

## Operational Use of NASA Research Satellite Data

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Climate change is a defining issue of our generation. Our responses to the challenges of climate change—accurate prediction, equitable adaptation, and efficient mitigation—will influence the quality of life for the nation, and indeed the world, for generations to come. As NASA continues to address pressing scientific and national issues associated with climate change and the nation’s climate research and monitoring capabilities, it is also apparent that quantitative short-range earth-system prediction has wide-ranging operational applications and provides very large benefits to society, both in terms of protection of life and property and in terms of direct and indirect contributions to nearly all sectors of the economy. The quantitative impact of just one such area of prediction activity, namely weather prediction, is estimated to amount to tens of \$485B/year (excluding extreme events and disasters; Lazo et. al. 2011) for the US alone. Global prediction systems in particular rely extensively on satellite data, since there is no alternative method for obtaining the global coverage of observations data required to drive the global models. Many operational prediction systems rely heavily on “non-operational” satellite systems such as those flown on NASA’s research platforms, and on NASA research in algorithms and satellite data processing capabilities. Operational use of research satellites happens sometimes by serendipity, sometimes by design. However, it is almost always highly desirable since the additional focus on calibration and validation of the satellite data tends to benefit both operational and scientific users. The availability of data from research satellites for weather forecasting is made possible by direct broadcast capabilities on the satellites and ground based antenna (Dodge 1999) and processing systems (e.g., Huang et al. 2004) for the local access to real time data.

In order for the nation to maximize the return on its investment in research satellite systems for earth observations, it is therefore important to focus not only on the scientific value of the data but also on the potential operational use of them. NASA recognizes this and is investing in research to operations transition both for its satellite data and for the research that is developed around the data. Complementing the flight portfolio, NASA will advance climate research and weather forecasting, multiply applications using the full set of available (NASA and non-NASA) satellite measurements for direct societal benefit, and develop / mature technologies required for the next generations of Earth observing missions. These non-flight activities, which are essential for transforming the global spaceborne measurements into accurate predictions, efficient information products for the broad range of end-users, and consistent bases for long-term monitoring, include (but are not limited to) the acceleration of operational use of NASA research products for

predictions, building on expertise developed at the Joint Center for Satellite Data Assimilation (JCSDA) and under the Short-term Prediction Research and Transition (SPoRT) program. The JCSDA is a partnership among NASA, NOAA, and DOD to accelerate and improve the use of satellite data and related research in the various US operational environmental forecasting systems, while SPoRT provides a way for local NOAA weather forecasters to learn how to best utilize NASA satellite data in their forecasting systems.

The JCSDA was established in 2001, initially as a NASA / NOAA collaboration aimed at accelerating the use of satellite data in NOAA's weather and climate prediction efforts. It was expanded in 2002 to include partners from the US Navy and the US Air Force, and its mandate now includes all quantitative environmental prediction systems that rely in whole or in part on assimilation of satellite data. Thanks to JCSDA efforts, several types of new satellite data are now assimilated operationally by one or more of the JCSDA partnering organizations, e.g. polar winds from MODIS, hyperspectral infrared radiances from AIRS and IASI, GPS radio occultation soundings from COSMIC and a number of other sensors.

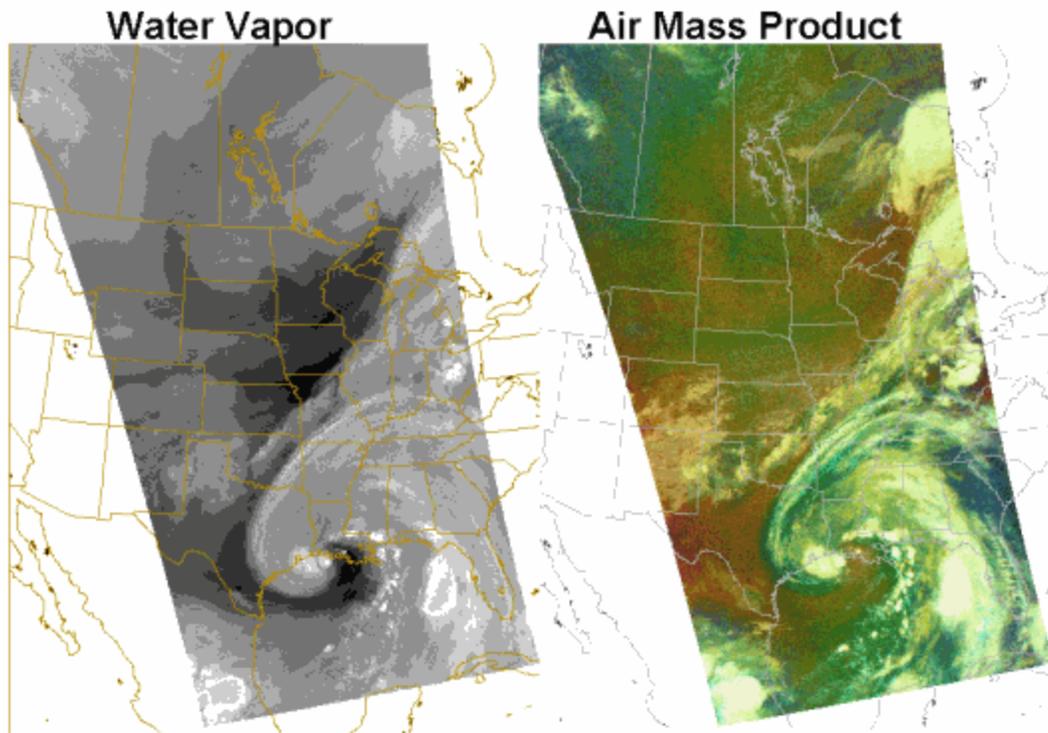
Preparation for assimilation of data from new sensors is a very important area of activity for the Joint Center which is again driven by economic considerations: Satellite systems represent major capital investments, the return of which is generally provided over a finite period of time, namely the operational lifetime of the satellite. The earlier in its lifetime society is able to benefit from it in terms of better environmental predictions, the larger the total lifetime benefit provided by a given satellite system will be. At this time (Aug 2011), the preparation for assimilation of data from NASA's NPP satellite is the highest priority for the Joint Center.

Research to operations transition involves transition of not only new data but also new science and new algorithms. Arguably the most important contribution to operations made by the Joint Center on the algorithm side is the Community Radiative Transfer Model (CRTM), a key component of any modern data assimilation system ingesting satellite measurements. The CRTM is used by all JCSDA partners both operationally and for numerous technical and scientific studies regarding the development of new sensors and systems.

Finally, in order to further increase the involvement of the research community in the JCSDA transition activities, the Joint Center has recently procured its own supercomputer on which copies of some of the main US operational prediction systems are maintained. The system, which jointly funded by NASA and NOAA and operated by NASA on behalf on the Joint Center is intended to provide a controlled test laboratory for researchers interested in testing out new data or new algorithms in a pseudo-operational environment with models and assimilation algorithms running at full operational resolutions.

Established in 2002 to demonstrate the weather and forecasting application of real-time EOS measurements, the SPoRT program has grown to be an end-to-end research-to-operations activity focused on the use of advanced NASA modeling and data assimilation techniques, the application of nowcasting techniques, and the use of unique high-

resolution multispectral observational data from EOS satellites to improve short-term weather forecasts on a regional and local scale. These activities are complementary to those of the JCSDA discussed above. SPoRT matches new data and a technology to forecast challenges, develops solutions to forecast challenges, and then infuses these capabilities into the operational weather environment. End user involvement in the entire process is critical to the success of the transitions. SPoRT currently focuses on over 30 data products from MODIS, AMSR-E, and AIRS, total lightning measurements from ground-based networks and output from a regional forecast model which assimilates high resolution NASA data to improve the initialization conditions and subsequent forecasts. High resolution imagery from MODIS is an important diagnostic tool to improve situational awareness of the presence of low clouds and fog, dust and smoke affecting visibility, and current weather conditions. MODIS channels sensitive to atmospheric temperature and moisture in various layers of the atmosphere are combined into red-green-blue (RGB) composites to portray details of tropical weather systems (Figure 1). AMSR-E estimates of rain rate are particularly useful in coastal ocean regions where coverage from ground-based weather radar is poor. High resolution composites of SST and vegetation fraction from AMSR-E and MODIS, and AIRS thermodynamic profiles are also used to provide better initial conditions for high resolution weather forecast models run at regional and local scales. Total lightning data from ground-based lightning networks provide forecasters a valuable tool to anticipate severe weather and prepares them for the use of future space-based observations. The SPoRT program will evolve to stay relevant to the changing needs of NASA research objectives and forecast issues in the Earth and atmospheric science community and new observations from upcoming missions.



**Figure 1. Terra MODIS water vapor imagery (left) and derived multispectral composite air mass product (right) for T. S. Lee at 0417UTC on September 3, 2011.**

Additional participation in JCSDA and SPoRT activities by the broader scientific community is facilitated through competitive research announcements which focus in the areas of algorithm development and refinement, product validation, and scientific data analysis. These opportunities offer the scientific community an opportunity to analyze, assess, and increase the impact of NASA data in research and operational environments, particularly in the areas of weather prediction. Proposals are regularly solicited to transition existing experimental data and research capabilities into the operational environments. In order to facilitate a rapid transition of research data into an operational environment, NASA requires close collaboration with SPoRT and the JCSDA in these transition activities.

References:

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