SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2019
Project Title:	In case mitigation fails: Exploring alternative methods to protect Europe against sea level rise, using the NEMO ocean model
Computer Project Account:	SPDEKJEL2
Principal Investigator(s):	Joakim Kjellsson Sjoerd Groeskamp
Affiliation:	GEOMAR Kiel, Germany UNSW, Sydney, Australia
Name of ECMWF scientist(s) collaborating to the project (if applicable)	
Start date of the project:	2019-01-01
Expected end date:	2019-12-31

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)			9 million	90 000
Data storage capacity	(Gbytes)			160 Tb	27 Gb

Summary of project objectives (10 lines max)

Sea-level rise poses a significant risk to many populated areas in Europe. We pursue an idea where Northern Europe is protected by an enclosure dam. However, such a massive dam would alter ocean hydrography and circulation significantly. We aim to investigate these changes using the NEMO ocean model. In particular, we wish to examine how the surface circulation and tides change when the North Sea is enclosed in a dam.

Summary of problems encountered (10 lines max)

We struggled to compile NEMO and XIOS on the ECMWF HPC, but managed to do it with assistance from the ECMWF helpdesk. Our configuration was a copy of the AMM7 configuration from the UK MetOffice, and it proved difficult to launch simulations despite using the exact configuration they use. In the end we had to chose a different version of XIOS and make some slight changes to the code.

Summary of plans for the continuation of the project (10 lines max)

We aim to run longer simulations as well as higher resolution simulations during the remainder of the project. We have not used much of our allocated CPU time yet as the 7km model is relatively cheap. Simulations with a 1/60 degree model will require much more CPU time.

List of publications/reports from the project with complete references

Groeskamp, S. & Kjellsson J. (2019) NEED: The Northern European Enclosure Dam for when climate change mitigation fails. Submitted to Bull. Amer. Meteor. Soc.

Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

We managed to install and launch NEMO simulations on the ECMWF HPC. All simulations spanned 1 year and cover the European Shelf waters with a horizontal resolution of 7 km. We performed three simulations, one control simulation, one with the enclosure dam, and one with an alternative configuration of the dam.

The control simulation performed well and was able to simulate the surface circulation as well as tidal amplitudes and phases quite well (Fig. 1). We then added the enclosure dam by modifying the land-sea mask and imposing strips of land across the North Sea and the English Channel. The result was that tidal amplitudes reduced by more than 90% inside the enclosure (Fig 2). There is also a gradual freshening of the North Sea when enclosed due to the lack of inflow of salt and lack of outflow of freshwater from. We also notice a change in surface circulation as the southward flow

near the Orkney Islands and the northward flow along the Norwegian coast are blocked. These flows amount to ~ 2 Sv and blocking them may have remote impacts in the North Atlantic.

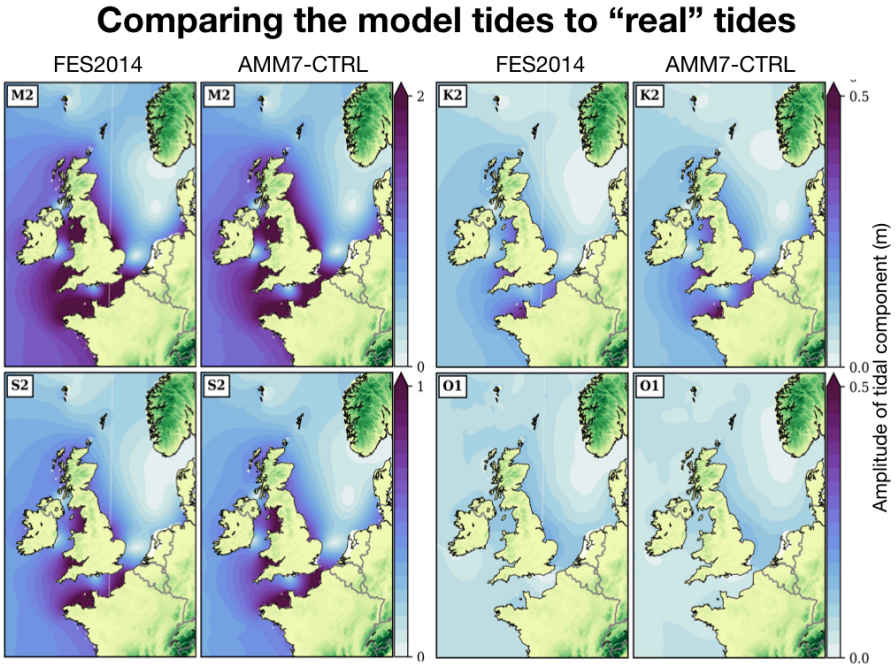

Fig 1. Comparison of amplitudes of the M2, S2, O1, K2 tides in NEMO to FES2014 tidal solutions.

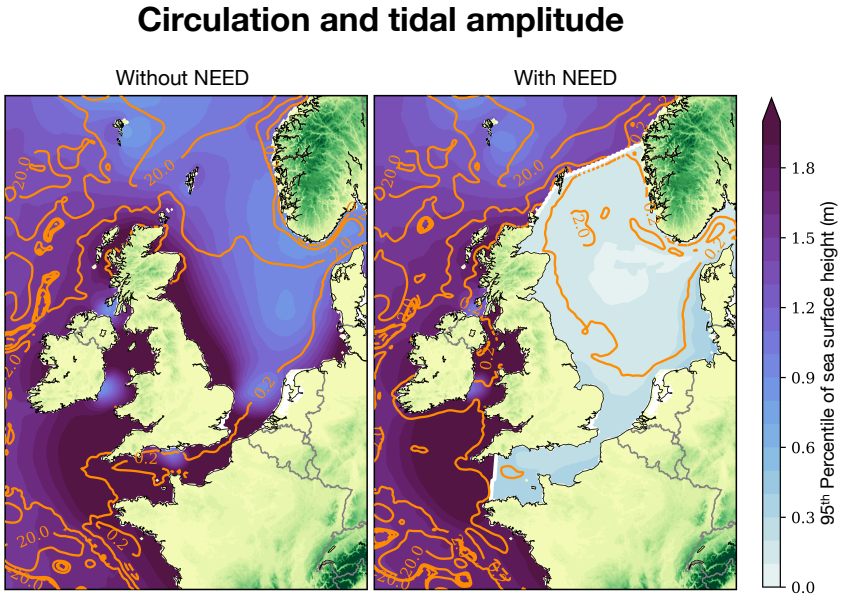

Fig 2. The 95th percentile of sea-surface height in the control simulation (left) and with the enclosure dam (right). Orange contours show contour lines of the barotropic circulation in Sv.