P5.29 NOAA'S PRODUCT PROCESSING PLANS FOR THE METOP MISSION

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1. INTRODUCTION

In November 1998, the National Oceanic and Atmospheric Administration (NOAA) and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) signed a Memorandum of Agreement for participation in the Initial Joint Polar System (IJPS). IJPS consists of two independent, but fully coordinated, polar satellite systems. In support of IJPS, NOAA will operate the NOAA-N and -N' satellites, which will be flown in a polar orbit with an afternoon (2:00 P.M.) equatorial crossing time. EUMETSAT will develop the Meteorological Operational (Metop) series of satellites to be flown in a polar orbit with a mid-morning (9:30 A.M.) equatorial crossing time. The mid-morning and afternoon satellites will each carry a set of jointly provided common instruments, plus additional instruments specific to each orbit and operating agency. Through the use of these satellites, NOAA and EUMETSAT will support the generation of products and services for their respective user communities. This paper will focus on NOAA's product processing plans in the IJPS era, including the impacts of changes to the current product suite and the new products to be generated from Metop data, which includes sea surface winds, advanced atmospheric soundings, and higher resolution products from Metop's global 1-km Advanced Very High Resolution Radiometer (AVHRR) data.

2. CURRENT SATELLITE STATUS AND PLANS

Currently NESDIS has two operational polar-orbiting satellites. NOAA-K, now designated NOAA-15, was launched into an early morning orbit (7:30 AM) in May 1998. NOAA-L, now designated NOAA-16, was launched into an afternoon (2:00 PM) orbit in September 2000. NOAA-M, now designated NOAA-17, was launched in June 2002 to replace NOAA-15. It was placed into a mid-morning orbit (10:00 AM). NOAA-17's new mid-morning orbit allows for increased temporal coverage and production of numerous imagery-based products, such as aerosol and vegetation index, currently not available from early morning orbits due to sun angle constraints. The new channel 3a (1.6 micron) added to the NOAA-KLM series for enhanced discrimination between snow/ice and clouds is also optimized in the mid-morning orbit. Additionally, NOAA-17 at 10:00 AM allows for a transition to and validation of the NOAA heritage instruments and their derived products scheduled for Metop-1. The planned launch dates for the NOAA and Metop satellites during the IJPS era follows:

NOAA-N – June 2004
Metop-1 – July 2005
NOAA-N' – March 2008
Metop-2 – August 2010

The first Metop satellite is planned to become operational in 2006 after an extensive checkout period.

3. IJPS INSTRUMENTS

The core environmental instrument set used for product processing on the NOAA and Metop satellites in the IJPS era are listed below. In addition, sensors for search and rescue and data collection are also part of the core instrument suite.

- Advanced Microwave Sounding Unit-A (AMSU-A) is a microwave sounder with 15 channels in the 23-90 GHz range. This instrument is used primarily for derivation of temperature soundings along with several surface and hydrological parameters.
- Advanced Very High Resolution Radiometer (AVHRR/3) is an imaging radiometer with six channels (3 visible/near infrared and 3 infrared) in the range of 0.6-12 microns. The

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Metop spacecraft will have the capability to record full resolution 1-km global imagery for one complete orbital pass. The NOAA-N and –N' satellites will continue to provide 4-km global imagery as well as more 1-km Local Area Coverage (LAC) imagery due to the use of digital recorders on the spacecraft. In addition to imagery this instrument supports the production of numerous ocean, land, and ice parameters along with hazard (fire, volcano) detection and monitoring.

- High Resolution Infrared Radiation Sounder (HIRS/4) is a temperature sounder with 19 infrared channels in the 3-15 micron range, and one visible channel. The HIRS/4 is an upgrade from the HIRS/3 currently orbiting aboard the NOAA-KLM series of satellites. The HIRS/4 has a smaller field of view at 10-km, compared to 20-km on the HIRS/3 model.
- Microwave Humidity Sounder (MHS) is a microwave sounder with five channels at 89, 157, and around 183 GHz supporting production of humidity profiles and other hydrological products.
- Space Environment Monitor (SEM-2) is a multi-channel charged-particle spectrometer.

In addition to the core instruments, the NOAA satellites will also carry:

- Solar Backscatter-Ultraviolet Radiometer (SBUV/2) is a spectral radiometer with 12 channels in the 252.0-322.3 nm in discrete mode and 160-400 nm in scan mode, used for generating total ozone and ozone profiles.

The Metop satellites will carry four new instruments:

- Advanced Scatterometer (ASCAT) is a pulsed C-band radar at 5.255 GH, and will be used to generate ocean surface wind vector products.
- Global Ozone Monitoring Experiment (GOME-2) is a nadir-viewing spectrometer with four channels in the range of 0.240-0.790 microns. NESDIS plans are for using the GOME-2 to derive total ozone and ozone profile products.
- Global navigation satellite system Receiver for Atmospheric Sounding (GRAS) is a radio occultation receiver that uses signals from the global navigation satellite systems. GRAS will only initially be used by NESDIS for research applications including atmospheric temperature and moisture profiles.
- Infrared Atmospheric Sounding Interferometer (IASI) is a Michelson interferometer covering the 3.6-15.5 micron range. IASI thinned radiances will be used initially by NESDIS and its users in a manner similar to those generated from the Atmospheric Infrared Sounder (AIRS) instrument aboard NASA's Aqua satellite. Plans also include the generation of atmospheric temperature and moisture soundings to complement the HIRS, MHS, and AMSU-based soundings.

Data streams from all core instruments, regardless of platform, plus the SBUV/2, will continue to be available at NESDIS in order to continue to meet current and planned Level 1 data and Level 2 product generation, distribution and archive requirements. In addition, access to the data and/or products of the four new Metop instruments will be supported in order to enhance fulfillment of NESDIS requirements.

4. DIRECT READOUT SERVICES

During the IJPS era, satellite data will continue to be available to direct broadcast local users worldwide. The NOAA and Metop satellites will broadcast via High Resolution Picture Transmission (HRPT), which is AVHRR based for NOAA satellites. Initially the Metop satellites will also only be AVHRR based, although the capability exists for utilizing other Metop instrument data at a future date.

While the NOAA satellites will continue to broadcast the 4-km AVHRR data via analog Automated Picture Transmission (APT) links, the Metop satellites will broadcast a new digital Low Resolution Picture Transmission (LRPT) data stream using the VHF band. LRPT includes selected channels of AVHRR data, as well as HIRS/4, AMSU-A, MHS, SEM, and the GRAS positioning and timing data.

5. IJPS PRODUCT PROCESSING

The products that will be generated during the IJPS era and their associated instrument datasets are depicted in Figure 1. Operational snow and ice, hazards, and significant event imagery are generated by the NESDIS Office of Satellite Data Processing and Distribution's (OSDPD) Satellite Services Division on the Satellite Environmental Processing System (SATEPS). Aerosol, global

vegetation, cloud imagery, sea surface temperature, radiation budget, atmospheric moisture and temperature soundings, ozone, and microwave surface and hydrological products are generated by the Central Environmental Satellite Computer System (CEMSCS) within OSDPD's Information Processing Division. Other products include sea ice analyses generated by the National Ice Center and space environment products generated by NOAA's Space Environment Center. Services during the IJPS era include search and rescue and the data collection services. Products are made available to a wide variety of users via the SATEPS and CEMSCS servers, the Internet, the National Weather Service Gateway, the Global Telecommunications System, or several other methods.

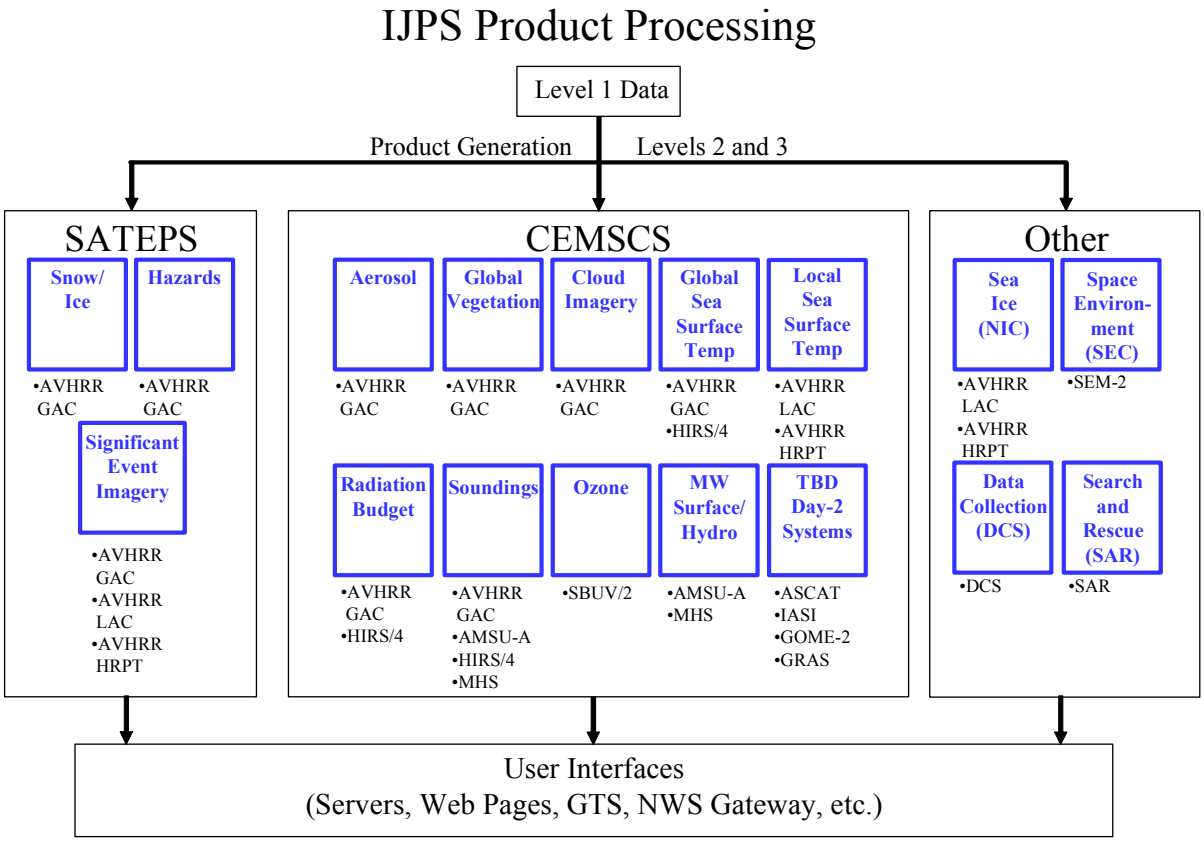

Figure 1. IJPS Product Processing and Services.

There will be a phased approached to product processing during the IJPS era based on mission priorities. The highest priority is continuing the morning mission and includes those products that are required to be generated, distributed, and archived on an operational basis at the transition from an older spacecraft (i.e., from NOAA-16 to NOAA-N or from NOAA-17 to Metop-1) in order to continue the fulfillment of existing requirements on the POES mission. These products are expected to become operational at launch of Metop plus six months and include products from AMSU-A, HIRS/4, MHS, SEM, Metop's HRPT AVHRR data, and the products based on the 4-km AVHRR data. Products based on the full global 1-km AVHRR data may also become operational at the transition. In addition, GOME-2 total ozone products are expected to become operational at the time of the transition for continuity of the NOAA-17 SBUV/2 products.

Products from new Metop data streams, in which product generation experience from similar sensors on other satellites exists, will be implemented at the transition to the Metop satellite or shortly thereafter. These include products from the ASCAT based on experience with other scatterometer data, and IASI thinned radiances based on experience with hyperspectral AIRS data, as well as any products using the global 1-km AVHRR data.

Products based on the application of new Metop data streams, including GRAS products and those non-AVHRR products from the Metop HRPT data, are not required for operational transition and will initially be categorized with a research status.

There will be a new method of generating products during the IJPS era. Data from the Metop satellites will be delivered to NESDIS from EUMETSAT in pipeline mode. Pipeline processing requires less bandwidth to transfer an equal amount of data. During pipeline processing, the various steps of ground processing are done in parallel, allowing for the simultaneous processing of different small parts of an orbit called granules. While some products will continue to be generated from orbital data sets, those products with a user timeliness requirement will need to be upgraded to allow for pipeline processing. Users with timeliness requirements may need to upgrade their systems to accept data streams smaller than an orbital file or product.

6. REQUIREMENTS PROCESS

While it is a priority to continue generating operational NOAA-17 products from the Metop-1 instruments at the time of transition to the IJPS morning satellite, it is also a goal to generate new and enhanced products from Metop's new data streams on a timely basis. All requests for new products from any of the IJPS instruments will follow the same procedure. As a requirement is received from a user, a process is started in order to fulfill that requirement. The process is illustrated in Figure 2.

After receipt of product requests, the products are evaluated from a scientific, technical, and business perspective to determine if the user request supports the NESDIS strategic goals. Approved user requests are added to the NESDIS prioritized list of products and developmental tasks and efforts are initiated to determine the feasibility of generating the product. In order to generate a product an algorithm is designed and tested while code and documentation are prepared. A product in the experimental phase is generated on a regular basis and is often made available on the Internet for user evaluation. However, experimental products are not given full support.

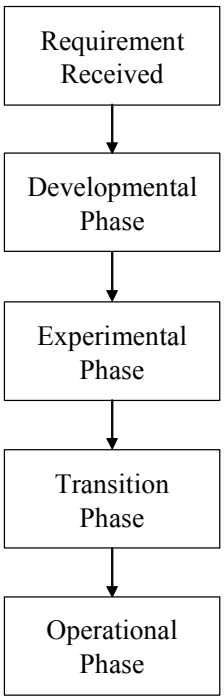

Figure 2. Requirements Process.

During the transition phase, the process is started to transfer products towards an operational environment. Operational code is put in place and calibration and validation procedures are conducted as required in order to baseline the operational products. Comparisons with ground truth or other satellite data are done, statistics are generated, and verification and monitoring of the products is started. Once it has been determined that a product is ready, it is given an operational status. Operational products are those that have long-term, routine production and distribution to users. They are supported 24 hours per day, 7 days per week in accordance with user product formatting, accuracy, and timeliness requirements. Operational products are also archived.

7. CONCLUSION

There are many changes expected to product processing during the IJPS era. Plans are in place to continue generating and distributing operational products, from both the Metop and NOAA satellites, with a core set of imagery and sounding instruments. In addition, new instrumentation on the Metop satellites will give scientists and other users of satellite data provided by NESDIS the opportunity to apply additional datasets to and develop new products for numerous atmospheric, oceanic, and land applications.

8. REFERENCES

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