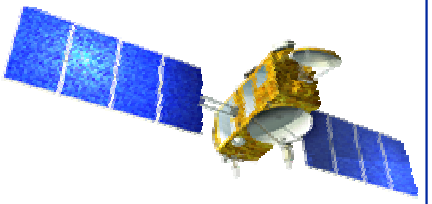


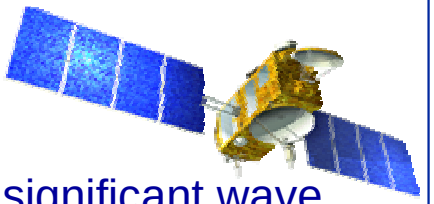
Comparison of the Ku-band Range Noise Level and the Relative Sea State Bias of the Jason-1, TOPEX and POSEIDON-1 Radar Altimeters

OZ. Zanifé, P. Vincent, L. Amarouche, JP. Dumont, P. Thibaut, S. Labroue

Very short synthesis of the paper that will be published in Marine Geodesy

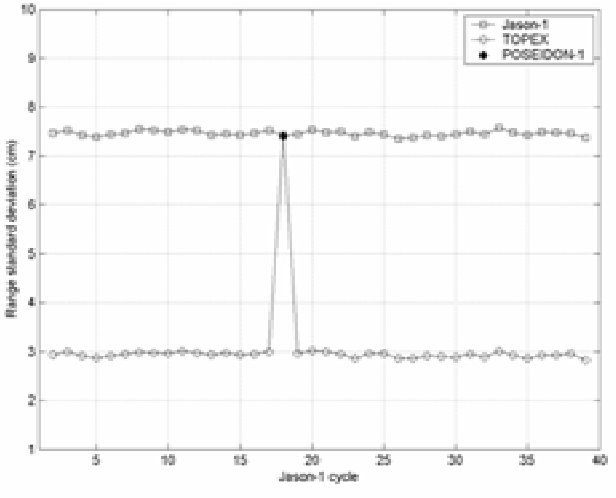
- Introduction
- Method
- Data
- Noise level results
- Relative SSB results
- Conclusions

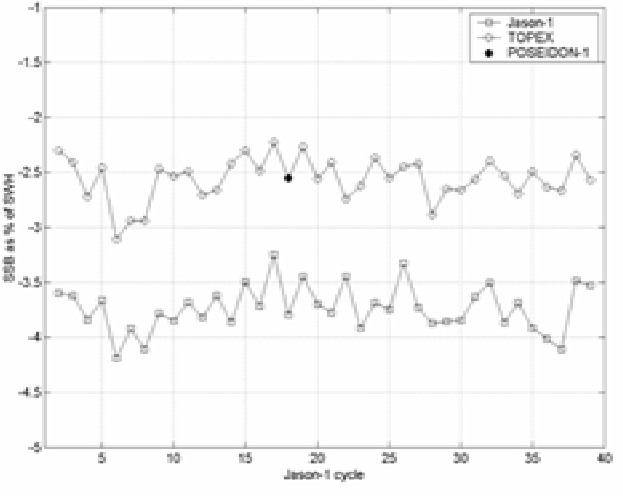
Introduction (1/2)



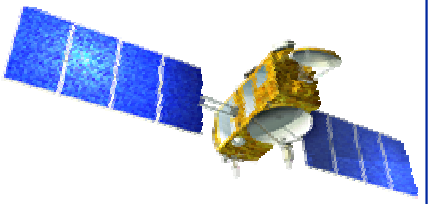
- From user products and for standard conditions (2 m significant wave height, SWH, and 11 dB backscatter coefficient, Sigma0) equivalent noise level and SSB :
  - TOPEX : 3.0 cm (10 Hz) and 2.5% SWH
  - POSEIDON-1 and Jason-1 : 7.5 cm (20 Hz) and 3.5% SWH

  (in the SSB diagram below POSEIDON-1 includes the normalization relative to TOPEX)



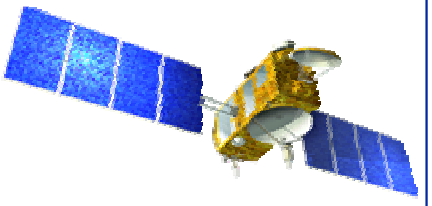


Introduction (2/2)



- It is recalled that operational TOPEX data are not retracked, while POSEIDON-1 and Jason-1 are retracked
- The retracking is one feature that could explain the differences between TOPEX and POSEIDON-1/Jason-1
- The objective is then to compare Ku band noise level and relative sea state bias (SSB) from TOPEX, POSEIDON-1 and Jason-1 using homogeneous data

Method (1/3)



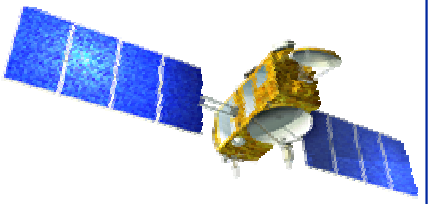
- Identical retracking of the three radar altimeter waveforms using the same part of the waveform

	TOPEX	POSEIDON-1	Jason-1
Samples used	5 to 56	5 to 56	18 to 70
Center sample	32.5	32	44
Waveforms rate (Hz)	10	10	10
Filter	Official one (Hayne et al. 1994)	Mission one	From LTM (Average over 20 cycles)
Antenna Beamwidth	1.08	1.1	1.28
Skewness coefficient	0	0	0
Max number of iterations	25	25	25
Gains for the retracking	(1,1,1)	(1,1,1)	(1,1,1)
Coefficient for SigmaP	0.513	0.513	0.513
Convergence criteria	MQE	MQE	MQE
Threshold	5.00E-04	5.00E-04	5.00E-04

OZZ retracking features

- The OZZ retracking is similar to the Jason-1 retracking except for :
  - 10 Hz waveforms to be similar to TOPEX waveforms (ground)
  - Jason-1 samples 18 to 70 instead of 14 to 116

Method (2/3)



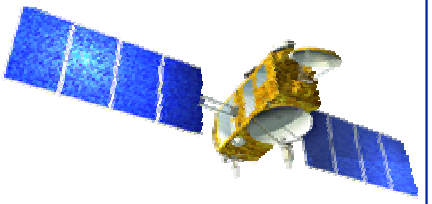
- The range noise level is computed through spectral analysis (periodogram method) using the polynomial residuals of the raw Sea Surface Height : *SSH_raw = Orbit – Range – Mean_Sea_Surface*

$$PSD(f) = \frac{1}{L}\sum_{l=1}^{L} \frac{\frac{1}{M}\left|\sum_{k=0}^{M-1} x_l(k)w(k)e^{-2\pi jfk}\right|^2}{\frac{1}{M}\sum_{k=0}^{M-1} w^2(k)}$$

$$Noise\,(m^2/Hz) = \frac{1}{N}\sum_{f_c}^{f_{max}} PSD(f)$$

$$Noise\ (cm) = \sqrt{\frac{Noise\ (m^2/Hz)*10^4}{2*\Delta\tau}}$$

Method (3/3)



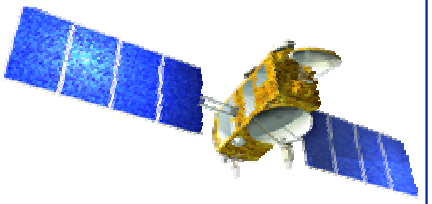
- The relative SSB is computed using the data from the verification phase : TOPEX/POSEIDON and Jason-1 on the same ground track and separated by about 72 seconds

$$res\_SSH_2 - res\_SSH_1 = \left(Orb_2 - range\_corr_2 - \varepsilon_{SSB2} - h_{MSS2}\right) - \left(Orb_1 - range\_corr_1 - \varepsilon_{SSB1} - h_{MSS1}\right)$$

$$\varepsilon_{SSB} = \alpha\ SWH$$

$$\left(Orb_2 - range\_corr_2 - h_{MSS2}\right) - \left(Orb_1 - range\_corr_1 - h_{MSS1}\right) = (\alpha_2 - \alpha_1) SWH_1$$

Data



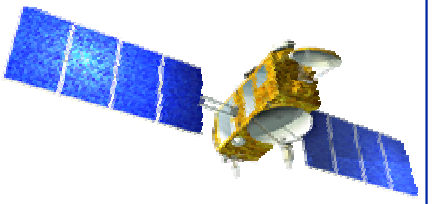
- Data from the verification phase and in particular comparison between :
  - TOPEX cycle 360 and Jason-1 cycle 17
  - POSEIDON-1 cycle 361 and Jason-1 cycle 18

- 218 passes used

- Editing criteria :
  - number of valid data /sec >= 9
  - SWH_Ku between 0 and 8 m
  - Sigma0_Ku between 7 and 15 dB

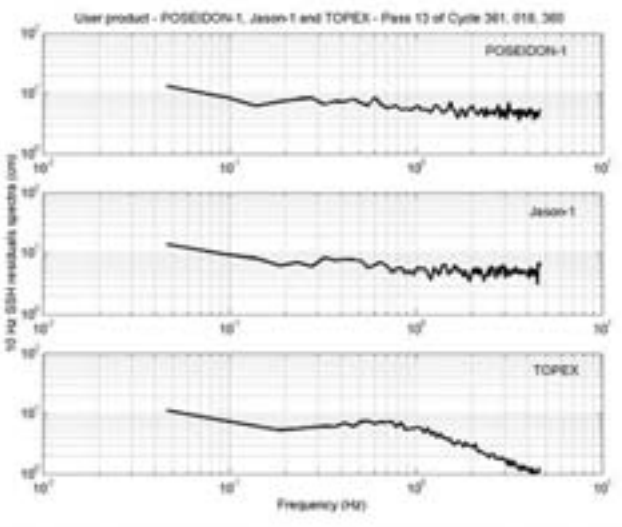
- ***IGDR data for Jason-1***

Noise level results (1/4)

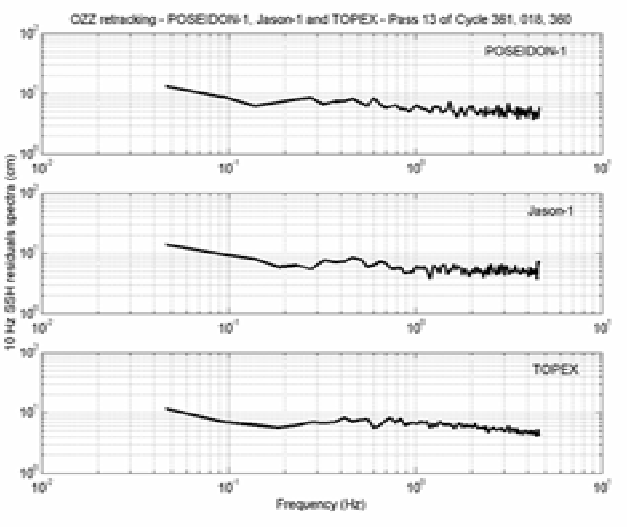


- 10 Hz noise level : analysis for one pass

User product

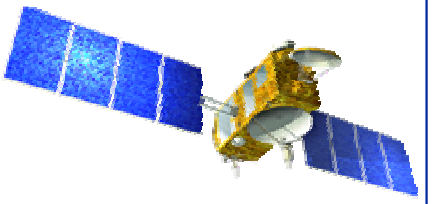


OZZ retracking

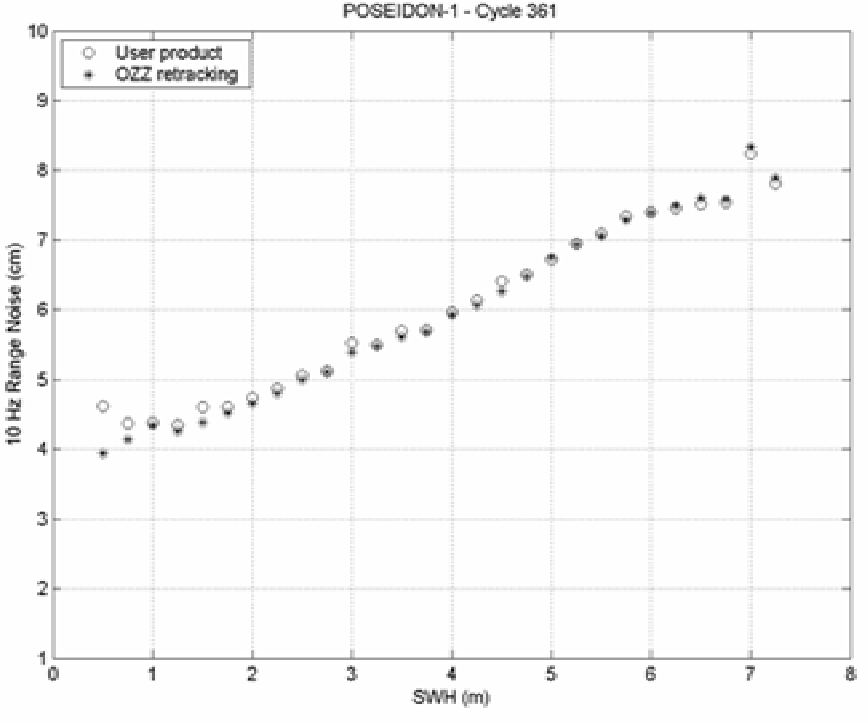


- The retracking whitens the TOPEX spectra

Noise level results (2/4)

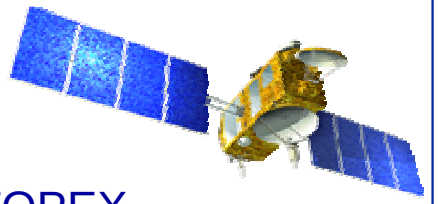


- 10 Hz noise level : analysis vs SWH – POSEIDON-1

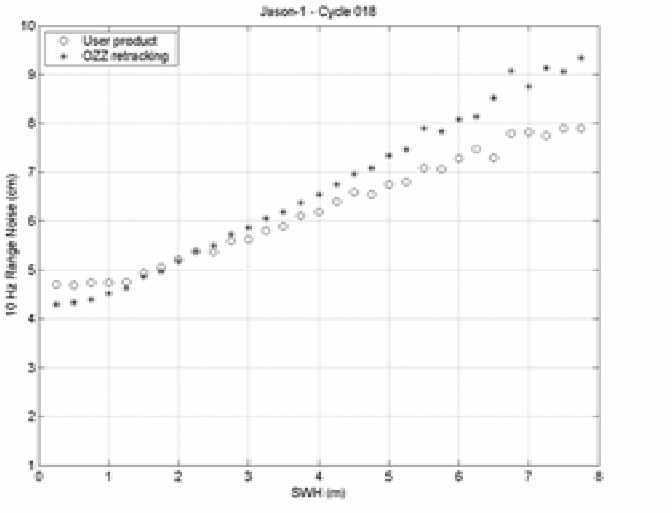


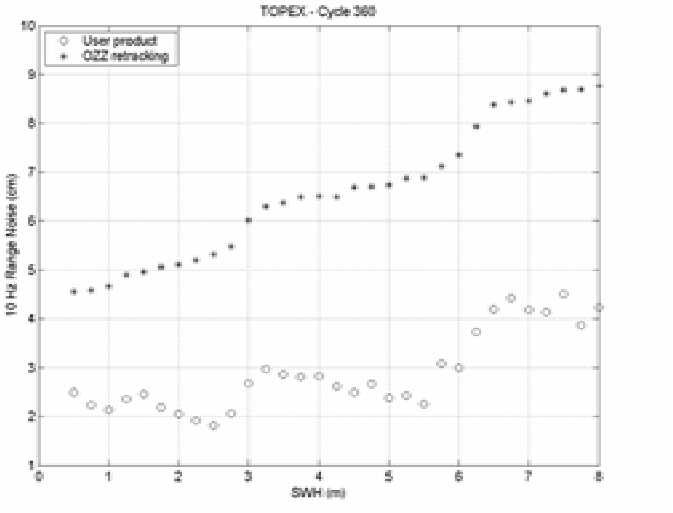
- a very good consistency between the POSEIDON-1 ground retracking and the OZZ retracking

Noise level results (3/4)



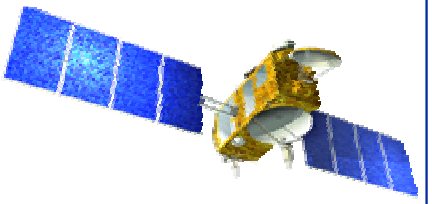
- 10 Hz noise level : analysis vs SWH – Jason-1 and TOPEX





- Jason-1 : differences between user product and OZZ retracking is due to the number of samples used in both retracking (CMA and OZZ)
- TOPEX : gate index effects appear at 1, 3 and 6 m
  retracking increases the noise which is white now

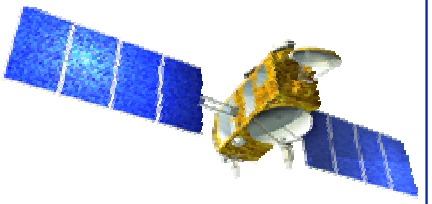
Noise level results (4/4)



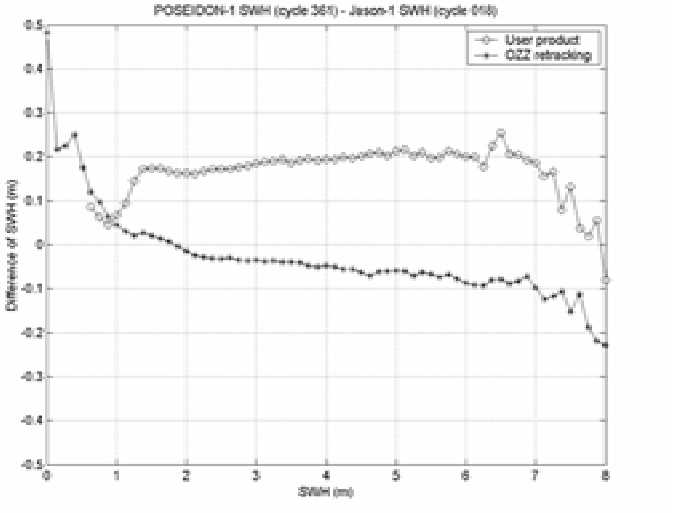
- TOPEX : the retracking is smoothing the gate index effects
- after OZZ retracking TOPEX, POSEIDON-1 and Jason-1 have a very similar noise level at about :

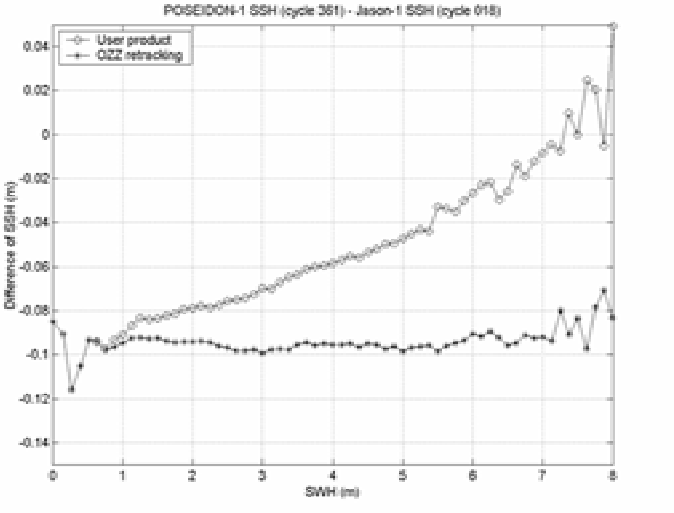
5 cm at 10 Hz for 2 m SWH which translates into 1.6 cm at 1 Hz

Relative SSB results (1/3)



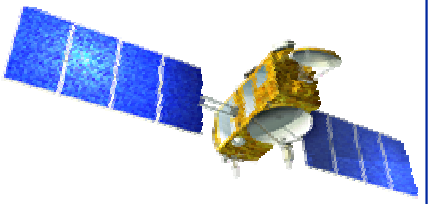
- analysis as function of SWH
- POSEIDON-1 vs Jason-1



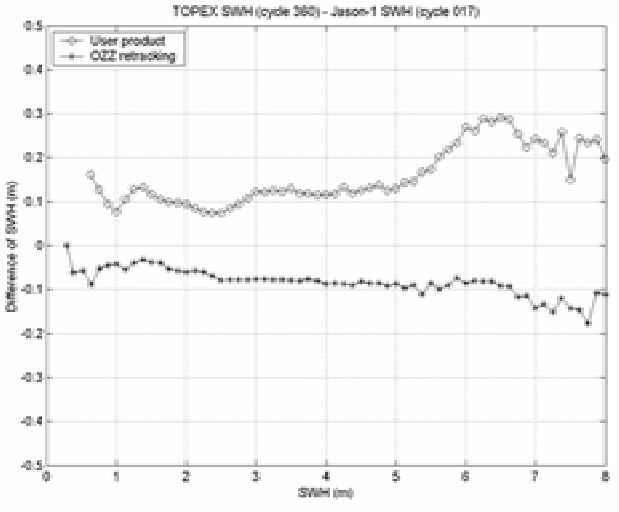


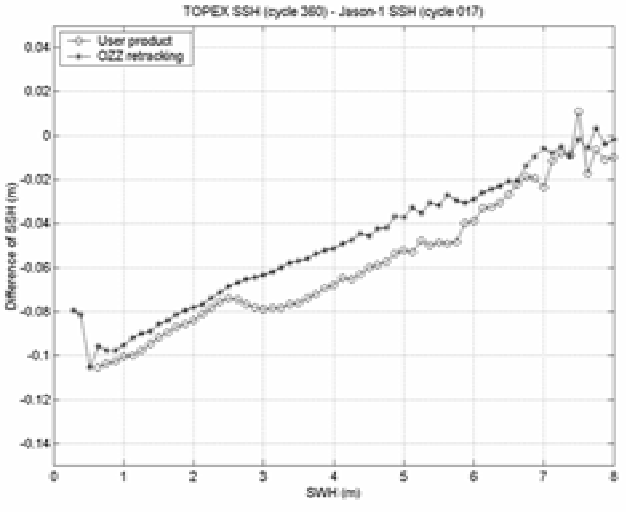
- The fact that after OZZ retracking the difference of SSH is a constant and does not show any SWH dependency indicates that the SSB of the two altimeters is very similar

Relative SSB results (2/3)



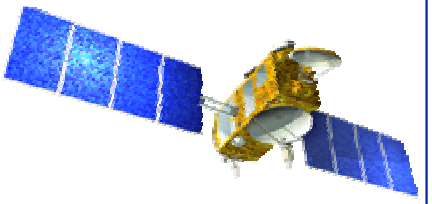
- TOPEX vs Jason-1



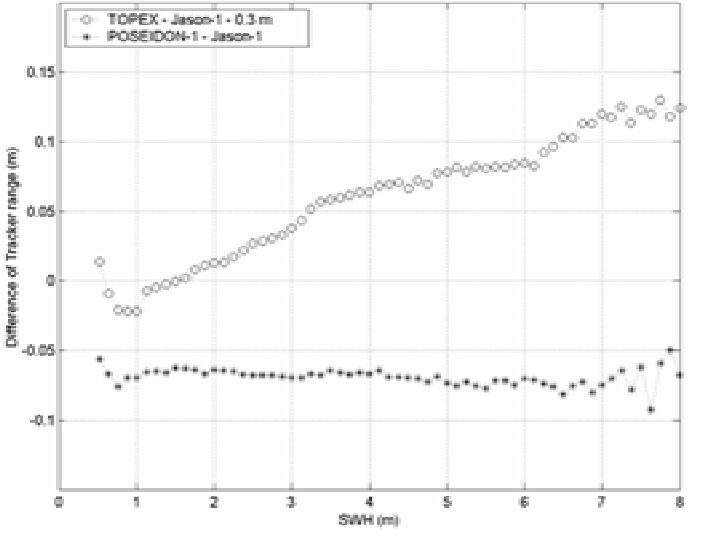


- Unlike the POSEIDON-1/Jason-1 case, the retracking does not remove the relative SSB
- This indicates that most of the relative SSB is coming from the trackers
- As for the noise level, the retracking smooths the gate index effects

Relative SSB results (3/3)

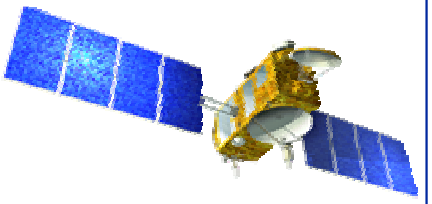


- Relative tracker bias



- Both POSEIDON-1 and Jason-1 behave the same way. This is an expected result as they are both using the same tracking algorithm
- TOPEX and Jason-1 present a relative SSB of about 2 % SWH and at the present stage of the study it is not possible to determine their relative contribution

Conclusions



- TOPEX, POSEIDON-1 and Jason-1 have been retracked using the same algorithm (OZZ), which is very similar to the Jason-1 one
- After OZZ retracking, all three altimeters exhibit the same noise level : 5 cm at 10 Hz equivalent to 1.6 cm at 1 Hz for 2 m SWH
- Nevertheless the OZZ retracking does not remove the relative SSB between TOPEX and POSEIDON-1/Jason-1
- The source of this relative SBB has been identified within the tracker and detailed simulations of the trackers will be carried out to identify more precisely which part of the tracker is responsible for it
- This study has to be re-done with Jason-1 GDR data with more cycles
- More details are given in the Marine Geodesy paper