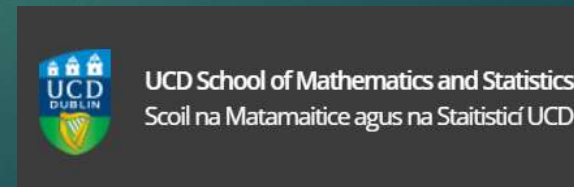


“Sensitivity analysis of dissipation parameterizations in the WAVEWATCH III spectral wave model using the ST6 source term packages for Ireland Coast”

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The work

- We assess the performance of WW3 using the **ST6** parametrization proposed by *Zieger-Babanin (2015)* by tuning different parameters which correspond to the wind input (**S_{in}**) term of the wave action balance equation.

The nonlinear wave-wave interactions (**S_{nl}**) was modelled using the discrete interaction approximation DIA (Hasselmann et al., 1985)

- The Bias, RMSE, Correlation Coefficient and Scatter index statistical parameters are used to validate the model by comparing the Significant wave height (H_s) probability density function, from local hindcast, with buoy measurements.

Wave action balance equation terms

The diagram shows the wave action balance equation with terms S_{ln} , S_{in} , S_{nl} , S_{ds} , S_{bot} , S_{db} , and S_{tr} . The terms S_{in} and S_{nl} are circled in blue. A red box labeled "Nonlinear wave-waves interactions" has an arrow pointing to the S_{nl} term. Another red box labeled "Atmosphere – Waves Interaction" has an arrow pointing to the S_{in} term.

$$S = S_{ln} + S_{in} + S_{nl} + S_{ds} + S_{bot} + S_{db} + S_{tr} +$$

Wavewatch III – ST6 Parametrization summary

- S_{nl} Nonlinear wave-wave interactions term was modelled using the discrete interaction approximation (DIA, Hasselmann et al., 1985).

Constant $\lambda_{nl} = 0.25$; $C = 3.0 \times 10^{-7}$.

- **Bulk Adjustments:** The FLX4 PARAMETRIZATION (Bananin 2011) was used to attenuate the Bias with **CDFAC parameters** = 0.8, 0.9 and 1.0.

- S_{in} . The directional distribution of winds W (Roger 2012) was modelled by tuning the parameter a_0 . The parameter is used to control the strength of swell decay due to wind effects.

$$W = W_1 - a_0 W_2$$

With: W_1 : Favorable winds

W_2 : Adverse winds

The used values for a_0 were proposed by:

Donelan 2012: $a_0 = 0.09$; Zieger 2015: $a_0 = 0.09$

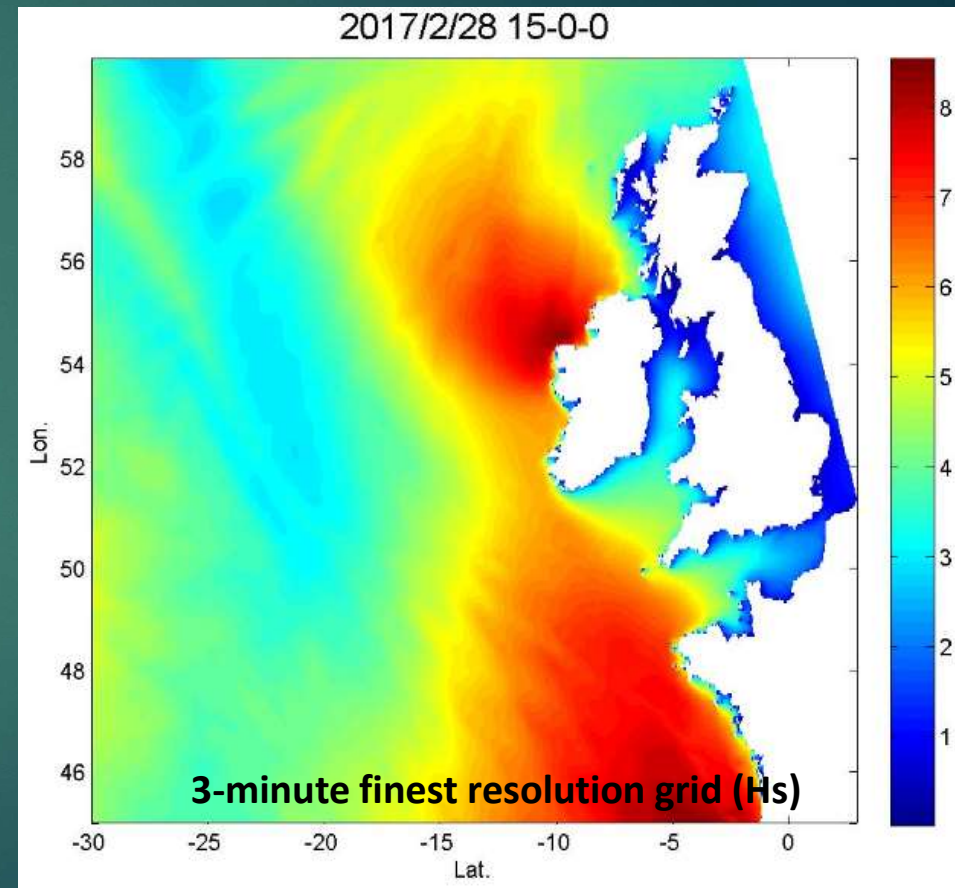
Reich 2014: $a_0 = 0.2$; Kahna 2016: $a_0 = 0.14$

Wavewatch III - Grids

A system of nested grids is used to model long distance swells generated in the North Atlantic Ocean and propagating all the way to the west coast of Ireland.

- A 30-minute coarse grid resolution for the whole Atlantic.
- A 6-minute intermediate grid resolution for the N-E Atlantic.
- A 3-minute fine grid resolution in coastal areas closer to Ireland.

Grids	Coarse	Intermediate	Finest
Coordinates	65°S - 80°N;	45°S - 70°N;	45°S - 60°N;
	100°W - 30°E	50°W - 5°E	30°W - 3°E
Spatial Resolution	0.5	0.1	0.05



Buoy measurements

Results are compared with four buoy data located in the west and south of the Ireland coast.

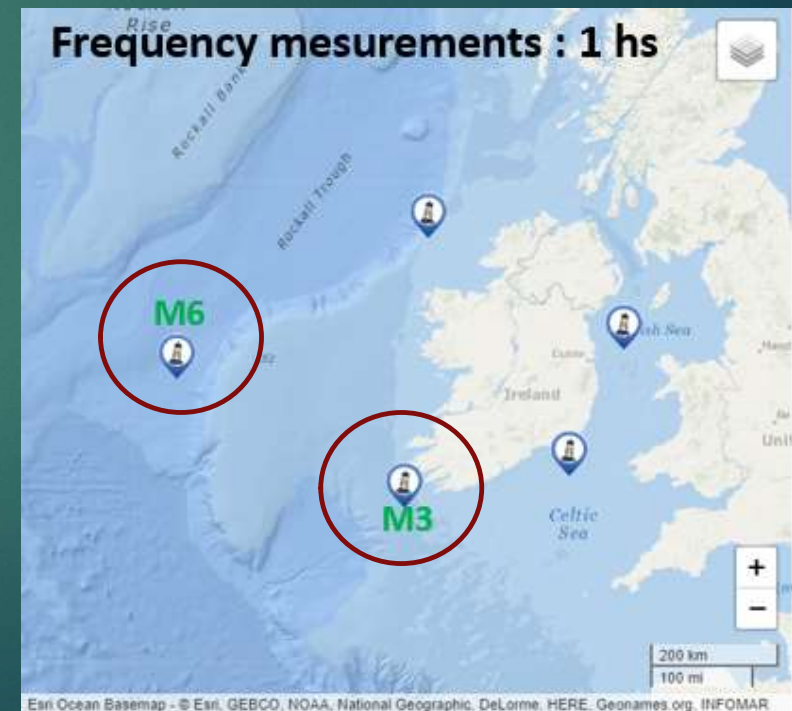
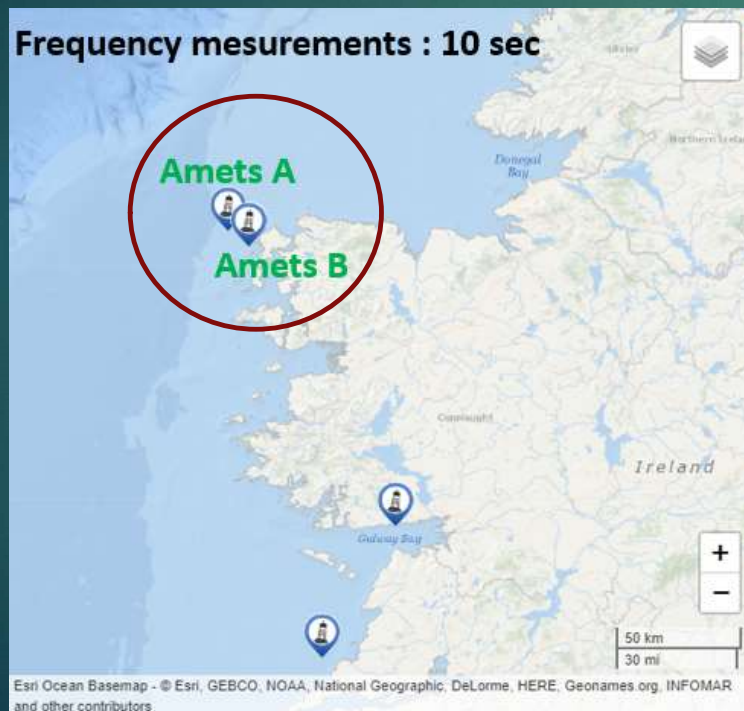
Period : February, March, April and May 2017.

1 - **Ajets A** buoy is located at 100 [m] water depth and 16 [km] off the coast.

2 - **Ajets B** Buoy is located at 50 [m] water depth and 6 [km] off the coast.

3 - **M3** Buoy is located 56 [km] southwest of Mizen Head off the Cork coast.

4 - **M6** buoy is located in deep ocean, approximately 389 [km] west southwest of Slyne Head.



Results

Validating the CDFAC parameters

CDFAC: 0.8, 0.9 and 1.0

(Fixed value: $\alpha_0 = 0.09$)

Results

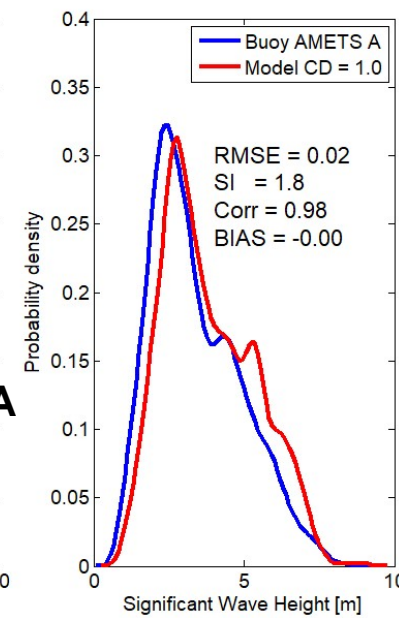
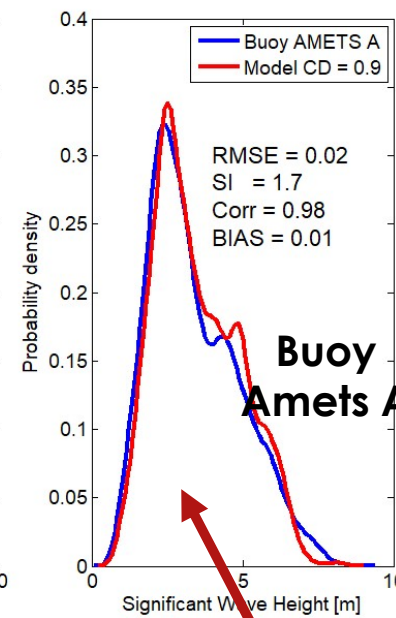
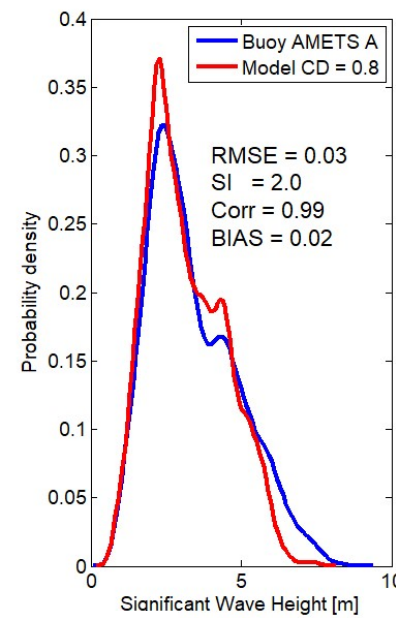
Probability distribution (H_s)

WW3 vs Buoys A & B

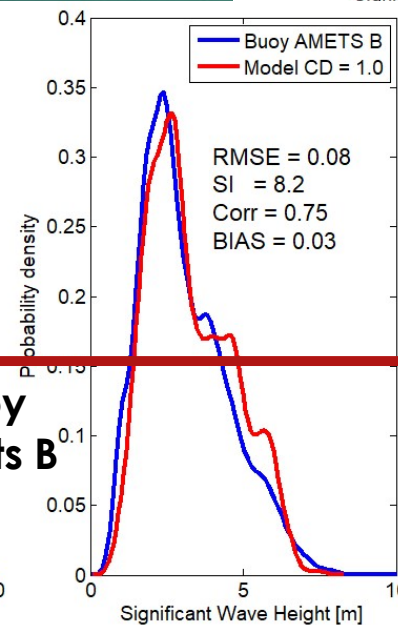
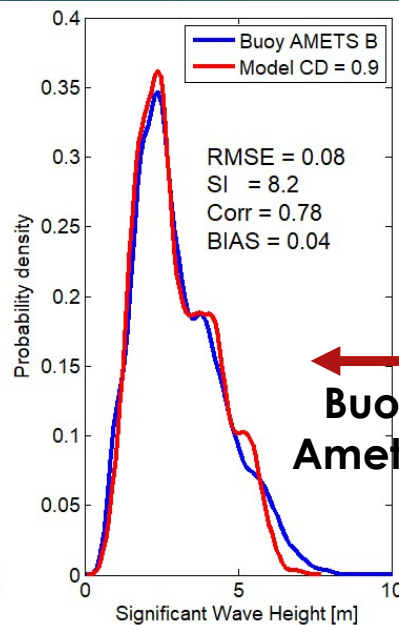
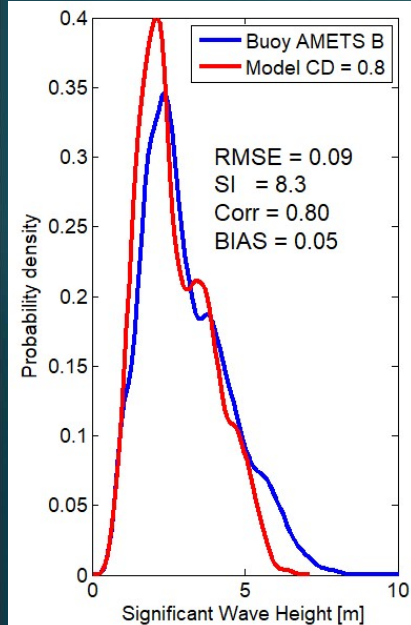
Wavewatch Bulk adjustment:

CDFAC: 0.9, 0.8 and 1.0

($\alpha_0=0.09$)



Buoy
Amets A



Buoy
Amets B

Good agreement using

CDFAC=0.9

Results

Fixed value: CDFAC: 0.9

Validating the wind input adjustment

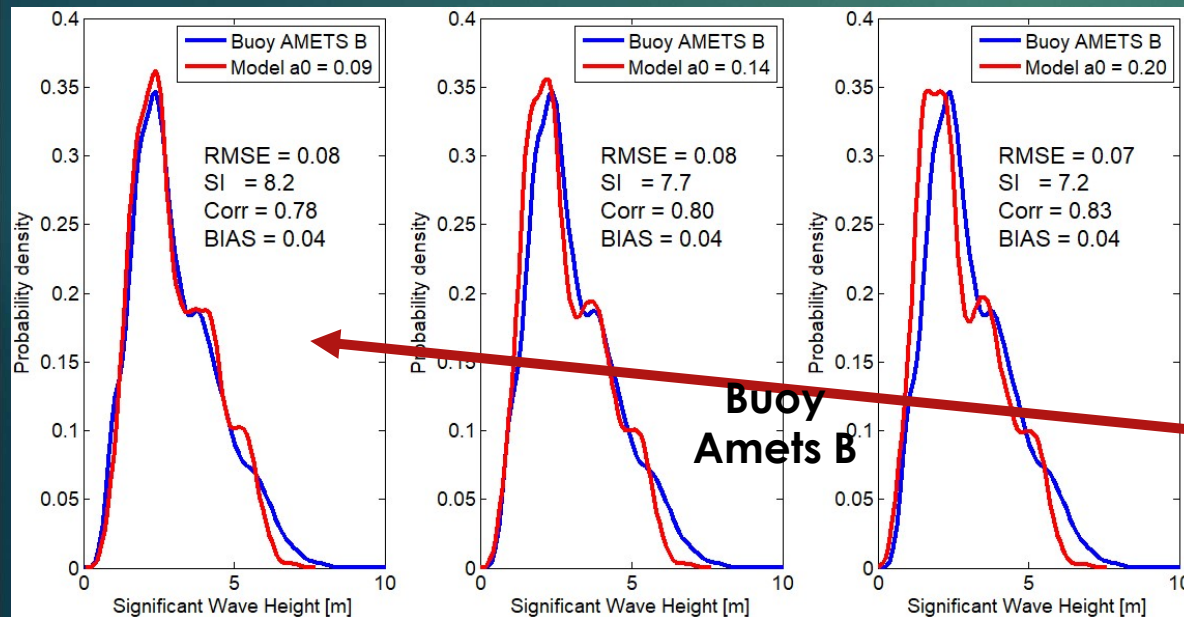
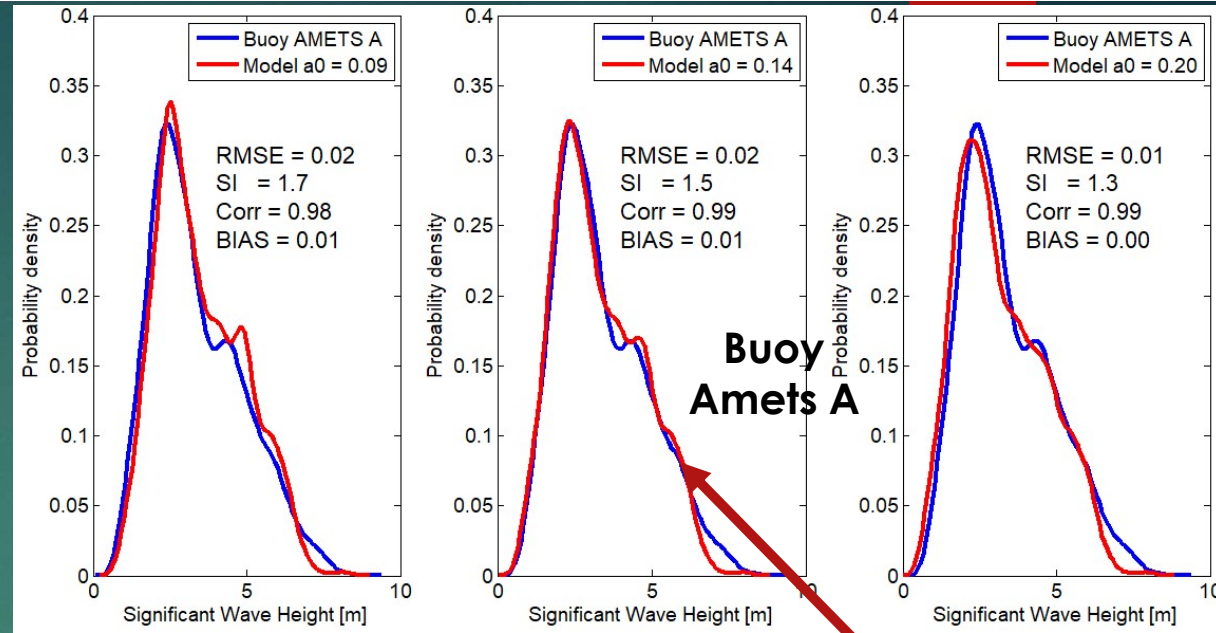
$\alpha_0 = 0.09, 0.14 \text{ and } 2.0$

Results

Probability distribution (H_s)
WW3 vs Buoys A & B

Bulk adjustment \rightarrow **CDFAC = 0.9**

Wind input adjustment \rightarrow **$a_0 = 0.09, 0.14, 2.0$**



Good agreement using
CDFAC=0.9
and
 $a_0 = 0.014$

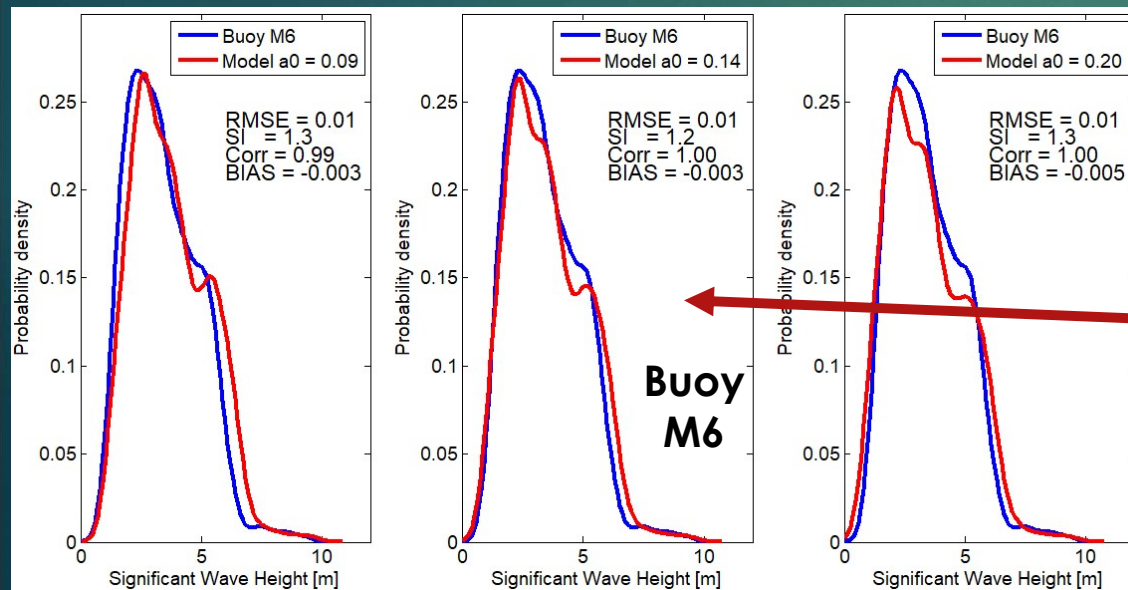
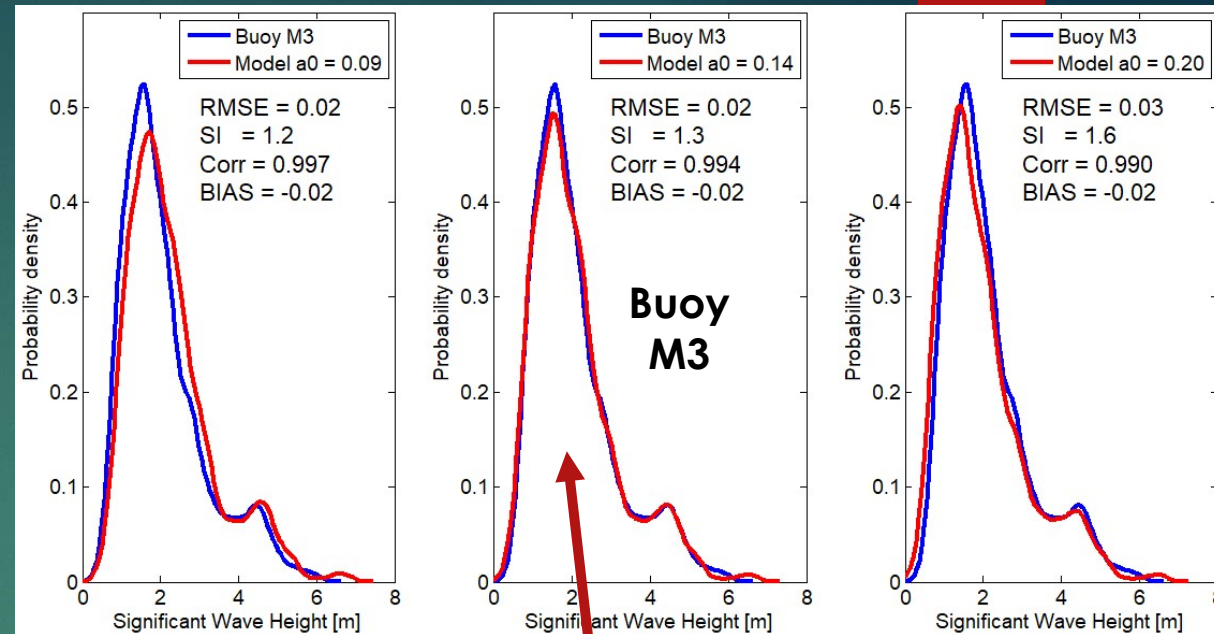
Good agreement using
CDFAC=0.9
and
 $a_0 = 0.09$

Results

Probability distribution (H_s) WW3 vs Buoys M3 & M6

Bulk adjustment → **CDFAC = 0.9**

Wind input adjustment → **$a_0 = 0.09, 0.14, 2.0$**



Good agreement using

**CDFAC=0.9
and
 $a_0 = 0.014$**

Results

Fixed value: CDFAC: 0.8

Validating the wind input adjustment

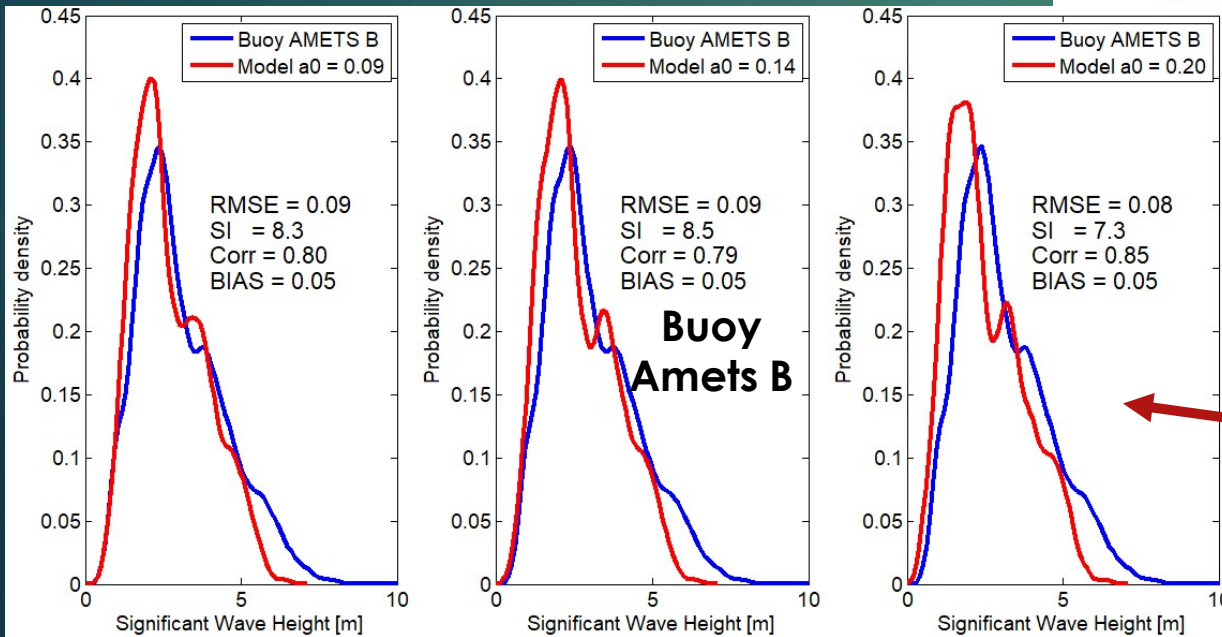
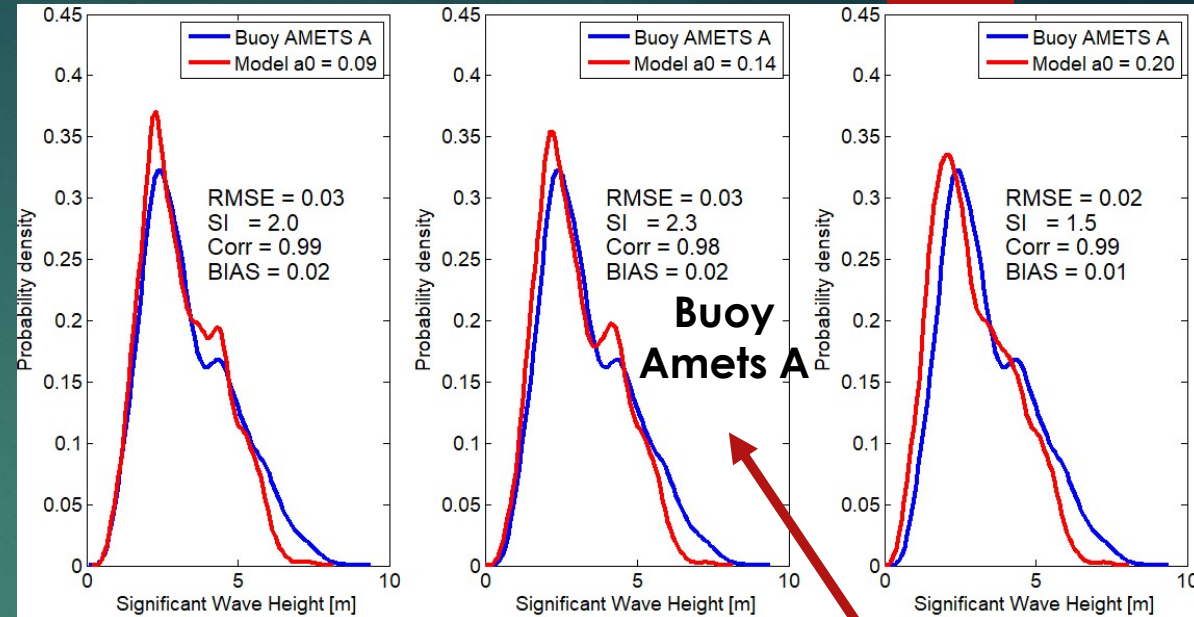
$\alpha_0 = 0.09, 0.14 \text{ and } 2.0$

Results

Probability distribution (H_s)
WW3 vs Buoys A & B

Bulk adjustment \rightarrow **CDFAC = 0.8**

Wind input adjustment \rightarrow **a_0 : 0.09, 0.14, 2.0**



Good agreement using
CDFAC=0.8
and
 $a_0 = 0.14$

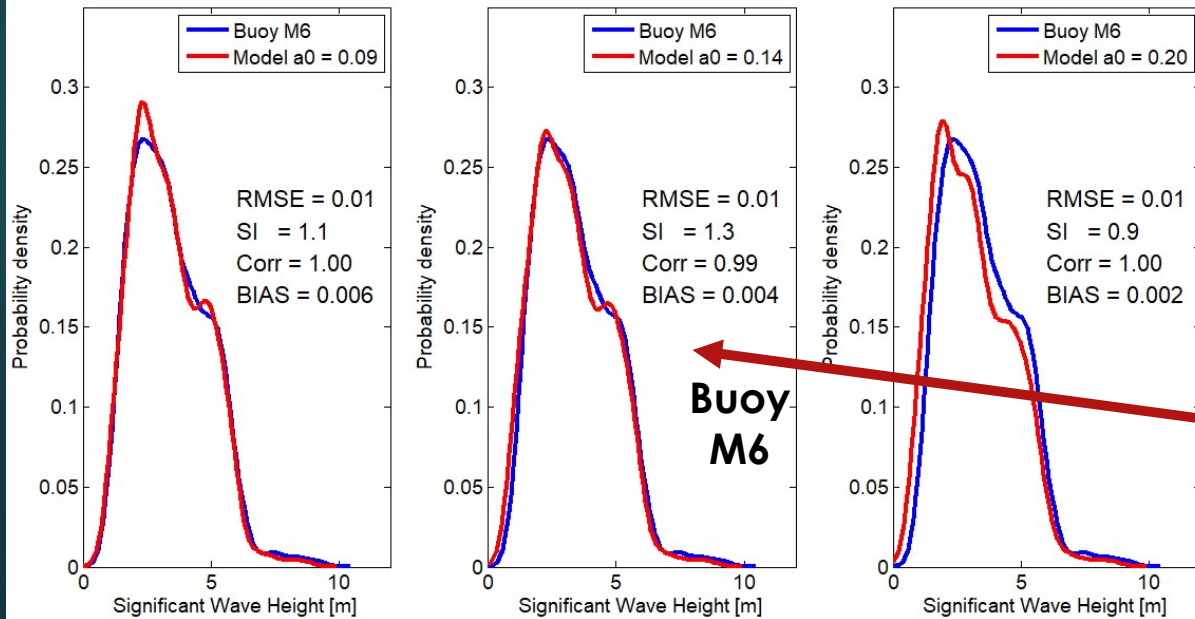
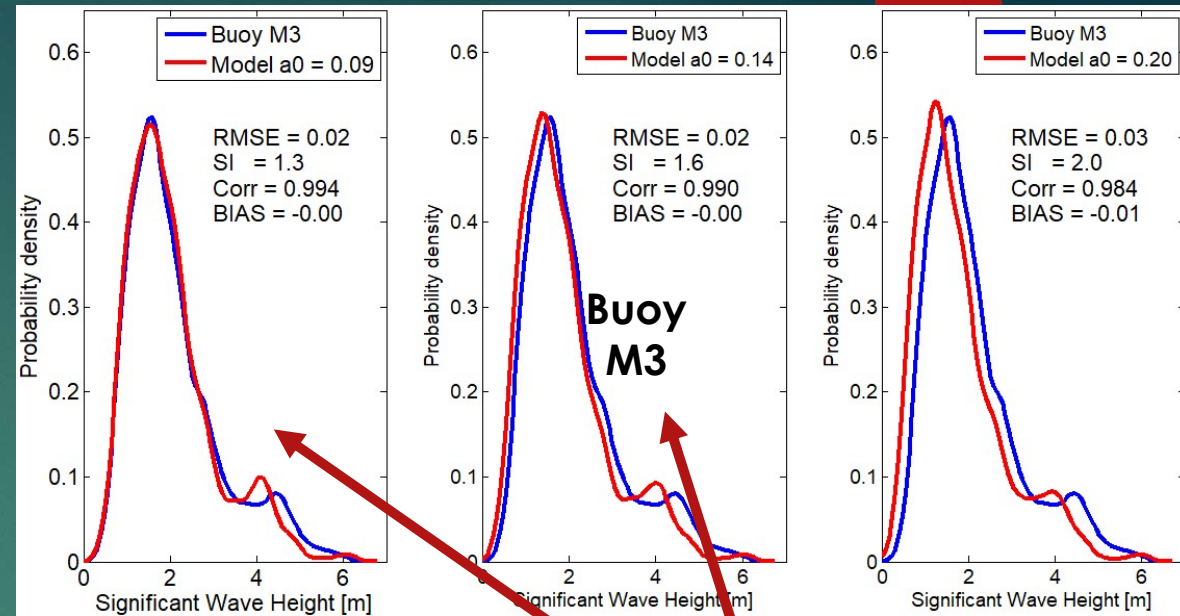
Good agreement using
CDFAC=0.8
and
 $a_0 = 0.2$

Results

Probability distribution (H_s)
WW3 vs Buoys M3 & M6

Bulk adjustment \rightarrow **CDFAC = 0.8**

Wind input adjustment \rightarrow **a_0 : 0.09, 0.14, 2.0**



Good agreement using

**CDFAC=0.8
 $a_0 = 0.014$ and 0.09**

**Good agreement using
CDFAC=0.8
 $a_0 = 0.014$**

Conclusions for the ST6 parametrization (1)

Using $\text{CDFAC} = 0.8, 0.9$ and 1.0 and a_0 proposed by Donegan 2012 and Zieger 2015 ($a_0=0.09$), Reich 2014 ($a_0=0.2$) and Kahna 2016 ($a_0=0.14$)

Conclusions are based on the analysis of the statistical parameters and the probability distribution functions obtained from the WW3 model results and buoy data.

CDFAC parameter:

On the whole, a good performance of WW3, following the set up of the model for the Irish coast, is given for the values of CDFAC 0.8 and 0.9 instead of for the recommended CDFAC 1.0 used in previous versions.

Conclusions for the ST6 parametrization (2)

Wind input coefficient a_0 :

With respect to the coefficient a_0 , although small differences are observed between the simulated cases in general, a good performance is observed using $a_0 = 0.14$ depending on the buoy data selected for the analysis.

The performance of WW3 compared with buoy *Amets A*, shows a good agreement when using $CDFAC = 0.9$ and $a_0 = 0.14$. A slight difference is observed in the comparison with the buoy *Amets B* where the best result is obtained for $CDFAC = 0.9$ and $a_0 = 0.09$.

The comparisons with the buoy *M3* data show an improvement of the values when using $CDFAC = 0.8$ with both, $a_0 = 0.014$ and $a_0 = 0.09$.

Finally, a good agreement is observed in the comparisons with the buoy *M6* data for both $CDFAC$ 0.8 and 0.9 with $a_0 = 0.014$.

Depending on the buoys selected the best performance of the model is found for different sets of parameters, although some common behaviour is found, further research is required to determine the best setting of WW3 using the ST6 parametrization.

Aknowlegments

Irish Centre for High-End Computing (ICHEC)

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