NEMO-WAVE WG Meeting
19 Jan 2017: 09.00-12.00
Room 103 (first floor) MEOM Group building

AGENDA

From	To	Subject	Presenter
9.00	9.20	UK Environmental Prediction - a high resolution, fully coupled atmosphere, ocean, and wave system"	J. Castillo
9.20	9.40	NEMO-WAVE coupling status and 2017 working plan	E. Clementi
9.40	10.10	Discussion on wave breaking enhanced mixing (introduction E. Clementi)	ALL
10.10	10.40	Discussion on Langmuir circulation (introduction G. Nurser)	ALL
10.40	11.00	Coffee break	
11.00	11.30	Discussion on Wave sea-ice coupling (introduction Y. Aksenov)	ALL
11.30	12.00	Discussion on further developments to be included	ALL
12.00	12.30	Summary and conclusions	ALL

PARTICIPANTS

From the NEMO-WAVE WG:
Emanuela Clementi (INGV - Bologna)
George Nurser (NOC -Southampton)
Yevgeny Aksenov (NOC -Southampton)
Juan Castillo (UK MetOffice – Exeter)
Stéphane Law Chune (Mercator Océan –Toulouse)

External Experts:
Kristian Mogensen (ECMWF - Reding)
Joanna Staneva (HZG – Geesthacht)
Øyvind Breivik (NMI -Bergen):
Fabrice Ardhuin LOPS –Brest)
Xavier Couvelard (LOPS - Brest)
Anne Marie Treguir (LOPS -Brest)

MINUTES

Juan Castillo's presentation
Juan presented work done at the UK MetOffice in the framework of the UK Environmental Prediction System using a high-resolution (1.5 km) atmosphere/ocean/wave/land/biogeochemistry coupled system implemented in the North West Shelf basin.
Two systems have been presented:
- UKC2 where the coupling between the wave model WW3 and NEMO is achieved by exchanging significant wave height and energy from WW3 to

NEMO and current and depth from NEMO to WW3. This coupling has proved to provide a better forecast of the significant wave height at 2 buoy locations during a winter storm event in December 2014.

- UKC3 where the coupling between NEMO and WW3 includes the processes implemented in the wave branch merged in December 2016 including the exchange of: wave height, energy flux, Stokes drift, wave period, wave number, stress fraction, drag coefficient. The system provides a sudden decrease in sea surface temperature along areas of high current values and steep topography. Some causes have been highlighted:
    - o the branch used has been recently updated and need further improvements, the revision number of the model used in the simulation should be updated. Note that after the meeting, Juan has tested the recent modifications and now the UKC3 system is working, but there are some differences between forced and coupled mode to be. Juan also managed to set up a low resolution UK regional model (7 km called AMM7) with similar results.
    - o The vertical mixing closure scheme needs to be checked.

Emanuela Clementi's presentation
Details on NEMO-WAVE model coupling included in the more recent development branch have been presented including details on routines and namelist changes. It has been highlighted that in next weeks this development will be further improved thanks to Gurvan, since even if the model is conserving salinity, the Stokes velocity used in tracer advection should be modified and a check of the Eulerian divergence used when evaluating the right hand side term of the SSH equation should be done.
It has been mentioned that tracer advection is implemented in the Symphonie model (Michaud et al., Ocean Science 2012), with a specific treatment of open boundary conditions. Symphonie is a very close cousin of NEMO (point of contact: Patrick Marsaleix, Laboratoire d'Aerologie, Toulouse).

Emanuela will work with Gurvan for updating the code. As soon as the updated NEMO-WAVE developments will be included into the code (this will require some weeks because the 2016 developments have been merged back into the trunk the first week of February and now some actions are required before starting with new 2017 developments), Emanuela will inform the enlarged Working Group specifying the code revision at which the modifications can be tested.
Then specific tests on different configurations at different institutions of the enlarged NEMO-WAVE WG could be carried out providing feedbacks.

DISCUSSIONS AND FUTURE ACTIONS

1) *New NEMO-wave coupling developments*
It has been agreed that as soon as the new developments from Gurvan and Emanuela will be included in NEMO (few weeks), Emanuela will send an email to the participants, so tests can be carried out at different institutions on different configurations and resolutions.
→ Update the documentation (Emanuela)
→ Feedbacks from the tests will be included during the following months to achieve

further improvements (ALL).

2) *New reference configuration ORCA2-LIM3-WAVE*
The workplan for 2017 includes the addition of an ORCA2-LIM3 configuration where wave to ocean coupling is activated. Some issues could arise due to the interaction between waves and ice, but it is agreed that this reference configuration is needed to check the model developments in a standardized way (restartability / reproducibility) not for scientific purposes. It is also recommended to add a readme file explaining the parameterizations of the wave model providing data fields to NEMO.
→ Kristian could provide the global wave dataset to be used for the tests.

3) *New Stokes Drift vertical profile formulation*
It has been agreed to add the new vertical profile formulation from Breivik et al., 2016 to the present one (Wave2NEMO project Breivik et al., 2014) and add it as a namelist option. This has been already implemented by Joanna who is going to provide the code to the meeting's participants.
→ To be included during 2017 in a new development branch (Emanuela).
A generalization for finite water depth (giving the right transport and surface drift) has been developed at LOPS for the MARS3D model. This will be adapted to NEMO by Xavier (end of 2017).

4) *Modification of surface momentum due to wave stress*
In the present model implementation, the stress to the ocean is modified by multiplying the atmospheric stress by a ratio of wave over air stress that is evaluated in the wave model. It has been proposed to add the possibility to directly exchange the wave stress and/or the difference of the stresses (air-wave stress) where this choice can be made in the namelist.
- More studies on the effects of wave-induced stress are needed, e.g. comparisons of the components provided by the different models (WAM, WWM) are needed.
→ To be included during 2017 in a new development branch (Emanuela and Juan).
When wave-sea ice coupling is included, some issues could arise related to the stress modification by ice interaction.
→ Available research should be checked (Yevgeny and Fabrice).

5) *Surface roughness length in GLS*
In the latest development (dev_branch_2016 revision n. 7598) an option for GLS has been added to set the surface roughness length equal to the prognostic significant wave height, this includes wave advection into sea ice and attenuation due to scattering. This can cause problems in case of null wave height and in the presence of ice.
→ A minimum roughness length should be included, Yevgeny already takes into account some limits in his experiments; these need to be checked and implemented.

6) *Enhanced mixing due to wave breaking*
The group agrees to maintain the Qiao 2010 formulation already implemented and to add a modification involving the flux (rather than a surface value) of turbulent kinetic energy from breaking waves in the TKE scheme. This is on-going work by Øyvind in Wave2NEMO and at Mercator. Xavier is reviewing this as part of CMEMS project "Albatros".

-Different codes and implementations will be made available among the group members (Joanna, Xavier)
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→To check already available implementations and include in 2017 new development branch (Emanuela).

7) *Langmuir turbulence parameterization*
It is recognized the importance to include a Langmuir turbulence parameterization, taking into account the Stokes Drift, for all the available mixing schemes in NEMO. George has already carried out studies and development using the OSMOSIS parameterization, and some work is in progress in WAVE2NEMO project by Øyvind.
→ Consistency of equations and pressure term was raised by George. This will be checked by Nobu Suzuki and Fabrice.
→ In 2017 further scientific research will be carried out in order to propose a development branch in 2018 (George, Øyvind, Fabrice? and Joanna)

8) Wave - Ice interaction
Some work is in progress at NOC in particular Yevgeny led the development of the ice break up by waves (PDRA Lucia Hosekova, NOC), the analysis of the waves impact on sea ice and upper ocean and the implementation of the collisional sea ice rheology (PhD student Stefanie Rynders, NOC) along with floe size distribution evolution (PhD thesis by Stefanie Rynders at U.Southampton/NOC to be submitted in March 2017).
Fabrice is also performing analysis of momentum and energy modifications in presence of ice.
→ In 2017 further specific discussions are needed on this issue. A separate meeting discussing the wave-sea ice coupling has been proposed to be organized as a side event at the 15th International Workshop on Wave Hindcasting and Forecasting to be held in Liverpool 10-15 September 2017.

9) Quantitative evaluation of parameters in different coupled systems:
Now that some of the "plumbing" is in place, it is time to "taste the water" that goes long the pipes: Joanna mentioned that users & MFCs will need some guidance. It was proposed that some of the UKMO runs could serve as a baseline for comparing numerical values of:
- Surface Stokes drift
- wind stress or drag coefficients. (a Ph.D. thesis by Lucia Pineau-Guillou at LOPS is looking at optimising the ECWAM formulation of drag for improving IFS forecasts. So far this was done by a "soft capping" of the Janssen 1991 parameterization. A second step in 2017 will provide a robust wave steepness based parameterization (i.e. robust to presence of swell and valid for all wind speed … not the case of Oost …).
- surface flux of TKE
Joanna will make available the wave-induced forcing data for the UKMO run
The WAM4.5.4 code that includes the additional parameters needed for NEMO will be provided by Wave2NEMO (Joanna)
Comparisons and further analyses are needed (Joanna) → Xavier has volunteered to coordinate this work.

CONCLUSIONS

The enlarged working group has discussed the recently implementation of the wave impacts on the ocean and has prioritized their finalization.

It has been agreed to test the final version that should be available in few weeks from now and provide feedbacks that could be included in further developments during 2017.

The UKMetO UKC3 code involving full coupling of WW3 then needs to be tested more widely later this year.

Langmuir circulation and sea-ice interaction need further research (e.g., the sea ice-waves interaction processes are essential for global model configurations). Some work is underway at different institutions in different projects. These items should be discussed in following meetings in order to plan model developments in 2018.

Is has been decided to meet in Liverpool in September, 2017 again (not only to discuss the wave-ice interaction but also to check the progress).

It was suggested that the working group should in the future invite those active in the development of wave-ocean interaction in the wider NEMO community, not just people from within the consortium. This could involve among other IFREMER, ECMWF, HZG and MET Norway.

It has been discussed to converge as much as possible the different wave-coupling versions and to try to provide a common WAVE-NEMO code that includes different implementations taking into account the NEMO consortium Strategic Plan which is a guidance for the mid-term objectives (over more than one year) and future yearly work plans.