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Towards soil moisture retrieval using multi-incidence angle observations

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The recently launched L-band (1.4 GHz) passive microwave satellite has not only heralded the first dedicated mission for global Soil Moisture and Ocean Salinity (SMOS) mapping, but its novel design also provides a unique opportunity to utilise multi-angle observations of the same area on the ground to derive more reliable land surface property information. One of the main motivations for the satellite mission is that meteorological and climatic predictions can be significantly improved using global soil moisture information as model input. However, the algorithms for this mission need to be thoroughly tested on different land surface conditions and spatial resolutions, since the developed parameterization has been mostly limited to small scale studies that focused on data from tower radiometers and simulation experiments.

The SMOS technology is based on the relationship between measured brightness temperature and the dielectric constant of the soil surface, which is related to its moisture content. Since this relationship with soil moisture is affected by a range of factors, including surface roughness and vegetation cover etc., the SMOS mission is using multi-incidence angle observations to estimate some of the ancillary parameters and hence facilitate the retrieval algorithm. In order to assess the performance of the model used by SMOS, called L-MEB (L-band Microwave Emission of the Biosphere), multi-angle airborne data at L-band from an Australian field campaign in 2006 (NAFE - National Airborne Field Experiment) were studied. The multi-incidence flights were conducted across a 75 km transect capturing a range of vegetation and soil moisture conditions at six observations days. The flights were flown alternating at 6 am and 6 pm local solar time. The primary airborne instrument aboard was the Polarimetric L-band Multibeam Radiometer (PLMR) which is capable of dual-polarized brightness temperature measurements at six different incidence angles. The multi-angle set up was based on a push-broom configuration of the sensor with all beams looking along the flight track, three forward and three backward. Supplementary instruments operated on the aircraft included a thermal imager, a tri-spectral NDVI scanner, an airborne laser scanner and a digital photographer. Additionally, near-surface soil moisture measurements, vegetation biomass samples and surface roughness profiles were collected concurrently in the morning and evening to support the airborne observations. Further climate data is available from three long-term monitoring stations that are aligned along the sampling transect.

In this research the L-MEB model was used to investigate the effect of varying roughness and vegetation conditions on the soil moisture retrieval algorithm. Moreover, the time of observation was studied in order to assess its influence on the model performance and soil moisture accuracy.