Satellite Altimetry over River Basins - Beyond Water Heights

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The unique contribution of satellite radar altimetry to river monitoring is well understood, with 'altimeter virtual gauge' heights increasingly ingested into river basin models. However, altimeters gather a wealth of additional information. Waveform shapes reflect underlying topographic variation, surface composition and roughness, and distribution of surface water within the footprint. Backscatter measurements allow soil surface moisture under the satellite track to be determined, using DRy EArth ModelS (DREAMS) crafted from multi-mission altimeter data and ground truth. Initially developed over desert areas, DREAMs are now being built over river basins to extend the scope of altimeter soil moisture measurement.

This paper investigates the potential contribution of these additional data to river basin analysis and modelling.

The following key questions are addressed.

1) How useful are the data encoded in complex waveform shapes?
2) Can altimeter soil moisture estimates contribute to modelling in river basins?

A series of example river basins were chosen in different topographic and climate situations, including the Amazon, Orinoco, Nile, Niger and Congo basins, and wetlands including the Okavango delta. This paper presents outcomes from analysis of multi-mission altimetry, with ERS-1/2, Envisat, Topex, Jason-1/2, Cryosat-2 and Sentinel-3A/B, plus a database of over 86,000 river and lake timeseries.

The analysis outcomes demonstrate the value of altimeter soil surface moisture estimates, both as co-temporal and co-spatial data with inland water height measurements, and as an independent validation dataset to assess soil moisture estimates derived from other remote sensing techniques. The precise backscatter cross-calibration of altimeters on successive missions allows derivation of long soil moisture time series. The ability of nadir-pointing altimeters to penetrate vegetation canopy gives a unique perspective in rainforest areas, with information on underlying water height and extent as well as surface soil moisture. Waveform shape classification allows diverse information to be gleaned, particularly at the higher pulse repetition frequencies of the new generation of SAR Altimeters. In conclusion, satellite radar altimeters collect a wealth of information over river basins; this valuable resource is not yet fully exploited.

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