Sea State Bias on the Jason-1/2 missions

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Content

- Part 1: Tracker bias differences between Jason-1 and Jason-2

- Part 2: Alternative SSB solutions for Jason-1 from the SLOOP project

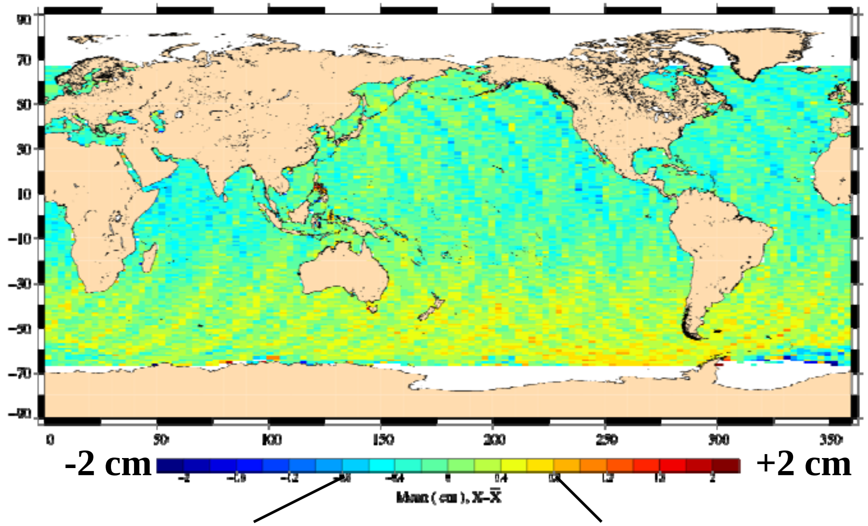
  - Analysis of the differences in term of SLA, SWH, wind speed and SSB estimates.

  - Since the two sensors should be subject to the same electromagnetic bias, any residual signal depending on sea state is considered to come from a tracker bias difference.

Comparison of Jason-1 & Jason-2 SLA (no correction)

Orbit - Range - MSS

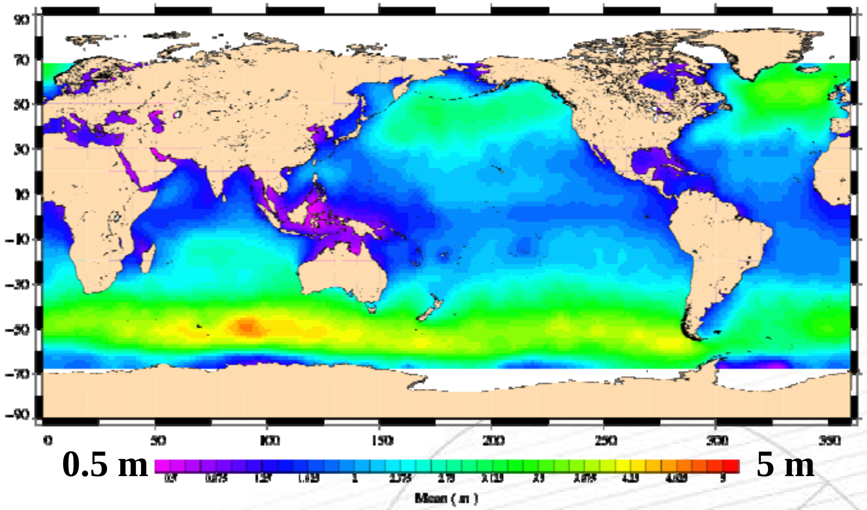
J1 – J2 (GDR cycles 240-259 / 1-20)



-2 cm +2 cm

-0.8 cm Centered map +0.8 cm

J2 SWH (GDR cycles 1-20)



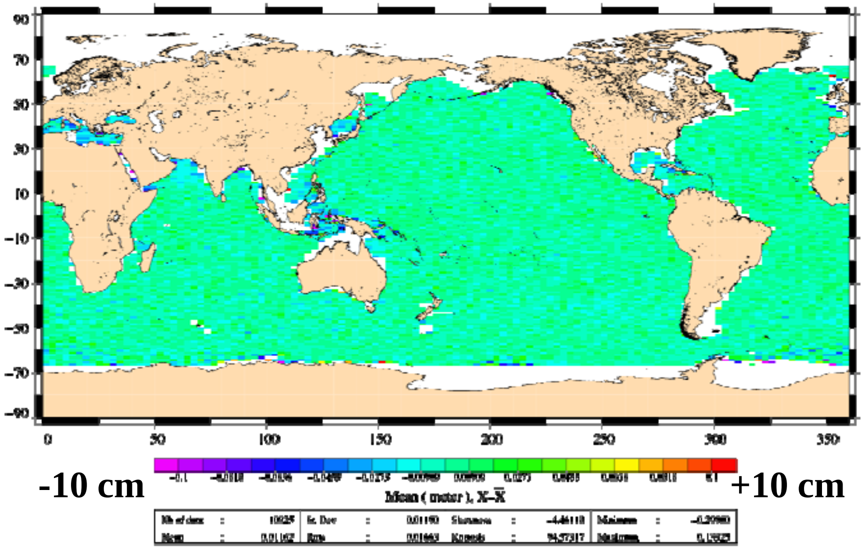
0.5 m 5 m

- Differences in SLA do not show any obvious correlation with waves
- They do not point out differences between the tracker biases of the two altimeters

Comparison of Jason-1 & Jason-2 SWH, Wind Speed

GDR cycles 240-259 / 1-20

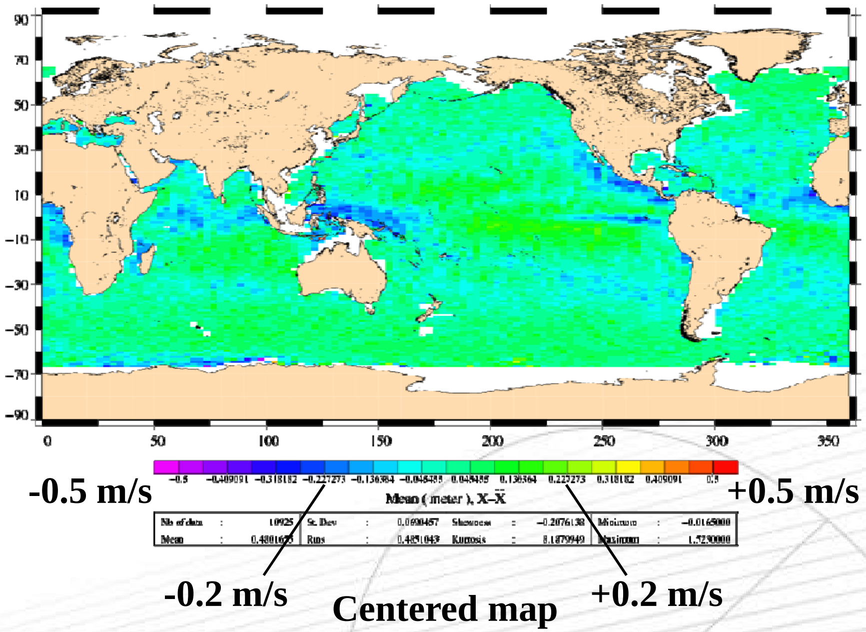
SWH differences



Centered map

Mean value = 1.16 cm,
RMS = 1.66 cm

Wind Speed differences



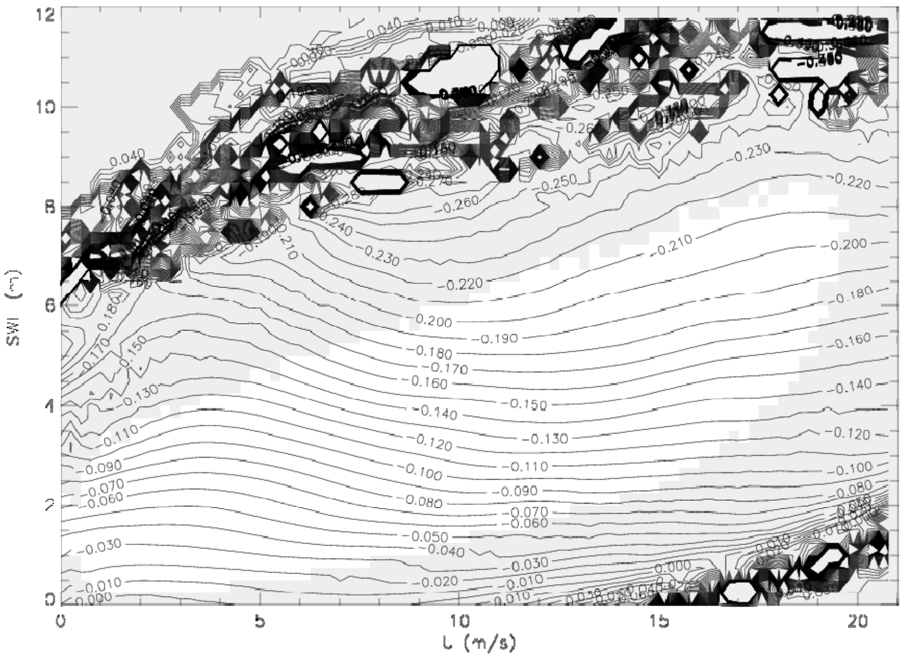
Centered map

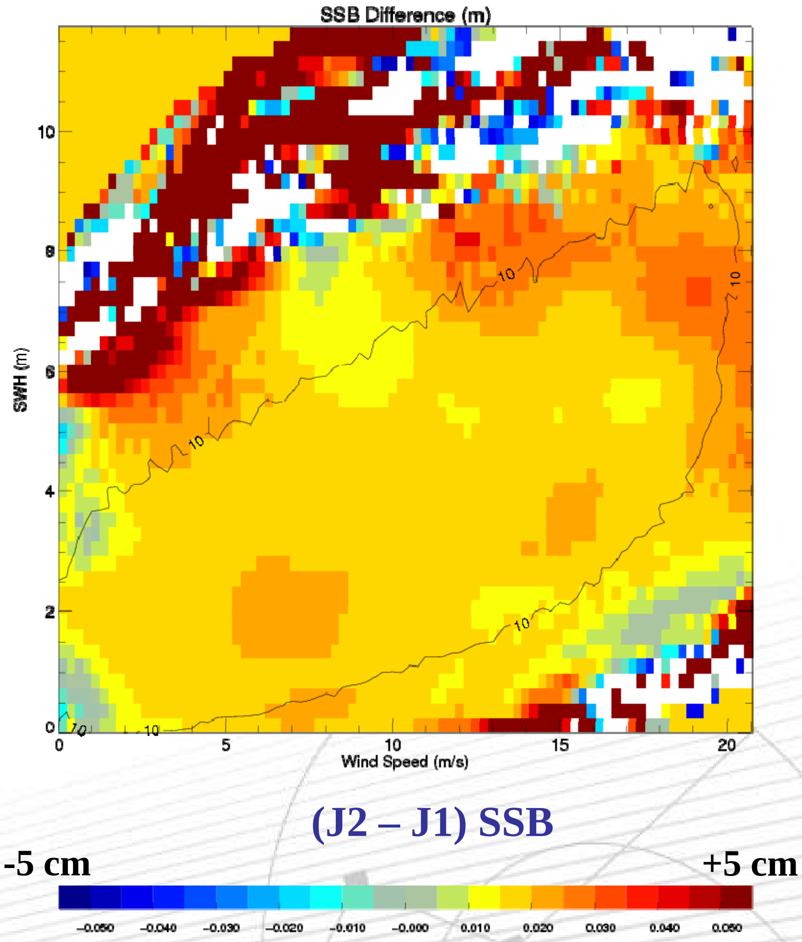
Mean value = 0.48 m/s,
RMS = 0.48 m/s

- Some patterns are observed in the tropical area

Comparison of Jason-1 & Jason-2 SSB

Jason-2 SSB



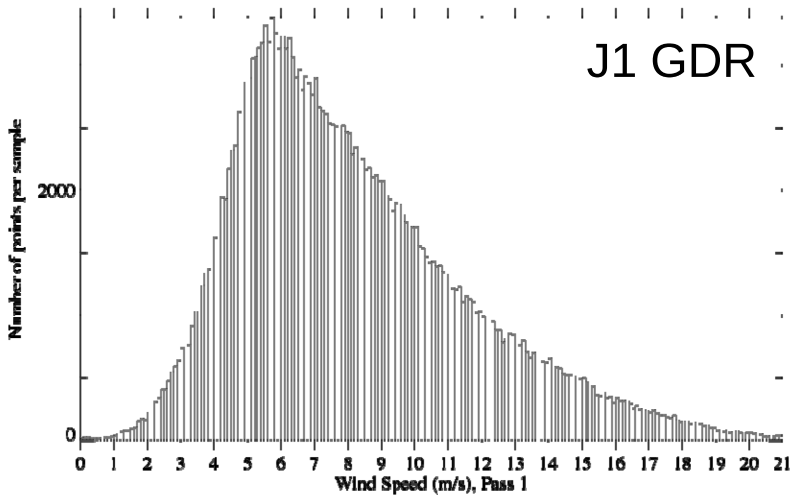


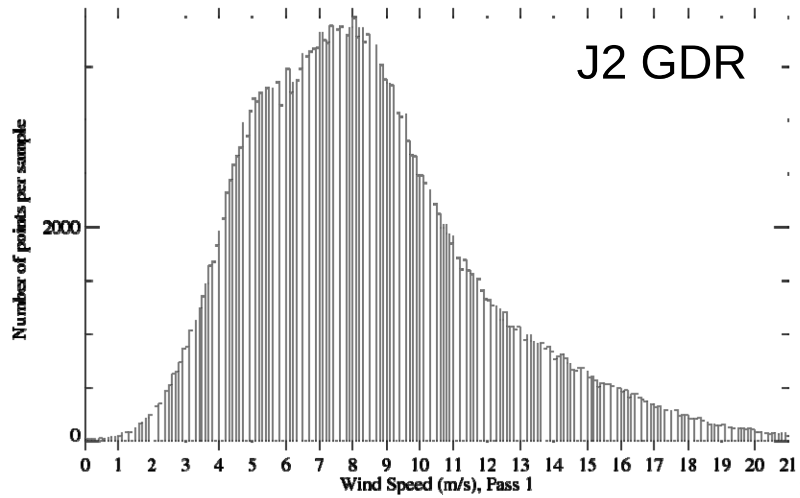
(J2 – J1) SSB

- J2 and J1 SSB both estimated on the tandem period data (20 cycles / GDR products)
- estimation with collinear approach (10-day differences)
- Close differences in most of the (SWH, U) plan of ~1.5-2.0 cm between the 2 solutions

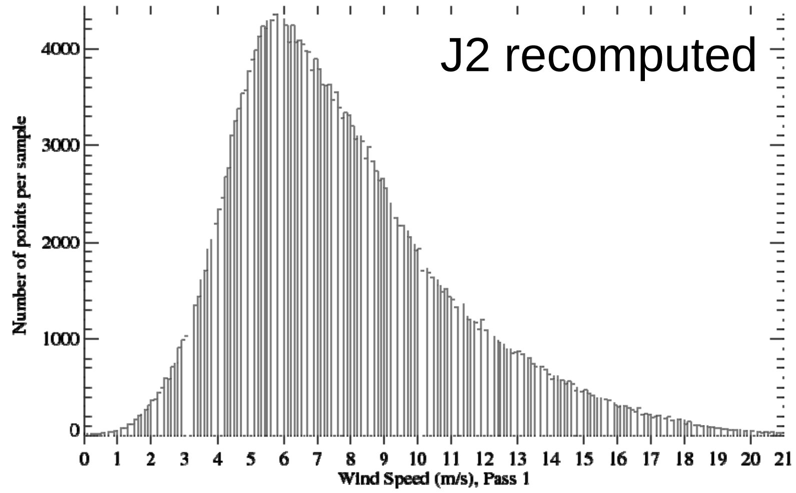
- very consistent SSB solutions are obtained for J1 and J2, no sea state dependence difference is pointed out here
- the tracker bias for the Jason-2 altimeter looks equivalent to the one for Jason-1

Finer look at Jason-1 & Jason-2 Wind Speed

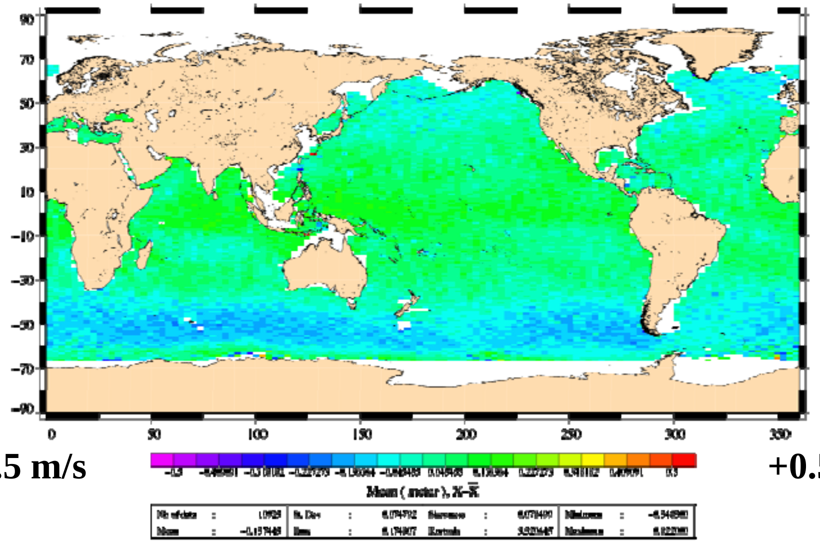




- Differences of shape of the wind speed distribution
- Test of a linear adjustment of sigma0 mainly before recomputing the wind speed (S. Phillips)
- J2 recomputed wind speed distribution looks more like the J1 one



Wind Speed differences (J2 recomputed)



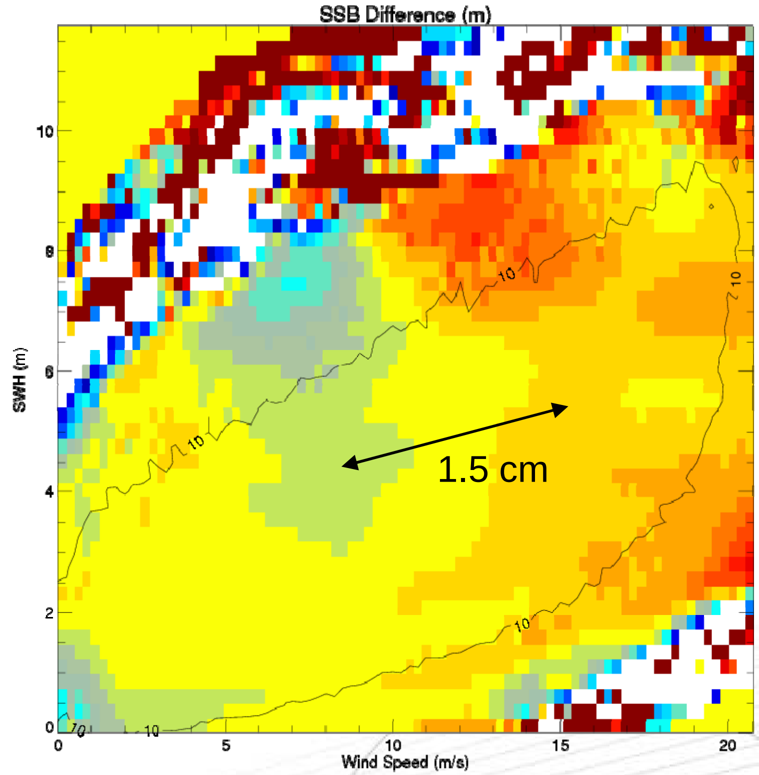
-0.5 m/s

+0.5 m/s

Centered map

Mean value = -0.16 m/s,

RMS = 0.17 m/s



(J2 – J1) SSB

-5 cm

+5 cm

- The previous statement on the tracker bias difference between the two altimeters has to be qualified, a slight difference is displayed here.
- It has to be qualified if the wind speed adjustment is needed through some validation of the J2 wind speed before conclusive analysis on the tracker bias difference can be done.

Content

- Part 1: Tracker bias differences between Jason-1 and Jason-2

- Part 2: Alternative SSB solutions for Jason-1 from the SLOOP project

  – To merge aspects of what is known about physical controls on the sea state bias with use of available but imperfect wave model correlative data to improve description of the SSB correction.

  – 2 approaches: global 3D models and class-based models.

  – Use of a pre-processing classification scheme to separate sea states into classes representing varied wave age and steepness regimes, i.e. swell-dominated, young seas and intermediate mixed seas.

  – This is expected to help the identification of sources of ambiguity residing within the altimeter-provided data (SWH, U) that leads to ambiguous SSB correction and hence altimeter range errors.

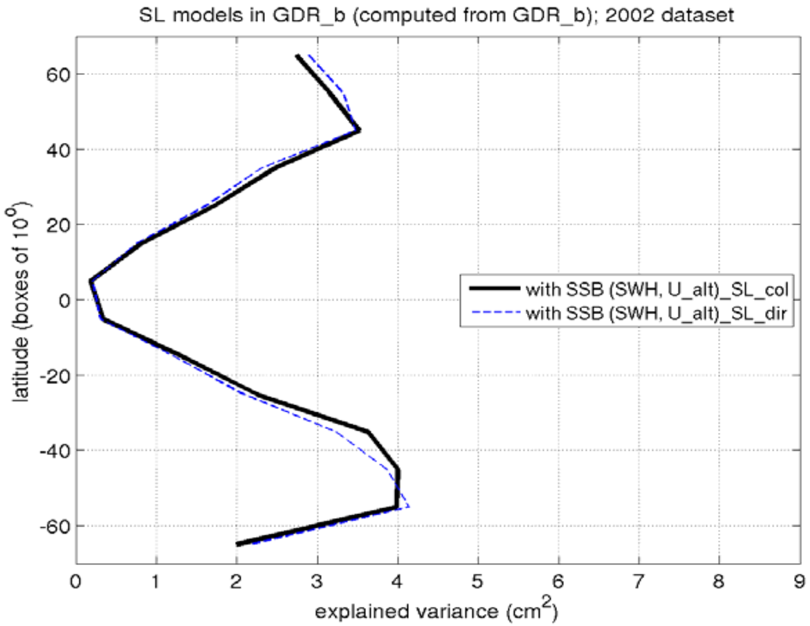
  – Different 3D SSB models are created for each of these classified data subsets to adapt the parameterization of the SSB to each of these particular regimes by keeping a low number of useful correlatives.

Approach overview

- Development of global 3D models based on (SWH, U, Tm) and (SWH, U, H_swell)

- Development of class-based models
  - Classification of the sea states into 2 classes from 2 parameters (Δh, Δs)
  - Development of different class specific 3D models based on:
    - (SWH, U, Tm)
    - (SWH, U, H_swell)

- SSB models derived with the direct approach
  - Collinear ΔSSH variance reduction gain from S. Labroue's models (BM1 serves as benchmark):
    - 2.45 cm² (collinear solution)
    - 2.40 cm² (direct solution)
  - Easier to manage with pre-processed classification step



- Performance evaluation based on collinear 10-day ΔSSH variance reduction

Classification input parameters

- clustering based on 2 input parameters (Δh, Δs):

$$\Delta h = \frac{H\_wsea}{SWH} \qquad \Delta s = \frac{mss\_long}{mss\_tot}$$

$$mss\_long = \frac{(2\pi)^4}{g^2} m4 \quad \text{and} \quad mss\_tot = \frac{R^2}{(Ku\_\sigma_0 - 2.4113)\_lin}$$

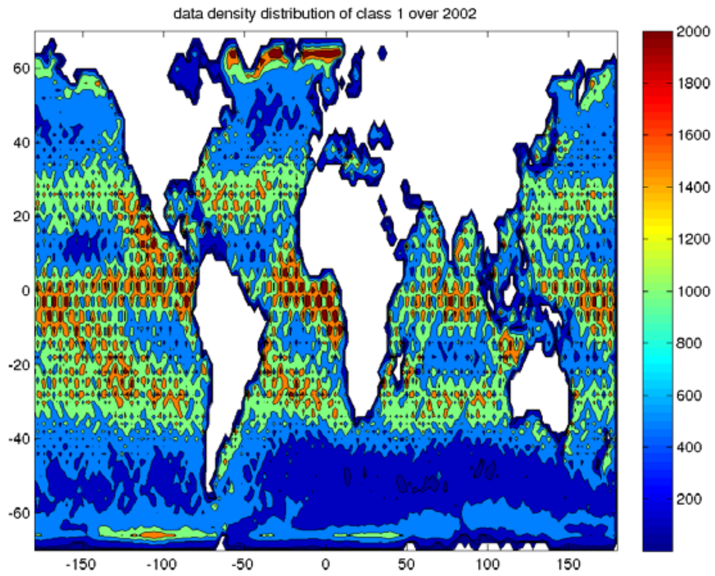
- mss_long is the slope variance associated with all long waves in S(f, q) up to a cutoff wave frequency of 0.4 Hz

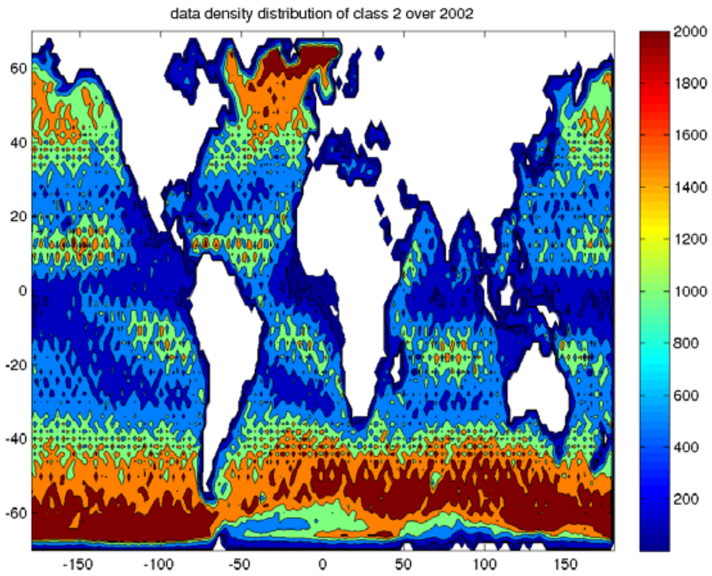
- These ratios have been chosen from a trade-off between physical and statistical reasons.

- These two parameters provide relevant wave spectrum information that lies in between the altimeter data that provides total wave elevation (SWH) and short wave slope variance (U_alt) data

Distribution of data per class from yearly dataset: 2002

Class 1





Class 2

2-class partition:
Class 1 (~mixed and old seas)
Class 2 (~mixed seas and young, step and high seas)

- an alternative classified model noted SSB (SWH, U_alt, X)_2c by coupling:

$$\begin{cases} \text{SSB (SWH, U\_alt, H\_swell)\_c1} \\ \text{SSB (SWH, U\_alt, Tm)\_c2} \end{cases}$$

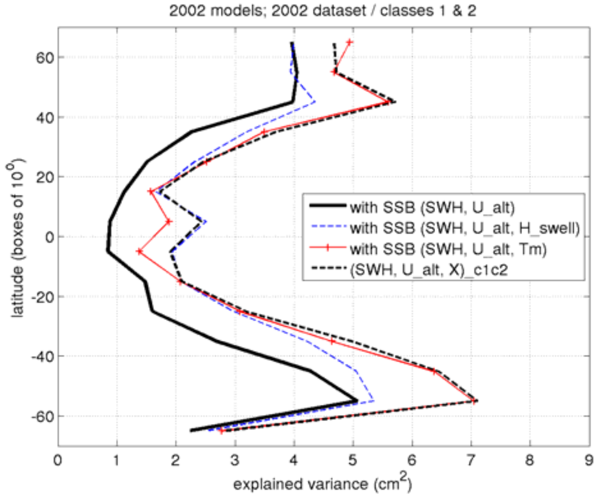
Global performances with collinear method data from 2002, 2003 & 2004

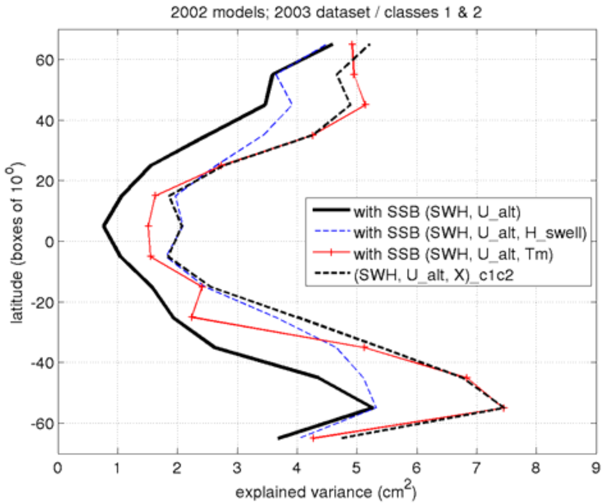
Variance explained by different models minus the variance explained by BM1 = -3.8% SWH (cm²)			
	2002	2003	2004
SSB (SWH, U_alt)	2.68	2.84	3.06
SSB (SWH, U_alt, H_swell)	3.45	3.69	3.97
SSB (SWH, U_alt, Tm)	3.94	4.21	4.62
SSB (SWH, U_alt, X)_2c	4.10	4.48	4.85

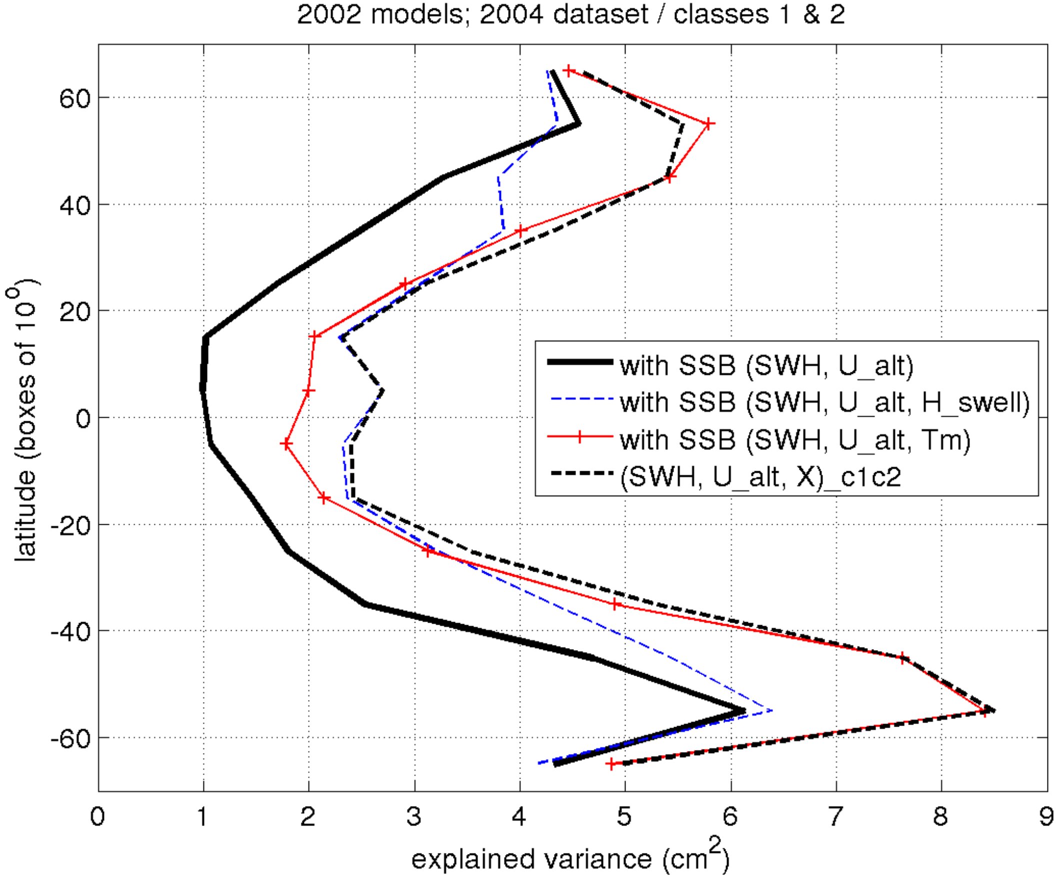
var (ΔSSH_withSSB_BM1) – var (ΔSSH_withSSB_tested)

- Differences (3D_Tm - 2D) models : ~1.40 cm²
- Differences (class-based - 2D) models : ~1.62 cm²

Performances as function of latitude
data from 2002, 2003 & 2004



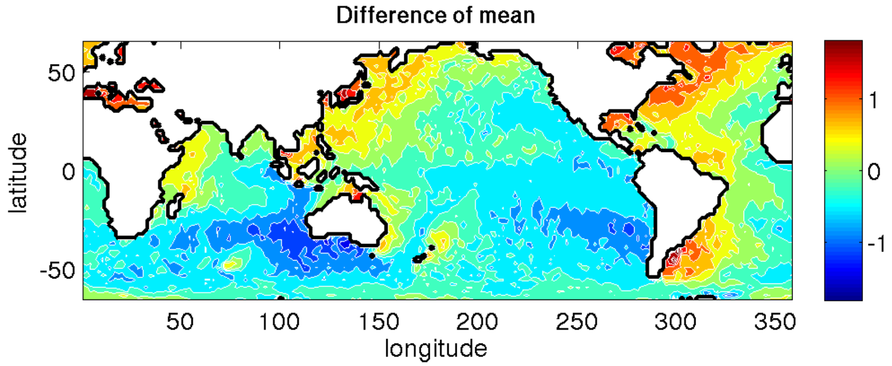


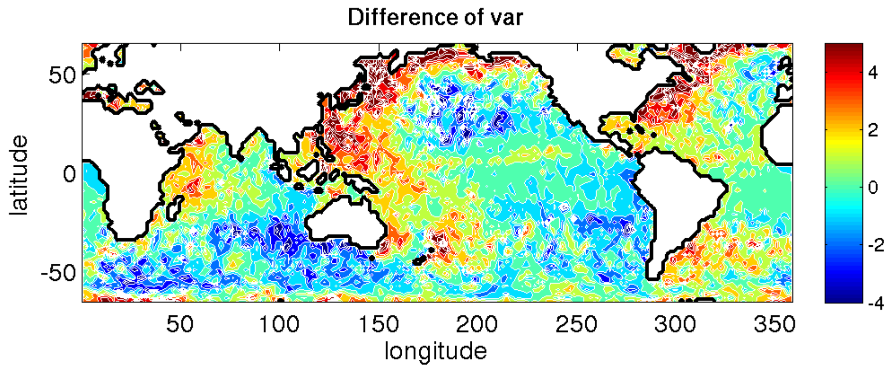


Comparison of SSB model features / yearly dataset

SSB (SWH, U_alt, Tm)

Mean (SSB (SWH, U_alt)) – Mean (SSB (SWH, U_alt, Tm))

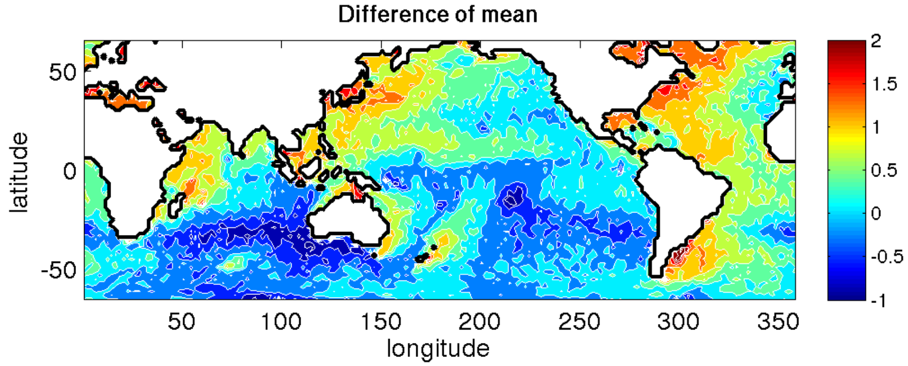


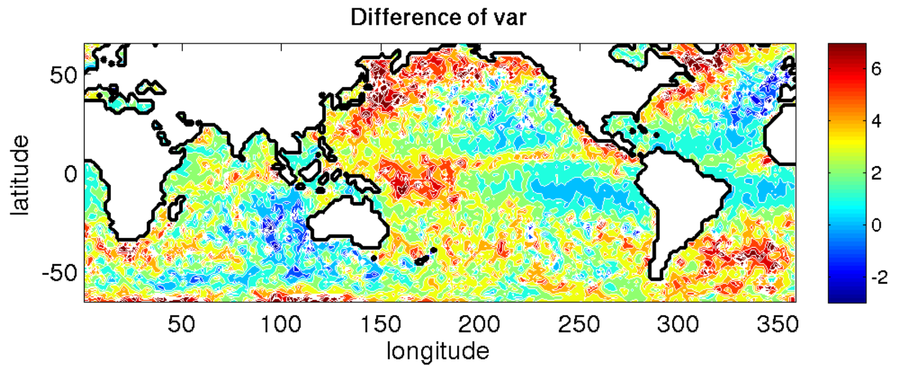


Var (SSB (SWH, U_alt, Tm)) – Var (SSB (SWH, U_alt))

SSB (SWH, U_alt, X)_2c

Mean (SSB (SWH, U_alt)) – Mean (SSB (SWH, U_alt, X)_2c)





Var (SSB (SWH, U_alt, X)_2c) – Var (SSB (SWH, U_alt))

Conclusions

- Part 1: Tracker bias differences between Jason-1 and Jason-2
  - Differences in SLA do not show any obvious correlation with waves.
  - SWH estimates are in really good agreement between J1 and J2.
  - However, wind speed estimates displayed some differences and some validation of J2 wind and updated one for J1 estimates are needed to assess if some J2 calibration has to be foreseen.
  - Conclusive analysis of the tracker bias differences cannot be made at the moment.

- Part 2: Alternative SSB solutions for Jason-1 from the SLOOP project
  - Positive results have been shown so far on the addition of ocean gravity wave parameters provided by the WW3 wave model in SSB description.
  - Validation and comparison of the 2 alternative solutions:
    - Global 3D model: SSB (SWH, U, Tm)
    - 2 class-based model

    are on-going in order to select one of them to propose for implementation in the operational chain.