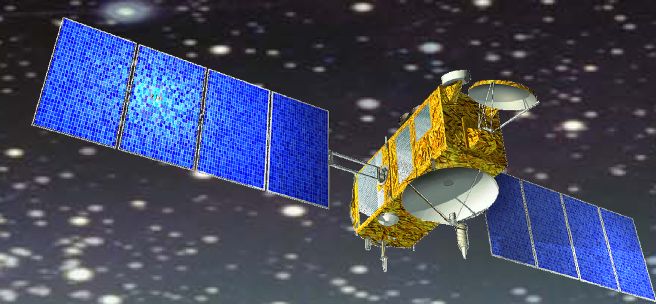
FIRST RESULTS OF AN IMPROVED SIGNIFICANT WAVE HEIGHT ESTIMATION



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This work deals with the improving of the Significant Wave Height (SWH) estimation. The Jason-1 parameters estimator uses the Maximum Likelihood Estimator (MLE) to estimate the ocean parameters. The Radar Point Target Response (PTR) approximation by a Gaussian shape in the waveform model used in the MLE has some effects on the estimated SWH. Currently, the ocean parameters estimated from the Jason-1 data are corrected from the PTR effects using a look up table.

The purpose here is to introduce a new method for SWH estimation which takes into account the PTR Gaussian approximation effects.

The MLE estimations

The MLE estimator uses the Hayne 's model. The Radar Point Target Response is approximated by a Gaussian shape with a width σ_p = 0.513 T (T being the length of the short pulse). This Gaussian shape has the same energy as the PTR with only the two first side lobes.

To show the effects of this approximation on the SWH estimation, we convolved, for different values of SWH, the altimeter return waveforms with 1) the true PTR, 2) the PTR with only the two first side lobes and 3) the Gaussian approximation. The MLE estimator was then applied to the obtained waveforms. The estimated SWH was found larger than the initial one. SWH estimation biases for the three cases are presented in the figure below. This figure shows that the width σ_p = 0.513 T was shosen so that for SWH equal to 2 meters the estimation bias is null. We can also deduce that the far side lobes should not be neglected in the PTR approximation.

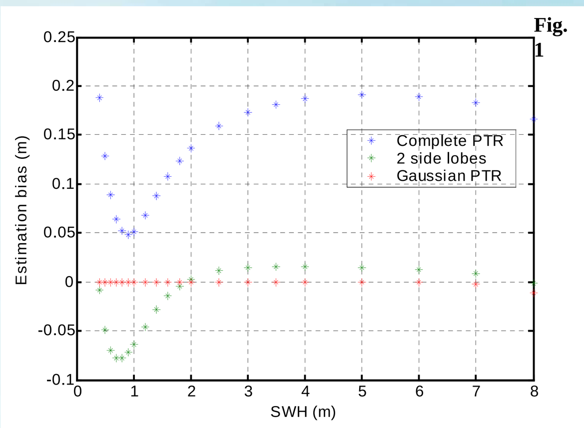

Fig. 1

A New Estimator Proposal

We tried to find a different approximation of the PTR in the MLE estimator. The width σ_p of the Gaussian approximation was modified and several values were tested but there was no value of σ_p that enabled us to well estimate simultaneously all the values of SWH. Thus, for each value of SWH, and using the Gaussian shape approximation, the best value of σ_p to estimate it was determined (see the figure below).

We further found that σ_p can be approximated using an nalytical function of the form :

$$\sigma_p = (\alpha.SWH^2 + \beta.SWH + \gamma)^{1/2} T$$

Where α, β and γ are constants determined by a fitting algorithm.

The MLE estimator gives the value of σ_c which is related to SWH and σ_p according to :

$$\sigma_c^2 = \frac{SWH^2}{4c^2} + \sigma_p^2$$

The new expression of σ_p is introduced in the equation above and the value of SWH is retrieved from the σ_c estimation using :

$$\frac{\sigma_c^2}{T^2} = \left(\alpha + \frac{1}{4T^2c^2}\right).SWH^2 + \beta.SWH + \gamma$$

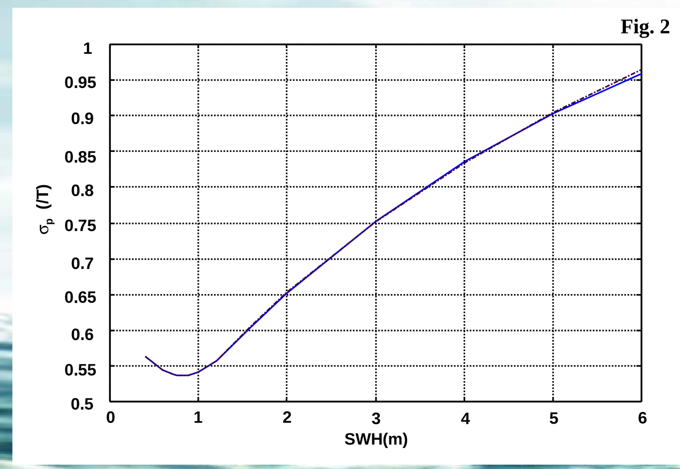

Fig. 2

First results

This new estimator was first applied to ocean waveforms without the speckle noise, and for SWH varying from 0.4 to 8 meters. Figure 3 compares the estimations of SWH in the case of the standard MLE and in the case of the new expression of σ_p and shows that the SWH estimation was improved.

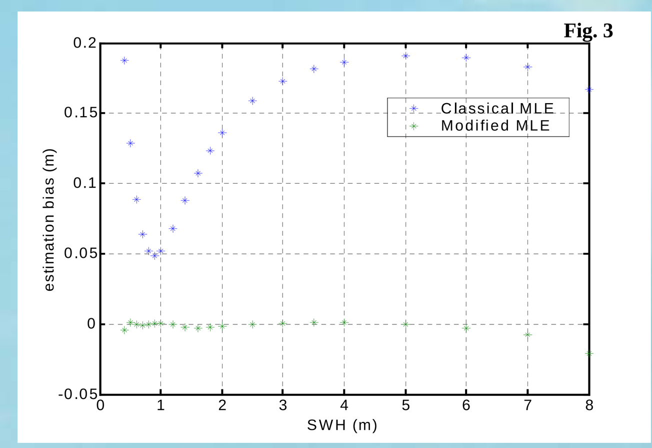

Fig. 3

To test the sensitivity of this estimator to speckle noise, ocean waveforms with speckle noise were generated. For each value of SWH, the new and the present MLE were applied to 3000 s of simulated data.

Figures 4 and 5 show respectively the SWH estimation biases and standard deviations. The new method improves the estimation bias. The standard deviation is of the same magnitude as for the MLE estimator.

Note that for both estimators and for small values of SWH (less than 0.8 meters), the speckle noise affects more the estimations than for greater values.

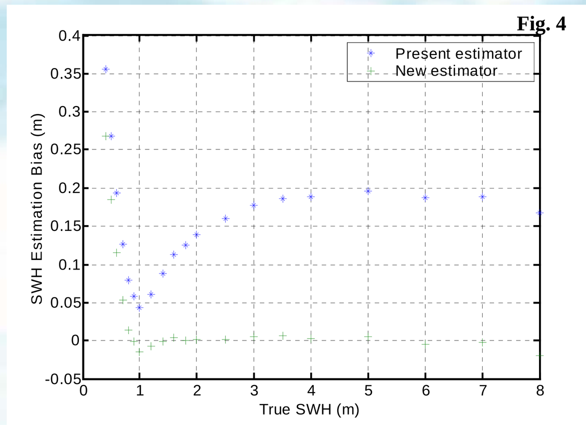

Fig. 4

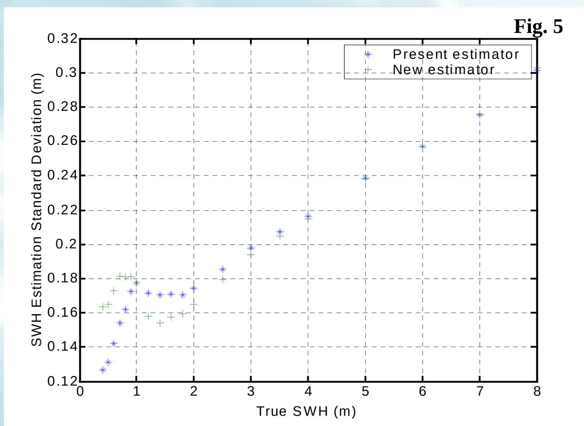

Fig. 5

Comparison with Jason-1 IGDR data

The figure 6 below compares the SWH estimations issued from Jason-1 MLE estimator (green), the corrected estimations according to the look up table (blue) and those given by the new algorithm introduced here (red). Our corrections are of the same sign as those applied by the look up table but are of smaller magnitude. Figure 7 summurizes and compares, for each value of SWH, our corrections to those applied by the look up tables.

The differences between our SWH estimations and those given by the look up table are due to the other effects considered when builting this table, while our method takes into account only the PTR Gaussian approximation effects. Indeed, this table is built using a simulator that generates waveforms according to the Hayne 's model and then introduces several effects on these waveforms (true PTR, filters, compression effects …). The difference between the initial SWH and the estimated one is the correction of the look up tables.

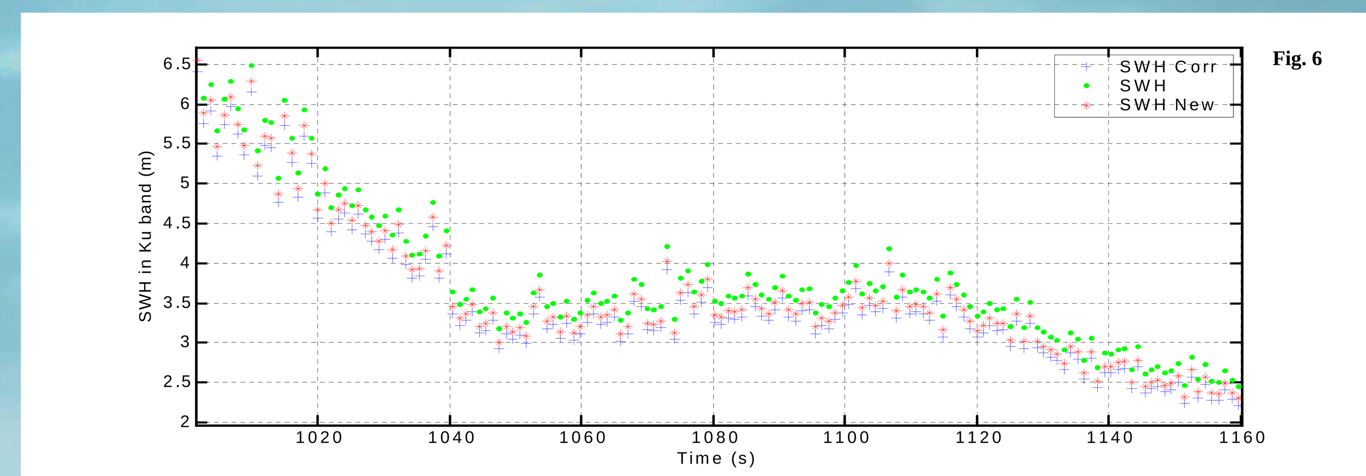

Fig. 6

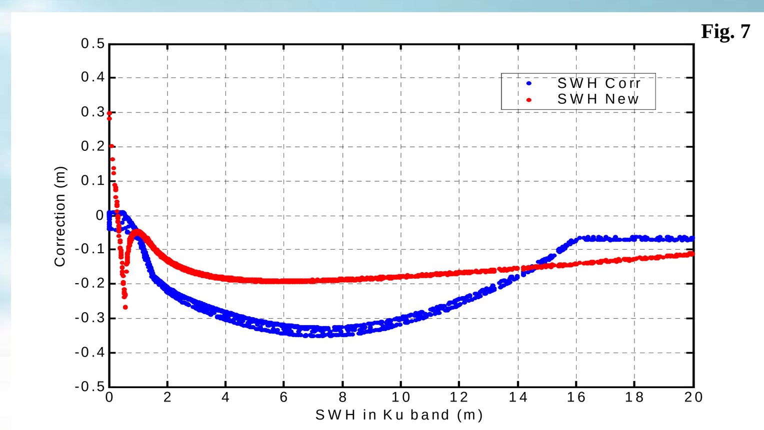

Fig. 7

Conclusions and perspectives

The effects of the PTR approximation by a Gaussian shape is studied and a new estimator of SWH is introduced. The SWH estimation bias is improved.

The first results are different from those given by Jason-1 look up table as this table takes into account other phenomena affecting the SWH estimation.

In the next future, our altimeter waveforms simulator will be compared to the simulator used for builting the look up table and the method presented here might be extended to the other effects influencing the SWH estimation.

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Jason-1 Science Working Team Meeting

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