The "Sentinel-3 Hydrologic Altimetry Processor prototypE" project

SHAPE: Sentinel-3 Hydrologic Altimetry Processor prototypE

Corresponding author: pfabry@along-track.com

Pierre Fabry(1), Nicolas Bercher(1), Mònica Roca(2), Bernat Martinez(2), Joana Fernandes(3), Clara Lázaro(3), David Gustafsson(4), Berit Arheimer(4), Américo Ambrózio(5), Marco Restano(6), Jérôme Benveniste(7).

(1) Along-Track - (2) IsardSAT UK - (3) Univ. Porto - (4) SMHI
(5) Deimos/ESRIN - (6) Serco/ESRIN - (7) ESA-ESRIN.

The Project

Outline

The SHAPE project is funded by ESA through the Scientific Exploitation of Operational Missions Programme Element to prepare for the exploitation of **Sentinel-3** data over the inland water domain (**water heights** and **discharge**).

Objectives

- Characterise CryoSat-2 SAR data over inland water.
- Assess the performances, in Hydrology, of applying the Sentinel-3 IPF to CryoSat-2 data and emulating repeat-orbit Alti-Hydro Products (AHP).
- Analyse weaknesses of the Sentinel-3 IPF at all levels.
- Assess the benefits of assimilating the SAR/RDSAR derived AHP into hydrological models.
- Design innovative techniques to build and/or to refine the L1B-S and assess their impact onto L1B and AHP.
- Improve SAR/RDSAR retracking over river and lakes.
- Provide improved L2 Corrections (tropospheric, geoid) for Sentinel-3 over land and inland water.
- Specify, prototype, test and validate the Sentinel-3 Innovative SAR Processing Chain for Inland Water.

Timeline

- *Past Milestones*: KO (2015-09), Scient. Req. R (2016-02)
- *Future Milestones*: Mid Term Review (2016-12),
- Acceptance Review (2017-06), Final Review (2017-09)

Team

Along-Track : Prime, Alti-Hydro, Innovative Signal Proc., Production and use of Updated Water Masks, Retracking.

isardSAT : Innovative SAR Altimetry Chain, Retracking.

SMHI : Assimilation of AHP into Hydrological Models.

University of Porto : Atmospheric and Geoid Corrections.

Regions and Time Periods of Interest

- Amazon (downstream): 2015-03→2016-02, Baseline C.
- Danube: 2015-03 → 2016-02, Baseline C.
- Brahmaputra: 2014-10 → 2015-09, Baseline C.
- Vänern lake: 2015-03 → 2016-02, Baseline C.
- Titicaca lake: 2015-03 → 2016-02, Baseline C.

Project Website

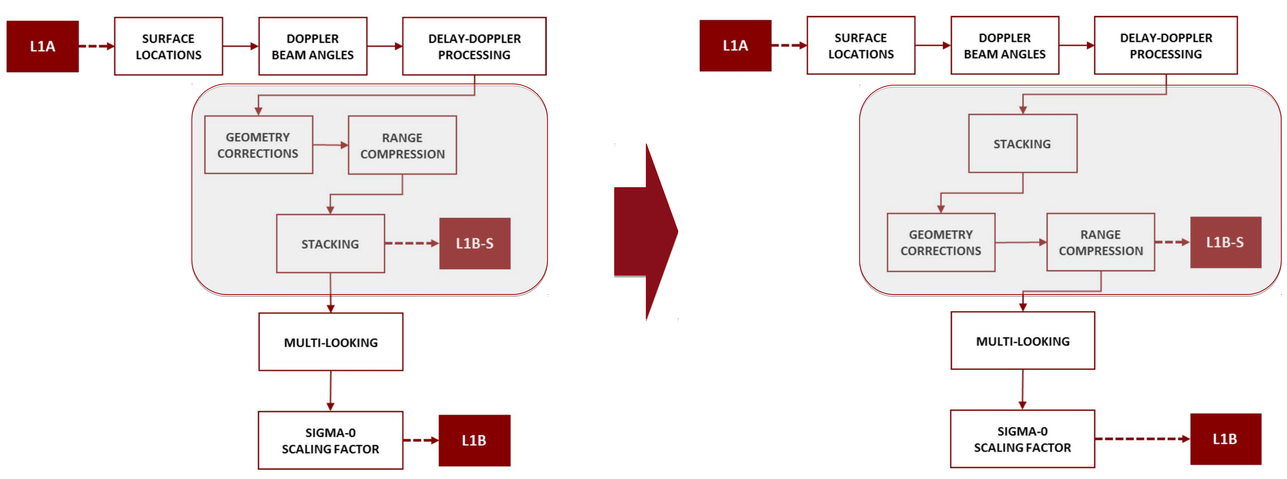
Documents & demo products to be available at

http://projects.along-track.com/shape/

New Delay-Doppler Altimetry Processor

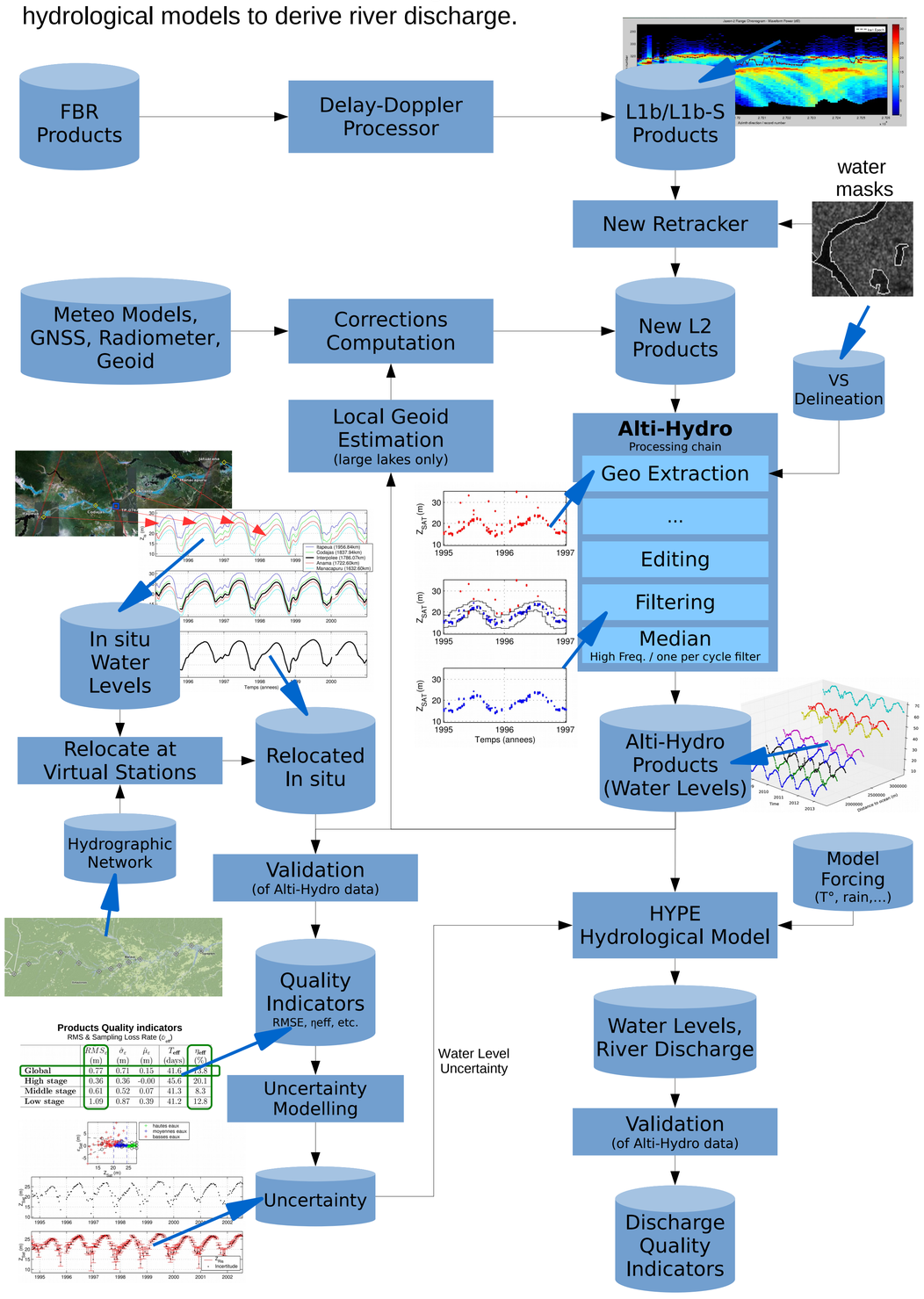
Change of architecture compared to previous altimetry SAR L1B processors

As this is done for Sentinel-6, the SHAPE processor will apply all corrections to surface-referenced echoes, instead of satellite-referenced. This is to help validation & verification processes and the incorporation of improvements in the stack generation. It is complemented by several innovative processing options such as the number of points and the use of roughness-related parameters for surface interpolation as well as a water mask driven placement of Doppler ground cells.



SHAPE Processor Overview

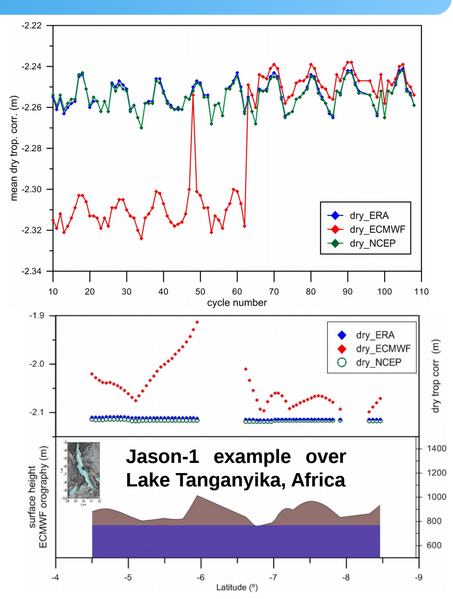
The SHAPE Processor implements all of the steps necessary to derive rivers and lakes water levels and discharge from Delay-Doppler Altimetry and perform their validation against in situ data. The processor uses FBR CryoSat-2 data as input (and will switch to Sentinel-3A data whenever possible) and various ancillary data (proc. param., water masks, L2 corrections, etc.), to produce surface water levels. At a later stage, water level data are assimilated into hydrological models to derive river discharge.



L2 corrections & Alti-Hydro Processing

L2 corrections

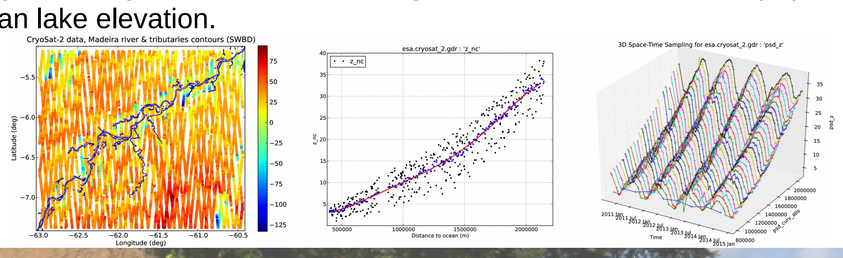
Over regions with GNSS or MWR the GNSS-derived Path Delay Plus (GPD+) algorithm is used to calculate an enhanced Wet Tropospheric Correction (WTC). Otherwise, model-derived WTC computed at lake or river height must be used. Model-derived Dry Tropospheric Correction (DTC) and WTC present on all altimeter products used in the project will be analysed by U. Porto to identify potential problems and to mitigate them, e.g., DTC height dependence (2.5cm/100m) may induce errors into altimetry products if the correction is provided at sea level instead of at surface height (top). Interpolation also introduce "V-shaped" errors of centimetre level (bottom).



Alti-Hydro Processing

For rivers, SHAPE implements the migration of CryoSat-2 measurements along the river path to mimic Sentinel-3A tracks pattern or to feed models at desired inlets. For lakes, the local geoid height is estimated using SHAPE + LRM altimetry prior computing the mean lake elevation.

Map of altimetry data (left) ; mean river profile (centre) used to migrate altimetric measurements to arbitrary places along the river path (right).

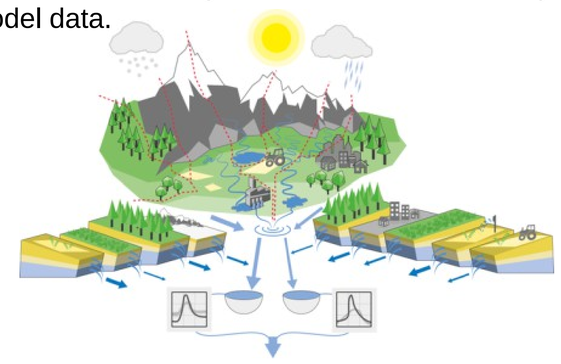


Hydrologic Modeling

The HYPE Model

The HYdrological Predictions for the Environment model (HYPE) is a semi-distributed multi-basin hydrological model developed and used for research and operational purposes by SMHI:

- Runoff from land calculated from meteorological inputs is routed through a lake and river network, as represented by the hydrography information.
- Water level in lakes and in rivers are transformed to discharge through empirical rating curves.
- Water level is the state variable which will be used to assimilate the altimetry data.
- The hydrography (sub-basin delineation, lake mask, river network and in situ data locations) is essential for successful integration of satellite altimetry and model data.



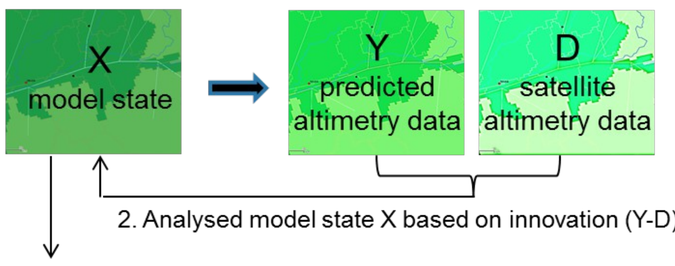
Visit http://hypeweb.smhi.se for more details.

Assimilation of Altimetry data

Assimilation into hydrological models provides a way of utilizing the full potential of the satellite altimetry data for transformation into river discharge, avoiding the need for co-located in situ data for rating curve establishment and frequent revisits at fixed locations:

- Altimetry data is assimilated into HYPE to correct the simulated water level and provide updated discharge calculations.
- Ensemble Kalman filters and/or Particle filters will be used as data assimilation techniques.
- The application of the 'observation operator' is the most crucial step, to bridge the gap between the spatial and temporal representation of the model and the satellite data.

1. Predicted model state X is transformed to predicted observation Y



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