Overview of the NOAA GCOM AMSR2 Algorithm Software Processor (GAASP)

Elizabeth McMichael[1], Thomas King[1], Letitia Souillard[1], Zorana Jelenak[2], Walter Wolf[3], Paul Chang[3], and Ralph Ferraro[3]

[1]I.M. Systems Group, Inc., Rockville, MD 20852
[2]UCAR, Boulder, CO 80301
[3]NOAA/NESDIS/STAR, College Park, MD 20740

Abstract

As part of NOAA's mission goal to serve society's need for weather and water information, NOAA/NESDIS is acquiring data from the Japan Aerospace Exploration Agency's (JAXA) Global Change Observation Mission (GCOM) to enable the distribution of data products to operational users. The first in the series of GCOM satellites, 1st-Water (GCOM-W1), was launched May 18, 2012 on board the Advanced Microwave Scanning Radiometer 2 (AMSR2) sensor on board to measure hydrometeorological parameters.

GCOM-W1 data will contribute to observations related to global water and energy circulation. A custom built software package, the STAR GCOM AMSR2 Algorithm Software Processor (GAASP), will combine all aspects of AMSR2 data processing and Environmental Data Record (EDR) production and will be implemented operationally at the Office of Satellite and Product Operation (OSPO). EDR algorithms being developed include ocean scene products (sea surface temperature, total precipitable water, cloud liquid water, sea surface wind speed, and ocean rain rate), snow and sea ice, soil moisture and surface type, and global rain rate. The GAASP software will be comprised of a preprocessor for the sensor data records (SDRs, brightness temperatures), the science algorithms, and a postprocessor for the EDRs. Output products will be made available in netCDF4, BUFR, and GRIB2 formats according to operational user needs.

The timeline of the project is to make AMSR2 brightness temperatures and day 1 products available operationally by November 2013. Details of the software and its products will be discussed.

Development Timeline

- Jan-Dec 12: Preliminary algorithm development
- Mar-Oct 12: Preliminary system design
- May 12: GCOM-W1 launched
- Nov 12: Preliminary Design Review (PDR)
- Nov-Dec 12: Hardware definition; design/choose algorithms
- Nov 13: Begin development of product netCDF4 readers and writers
- Dec 12: Begin documentation
- Dec13: Initial product validation
- Jan 13: Critical Design Review (CDR)
- Jan-Mar 13: Begin implementation of algorithms within processing system
- Feb 13: Begin development of scheduling system
- Feb-Mar 13: Test case processed
- Mar 13: Test Readiness Review (TRR)
- Apr 13: Extensive product validation
- Apr 13: Initial algorithm package delivery
- Apr 13: Software Review
- May 13: Pre-operational product output evaluated and tested within the ESPC environment
- May-Jun 13: Prepare documentation
- Jun-Jul 13: Update software
- Jun 13: All documentation complete
- Jun 13: Algorithm update delivery_1 to operations
- Jun-Sep 13: Prepare for transition to operations
- Jun 13: Operational Readiness Review (ORR)
- Jul-Aug 13: Validate OSPO products
- Sep 13: Transition pre-operational system to operations
- Sep 13: Operational phase beings
- Sep 14: Algorithm update delivery_2 to operations
- Sep 15: Algorithm update delivery_3 to operations
- Sep 16: Algorithm update delivery_4 to operations
- Sep 13-Sep 17: Operational product quality assurance and validation
- Apr 14-Sep 17: Product enhancement and refinements
- Sep 17: Final software and documentation deliver to CLASS

AMSR2 Product Information

- The brightness temperatures and day-1 products will be available approximately 18 months after launch.
- The day-1 AMSR2 retrieval algorithms will be based upon AMSR-E heritage algorithms to ensure product availability and continuity as soon as possible after launch.
- The second delivery will occur approximately 30 months after launch and will consist of day-2 products plus enhancements of day-1 products.
- All distributed netCDF4 files will be CF compliant.
- GAASP developers will work with NWP and other downstream users to ensure all required content is available for distirbution in BUFR and GRIB2 formats.

System Design

- **The GCOM-W1 Processing and Distribution System:**
  - GAASP will run within the GCOM Production and Distribution System (GPDS).
  - The GPDS (developed within the Office of System Development (OSD)) will ingest Raw Data Record (RDR) data from the receiving station KSAT, directed through IDPS to convert ASD to RDR files and stored within NDE.
  - In order to utilize the SDR producing code from JAXA, the RDR files must be converted back to binary APID Sorted Data (ASD) format.
  - The GPDS will schedule, manage, and monitor all GCOM processing operationally.
  - Binary SDR output will be converted to netCDF4 by customized reformatting tools.
  - The GPDS will also handle all product distribution.
 - The GPDS will be delivered to and run at the NOAA Office of Satellite and Product Operations (OSPO).

- **GAASP consists of 3 main parts:**
  - Preprocessor: Ingests AMSR2 SDR files (remapped and original) in HDF5 format and ancillary datasets. It converts data into binary files readable by the algorithm retrieval code.
  - Algorithms: Ocean, precipitation, snow/ice, and land sub-units. Inputs for the various units include static surface type from VIIRS/MODIS/AVHRR, VIIRS vegetation index, and FAO soil moisture texture map, USGS GTOPO 30, NSIDC snow cover classes, NCDC snow density climatology, GFS wind speed and direction, and AVHRR IEEE OI-SST for day 1 SST products.
    - Day 1 EDR products include brightness temperatures, total precipitable water, cloud liquid water, precipitation type/rate, sea surface temperature, and sea surface wind.
    - Day 2 EDR products include soil moisture, sea ice characterization, snow cover/depth, snow water equivalent, and surface type.
    - The day 2 data flow is different from day 1 because it takes advantage of the day 1 precipitation, snow and ice, and brightness temperature EDRs to improve the day 2 land EDRs.
  - Postprocessor: Converts AMSR2 land, snow and ice, ocean, and rain EDRs from binary to netCDF4 for distribution to the users.
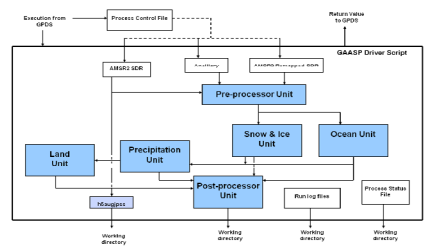

GPDS Interfaces
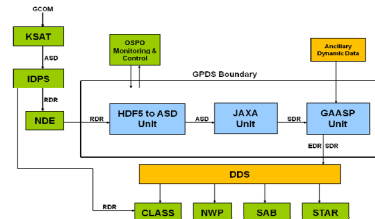
Day 1 GAASP Unit Data Flow
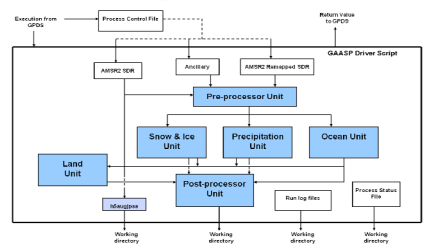
Day 2 GAASP Unit Data Flow

System Information

- **Hardware:**
  - Development machine: Intel Xeon CPU X5680
    - Red Hat Linux 6, 64-bit
    - 72 TB raw disk space, ~30 TB unallocated to logical volumes
    - 12 dual 6-core processors
    - 96 GB RAM, DDR3
    - 3.33 GHz processor clockspeed
    - Intel Fortran compiler
    - gcc C/C++ compiler
  - Separate machines for development, test, and production (Operated within NOAA/NSOF).

- **Code:**
  - All data handling and algorithms are written in Fortran 90. Perl scripts wrap the Fortran 90 main programs to manage the interface with the GPDS.
  - The current interface is assumed to be like that of the NDE system. No paths are hardcoded in the system. They are, instead, provided by the GPDS through a standard interface. All error handling/messaging is passed by to the GPDS. All higher-level tasks such as file management will be handled by the GPDS.
  - GAASP system code manages the interface between the science algorithms and the GPDS thus minimizing any necessary modification on either side.

- **Testing:**
  - At STAR, a continuous data feed of SDR files directly from JAXA is currently available. This allows for science and system development.
  - A prototype GAASP system will be established at STAR to provide early data products to users for testing data flow and to allow for early product validation.
  - The GAASP software package will be unit tested. Results will be documented and presented in a Code Test Review (CTR).
  - A Software Code Review (SCR) will be conducted to demonstrate that code is meeting SPSRB coding standards and ESPC security requirements.
  - The GAASP software package will be delivered in a Red Hat Package Manger (RPM)to the NOAA Office of Systems Development (OSD) for integration into the GPDS.
  - After integration and successful system testing the OSD contractors will deliver the GPDS to OSPO where it will be run operationally and monitored on a 24/7 basis.

AMSR2 EDR Products and Users

Products	Format	Users
Microwave Brightness Temperatures	netCDF4	NCEP/EMC, OSPO/SAB, NWS/NHC
Total Precipitable Water	netCDF4	NHC, CPC, NWSFO, NESDIS, OSPO/SAB
Cloud Liquid Water	netCDF4	NCEP/EMC
Precipitation Rate/Type	netCDF4	CPC, NWSFO, NHC, NESDIS, OSPO/SAB, NCEP/EMC
Sea Surface Temperature	netCDF4	NCEP/EMS, NWS/NHC, CoastWatch/OceanWatch, Coral Reef Watch, GHRSST, NCEP/EMC/MMAB, NCEP/OPC, NWS/NHC, NCEP/CPC, NMFS/Pacific Marine Lab, JCSDA, Navy, NASA/SPoRT, OAR/AOML, OAR/ESRL
Sea Surface Winds	netCDF4	OSPO/SAB , NWS/NHC
Soil Moisture	netCDF4	NCEP/EMS for SMOPS
Sea Ice Characterization	netCDF4	NIC
Snow Cover/Depth	netCDF4	NIC
Snow Water Equivalent	netCDF4	NIC
Surface Type	netCDF4	NW/S/CPC, NWS/NWSFO, NCEP/EMC

Above image courtesy of JAXA