Discharge of the river Rhine from multi-sensor data from empirical and physical methods

Luciana Fenoglio-Marc¹, Elena Zahkavova², Matthias Gärtner¹, Bahtiyor Zohidov¹, Salvatore Dinardo³, and Quang Duong⁴

¹University of Bonn, Institute of Geodesy, APMG, Bonn, Germany (fenoglio@geod.uni-bonn.de)
²Maynooth University of Ireland, Ireland
³CLS (Collect Localisation Satellites), Toulouse, France
⁴Bundesanstalt für Gewässerkunde, Koblenz, Germany

River discharge is a key variable to quantify the water cycle and its flux. This study focuses on the river Rhine, of width between 200 and 500 meters. River discharge is evaluated in this paper from the Sentinel-3 altimeter water level using various approaches, which are the empirical rating curve method, the semi-empirical Bjerklie method and the physically-based method based on hydraulic equations.

The Sentinel-3 GPOD ESA products from the SAMOSA+ retracker perform better than the standard Copernicus products that use the OCOG and ocean retrackers. Root-mean-square errors (RMSEs) between altimetry and in-situ stations are between 0.10 m and 0.30 m at 10 of the 17 virtual tide gauge locations. The empirical rating curve method applied to the altimetric water level and in-situ discharge provides estimates of the water discharge with accuracy of 3-7% (expressed as RMSE normalized with the mean of the discharge).

The performance of the semi-empirical Bjerklie method and of the physically-based Manning algorithm to estimate the river discharge is assessed from water surface slope, elevation and top width data for different part of the river and flow conditions. Firstly, daily synthetic water surface slopes and elevations are generated from selected in-situ gauges and mean top river widths. Secondly the input to the discharge algorithm comes from the 1D-hydrodynamic model Sobek. Various chosses for reach lengths and for number of observed time-series are considered. Different time sampling are used to study the effect of the repeat cycle of nadir altimeter and SWOT missions. The effect of the priori information on the accuracy of the flow water discharge is investigated.