NOAA Satellites and Information

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# B28 – Global Coverage of Total Precipitable Water using the Microwave Integrated Retrieval System

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## Introduction & Motivation

- Operationally, extend the TPW field over all surfaces from microwave sensors (traditionally only over ocean)
- Use a generic algorithm that could be applied on all sensors in a consistent fashion
- This has many useful applications (forecasters use it to determine precipitation potential for example)
- Global surfaces are distinguished by spectral signatures: ocean, sea-ice, land and snow.

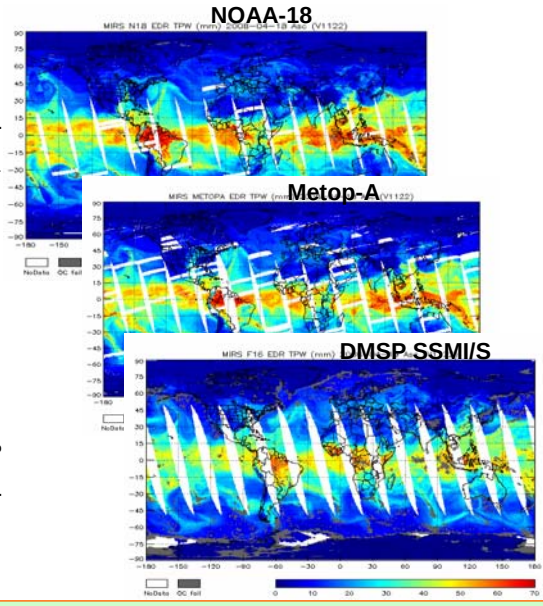
## Algorithm: Microwave Integrated Retrieval System (MIRS)

- 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:

$$J(X) = \left[\frac{1}{2}(X - X_0)^T \times B^{-1} \times (X - X_0)\right] + \left[\frac{1}{2}(Y^m - Y(X))^T \times E^{-1} \times (Y^m - Y(X))\right]$$

- 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).

Example of global fields of TPW retrieved from N18, Metop-A and SSMIS

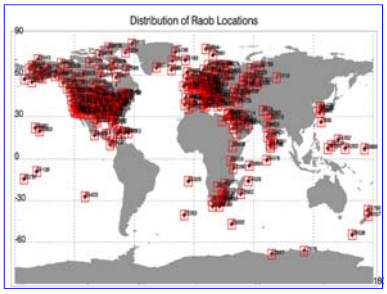


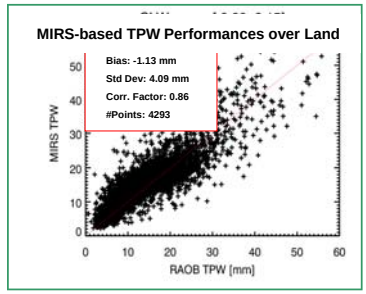

## Methodology: TPW retrieval over non-ocean Surfaces

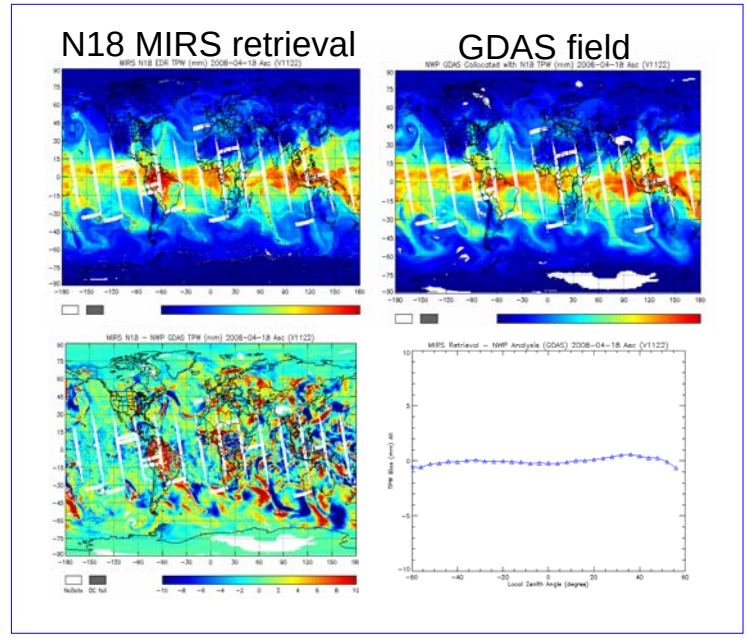
- Method is not new (Moncet et al., Forsythe et al., Ruston et al.)
- Key is the inclusion of emissivity spectrum in the retrieved state vector X.
- Only difference between the ocean, sea-ice and land retrieval is the emissivity being retrieved (and associated spectral constraints used: **B** & $\mathbf{X_0}$ arrays)
- Ocean emissivity constraints are built on FASTEM-3 model
- Non-ocean emissivity constraints (and backgrounds) are based on analytical emissivities computed with collocations between microwave measurements and Global Data Assimilation System (GDAS) Analyses
- the TPW is a result of post-processing vertical integration. The MIRS only retrieves moisture profile.

## Validation

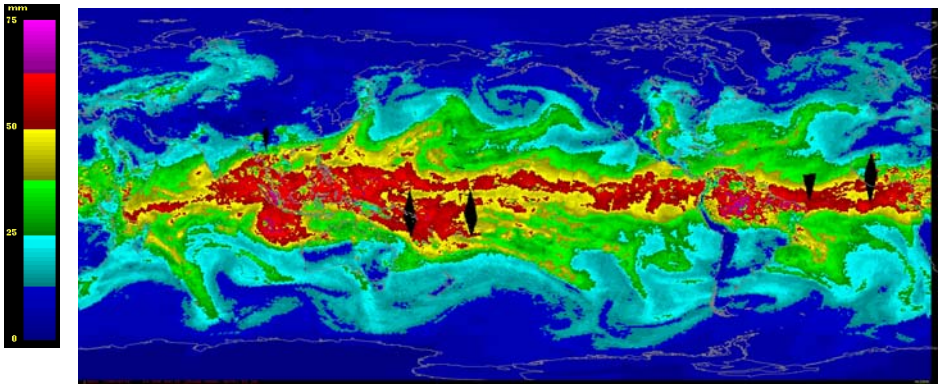
- Daily comparison to GDAS analyses fields (that assimilates radiosondes and GPS data over land) –see right panel-
- Monitoring of scan dependence of difference
- Monitoring map of difference to assess regional validity
- Daily comparisons to ECMWF
- Comparisons to radiosondes (see below)
- Stratified performances by surface types




| Perfs over Ocean | Bias (mm) | Std Deviation (mm) |
|---|---|---|
| N15 | 0.49 | 3.85 |
| N16 | -1.10 | 3.85 |
| N17 | -0.2 | 3.30 |




**Operational global TPW field, blended from N18 and Metop-A, available to forecasters**

## Conclusion:

- MIRS runs operationally for NOAA-18, METOP-A and will soon for DMSP/SSMIS
- MIRS produces TPW fields globally (ocean, sea-ice, land and snow) with no apparent discontinuies.
- TPW is produced in clear and cloudy areas
- Performances monitored for different surface types
- Retrievals compared to radiosondes on daily basis

## References:

- S.-A. Boukabara, F. Weng and Q. Liu. *"Passive Microwave Remote Sensing of Extreme Weather Events Using NOAA-18 AMSU and MHS"*, Geoscience and Remote Sensing, IEEE Transactions on Volume 45, Issue 7, July 2007 Page(s):2161 – 2162.
-J.-L. Moncet. *"Algorithm Theoretical Basis Document (ATBD) for the Conical-Scanning Microwave Imager/Sounder (CMIS) Environmental Data Records (EDRs). Volume 2: Core Physical Inversion Module"*. March 2001, Atmospheric and Environmental Research, Inc., Lexington, MA 02421
- J. M. Forsythe, S. Q. Kidder, K. M. Donofrio, A. S. Jones and T. H. Vonder Haar. *"Extending Satellite Microwave Humidity Retrievals from Ocean to Land"*. 11th AMS Symposium on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface, San Antonio, Texas. January 2007