

Determining the accuracy of MODIS Sea-Surface Temperatures – an Essential Climate Variable

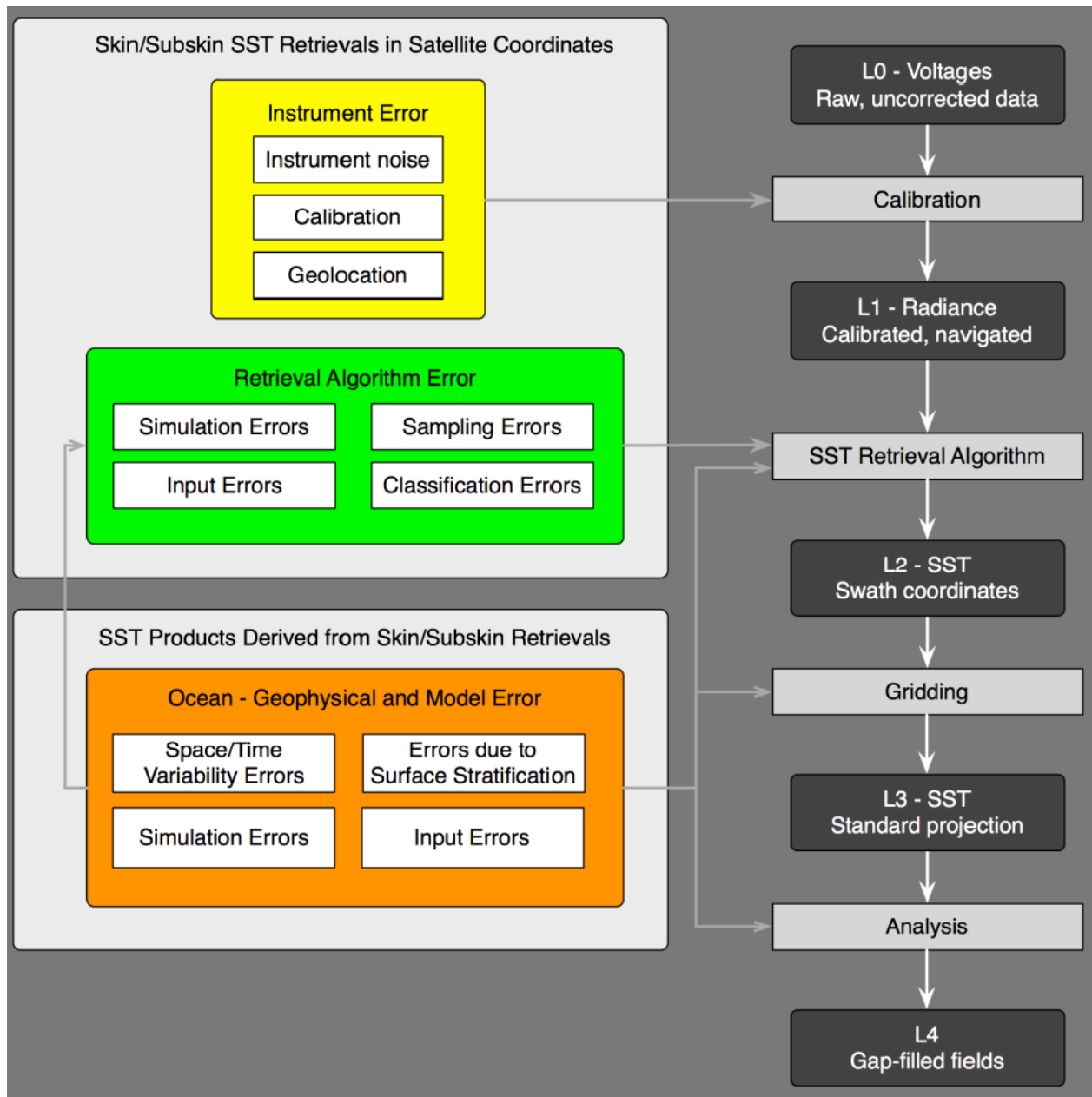
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Uncertainty estimates of satellite – derived SSTs

- Determined by comparisons with:
 - Drifting and moored buoys (subskin SST)
 - Ship-based radiometers (skin SST)
- Often expressed as a global mean and standard deviation, thereby hiding regional, seasonal and geophysical effects.
- Analysis of SST fields can reveal instrumental artifacts

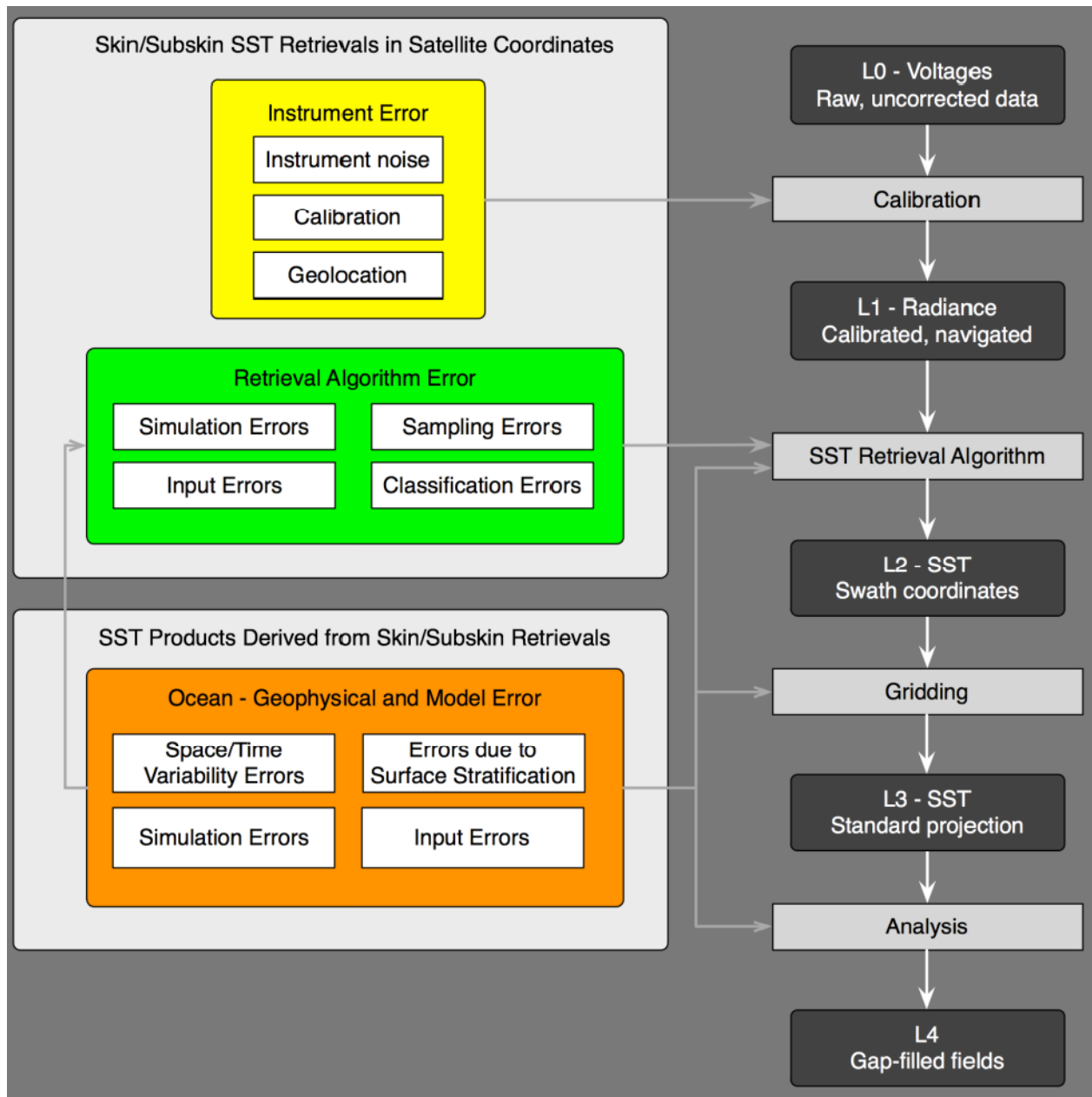
Uncertainty estimates



Each processing step is prone to additional error sources.

From Cornillon et al, 2010, Sea-Surface Temperature Error Budget White Paper. (<http://www.ssterrorbudget.org/ISSTST/>)

Uncertainty estimates

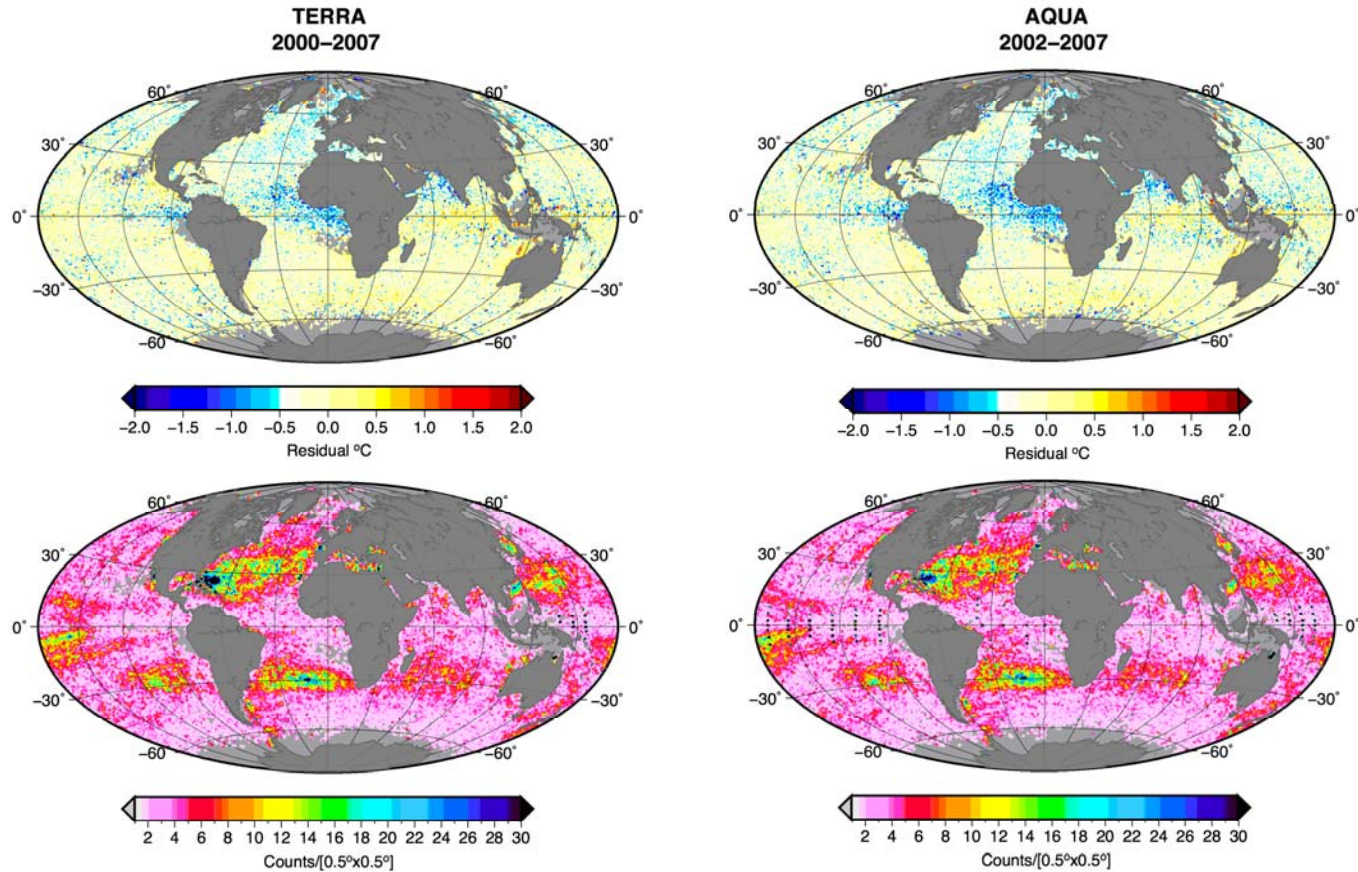


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Spatial distribution of errors



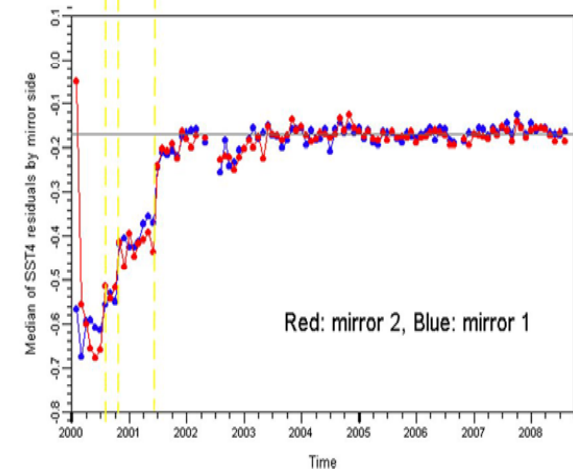
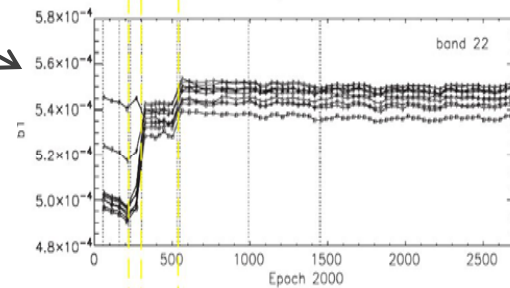
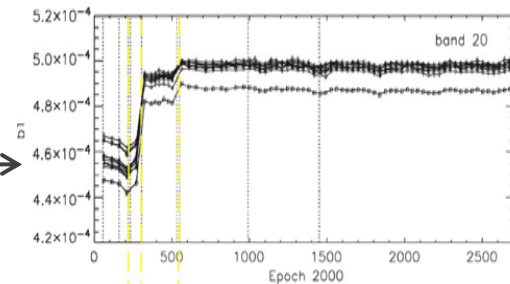
Areas of high bias errors can be related to geophysical phenomena: aerosols, upwelling, diurnal heating, anomalous humidity distributions

Development of Version 6, , Collection 6 SST algorithm Correction to SST4 bias resulting from TERRA configuration changes

MODIS-Terra calibration changes for
channels 20 and 22.

Median of SST4 residuals estimated
using 4 μ channels.

Calibration issues during 2000 and 2001
had considerable impact on SST
retrievals based on 4 μ m bands.



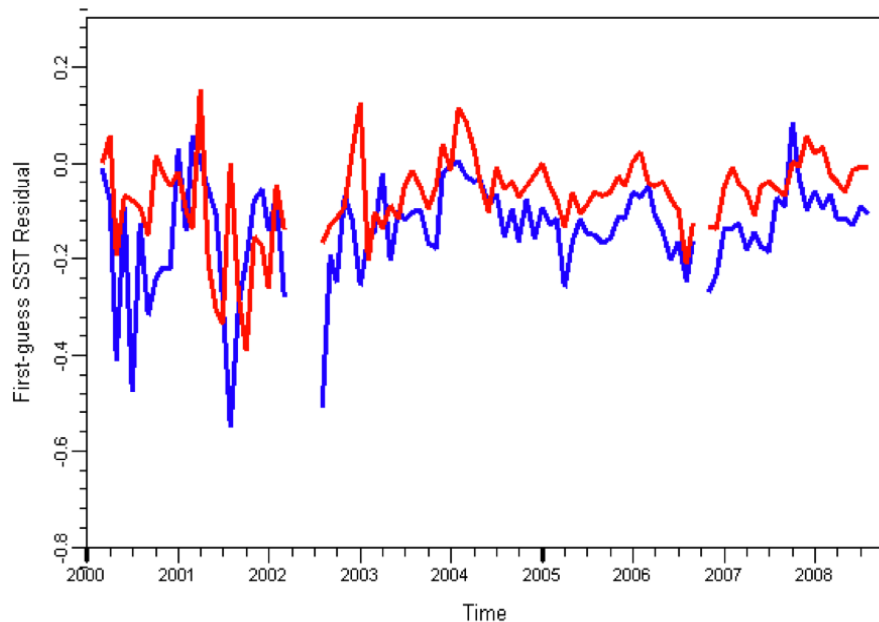
X-axis is time: 2000-2009



MODIS TERRA Mirror side and Scan Angle corrections to SST (also computed for AQUA)

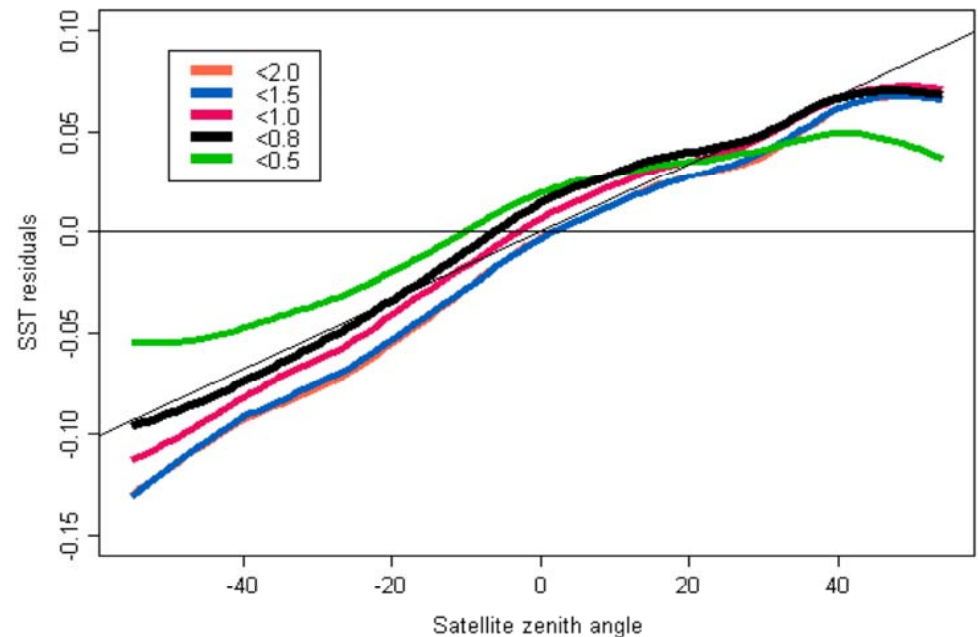
Mirror side offset
order 0.1K

TERRA - Residuals by mirror (blue:1; red:2)



Cross-scan
effect order 0.15K

MODIS AQUA Coll 6 - Effects of SZA



CEOS definitions

Calibration:

The process of quantitatively defining system responses to known, controlled signal inputs. Thus, a calibrated product is the output from the complete calibrated data generation chain. In the case of satellite-based measurements, vicarious calibration is indirect calibration achieved by simulating the signal at the satellite sensor input based on independently measured geophysical parameters, and comparing it to the actual signal measured by the sensor. The outcome of the comparison can be used to calibrate the sensor output.

Validation:

The process of assessing, by independent means, the quality of the data products derived from system outputs. Validation ensures that the quality of the products is properly assessed. In the case of satellite-based measurements, this is done via quantification of the uncertainties in Level 1b and Level 2 products. Thus, a validated product is the output from the complete validated data generation chain.

Traceability:

Refers to an unbroken chain of comparisons relating an instrument's measurement to a known standard. Calibration to a traceable standard can be used to determine an instrument's precision, accuracy and stability.

CEOS definitions

Calibration:

The process of **quantitatively defining system responses to known, controlled signal inputs**. Thus, a calibrated product is the output from the complete calibrated data generation chain.

Calibration is indirect, based on independently measured geophysical parameters, and comparing it to the actual signal measured by the sensor. The outcome of the comparison can be used to calibrate the sensor output.

Calibration is a pre-launch calibration.

On orbit, they are self-calibrating radiometers...

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Validation is post-launch:

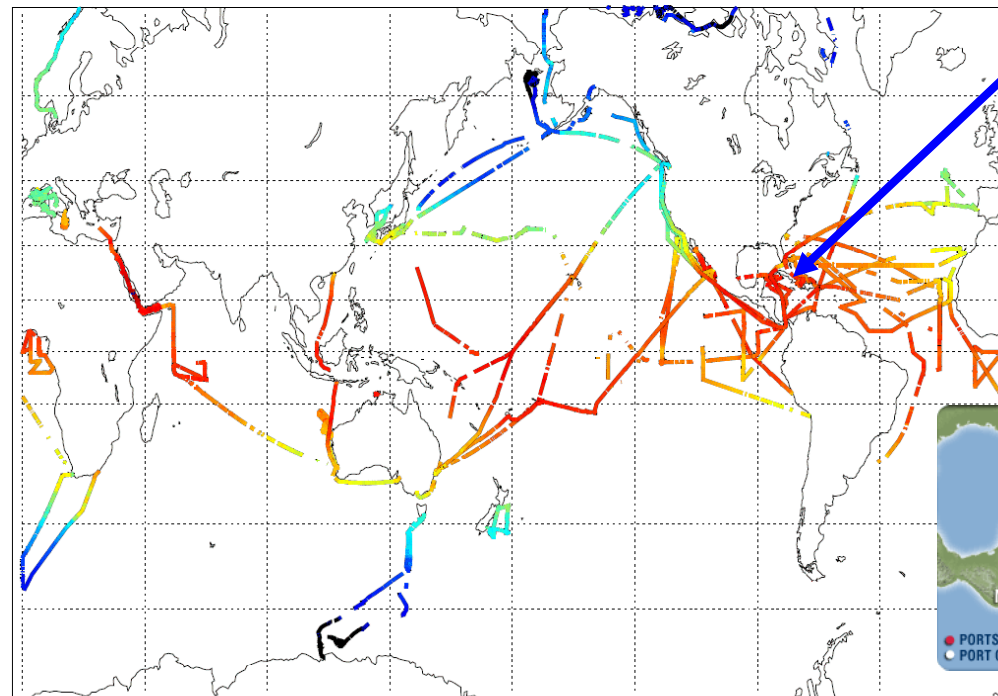
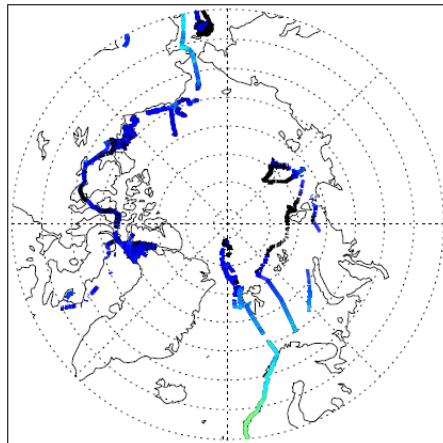
- Identify instrumental artifacts
- Performance of the atmospheric correction algorithm

Traceability:

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Calibration and validation are traceable to SI standards

M-AERI cruises for MODIS, AATSR & AVHRR validation



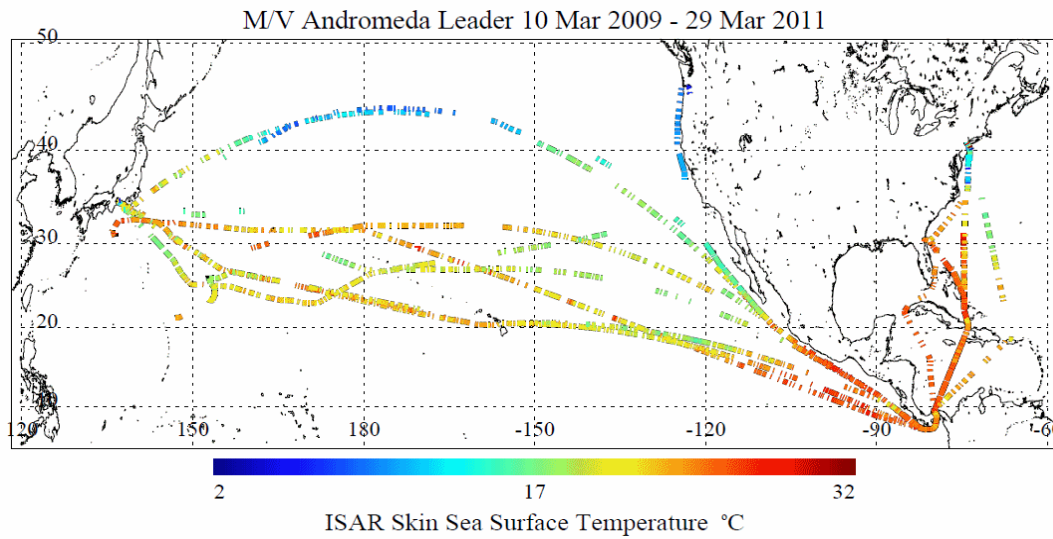
Explorer of the Seas



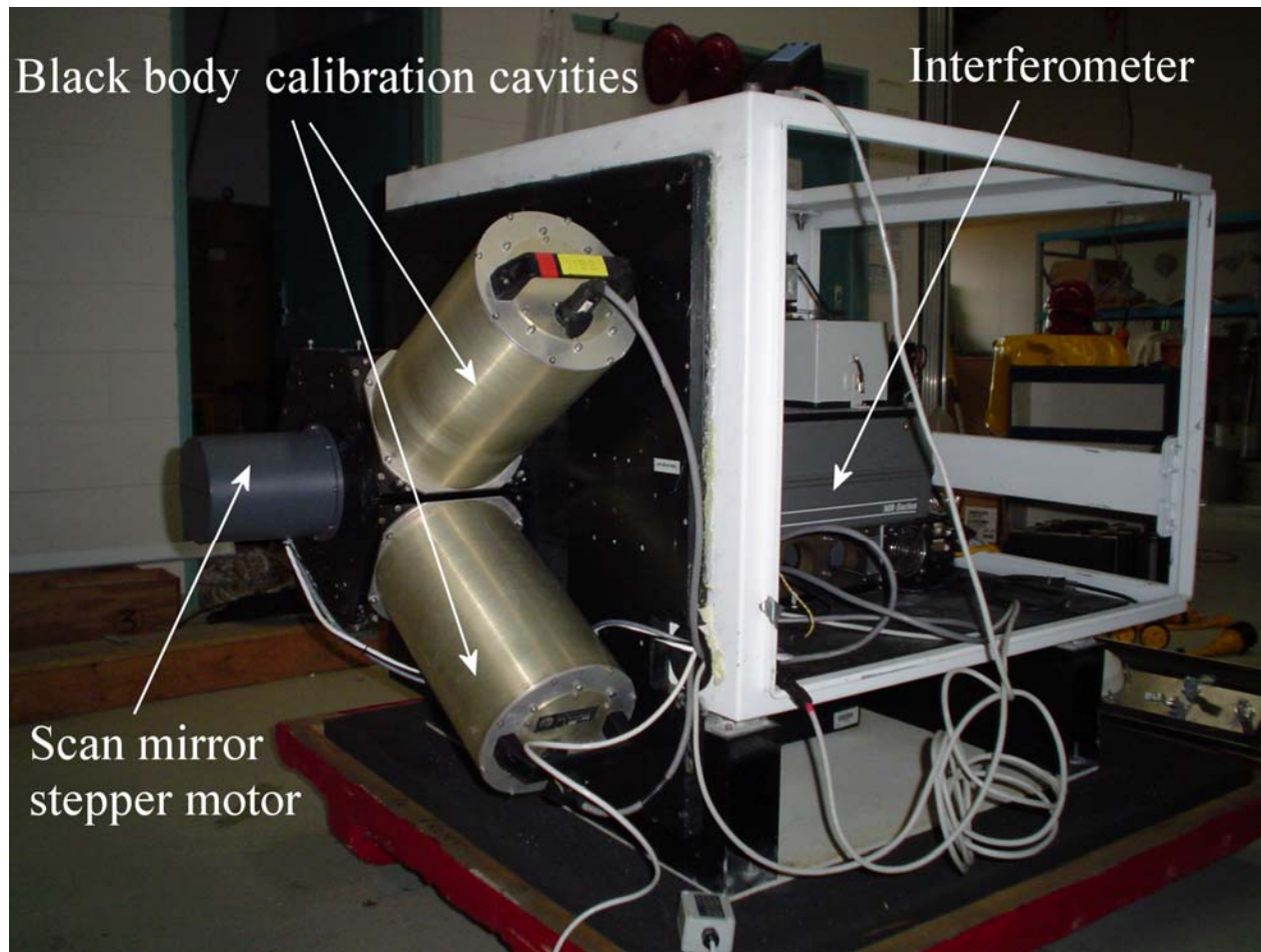
Explorer of the Seas: near continuous operation December 2000 – December 2007. Restarted February 2010.



ISAR cruises for MODIS, AATSR & AVHRR validation



Internal Calibration



NIST water-bath black-body calibration target



See: Fowler, J. B., 1995. A third generation water bath based blackbody source, *J. Res. Natl. Inst. Stand. Technol.*, 100, 591-599

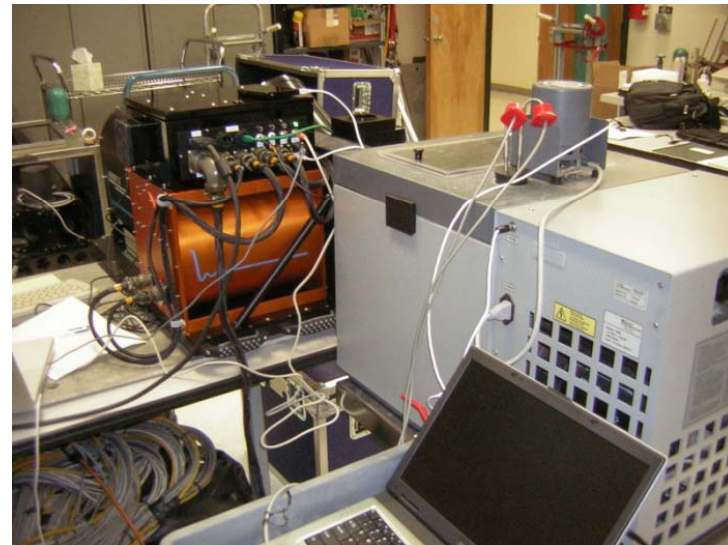
Traceability to NIST TXR

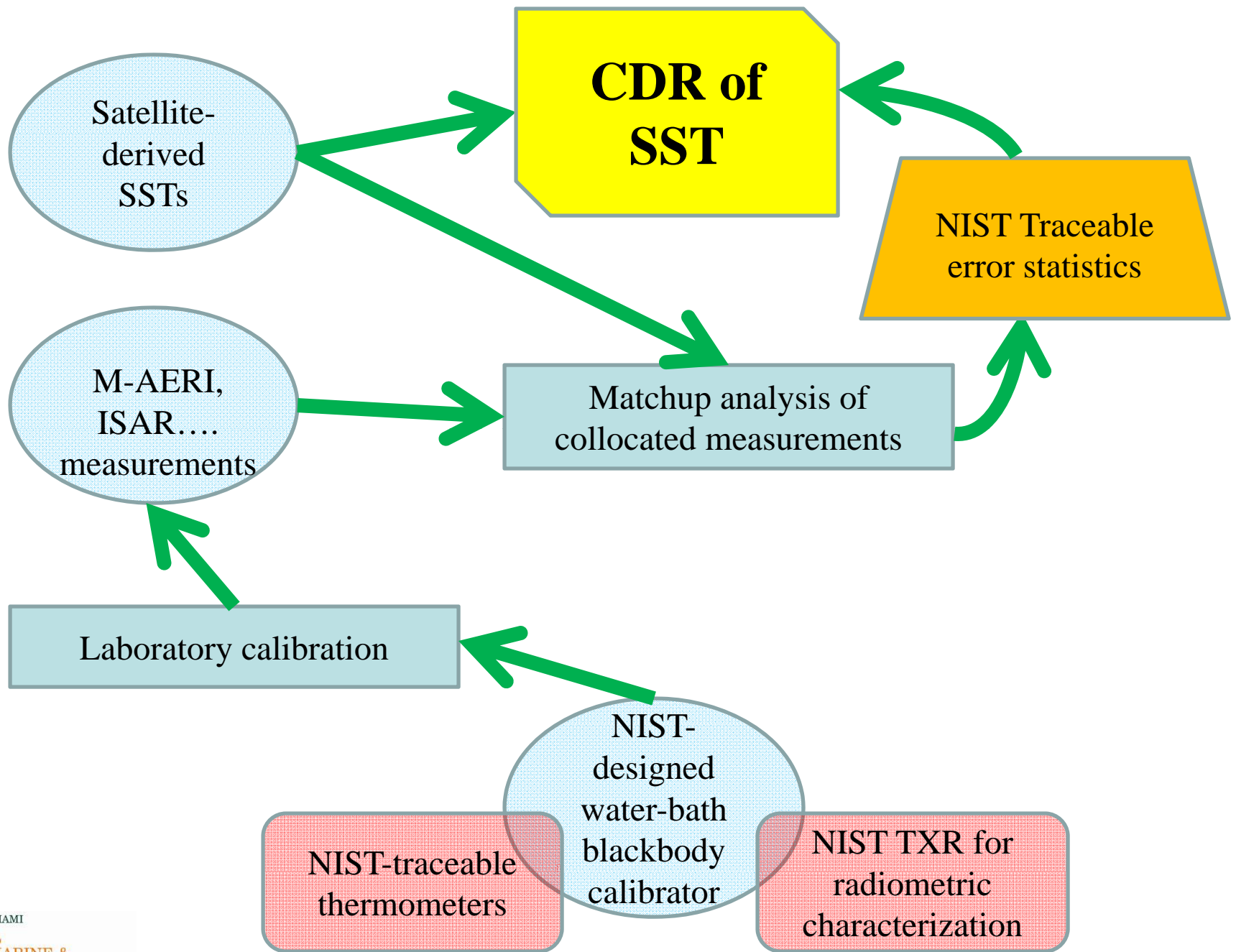


Next-generation ship-based FTIR spectroradiometer



M-AERI Mk-2 undergoing tests at RSMAS.

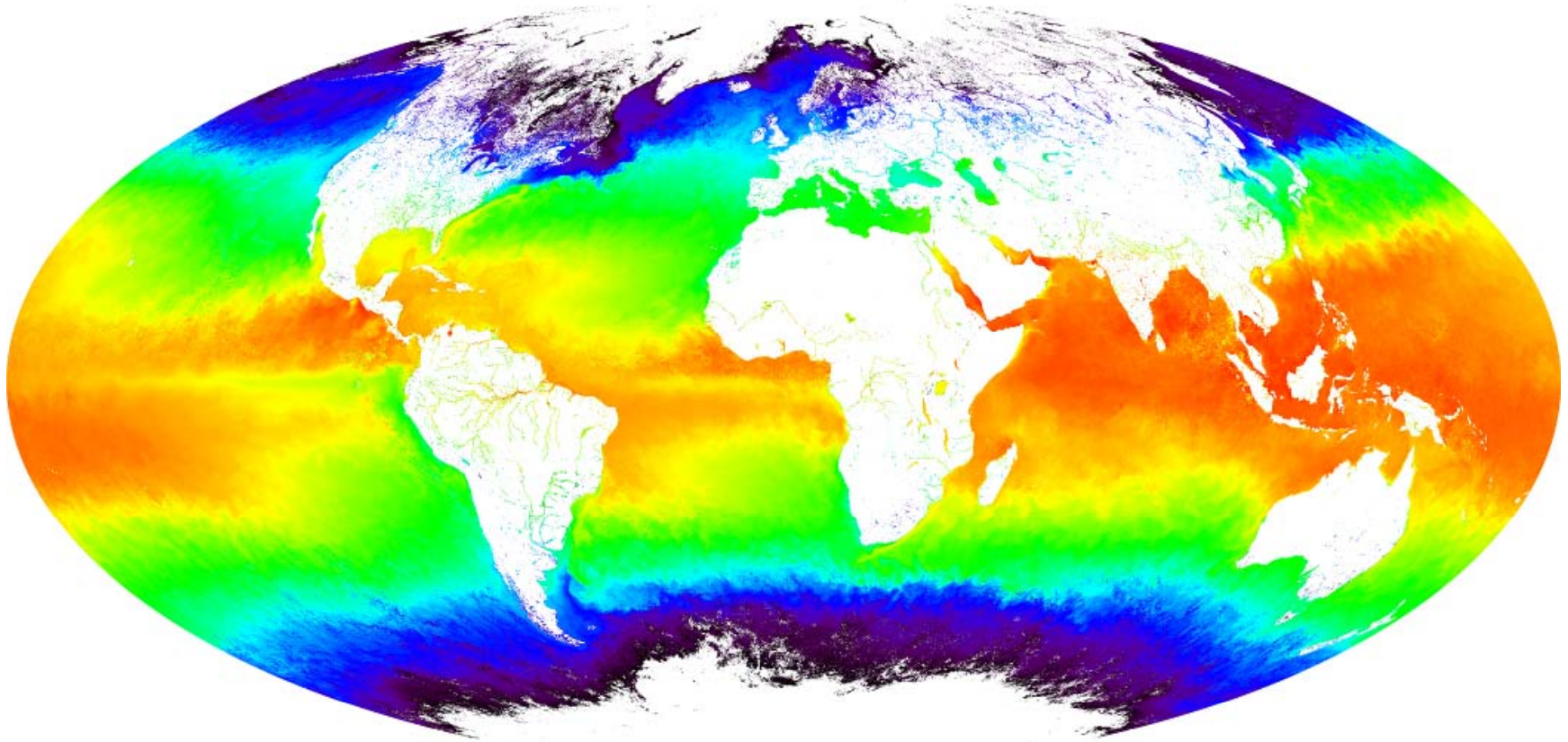




Future

- New ship-based spectroradiometers
- New spacecraft radiometers
- Better buoy temperatures
- Use modified Argo profilers, gliders
- More (autonomous) radiometers, also on UAVs
- Improved atmospheric correction formulations
- “Forward” solution for the atmospheric effect

Questions?



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and NASA PO program, Dr Eric Lindstrom

