Use of High Resolution SST Data for Operational Applications

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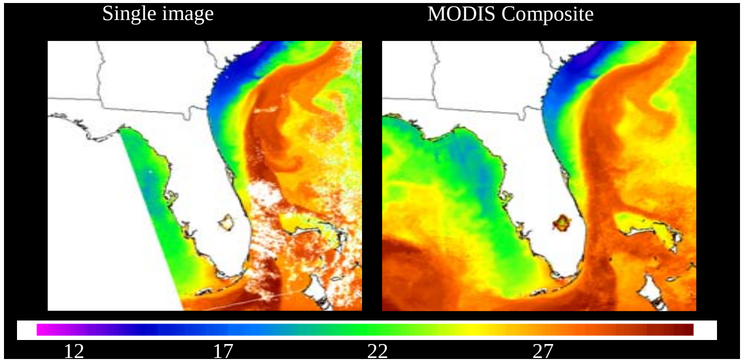
Problem

The regional weather forecast community requires continuous spatial fields of surface parameters for model initialization. Composite fields of high resolution satellite derived SSTs may provide a good way to provide this data. However, persistent cloud patterns can cause product latency and reduced accuracy.

- Previous work developed a SST composite product with MODIS data to provide high-resolution SST data over limited regions (Haines et al. 2007)
- Impact of MODIS SSTs (versus RTG) on fluxes of heat / moisture and subsequent weather forecasts was significant in coastal regions (Lacasse et al. 2008; Case et al. 2009)
- Regions of high latency reduced accuracy and impact



Objective

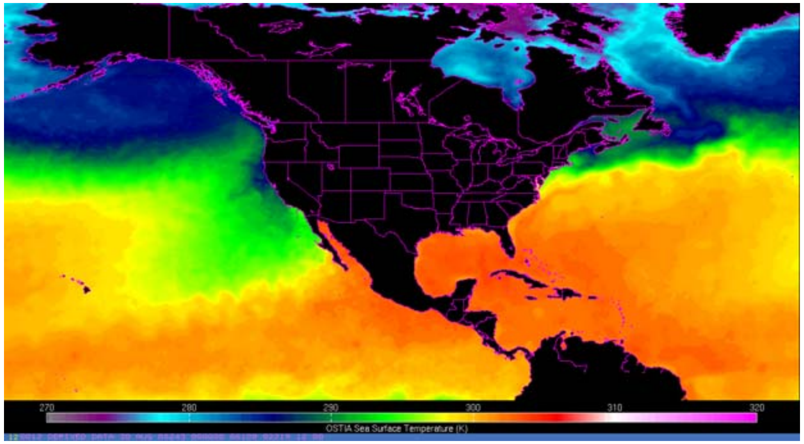
Develop an enhanced SST composite product – reduced latency

- **MODIS and AMSR-E, PO.DAAC L2P data stream, latency weighted compositing algorithm**

Demonstrate improvement and impact on forecasts

Approach overview

- **Increased SST data availability – transition from direct broadcast to more complete data source**
- **Bring in AMSR-E SST data for coverage in persistent cloud regions**
- **SST compositing algorithm changes – latency, error, and resolution weighted product**
- **Use near real-time L2P data stream (JPL) for MODIS and AMSR-E passes more passes**
  - expand product coverage
  - pixel by pixel quality estimates and bias
  - slight additional delay in data access – tolerable
  - better cloud / rain detection
  - AMSR-E data coarse resolution with no data near coast



Coverage of Enhanced MODIS/AMSR-E SST Product

Approach details

- **A *collection* of MODIS and AMSR-E SST values corresponding to the last 7 days is obtained for the JPL PO.DAAC for each pixel in a product region (at 1 km resolution), for the four Terra / Aqua overpass times**
  - MODIS proximity flags 4 and 5, bias adjustment
  - AMSR-E proximity flag 4
- **Apply latency weighted compositing scheme to the collection at each point in the 1 km resolution output file**

$$SSTcp(i,j) = \frac{\sum [\, SST(i,j,k) * (Wt(d,k) * (1/L(k)+1)) \,]}{\sum [Wt(d,k) * (1/L(k)+1)]}$$

where SSTcp (I,j) is a composite SST value at a point (I,j),

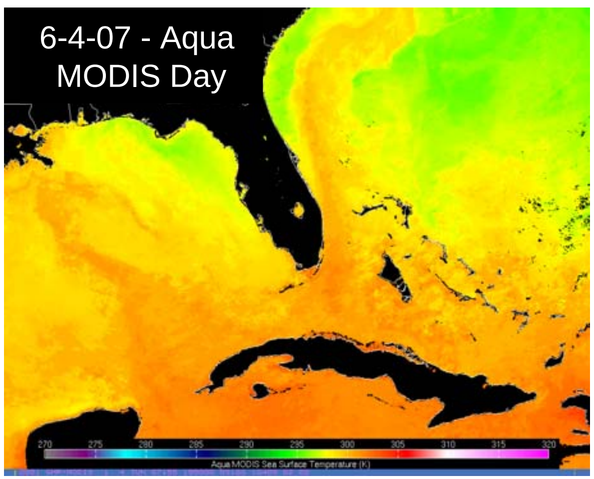
SST(I,j,k) is a SST collection (k is an index corresponding to date of data in collection),

L(k) is the latency (in days) of a particular SST value in the collection, and

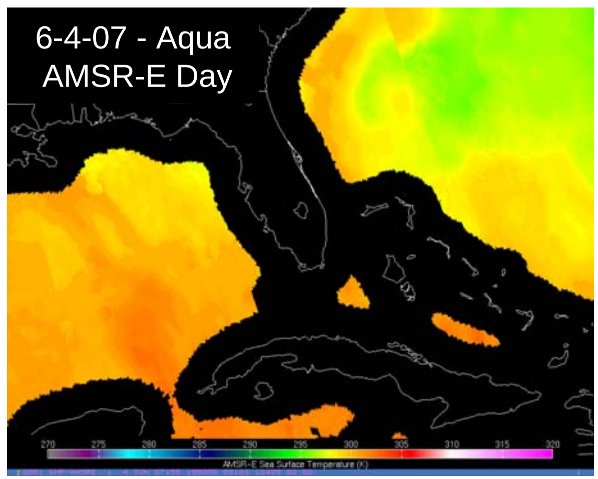
Wt(d,k) is a data weight factor where d corresponds to either MODIS (Wt=1.0), AMSR-E (Wt=0.20), or some other value for another instrument source.

- **The inverse latency formula uses all data in the collection and allows more recent data to have a greater influence on the composite**
- **The reduced AMSR-E weight factor (Wt) accounts for the large footprint compared to MODIS**

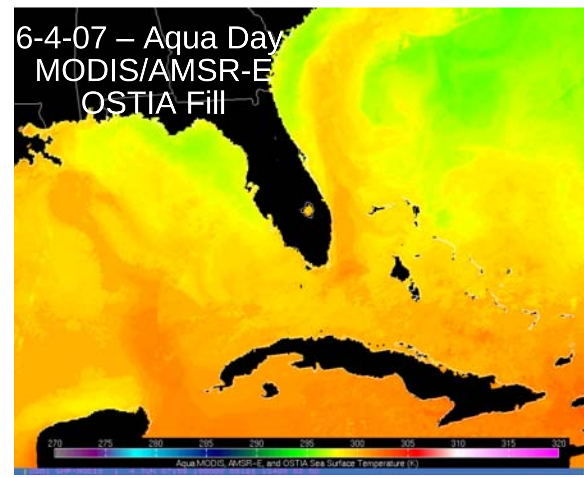
- **MODIS alone produces a high-resolution (1km) SST composite but with some latency issues and gaps**
- **AMSR-E alone reduces latency in the SST composite with coarser resolution data, but not near land**
- **Enhanced MODIS / AMSR-E SST composite a blend of both**
- **Product available 4x a day corresponding to Terra (day and night) and Aqua (day and night)**



MODIS Composite SST



AMSR-E Composite SST



MODIS/AMSR-E +

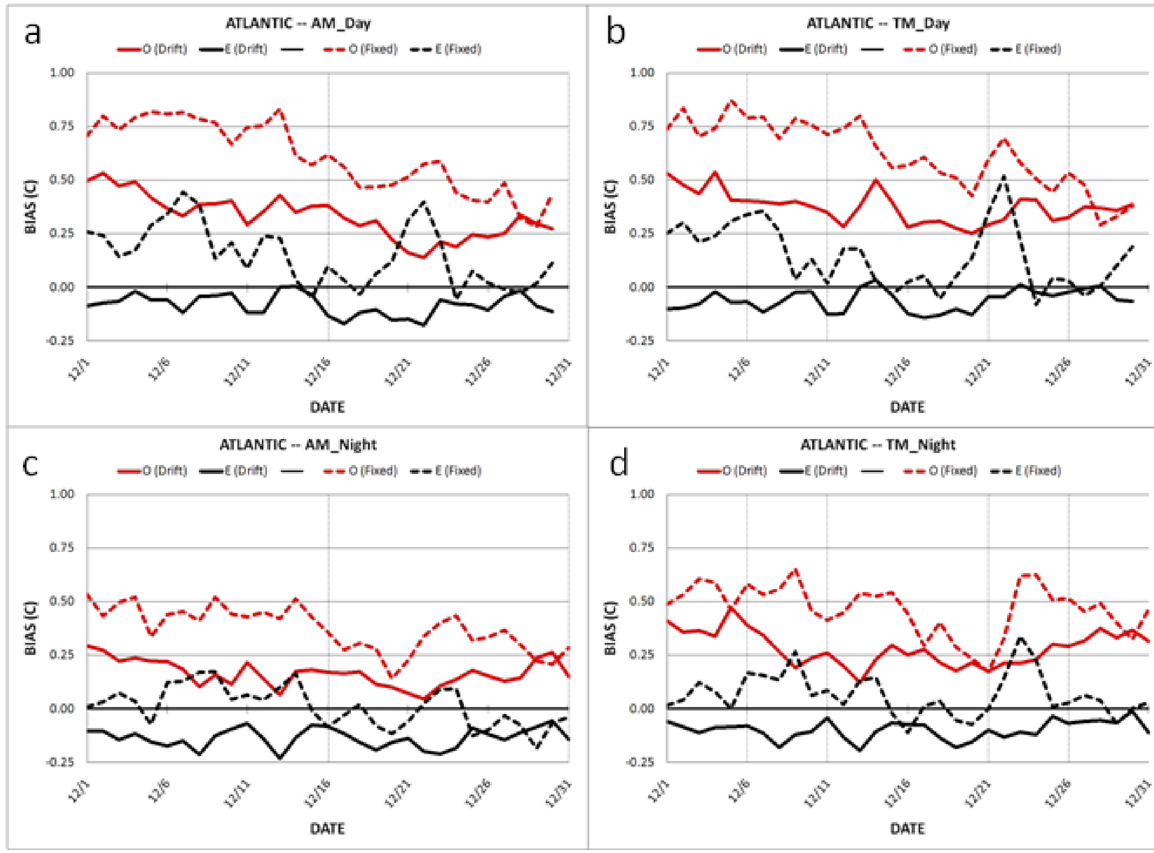
OSTIA data (with a Wt=0.20) used to fill in where neither MODIS nor AMSR-E coverage is complete (a few coastal areas)

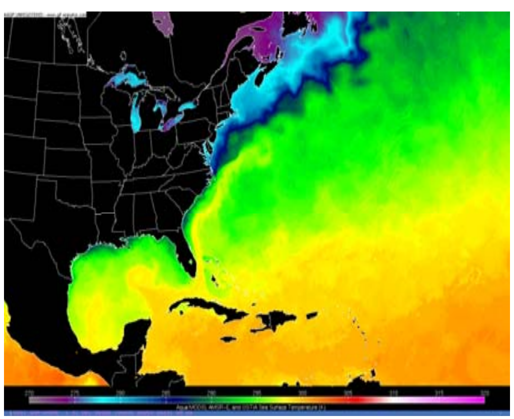
Validation

4 regions, 4 seasons, 4 times a day

60-70 fixed buoys (coastal and gradient regions), 90-100 drifting buoys (more open ocean) per time - bias and rms

- Enhanced (black) much improved over MODIS only (red) at all times – due to reduced latency
- Drifting buoy (solid lines) biases smaller than fixed (dashed)
- Biases generally <0.20 C, RMS <0.50 C
- Trend in MODIS only due to latency – no trend in enhanced SST composite bias

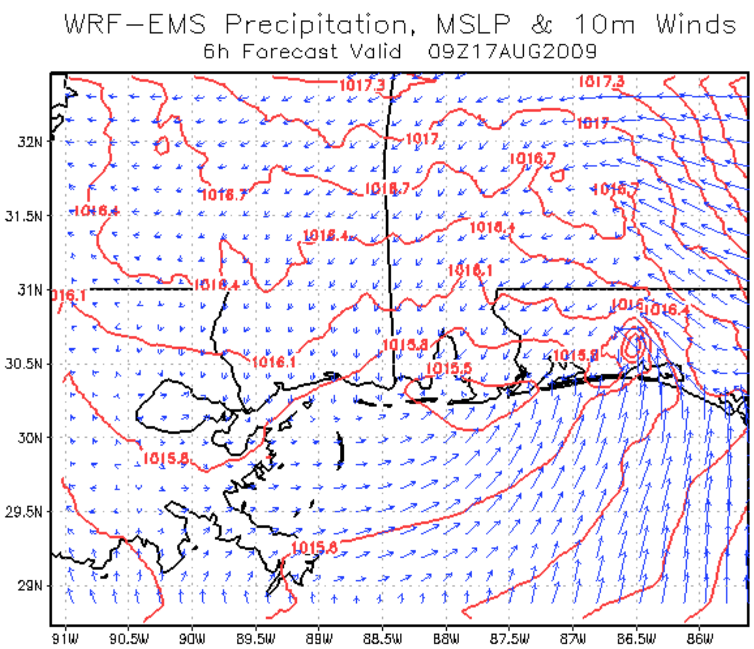


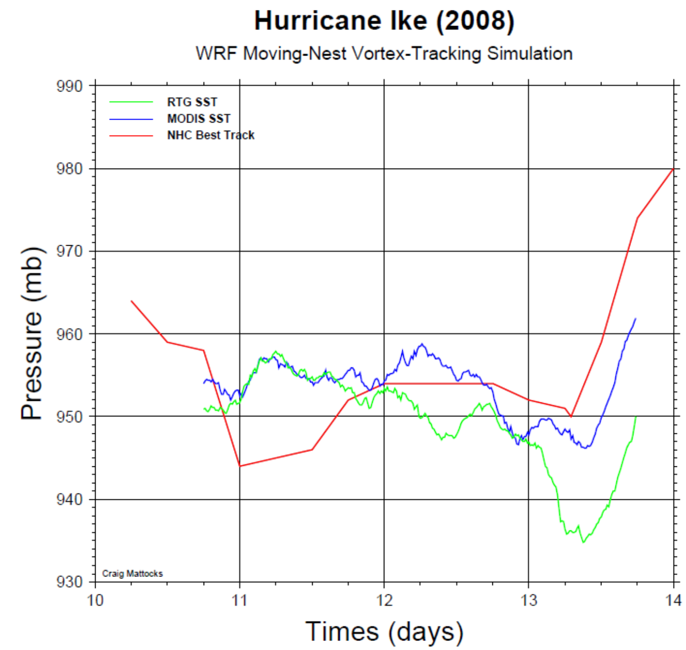


Forecast impact

High resolution SSTs have had a positive impact on a number of weather forecast applications.

WRF EMS 6h forecast by Mobile NWS WFO (using high reso SSTs instead of RTG) for T.S. Claudette (17Aug2009) better depicted location of landfall





Hurricane WRF forecasts with high resolution SST data show improvements in intensity versus RTG model runs for Hurricane Ike (Courtesy of Dr. Craig Mattocks – UNC).

Summary

- **Enhanced MODIS / AMSR-E SST composite approach reduces data latency and improves quality of the data set**
  - **1km resolution, 4 times a day, biases < 0.20 C**
- **Enhancements include use of GHRSST L2P data stream**
  - **access to all EOS passes for MODIS and AMSR-E**
  - **cloud masking / confidence flags / bias correction**
  - **latency / error / resolution weighted compositing algorithm**
- **Expanded coverage region over previous product – broader applications**
- **Positive impact on regional weather forecasts**

- **Real-time data available from NASA / SPoRT (GRIB2) –**
  ftp://ftp.nsstc.org/outgoing/lafonta/sst/grib2/conus/
- **Also available from JPL PO.DAAC in GRIB2 and netCDF (March 2010)**