Contribution ID: **84**

Type: **Poster presentation**

Fast Radiative Transfer Algorithms applied in 3-D for multi-spectral visible wavelengths and in 1-D for visible and IR for use in NWP evaluation and Data Assimilation

High spatial and temporal resolution image data of the Earth's environment reflecting cloud, precipitating hydrometeor, aerosol, and lower boundary surface conditions abound. Yet the bulk of the information in such observations isn't yet exploited for the initialization of Numerical Weather Prediction (NWP) model forecasts. This is because most information contained in the imagery data is inaccessible via the operationally used 2D radiative transfer models while their 3D versions are computationally prohibitively expensive.

Here we describe a recently developed fast 3-D visible light radiative transfer package called Simulated Weather Imagery (SWIm). SWIm produces visually and physically realistic displays of sky and landscape conditions from any vantage point in or above the atmosphere, based on digital analysis or forecast fields from NWP systems. The resulting RGB images can be used for subjective visual interpretation, while radiance and reflectance values at various visible light wavelengths permit objective comparison of image data (from ground-, air- or space-borne observations) with simulated conditions (from NWP analysis or forecast fields).

While 3-D radiative transfer can be used within a tomographic hydrometeor analysis, we are testing ray-tracing methods and cloud masks derived from ground-based all-sky camera imagery to improve a 500m resolution hydrometeor and aerosol analysis. Other data for this analysis includes GOES-ABI visible and IR, NEXRAD radar reflectivity, METARs, PM2.5 measurements, and a forecast first guess.

In addition to the 3-D visible multi-spectral ray-tracing algorithm described above, fast 1-D forward operators are being developed for use in hydrometeor assimilation and being compared with CRTM in the context of a non-variational global cloud analysis. These operators are being used to compare simulated radiances produced by CRTM using GOES ABI visible and IR channels centered at 0.64 and 10.3 microns, with the goal of performing variational assimilation experiments.

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Session Classification: Poster session with self-serve tea and coffee

Track Classification: 4th workshop on assimilating satellite cloud and precipitation observations for NWP