RC1: , Isabel Garcia Hermosa, 07 Nov 2025

Dear authors, I am unsure of the tone of other articles in this journal. I find this article interesting, clear and pedagogical.

We thank the reviewer for all the constructive suggestions and positive feedback.

Specific comments

Regarding my comments below they are suggestions and questions.

I don't ask to do any changes regarding to this point, I would like to comment about it. I don't know if I understood correctly, but you say for the bathymetry you have a 10 m minimum depth criteria. With so many islands and channels isn't this a bit risky? Maybe I didn't understand clearly. I guess, as the other reviewer (Shchepetkin) mentions, it cold be due to the breach of the courant criteria. Perhaps there are other methods, but really dependent on the bathymetry available. Also if in general you get good results, it is ok. However coastal and shallow areas, with channels and shoals are very dependent on bathymetry.

Answer: We are confident that the results from our Norkyst model system with ROMS as the numerical core are realistic and not particularly affected by our choice of minimum depth as 10m. You are right that the Norwegian coast is extremely complex with small islands, narrow straits and fjord arms, and our horizontal resolution of approx. 800m x 800m will not allow resolving this coast line by any perfection. Our choice of minimum depth of 10m is connected to the CFL-criteria, but it holds well in most regions as the actual areas with depth less than 10m are close to land with very little impact on the main dynamics. We maintain higher resolution models as well (not described in this manuscript), and we then aim to better resolve both coast line and bathymetry when spatial resolution is increased.

I don't know sufficiently the area but cold the issues present in some of the stations in Tables and figures be an artifact of this depth minimum?

Answer: The validation statistics describe hydrographic quantities mainly, and are also from relative open (exposed) locations. Since most of the Norwegian coastal zone is stratified with a relatively shallow surface layer all year, and that the horizontal scales of salinity and temperature are large, we are very confident that the model biases are not a result of the chosen minimum depth.

We have added a sentence in line 64 (chapter 2.1, after we state the minimum depth):

"Our choice of minimum depth is based on a compromise between maintaining the CFL criterion (Courant-Friedrichs-Lewy) and the fact that most of the Norwegian coast is deeper than 10m. Exceptions are mainly found along the shoreline with negligible impact on the main hydrodynamics."

A suggestion regarding Section 4. For clarity, I would reorganise it or add a sub section (observations used in evaluation) after an introductory sentence on what you are comparing. Introduce the section with a sentence to make it clear (as mentioned early in the introduction, as a reminder) that this section compares the hindcast that has such and such characteristics to in situ observations. Then put the rest of the information in line 166 (period available for the hindcast).

Answer: We agree that we can increase the clarity in this section, and we have added a new sentence in the beginning of section 4 and altered the rest of the text between line 148-165:

4. Model evaluation

We present verification from the long hindcast, only, which is the unconstrained model version of the forecast system where we evaluate hydrographical properties in offshore and coastal waters and hydrodynamical properties in one of the largest Norwegian fjords.

The hydrographic properties in the offshore open waters are evaluated for 2015-22 against the gridded CORA Dataset of temperature and salinity (E.U. Copernicus Marine Service Information (CMEMS) 2024; https://doi.org/10.17882/46219). CORA is a global CMEMS product of reprocessed in-situ measurements, developed by the In Situ Thematic Assembly Center (INS-TAC)l. Spatial resolution is 0.5 degrees in longitude, and varying in latitude from 0.5 degrees at the equator to 0.2 degrees at the North Pole. The vertical resolution is also variable with 87 layers and higher resolution closer to the surface.

The hydrographic properties along the Norwegian coast in Norkyst are evaluated for the entire model period (2012-23) against the measurements from Institute of Marine Research (IMR)'s fixed coastal stations (see e.g., Albretsen et al., 2012, and available data from http://www.imr.no/forskning/forskningsdata/stasjoner). Temperature and salinity profiles are measured 2–4 times per month, presently with RBR CTD sondes (https://rbr-global.com). The position of the seven coastal stations from Lista in the south to Ingøy in the north are shown in Fig. 1.

From one of the largest Norwegian fjords, Hardangerfjord, the IMR has conducted current measurements at a location in the middle of the fjord at N59 59.49, E05 54.87. This location is named Hardangerfjord East ("HfjE"). The bottom depth at this location is 540 m. The current mooring consists of two profiling current meters positioned at approximately 40 m depth. These are one Nortek Signature 250 measuring downwards in 2 m vertical bins and one Nortek Aquadopp measuring upwards in 1 m vertical bins (https://www.nortekgroup.com). The instruments measure for 4 minutes every 20 minutes, and in our evaluation we show results from Jan-Apr 2024 only. We also apply additional CTD measurements for the period 2017-23 from the location "H2" in the inner part of the Hardangerfjord at N60 23.32, E06 20.51. The bottom depth at this location is 850 m. Profiles were measured during monthly regular cruises. The instruments used are the SAIV SD204 (prior to 2019; http://www.saivas.no) and the RBR Concerto 3 or Maestro 3 (https://rbr-global.com).

The following sentence (starting in line 166) looks out of place as it mixes things and the link is not clear to me. Perhaps add some text to clarify why it is there? I am assuming it is something like this below, I don't know if I understood correctly.

"It should be noted that a continuous and internally consistent high resolution archive of atmospheric forcing data TO BE USED IN THIS HINDCAST has not been available for the entire period. PLEASE NOTE THAT BECAUSE OF XXX, IN THE HINDCAST a warm bias reaching up to 0.7-0.8 degrees IS PRESENT in the surface layer in summer, resulting from too high radiation forcing. THIS has been identified when using NORA3 data (period 2012-2020, see Gonzalez et al., 2025), which is discussed further below in Sec. 4.2".

It should be noted that a continuous and internally consistent high resolution archive of atmospheric forcing data to be applied in this hindcast has not been available for the entire period for all variables. Please be aware that because of an exaggeration of the solar radiation in the NORA3 atmosphere model (which was used for the simulation period 2012-20), we have identified a warm bias reaching up to 0.7-0.8 degrees in the surface layer in summer by performing a sensitivity test for 2021 where we had access to solar radiation estimates from both NORA3 and AROME MetCoOp. See Sec. 3.1. for references to the atmospheric models, and the same offset in sea temperature is also described in Gonzalez et al. (2025).

An additional question. You mention in the abstract that indeed the system you evaluate is the hindcast, but you want to use the system in forecast mode. There is no mention as to whether the forecasting system is expected to behave in the same way or not. Would it be worth clarifying?

Answer: Yes, we agree and have added text after the first paragraph in Sec. 6:

We aim at having a hindcast (reanalysis in the future) version that reflects the operational forecast version, however, an operational ocean model also depends on operational forcing data. A hindcast, however, dependent on the delay, has potentially easier access to better forcing data. The main purpose of the hindcast version is to allow users to access a long, consistent data series, but we also have better opportunities to test new forcing data, different numerics etc.

In figures showing salinity values there's no unit. Is this on purpose?

Answer: Thank you for pointing this out. We have added "psu" in the labels in Figure 7, 8 and 10.

I appreciated the colour diagrams shown in Fig 3, 4, 5, 6.

Answer: Thank you!

Just a suggestion not compulsory. For the metrics results in table 1 and 2, as you are lucky to have all these many metrics for quite a few locations, it would be really good to see them graphically. This could be done in a Taylor diagram.

Answer: Thank you for this suggestion. We agree and have displayed all coastal stations and the two depths (10 and 150m) for both temperature and salinity in one Taylor diagram. Table 1 and 2 is then replaced by a new Fig. 7 (Fig. 7, 8, 9 and 10 is now 8, 9, 10 and 11) with Figure caption:

Figure 7. Taylor diagram showing the correlation coefficient, normalized standard deviation, root-mean-square difference (grey curved lines) and normalized mean bias (bias divided by the observed standard deviation, indicated by symbol type and size) between modelled and observed temperature and salinity at 10 and 150 m depth at the seven fixed coastal hydrographic stations along the Norwegian coast for the period 2012-2023. Colors denote the different coastal stations. The two triangles below the horizontal axis represent salinity at 150 m depth at Sognesjøen and temperature at 150 m depth at Skrova shown with normalized standard deviation as the numerator and correlation coefficient as the denominator. The Taylor diagram is based on code from https://doi.org/10.5281/zenodo.15991044.

Sec. 4.2. (line 195-217) is rephrased to:

The hindcast archive has also been compared with the temperature and salinity profiles from the IMR fixed coastal stations for the period 2012-2023, and we have focused on the two vertical levels at 10 and 150 m depth, representing the surface layer and intermediate layer, respectively. Validation statistics are displayed for each station, depth level and parameter in a Taylor diagram (Fig. 7). The hydrographic properties in the surface layer are well reproduced by the model, with standard deviations close to the observed values and high correlations at all stations, although the agreement is better for temperature than for salinity. The normalized mean temperature biases are very low (<5%) at the southernmost stations, and somewhat higher at the northernmost stations and for salinity as the variability is lower. A complete time series from the station Ytre Utsira is displayed in Fig. 8, which demonstrates that the model closely follows the observations at this location which represents the southern part of the model domain. On shorter time and spatial scales, however, we can expect anomalously exaggerated water temperatures near the surface in the hindcast, and especially visible inshore.

The intermediate depth layer along the Norwegian coast is also reproduced realistically, though with slightly larger deviations between model and measurements. The validation statistics displayed in the Taylor diagram (Fig. 7) shows that the 150 m temperatures have realistic variability and generally high correlation with observations. An exception is the Skrova station, where the model overestimates the observed standard deviation and shows low correlation with observations. Similarly, the 150 m salinities at Sognesjøen are less well represented in Norkyst with relatively high standard deviations in the modeland low correlation coefficient. The latter low correlations are also seen in the intermediate layer salinities at Ytre Utsira, Eggum and Ingøy. A complete time serie from the station Skrova is shown in Fig. 9, and we see that while the model salinity is underestimated, the model temperature shows too high variability in the model.

Technical corrections

I would advise to correct a couple of typos throughout the document. The terms 'hydrographical' to be replaced by hydrographic, and 'horisontal' by horizontal.

Answer: We agree and have corrected these words accordingly.