NOAA's Geo-Polar Blended SST Analysis

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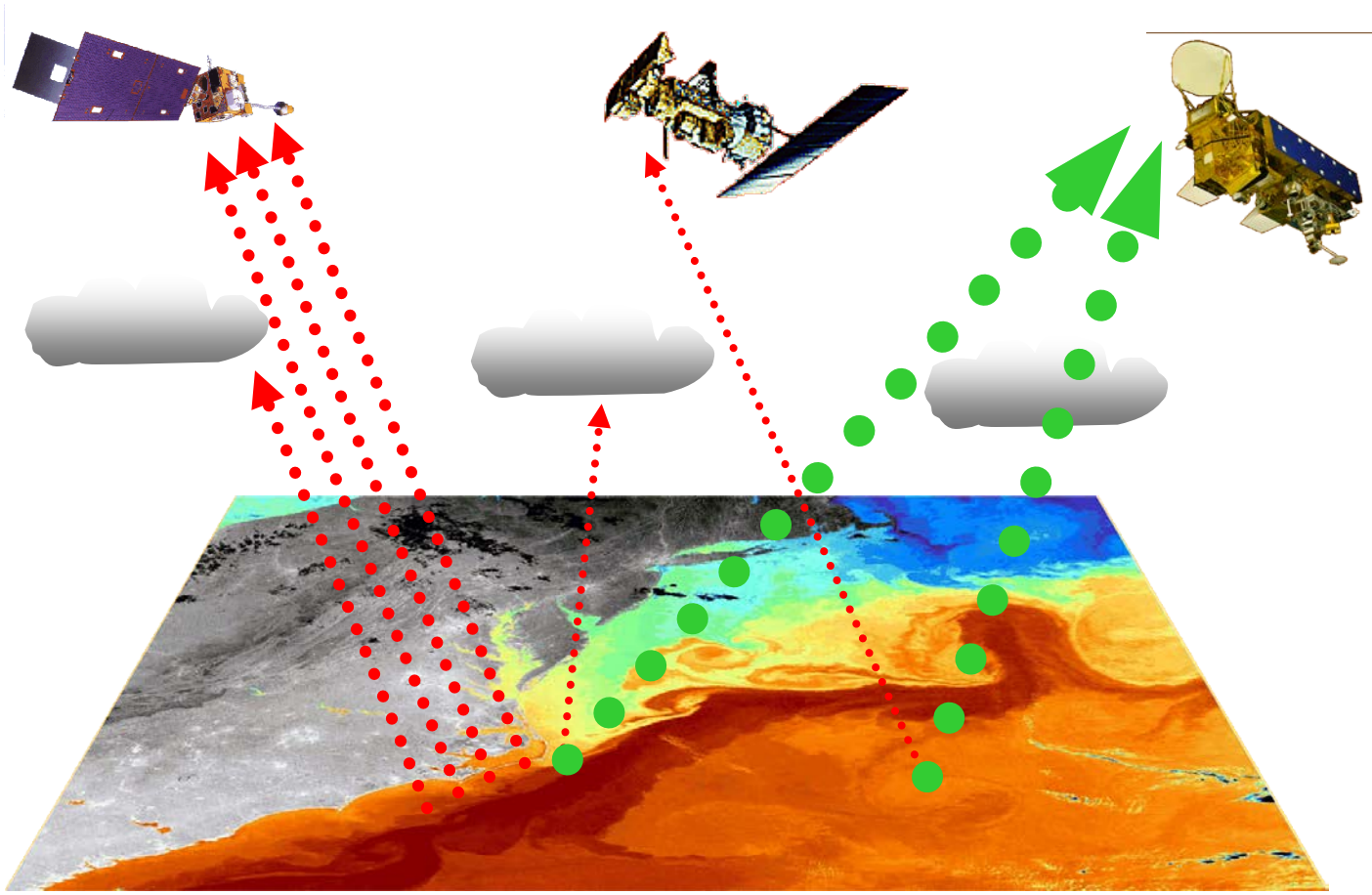
[3]NOAA/OAR/ESRL

[4]University of Reading, UK

[5]NOAA/NESDIS/OSPO

Maximize strengths – minimize weaknesses



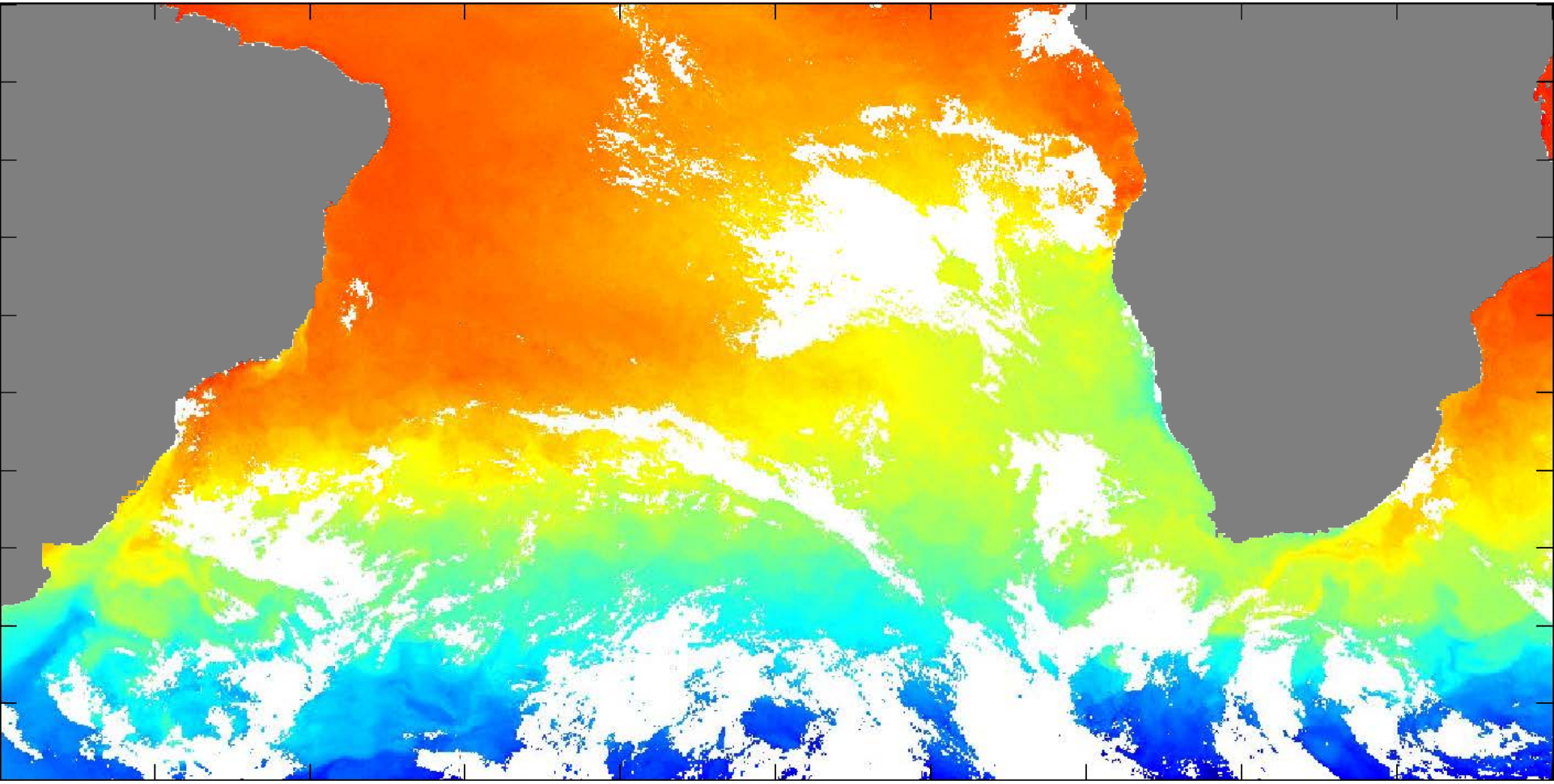
POES IR has **high spatial resolution**

GOES IR has **high temporal resolution**

Microwave has **all-weather capability**

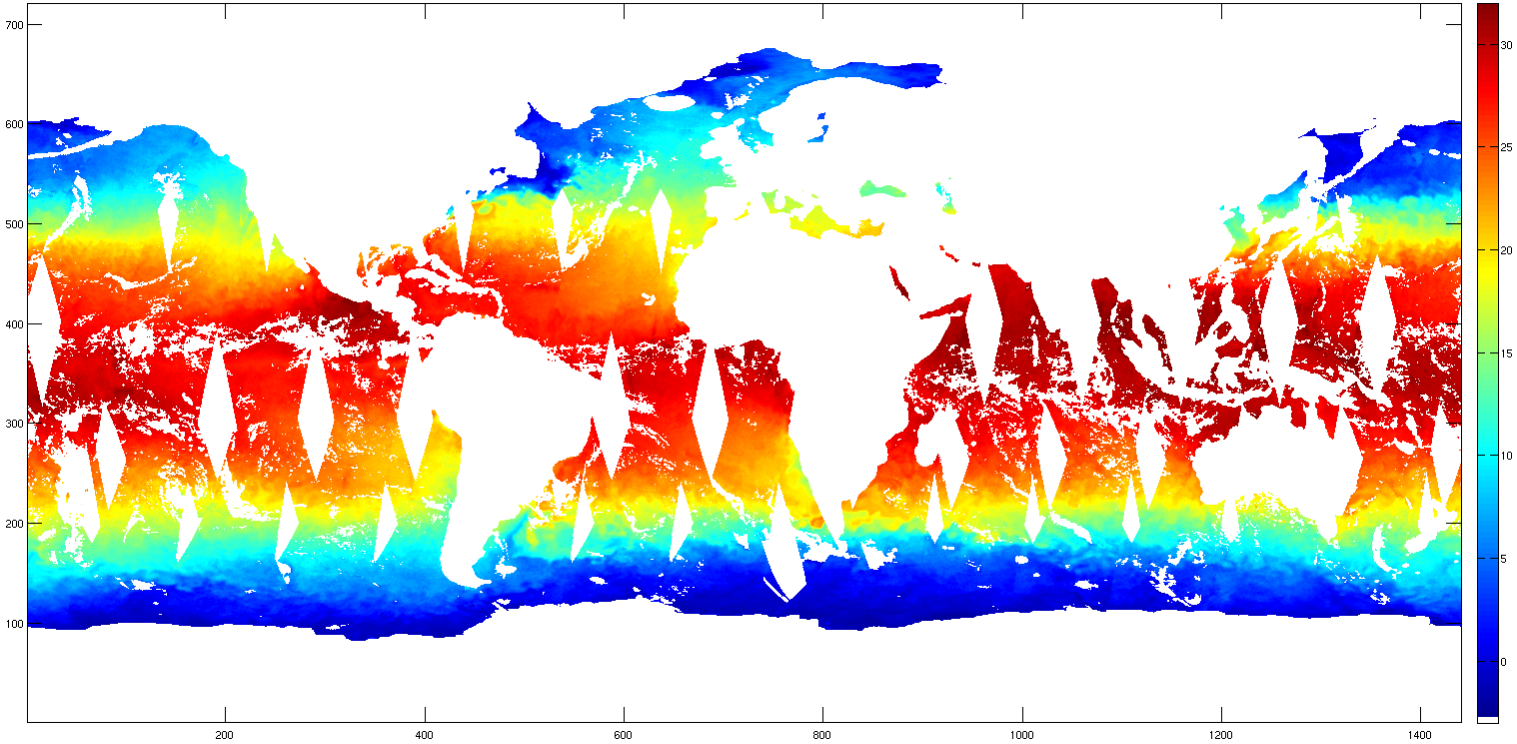
Combine to obtain the **optimal SST analysis**

Combined coverage



Geo-SST dominates low-to-mid latitudes

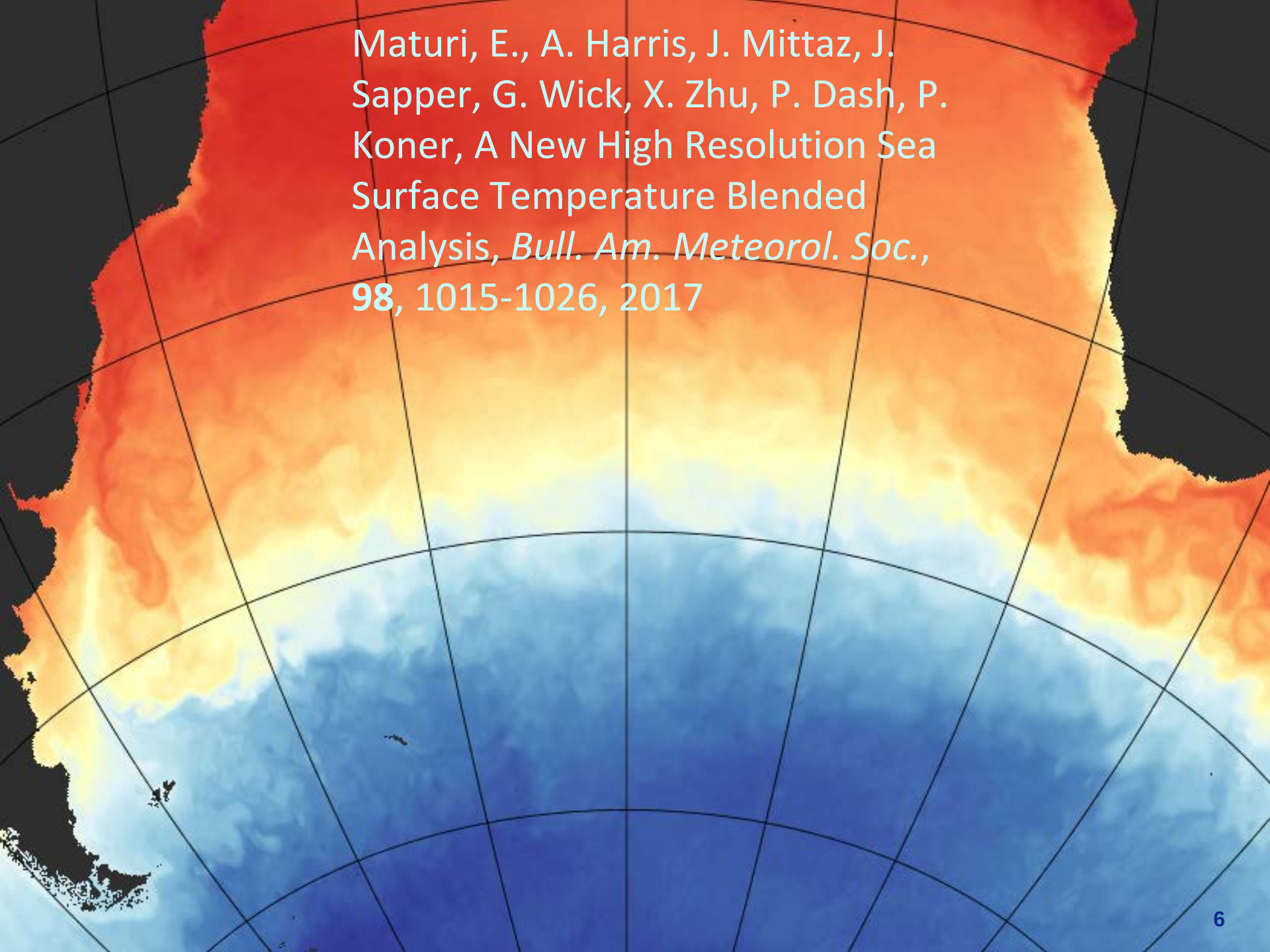
Data Coverage – AMSR-2



- Valid SST data coverage from AMSR-2 for 2014-05-01
  - » Improved coverage in both Tropics and High Latitudes
  - » 3 days gives almost complete coverage away from land & ice

5-km Blended SST Analysis

- **Produced daily from 24 hours of Polar- & Geo-SST**
  - MetOp-B
  - GOES-E/W Imager
  - Meteosat-10 SEVIRI [Meteosat-8 over Indian Ocean]
  - Himawari-8 Imager
  - VIIRS
  - [AMSR-2]
  - **Does <u>not</u> use buoy data**
- **Multi-scale OI**
  - Mimics Kalman Filter **(***Khellah et. al., 2005***)**
- **3 stationary priors**
  - Short, intermediate and long correlation lengths
  - Mimic non-stationary prior while preserving rigor
  - Interpolation of resultant analyses based data density
    - ➢ **<u>Allows fine resolution where possible without introducing noise</u>**

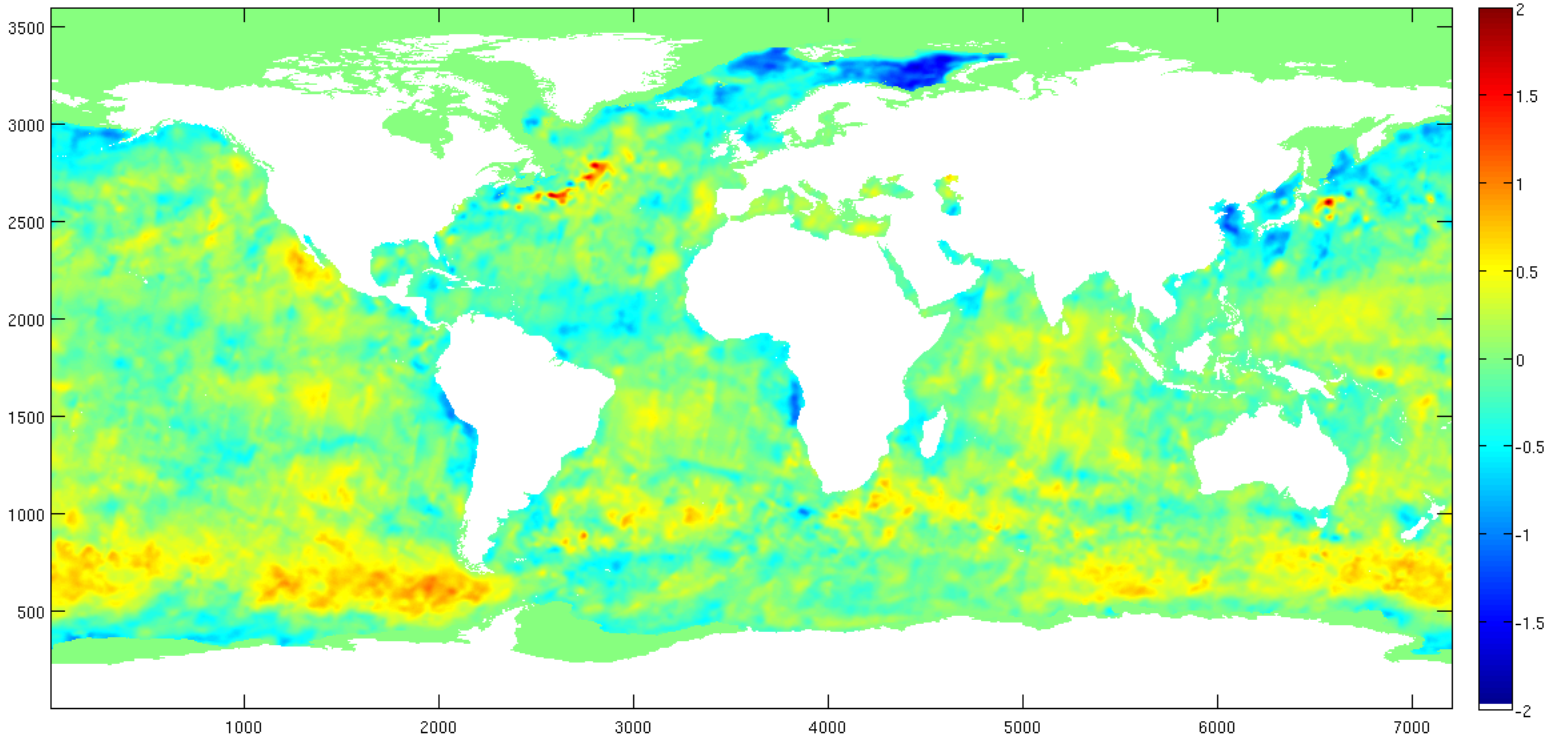


Maturi, E., A. Harris, J. Mittaz, J. Sapper, G. Wick, X. Zhu, P. Dash, P. Koner, A New High Resolution Sea Surface Temperature Blended Analysis, *Bull. Am. Meteorol. Soc.*, **98**, 1015-1026, 2017

AMSR-2 SSES Bias

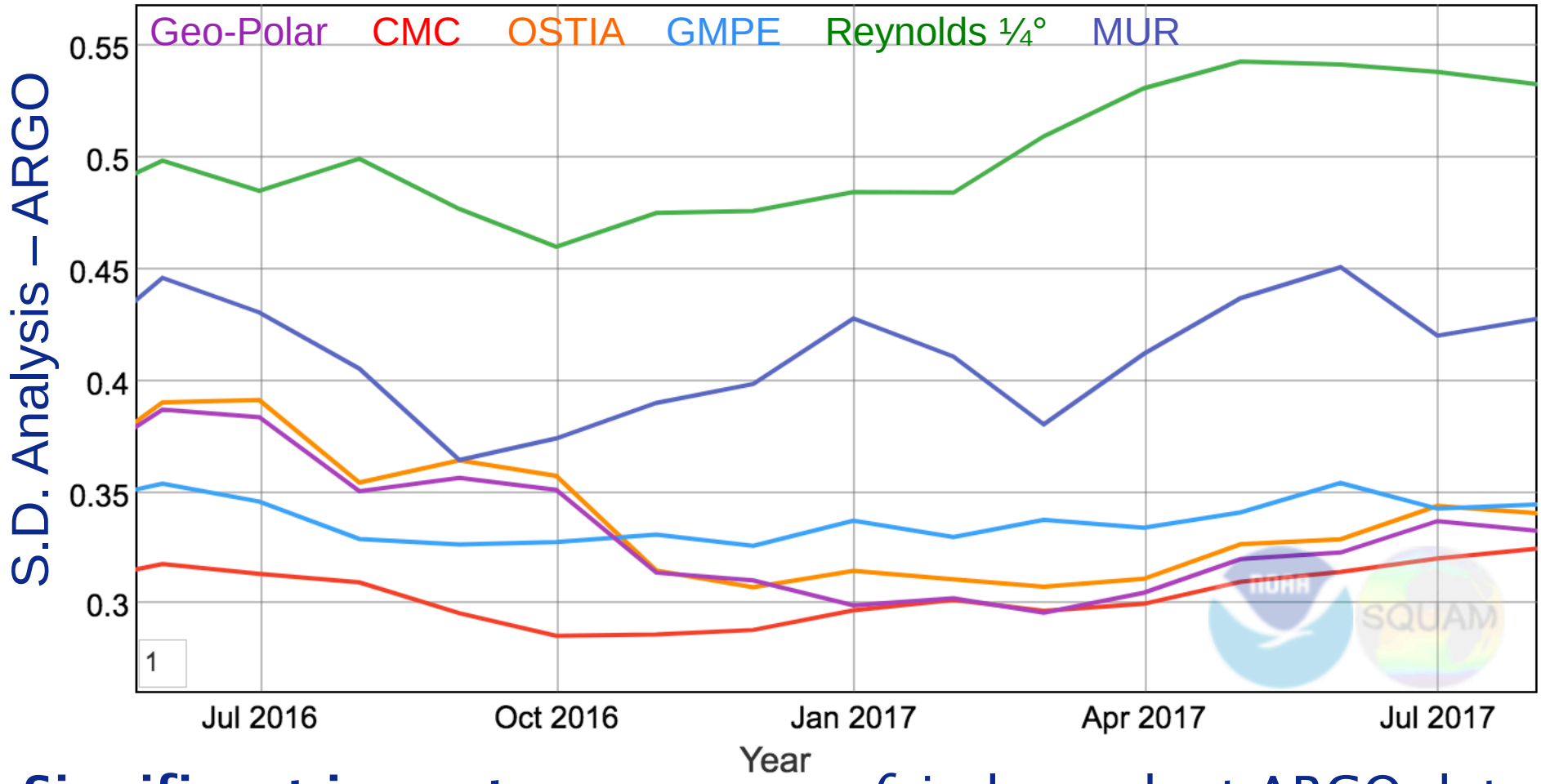
- **Lookup table based on incidence angle**

With SSES Bias Adjustment



VIIRS data

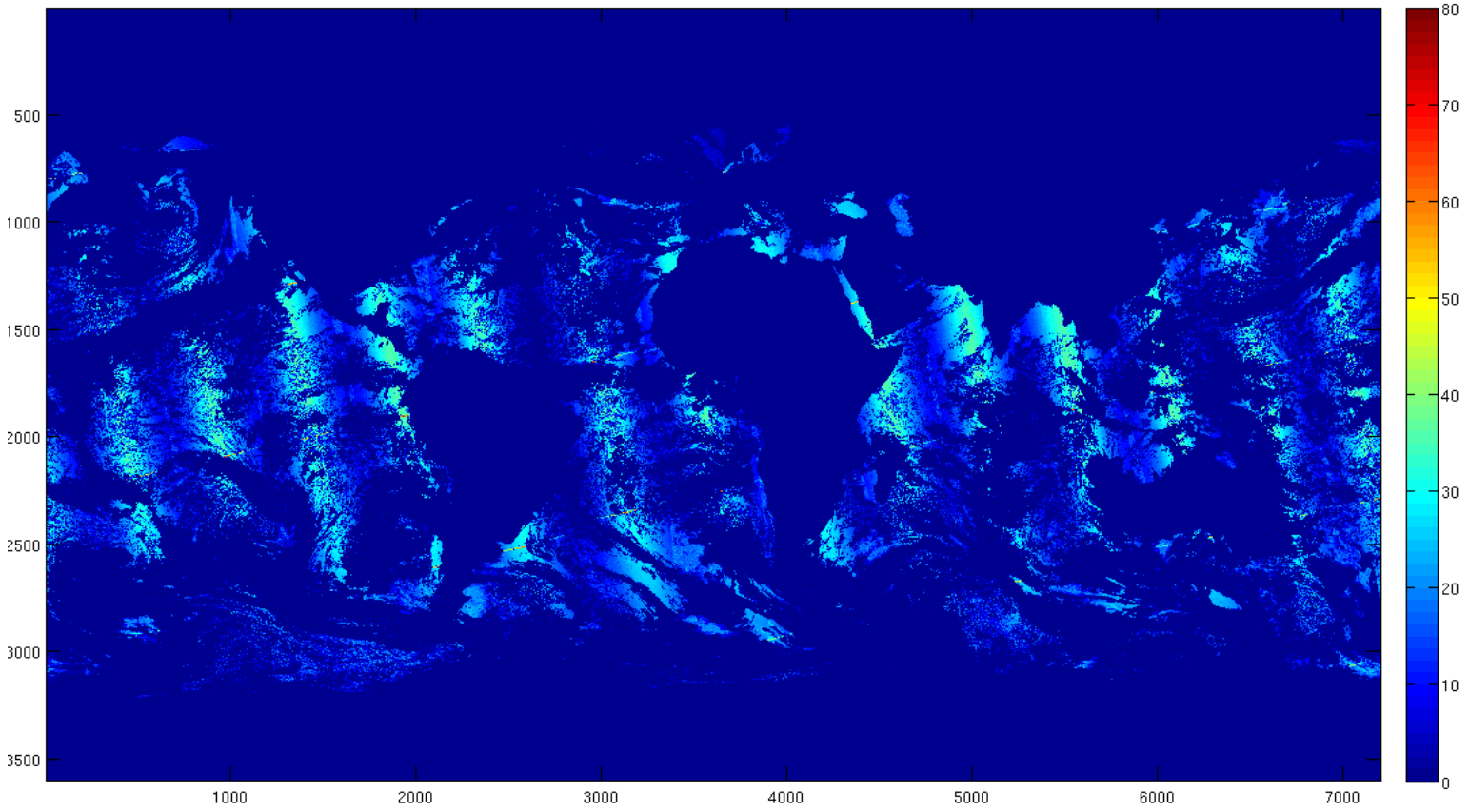
- **VIIRS incorporated into Geo-Polar Blended 5-km global SST analysis**



Significant impact on accuracy *cf.* independent ARGO data

VIIRS coverage

- Coverage is improved w.r.t. MetOp AVHRR



ACSPO AVHRR coverage

NOAA Coral Reef Watch

NOAA Satellite and Information Service
National Environmental Satellite, Data, and Information Service (NESDIS)

DOC > NOAA > NESDIS > STAR > CRW

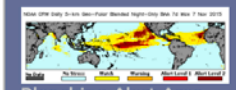
Coral Reef Watch

CRTF | CRCP | CREIOS | CoRIS

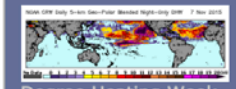
CRW Home

Products Overview

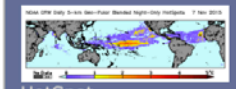
Near-Real-Time Data
(5-km Resolution)



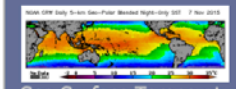
Bleaching Alert Area



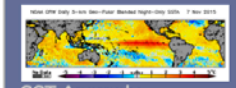
Degree Heating Week



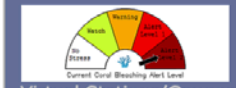
HotSpot



Sea Surface Temperature



SST Anomaly



Virtual Stations/Gauges

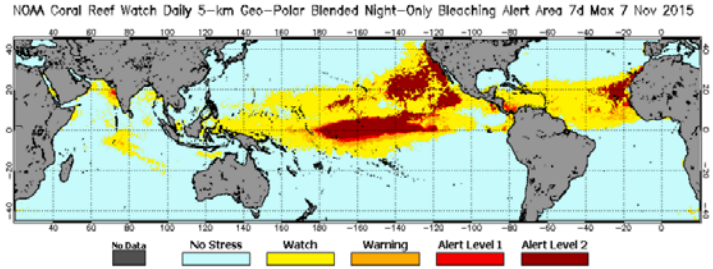
Near-Real-Time Data
(50-km Resolution)

Coral Reef Watch Satellite Monitoring

NOAA Coral Reef Watch is pleased to announce the release of its new Daily 5-km Satellite Coral Bleaching Thermal Stress Monitoring Product Suite. The 5-km products are accessible directly below, in the left navigation bar, and throughout this website. Access to our heritage suite of operational 50-km satellite monitoring products will still be possible for the next several months. We encourage all of our users to look over the new 5-km products and provide feedback to us at coralreefwatch@noaa.gov.

Click on buttons below image to change parameter; click on image to navigate to parameter's web page.

Switch to 50-km products ►



Alerts | HotSpot | DHW | SST | Anomaly | SST Trend | Outlook | Doldrums | Virtual Stations

El Niño bleaching patterns web page

The NOAA Coral Reef Watch program's satellite data provide current reef environmental conditions to quickly identify areas at risk for coral bleaching, where corals lose the symbiotic algae that give them their distinctive colors. If a coral is severely bleached, disease and partial mortality become likely, and the entire colony may die.

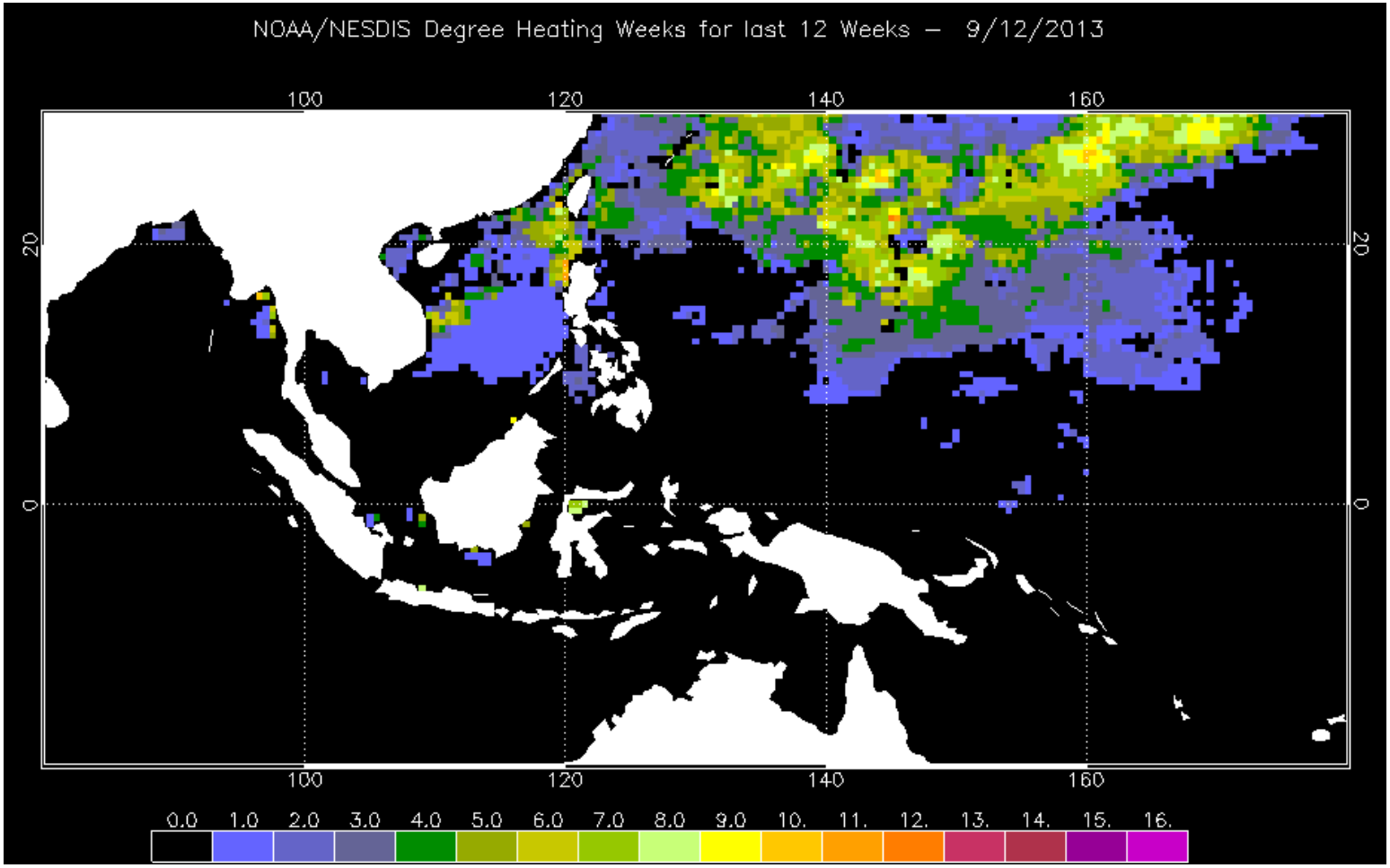
Continuous monitoring of sea surface temperature at global scales provides researchers and stakeholders with tools to understand and better manage the complex interactions leading to coral bleaching. When bleaching conditions occur, these tools can be used to trigger bleaching response plans and support appropriate management decisions.

Announcements

October 8, 2015: NOAA announces third ever global coral bleaching event on record! Read the NOAA press release here.

Coral Reef Watch Products

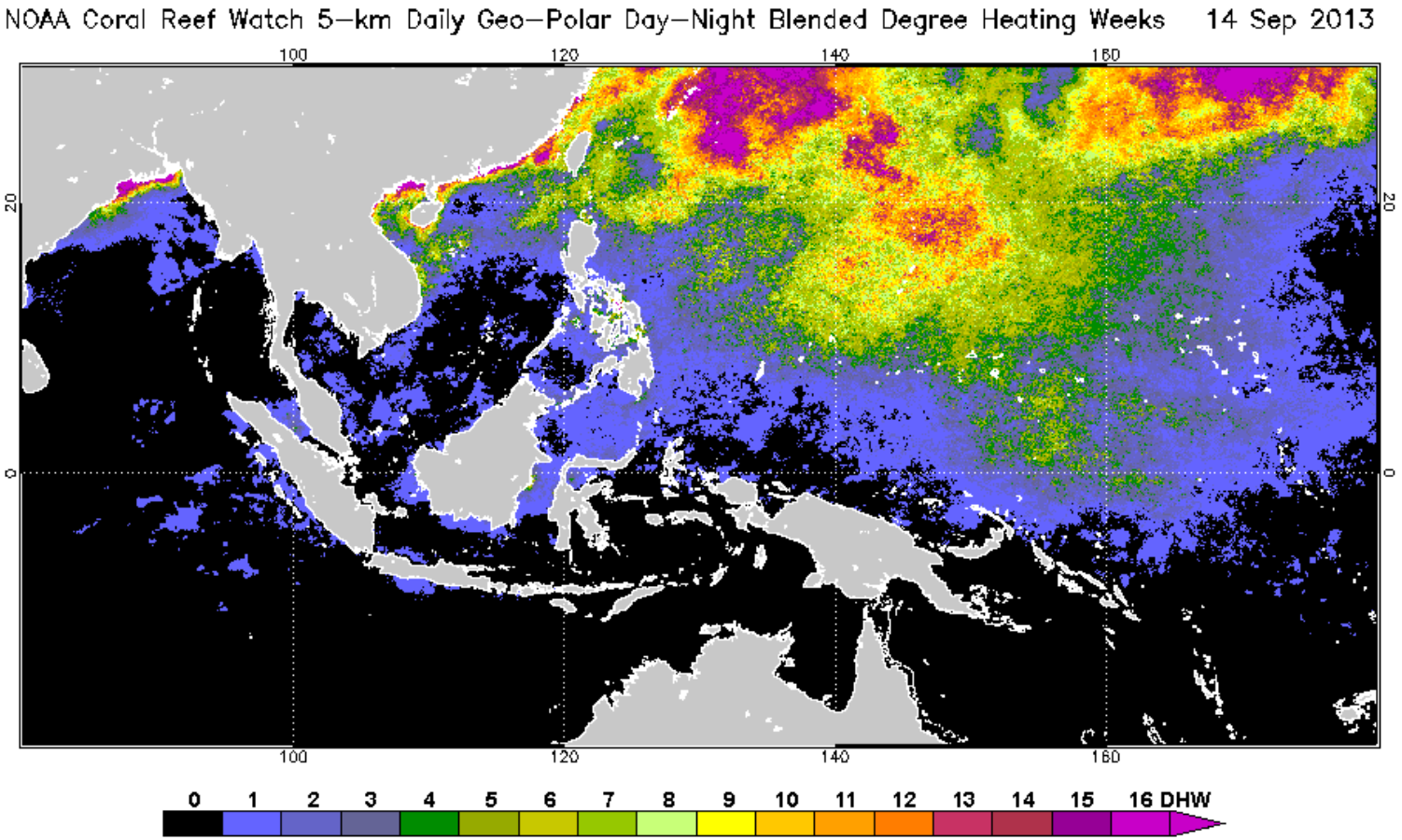
"Coral Triangle"



- **Accumulated thermal stress is predictor of bleaching risk**

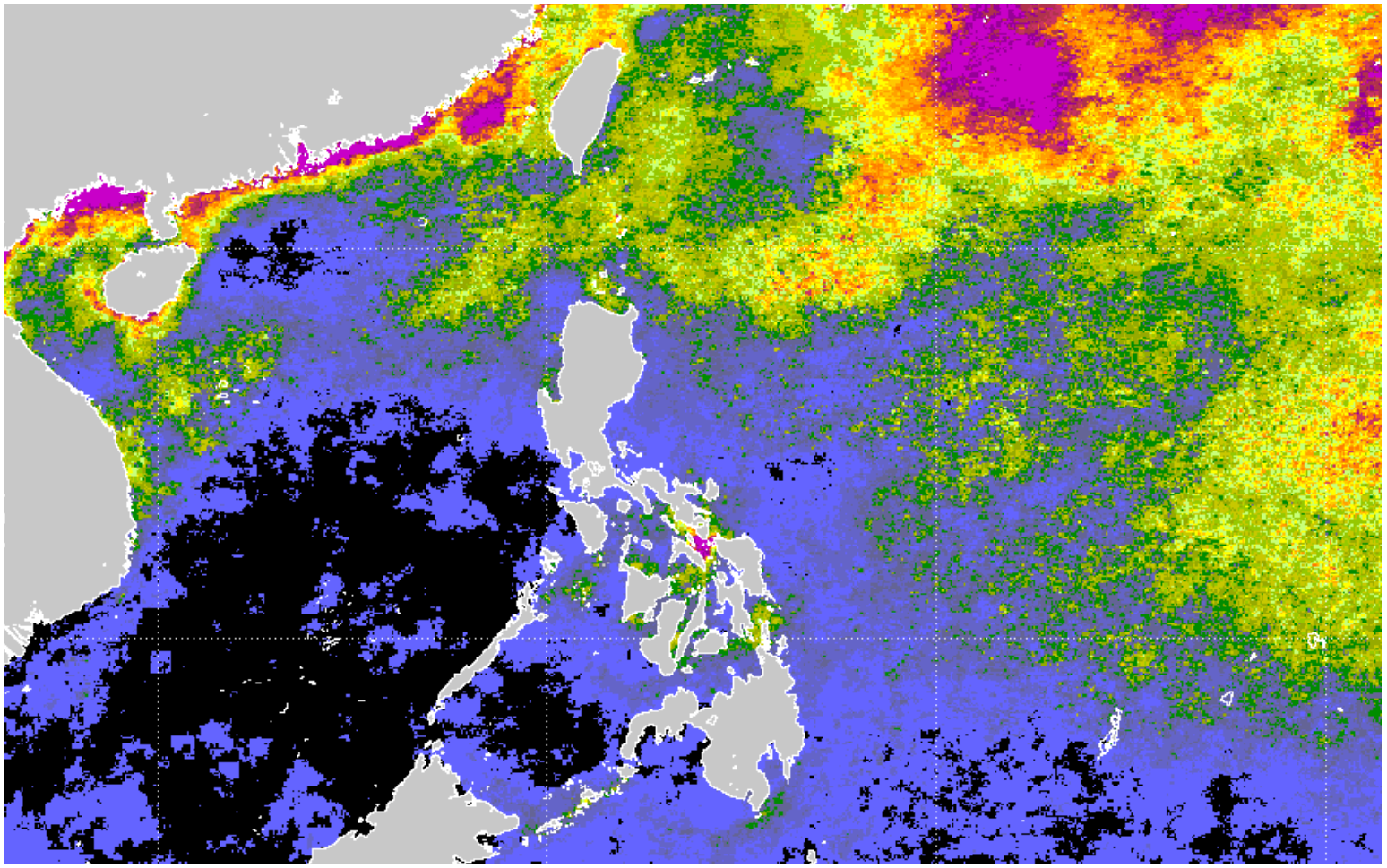
CRW Products based on 5-km SST

"Coral Triangle"



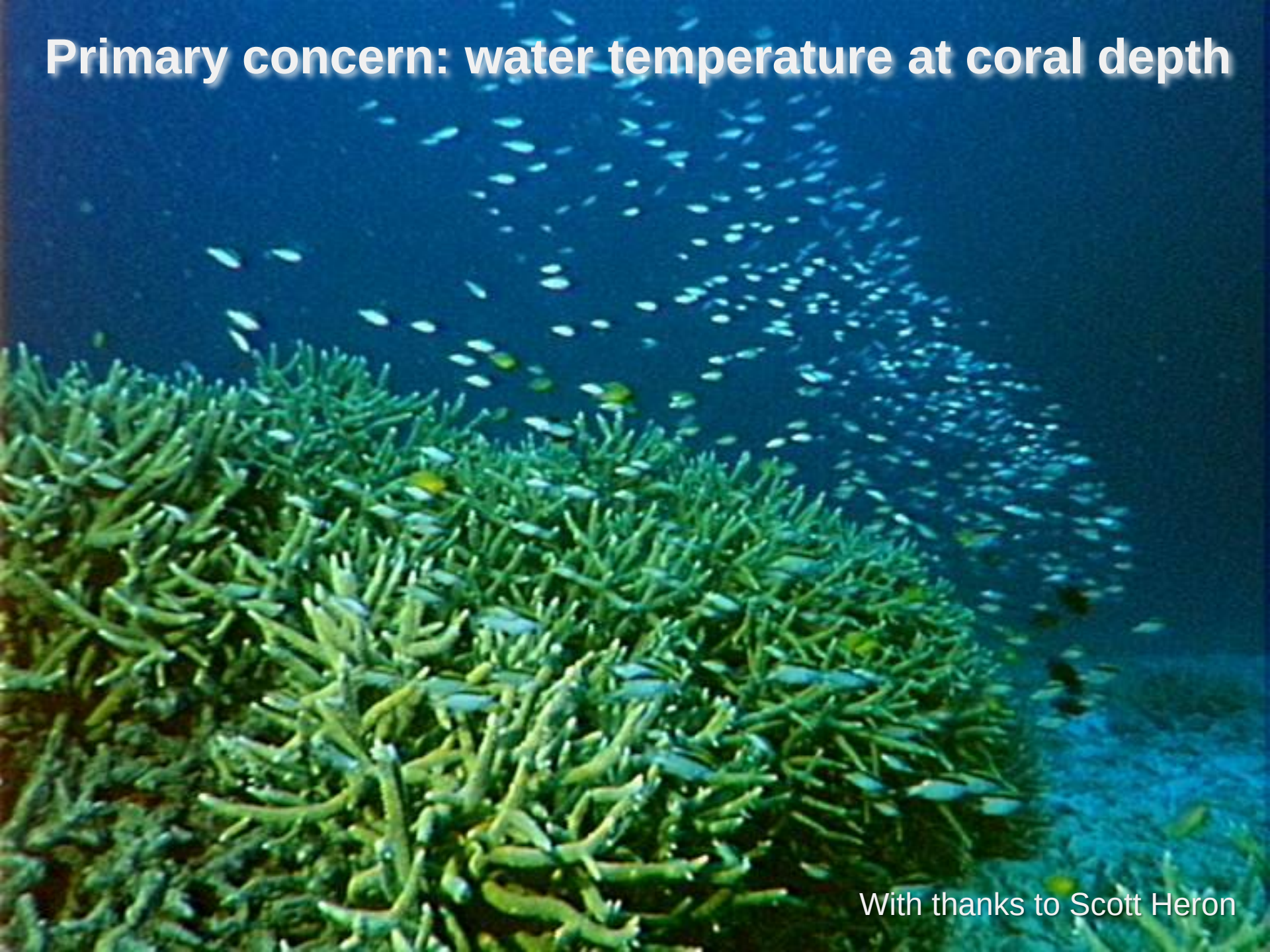
CRW Products – 5-km detail

"Coral Triangle"



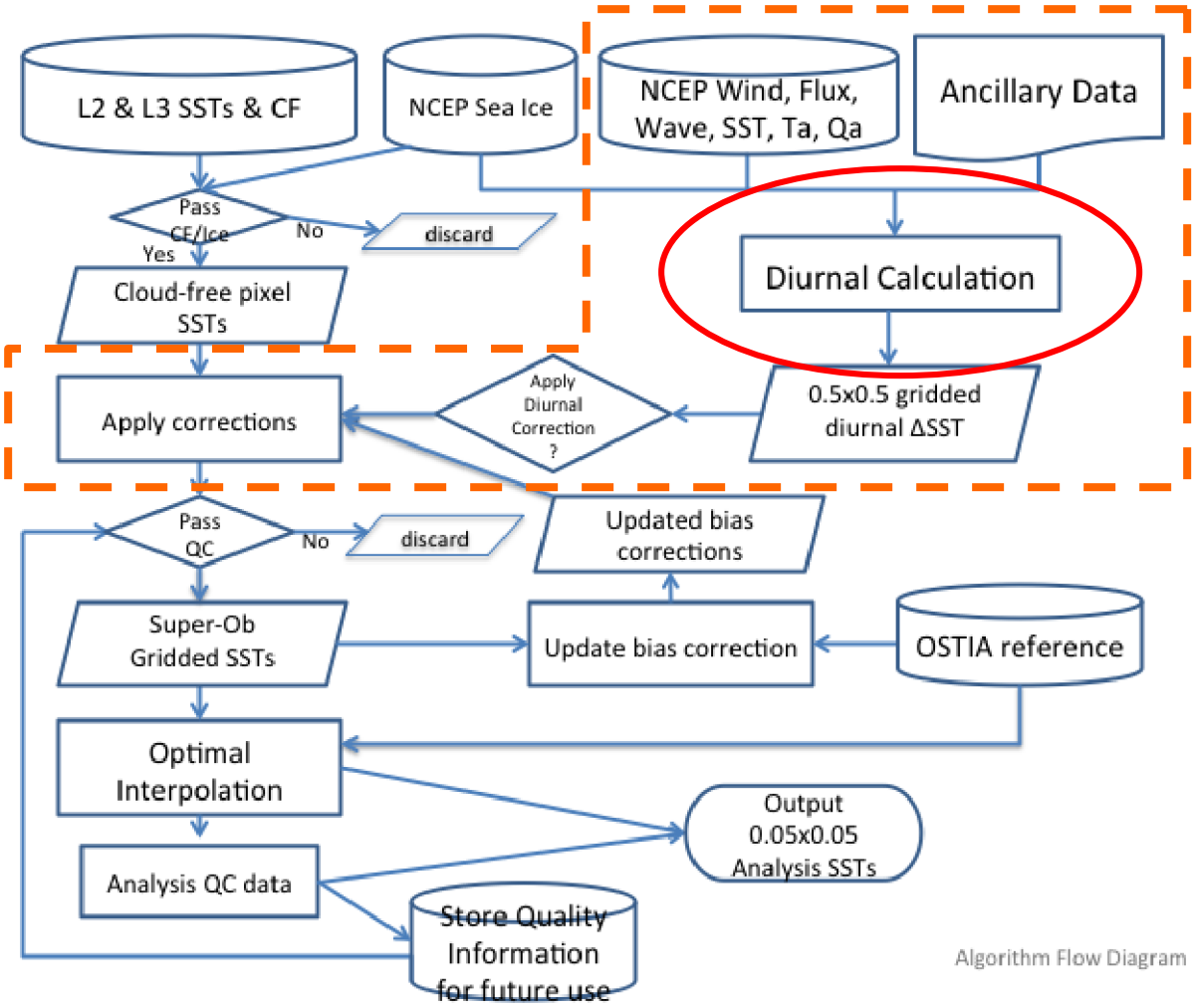
- **New analysis enables much greater precision, *e.g.* small fringing reefs**
- **However, <u>climatology is not derived from same dataset</u>**

Primary concern: water temperature at coral depth



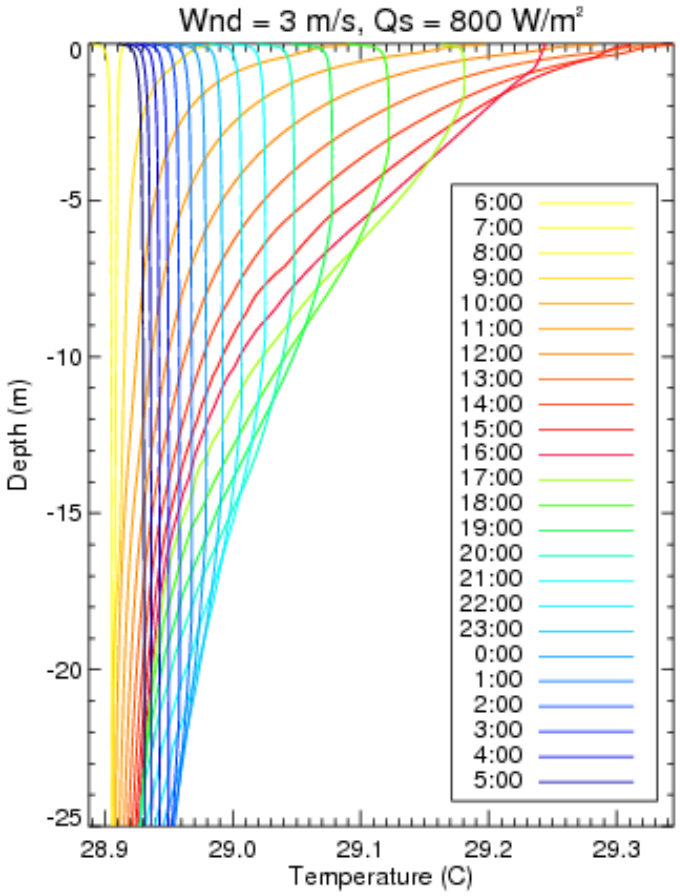
With thanks to Scott Heron

Including diurnal warming correction in SST analysis



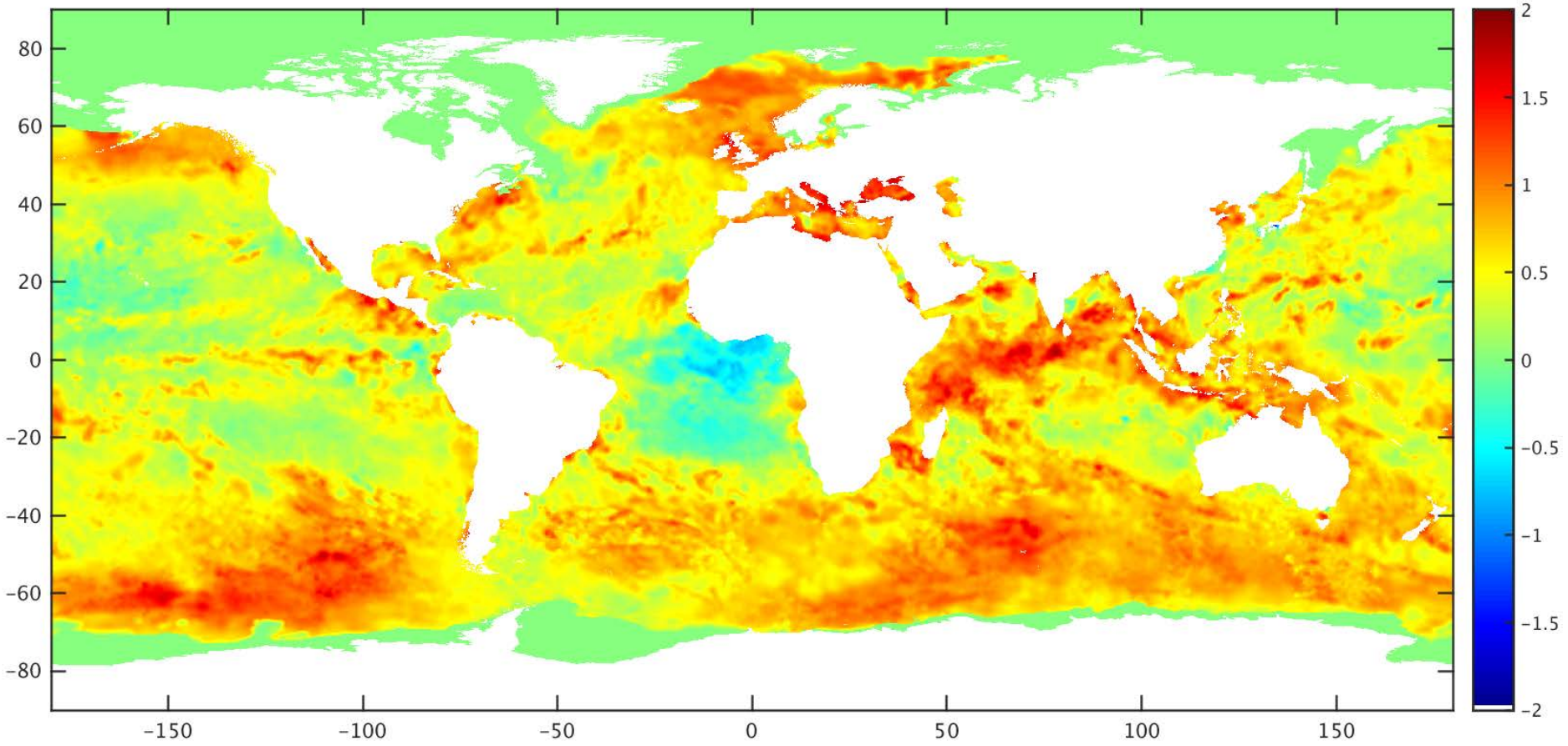
Diurnal Warming Correction – Sample Model Profile of Warming with Depth

- **Model simulates full vertical profile of warming**
  - Enables estimation of warming at arbitrary depth
  - Model presently run to a depth of 50 m
- **Time evolution of vertical temperature profile shown here for idealized forcing with a constant wind speed of 3 m/s and a peak insolation of 800 W/m²**



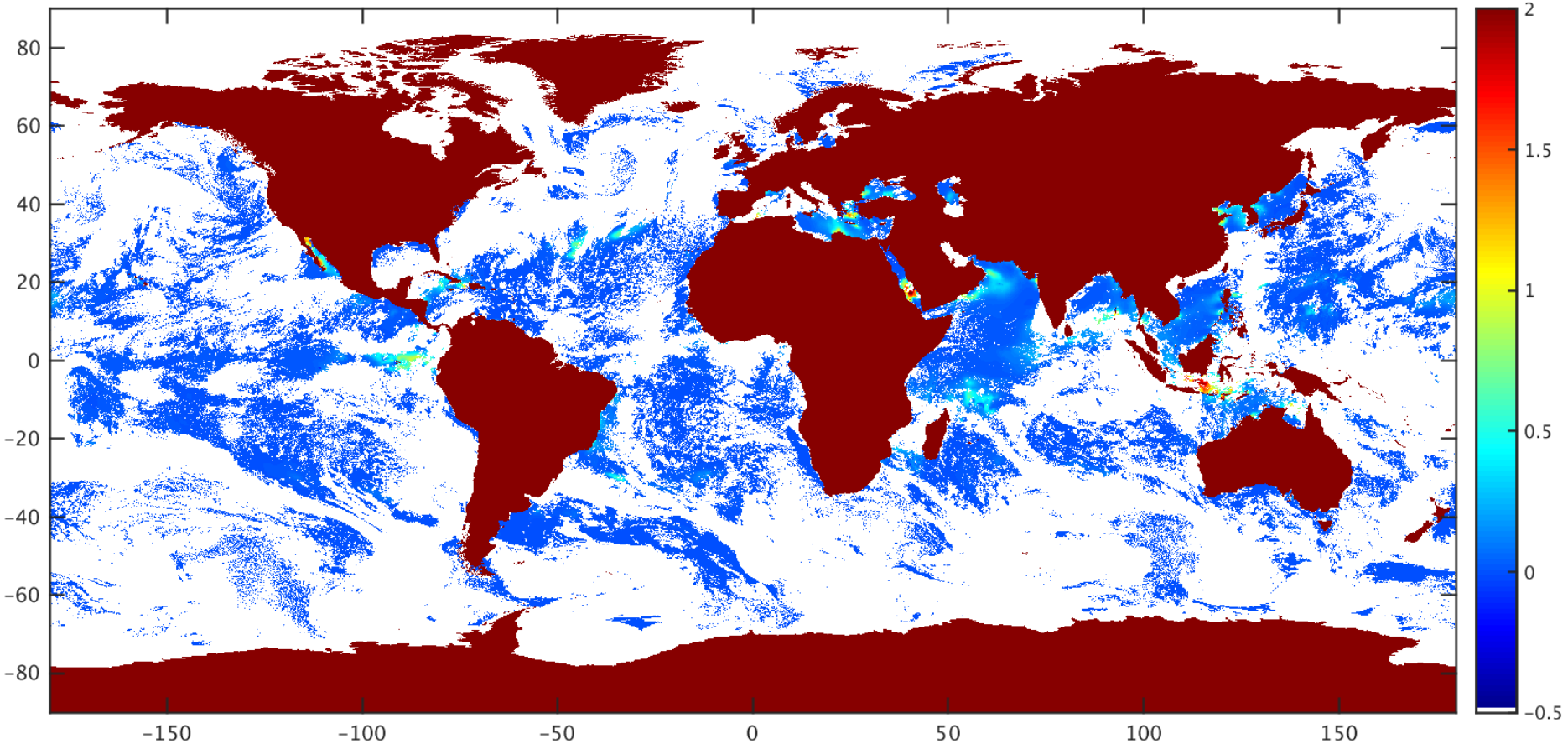
Magnitude of warming

Example bias correction field VIIRS daytime



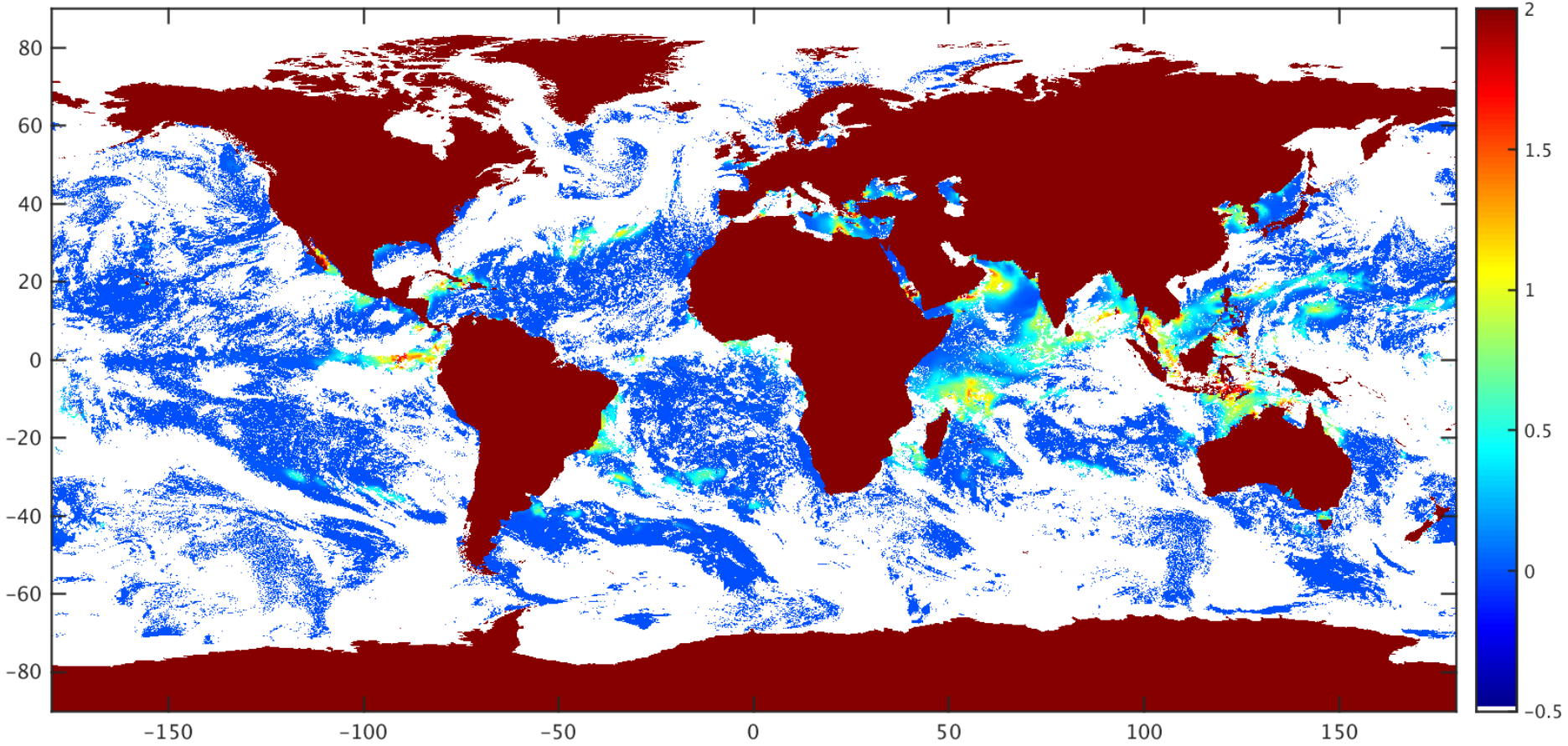
- **Bias correction usually <2 K**
- **Model response damped by including gustiness parameterization**
- **Why might the observed diurnal excursion be damped?**

Effect of diurnal adjustment on input data



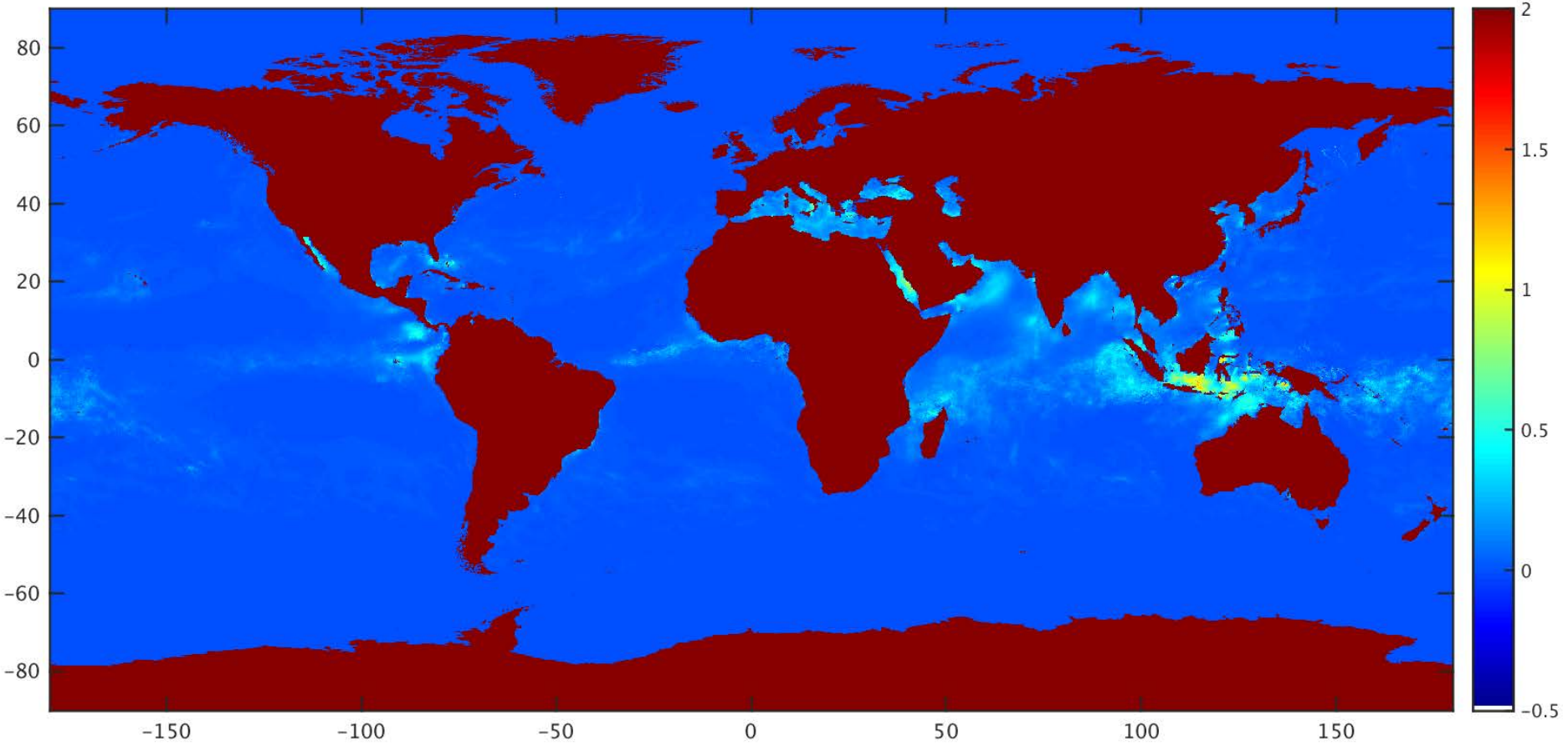
- **METOP adjustments are fairly modest**

Effect of diurnal adjustment on input data



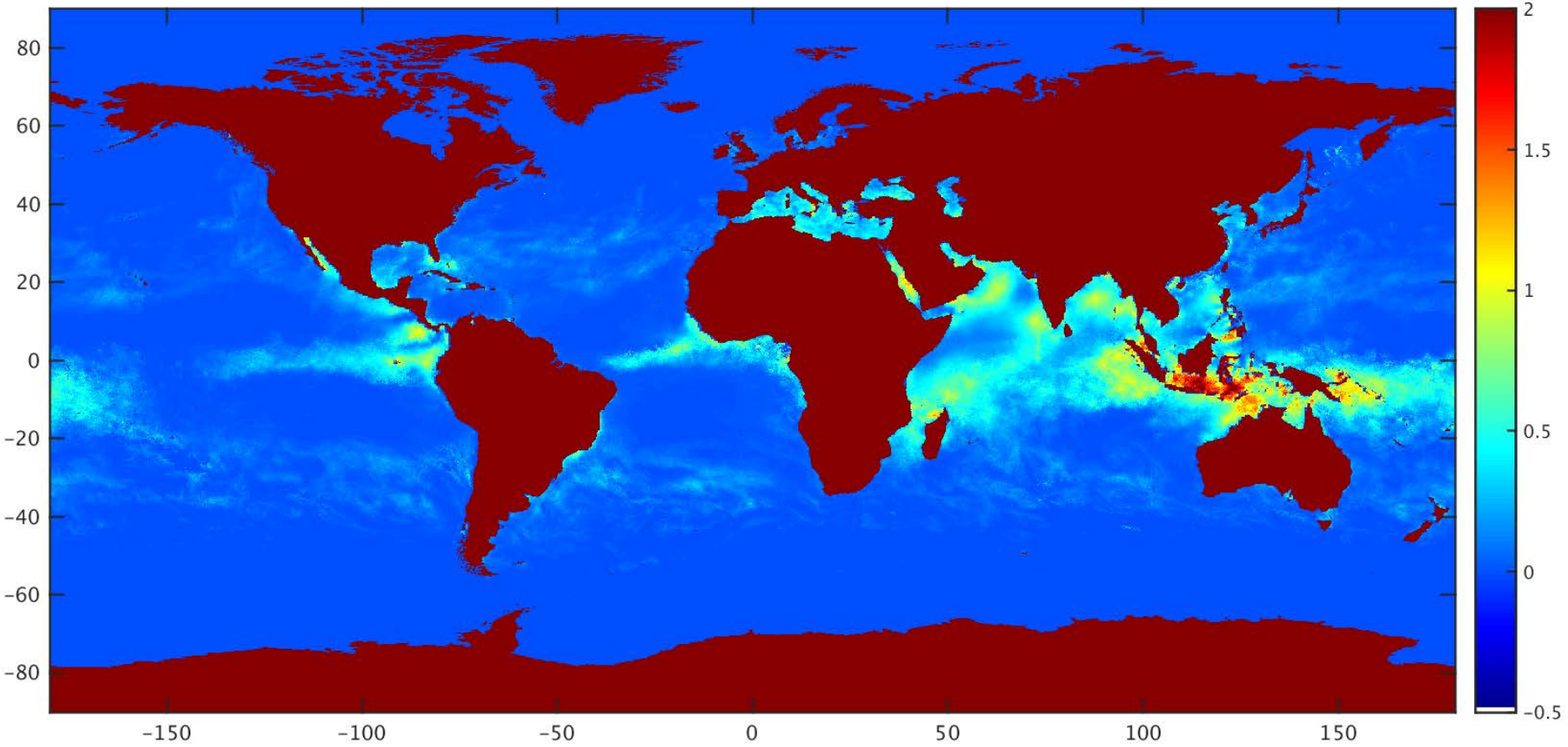
- **VIIRS adjustments are more significant**

Effect of diurnal adjustment on input data



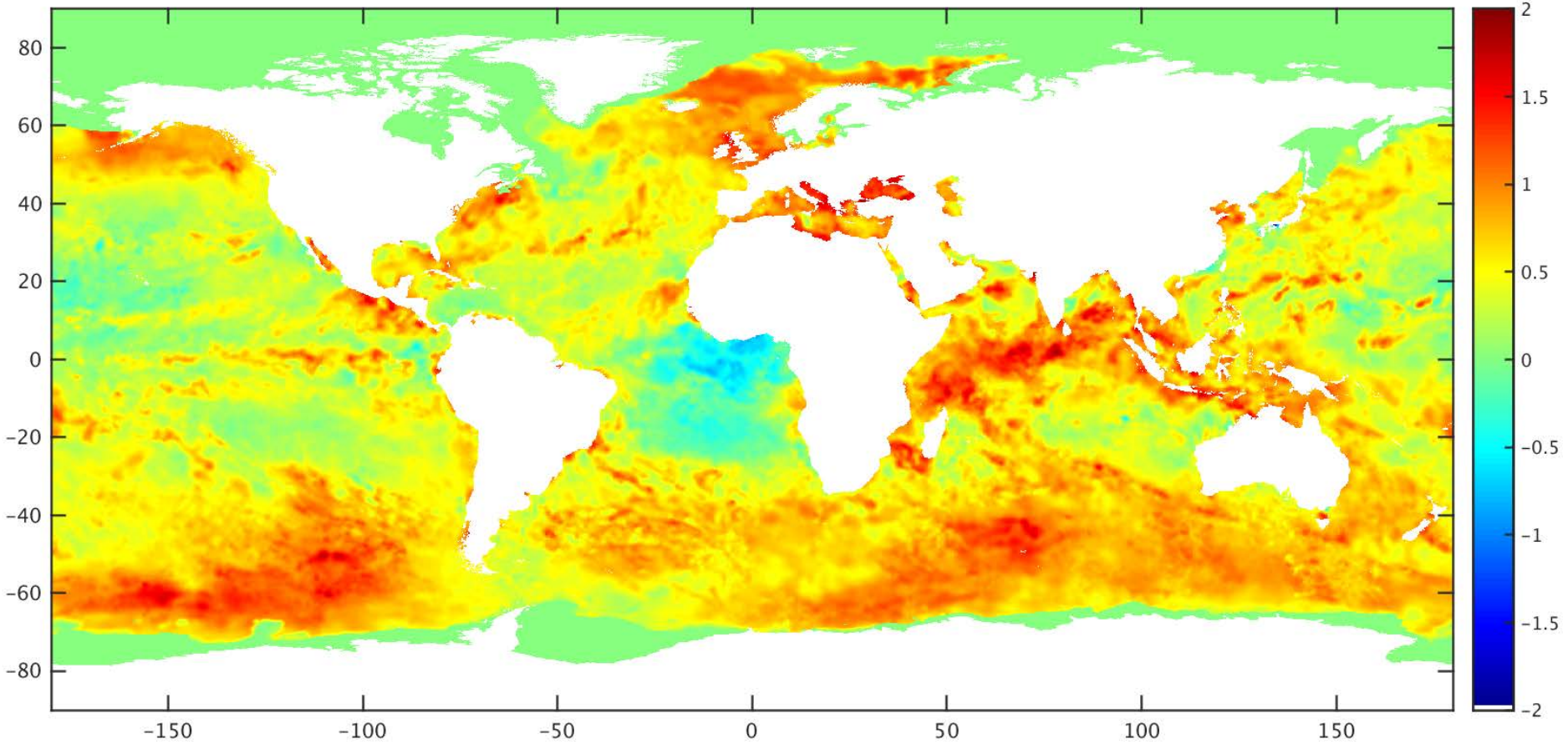
- **METOP monthly average for March 2016**

Effect of diurnal adjustment on input data



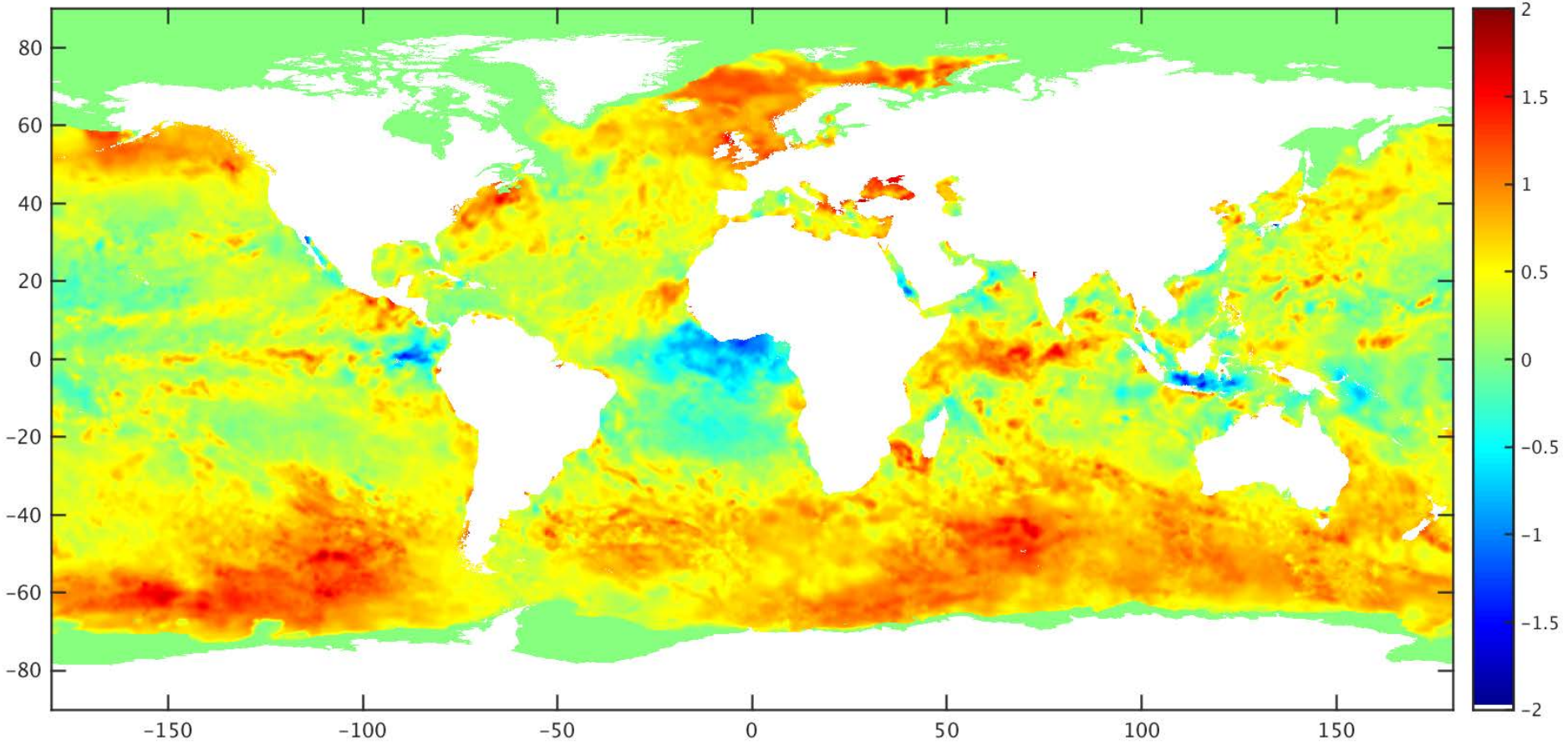
- **VIIRS monthly average for March 2016**

Effect of diurnal adjustment on bias correction



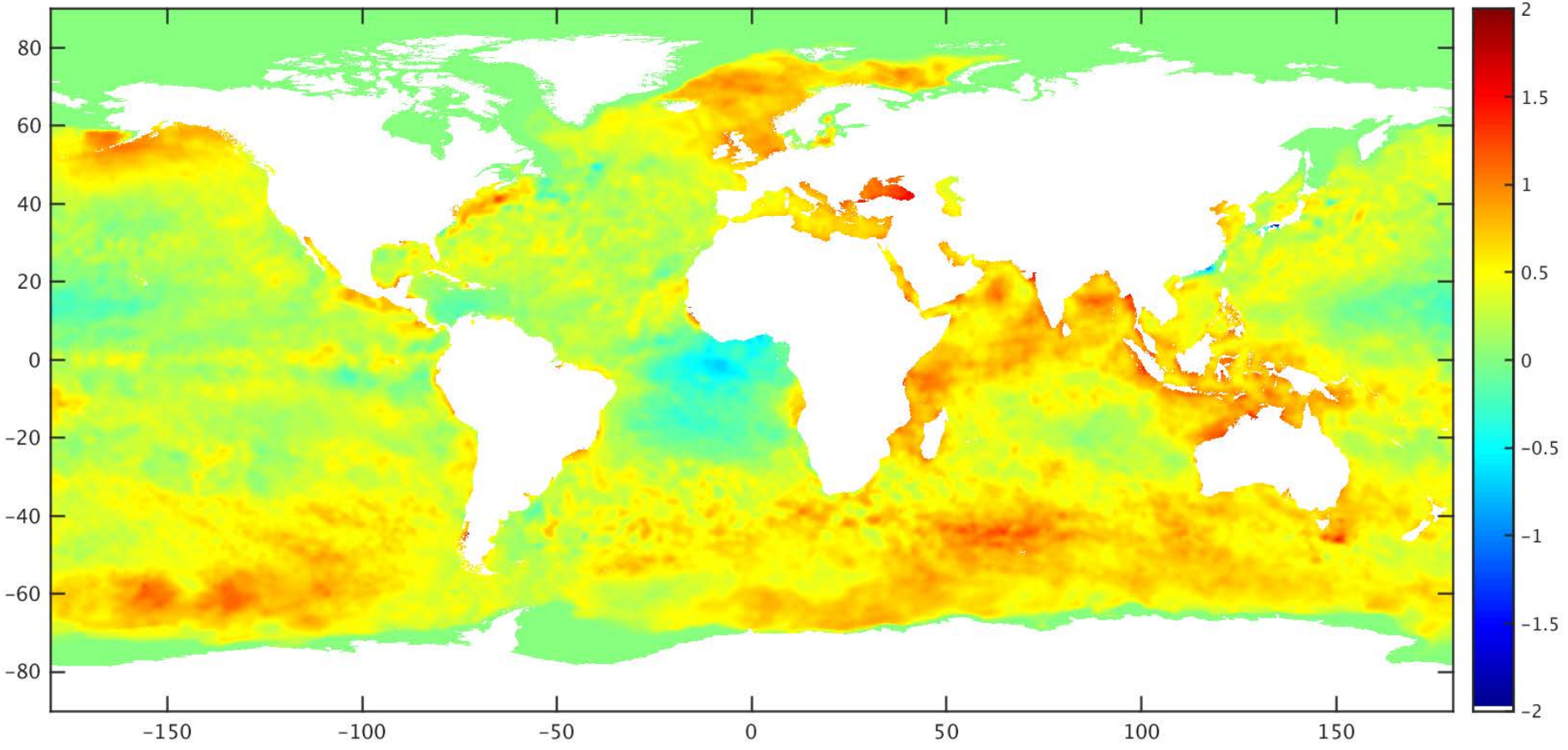
- **Unadjusted VIIRS (2016-03-21)**

Effect of diurnal adjustment on bias correction



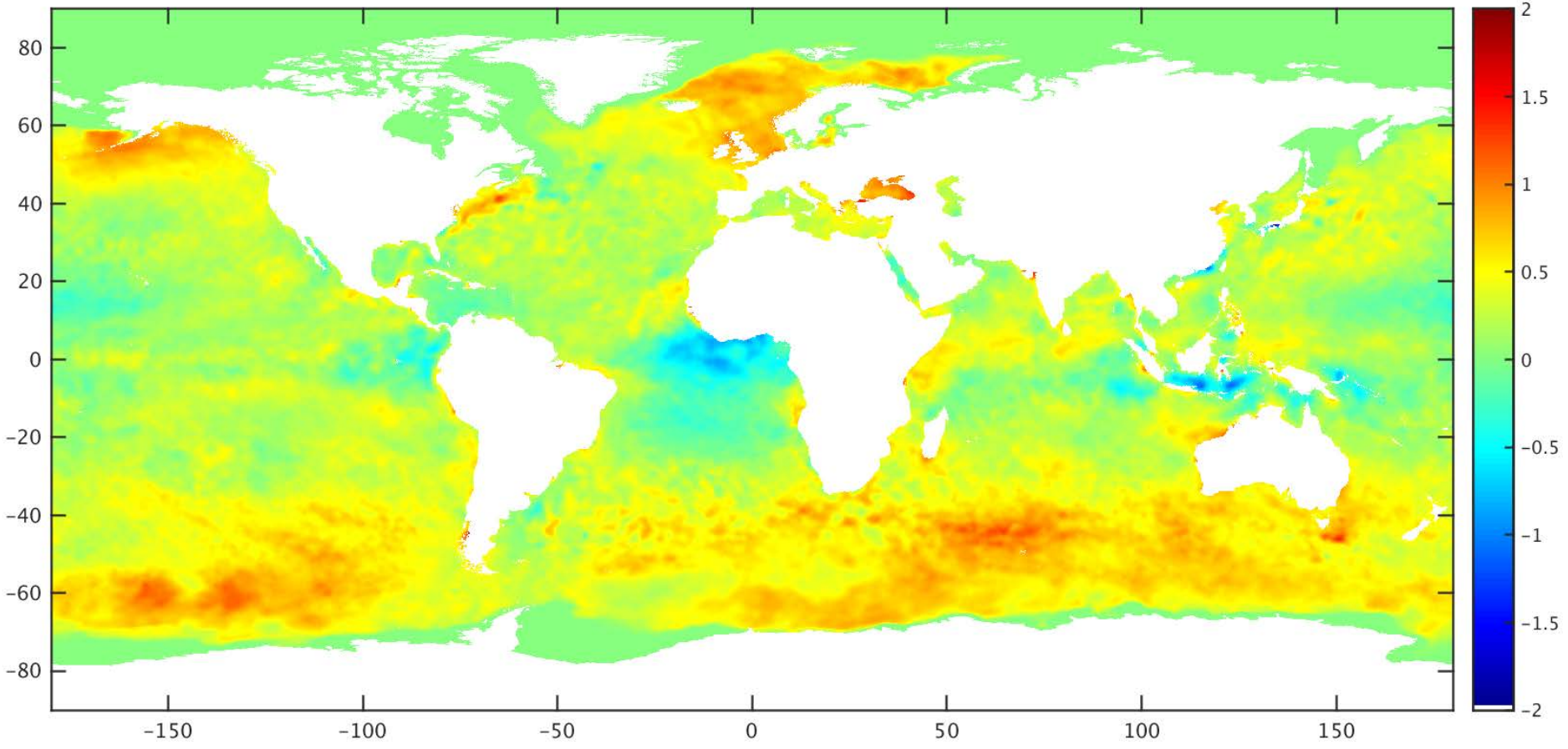
- **Diurnally adjusted VIIRS (2016-03-21)**

Effect of diurnal adjustment on bias correction



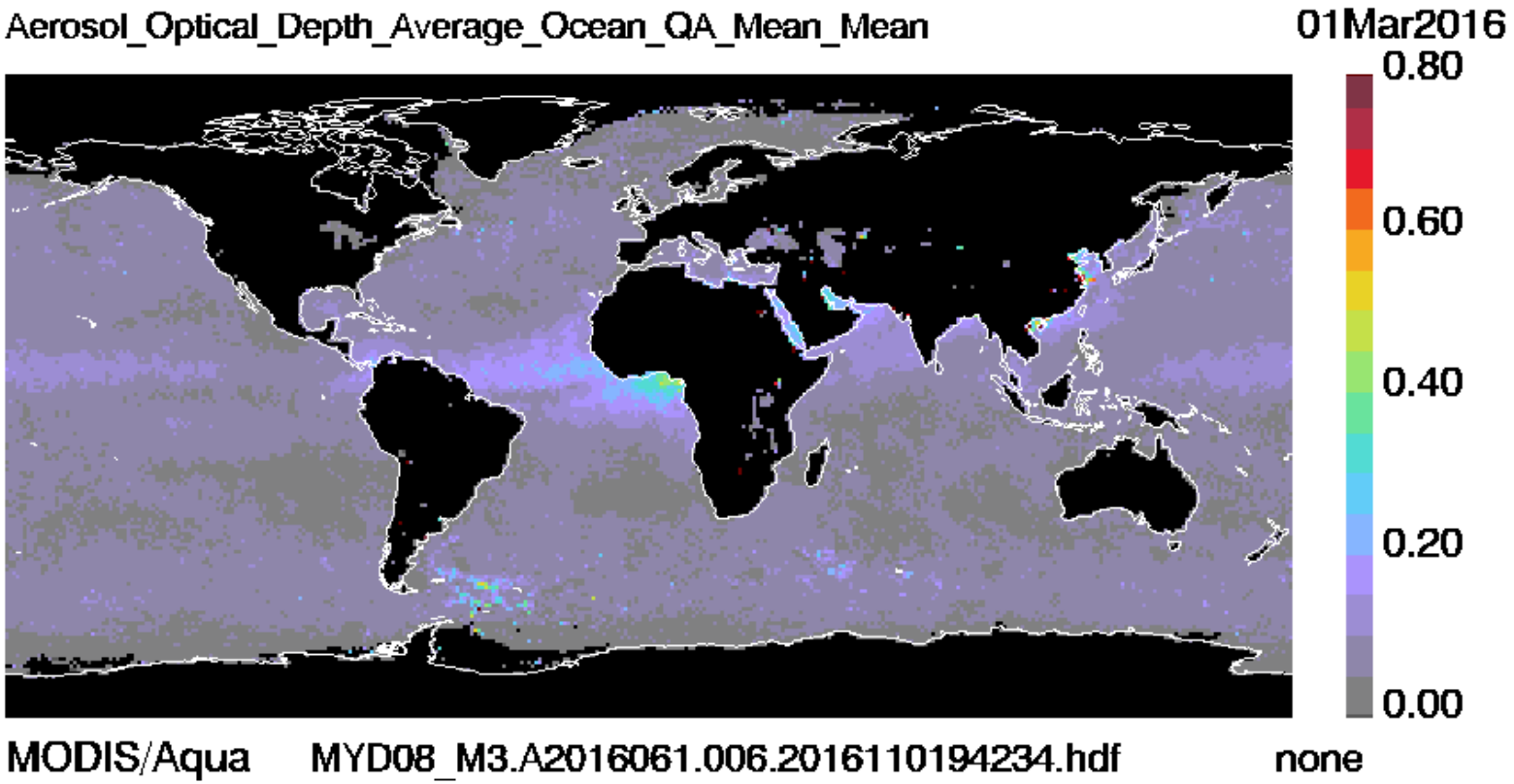
- **Unadjusted monthly average VIIRS**

Effect of diurnal adjustment on bias correction



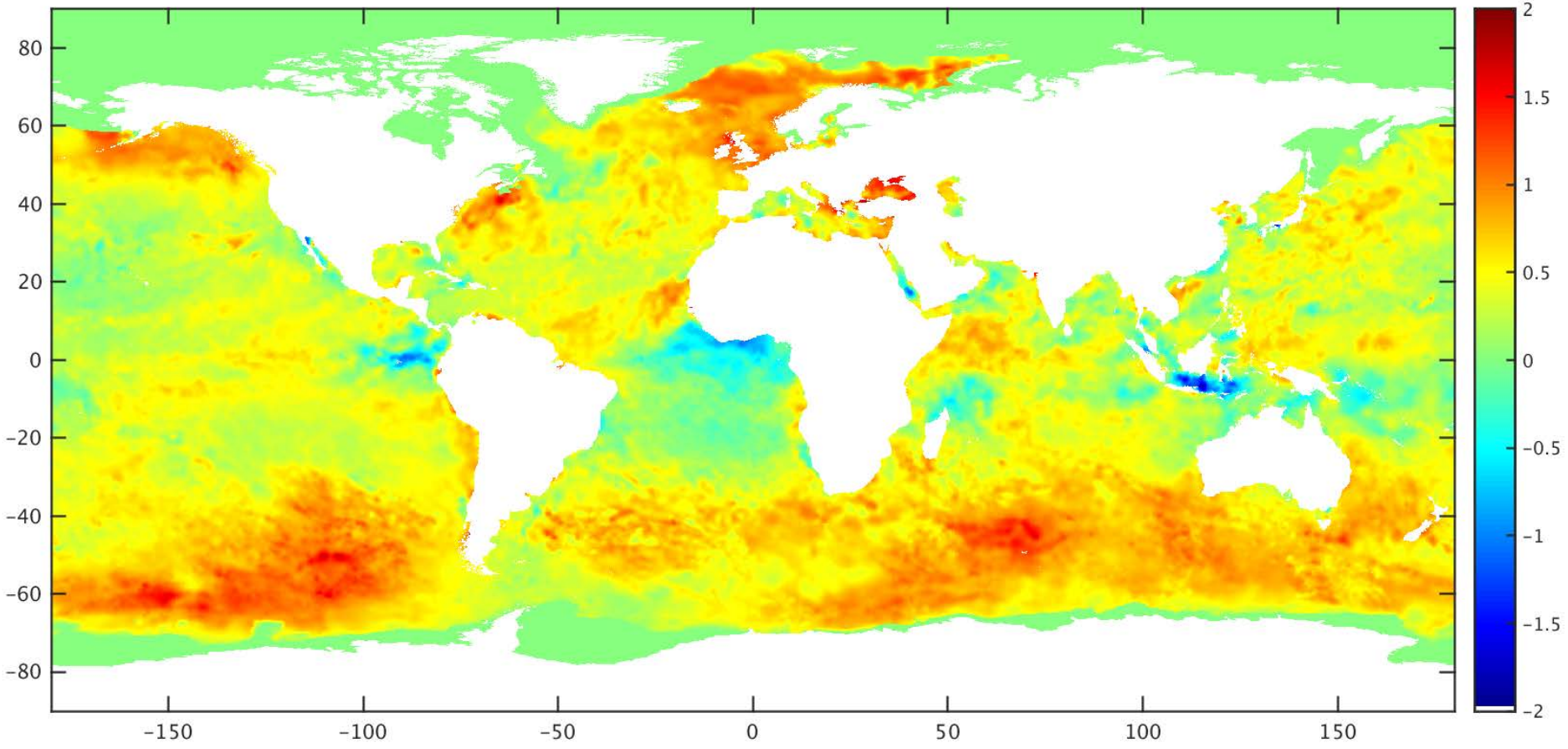
- **Diurnally adjusted monthly average VIIRS**

Retrieval biases – aerosol?



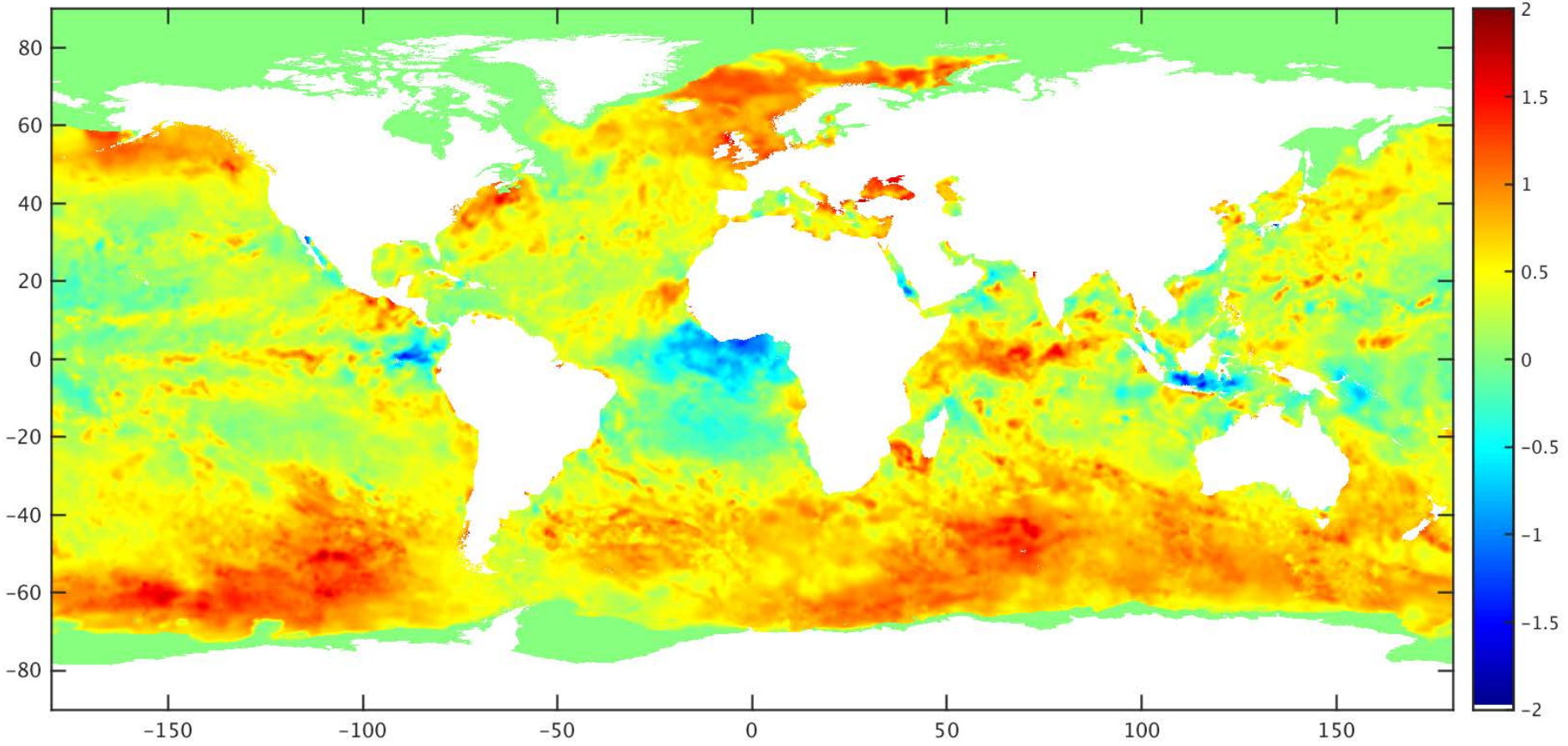
- **MODIS-A mean aerosol, Mar 2016**
- **Other atmospheric factors, *e.g.* water vapour loading**

Effect of diurnal adjustment on bias correction



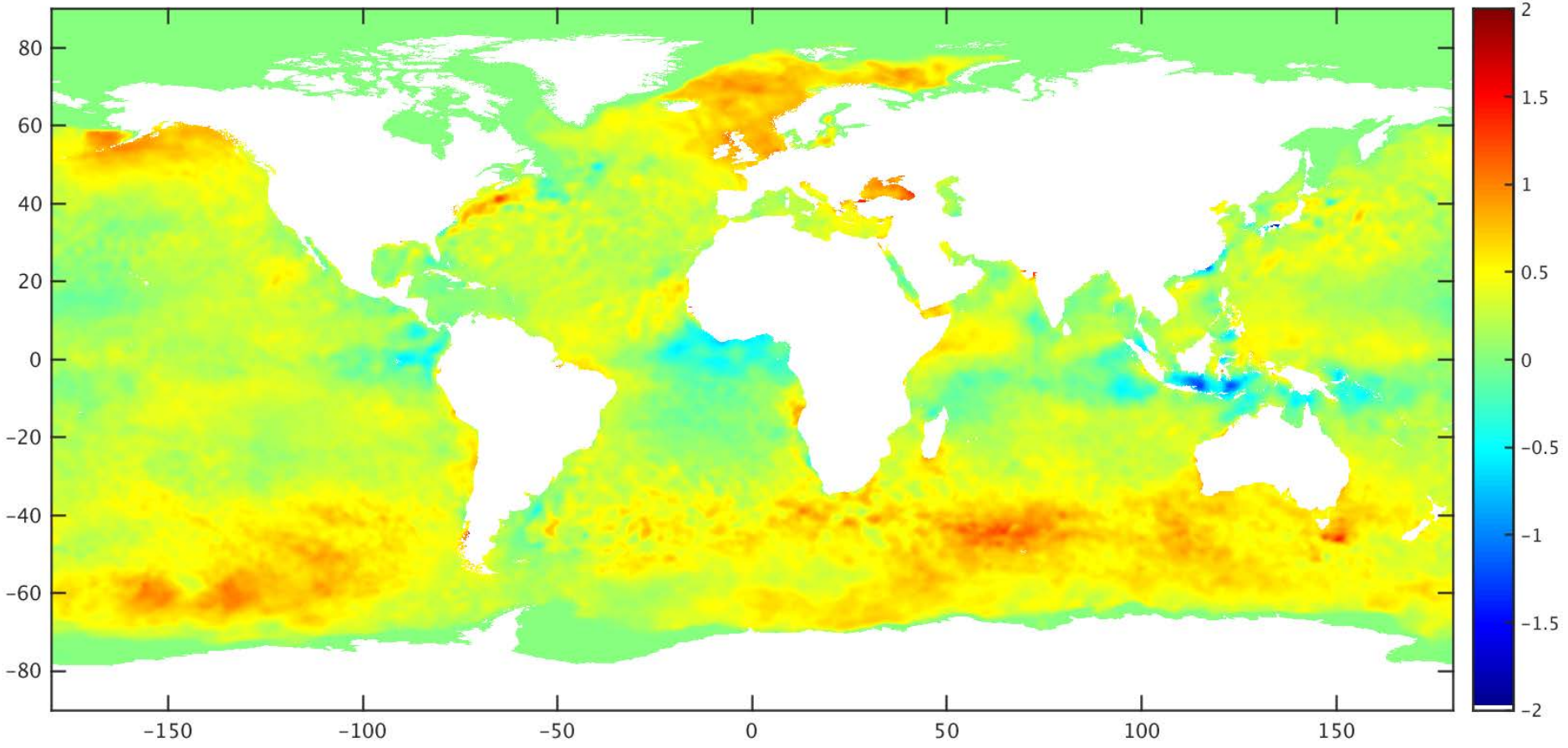
- **Diurnally adjusted VIIRS + SSES Bias (2016-03-21)**

Effect of diurnal adjustment on bias correction



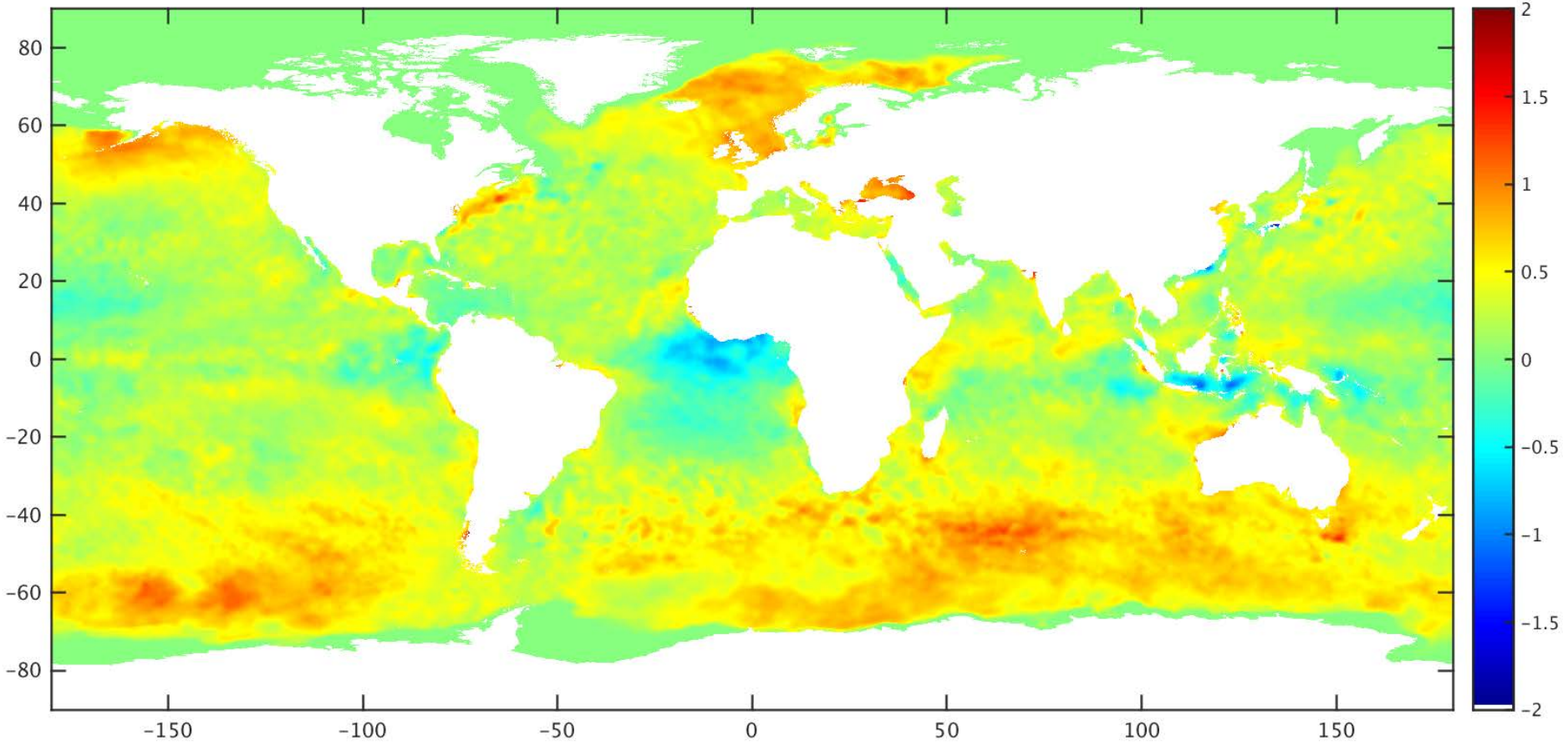
- **Diurnally adjusted VIIRS (2016-03-21)**

Effect of diurnal adjustment on bias correction



- **Diurnally adjusted monthly average VIIRS + SSES Bias**

Effect of diurnal adjustment on bias correction

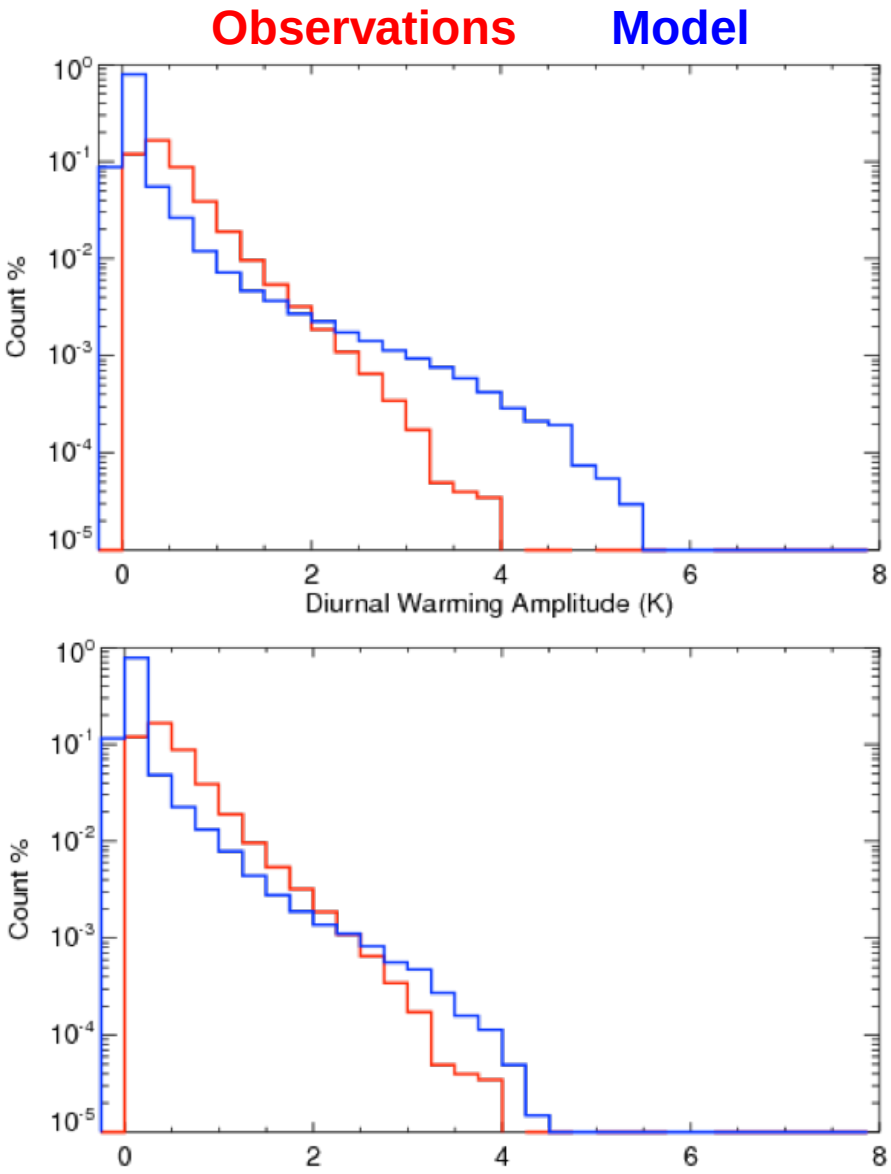


- **Diurnally adjusted monthly average VIIRS**

Improve Diurnal Adjustment

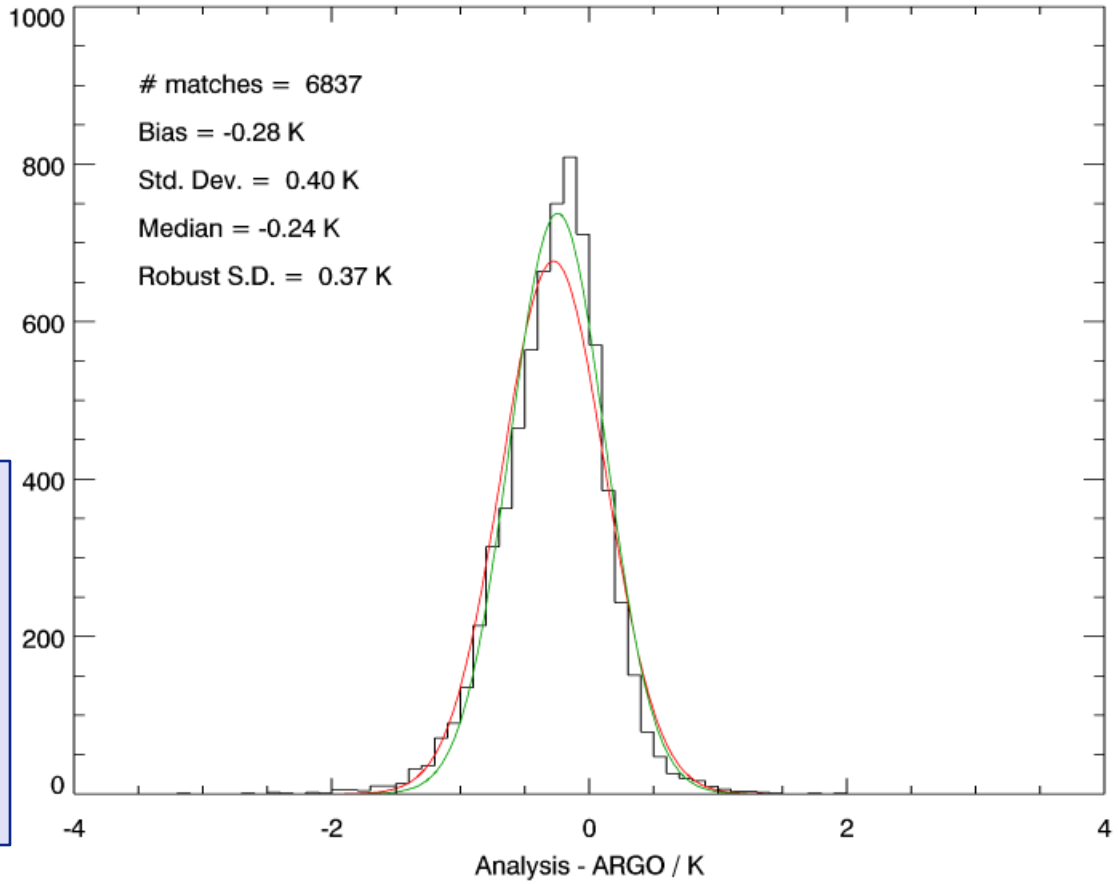
- **Difficult to model the observed distribution of warming**
  - Especially in tropics

- **New parameterization + wind gustiness**
  - Substantially improved distribution of modeled warming



Validation vs ARGO

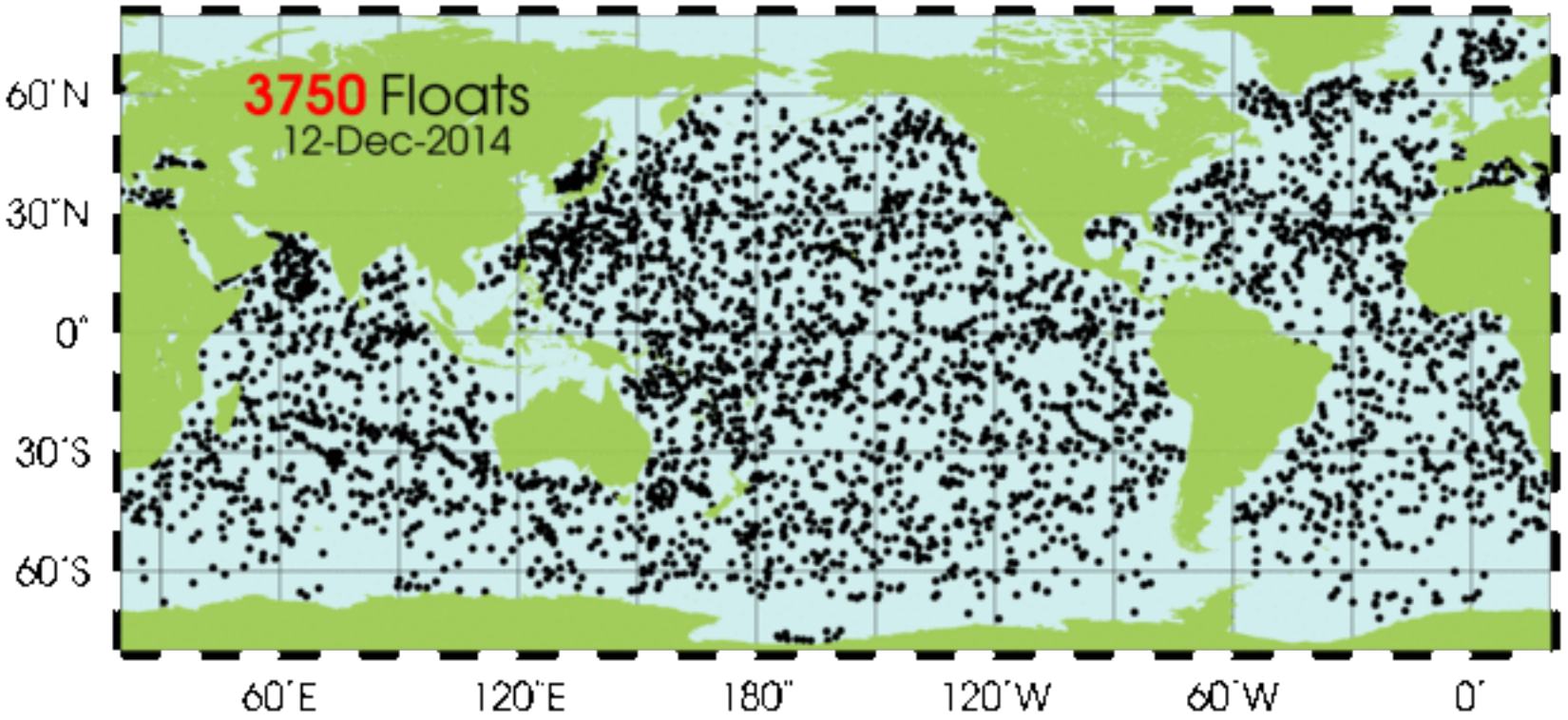
- March 2016
- iQuam QC
- 3 – 7 m depth



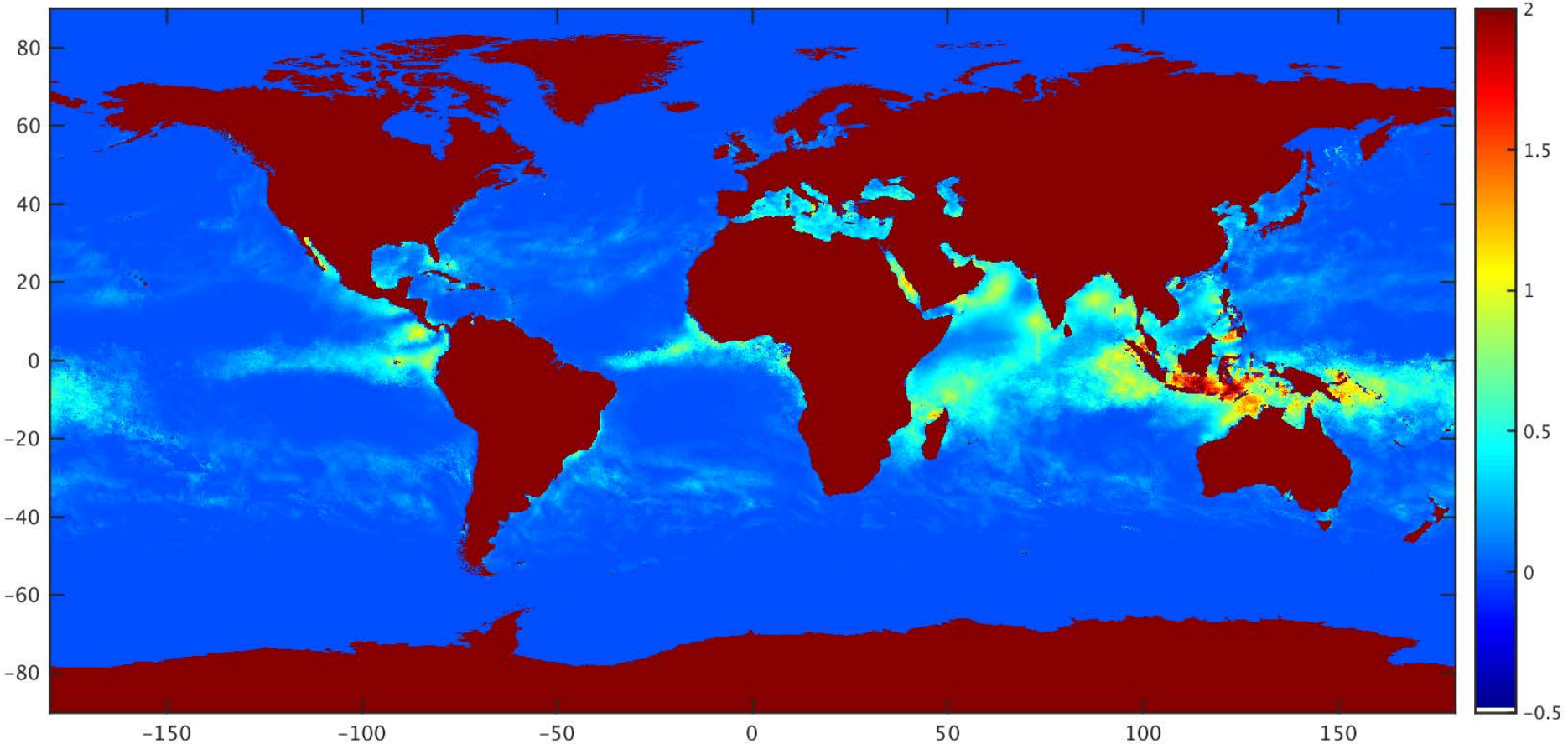
Global: -0.28±0.40 (0.37)
30+°N: -0.40±0.46 (0.36)
<|30°|: -0.18±0.36 (0.30)
30+°S: -0.40±0.41 (0.37)

N.B. **Virtually identical statistics to uncorrected analysis!**

Locations of currently active ARGO floats



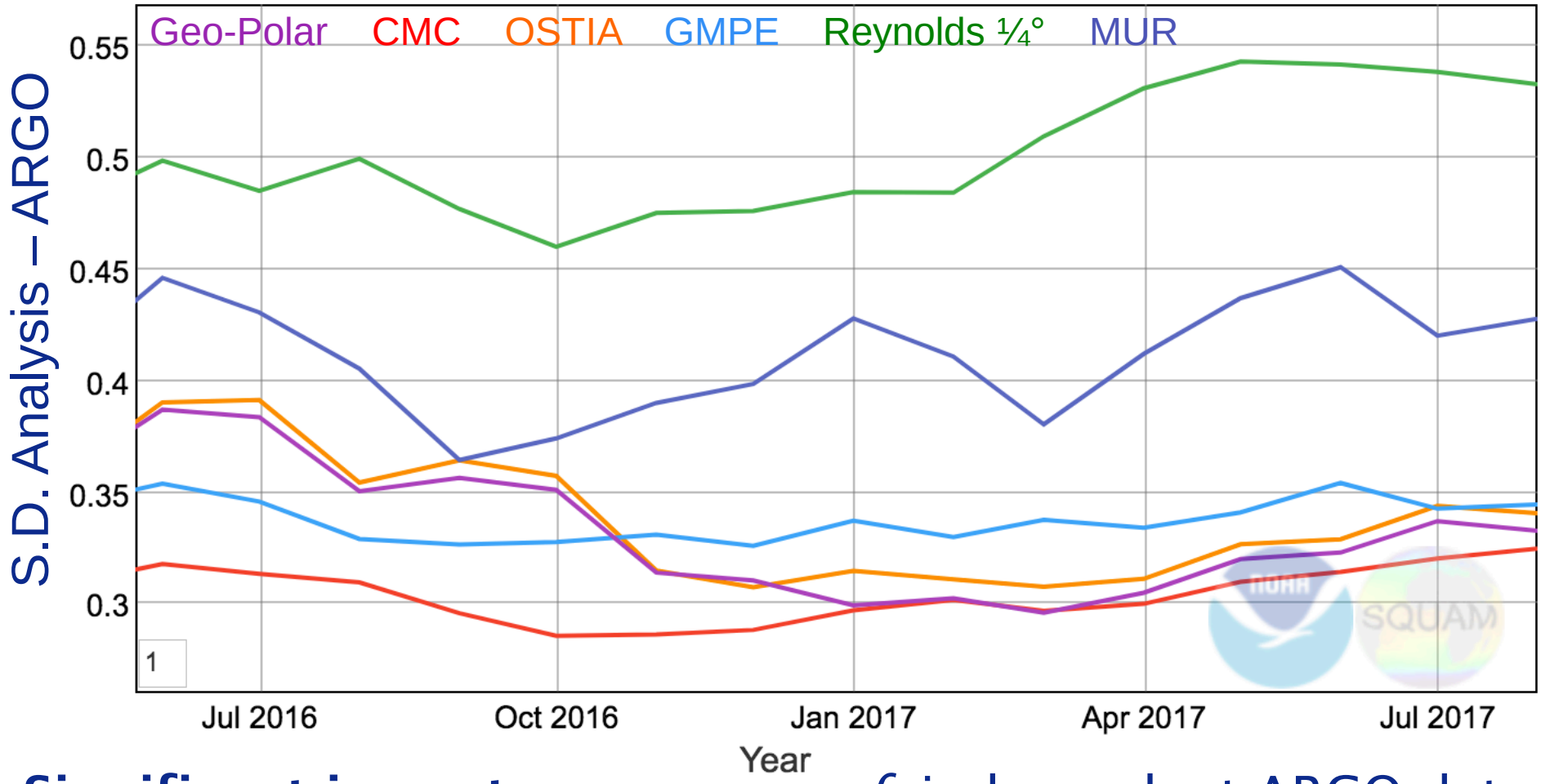
Effect of diurnal adjustment on input data



- **VIIRS monthly average for March 2016**

VIIRS data

- ***N.B.*** **VIIRS now used as bias correction reference for OSTIA**



Significant impact on accuracy *cf.* independent ARGO data

Summary

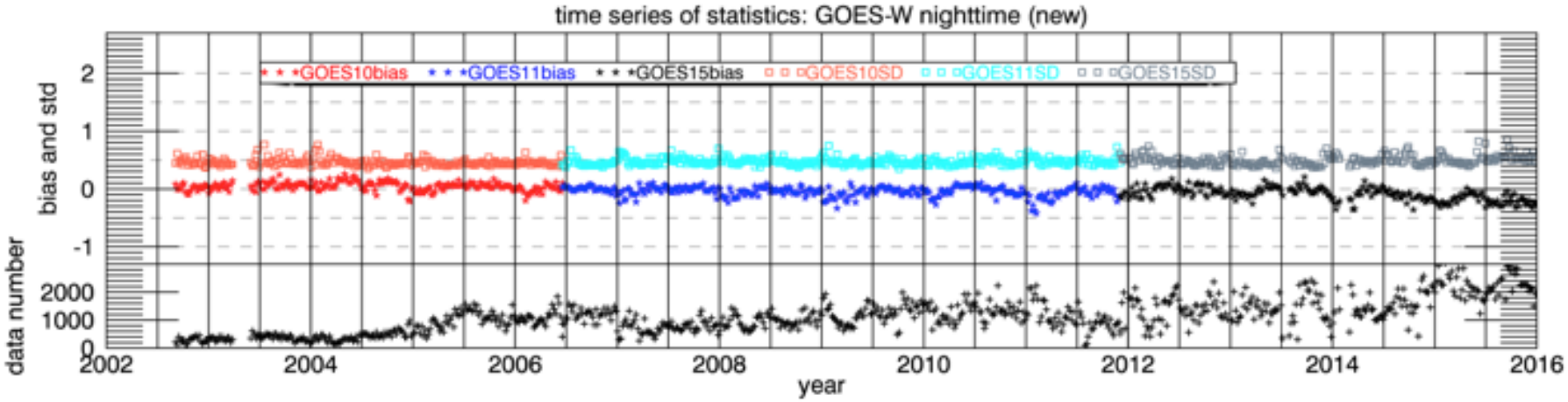
- **NOAA produces all the L2 data that go into the analysis**
  - Polar data – ACSPO regression SST
  - Geostationary – Bayesian cloud + MTLS Physical retrieval
  - *N.B.* Convergence on ACSPO means Himawari-8 is ACSPO
  - AMSR-2 SST is processed with NOAA GAASP algorithm
    - Initial SSES scheme **based on incidence angle**
- **L4 SST analysis continues to be improved**
  - Bias correction against OSTIA
    - OSTIA has improved *cf.* independent ARGO
    - Therefore Geo-Polar Blended 5-km Analysis has also improved
  - Analysis bias correction scheme due for overhaul
    - ACSPO VIIRS [+Sentinel-3 SLSTR]

Summary cont'd

- **Diurnal correction with turbulence model & Stokes' Drift**
  - Beneficial for applications that depend on SST at depth (*e.g.* CRW)
  - Daytime SST retrieval may not see full scope of DW, especially in tropics
  - Gustiness parameter damps warming (too much?)
    - Partly a work-around for above issue
  - New parameterization **substantially improves warming distributions**
    - Should be incorporated in next update to model
  - Other regional algorithm biases
    - On balance, using SSES bias + diurnal adjustment is better

Summary cont'd

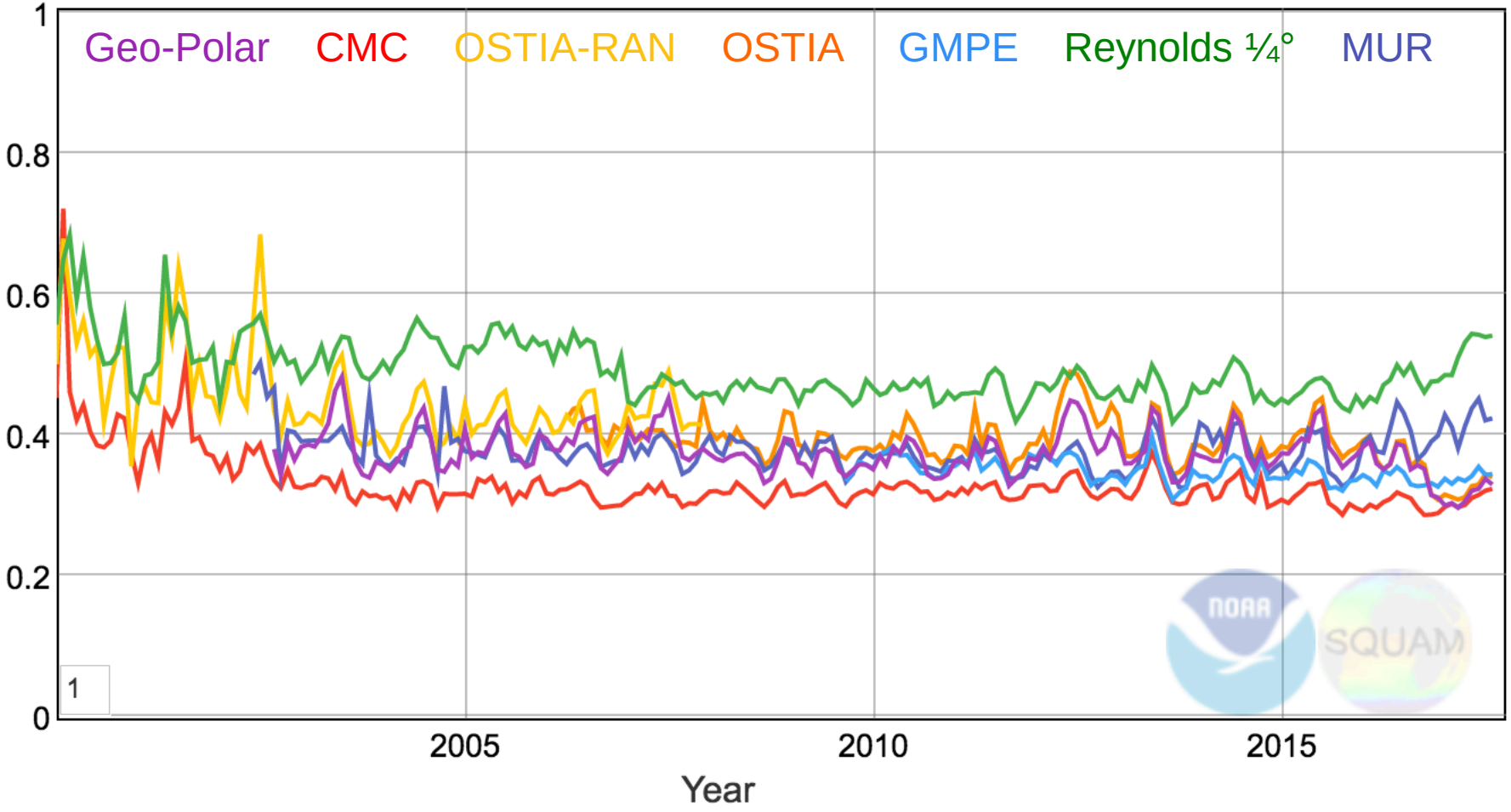
- **Reprocessing 2002 – 2016**
  - Improved baseline for CRW
    - ACSPO GAC AVHRR + Geo-SST (Physical+Bayesian) [*N.B.* no VIIRS]
    - OSTIA RAN + OSTIA Operational



Reprocessed GOES-W

Summary cont'd

- **Reprocess again using ACSPO nighttime 3-chan + SSES as reference?**



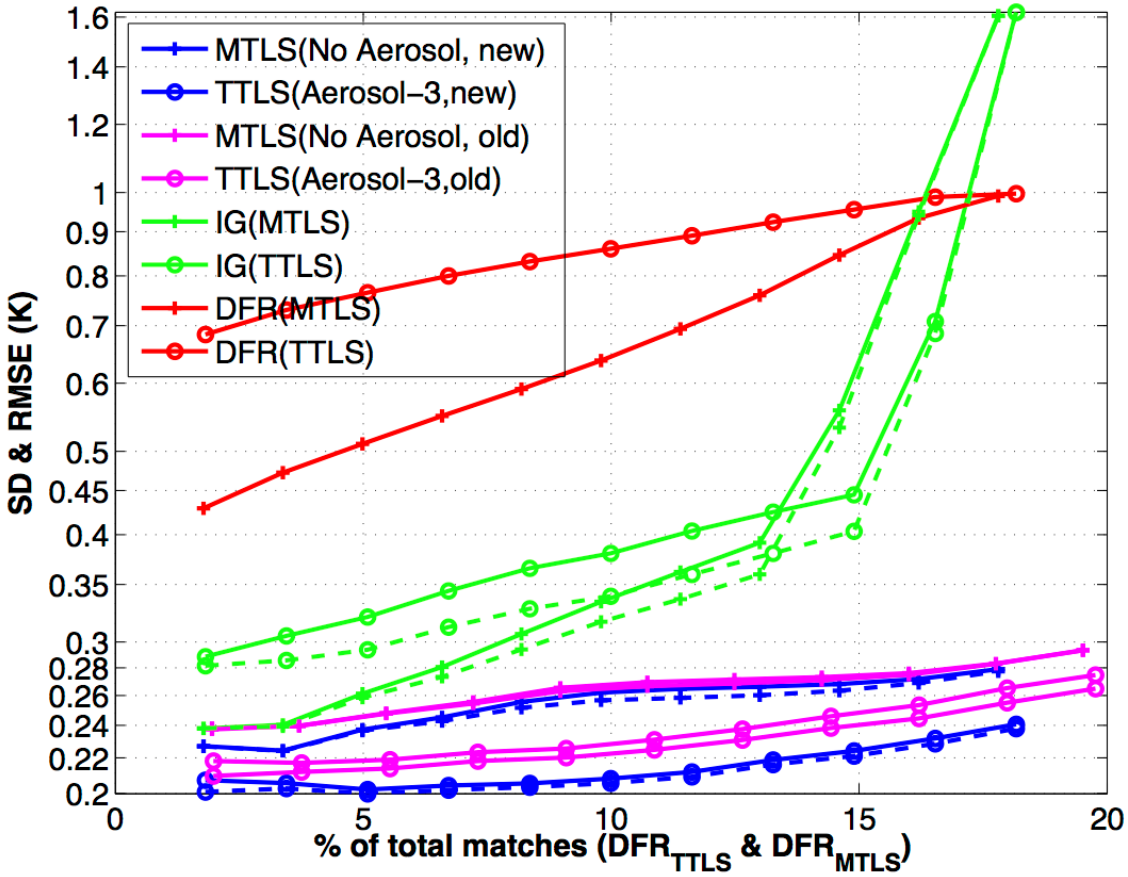
Backup slides

MODIS: Addition of aerosol

- **Put aerosol information in the CRTM**
  - NGAC profiles, multiple species (dust, salt, sulfate, soot)
  - Improve match of RTM to observation
  - Does this improve retrieval?
- **Put aerosol in the retrieval vector**
  - Allow Total Column Aerosol to vary
  - $\boldsymbol{x} = [\mathrm{SST}, \mathrm{WV}, \mathrm{TCA}]^T$
  - Jacobian now includes $\partial T/\partial TCA$ for each channel
  - Does this improve retrieval?
- **MTLS developed for 2-parameter retrieval**
  - Try different regularization operator since problem is now more ill-conditioned: **Truncated Total Least Squares (TTLS)**

$$|\Delta \boldsymbol{y}| \le 1: \ \lambda = (\sigma_{\text{end-1}})^2 \qquad |\Delta \boldsymbol{y}| > 1: \ \lambda = (\sigma_{\text{end-1}}/\log(|\Delta \boldsymbol{y}|))^2$$

Inclusion of aerosol



- **Accuracy with TTLS & joint [SST, WV, TCA] ~0.2 K**
- **Algorithm sensitivity is also improved *cf.* MTLS**