Effective SMOS PSF and Antenna Correlations

Given the interferometric characteristics of SMOS, SMOS snapshots are full-polarization brightness temperatures rendered on a hexagonal grid (the so-called synthetic antenna). In fact, what the instrument actually measures are the cross-correlations of all pairs of receivers, from which a visibility function can be derived. The vector of visibilities is linearly related to brightness temperatures TB by means of a reconstruction matrix **G**. Due to the imperfect knowledge of the matrix **G**, the difficulties to invert such a big matrix together with some aliasing effects, spurious spatial correlations on brightness temperature snapshots are induced. BEC team is investigating the scope of such correlations. The shape of the found correlations reveals a clear geometrical pattern.

a) X polarization correlation pattern. Correlation of the central point with the rest of the synthesized scene	b) Real part of XY polarization correlation pattern. Correlation of the central point with the rest of the synthesized scene
c) X polarization correlation pattern. Correlation of a point located in the edge of AF-FOV with the rest of the synthesized scene	d) X polarization correlation pattern. Correlation of a point beyond the horizon with the rest of the synthesized scene

Figure 1.- Correlation patterns for different polarizations and antenna points. Patterns corresponding to polarization Y and to the imaginary part of cross polarization are similar to those corresponding to X polarization (figures 1.a, 1.c and 1.d) and real part of cross polarization respectively (figure 1.b).

Correlations at antenna level can be characterized by means of effective Point Spread Functions (PSF). PSFs describes the response of the system to a punctual source (of the size of a snapshot pixel) presented at a point of the antenna. Our study indicates that SMOS PSF matrix can be computed in a fast way from actual SMOS measured data without any model or auxiliary data. As we observe that the PSFs centered at different points are in fact very similar, we can make the assumption that the PSF matrix is in fact a convolution matrix, which is defined in terms of a PSF convolution kernel. The PSF convolution kernel can be estimated with high quality with a relatively limited set of data (see figure below).

a) PSF convolution kernel for X polarization	b) PSF convolution kernel for real part of cross polarized scenes

Figure 2.- PSF convolution kernel for different polarizations. As in the correlations case, the PSF corresponding to polarization Y is very similar to that corresponding to X polarization (figure 2.a), while the imaginary part of cross-polarization corresponds to the same PSF as the one for real part of cross polarization (figure 2.b).

The knowledge of the PSF convolution kernel allows us to define simple metrics to assess the impact of changes in the calibration or processing procedures on antenna correlations and on energy dispersion.

The presence of non-negligible (~10 dB along the main image axis) PSF can be the cause of the observed image biases in SMOS. Once the PSF is known, the following goal is to deconvolve it from SMOS images, in order to produce a better quality brightness temperature and therefore more accurate Ocean Salinity and Soil Moisture products.