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

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1. COLLOCATED AMSR-E – WINDSAT BRIGHTNESS TEMPERATURES

Our study provides a detailed intercomparison between AMSR-E and WindSat top of the atmosphere (TOA) brightness temperatures (TB) over land scenes. The data set has been collected over the time period of 12 months at tropical rain forest scenes in central South America and central Africa. We take an AMSR-E TB measurement of the descending (night-time) overpass, whose local equatorial crossing time is at 1:30 AM. This measurement is collocated with a WindSat TB measurement of the corresponding channel (frequency and polarization) from the descending (early-morning) overpass, whose equatorial crossing time is at 6:00 AM. Using the AMSR-E night-time and WindSat earl-morning overpasses minimizes diurnal differences, which might influence especially the higher frequencies that are sensitive to atmospheric water vapor and clouds. Over the densely vegetated rain forest, the TOA 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 the temperature and absorption of the atmosphere This is evident when computing the standard deviation of the TB difference between AMSR-E and WindSat (left panel of Figure 1), which shows a very small variability at the rain forest scenes. The spectral variation of the TOA TB between 6 and 37 GHz for those scenes can then be deducted from a land surface radiative transfer model (RTM) [1;2] and an ancillary data set of temperatures and atmospheric vapor and liquid cloud water from a numerical weather prediction model. This can also be used to correct for the variability in Earth incidence angle of the WindSat radiometer, which has a small effect on the TOA TB. It allows then a direct intercomparison between AMSR-E and WindSat TOA TB for those scenes.

2. BRIGHTNESS TEMPERATURE CALIBRATION OVER LAND

Radiometer calibration is the transformation of radiometer counts into TOA TB. It consists of 2 basic steps: The first one is the transformation from radiometer counts into antenna temperatures (TA) and the second step is the antenna pattern correction that transforms TA into TB by correcting for spillover and cross polarization contamination. A detailed account of all the major steps involved can be found in [3]. The general assumption is that both transformations are linear. Because pre-launch values for the antenna pattern coefficients (spillover and cross polarization) are either not available or not reliable to the needed degree of accuracy, it is necessary to perform an absolute calibration of ocean scenes TOA TB to the RTM [4-6]. The use of ocean scenes allows an accurate modeling of TOA TB. This absolute calibration method determines the values of the antenna pattern coefficients and by default provides precise calibration over the ocean.

Both instruments, AMSR-E and WindSat exhibit significant solar intrusion into the hot calibration load, which can lead to erroneous values for the hot load temperature [7;8]. It is therefore necessary to tie the hot load temperature to the TB of the ocean scenes using the RTM [3;8;9]. The hot calibration is therefore eliminated as a separate degree of freedom because it is not independent of the ocean calibration any more. However, hot Earth scenes over land or sea ice can be used as an independent consistency check of the calibration. If the radiometer response functions transforming counts into TA were truly linear and the cold calibrations were free of errors, then an extrapolation based on the cold calibration and the ocean calibration would provide accurate TB for those hot Earth scenes. The observation of significant deviations indicates either a non-linearity in the receiver response function or a problem with the cold mirror. Previous analyses by both JAXA and by us have clearly show that at 6.9 GHz the AMSR-E radiometer response function is not linear. Also it is possible that there are some non-linearity effects at the high frequencies. On the other hand, the WindSat radiometer response functions are believed to be linear [7].

3. RESULTS AND CONCLUSIONS

Figure 1 - Figure 3 show the results of our study for the most interesting cases. We have analyzed both the spectral variation of the TOA TB as function of frequency for each instrument as well as the differences between the two instruments for a given channel.

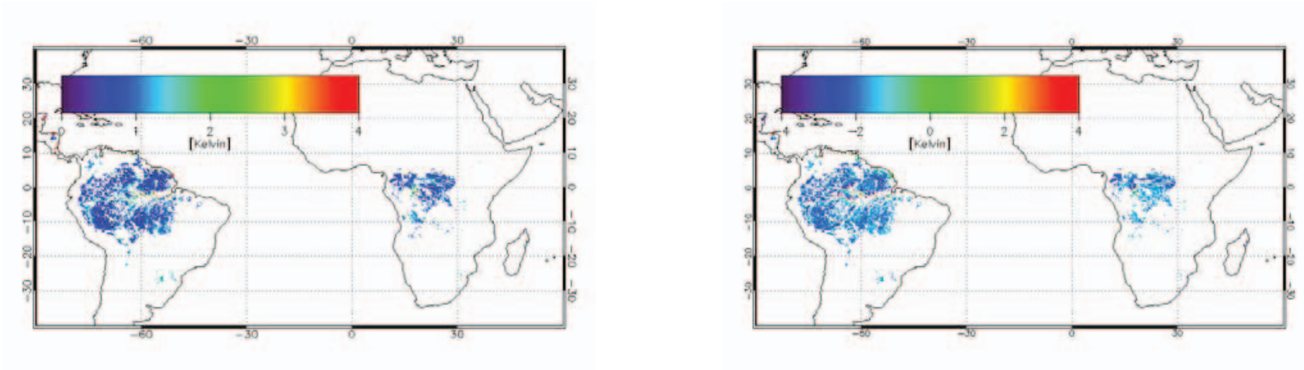

Figure 1: Difference between 6.9 GHz v-pol brightness temperatures of the AMSR-E descending swath (1:30 AM local equatorial crossing time) and the 6.8 GHz v-pol brightness temperatures of the following WindSat descending swaths (6:00 AM local equatorial crossing time) collected over 1 year over the tropical rain forest. The left panel shows the standard deviation of the TB differences , the right panel shows the TB differences themselves.

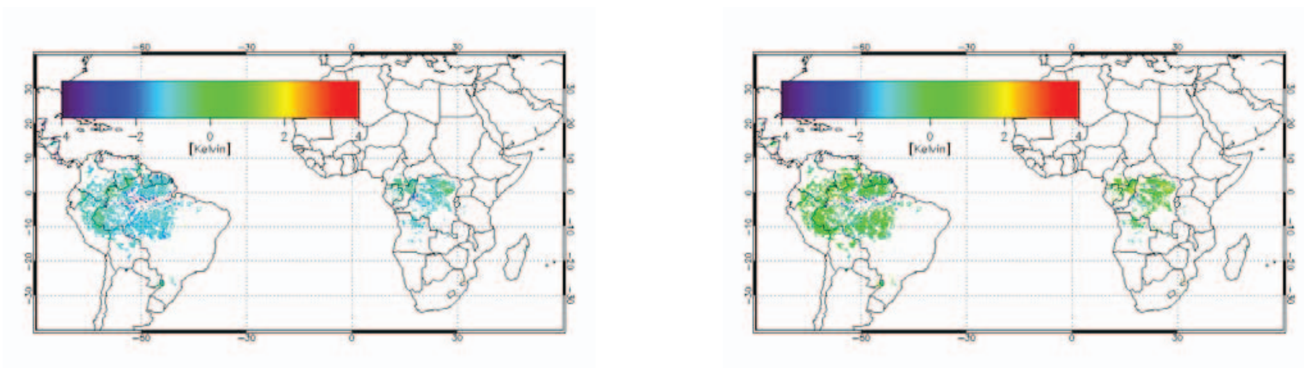

Figure 2: Difference between 6.9/6.8 and 10.7 GHz v-pol brightness temperatures over the tropical rain forest. AMSR-E (left panel) and WindSat (right panel).

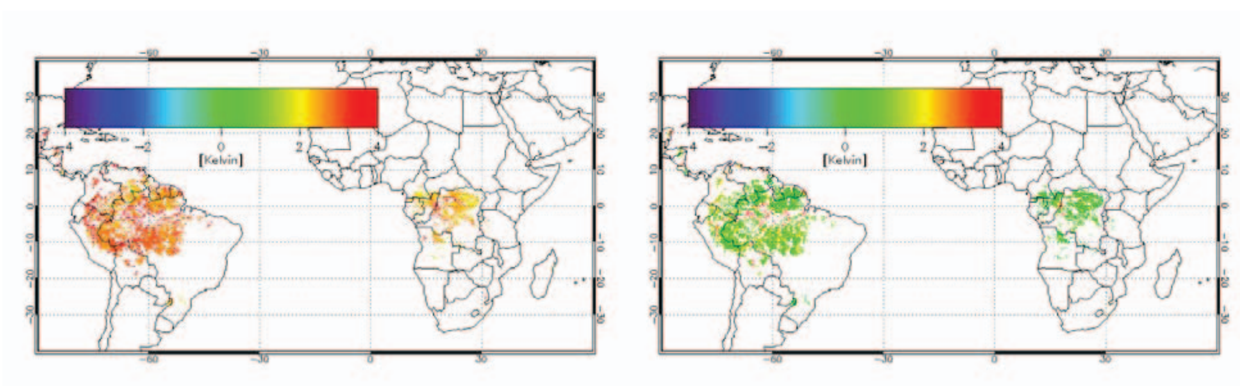

Figure 3: Difference between 18.7 and 10.7 GHz v-pol brightness temperatures over the tropical rain forest. AMSR-E (left panel) and WindSat (right panel).

The TOA TB of all WindSat channels over the tropical rain forest seem to be consistent with the absolute calibration over ocean scenes and the assumption of a linear receiver response. The WindSat instrument can therefore serve as a good intercalibration reference for other satellites, such as SSM/I, SSMIS, TMI, and also AMSR-E.

For the AMSR-E channels we find that over the tropical rain forest scenes the two 6.9 GHz channels are about 2- 3 K too low and the two 19.7 GHz are about 3 K too high. As mentioned above that could result from a non-linear receiver response function and will need to be further investigated.

We have not detected any significant problems with the either the 10.7, 23.8 or 36.5 GHz AMSR-E channels.

4. REFERENCES

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