Geoscientific

Model Development

Discussions

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Interactive comment on "Nemo-Nordic 1.0: A NEMO based ocean model for Baltic North Seas, research and operational applications" *by* Robinson Hordoir et al.

Anonymous Referee #2

Received and published: 29 May 2018

1 Overview

This system description and evaluation paper constitutes a useful contribution to the ocean modelling community at large and in particular to researchers focused on the North and Baltic Seas. The authors make a clear case for the potential advantages from modelling both basins and their interconnection all in one system. They also note some of the difficulties that entails and some of the compromises that are required to model these two basins with considerably different dynamics. The paper is generally well written. There are a surprising number of typos and technical inconsistencies but nothing a copy editor should not pick up on. There were a few instances where the

text was not particularly clear but overall it is of a good quality. The paper gives a useful assessment of the model skill compared to relevant observations in each basin on a variety of time scales. I believe the paper with some minor corrections should be put forward for publication. Below I have some comments that the author may wish to consider to help refine the paper a further.

2 General Comments

C1 I think within the introduction (∼L85) or the Model set up needs mentioning of the two differing resolution models that are referred to later in the paper. It is not immediately obvious which version of Nemo-Nordic is being assessed at any one time, especially as both are later compared against each other. I think it would help the reader if there was some way to make this clearer, e.g. Nemo-Nordic 1nm/2nm etc. or some other similar labelling strategy early in the paper and a description of these. In the model description there is only a description of the 2nm version. Perhaps restricting nautical miles to metric equivalents will be more in line with GMD.

C2 L105. With regards to the 2nm grid description, it might be useful to state if the grid is rotated, otherwise it would be hard to see how the stated grid resolution would be retained at a relatively high latitude.

C3 L113-L116 The stated vertical resolution is surprisingly coarse in a regional model. I appreciate there is a need to focus resolution with regards to the overflows but 3 m surface resolution seems quite low. I refer the authors to Stewart et al. with regards to what would be an optimal vertical resolution for a z-level model in a global context. K.D. Stewart, A.McC. Hogg, S.M. Griffies, A.P. Heerdegen, M.L. Ward, P. Spence, M.H. England,Vertical resolution of baroclinic modes in global ocean models,Ocean Modelling,Volume 113, 2017,Pages 50-65,https://doi.org/10.1016/j.ocemod.2017.03.012. Towards the end of the paper there is an analysis compared to an SST product. The bias is surprisingly large and cold given the warm bias in the atmospheric forcing, could the surface resolution play a part? What is defined as SST in this context?

C4 L124 The issue of model resolution and the Danish straits is correctly brought to the attention of the reader and the method by which the barotropic flux can be maintained by retaining the same cross-sectional area. However, this must be problematic with regards to the baroclinic part of the flow. Particularly so as one of the main motivations of having the interconnect is to model bottom saline intrusions form the North Sea that enter the Baltic. Perhaps there is justification here for some more comment on the effects on the baroclinic flows by attempting to retain the barotropic flux.

C5 L136 It is mentioned that 'tuning' is done with regards to optimizing model SSH. It is not clear what the optimization is, perhaps this could be elaborated as it could potentially save others time in the future or suggest useful strategies. I wonder could the authors supply a graphic/map in the supplementary material with regards to the 2d varying bottom friction "following the barotropic Kelvin wave", what is the physical grounds for this?

C6 L174-L175 The use of variable diffusivity and viscosity appears to be an interesting pragmatic engineering solution to the model difficulties concerning mixing and the dense water overflows. That is an interesting solution and appropriate for short time scale like a forecast model, but I wonder if it is appropriate for climate scales? That is this strategy assumes a-priori what the structure of the water column is, but on climate time scale that could change but the model may in effect be imposing it as it is, could the authors comment on this. It seems that as the authors note, a hybrid z* with sigma at the bottom is a much better vertical framework for the problem at hand. Could the authors comment on why such a huge viscosity is required at the boundary region? This is likely to cause severe issues for any coupled biogeochemistry model here. I suggest it is worth investigating what is happening to vertical velocity and tke here.

C7 L210 There are a number of chl products that are available. Do the authors consider using say even just a monthly climatology rather than a uniform value domain wise.

C8 Fig 2,3,4

I think the use of Taylor plots here is not appropriate, as there are only two data points. It could save a lot of space to reduce the Taylor plots to numerical tables. Taylor plots are beneficial when analysing a large 'cloud' of data. In a model sensitivity, they are useful if tuning say one parameter a number of times. In this case, there are just 2 model resolutions, it might be more appropriate if there are several model resolutions to intercompare. Enabling the modeller to visualise if there are say competing trends between rms, correlation and standard deviation. However, with just two data points there can be no trend to discern. In conclusion, a table might be quicker to interpret and save considerable space I do not think the Taylor plots here bring any advantage. With regard to the tides in the North Sea, the inclusion of a Co-tidal amp/phase plot of say M2 could be useful to give a quick look at how overall the model is doing in space with regards to tides.

C9 Fig 5

The climatological currents from North to South along the boundary in the English channel are very odd and suggest some problem in the bdy implementation here. Could the problem be related to using clim. TS in a highly tidal area? Ignoring the general cold bias in Fig 17, there is still an obvious bdy issue both in the north and in the south in JJA, again perhaps relates to the bdys provided. Too much vertical mixing??

C 10 L256 It is noted that the north sea underestimate lower frequencies but these are unbiased in the Baltic. (due to amplification?) Is there a case to be made that the model Is overdoing amplification of waves that are initially underestimated in the North Sea? If so could that have other adverse effects?

C 11 L 425 the authors show a large freshwater bias at the Frisian front location. May I also suggest that the riverine input from HYPE could be a possible issue here, Have the authors made an assessment of the HYPE model along this coastline? The accuracy is assessed for the Baltic Basin but not for the North Sea?

3 Minor Technical points/errata These are likely but a subsection of minor points that need further editing.

T1 The text in general refers to the configuration as Nemo-Nordic, but a number of the figures capitalise the term NEMO.

T2 L96, User of However needs a following comma, this occurs in a number of places.

T3 L108 "which is more simple as->than some Baltic Sea Models"

T4 L111 "showed-> shown"

T5 gaps between numbers and units often missing e.g. line114 60m instead of 60 m.

T6 L124. "The cross section(al) area"

T7 L229 "Benefits from the use(s)" T8 L239 "Straights->Straits"

T9 L252 "has a low->negative bias"

T10 L264 'which are one of the main driver(S) of the Baltic Sea'

T11 L265 : reword "The SSH in the Danish Straits bearing a high variability part along the coasts was less of a concern"

T12 Fig 2, change "up to bottom " to "top to bottom" in captions

T13 Fig 4 caption "North Sea and *English* Channel"

T14 Use of the term British Islands might want to be replaced with British Isles, e.g. L41

T15 L 329 In order to avoid these? Effects(s?)

T16 L346 "The Surface water at these station(s)"

T17 L369 "Major Baltic inflows *of* 1993 and 2003

T18 L340 "recorded duration(s)"

T19 L373 "this further suggest(s)"

T20 L383 suggest adding degree sign and N/E etc.

T21 L393 "are show(n) in the Figure *?*"

T22 L 407 "It exhibits mostly seasonal variations in *the* form of .."

T23 Fig 16 caption,, seems "a)" is not required (Fig 17 ok) and depth [m] needs reformatting

T24 L456 "an subdivide" -> "and subdivide"

T25 L476 "data set in the" -> "data set in"

T26 L501 "proper(ly)"

Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2018-2, 2018.