

# Time series over the Brahmaputra and Ganges rivers from Envisat, CryoSat-2 and SARAL/AltiKa altimetry

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## 1. Motivation

Satellite-derived river levels serve many different purposes, such as:

- ❖ Hydrological modeling.
- ❖ Water resources management.
- ❖ Climate change detection.
- ❖ Development of warning systems.

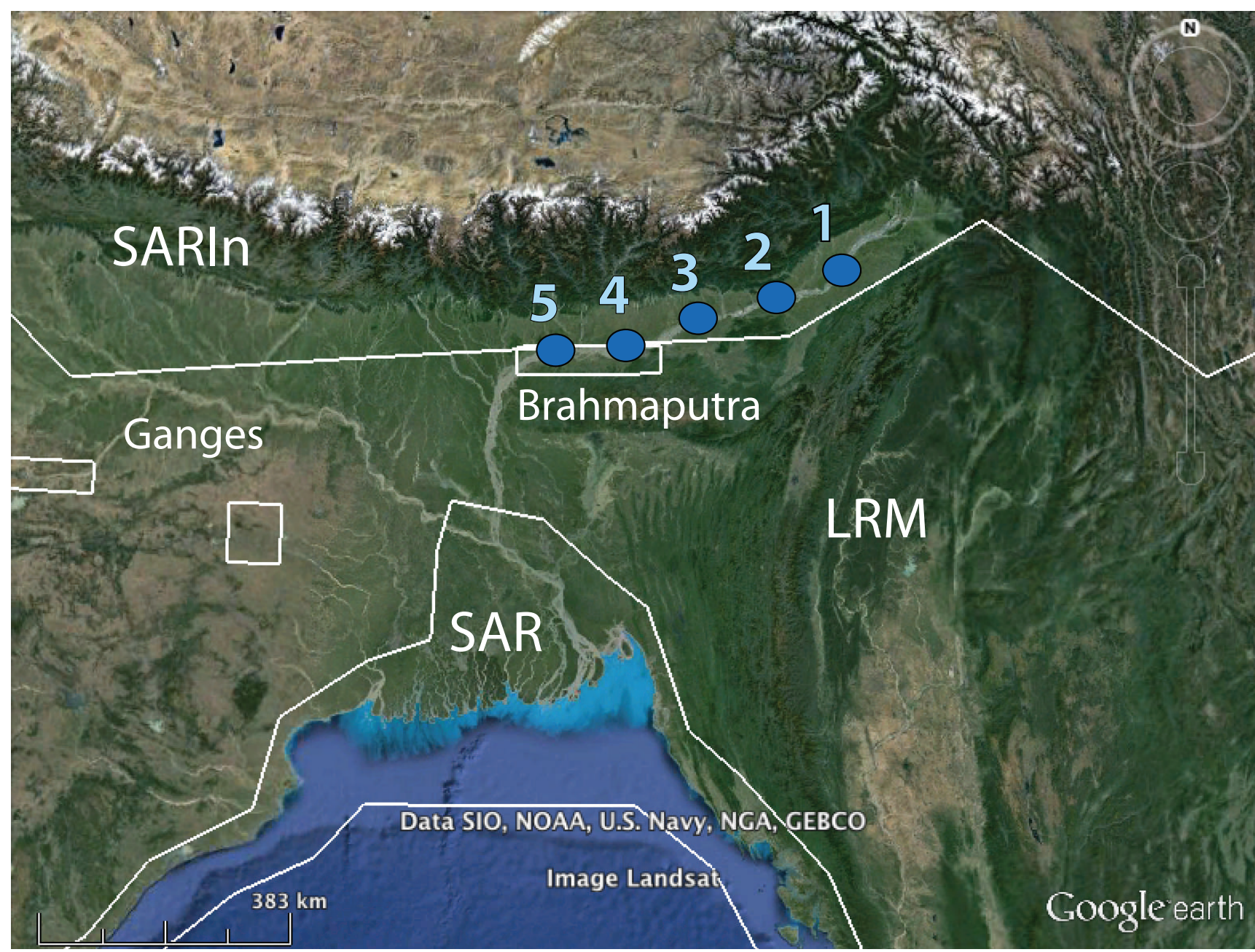
A key concern of the CryoSat-2 orbit has been its long repeat period of 369 days, which is usually too long for river and lake monitoring. In order to evaluate the possibilities of CryoSat-2 altimetry for inland water monitoring time series were constructed and compared with Envisat and SARAL/AltiKa time series.

Previous projects such as ESA River & Lakes, HYDROWEB, and GLRM have provided time series of inland water altimetry river levels. However, none of these include CryoSat-2 data.

## 2. CryoSat-2 data

Here, only the results from the SARIn data are shown. Similar results were obtained in the Ganges River, where the altimeter operates in SAR and LRM mode.

The mode mask of the SARAL altimeter is seen below together with the locations of the virtual stations.



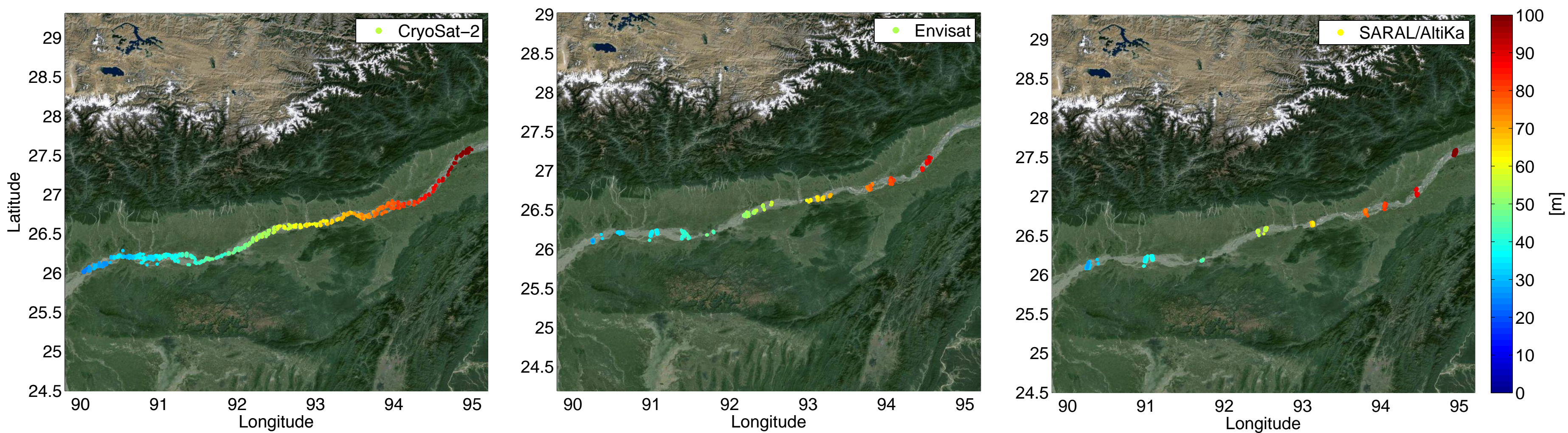
CryoSat-2 mode mask and locations of chosen virtual stations. The virtual stations (VS1—VS5) are shown as blue dots.

## 3. Data processing

- ❖ **Retracking:** Envisat and SARAL/AltiKa: ICE-1  
CryoSat-2: threshold retracker.
- ❖ **Masking:** All retracked heights are masked using the MOD44W land-water mask.
- ❖ **Referencing:** All heights presented here are referenced to EGM2008.
- ❖ **Relocation of track means:** The mean for each track is relocated to the designated virtual station.

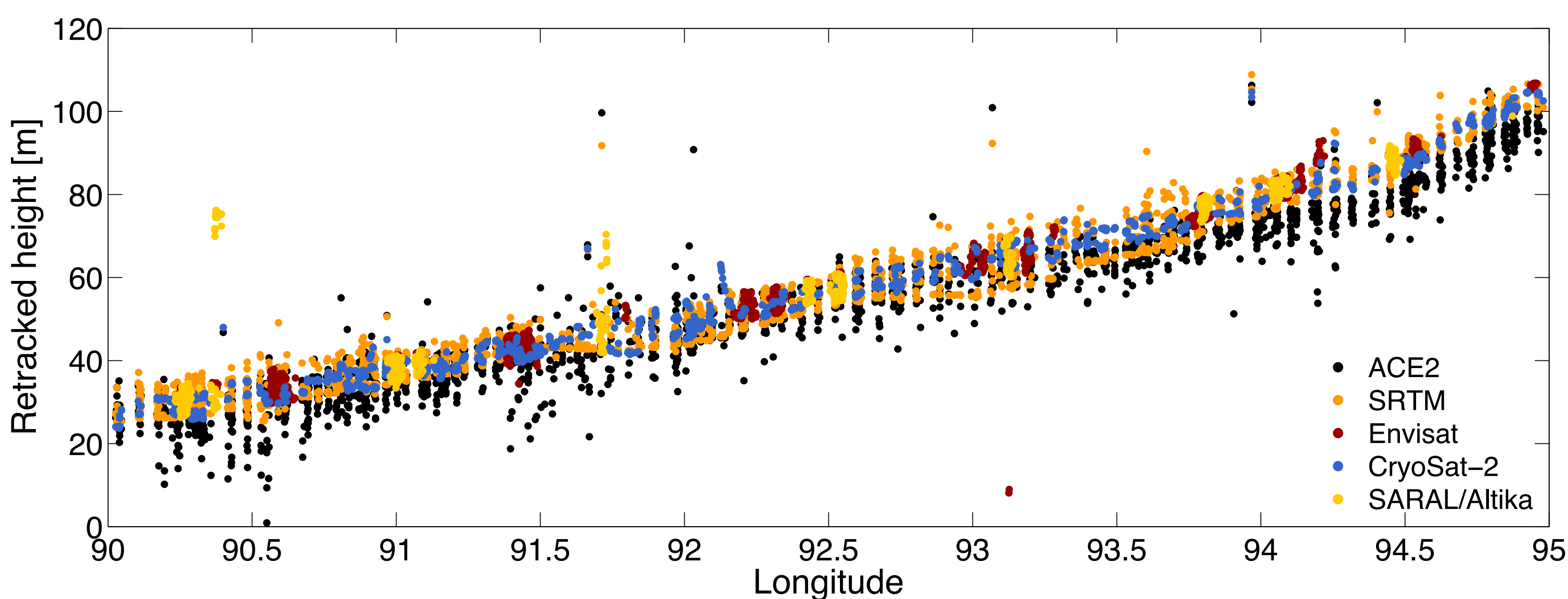
## 4. Intermediate results - Retracked heights

The masked retracked heights from the three different missions.



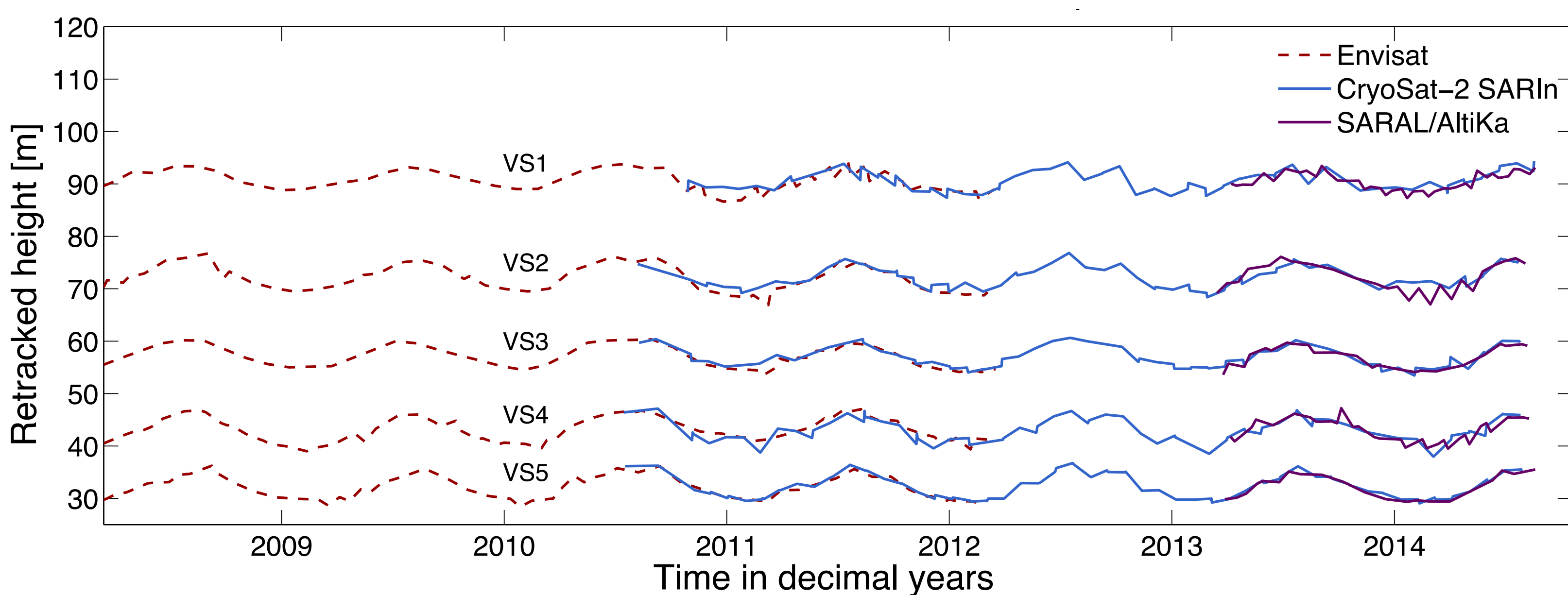
## 5. Comparison with digital elevation models

Comparison of altimetric heights in the Brahmaputra river with heights from the Shuttle Radar Topography Mission (SRTM) and the Altimetry Corrected Elevations (ACE2).



## 6. River level time series

The time series retrieved over the Brahmaputra River from Envisat, CryoSat-2 and SARAL/AltiKa data are shown below.



## 6. Conclusions

Time series were developed using CryoSat-2 SARIn data and compared with Envisat and SARAL/AltiKa time series.

- ❖ The retracked CryoSat-2 heights have fewer outliers compared to the DEMs ACE2 and SRTM.
- ❖ The CryoSat-2 time series correspond well with the Envisat and SARAL/AltiKa time series even though they are not from an exact repeat orbit.

These results reveal the great potential of CryoSat-2 within inland water altimetry. Taking advantage of the CryoSat-2 data set it is possible to continue the already existing and very useful river level time series archives.

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## References

Part of this work has been submitted to Remote Sensing of Environment with the title "CryoSat-2 altimetry for river level monitoring — Evaluation in the Ganges-Brahmaputra river basin". The paper is currently under revision.

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**ICE-1 retracker:** Bamber, J.L. Ice sheet altimeter processing scheme (1994).

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**MOD44w:** Salomonet et al. (2004). Global land-water mask derived from MODIS Nadir BRDF-adjusted reflectances (NBAR) and the MODIS land cover algorithm.  
**SRTM:** Farr et al. (2007). The Shuttle Radar Topography Mission..  
**ACE2:** Berry et al. (2010). ACE2: The New Global Digital Elevation Model.