The Next Generation of Data Systems for Continuing the Climate Record of Cloud and Atmosphere Observations

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1. INTRODUCTION

The NPOESS Preparatory Project (NPP) satellite mission is a joint project between NASA and the NPOESS Integrated Program Office (IPO). Currently scheduled to launch in mid-2010, NPP will provide a first look at a new generation of products from U.S. operational polar orbiting Earth observing satellites. The NPP mission will (a) provide a bridge mission between the current constellation of NASA Earth Observing System (EOS) satellites including Terra, Aqua, and Aura and the future constellation of NPOESS satellites; (b) continue the record of global climate observations established by EOS; and (c) provide the NPOESS project and customer community with risk reduction for selected NPOESS instruments, algorithms, products, and ground processing. The NPP sensor payload includes the following sensors:

- Visible Infrared Imager Radiometer Suite (VIIRS): Multispectral scanning radiometer with 22 spectral bands, FOV 370/740 meters;
- Cross-Track Infrared Sounder (CrIS): Michelson interferometer with 1297 spectral bands, FOV 14 kilometers;
- Advanced Technology Microwave Sounder (ATMS): Passive microwave radiometer with 22 channels, FOV 75/33/15 kilometers;
- Ozone Mapping & Profiling Sensor (OMPS): three hyperspectral imaging spectrometers (Nadir Mapper, Nadir Profiler, Limb Profiler);
- Clouds and the Earth's Radiant Energy System (CERES); broadband scanning radiometer.

The prime contractor for NPOESS (Northrop Grumman) is responsible for NPP product generation within the Interface Data Processing Segment (IDPS) of the NPOESS Ground System. The IDPS will create global products in real-time from VIIRS, CrIS, and ATMS, while OMPS and CERES products will be generated by NASA GSFC and LARC, respectively. The NASA NPP Science Team has been tasked with evaluation of the operational products from the IDPS within a NASA facility known as the Science Data Segment (SDS). NASA has established five Product Evaluation and Algorithm Test Elements (PEATEs) within the SDS to enable the NPP Science Team to evaluate the operational Sensor Data Records (SDRs) and Environmental Data Records (EDRs) from NPP in an efficient and effective manner. In particular, the NPP Science Team is tasked to evaluate products from the IDPS for their suitability in continuing the NASA climate data record. The PEATEs will allow the Science Team to evaluate whether the operational NPP products are of sufficient quality to continue the climate record established by other observation systems including EOS.

2. ROLE OF THE ATMOSPHERE PEATE

The PEATEs are organized into categories including Atmosphere, Land, Ocean, Ozone and Sounder. The Atmosphere PEATE was established within the Space Science and Engineering Center (SSEC) at the University of Wisconsin-Madison (all other PEATEs are located at NASA centers). The Atmosphere PEATE at SSEC assists the NPP Science Team in: (a) evaluating the suitability of the NPP Atmosphere EDRs for continuing the NASA climate record; (b) assessing the performance of the NPP Atmosphere EDRs through comparison with other ground-based and satellite-based measurements; (c) incorporating new research advances to continually improve the products; and (d) developing improved or alternative Atmosphere NPP EDR algorithms for the NPP products that are shown to be of insufficient quality. The Atmosphere PEATE allows the NPP Science Team to rapidly assess the climate quality of the NPP atmosphere algorithms in the pre-launch period using proxy data including MODIS, AIRS, and IASI, and validation data from ground based, aircraft, and satellite sources including CALIPSO and CloudSat.

The Atmosphere PEATE provides a Science Processing System (SPS) to enable the NPP Science Team to rapidly evaluate climatologically significant datasets from proxy sources pre-launch and NPP post-launch. The SPS leverages knowledge and expertise from the NPP Ocean and Land PEATE processing systems, and is deployed at SSEC on commodity compute and storage hardware running Linux. The SPS allows the NPP Science Team to evaluate global NPP cloud and aerosol EDRs. Part of the strategy is to leverage NPP Science Team experience in both imager and interferometer radiance calibration, as this is critical to the accuracy of the products. The second part of the strategy is to use Aqua MODIS and AIRS proxy data for VIIRS and CrIS, respectively, as years of global data and heritage products currently exist. Assessment of the performance of the NPP algorithms will be gained through comparison of global cloud and aerosol products to those obtained from CALIPSO and CloudSat data as well as data from ground-based systems such as AERONET. The NPP cloud and aerosol EDRs will be generated using the latest available versions of the operational (OPS) codes provided by the NPP instrument contractors.

3. DATA SYSTEM FOR EVALUATING AND GENERATING CLIMATE DATA RECORDS

The Atmosphere PEATE's primary responsibilities are to assist the NPP Science Team Atmosphere Group in evaluating NPP SDRs and atmosphere EDRs; suggesting improved and alternative algorithms for deriving atmosphere EDRs; and creating prototype atmosphere CDRs. The NPP EDRs which are assigned to the Atmosphere PEATE are Cloud Mask (IP), Cloud Cover/Layers, Cloud Effective Particle Size, Cloud Top Height, Cloud Top Pressure, Cloud Top Temperature, Cloud Base Height, Cloud Optical Thickness, Aerosol Optical Thickness, Aerosol Particle Size, and Suspended Matter.

To assist in this task, the Atmosphere PEATE has developed (and is continuing to enhance) an advanced data system for evaluating and generating climate data records of cloud and atmosphere observations. Capabilities of the system include:

- Configurable Data Ingest Systems for ingesting and monitoring data flows from external FTP or HTTP sites (key technologies: Web services)
- Flexible Data Management System using pools of generic storage servers for high performance data serving (key technologies: Sun SATA storage servers, Solaris 10, ZFS, PostgreSQL)
- Job Management System using an open source off-the-shelf workload management system which allows jobs to be distributed across one or more physical computer clusters (key technologies: Sun Grid Engine)
- Job Creation System allowing routine and reliable scheduling, execution, and monitoring of climate data processing tasks (key technologies: PostgreSQL)
- Observation Collocation System allowing multi-sensor observations to be efficiently collocated in space and time (key technologies: Orbit Prediction Model, Sensor Viewing Geometry Model)
- Interactive Gridded Product Generation System allowing global equal angle or equal area gridded products to be generated on the fly (key technologies: PostgreSQL on multi-core servers)

The Atmosphere PEATE Science Processing System (SPS) integrates these elements into a facility which allows NPP scientists to rapidly assess the quality of NPP algorithms and products; run 'what if?' algorithm scenarios on climatologically significant amounts of satellite data; and generate climate data records on datasets up to and including complete satellite mission records. This presentation will describe the individual elements of the Atmosphere PEATE SPS, and how they allow the next generation of remotely sensed cloud and atmosphere products to be generated and evaluated.