Editing and Validation of Altimetry Water Surface Height Measurements over Rivers and Lakes

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Context:

• Rivers and lakes monitoring is indispensable for economic and societal stakes but remains a challenge due to the limited accessibility to upstream regions, the scarce repartition of in situ gauges and the limited dissemination of their measurements.

• Though the quality of their measurements over hydrological areas is significantly lower than over oceans, the existing **altimetry data allows a massive live and historical access to a wide network of information**.

• We developed an algorithmic approach to produce an as **exhaustive** as possible **database of Water Surface Height (WSH) virtual gauges** combining the SRTM land/water mask and high-resolution altimetry. This could supplement Theia - Hydroweb.

• **Assessing the quality** of our database and **providing WSH uncertainty estimations** is a major concern, we therefore propose a **methodology to edit and validate** these numerous records based on intra-mission comparisons and assess its performances by comparing it with another existing method.

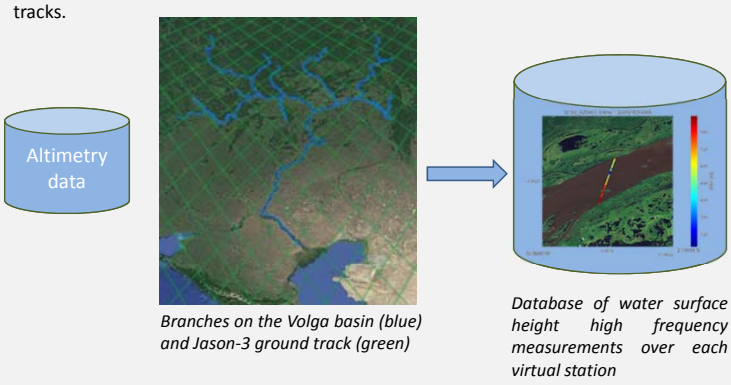
• In order to process recent data (e.g. Jason-2 interleaved, Sentinel-3A) we developed **an algorithm able to also deal with short time series** (< 1 year).

Database organization:

• Our software **automatically** produces a delineation mask of the river reaches over several main hydrological basins - using the SRTM Water Body Dataset mask.

• **Branches** are connected between each others at the nodes of an **organized tree**, providing a database of the basin structure.

•**Virtual stations automatically defined** at the intersections of branches and satellite tracks.



Branches on the Volga basin (blue) and Jason-3 ground track (green)

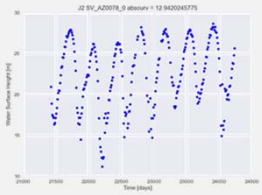
Database of water surface height high frequency measurements over each virtual station

Data compression:

• On a transect, several high frequency measurements (hereafter HR) are obtained.

• Compressed values are defined as the median over a transect for robustness.

• WSH time series are composed of compressed values for every virtual station.



Editing:

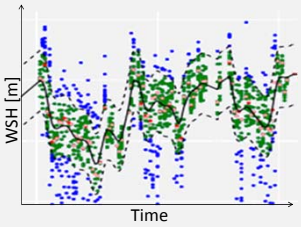
• WSH estimations can be contaminated by off-nadir distortions (e.g. nearby strongly reflecting surface).

• Erroneous HR measurements lead to wrong compressed value estimates within the time series.

• We developed a **method (*editing filter*) to detect and flag the HR measurements.** It is **applicable for** a large database containing **artificially regulated rivers**.

Details on the second step :

- 6 cycles (satellite repetitiveness) low pass filter on the compressed values → trend
-Compute residuals between the filter and the compressed values
- Build a 3σ template around the filter (σ stands for the residuals dispersion)
- Flag HR measurements off the template
- Re-compute compressed values
- Iterations stopped when σ < 50cm



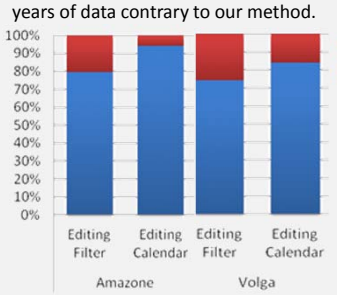
• Method **only requires a few cycles to be initialized**, which makes it attractive for an automated chain treating data from recently launched missions.

• Editing performed on HR data → allows not to flag a full transect

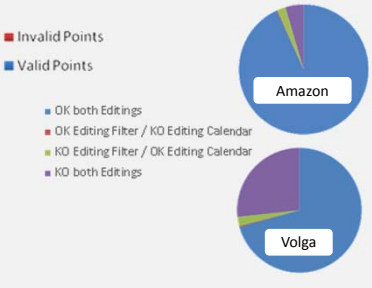
.. *Raw compressed series*
- *Filtered compressed series*
-- *3σ template*
.. *Flagged HR data*
.. *OK HR data*
.. *New compressed series*

Editing statistics:

Assessing of the editing performance : **comparing its results with those of a *calendar editing***. This latter was set up accordingly to reflect the method described in the Hydroweb handbook. One major difference is that calendar editing requires several years of data contrary to our method.



Ratio of Jason2 invalid to valid HR data over the different basins.



Ratio of Jason2 invalid to valid compressed data over different basins.

• Our editing filter presents **higher rejection rates on HR data** (20 - 25%).

• Despite more constraining HR editing, the **number of valid compressed points** is **close to the values obtained with the calendar editing**.

• **Highest selectivity of the filter editing → expected reduction of the uncertainties on compressed values**.

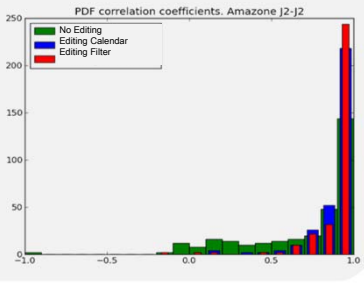
Editing validation:

• Rejecting outliers improves the consistency between close stations series.

• Physical quantity relating 2 stations is discharge, but for short enough branches the river morphology does not significantly vary between 2 stations.

→ Correlation between water surface height series along a same branch is expected to be improved after editing.

Estimator of the editing efficiency: probability density function (PDF) of the correlation coefficient between the temporal series belonging to a same branch.



• Editing strongly tilts the PDF towards higher correlation values.

= **Improvement of coherence** between virtual stations time series.

Conclusion and Perspectives:

• Editing filter method **does not require long time series**, allowing for fast **processing of recent missions data**.

• **The method might not be able to disentangle between erroneous measurements and physical water surface height anomalies** (e.g. important precipitations). Further developments including inter-station as well as inter-mission comparisons and use of In Situ measurements will be investigated.

References :
N. Bercher PHD thesis, 2008

Hydroweb : http://www.theia-land.fr/en/products/water-levels-rivers-and-lakes-hydroweb
Hydroweb Product User Manual