TMI and AMSR-E Microwave SSTs

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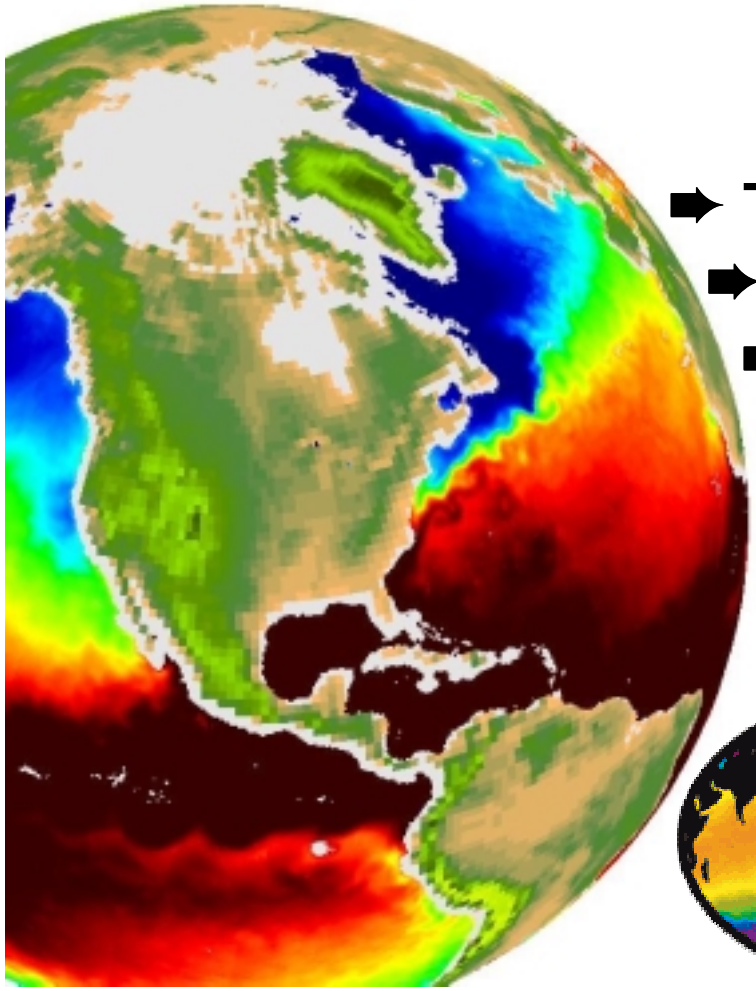


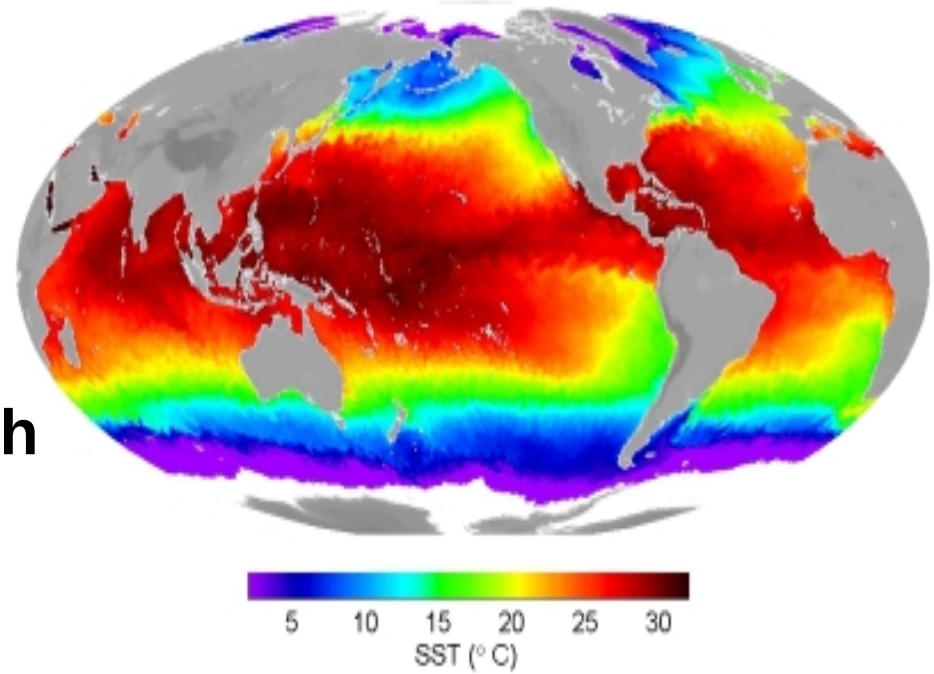
- **TMI/AMSR-E**
- **MW SST algorithm development**
- **Validation Results**
- **Sensor Issues**
- **Useful for Climate research**

GHRSST-PP

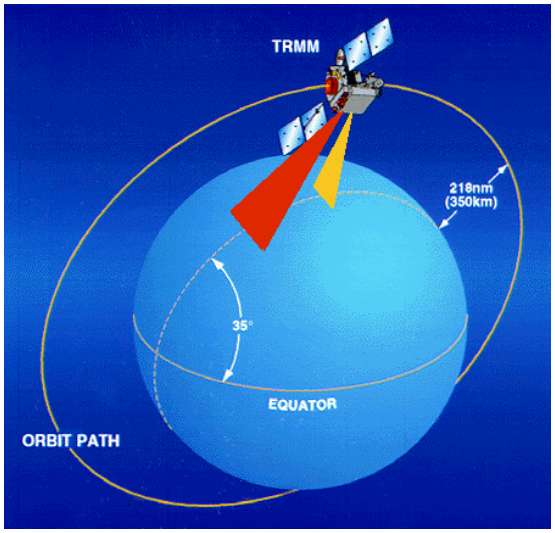
GODAE High Resolution Sea Surface Temperature Pilot Project

Outline of Talk

- **Current status of TMI & AMSR-E SSTs**
  - **Sensor description**
  - **RSS MW SST algorithm**
- **Validation Results**
- **Calibration problems**
- **Useful for Climate research**



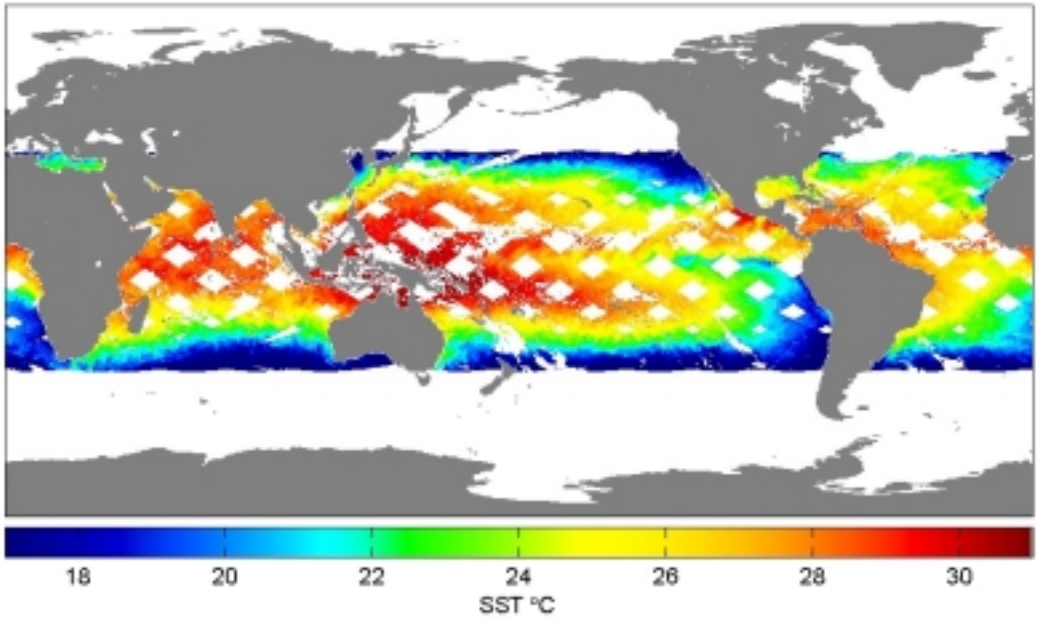
TRMM Orbit



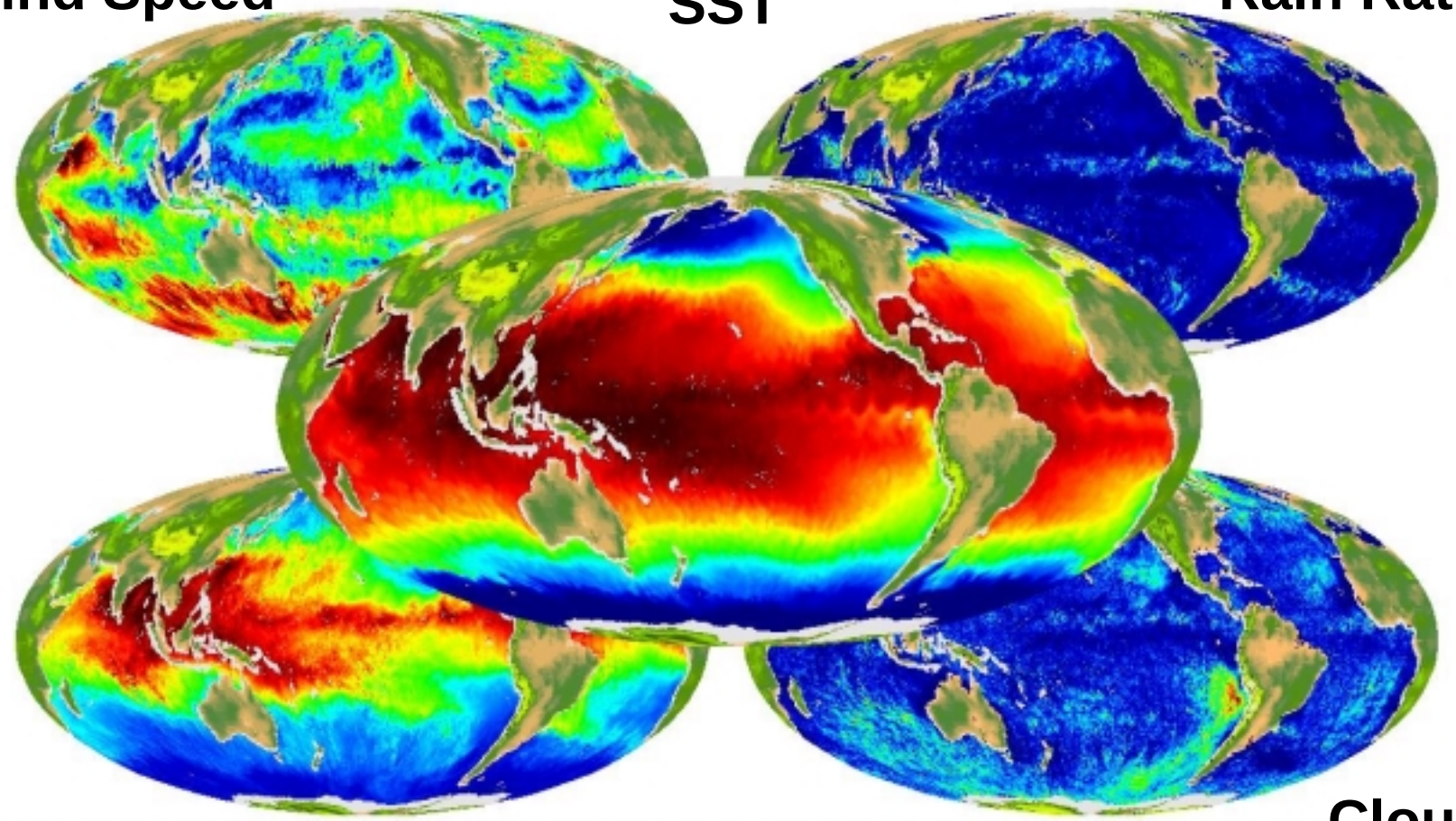
- 50 km footprint
- Swath width: 760 km
- 5 channels:
  10.7, 19.4, 21.3, 37, 85.5 GHz

- 35° inclination.
- Altitude of 350km.
- Full coverage in
  ~2 days.

TRMM SST, November 23, 2000



TMI/AMSR-E
Suite of Ocean Products



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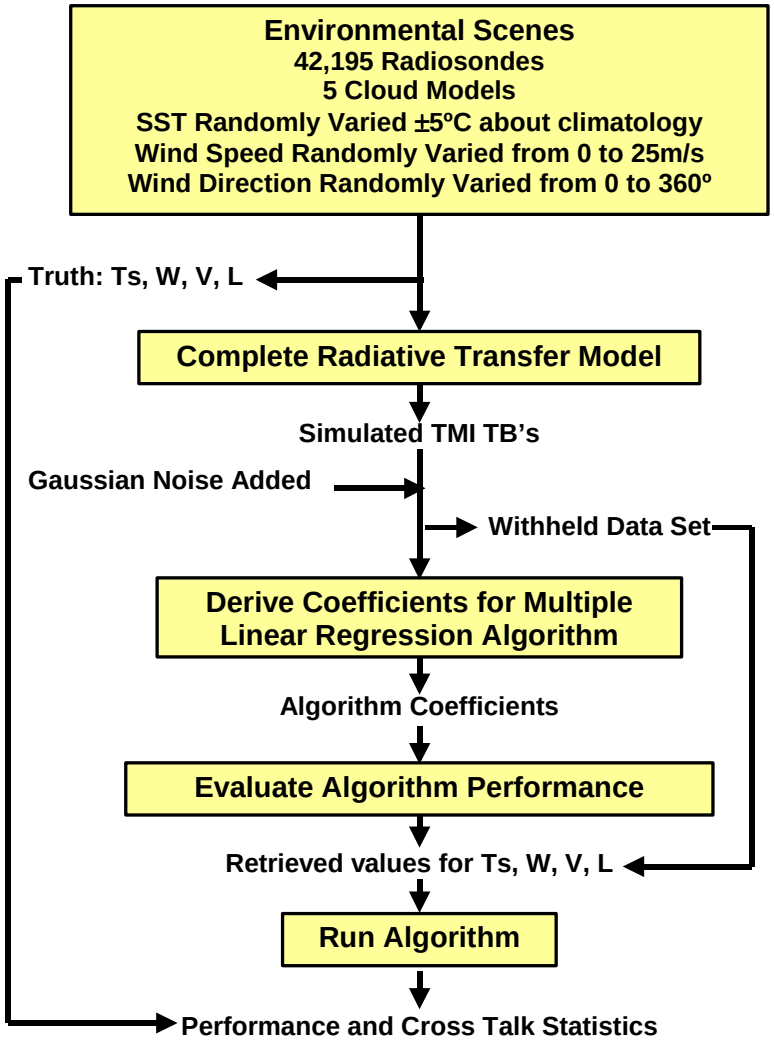
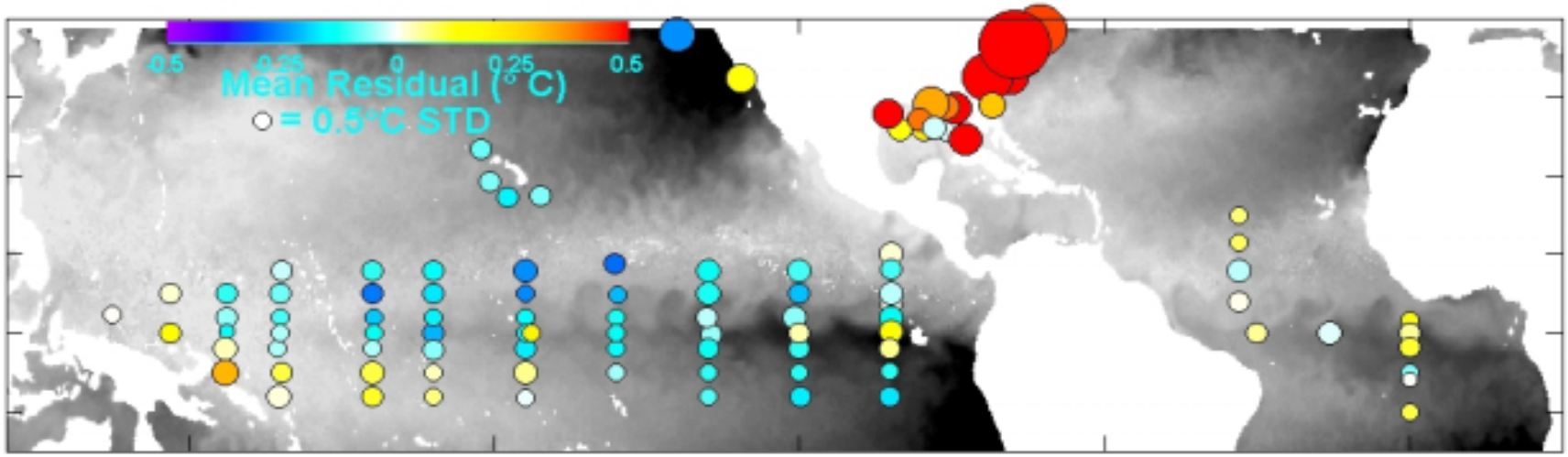
Algorithm Derivation



TMI, AMSR-E, AATSR coefficients calculated by regression to RTM generated TBs.

AVHRR SST monthly coefficients calculated by blind regressions to in-situ (drifters/buoys/ship) measurements.

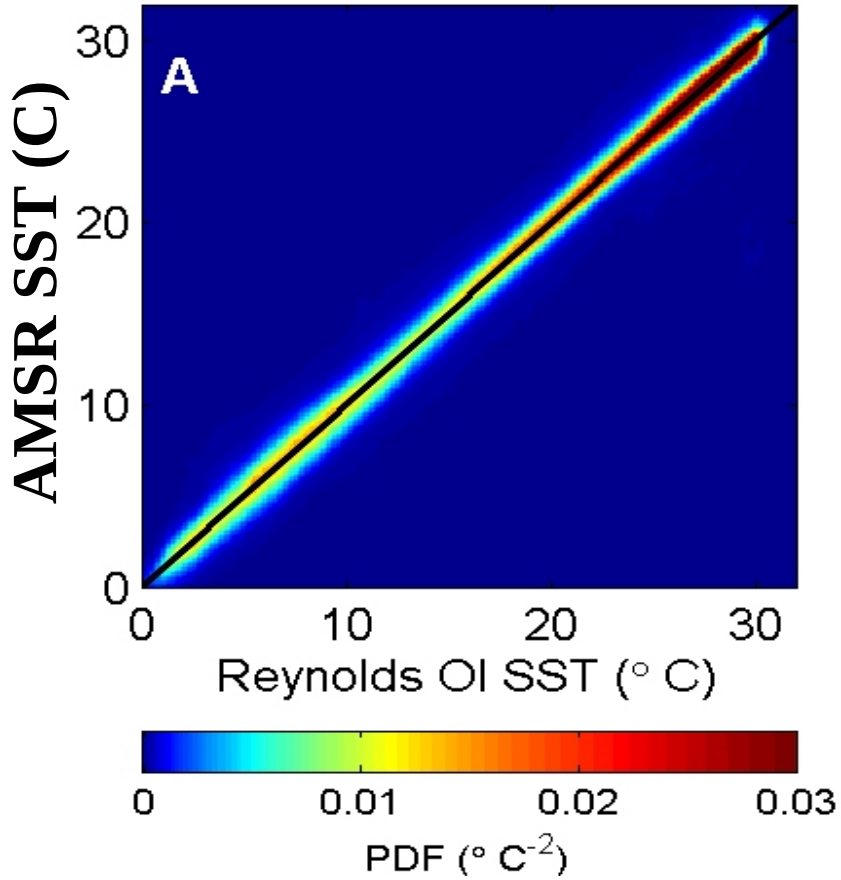
TMI SST Validation



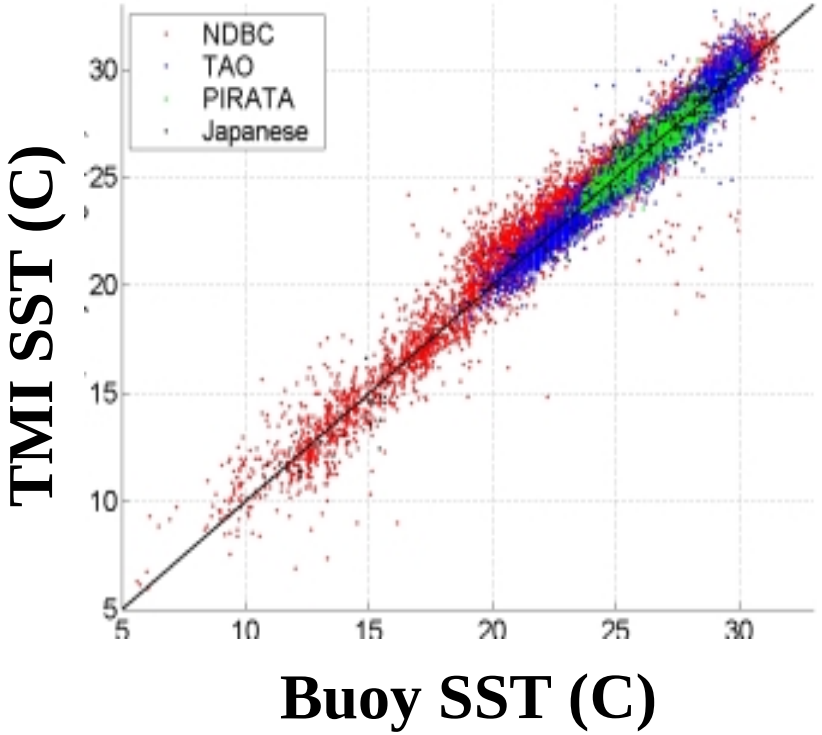
		Orbital Collocations TMI – Buoy SST	
	collocations	Mean Dif.	STD
TAO	28176	-0.08	0.57
PIRATA	4913	0.03	0.55
NDBC	19493	0.28	0.92

AMSR-E/TMI Validation

AMSR-E vs. Reynolds
STD=0.67 C

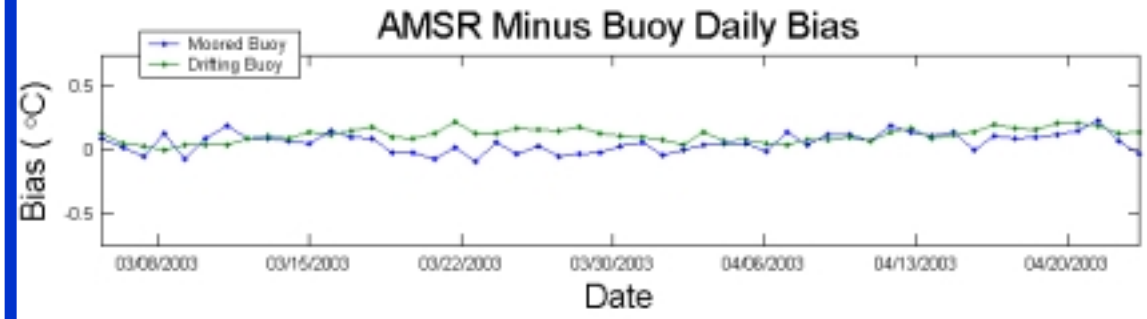


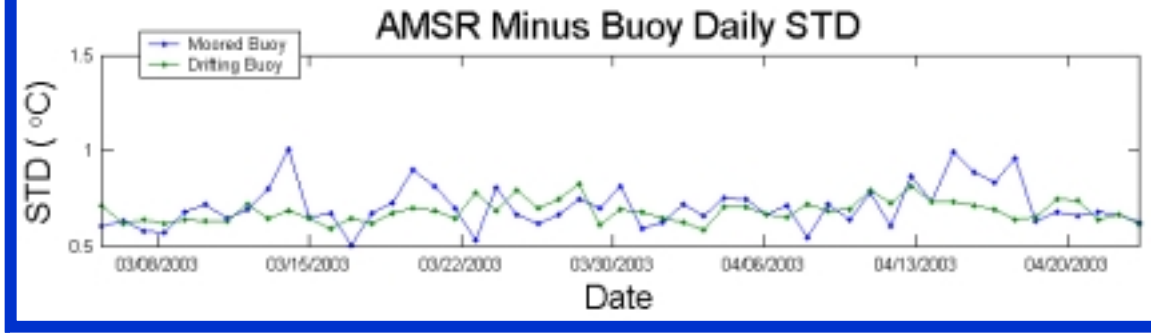
TMI vs. Buoy SSTs
STD=0.57 C

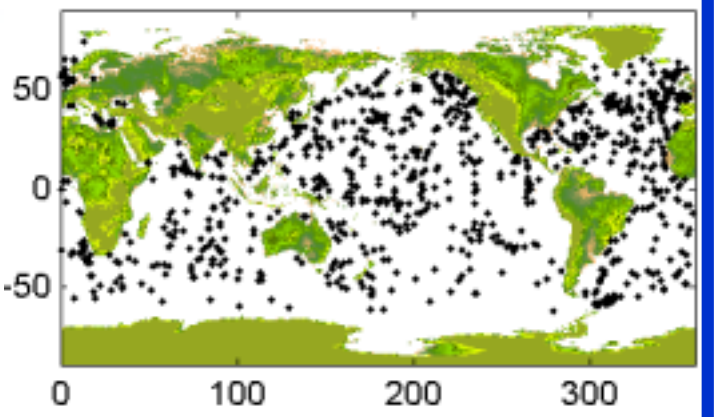


Near real time AMSR-E SST Validation Using Buoys & Ship Measurements from NRL-Monterey

- Updated twice daily
- Figures show last 50 days bias/std and locations of previous day collocations
- Complete collocated dataset available







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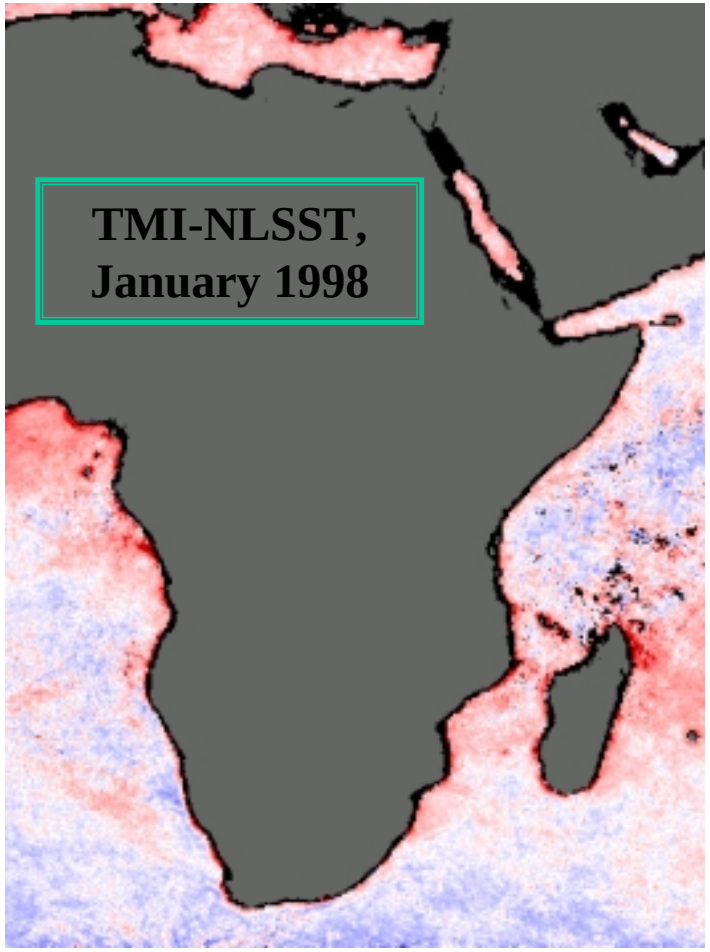
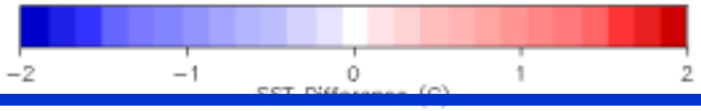
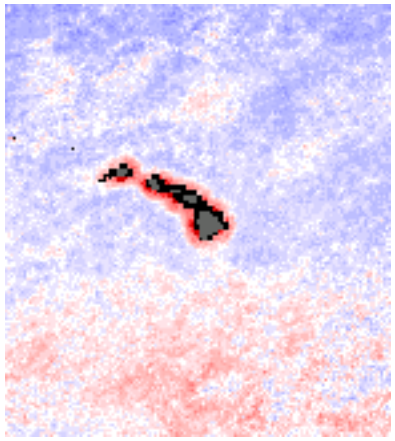
Land contamination in TMI & AMSR-E





- Microwave observations within 50-100 Km from land affected by warm emission by land ($1^{\circ}C$)

- WARM bias of coastal SSTs



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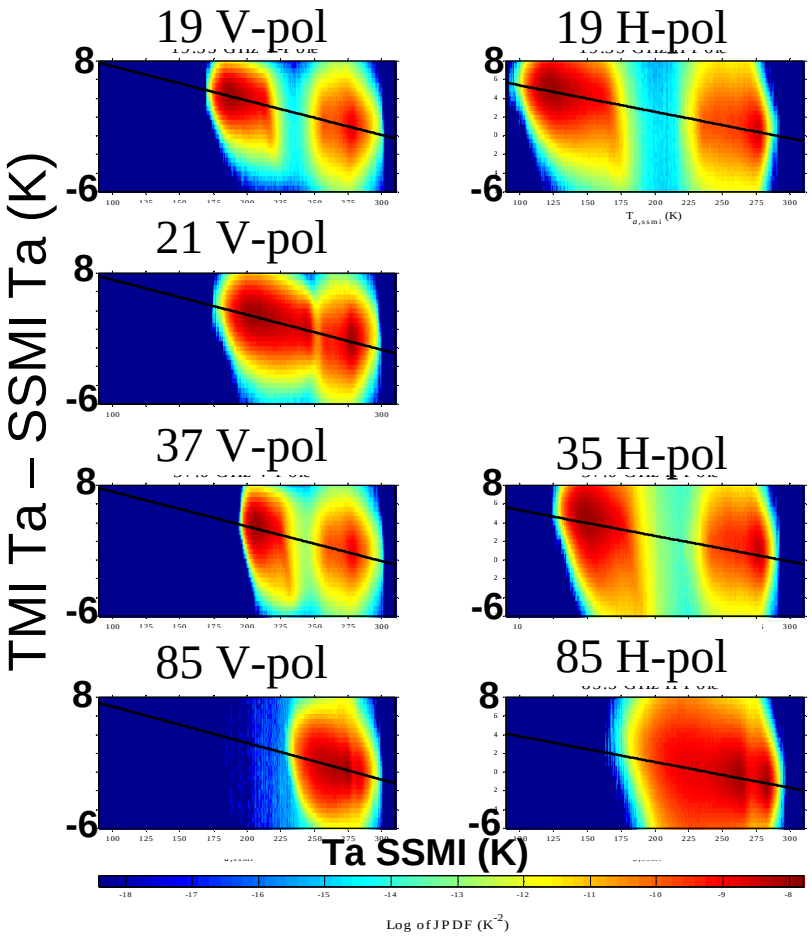
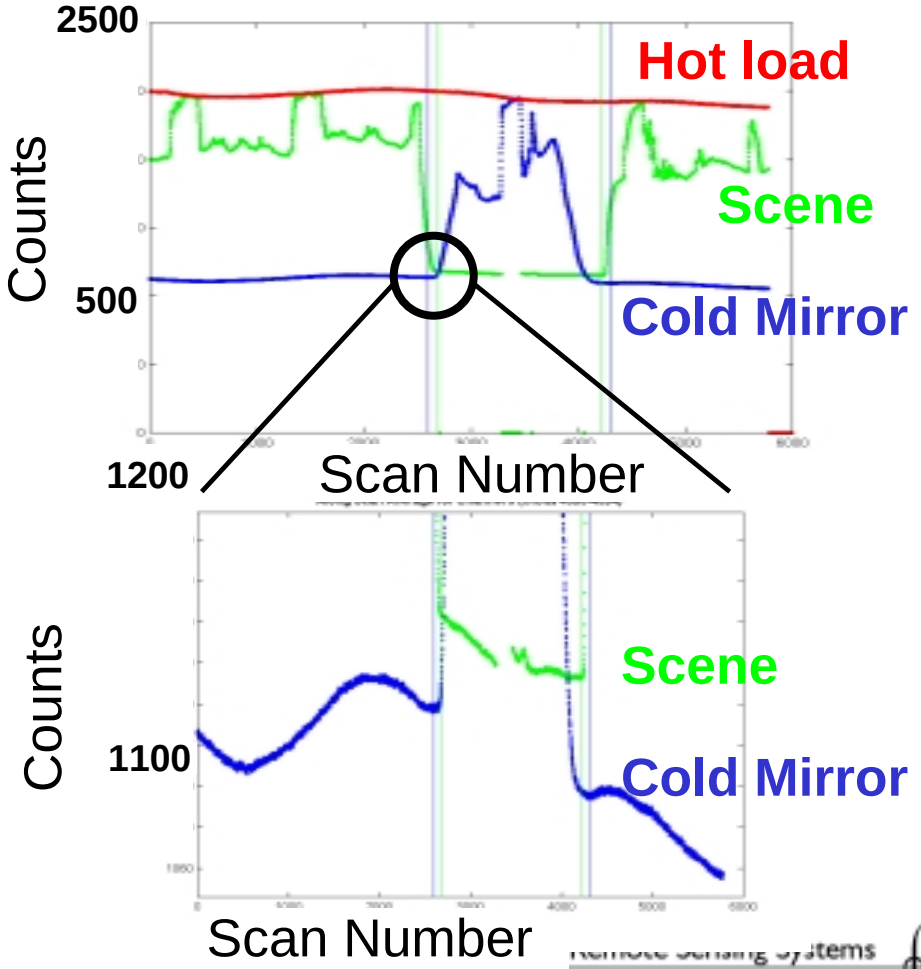
Initial Post-launch TMI inter-calibration

SSM/I Versus TMI Comparisons



TRMM Pitch-Over



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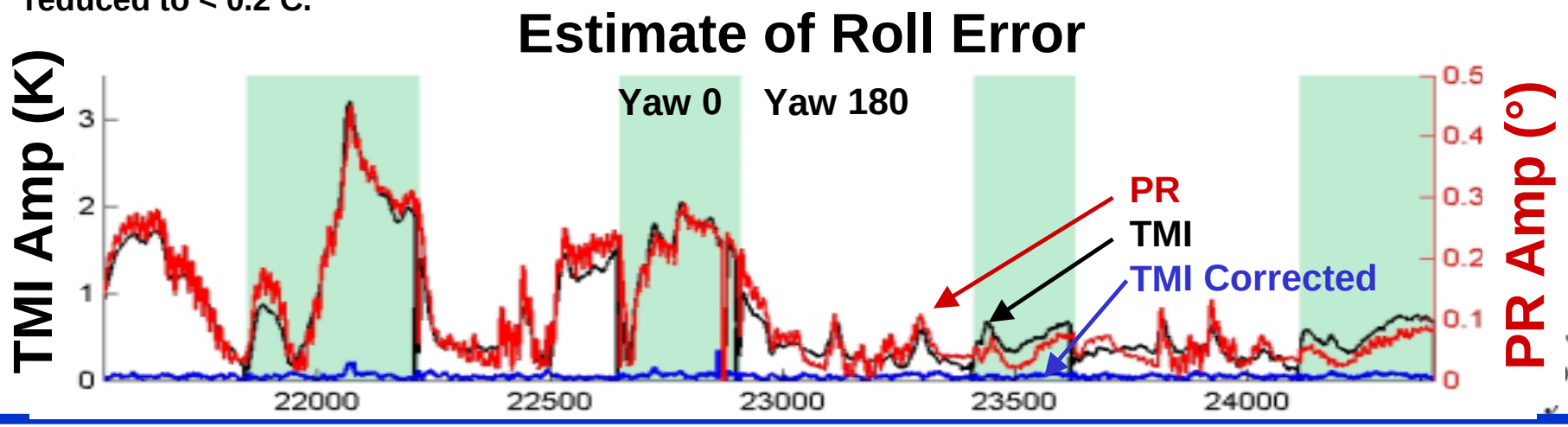
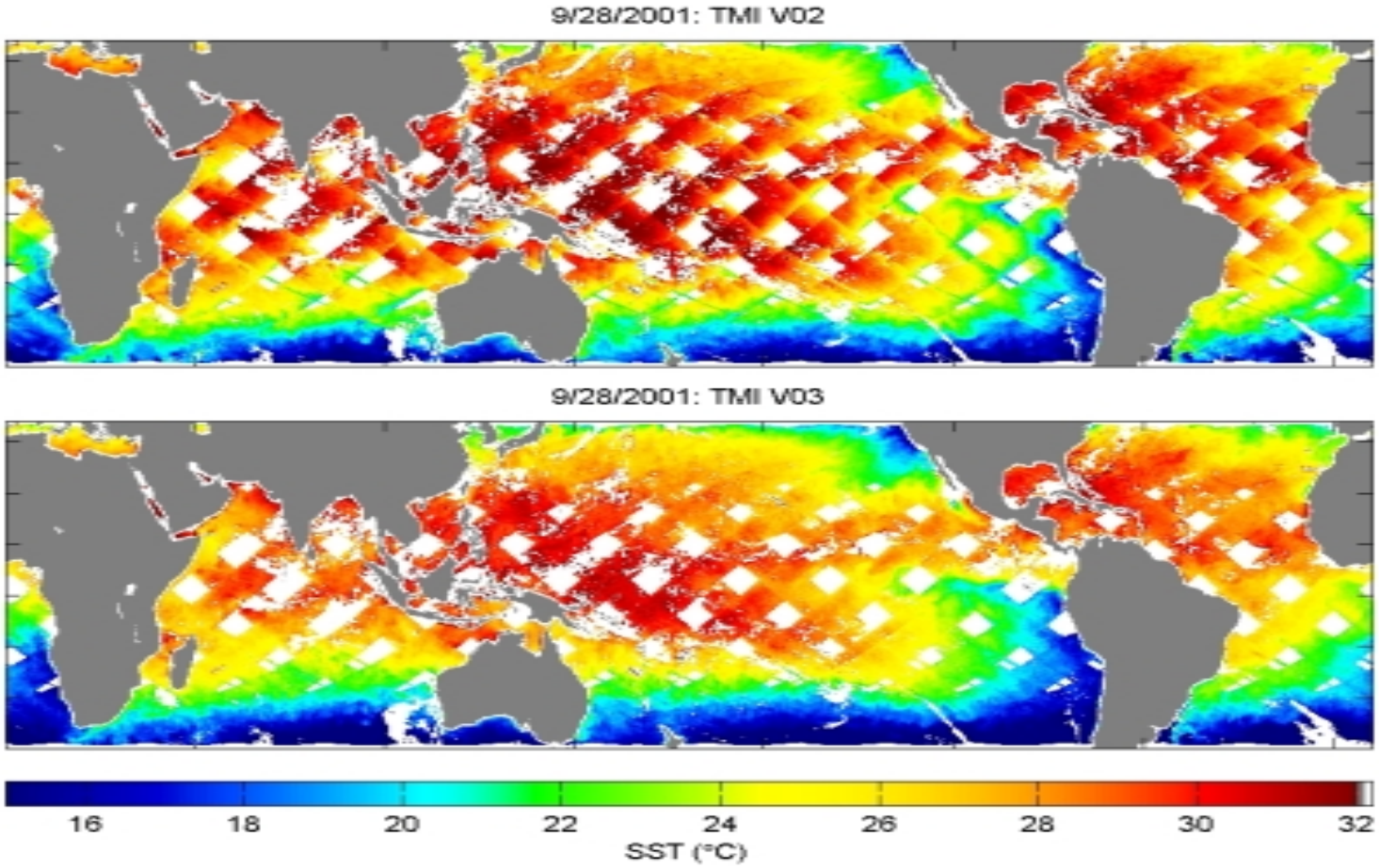
TMI Post-orbital Boost Roll Error

- On August 25, 2001 TRMM finished a maneuver to boost the altitude from 350 to 402 km.
- TRMM's attitude control system (ACS) controls yaw/pitch/roll based on onboard attitude estimates. Pre-boost ACS utilized an Earth horizon sensor for roll and pitch.
- The altitude increase resulted in the loss of the Earth horizon sensor, the ACS backup system uses a 'Kalman filter' with weighted input from the gyros, sun sensor, magnetometer.
- Post-boost errors in the PR rain and TMI SST were immediately apparent. Independent estimates of errors in roll from GSFC PR team (Red) and RSS TMI SST team (Black) are in close agreement.
- **Post-boost roll errors peaked at 0.5 degrees at the end of September -- these errors translate to 3 C errors in SST before correction. Using the RSS calibration developed, SST errors due to roll were reduced to < 0.2 C.**



Before and After SST Retrievals



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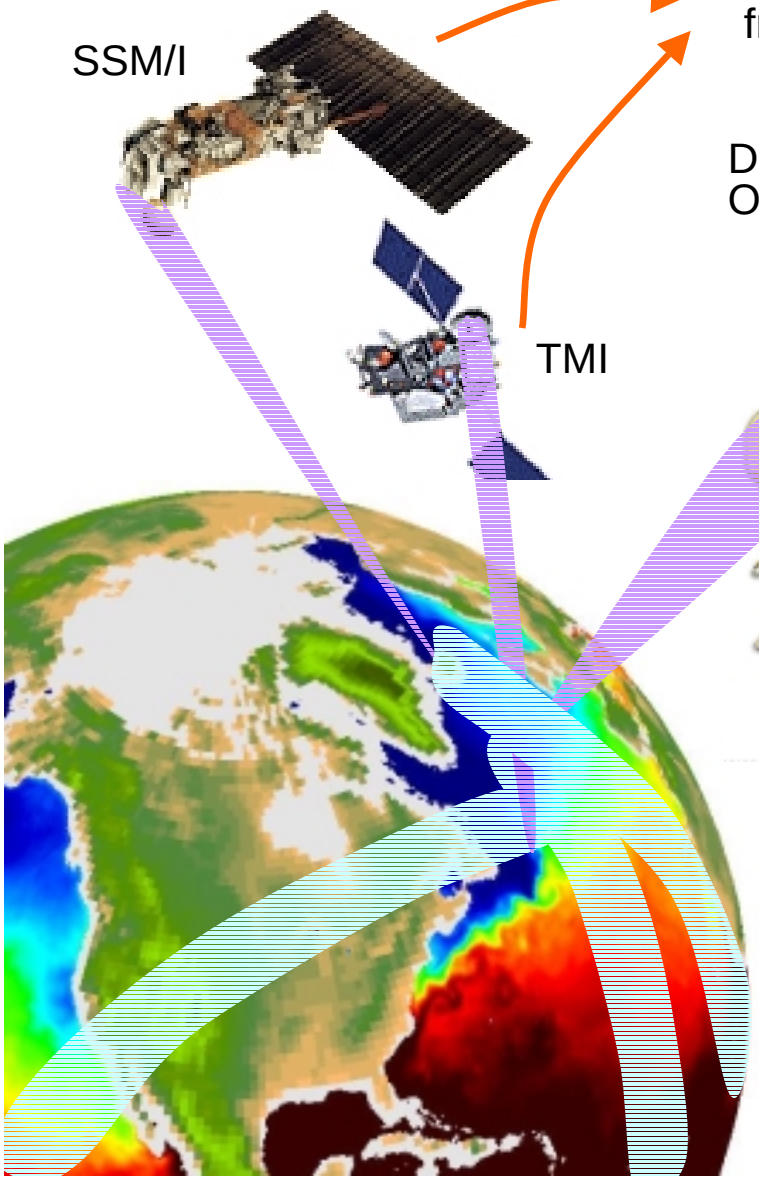
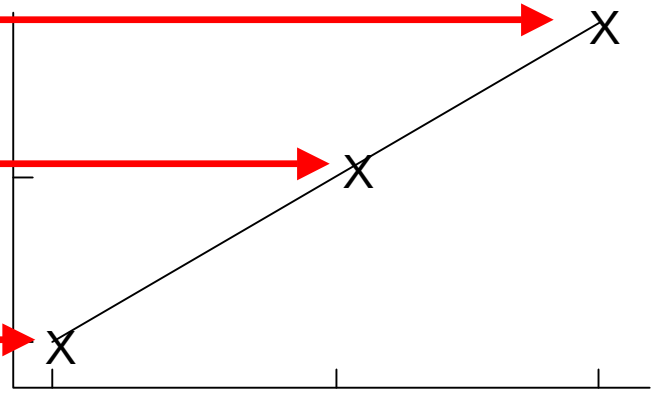
On-Orbit Calibration of AMSR-E Hot Load



Solution for Effective Hot Load Temperature

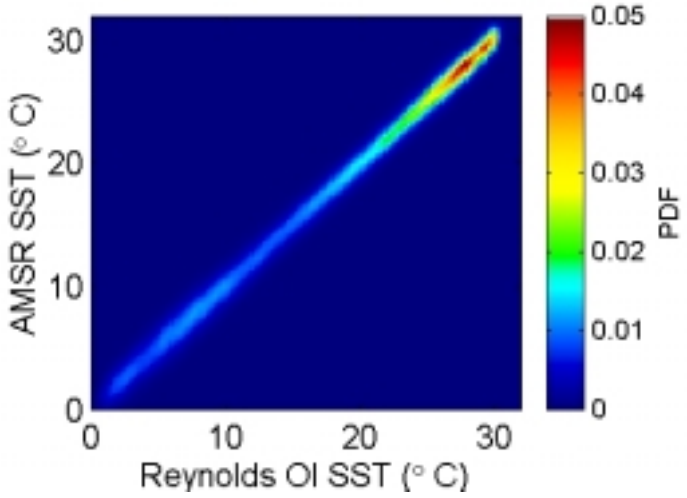
Earth Temperature from Satellite Network

Deep Space Observation = 2.7 K

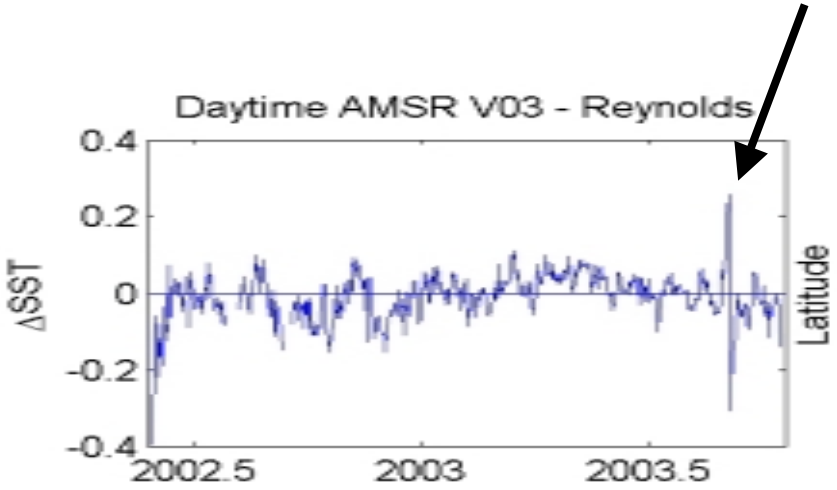


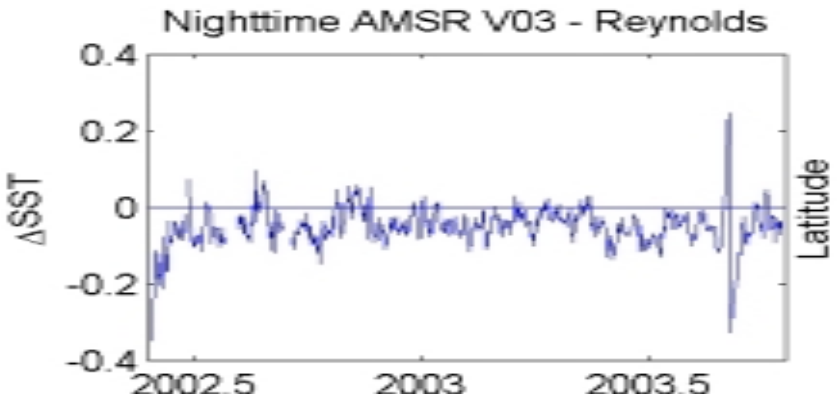
AMSR-E Radiometer Observations (Counts)

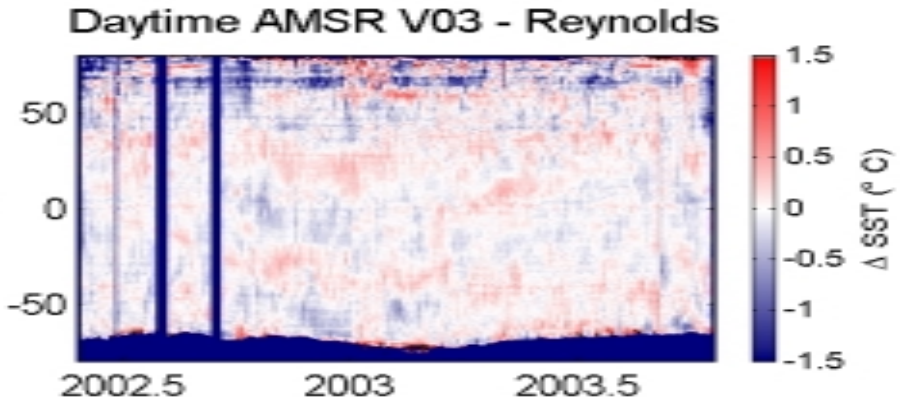
On-Orbit Calibration significantly improves accuracy of AMSR-E retrievals

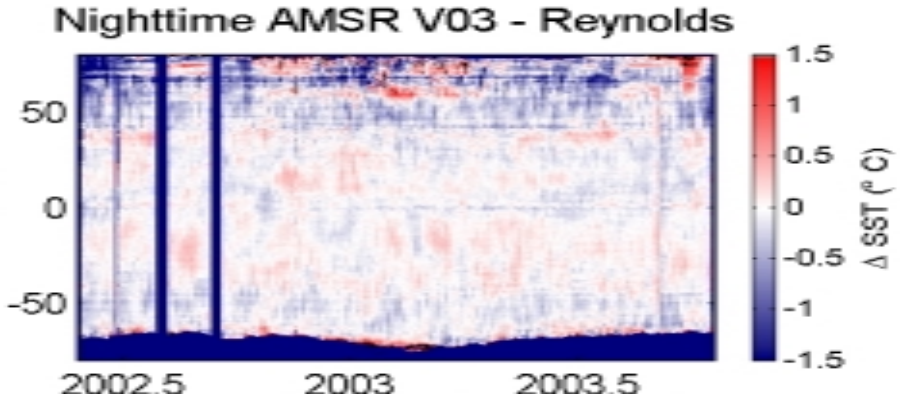


Aqua Pitch Error









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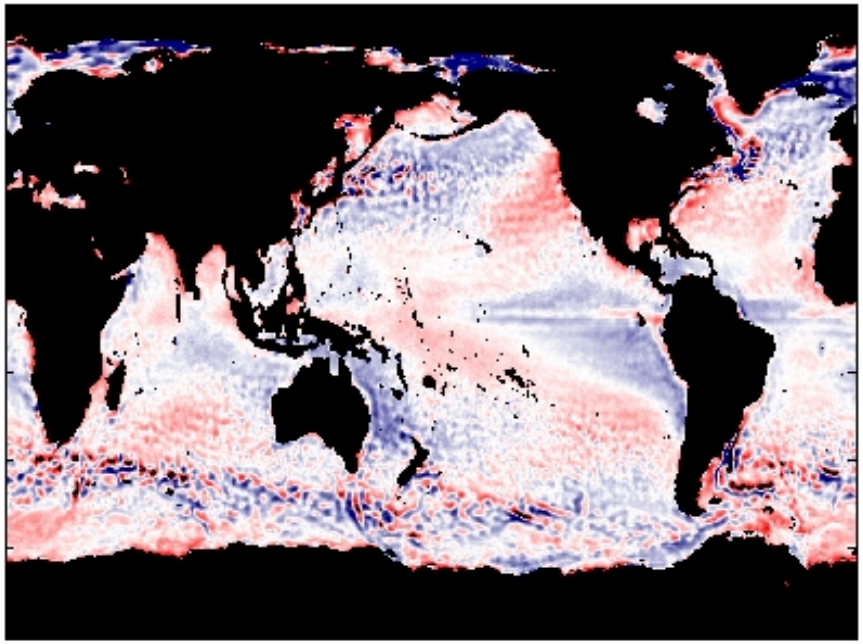
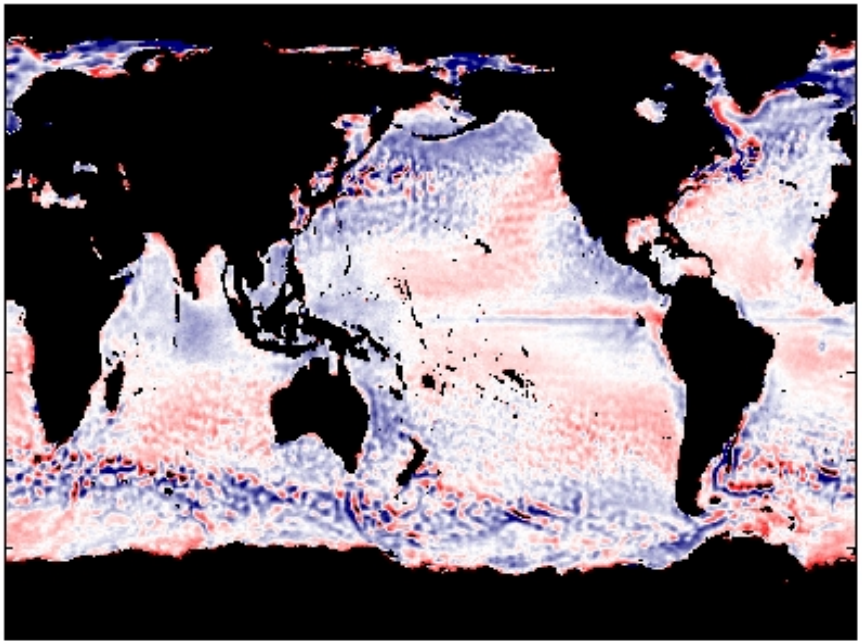
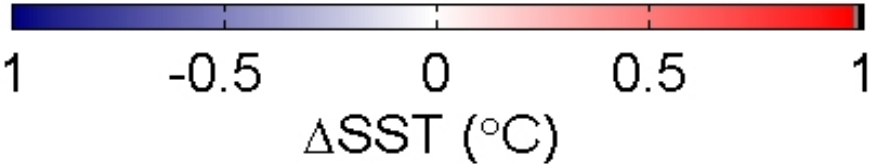
Global Difference : June 2001 – October 2003

AMSR-E Day - Reynolds



AMSR-E Night - Reynolds





Bias = -0.01 °C

STD = 0.67 °C

Bias = -0.05 °C

STD = 0.66 °C

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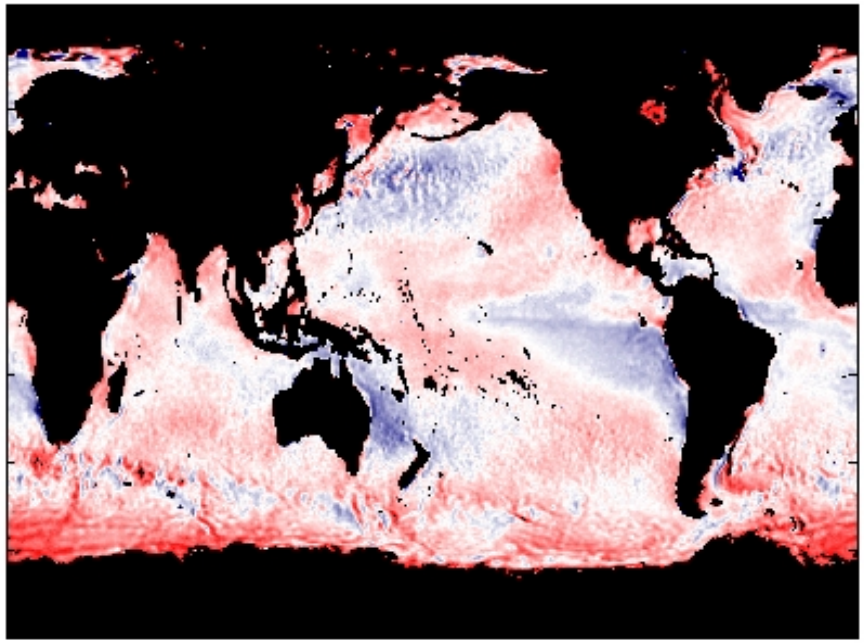
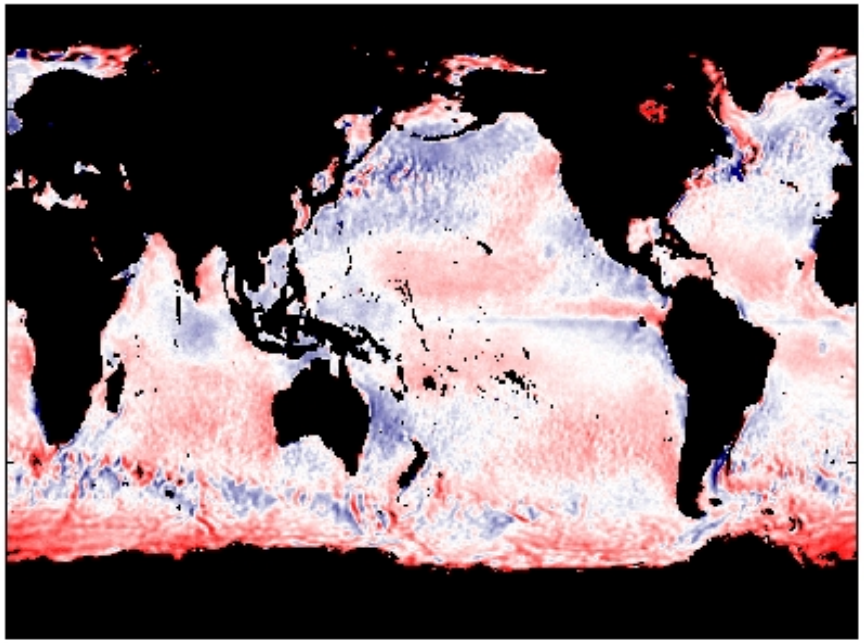
Global Difference: June 2001 – October 2003

AMSR-E Day - RTG SST



AMSR-E Night - RTG SST



Bias = 0.08 °C

STD = 0.66 °C

Bias = 0.05 °C

STD = 0.66 °C

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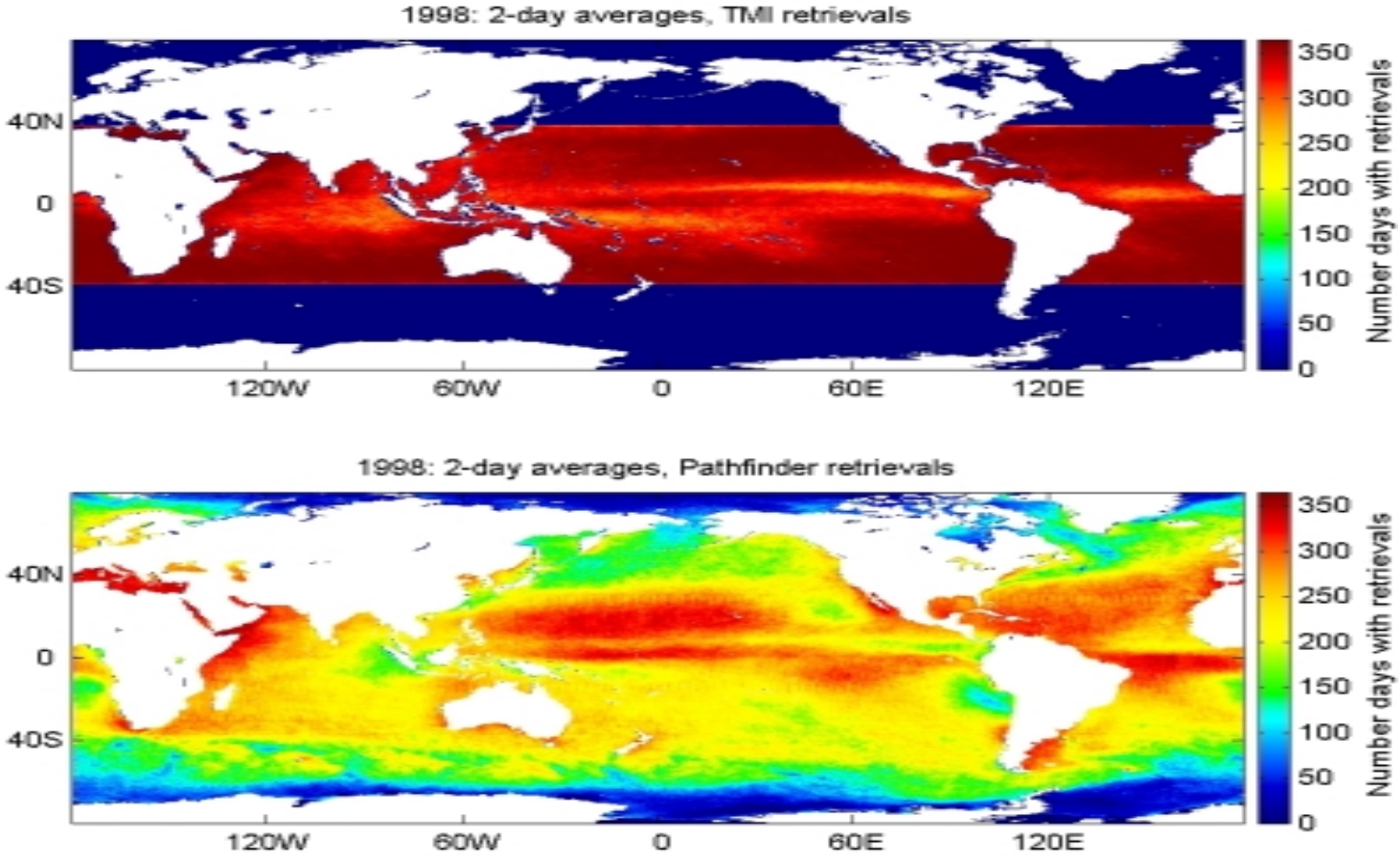
Better Coverage: IR/MW retrievals

NPOESS requirement: 6-hour revisit



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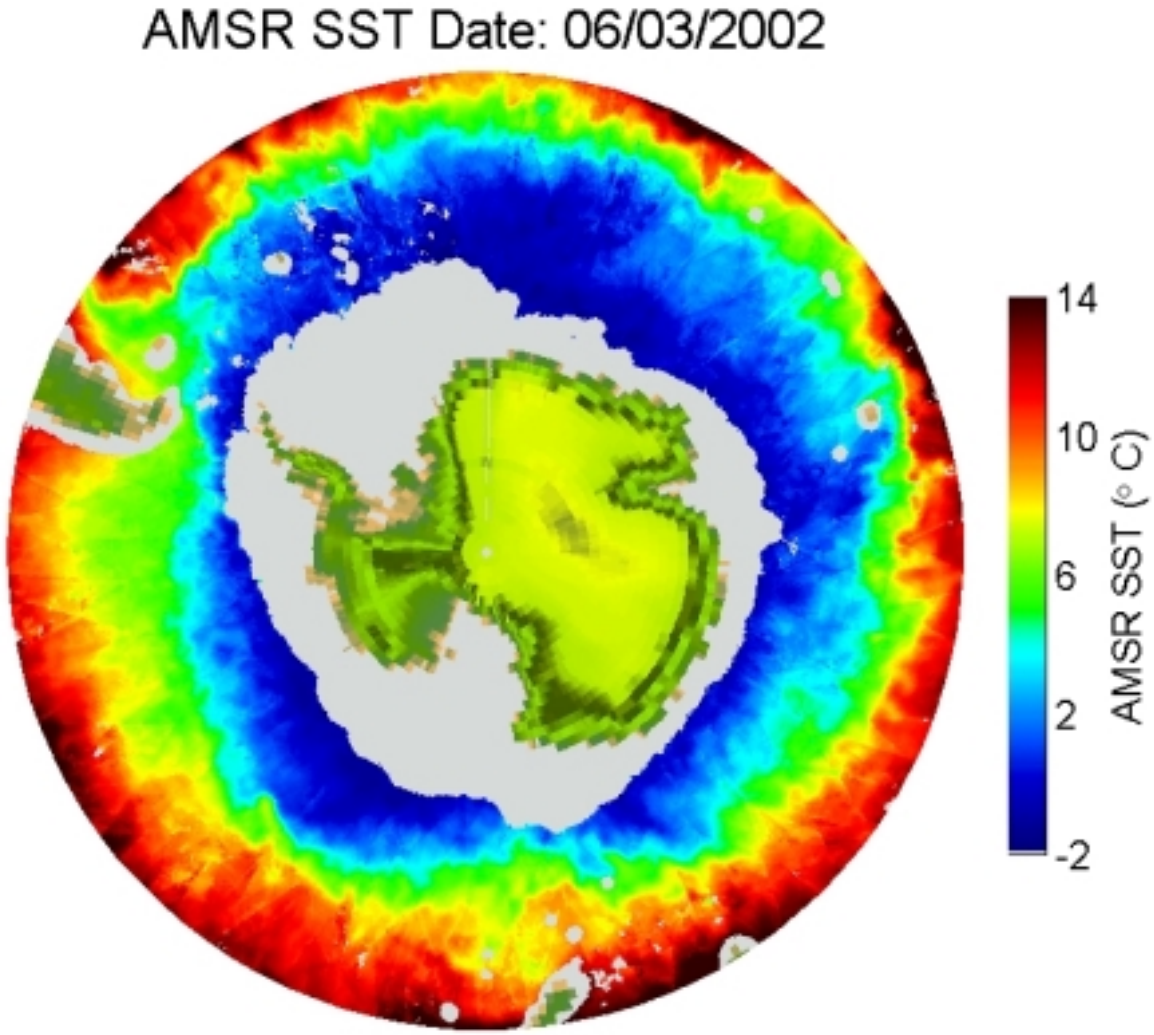
3-day average: Polar SST



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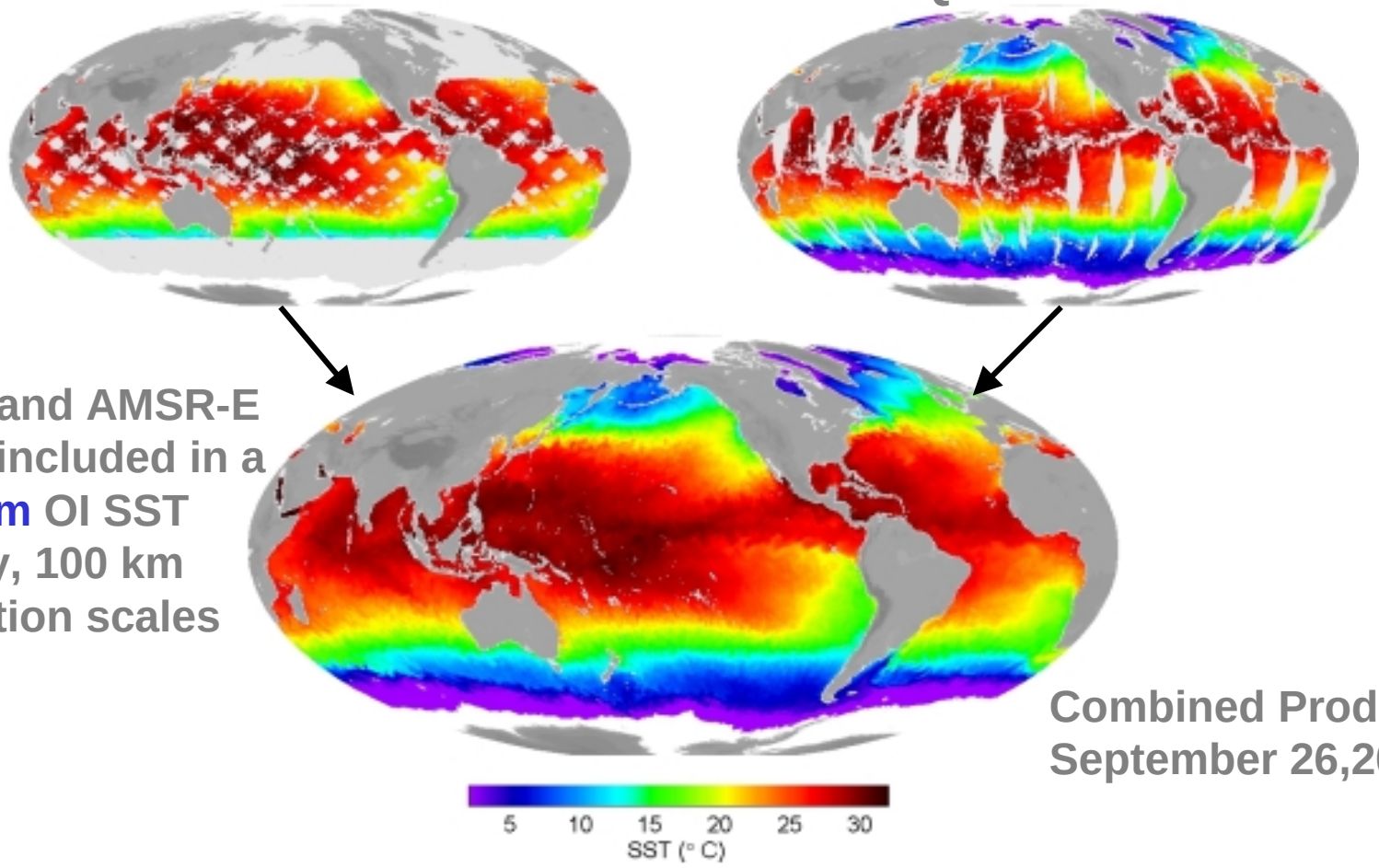
Optimally Interpolated TMI & AMSR-E SSTs

TRMM TMI

AQUA AMSR-E



Both TMI and AMSR-E SSTs are included in a daily, 25km OI SST with 1-day, 100 km decorrelation scales

Combined Product September 26,2002

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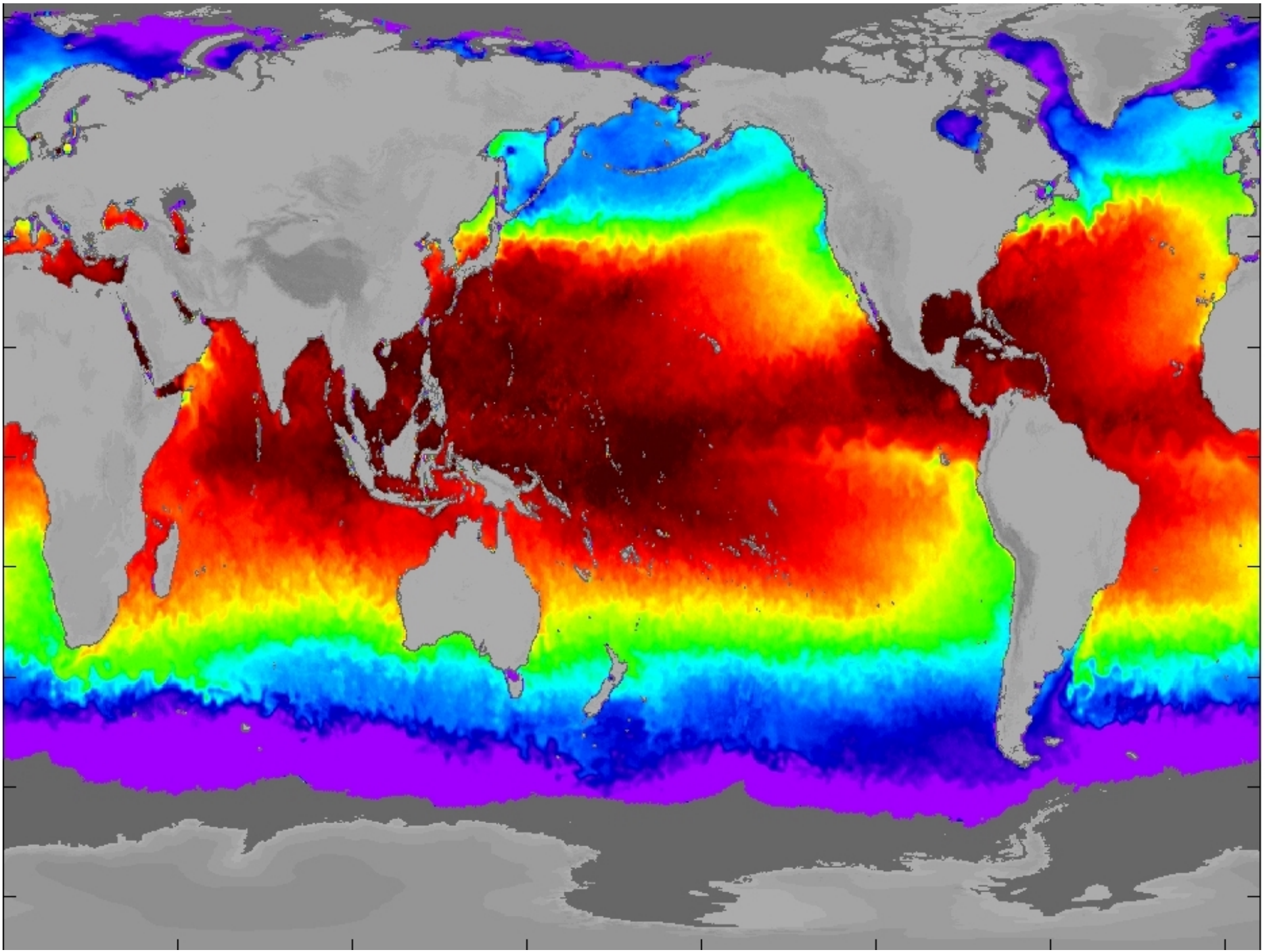
Conclusions:

- AMSR-E and TMI available in NRT
- Significant improvement in accuracy and coverage of polar SSTs
- Daily, high-resolution OI SSTs for TMI, AMSR-E, and TMI+AMSR-E available as research product in NRT
- www.remss.com
- STD 0.67 and 0.57 (AMSR-E and TMI)



The Next 20 Years

Mission/Sensor	Dates	Comments
ADEOS-2 AMSR + SeaWinds	2002-2003	Radiometer and Scatterometer Died: October 25, 2003
AQUA AMSR-E	2002-2005	Complements ADEOS-2 Coverage
WindSat (Navy)	2002-2005	Two-Look Polarimetric Radiometer
GCOM B-1 AMSR + α-SCAT	2006-2010 (?)	Radiometer and Scatterometer
NPOESS CMIS	2009 -2020	Single-Look Polarimetric Radiometer (?)

Improved Performance

6.9, 10.7, 19, 23, 37, 90 GHz

2 meter antenna

50 km resolution, 1600 km swath

Better Pre-launch Calibration

Supplementary information on wind

SST Accuracy 0.2 C for 3-day averages at 50-km resolution

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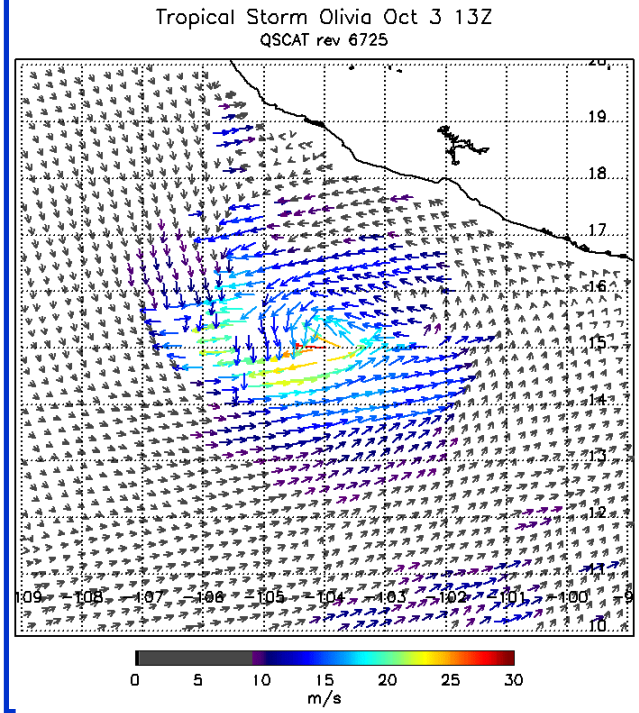
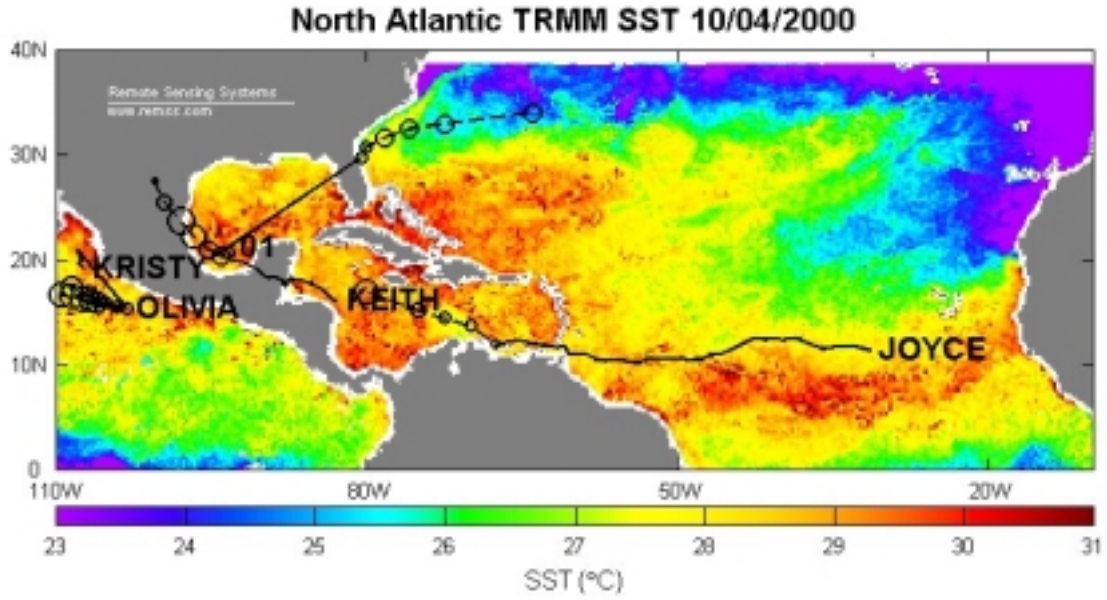
Storm Type	Storm Name	Forecast	Date	Time (UT)	Latitude (deg)	Longitude (deg)	Wind (m/s)	Pressure (mb)	TMI SST (C)
STO	OLIVIA	00 hr	10/ 4/2000	21:00	16.00	253.90	28.32	994	27.25
???	OLIVIA	12 hr	10/ 5/2000	6:00	16.10	253.30	28.32	???	27.55
???	OLIVIA	24 hr	10/ 5/2000	18:00	16.30	252.50	30.90	???	27.87
???	OLIVIA	36 hr	10/ 6/2000	6:00	16.50	251.50	30.90	???	28.08
???	OLIVIA	48 hr	10/ 6/2000	18:00	16.70	250.50	33.48	???	28.05
???	OLIVIA	72 hr	10/ 7/2000	18:00	17.00	248.50	26.27	???	27.50

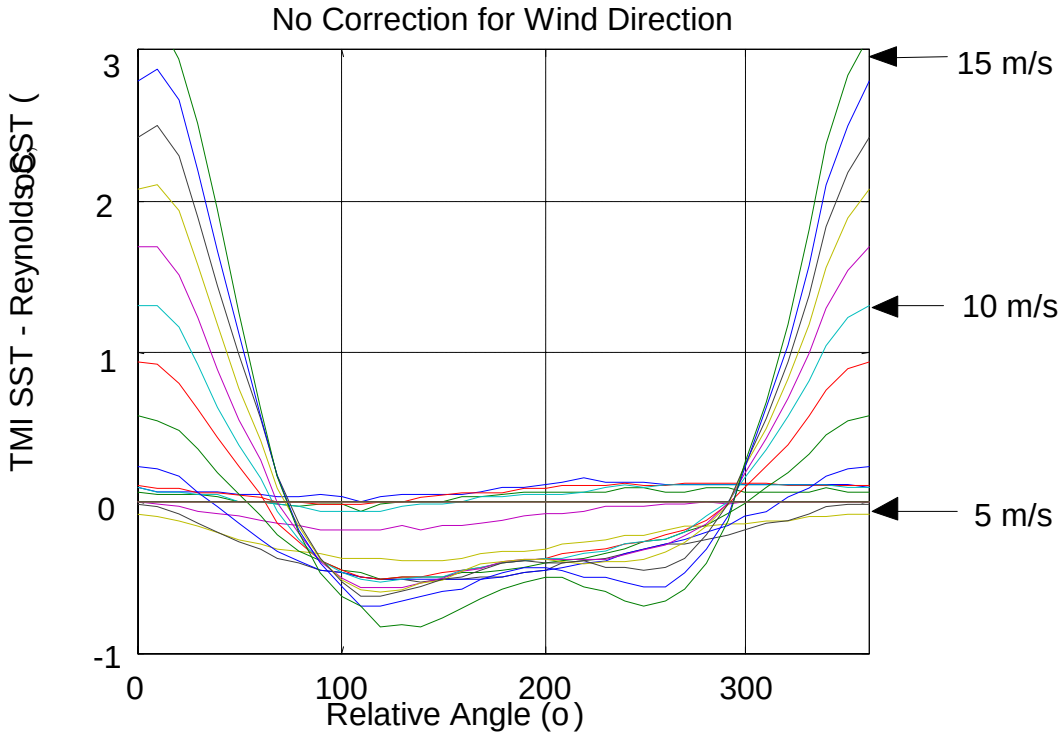





TRMM
NASDA


AMSR-E

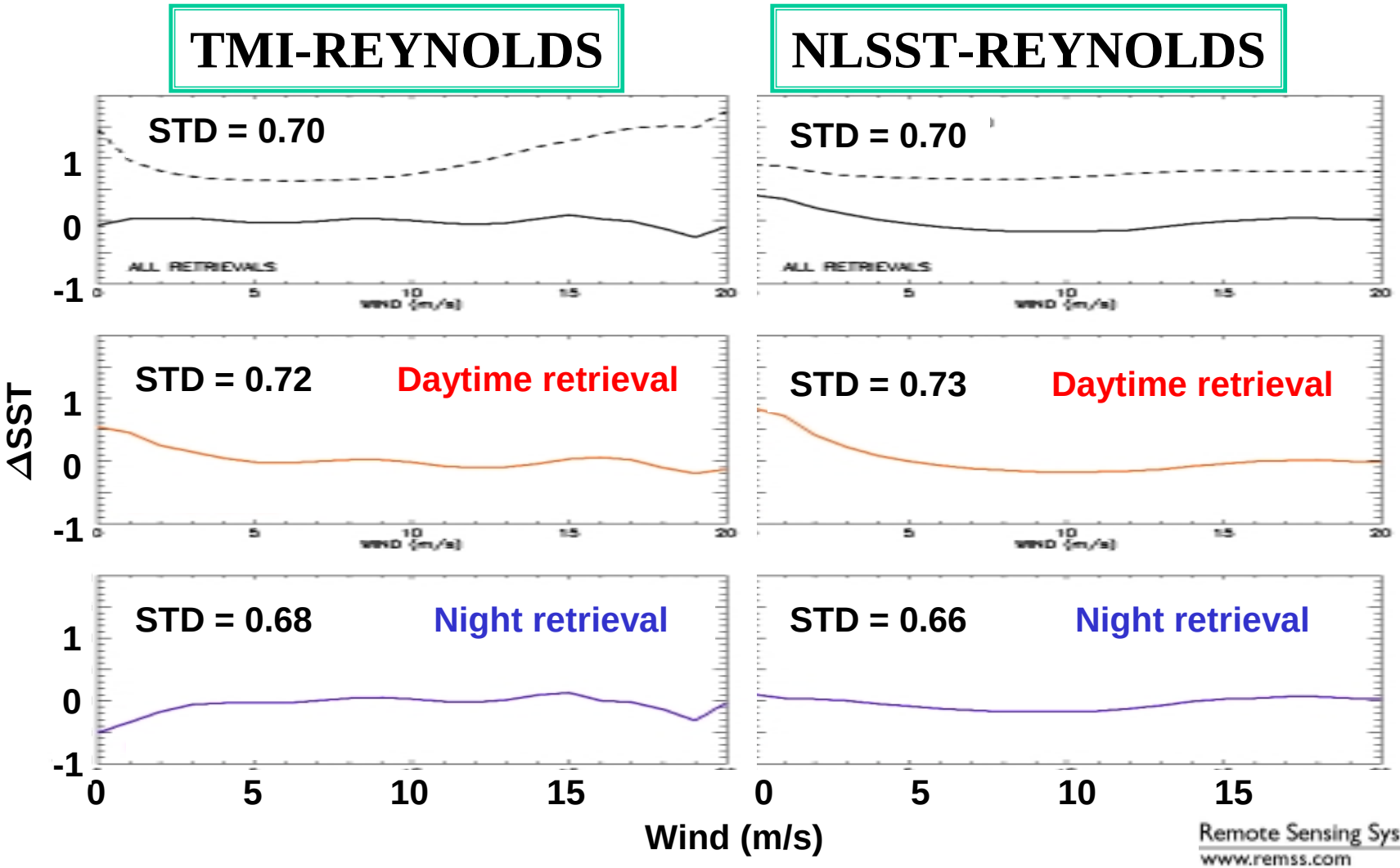
Wind Direction Effects



Effect of wind direction on SST retrievals. Reynolds SST, which should have no wind direction dependence, is subtracted from TMI SST. No correction for wind direction has been applied to the TMI SST. This difference is binned according to wind speed and is plotted versus the relative wind direction, which is the satellite's azimuthal viewing angle minus wind direction (from NCEP). The colored curves show the results for each wind speed bin from 0 to 15 m/s, in 1 m/s steps. At low wind speeds (< 5m/s) there is no appreciable error. Above 5 m/s the peak-to-peak amplitude of the error increases to a maximum of 4ºC when winds are 15 m/s.

Wind effects on TMI SSTs

Ocean MW emissivity changes at high winds due to increased sea roughness
Wind correction needed for MW SST retrievals: no Bias but higher StDev.



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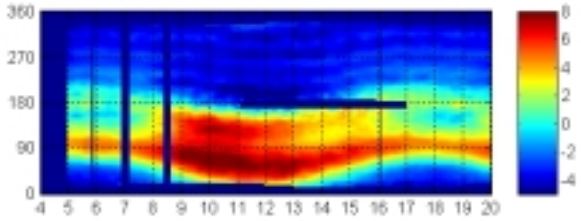
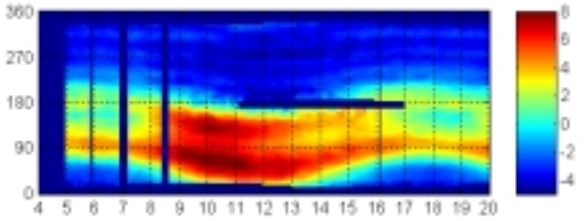
Effective Temperature of Hot Load (Versus Latitude and Month)

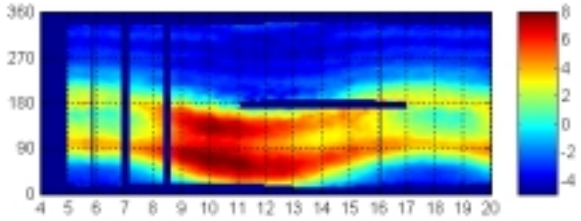
7 GHz



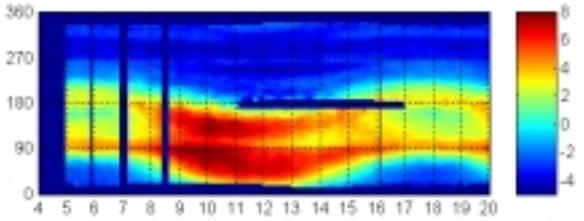
11 GHz



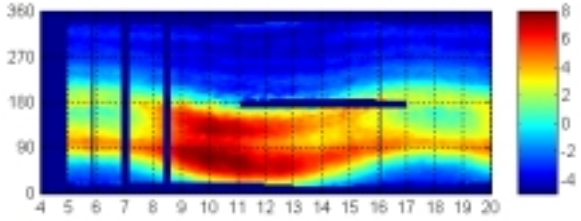
19 GHz



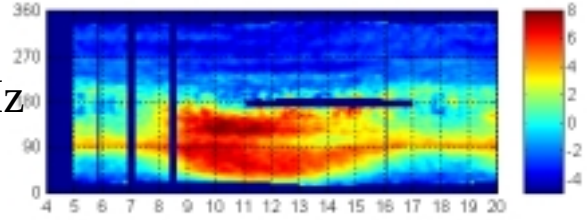
23 GHz



37 GHz



89A GHz



89B GHz