Geophysical Research Abstracts
Vol. 21, EGU2019-6154, 2019
EGU General Assembly 2019

Assessing the influence of seasonal and minute-scale crop dielectric changes on Differential Interferometric SAR observables at L-, C- and X-bands

Manuele Pichierri (1), Virginia Brancato (2,3), Bernhard Rabus (1), Irena Hajnsek (4,5)

(1) Simon Fraser University, School of Engineering Science, Burnaby BC, Canada (manuelepichierri@gmail.com), (2) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, (3) University of California Irvine, Irvine, CA, USA, (4) Institute of Environmental Engineering, ETH Zurich, Switzerland, (5) Microwaves and Radar Institute, DLR Oberpfaffenhofen, Germany

Differential SAR Interferometry (DInSAR) exploits the phase difference of two non-instantaneous complex-valued SAR images to measure displacements of the Earth's surface. With respect to agricultural areas, DInSAR is influenced also by changes in soil and vegetation properties (e.g. vegetation biomass, soil roughness, plant structure) potentially occurring in between the non-instantaneous acquisitions. These structural and dielectric changes can introduce errors in the DInSAR estimated surface displacements of several centimeters (1-5 cm). The influence of soil and vegetation hydrodynamics on the main DInSAR observables (i.e. coherence and phase) remains, to date, poorly understood due to the lack of suitable interferometric observations. Single-polarization and/or single-frequency DInSAR measurements do not provide sufficient information to separate the influence of vegetation changes from soil roughness or moisture changes.

In 2014, an airborne F-SAR campaign conducted by the German Aerospace Center provided unique time series of repeat-pass fully-polarimetric SAR acquisitions in L-, C- ad X-bands over an agricultural area in Germany. This dataset is used to conduct quantitative research on the influence of soil and vegetation water changes on the DInSAR observables and elucidate the potential of DInSAR for estimating soil and vegetation properties.

The presented study has two main objectives. First, we investigate the relationship between seasonal variations of DInSAR observables and soil and crop parameters (i.e. soil moisture and wet biomass) and provide a first assessment of the potential of estimating such parameters using DInSAR. This investigation indicates that the L-band DInSAR polarimetric phase difference (HH-VV) over wheat, barley and rapeseed is significantly associated with wet biomass changes but mostly insensitive to changes of soil moisture or atmospheric water content. The wet biomass changes estimated with the DInSAR polarimetric phase difference are in good agreement with the collected ground measurements (coefficient of determination between 0.8 and 0.9).

Second, we assess the temporal evolution of minute-scale DInSAR phase and coherence to shed light on the influence of crop structural/dielectric changes on the DInSAR observables at this time scale. Results show that there is a pronounced early morning decorrelation over sugar beet (e.g. by up to 95% after 60 minutes in X-band) and a corresponding decrease of the optical path length, regardless of polarization, at a rate ranging from 0.5 cm/h in X-band to 1.5 cm/h in L-band. These trends, observed at all frequencies and polarizations but with different magnitudes are unlikely due to soil deformation or plant structural changes. Rather, they appear to be consistent with dielectric changes from moisture re-distribution. We suspect that the observed trends of the DInSAR observables reflect a decrease in the moisture content of both soil and vegetation owing to plant transpiration.

In summary, our findings draw attention to the effects of re-distribution of soil and vegetation moisture at different time scales on the estimation and monitoring of vegetation properties. Knowledge of these effects can be used to correct DInSAR displacement estimates obtained over agricultural areas. Additionally, our study results set the stage for a more extensive use of DInSAR as a tool for monitoring soil and plant hydrodynamic processes.