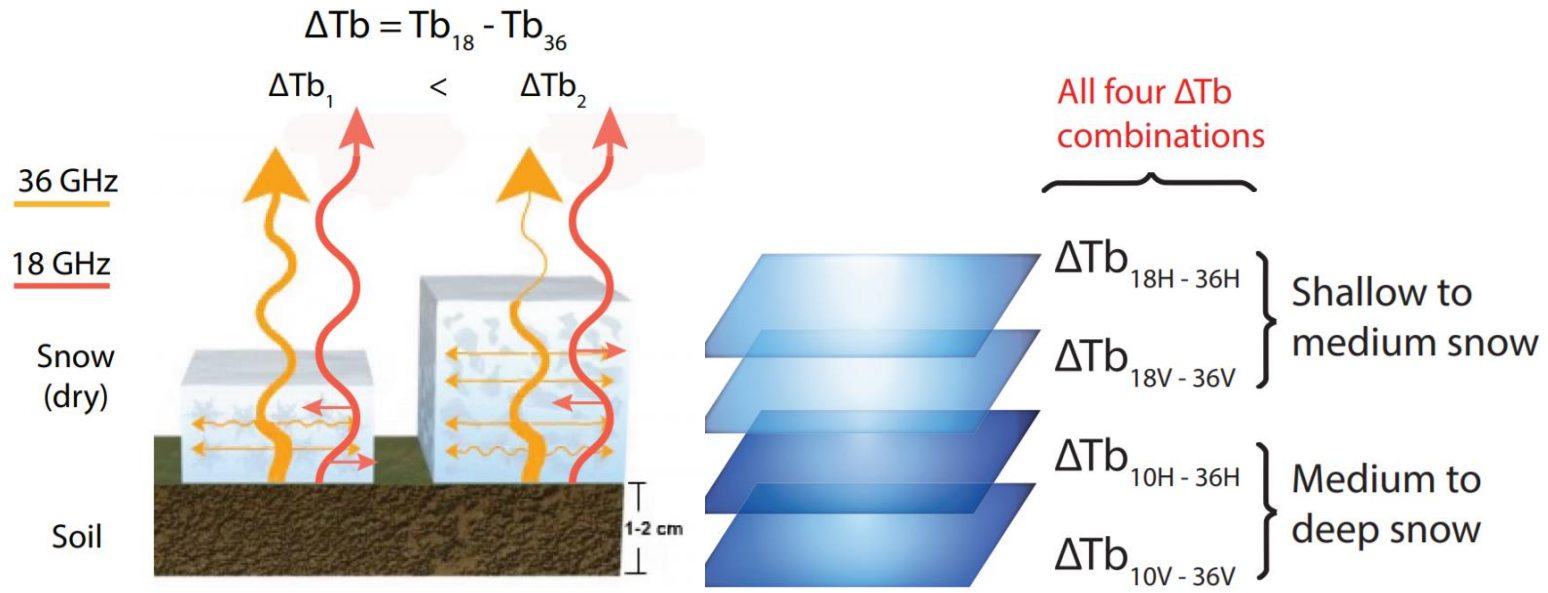
Automatic bias correction for satellite radiance through combining multiple channels

YINGHUI LU

AUG. 17, 2017

Motivation

- Combination of microwave brightness temperatures from different channels can be used to retrieve snow water equivalent.

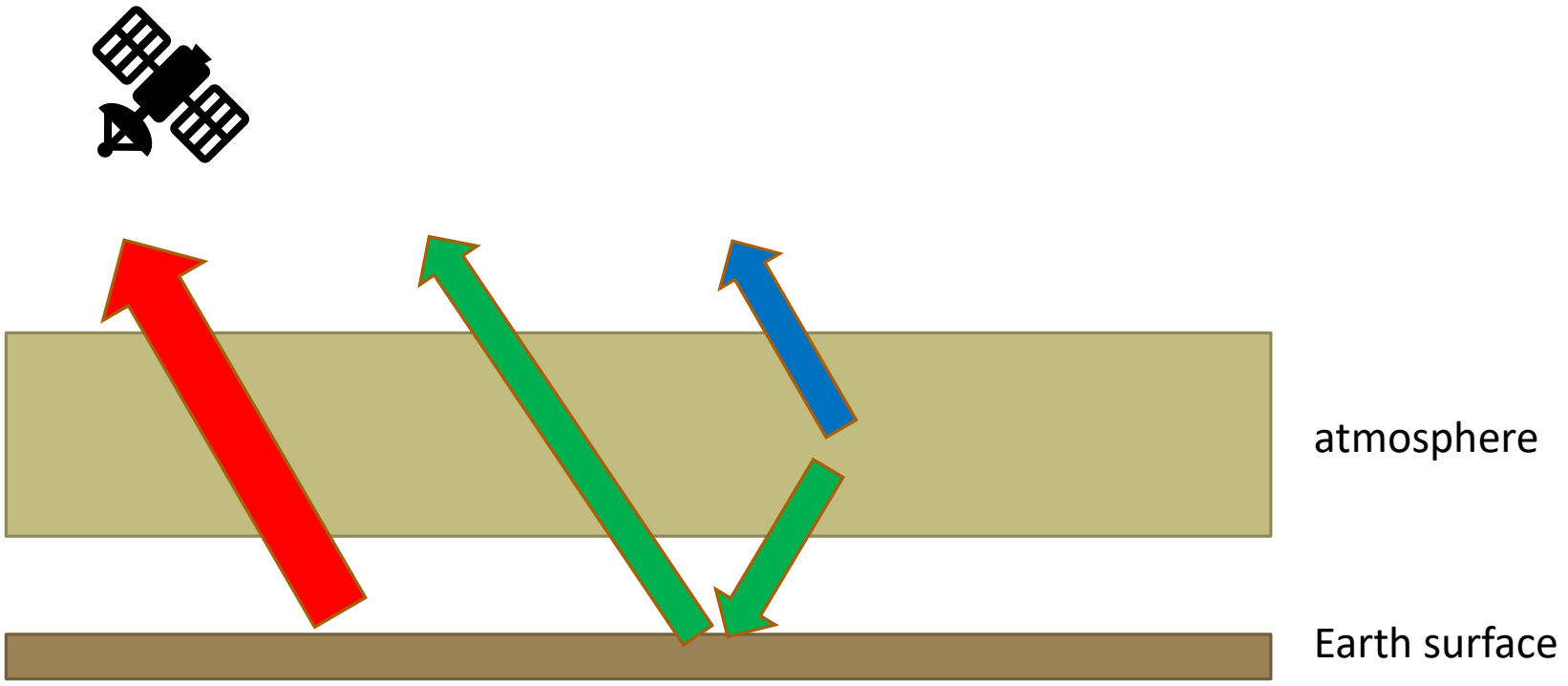


(Yuan Xue and Barton A. Forman, PSU-UMD DA workshop 2017)

Motivation

- Combination of microwave brightness temperatures from different channels can be used to retrieve snow water equivalent.
- Surface properties (emissivity and skin temperature) are big source of bias in window channels.
- Purpose:
- (1) Would it be possible to reduce the bias due to surface properties by combining multiple channels?
- (2) One step further, would it be possible to retrieve surface properties by combining multiple channels?

Simplest case: ocean, clear sky



$$I(\nu) = \tau(\nu)\underline{\epsilon(\nu)}B(\nu,\underline{T_s}) + \tau(\nu)[1-\underline{\epsilon(\nu)}]I^{\downarrow}_{atm}(\nu) + I^{\uparrow}_{atm}(\nu)$$

In a tangent linear view

$$I(\nu) = \tau(\nu)\epsilon(\nu)B(\nu, T_s) + I^{\uparrow}_{atm}(\nu) + \tau(\nu)[1 - \epsilon(\nu)]I^{\downarrow}_{atm}(\nu)$$

$$\Delta I(\nu) = \tau\epsilon \frac{\partial B}{\partial T}\Big|_{T_s} \Delta T_s + \tau\left[B - I^{\downarrow}_{atm}\right]\Delta\epsilon + \Delta I_{atm}$$

$$= \quad M \ \Delta T_s + \quad N \ \Delta\epsilon + \Delta I_{atm}$$

Assume: $\Delta\epsilon$ is the same for all three channels

Define synthetic channel: $I_{syn} = a_1 I_1 + a_2 I_2 + a_3 I_3, where$

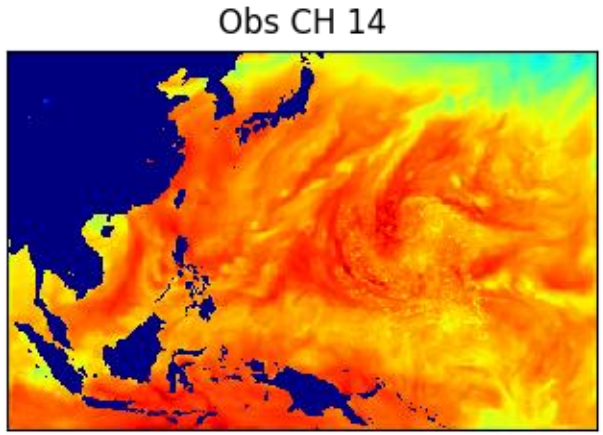
$$\begin{cases} a_1 M_1 + a_2 M_2 + a_3 M_3 = 0 \\ a_1 N_1 + a_2 N_2 + a_3 N_3 = 0 \\ a_1 + a_2 + a_3 = 1 \end{cases}$$

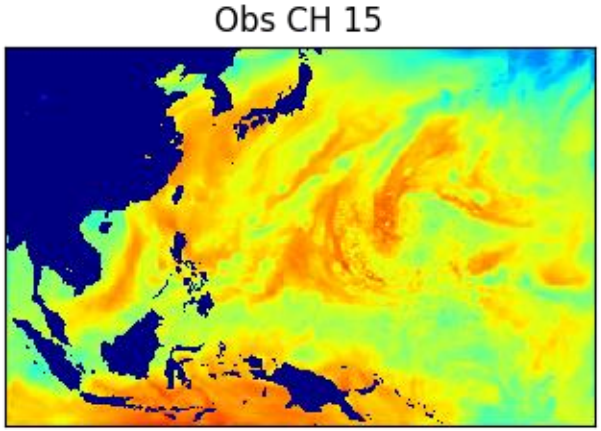
Then $\Delta I_{syn} = \mathrm{M}_1 \Delta I_{atm,1} + \mathrm{M}_2 \Delta I_{atm,2} + \mathrm{M}_3 \Delta I_{atm,3}$

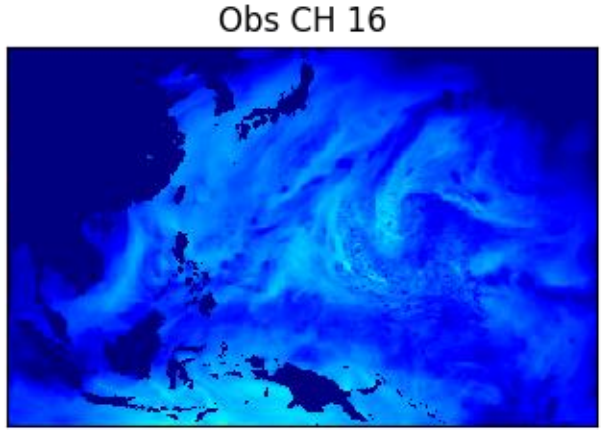
OSSE – IR, clear sky

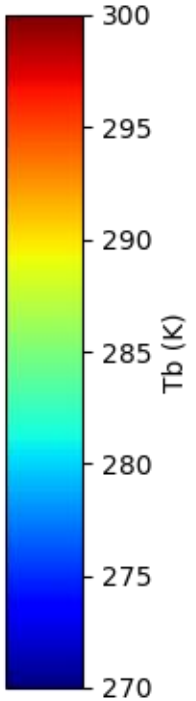
Truth (or observation)

- Obtain a WRF run from Masashi
- Remove all the clouds
- Run CRTM forward model on AHI channels 14, 15, 16.





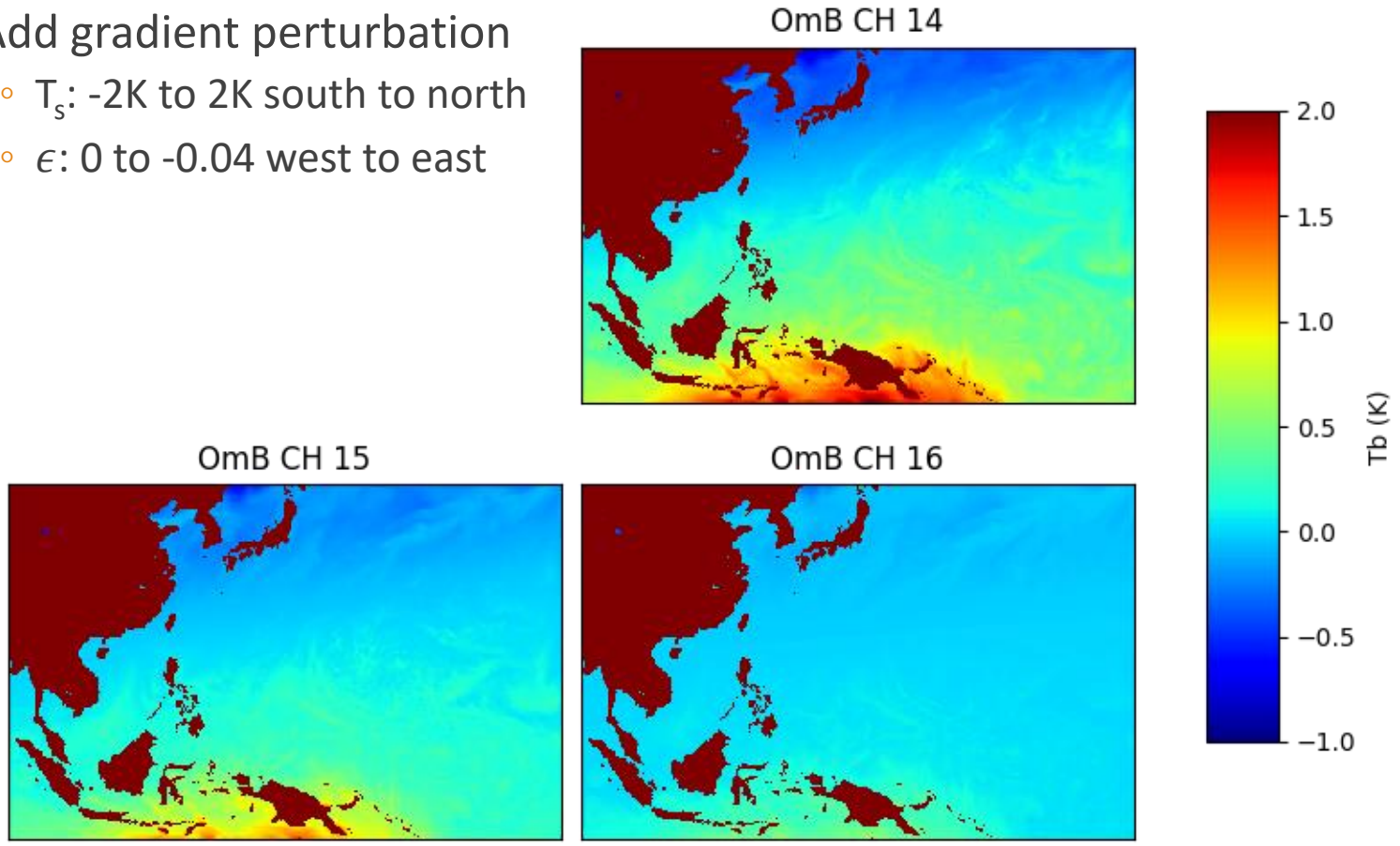




Perturb the surface …

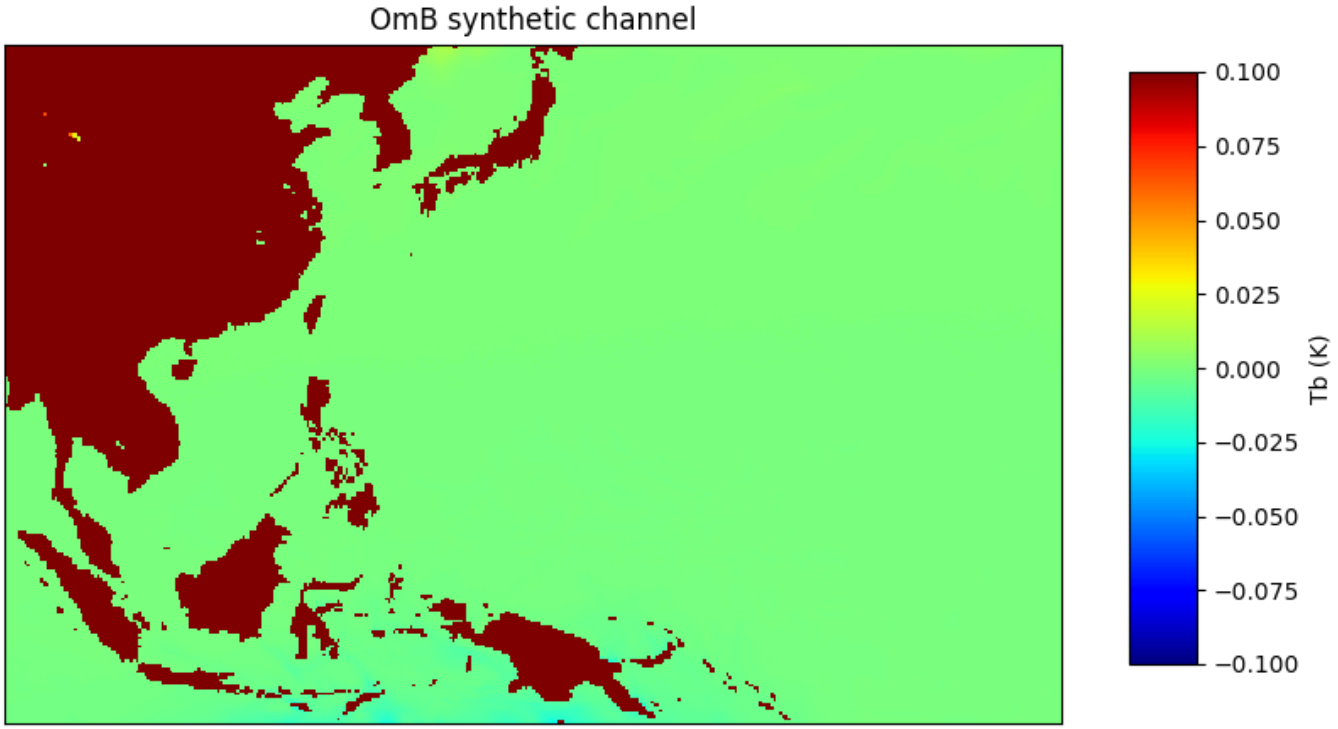
Add gradient perturbation

- T_s: -2K to 2K south to north
- ϵ: 0 to -0.04 west to east



OmB synthetic observation

- Looks Good!
- Bias from surface removed



Future?

Would it be possible to calculate the "true" surface temperature?

- Signal to noise ratio is low ($\Delta I(\nu) = \tau\epsilon \frac{\partial B}{\partial T}|_{T_s} \Delta T_s + \tau\left[B - I_{atm}^{\downarrow}\right]\Delta\epsilon + \Delta I_{atm}$)
- Depends on ΔI_{atm}

Would it be possible to work on cloudy scene?

- Possible. Cloud top is the new "earth surface"!

How sensitive to atmospheric profile?

- Add perturbation to atmosphere profile

Thank you!

Questions and comments?