SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year ……2018……..……

Project Title: Fast solver for Wave modelling anf fitting of coefficient

……..……

Computer Project Account: …spcrduto……..……..……

Principal Investigator(s): …Mathieu Dutour Sikiric……..……

……..……

Affiliation: …Institut Rudjer Boskovic……..……

Name of ECMWF scientist(s) collaborating to the project (if applicable) …none……..……

……..……

Start date of the project: …2018……..……

Expected end date: …2020……..……

Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)				0
Data storage capacity	(Gbytes)				0

Summary of project objectives

(10 lines max)

……The goal of the work is twofold: ……

……A) Examine parallelization and how to improve speed of fast solver.……

……B) Fit coefficients of the source term in order to get better forecasts……

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Summary of problems encountered (if any)

(20 lines max)

……I had problem accessing to the ECMWF computer and so the computation were done on other computers.……

……I hope to continue the second part of the computation on ECMWF computer later on……

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Summary of results of the current year (from July of previous year to June of current year)

This section should comprise 1 to 8 pages and can be replaced by a short summary plus an existing scientific report on the project

……We decided to use the Ardhuin source term for the simulation……

……We found out that the value beta_max = 1.85 is best for the Adriatic simulation……

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List of publications/reports from the project with complete references

…One part that is still under consideration and not accepted is following:……

…Mathieu Dutour Sikiric, Damir Ivankovic, Aron Roland, Stjepan Ivatek-Sahdan, Martina Tudor, Operational Wave Modelling in the Adriatic Sea with the Wind Wave Model. ……

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Summary of plans for the continuation of the project

(10 lines max)

……The next part of the project is to consider how the model can sped up for the implicit solver.

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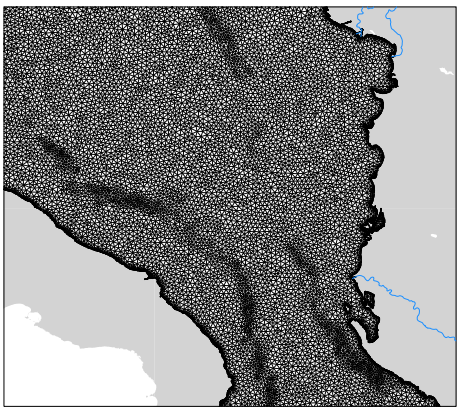

FIGURE 1 – Part of unstructured Grid of the model

MOTIVATION

At the DHMZ, the PI is setting up the wave model for operational applications. The model is used to make forecasts. Right now the forecasts are made starting at 00 UTC for 36 hours of simulation. The objective is to get as good as possible wave forecasts.

The model that we use is the Wind Wave Model. It is a third generation wave model that uses advanced numerics and source term formulation. It is fully parallelized and has a simple user interface.

The model setup is done according to the following lines :

1. The 2km ALADIN wind fields are used. Those are obtained from 2km dynamic adaptation winds, which themselves are obtained from 8km forecasts.
2. At the Ottranto strait, the 2D wave forecasts from the WAM model at ECMWF are used for the boundary forcing.
3. The minimum frequency is set at 0.06 Hz and the maximum at 1.69 Hz. The frequency increment is 1.1. This higher range is frequency is done so because the waves in the Adriatic are younger than in the Mediterranean Sea. This is because the swell can enter only at the Ottranto strait and that is quite limited.
4. We use 36 directions and 36 frequencies.
5. The grid used is unstructured (see details below).
6. The source term used are the Ardhuin formulation [**?**] for the source terms.
7. We use an implicit scheme with an integration scheme of 300 seconds which integrates the whole Wave Action Equation (Advection, Refraction, Frequency shifting, Source terms).
8. The period of interest used for the comparison is the year 2016.

The grid that we used for the modelization is an unstructured grid with $8.4.10^5$ nodes, $1.3.10^6$ elements, and a resolution that varies between 10m and 4km. Of those $3.5.10^5$ nodes are boundary nodes which reflects the higher resolution near the coast. 435 islands are resolved with the smallest coastline measuring 0.93 km and the average 10 km. There are $1.7.10^5$ points in the land boundary for a length of $4.3.10^3$ km. The open boundary condition at the Ottranto strait and visible in Figures is located at latitude 40 deg and contains 67 nodes. The grid resolution varies continuously between the coastline and the open ocean, which is a major advantage of unstructured grids and allow to resolve the islands in a nice way. See Figure 1.

PHYSICAL PROBLEM

TABLE 1 – Mean Error (ME), Absolute Error (AE), Root Mean Square Error (RMSE) in term of β_{max} for the 2016 period in term of β_{max} in comparison with the SARAL satellite.

β_{max}	ME (cm)	AE (cm)	RMSE (cm)
1.70	-12	24	31
1.75	-9	21	27
1.80	-8	21	27
1.85	-7	20	26
1.90	-8	20	27

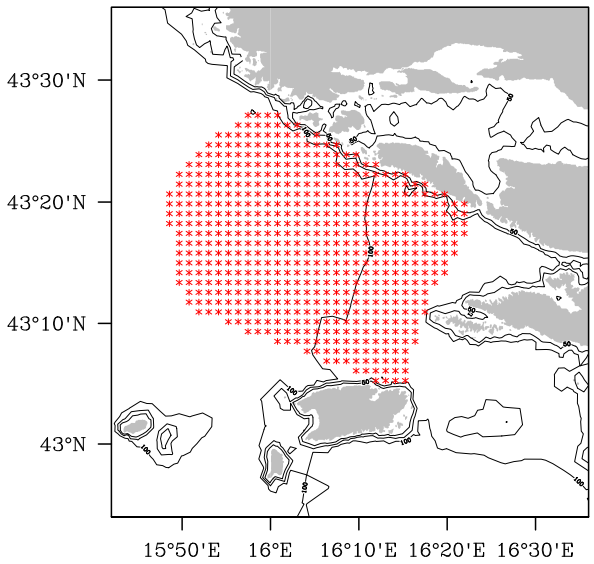

FIGURE 2 – Measurement points of the wave radar.

One key problem that we need to address when running the model is that the wind speeds as given by the ALADIN model underestimate the real wind fields. This problem is explained in [**?**, Section 2.1] and is due to the acceleration of wind speed at the transition land/sea for the bora wind. The canonical way to address this is to have higher resolution wind fields. Unfortunately this solution is expensive and so hard to implement in practice.

One solution to the problem is to adjust the wind speed by an empirical process of rescaling. This approach was proposed in [**?**] and is quite efficient. An alternative that we consider here is to use adjust the coefficient β_{max} used in the source term formulation. The main tool used for the comparison is the altimeter which provides significant wave height estimates in the Adriatic Sea. We use the SARAL satellite which is the most modern altimeter (see [**?**]) using Ka-band with a wave length of 0.8 cm while other more conventional altimeters use the Ku-band with a wave length of 2.5 cm (see [**?**, Section 2.5.2.1]).

CONCLUSION

We found that the value of the parameter β_{max} that seem the most plausible with respect to the mean error, absolute error and root mean square error is 1.85 (see Table 1). Note that when using the Cycle IV source terms, the most adequate value for β_{max} was found to be 1.75.

See in Figures 3 and 4 the plots of the altimeter and the buoy. See in Figure 2 the position of the buoy used.

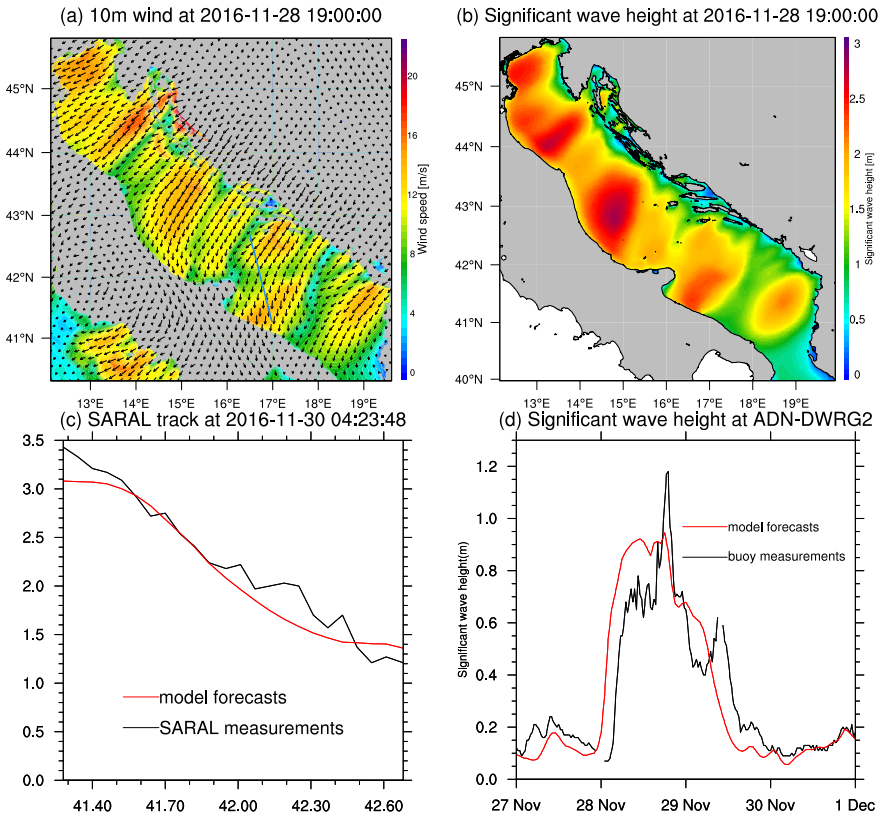

FIGURE 3 – Data for bora event from 2016-11-27 23 :00 to 2016-11-30 14 :00 : (a) 10 m wind speed obtained from the ALADIN 2km forecast and the track of the altimeter, (b) H_s forecast by the model, (c) Altimeter track and (d) measurements of buoy ADN-DWRG2.

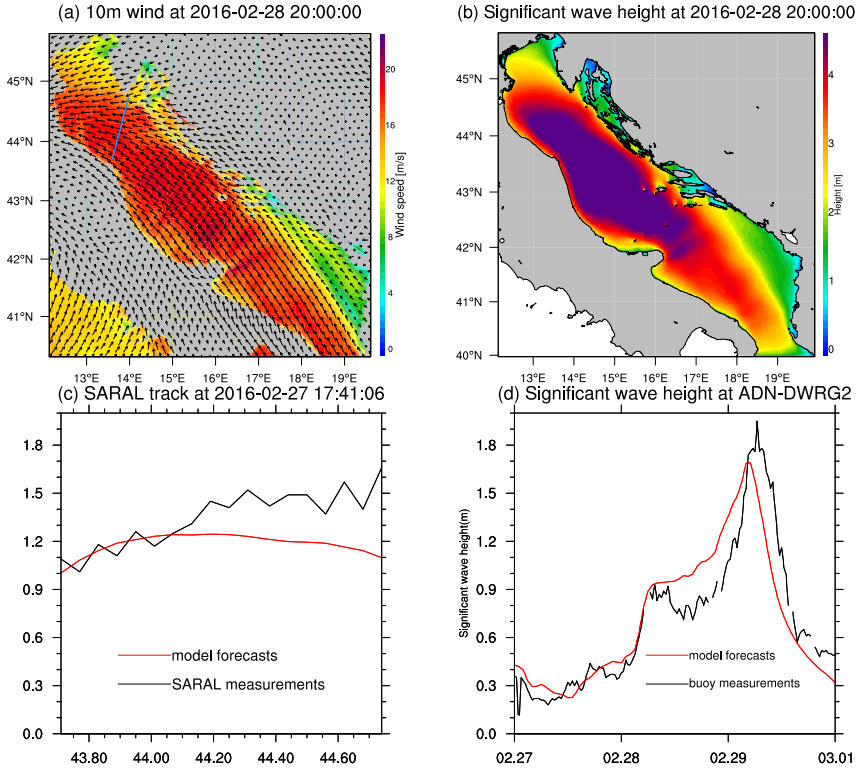

FIGURE 4 – Same as Figure 3 for sirocco event from 2016-02-27 05 :00 to 2016-02-29 05 :00.