EFFECT OF FOREST CANOPY ON REMOTE SENSING SOIL MOISTURE AT L-BAND

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Global maps of soil moisture are needed to improve understanding and prediction of the global water and energy cycles. Accuracy requirements imply the use of lower frequencies (L-band) to achieve adequate penetration into the soil and to minimize attenuation by the vegetation canopy and effects of surface roughness. Success has been demonstrated over agricultural areas, but canopies with high biomass (e.g. forests) still present a challenge. Examples from recent measurements over forests with the L-band radiometer, 2D-STAR, and its predecessor, ESTAR, will be presented to illustrate the problem.

ESTAR and 2D-STAR are aircraft-based synthetic aperture radiometers developed to help resolve both the engineering and algorithm issues associated with future remote sensing of soil moisture. ESTAR, which does imaging across track, was developed to demonstrate the viability of aperture synthesis for remote sensing. The instrument has participated several soil moisture experiments (e.g. at the Little Washita Watershed in 1992 and the Southern Great Plains experiments in 1997 and 1999). In addition, measurements have been made at a forest site near Waverly, VA which contains conifer forests with a variety of biomass. These data have demonstrated the success of retrieving soil moisture at L-band over agricultural areas and the response of passive observations at L-band to biomass over forests. 2D-STAR is a second generation instrument that does aperture synthesis in two dimensions (along track and cross track) and is dual polarized. This instrument has the potential to provide measurements at L-band that simulate the measurements that will be made by the two L-band sensors currently being developed for future remote sensing of soil moisture from space: Hydros (conical scan and real aperture) and SMOS (multiple incidence angle and synthetic aperture). 2D-STAR participated in the SMEX-03 soil moisture experiment, providing images from the NASA P-3 aircraft. Preliminary results include images of the experiment site area near Huntsville, AL that included a mixture of forest and agriculture. Changes during a rain event further illustrate the issues presented by forests.

Work is continuing to reduce the 2D-STAR data and to support the two future remote sensing missions. Among the goals is to process the 2D-STAR data to create multiple looks (at the same pixel) with different incidence angles. Data in this format can be used to test algorithms for retrieving soil moisture and biomass such as are planned for SMOS. Also, the data are being processed to provide images at constant incidence angles such as will be obtained by Hydros. Although Hydros will have only one incidence angle, it will also carry an L-band radar. The goal is to use the radar to improve spatial resolution, an issue for remote sensing from space at the long wavelengths. Simultaneous observations with active and passive sensors also offers interesting prospects for treating areas of high biomass (forests) and irregular terrain and may be the challenge for the future.