Water level variations within the Lower Mekong River network derived by satellite altimetry

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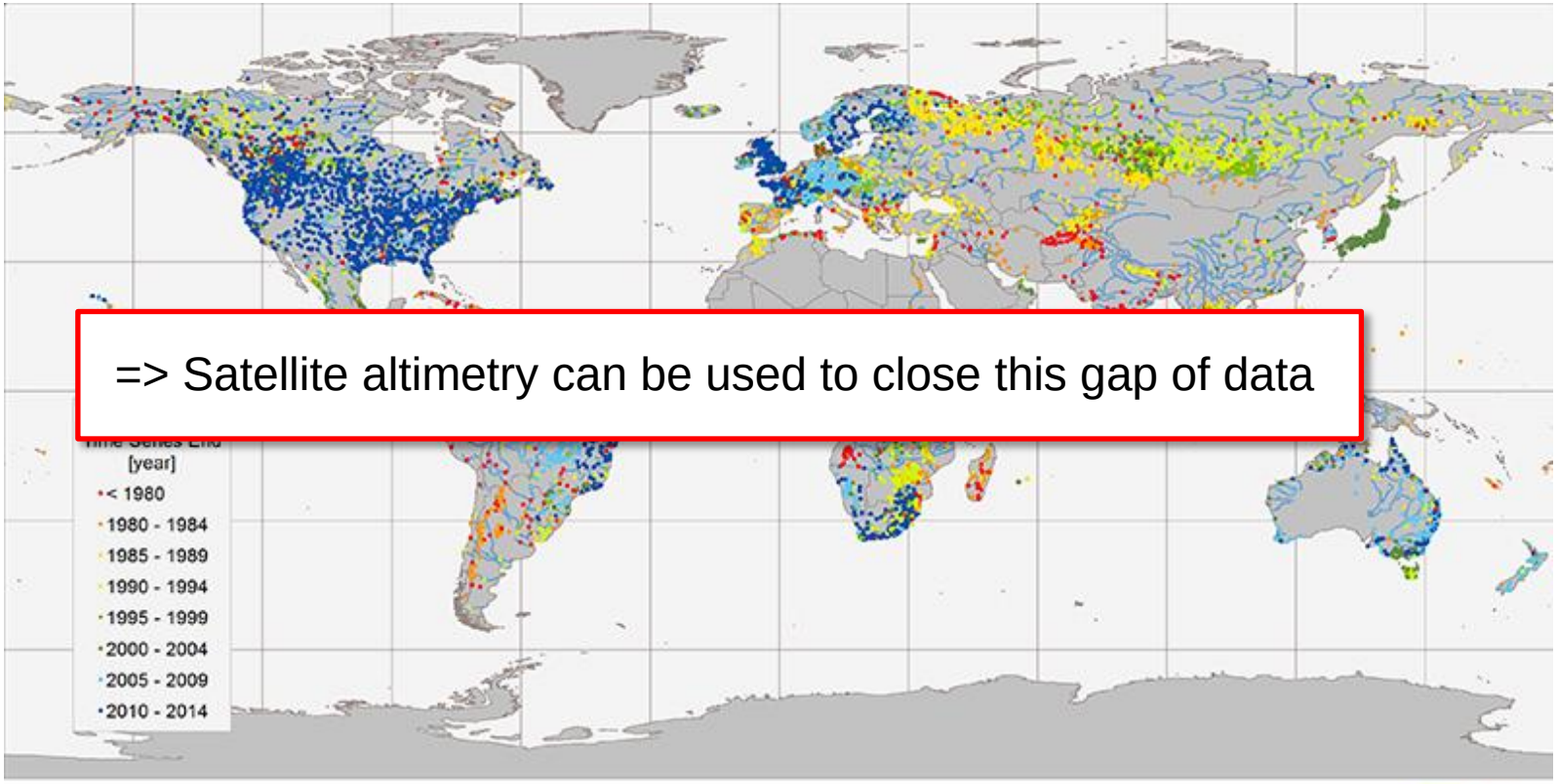
Motivation

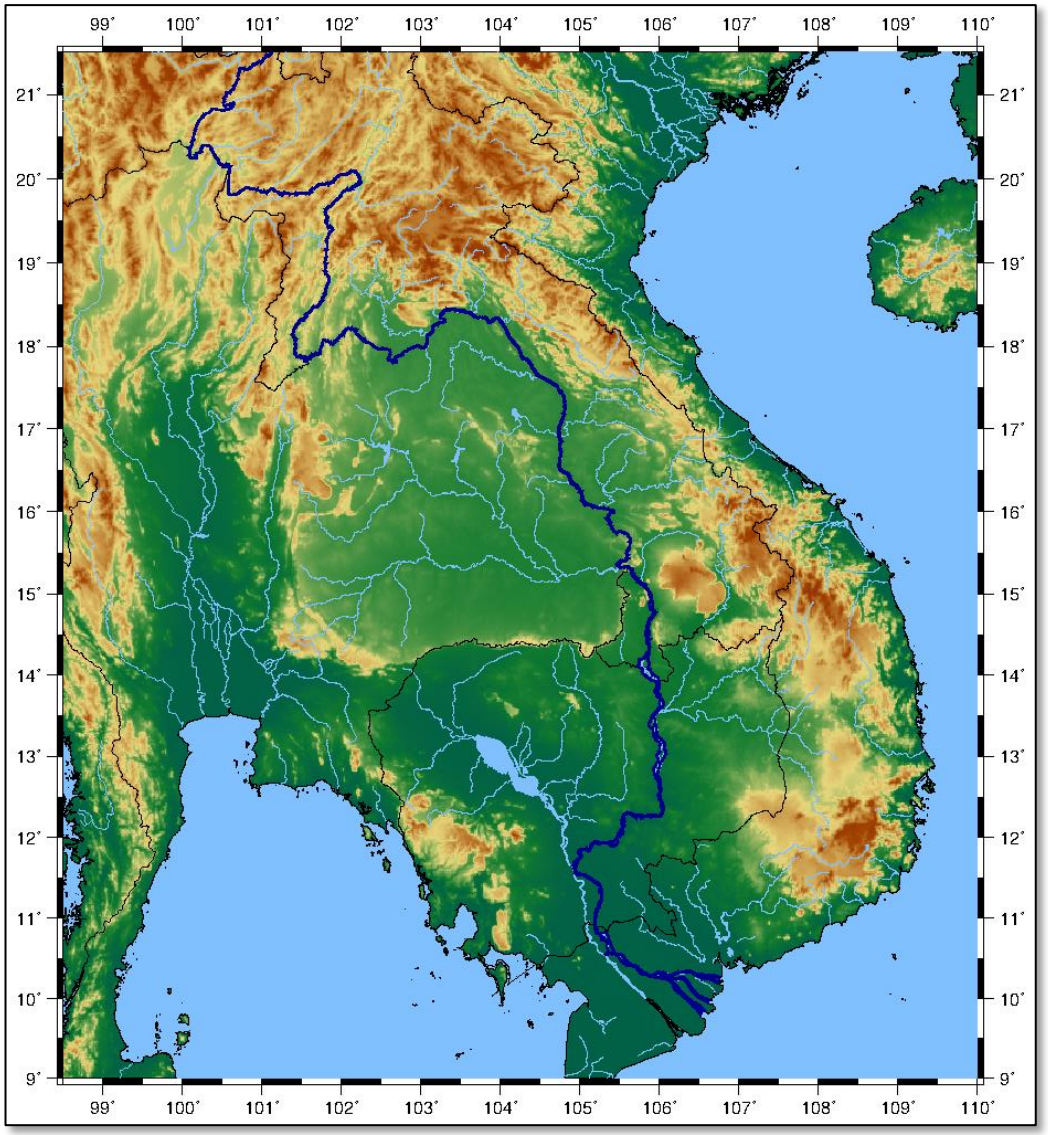
- For monitoring and modelling the water cycle it is necessary to have knowledge of water levels of inland waters
- However, the number of available in-situ gauges is decreasing



=> Satellite altimetry can be used to close this gap of data

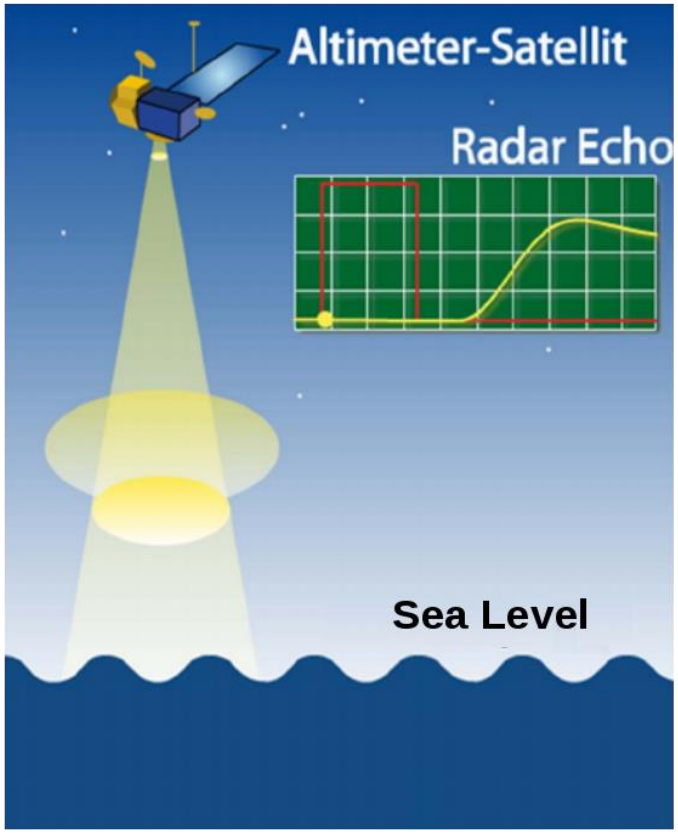
9011 GRDC stations with monthly data, incl. data derived from daily data (Status: 18 Dec 2014)
Koblenz: Global Runoff Data Centre, 2014.

Introduction



- We are using satellite altimetry data for observing inland water bodies
- Case study for the lower Mekong River in South East Asia

Altimetry



- Altimetry measures the two way travel time of a radar signal between the satellite and the water surface
- Assuming a nadir looking satellite one is able to determine the height of the water surface, if the position of the satellite is known

Inland Altimetry:

- Land in the footprint disturbs the measurements
- Using altimetry over inland waters the data needs special treatment (e.g. retracking and higher temporal resolution)

Data

We are using 5 satellite altimetry missions:

- Envisat (2002 – 2010)
- Envisat EM (2010 – 2011)
- Saral/AltiKa (2013 – today)
- Jason-2 (2008 – today)
- Cyrosat-2 (2010 – today)

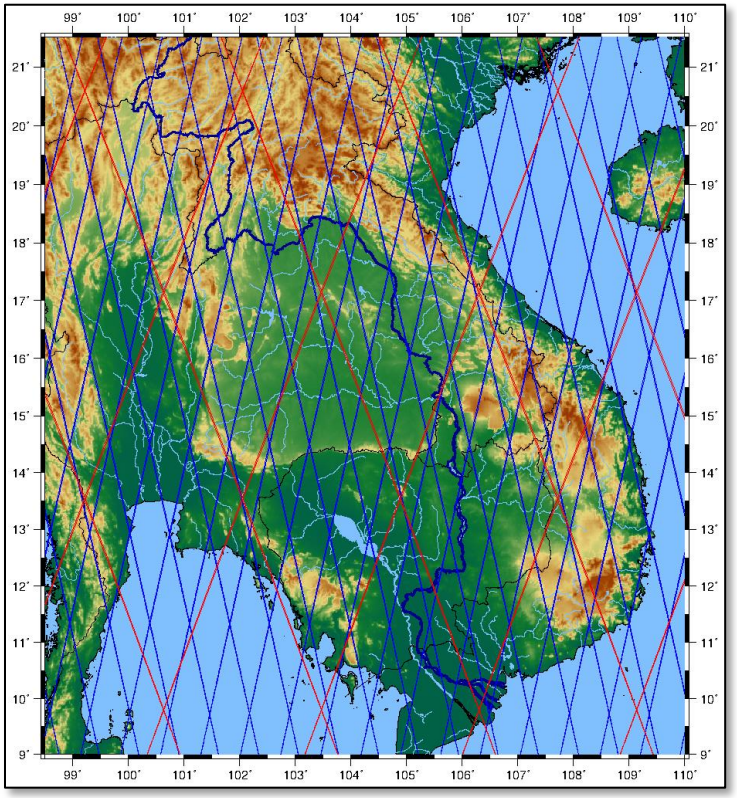
Missions with repeat orbit

Missions with long-repeat orbit

Repeat and non-repeat missions

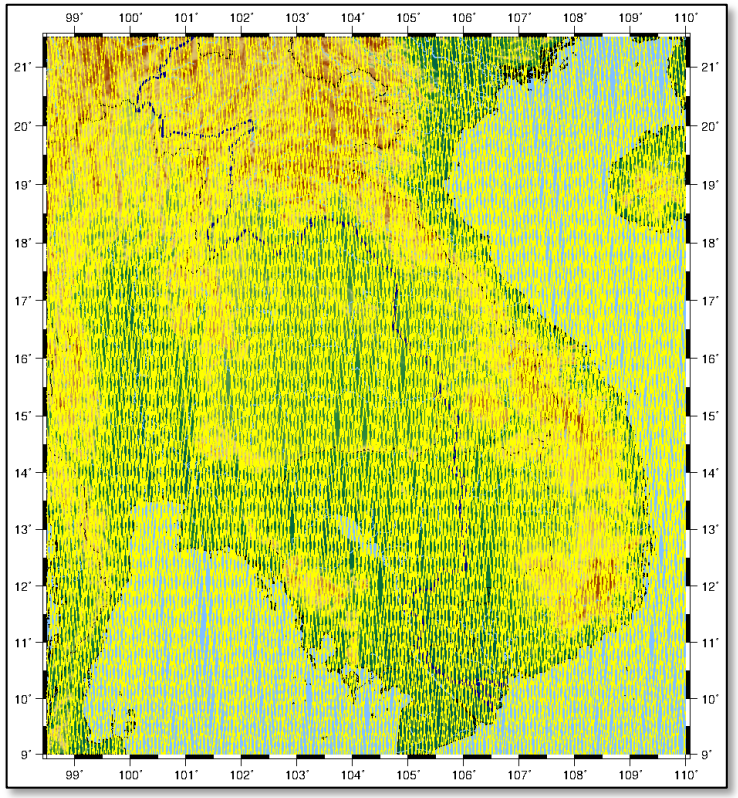
Repeat orbit:

- Returning measurements at the same point (35 days Envisat, 10 days Jason-2)
- Data can be composed to time series



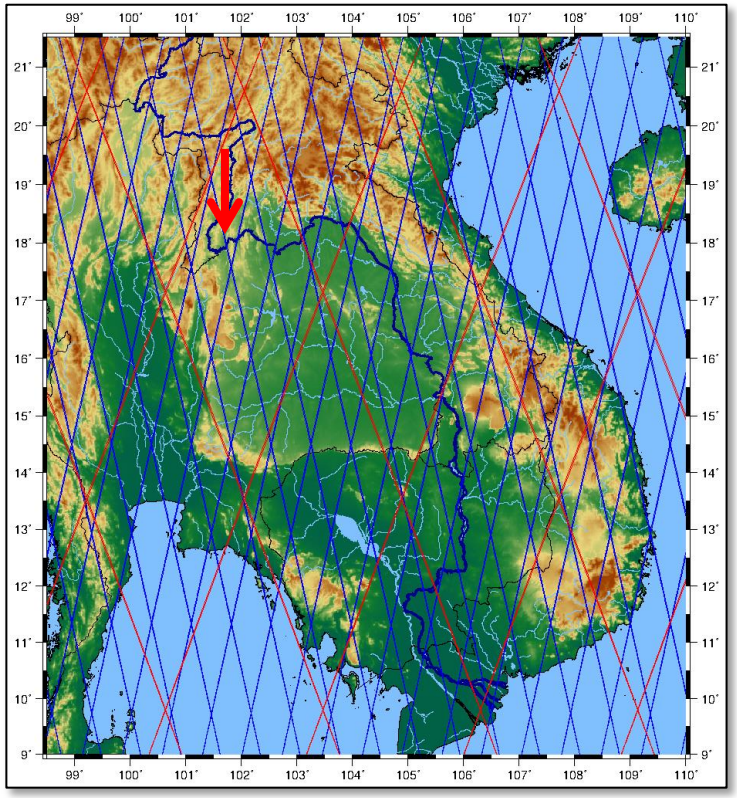
Long-repeat orbit:

- Very long repeating time (369 days for Cryosat-2)
- Denser spatial distribution
- No time series extraction possible



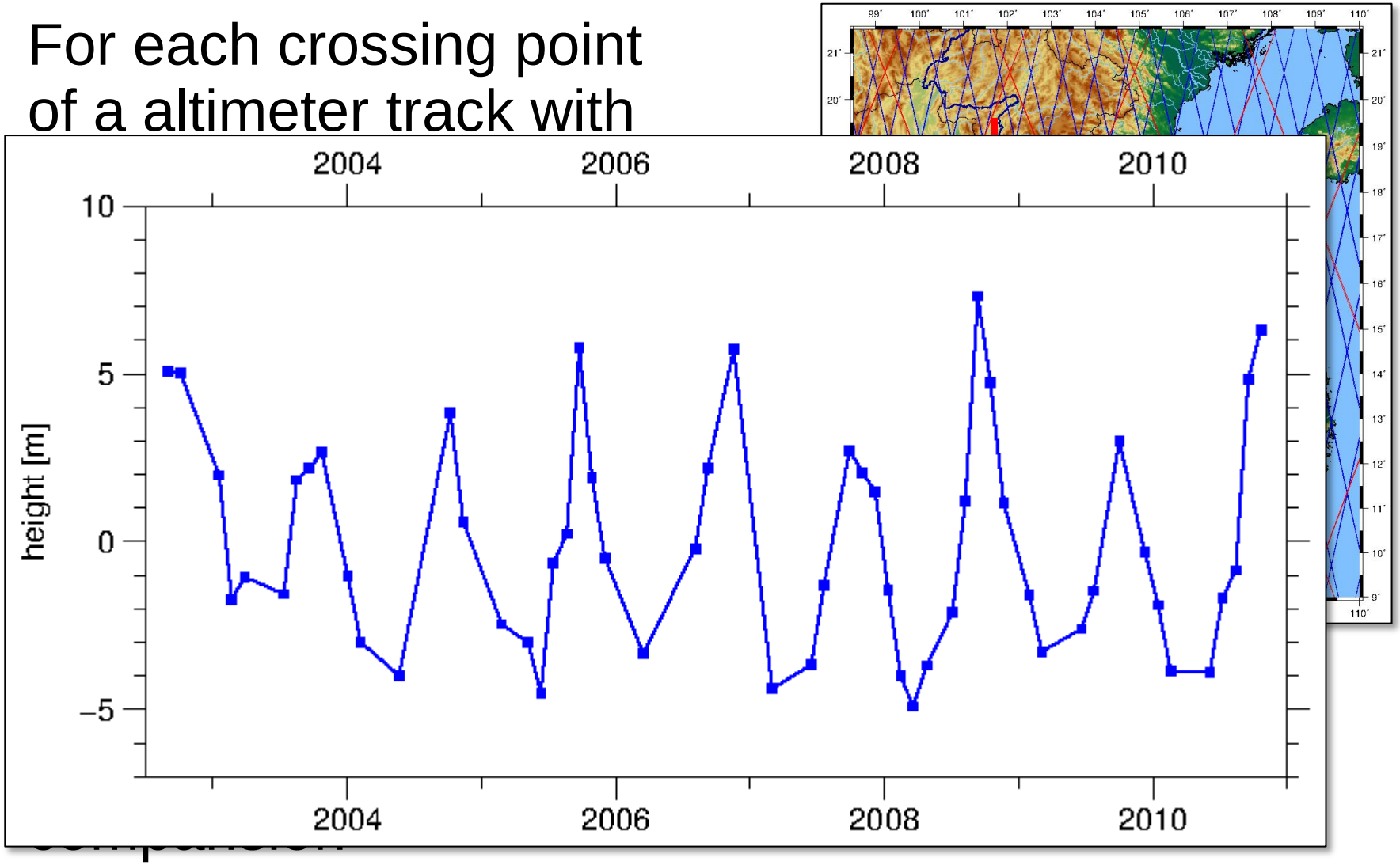
From altimetry data to water level time series

- For each crossing point of a altimeter track with the river we get one time series
- All measured height over the river at one pass are taken to calculate one water level for this epoch
- Mean water level is reduced for better comparision



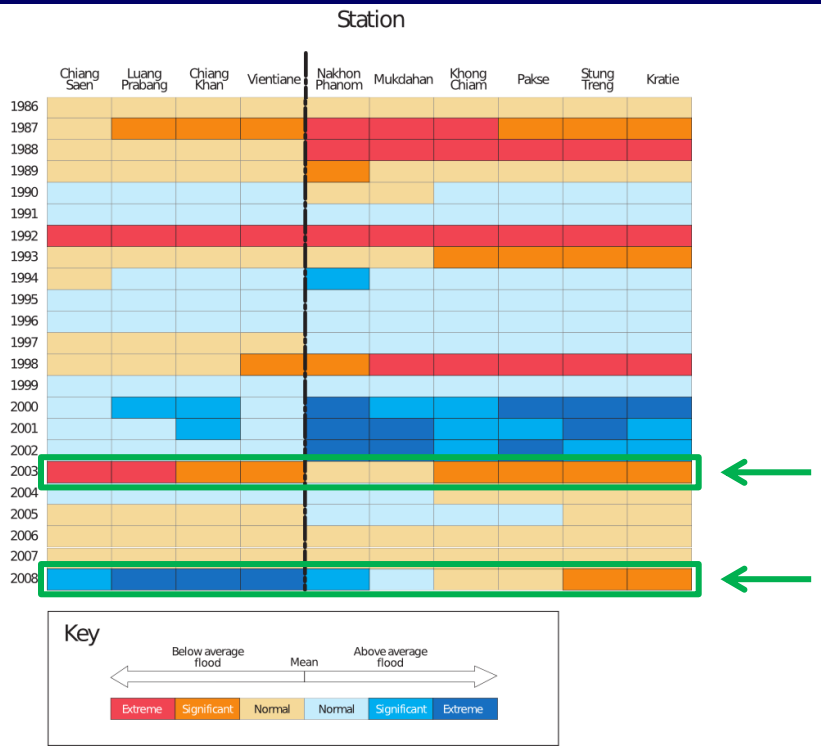
From altimetry data to water level time series

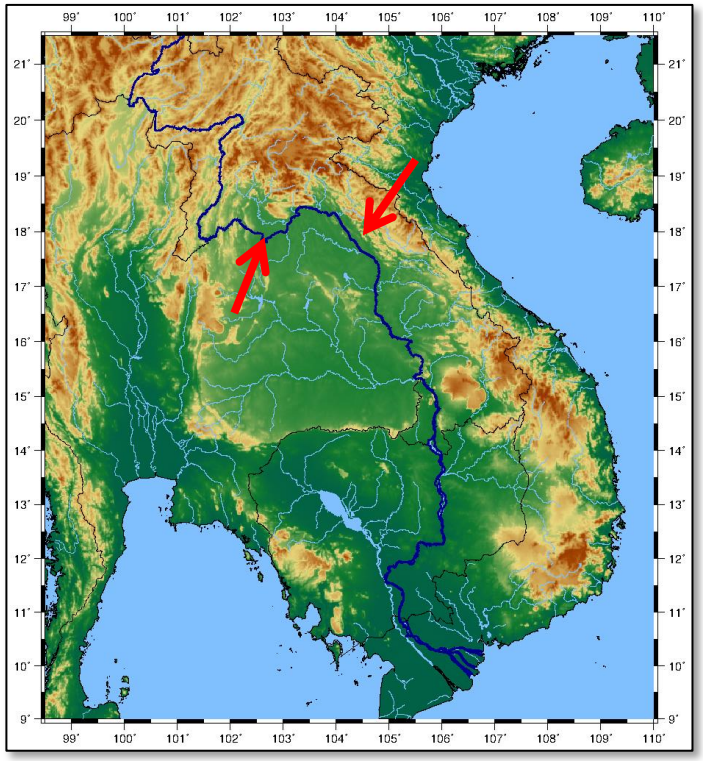
- For each crossing point of a altimeter track with



Altimetry for hydrology

Hydrological discontinuity



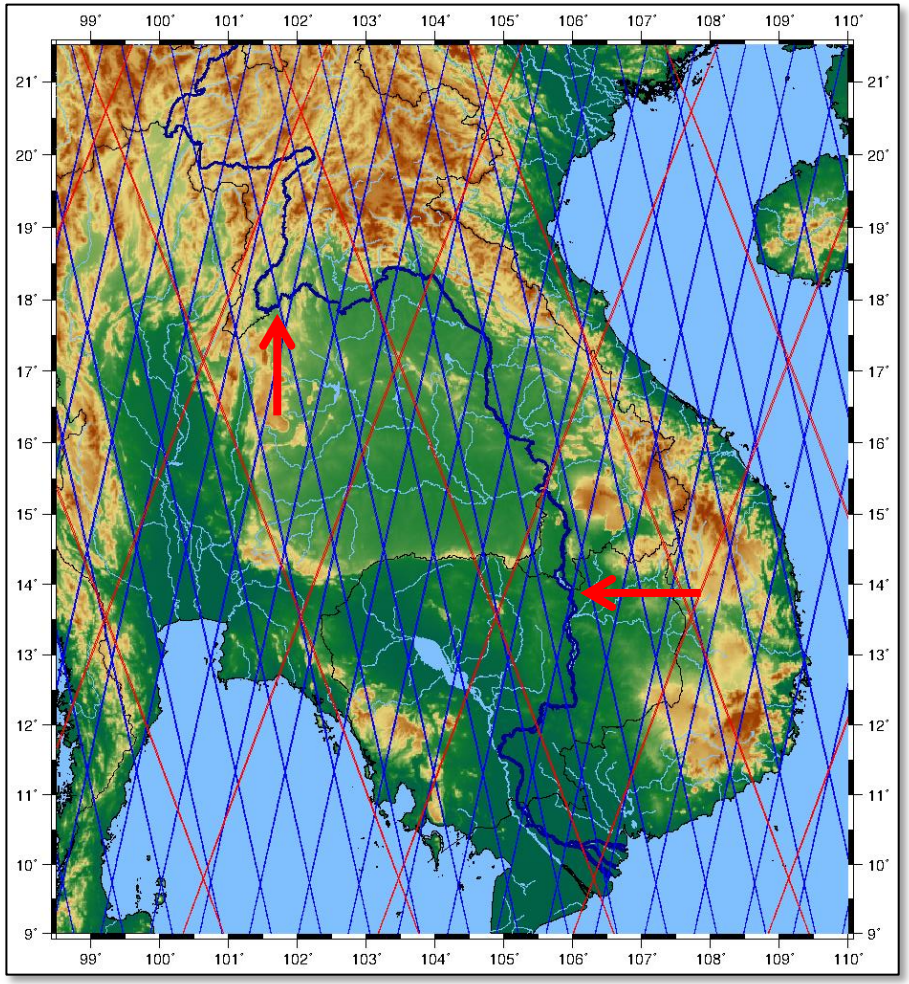


Hydrological discontinuity occurs between Vientiane and Nakhom Phanom:

- Upstream the river flood is governed by the precipitation on the Tibetan plateau
- Downstream by the precipitation of the monsoon
- This leads to different flood and drought behavior up and downstream
- Visible in altimetry data

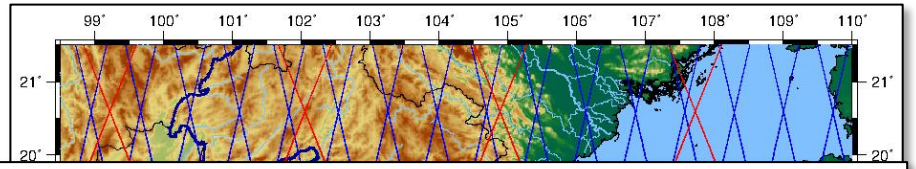
Hydrological discontinuity

Two altimetry time series, one above and one below the hydrological discontinuity



Hydrological discontinuity

Two altimetry time series, one



2003: above a drought, below normal

2008: above a flood, below a drought/normal

height [m]

10
5
0
−5

2004
2006
2008
2010

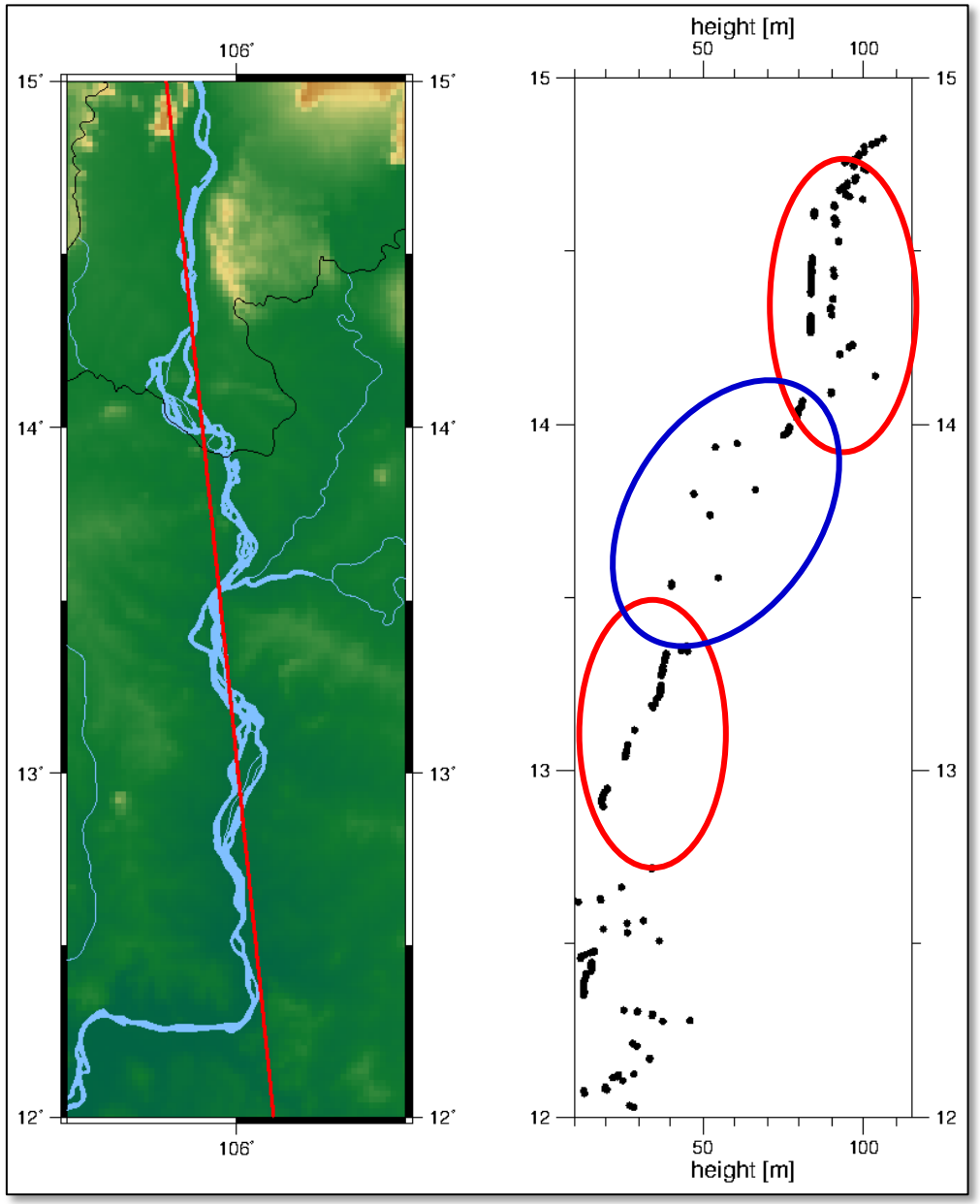
below hydrological disc.
above hydrological disc.

Mekong Falls

- Series of rapids and falls over 10 km
- Highest step falls 21 m

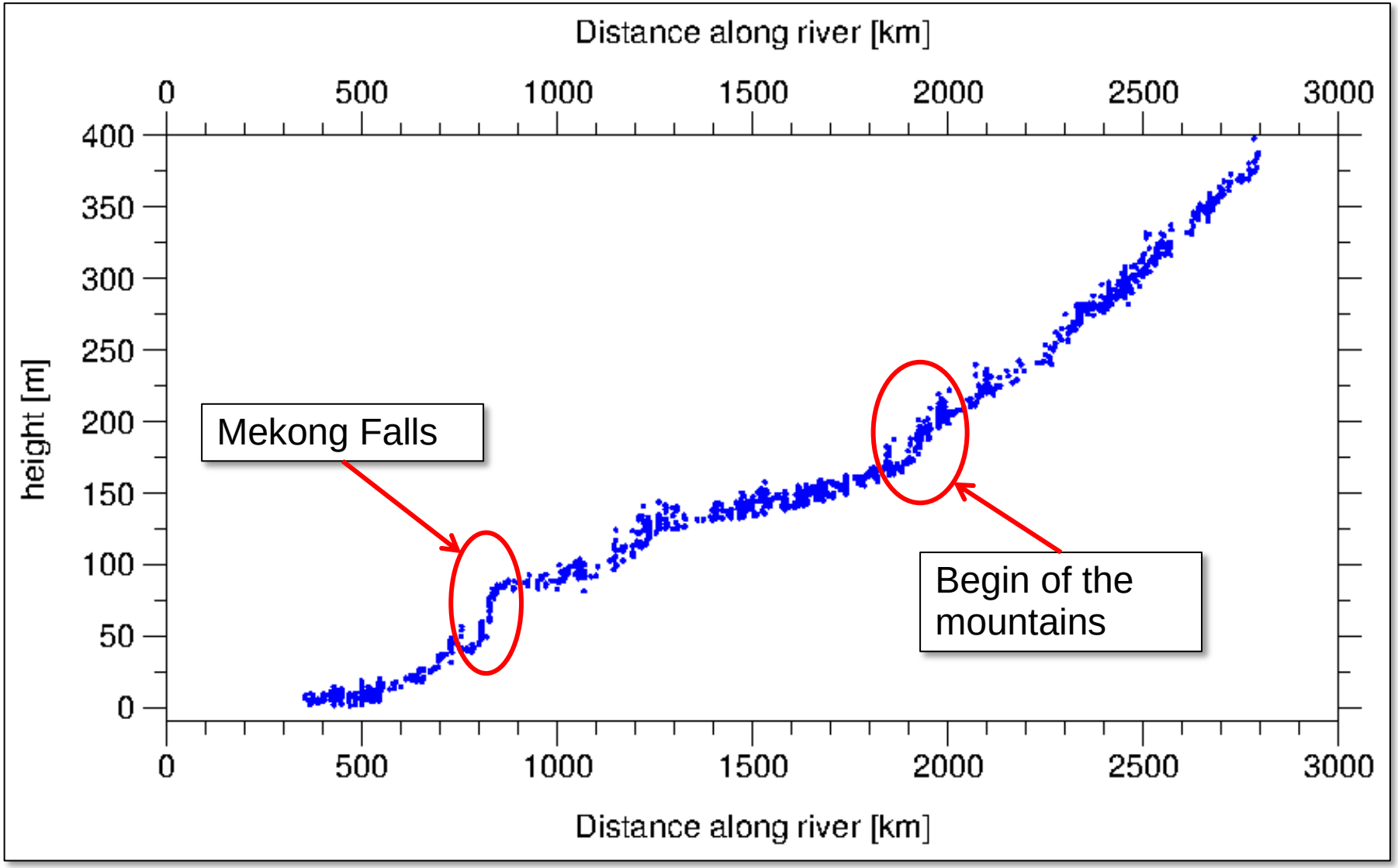
https://commons.wikimedia.org/wiki/File:Khone_Phapheng_Falls_-_2.jpg

Mekong Falls

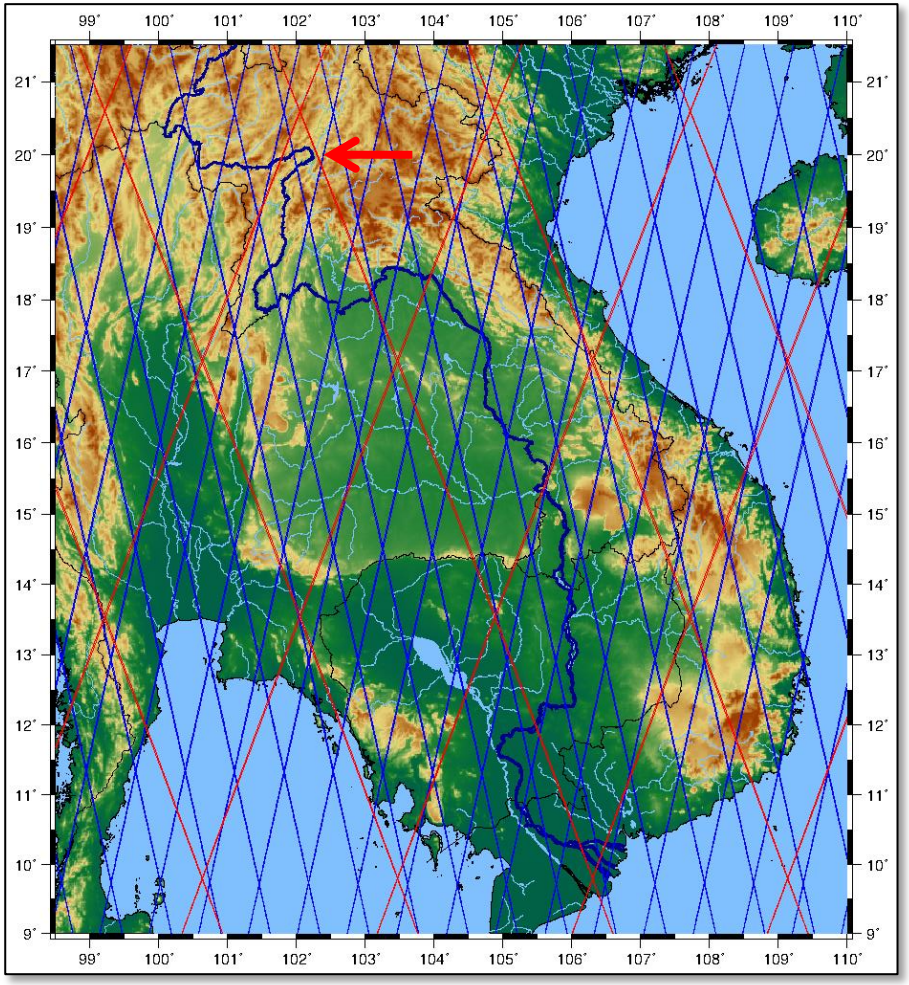


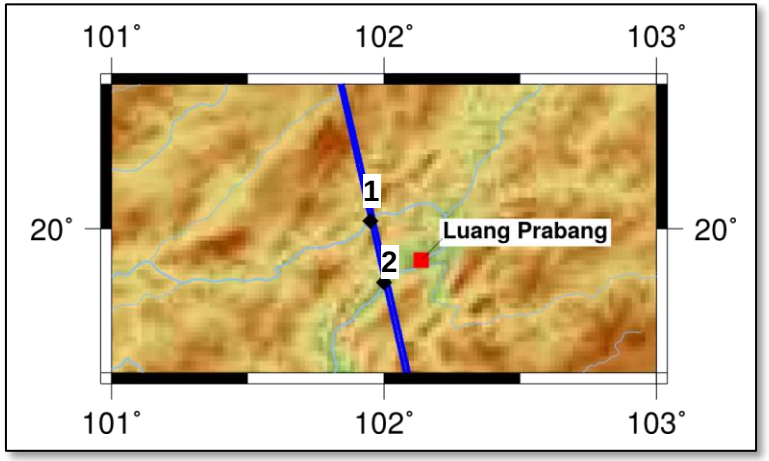
- Cryosat pass directly over waterfall
- Stretches of water and drop are clearly visible in altimeter measurements

Height profile of Mekong



Topography Influence - Example Luang Prabang





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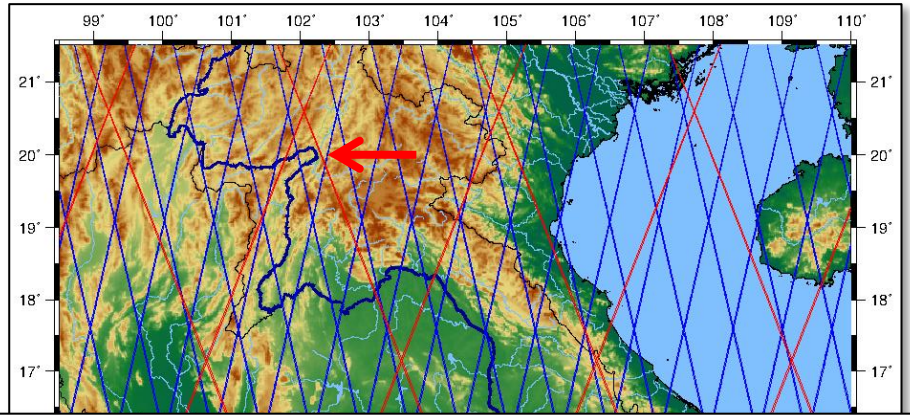
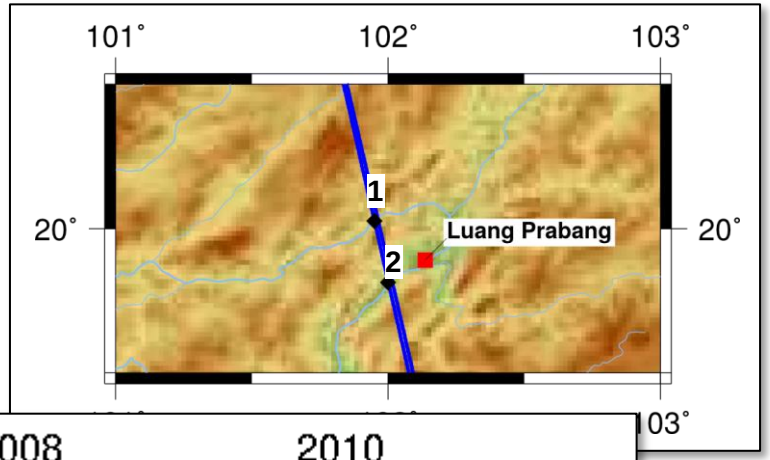
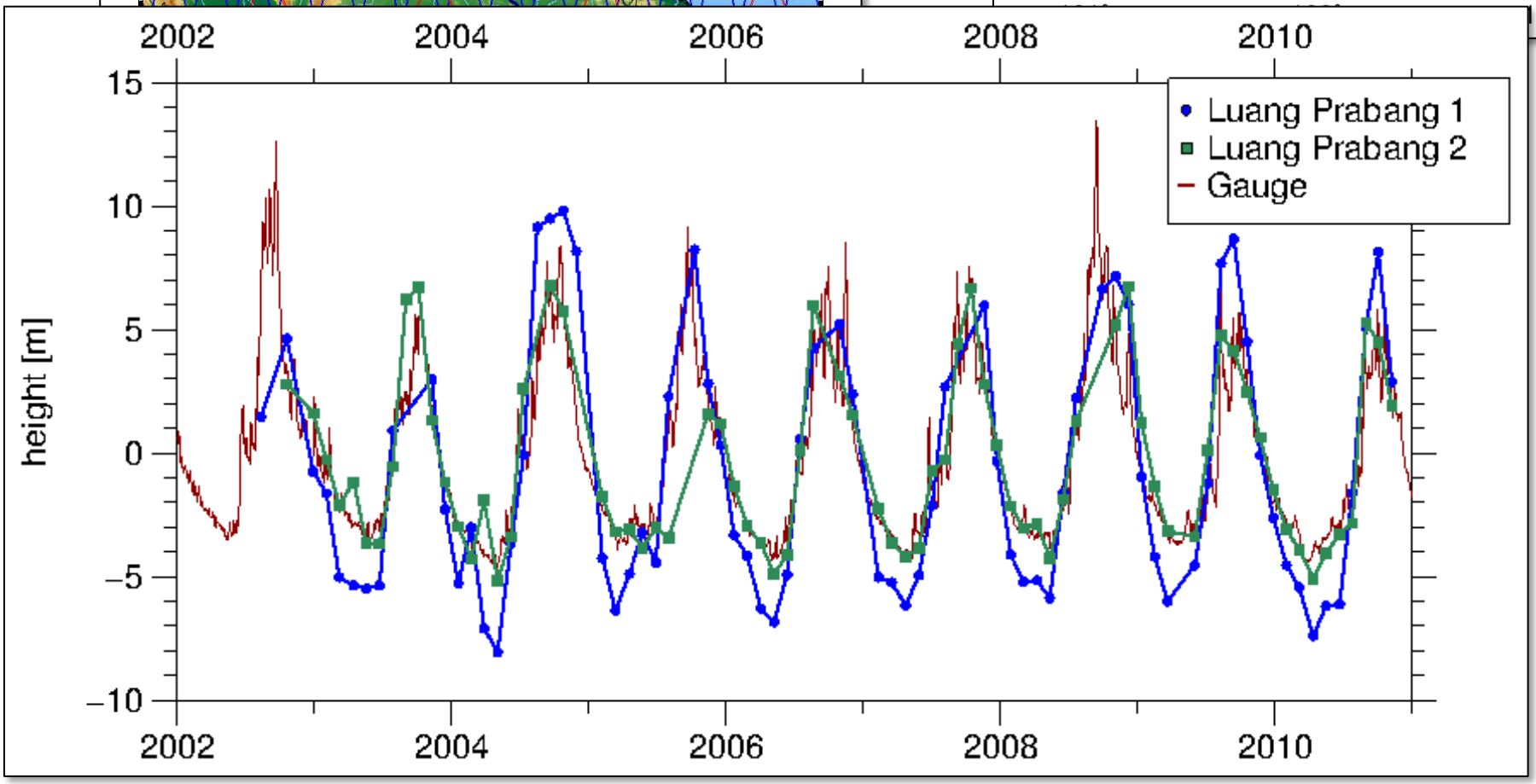
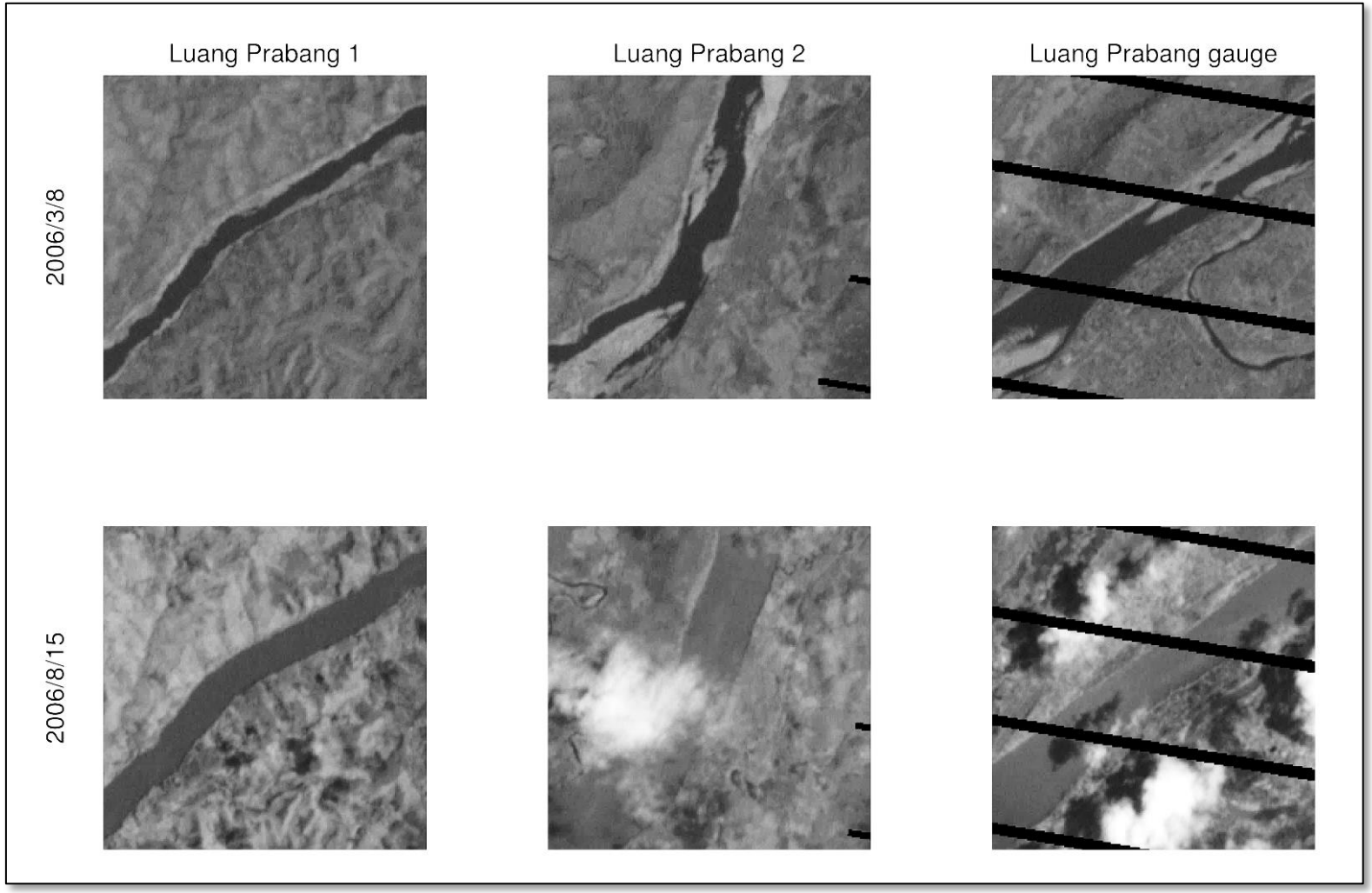


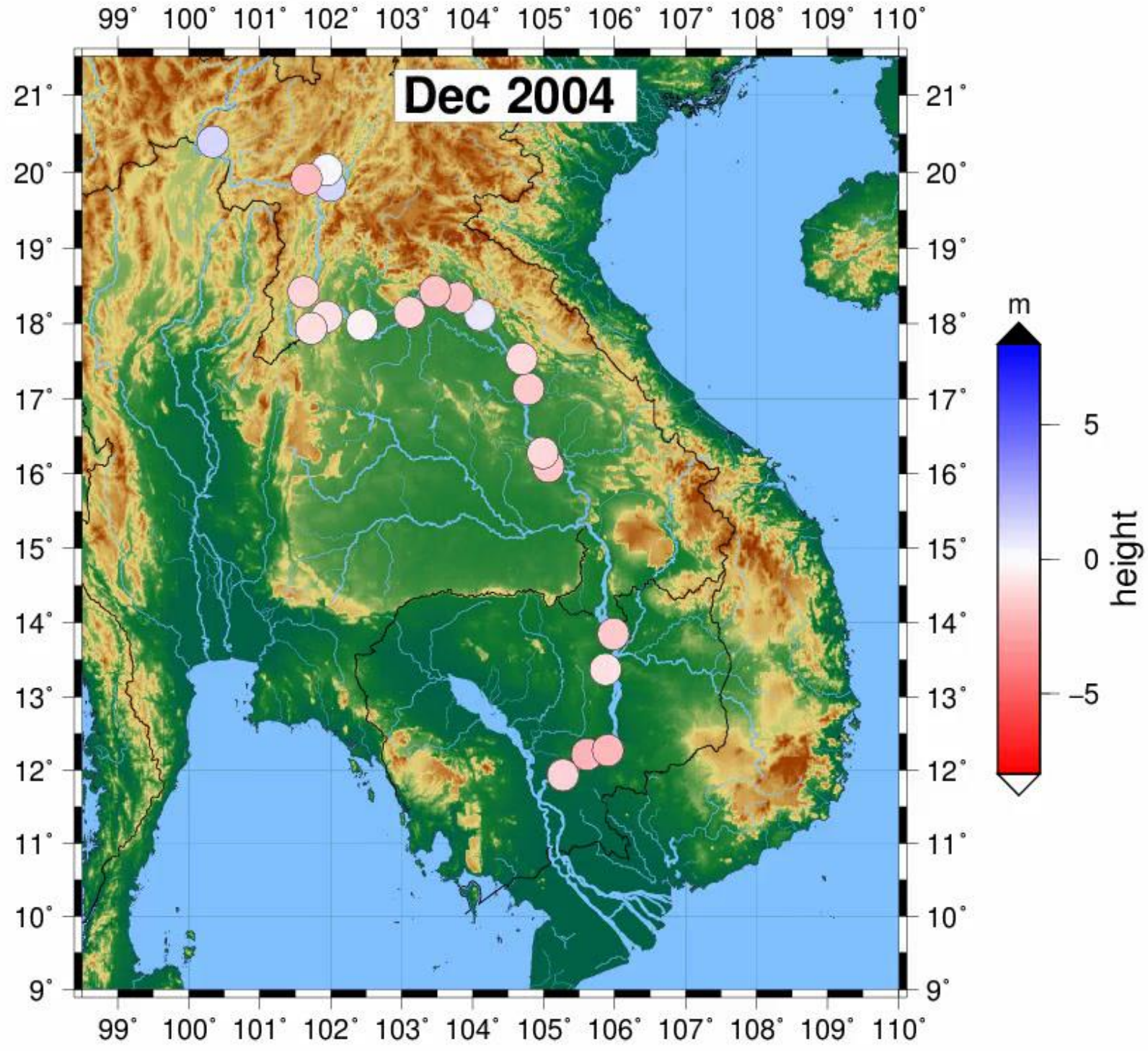




Topography Influence - Amplitude Differences

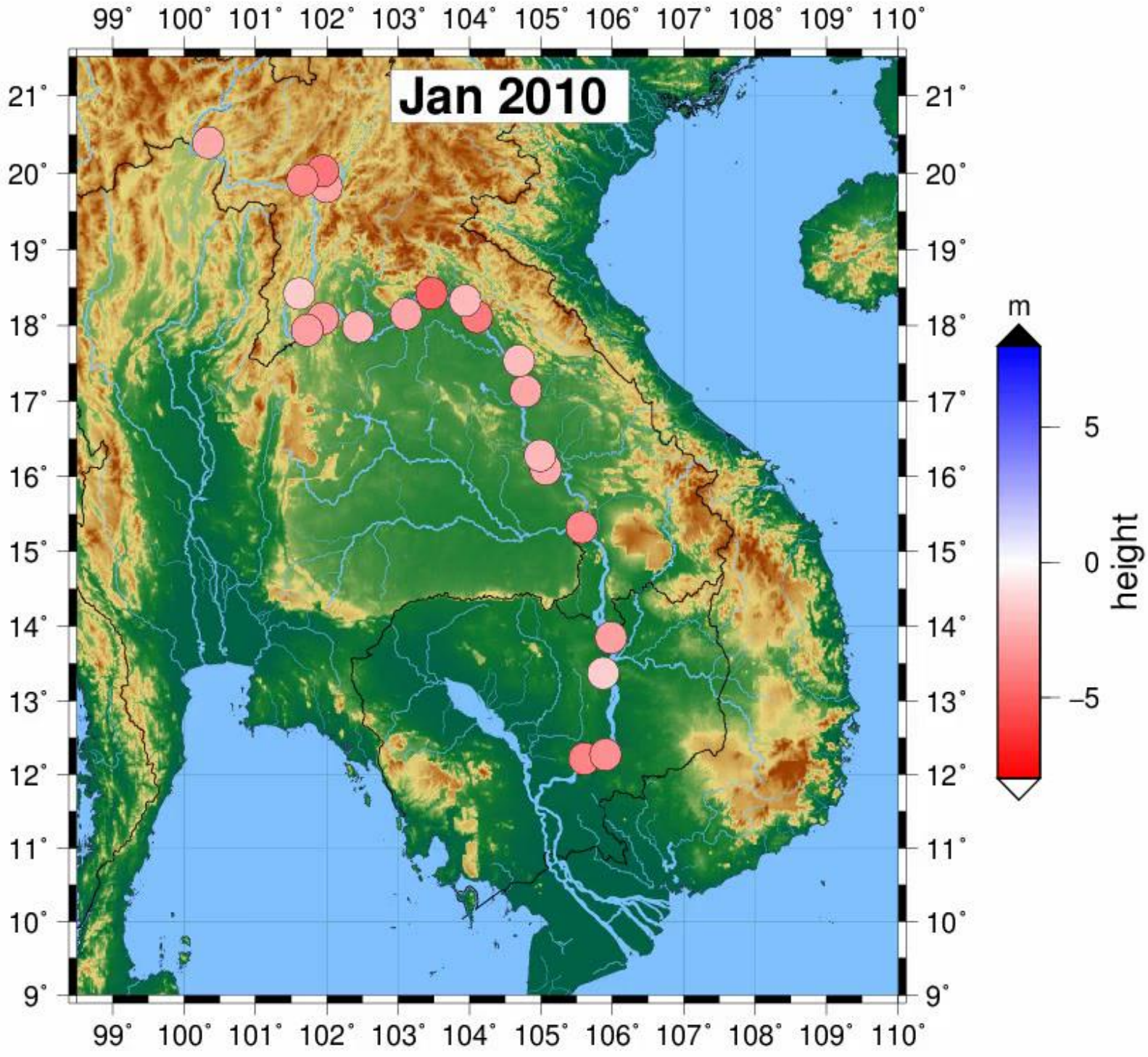


At Luang Prabang 2 and the gauging station the river can expand more than at Luang Prabang 1. This leads to the differences of amplitude.


Dec 2004
99° 100° 101° 102° 103° 104° 105° 106° 107° 108° 109° 110°
21° 20° 19° 18° 17° 16° 15° 14° 13° 12° 11° 10° 9°
m
5
0
−5
height

Altimetry time series in the Mekong region

- Data gap between 2010 and 2013 (between the Envisat and Saral missions)
- Cryosat 2 data might close this gap
  - Long-repeat mission
  - -> no time series from which we can reduce mean level
  - Mean level has to be estimated with the topography


Jan 2010
99° 100° 101° 102° 103° 104° 105° 106° 107° 108° 109° 110°
21° 20° 19° 18° 17° 16° 15° 14° 13° 12° 11° 10° 9°
m
5
0
−5
height

Conclusion

- Inland altimetry proves to be a valuable tool for hydrology in the Mekong region
- Altimetry is globally available, even for remote locations
- By now at least 15 years of time series are available (can be expanded further back with less accuracy)
- The use of data from long-repeat missions is still challenging but can close the data gap between Envisat and Saral

Database for Hydrological Time Series of Inland Water (DAHITI)

Earth Observation for Water Cycle Sciene 2015

http://dahiti.dgfi.tum.de