

# A BUFR and GRIB Tailoring System for NPP/NPOESS Products

Yi Song<sup>1</sup>, Thomas King<sup>2</sup>, Walter Wolf<sup>3</sup>, and Zhaohui Cheng<sup>2</sup>  
<sup>1</sup>IMSG, Rockville, MD 20852  
<sup>2</sup>DELL/PSGS, Fairfax, VA 22031  
<sup>3</sup>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 GRIB2 formatted files is under development at NOAA/NESDIS/STAR. This NetCDF4 Reformatting Toolkit will produce all the tailored BUFR and GRIB2 products for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Data Exploitation (NDE) project. NDE will make these data available to Numerical Weather Prediction (NWP) customers in near real-time. In phase I, the Cross-track Infrared Sounder (CrIS) Radiances, Advanced Technology Microwave Sounder (ATMS) Radiances, Visible/Infrared Imager Radiometer Suite (VIIRS) Radiances, Aerosol Optical Thickness (AOT), Nadir Profile and Total Column Ozone (OMPS), Sea Surface Temperature (SST) and Polar Winds will be distributed in BUFR format. The Green Vegetation Fraction will be distributed in GRIB2 format. At this time, the BUFR tables of both CrIS and ATMS radiances are completed, and their test BUFR data from the simulation data are available. The BUFR tables of VIIRS radiance and its sample BUFR data from the simulation data have been sent out for review. The SST and AOT BUFR tables have been delivered to NOAA NCEP for review. The OMPS and Polar Winds BUFR tables are under development. The NPOESS Preparatory Project (NPP) launch is currently scheduled for September 2011. The radiance products in BUFR format will be made available approximately 6 months after NPP 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
- Oct 08: Distribute CrIS BUFR table for review.
- Nov 08: CrIS BUFR table were finalized.
- Dec 08: Work with product developers and customers to gather product requirements
- Mar 09: Distributed sample CrIS BUFR file for test
- Apr 09: Preliminary Design Review
- Apr 09: Preliminary System Development
- May 09: Distributed ATMS BUFR table for review.
- Aug 09: ATMS BUFR table was finalized
- Aug 09: Distributed VIIRS Radiance BUFR table for review.
- Sep 09: Critical Design Review
- Dec 09: Distributed sample ATMS BUFR file for test
- Apr 10: Distributed sample VIIRS Radiance BUFR file for test

## Future Development for the NetCDF4 Reformatting Toolkit at NOAA

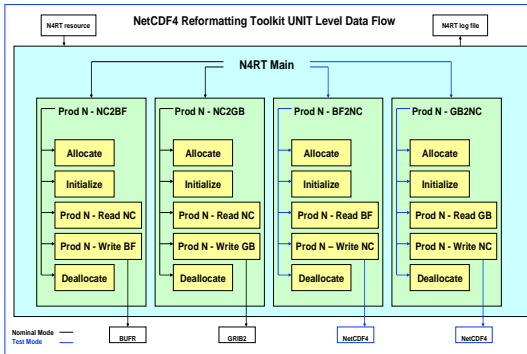
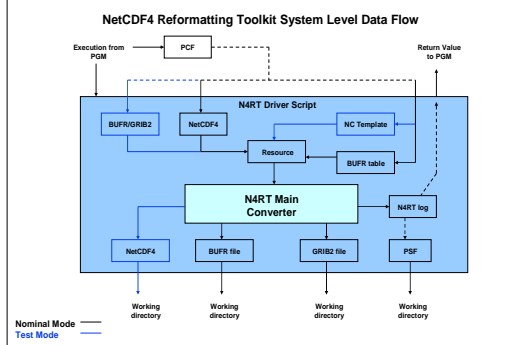
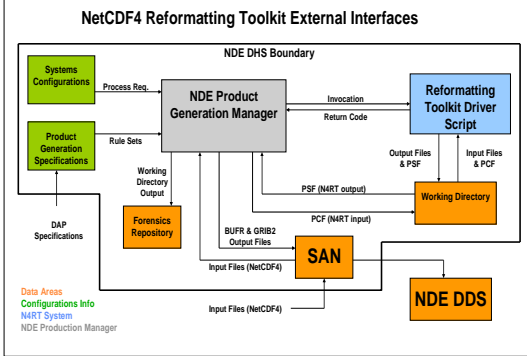
- Apr 10: Test Readiness Review (TRR)
- May 10: Code Unit Test Review (CUTR)
- May 10: Complete the draft of Nadir Profile Ozone BUFR table.
- June 10: Distribute sample of VIIRS SST BUFR file for test.
- July 10: Distribute sample of VIIRS AOT BUFR file for test.
- August 10: Complete the draft of Polar Winds BUFR table for review.

## System Information

- BUFR and GRIB Tailoring System development will be 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.
- After successful system tests, the NDE plans to check the code into configuration management and then promote it to the IBM Test/Production machine.
- All data handling and algorithms are written in C++ and Fortran 90.
- NCEP BUFRLIB and GRIB2 encoders will be used for tailoring.
- All high-level system management is written in Perl.

## System Design

- External interfaces:**
  - NDE is the interface for all NPP/NPOESS data within OSDPD.
  - 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).



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

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	

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	

Satellite ID	Latitude	Cloud Mask
ID of Originating Center	Longitude	Adjacency Cloud Mask
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	

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 Wavelength Angstrom Exponent
Day	Solar Azimuth	Channel Wavelength
Hour	Satellite Height	Optical Depth
Minute	Geolocation Quality	
Second	VIIRS Geolocation Quality	

- ## 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 be consistency with the heritage products.
  - The contents of the original NetCDF4 will be kept as exact as possible, such as 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.

International TOVS Study Conference, 17<sup>th</sup>, ITSC-17, Monterey, CA, 14-20 April 2010.  
Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center,  
Cooperative Institute for Meteorological Satellite Studies, 2011.