INTERCALIBRATION OF AMSR-E AND WINDSAT BRIGHTNESS TEMPERATURE MEASUREMENTS OVER LAND SCENES

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ABSTRACT

Our study provides a detailed intercomparison between AMSR-E and WindSat top of the atmosphere brightness temperatures (TB) over land scenes.

Index Terms— WindSat, AMSR, Sensor intercalibration, Land scenes.

1. COLLOCATED AMSR-E – WINDSAT BRIGHTNESS TEMPERATURES

We have collocated top of the atmosphere(TOA) TB from AMSR-E and WindSat at 3 tropical rain forest calibration sites in central South America and central Africa over the time period of 12 months (Figure 1). The sites are classified as evergreen broadleaf forest in the USGS Global IGBP (International Geosphere Biosphere Programme) Version 2 maps.

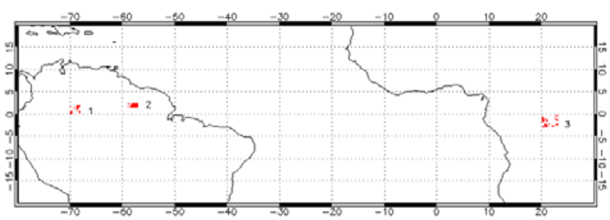

Figure 1: Rain forest calibration sites.

An AMSR-E TB measurement of the descending (night-time) overpass (local equatorial crossing time 1:30 AM) is collocated with a WindSat TB measurement of the corresponding channel (frequency and polarization) from the descending (early-morning) overpass (equatorial crossing time 6:00 AM). Using the AMSR-E night-time and WindSat early-morning overpasses minimizes diurnal differences, which might influence especially the higher frequencies that are sensitive to atmospheric water vapor and clouds.

The AMSR-E 7 GHz channels have been corrected for a non-linearity in the receiver.

2. RADIATIVE TRANSFER MODEL OVER RAINFOREST CALIBRATION SITE

Over the densely vegetated rain forest, the top of the atmosphere TB shows no or very little dependence on the properties of the ground (composition, temperature, roughness) but only on the temperature of the canopy as well as the temperature and absorption of the atmosphere and the scattering albedo ω of the canopy.

The radiative transfer model (RTM) equation for the top of the atmosphere TB reads:

$$T_B \approx T_{B,atm\uparrow} + \tau_{atm} \cdot (1-\omega) \cdot T_{veg} + \tau_{atm} \cdot \omega \cdot T_{B,atm\downarrow} \quad (1)$$

T_{veg} is the temperature of the canopy, which is assumed to be equal to the temperature of the surface.

τ_{atm}, $T_{B,atm\uparrow}$ and $T_{B,atm\downarrow}$ are the atmospheric transmittance, upwelling atmospheric brightness temperature and downwelling atmospheric brightness temperature, respectively, and depend on frequency. We derive all those parameter from an ancillary data set of temperatures and atmospheric vapor and liquid cloud water from a numerical weather prediction model (e.g. NCEP GDAS).

3. FIT OF SCATTERING ALBEDO

We fit the value of the scattering albedo ω from the observed TB (Figure 2). We assume that does not depend on Earth incidence angle. It can have different values at different calibration sites. Its frequency dependence is not known a priori. However, a certain degree of spectral consistency is required. For example, the value for at 18.7 GHz should be very close to its value at 23.8 GHz. Figure 2 clearly indicates that the AMSR-E observations at 18.7 GHz do not fit into this scheme.

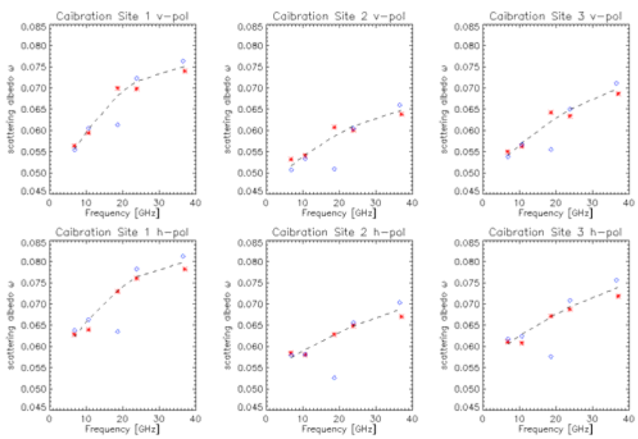

Figure 2: Scattering albedo for the 3 rain forest calibration sites. Upper panel: v-pol, lower panel: h-pol. Blue diamonds are the values from AMSR-E, the red stars are the values from WindSat. The dashed curves are the best fits to a quadratic curve after omitting the AMSR-E outlier at 18.7 GHz.

4. AMSR-E - WINDSAT BRIGHTNESS TEMPERATURE INTERCOMPARISON

With the fitted values for the scattering albedo , the RTM equation (1) can be used to perform a direct intercomparison of measured TOA TB from one instrument at different frequencies or from the same channel at the two instruments. Differences in frequency, Earth incidence angle and diurnal variability due to the different overpass times can be compensated by correcting the TB using the RTM equation.

Figure 3 shows the differences between measured and RTM top of the atmosphere TB. With the exception of the two AMSR-E 18.7 GHz channels, all observations fit within the expected margin of error.

We have already applied a non-linearity correction for the two AMSR-E 7 GHz channels. The fact that the observed values line up well with the WindSat observations is an indication that this non-linearity correction is indeed appropriate.

The 2 AMSR-E 18.7 GHz channels are running high by about 2 K, which points to potential problems with the calibration of these channels. This issue needs further investigation.

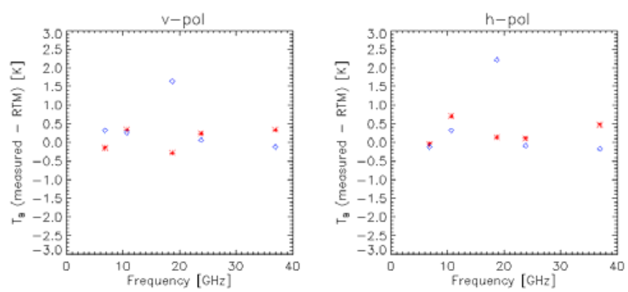

Figure 3: Differences between measured and RTM TOA TB averaged over all 3 calibration sites. The left panel is v-pol; right panel is h-pol. Blue diamonds are the values from AMSR-E; the red stars are the values from WindSat.