

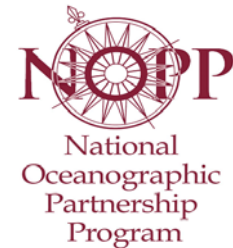
Multi-sensor Improved SST (MISST) for GODAE:

A US contribution to the Global Ocean Data Assimilation Experiment High Resolution Sea Surface Temperature Pilot Project (GHRSSST-PP)

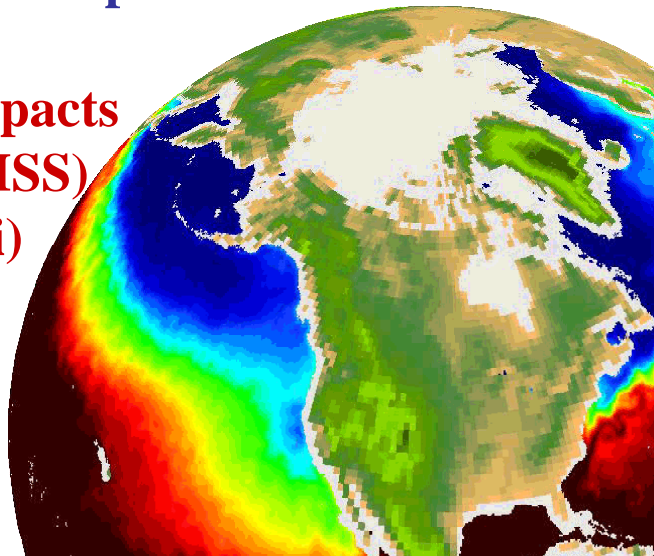
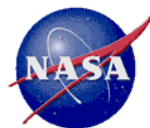
Research, Data, and Impacts

C. L. Gentemann (REMSS)

P. J. Minnett (U. Miami)



Remote Sensing Systems
www.remss.com



MISST

Remote Sensing Systems
www.remss.com

- 5-year project funded in 2004 by NOPP
- Strong partnership (24 scientists)

Industry:

(Lead-PI): [Remote Sensing Systems](#): Chelle L. Gentemann

Academic Partners:

[U. Colorado](#): Sandra Castro, [Florida State U.](#): Eric Chassignet,

[U. Miami](#): Robert Evans, Peter J. Minnett, [U. of Maryland](#): Andrew Harris,

[U. Edinburgh](#): Christopher J. Merchant, [Nat. U. Ireland](#): Brian Ward

Governmental Partners:

[NRL](#): James Cummings, Nancy Baker, Charlie Barron, James Goerss

[Naval Oceanographic Office](#): Doug May, Bruce McKenzie

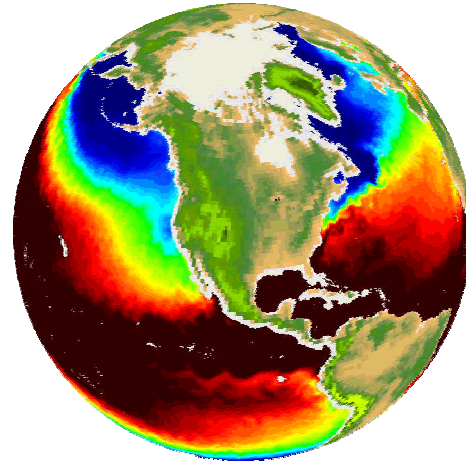
[NOAA](#): Gary A. Wick, Eileen Maturi, Kenneth Casey, Joe Cione, Mark DeMaria, Ming Ji, Richard Reynolds, Joseph Sienkiewicz,

[NASA](#): Jorge Vasquez

Other Partners:

[European Space Agency](#): Craig Donlon

- Project had three main foci:
 - Produce data
 - R/D
 - Study impacts



Key successes 2004-2009

- Strong, productive collaboration between NASA, NOAA, US Navy, academia, and industry.
- Successful transition of research results to operational activities.
- Production of multiple new satellite SST data tailored for operational weather forecasting needs both in the US and abroad.
- Access and use of GHRSSST partner's non-USA satellite SST data for national interests.
- Demonstrated positive impact of new SSTs on hurricane track forecasts (Navy), hurricane intensity forecasts (NOAA), operational SST products (NOAA and Navy).
- Development of new cool skin and diurnal warming models.
- Advances in SST error estimation.
- Strong presence on GHRSSST science team. This is a vehicle for US participation in GHRSSST. Many future sensors and bridge sensors depend on ESA satellites; therefore, as GHRSSST continues, we need to ensure that GHRSSST meets US needs.

- NAVOCEANO
 - L2P: AVHRR LAC 16/17/18
 - L2P: AVHRR GAC 16/17/18
 - L2P: AVHRR METOP-A
 - L4: K10
- REMSS
 - L2P: TMI, AMSR-E orbital
 - L3P: TMI, AMSR-E gridded
 - L4: MW+IR OI SST
- NOAA
 - L2P: GOES-East&West
 - L4: Reynolds AVHRR+AMSR OI
 - L4: Reynolds AVHRR OI
- JPL GDAC & RSMAS
 - L2P: MODIS Terra&Aqua

Successful production of 15 SST L2P/L3P datasets with time of observation, location, bias, standard deviation,, 4 L4 products

- Impact at NAVOCEANO/NRL
 - Access to multiple SST data sets from national and international providers
 - More data into K10, MODAS, and NCODA analyses (testing MSG & AATSR & FRAC)
 - K10 now operationally uses AVHRR LAC, AVHRR GAC, GOES, and AMSR-E data
 - NCODA has been designed to assimilate multiple data sets, currently it assimilates AVHRR, GOES, AMSR-E, AATSR, MSG
 - Evaluation of HYCOM use of improved NCODA
 - Evaluation of AMSR-E on hurricane track and intensity forecasts

Prioritized feedback:

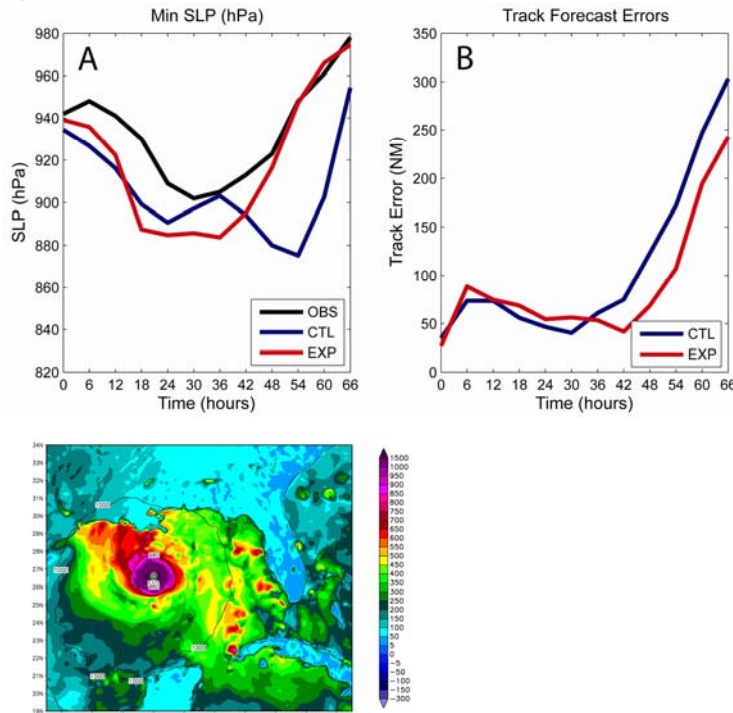
Positive impact on NAVOCEANO operations: More data sources

Evaluation of analysis improvement

Better uncertainty estimates

Diurnal model

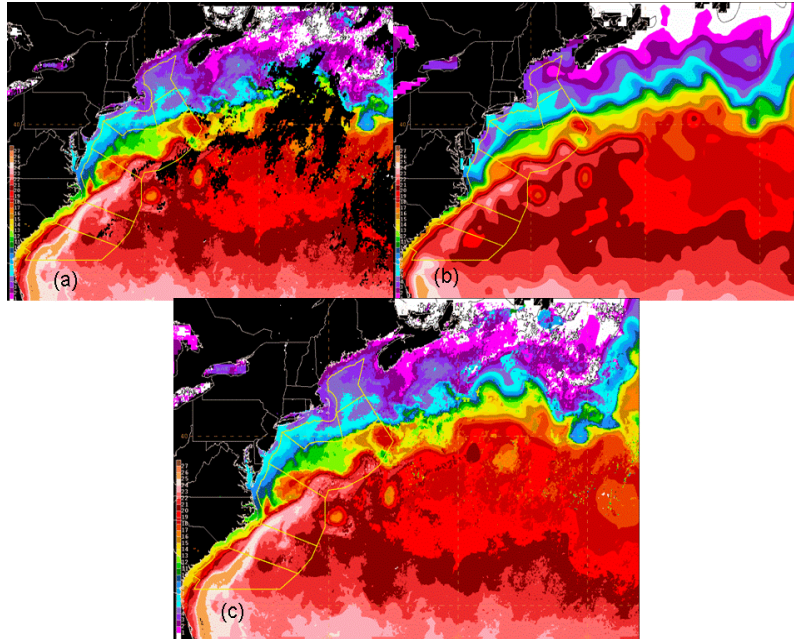
Improves hurricane TRACK and intensity forecasts



- Improved track forecast
- Better enthalpy fluxes
- Better intensity forecasts

- Impact at NOAA
 - Development of sensor errors for GOES SST
 - Improvements to three NOAA OI SSTs: NOAA POES/GOES and Reynolds AVHRR & AMSR-E+AVHRR OI SST
 - Bring advances in SST to the National Centers Advanced Weather Interactive Processing System (N-AWIPS) operational workstations
 - Development of LTSRF at NODC (international archive)
 - Prioritized feedback
 - Positive impact on operational SSTs feeding into NWP and responding to feedback
 - Distribution of new high-res SSTs through N-AWIPS
 - Emphasized need for more retrospective re-analysis (individual products and blended products)
 - Sustain archive and operational data streams

Reynolds 25 km and GOES now available to forecasters

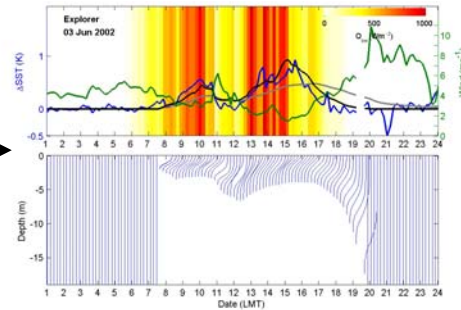
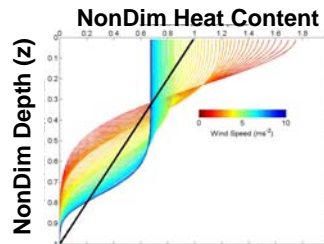


- Impact at NASA
 - Improved NASA SST data accuracy through validation efforts
 - Improved understanding/modeling of cool-skin and diurnal variability
 - High-res sea ice algorithm development
 - Development of data fusion methodologies utilizing research results
 - Improved skin SSTs: research into CO₂ fluxes & air-sea interactions
 - **Prioritized feedback**
 - Need refinement of SSES errors for GDS2.0
 - Need operational model of DV

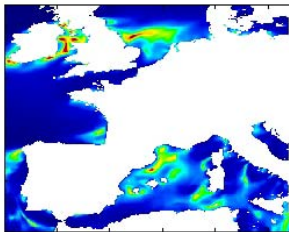
Diurnal warming

- New diurnal model that links the advantages of bulk models (speed) with the vertical resolution provided by turbulent closure models
- Profiles of Surface Heating (POSH) model:

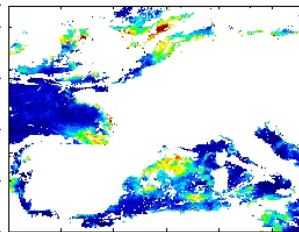
Surface
forcing:
(NWP
or in situ)



POSH DW

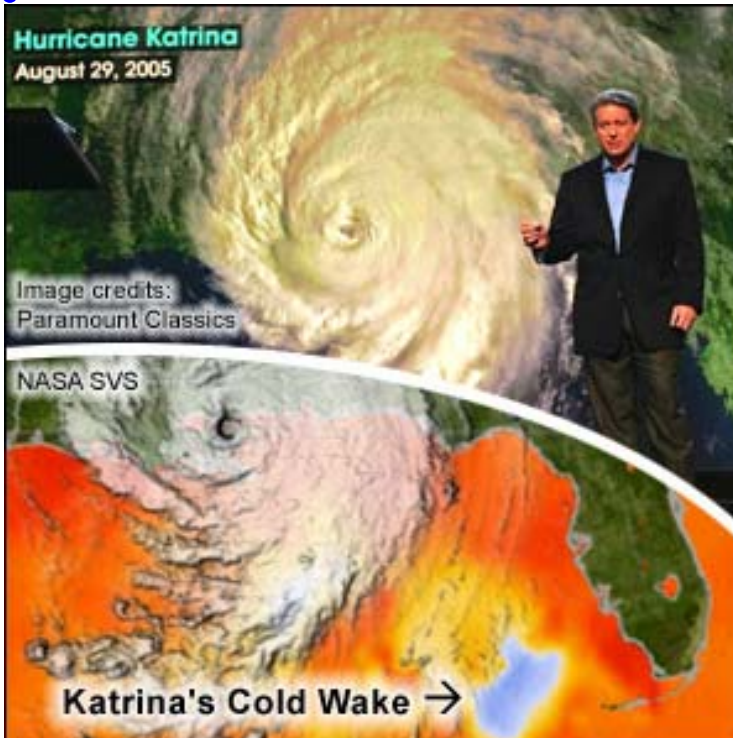


SEVIRI DW



Here POSH was run with ALADIN surface forcing. The figures compare the predicted warming from POSH to the SEVIRI 12:00 local time diurnal warming (SEVIRI 12:00 – night)

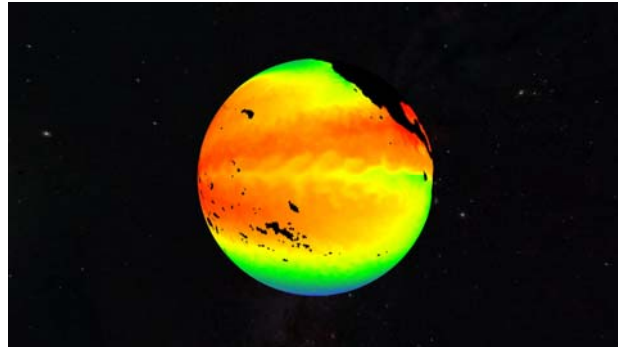
Public Impacts



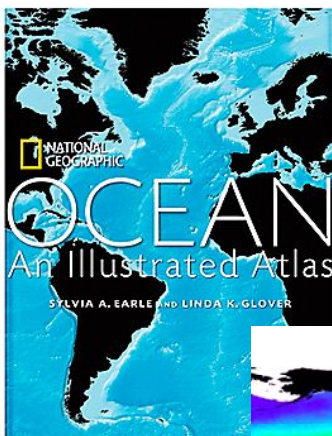
- MISST SSTs used in “An inconvenient Truth”
- Imagery prepared by NASA SVS

Public Impacts

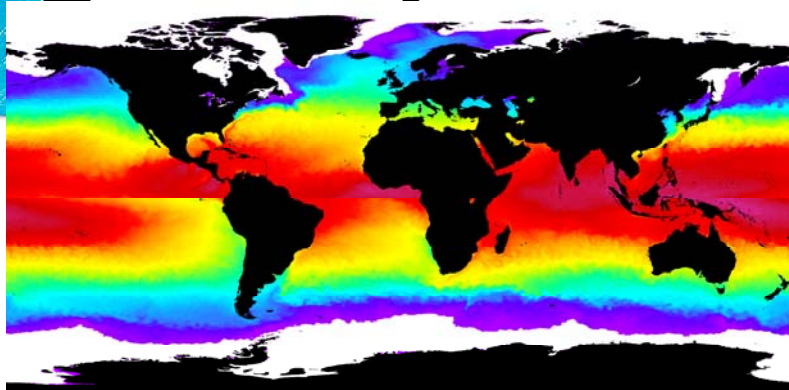
- MISST SSTs used in “Fragile Planet” movie from California Academy of Sciences, soon to be released as DVD
- Imagery prepared by NASA SVS

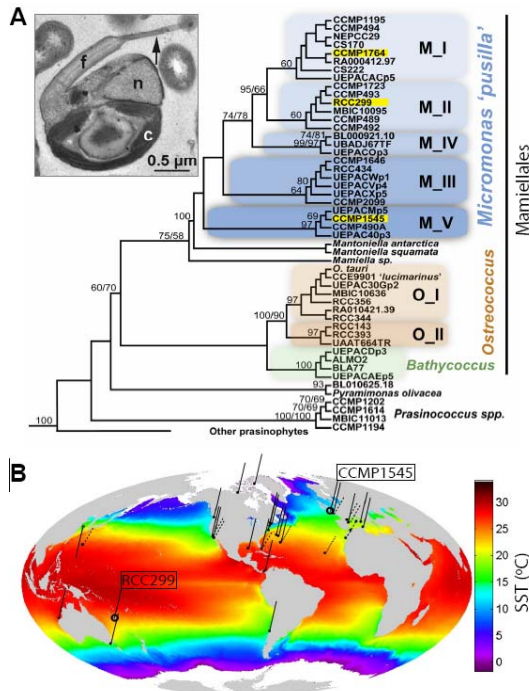


National Geographic Ocean Atlas



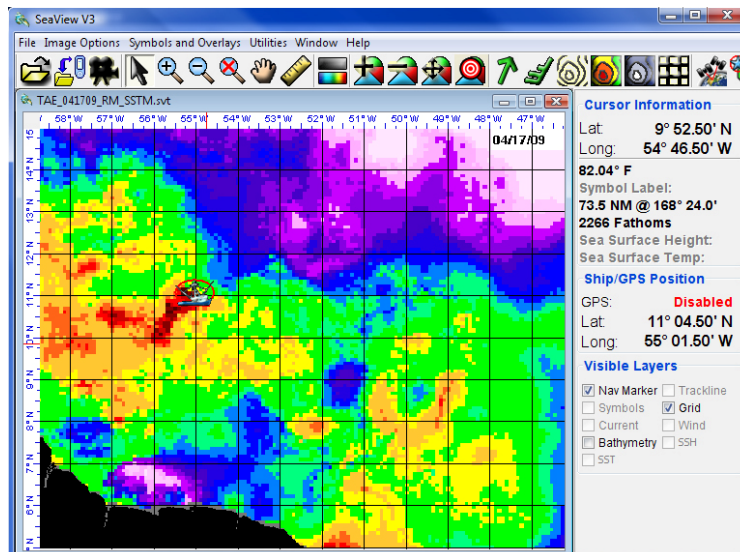
- Organized around ocean basin – each chapter opens with an image of the ocean basin using MISST SSTs





Worden, A.Z., et al., "The genomes of Micromonas: global reporters in marine environments", Science, 324(5924), 268-272, DOI: 10.1126/science.1167222, 2009.

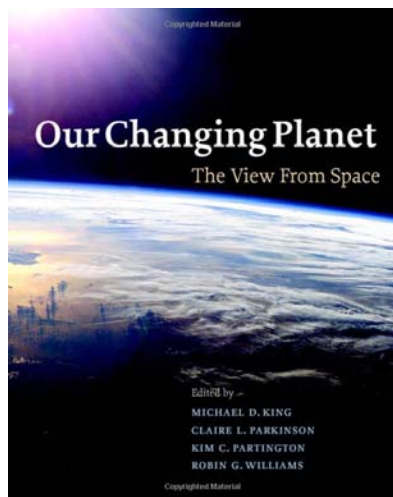
Ocean Imaging provides commercial and recreational fisherman with SSTs from the MISST project. Feedback: "fishermen have come to depend on these products as one input used in their day-to-day decision making"



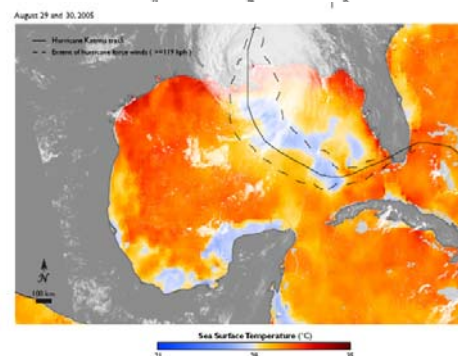
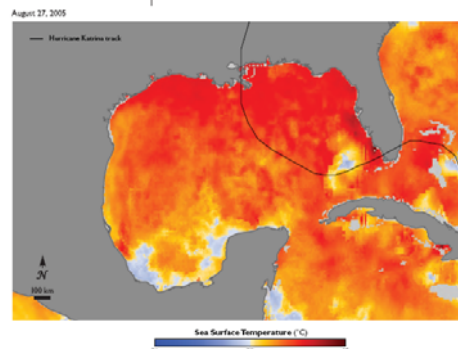
NASA news articles featuring MISST SSTs

- Microwave Imager Measures Sea Surface Temperature Through Clouds
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=2918
- Global Sea Surface Temperature from AMSR-E
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=15305
- La Nina in Progress
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17180
- El Nino Chills the Western Pacific Ocean
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17501
- Super Typhoon Ioke's Cool Wake
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17392
- Atlantic Sea Surface Temperature Anomaly
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17340
- Initial Conditions for the 2006 Atlantic Hurricane Season
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17292
- El Niño, the Usual Suspect?
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=10913
- Hurricane Alley Heats Up
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=16996
- Hurricane Fabian's Trail
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=16299
- Sea Surface Temperature in Western Pacific
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=16704
- Hurricane-Ready Sea Surface Temperatures
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17368
- Dust Dampens Hurricane Formation
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17617
- Hurricane Isabel
http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?img_id=11720
- Hurricane Frances
http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?img_id=12417
- Typhoon Mawar
http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?img_id=13086
- Feature Article: Seeing into the heart of a Hurricane <http://earthobservatory.nasa.gov/Study/HurricaneHeart/printall.php>

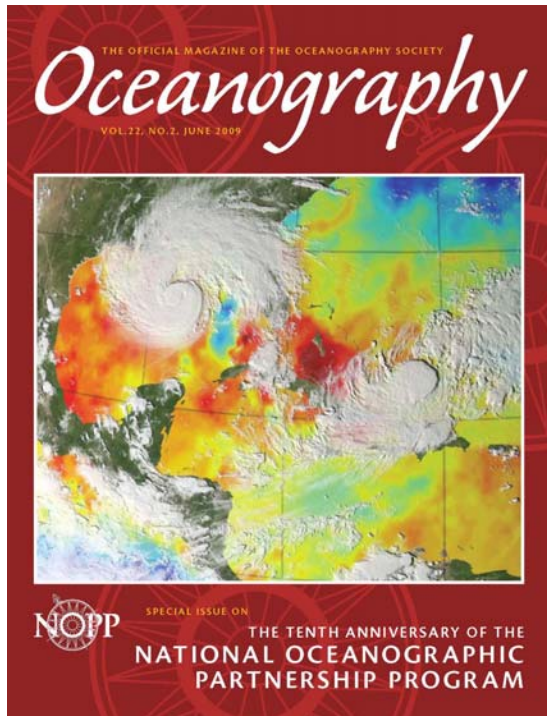
“Our Changing Planet”



- MISST SSTs featured in “Our Changing Planet”



June 2009: Cover image & article in "Oceanography"



2008 NOPP award

2008 NOPP Excellence in Partnering
Award given to MISST project

41 peer reviewed journal articles, 12 in
diurnal warming alone.



Summary

- MISST project impacted NOAA and US Navy operations
- Research results published in journals
- Advances in satellite SST error budget estimation, upper ocean physics