Analyses of soil moisture data with respect to climate change and natural hazard events

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Abstract

Soil moisture derivation based on remote sensing data is mainly done from radar data. The backscattering coefficient σ^0 measured by scatterometers depends on surface roughness and dielectric properties of the surface as well as look direction of the sensor. Since the dielectric constant is mainly influenced by the water content of a surface it represents an indirect measure for surface moisture. This quantity can thus be extracted while effects of surface roughness changes and vegetation influences can be corrected. The radar group of the Institute of Photogrammetry and Remote Sensing, IPF, at Vienna University of Technology derives daily soil moisture data from the satellites ERS-2 since 1992 on. The ERS Scatterometer data allows a near-daily global coverage at 50km pixel spacing. From this data surface soil moisture in the upper centimetre and the Soil Water Index (SWI) in the upper metre (both 0-100), based on a multitemporal change detection approach as presented in Wagner et al. 1999 and Wagner et al. 2003, is derived.

The 15 years SWI time series is extended about every three days, currently employing ERS-2 data and ready for feed of ERS-2 and METOP data simultaneously. It is the only globally existing soil moisture time series of this extent and additionally holds the advantage that it is not affected by cloud cover. This allows for the temporal detection of outstanding moist or dry regions and the overall analysis of soil- and surface moisture patterns. The data is provided by IPF to interested scientists and organisations via ftp free of charge.

Currently, scatterometer derived products at 50 km (ERS-2) and now 25 km (METOP) scale are mainly used within the scientific radar- and/or soil moisture community as well as for meteorological applications such as SVAT modelling within the meteorological sciences. However, the applicability of the available soil moisture data goes beyond these groups. We believe that soil moisture products can substantially support the observation of climate-change related phenomena and hazard phenomena, not necessarily detectable in optical remote sensing data. New fields of application will especially open up with the downscaling of existing soil moisture information to 1 km pixel resolution with approaches, currently under completion.

In this paper we present several example cases to demonstrate, how scatterometer derived soil moisture data reflects slow onset natural hazards such as global El Nino Phenomena or droughts as well as short term hazards such as floods. We could observe that most climate-change- or hazard related phenomena of larger spatial extent are clearly represented in the 15 year soil moisture data time series, as well as in the calculations of individual monthly or 10day or weekly anomalies with respect to the 15 year monthly-, 10day or weekly average. Especially in the context of flood monitoring and flood warning, soil moisture data holds a large potential not only for the observation of flood events but also for early warning strategies.

Keywords: natural hazards, soil moisture, time series, climate phenomena, ERS-2, METOP