Developing Winter Precipitation Algorithm Over Land from Satellite Observations and C3VP Field Campaign Data

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1. Introduction

The remote sensing of precipitation in mid- and high-latitudes is a major point of emphasis for the GPM mission. One of our focus areas in the past year is to understand the radiometric snowfall signals over land by comparing satellite snowfall observations with simulated brightness temperatures and radar reflectivity. In addition to the complicated snow scattering properties, land surface emissivity is another main source of errors in matching the brightness temperatures, particularly at the window channels (85 and 160 GHz) and the lower atmosphere peaking water vapor (183+-7). This study also looks into variability of surface emissivity where the surface is covered with ground snow.

2. Bayesian Snowfall Estimation In An Idealized World

We use the Integrated Water Path (IWP) and surface Ice Water Content (IWC) values from the C3VP WRF database and simulated brightness temperatures at 89GHz, 165 GHz, 183±3 GHz and 183±9 GHz vertical polarizations (the high-frequency GMI channels). The IWP values are used as a proxy for the snowfall rates, The database is created using a training set of WRF profiles over a 456 km x 456 km area around the CARE site at a 1 km horizontal resolution for 0600Z January 22nd, 2007. IWP from Tb vectors using a Bayesian form similar to the one described in Grecu and Olson 2006. Figure 1 shows the training IWP from the WRF models for 0600Z on January 22nd, and the corresponding retrieved IWPs for that hour, for a constant emissivity value of 0.6. Zero-mean Gaussian noise with Standard deviations of 0.1K, 0.5K and 2K added. Figure 2 shows the surface IWC retrievals. It is not always possible to distinguish ice content near the surface from ice at higher levels from the Tb values, and the retrievals sometimes assign high surface IWC values in pixels where there are high IWC values in the higher layers.

Figure 1: Synthetic IWP retrievals

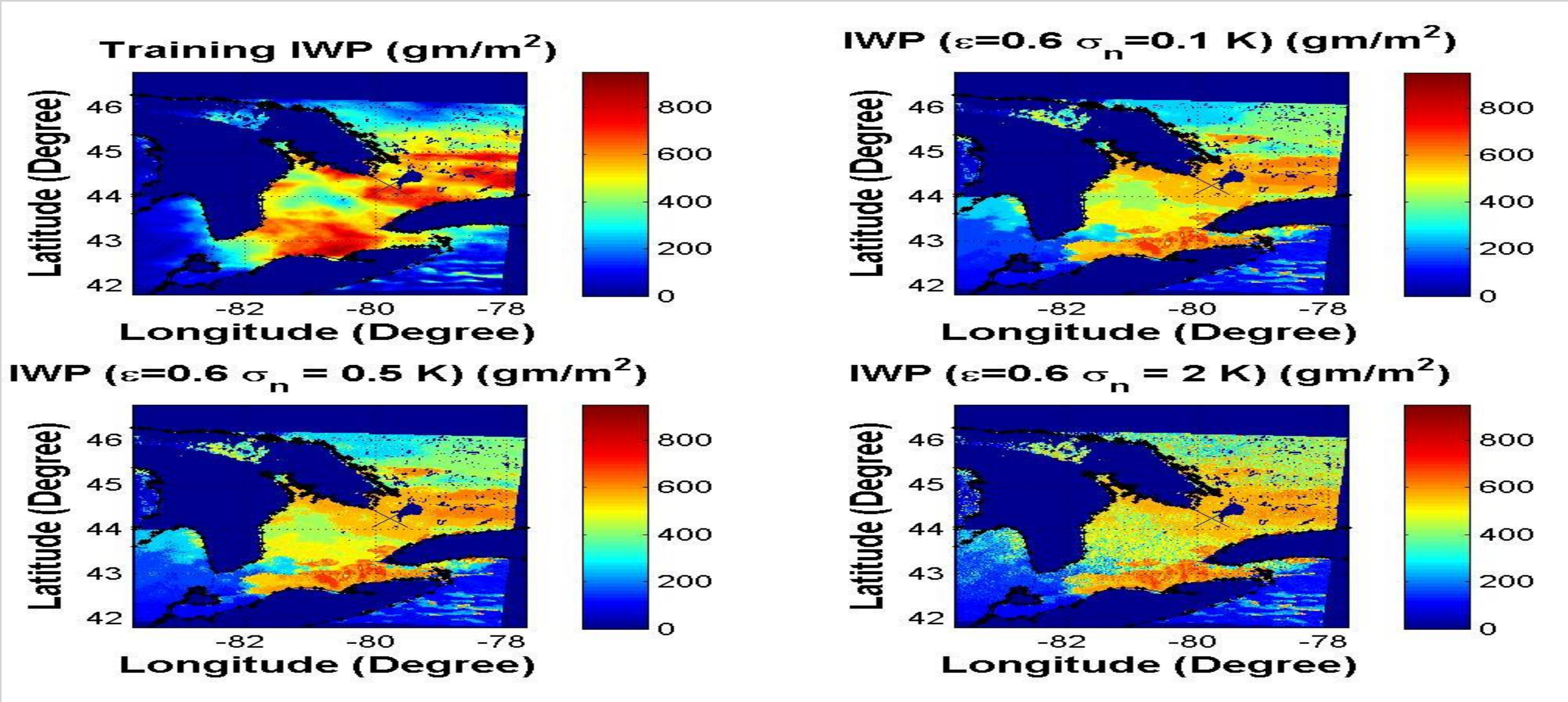
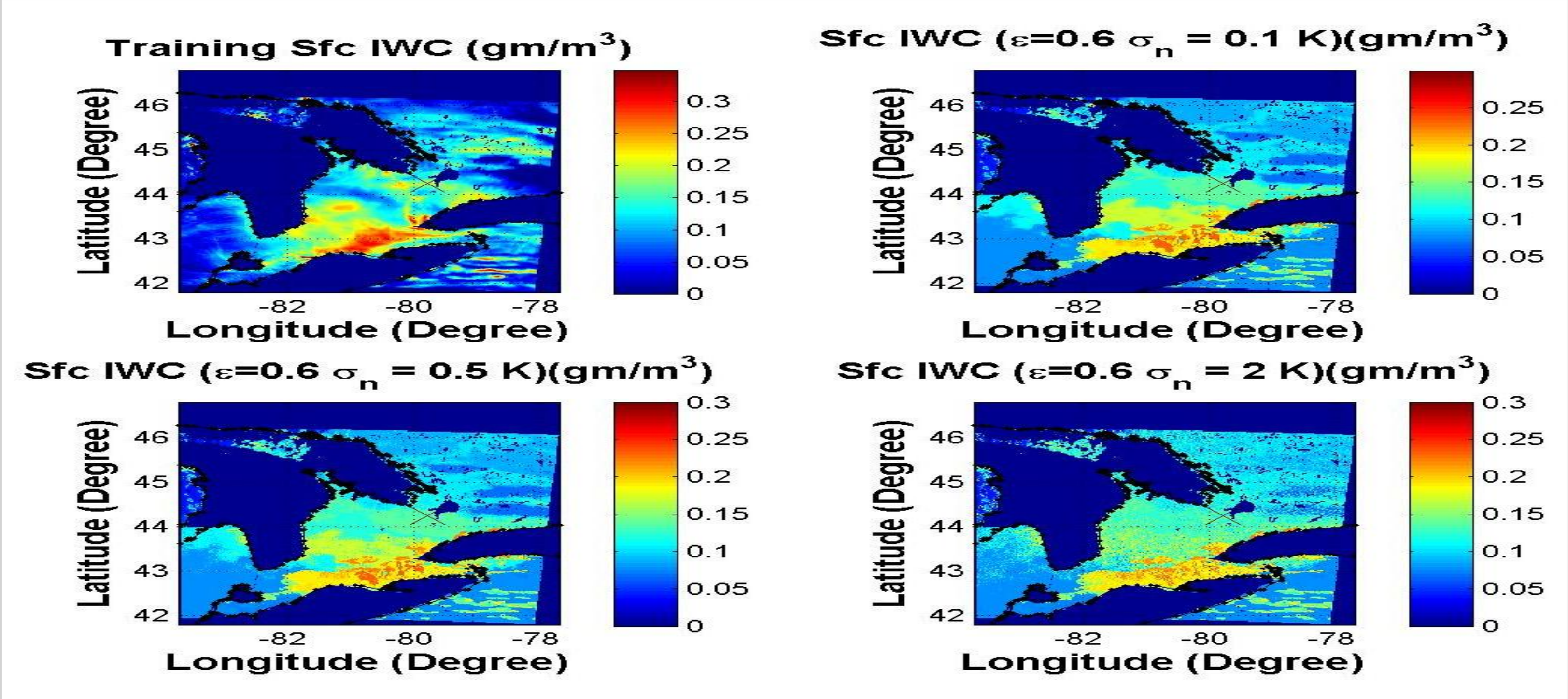


Figure 2: Synthetic surface IWC retrievals



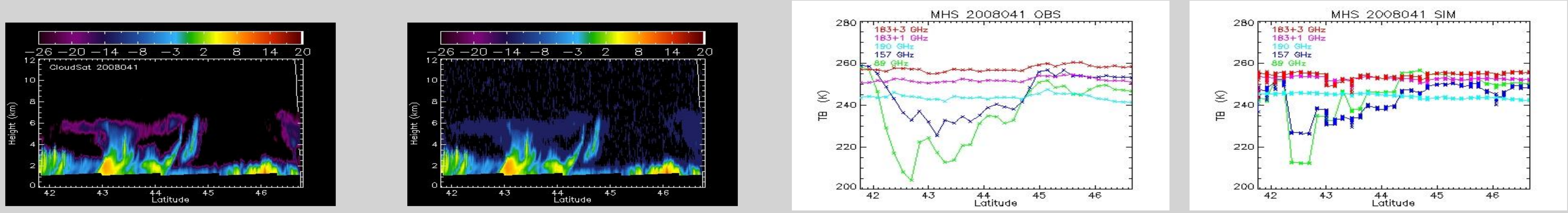
3. Satellite Observations and Simulations of Snowfall

CloudSat radar reflectivity and NOAA MHS brightness temperatures are simulated and compared for a snowfall event took place near C3VP CARE site on February 10, 2008. Gamma size distribution is assumed and single scattering properties from non-spherical snow particle models(Liu, 2004) are used.

Figure 3. Snowfall event on February 10, 2008

CloudSat

NOAA 18 MHS



4. Seasonal Surface Emissivity Variations

Four years of surface emissivity in the frequency range of 6-183 GHz at a1X1 grid box centered at [43.9, -80.5] are estimated using coincident AMSR-E and MHS clear air TBs. Figure 4 shows the distribution of surface emissivity (in black) and the averaged emissivity spectrum (in red) from the summer (June, July, August) and winter (December, January, February) for AMSR-E and MHS.

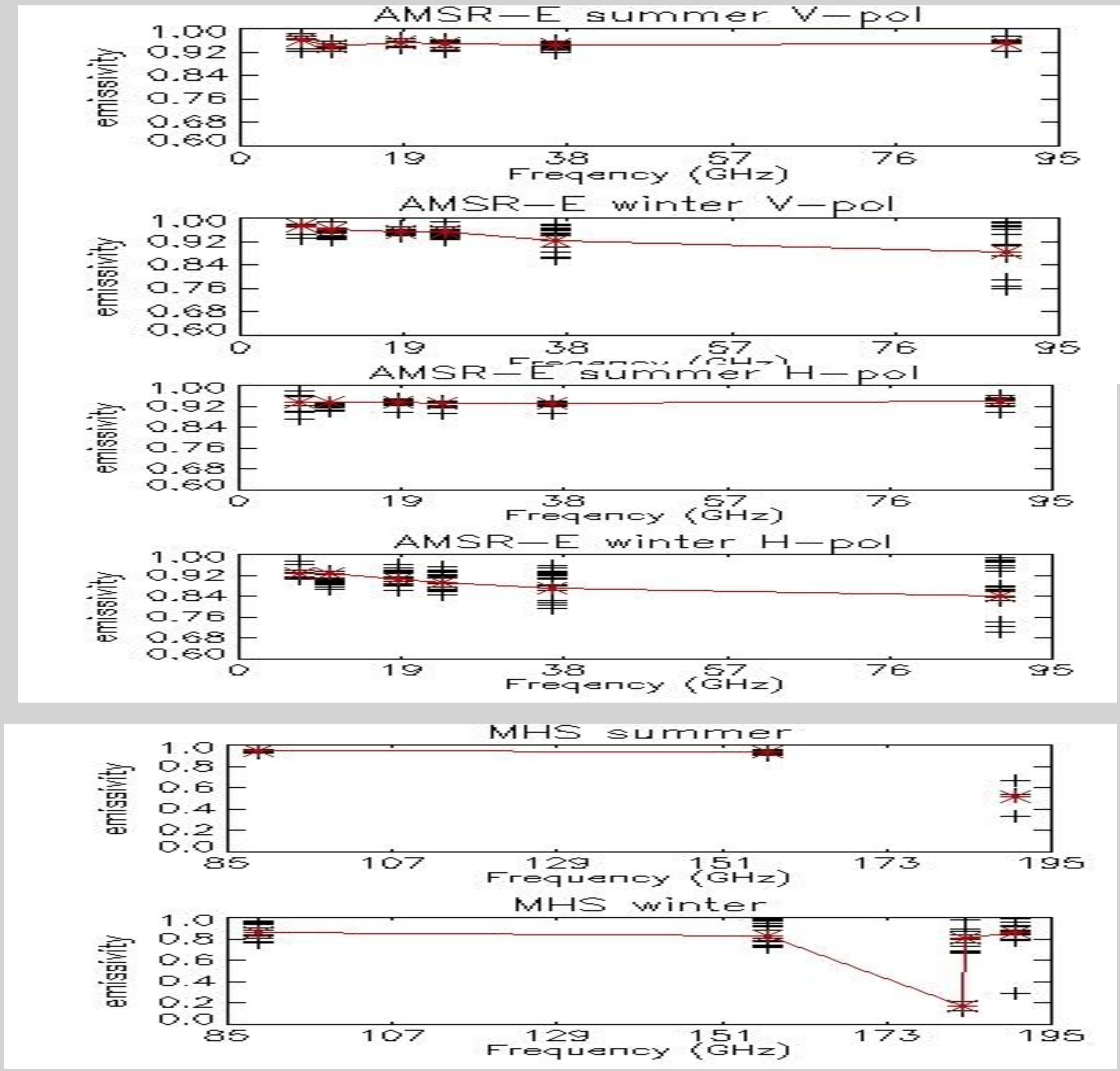


Figure 4. emissivity estimates from AMSR-E and MHS for the summer and winter from 4 years of co-located AMSR-E/MHS/CloudSat data.

5. Summary

We continue making progress towards understanding the microwave radiometric snowfall signatures from the atmosphere and the surface Perspectives. Our next step is to compute the error covariance matrix from the surface emissivity for the GMI spectrum range.