Comment on gmd-2021-235
Anonymous Referee #1

Summary:
The manuscript represents updates of a South China Sea Operational Oceanography Forecasting System from version 1 to version2, which provide daily updated hydrodynamic forecasting in the South China Sea for the future 5 days. Comprehensive updates of model configuration and assimilation schemes have been mentioned. Among them, three major changes have been highlighted, namely the way of prescribing buoyancy flux, the tracer advection discrete scheme and data assimilation scheme. The model shows enhanced performance in the accuracy of the sea surface temperature and sea surface height.
Ocean states prediction has always been a challenging task and is of vital importance to the hazard prevention such as tropical cyclones and internal waves and so on. The South China Sea has unique monsoon system and topography and external Kuroshio forcing, which masks it a challenging region for ocean prediction. This paper is generally well written, and the way of improvement is well presented, which makes the comparison of results quite convincing. I believe this manuscript can be the basis of a useful publication after minor improvements.
The authors thank the reviewer for the insightful comments, and we completely agree with the questions and comments raised by the reviewer, which have helped us to improve the quality of the manuscript. We have carefully considered the reviewer's comments. Detailed replies to specific comments by the reviewer are presented below:

1 There are too many acronyms and I sometimes have to go back to look for its meaning. I would recommend keeping some acronyms frequently used by other articles, such as SCS and OFS and SST, but don't use abbreviation for only two words (such as RTOFS, PI) and abbreviation that is too hard to recall (such as RSUP3, U3H and C4V).
Line46: remove (GODAE);
Line52: remove (CONCEPTS);
Line54: remove (RTOFS)
Line56: remove (HYCOM)
Line58: remove (JMA)
Line61: remove (WNP)
Line62: remove (CGOFS)
Line75: remove (3DVAR)
Line77: remove (4DVAR)
Line86: remove CMEMS, and ; Lellouche et al.
Line172: remove (JMA)
Line287: remove (RSUP3)
Line289: replace RSUP3 with the rotated split upstream third-order scheme
Line291: remove (hereafter referred to as U3H)
Line292: remove (hereafter referred to as C4V)
Line298: remove ,hereafter referred to as ISO

Line303: replace U3H with third-order upstream horizontal advection, replace C4V with fourth-order centered vertical advection, replace ISO with horizontal mixing on epi-neutral surfaces

Line518, 519: replace GODAE with GOV

2 Line 1: The improvements to the regional South China Sea Operational Oceanography Forecasting System include all the previous versions. I suggest removing the acronym of "(SCSOFSv1)".

Thanks for your pointing out this. But the acronym of "(SCSOFSv1)" and its version number are added following with the editor's review before public discussion.

3 Line 199: Please clarify the wards in this headline. What are the highlights and sensitive updates respectively?

We think the three improvements mentioned in this section are most important than others mentioned in section 2. They have significantly improved the model skill of SCSOFS from different aspects. And we have added some explanation it in Line 212.

4 Section 3.1, Line 220: The use of bulk formulation to calculate the buoyancy fluxes is reasonable, but it is not a real negative feedback because the atmospheric forcing, such as air temperature, relative humidity are prescribed, which are not adjusted from the modelled SST. Please clarify this sentence, e.g. how the SST is improved through the use of bulk formulation should be further elaborated.

Thanks for pointing out this. We agree that the use of bulk formulation does not represent a real negative feedback like ocean-atmosphere coupled model, since the atmospheric forcing is prescribed. But it still can play a role with negative feedback function to the simulation of SST, because the calculation of sensible heat flux, latent heat flux and longwave radiation uses SST calculated by ocean model. We have added a reference Li et al. (2021) to elaborate the calculation of three air-sea fluxes in Line 230 and Line 757.

5 Figure 3. For the SCSOFSv1, the area north of 24°N in the BulkFormula is even warmer than that in the no BulkFormula experiment. But the SST is much improved in the SCSOFSv2. Later results in Section 3.2 indicate that it may be related to the improved advection and mixing scheme. Please further explained this by providing more information.

Thanks. We think this should be considered as two different problems separately. For the first one, the area north of 24°N in the BulkFormula is even warmer than that in the no BulkFormula experiment, it should be attributed to the local complicated air-sea interactions in the area and tidal mixing is missing in the model. For the second one, the SST is much improved in the SCSOFSv2, it mainly due to the improved advection and mixing scheme representing the vertical heat transport well, then the surface layer affected by subsurface and deep layer processes. We have added more explanations in Line 274, Line 278, and Line357-Line360. We also changed the title of figure 3 from SCSOFSv2 to SCSOFSv1.3, it was from the model result without data assimilation.

6 Section 3.2: What about the temperature and salinity bias in the subsurface layer in

the AAG scheme combination?
Please refer to Figure 13 and 14 for the results from v1.3. We have modified it in Line 365.

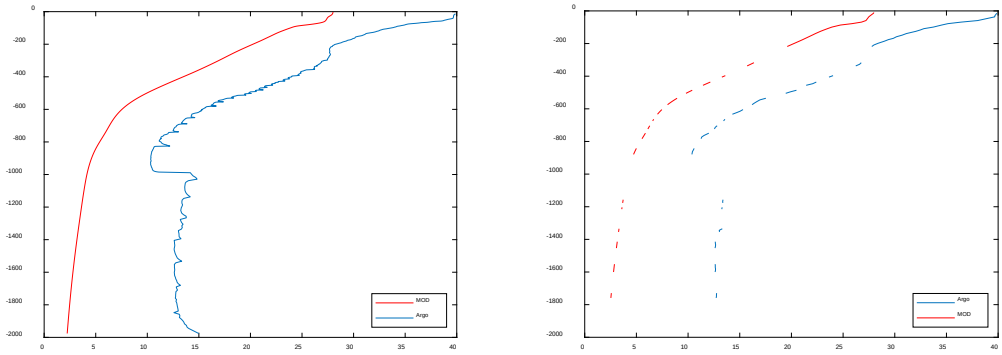
7 Line 335. Please explain the improvement of temperature and salinity with more detail. What is the diffusion term and advection term look like in the AGG scheme combination?
Thanks. The harmonic mixing scheme is used for both viscosity for momentum and diffusion for tracers in horizontal. And Mellor-Yamada Level-2.5 vertical mixing closure scheme is used for both momentum and tracers. This has been explained in Line 194-Line199.
8 Line 360: Why do you set observational error for the SLA and SST as 0.09 cm and 0.5 °C? The along-track satellite data contains high-frequency noise, especially for the shallow area (Zhou et al., 2015). How do you filter out this noise?
Zhou, Xiao-Hui, Dong-Ping Wang, and Dake Chen. "Global wavenumber spectrum with corrections for altimeter high-frequency noise." Journal of Physical Oceanography 45.2 (2015): 495-503.
Thanks for pointing out this issue. We have revised this in text Line 378-Line386.
We have used filtered SLA for assimilation products specially from AVISO, which is filtered with 20-day cutoff-period but not subsampled unlike other L3 products.

9 Line 428: In the section 4, I suggest introducing why the SST, SLA and T/S profiles are used to validate the model. Are those element enough to represent the outputs from the model? In addition, you provide the importance of SST in Line 210 to connect with the sea surface atmospheric forcings, but what kind of validations is related to section 3.2 and 3.3.
Thanks. We employ the IV-TT Class4 verification framework to validate the model, which is an international common verification metric. The main reason for using the SST, SLA, and T/S profiles is that public data are easy to obtain and has accumulated plenty of data. Of course, these elements are not enough to represent the outputs from model. But we can not get enough currents observation data to validate our model. Validations with the subsurface layer temperature and salinity using T/S profiles mainly relate to section3.2, all those validations are related to section 3.3, since all those three kinds of data have been assimilated by MOOAS.
10 Table 1: In Line 145 you mentioned the the new SODA 3.3.1 and 3.3.2 reanalysis were used, but in Table 1 you still mention the SODA 2.2.4, please check all the settings in this table.
Thanks. We have added one more information in new Table 2, as "Changing the **open boundary data** from SODA 2.2.4 monthly mean to SODA 3.3.1 and 3.3.2" while upgrading from v1.2 to v1.3.

11 Figure 13: Why the RMSE of temperature is suddenly large in June in Fig. 13b? In the paper of a recently published paper (Ding et al., 2021), there is also a similar large bias in June, can you provide some explanations to this?

Ding, R., Xuan, J., Zhang, T., Zhou, L., Zhou, F., Meng, Q., and Kang, I. (2021), Eddy-Induced Heat Transport in the South China Sea, Journal of Physical Oceanography, 51(7), 2329-2349, doi: 10.1175/JPO-D-20-0206.1.

Thanks for pointing out this issue. We have checked the original data in detail, and found that there were two Argo temperature profiles with bad quality as shown in following figures. The temperature observation is almost 40 °C at surface, and more than 10°C below 1000m layer. We have removed the two profiles, recalculated RMSE and replotted the figure 13b. We are sorry about this.



12 Please check the font size in all the figures to make sure it is clear. Also add title for similar plots.

Thanks. We have replotted the figure 2, 3, and 12 with larger font size.