Impact Study of the Assimilation of Surface Sensitive Microwave Radiances in the GEOS

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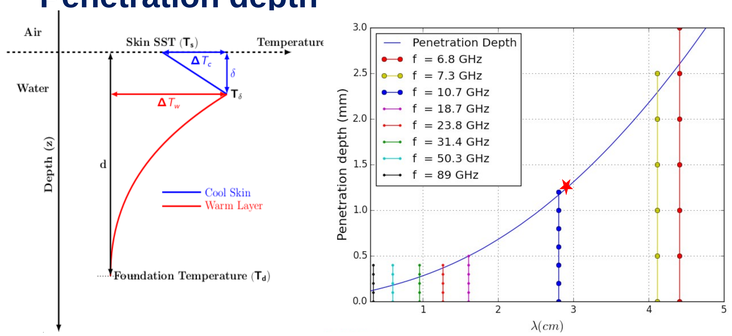
Motivation

The aim of this study is to investigate the feasibility of assimilating low frequency microwave observations from different satellite Microwave radiometers such as the Advanced Microwave Sounding Unit-A (AMSU-A), Global Precipitation Measurement (GPM) Microwave Imager (GMI), and Advanced Microwave Scanning Radiometer 2 (AMSR2). These observations are relevant to the description of air temperature, humidity, and surface parameters such as ocean surface temperature. Their assimilation into Goddard Earth Observing System (GEOS) modeling and assimilation system helps better constrain models in regions where very few observations are assimilated. In recent years, Channels 1–4 and 15 have not been assimilated in GEOS because of their large sensitivities to uncertain surface parameters such as emissivity and skin temperature.

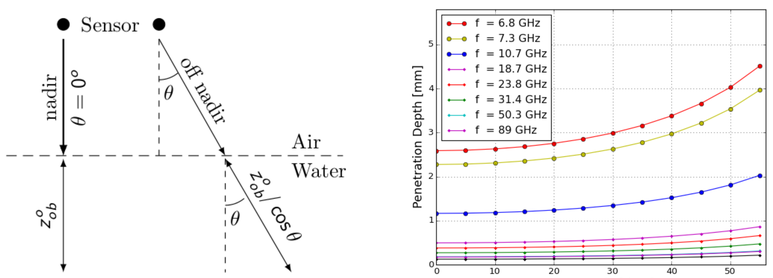
Variation of temperature with depth & Penetration depth



$$\frac{\partial T}{\partial z} = \begin{cases} \Delta T_c/\delta & \text{if } 0 \le z \le \delta \text{ (Cool Layer)}, \\ -\mu \frac{\Delta T_w}{z-\delta} \left(\frac{z-\delta}{d-\delta}\right)^{\mu} & \text{if } \delta < z \le d \text{ (Warm Layer)}. \end{cases}$$

$$\mathcal{C}_{T_B} = T_B^{new} - T_B = H[T(z_0 + \delta z)] - H[T(z_0)] = \frac{\partial T_B}{\partial T(z)} \frac{\partial T(z)}{\partial z} \delta z + O(\delta z^2).$$

Penetration depth scan angle dependence

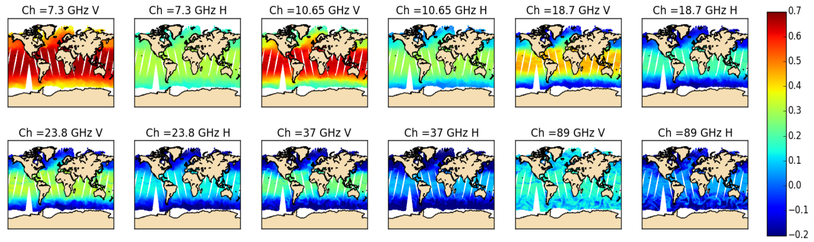


$$z_{ob} = z_{ob}(\theta = 0)/\cos\theta, \text{ where } z^o_{ob} = z_{ob}(\theta = 0)$$

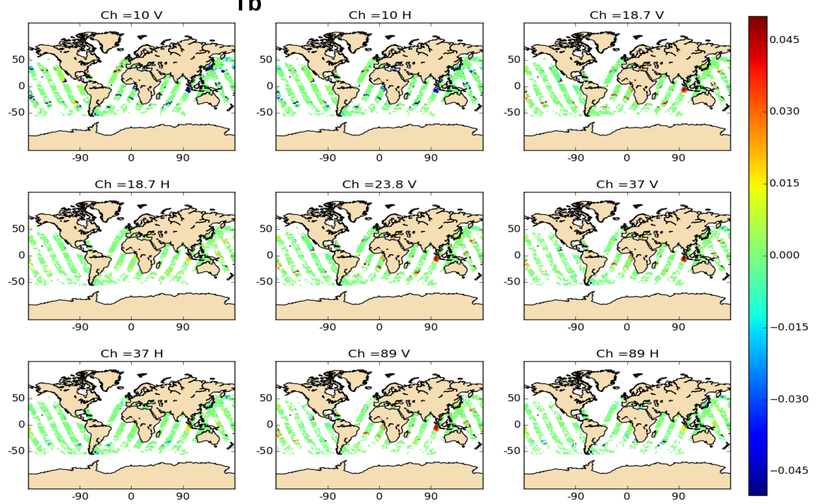
Experiment

This experiment was performed for AMSU-A suface sensitive channels between 23.8 to 89 GHz, GMI channels from 10 to 89 GHz and AMSR2 channels 6.9 to 89 GHz. The experiments are configured on a cube sphere (C360) grid, and all experiments are started with the same initial conditions.

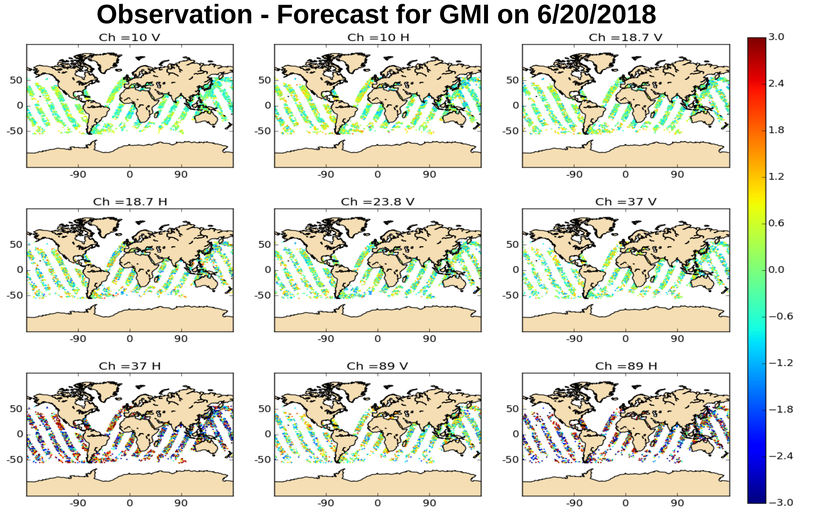
dTb / dT(z) for AMSR2



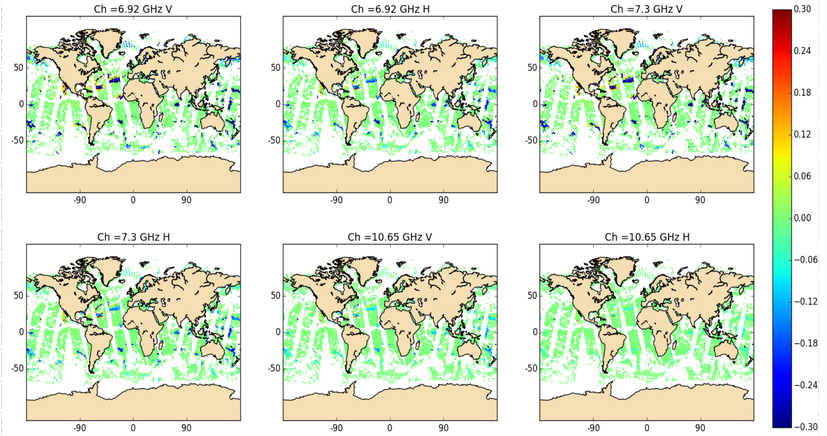
C_{Tb} for GMI on 6/20/2018



Observation - Forecast for GMI on 6/20/2018



C_{Tb} for AMSR2



Observation - Forecast for AMSR2

Conclusions

Initial attempt to assimilate surface sensitive channels have been performed in GEOS system. Penetration depth changes vs frequency and scan angle changes and it's effect on measured Tbs has been investigated, which for channels higher than 10 GHz is negligible. However for 10 V GHz the correction can be in order of 0.1K, and for channels 6.9 and 7.3 GHz in AMSR2 we see up to 0.7 K correction. Also, it's been noticed on some channels there are significant difference between observation and forecast, which appears to be Radiative transfer model issue. A further investigation is needed to resolve this matter.

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