Next Generation GSMaP MWI Precipitation retrieval algorithm

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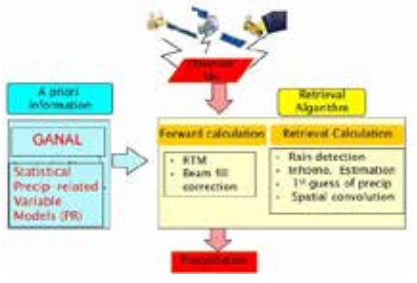
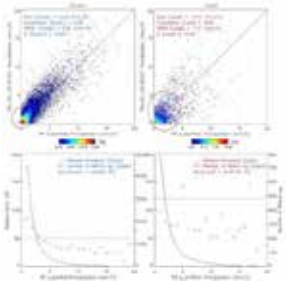
1. Introduction:

The current GSMaP Microwave Imager (MWI) precipitation retrieval algorithm degrades retrieval accuracy for weak precipitation areas where MWI TBs are sensitive to physical variables other than precipitation. In order to address this issue, we have been developing a new algorithm that retrieves the physical variables including precipitation from MWI TBs. The basic idea of this algorithm is to derive the statistically optimal values of the physical variables, based on Bayes' theorem (Elsaessar and Kummerow 2008, Boukabara et.al 2011).

Basic Idea of the Current Retrieval Algorithm

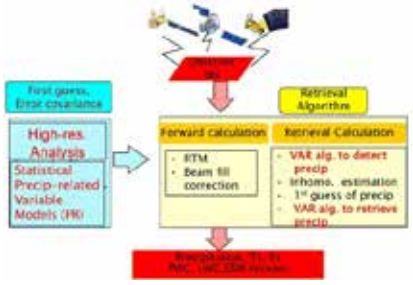




TMI Retrieval V6.1.20130201 vs. PR Estimated Surface Rain

Ave. over TMI 10GHzFOV

Basic Idea of the NEW Retrieval Algorithm



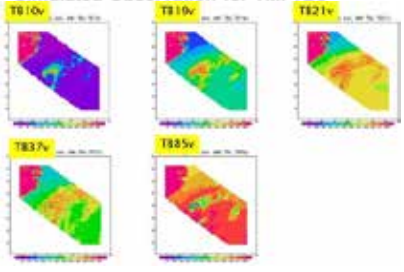
2. Methodology:

We adopted an ensemble-based variational method (EnVA) for deriving the optimal values from MWI TBs that are non-linear functions of the physical variables. The retrieval algorithm consists of the precipitation detection part and the retrieval part for physical variables in precipitation areas.

Variational algorithm to detect precip:

- 1st guess from NWP forecasts (Ts, Us, Vs, RHW2, PT)
- **TBc calculated, assuming no precip or CLWC using Liu's RTM.**
- Most likelihood values with EnVA.
- **Points with large innovation, post-fit residual > Precip. areas**

Simulated Observation for TMI TBs



Thresholds

Innovation: $|Y - H(X^f)| > beta * s_{H(X^f)}$

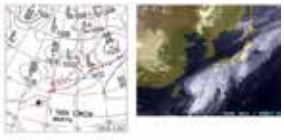
Cloud water content : qc > qcth

Cloud ice content: qci > qcith

Post fit residual $\sum (Y - H(X^a))^2 / s_o^2 > c_{th}^2$

OSSE design

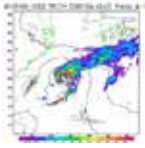
Typhoon Conson (04/6/9/22 UTC)



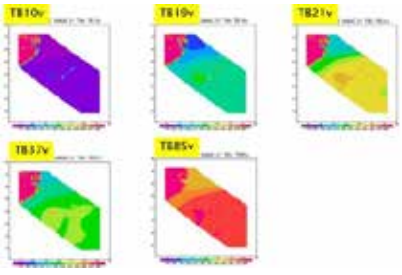
JMANHM(Saito et al, 2005) 5 km res.

Ensemble forecast (04/6/9/15) : 100 members started with perturbed initial data

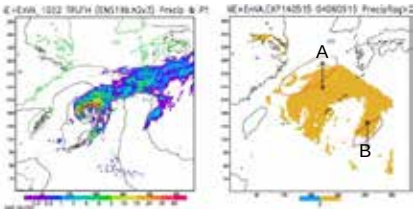
Regard one member as the "truth"



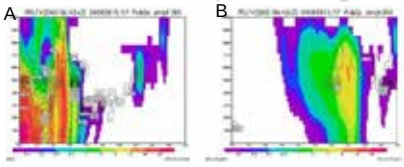
TBc from 1st guess Assuming no precip or CLWC



Truth of Precip and Precip Flag



Cross sections of Precip and Qc along A & B



Variational algorithm to retrieve precip:

- To find the optimal state of variables (precip, CLWC, PWC, SSW, Ts, Es)
- 1st guess from NWP forecasts, PR statistical data, etc.
- Most likelihood values with EnVA.

EnVA: Ensemble-based Variational Assimilation Scheme

- Minimize the cost function with non-linear Obs. term.

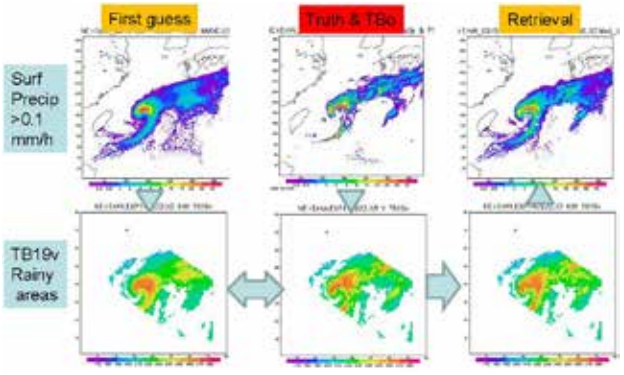
$$J_x = 1/2(\vec{X} - \bar{X}_f)P_f^{-1}(\vec{X} - \bar{X}_f) + 1/2(Y - H(\vec{X}))R^{-1}(Y - H(\vec{X}))$$

- Assume the analysis error belongs to the Ensemble forecast error subspace (Lorenc, 2003):

$$\vec{X} - \bar{X}^f = P_e^{f/2} 0 W \qquad W = [\vec{w}_1, \vec{w}_2, ,,,, \vec{w}_N]$$

$$P_e^{f/2} = [\vec{X}_1^f - \bar{X}^f, \vec{X}_2^f - \bar{X}^f, ,,, \vec{X}_N^f - \bar{X}^f]$$

Precip and TB19v for (04/6/9/22 UTC)



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