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Studying large river hydrology with no gauging data: Can altimetry satellites help in data-poor regions?

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Many large rivers (especially those in remote and dryland regions) have sparse or no hydrological gauging data. We explore whether altimetry satellites can provide a remote sensing approach to measure discharge at "virtual" gauging stations, where altimetry tracks intercept large rivers. Based on our evaluation of the Topex/Poseidon (T/P), Jason 1 &2, Envisat, GFO and ICESat platforms on permanent terrestrial water bodies (Lake Argyle and Lake Eildon in Australia), we found that some satellites (ICESat (operational 2003-2009) and Jason-2 "PISTACH" (Prototype Innovant de Système de Traitement pour les Applications Côtières et l'Hydrologie data (operational 2008 to present)) could deliver high accuracy data (RMSE vertical accuracies of 10-25cm.) for large channel and floodplain flows where the inundated area was at least 1km wide.
For six locations where Jason-2 tracks passed over the Cooper Creek and Diamantina River (Lake Eyre Basin), we installed water pressure loggers to evaluate the accuracy of Jason-2 PISTACH data during the 2011/12 wet season. While altimetry platforms are impacted by "edge" affects (e.g. trees), these large rivers where the inundated floodplain width can extend up to 65km is highly suited to virtual gauging by Jason-2 altimetry data. Across the six study sites , which included 49 satellite passes across the 2011-12 flood, we find a R2 between 0.90 to 0.98 (mean = 0.955) at the gauges we installed. The altimetry satellites provide continuous water level data at the resolution of every 10 days and reproduces the hydrograph from the water level loggers. The offset path (i.e. non-perpendicular to river channel) also gives important hydrodynamic data on downstream water surface slope. We conclude that altimetry satellite data across the legacy archive available from ICESat, and the Jason-2 data since 2008 is able to provide high accuracy (and near real-time) water level data that can be used for direct data assimilation and model calibration of (wide) channel and floodplain hydraulic models in areas with sparse or no gauging data.