Impact of urban cover fraction on SMOS and SMAP surface soil moisture retrieval

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L-band (~1.4 GHz) microwave radiometry has been widely acknowledged as the most promising technique for surface (top ~5cm) soil moisture observation at regional and global scales, due to its all weather capability, direct relationship to soil moisture, and reduced sensitivity to surface roughness and vegetation. Radiometer observations of microwave emission from the soil surface are used to estimate soil moisture through a radiative transfer model using ancillary information including land cover and soil properties etc. This technique has been applied to the ESA’s (European Space Agency) Soil Moisture and Ocean Salinity (SMOS) satellite, the first soil moisture dedicated space mission, launched on 2nd Nov. 2009. Similarly, radiometer techniques will be employed by NASA’s (National Aeronautics and Space Administration) Soil Moisture Active and Passive (SMAP) mission, in both the passive and active-passive products. However, passive microwave soil moisture retrieval suffers from land surface heterogeneity at coarse scales; with the radiometer footprints of both missions being ~40 km, which is the best spatial resolution currently achievable using current satellite antenna technology. In order to achieve the ~0.04 m^3/m^3 target volumetric soil moisture accuracies at such scales, microwave contributions of non-soil targets (such as urban areas) within the sensors’ field-of-view needs to be considered in the retrieval algorithm error budget and implementation, since the impact could potentially be significant if ignored. Currently there is a lack of knowledge on the microwave behaviour of non-soil targets, with little assessment of their microwave emissions and impact on satellite scale footprints. Therefore, the objectives of this study are to 1) investigate the relationship between urban induced brightness temperature uncertainties and urban fraction, 2) extract urban fraction thresholds for negligible brightness temperature impact by urban areas based on the SMOS and SMAP error budgets, and 3) use these thresholds to identify SMOS and SMAP pixels with likely non-negligible urban impacts world-wide. In this work, airborne datasets from three field campaigns in the Murrumbidgee catchment, in southeast of Australia, were used: i) the NAFE’06 (National Airborne Field Experiment in 2006), ii) the AACES-1 (Australian Airborne Cal/val Experiment for SMOS), and iii) the AACES-2. During these campaigns, brightness temperature observations were made at 1-km resolution across 20 independent SMOS/SMAP sized footprints of which a number contain urban areas of different size. The NSW (New South Wales, Australia) Land use map with 50 m resolution was used to distinguish brightness temperature observations of the urban area and surrounding natural land surface, from which urban fraction thresholds for SMOS and SMAP were derived. These thresholds were then applied globally based on an urban fraction map calculated using the MODIS Urban Land Cover 500-m product.