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Sea Surface Temperatures from MODIS

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Introduction

Sea-surface temperature (SST) is an important geophysical variables derived from MODIS measurements. Accurate SSTs require:

- Good understanding of the behavior of the radiometer
- Good onboard calibration to give calibrated spectral radiances
- Accurate corrections for the effects of the intervening atmosphere
- Reliable techniques for identifying pixels contaminated by infrared emission from clouds and aerosols
- A reliable method of determining residual inaccuracies

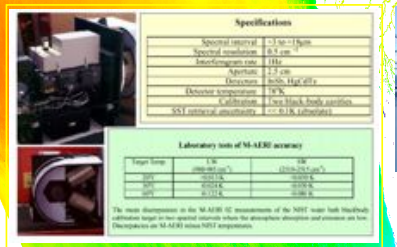
The accuracies are determined by comparison with sub-surface temperature measurements from drifting and moored buoys, which provide a large number of "match-ups" that sample a wide range of climatological variability of the atmosphere, and ship-mounted infrared radiometers that provide high-accuracy measurements of the skin SST of the ocean. See figures below right.

For satellite-derived variables to be considered as part of the "Climate Record" they require traceability to National Standards. For MODIS SST this is provided by traceability of the RSMAS infrared calibration facility to NIST Standards.

SST Validation & NIST Traceability

The radiometric skin SSTs are provided by the Marine-Atmospheric Emitted Radiance Interferometer (M-AERI; *Minnett et al, 2001)* and the Infrared Sea Surface Temperature Autonomous Radiometer (*Donlon et al, 2008).* The M-AERIs are usually mounted on research vessels and the ISARs on freighters and ferries.

NIST traceability is provided by the characterization of the RSMAS Water-Bath Black Body Calibration Target by the EOS TXR (Transfer Radiometer) that was part of an international workshop in 2001 (*Rice et al*, 2004).



M-AERI specifications and accuracies

M-AERI on the R/V *Tangaroa*

ISAR on the M/V *Andromeda Leader*

Accuracies

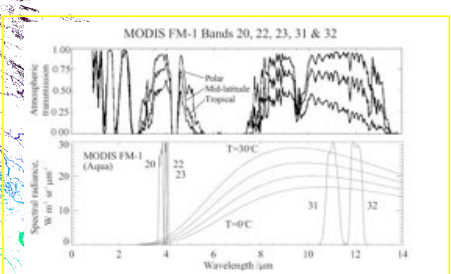
Buoys:
Mean ~0.17K, σ ~0.4 – 0.7K
M-AERI:
Mean ~0.0K, σ ~0.3(5) – 0.6K

Future directions

- Maintain and develop MODIS atmospheric correction algorithms, using comparisons with measurements from buoys, M-AERI and ISAR to ensure longer-term accuracy of the SST fields and monitor the time-dependent effects of instrumental artifacts.

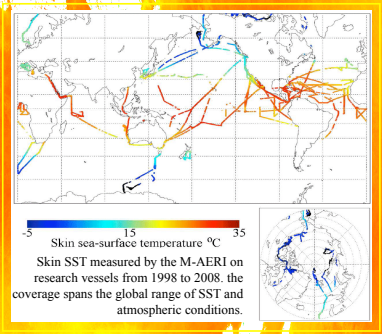
- Improve atmospheric correction algorithm especially in regions of aerosols contamination and areas of enhanced uncertainties.

- Develop Second-Generation M-AERI to ensure NIST-traceable ship-mounted radiometers to end of MODIS missions, and to extend SST CDRs into the NPP and NPOESS era.

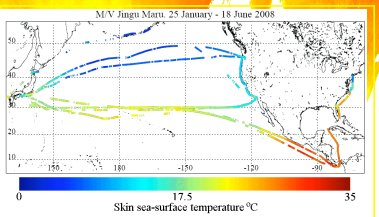


Top: Spectra of atmospheric transmission for three representative atmospheres. Note that the variations in atmospheric transmission is smaller at 4µm than at 10-12µm.

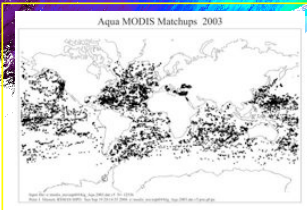
Below: Spectral response functions for the Terra MODIS bands used for retrieving SST, with the Planck Function for temperatures 0, 10, 20 and 30°C. The emission at ~4µm is much smaller than at 10-12µm, but the temperature sensitivity is much greater.



Skin SST measured by the M-AERI on research vessels from 1998 to 2008. the coverage spans the global range of SST and atmospheric conditions.



Tracks of the M/V *Jingu Maru* between 25 January and 18 June 2008. The colors indicate the skin SST measured by an ISAR. Even though the cruise tracks are essentially zonal, they have sampled most of the SST range in this period of about 6 months.



Positions of buoys reporting SST (at a nominal depth of 1m) during 2003. Only measurements within 30 minutes of the satellite overpass, and which pass the most stringent quality test for MODIS SSTs are shown and used in the analyses.

References

Donlon, C., I. S. Robinson, R. M. Reynolds, W. Wimmer, G. Fisher, R. Edwards, and T. J. Nightingale, 2008. An Infrared Sea Surface Temperature Autonomous Radiometer (ISAR) for Deployment aboard Volunteer Observing Ships (VOS). Journal of Atmospheric and Oceanic Technology, 25, 93-113

Minnett, P.J., R.O. Knuteson, F.A. Best, B.J. Osborne, J.A. Hanafin, and O.B. Brown, 2001.The Marine-Atmospheric Emitted Radiance Interferometer (M-AERI), a high-accuracy, sea-going infrared spectroradiometer, Journal of Atmospheric and Oceanic Technology, 18 (6), 994-1013, 2001

Rice, J. P., J. J. Butler, B. C. Johnson, P. J. Minnett, K. A. Maillet, T. J. Nightingale, S. J. Hook, A. Abtahi, C. J. Donlon, and I. J. Barton, 2004: The Miami2001 Infrared Radiometer Calibration and Intercomparison: 1. Laboratory Characterization of Blackbody Targets. Journal of Atmospheric and Oceanic Technology., 21, 258-267

Summary

- Most MODIS instrumental artifacts are corrected.
- Accuracy is established by comparison to buoy and M-AERI & ISAR measurements.
- M-AERI & ISAR are NIST traceable.
- **MODIS SSTs are *Climate Data Records.***

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