Transitioning NPOESS Data to Weather Offices: The SPoRT Paradigm with EOS Data

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1. INTRODUCTION

The use of polar orbiting data for weather forecasting applications at WFOs has been limited for a number of reasons. Data latency has been the biggest hurdle to its use, followed by the limited access to high resolution imagery in AWIPS. The coarse time resolution of NOAA polar data sets at times limits its applicability compared to GOES data. Additionally, many forecasters have only been trained with GOES data applications, making some of the observational capabilities with polar orbiting difficult for the operational weather forecasters to understand and use.

Data from the NASA EOS satellites launched over the last seven years have the potential to help forecasters at WFOs address specific forecast problems. Data from the MODIS, AIRS, and AMSR-E instruments have direct readout capabilities providing real-time data to ground receiving stations. These instruments have unique spectral and spatial observing capabilities that surpass current NOAA polar orbiting observation platforms. While limited in temporal coverage, they provide a unique vantage point to view high latitude surface and atmospheric processes over areas where the current GOES satellites provide poor spatial resolution.

The NASA Short-term Prediction Research and Transition (SPoRT) project (Goodman et al. 2004) at Marshall Space Flight Center (MSFC) has demonstrated the utility of MODIS, AMSR-E, and AIRS data to improve short term weather forecasts on regional scale. SPoRT scientists, working with many Southern Region WFOs, have established a working paradigm for the transition of these unique NASA observations and research capabilities into WFOs in real time. The data and model products are ingested and displayed in AWIPS for use by forecasters along with their standard operational products. SPoRT has worked with other entities to extend the concept to other regions (Gerth and Bachmeier 2009; Gerth 2007).

The NPOESS observation platforms (Jones and Nelson 2006) provide follow-on observing capabilities similar to those of the NASA EOS instruments to extend climate observations (begun with the EOS and precursor instruments) and provide the WFOs continuity in measurements and capabilities demonstrated by SPoRT to improve short term weather forecasts on a regional and local scale.

2. THE NASA SPORT CENTER

The SPoRT (http://weather.msfc.nasa.gov/sport/) project seeks to accelerate the infusion of NASA Earth science observations, data assimilation, and modeling research into weather forecast operations and decision-making at the regional and local level. It directly supports the NASA strategic plan of using results of scientific discovery to directly benefit society (NASA 2006, 2007). The program is executed in concert with other government, university, and private sector partners. The primary focus is on the regional scale and emphasizes forecast improvements on a time scale of 0-24 hours. The SPoRT program has facilitated the use of real-time NASA data and products to address critical forecast issues at 13 NWS WFOs and several private weather entities primarily in the southeast United States. Numerous new techniques have been developed to transform satellite observations into useful parameters that better describe changing weather conditions.

The success of the SPoRT program lies in three key components of its collaborative relationship with end users, namely, the need to 1) match data to a particular forecast problem(s), 2) integrate real time products into the AWIPS environment, and to develop a strong end user relationship to facilitate the above items and to 3) provide training, encourage product feedback, and to conduct user assessments of the products and activities. These efforts provide a strong end user advocacy for new products, raises the knowledge level of the forecasters, and better prepares them for future NOAA operational satellite capabilities from NPOESS and GOES-R instruments.

3. EOS DATA USED IN WEATHER FORECAST OPERATIONS

The unique NASA weather products have helped local weather service offices improve diagnostic analysis and forecasts in a number of ways. While critical forecast items vary from office to office, Southern Region WFOs have a number of forecast issues in common. In particular, the forecasters need additional help with forecasting the timing and location of thunderstorms and severe weather, diagnosing cloud cover, fog, visibility, and associated local weather conditions especially at night, maximum and minimum temperatures (particularly where terrain or other local conditions influence the weather), coastal weather processes (sea breeze convection and temperature changes and off-shore weather), and weather conditions in data void regions. SPoRT provides the WFOs with real time high resolution MODIS data (down to 250m) in

selected channels. It also provides a number of derived products to address the state forecast problems. SPoRT assimilates selected MODIS products and AIRS profiles and radiances in to regional weather models. The resulting forecasts are made available to WFOs as supplemental model products. Precipitation estimates from AMSR-E provide rainfall information for weather systems approaching coastal regions. Many of these channels and products are similar to those on future NOAA operational instruments such as NPOESS (Lee and Miller 2006) and GOES-R (Schmit et al. 2005).

4. NPOESS DATA

The NPOESS will replace the NOAA and DOD polar orbiting satellites with the launch of the first satellite in the series, NPP, scheduled for 2011. The satellite series will also provide continuity to some of the climate observations currently being made by EOS satellites as well their particular weather forecast applications. Successive satellites (NPOESS C1, C2….) will be launched on a 2-3 year cycle. The NPOESS satellites consist of a number of Earth and space observing instruments. Of particular interest to the Earth science community are the Visible-Infrared Imager Radiometer Suite (VIIRS), the Cross-track Infrared Sounder (CrIS), the Advanced Technology Microwave Sounder (AMTS), and the Microwave Imager Sounder (MIS), the latter of which will not be flown until NPOESS C2. VIIRS has similar channel characteristics to MODIS (Barnes et a. 1998) and the CrIS/ATMS (Aumann et al. 2003; Chahine et al. 2006) provides similar sounding capabilities to the AIRS/.AMSU combination on the EOS Aqua satellite.

The NPOESS Data Exploitation (NDE) is a NESDIS activity to provide products derived from the NPOESS observations to NOAA's operational and climate communities and other civilian customers (Yoe et al. 2009). The NDE system will receive data from the NPOESS ground system, process and package it to meet customers requirements, ensure that the data is archived and distributed to authorized users. SPoRT is collaborating with the NDE to facilitate the use of NPOESS data for short-term weather forecasting applications in an analogous way to its use of EOS data at WFOs.

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Table 1 presents a list of observed and derived parameters available from the suite of NPOESS instruments which can address a series of short term weather forecast problems faced by forecasters at RFCs and WFOs across the country. The bold parameters listed in column 1 have EOS equivalents which have been transitioned to WFOs. Numerous channels of the VIIRS provide high resolution imagery in specific channels similar to those of MODIS. The data will provide detailed monitoring of atmospheric and surface features. Additional natural and false color composites derived from the basic channels will be used to further identify features important for monitoring surface and atmospheric processes. The imager data will also be used to derive cloud and atmospheric moisture parameters. Profiles of temperature and moisture derived from the CrIS/AMTS will provide asynoptic information on the thermodynamic structure of the atmosphere. These profiles and hyperspectral radiance data will provide improved initial conditions for regional forecast models (McCarty et al. 2009; McCarty and Jedlovec 2007). The integration of most of these products have been identified as moderate or high priority items based on their potential impact and use in WFO forecast activities.

Near real-time NPOESS data will be accessed by SPoRT from the NDE data servers and provide the input data stream use to disseminate products to WFOs. Both level 1 channel data and level 2 derived products will be obtained from NDE. Additional level 2 and 3 products will be derived by SPoRT to address unique forecast issues. Data and products will be provided to NWS regional offices for distribution to WFOs via LDM in a similar way SPoRT distributes EOS data to WFOS.

5. AWIPS II

A key component to the use of unique and new data in the operational weather environment is to make the data or capabilities available to the forecaster in their decision support system. The NWS is under-going an upgrade to their AWIPS system and will be phased into the WFOs in 2010. The AWIPSII is being developed under a new paradigm which will make the addition of new data and applications possible (ref). SPoRT is currently developing JAVA-based plugins to be used in the AWIPSII environment for the ingest and of unique data such as from the NPOESS satellites. Additional local applications are planned to provide enhanced display capabilities for this data that are limited in the current system.

6. TRAINING

It is important for weather forecasters to be familiar with and understand the capabilities and limitations of new products and capabilities brought into the operational weather environment. SPoRT has developed numerous training modules for the NASA EOS data in use at Southern Region WFOs. These modules consist of short presentations often with animation and audio which provides scientific background and examples of the use of the product to address particular forecast problems. These training products are available to forecasters on local office intranets or the SPoRT web site. Additionally, some of these modules have been developed collaboratively with NOAA's COMET program and are available for access by the entire operational weather community. SPoRT plans to develop similar training modules on the use of NPOESS data for weather forecast applications.

Table 1 NPOESS products to be transitioned to RFCs and WFOs.

	END USER	APPLICATION / PROBLEM	PRIORITY	COMMENT
IMAGERY				
visible, 6.7µm, 11 µm	WFO, RFC	nowcasting, diag. analysis		<0.5km, higher resolution supplements geostationary data
multi-channel composites	WFO, RFC	nowcasting, diag. analysis	HIGH	~1.0km identify atmospheric and surface features not seen in single channel
SOUNDING				
temperature(p) moisture(p)	WFO	supplement raobs in time/space voids, local modeling	MODERATE	~10km horizontal resolution, monitor changes in stability
layered precipitable water	WFO	supplement raobs in time/space void local modeling	MODERATE	~10km horizontal resol., monitor changes in moisture leading to clouds and storms
CLOUD PRODUCTS				
cloud base (P, T, z)	WFO	forecast prep. nowcasting	MODERATE	~1km resol., aids in understanding storm dynamics and sfc visibility
cloud top (P, T, z)	WFO	forecast prep. nowcasting	MODERATE	~1km resol.,storm dynamics, adjustments to T based on insolation and clouds
cloud cover – layers	WFO	forecast prep. nowcasting	MODERATE	~1km resol., cloud amount, phase, in various layers of the atmosphere
icing levels	WFO	aviation forecasts	HIGH	~1km resol., significant aid in aviation forecast preparation
IMAGE PRODUCTS				
night time fog product	WFO	aviation, public forecasts, nowcast	HIGH	<1km resol., identify regions of developing / existing fog
total precipitable water (TPW)	WFO	moist. variability for storm devel.	MODERATE	~1km resol. useful, good cloud detection / filtering is necessary
aerosols - type, AOT	WFO	air quality, visibility forecasts, fire wx	LOW	type and optical depth - local visibility and air quality forecasts, smoke from fires
precipitation rate and type	WFO	local- short term hazard forecasts	MODERATE (coastal)	stratiform, convective, snow, or rain -useful over ocean radar coverage is poor
sea surface winds	WFO	marine forecasts	VERY HIGH (not avail.)	from coast to 60nm, ~10km spacing
wave height	WFO	marine forecasts	VERY HIGH (not avail)	3ft increments, from coast to 60nm, 10km spacing
sea surface temperature	WFO,NCEP	marine forecasts, local model init.	MODERATE (coastal)	resolutions down to 1km, coast to 60nm, 10km spacing continuous coverage
suspend solids	WFO	marine forecast	MODERATE (coastal)	marine hazards and applications to fisheries
chlorophyll	WFO	marine forecast	MODERATE (coastal)	marine hazards and applications to fisheries
soil moisture	RFC, WFO	local and regional forecast	HIGH (not avail.)	at highest resolution possible, affects local storm development / temp. forecast
surface vegetation type	RFC	impact in local models	LOW	
snow product - cover / depth	RFC, WFO	max/min temp. flood forecasts	HIGH (seasonal)	< 1km, discriminates between clouds and snow on ground, spring-time flooding
land surface temperature	RFC, WFO	max/min (frost), local model init.	MODERATE (seasonal)	~ 1km, resolution, at times surrogate for surface temperature

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