Review of "Variability of coastal downwelling circulation in response to high-resolution regional atmospheric forcing off the Pearl River Estuary"

This paper by Lai and Gan investigated the variabilities of coastal circulation and dynamics in response to spatiotemporally variable high-resolution atmospheric forcing off the Pearl River Estuary during the downwelling wind. The authors conducted three numerical experiments based on (1) single station observation, (2) global reanalysis data and (3) high-resolution regional atmospheric model. Results show that the model with high-resolution atmospheric forcing significantly improved the temperature-salinity profiles and ocean current simulation. In addition, the model with high atmo-forcing improved the estimation of cross-isobath transport. This paper is well-written and organized, and the results are beneficial for ocean modeler to improve their model results and associated studies. I would suggest a minor revision for this paper before publishing it.

Response: Thank you for your constructive comments. We appreciate the positive feedback and are pleased to know that our work is beneficial for ocean modelers. We hope that our revisions have adequately addressed your concerns.

Major Comments:

(1) One of the comment problems in ocean model is the over-heating in the surface layer. Usually the ocean model needs surface temperature nudging to the reanalysis or climatology SST data, such as GHRSST and MODIS, to avoid over-heating in the surface layer. In this paper, the author mentioned that ROMS were forced by high-resolution wind stress and heat fluxes. I wonder whether ROMS model in this paper only driven by high-resolution heat fluxes without SST nudging, or only driven by high-resolution SST. Please clarify it in the discussion.

Response: We understand that the surface temperature nudging to reanalysis or climatology SST data in the ocean model is important. However, in this study, we did not apply additional surface temperature nudging to the reanalysis or climatology SST data. This is because we conducted a short-term simulation, with the main driving forces being wind stress and heat fluxes. Applying high-frequency SST nudging could potentially twist the physical dynamics.

Furthermore, in this coastal region, the accuracy of GHRSST and MODIS SST is highly questionable, and the variability of SST in this region is large, making it difficult to find high-quality SST data for the coastal area.

(2) The author used the ERA data with 75 km resolution as the "coarse" resolution product to compared with the WRF 1 km production. Actually, in nowadays, the 12-15 km resolution and 0.2 degree (approximately 22 km) resolution products are quite common, and provided by ECWMF and CFSV2 (from NECP), respectively. Ocean model driven by this 10-20 km resolution products may be closed to that driven by WRF 1 km product. The author may give some comment on this.

Response: We acknowledge that other relatively high-resolution datasets are available, such as the latest ERA5 data from ECMWF with a 0.25-degree resolution and the 0.2-degree products from

CFSv2 from NCEP. However, different reanalysis datasets can have differences in spatial and temporal resolution, as well as in the way they assimilate observations and model data, leading to different influences on ocean model performance. Thankaswamy et al. (2022) investigated the sensitivity of different reanalysis data (ERA-Interim and NCEP-CFSv2) on WRF dynamic downscaling for the South China Sea and found that the model forced with ERA-Interim data provides the best simulation of surface wind speed characteristics in the region.

In this study, we also employed the latest ECMWF ERA5 data to force the ocean model and obtained results that were comparable to those driven by the ERA-Interim data. The figure below shows the comparisons of the along-shore and cross-shore winds of the observations, ERA-interim and ERA5 data at Shan Wei, Waglan Island and Shang Chuan Dao stations in July 2017. The comparison suggests a certain degree of similarity between the ERA-interim and ERA5 data; however, both datasets exhibit deviations from the observed winds.

Our primary focus of this study was to compare the high-resolution coastal ocean model (less than 1 km horizontal resolution) results driven by our high-resolution WRF forcing with the widely used global reanalysis data to demonstrate the benefits of using high-resolution atmospheric forcing. Therefore, we chose to compare our ultra-high-resolution (1 km horizontal resolution) WRF forcing with the relatively coarser ERA-Interim data.

We have briefly explained this in the section 2.2 of the revised ms..

“Although the latest ERA5 reanalysis data from the ECMWF comes with many improvements compared with ERA-Interim data, such as enhanced spatial and temporal resolution, we found that the performance of these two datasets is comparable in this coastal region. Therefore, we opted to use the relatively coarse-resolution ERA-interim data to drive the ocean model, aiming to showcase the advantages of employing higher resolution atmospheric forcing from a regional model.”

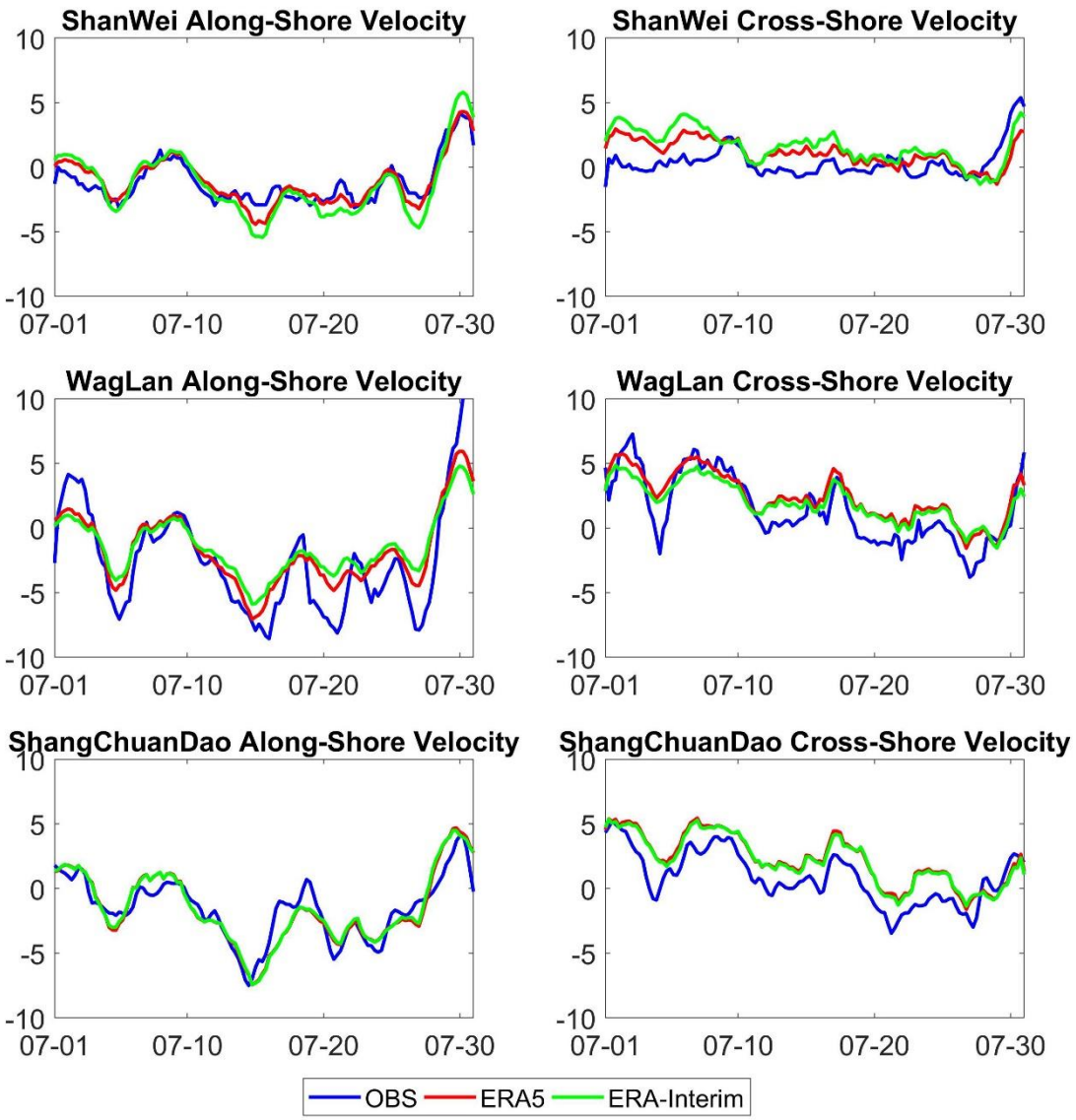

Figure 1. the comparisons of along-shore and cross-shore winds of the observations, ERA-interim and ERA5 data at Shan Wei, Waglan Island and Shang Chuan Dao stations in July 2017.

Reference:

Thankaswamy, A.; Xian, T.; Ma, Y.-F.; Wang, L.-P. Sensitivity to Different Reanalysis Data on WRF Dynamic Downscaling for South China Sea Wind Resource Estimations. Atmosphere 2022, 13, 771. https://doi.org/10.3390/atmos13050771