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Abstract Title

Multi temporal soil moisture retrieval using Synthetic Aperture Radar (SAR)

Abstract Text

In this study a method for retrieving accurate time series of near surface soil moisture (SM) from synthetic aperture radar (SAR) observation at multiple frequency is tested using time series of airborne L-band and spaceborne X-band data. Global and frequent SM observations are a scientific priority due to their crucial role in controlling land-atmosphere energy exchanges. Although space-borne passive microwave sensors currently achieve only modest resolutions (~40 km), SAR sensors can achieve very fine resolution (<10m), with the potential to provide SM mapping at scales relevant to agricultural applications such as irrigation management. One major limitation toward operational SM monitoring using SAR is the inherent difficulty in detangling the effect of SM and SR from the backscattered signal. Several studies have shown that the impact of surface roughness (SR) can be more significant than that of SM, depending on the sensor configuration and wetness conditions, resulting in an ambiguity between SM and SR for a given SAR measured signal. The ever increasing availability of dense time series of SAR observations has boosted the interest in using such multi temporal information to resolve such ambiguity. Moreover, since the microwave reflectivity depends on both surface parameters (SM and SR) and sensors parameters (frequency and polarization of the incident wave), concurrent observations at different frequencies and polarizations have the potential to further enable isolating the influence of SM on the backscattered signal. Although there is currently no space-borne SAR sensors with multi-frequency capabilities, the near future will see the availability of both L-band (1.26GHz) SAR observations from the Advanced Land Observing Satellite-2 (ALOS-2) and X-band (9.5GHz) observations from the TerraSAR-X and TanDEM-X platforms. Both platforms will have finer resolutions (<10m) and shorter revisit times (11-14 days) than achieved by the previous generation of SAR sensors and are therefore better suited to track SM changes. With a view to this forthcoming scenario, the objective of this paper is to assess the potential use of time series of L-band and X-band SAR observations in a time series approach to provide accurate soil moisture retrieval from global SAR observations. The time series method tested in this study is that proposed by [1]. The method assumes that SR properties are constant during the time series interval, so that only a single SR estimate is produced for the entire time series. The use of this single SR estimate as a constraint then drives the SM retrievals at each time step. The airborne, spaceborne and ground data used in this study were collected during the Soil Moisture Active Passive Experiment (SMAPEx) conducted from September 5-23 in a semi-arid intensive agricultural area in the Murrumbidgee catchment in south-eastern Australia [2]. Nine airborne flights were undertaken using the Polarimetric L-band Imaging SAR (PLIS, 1.26GHz, fully polarimetric) with a revisit time of 2-3 days.

Additionally, four TerraSAR-X/Tandem-X observations of the study area were available in two configurations, VV & HH at 37.8° (Sept 4 and 15) and VH & VV at 42.3° (Sept 9 and 20, see Figure 1). For the purpose of this study, L- and X-band observations were extracted over 34 bare agricultural plots ranging in size from 10 to 500ha and with varied tillage conditions, including rolled, harrowed, ploughed and seedbed. SAR observations were supported by ground monitoring of SM at 250m spacing conducted on each PLIS flight day. SR was measured once at 14 of the plots using 3-m long manual surface profilers. [1] S. T. Kim, L. Tsang, J. T. Johnson et al., “Soil Moisture Retrieval Using Time-Series Radar Observations Over Bare Surfaces,” Geoscience and Remote Sensing, IEEE Transactions on, vol. 50, no. 5, pp. 1853-1863, 2012. [2] R. Panciera, J.P. Walker, T.J. Jackson, D. Ryu, D. Gray, A. Monerris, Y. Yardley, M. Tanase, C. Rudiger, X. Wu, Y. Gao, and J. Hacker, "The Soil Moisture Active Passive Experiments (SMAPEx): Towards Soil Moisture Retrieval from the SMAP Mission ", Accepted for Publication in IEEE Transactions of Geoscience and Remote Sensing,2012.

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