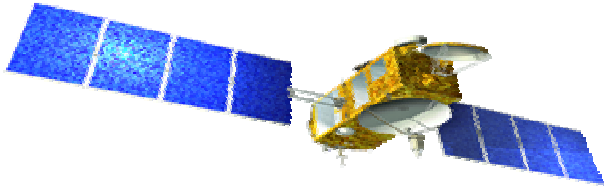


Fitting JASON 1 sea state bias

S. Labroue, P. Gaspar, J. Dorandeu and O.Z. Zanife

- 1 - Estimation of JASON 1 SSB
- 2 - Estimation of TOPEX SSB
- 3 - Conclusions

Data sets for SSB estimation

- The SSB provided in the GDR products has been fitted on IGDR data from cycles 19 to 30, with SSH differences from collinear tracks

- The aim of this work is to compare the product SSB table with a new one derived from GDR data. The SSB is estimated from 3 different data sets :
  - crossover SSH differences
  - collinear SSH differences
  - direct measurements : SLA data

  => check the consistency between the 3 SSB estimates

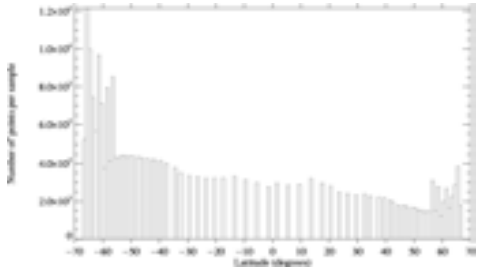
- Same method and conditions for crossover and collinear : only the data sets change
- The direct estimate simply fits the SLA data using the non parametric technique

- The 3 data sets use the same corrections from GDR data :
  - radiometer wet tropospheric correction
  - dual frequency ionospheric correction (smoothed)

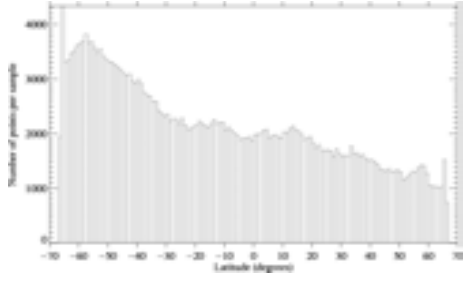
- The whole year 2002 is used (cycle 1 to 37) to take into account seasonal variations
- JMR step around cycle 30 : radiometer correction replaced by model correction => little impact on SSB

Data sets for SSB estimation

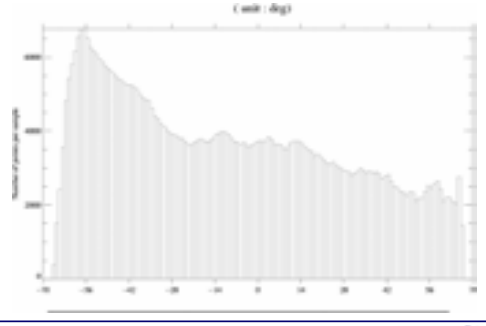
- Crossover SSH differences
  => remove North/South errors
  => more data at high latitude
  => considering differences of SSH and SWH/U is very sensitive to a few millimetre errors



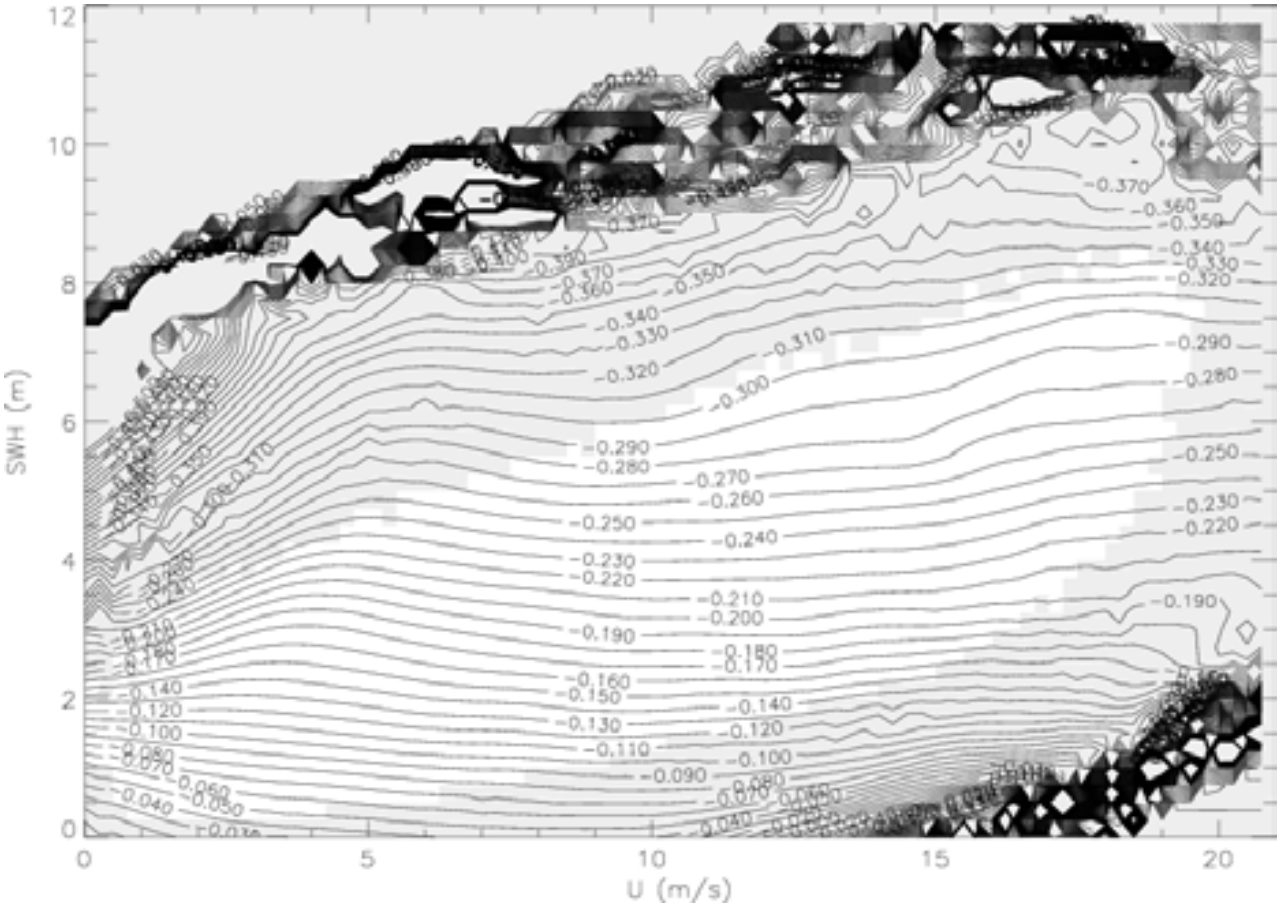
- Collinear SSH differences
  => remove ascending/descending errors
  => latitude distribution close to the 1Hz data
  => 10 day differences
  => considering differences of SSH and SWH/U is very sensitive to a few millimetre errors



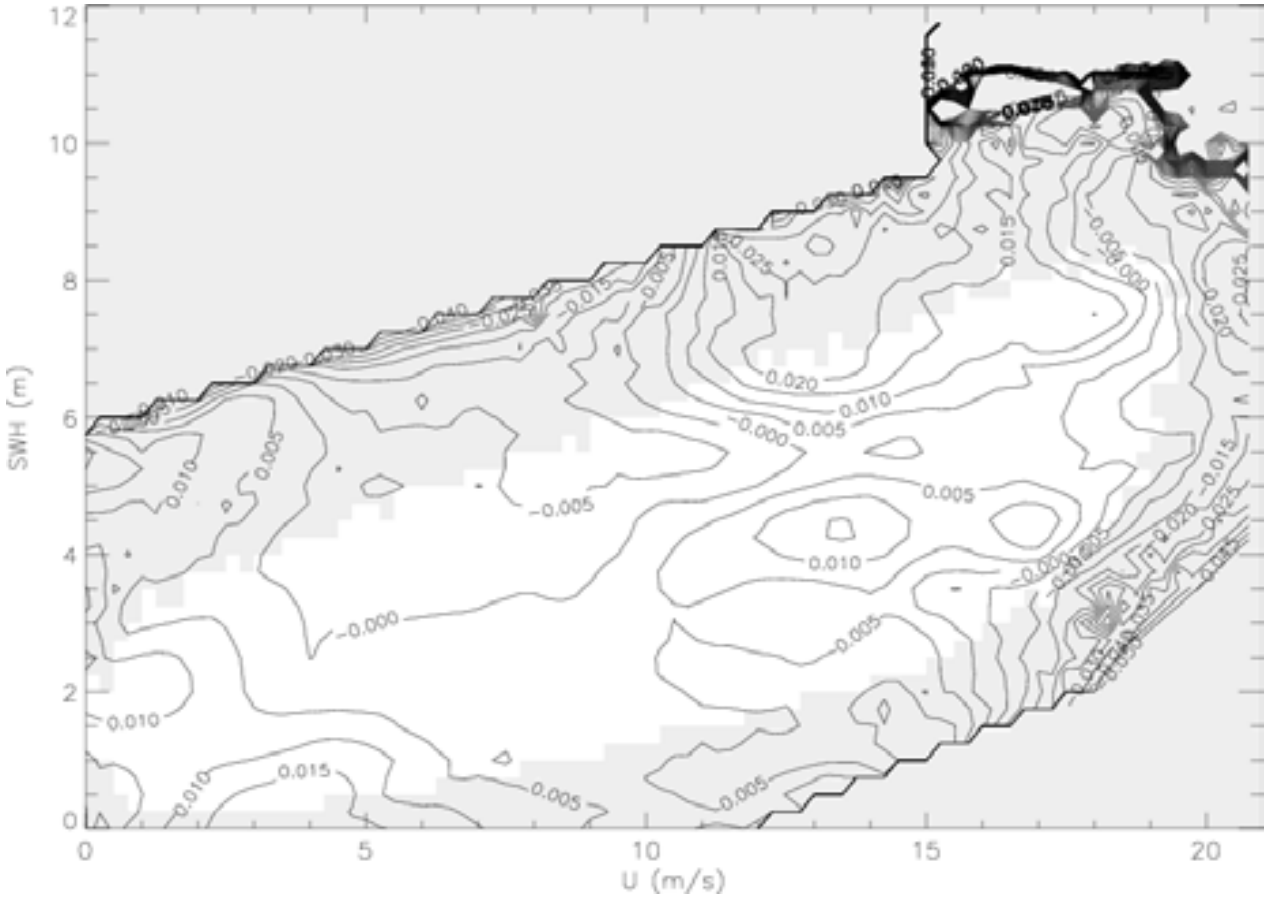
- Direct method
  => averages all the errors (North/South/ascending/descending)
  => uses a lot of measurements
  => oceanic variability



Collinear SSB, Cycles 1-37



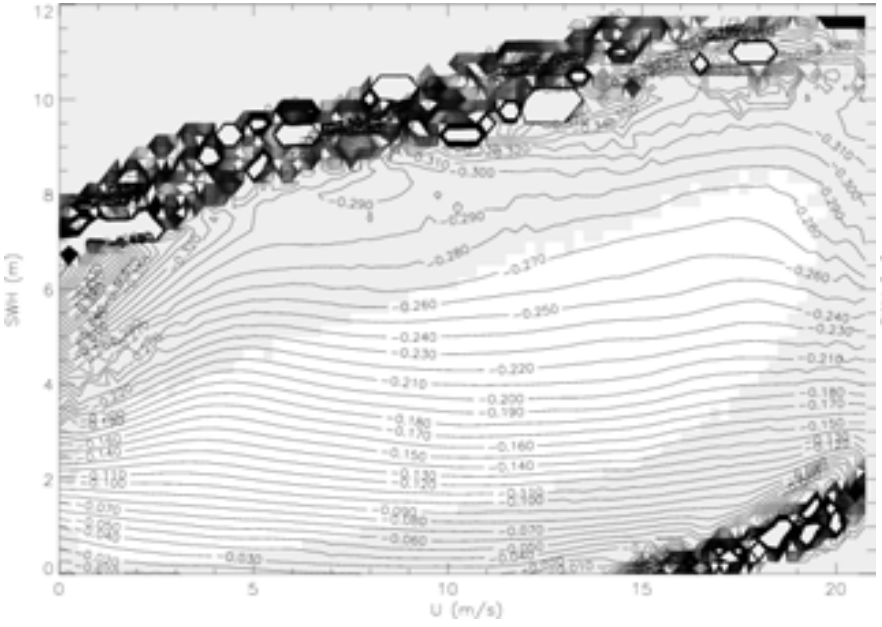
SSB difference : Collinear - Product SSB (Collinear IGDR 19-30)



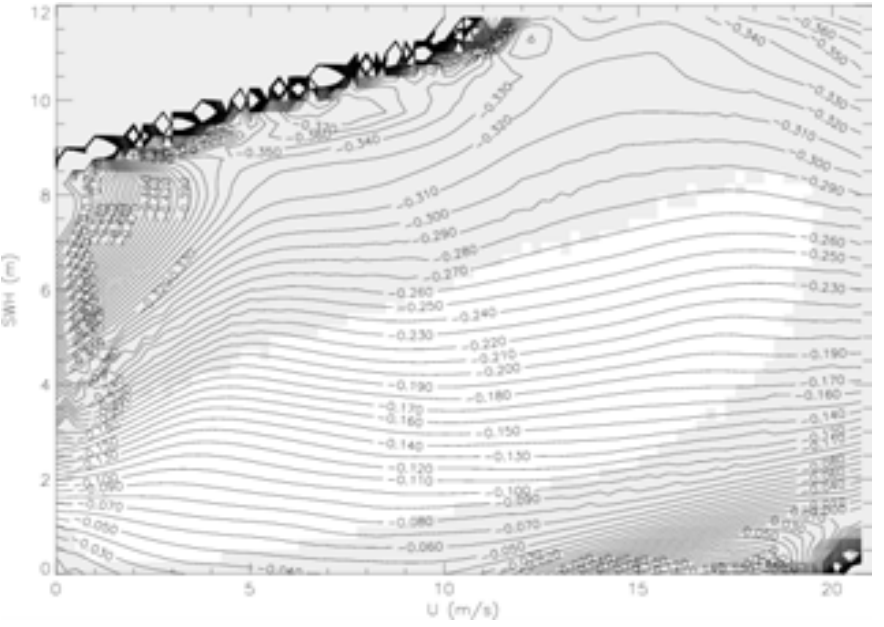
Crossover and direct SSB, Cycles 1-37

Both estimates agree for the general shape.

The direct SSB shows less SWH gradient than the crossover estimate.



Crossover SSB



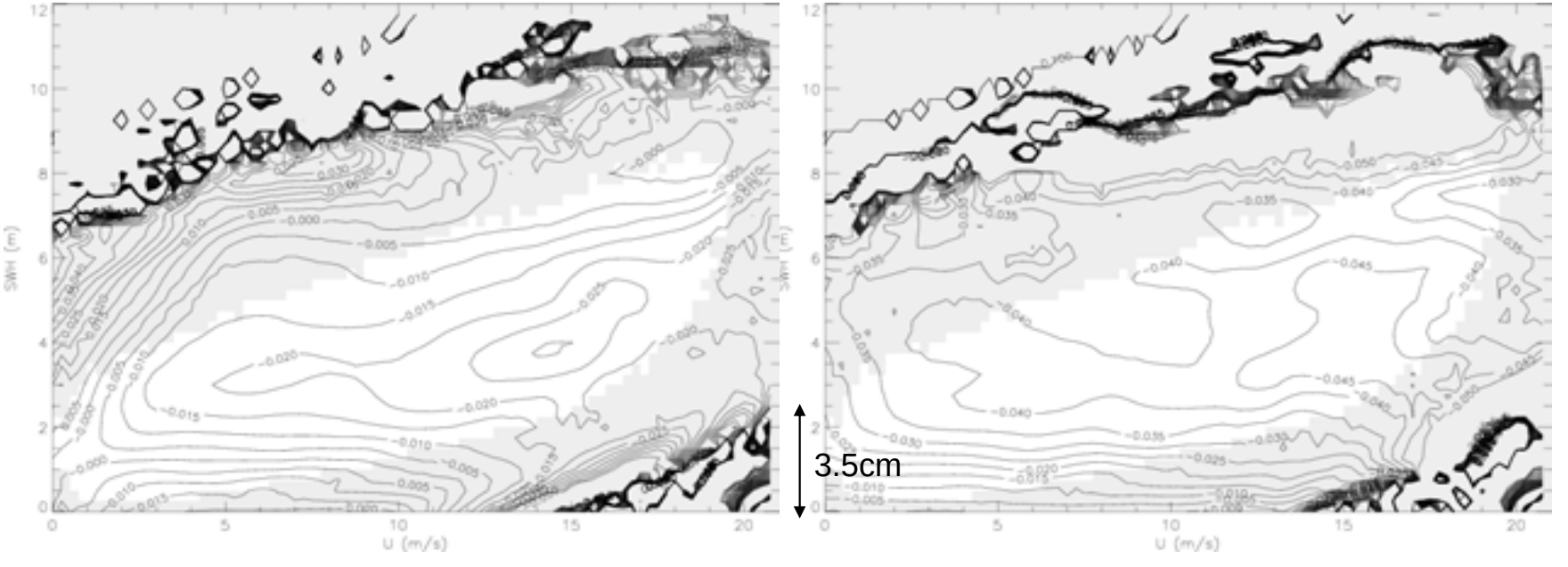
Direct SSB

SSB differences

The difference magnitude is of 3.5 cm between 0 and 2.5 m of waves

=> same behavior with crossover and collinear estimation

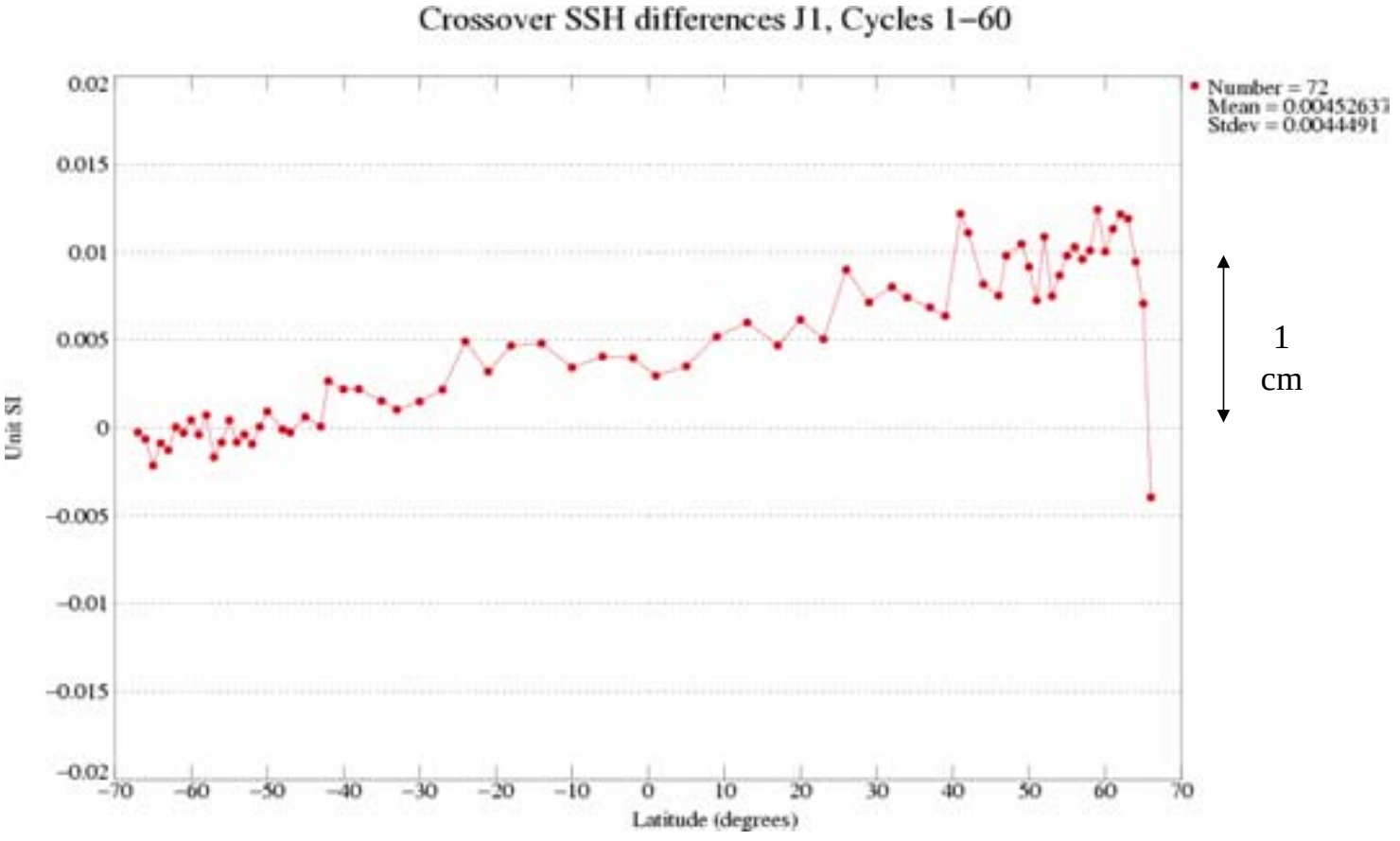
=> the direct estimation shows less SWH gradient

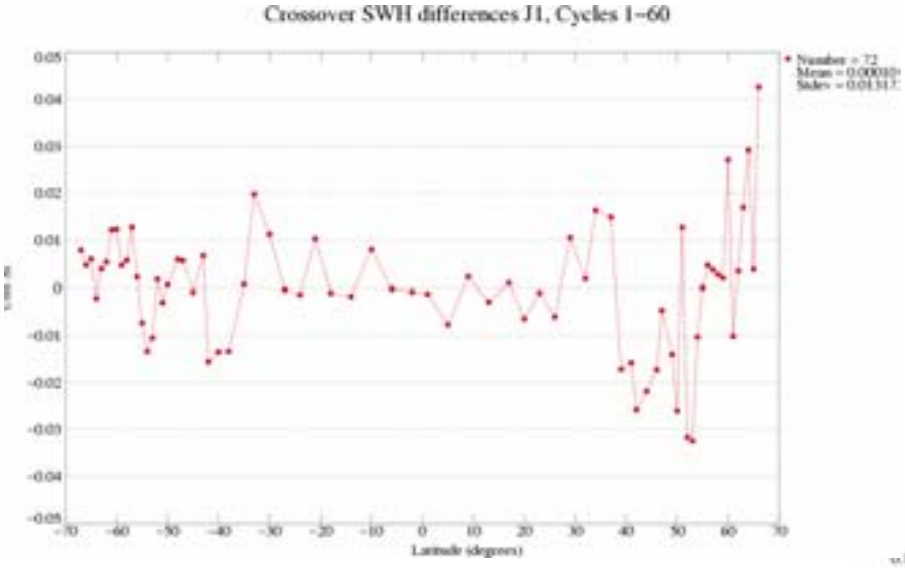


Crossover - Direct

Collinear - Direct

Crossover SSH (no SSB correction)

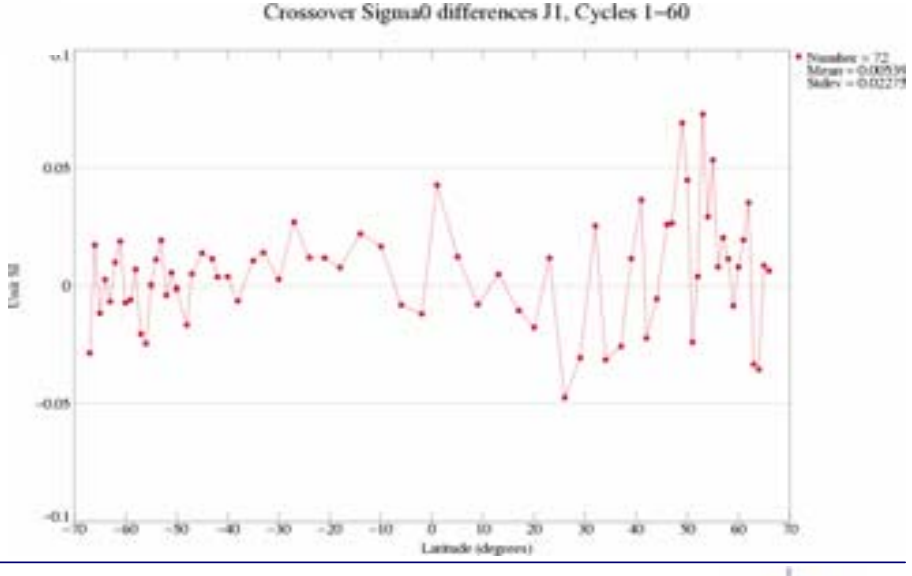




SWH_2-SWH_1 = + 2 cm

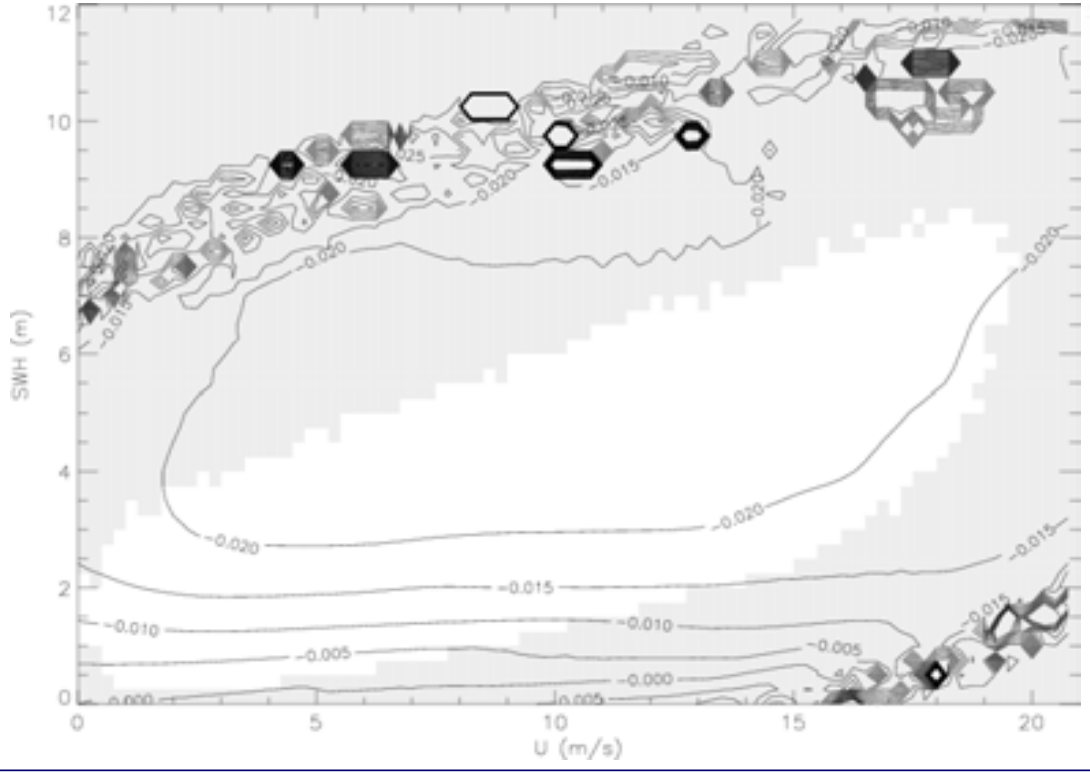
=> SSB_2-SSB_1 = -0.05*(SWH_2-SWH_1)

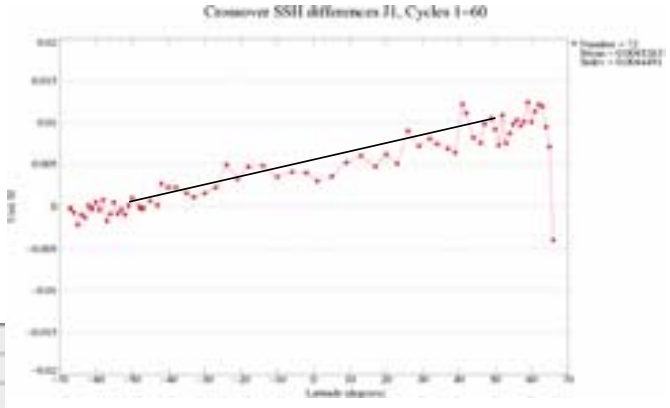
= -1 mm



Impact of the crossover correction on SSB

Init SSB - corrected SSB





Correction=0.2*Lat+0.05

=> 1cm between -50° and +50°

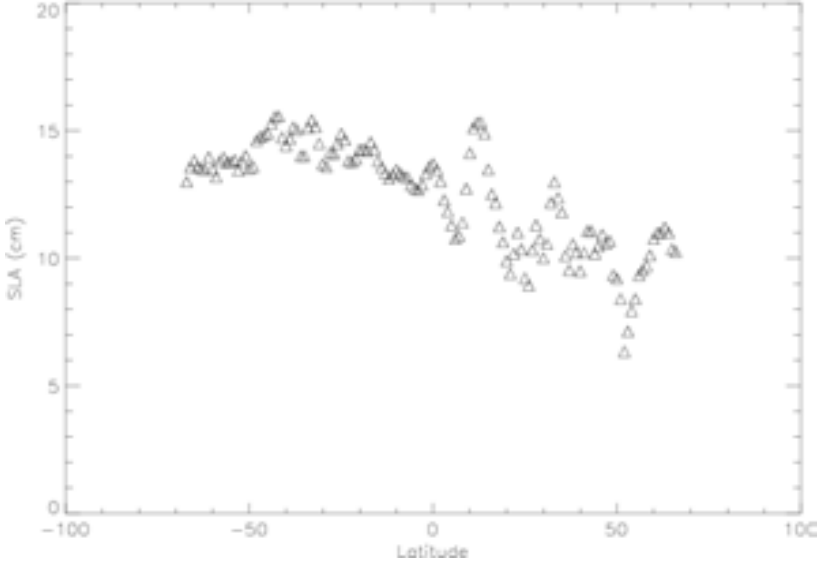
The correction applied on the SSH differences decreases the SWH gradient in the SSB

=> Crossover SSB is closer to the direct SSB

Direct method : SLA data

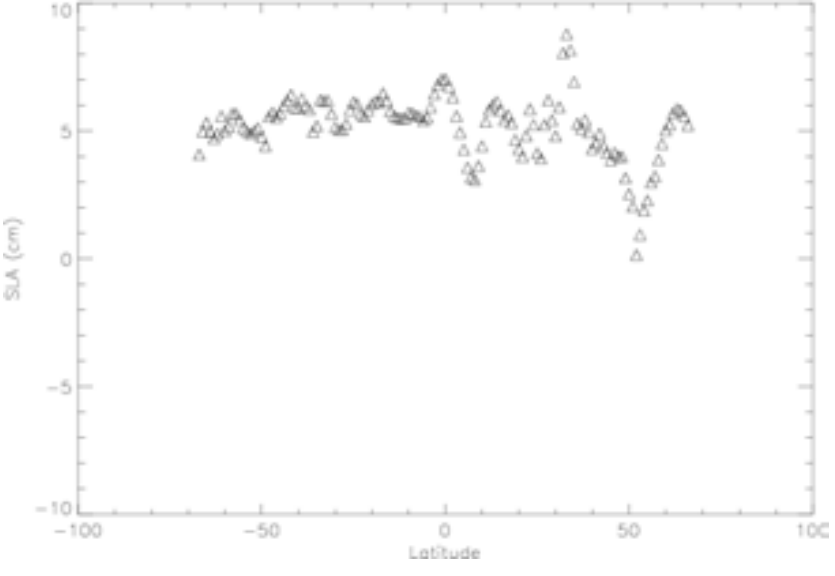
SLA corrected with direct SSB

JASON 1-37

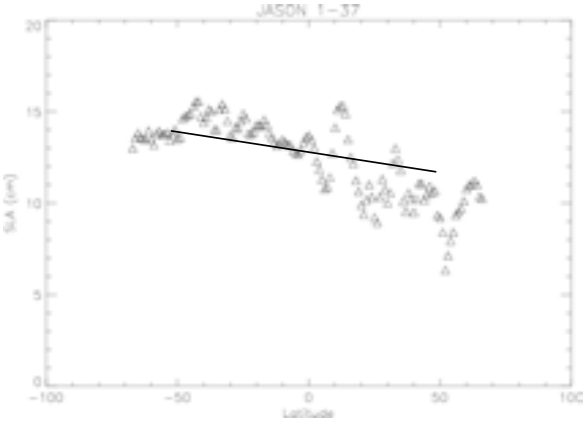


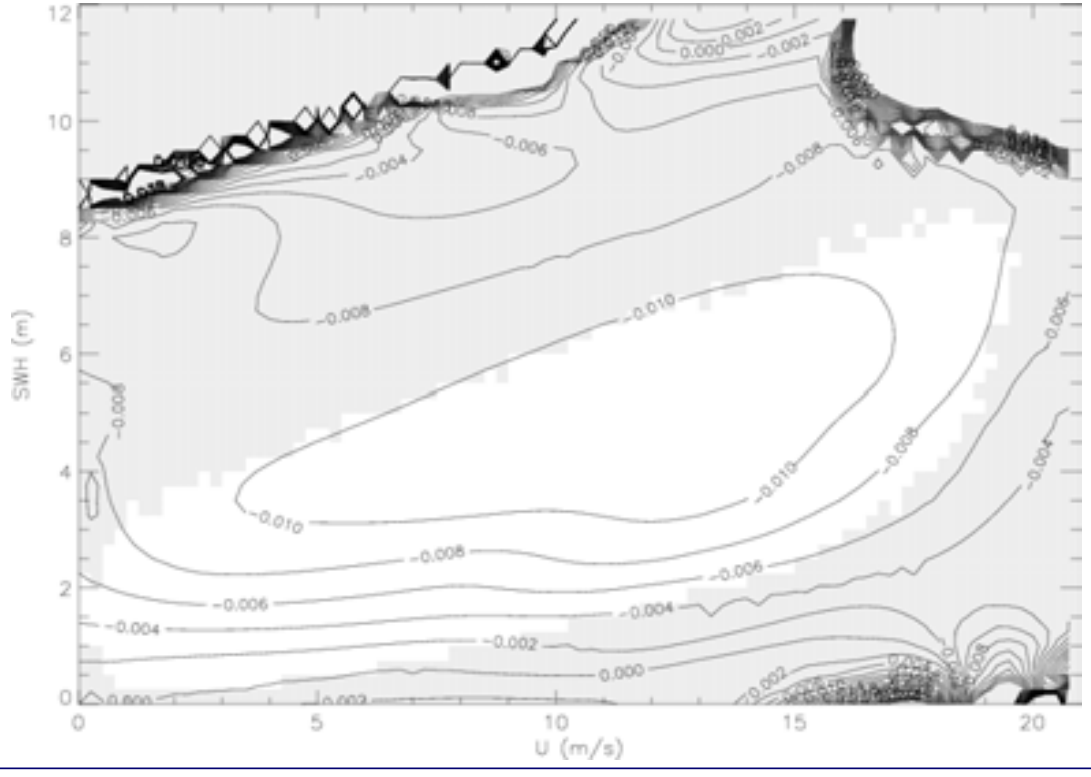
SLA corrected with direct SSB

TOPEX 344-380



Impact of an error depending on latitude on direct SSB





Correction=0.0002*Lat+0.01

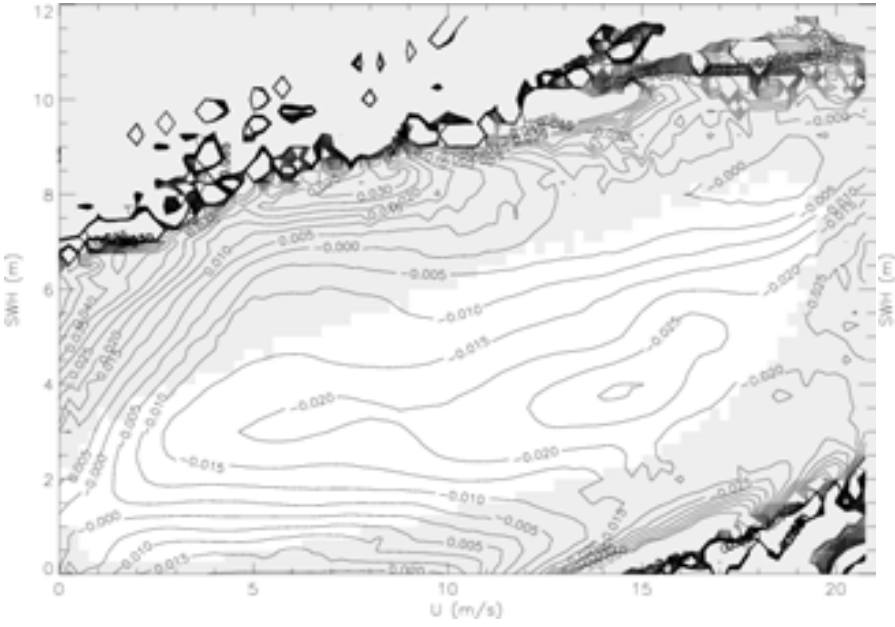
=> 2cm between -50° and +50°

The correction applied on the SLA data increases the SWH gradient in the SSB

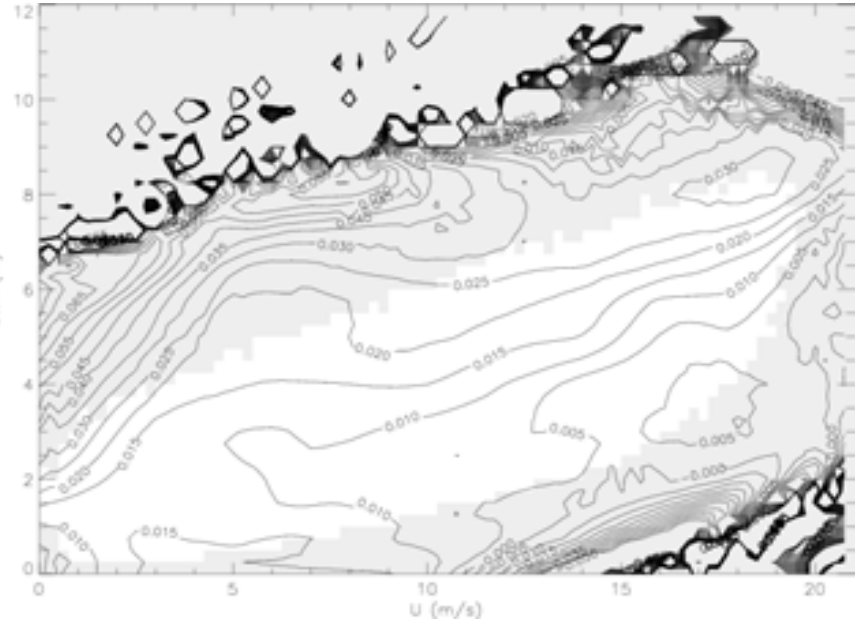
8 mm

SSB differences : Crossover - Direct

• The SWH gradient for SWH<2m disappear after correcting the crossover SSH and SLA data before estimating the SSB

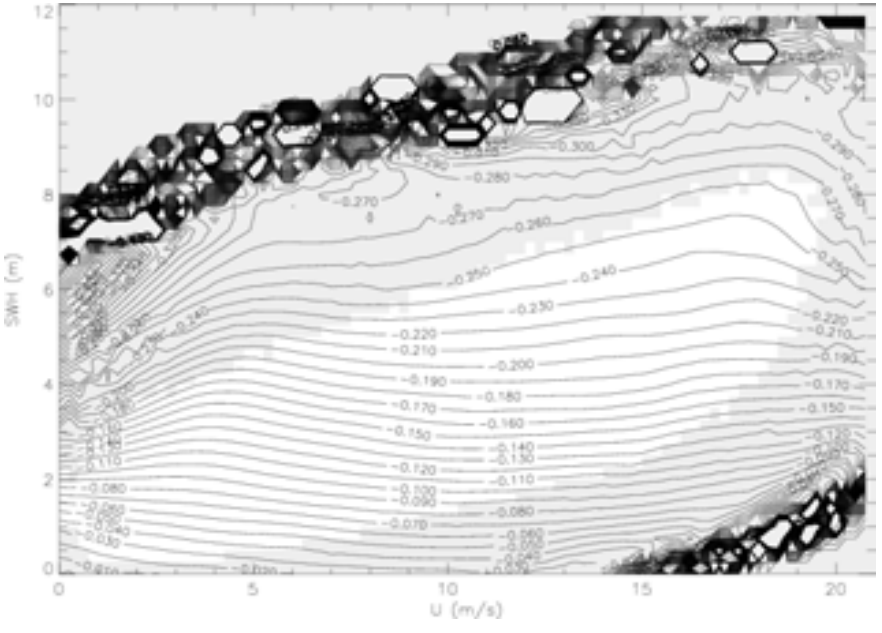


Crossover Init - Direct Init

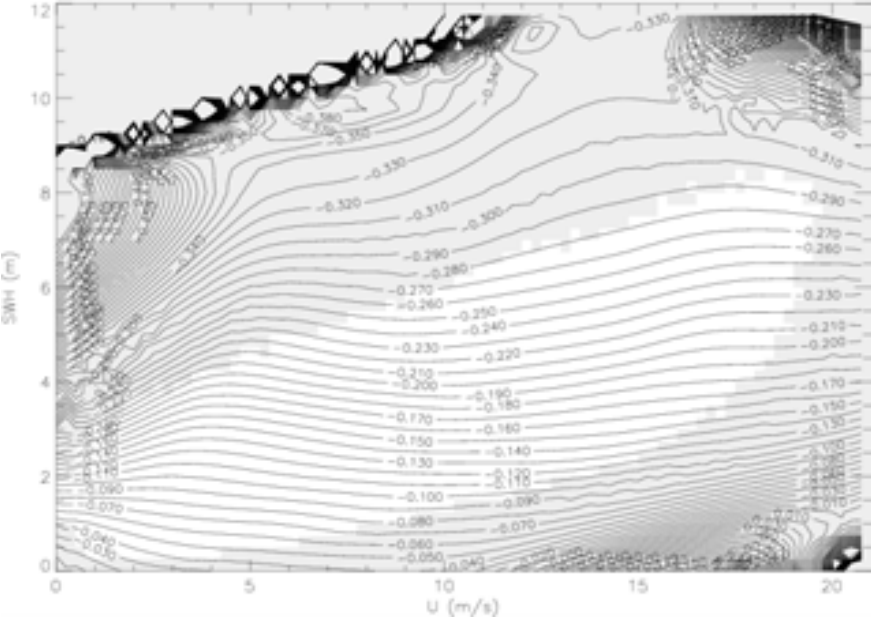


Crossover - Direct after SSH and SLA correction

Crossover and direct SSB after correction, Cycles 1-37



Crossover SSB



Direct SSB

Conclusions

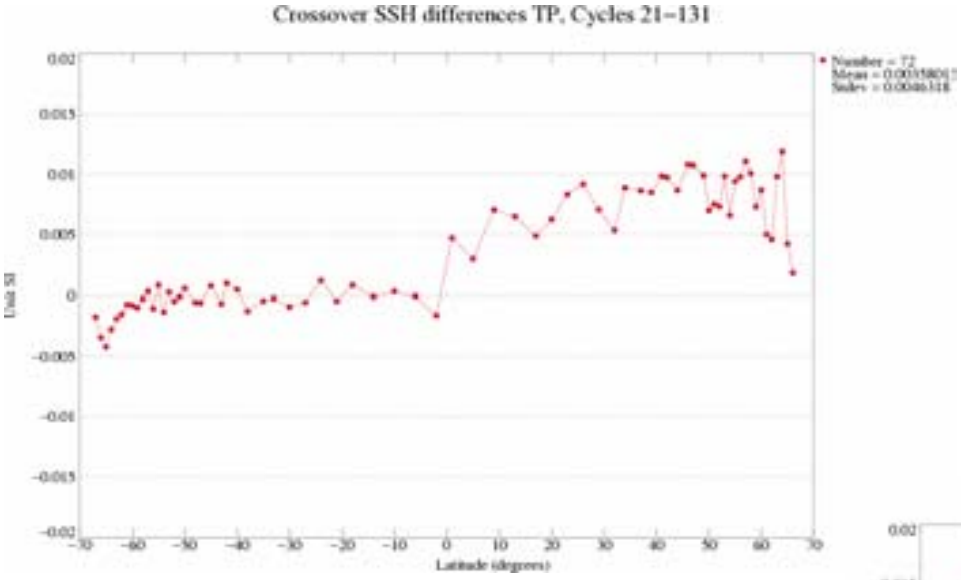
- An error depending on latitude affects the SSB estimates
  - an error of 1 cm on SSH difference => SWH gradient of 1.5 cm on the crossover SSB
  - an error of 2 cm on SLA => SWH gradient of 0.8 cm on the direct SSB

  => both estimates are closer after correcting crossover and SLA measurements for this effect

- Collinear : such a trend is not clearly detected => under investigation

- We need an independent criterion to compare the various SSB : analysing the variance reduction at crossover or collinear SSH always select the estimate fitted on the tested data set.

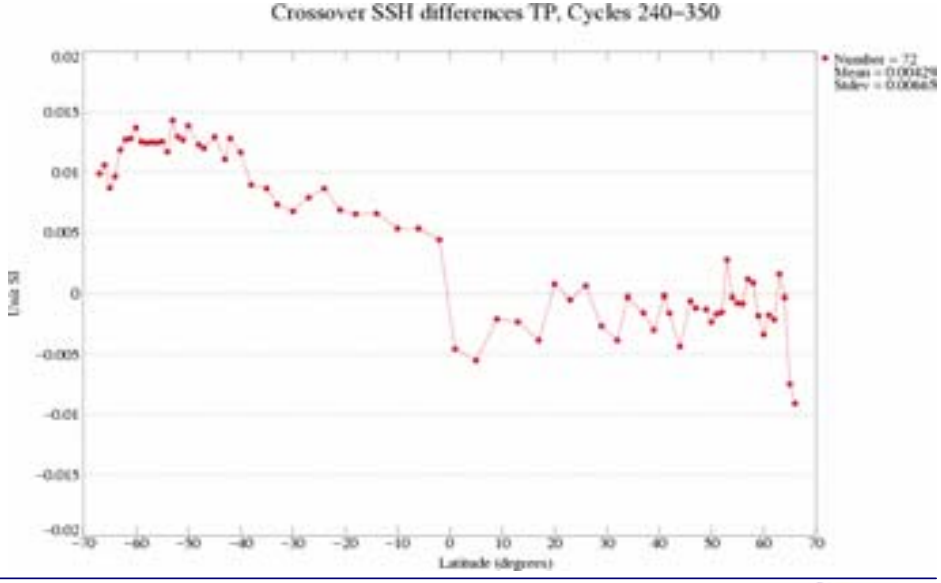
- Simulations tend to indicate that crossover SSB is more accurate and more stable than collinear SSB => more work is needed to confirm this result

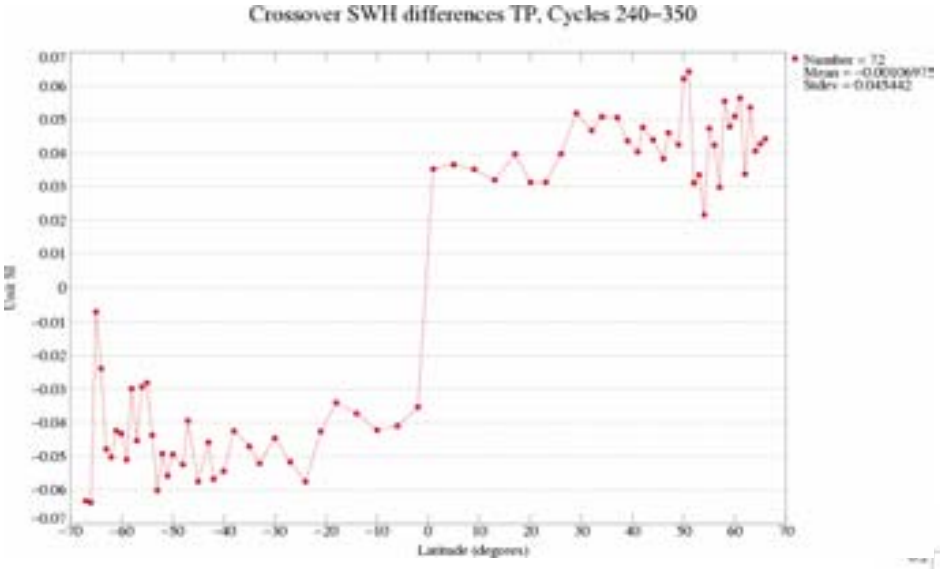


TOPEX Crossover SSH

- Time tag bias : TP A = -0.23 ms

  TP B = +0.21 ms
- Crossover SSH mean close to 1 cm for TPB
- Change in the SSB estimation between side A and B using crossovers

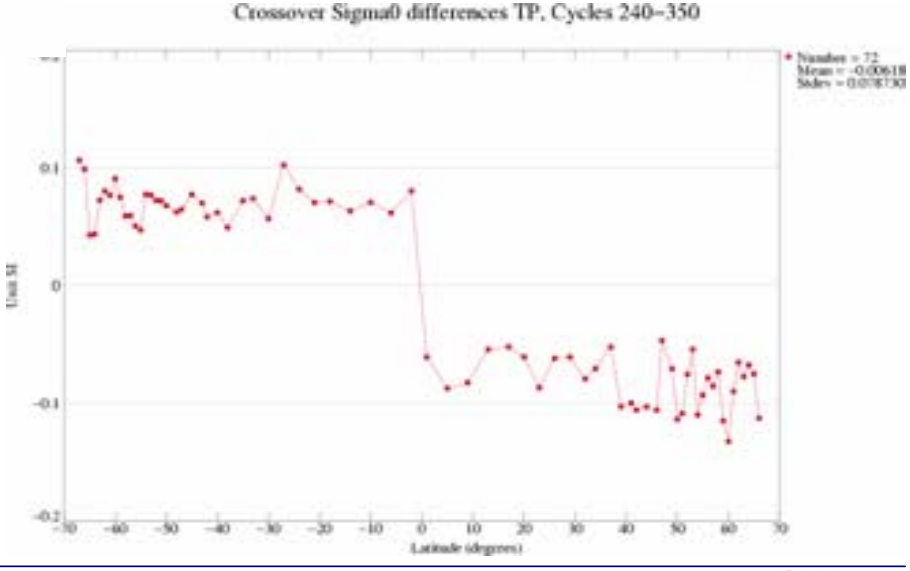




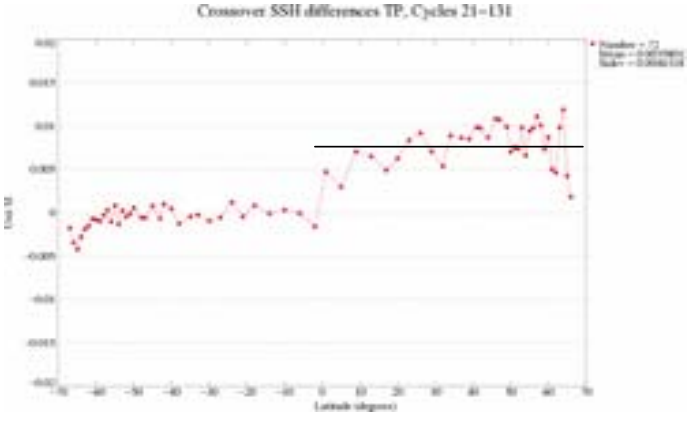
SWH_2-SWH_1 = + 5 cm

=> SSB_2-SSB_1 = -0.03*(SWH_2-SWH_1)

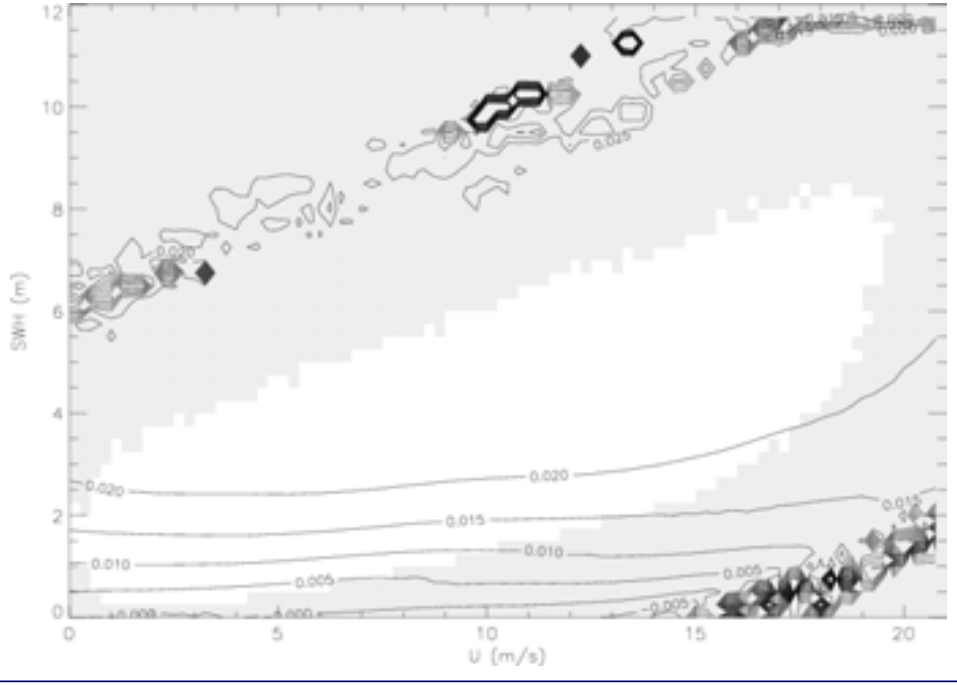
= -1.5 mm



Impact of the crossover correction on SSB
TOPEX A, cycles 21-131

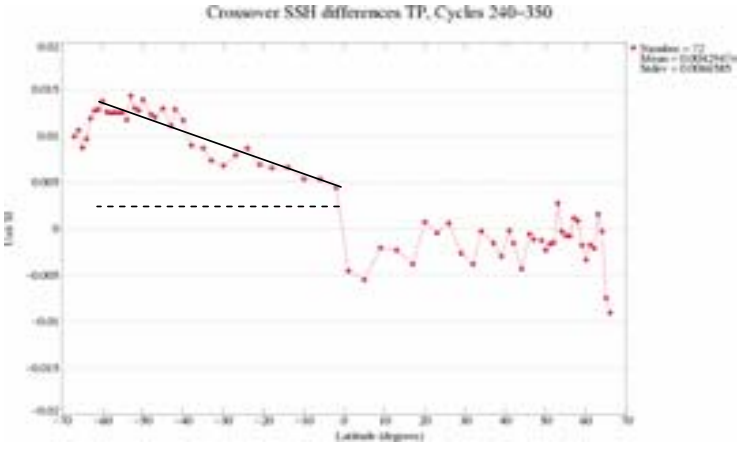


Corrected SSB - Init SSB

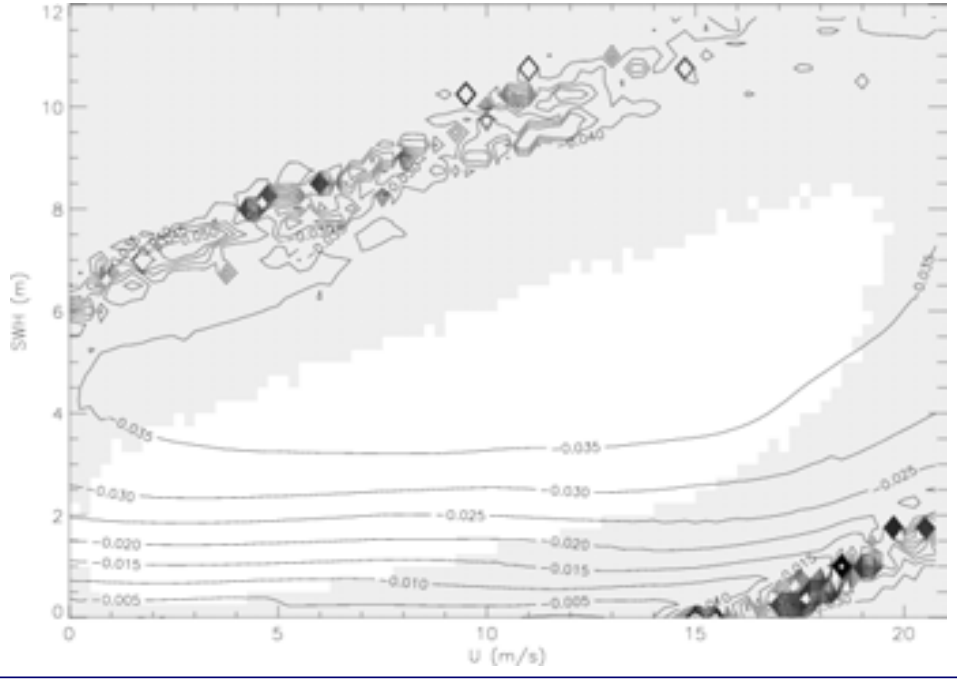


Correction = -7mm for North SSH

Impact of the crossover correction on SSB
TOPEX B, cycles 240-350



Corrected SSB - Init SSB

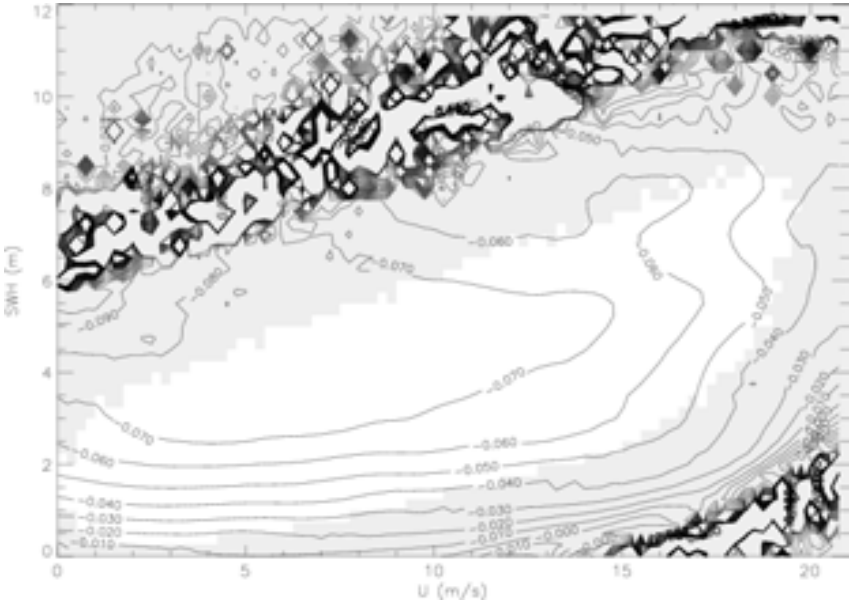


Correction for South SSH

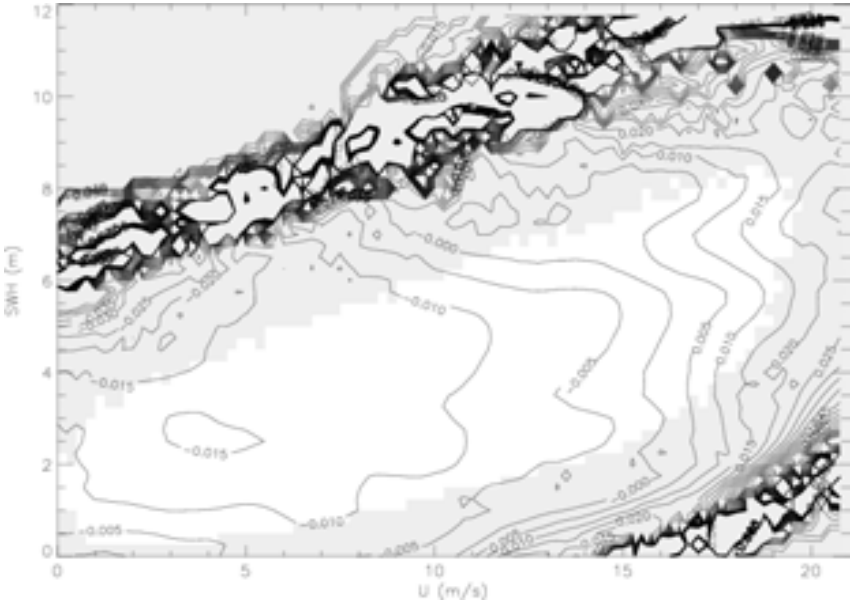
=> SSH centred to +2 mm

Crossover SSB differences : TOPEX side A - TOPEX side B

- SSB for TOPEX side B is more in agreement with the SSB for TOPEX side A after correcting the SSH
- The main differences are observed for strong sea conditions (U>10m/s and SWH>3m).



Crossover side A Init - Crossover side B Init

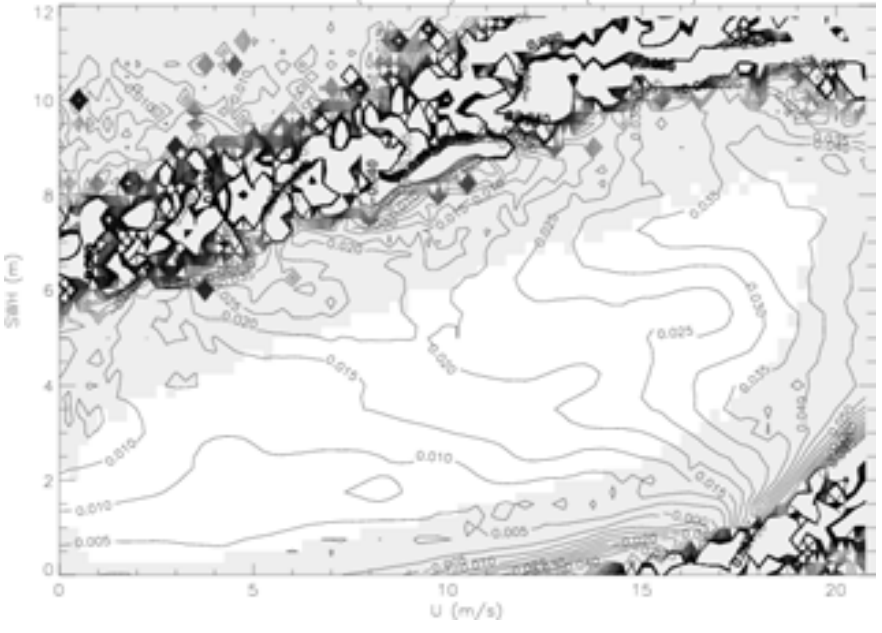


Crossover side A - Crossover side B

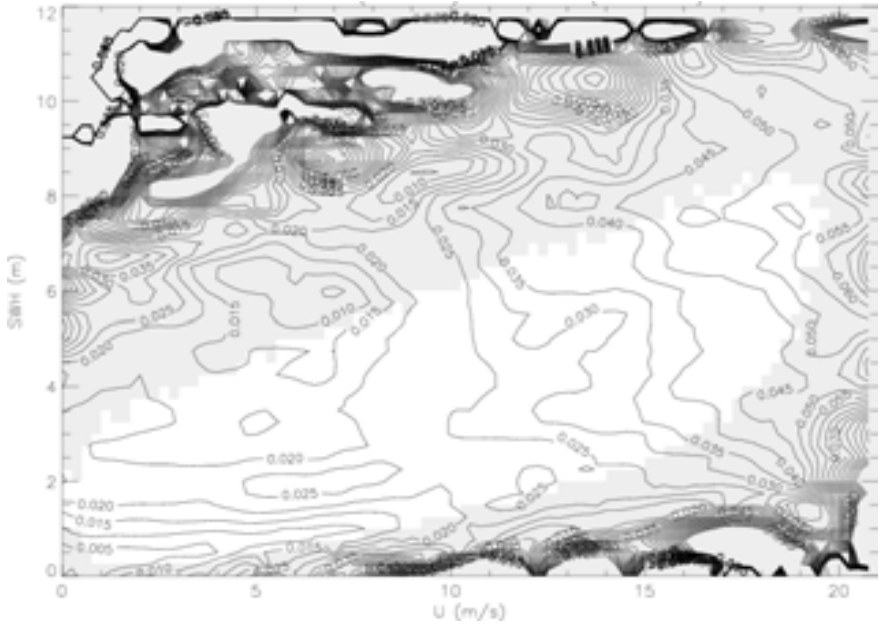
After SSH correction

SSB differences : TOPEX side A - TOPEX side B

The main differences are observed for strong sea conditions (U>10m/s and SWH>3m).



Collinear side A - Collinear side B



Direct side A - Direct side B

Conclusions

- TOPEX A
  - collinear = direct
  - collinear - crossover = SWH gradient for SWH<2m
  - collinear = crossover after correcting north crossover SSH

    => the 3 estimates give the same answer after correction

- TOPEX B
  - collinear = direct with a small difference for SWH < 1m which behaves as iono correction
  - collinear - crossover : large SWH gradient for SWH<2m
  - closer to collinear after correcting south crossover SSH

    => a slight difference remains for the crossover SSB after correction

- JASON 1
  - crossover : SSH difference corrected for an error depending on the latitude
  - direct : SLA corrected for an error depending on the latitude
  - collinear : no correction

    => crossover close to direct SSB when correcting both data sets for the latitude trend

    => collinear SSB is apart, showing a larger SWH gradient

Conclusions

- An effect depending on the latitude in the SSH difference (orbit error, time tag bias…) does impact the SSB estimation for SWH<2m. Tests on TOPEX A, TOPEX B and JASON show it can add or remove some SWH gradient.

- This effect has to be studied more in details to understand how it affects the SSB estimation. Preliminary simulation made on TOPEX A show that taking the SSH differences as a simple constant give the same kind of result with a SWH gradient for SWH<2m. Some work is ongoing to clarify and explain these features.

- In the same way, an error as a function of latitude (MSS error …) does impact the SSB fitted with the direct estimation.

- The 3 data sets used to estimate the SSB should give the same results with differences less than 1 cm and without any particular structure in the difference.
  - OK for TOPEX A, slight difference for TOPEX B
  - Still too large differences for JASON => further work is needed to improve the SSB estimates

- A good criterion is needed to select the best SSB estimate for JASON :
  - crossover variance reduction => the crossover estimate has been fitted on this data set
  - TOPEX - JASON residuals as a function of SWH => what about the errors on TOPEX B SSB estimate and the errors depending on latitude which may affect the conclusions ?