AN ENHANCED MODIS / AMSR-E SST COMPOSITE PRODUCT

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ABSTRACT

A combined MODIS / AMSR-E SST composite product was developed using the GHRSST L2P data set and an enhanced algorithm to reduce latency and improve the quality and accuracy of the SST data for weather forecasting applications.

1. INTRODUCTION

Accurate high resolution specification of sea surface temperature (SST) is important for regional weather forecasting studies and coastal ocean applications. Chelton et al. (2007) and Lacasse et al. (2008) showed that the use of coarse resolution SST products such as from the real-time global (RTG) SST analysis (Thiebaux et al. 2003) in regional weather forecast models do not properly portray the fluxes of heat and moisture from the ocean that drive the formation of low level clouds and precipitation over the ocean. Case et al. (2008) presents a detail analysis of the impact of the composite SST product in coast regions. Regional coverage of accurate SST variability is also important for hurricane track and intensity forecasts and verification of ocean circulation models.

Haines et al. (2007) described a polar orbiting data compositing technique which provides spatially continuous, accurate, high-resolution SST fields using data from the Moderate-resolution Imaging Spectrometer (MODIS) on NASA’s Terra and Aqua satellites. The compositing technique generates four daily maps of SST using data from the previous days to augment and fill in for clouds and missing data in the current days / times MODIS orbital swath. The approach was limited during periods of long-term cloud cover where latency of past data reduced the accuracy of the data presented in the composites.

The research discussed in this paper is in collaboration with and a companion to the work of Vazquez et al. (2009) reported on in this symposium to develop an enhanced SST composite product for regional weather applications. The enhancements come from the addition of AMSR-E data to reduce the latency of the MODIS due to prolonged cloud cover, and by incorporating a more sophisticated temporal weighting scheme which includes observational errors for each data set. The enhanced SST composite product will be integrated into NASA’s Short Term Prediction and Research Transition (SPoRT) program (Jedlovec et al. 2006) and distributed to the NWS, other government agencies, and the public for use in regional weather forecast applications. This paper describes the methodology used to overcome several limitations of the MODIS / AMSR-E L2P data set in order to produce the SST composite product. The companion paper provides a comparison between SST maps produced using these methodologies, as well as direct comparisons with gridded maps of SST derived from the Advanced-Along Track Scanning Radiometer (AATSR).

The previous approach of Haines et al. (2007) calculated high-resolution (1km) SST composites based on finding a minimum of three cloud free pixels at each location for a given collection period (up to 30 days). The two warmest pixels were then averaged and the value was used to represent the SST at that pixel. A latency map was generated for each composite that provided information on how many days were necessary to find the minimum three cloud free pixels. With the availability of GHRSST L2P data, several enhancements were add to the composite methodology:

- include passive microwave SST data into the compositing process,
- implement a straightforward strategy for using the error characteristics in GHRSST L2P data in the calculation of the composites,
- extend the compositing region to the entire West and East Coasts of the United States,
- use the proximity flags in the GHRSST L2P data to remove cloud and erroneous pixels.

2. METHODOLOGY AND DATA

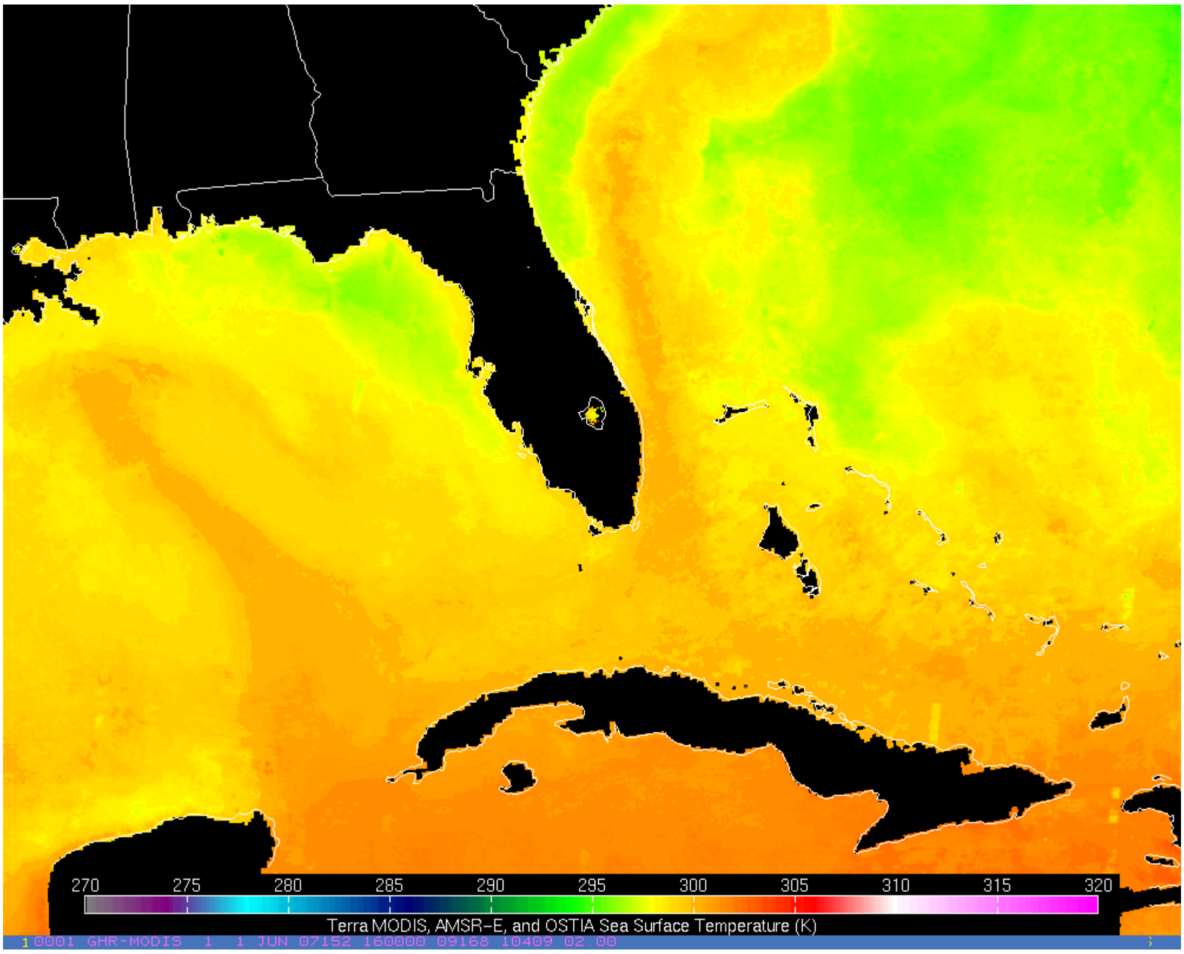
The methodology used here and in Vazquez et al. (2009) are similar to each other andis highlighted below. SST composites are produced over a given region at four times each day corresponding to Terra and Aqua equator crossing times (i.e., Terra day, Aqua day, Terra night, and Aqua night). Day-time (night-time) AMSR-E SST data from Aqua are used with both Terra and Aqua MODIS day-time (night-time) SST data sets. For a given day and region, the data from the previous seven days form a collection used in the compositing. At each 1km pixel, cloud-free SST values (as determined by the L2P confidence flags) from the collection (both AMSR-E and MODIS) are used to form a weighted average based on their latency (number of days from the current day) and quality (also from the L2P data stream). In this way recent SST data are given more weight than older data. One of the primary issues involved in incorporating the AMSR-E microwave data in the composites is the tradeoff between the decreased spatial resolution of the AMSR-E data (25km) and the increased coverage due to it's near all weather capability. Currently, the AMSR-E is given a weight of around 20% compared to MODIS data. In this way the spatial structure observed in the 1km MODIS data is preserved.

3. COMPOSITE LIMITATIONS CAUSED BY THE L2P DATA

Several limitations surfaced in the adaptation of this enhanced compositing approach. The use of a seven day collection period was initially thought to be sufficient to provide complete data coverage over the ocean regions in the MODIS / AMSR-E composite product. This turned out not to be the case because of AMSR-E constraints and MODIS cloud detection problems. The use of the AMSR-E reduced the latency of the data in the collection and produced a better (still needs to be quantified) SST composite product, however, missing data within 125km of land (coastal regions or islands) created some seemingly artificial gradients in these regions. In addition,, the confidence flags in the MODIS L2P data stream consistently rejected data in high SST gradient regions (along the Gulf stream) despite the lack of cloud cover.

4. RESULTS

The figure below presents an example of the MODIS / AMSR-E SST composite product for June 1, 2007 using the above methodologies. The use of MODIS data preserves much of the detailed structure in the 1km data as can be seen in the various thermal features such as the loop current in the Gulf of Mexico and details of the Gulf Stream off the east coast of the



United States. To overcome the limitations of the L2P data set described above, the Operational Sea Surface Temperature and Sea Ice Analysis (OSTIA) SST product (Stark et al., 2007) was introduced as an "observation" along with MODIS and AMSR-E and subsequently was included in the temporal weighted average composite. In this way, when no AMSR-E or MODIS data are present in the seven day collection, composite SST values are represented by the OSTIA values. The regions where this occurs are not readily apparent because of the blending provided by the weighted compositing approach.

This collaborative work will produce the enhanced MODIS / AMSR-E composite data set for use in weather forecasting over four regions:

-90W to -70W and 20N to 35N – Florida
-100W to -50W and 10N to 40N - Hurricane
-110W to -45W and 10N to 52N - Atlantic
-140W to -90W and 20N to 50N - Pacific

These data sets will be made available in real-time via a public ftp site.

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