Title: THE SOIL MOISTURE ACTIVE PASSIVE (SMAP) MISSION L-BAND RADAR/RADIOMETER INSTRUMENT

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In January 2007, the U.S. National Research Council (NRC) released the first decadal survey of Earth science, Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond. The Soil Moisture Active/Passive (SMAP) Mission was recommended to launch as one of the first in this series of missions. The science objectives of SMAP are to provide frequent, global measurements of surface soil moisture and surface freeze/thaw state.

To measure both soil moisture and freeze/thaw state at the required resolution, a combined active/passive L-Band microwave instrument is employed.
The key instrument requirements were determined by the SMAP Science Working Group to be: 1) Dual-polarization L-Band radiometer measurements at 40 km resolution, 2) Linear HH, VV and HV L-Band radar measurements at 3 km resolution or better, and 3) A wide swath to ensure global three-day refresh time for these measurements (1000 km swath at the selected orbit altitude of 670 km).

As a solution to this challenging set of requirements, a 6-meter, conically-scanning reflector antenna architecture was selected for the instrument design. The deployable mesh antenna is shared by both the radiometer and radar instruments by using a single L-Band feed. Whereas the radiometer resolution is defined in the standard manner as the real-aperture antenna footprint, the higher resolution radar measurements are obtained by utilizing synthetic aperture radar (SAR) processing.

As with most microwave instruments, the antenna is the dominant instrument subsystem that both determines the ultimate measurement performance and governs spacecraft accommodation. A variety of other antenna architectures were considered (phased array, separate antennas for radiometer and radar, etc.), but the rotating shared reflector approach was found to be optimum in terms of maximizing performance while minimizing implementation cost and risk. Although large deployable mesh antennas have been used in space-borne communication applications, this will mark the first time such technology is applied in a rotating configuration for high-resolution L-Band remote sensing. The key mechanical issues associated with maintaining pointing for this instrument architecture will be described.

Even with a six-meter antenna, at L-Band the real-aperture radar measurements will have a resolution on the order of 30-40 km at the SMAP orbital altitude. To improve the radar resolution to the required 3 km, a modified SAR processing scheme is employed. The unique aspects associated with extending standard SAR techniques to the conically scanning radar geometry will be addressed.

Spectrum considerations are a key concern with L-Band sensors making high-accuracy global measurements over the Earth's land surface is. For SMAP, this problem involves both 1) cases where these sources represent radio-frequency interference (RFI) contamination to either the pass or active bands, and 2) the situation where the SMAP spectrum selection must avoid causing interference with services that are critical to either national security or public safety. The environment, constraints, and novel mitigation strategies employed by the SMAP instrument will be discussed.

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