

# Status of Sea-surface Temperatures from the Moderate-resolution Imaging Spectroradiometer (MODIS)

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MODIS-VIIRS Science Teams Meeting  
Washington DC. January 26-28, 2010.

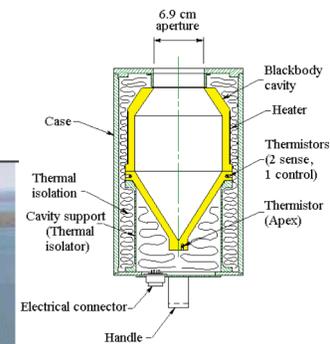
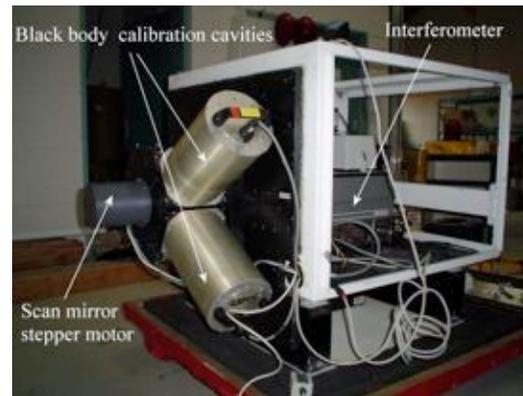
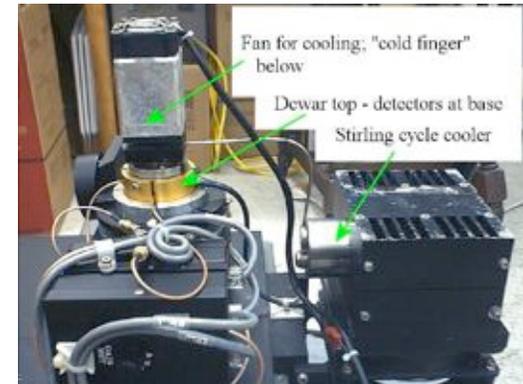
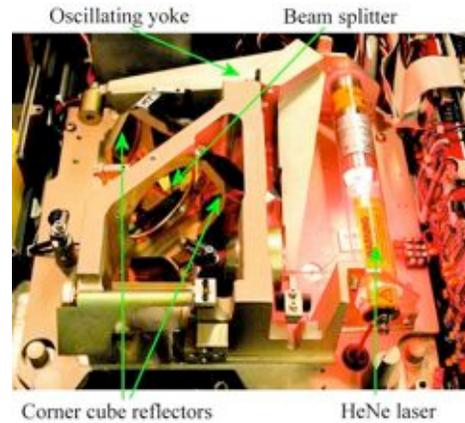


# Introduction

- Continuing validation efforts of existing algorithms
- Validation statistics
- Instrument development
- New atmospheric correction algorithms
- Future developments

# M-AERI

- The Marine-Atmospheric Emitted Radiance Interferometers were built to measure skin SST for MODIS validation.
- FTIR taking measurements from  $\sim 3$  to  $\sim 18\mu\text{m}$  wavelengths.
- Internal blackbody cavities for at-sea calibration.
- Built by SSEC, U. Wisconsin.



# SST (& LST) radiometers - 2009

## 3<sup>rd</sup> Miami IR Radiometry Workshop



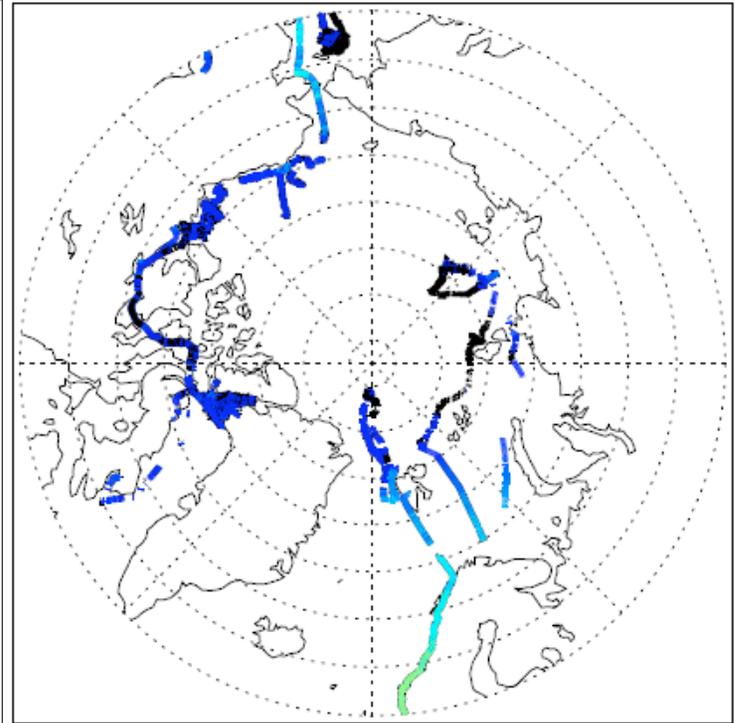
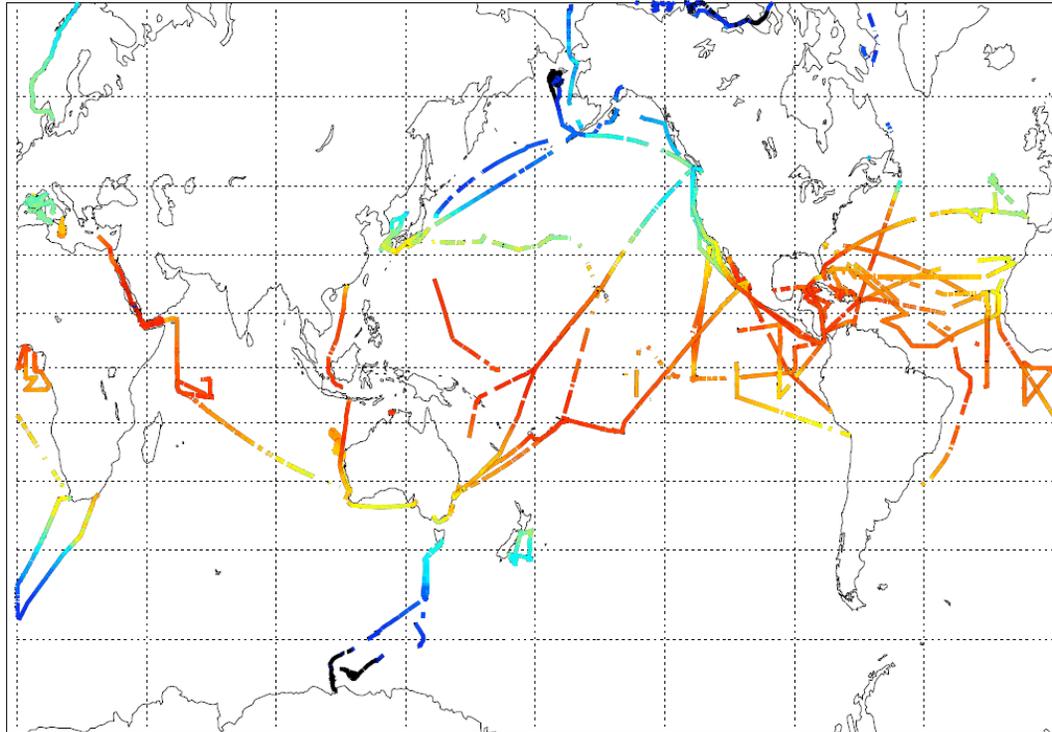
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# M-AERI deployments

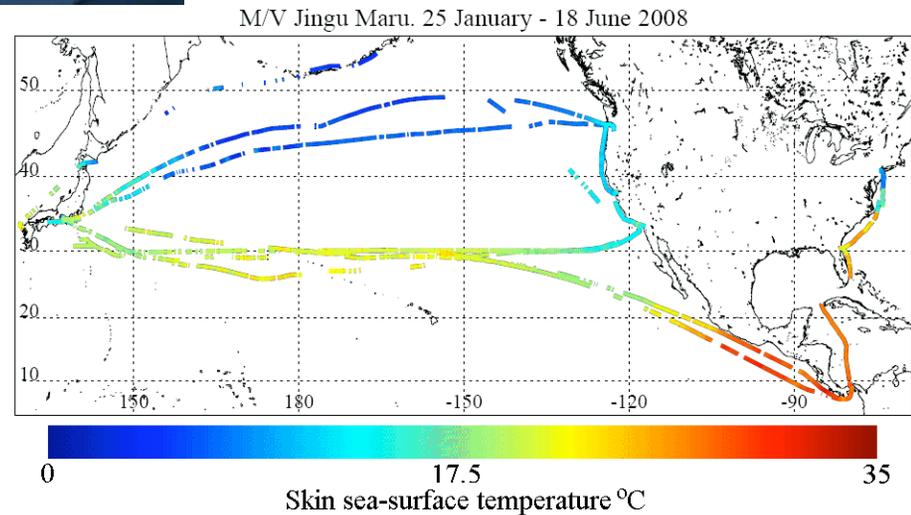
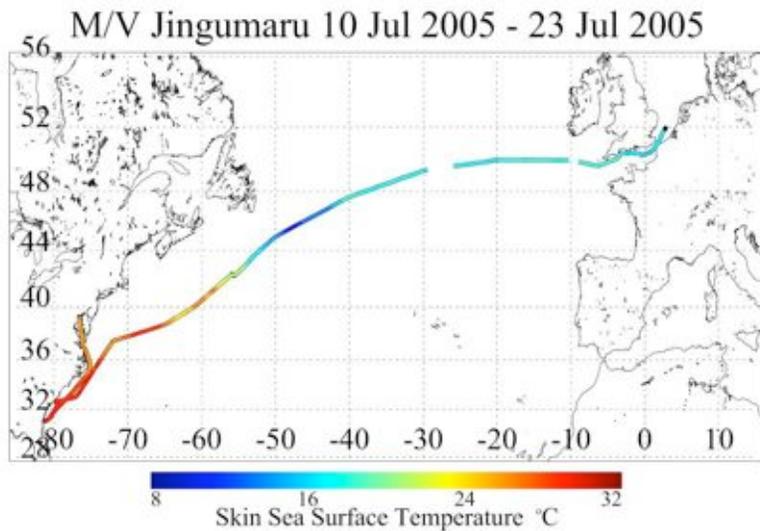
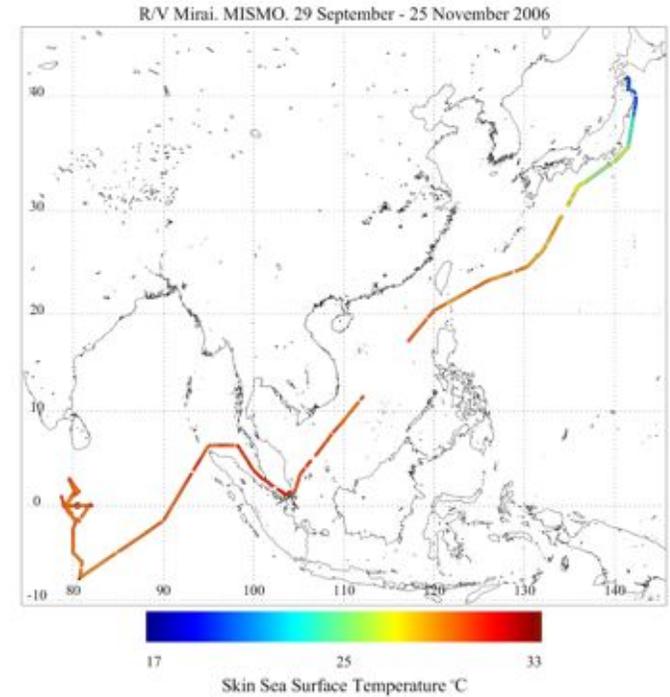


Excluding Explorer of the Seas

# ISAR deployments



ISAR on the M/V *Andromeda Leader*



# MODIS SST statistics referenced to M-AERI validates MODIS skin temperature retrievals

Uncertainties in the *Terra* MODIS SST retrievals vs M-AERI.

Data	Mean	St. Dev	N	Mean	St. Dev	N
	11 $\mu\text{m}$ SST			4 $\mu\text{m}$ SST		
All	0.04 K	0.53 K	4751			
Day	0.09 K	0.58 K	1999			
Night	0.01 K	0.53 K	2752	-0.02 K	0.43 K	3056

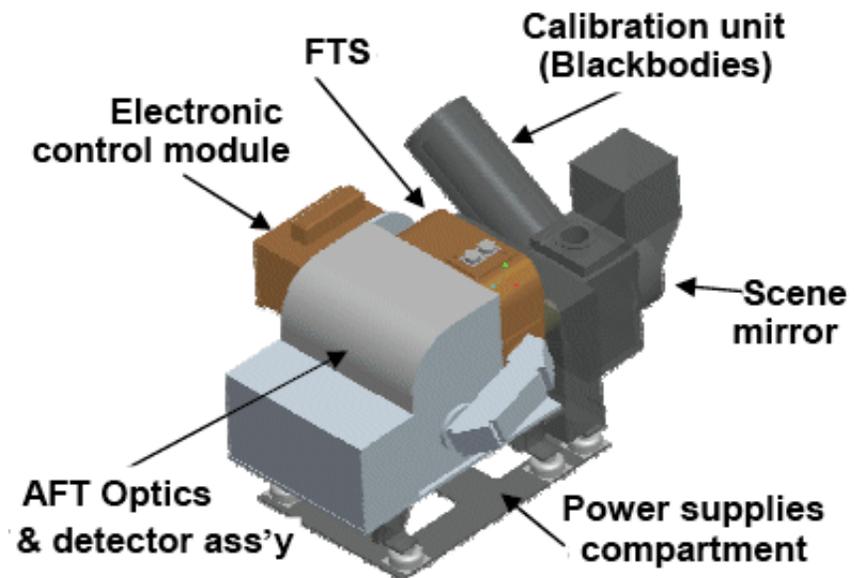
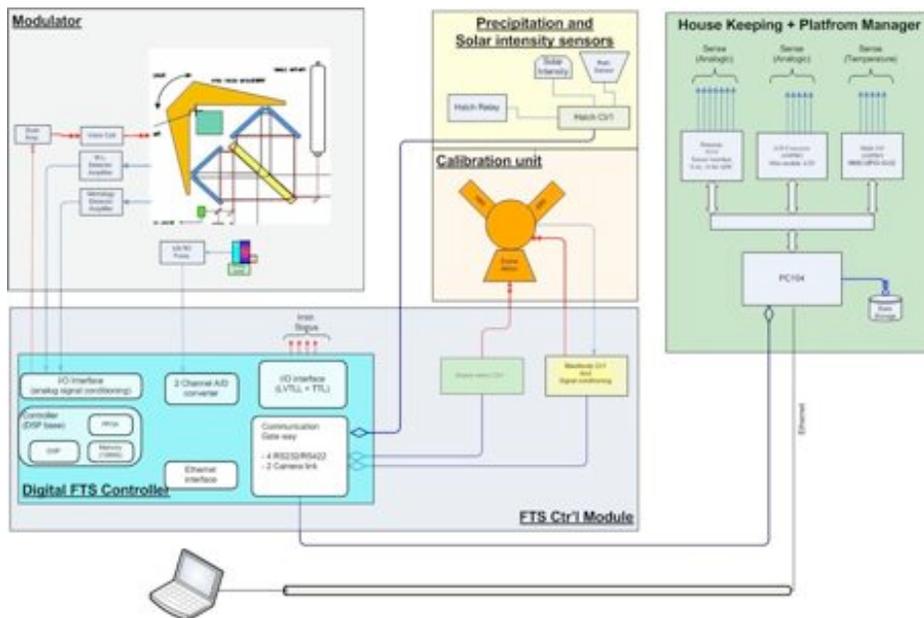
Uncertainties in the *Aqua* MODIS SST retrievals vs M-AERI.

Data	Mean	St. Dev	N	Mean	St. Dev	N
	11 $\mu\text{m}$ SST			4 $\mu\text{m}$ SST		
All	0.00 K	0.56K	2093			
Day	0.04 K	0.59 K	832			
Night	-0.02 K	0.53 K	1261	-0.06 K	0.45 K	1399

# M-AERI Mk2

M-AERIs (3) have now >10 yrs sea time and are increasingly difficult to maintain.

M-AERI Mk-2 is being developed with NASA funding; proposal to NIST to build 4 more.



Schematic from LR Tech Inc.

# ‘LATBAND’ improvements

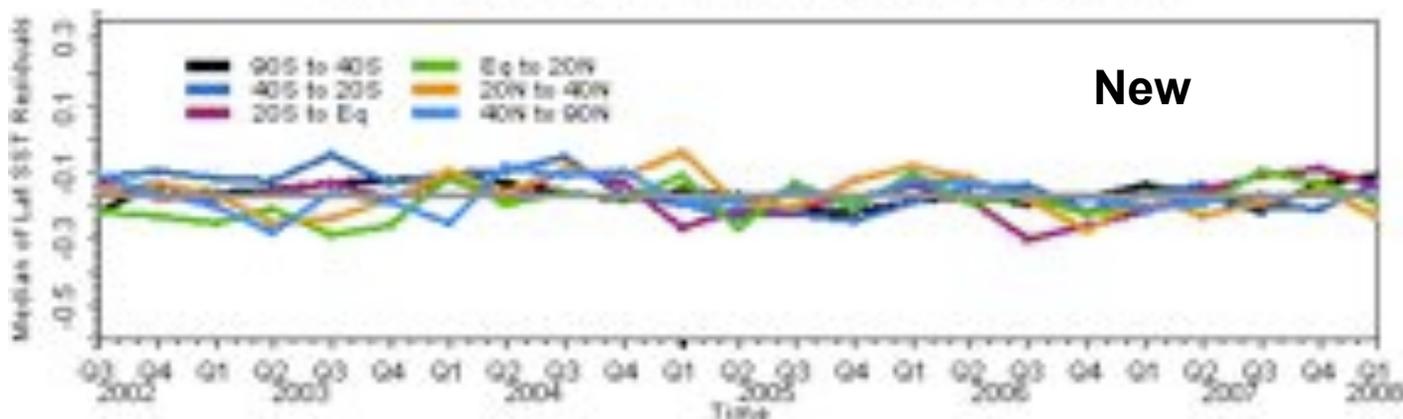
- Current MODIS equation coefficients are based on two regimes, effectively tropical and mid-high latitudes defined by the brightness temperature difference between the 11 and 12 $\mu$ m bands.
- This approach works reasonably well but includes a small, seasonal bias that increases with latitude.
- Changing to six 20° wide zonal bands has significantly reduced these biases and the overall retrieval algorithm Std Dev.

# Status of MODIS SST

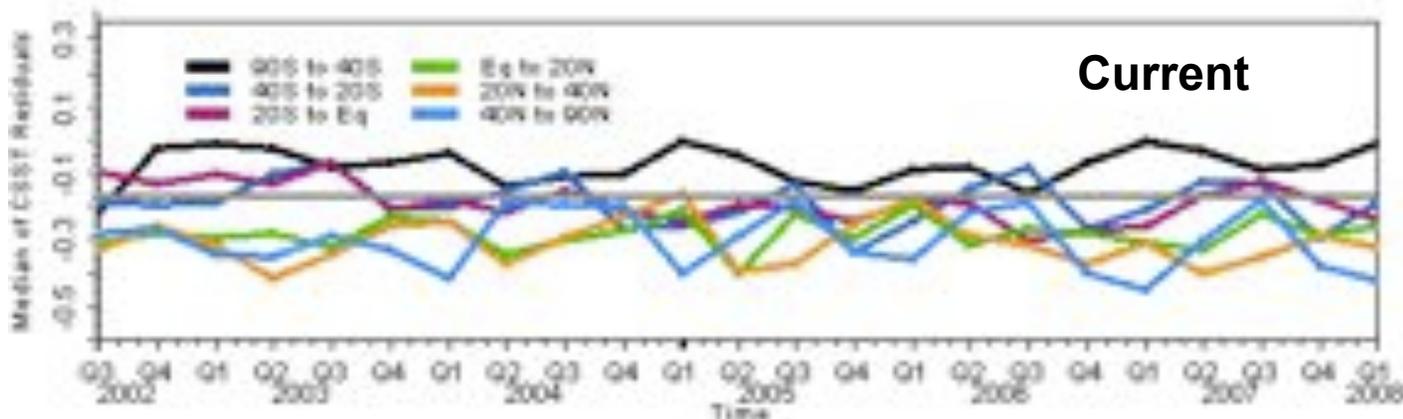
- Current SST retrieval coefficients delivered based on Version 5 Aqua calibration and new, 6 zonal band, monthly, 'LATBAND', formulation.
- Using the same approach, bias problems are seen in the first 3 years of the TERRA mission for 4um SST.
- Need to generate new SST retrieval coefficients based on Version 6 MODIS instrument calibration.
- OBPG will provide MODIS brightness temperature observations, RSMAS will make matchup DB and derive SST coefficients.

# Application of LATBAND to MODIS AQUA, V5 LUT

AQUA - Median of Lat SST Residuals by Latitude Band



AQUA - Median of CSST Residuals by Latitude Band



Median of SST residuals (VALIDATION set) by quarter (2002-2008). Each line corresponds to a latitude band. Upper panel corresponds to latitude-specific SST; lower panel is previous SST (CSST).

# AQUA MODIS Summary statistics for SST and SST4 LATBAND Algorithm, V5 (LUT) MODIS calibration relative to buoy SST

Summary statistics for SST4 residuals. (3-4 $\mu$ m bands)

Data set	Min	Q1	Median	Mean	Q3	Max	RMS	Std Dev
Training	-2.2178	-0.3563	-0.1766	-0.2083	-0.0172	2.2372	0.4038	0.3401
Validation	-2.1226	-0.3579	-0.1771	-0.2080	-0.0175	2.1757	0.4036	0.3377

Summary statistics for SST residuals. (11-12 $\mu$ m bands)

Training	-2.5091	-0.3986	-0.1644	-0.1781	0.0565	2.1140	0.4258	0.3867
Validation	-2.2854	-0.4032	-0.1704	-0.1813	0.0554	2.3478	0.4291	0.3889

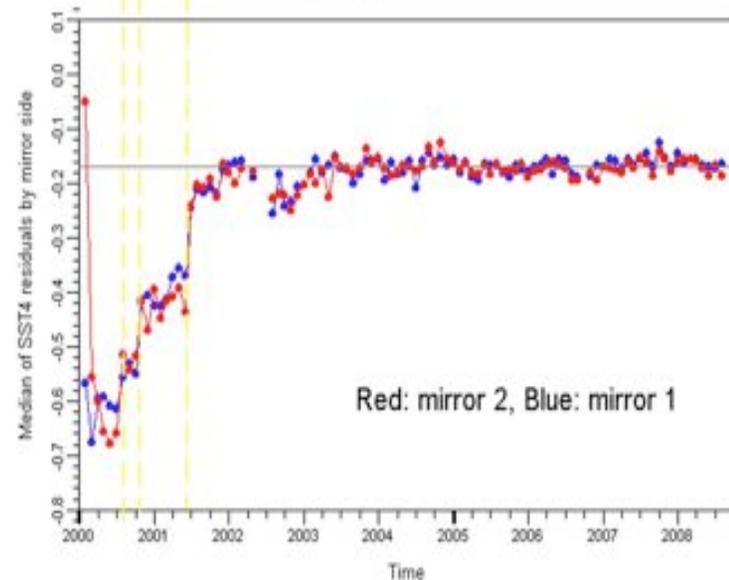
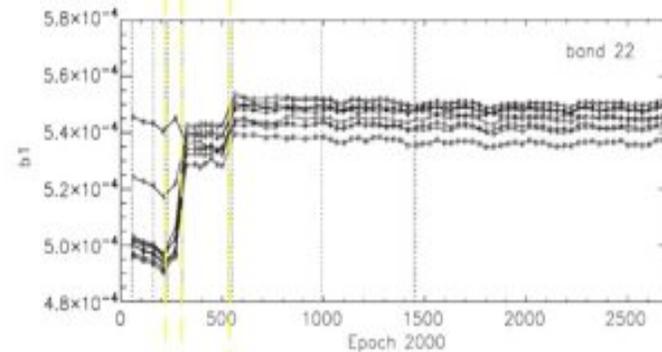
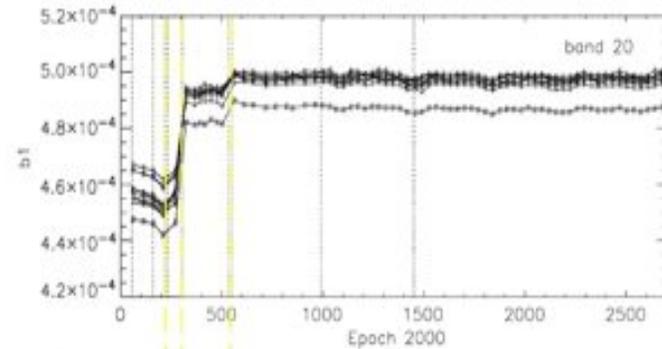
Statistics are reported separately for training and validation sets. NOTE: The residuals can be considered as “skin SST” as a correction has been introduced in the constant term of the SST equation.

$$\text{SST residuals} = \text{SST}_{\text{sat}} - \text{SST}_{\text{buoy}}$$

# 4 $\mu$ m SST bias trend and MODIS instrument calibration changes, V5 LUT

MODIS 4 $\mu$ m instrument calibration  
changes vs time – from MCST

MODIS 4 $\mu$ m SST error vs in situ  
with retrieval coefficients  
referenced to post 2003.



# Status and Outlook

- Test using V5 SST coefficients with V6 MODIS calibration showed 0.1-0.2 bias, thus generation of V6 SST coefficients using V6 MODIS calibration is required.
- LATBAND code has been delivered and implemented at OBPG.
- OBPG has delivered AQUA 2008 extractions, MIAMI generating matchup records.
- Implementation of the MODIS Version 6 LATBAND algorithm based on MODIS Version 6 instrument calibration (LUT 6) will follow delivery of full mission Version 6 MODIS matchup extractions from the OBPG.