Climate Data Records of Sea-Surface Temperature

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Outline

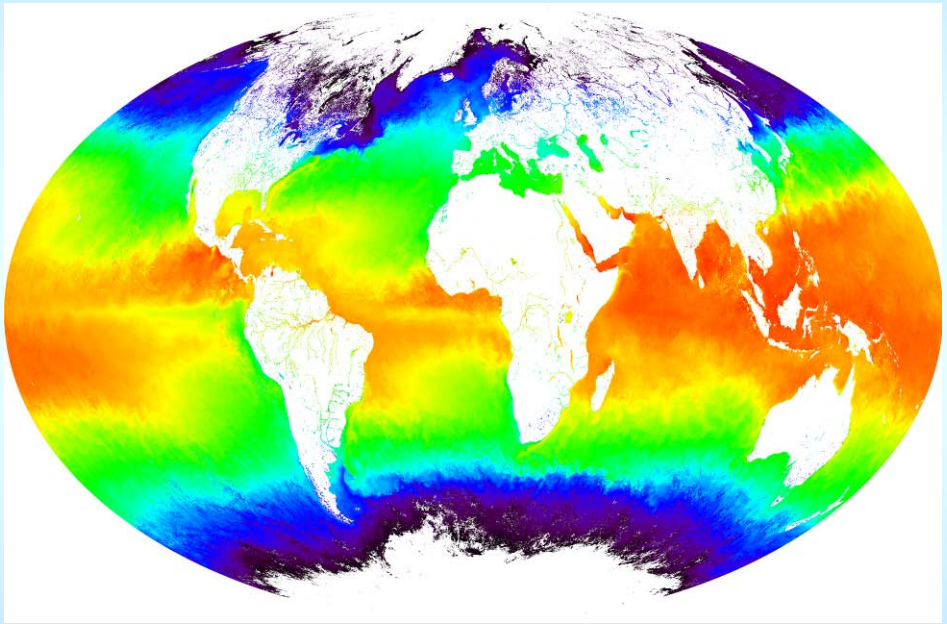
- Brief Project Overview
- Approach to generating SST CDRs
- Background to SST
- Results/Accomplishments
- Validation Strategy/Results
- Algorithm/Product Maturity
- Issues/Risks & Work-Off Plans
- Schedule
- Research-to-Operations or Delivery Plan
- Resources

Overview

- Goals:
  - -To establish uncertainty characteristics of several satellite-derived SST data sets
  - - Provide traceability to NIST standards for CDRs
- Source Data:
  - - Satellite-derived SSTs
  - - Ship-based radiometric skin SSTs
  - - Calibration of ship-based radiometers using NIST references
- Deliverables:
  - - Uncertainty characteristics of several satellite-derived SST data sets
- ECVs addressed:
  - - Sea-surface temperature (SST)
- Current/expected user communities:
  - - NWP, Ocean Forecasting, Climate research, Oceans & Human Health

Approach: Generating CDRs of SST

- The generation of CDRs of SSTs requires traceability to National SI Standards.
- In the US that is traceability to NIST thermometric & radiometric references.



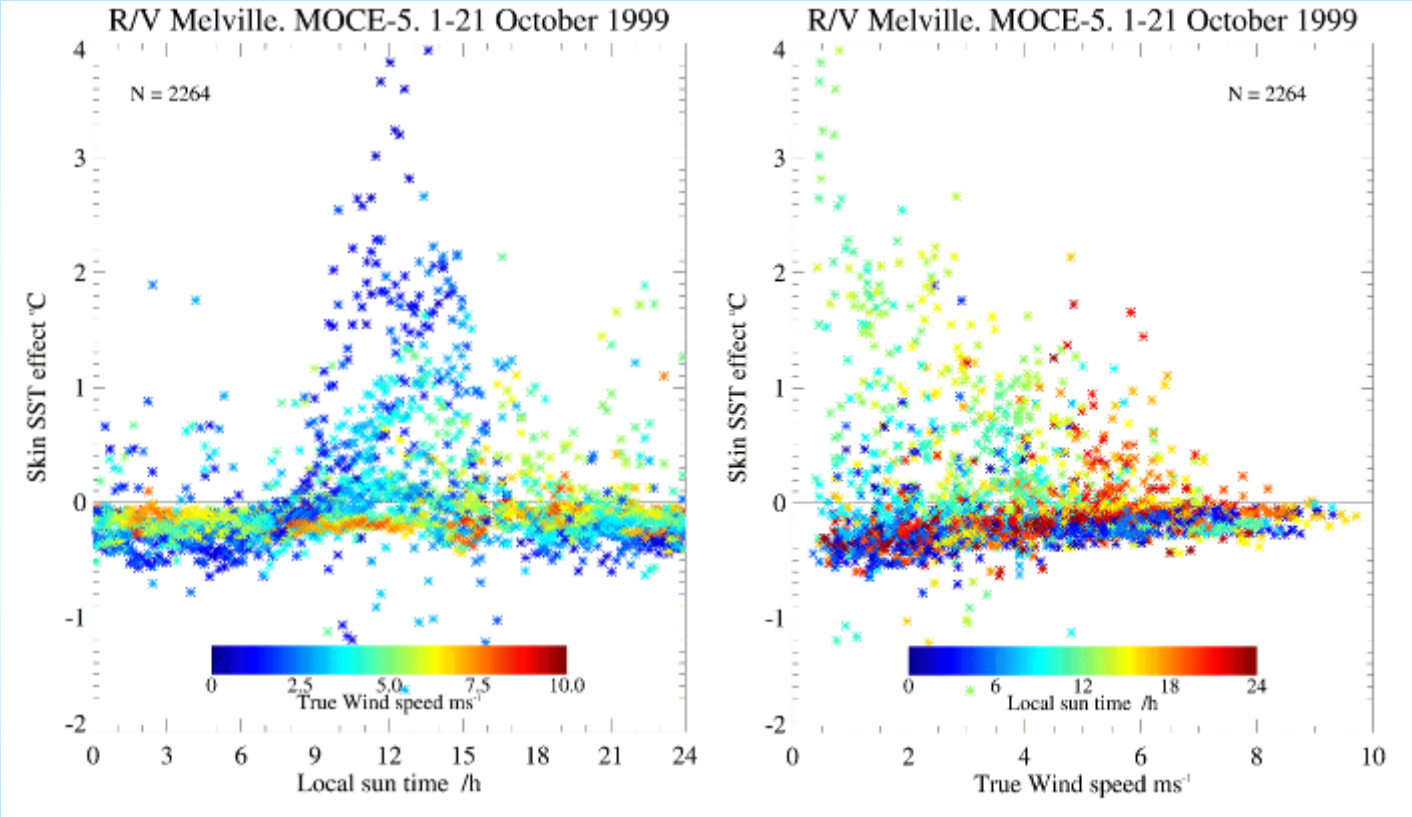
Approach: Generating CDRs of SST

- Validation by ship-board radiometers to determine the error characteristics of the satellite retrievals.
- CDRs from MODIS already done (continuing). This project to generate CDRs for AVHRRs, AMSR-E, SEVIRI & ….
- Lead into VIIRS.

Background: Skin – bulk SST differences

Example of wind speed dependence of diurnal & skin effects – off Baja California.

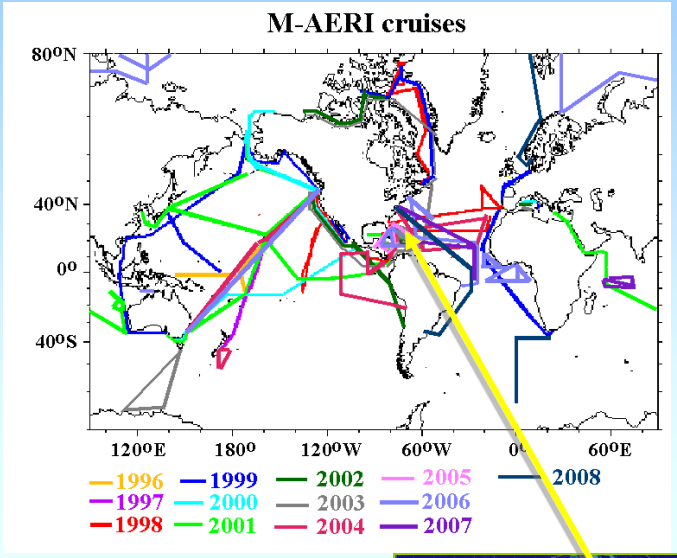
These, or uncertainties in their corrections, contribute to the errors attributed to the satellite retrievals.

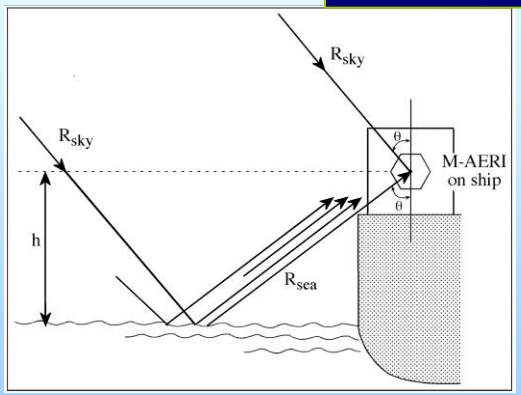


From: Minnett, P. J., 2003: Radiometric measurements of the sea- surface skin temperature - the competing roles of the diurnal thermocline and the cool skin. International Journal of Remote Sensing, 24, 5033- 5047.

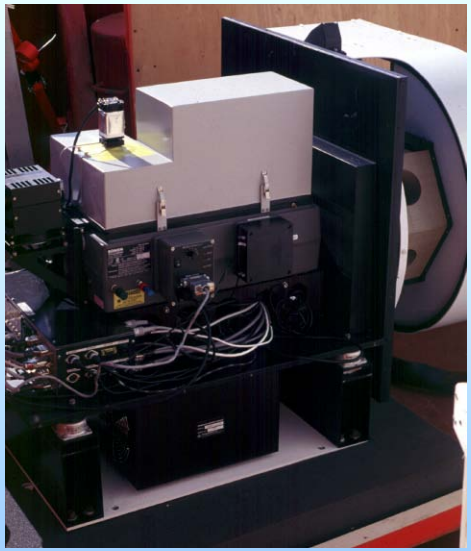
Surface radiometry

- Use ship-based radiometers, e.g. M-AERI & ISAR (and others from other groups).
- M-AERI is the reference standard for MODIS SST retrievals and for other ship-board radiometers.





Marine- Atmospheric Emitted Radiance Interferometer (M- AERI)



Laboratory tests of M-AERI accuracy

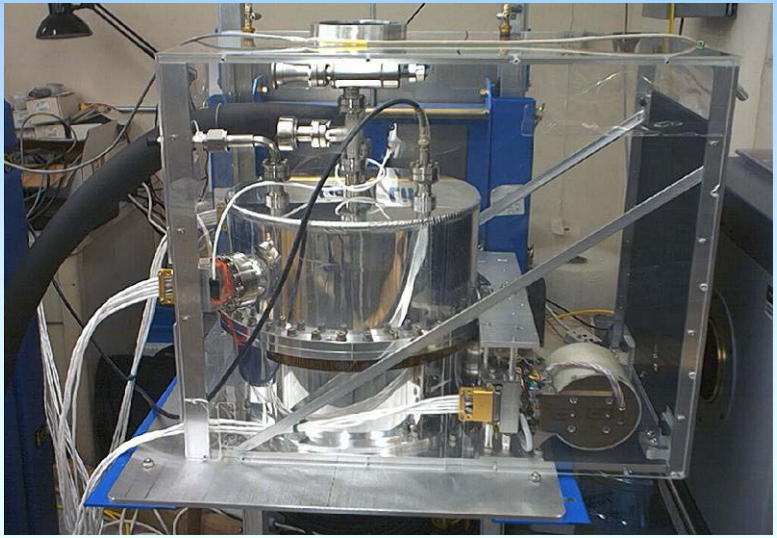
Target Temp.	LW (980-985 cm^{-1})	SW (2510-2515 cm^{-1})
20°C	+0.013 K	+0.010 K
30°C	-0.024 K	-0.030 K
60°C	-0.122 K	-0.086 K

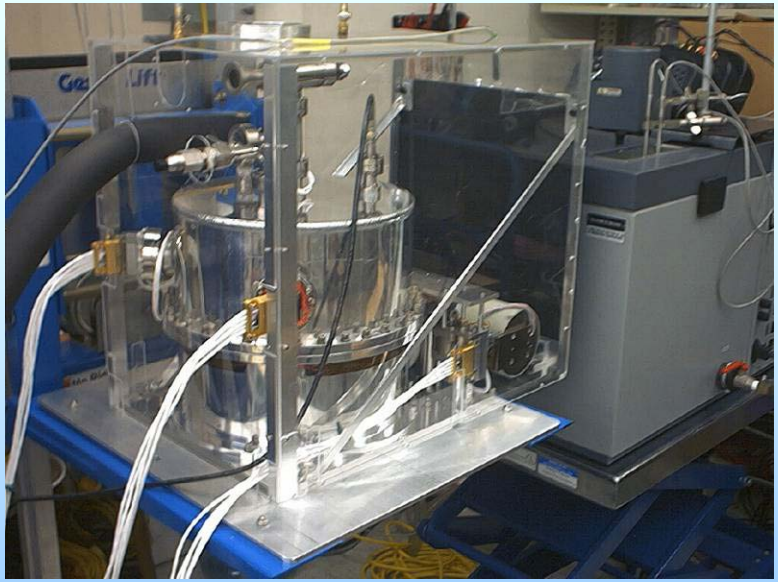
The mean discrepancies in the M-AERI 02 measurements of the NIST – characterized water bath blackbody calibration target in two spectral intervals where the atmosphere absorption and emission are low. Discrepancies are M-AERI minus NIST temperatures.

Specifications	
Spectral interval	~3 to ~18μm
Spectral resolution	0.5 cm^{-1}
Interferogram rate	1Hz
Aperture	2.5 cm
Detectors	InSb, HgCdTe
Detector temperature	78°K
Calibration	Two black-body cavities
SST retrieval uncertainty	<<0.1K (absolute)

Constructed by SSEC, U. Wisconsin - Madison

Traceable to National Standards: NIST EOS TXR





EOS Standard
Cryogenic detectors (liquid N_2)
□= 5 & 10μm

Rice, J. P. and B. C. Johnson, 1998. The NIST EOS Thermal-Infrared Transfer Radiometer, *Metrologia*, 35, 505-509.

SST (& LST) radiometers - 2009

3rd Miami IR Radiometry Workshop

Validation Strategy

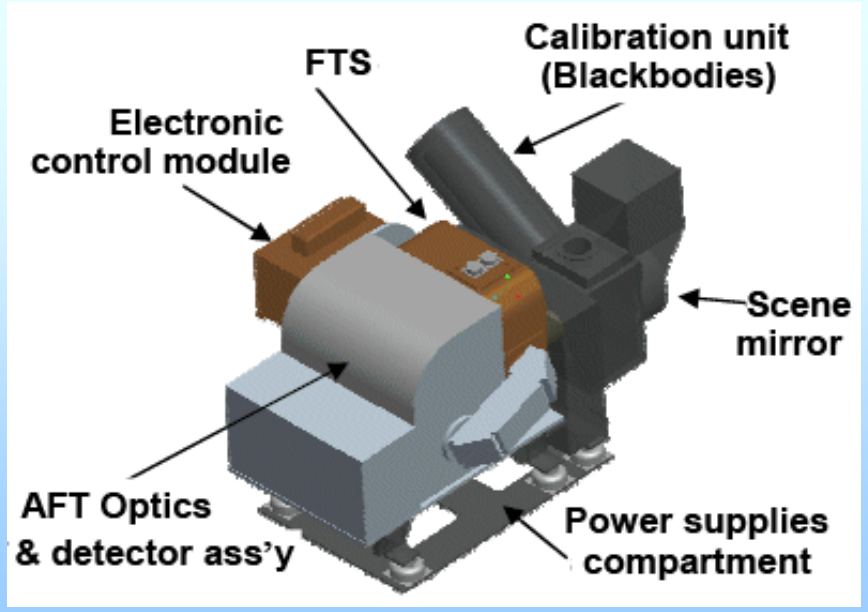
- The radiometric SSTs provide the validation of the satellite SSTs and determine the uncertainty characteristics of the satellite SST fields.
- Continue to retain traceability to NIST (or UK NPL) within the CEOS framework.
- Continue activities within GHRSST.
- Use radiometric and sub-surface SSTs to continue studies of diurnal heating and skin effect.

Product Maturity (SST) & M- AERI/ISAR validation

Maturity	Sensor Use	Algorithm stability	Metadata & QA	Documentation	Validation	Public Release	Science & Applications
1	Research Mission	Significant changes likely	Incomplete	Draft ATBD	Minimal	Limited data availability to develop familiarity	Little or none
2	Research Mission	Some changes expected	Research grade (extensive)	ATBD Version 1+	Uncertainty estimated for select locations/times	Data available but of unknown accuracy; caveats required for use.	Limited or ongoing
3	Research Missions	Minimal changes expected	Research grade (extensive); Meets international standards	Public ATBD; Peer-reviewed algorithm and product descriptions	Uncertainty estimated over widely distributed times/location by multiple investigators; Differences understood.	Data available but of unknown accuracy; caveats required for use.	Provisionally used in applications and assessments demonstrating positive value.
4	Operational Mission	Minimal changes expected	Stable, Allows provenance tracking and reproducibility; Meets international standards	Public ATBD; Draft Operational Algorithm Description (OAD); Peer-reviewed algorithm and product descriptions	Uncertainty estimated over widely distributed times/location by multiple investigators; Differences understood.	Data available but of unknown accuracy; caveats required for use.	Provisionally used in applications and assessments demonstrating positive value.
5	All relevant research and operational missions; unified and coherent record demonstrated across different sensors	Stable and reproducible	Stable, Allows provenance tracking and reproducibility; Meeting international standards	Public ATBD, Operational Algorithm Description (OAD) and Validation Plan; Peer-reviewed algorithm, product and validation articles	Consistent uncertainties estimated over most environmental conditions by multiple investigators	Multi-mission record is publicly available with associated uncertainty estimate	Used in various published applications and assessments by different investigators
6	All relevant research and operational missions; unified and coherent record over complete series; record is considered scientifically irrefutable following extensive scrutiny	Stable and reproducible; homogeneous and published error budget	Stable, Allows provenance tracking and reproducibility; Meeting international standards	Product, algorithm, validation, processing and metadata described in peer-reviewed literature	Observation strategy designed to reveal systematic errors through independent cross-checks, open inspection, and continuous interrogation	Multi-mission record is publicly available from Long-Term archive	Used in various published applications and assessments by different investigators

Issues/Risks & Work- Off Plans

- Please note
  - M-AERIs (3) have now >10 yrs sea time and are increasingly difficult to maintain.
  - M-AERI Mk-2 to be developed with NASA funding; proposal to NIST to build 4 more.



Schematic from LRTech Inc.

Schedule

- Year 1
  - Q-A of existing M-AERI & ISAR data (√)
  - Obtain AMSR-E orbital data & develop validation strategy (√)
  - Hold 3rd Miami Int'l IR Workshop (√)
- Year 2
  - Continue Q-A of incoming M-AERI & ISAR data
  - Deliver M-AERI data to AATSR team to do matchups (√)
  - Determine AMSR-E SST uncertainties using M-AERI & ISAR
  - Obtain SEVIRI data & develop validation strategy
  - Collaborate with Bob Evans with AVHRR Pathfinder SSTs matchups
- Year 3
  - Continue Q-A of incoming M-AERI & ISAR data
  - Complete AMSR-E analysis
  - Complete AVHRR analysis
  - Complete SEVIRI analysis
  - Deliver results to GHRSST & NCDC

Research- to- Operations or Delivery Plan

- Deliver SST Error Characteristics of AVHRR, AMSR-E & SEVIRI to GHRSST, NODC & NCDC

Resources

- Key personnel:
  - P.J.Minnett (PI)
  - M. Szczodrak (Assoc. Scientist)
- Instruments:
  - M-AERIs & ISARs on research vessels and commercial ships
- Key collaborating projects & personnel
  - AVHRR Pathfinder SST (R. Evans)
  - GHRSST (C. Donlon, C. Gentemann, P Le Borgne & …..)
  - AATSR Project, PI: D. Llewellyn-Jones; Validation Sci: G. Corlett
  - NOAA NODC, PI: K. Casey
- NOAA points-of-contact or collaborators, as applicable
  - NOAA NODC, PI: K. Casey
- Target NOAA Data Center
  - NOAA NODC & NCDC