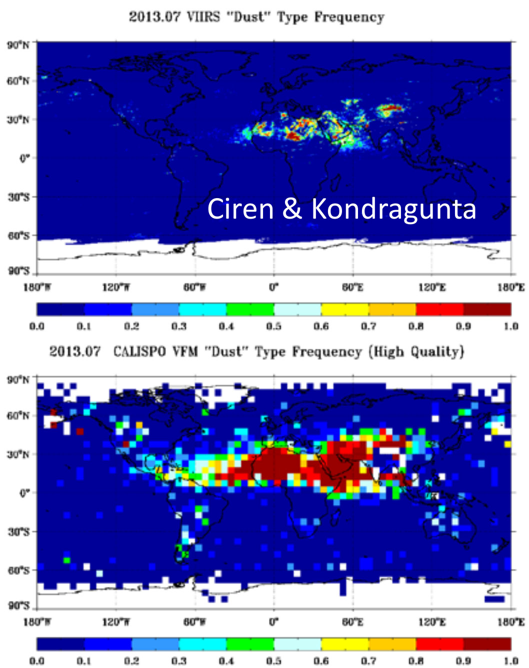




Alternative Algorithms

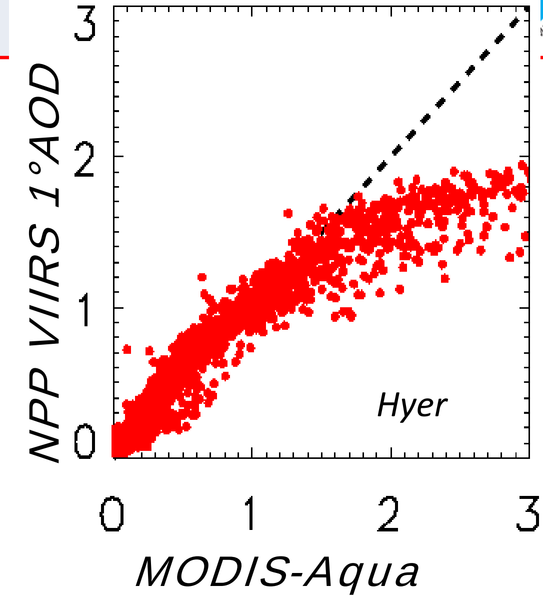


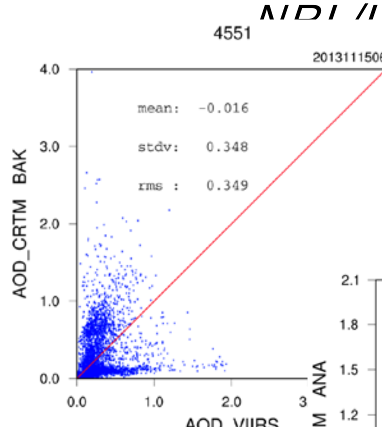
- AOT & APSP
  - algorithm uses features of ABI/MODIS and current IDPS approaches
    - same algorithm for VIIRS and ABI
    - more coverage
    - better accuracy over land, comparable accuracy over ocean
    - meets L1RD requirements
    - need more tuning, testing and acceptance by users
- SM
  - based on observations from deep-blue and shortwave-IR channels
    - peer reviewed
    - dust and smoke detections meet L1RD requirements
    - additional validation on smoke detection is needed
    - additional investigation of data artifacts (false detections) is required to enhance product accuracy



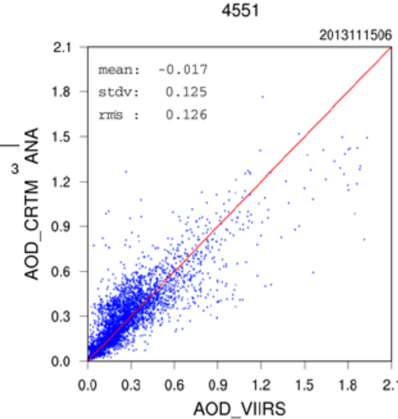
Aerosol Assimilation

- VIIRS has about twice the coverage of MODIS (good)
- VIIRS is higher in low-AOT areas and has elevated AOT where MODIS does not. (not so good - outliers are very bad for assimilation)
- Current AOT range of [0-2] is not sufficient; results in a truncation effect on averaged data
- Events with elevated AOT may not be properly captured
- NCEP aerosol forecasts are routinely evaluated with aerosol data from different sources; aerosol analysis using VIIRS AOT is a priority in Phase 3 (post FY15) of their planned system enhancement
- Assimilation of VIIRS AOT improved aerosol analysis and subsequent forecasts over East-Asia





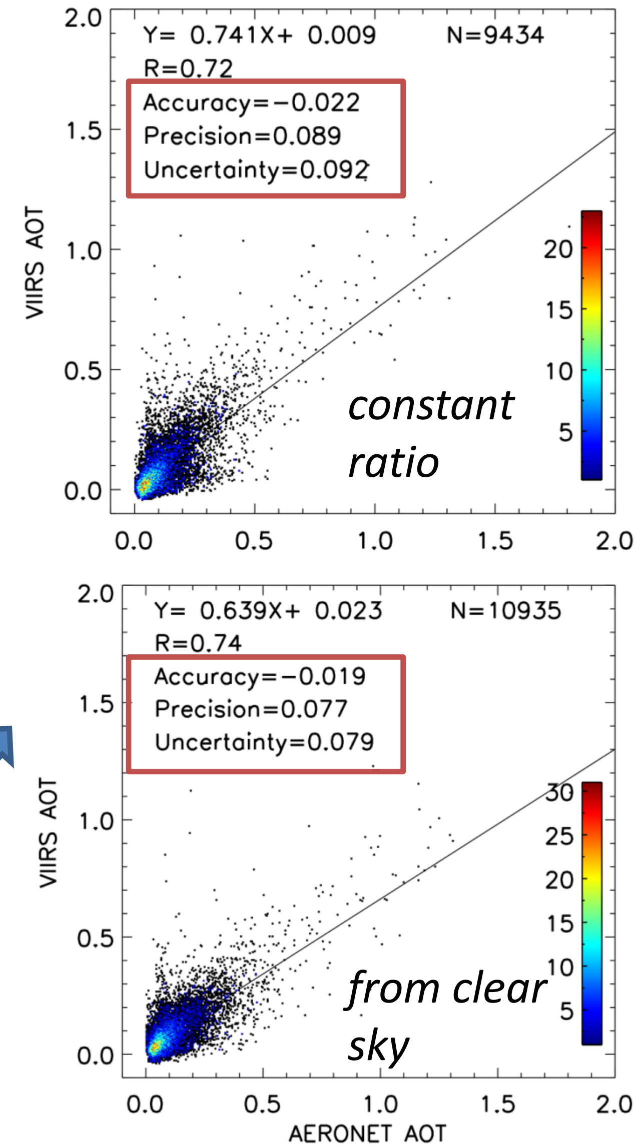
Zhiquan Liu



Current and future efforts

Addressing issues identified by cal/val team and/or raised by users

- extending the AOT reporting range to [-0.05,5.00]
- more aggressive filtering for detecting possible cloud contamination, snow/ice contamination:
  - spatial homogeneity
  - new spectral test and thresholds (e.g. NDSI and its variants)
- develop regional and seasonal land surface reflectance relationships to reduce overall high AOT bias over land
- implement some version of the deep blue algorithm



poster by Hai et al.

Concerns/questions

- **At least one group of users needs MODIS-like output files**
  - cal/val team can design "conversion software, but would it be part of IDPS (new format instead of current one), or would it be run outside of IDPS. If latter, who would do it?
    - required content (aggregated "aerosol" reflectances) suggests it should be part of the retrieval, that is IDPS
- **Path forward is not clear:**
  - algorithms are going to IDPS or NDE?
  - what is the maturity level assessment, i.e. validation plan?
    - if an algorithm goes to NDE,
    - if an alternative algorithm replaces the current IDPS algorithm (repeat maturity assessment starting with beta?)
- **Breakout was by discipline**
  - no VCM presentation (input to aerosol)
  - land product breakout was parallel; would have liked to get feedback on AOT from surface reflectance team (AOT is input to them)
- **Would/should NCEP aerosol forecast replace NAAPS in the future?**

Cloud Breakout Summary

Andrew Heidinger

May 16, 2014

Cloud Breakout Presentations 1

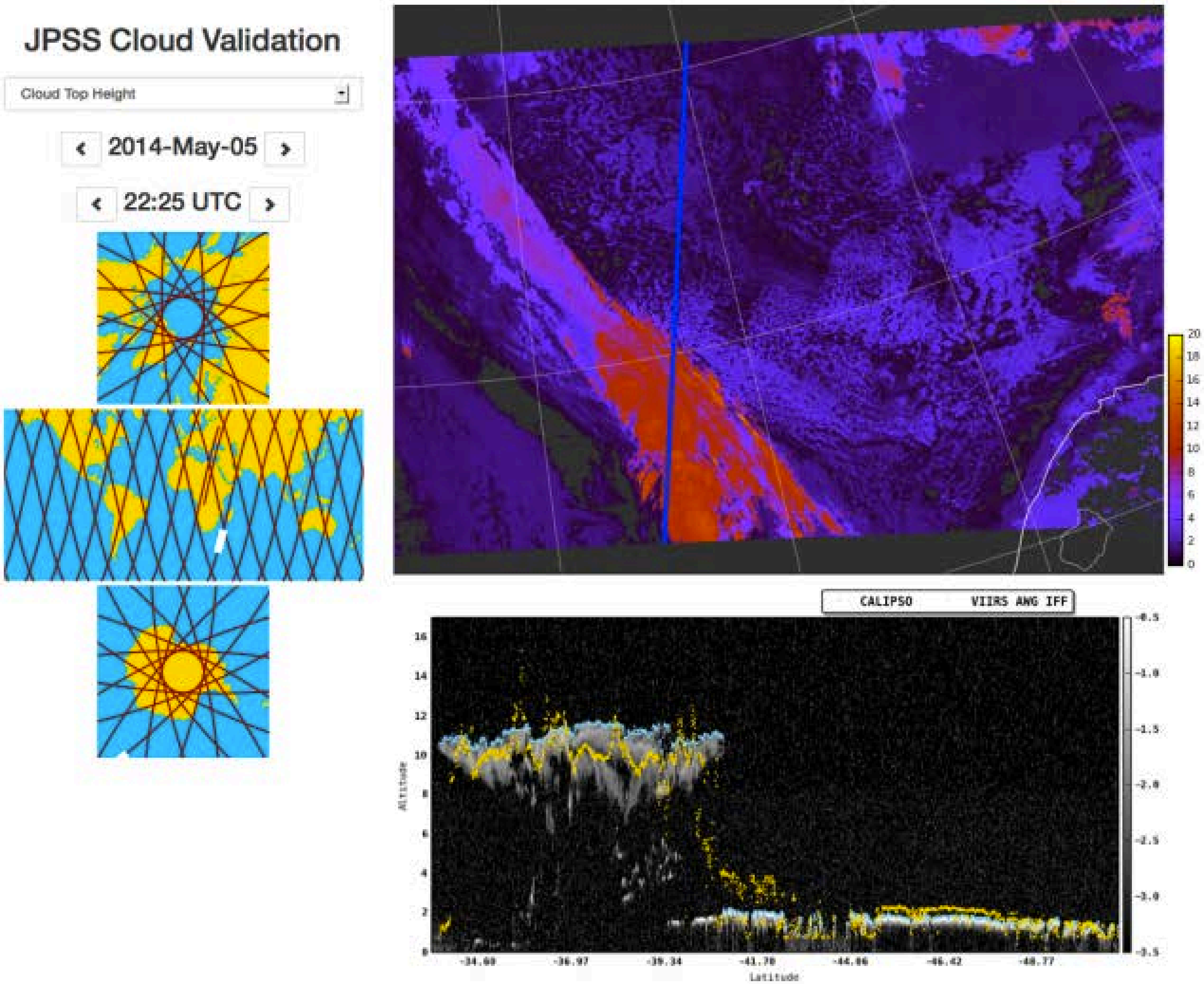
- **Eric Wong – NGAS**:
  - Identified two issues that could be major driver of issues with IDPS NPOESS-era algorithms.
    - Inaccurate Surface Reflectance for Day COP
    - Wrong RTM used for Cloud Height
  - Initial analysis shows IDPS results move towards NDE/CLAVR-x Performance with these fixes.
- **Curtis Seaman – CIRA**:
  - Cloud Base issues mainly attributable to Cloud Height and Cloud Type.
  - When Cloud Height works, cloud base is useful but issues still remain that can addressed using CloudSat information.
  - Analysis shows NDE/CLAVR-x base performs better but room for improvement.

Cloud Breakout Presentations 2

- **Kurt Brueske - Raytheon**:
  - Demonstrated Raytheon capabilities to diagnose issues and demonstrate impact of algorithm changes.
  - Example shown was a nighttime snow VCM issue.
- **Bob Holz - CIMSS**:
  - A new website is being developed using UW/Atmos PEATE tools.
  - Site will allow for comparison of individual granules or generate of long term metrics.
  - Tools are general and support many sensor matchups.
  - Using CALIPSO/CALIOP as a standard, NDE/CLAVR-x performance exceeds that of IDPS.

JPSS Cloud Validation Interface

Bob Holz et al.



Issues Raised in Breakout

- Some of the Imagery Team consistency tests should be applied to cloud products.
- CLAVR-x/NDE performance is better that IDPS NPOESS-era algorithms. Move to NDE is going forward for cloud products. **Need sample data set for users to get ready. Minimize user confusion.**
- Any cloud mask switch should follow a more cautious path and move to NDE mask will occur only after Application Teams agree.
- Next time, a VCM breakout session would be good.

Potential Applications from User Breakout

- Routine Mesoscale Analysis or URMA are NWS applications that could benefit from VIIRS Cloud Products in the short term.
- NESDIS PSDI Alaskan Cloud Composites (AVHRR + GOES) are another good application for VIIRS
- JPSS-RR DNB VIIRS cloud products and cloud applications over Hawaii would be useful for the nighttime data-void.
- NWS AWC is interested in cloud layers from VIIRS.
- User applications identified here will be pursued likely in JPSS-PG.

Center for Satellite Applications and Research
formerly ORA — Office of Research and Applications

Soundings: Team Lead Report

Tony Reale and Mark Liu
Center for Satellite Applications and Research (STAR)

May 16, 2014

Summary

- Very well run
- 13 presentations and over 50 participants for Soundings
- Presentations addressed a variety of atmospheric sounding techniques validated in a variety of ways
- User applications were focused on level 2 and level 3 products rather than the radiance measurements
- The topic of atmospheric rivers (initiated by Chris Barnet) echoed user interests focused on sever weather events … refreshing!
- Sounding product performance and validation was a common theme among providers (Bill, Joel, Chris G, Xu Liu, Antonia, Tony, Chris G)
- Feedback to planned EDR sounding work at STAR/JPSS not so much …

Thoughts

- Presentations from users (3) should be formulated into an evolving list of users and applications, formal project interaction with SPoRT, etc
- The distinction between the direct readout and global product environments must be clearly understood; they are not the same
- Clearly define the source and commitment wrt NOAA unique NESDIS retrieval across IASI/AIRS and CrIS
- Clearly define STAR's position wrt project independent oversight for respective product development, implementations (research to OPS), routine monitoring and validation; NPROVS/NPROVS+ as source of standardized validation (RT model, sensor) at STAR
- Support (mandate) active engagement of EDGE analytic interface among atmospheric (T, h20) product providers at STAR (NUCAPS, MiRS …)

Thoughts

- Clearly define role/requirement for externals (NASA and CIMSS) in EDR development/validation … $
- Plan for gas retrievals
- It would be wonderful to formally share EDR products at STAR, examples, soundings to routinely append cloud products to " validation" datasets (NPROVS+) and in special cases (AEROSE) to include dust/aerosol, etc
- Address the question why soundings (or any EDR) which does not (appear) to have a clear user mandate; creates an official, sanctioned STAR view … formal STAR position
- Address the question of sustained satellite synchronized validation; many speakers desire closely matched ground and satellite data to best demonstrate potential product value and impact; make available the validation datasets (NPROVS+, VALAR)

Thoughts

- Talks directly relevant to STAR/JPSS mission: Antonia (3), Feltzer (5), Chris G (7), Tony (9), Emily (SPORT, 10), Nalli (11), Ward 912) and Kopacz (13, gas)

- AK talk points to need for direct interaction between STAR (NPROVS, etc) and OPS concerning monitoring and feedback between STAR / OPS including the transition from research to operations (Walter…)

- Some comparisons against NUCAPS (ie Joel) (Xu Lui vs IDPS) reported; engage others to validate our products; make product (including test) available.

Looking Forward

- CrIS full spectral resolution data (from Dec. 2014?).
- Continuous CrIS full spectral data beyond JPSS-1.
- NPROVS+ builds testbed for the validations of common sounding products; internalization, internationalization.
- JPSS-funded integrated sounding system for all hyperspectral sensors … unified NESDIS …
- Explore (better) performance sounding products associated with severe weather (clear and cloudy) … EDGE, etc
- Carbon products for climate studies.
- Sounding product applications for air quality monitoring and forecasting.
- Uncertainty estimates!

Report Back on
Ozone and OMPS Products

L. Flynn

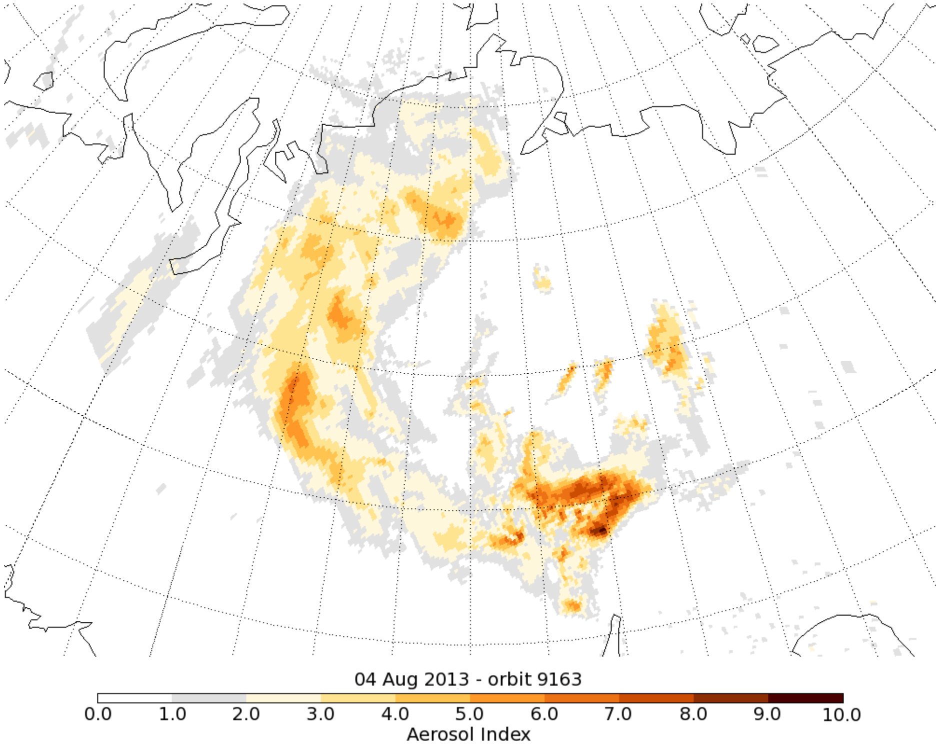
May 16 NOAA STAR JPSS Science Meeting

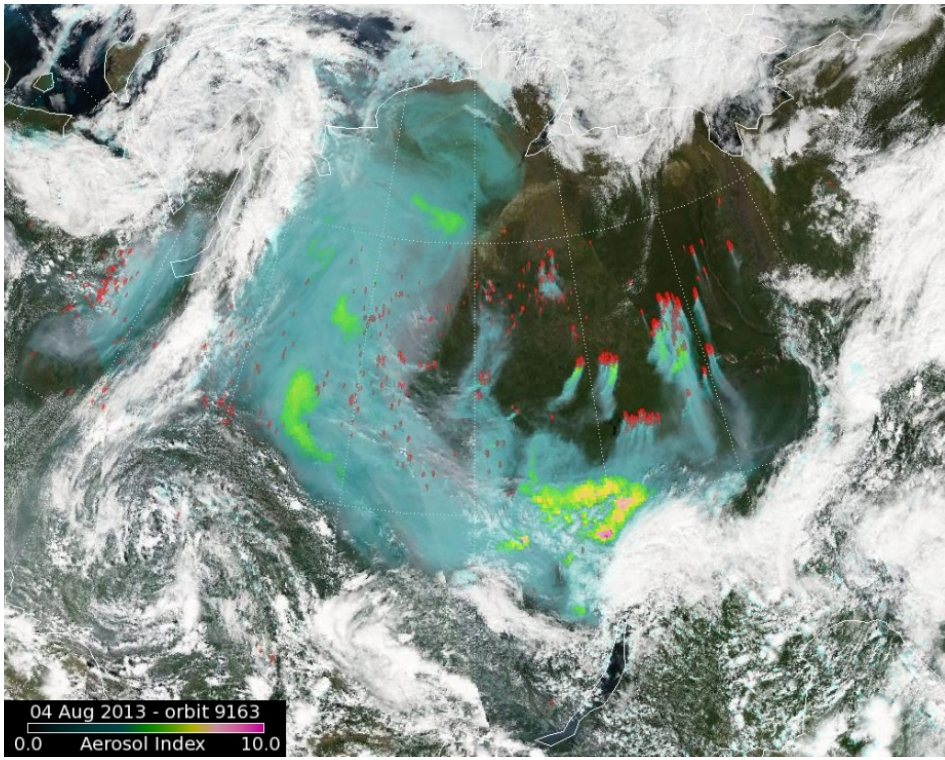
Outline

- Aerosol Products
- Atmospheric SO_2 Products
- Blended IR/UV Ozone Products
- SPORT Ozone Anomaly Products
- OMPS Limb Profiler Products
- Ozone Applications
- V8Pro Status
- V8TOz and V2LP Statuses

High Resolution OMPS Aerosol Index

Wild fires over Russia on August 4, 2013





- Never seen before detail in UV Absorbing Aerosol Index imagery
- Individual smoke plumes can be resolved
- Smaller FOVs would facilitate quantitative interpretation (Absorbing Aerosol Optical Depth, Single Scattering Albedo)

Courtesy of Colin Seftor/SSAI

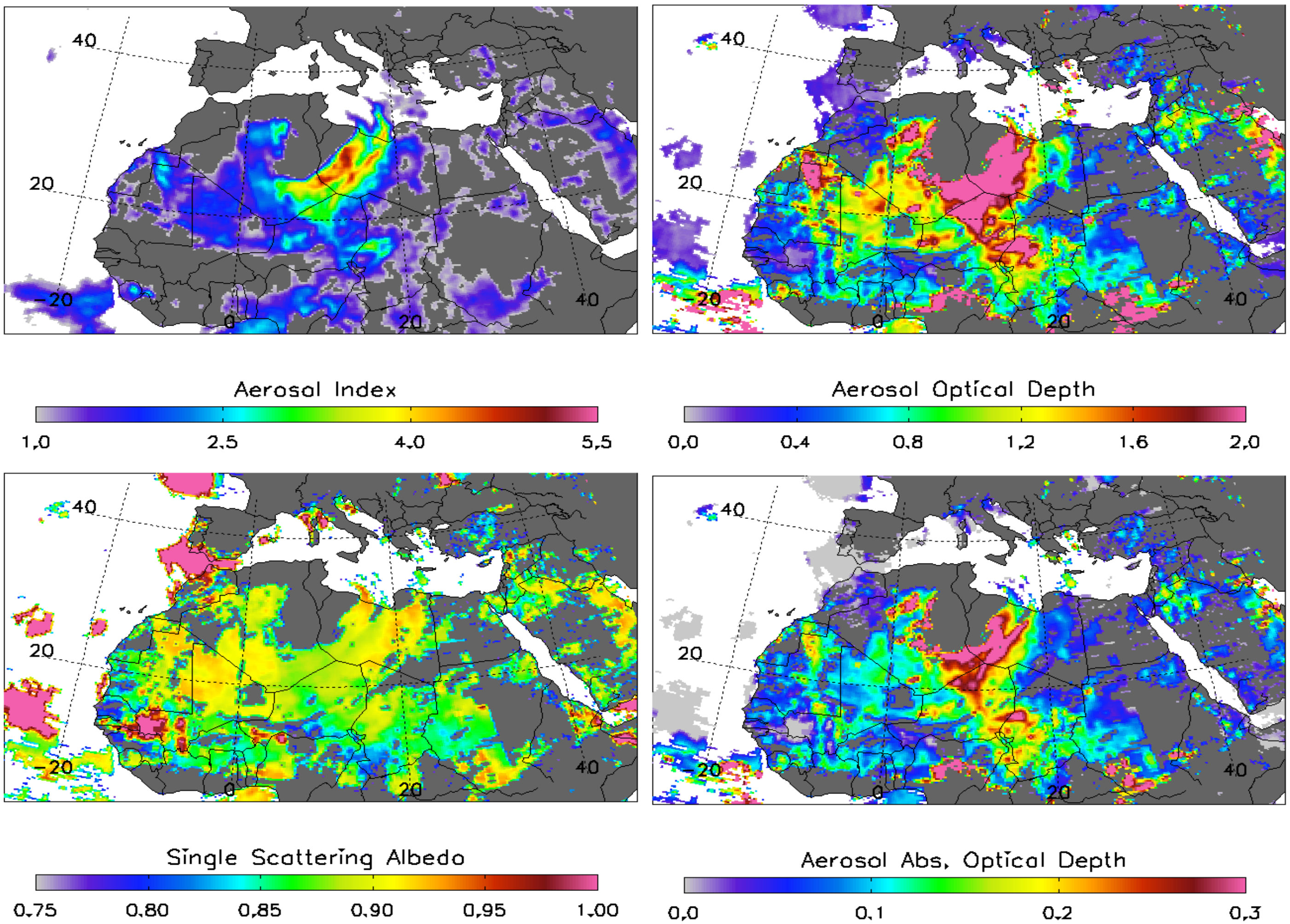
UV Aerosol Products (O. Torres Presenter)

- The UV Absorbing Aerosol Index is an intermediate product for the total ozone algorithms.
- This OMPS product will continue the 35-year record.
- Aerosol Single Scattering Albedo and Optical Depth can be simultaneously retrieved with OMI algorithms .
- A 3×12 km^2 spatial resolution for two near-UV reflectivity channels is recommended for retrieval of aerosol properties from OMPS observations.
- The combination of OMPS and VIIRS observations present a great opportunity for more accurate retrieval of aerosol properties (AOD and SSA) with the possibility of estimating altitudes.

From qualitative to quantitative aerosol absorption information

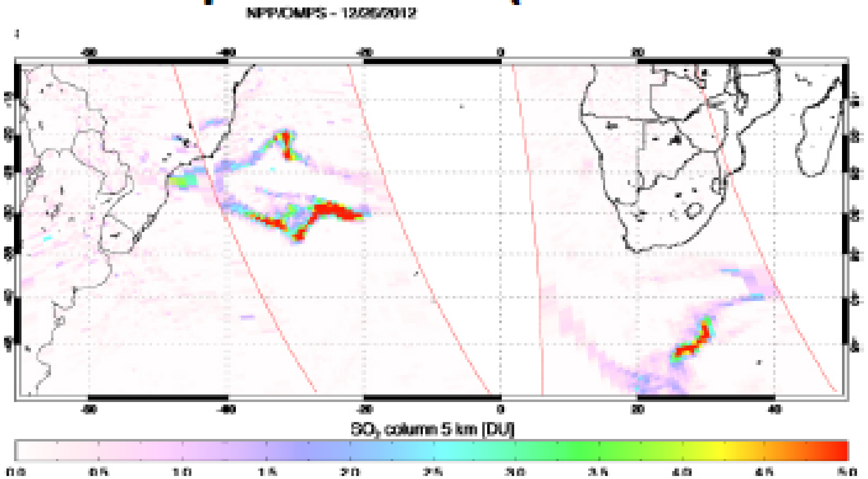
Aerosol Single Scattering Albedo and Optical Depth can be simultaneously retrieved.

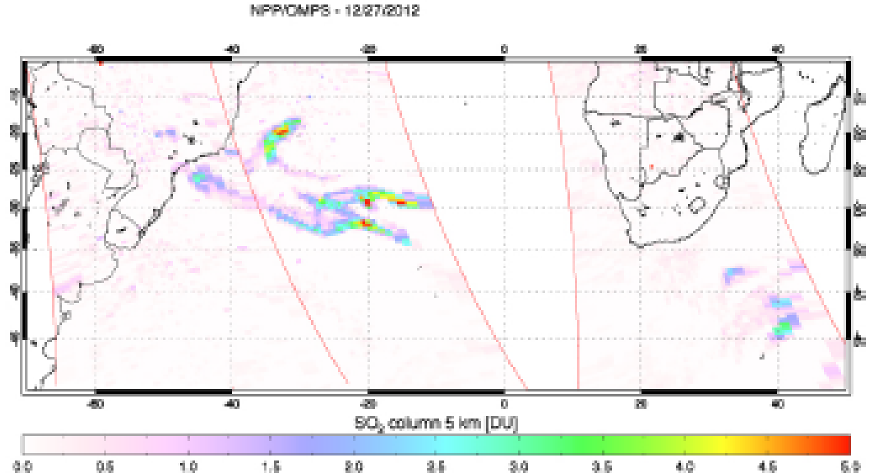
(Height of absorbing aerosol layer must be prescribed)

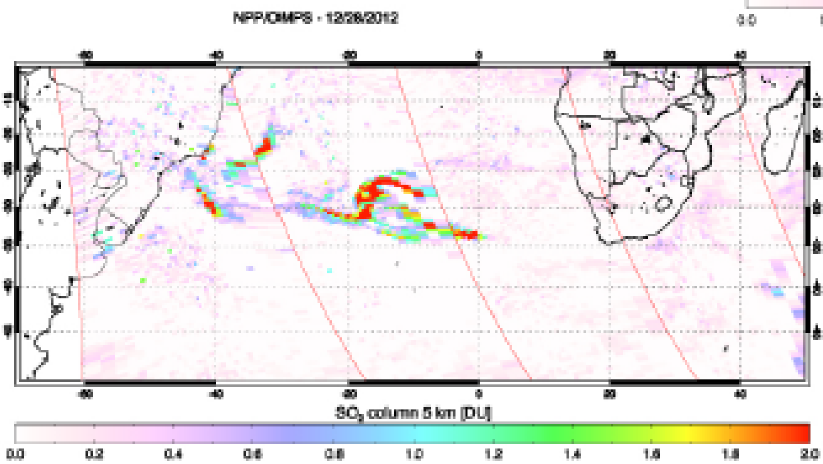


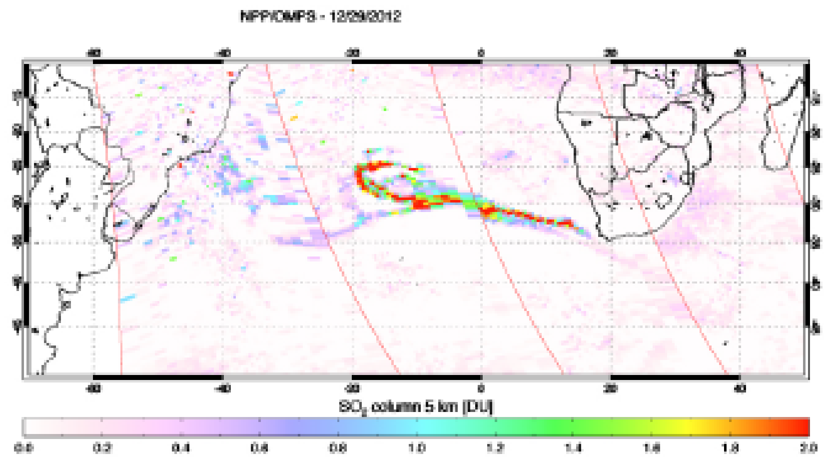
OMI Retrieved Dust Properties (March 9-2007)

S-NPP OMPS LF SO_2:
Copahue (Chile & Argentina), Dec 2012









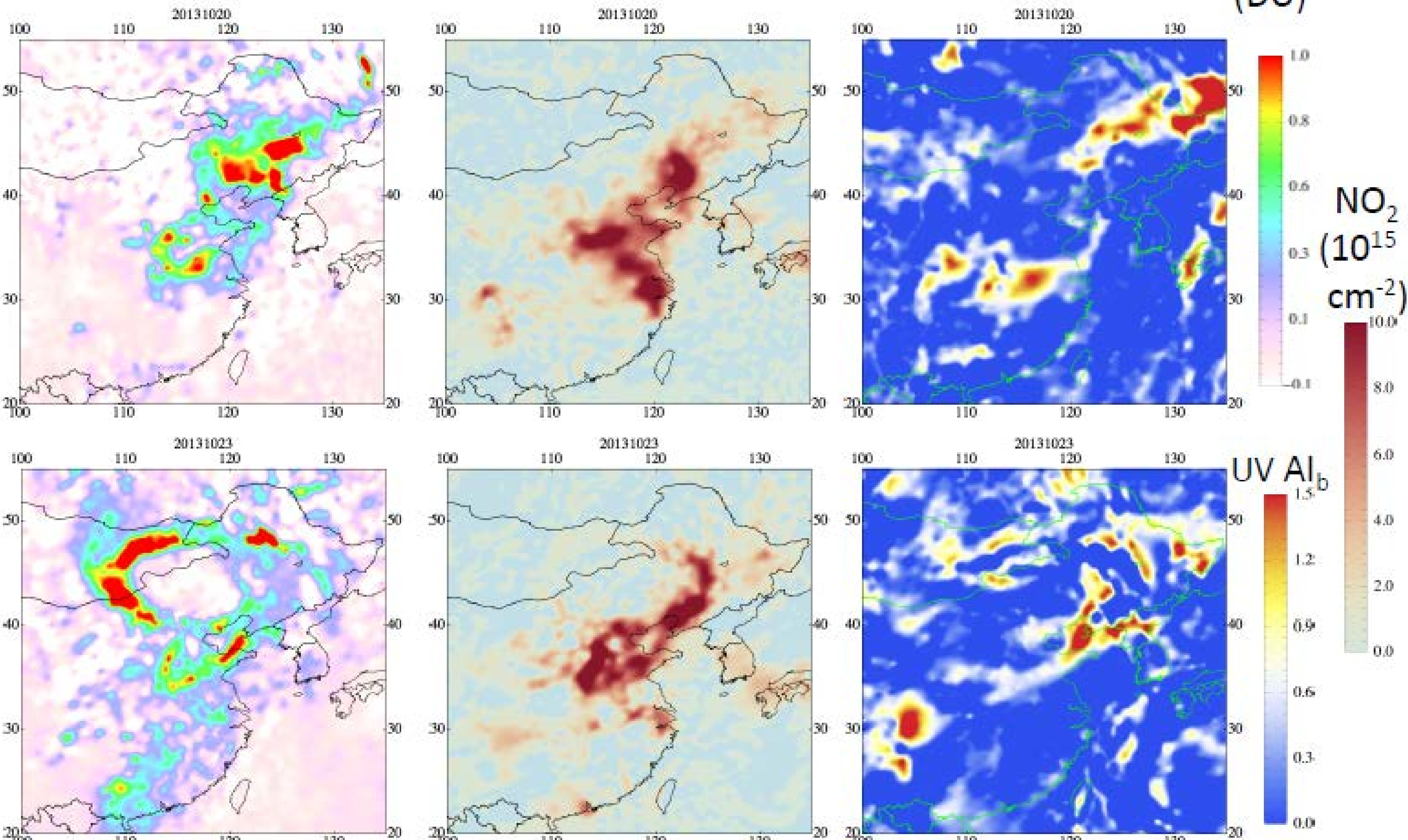
SO_2 Products (K. Yang Presenter)

- An SO_2 Index is an intermediate product for the total ozone algorithms. It has been found wanting.
- The Version 8 Total Ozone Algorithm provides the input needed by a Linear Fit SO_2 column retrieval algorithm.
- Higher spatial resolution measurements will improve information for hazard and air quality applications.
- Accurate SO_2 estimates are needed to correct ozone estimates – 1 DU of SO_2 is interpreted as 2 DU of O_3 without correction.

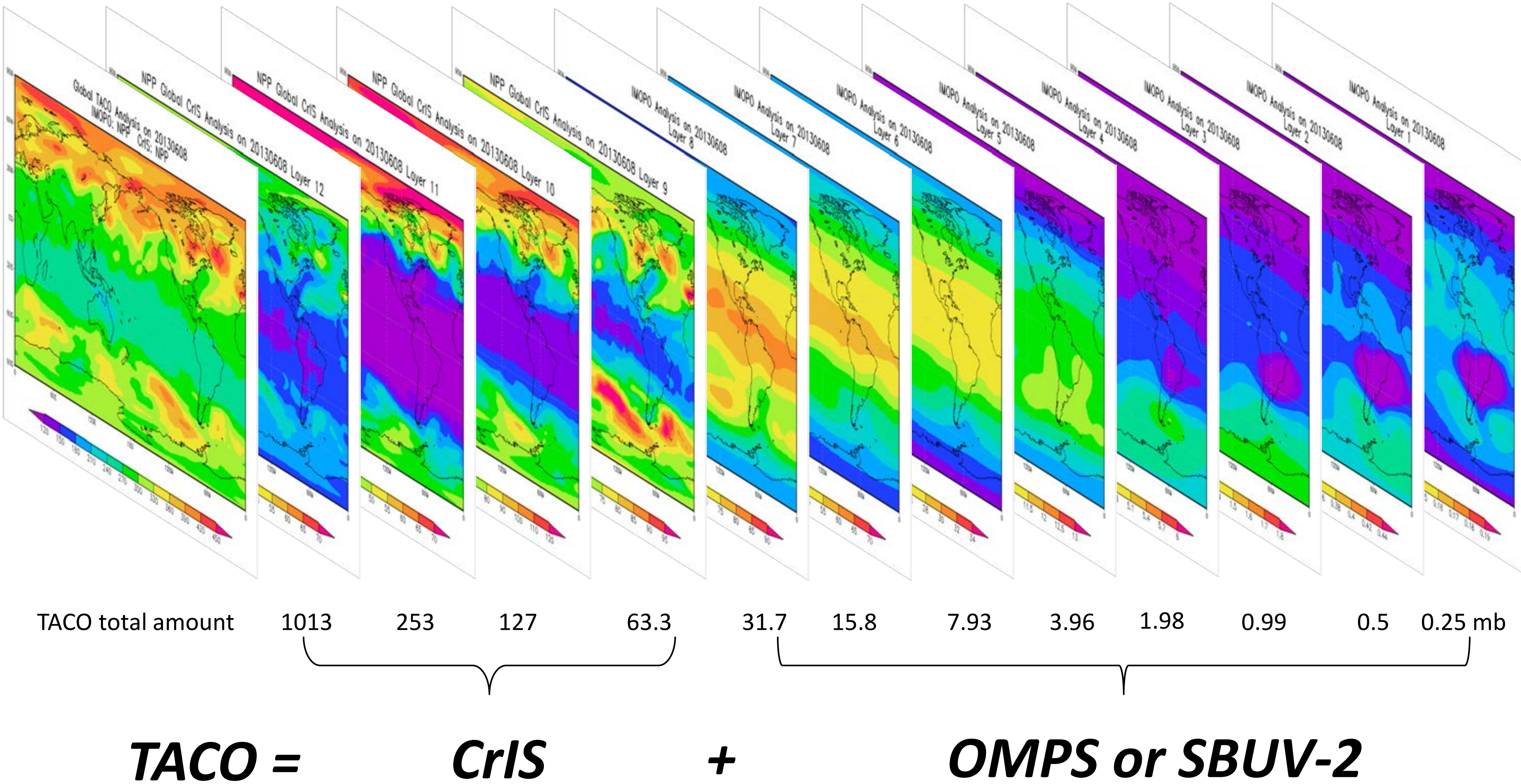
SO_2 Users

- **VAACs: The SO_2 products are used to track volcanic eruptions for aviation hazards. This is the most important NRT application.**
- **EPA & ARL: Air Quality forecasts and monitoring (O_3, SO_2 & NO_2 amounts, aerosol classification)**
- **USGS/AID: Passive volcanic outgassing**
- **Atmospheric chemistry and climate change research**
- **MACC II ECMWF**

Daily Global Pollution Monitoring with OMPS

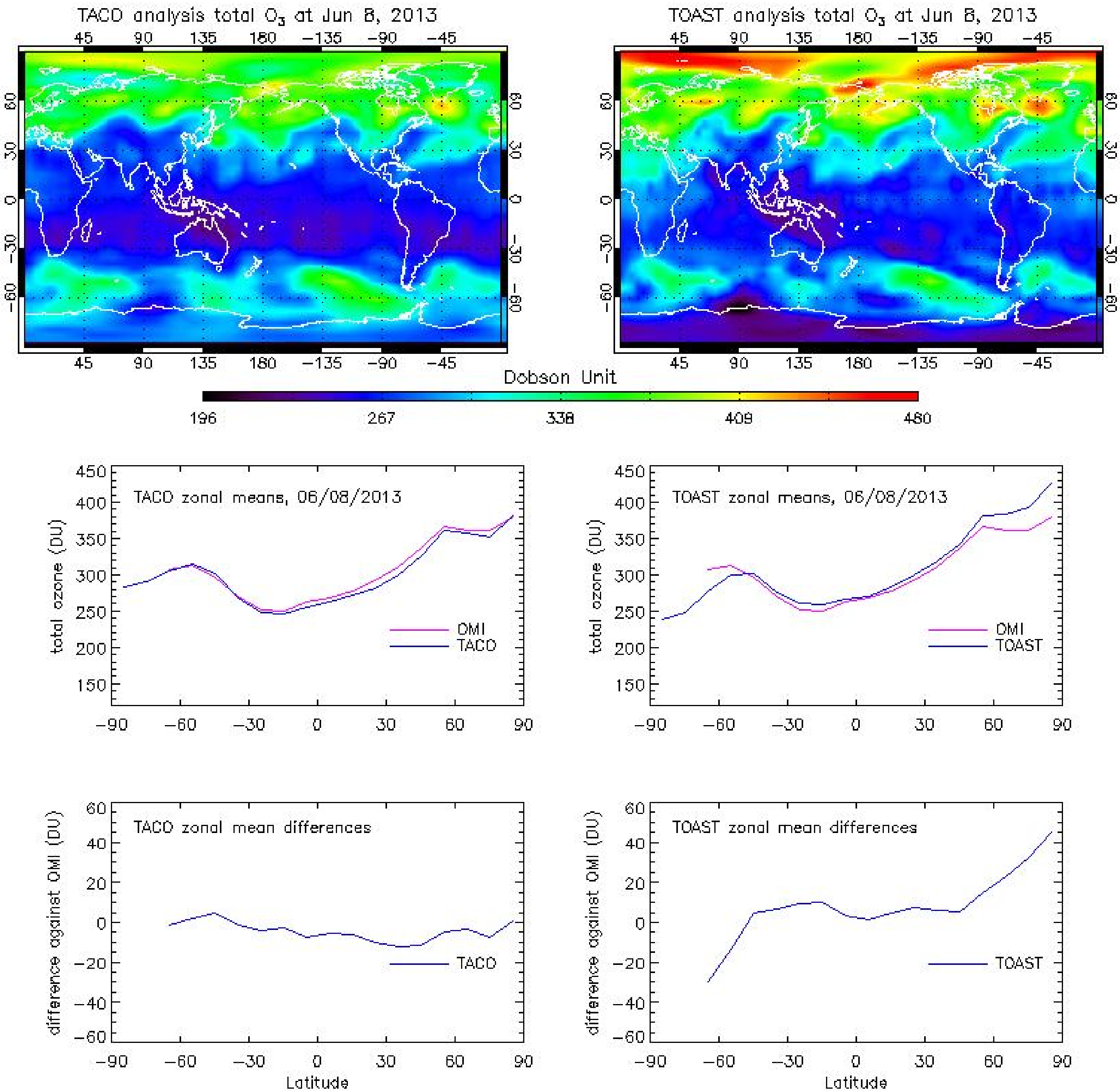


Composition of Total ozone Analysis for CrIS and OMPS (TACO) products



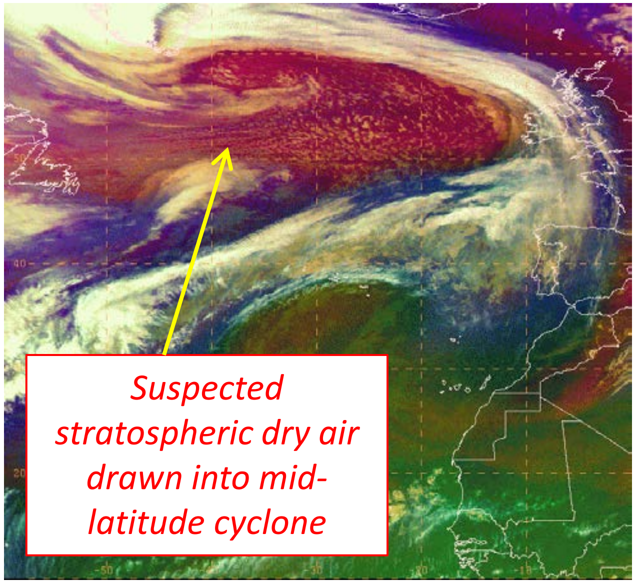
Combined UV/IR Ozone Products (J. Niu Presenter)

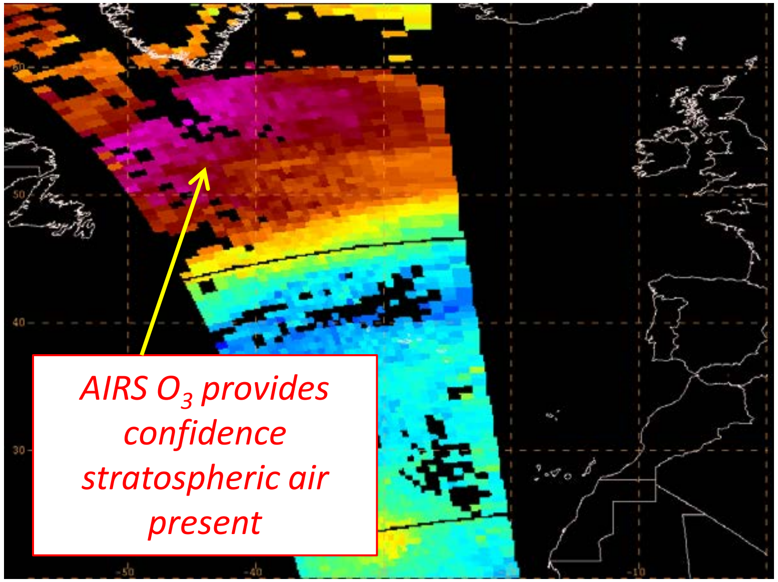
- CrIS and OMPS ozone products will be used to continue the SBUV/2 and HIRS TOAST products.
- Full UV/IR retrievals developed for EOS Aura TES and OMI are proposed for use with CrIS and OMPS. (IASI and GOME-2 algorithms are also under development).
- Orbital update to the analysis can be implemented to improve product timeliness.



TACO analysis total O3 at Jun 8, 2013
TOAST analysis total O3 at Jun 8, 2013
Dobson Unit
196
267
338
409
480
TACO zonal means, 06/08/2013
TOAST zonal means, 06/08/2013
total ozone (DU)
OMI
TACO
TOAST
TACO zonal mean differences
TOAST zonal mean differences
difference against OMI (DU)
Latitude

The Forecast Challenge and Ozone Retrievals



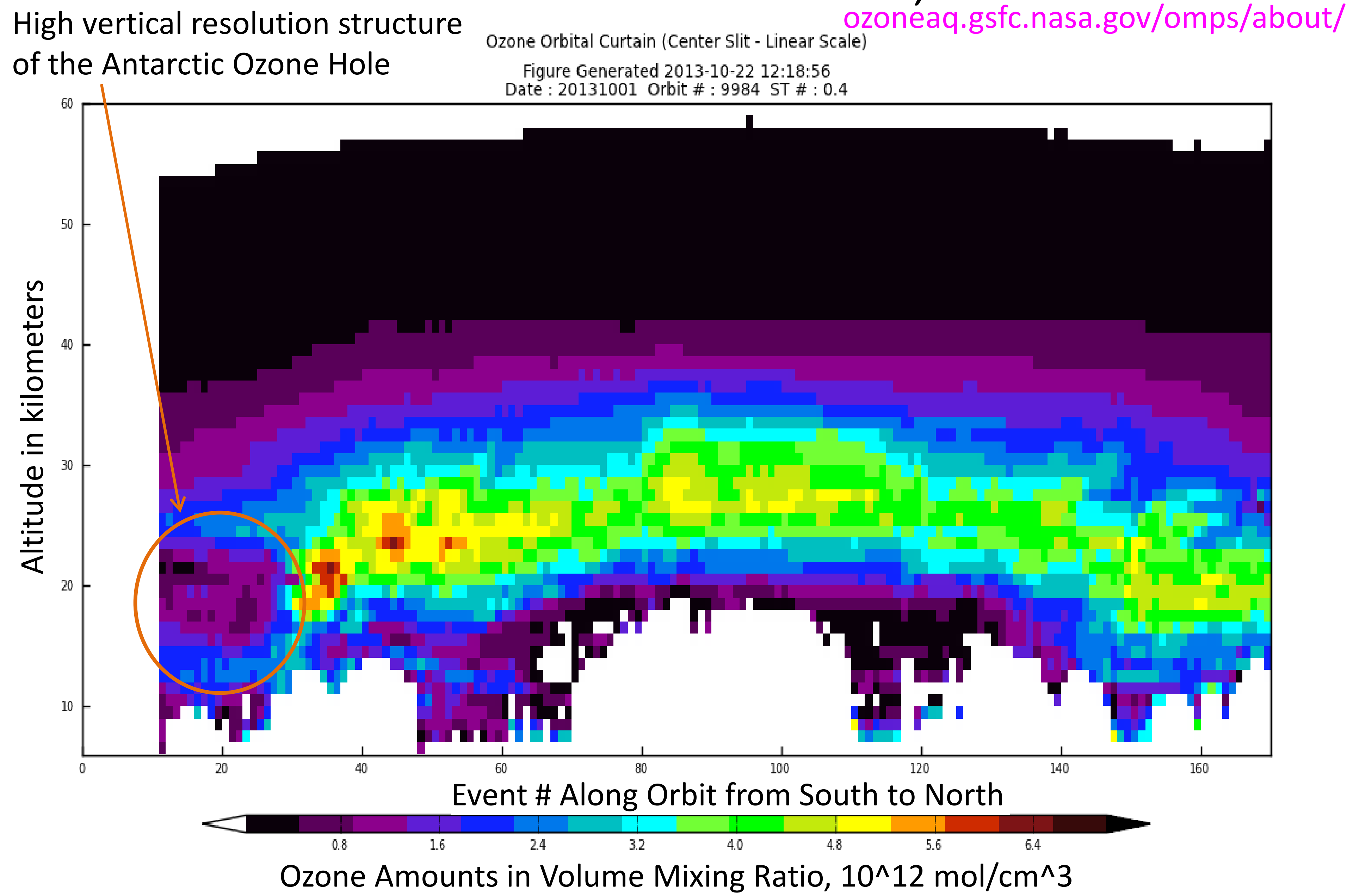


- SPoRT has worked closely with the GOES-R and JPSS Proving Grounds to develop and transition ozone products in N-AWIPS format to OPC
- OPC has used the Air Mass RGB product to identify stratospheric air, however uncertainty exists about interpreting the new qualitative product
- Legacy AIRS ozone retrievals can be used to increase forecaster confidence in the Air Mass RGB and enhance interpretation

Infrared Ozone Products for Operational Meteorology (E. Berndt Presenter)

- Ozone anomalies can be used to identify regions of stratospheric air and potential for tropopause folding.
- Maps of ozone deviations from climatology can be used by forecasters to assist in recognition of severe event potential.
- JPSS (IASI, CrIS, GOME-2, OMPS) offers a wealth of total ozone maps in NRT.

Center Slit, OMPS Limb Ozone Profile Retrievals for one Orbit on October 22, 2013

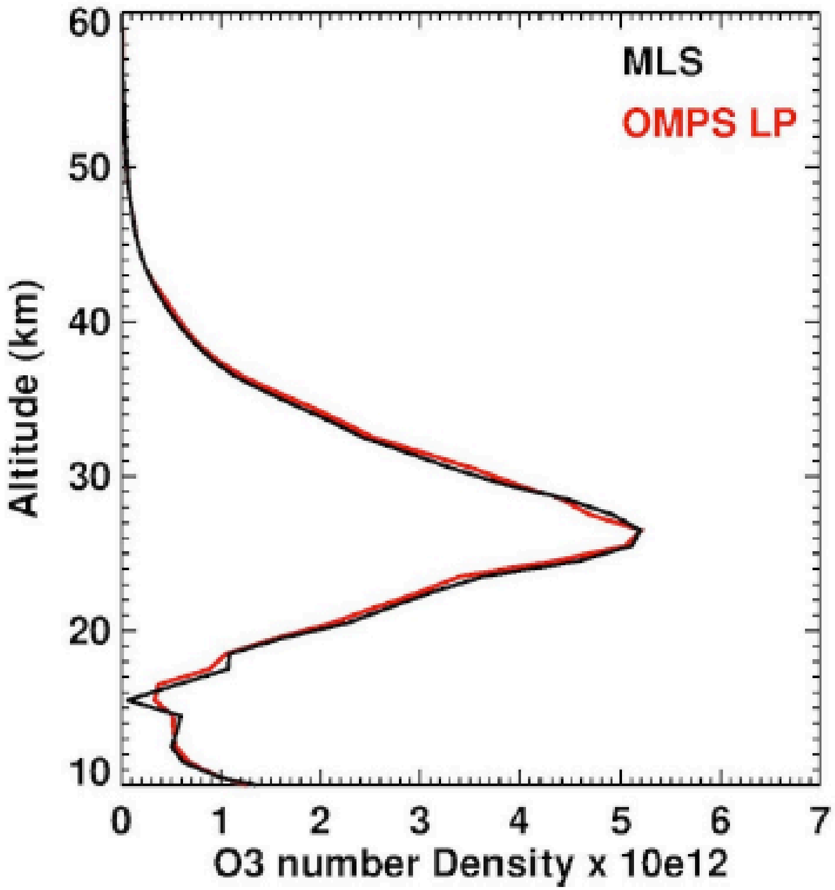


OMPS Limb Profiler Ozone Profile

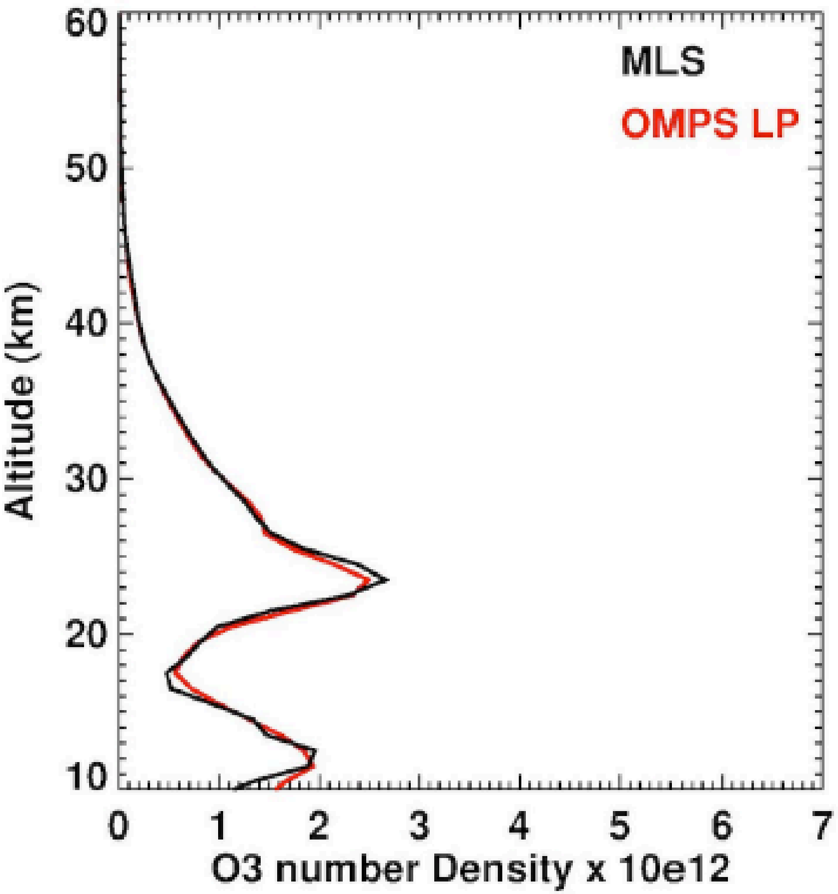
- The NASA Ozone PEATE has processed the complete OMPS LP record with the Version 2 retrieval algorithm for all three slits.
- The retrievals combine upper level UV retrievals with lower level Visible retrievals.
- Adjustments for height/pointing errors have been improved.
- The aerosol retrieval is now a separate module. It was able to track the stratospheric dust anomaly produce by the explosion of a meteorite over Russia.

Sample Limb Profiler Profiles vs. EOS Aurea MLS

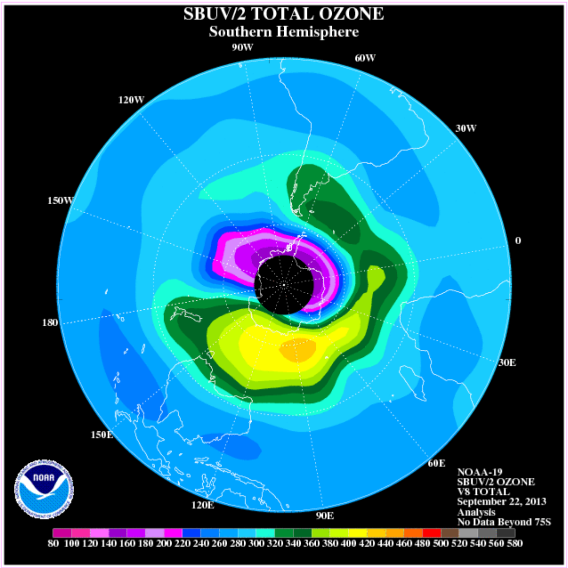
Latitude 2°S



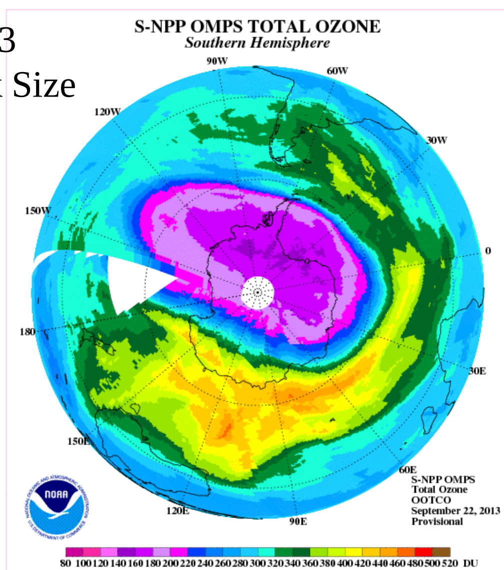
Latitude 76°S



Day-to-Day Time Scales



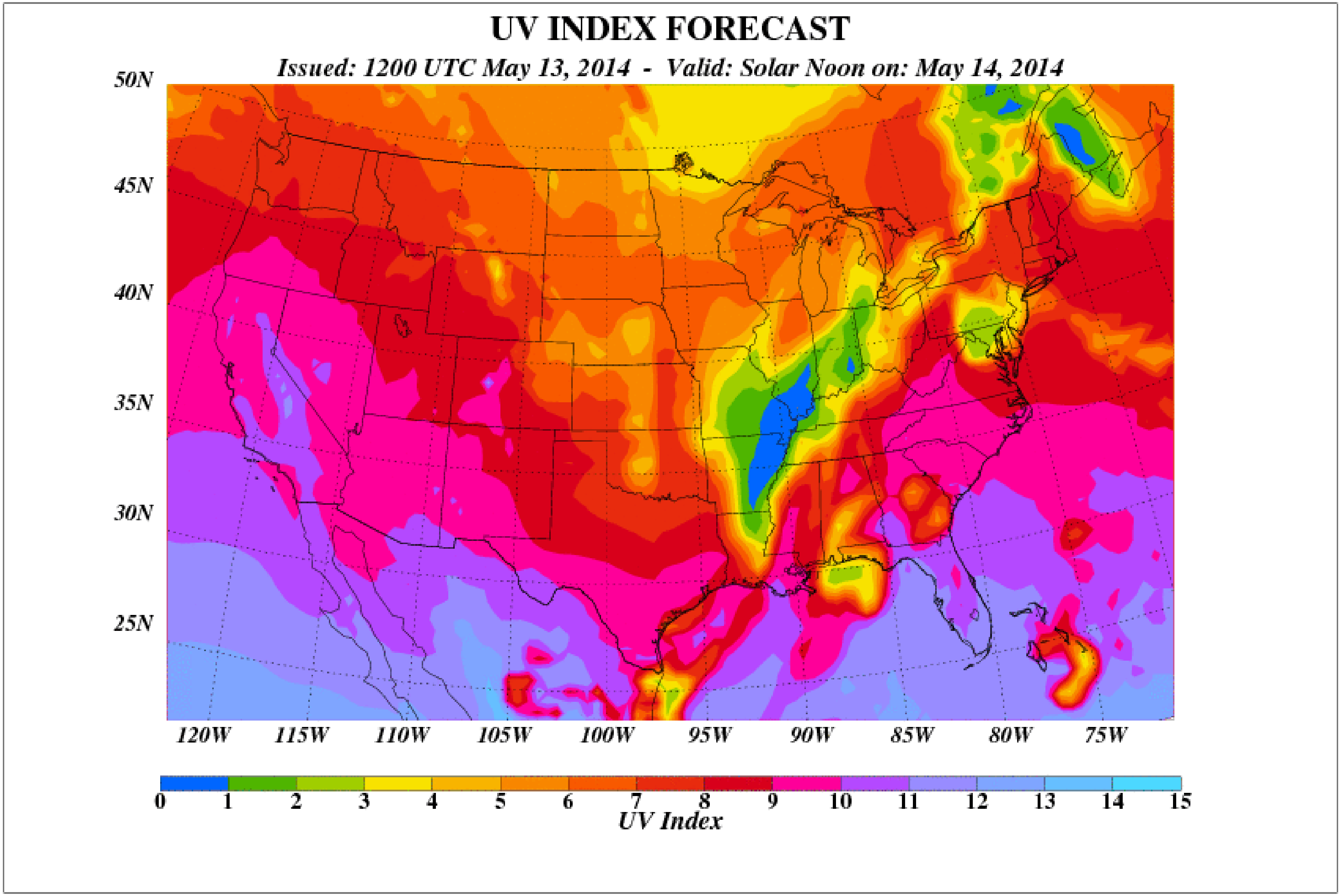
Sept 22, 2013
Date of Peak Size



- Using the SBUV/2 nadir observations, CPC uses a Cressman Scheme to make a polar stereographic analysis of the Total Column Ozone. (top)
  - Smoothes out or misses fine features
- OMPS TC provides full global coverage.
  - Heritage: TOMS and OMI
  - Currently is providing 35 scan positions
  - Has potential of ~100 scan positions with out compromise to S/N ratio
- www.cpc.ncep.noaa.gov/products/stratosphere/sbuv2to/
- www.cpc.ncep.noaa.gov/products/stratosphere/omps/

Ozone Applications at NCEP (C. Long Presenter)

- The OMPS Version 8 nadir ozone profile products will continue the 35-year SBUV(/2) CDR for Ozone Layer monitoring and assume the SBUV/2 product roles in year-to-year Ozone Hole monitoring and NRT assimilation.
- The OMPS Version 8 total column ozone products will continue the TOMS/OMI CDRs. They will assume the roles of EOS OMI in NRT assimilation leading to UV Index Forecasts. Models can make good use of higher spatial resolution.
- The OMPS limb profiles will continue the high-vertical resolution ozone layer monitoring of the EOS Aura MLS and provide new resolution of ozone in the lower stratosphere for NRT assimilation.


UV INDEX FORECAST
Issued: 1200 UTC May 13, 2014 - Valid: Solar Noon on: May 14, 2014
50N
45N
40N
35N
30N
25N
120W
115W
110W
105W
100W
95W
90W
85W
80W
75W
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
UV Index

Nadir Ozone Profile Path Forward (T. Beck Presenter)

- Nadir ozone profile algorithm (V8Pro)
  - ADL implementation completed.
  - Moving forward to implementation in IDPS.
  - Converges POES, CDR and JPSS products.
  - First iteration of soft calibration adjustments has been tested. Additional tuning will follow SDR updates.
  - Refinements for information concentration / outlier detection and smaller FOVs are under development.

Mapper and Limb Path Forward (L. Flynn Presenter)

- Total column ozone algorithm (V8TOz)
  - Moving forward to implementation in IDPS
  - Converges EOS, MetOp, CDR and JPSS products.
  - An SO2 module will be adapted from the OMI Linear Fit algorithm.
  - Adaptations for smaller FOVs are in preparation.
  - Refinements for information concentration / outlier detection have to be integrated into Input module.
- Limb ozone profile algorithm (V2LP)
  - The NASA S-NPP Science Team V2LP is in R2O for NDE.

Summary

- The OMPS instruments are performing well and delivering ozone products to continue the over 30-years of satellite monitoring.
- Validated nadir total column ozone and ozone profiles will be available operationally by fall 2014.
- The limb ozone profiles provide global coverage of the ozone layer with high vertical resolution.
- The OMPS measurements can be used to provide other atmospheric chemistry and composition products at good horizontal resolution.

Backup slides

SDR Path Forward (Solution Key: DONE, READY, KNOWN APPROACH, UNKNOWN, *FUTURE WORK*)

A. OMPS NP Ozone Profile

A.i. Turn on the 253 nm channel in the retrieval algorithm -- DONE.

A.ii. First version of the stray light correction. – March 17 in Mx8.3 DONE.

A.iii. Improved/tuned stray light correction table -- April (SDR Table Tuning) Analysis shows more work is needed. Which channels are the best proxies?

A.iv. New Day 1 Solar irradiance spectrum and wavelength scale – May (SDR Table Tuning)
I recommend that this be a simple -0.115 nm shift relative to Day 0. We would revisit with annual wavelength scale variations and wavelength dependent shifts in the future. (Should this also adjust the radiometric coefficients for the shift/dichroic? Should the solar activity level be picked for the current Mg II 27-day average state?)

A.v. Proper matchup for Nadir Mapper and Nadir Profiler FOVs – TTO May 19 in Mx8.4 (EDR only).

A.vi. Error in smear subtraction creating offset bias error – Correct code (in Mx8.5), Change Input Bias to 742 counts.

A.vii. Soft Calibration adjustments including dichroic to Day 1 Solar or CF Earth -- May (SDR Table Tuning).

A.viii. Annual variations in the wavelength scale correlated with temperature gradients. SDR.

A.ix. Adjustments to Day 1 Solar for solar activity. SDR.

B. OMPS NM Total Column Ozone

B.i. Measurement-based wavelength scale adjustments – February 19 Mx8.1. DONE.

B.ii. Revised profile mixing fraction logic – March 17 in Mx8.3 (EDR only) DONE

B.iii. First version of OOR Table for the stray light correction -- May (SDR Table Tuning and Code Change)
New Table received. OOR cross-track dependence requires code change.
CCR to proceed with this for the Mx8.5 build. It is a change to the code and table dimensions. Minor ATBD and OAD and CDFCB changes.

B.iv. New Day 1 Solar irradiance spectra and wavelength scales. Should be set to middle of orbital scale variation. Cross-track dependence is complex. – May (SDR Table Tuning)

B.v. Soft Calibration adjustments to Day 1 Solar or CF Earth -- May (SDR Table Tuning)

B.vi. *Check flagging and logic for total ozone out of range and fill for triplet retrievals. (EDR)*

B.vii. *Possible bandpass changes -- ground to flight, intra-orbit.*

Algorithm Path Forward

OMPS NP V8

- C.i. Provide 12 soft calibration adjustments
- C.ii. Change to work with smaller FOVs (just along track)
- C.iii. Put in N-value fitting (Noise reduction, outlier identification and removal, and information concentration)
- C.iv. Add Solar Activity / Scale Factors

OMPS TC V8

- D.i. Provide 12 soft calibration adjustments
- D.ii. Change to work with smaller FOVs (Interpolate the 35 Cross-track table as needed.)
- D.iii. Put in N-value fitting (Noise reduction, outlier identification and removal, and information concentration)
- D.iv. Put in Linear-Fit SO2 module. (Eight Granules)

JPSS STAR Science Team Annual Meeting
VIIRS EDR Imagery Report Back

Don Hillger, PhD
NOAA/NESDIS/StAR (CIRA)
EDR Imagery Team Product Lead

16 May 2014

Lessons from other Teams

- Interaction with VIIRS **SDR Teams**:
  - We are available to check VIIRS EDR Imagery when asked by SDR Teams. For example, the potential mis-alignment issue in VIIRS SDR Imagery has been explored and dismissed by the EDR Imagery Team.
  - Need to pay more attention to the many details that the SDR Teams handle: For example, geo-location and radiance/reflectance fixes, and when they took place.
  - South Atlantic Anomaly worth looking at to see if it affects EDR Imagery
  - Concern that reprocessing potentially causes differences in same products at different PEATEs.
- Interaction with other **EDR Teams:**
  - Use of Imagery at NIC by Cryo Team (Sean Helfich)
  - Use of GTM remapping by SST Team (Sasha et al).

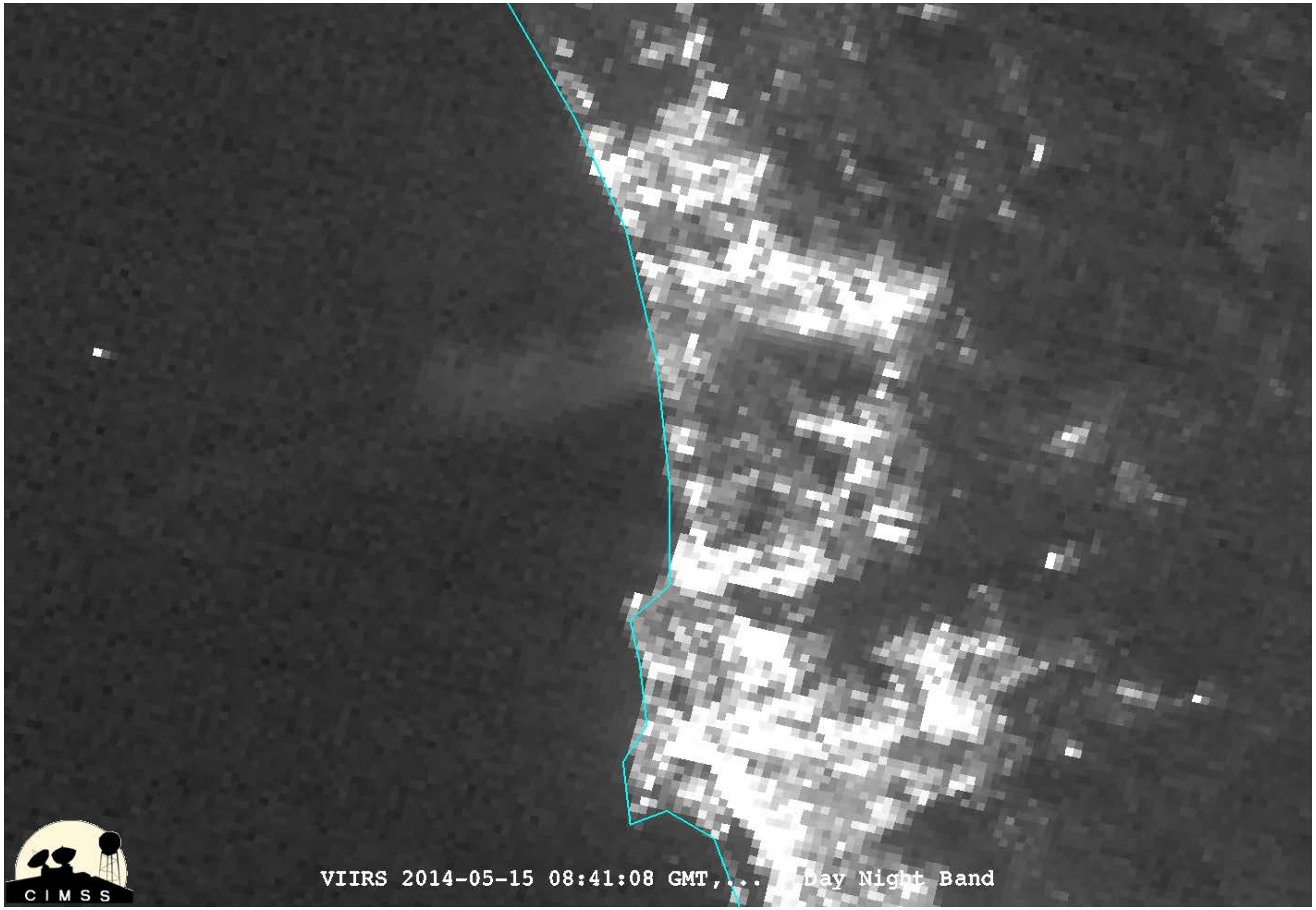
Shared Issues

- **Lower VIIRS latency** is needed by Imagery and Cloud Teams in particular, but also by some, but not all, of the other Teams.
  - Alternative is **Direct Broadcast**, but that's not available globally.
  - Pursue more DB sources for VIIRS.
- **DNB/NCC** is widely used and sought
  - Imagery Team can be a source of help for users.
  - There is VIIRS training/information available.

Future Plans

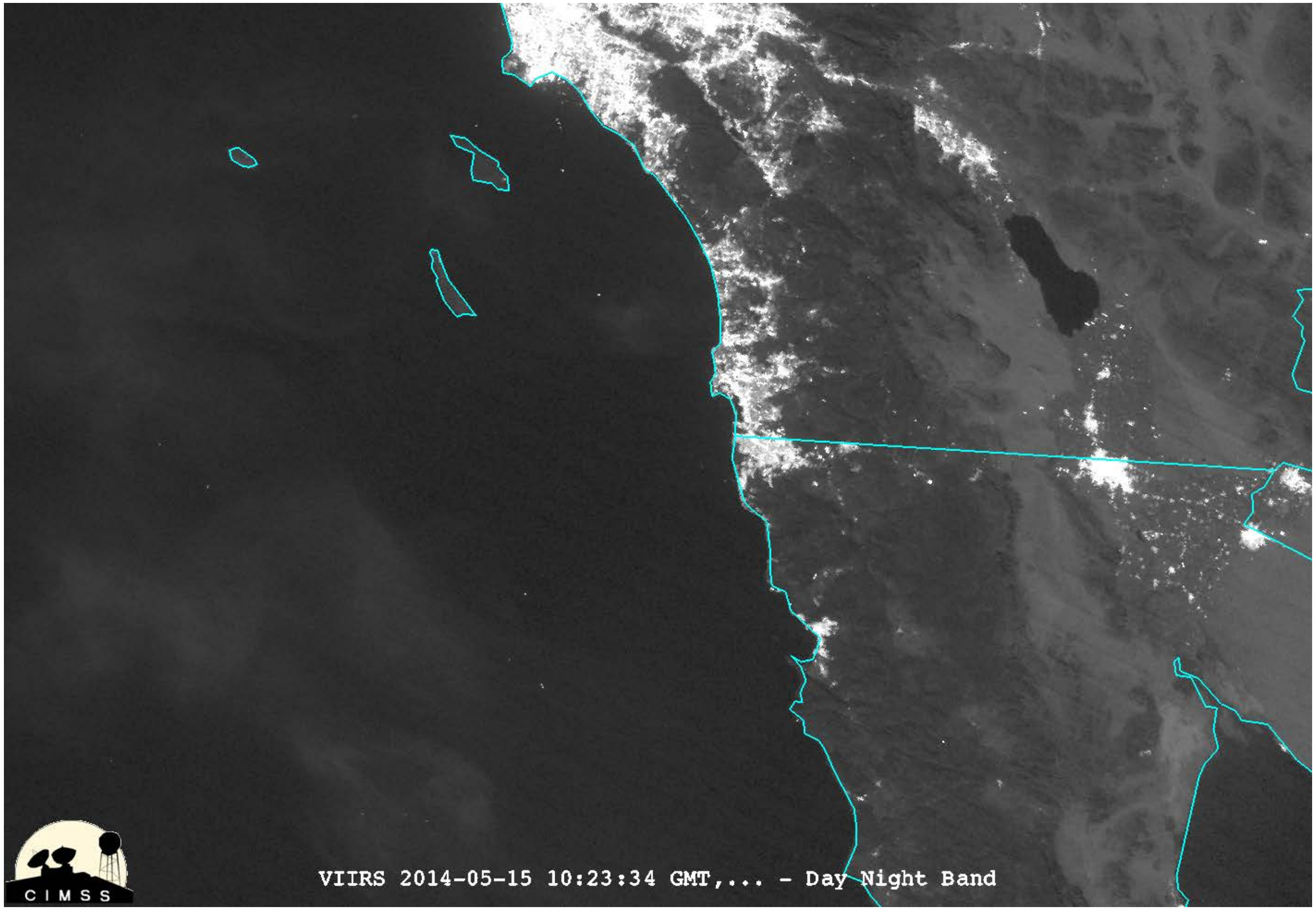
- **Continue to pursue lower latency Imagery thru GRAVITE**
- **Explore new Direct Broadcast sources for lowest latency data:**
  - Sites in AK, HI, OR, and FL.
- **Pursue missing M-bands as EDRs:**
  - This limits image products, including RGB combinations, one being true-color imagery.
- **Involve additional Imagery users:**
  - Depends on data availability issues, such as lower latency and sufficient bandwidth to carry VIIRS Imagery.
- P**ush for Terrain-Corrected (TC) geo-locations for NCC Imagery.**

Smoke from San Diego area fire 2014-05-15 0842 UTC



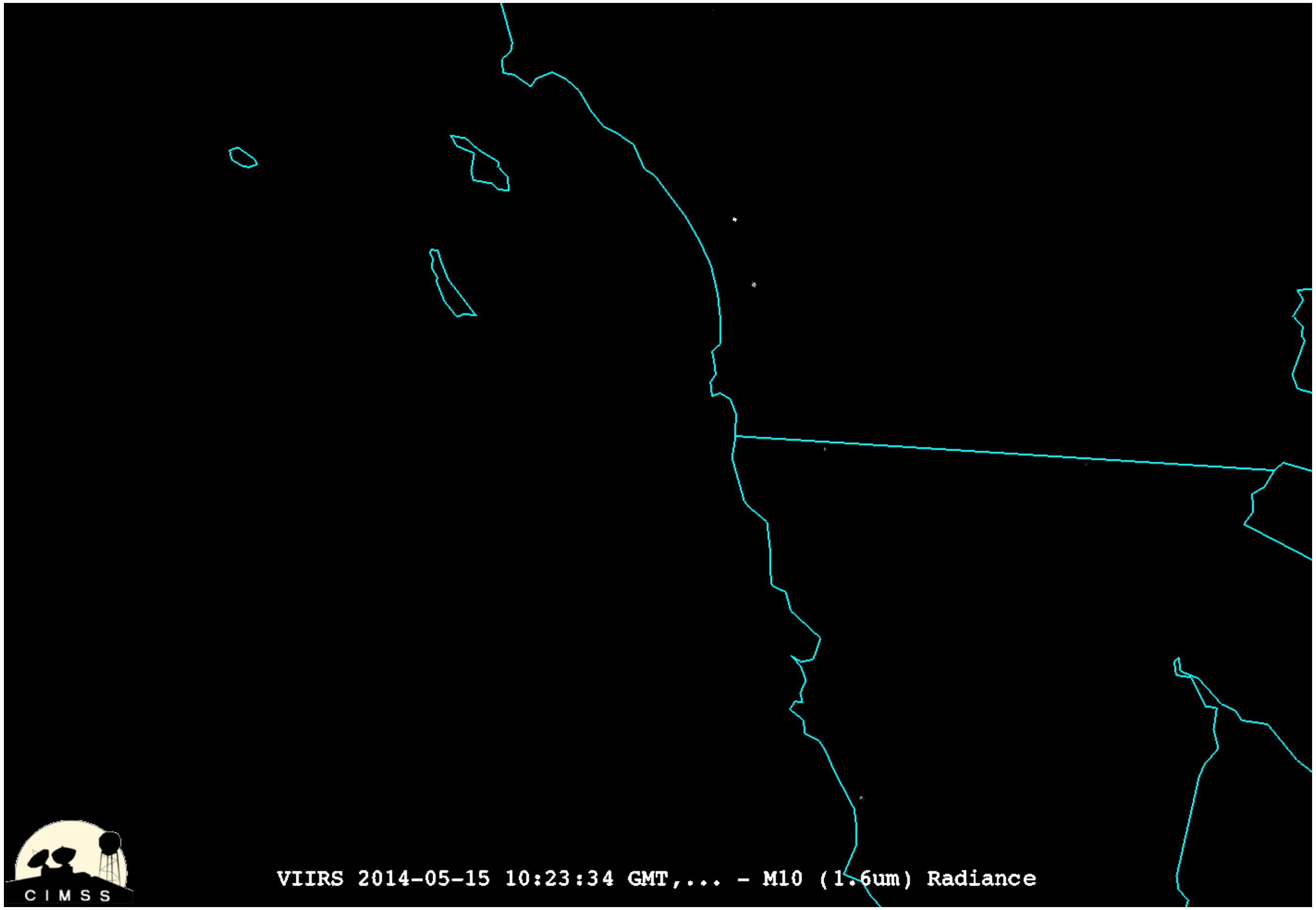
VIIRS DNB – Courtesy of W. Straka III, CIMSS

Smoke from San Diego area fire 2014-05-15 1023 UTC



VIIRS DNB – Courtesy of W. Straka III, CIMSS

Hot spots from San Diego area fire 2014-05-15 1023 UTC



VIIRS 1.6 µm – Courtesy of W. Straka III, CIMSS

Land breakout session report

Issues discussed (2/1)

- Product / algorithm “classification”
- Remaining work with SNPP
  - Most products are on track to complete S-NPP cal/val and algorithm development, with well defined expected outcome
  - Major issues remain
    - Dark Pixel Surface Albedo, Gridding / granulation
      - Related to DPSA and VCM
- J1 readiness
  - Algorithm upgrades (per L1) – Vegetation Index and Active Fires
  - Any other critical upgrades – LST (emissivity implicit)
  - J1 test data: S-NPP as proxy, but critical J1 features need to be captured

Issues discussed (2/2)

- Common algorithms
  - Science readiness and feasibility
    - LST is a good candidate
  - Merged / fused products
    - Albedo is a good candidate, but possibly outside of NOAA JPSS cal/val program
- Ground implementation options
  - IDPS, NDE, NASA
    - Need for implementation –agnostic product and algorithm development
    - Need for single thread or pre-processing for within the same product family (i.e. VI, GVF, VH etc.)
- Quality flags
  - Need for thorough assessment of input as well as output
- Product validation
  - Product intercomparison vs. independent validation
  - Common validation protocols (CEOS WGCV LPV)

Product / algorithm “classification”

NPOESS algorithm has evolved into the NOAA-endorsed JPSS algorithm and any needed improvements should continue

Surface Reflectance, Surface Type (IP offline, potentially new algorithm), BPSA

NPOESS (or evolved) algorithm will not meet requirements or effort is too large, replace with NOAA-endorsed JPSS algorithm

VI – J1 in process

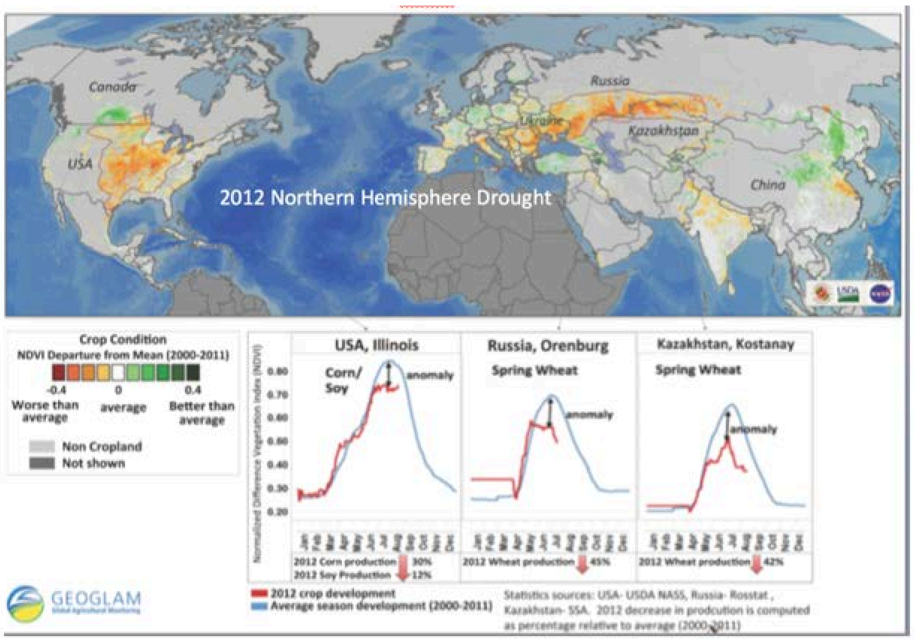
AF (J1 in process)

DPSA (key decisions to be made – in conjunction with gridding and VCM)

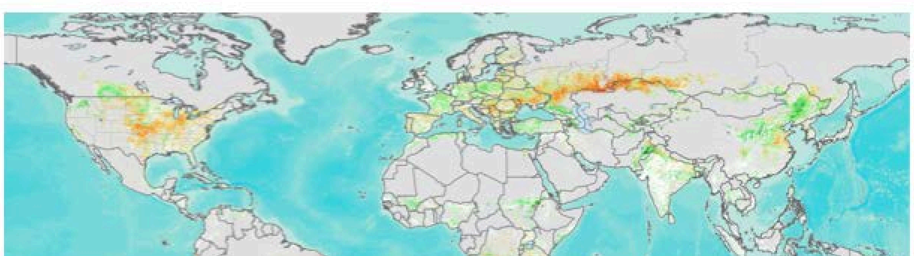
NOAA-endorsed algorithm should be used even if NPOESS (or evolved) algorithm meets performance because of legacy, enterprise, blended products, and other considerations

LST

VIIRS SR potential to replace MODIS in agriculture applications (GEOGLAM drought monitoring) has been explored



Assessment of the impact of the 2012 Northern Hemisphere Drought from the MODIS Climate Modeling Grid daily NDVI data



A VIIRS NDVI anomaly (prototype) computed for the same date (July, 30th 2012) as the MODIS NDVI anomaly shown above, generated from data produced at the Land PEATE

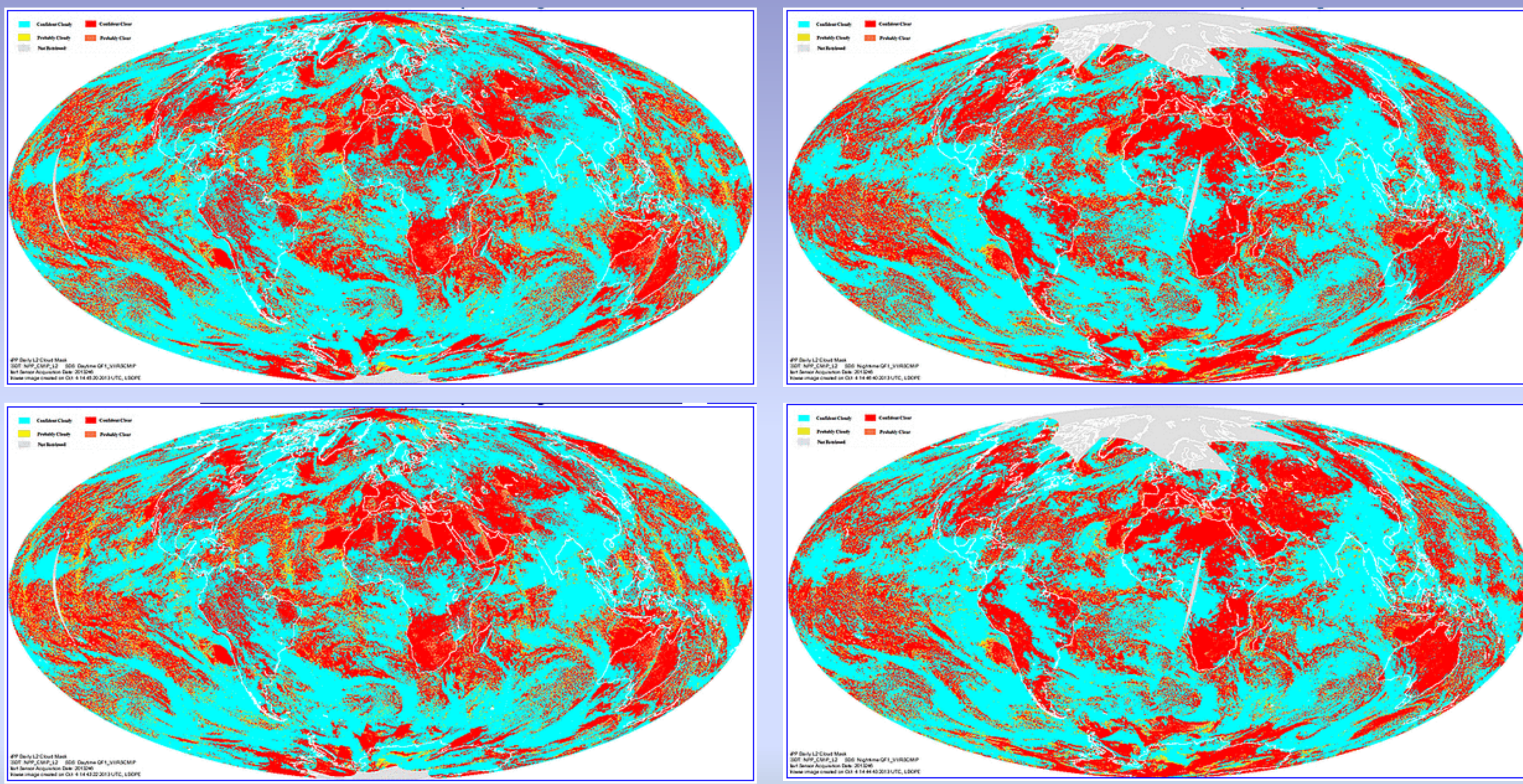
VCM: simplified NDVI input in C1 reprocessed dataset

- **Day Time Cloud Confidence from NPP_VCM_IP: Day 2013246**

Day time | Night time

IDPS

LPEATE- C1



Confident clear
Probable clear
Probable cloud
Confident cloud

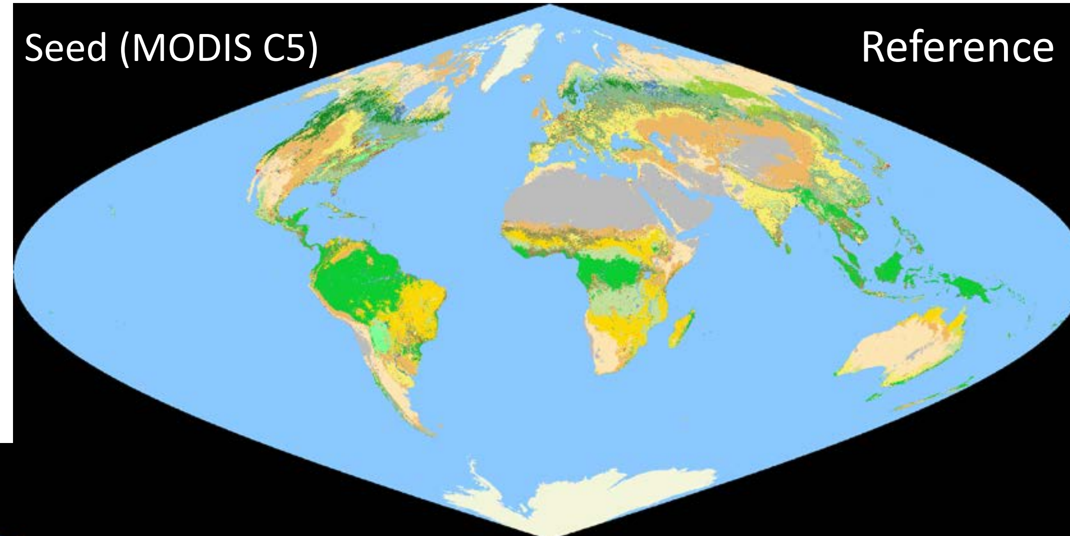
VIIRS DPSA offline vs MODIS Daily V006

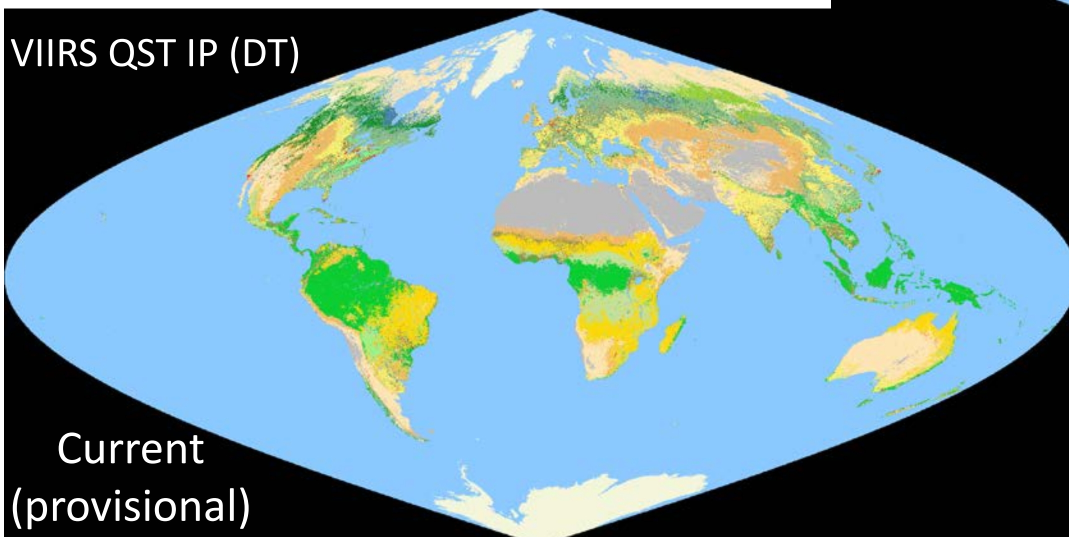
Suomi NPP VIIRS

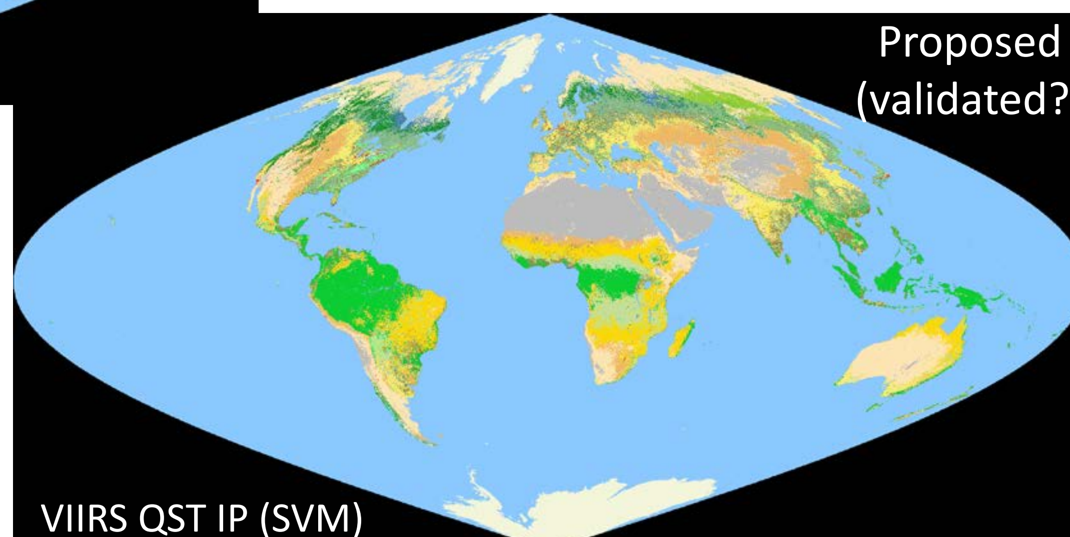
MODIS V006

True color BSA of tile H12V04 of New England and southeastern Canada, Sept 2013

Surface Type

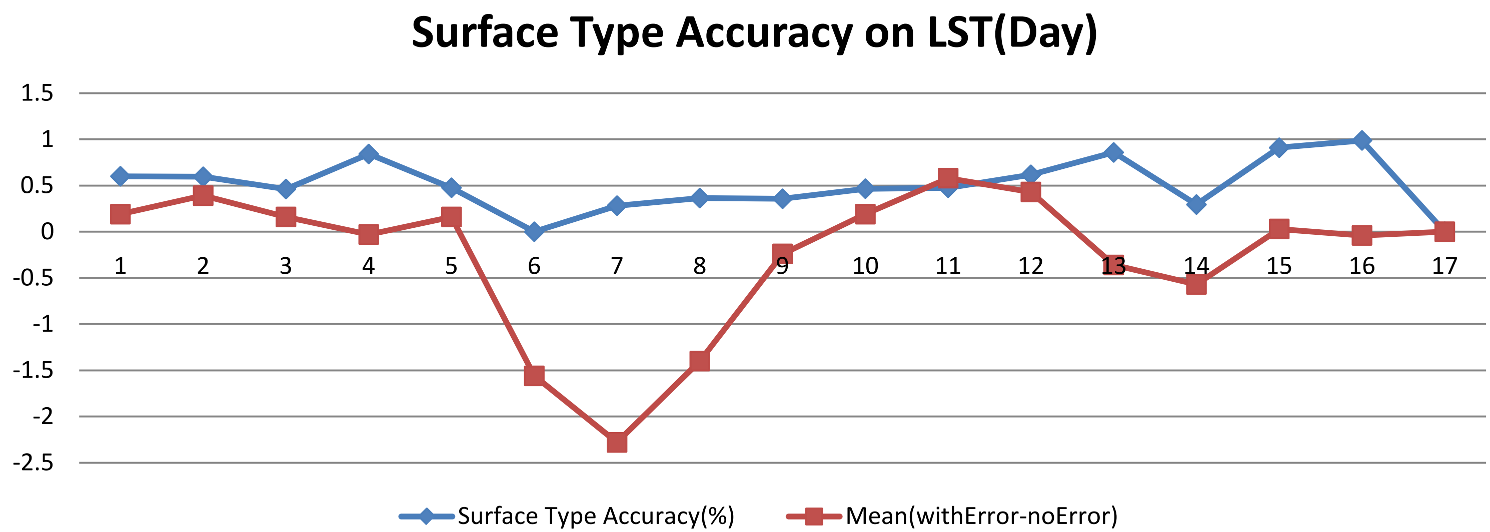


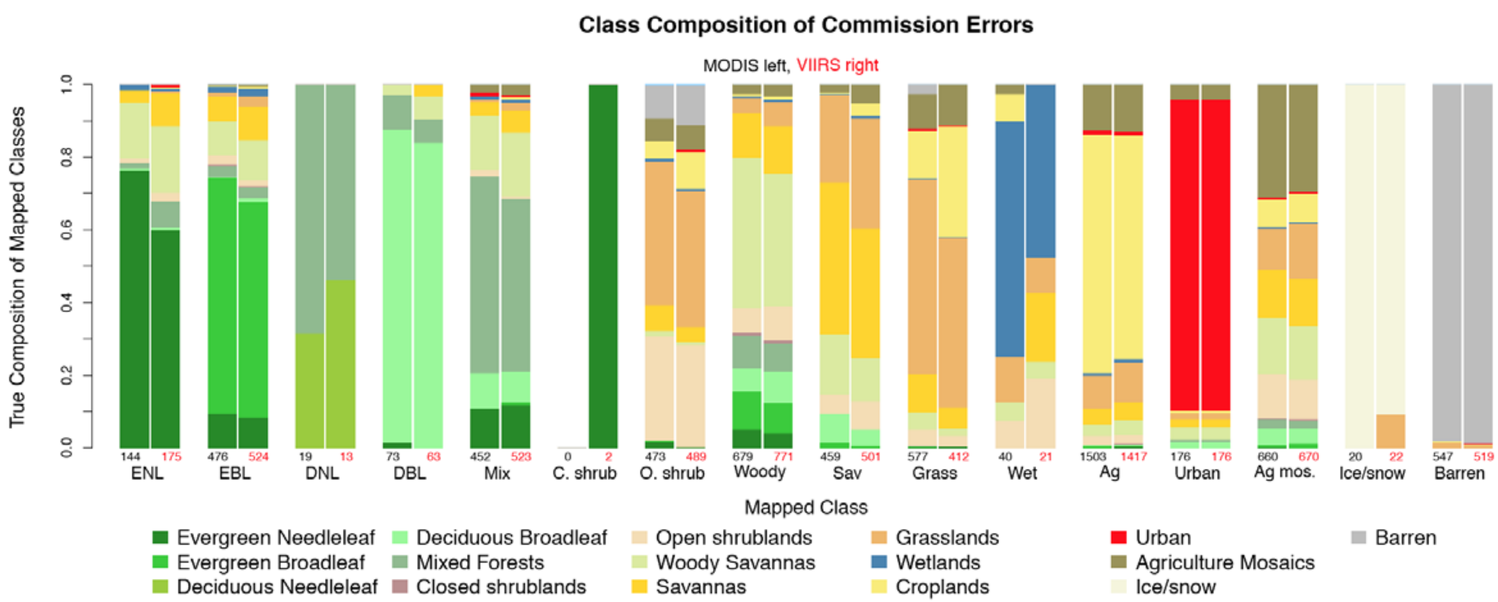




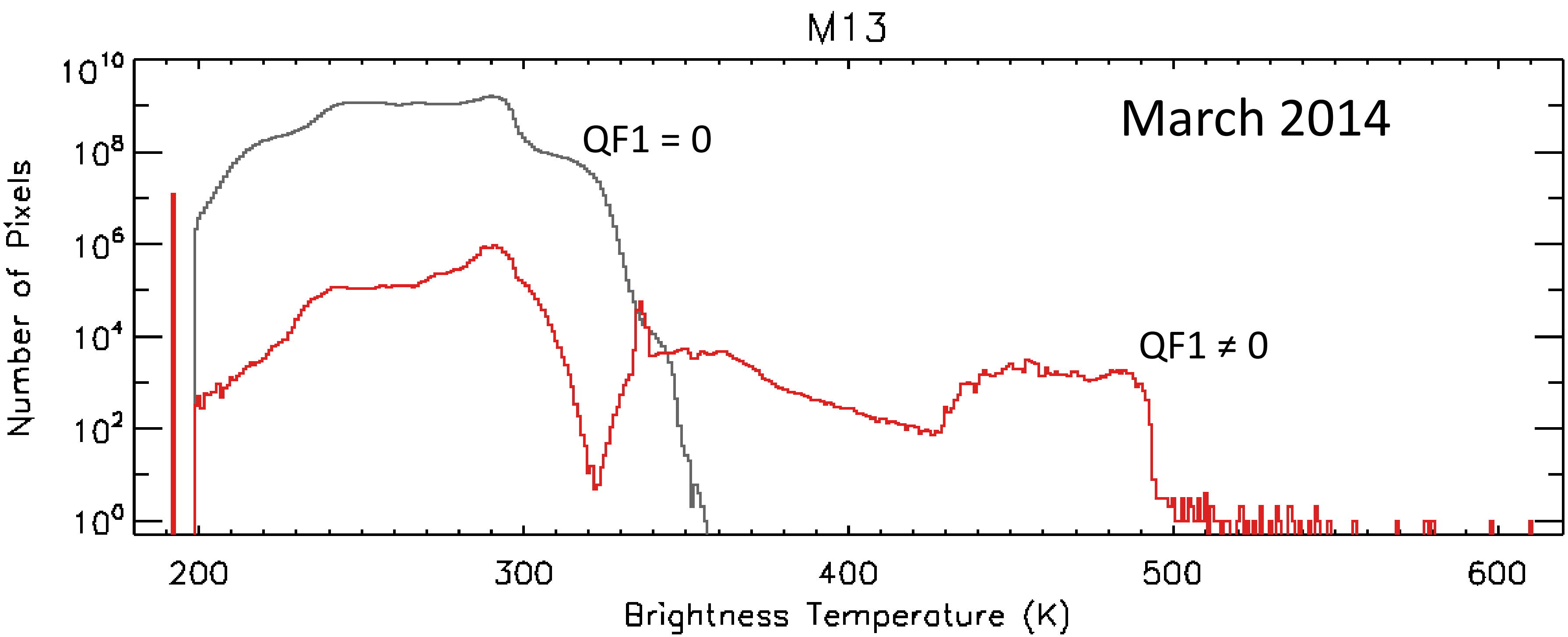
evaluation of SVM is ongoing towards meeting requirements

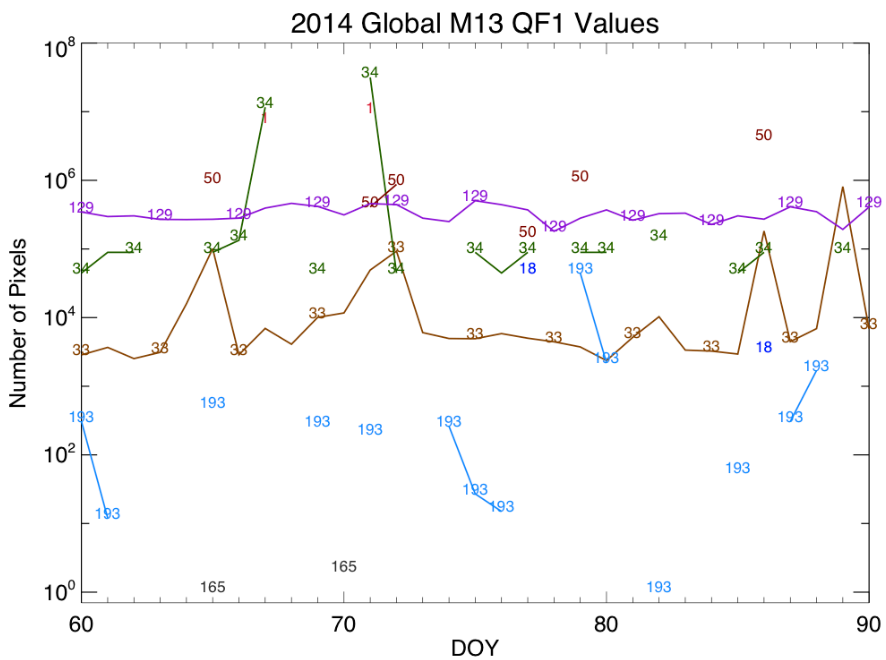
Surface type accuracy on LST(Day)





dependence of LST quality on surface type misclassification





NB. QF1 ≠ 0 curve does not include trim (QF1 = 2) or fill (QF1 > 247).

"Garbage in, garbage out"

Fixes expected to go into Mx8.5 (early August)

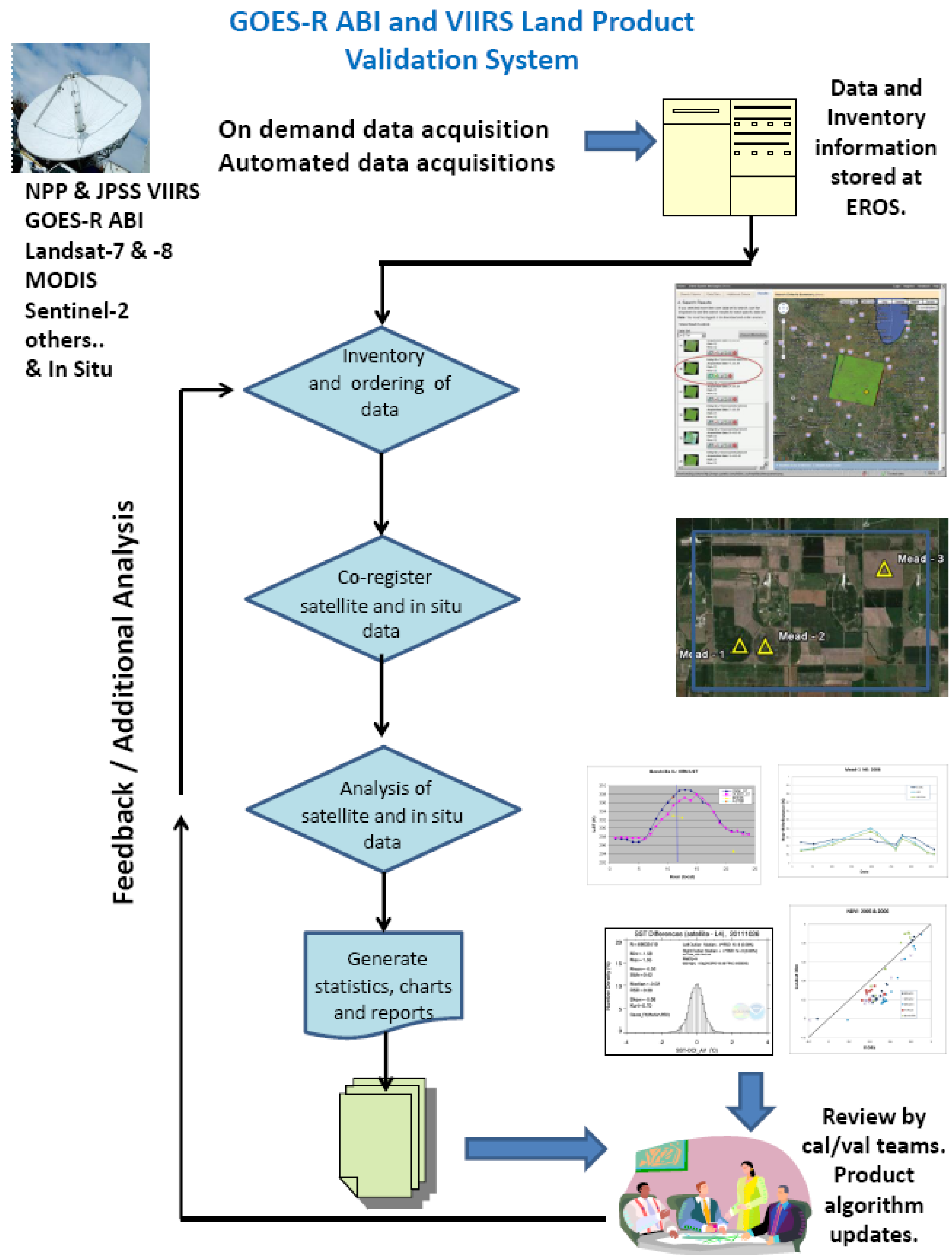
Active fire – valid observations are "anomalies" compared to typical conditions

Quality flag general issues

- Quality flags in input data
  - Ensure that the definition of conditions defined to set quality flags provides useful information for
    - Tracking the quality of the given input product
    - Characterizing input data for downstream algorithms
    - Characterizing the quality of the data for end users
  - Work with upstream product teams and thorough understanding of the definition and performance of the quality flags is critical
    - QF-based data filtering and/or additional internal tests
- Quality flags in output data
  - Same as above!
- Another strong argument for reprocessing

Validation

- Multi-satellite intercomparison including Landsat
- Linkage to CEOS, GCOS ECVs and other coordination efforts



JPSS STAR Science Team Annual Meeting

Cryosphere EDR Team Report

Jeff Key

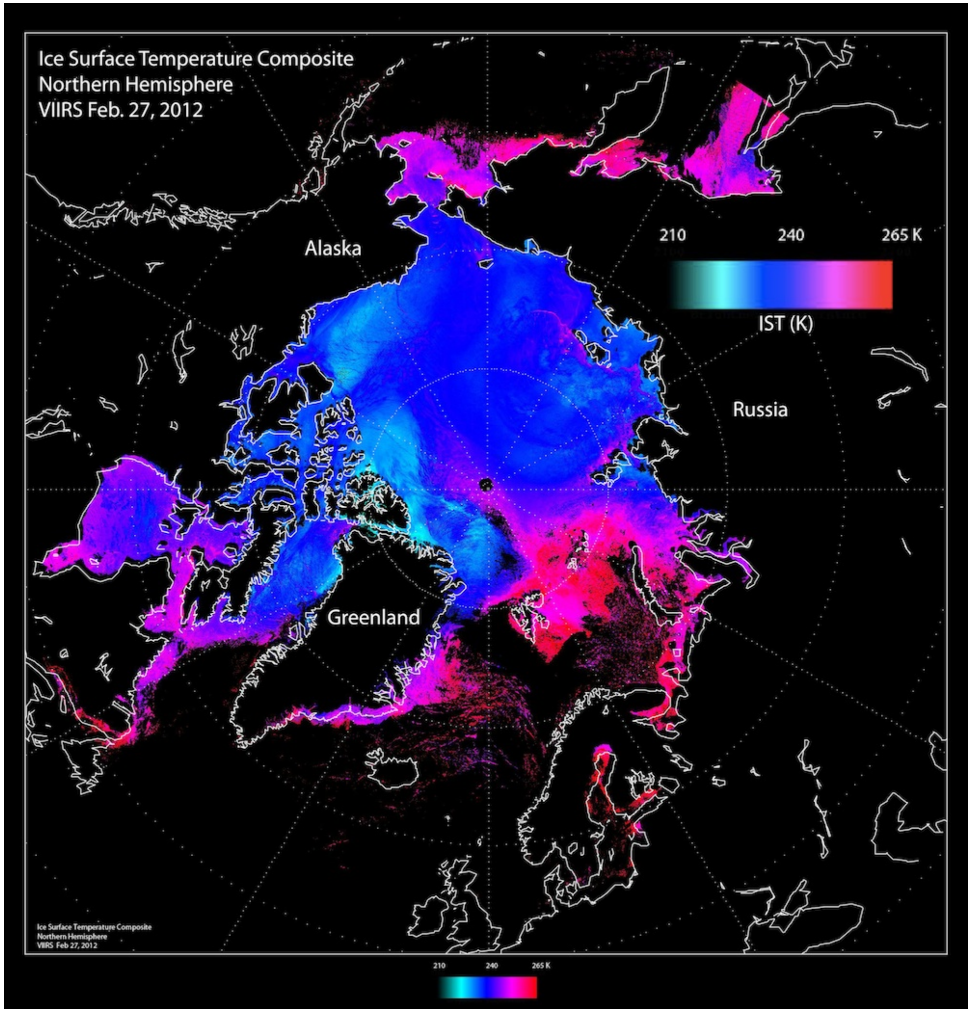
Cryosphere Team Lead

May 16, 2014

Cryosphere Accomplishments for FY14

- Completed new, comprehensive validation studies for:
  - *Ice Surface Temperature* EDR
  - *Sea Ice Concentration* IP
  - *Sea Ice Characterization* EDR
  - *Snow Cover* EDR:
    - *Binary snow cover*
    - *Snow fraction*
- Maturity reviews: Provisional to Validated Stage 1, depending on the EDR
- Code and LUT changes
- CCRs: 10
- Improved gridding significantly.
- Implemented and began testing new fractional snow cover algorithm.

Status: Ice Surface Temperature

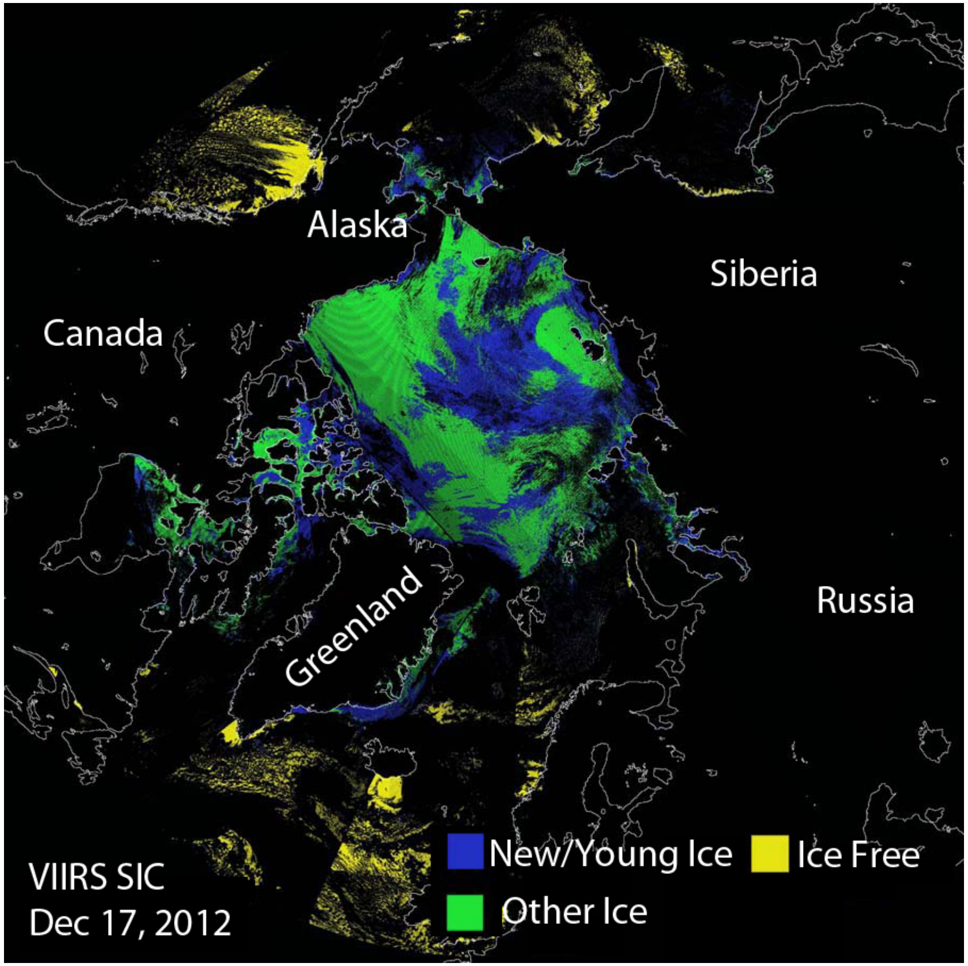


In most cases IST meets the 1.0K uncertainty requirement.

There is a cold bias compared to MODIS and IceBridge KT19, typically <1K, and a warm bias compared to NCEP.

Maturity: Validated Stage 1

Status: Sea Ice Concentration and Characterization



Concentration IP: Performs well (there are no requiremens for IPs).

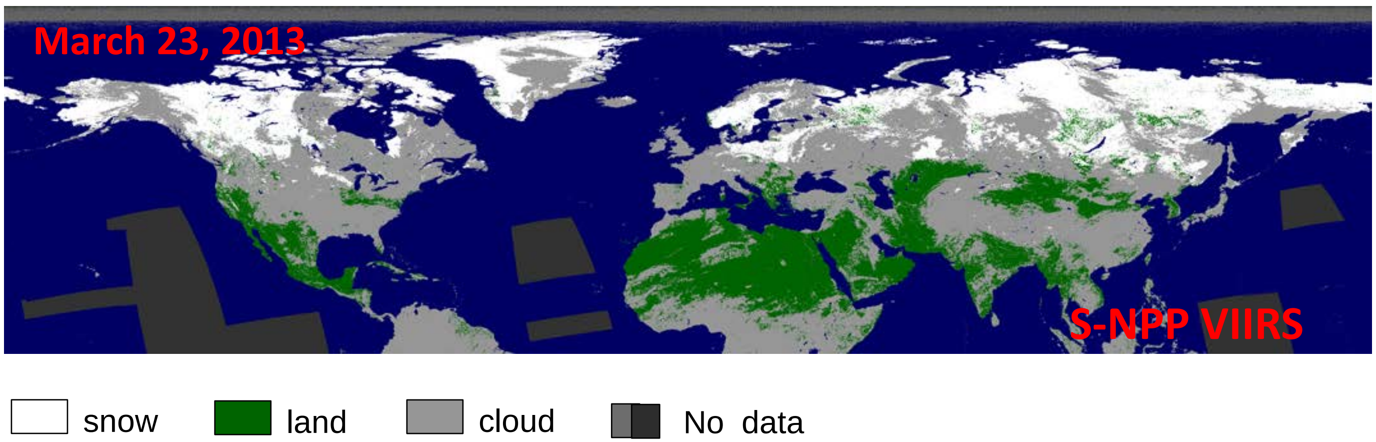
Characterization EDR: There are times when performance is good, and other times (too many) when performance is not good. Overall, it does not appear to be meeting the accuracy requirements.

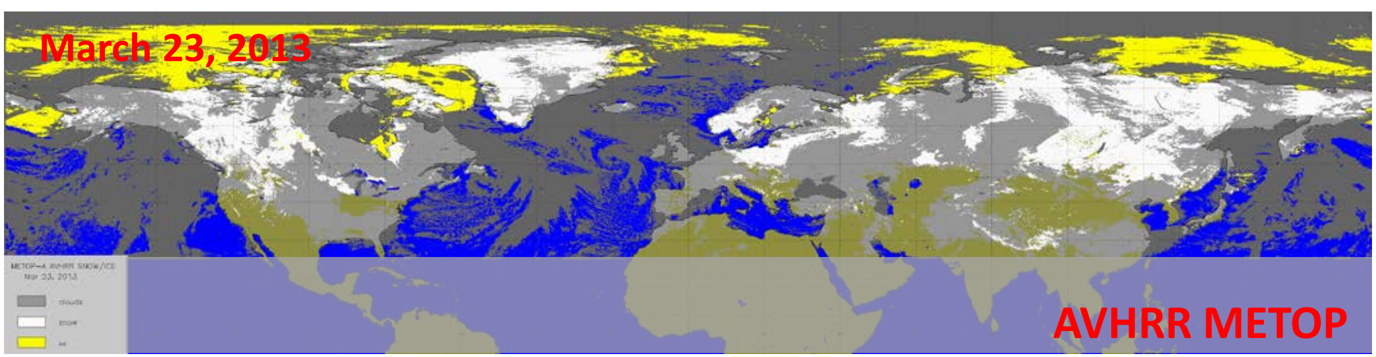
Solutions are elusive. Alternate algorithms are being investigated.

Maturity: Provisional

Status: Binary Snow Cover

Binary snow cover meets the accuracy requirement. Remaining issues are related to cloud masking. Some potential exists to improve the algorithm. Maturity: Validated Stage 1



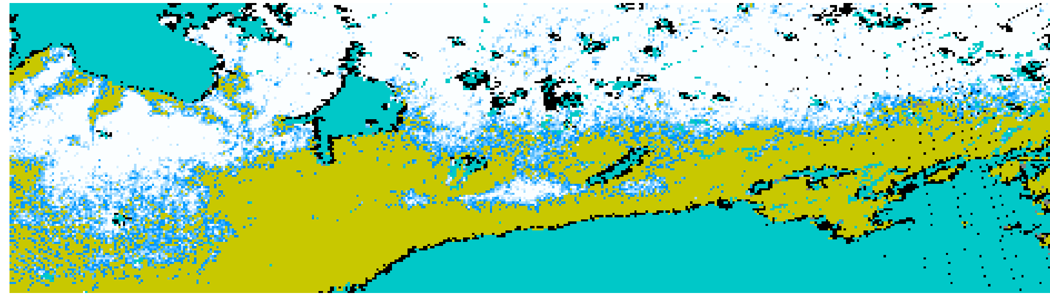


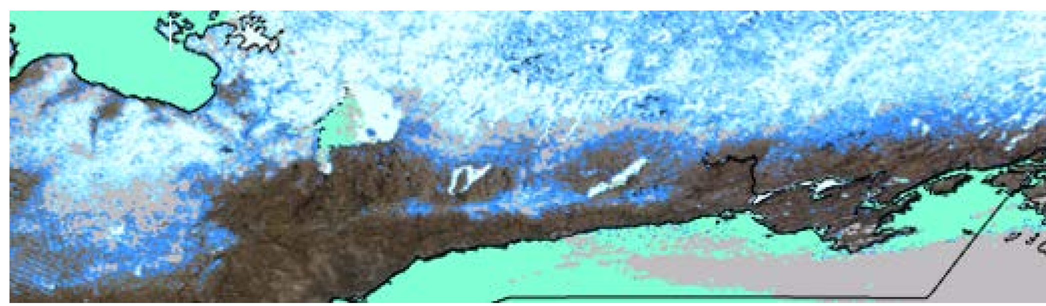
Status: Fractional Snow Cover

The current product is of little value. The 2x2 pixel aggregation scheme can only provide a small set of values and cannot meet the 10% accuracy requirement.

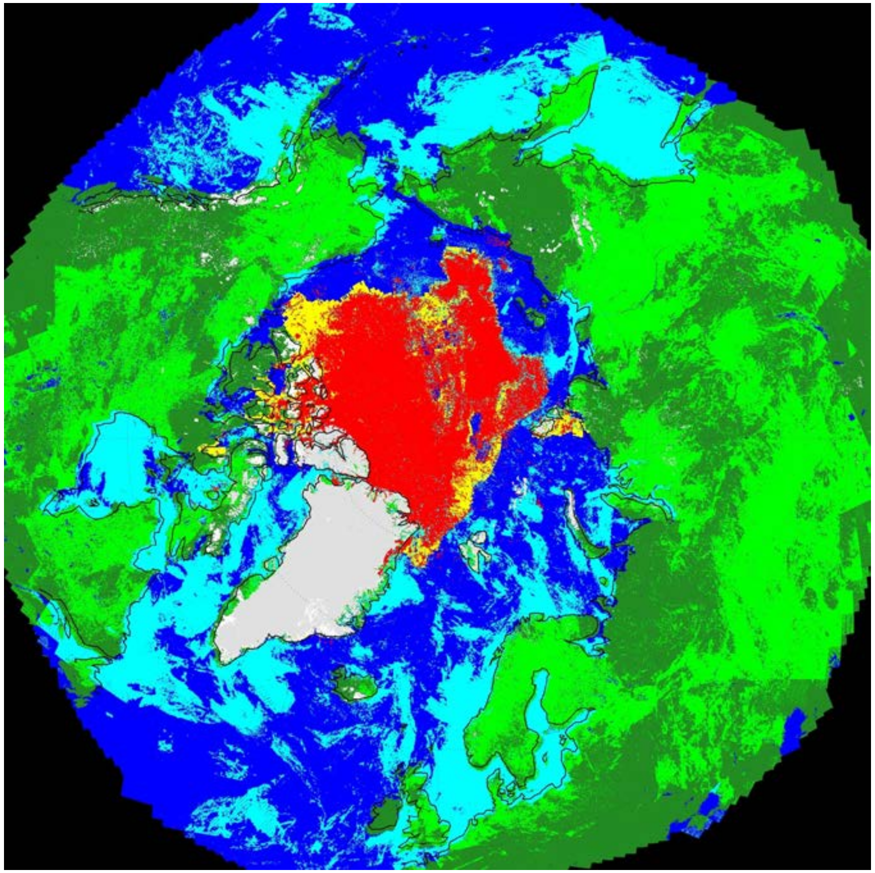
A number of different snow fraction algorithms are available and are being tested.

Maturity: Provisional





VIIRS Snow/Ice Gridding



Improvements in the gridded Snow/Ice have occurred due to the addition of an ancillary snow/ice product (GMASI), VCM updates, and additional quality control criteria.

GMASI must be automatically updated on a daily basis before gridding is turned on. This may be sufficient for downstream processing.

Further reduction in Snow/Ice gridding errors will require significant effort.

Cryosphere Issues

- J1 readiness:
  - Snow fraction – The IDPS algorithm will be replaced.
  - Sea ice characterization – It remains unclear how much effort it will take to fix the IDPS algorithm.
  - Gridding – Given the improvements to date, recommendations, and limited resources, additional work will be limited.
- Common algorithms and ground implementation:
  - Similar algorithms, arising from GOES-R development, will be run in NDE.
  - Maturity reviews: What if a product is not meeting requirements? If we replace an algorithm, is there any point in doing maturity reviews for the current IDPS product?

Algorithm Recommendations

Recommendations for IDPS algorithms:

Product	SNPP	JPSS
Sea Ice Concentration IP	1	1/3
Ice Surface Temperature	1	1/3
Sea Ice Characterization/age	1/2 (TBD)	2/3
Binary Snow Cover	1	1/3
Fractional Snow Cover	2	2

1. NPOESS algorithm has evolved into the NOAA-endorsed JPSS algorithm and any needed improvements should continue.
2. NPOESS (or evolved) algorithm will not meet requirements or effort is too large, replace with NOAA-endorsed JPSS algorithm
3. NOAA-endorsed algorithm should be used even if NPOESS (or evolved) algorithm meets performance because of legacy, enterprise, blended products, and other considerations.

User Feedback

- Main users
  - NIC, National/Naval Ice Center
  - Naval Research Laboratory and NAVO
  - NWS, including the Alaska Ice Desk and NCEP
- Continuity: VIIRS, AMSR2, and ATMS products provide continuity with products from heritage imagers such as AVHRR, MODIS, and OLS for some products.
- What's new? VIIRS sea ice concentration and ice "age"/thickness, AMSR2 sea ice type, ATMS snow grain size
- What's missing? Automated algorithms for ice motion, ice edge, and icebergs.
- What more can we get? Snow density over land, snow depth on sea ice, ice motions, iceberg detection, ice edge, uncertainty metrics, ice age (years), freshwater ice concentration and thickness.
- Other issues: data formats, quality flags, validation tools

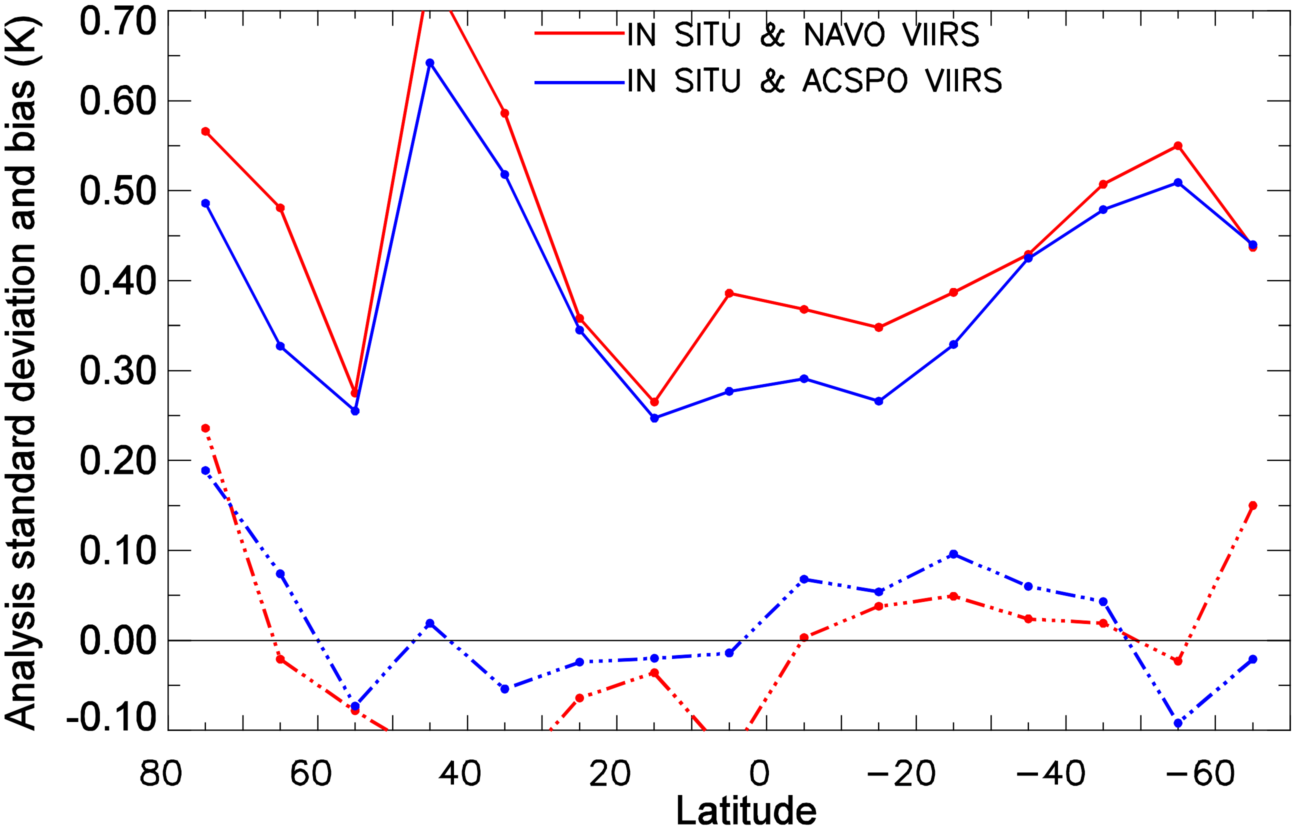
SST Report Back

Alexander Ignatov, and SST Team

Ignatov – Status of JPSS SST Products

- ✓ Over past year, NOAA has consolidated 2 SST products (IDPS and ACSPO) into one – ACSPO
- ✓ IDPS daytime SST does not meet specs, and users want ACSPO
- ✓ 2 VIIRS SST products available to users in GDS2 via JPL PO.DAAC / NODC – ACSPO and NAVO
- ✓ Users keep asking "What product do I use?" Special analyses were performed to compare the two products
- ✓ ACSPO retrieval domain is factor of ×3 that of NAVO (narrow swath VZA<54°, conservative cloud mask, 2×2 processing)
- ✓ NAVO and ACSPO have comparable performance, NAVO outperforming ACSPO by a narrow margin

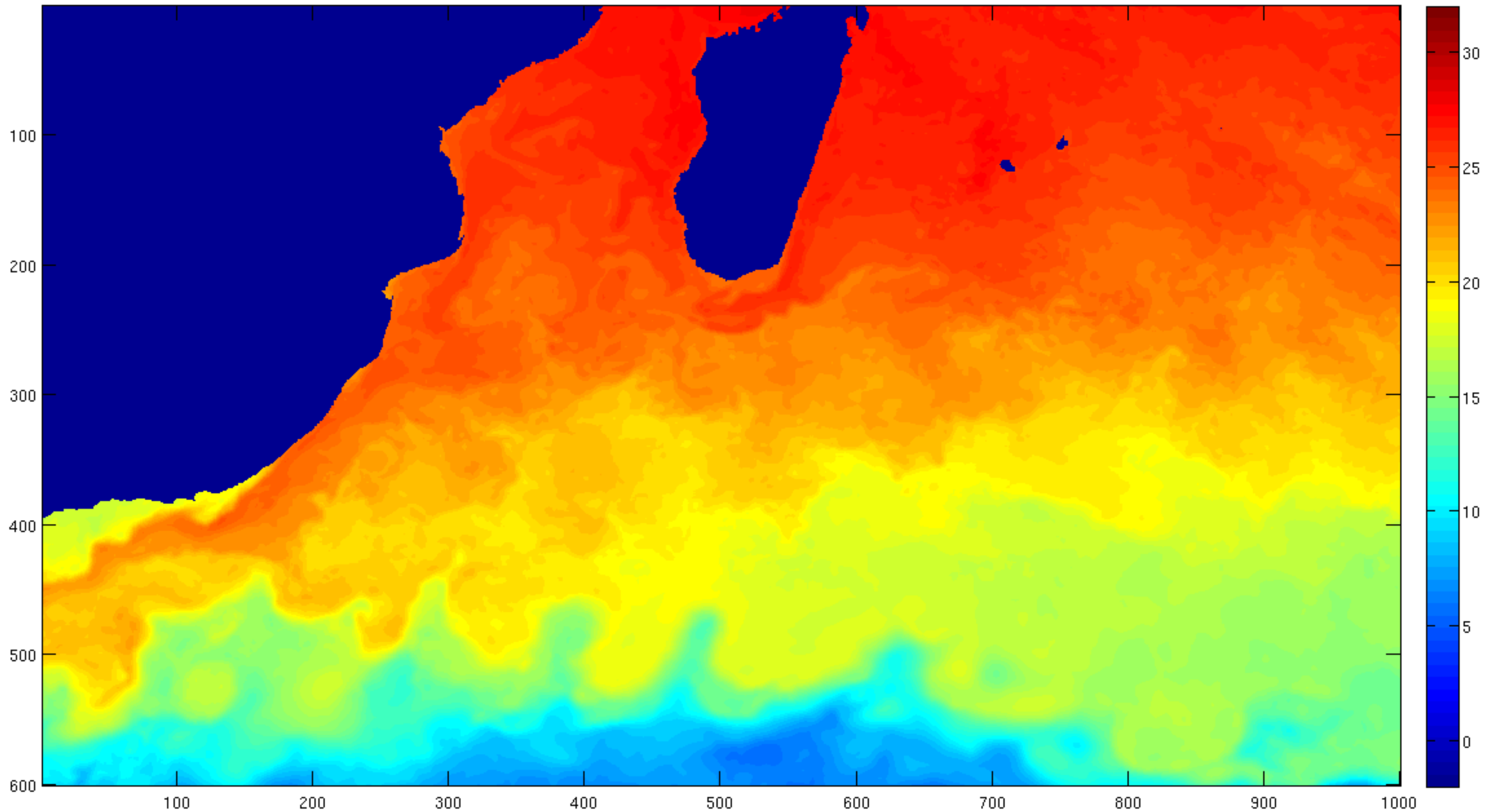
Brasnett – Assimilating NAVO and ACSPO SSTs



Using ACSPO instead of NAVO improves assimilation

Harris – NOAA Geo-Polar Blended L4 SST

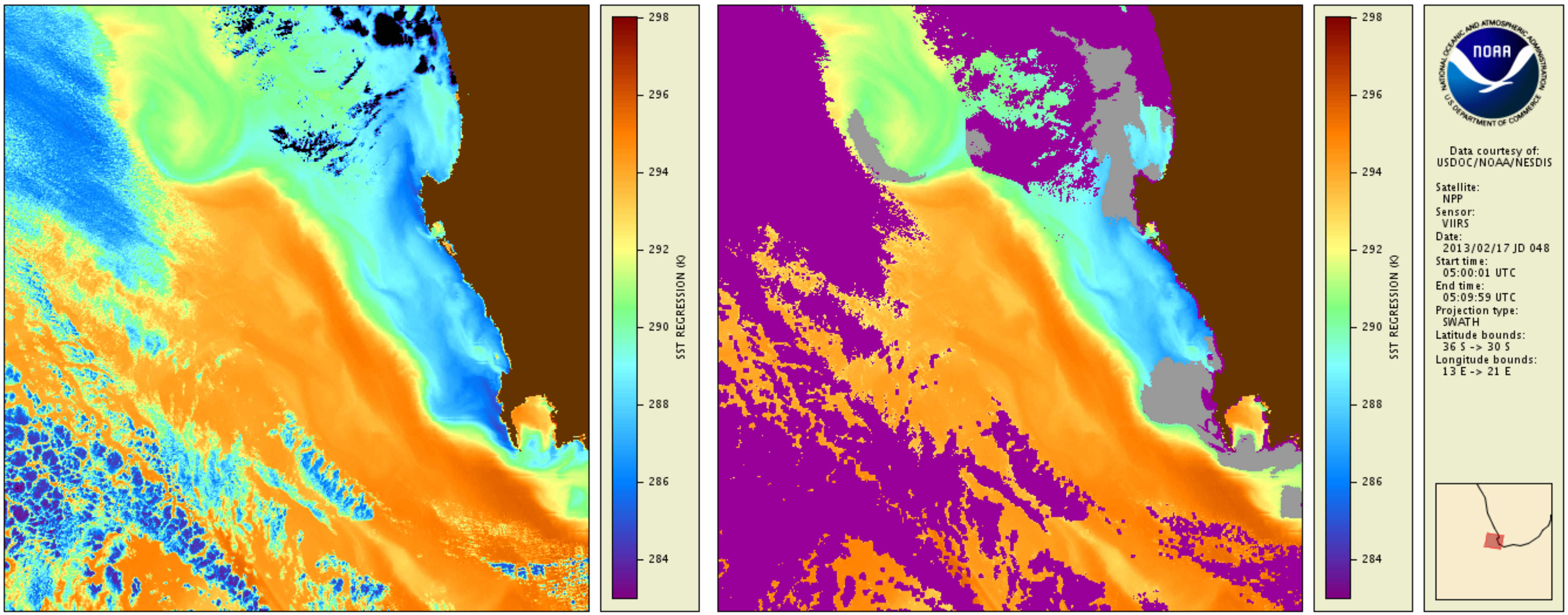
- VIIRS successfully incorporated into Geo-Polar Blended 5-km global SST analysis



Super-Ob'd VIIRS SST data

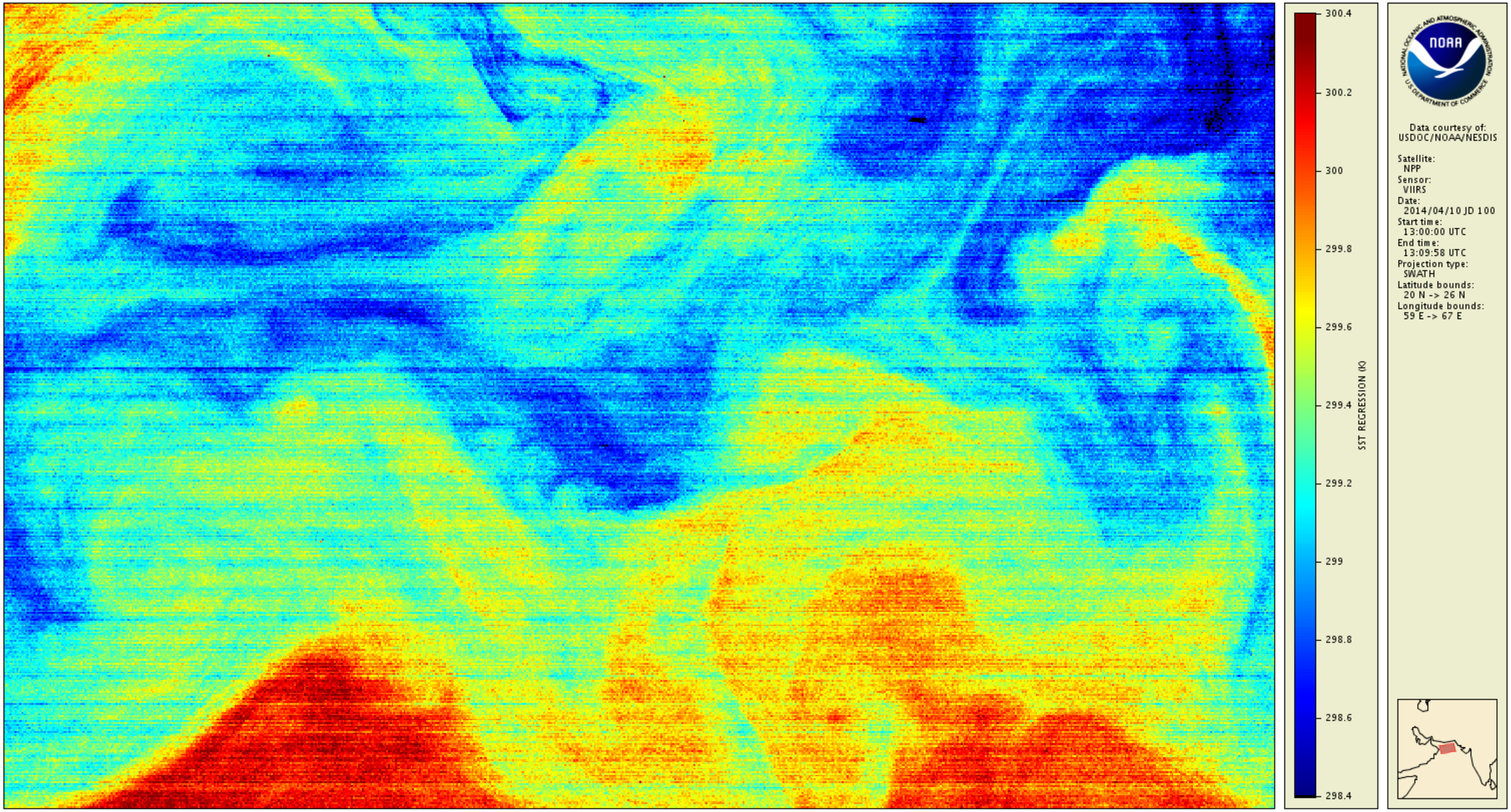
Final SST analysis

South Africa, 02/17/13

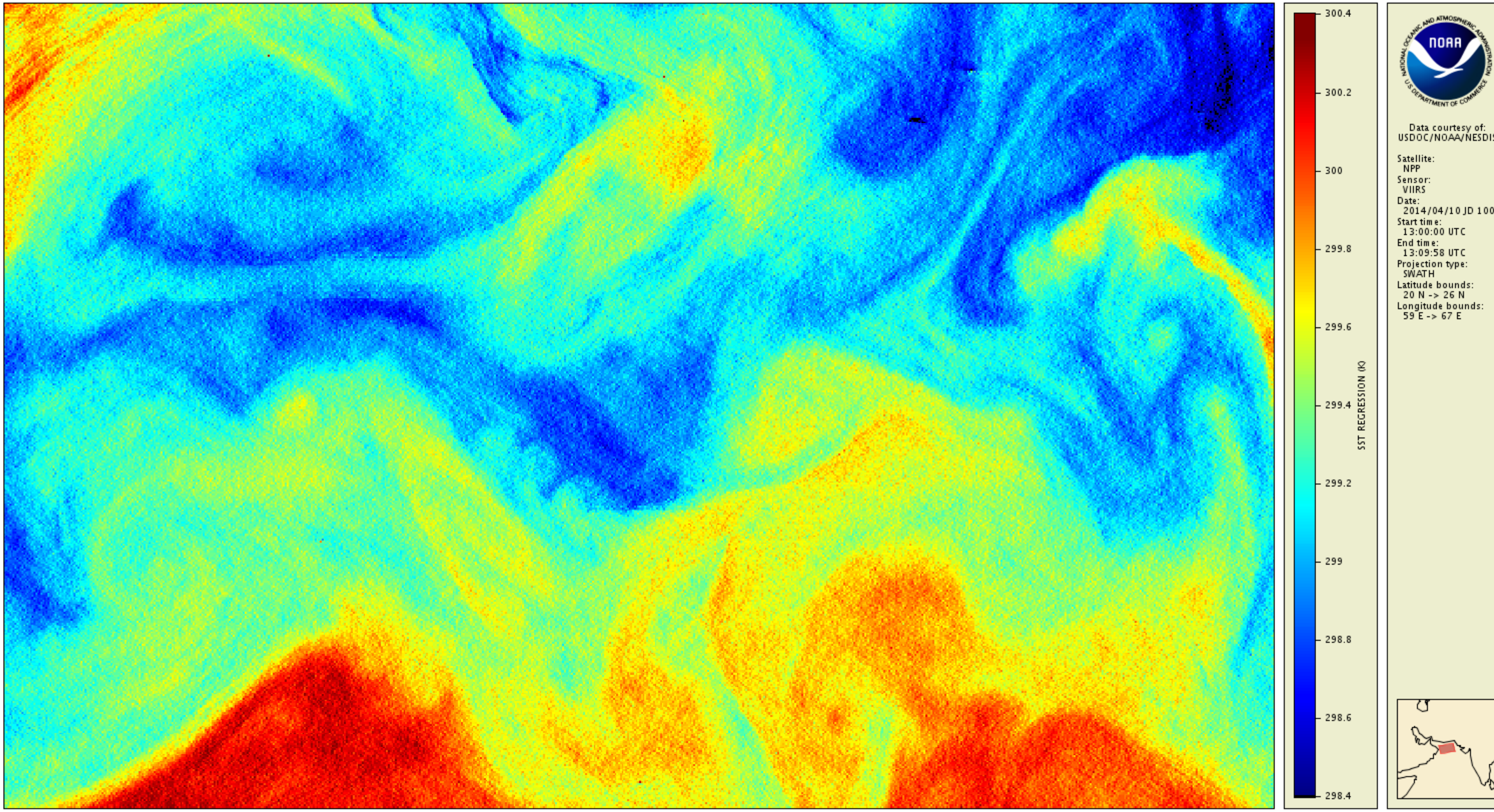


Pattern Recognition Improves ACSPO Clear-Sky Mask

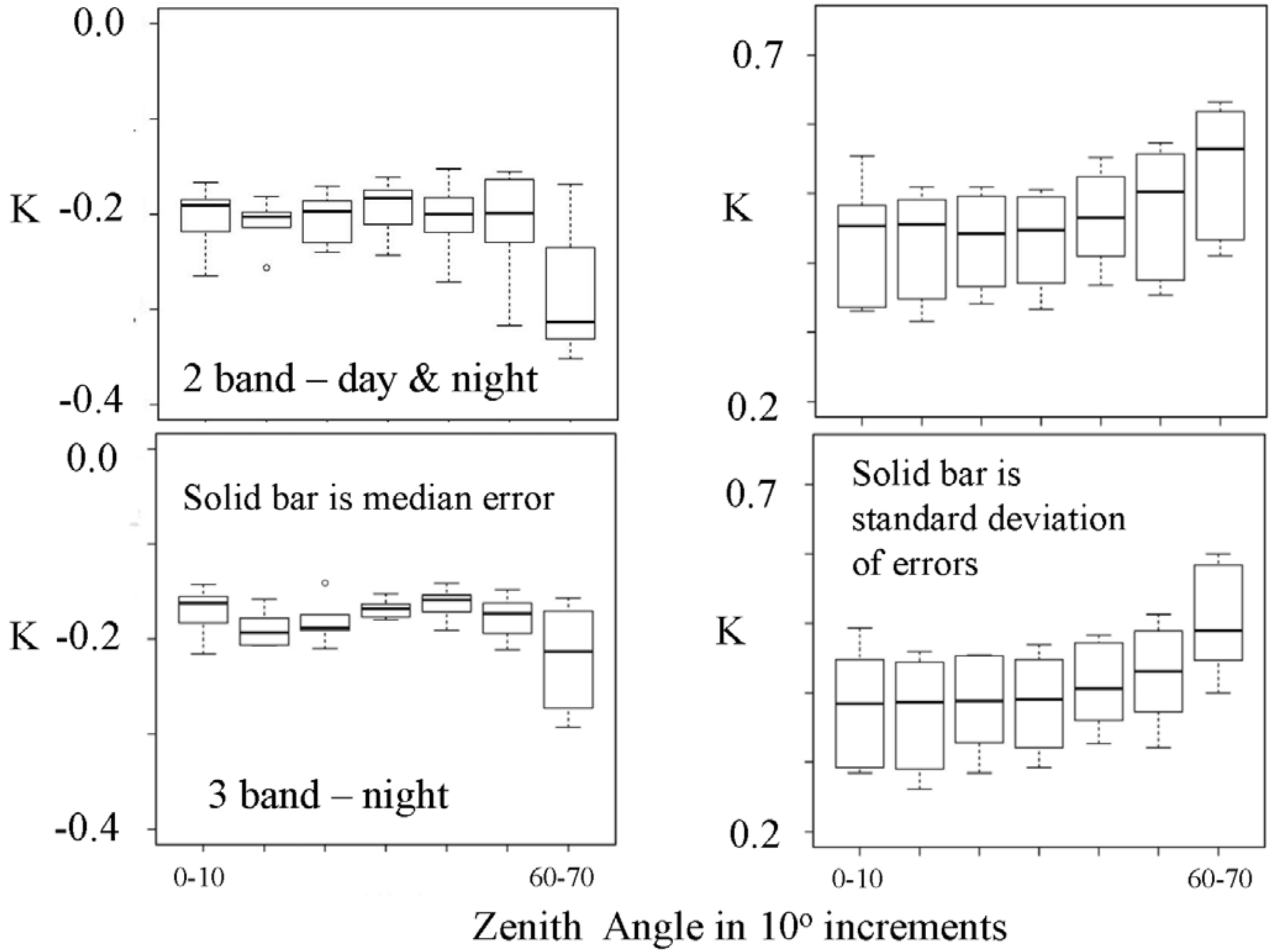
Mikelsons – DAY SST from original BTs



Mikelsons – DAY SST from destriped BTs

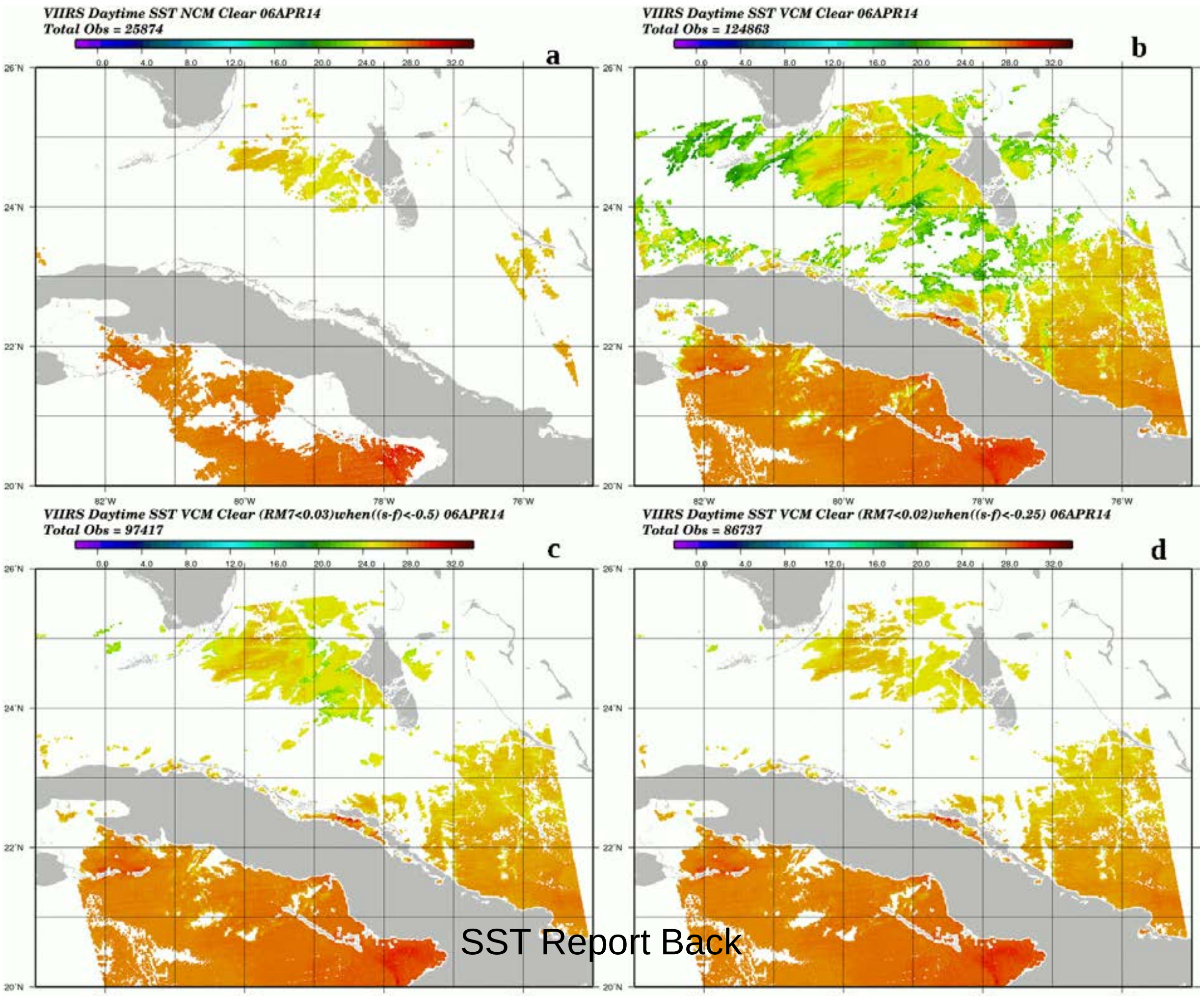


Minnett – Zenith angle dependence



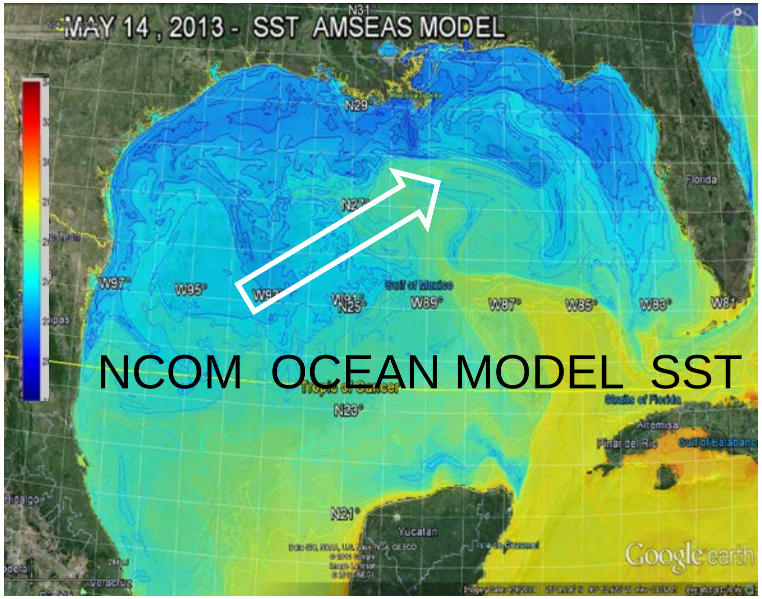
Cayula – VCM effect on SST accuracy

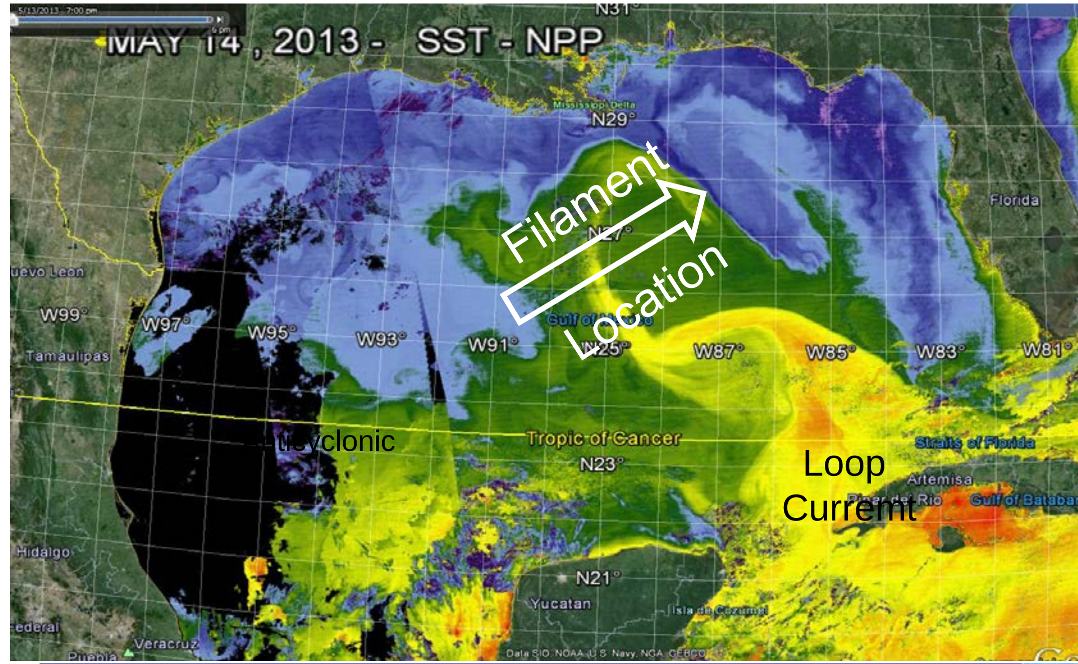
Example: Daytime SST fields on April 6, 2014 a) for NCM clear, b) for VCM clear, c) for VCM clear with additional test, d) with a tightened additional test to remove remaining cloud leakage



Arnone - SST (University of Southern Miss)

Regional Studies -   Filament Location

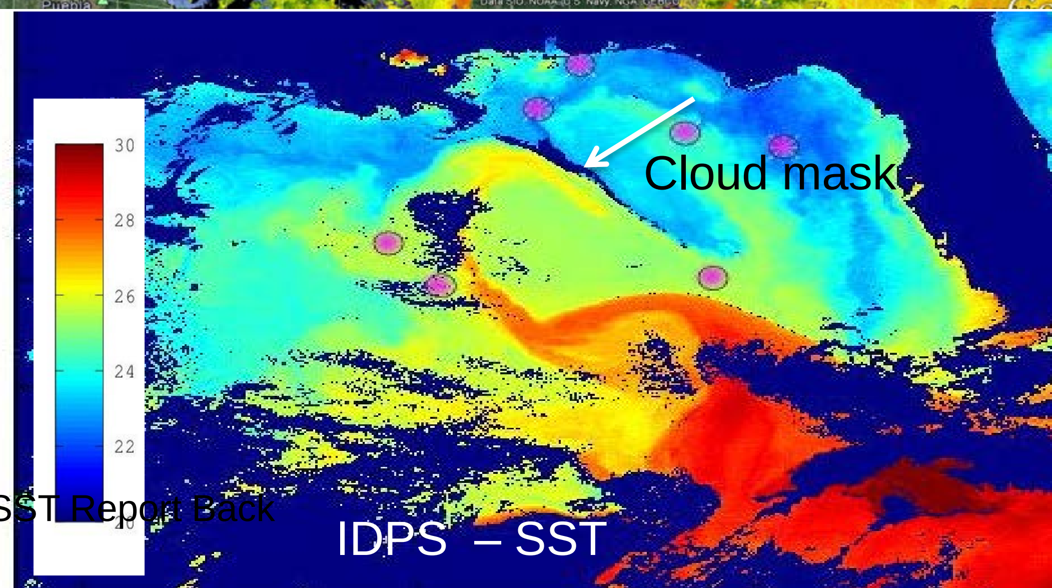




Over compensation in Cloud Mask can impact the Ocean Model SST

Difference in Filament location of Model and SNPP SST - associated with Assimilation and Cloud MASK

16 May 2014



Coming Year Work – STAR Focus

- ✓ Focus on users – work individually, address concerns
- ✓ Archive ACSPO L2 GDS2 at JPL/NODC, discontinue IDPS. Establish reprocessing, back-fill ACSPO VIIRS to Jan'2012
- ✓ Generate ACSPO VIIRS L3 GDS2 product, archive JPL/NODC
- ✓ Go validated with ACSPO SST (meets specs, long term monitoring established)
- ✓ Explore improved Quality Flags / Levels in ACSPO
- ✓ Implement destriping operationally (SDR feedback/Tue PM – Ignatov; SST breakout/Wed – K. Mikelsons)
- ✓ Explore pattern recognition ACSPO clear-sky mask enhancements (innovative science talk – I. Gladkova)
- ✓ Continue Monitoring, Validation and cross-evaluation of various SST products in SQUAM, iQuam, MICROS

Coming Year Work – Partners Focus

U. Miami

- ✓ High-latitudes – cloud mask, ice mask, SST algorithm
- ✓ Performance of SST algorithm in full sensor swath

USM/NRL

- ✓ Algorithm performance in coastal areas
- ✓ Assimilation in models
- ✓ SST consistency from consecutive swaths

NAVO

- ✓ Explore increased SST domain
- ✓ Continue comparisons with ACSPO

JPSS STAR Science Team Annual Meeting

12-16 May 2014

Ocean Color Team Report

Menghua Wang

VIIRS EDR Ocean Color Lead

16 May 2014

VIIRS Ocean Color Team Members' Roles & Responsibilities

EDR	Name	Organization	Funding Agency	Task
Lead	**Menghua Wang (EDR Lead), , L. Jiang, X. Liu, W. Shi, S. Son, L. Tan, X. Wang, P. Naik, J. Sun, V. Lance, K. Mikelsons, M. Ondrusek, E. Stengel**	NOAA/NESDIS/ STAR	JPSS/NJO	Leads – Ocean Color EDR Team OC products, algorithms, SDR, EDR, Cal/Val, vicarious cal., refinements, data processing DR- Software updates
Ocean Color	**Robert Arnone** **Sherwin Ladner, Ryan Vandermeulen Adam Lawson, Paul Martinolich,** **Jen Bowers, Giulietta Fargion**	U. Southern MS NRL QinetiQ Corp. SDSU	JPSS/NJO	Coordination Look Up Tables – SDR-EDR impacts, vicarious calibration Satellite matchup tool (SAVANT) – Golden Regions cruise participation . WAVE_CIS (AERONET site)
	Carol Johnson	NIST	JPSS/NJO	Traceability, AERONET Uncertainty
	Curt Davis, Nicholas Tufillaro	OSU	JPSS/NJO	Ocean color validation, Cruise data matchup West Coast
	Burt Jones, Matthew Ragan	USC	JPSS/NJO	Eureka (AERONET Site)
	Sam Ahmed, Alex Gilerson, Soe Hlaing	CUNY	JPSS/NJO	LISCO (AERONET site) Cruise data and matchup
	Chuanmin Hu	USF	JPSS/NJO	NOAA data continuity
	Ken Voss & MOBY team	Univ. Miami	JPSS/NJO	Marine Optical Buoy (MOBY)
	ZhongPing Lee, Jianwei Wei	UMB	JPSS/NJO	Ocean color IOP data validation and evaluation Ocean color optics matchup
	Patty Pratt, J. Ip	NGAS	JPSS/NJO	Detector tool Matchup and DR and IDPS updates

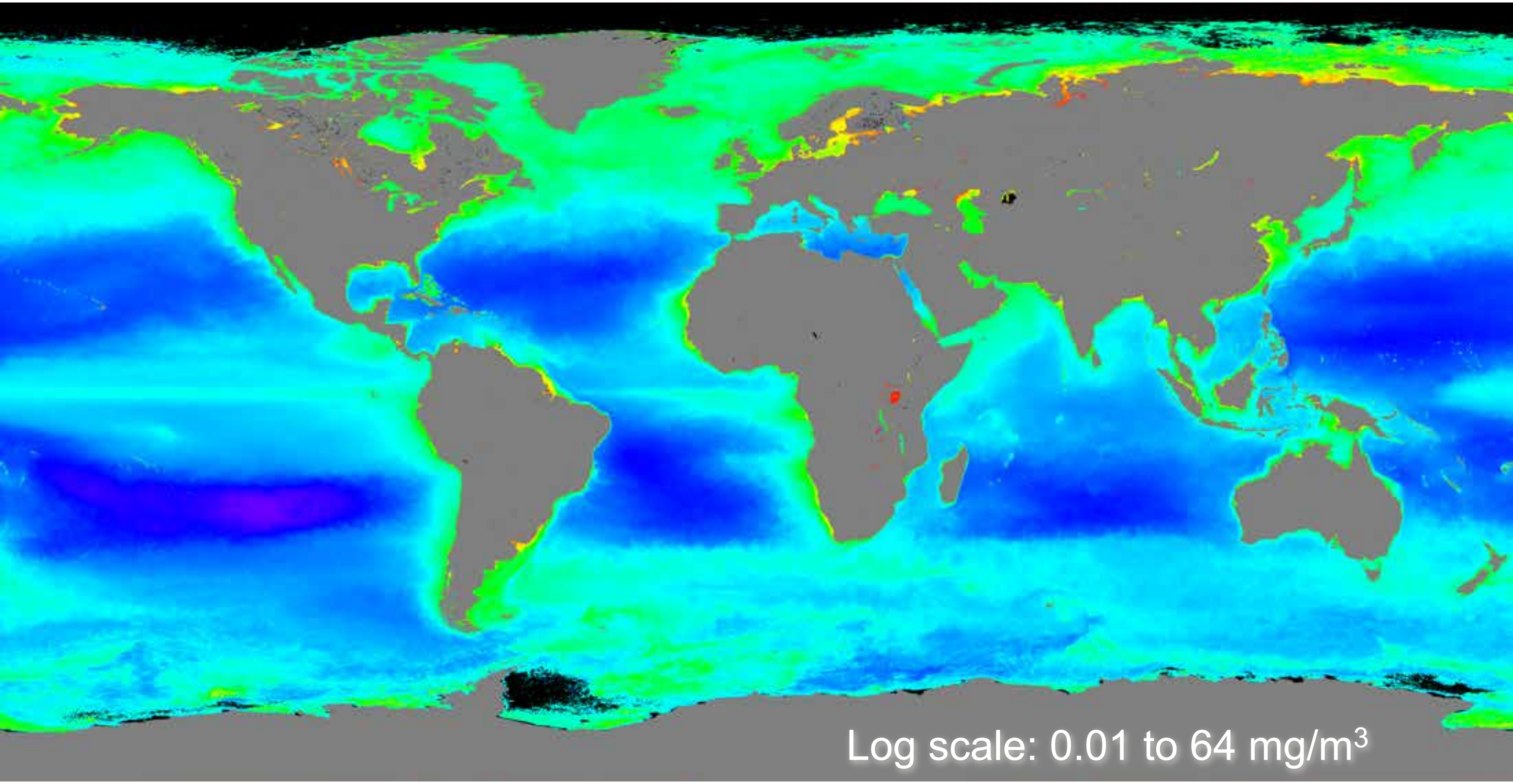
Working with: VIIRS **SDR team**, DPA/DPE (e.g., R. Williamson, Neal Baker), Raytheon (e.g., Marine Hollingshead), NOAA OC Working Group, NOAA various line-office reps, NASA OC Working Group (K. Turpie, B. Franz , et al.), NOAA OCPOP, etc.
Collaborators: D. Antoine (BOUSSOLE), B. Holben (NASA-GSFC), G. Zibordi (JRC-Italy), and others

Multi-Sensor Level-1 to Level-2 (MSL12) Ocean Color Data Processing

- Multi-Sensor Level-1 to Level-2 (MSL12)
  - ✓ MSL12 was developed during NASA SMIBIOS project (1997-2003) for a consistent and common ocean color data processing for multiple satellite ocean color sensors (*Wang*, 1999; *Wang and Franz*, 2000; *Wang et al.*, 2002).
  - ✓ It has been used for producing ocean color products from various satellite ocean color sensors, e.g., SeaWiFS, MOS, OCTS, POLDER, MODIS, etc.
- NOAA-MSL12 Ocean Color Data Processing
  - ✓ NOAA-MSL12 is based on SeaDAS version 4.6.
  - ✓ Some significant improvements: (1) the SWIR-based data processing, (2) Rayleigh and aerosol LUTs, (3) detecting absorbing aerosols and turbid waters, (4) ice detection algorithm, (5) improved straylight and cloud shadow algorithm, and others.
  - ✓ Capability for multi-sensor ocean color data processing, e.g., MODIS, **VIIRS**, GOCI, and will add OLCI/Stentinel-3, SGLI/GCOM-C, **J-1**, **J-2**, and others.
- MSL12 for **VIIRS** Ocean Color Data Processing
  - ✓ Standard ocean color products: **normalized water-leaving radiances** ($nL_w(\lambda)$) at VIIRS M1 to M5 bands; **chlorophyll-a** concentration, and water **diffuse attenuation coefficient** at the wavelength of 490 nm ($K_d(490)$).
  - ✓ Experimental products: photosynthetically available radiation (PAR), inherent optical properties (IOPs), and others.

VIIRS Climatology Chlorophyll-a Image

(April 2012 to December 2013)

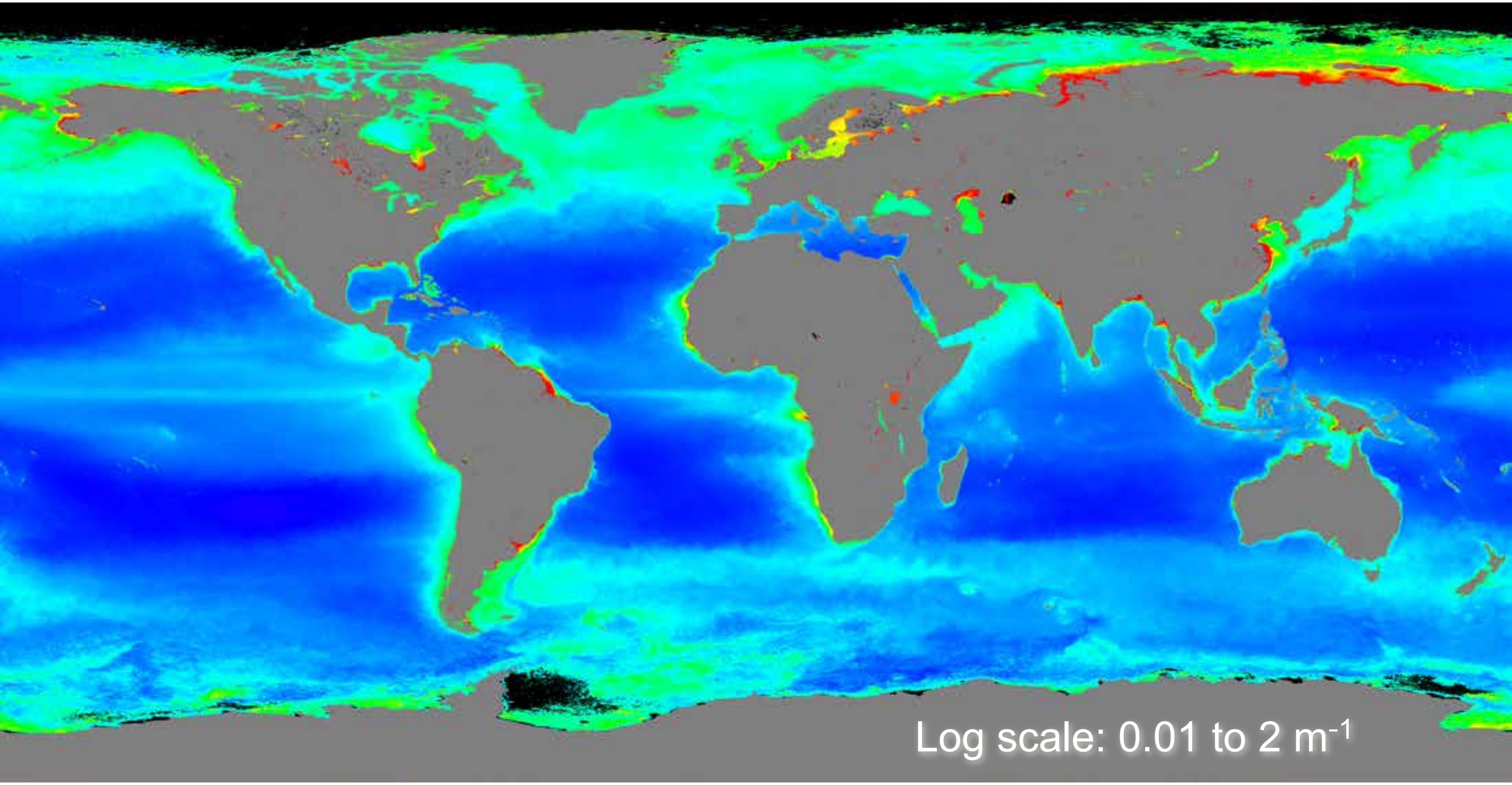


Generated using MSL12 for VIIRS ocean color data processing

Wang, M., X. Liu, L. Tan, L. Jiang, S. Son, W. Shi, K. Rausch, and K. Voss, "Impacts of VIIRS SDR performance on ocean color products," *J. Geophys. Res. Atmos.*, **118**, 10,347–10,360, 2013. http://dx.doi.org/10.1002/jgrd.50793

Menghua Wang, NOAA/NESDIS/STAR

VIIRS Climatology $K_d(490)$ Image
(April 2012 to December 2013)

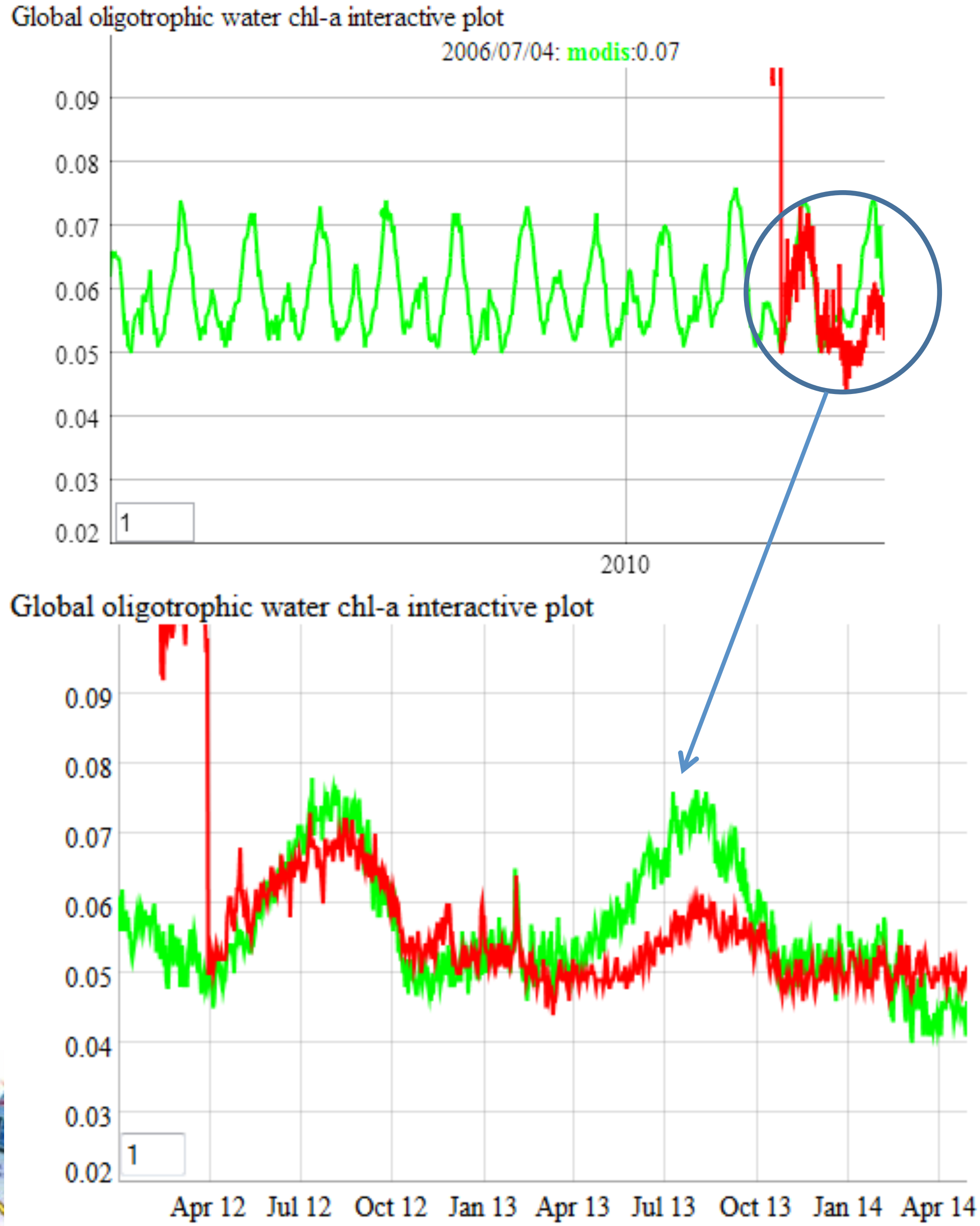


Generated using MSL12 for VIIRS ocean color data processing

Wang, M., S. Son, and L. W. Harding, Jr., "Retrieval of diffuse attenuation coefficient in the Chesapeake Bay and turbid ocean regions for satellite ocean color applications," *J. Geophys. Res.*, **114**, C10011, 2009. http://dx.doi.org/10.1029/2009JC005286.

Menghua Wang, NOAA/NESDIS/STAR

VIIRS Calibration Issue



MODIS-Aqua global oligotrophic water Chl-a from 2002 to 2013 (green), overplotted with VIIRS data from 2012 to 2013 (red)

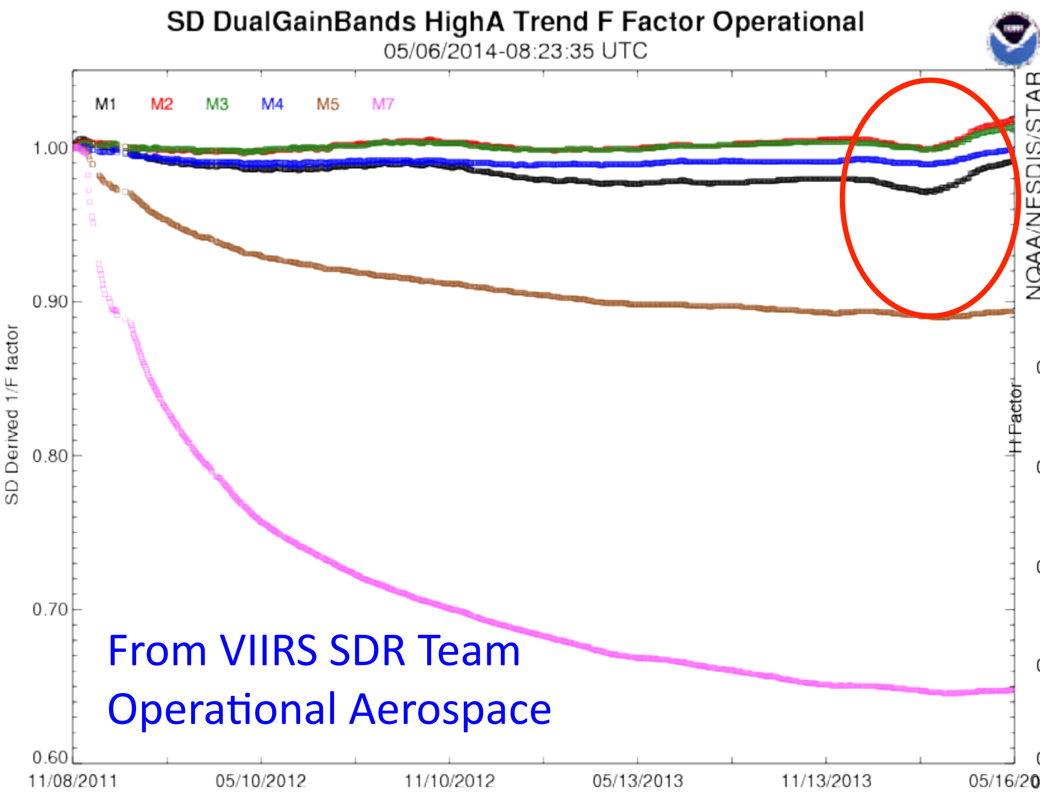
—— MODIS-Aqua

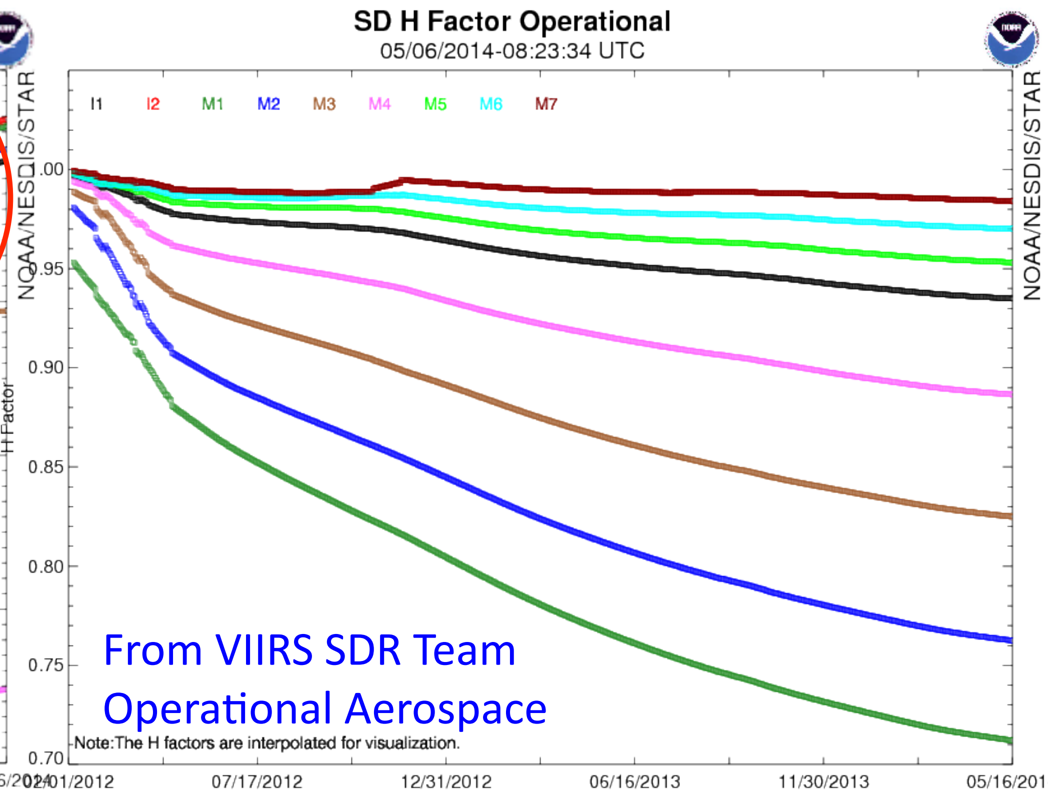
—— VIIRS (NOAA-MSL12)

- VIIRS and MODIS-Aqua match each other quite well in 2012.
- They have noticeable difference in 2013 (biased low from VIIRS).
- Since MODIS-Aqua has a reasonable Chl-a annual repeatability, It is confirmed that VIIRS SDR has calibration issues, in particular, **for the M4 (551 nm) band (biased low), at least for 2013.**

Recent Operational RSB H&F Factors Trends

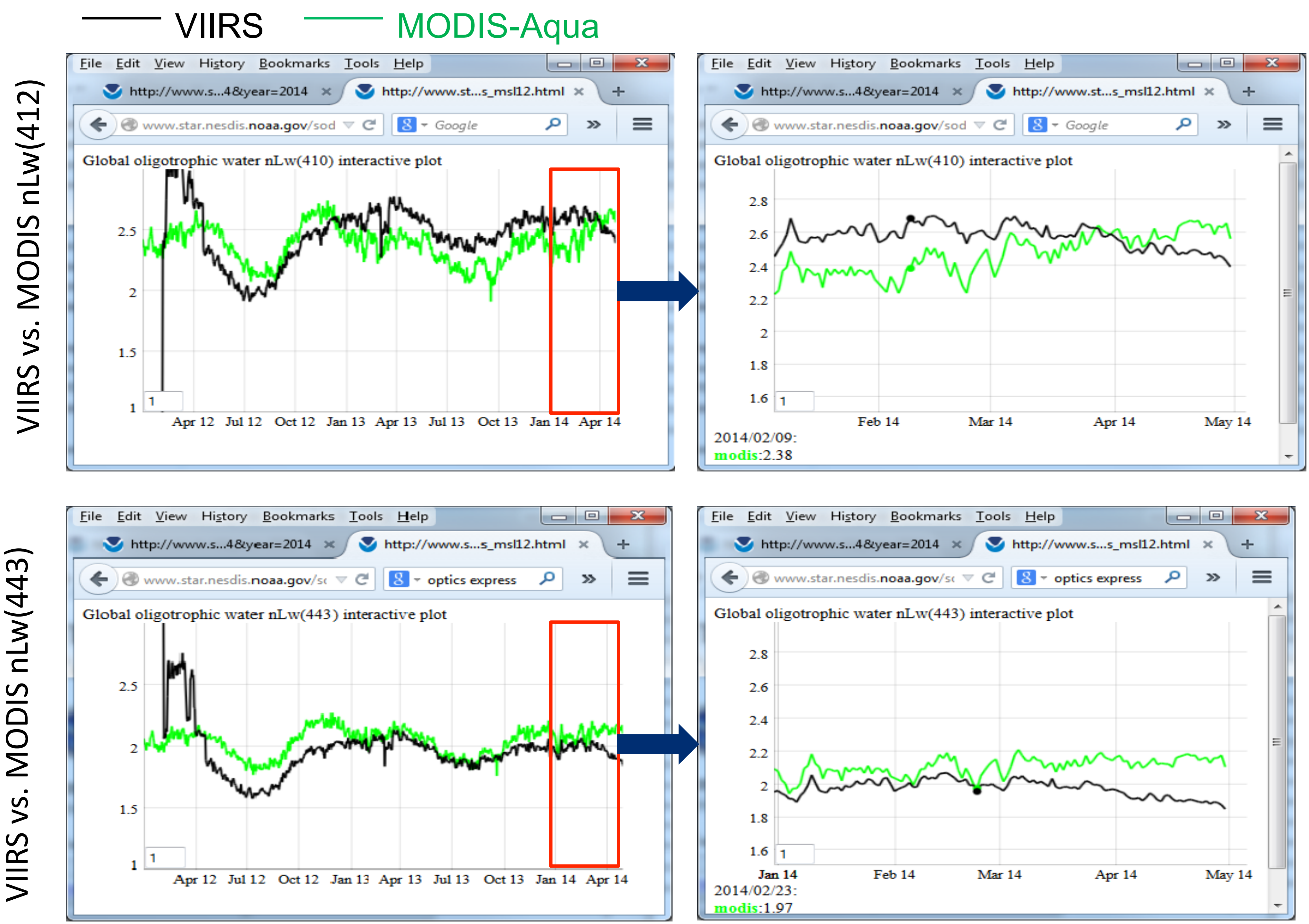
(More detail this afternoon)



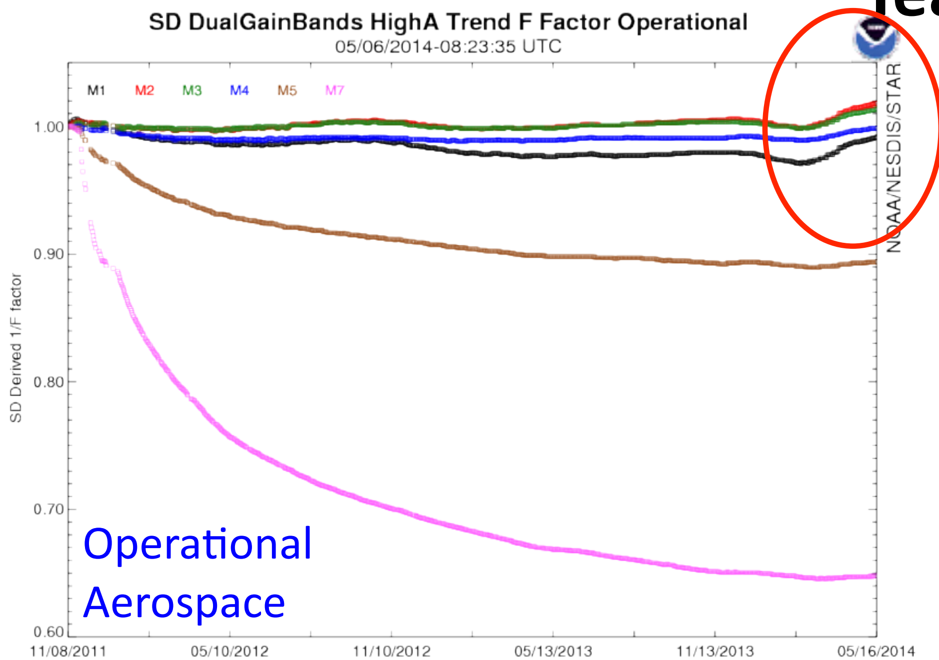


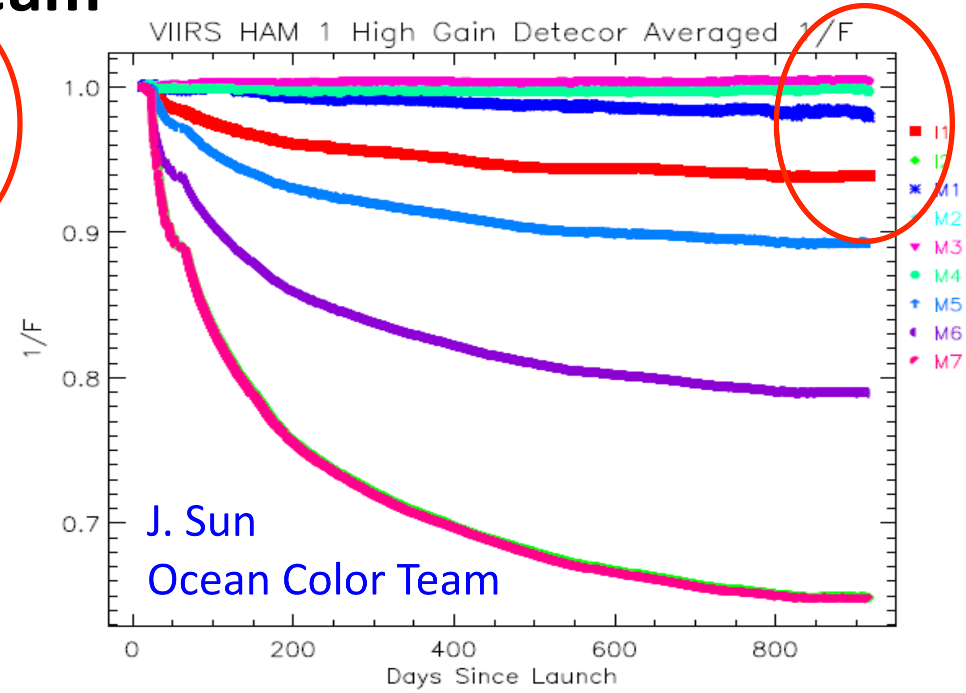
- Recent F-factors (1/F) show significant trend change which suggests that degradation has stopped or even reversed.
- F-lookup tables (1/F) for M1-M4 show significant increase of ~1-2% since early February. F factors for M1 and M2 increased ~2% in 3 months.
- Thus, calibration gains (TOA radiances) are decreased by ~2% for M1 and M2.

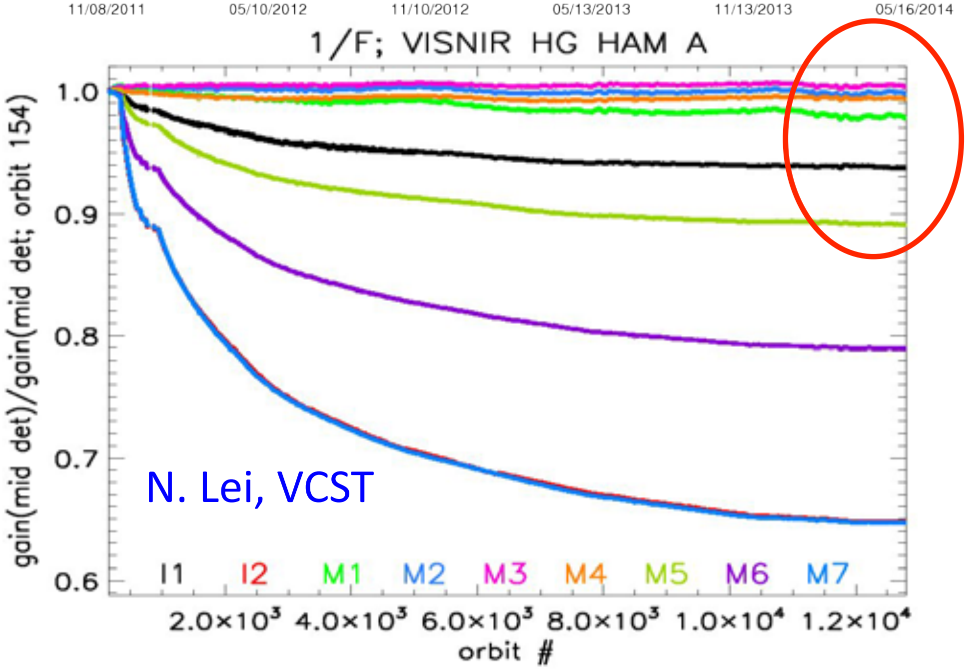
Quantitative Evaluation for Global Oligotrophic Waters



F factors from Operational, VCST, and Ocean Color EDR Team







- **The recently F-factors (1/F) increase (Cal. gains decrease) in short wavelength bands observed in operational F-LUTs is not seen in F factors derived by Ocean Color Team and VCST.**
- **The artificial F-factors increase lead to the EV radiance/reflectance decrease and significantly impacted VIIRS ocean ocean products, leading to biased low nLw values and missing values due to nLw < 0.**

Ocean Color Breakout Discussions

- **Ken Voss** (Univ. Miami): Why MOBY and why MOBY refresh?
- **Kevin Turpie** (NASA/UMBC): Calibration uncertainty and satellite ocean color trends
- **Mike Ondrusek** (STAR): Validation ocean color sensors using a profiling hyperspectral radiometer
- **Puneeta Naik** (STAR): Effective band center wavelengths for MODIS and VIIRS for open ocean waters
- **Discussions**: OC data quality, SDR issues, long-term time series, need lunar calibration, J-1 polarization issue (most impact to OC products), etc.

➢ VIIRS Ocean Color Team contributed **7** posters covering various topics.

Ocean Color Users Feedback

- Participants from
  - **Fisheries**
    - Northeast – **Kim Hyde**
    - Atlantic/Florida – represented by **Ron Vogel**
    - Pacific -- **Cara Wilson**
      - Surveys (NRT)
      - Long term model predictions
  - **NWS** – **Tony Siebers**
    - Ecosystem Forecasting – moving toward operational - **Chris Brown**
    - EMC - **Sudhir Nadiga**, **Eric Bayle**
  - **NOS** – **Rick Stumpf**
    - HAB
    - Sanctuaries
  - **OAR** (e.g., **D. Tong**, Isoprene emission)
  - **NESDIS** ecosystems – Chris Brown
  - **AOML/AOR** (not present but discussed)

PRODUCT Needs & Latency Requirement

- Current Operational products all need to be regularly reprocessed with VIIRS, to provide high quality data **time series** (expressed by ALL users).
- **Required** Products: **nLws**, **Chlorophyll-a**, **Kd(490)**, Kd(PAR) (from EMC). Anomaly products. Global data.
- New products desired
  - Primary Productivity
  - Chromophoric Dissolved (Organic) Matter (CDM or CDOM)
  - Suspended Particulate Material
  - Particulate Inorganic Carbon (PIC)
  - Chlorophyll Frontal Product
- **Data Latency Requirement**: generally 12 hrs, but some applications need 3 hrs or less. Need DB data.

Conclusions

- In general, VIIRS OC normalize water-leaving radiance spectra show reasonable agreements with in situ measurements at MOBY, AERONET-OC sites, and various other ocean regions.
- In global deep waters, the VIIRS ocean color products generated from MSL12 were consistent with MODIS-Aqua in 2012, but discrepancy started to become noticeable for IDPS and MSL12 Chl-a data since early 2013. We confirmed that this is a VIIRS calibration problem in 2013, particularly for M4 band.
- Following the reverse trends of VIIRS SDR F-LUTs, global VIIRS nL_w data show decreasing trends from February to May of 2014. $nL_w(410)$ (M1) and $nL_w(443)$ (M2) drifted lower ~**15-20%** as of early May 2014, and $nL_w(488)$ (M3) decreased ~**8-10%** for global oligotrophic waters. These are very significant! The nL_w trends are continuing, and the correct F-LUTs should be used now!
- VIIRS ocean color products are critical to NOAA users (also to broad ocean community). High quality time series data are required. Thus, regularly data reprocessing is necessary for both SDR and EDR. The VIIRS OC team will carry out a mission-long data reprocessing when the SDR issues are solved.
- It has been shown in the VIIRS mission that ocean color EDR is extremely sensitive to SDR data quality. Thus, both solar and **lunar** calibrations (require **lunar maneuvers**) are necessary for SNPP, and future **J-1** and **J-2**.

Center for Satellite Applications and Research*

JPSS STAR Science Teams Annual Meeting: Wrapup

Lihang Zhou (Lihang.Zhou@noaa.gov)

JPSS STAR Program Manager

Meeting Objectives

- √ Review the progress of the JPSS STAR program over the past year and review objectives of the coming year.
- √ Present results/issues/science from the JPSS STAR science teams including: algorithm validation and maturity status, SNPP science results, plans for the coming year, and progress in preparing for JPSS-1.
- √ Hold individual meetings with the science teams and management to review the work plan, budget, and other management matters for the upcoming Fiscal Year.
- √ Hold user splinter meetings to develop plans for improved utilization of selected JPSS products.
- √ Inform the JPSS Program Office and NESDIS management on the status of the program

Recommendations:

- Real-time data access for data product monitoring and anomaly detection and resolution
- Quality assurance of JPSS product stability and consistency during the mission life cycle
- Bridge gaps between the products developed and users need:
  - Engaged users in the product development early
  - Tailored products
  - User friendly data access
  - Test bed for user interaction and impact assessments
  - Website visualization
- About the annual meeting:
  - Hold this meeting every month
  - Invite more users to the next meeting
  - Have the same room for the sounding group

R&D – Operation – Applications
Scientist – System Engineer – Users

If you want to go fast,

go alone.

If you want to go far,

go together.

Thank You!