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Global Land Surface Hydrology Monitoring using Sentinel-1: Opportunities and Challenges

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Since the beginning of the 1990s several spaceborne Synthetic Aperture Radar (SAR) instruments have been launched that demonstrated the high potential of this remote sensing technique for monitoring of hydrological land surface processes. Among the hydrological parameters that can be retrieved from SAR measurements are soil moisture, surface water extent and freeze/thaw state. Yet, the practical utility of SAR instruments has so far been very limited because their revisit time was too long and/or irregular in order to capture the highly dynamic hydrological processes. Probably most progress has been achieved using the Wide Swath (WS) and Global Monitoring (GM) modes of the Advanced Synthetic Aperture Radar (ASAR) on board of ENVISAT which provided over some regions (e.g. Australia, Siberia, etc.) several acquisitions per week. While still not fully optimal in terms of their spatio-temporal sampling and radiometric accuracy, these two ASAR modes have at least provided an ideal test bed to develop and demonstrate operational services for monitoring of surface waters, soil moisture and freeze/thaw state.

ENVISAT ASAR has thus prepared us for Sentinel-1, the first operational multi-satellite SAR mission that will provide frequent sampling (every three days in Europe, every eight days worldwide) at a high spatial resolution (5x30 m2) and short date latency (delivery of data products to users three hours after acquisition). Sentinel-1 would thus be ideally suited for developing a global data service that provides high-resolution water body, soil moisture and freeze/thaw maps in near-real-time to hydrologic services and related applications. Yet, despite the fact that there are rather robust algorithms for the automatic retrieval of all three hydrologic parameters, the technical challenges must not be underestimated. This is mostly due to the fact that each Sentinel-1 satellite will produce a raw data volume (Level 0 and Level 1) of about 1 Terabyte each day. Over the complete Sentinel-1 mission live time, just the raw data volume may thus reach 10 Petabyte. With each separate value-added data product, the data volume will at least expand by a factor of five to ten. This outstrips the capacity of even the largest current earth observation data centers. Recognizing that each service will not just consist of a near-real-time component but must include a reprocessing facility for regular updating and harmonizing of the historical data archive, the tremendous technical challenges towards the development of such a global Sentinel-1 land surface hydrology service become evident. Nevertheless, only through such a global, fully automatic approach the real utility of Sentinel-1 would be properly exploited, delivering standard products and services to a wide range of applications, including hydrologic forecasting, water resource management, agricultural yield monitoring, epidemiological monitoring, etc.