Utilisation de la marégraphie pour l'altimétrie et l'océanographie opérationnelle

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Use of tide gauge data for altimetry and operational oceanography

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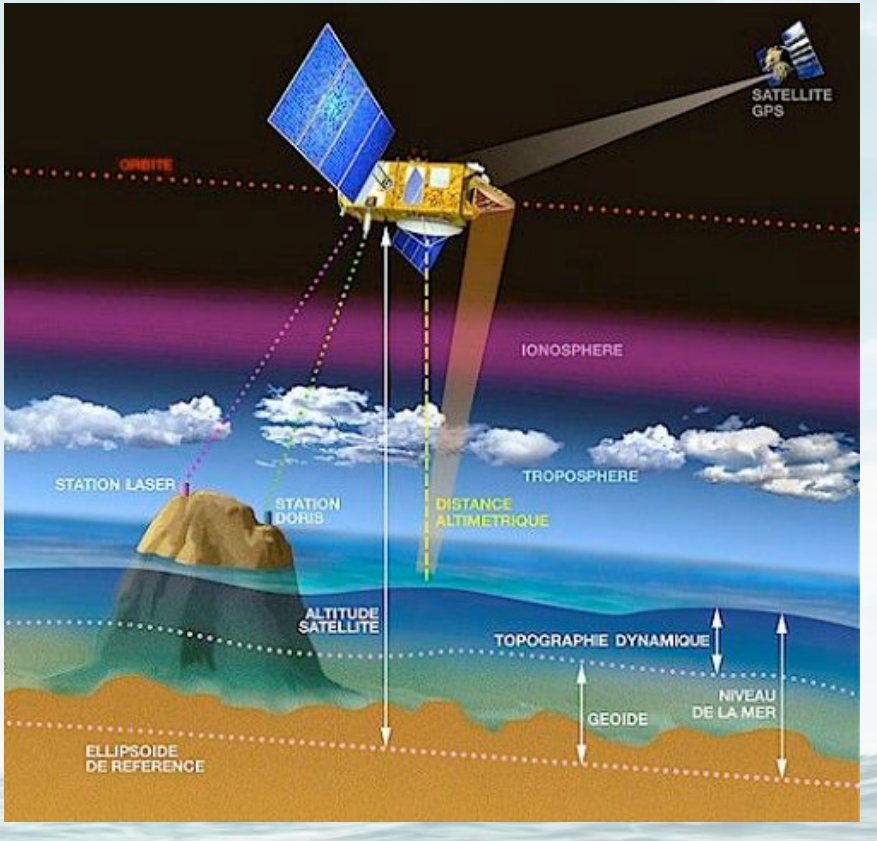
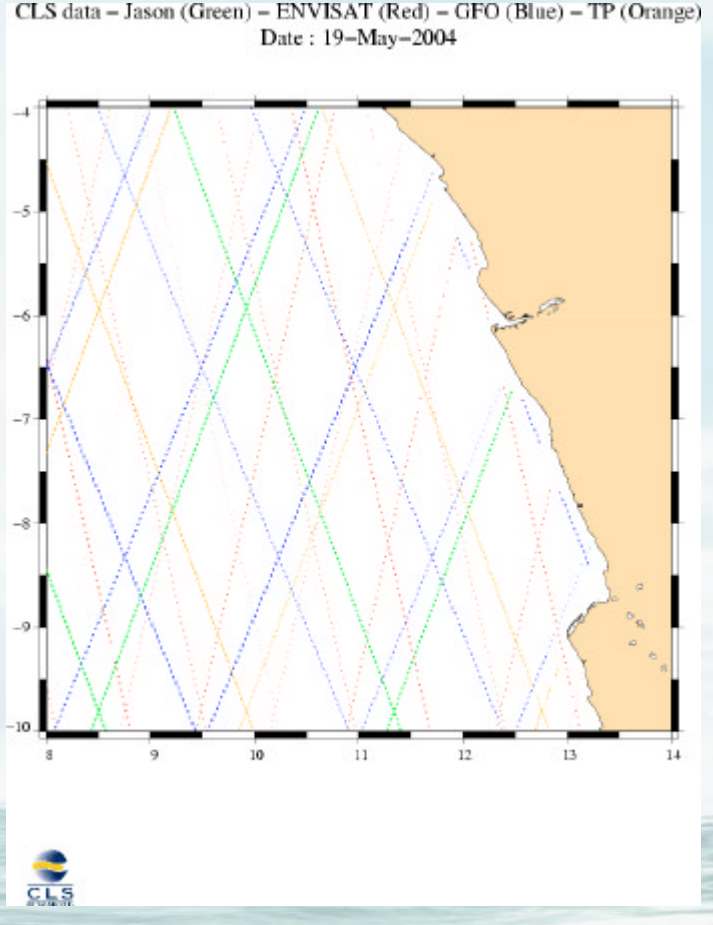
Purposes of the talk

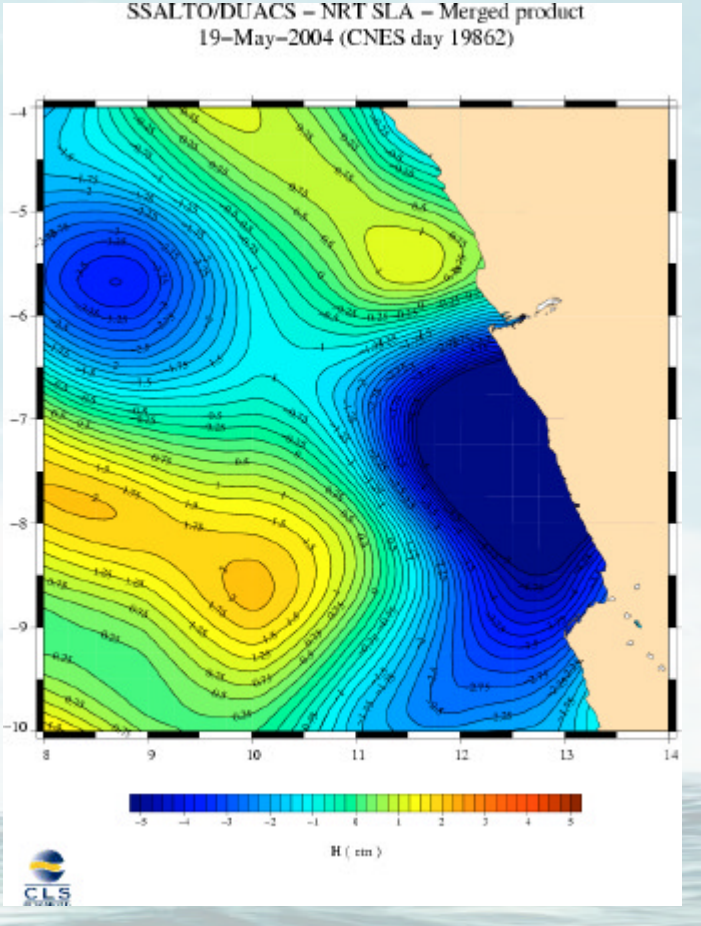
- Principle of altimetry
- Use of tide gauge data for altimetry purposes
  - In the past:
    - Altimetry compared to tide gauge data: absolute calibration
    - Global tide models
  - Today:
    - To compare value added altimetry works
    - Altimetry compared to tide gauge: relative calibration
  - In the future:
    - Needs to improve altimetry in coastal area: mean altimetry profiles
    - Surfaces of reference :
      - Mean Sea Surface
      - Mean Dynamic Topography
      - Lowest water level surface (Zéro hydro…)
- Conclusions

How altimetry works



Altimetry data





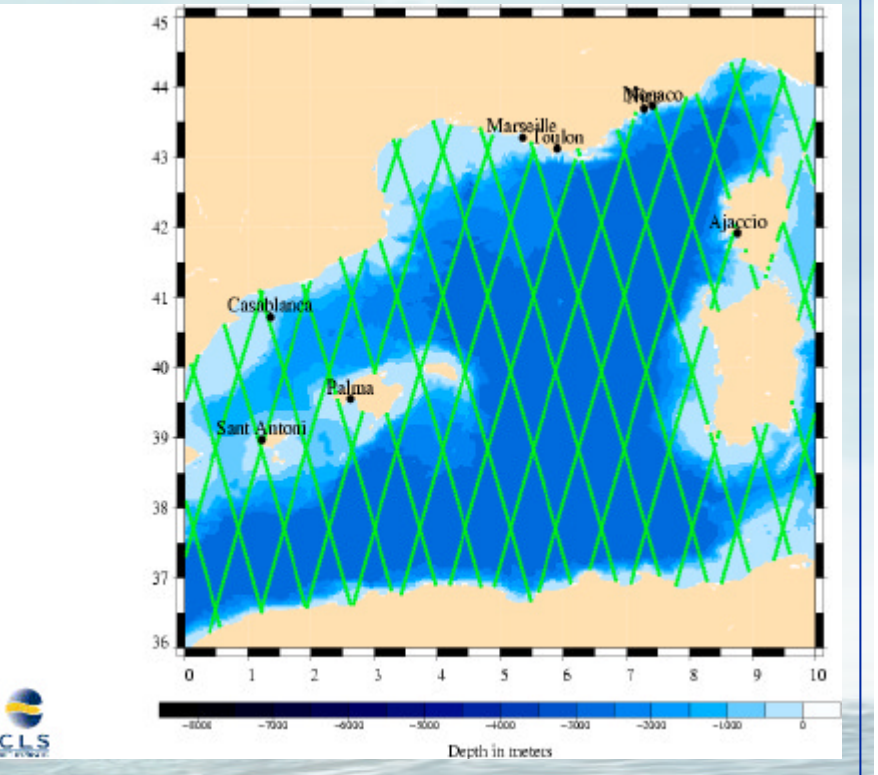
Use of tide gauge data in the past

Absolute calibration: purposes

- ESA study en 2003:
  - To compute the absolute bias of the altimeter RA-2 of ENVISAT
  - Just after the launch of ENVISAT
  - In the western Mediterranean Sea
  - Against tide gauge data

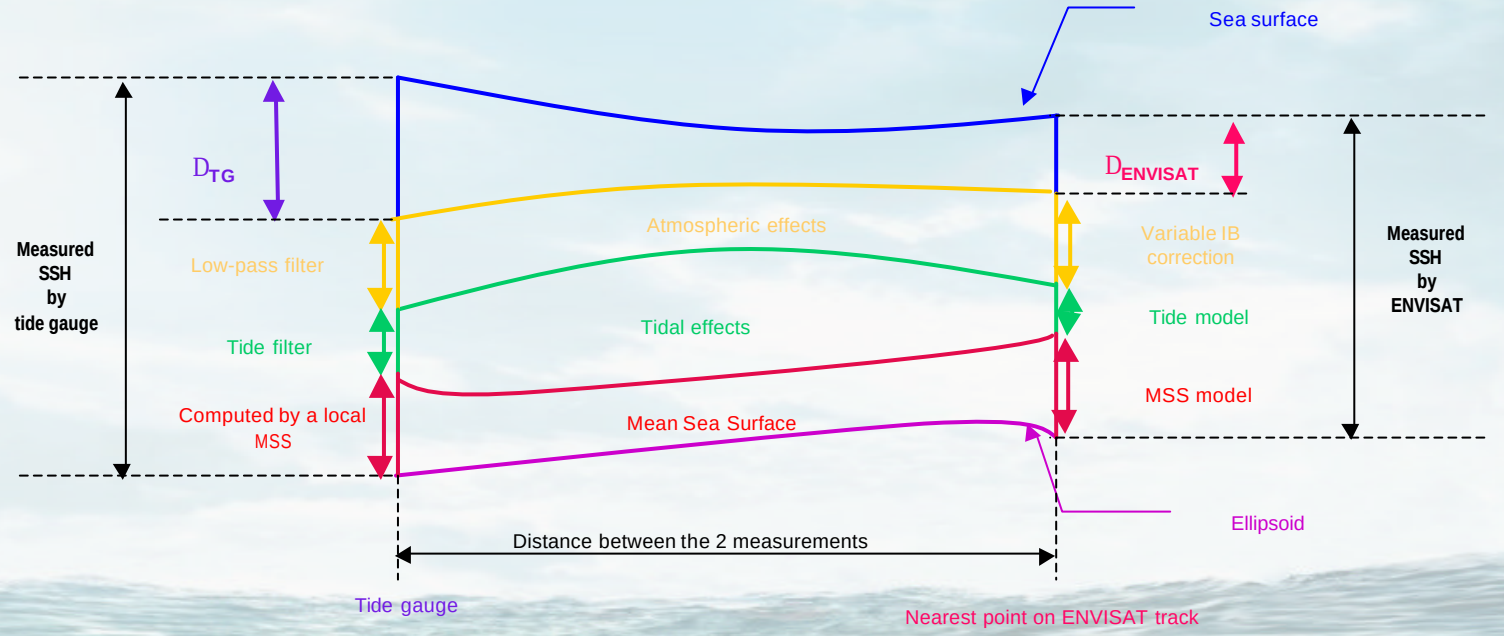
- Used tide gauge data:
  - IEMEDEA (Spain)
  - ICM (Spain)
  - SONEL (France)

- Problem: how compare ENVISAT data with in situ tide gauge data which are not under ENVISAT tracks?
- Solution: propagate in-situ measurements towards the satellite tracks by the use of specific algorithms



Absolute calibration: determination of the bias

Bias = DENVISAT - DTG (+/- errors on models and measurements)



Absolute calibration: computation of the Sea Surface Height (SSH)

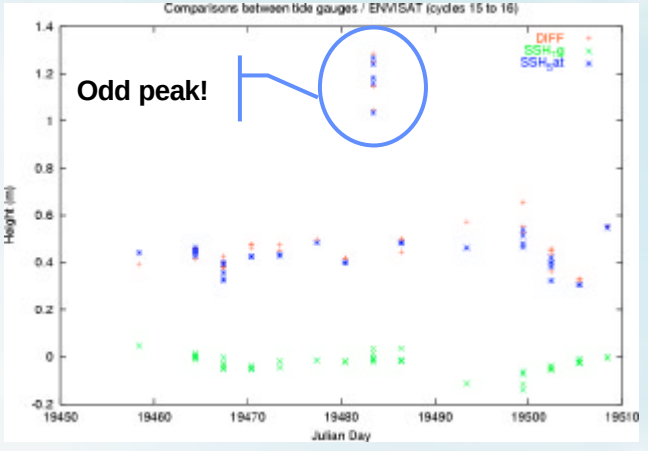
- SSH is approximated by the sum of:
  - the Mean Sea Surface (MSS)
  - the tidal elevation
  - the sea level elevation due to atmospheric effects

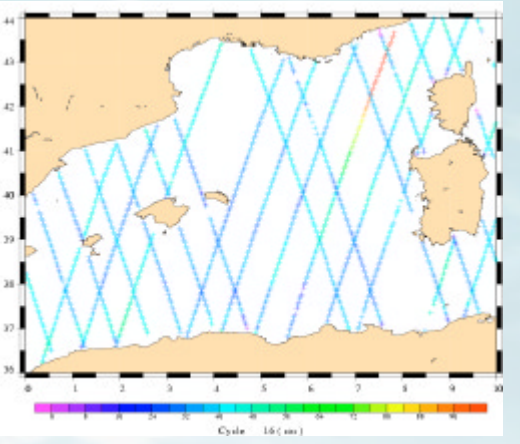
- SSH allows to link:
  - in situ measurements (with absolute reference to the ellipsoid)
  - to ENVISAT measurements (referenced to the ellipsoid)

- $?_{ENVISAT} = SSH_{ENVISAT}$ - (MSS model + tide model + var. IB cor.)

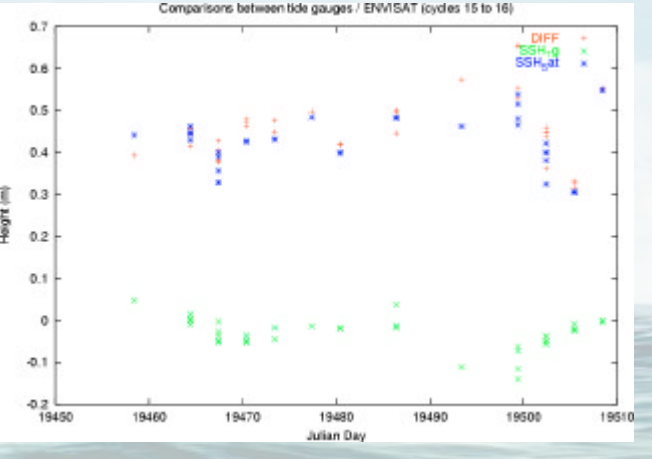
- $?_{TG} = SSH_{TG}$ - (local MSS + tide filter + low pass filter)

Absolute calibration: detection of errors in altimetry data



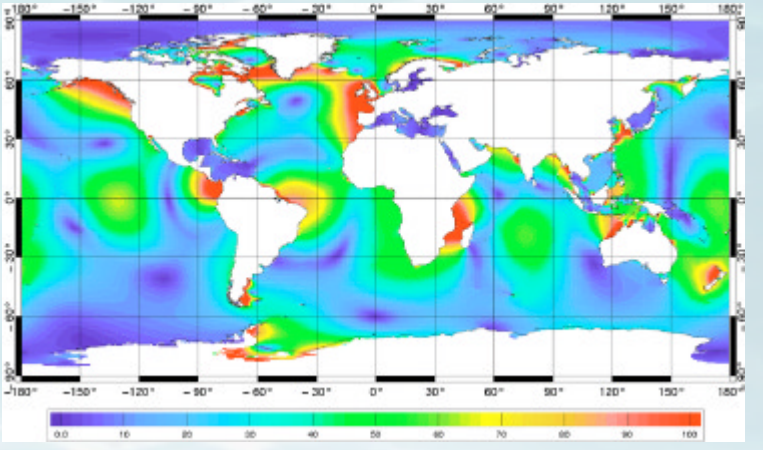


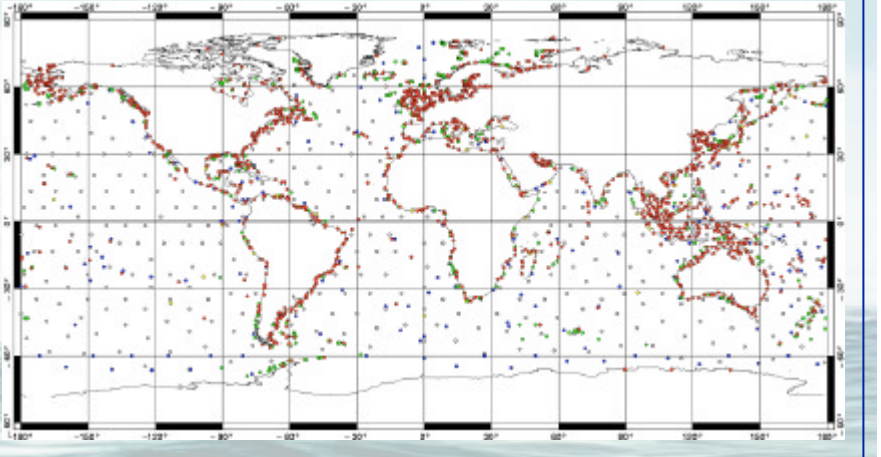
- SSH on cycle 16:
  - Bad data on track with SSH reaching 1 meter (in red)
  - Switching of RA-2 approaching the coast
  - Was not taken into account by the preprocessing of the data
- Some problems on satellite data can be highlighted by the comparison with tide gauges



Global tidal models

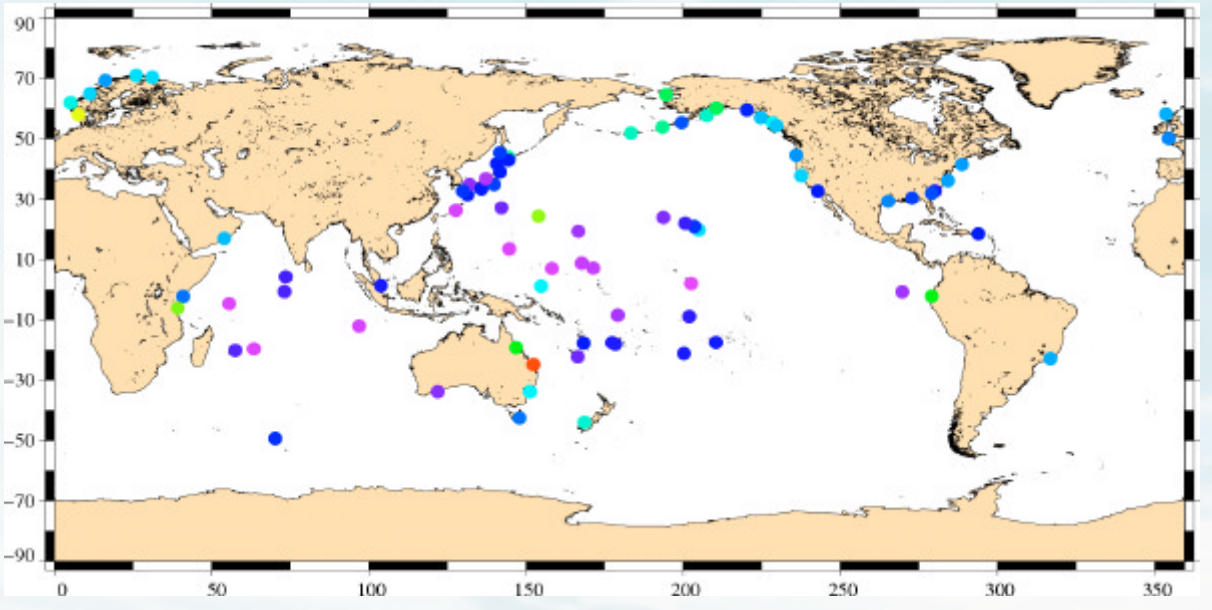
- Finite Element Solutions (Le Provost et al.):
  - FES99 (Lefèvre et al.)
  - FES2004 (Lyard et al.)
- Tidal harmonic components:
  - are assimilated into hydrodynamic models
  - to improve performances (especially along coastlines)
- Used network:
  - IAPSO
  - WOCE
  - IHO





Use of tide gauge data today

Altimetry validation



RMS diff (% of TG)
Pascual et al., 2005

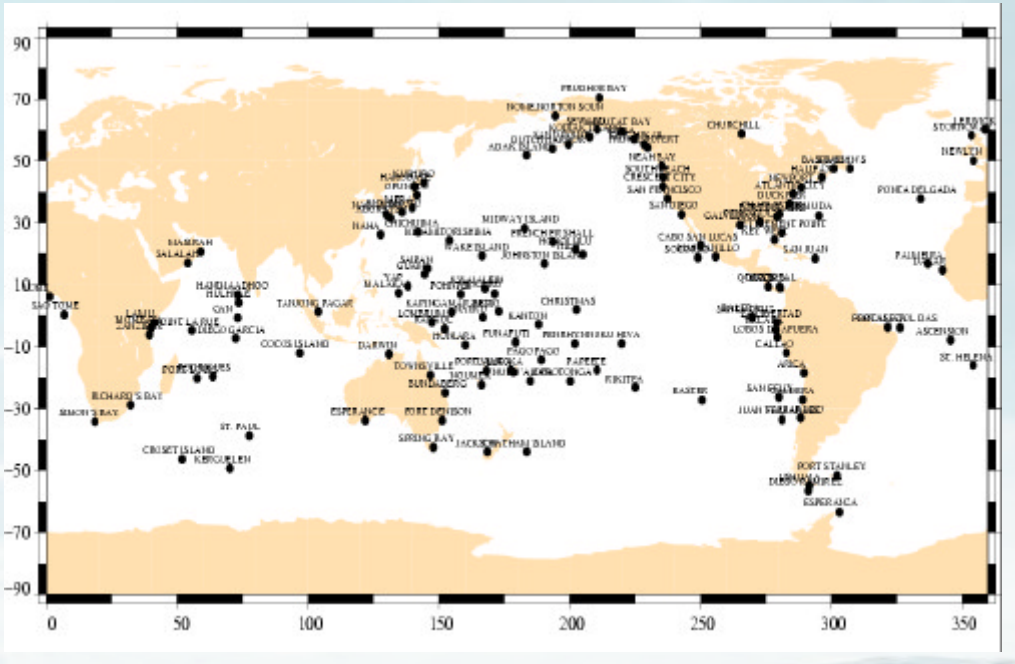
In average

	2 missions	4 missions
Old Corrections	**46.7%**	**35.3%**
New Corrections	**36.7%**	**29.7%**

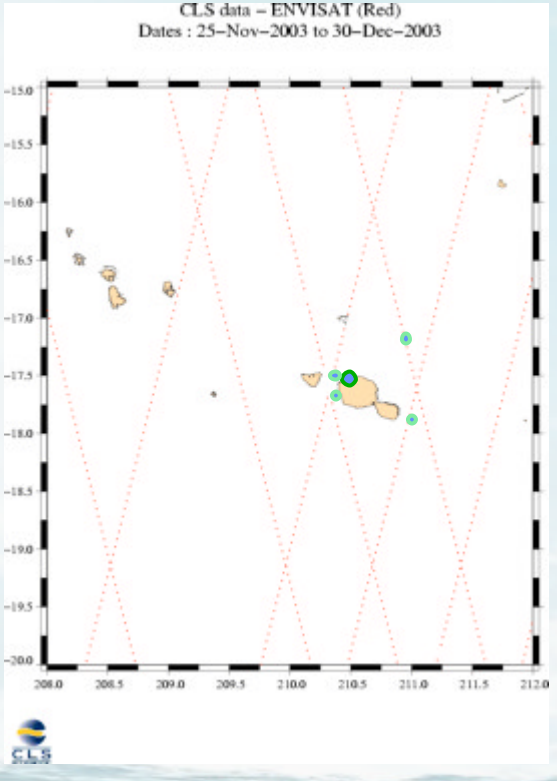
Relative calibration: purposes

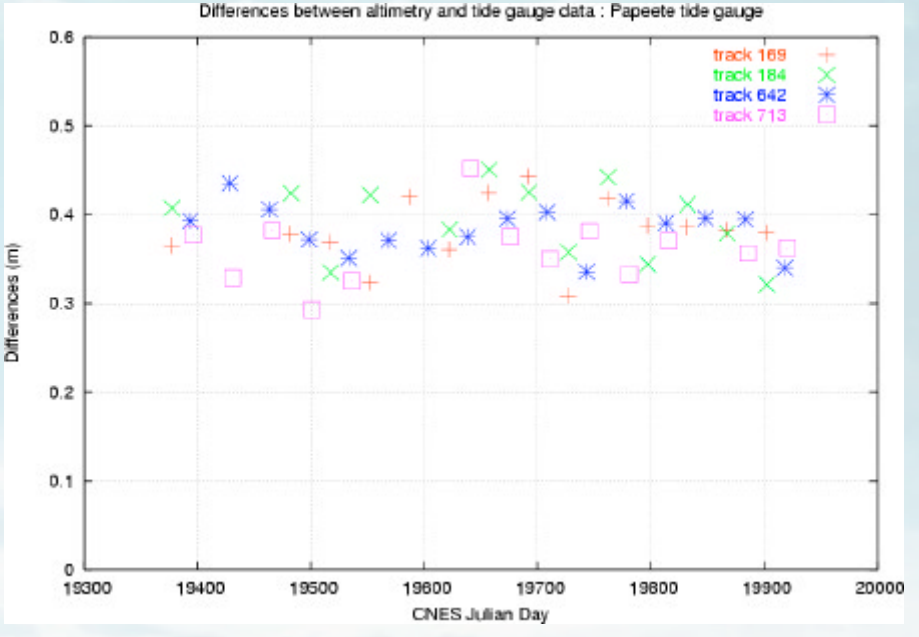
- Purposes:
  - To perform the ENVISAT RA-2 monitoring using a global tide gauge network
  - To do the long term monitoring of the determination of the ENVISAT RA-2 bias

  Relative calibration
  - Is based on the development of the absolute calibration
  - previous works (Mitchum, 1994, 1998, Cazenave et al., 1999)
  - Interest of a large number of measurements to reduce random errors
  - Tide gauge data are not absolutely referenced
  - Use of the GLOSS/CLIVAR network available at USHLC/Hawaii



Relative calibration: method

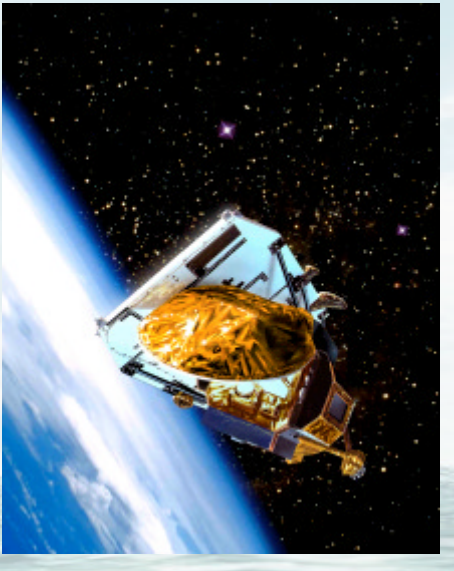




- For each tide gauge, altimetry data must be selected according to several criteria
- Choosing tide gauge stations where the differences between altimetry heights and the tide gauge sea levels are small is essential to get good variance estimates

Relative calibration: results

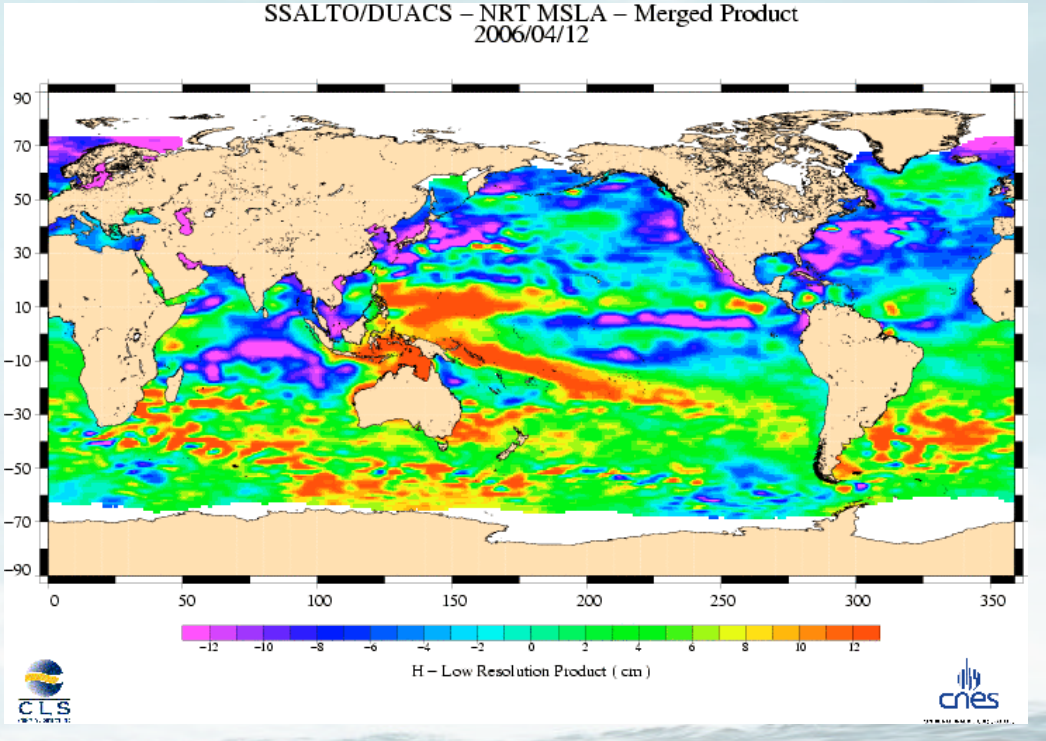
- Is used routinely at CLS
- Is part of the Quality Working Group of the ESA RA-2 monitoring
- Is also used for other altimetry satellites (Jason-1, GFO and T/P)



Use of tide gauge data in the future

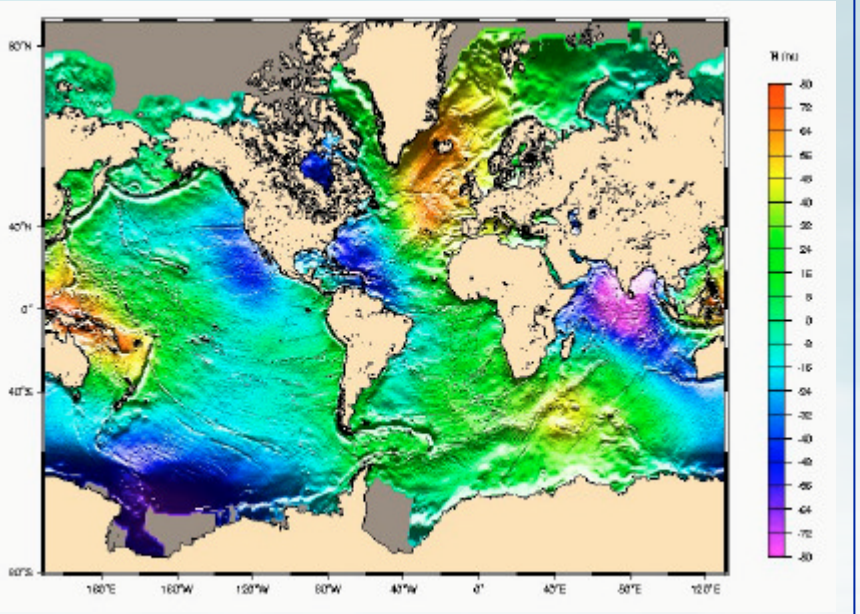
Mean altimetry profiles

- Computation of mean altimetry profiles:
  - Improvement in shallow water areas
  - Compared to tide gauge data
  - Tide gauge data used to link altimetry to the coast
- Computation of value added products:
  - SSALTO/DUACS system (CLS/CNES)
  - Provides:
    - Validated along track data
    - bi weekly maps of SLA and SSH in NRT



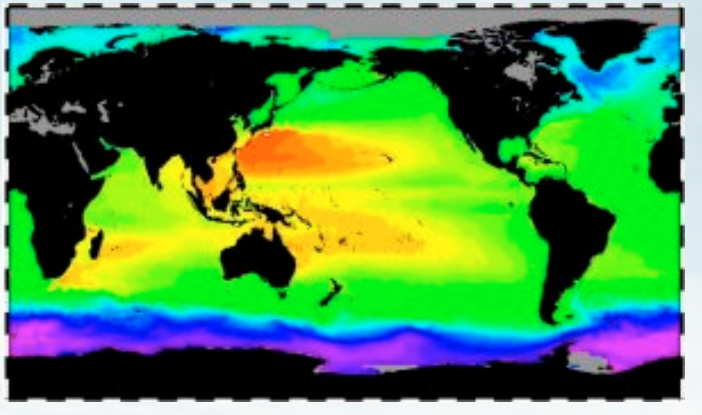
Mean Sea Surface

- MSS CLS01 (Hernandez et al., 2001)
- In the future: use of tide gauge data
  - To improve MSS in coastal areas
  - To ‘link” land to sea surface



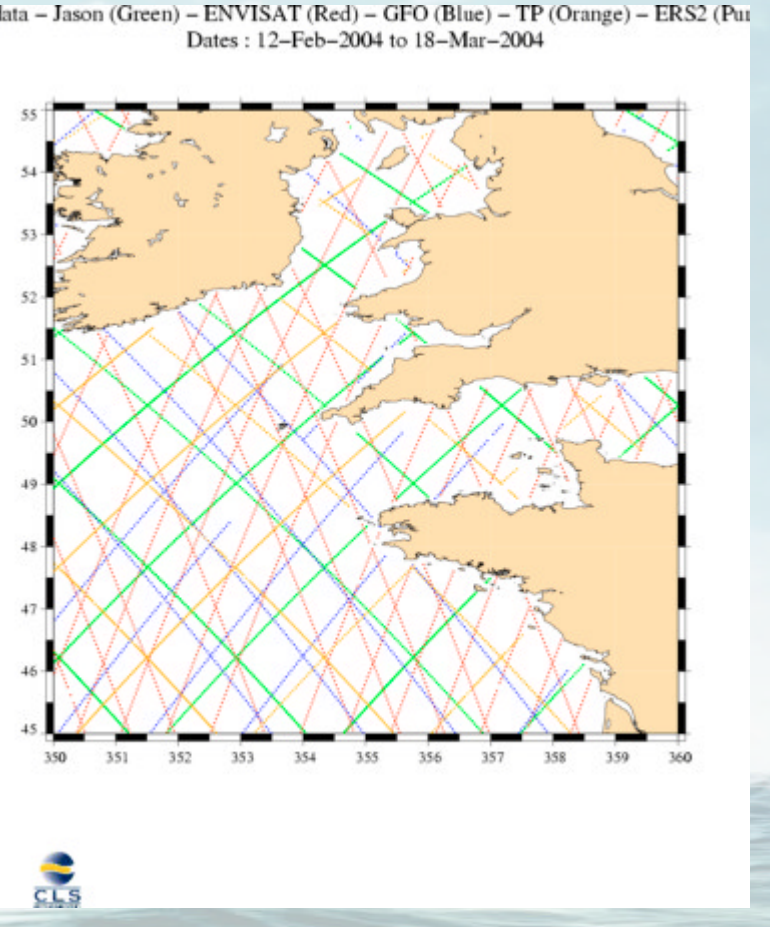
Mean Dynamic Topography

- CMDT-RIO05 (Rio et al., 2005)
- Use of altimetry data
  - To validate MDT in coastal areas
  - To improve MDT in coastal areas



Lowest water level surface (zéro hydrographique)

- Ocean surface of the lowest water levels (without tides)
- Specific computations on shelves and coastal areas with refined tide models
- How to link altimetry data to the coast with tide gauges?
- Study will start with SHOM soon



Conclusions 1

- 2 kind of altimetry data:
  - HH (historical data):
    - best altimetry data with best corrections
    - time delay of several weeks to several month
  - NRT (near real time data):
    - accurate data
    - time delay of one to several days

- Altimetry data are used to compute
  - Mean profiles
  - Surfaces of reference (static or dynamic: MSS, MDT, SLA, SSH…)
  - Value added products (operational oceanography)

Conclusions 2

- Tide gauge data (sea level stations…):
  - Are of main importance for altimetry purposes:
    - Calibration of altimeter sensors
    - Validation of altimetry processing chains
    - Improvements of altimetry value-added products in coastal areas (MSS, MDT…)
  - Need to be delivered
    - ~daily
    - with a time delay of ~1 day
  - If possible, to be referenced to earth motions

- Regional altimetry products are of foremost importance today (MERSEA…)