What Is New in This Release Version

The following lists some of the new functions and changes included in the GSI release v3.6 versus the previous v3.5:

Observational aspects:

• Assimilation of full spectral resolution CrIS radiance observations
• Added near surface temperature (NSST) analysis
• Added options to use correlated radiance observation errors

Code optimization and refactoring:

• Refactored the observer modules using polymorphic code
• Generalized all radiance assimilation across different sensors/instruments for cloud and aerosol usages in GSI
• Removed the First-Order Time extrapolation to the Observation (FOTO)
• Updated to netCDF v4.0 functionality
• Removed unused modules/variables

Application specific updates:

• Non-variational cloud analysis
  – Added number concentration for cloud water, cloud ice and rain to match cloud analysis with the Thompson Microphysical scheme
  – Added functions using visibility/fog observation to improve cloud fields in the lowest two levels
  – Added capability to read BUFR format NASA LaRC cloud products directly

• RTMA
  – Added variational QC algorithm using super-logistic distribution function
  – Added cloud ceiling height and scalar wind as analysis variables

Other updates:

• Added Advanced Research WRF (ARW) hybrid vertical coordinate background to GSI
• Added vertical dependence of hybrid background error weighting, horizontal and vertical localization scales in GSI 4 1. Overview
• Added NCEP nemio interface for GFS forecast and GFS ensemble forecast
• Utility updates such as using GFS ensemble forecast perturbations to initialize WRF ensemble forecasts
• Bug fixes

Besides the above-mentioned changes, the release code also includes a new cmake-based build utility. This utility is currently being tested for its portability and has been included in v3.6 as a beta version. In the near future, the DTC and EMC will use the same cmake build utility for all operational and research code. Transition to this new build utility will be completed by early 2018.

Please note due to the version update, some diagnostic files and static information files might have been modified as well.

**Observations Used by This Version**

GSI is being used by various applications on multiple scales. The types of observations GSI can assimilate vary from conventional to aerosol observations. Users should use observations with caution to fit their specific applications. The GSI v3.6 can assimilate, but is not limited to, the following types of observations:

- Conventional observations (including satellite retrievals):
  - Radiosondes
  - Pilot balloon (PIBAL) winds
  - Synthetic tropical cyclone winds
  - Wind profilers: USA, Jan Meteorological Agency (JMA)
  - Conventional aircraft reports
  - Aircraft to Satellite Data Relay (ASDAR) aircraft reports
  - Meteorological Data Collection and Reporting System (MDCRS) aircraft reports
  - Dropsondes
  - Moderate Resolution Imaging Spectroradiometer (MODIS) IR and water vapor winds
  - Geostationary Meteorological Satellite (GMS), JMA, and Meteosat cloud drift IR and visible winds
  - European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) and GOES water vapor cloud top winds
  - GEOS hourly IR and cloud top wind
  - Surface land observations
  - Surface ship and buoy observation
  - Special Sensor Microwave Imager (SSMI) wind speeds
  - Quick Scatterometer (QuikSCAT), the Advanced Scatterometer (ASCAT) and Oceansat-2 Scatterometer (OSCAT) wind speed and direction
  - RapidScat observations
  - SSM/I and Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) precipitation estimates
- Velocity-Azimuth Display (VAD) Next Generation Weather Radar (NEXRAD) winds
- Global Positioning System (GPS) precipitable water estimates
- Sea surface temperature (SST)
- Doppler wind Lidar
- Aviation routine weather report (METAR) cloud coverage
- Flight level and Stepped Frequency Microwave Radiometer (SFMR) High Density Observation (HDOB) from reconnaissance aircraft
- Tall tower wind

Satellite radiance/brightness temperature observations (instrument/satellite ID):
- SBUV: NOAA-17, NOAA-18, NOAA-19
- High Resolution Infrared Radiation Sounder (HIRS): Meteorological Operational-A (MetOp-A), MetOp-B, NOAA-17, NOAA-19
- GOES imager: GOES-11, GOES-12
- Atmospheric IR Sounder (AIRS): aqua
- AMSU-B: MetOp-B, NOAA-17
- SSMI: DMSP F14, F15, F19
- SSMI/S: DMSP F16
- Advanced Microwave Scanning Radiometer for Earth Observing System (AMSR-E): aqua
- GOES Sounder (SNDR): GOES-11, GOES-12, GOES-13
- Infrared Atmospheric Sounding Interferometer (IASI): MetOp-A, MetOp-B
- Ozone Monitoring Instrument (OMI): aura
- Spinning Enhanced Visible and Infrared Imager (SEVIRI): Meteosat-8, Meteosat-9, Meteosat-10
- Advanced Technology Microwave Sounder (ATMS): Suomi NPP
- Cross-track Infrared Sounder (CrIS): Suomi NPP
- GCOM-W1 AMSR2
- GPM GMI
- Megha-Tropiques SAPHIR
- Himawari AHI

Others:

- GPS Radio occultation (RO) refractivity and bending angle profiles
• Solar Backscatter Ultraviolet (SBUV) ozone profiles, Microwave Limb Sounder (MLS) (including NRT) ozone, and Ozone Monitoring Instrument (OMI) total ozone
• Doppler radar radial velocities
• Radar reflectivity Mosaic
• Tail Doppler Radar (TDR) radial velocity and super-observation
• Tropical Cyclone Vitals Database (TCVital)
• Particulate matter (PM) of 10-um diameter, 2.5-um diameter or less
• MODIS AOD (when using GSI-chem package)

Please note some of these above mentioned data are not yet fully tested and/or implemented for operations. Therefore, the current GSI code might not have the optimal setup for these data.