

# Quality and uncertainty of satellite derived river water level time series

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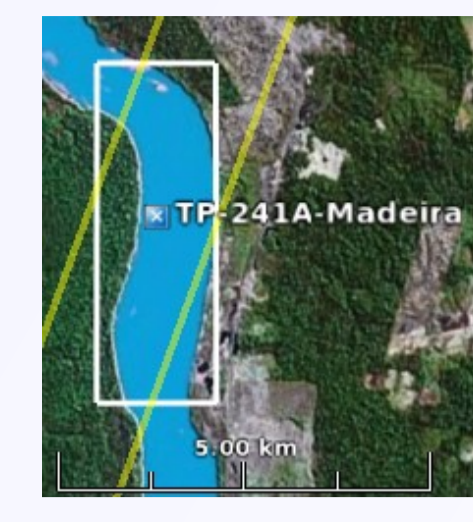
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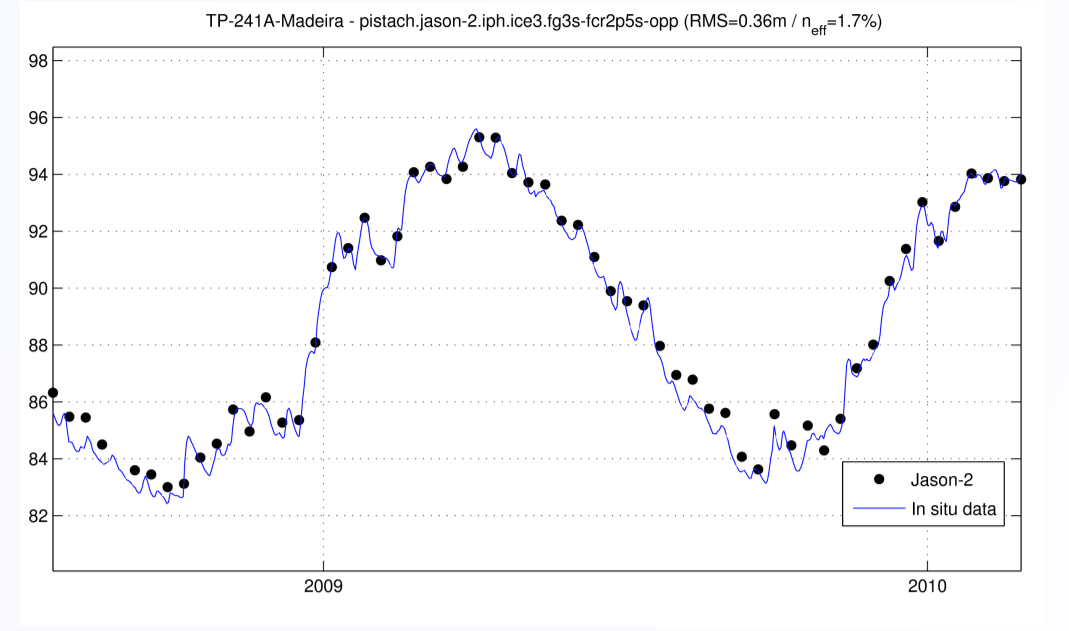
## 1. Introduction & context

During the last 20 years, satellite radar altimetry data have been intensely used to derive river water level time series in order to elaborate "Alti-hydrological Products" (CASH, River and Lake and PISTACH projects, HydroWeb database, etc.). They provide a high value information for river monitoring at global scale and an interesting complement to in situ measurement networks.

The present study proposes a standard method to assess the quality (accuracy & sampling efficiency) of satellite derived river water levels. Moreover, uncertainty outputs can be computed (based on error quantification) and combined into water level products, thus making useful data sets for end users.



Virtual station: Madeira river, Amazon basin, Image Google Earth<sup>®</sup>



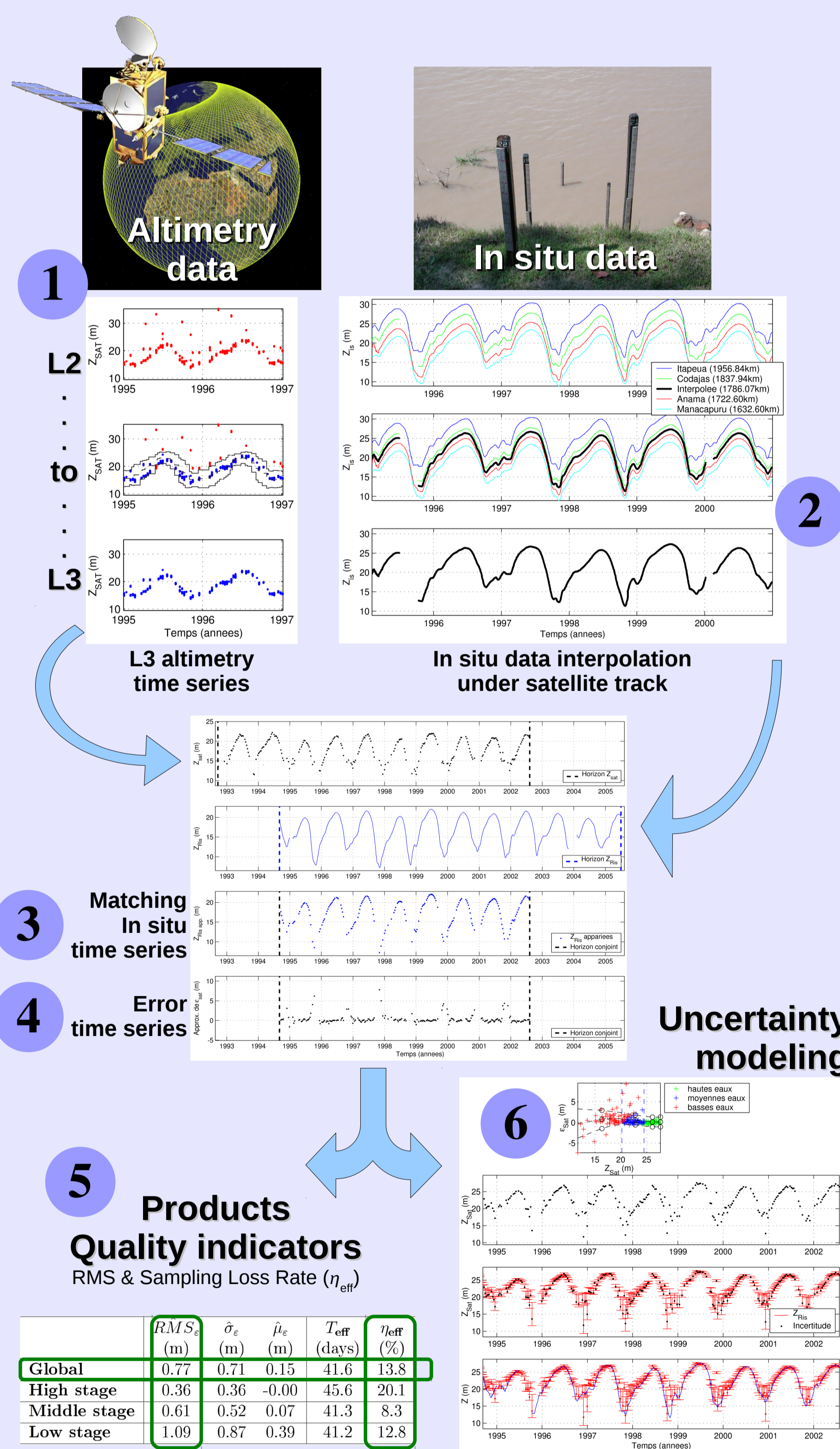
Extracted, edited & filtered Jason-2/PISTACH (ice3) time series at Madeira river virtual station, Amazon basin.

## 2. Standard method for quality and uncertainty estimation

The "standard method" allow to estimate quality (accuracy and sampling efficiency) and uncertainty of satellite derived river water levels time series for a wide variety of sites (track / rivers crossings) for statistical significance.

- (1) "Level 3" product for hydrology: satellite water level time series are extracted within geographical windows.
- (2) Interpolated in situ river water level time series where satellite tracks cross rivers.
- (3) Spatio-temporal matching of satellite & in-situ water level time series.
- (4) Error time series (satellite (1) minus in-situ (2) measurements).
- (5) Quality indicators of error time series: accuracy (RMS) and sampling loss rate ( $\eta_{eff}$ ).
- (6) Uncertainty models build to estimate satellite measurements uncertainty bars.

Finally, satellite "measurements + uncertainty" can be used as an input for hydrological models (see fig. A, panel 3).



## 3. Applications & results

The method have been applied on a wide variety of "Level 2" products (AVISO M-GDR, CASH Ice2, PISTACH) and "Level 3" products (River & Lake, HydroWeb) including ERS-2, ENVISAT, Topex/Poseidon and Jason-2 missions.

Products were extracted and characterized on tens of virtual stations (typically ~80) over the Amazon basin.

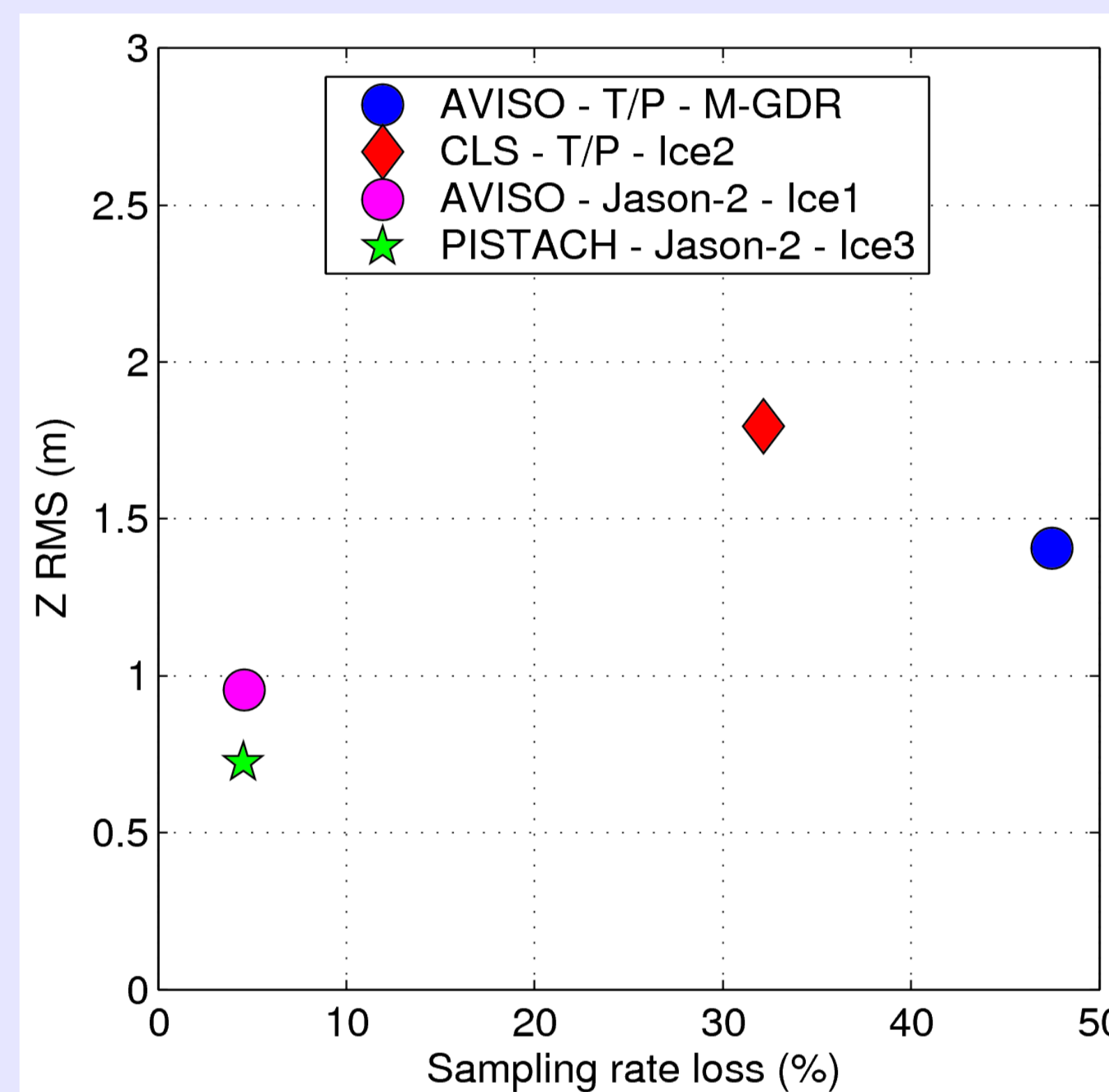
Multiple L2 to L3 scenarios are processed (different filtering chains, etc.), best results only are taken into account for the presented comparisons.

Indicators pairs (RMS ; Samplig Loss Rate) are computed for each of these extractions.

Mean indicators, mean RMS (m) vs mean Sampling Loss Rate (%), are used to represent synthetic quality results, see figures B1, B2 and C.

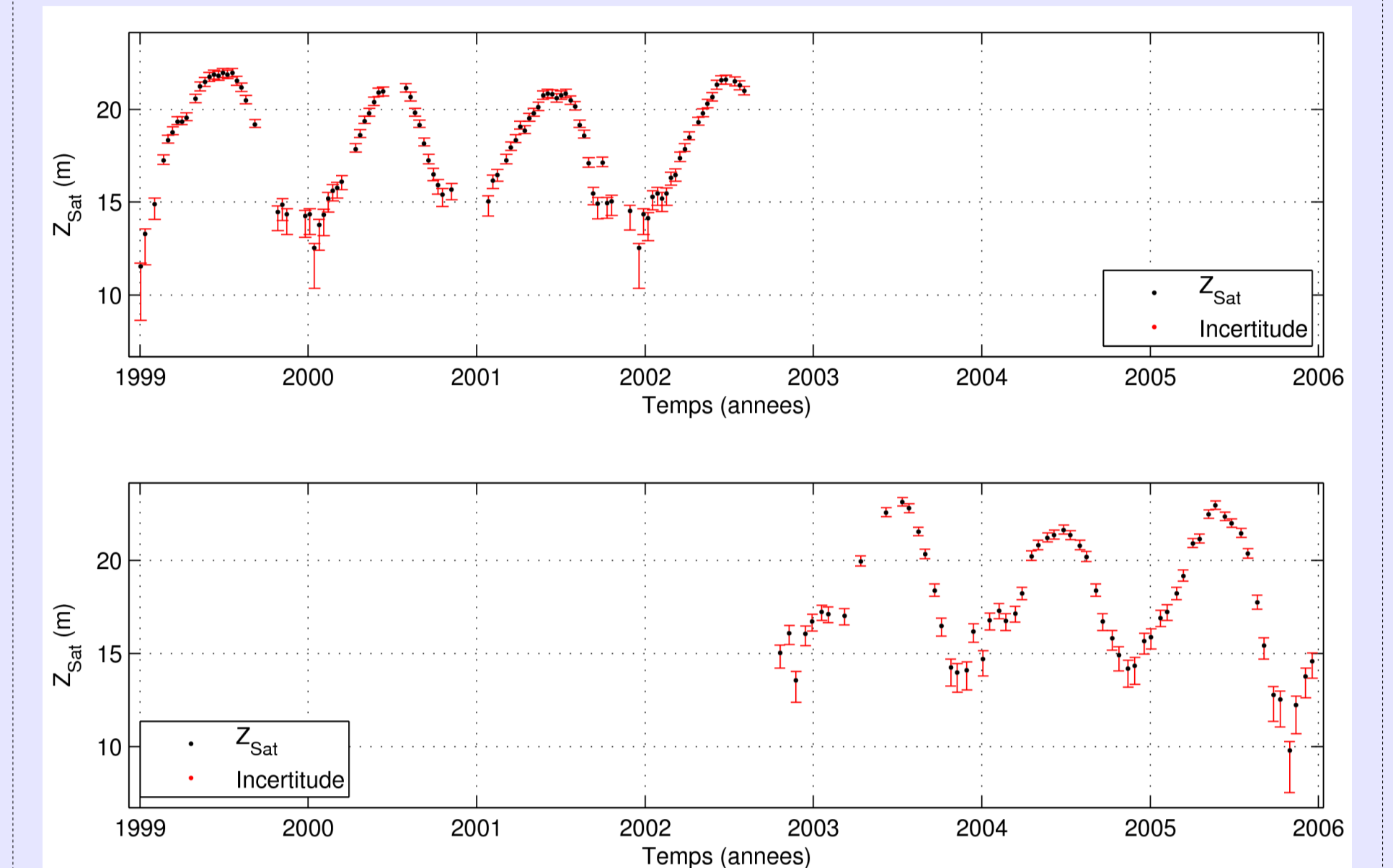
### B1. Performance comparison

Comparison: same orbit, same 55 sites (Amazon basin)



### A. Measurements uncertainty bars

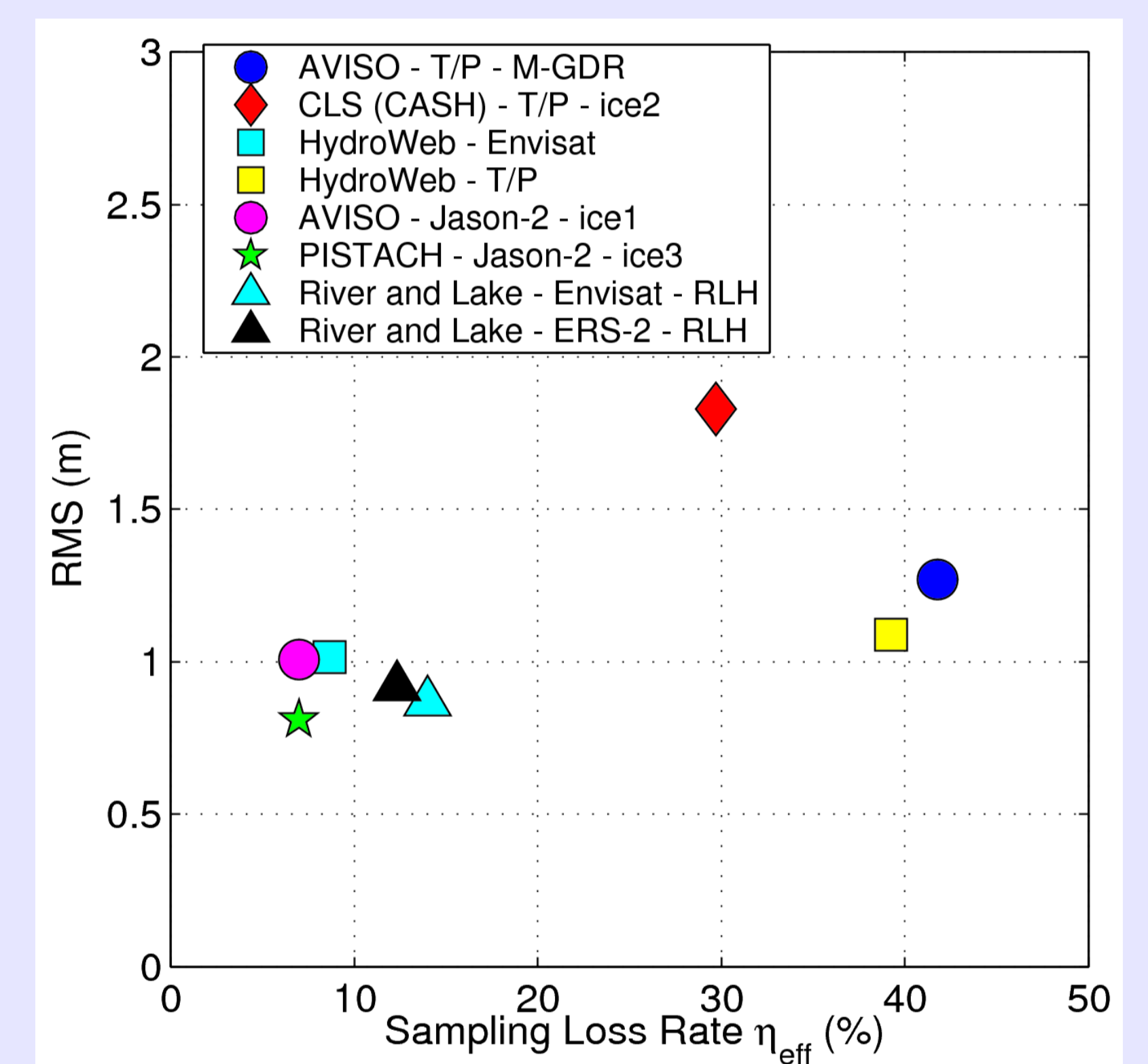
Satellite measurements error results allow uncertainty modeling and uncertainty bars estimation.



Topex/Poseidon (top) & ENVISAT (bottom) times series over the Solimões river with uncertainty bars.

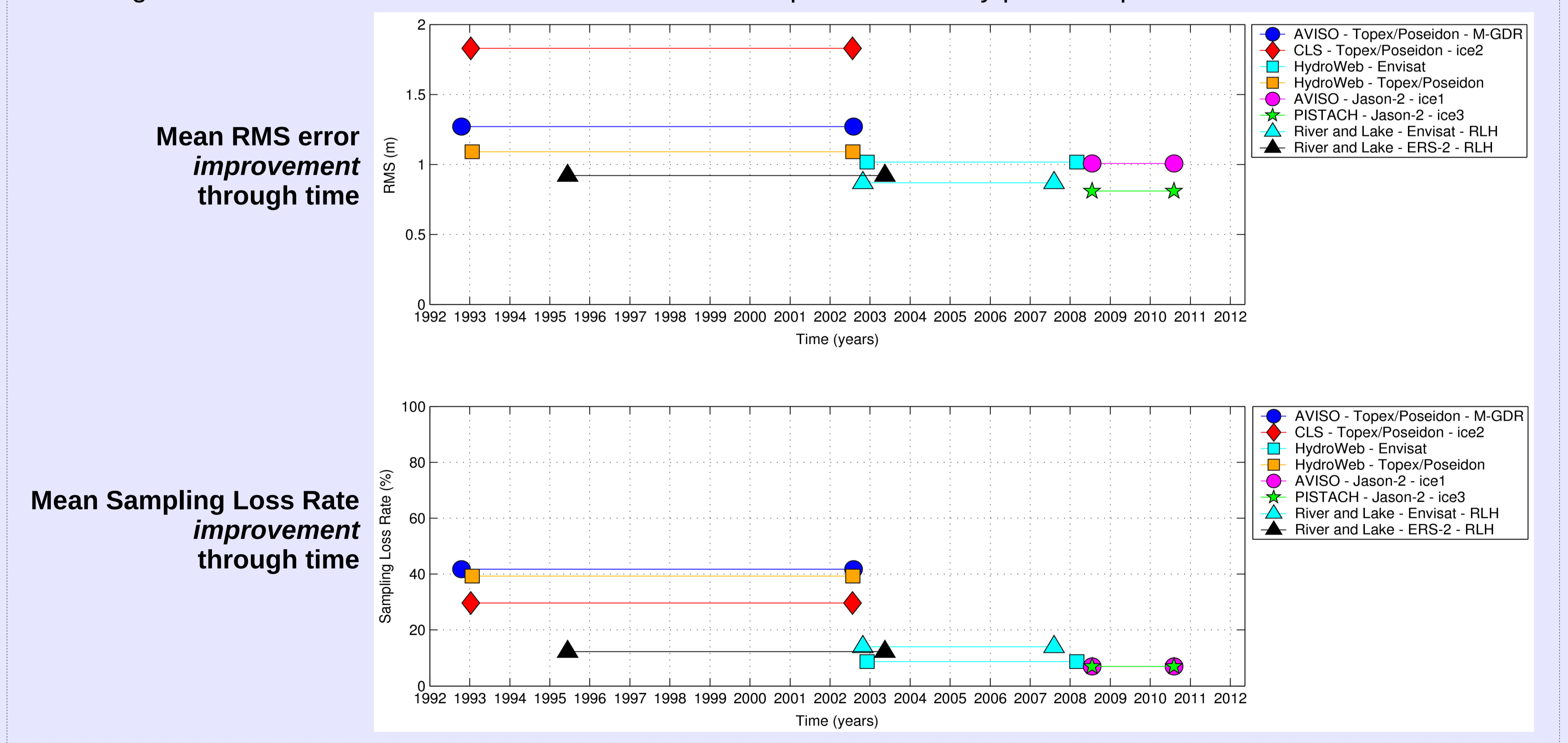
### B2. Thematic comparison

Aptitude to monitor ~2400km of Amazon & Solimoes



### C. "18 years of progress in radar altimetry for rivers monitoring..."

Monitoring of Amazon and Solimões rivers results for most important altimetry products processed



## 4. Conclusion & perspectives

- The presented method allows to estimate quality & uncertainty of "Level 3" Alti-Hydrological Products
- It produces uncertainty models and uncertainty bars: qualified products for hydrological models, etc.
- Overall results show encouraging progresses of satellite measurements quality for large rivers monitoring, recent missions such as Jason-2 (PISTACH, ice3) provides impressing results: RMS=0.07m at best
- Future works & perspectives: mixed multi-mission / in situ datasets, better uncertainty modeling, improvement of "Level 2" to "Level 3" processing, validation over Niger basin, dynamic web services for end user data delivering.

## Acknowledgments

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- Satellite data from AVISO (Topex/Poseidon, Jason-2), HydroWeb (Topex/Poseidon, ENVISAT), River & Lake project (ERS-2, ENVISAT), CLS (CASH) and the PISTACH project (Jason-2).
- Amazon basin in situ water levels provided by ANA (Agência Nacional de Águas), Brazil.

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