End to End Testing Using GRAFIIR

GRAFIIR (GOES-R Analysis Facility for Instrument Impacts on Requirements): An Efficient End-to-End Semi-Automated GOES-R ABI Algorithm Performance, Analysis, and Implementation Verification System

GRAFIIR Team at CIMSS

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GRAFIIR Outline

- What is GRAFIIR?
  - Connecting the Dots
- GOES-R ABI Instrument Effect Modeling
- Glance: Statistical Analysis Tool
- GOES-R ABI Instrument Waiver Analysis

What is GRAFIIR?

- **G**OES-**R** **A**nalysis **F**acility for **I**nstrument **I**mpacts on **R**equirements (GRAFIIR)
  - How do instrument effects such as noise or navigation issues affect products?
  - Assisting the Government on addressing instrument specification waivers.
- GRAFIIR is for "connecting the dots"
  - Dots are AWG sensor models, processing algorithms, & processing frameworks

GOES-R AWG has many Components (i.e. Dots)

Visualization
McIDAS-V

Imagery
Tbb
Grayscale

AWG
Soundings
T(P)
Q(P)
O_3

AWG
Proxy
Datasets
Databases
RT Model
Tools
Doc.

AWG
Clouds
Mask
Phase
Height

AWG
Winds
Speed
Direction
Verification

AWG
FIRE
Detection
Size
Intensity

AWG

AWG

Sensor Modeling
Noise
CAL.
Nav. Err.
Co-Reg. Err.
SRF
Etc.

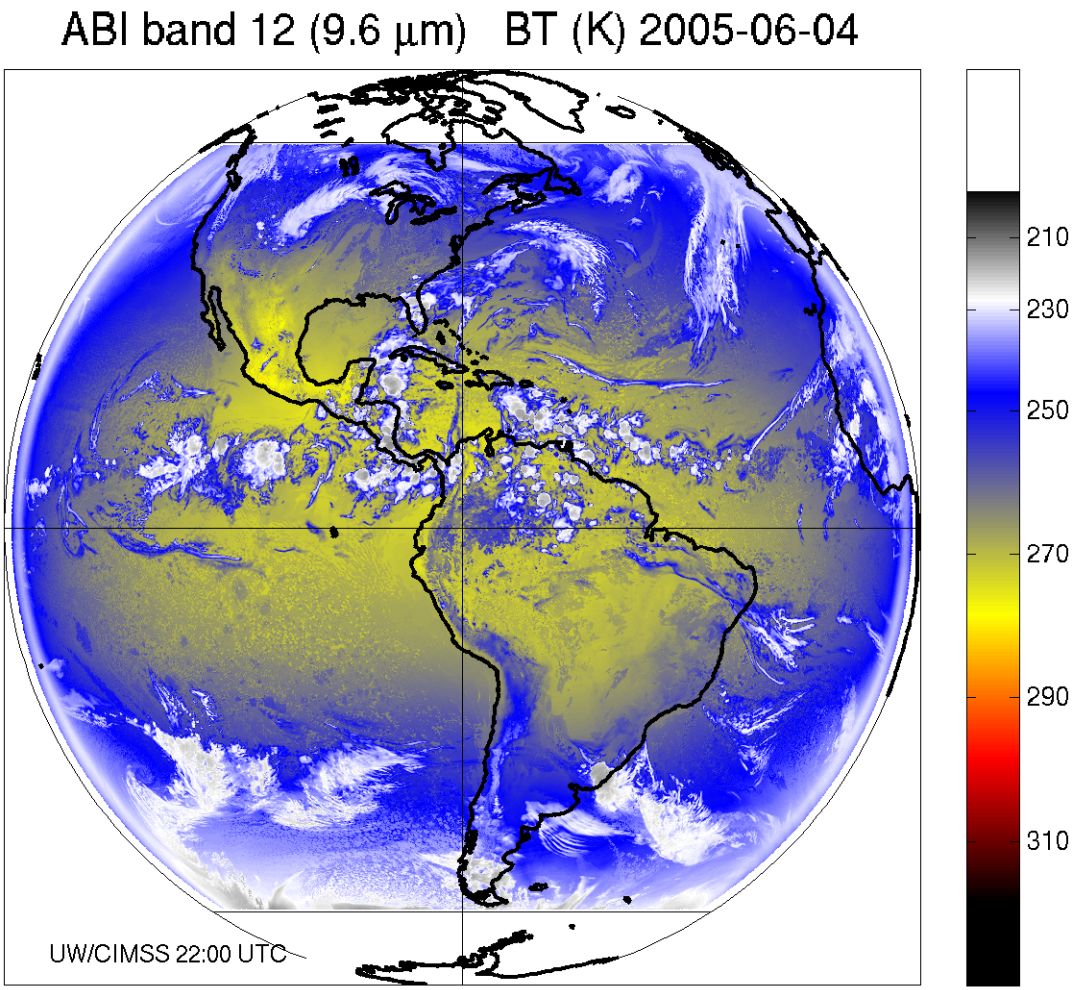
Instrument Trade Study

Instrument Vendor Sensor Model

GRAFIIR: Connecting The Dots

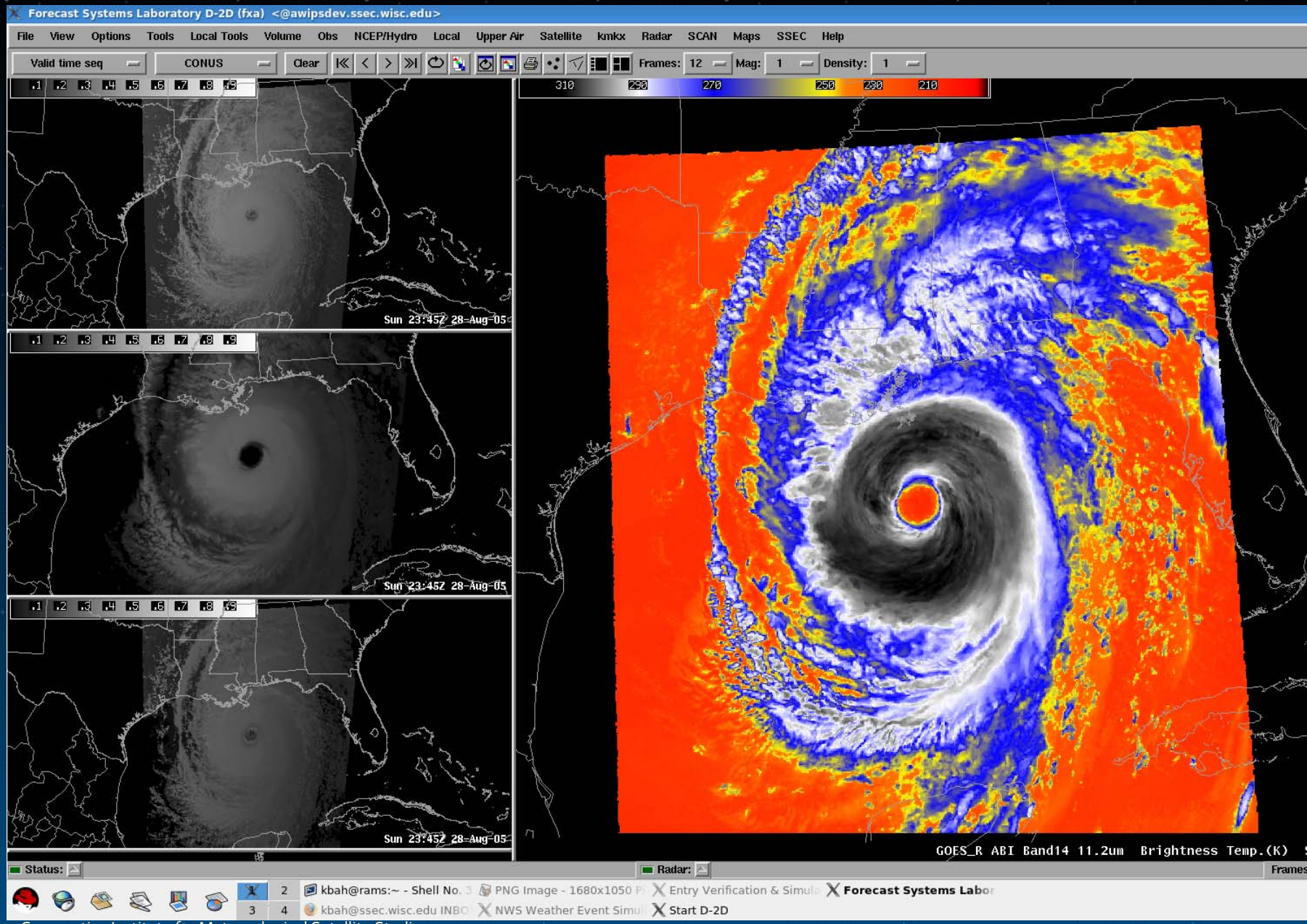
- Bringing all the AWG ABI algorithms under one processing system (GEOCAT and Framework)
  - Same Proxy Data Format
  - Same Calibration
  - Same Ancillary Data
  - Same Output Format
- This allows us to experiment with the official Product Algorithm to investigate instrument effects

AWG Proxy Data at CIMSS (ABI Full Disk Image)

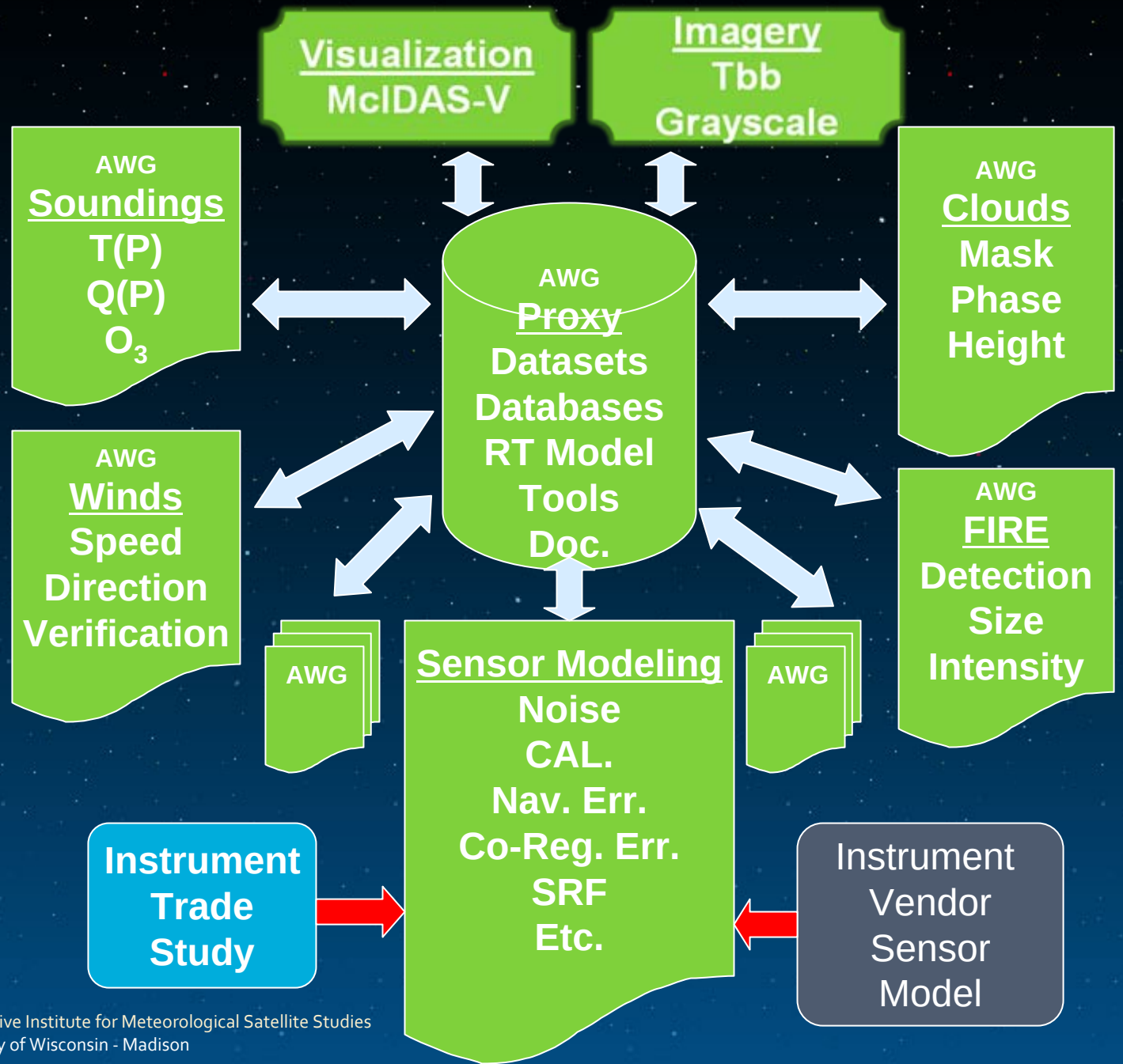


AWG Proxy Data at CIMSS

(Simulated ABI Image in AWIPS)



GRAFIIR: Connecting The Dots



Outline

- What is GRAFIIR?
  - Connecting the Dots
- **Instrument Effect Modeling**
- Glance: Statistical Analysis Tool
- Instrument Waiver Analysis

Instrument Effect Modeling

- Start with "Pure" Proxy Data
  - Random Noise
  - Calibration Offset
  - Navigation Error
  - Striping
- Based on ABI specifications, add 1x and 3x the specified instrument effect – generating 1x, 3x, and Pure datasets.

Instrument Effect Modeling
Vendor Instrument Model

- The ABI instrument vendor has a sophisticated instrument model which simulates the effects of their engineering model on imagery.
- Ideally this model can be used on data from the ABI proxy team to simulate predicted instrument performance.
- In the case of some component not meeting instrument specifications, this model could potentially produce data reflecting the change.

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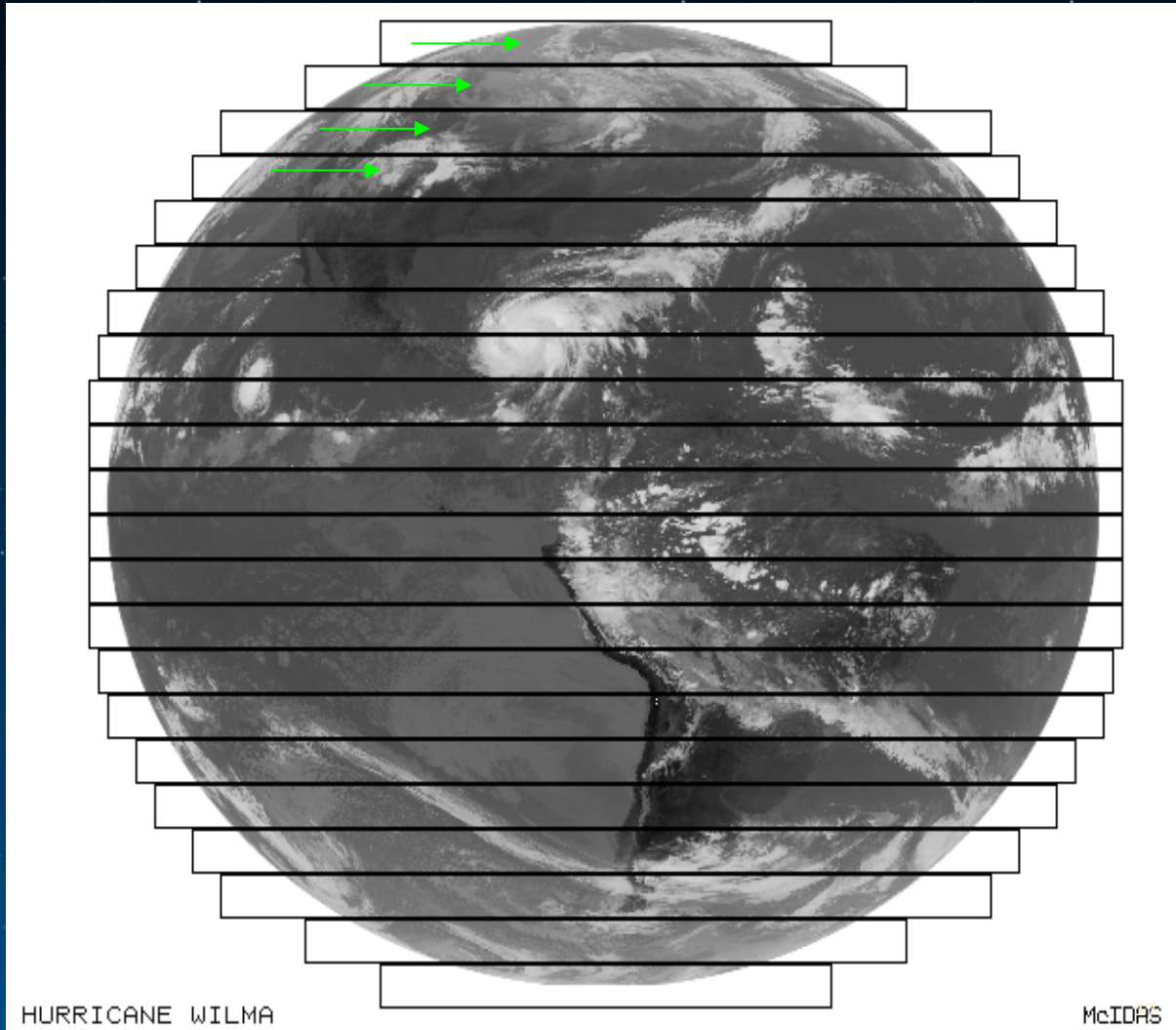
Glance: An Efficient Comparison and Analysis Tool

- With the capability to produce data with and without various instrument effects added, it becomes necessary to compare those datasets in a fast, consistent, and robust manner.
- Glance can compare input or output files, produces statistical analysis and graphical analysis, and generates a browser-ready report.

Glance

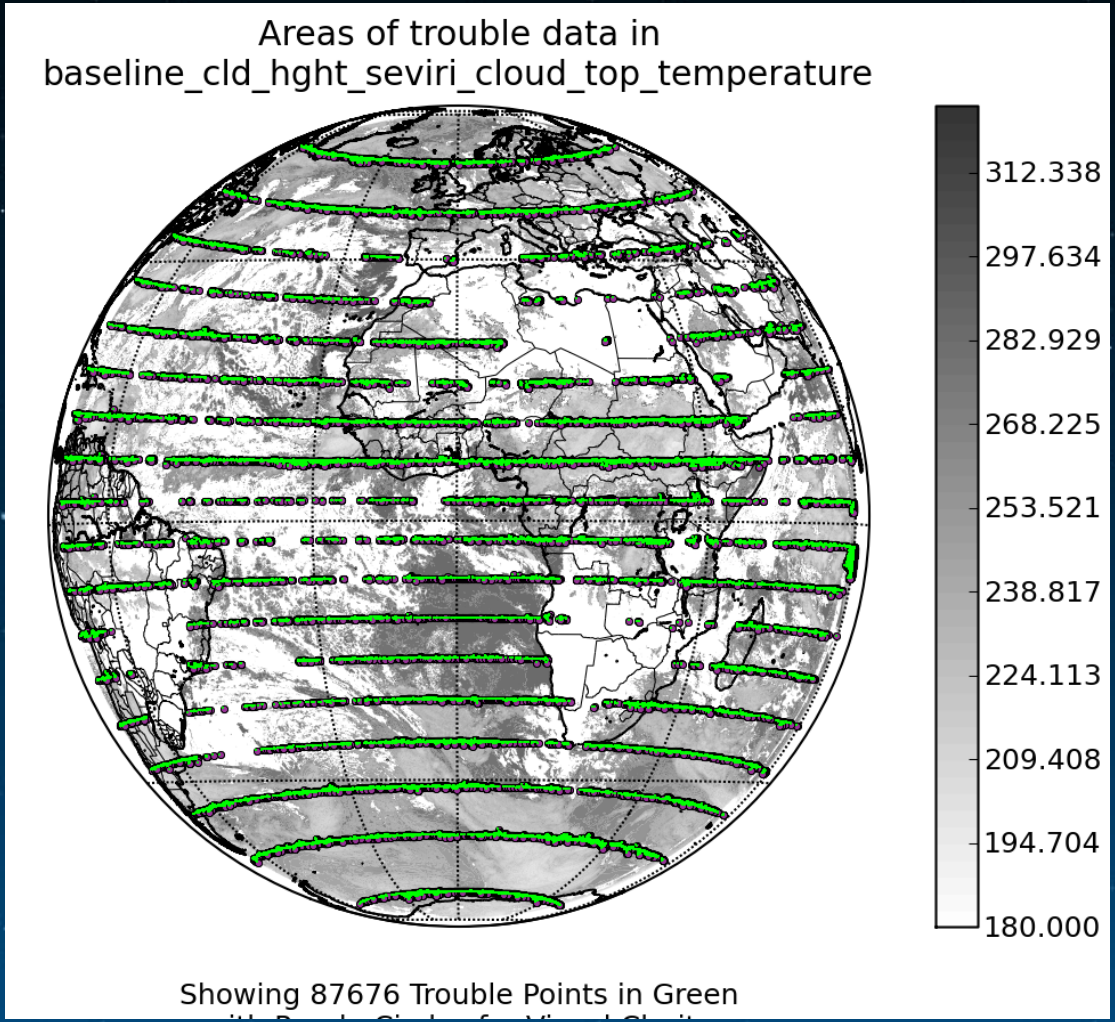
Full Disk vs “Chunk” Example

- ABI data will be scanned in “chunks” as a full disk image is assembled.
- One possible product processing strategy is to process the data as they come in.
- Some algorithms rely on data in surrounding fields of view.



Glance

Full Disk vs “Chunk” Example



Click Image to go to web report

Glance

What is Glance?

- It is a tool for comparing complex data sets stored in hdf (4/5) or netcdf (3/4) format, constructed with scientific python libraries.
- It is run from the command-line on Unix-like systems including Linux and Mac OSX and is highly automated.
- It provides wide variety of statistics as well as HTML comparison reports, graphical charts, and plots of the data placed on the earth.
- Given guidance about comparison tolerances, it is a useful tool to verify the similarity of two datasets in a semi-automated way and provides high quality output surveying the results.
- It is being integrated with GRAFIIR automation to provide summary pass/fail analyses showing areas of significant difference.

Glance

What has Glance been used for?

- Primarily Glance has been used for comparisons between the output from the NOAA GOES-R Algorithm Integration Team's Framework AIT (FWAIT) and output from the GOES-R Algorithm Working Groups at CIMSS.
- Analysis by GRAFIIR in testing the impacts of instrument effect (i.e. noise etc.) in simulated ABI data
- Analysis between output from separate runs of FWAIT and other GOES-R science code to test robustness
- Testing is underway for other large datasets, including output from International Polar Orbiter Processing Package (IPOPP).

Outline

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- Instrument Waiver Analysis

GRAFIIR Instrument Waiver Analysis

- The government (NASA and NOAA) has an "Integrated Modeling Working Group"
- Identify existing capabilities
- Identify gaps in current capabilities
- Formulate a waiver analysis plan

GRAFIIR Instrument Waiver Analysis

The Plan Basics

- Identify which resources are needed to address a waiver
  - Key People
  - Models
  - Data
- Generate a report with a recommendation
  - For ABI, likely GRAFIIR would be involved and Glance would be used.

GRAFIIR Instrument Waiver Analysis

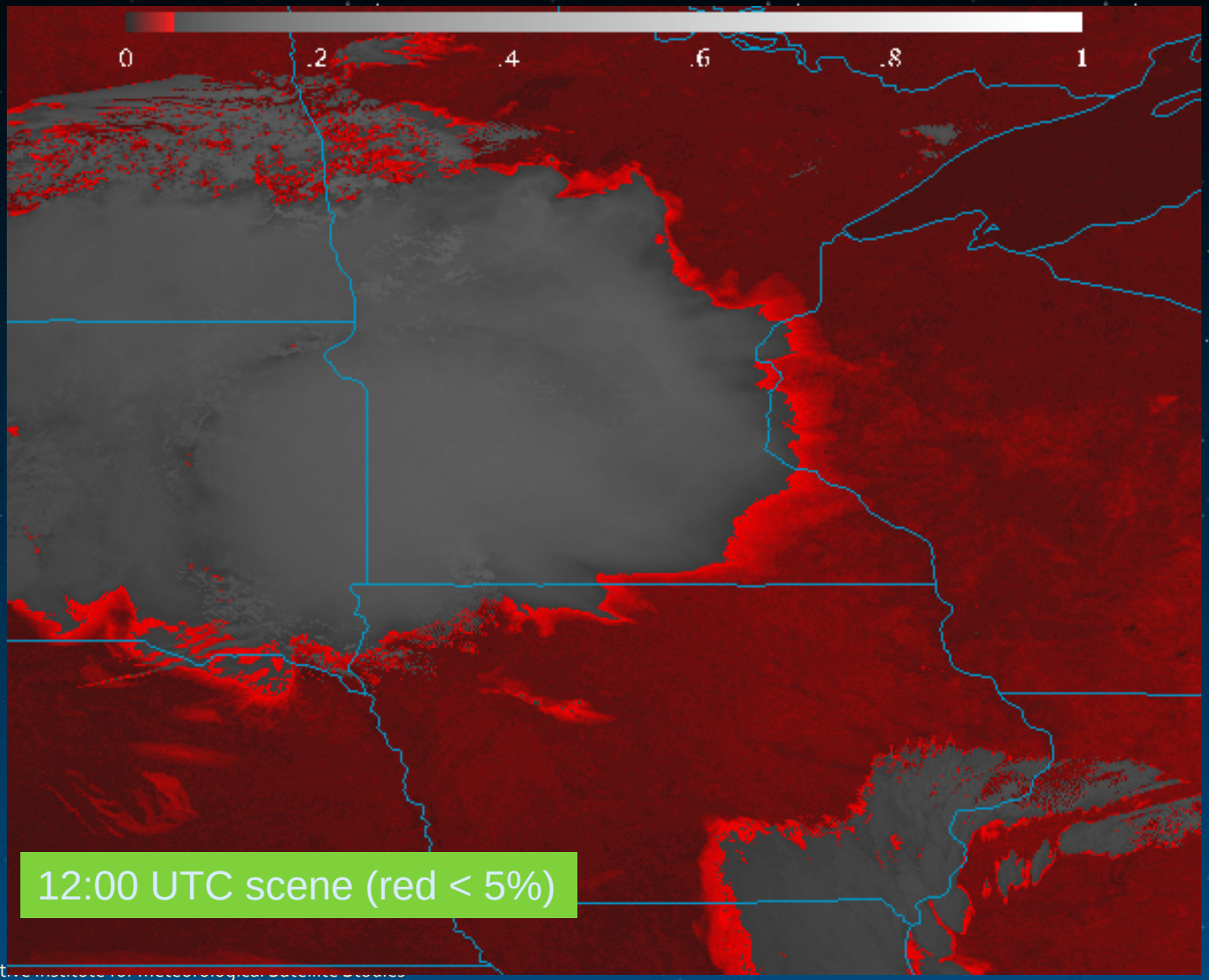
Visible Band Noise Waiver

- What if the visible band (ABI band 2, 0.64um) could not meet the low-light noise specification?
- There are two specifications for noise in the visible/near-IR bands.
  - General spec for 100% albedo
  - Low-light situations (5% albedo).
    - 5% albedo happens often – most bodies of water are less than 5% albedo even during the day, unless sunlight is directly reflected back at the sensor; also near the day/night terminator.

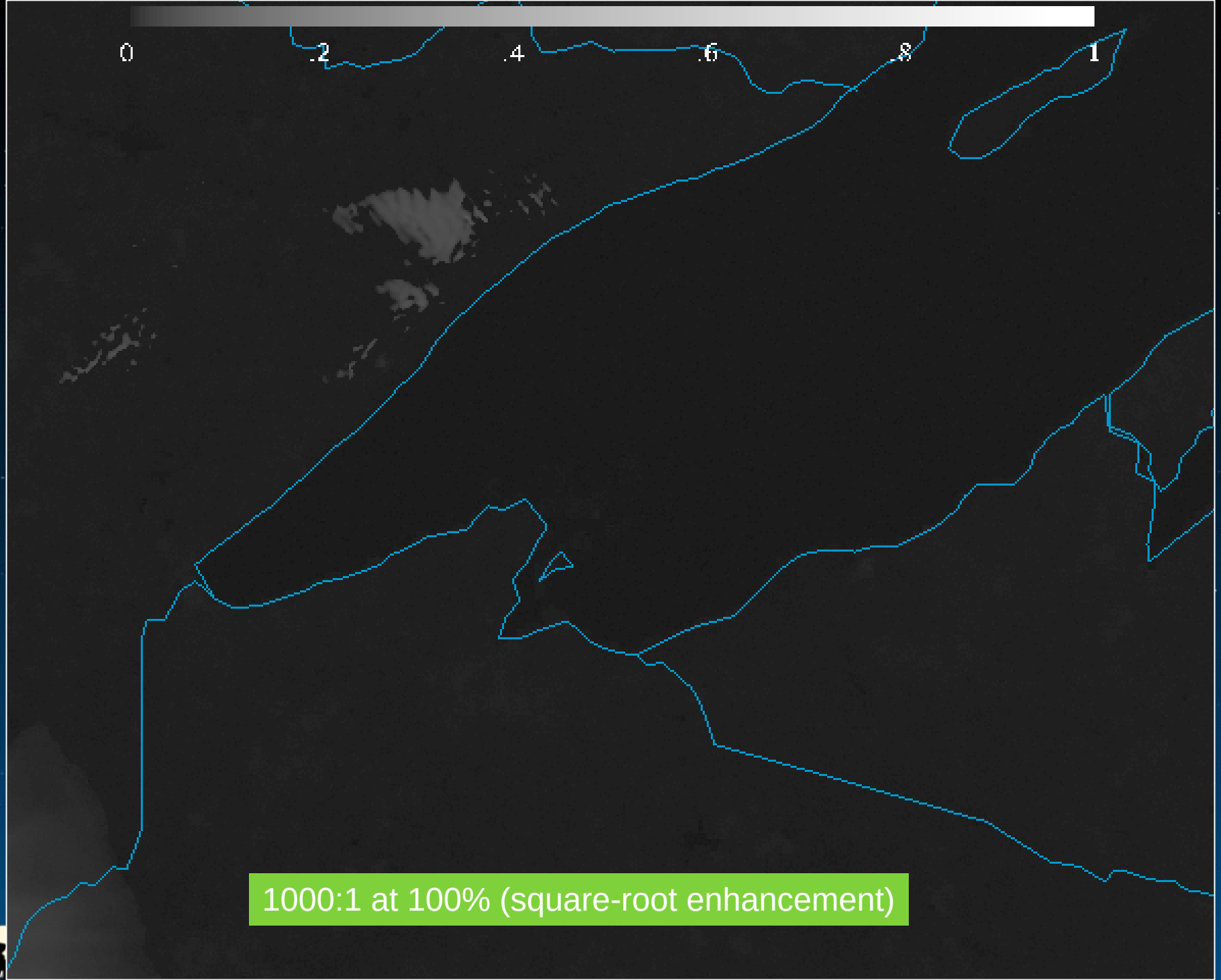
GRAFIIR Instrument Waiver Analysis
Visible Band Noise Waiver

- Efforts part of GOES-R 'triage' board on waivers
- Start with CIMSS proxy ABI data via the AWG project at 0.5 km without any noise
- Add random (gaussian) noise (mean of zero and standard deviation of 1/SNR):
- 1000:1 at 100% (equates to 50:1 at 5%)
- 300:1 at 100% (equates to 15:1 at 5%)
- Bin data to 2^12 bins (assumed bit depth in this band)
- Start with a dark/'worst case' scene (12 UTC)
- Displayed in McIDAS-V

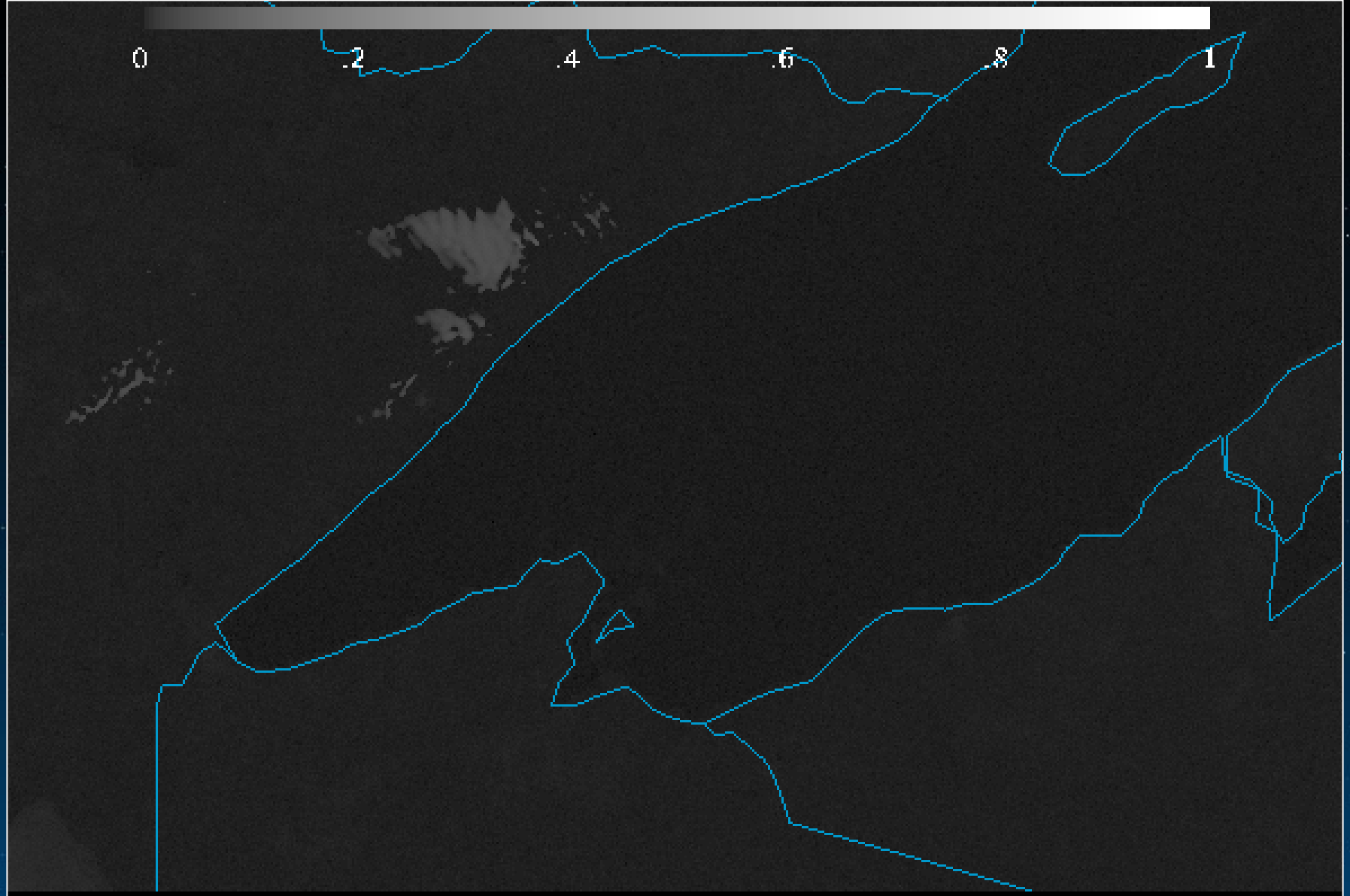
GRAFIIR Instrument Waiver Analysis



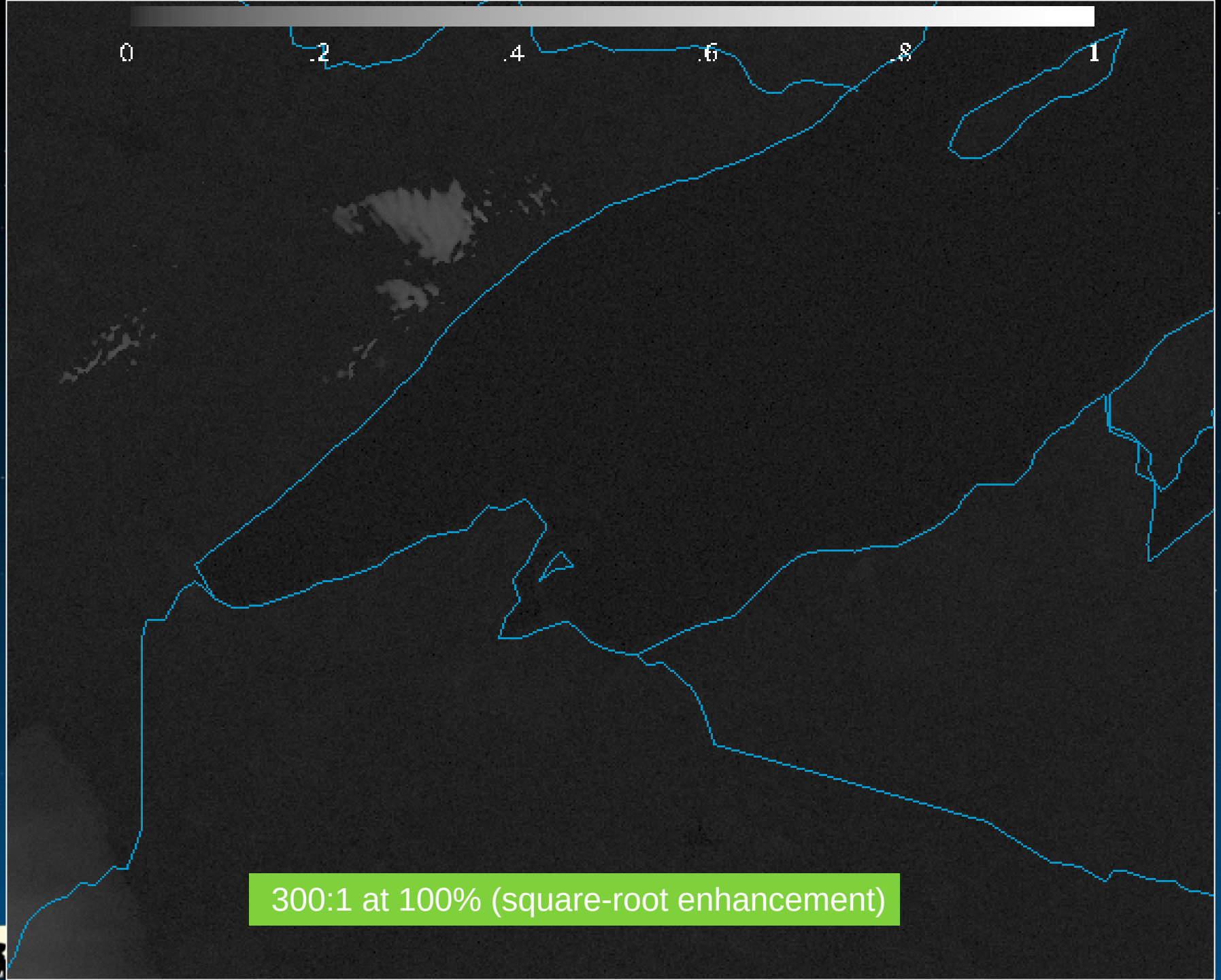
12:00 UTC scene (red < 5%)



1000:1 at 100% (square-root enhancement)



400:1 at 100% (square-root enhancement)



300:1 at 100% (square-root enhancement)

GRAFIIR's Summary

Visible Band Noise Waiver (for the dark scenes)

- Good image quality with 1000:1 SNR.
- 300:1 SNR at 100% (or 15:1 SNR at 5%) seems to be too noisy over dark scenes and hence a mitigation strategy should be employed (e.g., down-weight these detectors) or spec a range of SNR, etc.
- 400:1 SNR at 100% (or 20:1 SNR at 5%) seems an allowable noise performance.

GRAFIIR Instrument Waiver Analysis

Visible Band Noise Waiver (SNR 1000:1 vs. 300:1)

Glance Output

file A: path: ../TOArads_abi_soivis_2006_0719_1200_band02_Noise**1000**to1.cdf
file B: path: ../TOArads_abi_soivis_2006_0719_1200_band02_Noise**300**to1.cdf

General Statistics

a_missing_value*: None
b_missing_value*: None
epsilon*: 0
max_a*: 0.2415
max_b*: 0.2427
min_a*: 0.007814
min_b*: 0
num_data_points*: 4000000
shape*: (2000, 2000)
spatially_invalid_pts_ignored_in_a*: 0
spatially_invalid_pts_ignored_in_b*: 0
trouble_points_count*: 3833353
trouble_points_fraction*: 0.9583

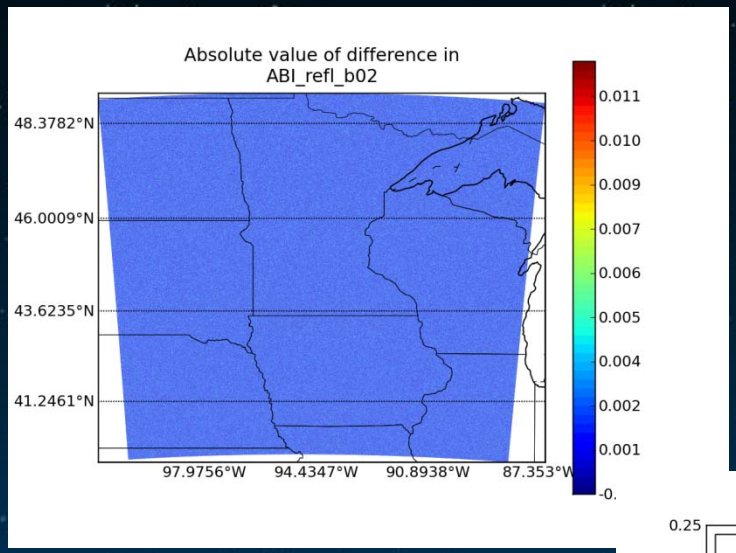
Numerical Comparison Statistics

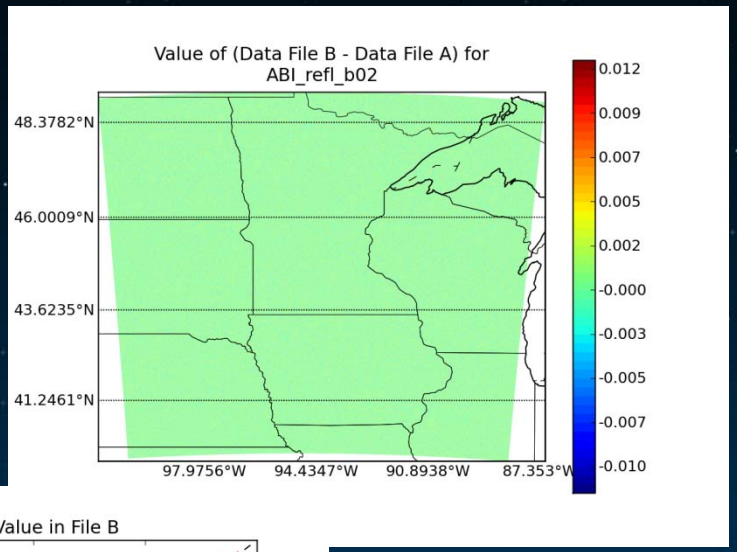
correlation*: 0.9967
diff_outside_epsilon_count*: 3833353
diff_outside_epsilon_fraction*: 0.9583
max_diff*: 0.01221
mean_diff*: 0.001916
median_diff*: 0.001465
perfect_match_count*: 166647
perfect_match_fraction*: 0.04166
rms_diff*: 0.002346
std_diff*: 0.001407

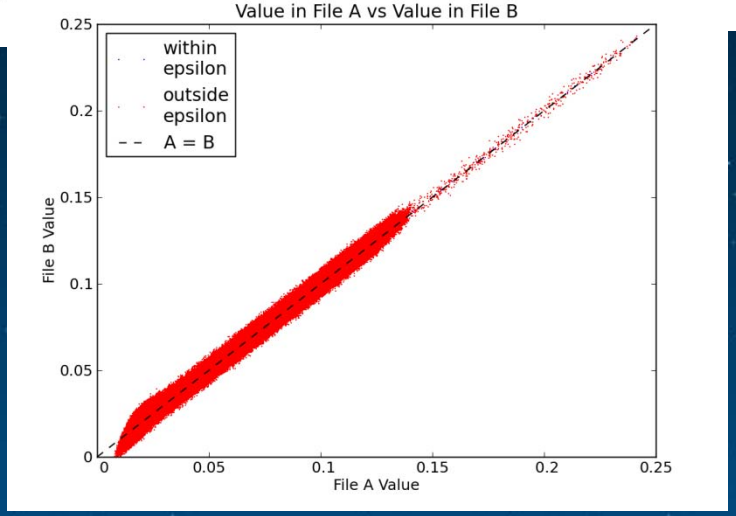
GRAFIIR Instrument Waiver Analysis

Visible Band Noise Waiver (SNR 1000:1 vs. 300:1)

Glance Output







GRAFIIR Instrument Waiver Analysis

Visible Band Noise Waiver

Summary

- The ABI could not meet the specifications for noise in band 2 (0.64um).
- The aerosol AWG team provided analysis also used in the decision-making process.
- Based on visualization and product analysis, it was deemed the waiver could be accepted.

GRAFIIR Summary

- Addressing the government's needs for ABI waiver analysis.
  - Integrated Modeling & Simulation Master Plan
- Connecting the dots with visualization, imagery, and product processing.
  - McIDAS-V for visualization
  - netCDF and HDF file formats
  - AIT Framework output
- Statistical and visual analysis through Glance

GRAFIIR Summary

- Implement a facility environment (leveraging GEOCAT and the AIT "Framework") to allow easy and consistent use of AWG proxy data and product algorithms.
  - Potential to test output from vendor's instrument model in AWG algorithms.
- Design an efficient approach in coordination with ABI sensor and algorithm scientists to analyze the effects of sensor components such as noise, navigation, band to band co-registration, and other effects identified to be significant on product algorithms and imagery.
- Assist the government's response to ABI instrument waivers by providing statistical analysis, reports, and imagery.

End to End Testing Using GRAFIIR

Thank you for your patience

Please continue to enjoy your lunch

Any question is welcome!