1. Background

MiRS (Microwave Integrated Retrieval System) is a One-Dimensional Variational Inversion scheme (1DVAR) (Bosartella et al. 2013) that employs the Community Radiative Transfer Model (CRTM) as the forward and adjoint operators. It simultaneously solves for surface (Tskin, emissivity), and atmospheric parameters (temperature, water vapor, non-precipitating cloud and hydrometeor properties). Depending on the version of MiRS, it may also retrieve information on the precipitation vertical cloud water (CLW), rain water profiles (RWP), graupel water profiles (GWP), and meteorological parameters. The version of MiRS used in this study was MiRS v2.1.5, which was operational at NOAA for Suomi-NPP/ATMS, POES N18/N19, Metop-A, Metop-B, DMSP-F17/F18, and Jason-2 (see Section TBD).

2. MiRS 1DVar Algorithm

The 1DVAR algorithm uses an iterative scheme, in which a solution is sought which best fits the observed satellite radiances, subject to other constraints. To reach the iterative solution, the algorithm seeks to minimize the cost function

\[ \chi^2 = \sum (\Delta T - \tilde{T})^2 \]

where \( \Delta T \) is the difference between the observed and predicted radiances, and \( \tilde{T} \) is the predicted radiances obtained from CRTM. For each iteration, the following steps are performed:

- **Forward RT Model (CRTM)**: CRTM is used to simulate the observed radiances based on the current state vector of retrieval state vector.
- **Jacobian Calculation (dTB/dX)**: The Jacobian matrix is calculated to determine the sensitivity of the radiances with respect to each of the retrieval state vector.
- **Cost Function Minimization**: The cost function is minimized using a 1D minimization routine (e.g., the Newton-Raphson method).

The solution is considered converged when the cost function reached its minimum, and the changes in the retrieval state vector are less than a specified threshold.

3. CRTM Hydrometeor Jacobians

All versions of MiRS starting with v1.1 utilize Version 2.1.1 of CRTM. The key element of CRTM that allows for the rapid retrieval of CLW and hydrometeor properties is the Jacobian approach that incorporates both forward simulated radiances, and their corresponding Jacobians (sensitivity of radiances with respect to retrieval state vector). The scattering calculation in this version of CRTM assumes spherical particles (Mie approximation). The precipitation retrieval is performed using CRTM and Jacobians (sensitivity of radiances with respect to retrieval state vector). The rain rate is then computed from the following equations:

\[ \text{Rain Rate} = \frac{\text{CLW}}{\text{Liquid Water Path}} \]

where CLW is the cloud water path, and LW is the liquid water path.

4. MiRS Global Precipitation from ATMS and GMI

The primary change in v2.2 is the extension of MiRS to GPM/GMI measurements. Validation activities are continuing with the goal to determine performance in different seasons.

5. SNPP/ATMS Baseline Comparisons with Stage IV and GPROF

6. Baseline Performance of MiRS GPM/GMI

7. Evaluation of CLW/Light Rain Detection over Land

8. 3-Dimensional Hydrometeor Structure

9. Summary

A new version of the NOAA MiRS algorithm (v2.1.5) has recently been released and will be transitioned to operations at NOAA. Work is ongoing to assess, validate and improve the precipitation products from MiRS.

- **MiRS**: has been extended to routinely process data from GPM/GMI making a total of 9 satellites processed by the MiRS algorithm operationally.
- **Rafael retrievals over ocean show satisfactory performance in terms of error standard deviation, correlation, and consistency**.
- **Detection and estimation of light precipitation (< 3 mm/h) over land has been improved by the incorporation of non-scattering cloud water in the rainfall rate relationships**.
- **MiRS can facilitate the depiction of the 3-dimensional structure of hydrometeors, rain rate, and temperature in severe weather systems**.

10. Acknowledgements


11. References
