

**THE MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT
NATIONAL REMOTE SENSING DEPARTMENT (NRSD)**

**THE APPLICATION OF SATELLITE RADAR ALTIMETRY
IN VIETNAM**

Hanoi, 2017

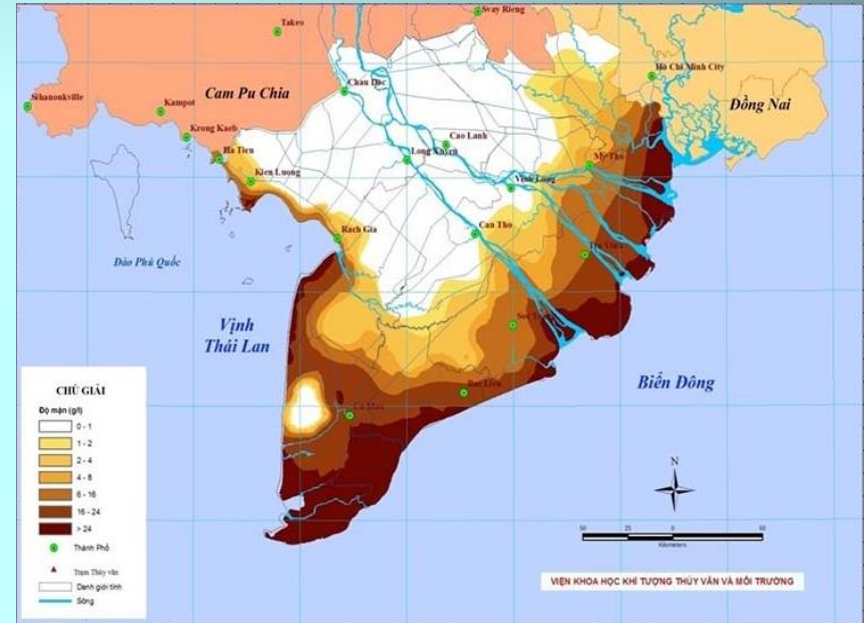
The Outline

1. Water Resource in Vietnam and the role of satellite altimetry in water resource management.
2. Introduction to some case studies in satellite altimetry at the National Remote Sensing Department (NRSD).

PART 1

Water Resource in Vietnam and the role of satellite altimetry in water resource management.

Severe Drought and Salinity Intrusion in 2016 in the Mekong Delta Basin, Vietnam



The worst drought and salinity over a century:

- 9/13 provinces with 160 000 ha of cropland was damaged by salinity.
- Fresh water shortage for 600 000 people.

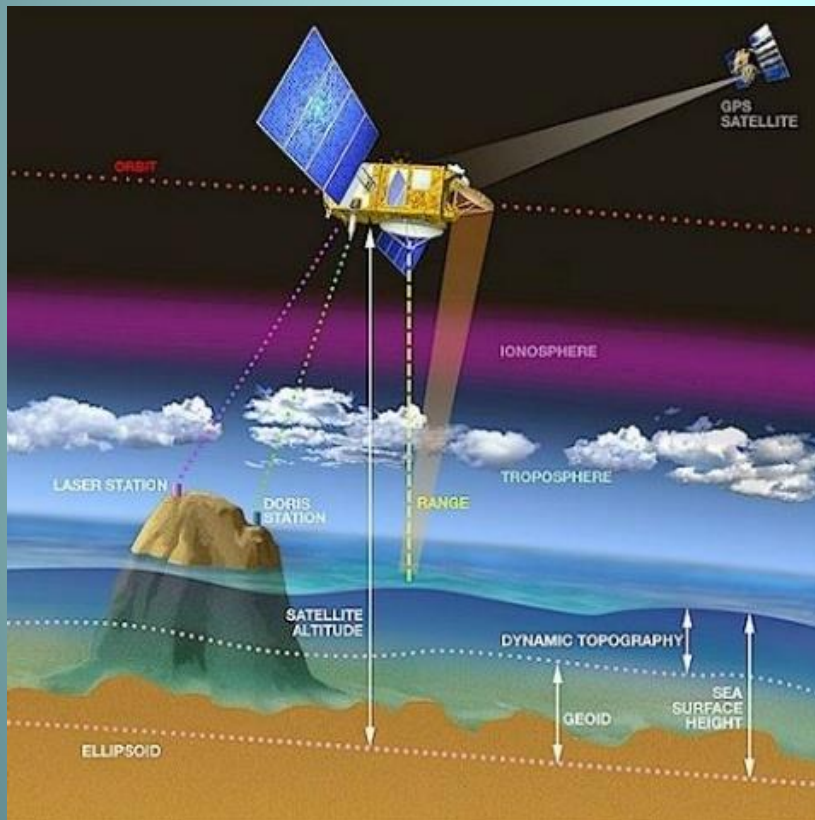
Water Resources in Vietnam

- Depends greatly on the large transboundary rivers such as Mekong river and Red river which account for over 60% of total water volume.
- The computation in water resource management must be done for the whole catchment-area. However, hydrological data from the Upper Mekong region are not available in some case.
- Measurements from the national network of gauge stations almost are not adequate for monitoring.
- Therefore, satellite altimetry can be considered as an alternative way to supply complementary data used to monitor time series of river water level variation.

The advantages and shortcomings of satellite altimetry

- The advantages:
 - ✓ Global coverage datasets.
 - ✓ Historical data archive (from 1992).
- The shortcomings:
 - ✓ Temporal resolution (satellite revisit period) that are only from 10 days to 35 days in comparison with the daily precise measurements from “*in situ*” hydrologic stations.
 - ✓ Distances between groundtracks.
 - ✓ Not every water body can be monitored.

Principles of Satellite Altimetry



$$\text{WSH} = \text{Alt} - \text{R} + [\text{DTC} + \text{WTC} + \text{IC} + \text{T}]$$

Where:

Alt is satellite orbit altitude; R is distance measurement; and other corrections includes DTC is the dry troposphere correction, WTC is the wet troposphere correction, IC is the ionosphere correction and T is the solid Earth tides correction.

PART 2

Introduction to some case studies in satellite altimetry at the National Remote Sensing Department (NRSD).

Case Study 1: The Lower Mekong River in Vietnam



- **Data in use**

- ✓ ENVISAT RA-2 18 Hz

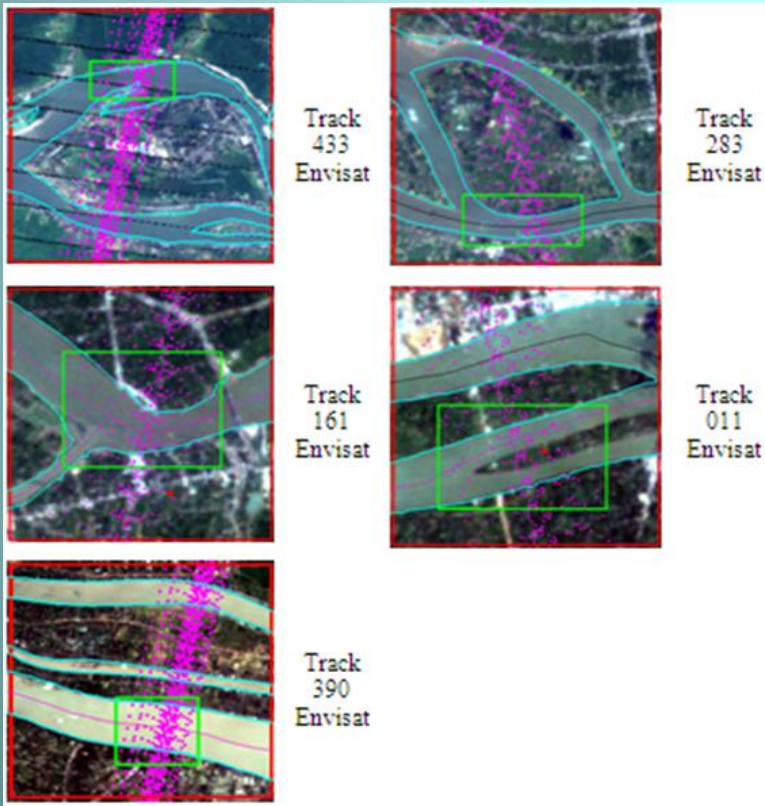
Provided by EOHelp from 2006 to 2008;

- ✓ Jason-2 20 Hz

Provided by the AVISO/CNES (Archiving, Validation and Interpretation of Satellite Data in Oceanography) Data Center from 2009 to 2010.

Virtual Stations

ENVISAT



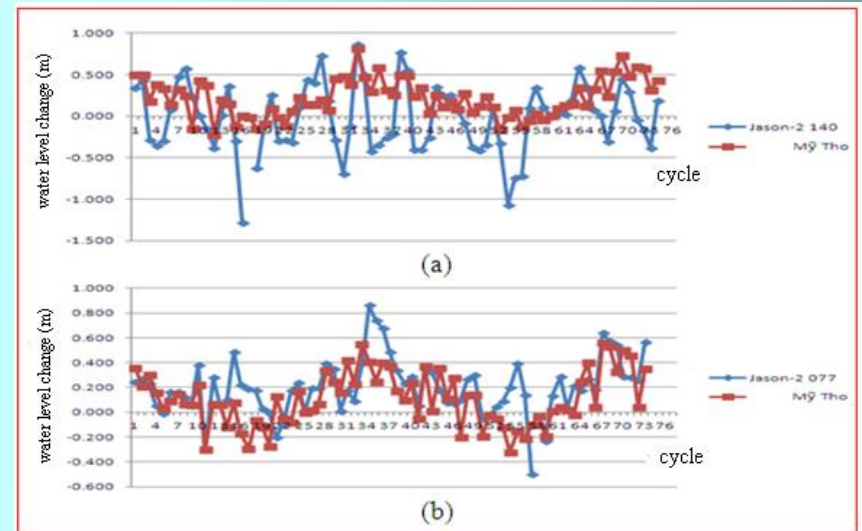
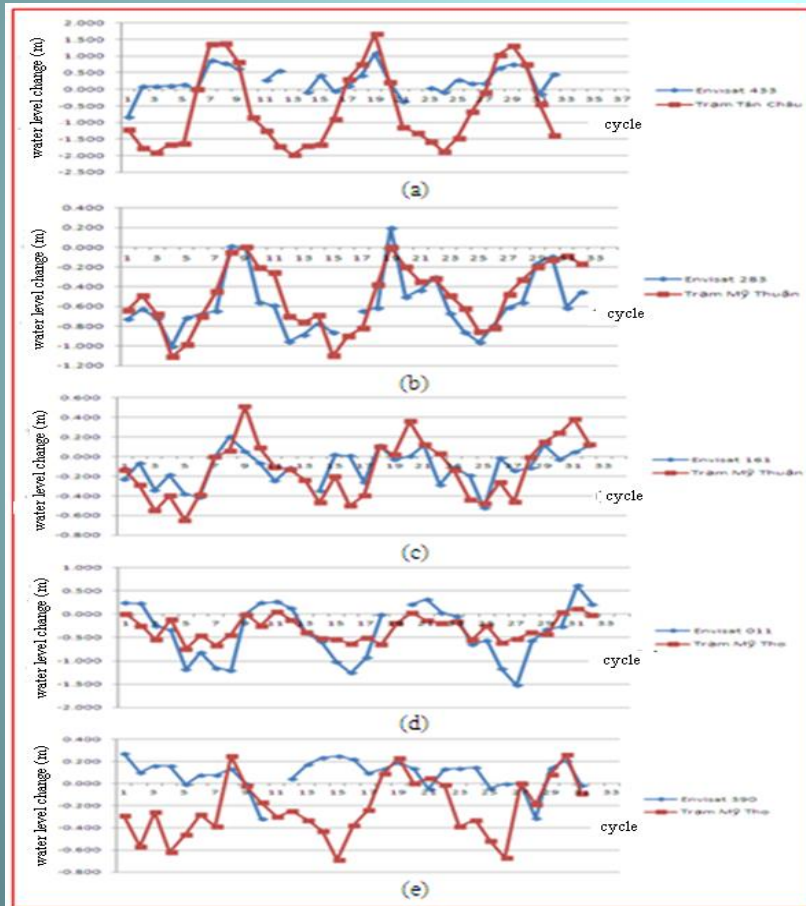
JASON-2



Statistics on hydrological stations and “Virtual” stations

| Mission | Track | Position (WGS-84) | Window width (km) | River width (km) | Station | Distance from station (km) | RMS (m) |
|---------|-------|------------------------------------|-------------------------|------------------------|-------------|----------------------------------|------------|
| Envisat | 433 | 105.290, 10.826 105.312, 10.816 | 1.50 | 0.50 | Tan Chau | 8 (Upstream) | 0.629 |
| Envisat | 283 | 105.600, 10.415 105.621, 10.406 | 1.00 | 0.40 | My Thuan | 39 (Downstream) | 0.188 |
| Envisat | 161 | 105.888, 10.284 105.908, 10.269 | 1.60 | 0.56 | My Thuan | 1 (Downstream) | 0.192 |
| Envisat | 011 | 106.338, 10.338 106.360, 10.325 | 1.50 | 0.90 | My Tho | 1 (Downstream) | 0.500 |
| Envisat | 390 | 106.598, 10.257 106.619, 10.237 | 2.10 | 1.40 | My Tho | 30 (Upstream) | 0.419 |
| Jason-2 | 140 | 106.117, 10.291 106.139, 10.275 | 1.70 | 1.00 | My Tho | 25 (Downstream) | 0.248 |
| Jason-2 | 077 | 106.469, 10.292 106.485, 10.276 | 1.80 | 0.80 | My Tho | 15 (Upstream) | 0.243 |

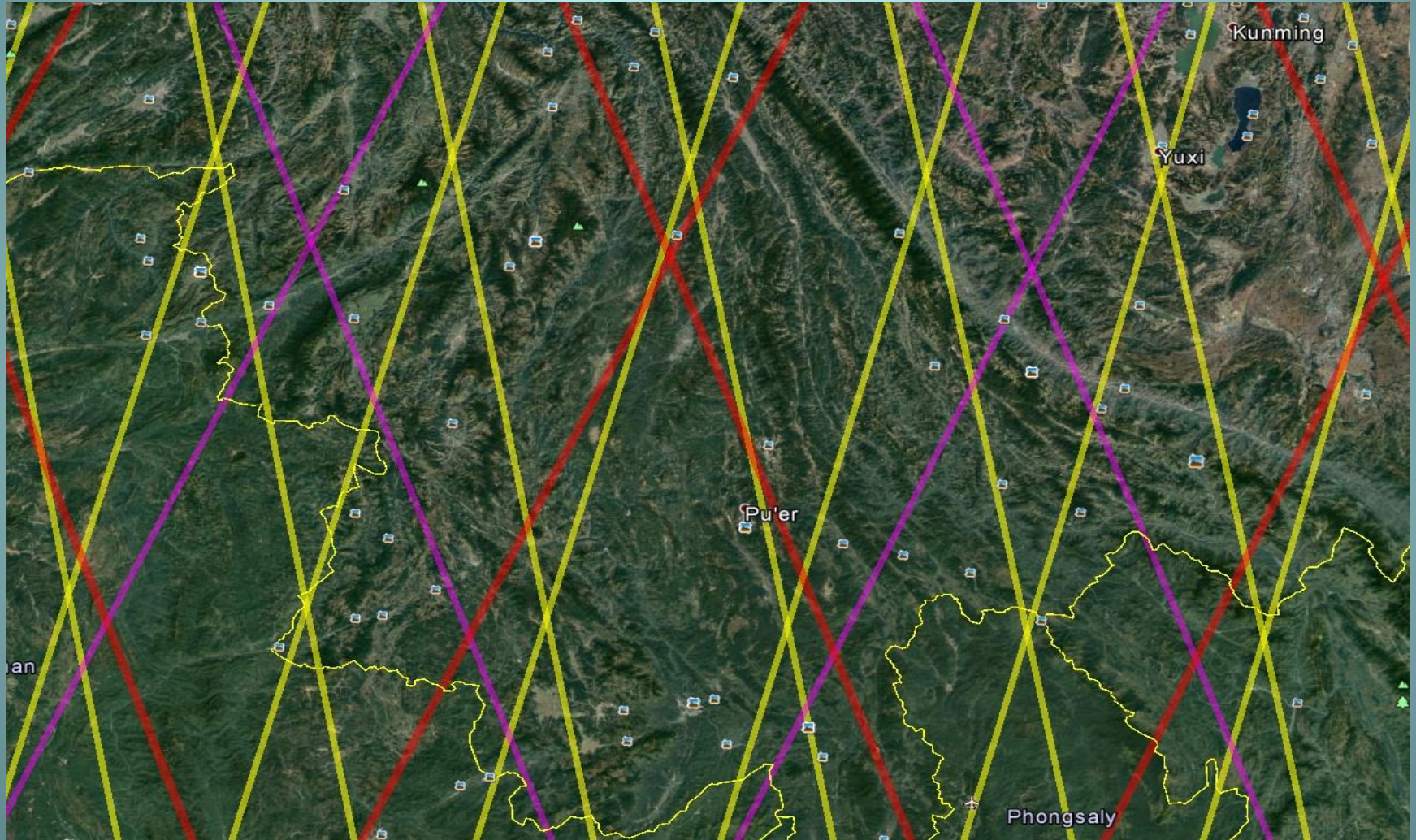
Comparison of altimetry-derived time series of water level variation from ENVISAT and JASON-2 with gauge-derived time series of water level variation



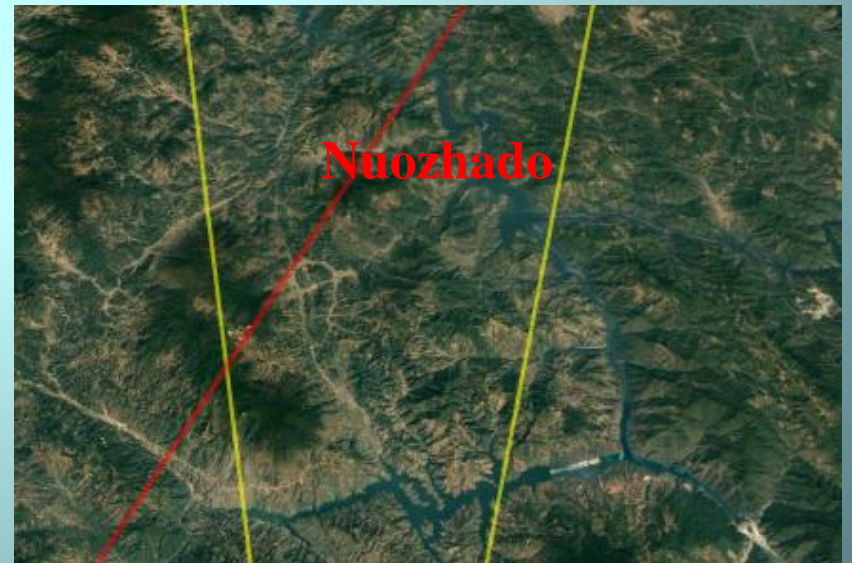
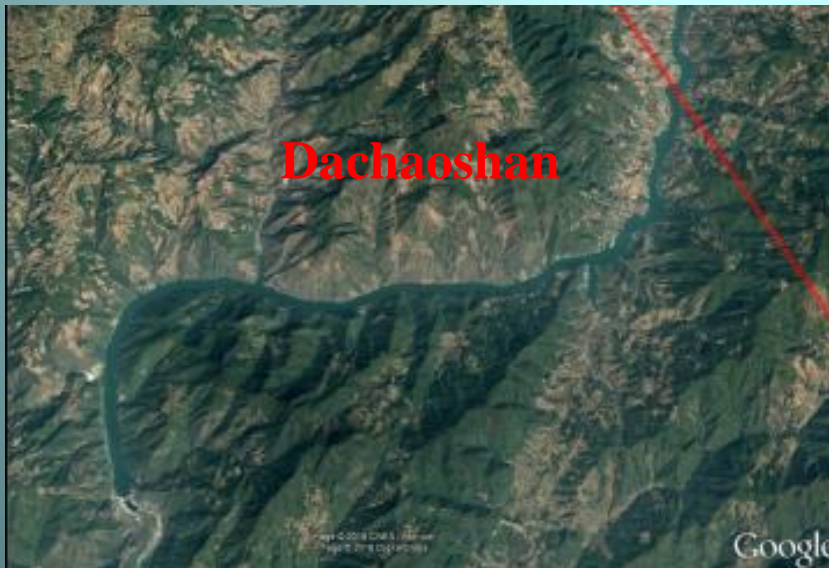
Results on Accuracy Assessment

| Mission | Groundtrack | Hydrological Station | RMS (m) |
|---------|-------------|----------------------|------------------|
| ENVISAT | 433 | Tan Chau | 1.237 (0.499) |
| ENVISAT | 283 | My Thuan | 0.206 |
| ENVISAT | 161 | My Thuan | 0.222 |
| ENVISAT | 011 | My Tho | 0.384 |
| ENVISAT | 390 | My Tho | 0.437 |
| JASON-2 | 140 | My Tho | 0.464 |

Case Study 2: The Upper Mekong River in China

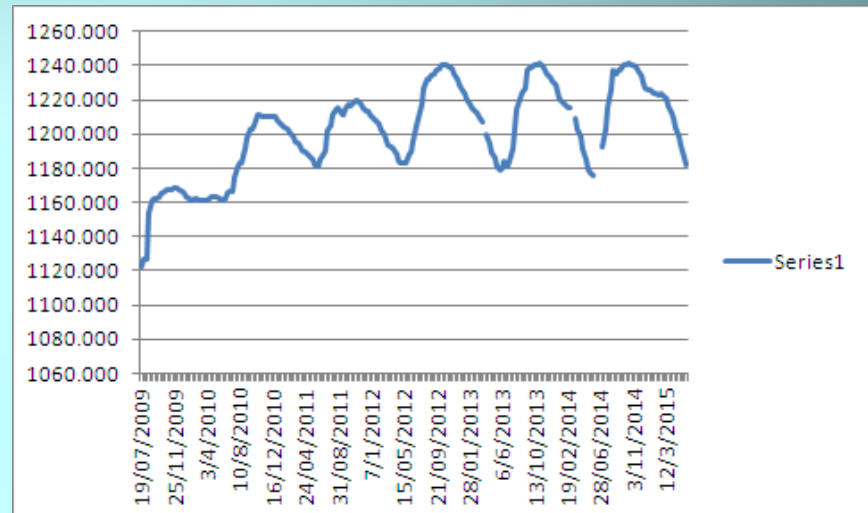


Some Dams in the Upper Mekong River in China



An Example: Dams Xiaowan

| Đập Tiểu Loan | | | | | |
|---------------|---------------------|-------|---------|---|-------|
| Latitude | 24 | 51 | 18.4158 | N | WGS84 |
| Longitude | 100 | 10 | 32.1633 | E | WGS84 |
| | | | | | |
| | | | | | |
| Date | Water Level - EGM96 | RMS | | | |
| 19/07/2009 | 1122.635 | 0.261 | | | |
| 29/07/2009 | 1126.606 | 0.246 | | | |
| 8/8/2009 | 1127.113 | 0.544 | | | |
| 18/08/2009 | 1154.043 | 0.437 | | | |
| 28/08/2009 | 1161.306 | 0.266 | | | |
| 6/9/2009 | 1162.176 | 0.325 | | | |
| 16/09/2009 | 1162.582 | 0.338 | | | |
| 26/09/2009 | 1163.425 | 0.515 | | | |
| 6/10/2009 | 1165.226 | 0.453 | | | |
| 16/10/2009 | 1166.551 | 0.353 | | | |
| 26/10/2009 | 1167.160 | 0.192 | | | |
| 5/11/2009 | 1167.228 | 0.344 | | | |
| 15/11/2009 | 1167.743 | 0.380 | | | |
| 25/11/2009 | 1168.620 | 0.445 | | | |
| 5/12/2009 | 1168.131 | 0.308 | | | |
| 15/12/2009 | 1167.010 | 0.656 | | | |
| 25/12/2009 | 1166.740 | 0.408 | | | |
| 3/1/2010 | 1165.009 | 0.260 | | | |



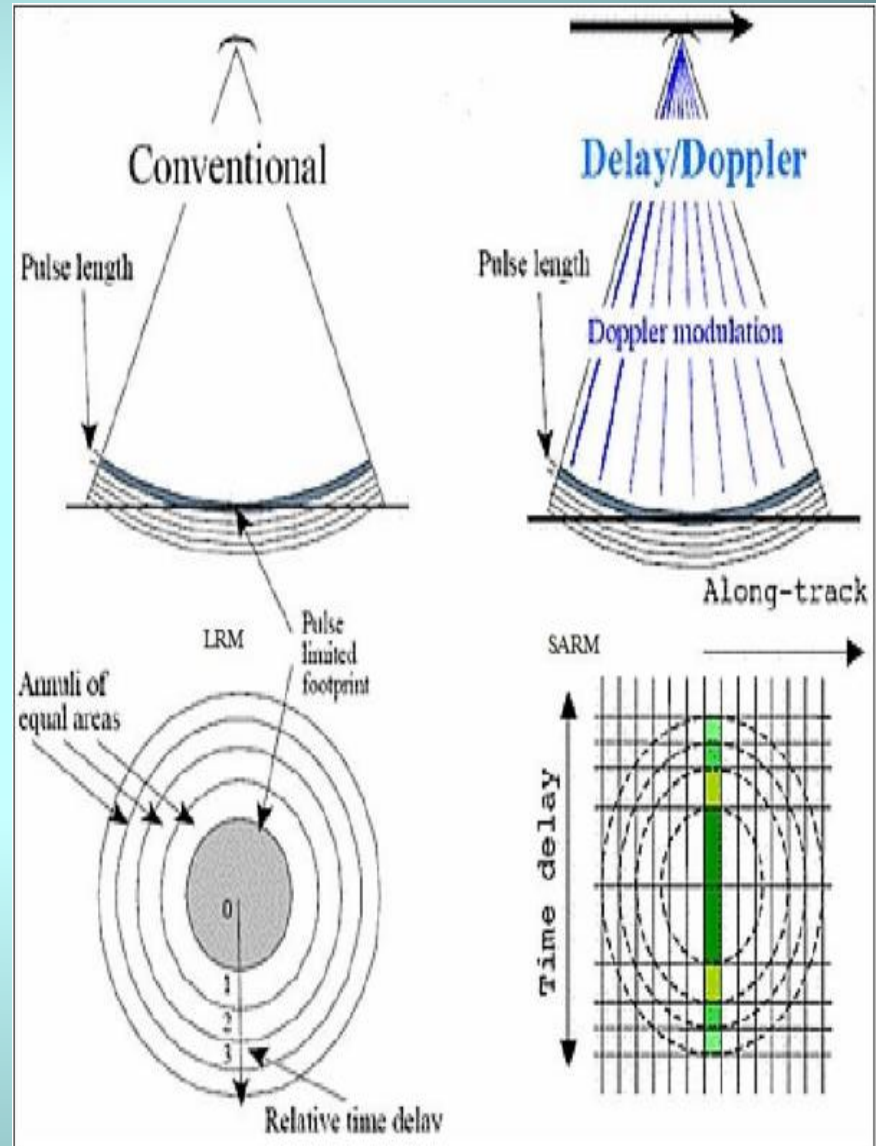
Case Study 3: Monitoring dams and reservoirs

- Project in cooperation with the Vietnam National Mekong Committee.
- To monitor the water level variation and volume variation of dams and water reservoirs in the Upper Mekong region from 2018 to 2019.
- Data in use
 - ✓ Jason-2;
 - ✓ Jason-3;
 - ✓ Sentinel-3.



Recent Advance in Altimetry Technique

- In 2016, the most important events are the satellites Jason-3 và Sentinel-3 were launched successfully into orbits that applied the advance techniques like SAR that permit to narrow the *footprint* size down to approximately 200 m.



Conclusion

Satellite altimetry technology is a useful tool and is feasible in some hydrological applications such as monitoring the water levels variation seasonally or interannually. Satellite altimetry data can be combined with remote sensing imagery to estimate the water flow and water reserves. The source of this data is currently being offered for free for the user community to serve the research, monitoring of water resources and the phenomenon of global climate change.

Thank you!