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Statistical analysis of the accuracy of Satellite radar altimetry over rivers: Comparison of retracking algorithms

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Significant efforts have been dedicated, during the last ten years, to develop the application of satellite radar altimetry over continental water bodies: lakes, reservoirs, rivers, wetlands. Various groups currently provide water level time series for inland water bodies, derived from various satellites (Topex Poseidon, ERS, Envisat, Jason, IceSat) using various sets of retracking algorithms and expert systems. However, there is still a major gap in the characterization of the accuracy (or uncertainty) of these water level time series. While some optimistic figures are regularly announced, such as a 0.25m accuracy over large rivers, it appears that actual performances of satellite radar altimetry over large rivers do not, by large, reach these standards.

A statistical analysis of the performances (accuracy and time sampling efficiency) of satellite radar altimetry water level time series has been realized for various retracking algorithms over one hundred intersections between Topex Poseidon satellite tracks and the Amazonian hydrographic network (river width from 80m to 17 000m). The Amazonian hydrographic network presents a large diversity of river sizes and morphologies that allow a detailed and statistically significant analysis of radar altimetry performances. This statistical analysisis based on a standardized methodology for the quantification of the accuracy of satellite radar altimetry measurements through confrontation with in situ measurement data from hydrometric networks.

Results show that average accuracy (root mean square error) of the basic Topex tracking algorithm is of the order of 1.7 meter (from 0.3 to 5.6m): accuracy is better than

1.0m for only 21% of the river intersections and worse than 2.8m for 20% of the cases. Accuracy seems to be broadly correlated with the intensity of the back scanner coefficient (it increases - uncertainty decreases - when the backscatter coefficient increases). However, up to 6000m wide, the accuracy appears not to be correlated with river width. In general, for a given river section, the radar altimetry measurement error is not of Gaussian type: it appears to be structured according to the water level: while itdecreases down to 0.25m at high river stage (33% of the time) it currently exceeds 2.0m at low river stage with a systematic bias (satellite radar altimetry over estimating the actual water level at low river stage).

More generally, the performances of a given radar altimetry system (a satellite +a retracking algorithm or retracking expert system + a correction system (troposphere) + an extraction window strategy + a filtering system) can be represented as a cloud of 100 dots in a plan whose coordinates are uncertainty and sampling loss rate (rate of loss in sampling from the satellite theoretical sampling period). In such a representation, an improved radar altimetry system (for instance an improved retracking system) will drag the cloud towards a weaker uncertainty and sampling loss rate, thus enabling to quantify the gain in performances. Performances of 5 different retracking algorithms will be presented and compared.

Improving the performances of traditional satellite radar altimetry (nadir) over continental waters is a major challenge. Adopting a common standardized methodology and reference river network (for instance Amazon) to assess the performances of various techniques and retracking algorithms will help research and development teams to identify the main weakness and significant breakthroughs in their developments.