First results of the CCI River Discharge precursor project

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https://climate.esa.int/fr/projects/river-discharge/

Objective: Proof-of-concept of a river discharge Essential Climate Variable (ECV) product ➔ long term (at least from 2002 to 2022) river discharge time series at selected locations from satellite nadir altimeter data, multispectral images, and ancillary data

Duration: Phase 1 (Feb. 2023-Oct. 2024) / Phase 2 (Nov. 2024-Dec. 2026) - **Science lead:** S. Biancamaria ([1]CNRS-LEGOS) - **Project manager:** P. Mourot ([2]CLS)
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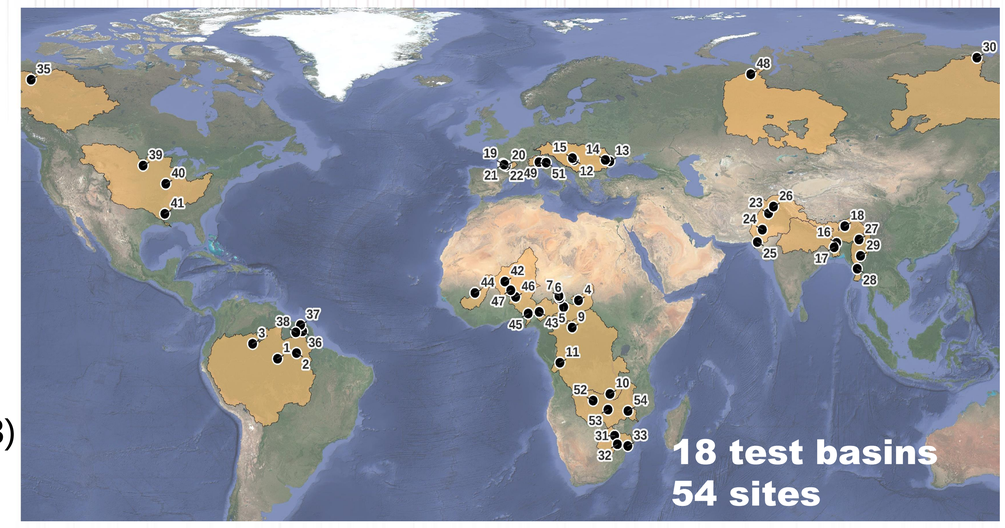
Requirements, test sites and data

Threshold requirements from interviewed users:

At least 20 years' time series (from 2002-2022) at EO observation sampling dates, over 18 river basins (with different climatic zones and anthropization, include exorheic and endorheic basins), sites should cover the basin outlet and different drainage area.



Earth Observation satellite data

- Water Surface Elevation (WSE) from nadir altimeter (ERS-2, Envisat, Saral, Topex/Poseidon, Jason-1/2/3, Sentinel-6A [S6A], S3A/B)
- Reflectance index btw dry/wet pixels from multispectral images (Landsat-5/7/8/9, MODIS, S2/3)
- River width (MODIS, Sentinel-2) – new in phase 2

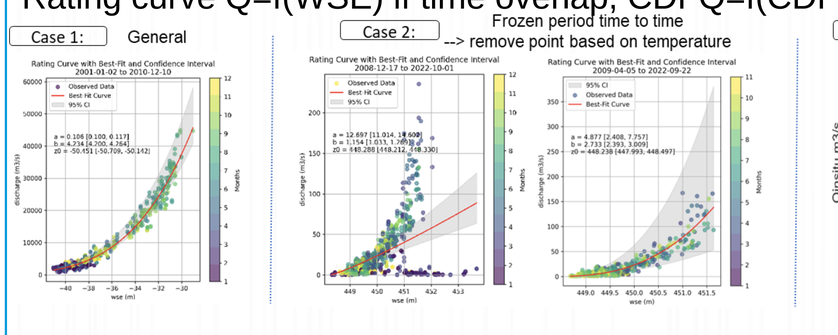
In situ discharge data

Daily discharge from international/national open databases: GRDC, AIPo, HydroPortail, SO-HyBAm, HYDAT, ArcticGRO, RivDIS, USGS

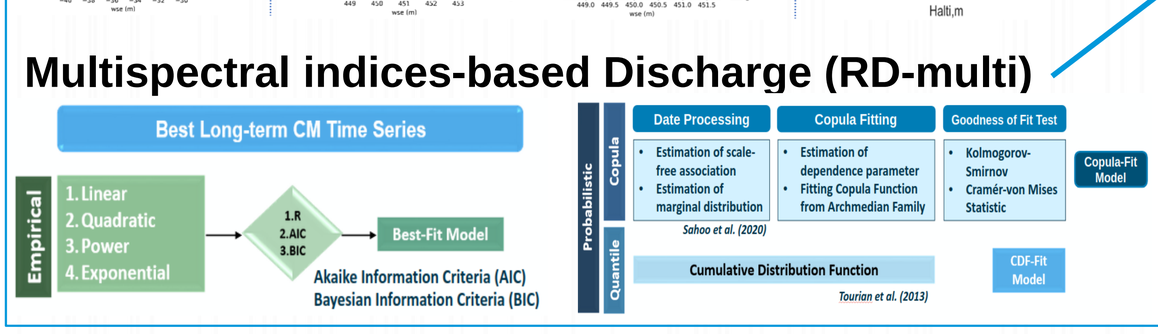
River Discharge (RD) products

Altimetry-based Discharge (RD-alti)+uncertainties

Rating curve Q=f(WSE) if time overlap, CDFQ=f(CDFWSE) otherwise



Multispectral indices-based Discharge (RD-multi)



River width-based Discharge (RD-width)

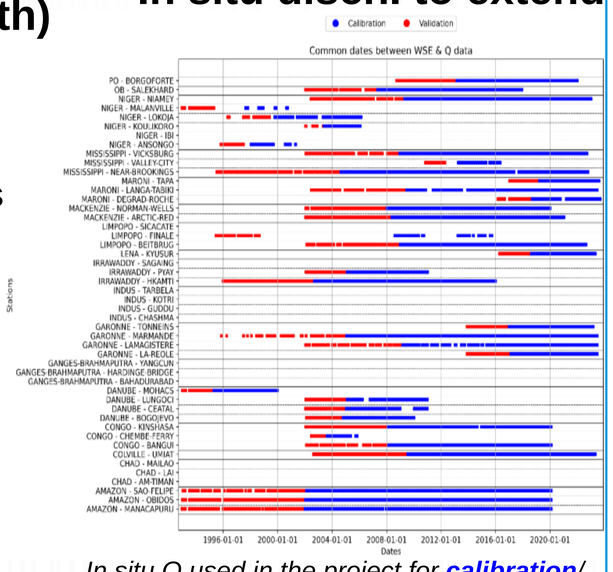
- Derived river-width, apply specific algorithm and computations to avoid errors
- Using nonparametric quantile matching approach to estimate river discharge and its uncertainty

Merged Discharge (RD-merged)

Multiple approaches have been tested:

- Combining alti. WSE with multispectral indices converted to equivalent WSE (with a Copula approach) + rating curve (mergedL2)
- Combining RD-alti and RD-multi (mergedL3)

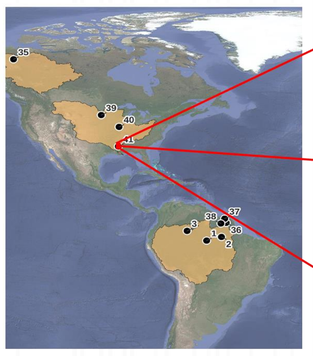
In situ disch. to extend

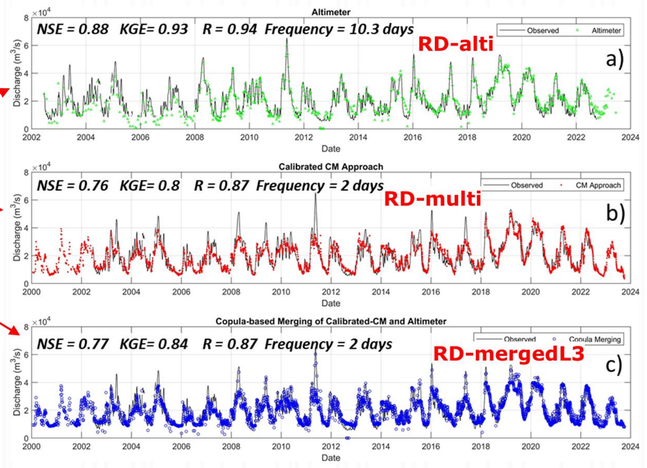


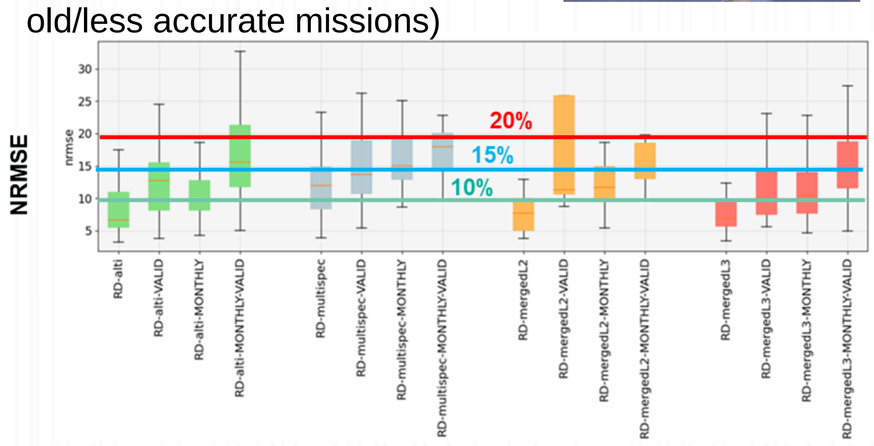
*In situ Q used in the project for **calibration**/ **validation** (31 locations/54) + 19 locations with discharge before EO data (+ 4 locations without in situ discharge -> no RD computed)*

Results and validation

- Validation on val. periods + 16 independent in situ time series
- Better results with RD-alti, still very good results with RD-multi (NRMSE<13.5%, KGE>0.75) -> compliant with GCOS threshold requirements on river discharge ECV (statistics largely affected by old/less accurate missions)







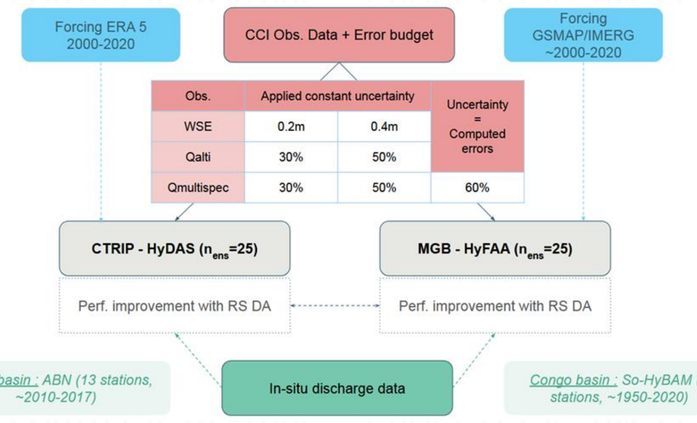
- Round robin:

	RD-alti	RD-multispec	RD-mergedL2	RD-mergedL3
Format				
Temporal resolution				
Spatial coverage				
Error				
Uncertainty				
Trends and variability				
Total	16	14	12	16

4 points | 3 points | 2 points | 1 points

- First climate assessment:
  - CCI RD products show high capacity to represent long-term changes. Significative trends identified at 36 locations, 82% of them confirmed by similar trends in CCI SSM
  - 60-80% of recorded flood-related hazard events in the in situ data could be identified with these precursor CCI_RD products,
  - CCI RD products time series are able to represent well both drought and wet periods

Use case: Assimilation in large-scale hydrology models



- Models= ISBA-CTRIP and MGB; Method = EnKF; Basins = Congo and Niger; Assimilated observation = RD and WSE from CCI products
- Assimilating Q and WSE improves significantly modelled river discharge at each locations, less impact on the rest of the river network
- Balance btw data quality and temporal density is crucial -> need to increase locations with RD products

New in phase 2: river width-based RD product, improve algorithms, add uncertainties, densify locations with WSE, 2 new use cases (benefits of SWOT; impact of river plumes in coastal waters)

WSE & discharge products available: https://dx.doi.org/10.5285/c5f0aa806ec444b4a4209b49efc4bb65 (WSE), https://dx.doi.org/10.5285/44c930e1388f40728884fbdf7e28c109 (RD-alti), https://dx.doi.org/10.5285/a8422dd3766c447d8b5fa80920649f31 (RD-multi) https://dx.doi.org/10.5285/d32244e674dd438ca4d321560daad755 (RD-merged)

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