A BUFR and GRIB Tailoring System for NPP/NPOESS Products

Yi Song[1], Thomas King[1], and Walter Wolf[2]
[1]Riverside, Fort Collins, CO. 80528
[2]NOAA/NESDIS/STAR, Camp Springs, MD 20746

Abstract

A tailoring software system that will convert network Common Data Form version 4 (NetCDF4) formatted files to Binary Universal Form for the Representation of meteorological data (BUFR) and GRIdded Binary Edition 2 (GRIB2) formatted files is under development at NOAA/NESDIS/STAR. This NetCDF4 Reformatting Toolkit will produce the tailored BUFR and GRIB2 products for the NPOESS Preparatory Project (NPP) Data Exploitation (NDE). NDE will make these data available to Numerical Weather Prediction (NWP) customers in near real-time. The Cross-track Infrared Sounder (CrIS) Radiances, Advanced Technology Microwave Sounder (ATMS) Radiances, Visible/Infrared Imager Radiometer Suite (VIIRS) Radiances, Aerosol Optical Thickness (AOT), Ozone Mapping and Profiler Suite (OMPS) Nadir Profile and Total Column data, Sea Surface Temperature (SST) and Polar Winds will be distributed in BUFR format. The Green Vegetation Fraction will be distributed in GRIB2 format. Currently, the BUFR tables of CrIS, ATMS and VIIRS radiances are completed and BUFR formatted files are available containing simulated data publicly. The BUFR tables of SST, AOT and OMPS Nadir Profile are under review and the Polar Winds BUFR table and OMPS Total Column BUFR table are under development. Since November 8, 2011, NDE has been running ATMS data through this toolkit for internal testing purposes. The CrIS BUFR files on the golden day (02/24/2012) are available for EMC and EUMETSAT test since March 12, 2012. The real time level 2 products (SST, AOT and OMPS NP) BUFR files are expected to be available for test in May 2012. The operational radiance products in BUFR format will be made available once the NPP data are released approximately 6 months after launch. The details of the tool and its products will be discussed.

Development History of BUFR and GRIB Tailoring System (NetCDF4 Reformatting Toolkit) at NOAA

- July 08: IPT Branch Lead informed to begin product development.
- July 08: Working with NDE to verify product requirements.
- Aug 08: Design the BUFR and GRIB Tailoring toolkit
- Nov 08: CrIS BUFR table were finalized.
- Apr 09: Preliminary Design Review
- Aug 09: ATMS BUFR table was finalized
- Sep 09: Critical Design Review
- June 10: VIIRS BUFR table was finalized
- Apr 11: Test this system with NDE P72 data.
- May11: VIIRS M-Band BUFR file was decided to include band 12, 13, 15 and 16 only.
- June 11: VIIRS I-Band BUFR file was decided to included band 5 only.
- July 11: Subset of CrIS was selected as 399 Channels and would be included into BUFR file.
- Aug 11: Test utility h5augjpss and would use this utility to convert HDF5 file to NetCDF4 file.
- Oct 11: SST, AOT and OMPS Nadir Profile BUFR tables were approved as pre-operational.
- Oct 11: Test Readiness Review for Phase 1 SDR Products.
- Nov 11: Real time ATMS BUFR files are available for internal test.
- Mar 12: CrIS BUFR files on the golden day (02/24/2012) are available for test

Future Development for the NetCDF4 Reformatting Toolkit at NOAA

- May 12: Software Review for Phase 1 EDR and Phase 2 EDR Products.
- Jul 12: Conduct Algorithm Readiness Review for Phase 1 EDR and Phase 2 EDR Products
- Aug 12: Deliver operational Phase 1 EDR & EDR NetCDF4 reformatting toolkit to NDE for operation.

System Information

- BUFR and GRIB Tailoring System development is conducted on the IASI development machine at NSOF. It is IBM P570 (AIX 5.3) with 6 TB disk space, 16 CPU, 2 GB/CPU. IBM XL 7.0 C/C++ and IBM XL 10.1 Fortran 77/90 are on it.
- The BUFR and GRIB Tailoring System testing and integration will be conducted on the NDE SADIE integration platform working with NDE integration personnel. This hardware is located at NSOF. It is IBM P561 (AIX 5.3) with 50 TB disk space, 16 CPUs, 2 GB/CPU. IBM XL 7.0 C/C++ and IBM XL 11.1 Fortran 77/90 are on it.
- All data handling and algorithms are written in C++ and Fortran 90.
- NCEP BUFRLIB and GRIB2 library are used for the tailoring.
- NetCDf4.1.3 and HDF5 1.8.7, the latest versions, are used in this system.
- All high-level system management is written in Perl.
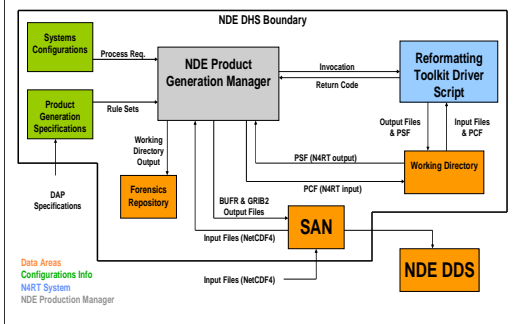
System Design

- **External interfaces:**
  - NDE is the interface for all NPP/NPOESS data within OSPO.
  - NDE DHS will schedule, manage, and monitor all NUCAPS processing operationally.
  - NDE DDS handles all product distribution and access for input CrIS, ATMS, VIIRS radiance, SST, AOT, Polar Winds and Nadir Profile Ozone BUFR data.
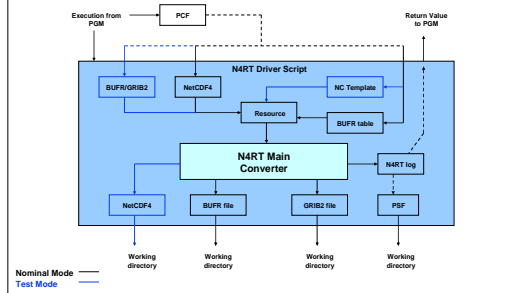 - The NetCDF4 Reformatting Toolkit code will run as a stand-alone unit within the NDE DHS.
- **Composed of 4 Components:**
  - NC2BF: Converts NetCDF4 file (input) to BUFR file (output).
  - NC2GB: Converts NetCDF4 file (input) to GRIB2 file (output).
  - BF2NC: Converts BUFR file (input) to NetCDF4 file (output).
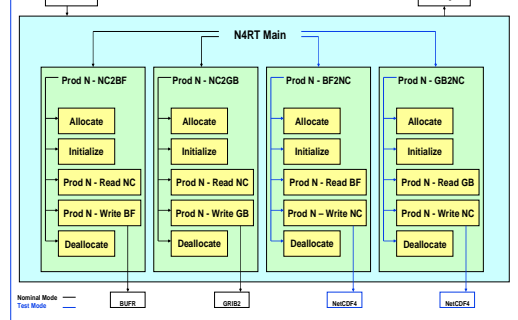 - GB2NC: Converts GRIB2 file (input) to NetCDF4 file (output).

NetCDF4 Reformatting Toolkit External Interfaces

NetCDF4 Reformatting Toolkit System Level Data Flow

NetCDF4 Reformatting Toolkit UNIT Level Data Flow

CrIS Radiance BUFR Table Entries

Satellite ID	Satellite Azimuth	Radiance Type Flags
ID of Originating Center	Solar Zenith	Scan-Level Quality Flags
Satellite Instrument	Solar Azimuth	Type of Band
Satellite Classification	Ascending/Descending flag	Starting Wavenumber (per band)
Year	Scan Line Number	Ending Wavenumber (per band)
Month	Field of Regard	Start Channel (per band)
Day	Field of View	End Channel (per band)
Hour	Orbit Number	Calibration Quality Flags
Minute	Height of Land Surface	Field of View Quality Flags
Second	Satellite Height	Geolocation Quality
Location of Platform	Land Fraction	NUCAPS Quality
Latitude	Land/Sea Qualifier	Channel Number
Longitude	Cloud Cover	Channel Radiance
Satellite Zenith Angle	Height of Cloud Top	

ATMS Radiance BUFR Table Entries

Satellite ID	Scan line number	Satellite antenna corrections version number
ID of Originating Center	FOV Number	Channel Number
ID of Originating Sub-Center	Granule level quality flags	Channel Central Frequencies
Satellite Instrument	Scan-Level Quality Flags	Channel Bandwidth
Satellite Classification	Geolocation Quality	Antenna polarization
Year	Latitude	Antenna Temperature
Month	Longitude	Brightness Temperature
Day	Satellite Height	Noise-equivalent delta temperature while viewing cold target
Hour	Satellite Zenith Angle	Noise-equivalent delta temperature while viewing warm target
Minute	Satellite Azimuth	Channel-Level Quality Flags
Second	Solar Zenith	
Orbit number	Solar Azimuth	

VIIRS SST BUFR Table Entries

Satellite ID	Latitude	Cloud Mask
ID of Originating Center	Longitude	Retrieval data quality information
Satellite Instrument	Satellite Zenith Angle	SST Pixel-Level Quality flag
Year	Satellite Azimuth	SST (skin)
Month	Solar Zenith	SST (skin) Quality
Day	Solar Azimuth	SST (bulk)
Hour	Satellite Height	SST (bulk) Quality
Minute	Geolocation Quality	
Second	VIIRS Geolocation Quality	

VIIRS AOT BUFR Table Entries

Satellite ID	Latitude	Retrieval Quality
ID of Originating Center	Longitude	Surface Type
Satellite Instrument	Satellite Zenith Angle	Aerosol Type (land)
Year	Satellite Azimuth	AOT Quality Flag
Month	Solar Zenith	Aerosol Angstrom Wavelength Exponent
Day	Solar Azimuth	Channel Wavelength
Hour	Satellite Height	Optical Depth
Minute	Geolocation Quality	
Second	VIIRS Geolocation Quality	

VIIRS Radiance BUFR Table Entries

Satellite ID	Second	Satellite Azimuth
ID of Originating Center	Orbit number	Solar Zenith
ID of originating sub-center	Scan line number	Solar Azimuth
Satellite Instrument	Field of view number	Cloud Mask
Satellite classification	Type of Band	Surface Type
Year	Geolocation Quality	Channel Number
Month	Latitude	Channel Wavelength
Day	Longitude	Radiance Quality
Hour	Satellite Height	Channel Radiance
Minute	Satellite Zenith Angle	Channel Reflectance

Product Quality Assurance

- All code development platforms are nearly identical to the production target platforms.
- Only the official releases of the NCEP BUFRLIB, GRIB2, and NetCDF4 libraries will be used in the software..
- The generated BUFR and GRIB2 files will be directed back into the Reformatting Toolkit to generate new NetCDF4 files, and compare to the source NetCDF4 files before distributing.
- All the BUFR files will maintain consistency with the heritage products.
- The contents of the original NetCDF4 will be kept as exact as possible; the negative radiances will be stored in BUFR files.
- The BUFR and GRIB2 products, tables, and additional resources will be released early to allow for WMO approval and customer validation of products.