

# The NOAA Unique CrIS/ATMS Product Processing System (NUCAPS)



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## Abstract

The NOAA Unique Cross-track Infrared Sounder (CrIS) and Advanced Technology Microwave Sounder (ATMS) Product System (NUCAPS) is under development at NOAA/NESDIS/STAR. The system will produce thinned apodized CrIS radiances, principal components of CrIS radiances, cloud-cleared CrIS radiances, and trace gas profile products for Numerical Weather Prediction (NWP) customers in near real-time. The radiance products will be available in Binary Universal Form for the Representation of meteorological data (BUFR) and network Common Data Form version 4 (netCDF4). The principal components and trace gas profile products will be available in netCDF4 format. At this time, the system components are being developed and tested with simulated and actual beta CrIS and ATMS data. In addition, CrIS test BUFR data files are available to the user community. NUCAPS will be run operationally within the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Data Exploitation (NDE) Data Handling System (DHS). The thinned apodized radiances data will be available once the NPP data are released (approximately 6 months after launch); the rest of the products will be released one year later. The details of the system and its products will be discussed.

## Development Timeline

- Jun 06: Begin building the CrIS/ATMS simulation system
- May 07: Preliminary Design Review
- May 07: Preliminary System Development
- Nov 07: Meeting with NCEP and EUMETSAT for definition of the CrIS BUFR table content
- Dec 07: Test case processed for simulation system
- Jan 08: CrIS simulated system has been run in near real-time (NRT)
- Sep 08: Critical Design Review
- Oct 08: Begin collaboration with NWP centers on preliminary CrIS BUFR table
- Oct 08: Subsetter and NUCAPS system development
- Nov 08: Subsetter code is prepared for implementation into CrIS/ATMS NRT simulation system
- Jan 09: Implement updates to CrIS BUFR table
- Jun 09: Distribute simulated CrIS data in BUFR format to NWP centers for review
- Jul 10: Test Readiness Review (TRR)
- Aug 10: Code Unit Test Review (CUTR)
- Sep 10: Deliver NUCAPS to NDE
- Oct 10-Aug 11: Assist with NDE system testing and system documentation
- Oct 11: NPP launch
- Jul 12: SDR thinned radiance products to become operational
- Jan 13: NUCAPS retrieved products to become operational
- Jan 14: Update to retrieval and principal component products becomes operational
- May 14: VIIRS cloud products collocated to CrIS and ILS correction become operational

## CrIS Radiance Apodization

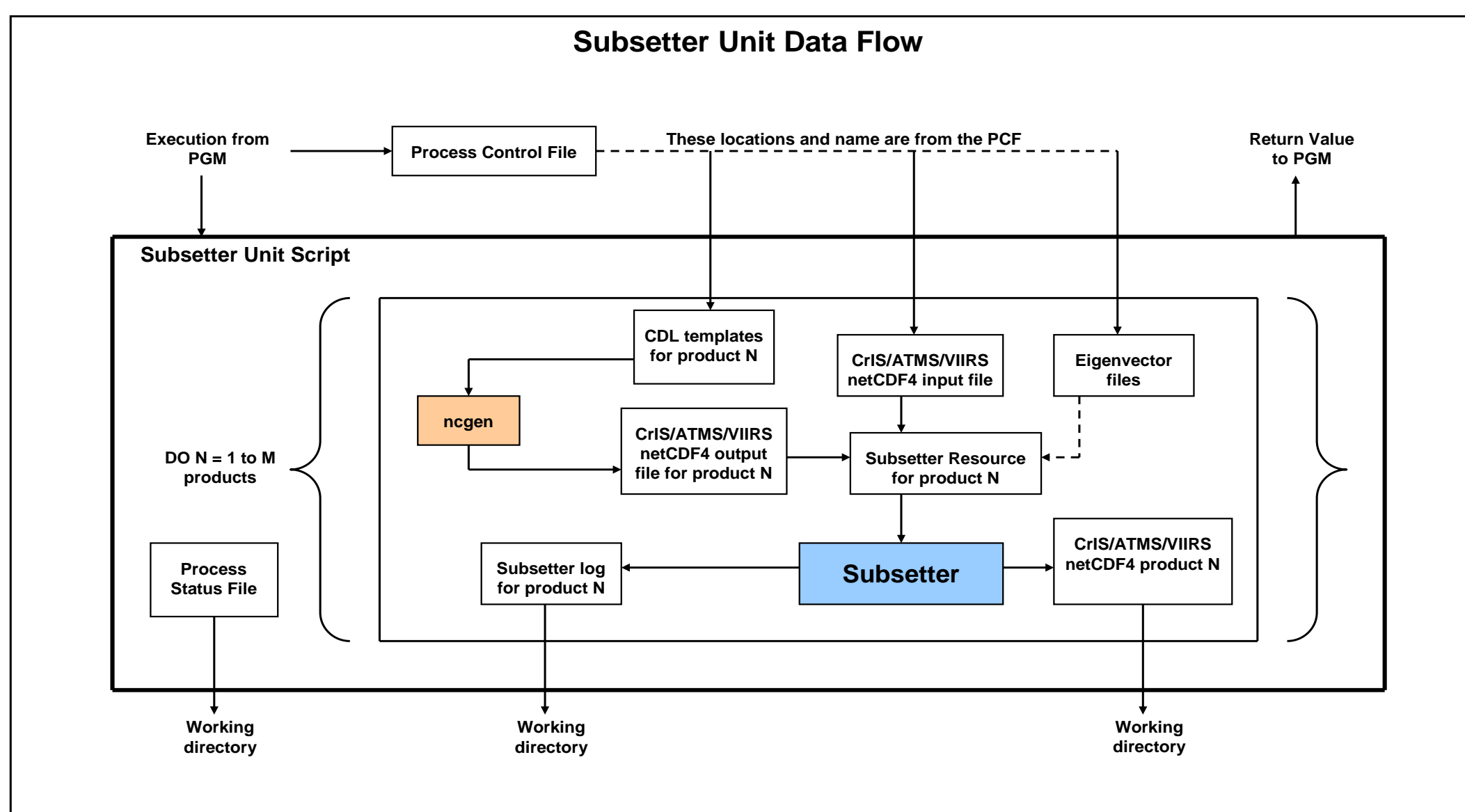
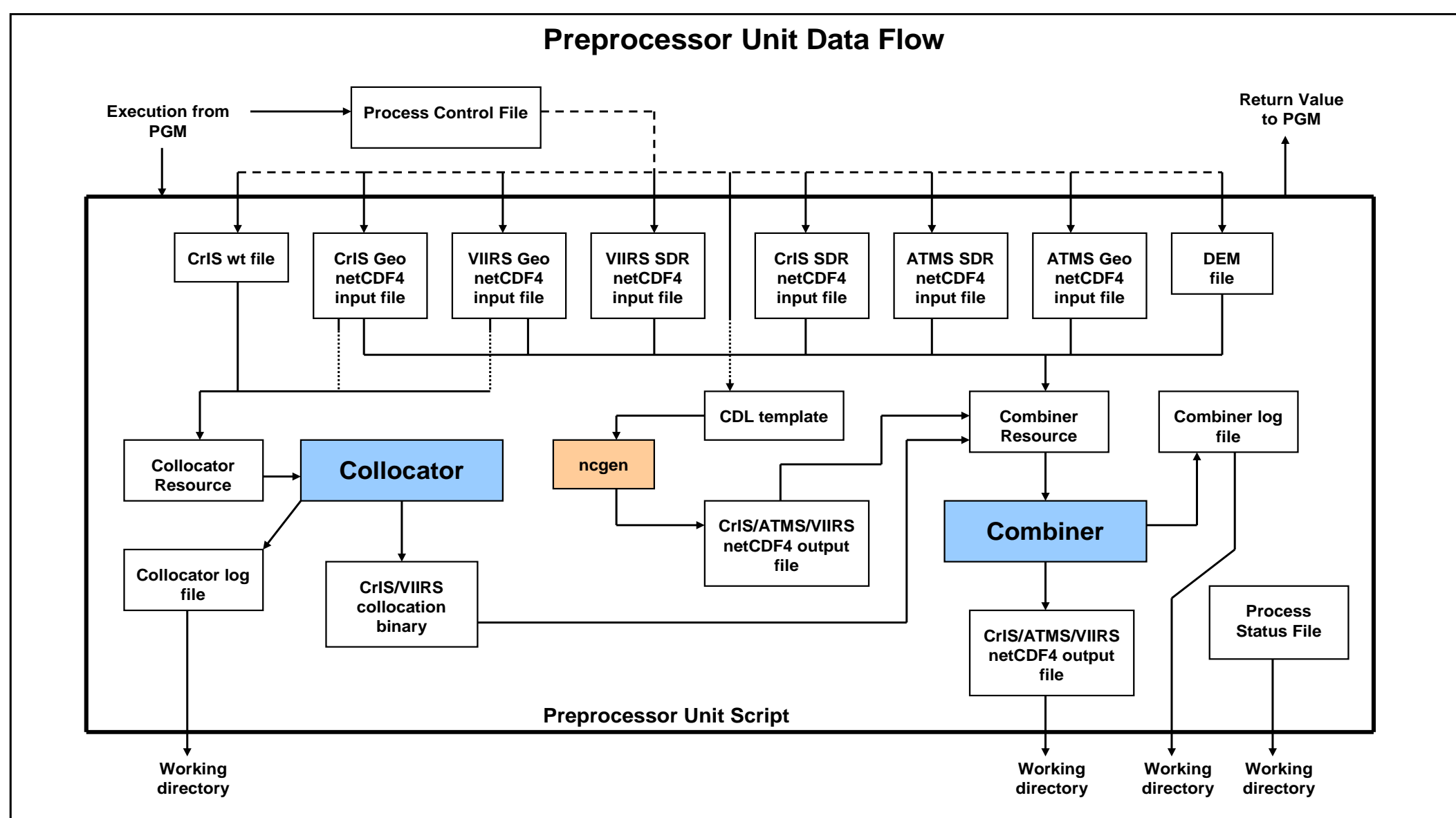
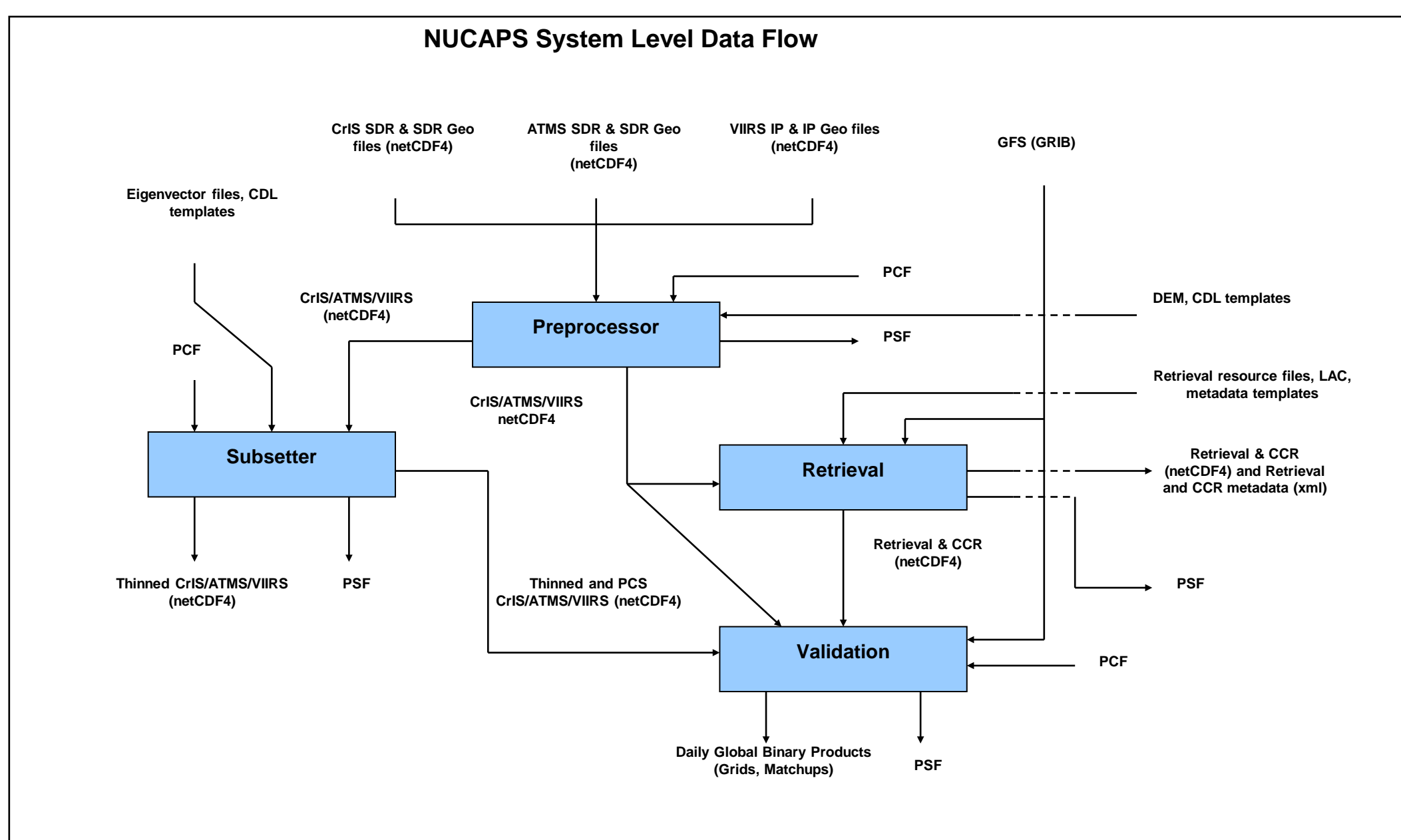
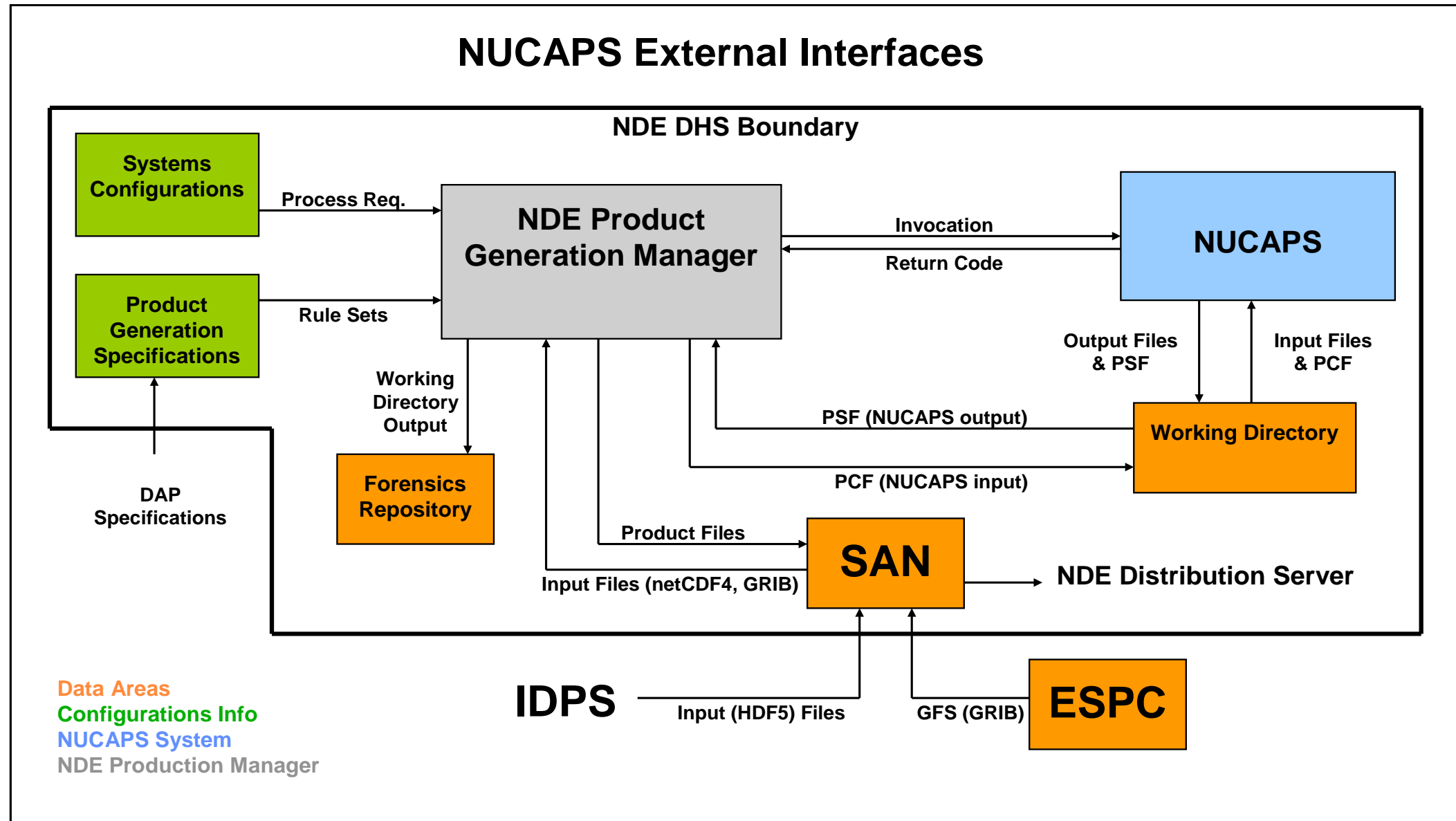
- CrIS SDR radiances are de-apodized (instrument self apodization has been removed)
- STAR will apodize the CrIS radiances using a Hamming apodization function consistent with the UMBC rapid algorithm
- Hamming is a reversible apodization therefore enabling the users to apply their own apodization

## NUCAPS Product Information

- A subset of 399 channels has been selected by the NUCAPS science team for the CrIS thinned SDR BUFR.
- The CrIS thinned radiances will be available approximately 6 months after launch.
- VIIRS cloud top EDR fields will be collocated to CrIS FOVs and averaged to help users identify clear and cloudy fields of view in the CrIS BUFR and to improve cloud clearing in the retrieval.
- More details of the CrIS BUFR are presented in the poster entitled: A BUFR and GRIB Tailoring System for NPP/NPOESS Products.
- All distributed NetCDF4 files will be CF compliant.
- The NUCAPS retrieval algorithm is the same used for AIRS and IASI.
- The retrieval preprocessing includes:
  - Matching CrIS and ATMS FOVs
  - Correcting the CrIS radiances for local angle viewing
  - Averaging the ATMS FOVs to the CrIS FORs using Backus-Gilbert derived weights
- The NUCAPS retrieval products will be made available approximately 12 months after launch.

## System Design

- **The NDE Data Handling System:**
  - NUCAPS (along with MIRS, SST, GVT, and Polar Winds) will run within the NDE DHS.
  - NDE will ingest CrIS, ATMS, and VIIRS SDR data from the IDPS.
  - The NDE DHS will schedule, manage, and monitor all NUCAPS processing operationally.
  - NUCAPS output will be converted to BUFR by the NetCDF-to-BUFR/GRIB tailoring system.
  - The NDE DDS will handle all product distribution.
- **NUCAPS Consists of 4 processing units:**
  - Preprocessor: Extracts file headers for instrument mode and maneuver checks, conducts range checks of data, collocates CrIS, ATMS, and VIIRS data onto the same fields of view, performs the apodization on the CrIS radiances, applies a digital elevation model, and reformats all the output for the downstream processing units.
  - Subsetter: Generates CrIS thinned radiances and principal component products. Reformats CrIS products for downstream tailoring into BUFR.
  - Retrieval: Reformats the CrIS, ATMS, and GFS data for the retrieval code, performs the CrIS local angle correction, runs the retrieval, generates metadata, and reformats the output into product formats.
  - Validation: Generates daily global products of satellite radiances collocated to grids and in-situ instrument measurements (e.g. radiosondes and aircraft) for science monitoring, offline eigenvector generation, and climate reprocessing efforts.



## System Information

- **Hardware:**
  - IBM P6 with 16 4.2 GHz CPUs, 2 GB/CPU, 50 TB SAN storage, running AIX 5.3 (leveraging the IASI development machine).
  - 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 NDE DHS.
  - NUCAPS system design is based on that developed for IASI and AIRS.
- **Testing:**
  - At STAR, a data simulation system runs continuously to produce global coverage CrIS and ATMS SDR 32-second granule data in the IDPS HDF5 format.
  - The simulated data enables system testing of all the code and hardware to ensure it is robust, can handle the data volumes, and can meet the product latencies.
  - P72 and actual data sets from JPSS focus days (Feb 7, 24-26, 2012) have been used for testing.
  - A prototype NUCAPS system has been running in NDE providing pre-beta SDR data to EMC and EUMETSAT for testing data flow since January.
  - 12 seconds to produce all SDR subsets and principal components per granule.
  - 50 seconds for the retrieval to generate profiles and reconstructed radiance products.
  - The simulated data prepares users for data ingest. CrIS BUFR files are available at: [ftp2.orbit.nesdis.noaa.gov/ftp/anon/snacd/king/CrIS\\_BUFR](ftp2.orbit.nesdis.noaa.gov/ftp/anon/snacd/king/CrIS_BUFR)
  - Test data, procedures, and test results are made available to NDE as part of the Delivered Algorithm Package (DAP).
  - Testing for Phase 1 is complete and final delivery to NDE was made March 14, 2012.

## NOAA-Unique Thinned CrIS SDR Products

| Products  | Format         | Users                                      |
|---|----------------|--|
| CrIS SDR radiances (399 channels, all FOVs/FORs)                      | BUFR           | NCEP, JCSDA, GMAO, EC, CMC                 |
| CrIS SDR Radiances (1305 channels, all FOVs/FOR)                      | BUFR           | EUMETSAT (ECMWF, UKMet, DWD, Meteo France) |
| CrIS SDR Principal Components (1 & 3-bands of 300 components FOV/FOR) | NetCDF4        | STAR, OSPO                                 |
| Daily SDR Global Grids (3X3 and 0.5X2)                                | Gridded Binary | NCDC, STAR                                 |
| Daily GFS and CrIS Forecast Global Grids (0.5X2)                      | Gridded Binary | STAR                                       |
| SDR and EDR Radiosonde Matchups                                       | Binary         | STAR                                       |

FOV = Field of View; FOR = Field of Regard

## NOAA-Unique CrIS/ATMS Profile Products

| Products  | Format         | Users             |
|---|----------------|-------------------|
| CrIS/ATMS profiles for 100 levels (O <sub>3</sub> , CH <sub>4</sub> , CO <sub>2</sub> , N <sub>2</sub> O, SO <sub>2</sub> , HNO <sub>3</sub> , H <sub>2</sub> O, T) | NetCDF4        | AWIPS, NCDC, STAR |
| CrIS/ATMS Cloud-Cleared Radiances for 399 channels  | NetCDF4        | NCDC, STAR        |
| Daily Profile Global Grids of radiances (3X3 and 0.5X2)   | Gridded Binary | STAR              |
| Daily EDR Global Grids of retrieved profiles (3X3 and 0.5X2)  | Gridded Binary | STAR              |
| EDR Radiosonde Matchups   | Binary         | STAR              |

FOV = Field of View; FOR = Field of Regard.

