NOAA Satellites and Information

National Environmental Satellite, Data, and Information Service

14th Conference on Satellite Meteorology and Oceanography:

P 5.6 – Microwave Variational Retrieval of Surface and Atmospheric Parameters: Application to AMSU/MHS and SSMI/S Sensors

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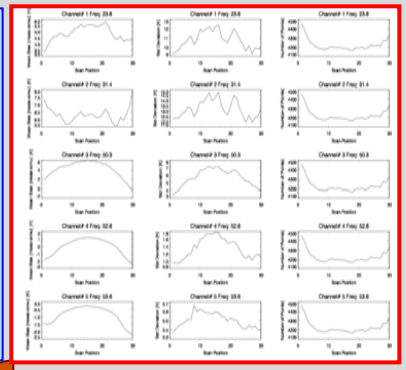
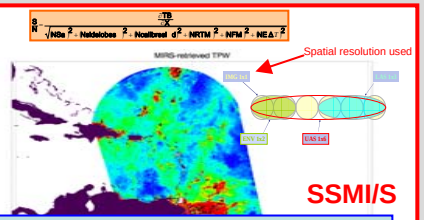
Testbed

MIRS Testbed:

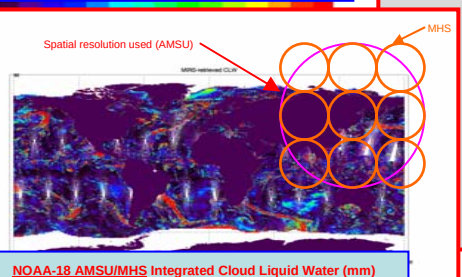
Applied to NOAA-18 AMSU/MHS and SSMI/S

AMSU/MHS Bias removal using GDAS and CRTM

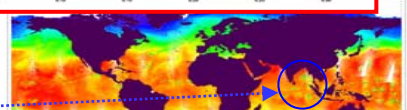




DMSP F-16 SSMI/S Integrated Water Vapor (mm)



NOAA-18 AMSU/MHS Integrated Cloud Liquid Water (mm)



NOAA-18 AMSU/MHS Temperature @ 500 mbars (K)

Precip. Retrieval OFF for these cases

Microwave Integrated Retrieval System (MIRS)

•1DVAR Algorithm based on Optimal Estimation theory (iterative approach)
• Assumptions made: (1) Locally-linear problem, (2) Gaussian distributions of geophysical state, (3) Non-biased radiances, (4) Gaussian instrumental errors . With these assumptions, the cost Function to minimize is:

$$J(X) = \left[\frac{1}{2}(X - X_a)^T \times B^{-1} \times (X - X_a)\right] + \left[\frac{1}{2}(Y^m - Y(X))^T \times E^{-1} \times (Y^m - Y(X))\right]$$

• MIRS suits moderately non-linear/ non-Gaussian problems
• Accommodates sounders and/or imagers
• Covariance matrix computed from NOAA-88, ECMWF sets (clear sky) and from a set of MM5 runs (for cloud & precipitation parameters).

(1)

MOTIVATION

The main motivation of this study is to develop the capability of assimilating microwave radiances impacted by atmospheric hydrometeors. This has the potential to improve forecast models skills and enhance storm forecast capabilities. An additional motivation is to extend the current operational system at NOAA (Microwave Surface and Precipitation Products System - MSPPS) to include the sounding of atmospheric constituents.
MIRS is a retrieval algorithm, running daily at NOAA/NESDIS/STAR, with an imbedded capability to invert both surface and atmospheric parameters (including cloud and precipitation parameters). It is therefore ideal for the assimilation of rain-impacted radiances. The atmospheric constituents are derived in a profile form.

POSTER ORGANIZATION

This poster aims at presenting the MIRS system **(1)** , its physical Basis **(2)**, examples of its application to NOAA-18 AMSU/MHS and DMSP/SSMIS sensors (through the testbed **(3)**). It also aims at highlighting some limitations of retrieving precipitation parameters, related to the non-uniqueness of the solution **(4)** and finally at showing the approach followed to build the covariance matrix over land in order to extend the MIRS system over non-ocean cases **(5)**.

(2)

(3)

(4)

(5)

Theoretical Basis

Forward Model

• Community Radiative Transfer Model (CRTM)
• For radiances & Jacobians
• Validated independently
• Valid in all-spectral regions
• Accounts for scattering by various parameters (cloud, precip., aerosols, etc)
• Uses Optran for atmospheric Absorption

Retrieved Parameters

The selection of which parameter to retrieve is user-driven and depends on the information content in the radiances.
• Temperature & Water Vapor Profiles
• Skin Temperature
• Emissivity spectrum
• Non-precipitating cloud amount profile
• Precipitating parameters profiles: Graupel, ice, snow & rain

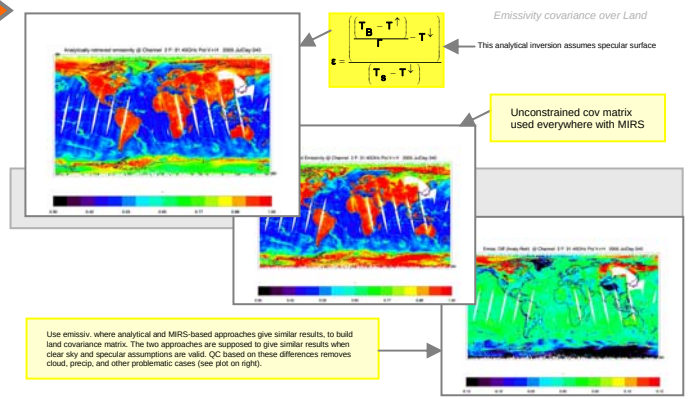
Key Scientific Features

• Use of the Joint Center for Satellite Data Assimilation (JCSDA) CRTM as a forward operator
• Jacobians are computed using Tangent Linear and Adjoint of the model (All inputs to the forward model have their corresponding Jacobians)
• All-weather conditions capability
• All-surface types capability (in progress)
• Retrieval of Cloud/Precip. profiles
• Retrieval in EOF-reduced space
• Highly modular/flexible (radiometric and geophysical)

Things to note:

- Retrieval of WV, Cloud & precip. parameters in Log space (smoothly force >0 values)
- Retrieval of Emissivity in Log(-Log) space (smoothly forces *[0-1] range*)
- NEDT computed daily (Tsan Mo's method) from raw data, is digested into the retrieval

Null-Space/Non-Uniqueness
Radiometrically correct
But geophysically wrong



Summary/Future Developments

- MIRS is an algorithm for a multitude of microwave sensors, applied already to AMSU/MHS, SSMI/S & NPP-NPOESS/ATMS
- Inversion of cloud/precip. profiles but null-space is important
- Method amounts to cloud/precip. clearing, aiming at targeting temperature and water vapor profile retrieval in precip. conditions

On-going: (1) Land extension (developing a covariance matrix for emissivity), (2) Validation in all conditions