

Evaluation of Enhanced High Resolution MODIS/AMSR-E SSTs and the Impact on Regional Weather Forecasts



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Background

- The NASA Short-term Prediction Research and Transition (SPoRT) Center currently produces a high-resolution sea surface temperature (SST) composite with superior resolution to current operational SST products
 - Derived from Moderate Resolution Imaging Spectroradiometer (MODIS) instrument aboard the Earth Observing System (EOS) Aqua and Terra satellites
 - Occasionally suffers from high latency due to persistent cloud cover, which can affect the product's accuracy and use in weather forecasting applications
- SPoRT developed an enhanced high-resolution SST product
 - Incorporates alternative microwave satellite data sources
 - Decreases latency encountered in the original product
- Project goal:** Evaluate / quantify the improvements made to the enhanced SPoRT SST product and impacts on numerical weather prediction model forecasts

Operational Real-time Global (RTG) SST Product:

- Once daily product output with 1/12 degree resolution
- Operational standard issued by the National Centers for Environmental Prediction

Original SPoRT MODIS SST Product:

- 4x daily product output at 0400, 0700, 1600 and 1900 UTC with 1-km resolution
 - Centered on the southeastern U.S.
 - Corresponds to over-pass times of Terra and Aqua EOS satellites
- Weighted composite of three most recent cloud-free pixels in last 30 MODIS over-passes

Enhanced High Resolution SST Product:

- Incorporates Advanced Microwave Scanning Radiometer-EOS (AMSR-E) and European's Operational Sea Surface Temperature and Sea Ice Analysis (OSTIA) data
 - Fills cloud-covered, high latency areas with 20% weight from each source
 - Improves latency in open water regions (AMSR-E) and near coastal zones (OSTIA)
- Corresponds to weighted seven-day composite of respective MODIS over-passes

Conclusions and Future Work

- The NASA SPoRT Center has improved upon its high-res, MODIS-based SST dataset:
 - Captures fine-scale detail in oceanic SST as in original MODIS product
 - Improves on data latency by incorporating information from AMSR-E and OSTIA, allowing for more accurate short-term forecasts for sensible weather
 - Verifies better than original SPoRT MODIS and operational RTG SSTs
- Future SPoRT SST efforts may include:
 - Examining impact of diurnal SST variability in local forecast models
 - Replacing current MODIS SST with enhanced product for end-users
 - Investigating applications in tropical meteorology, including SST impacts on hurricane development

Case Study: Florida, June and July 2007

Original MODIS vs. Enhanced SST

- Enhanced SST has slightly smoother features due to the lower-resolution AMSR-E and OSTIA datasets.
- The enhanced SST product is generally warmer than the original MODIS, especially at night, due to reduced latency in product, which better portrays trends and reduces the influence of cloud cover.

Buoy Validation

- Original MODIS and enhanced SST composites were compared with in-situ observations at 11 buoy locations throughout the Florida domain. (Map and key for buoys at left)
- The enhanced SST product shows bulk improvement in accurately determining the SSTs over the Florida domain at the 0400 and 0700 UTC (night) composite times.
- At 1600 and 1900 UTC (day) composite times, mean biases of the enhanced product increase slightly from those of the original product.
 - Mean biases of the daytime original product already small compared to those at night
 - Difference in day to night bias likely due to reduced accuracy of cloud detection schemes and increased data latency at night

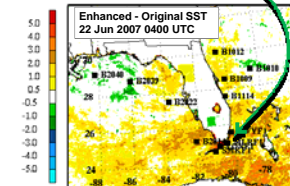
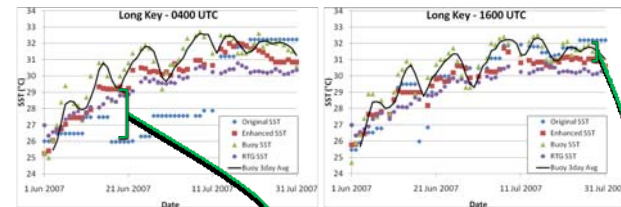
Mean difference (bias) in SST (°C) at each product composite time incorporating all 11 observational buoy locations.

| Difference | 0400 UTC | 0700 UTC | 1600 UTC | 1900 UTC |
|-----------------|----------|----------|----------|----------|
| Original - Buoy | -0.916 | -1.342 | -0.150 | -0.298 |
| Enhanced - Buoy | -0.273 | -0.459 | -0.174 | -0.428 |

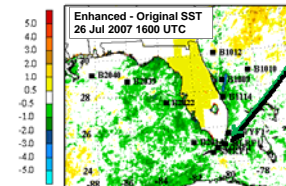
Buoy Comparison at Long Key

- 0400 UTC: enhanced SST product decreases mean bias and variance, increases correlation
- 1600 UTC: enhanced product has more bias, but still improved correlation and variance

| | 0400 UTC | Mean Bias | Correlation | Variance | 1600 UTC | Mean Bias | Correlation | Variance |
|-----------------|----------|-----------|-------------|----------|-----------------|-----------|-------------|----------|
| Original - Buoy | | -1.933 | 0.587 | 4.296 | Original - Buoy | -0.395 | 0.881 | 0.998 |
| Enhanced - Buoy | | -0.693 | 0.915 | 0.595 | Enhanced - Buoy | -0.678 | 0.909 | 0.546 |



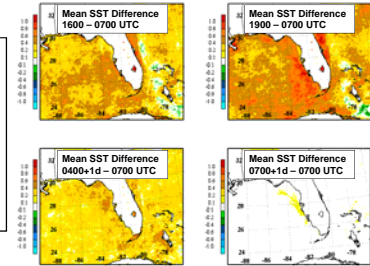
Reduction in cold bias



Reduction in warm bias

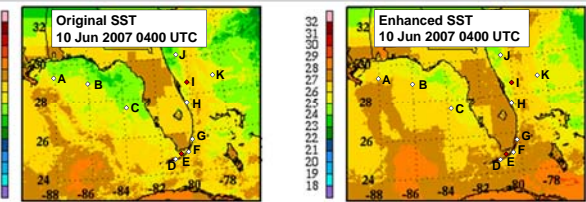
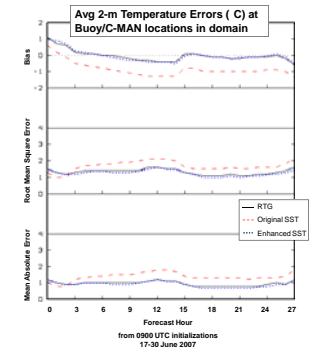
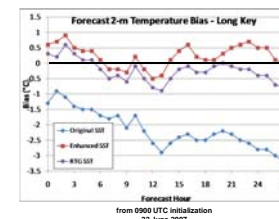
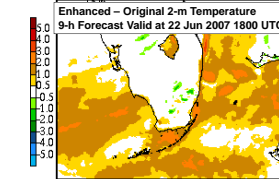
Enhanced SST Product Diurnal Trends

- Warming shown throughout the day
 - Largest diurnal change near coastal Florida waters.
 - Corresponds with shallow continental shelf waters.
- Slight warming from morning to morning consistent with seasonal trend in June and July.

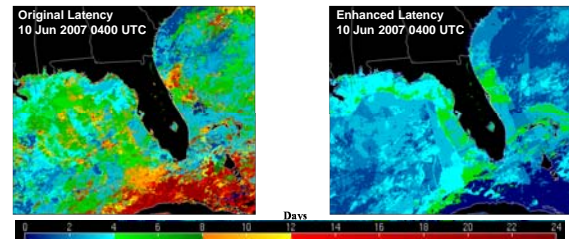


Application to Local Forecast Model in Miami Domain - 0900 UTC Initialization

- Control run SSTs: closest previous RTG SSTs
- Experimental run SSTs: 0400 UTC original and enhanced MODIS SST composites
- 27 hour runs, constant SSTs, 4-km resolution over southern Florida domain
- Higher SSTs result in improvements in forecast through:
 - Increased latent heat flux over water
 - Greater atmospheric mixing and higher wind speeds
 - Higher 2-m temperature, lower 2-m dew point and relative humidity



| Buoy ID Name | Buoy ID Name | Buoy ID Name |
|-------------------------|-----------------------|------------------------|
| A 42040 Mobile South | E LONF1 Long Key | I 41009 Canaveral |
| B 42039 ESE Pensacola | F MLRF1 Molasses Reef | J 41012 St Augustine |
| C 42022 West FL Central | G FWYF1 Fowey Rocks | K 41010 Canaveral East |
| D SMK1 Sombbrero Key | H 41114 Fort Pierce | |



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