4.2 MULTI-SENSOR IMPROVED SEA SURFACE TEMPERATURE (MISST) FOR GODAE

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1. INTRODUCTION

The Multi-sensor Improved Sea Surface Temperatures (MISST) for the Global Ocean Data Assimilation Experiment (GODAE) project intents to produce an improved high-resolution global near real-time sea surface temperature through the combination of observations from complementary infrared (IR) and microwave (MW) sensors and demonstrate the impact of the new SST on operational ocean models, numerical weather prediction, and tropical cyclone intensity forecasting.

Sea surface temperature is one of the most important variables related to the global ocean-atmosphere system. It is a key indicator for climate change and is widely applied to studies of upper ocean processes, to air-sea heat exchange, and as a boundary condition for numerical weather prediction. The importance of SST to accurate weather forecasting of both severe events and daily weather has been increasingly recognized over the past several years. Multiple operational SST products are currently available and are in widespread use. Despite the well-established state of SST measurements, there are still significant weaknesses in the existing operational products, namely their reliance on a single sensor can result in interruptions of data availability.

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The launch of improved satellite IR sensors (e.g. Moderate Resolution Imaging Spectroradiometer (MODIS) on Terra and Aqua, Advanced Along-Track Scanning Radiometer (AATSR) on EnviSAT-1, existing IR sensors such as the GOES imagers and Advanced Very-High Resolution Radiometer (AVHRR) carried on several NOAA satellites, and new MW sensors such as the Advanced Microwave Scanning Radiometer (AMSR) Earth Observing System (AMSR-E) on Aqua, Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) on TRMM, and WindSAT, provide the opportunity for notable advances in SST measurement. Not only do the additional sensors provide more frequent coverage for increasing temporal resolution, the IR and MW retrievals are highly complementary. While clouds, aerosols, and atmospheric water vapor affect IR retrievals, these have little impact on MW retrievals. Characteristically, IR SST provides high spatial resolution (~4 km grid) but poor coverage due to clouds. Although having a reduced resolution (~25 km grid), MW SST provide >90% coverage of the global ocean each day. These factors have motivated interest in the development of merged IR and MW SST products to leverage the positive characteristics of each sensor type. Merging multiple SST sensors into a single analysis will result in enhanced reliability, availability, and accuracy. Figure 1 shows an example of data merging in the Gulf Stream region. AMSR-E (top image) and MODIS (center image) data clearly show some of the MW and IR data characteristics discussed above. The optimally interpolated IR

and MW data shown in the bottom image is clearly better than either individual product.

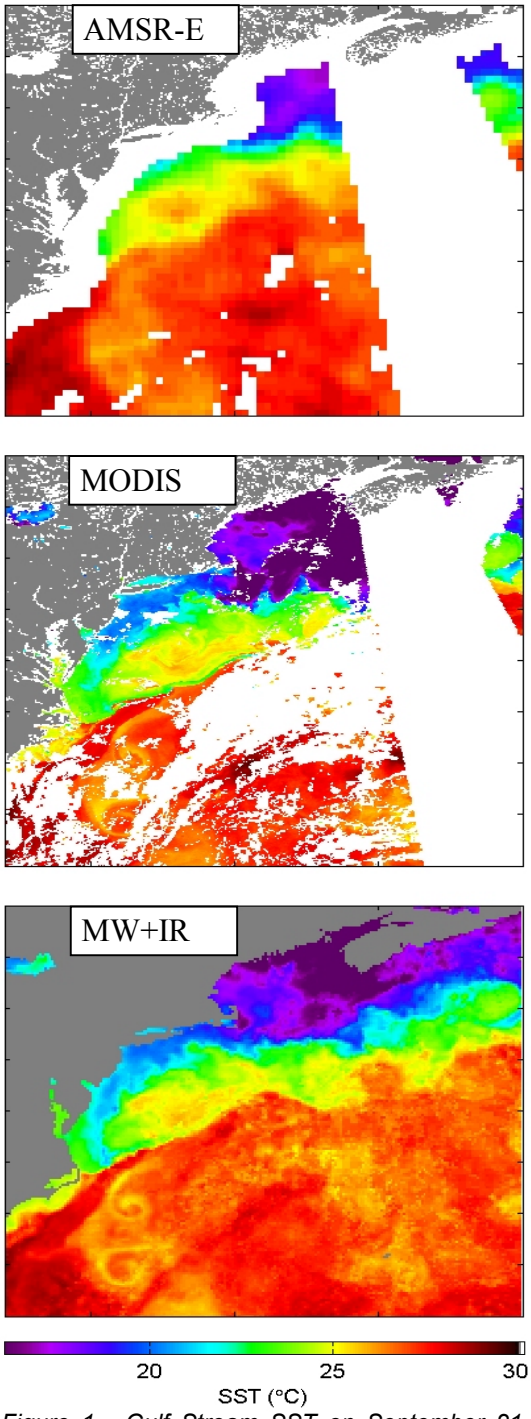

Figure 1. Gulf Stream SST on September 21, 2003. The top image shows 25 km AMSR-E SSTs, the center image shows 4 km MODIS SSTs, and the bottom image shows a 10 km optimal interpolation of the AMSR-E and MODIS data for a three-day window centered on September 21, 2003.

2. MISST Project Objectives

To produce global multi-sensor improved SSTs and successfully assess the impact of these products, five clear project tasks have been identified:

1) Computation of sensor-specific observational error characteristics required for optimal application and data fusion techniques.
2) Parameterization of IR and MW retrieval differences, with consideration of diurnal warming and cool-skin effects required for multi-sensor blending.
3) Production and dissemination of sensor-specific SST products with associated retrieval confidence, standard deviation (STD), and diurnal warming estimates to the application user community.
4) Production and dissemination of improved multi-sensor high-resolution skin and bulk SST analyses to demonstrate and optimize utility in operational applications.
5) Targeted impact assessment of the SST analyses on hurricane intensity forecasting, numerical data assimilation by ocean models (both national and within GODAE), numerical weather prediction, and operational ocean forecast models.

This project has two parts to address the two distinct aims within the objectives of the current effort. Part 1 focuses on producing an improved sea surface temperature (SST) product through the combination of observations from complementary infrared (IR) and microwave (MW) sensors (objectives one through four). Part 2 focuses on demonstrating the impact of improved multi-sensor SST products on operational ocean models, numerical weather prediction, and tropical cyclone intensity forecasting (objective five).

Close collaboration and the international coordinated exchange of SST products with error statistics with operational agencies will optimize utility of these new data streams by US and international operational agencies. Innovative techniques to blend these complementary data will be applied in operational frameworks at NOAA and Navy. This project will make a direct US contribution to the Global Ocean Data Assimilation Experiment (GODAE) by working within the GODAE High-Resolution SST Pilot Project (GHRSST-PP), initiated by the international GODAE steering team, to coordinate the production of a new

generation high-resolution SST. Within the GHRSST-PP framework close coordination with complementary efforts in Europe and Japan have already been established. By contributing to the GHRSST-PP this team will minimize duplication of efforts, harmonize research and development activities, and maximize data access.

We will participate in existing GHRSST-PP partner research by establishing a US Regional Data Archive Center (RDAC) facilitating the exchange of data and knowledge. The enhanced sensor characterization and blending technology to be developed will be applied to the rapid formation of a multi-sensor improved SST (MISST) science product for immediate application to GODAE and hurricane warning projects and in parallel to the operational production systems of the Navy and NOAA. Development of a science product will facilitate immediate application and evaluation of the techniques outside the constraints of an operational system. Implementation in the operational systems will take advantage of the existing frameworks and provide for continued product availability following the end of the project. To explore the possibilities for sustainable data production, expertise developed during the project will be made available to the operational SST production agencies via enhanced SST data products, data fusion methodologies, and user application feedback.

3. Conclusions

Consolidation of the numerous SST data products into optimum, easily accessible new generation products shared by the US and international community, will be particularly valuable as it will maximize the synergy benefits of combined IR and MW SST products never before available. This effort will ensure that US scientists and operational activities remain at the forefront of the international ocean and weather forecasting activities and are provided with state-of-the-art SST data products and analyses.

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