Inter-comparison between CRTM and RTTOV in NCEP Global Model

Emily Huichun Liu\textsuperscript{1}, Andrew Collard\textsuperscript{2}, and John Derber\textsuperscript{3}

\textsuperscript{1}SRG@NOAA/NCEP/EMC  \textsuperscript{2}IMSG@NOAA/NCEP/EMC  \textsuperscript{3}NOAA/NCEP/EMC

**Objective and Information**

The capability of using RTTOV in GSI, in addition to CRTM, has been added in NCEP global model for the following purposes:

- to have a more consistent and flexible way in comparing radiative transfer models (RTMs) by using the same model input,
- to better understand differences in optical properties, radiances, and Jacobians between the two,
- to help in spotting errors by cross validating each other,
- to establish symbiotic relationship between the two RTMs by exploring new features in each one.

GFS profiles input to both RTMs are GFS T1534L64 3-9 hour forecasts from the previous analysis and the RTM solutions are compared with the forecast within the 6-hour window.

The same NCEP trace gas profiles for CO\textsubscript{2}, CH\textsubscript{4}, CO, and N\textsubscript{2}O are used as input to both CRTM and RTTOV, respectively.

Statistics shown in this study are samples collected from 120 6-hour assimilation windows.

CRTM release 2.2.3 and RTTOV v12 are used in the comparison for IASI onboard of MetOp-A over the ocean. Issues found in comparison, possible solution for improvement and work plan are summarized and discussed.

**Emissivity Check**

- RTTOV v12 introduced a new sea surface emissivity model (IREMIS) based on Newman (2005), in which the surface emissivity is estimated as a function of wavelength, wind speed, sensor zenith angle, and sea surface temperature.
- CRTM uses IR Sea Surface Emission Model (IRSSSE) estimated surface emissivity as a function of wavelength, wind speed, and sensor zenith angle (Nalli 2008).

**Surface Emissivity Difference (RTTOV - CRTM)**

- The CRTM IRSSE systematically estimates higher surface emissivity than RTTOV IREMIS over ocean across the Infrared spectrum and globally.
- The difference in emissivity is much higher in polar regions.
- The corresponding difference in brightness temperature is more than 1K in polar regions.

**Test of New Sea Surface Emissivity Model (IREMIS) in CRTM**

- Use CRTM option - use_emissivity to import emissivity values estimated from IREMIS in RTTOV to replace values estimated from IRSSE in CRTM.
- This is to test if the IREMIS would reduce the CRTM window channel OMF in general, especially in polar regions.

- CRTM using IRSSE (default)
- CRTM using IREMIS from RTTOV

**Summary and Future Plan**

- The major difference between the IRSSE (CRTM) and IREMIS (RTTOV) is that the IREMIS model includes the sea surface temperature as one of the predictors to estimate sea surface emissivity while the IRSSE does not. Newman (2005) compared the sensitivity of sea surface temperature and salinity to the sea surface emissivity, and concluded that sea surface temperature played a more important role than salinity in determining sea surface emissivity.
- The plan is to discuss with the CRTM development team about considering sea surface temperature in the surface emissivity model, and test the new model in NCEP global assimilation model for impact.
- The inter-comparison between CRTM and RTTOV will be explored in all-sky condition for hyperspectral Infrared sensors (will initially focus on cirrus cloud comparison).
- The larger BT differences in solar affected channels will be explored.

**References**


