Geophysical Research Abstracts, Vol. 8, 09887, 2006
SRef-ID: 1607-7962/gra/EGU06-A-09887

Quality of river water level time series issued from satellite radar altimetry : influence of river hydrology and satellite measurement accuracy and frequency

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Numerous works during the last fifteen years have shown the potential contribution of satellite radar altimetry for the monitoring of water levels of inland water bodies. Recently, various groups have dedicated large efforts to build data bases of rivers and lakes water levels ("Global reservoir and lake monitor" Project, "River and Lake" Project, "CASH" Project) derived from satellite radar altimeters (Topex Poseidon, ERS, Envisat, Jason).

Hydrologists generally require daily sampled time series of water levels for main rivers, with accuracy of a few centimeters. In order to use river water level time series issued from satellite radar altimetry, hydrologists need a standardized characterization of their quality. The overall quality of reconstructed time series depends on the combination of (1) satellite measurement accuracy (that depends on both river morphology and waveform retracking algorithms), (2) satellite effective sampling frequency and (3) hydrological dynamics of the natural river water level signal. This paper is dedicated to the analysis of the combination between these three main factors both on a theoretical point of view and through illustration on a few rivers.

Theoretical sampling periods of radar altimetry satellites range from 10 days (Topex Poseidon, Jason) to 35 days (ERS, Envisat). However, effective sampling periods over over rivers are quite often greater than their theoretical values, due to gaps in measurement series caused by limitations of the waveform retracking algorithms (for instance, over the Amazon basin Topex Poseidon shows a ˜40 to 50 days effective sampling period at low river stage). The satellite effective sampling period has an important

coupling effect with the natural observed temporal signal, as it does not allow the reconstruction of the high frequency part of the natural signal. Interpolating between sampled measurements induces errors in the reconstructed time series (temporal approach) that are linked with both the signal characteristics and the sampling period. A frequency approach is relevant to quantify this phenomenon : the hydrological behaviour of a river water level signal at a given location (depending on precipitation regime, hydrology of the upstream catchment, and local hydraulic conditions) can be characterized by its spectral signature and frequency bandwidth. As stated by the Shannon theorem, sampling of this signal at a low frequency induces information loss by spectral aliasing. Equivalence between the frequency approach (signal processing) and the temporal approach (hydrological) will be discussed. Additionnaly the presentation will demonstrate the coupled influence of satellite measurement accuracy and satellite effective sampling on the overall quality of the reconstructed time series, depending on the characteristics of river hydrology.

Application to a priori characterization of the quality of river water level monitoring from satellite radar altimetry for a given river/satellite configuration will be discussed.