SMAPVEX16-MB objectives

Reducing risk to Canadians and enabling informed decision making, from individual decisions to government policy development, is supported by the availability of timely and accurate information. The impact of improved soil moisture monitoring extends to several areas of Canadian human and economic life and is of enormous value to Canadians. Timely, comprehensive and accurate soil moisture information leads to a better understanding of current and future weather, flood and drought risk, and better management of environmental and health issues. Improved monitoring and prediction of soil moisture conditions provides critical information needed to reduce liability from climate related extremes and target programs towards areas where they are most needed. In the agricultural sector, limited access to spatially detailed and high quality data on soil moisture across Canada significantly impacts the ability to deliver programs and policies to mitigate and respond to risk. Access to accurate and temporally frequent soil moisture data improves response to drought/excess moisture conditions, assists in the development and delivery of water management strategies and agricultural best management practices. Access to spatially distributed surface soil moisture can improve numerical weather prediction and air quality monitoring through an improved characterization of land surface processes. In hydrology, better knowledge of soil moisture can improve model predictions of surface runoff and ground water recharge, enabling better prediction of water availability, transport of contaminants and flood prediction. These improved predictions will bring social, environmental and economic benefits to all Canadians.

In June of 2010, a first field campaign (the Canadian Experiment for Soil Moisture in 2010 or CanEx-SM10) was conducted over sites in Saskatchewan. This was followed in 2012 by the SMAP Validation Experiment 2012 (SMAPVEX12) in southern Manitoba. Data collected during both these campaigns supported pre-launch validation and algorithm development for SMAP.

A post-launch SMAPVEX 2016 campaign will be conducted in Manitoba (SMAPVEX16-MB). This experiment has the following research objectives:

1. Investigate and resolve anomalous observations and products

Despite the encouraging results reported to date by the cal/val team, some discrepancies have been noted:

- SMAP retrievals often underestimate soil moisture as measured in situ;

- For some core validation sites, after rain events and as soils dry, SMAP estimates a faster rate of soil dry down relative to in situ measurements; and
- Errors tend to be higher for sites dominated by annual crops.

Of the core validation sites, the highest errors are observed for the Carman/Elm Creek site in Manitoba. In addition, the discrepancies listed above are all pronounced in the comparisons between SMAP retrievals and in situ observations, at this site. Thus, an important objective of the 2016 experiment will be to investigate and if possible mitigate the sources of these discrepancies. Although this Canadian site has the most pronounced differences, what is learned here will be of use for other calibration sites where annual crops dominant the land cover.

2. Improve up-scaling functions for core validation sites

The Agriculture and Agri-Food Canada (AAFC) Real-time In-situ Soil Monitoring for Agriculture (RISMA) network was installed primarily for validation of soil moisture products from RADARSAT-2. Specific station locations were selected via geostatistical analysis to capture soil texture variances in this region. This site served to capture diverse soil textures (and thus moisture) over a very small footprint with a dramatic break between heavy clays and loams/sandy loams. For the Carman/Elm Creek site, the up-scaling function developed by AAFC is based on a weighted average according to the soil texture fraction present in the SMAP core pixel. RISMA has proven well suited for validation of RADARSAT-2 soil moisture retrievals, yet was not designed with SMAP footprints in mind. SMAPVEX16-MB will provide an opportunity to test whether the AAFC approach to up-scaling is contributing to discrepancies between SMAP soil moisture retrievals and RISMA measured soil moisture and if so, to improve upon the current up-scaling approach.

3. Develop, validate and improve SMAP downscaling approaches

With the failure of the SMAP radar, options are being investigated to downscale SMAP passive microwave data. Methods being considered include the use of other active radar satellites (both C- and L-band), visible/infrared/thermal satellites as well as the use of products from land surface models. Data collected during SMAPVEX16-MB will be used to assess and improve upon these downscaling methods.

4. **Deployment of ground-based microwave instruments to better understand the spatial and temporal variances in soil and crop contributions to microwave responses**

Instruments to be included:

- L-band ground based radiometers and C-band scatterometer: These instruments will provide dense temporal measurements of emissions and backscattering coefficients under varying soil and crop conditions. Measurements will be helpful to validate SMAP radiometer data, to analyse the scaling effect on microwave measurements and on soil moisture inversion algorithms using ground, airborne, and satellite microwave data, and to investigate the combination of L-band radiometer and C-band scatterometer data for both soil moisture retrieval and disaggregation.
- UAV-mounted radiometer: flown over select fields/groups of fields to examine in a relative sense, landscape spatial variances in radiometer response

5. **Acquire data for ongoing validation of SMAP Level 2-4 products.**

Of specific interest to the Province of Manitoba (a significant potential user of SMAP data) is the validation of root zone soil moisture products.

6. **Contribute to broader science/application objectives to prepare for future satellite missions**

The scope of soils and crop data expected to be collected during SMAPVEX16-MB could support development of algorithms for information retrieval from future missions including the RADARSAT-Constellation (launch date of 2018), the NASA-ISRO SAR Mission (NiSAR), the Orbiting Carbon Observatory-2 (OCO-2), as examples. The “re-purposing” of SMAPVEX16-MB data for these missions is encouraged.

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