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Ocean Science
Discussions

Interactive comment on "Long-Term Evolution of the Caspian Sea Thermohaline Properties Reconstructed in an Eddy-Resolving OGCM" *by* Gleb S. Dyakonov and Rashit A. Ibrayev

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We thank Dr. Özsoy for his constructive comments and suggestions. Further the indicated remarks are discussed one-by-one. Attached is the revised manuscript provided in 2 versions for your convenience: with and without markup of changes (otherwise, the two documents are identical). Note: only substantial changes are marked-up in the attached manuscript.

1. Referee Comment: The improvements on air-sea fluxes, bottom friction in shallow areas, initialization and spin-up and interaction of shallow waters with the deep sea are some of the issues that the authors have given care. It is shown that detailed

eddy-resolving modeling with adequate fine-resolution representation of specific key processes and fluxes is able to produce and closely simulate the observed response of the Caspian Sea to both seasonal and climatic events. Yet information with sufficient detail is not given on how adjustments were made to tune the model with respect to identified key processes. For example, it would be desirable to know, from the reader's standpoint, what numerical values were selected and which parameterizations were used for bottom and internal friction, advection and diffusion schemes, and surface fluxes.

Author Response: Comprehensive description of the model design would require considerable extension of the paper, so we discuss it only briefly. As for the bottom friction parameterization, it is based on the classical scheme from Weatherly & Martin, 1978. Its implementation is not straightforward, but its description would require describing also the entire model framework, and therefore it is omitted. Nonetheless, we agree that certain details of model design could be interesting for a reader and should be added.

Changes in manuscript: Section "2.1 Model description" was supplemented with details of the parameterizations and schemes used in the model, including particular numerical values. In section "2.2 External forcing" the performed corrections of atmospheric forcing were specified. Correction of solar radiation is no longer mentioned in this section, as in this particular experiment this flux was not altered (which was overlooked when preparing the initial draft).

2. Referee Comment: Some of the investigated long-standing questions are well resolved by this work, such as the relative roles of buoyancy and wind-driven circulations, inter-basin transports, shallow-deep sea interactions, winter-time convective mixing, as far as we know for the first time at such high resolution but not sufficiently emphasized by displaying these characteristics in some detail or in the conclusions. The paper is focused on climate response, but all the fine detail that finally achieves performance would be better appreciated if they could be better exposed and emphasized. For

instance, surviving myth on total overturn of deep waters by severe winter convection seems finally to be settled by demonstration of limited penetration in the present period of investigation. However, remembering even greater excursions in past climates and consequent greater shifts in sea-level, it may be desirable to discuss in the last section of the paper if and how such more extreme changes could be expected or simulated by extension of the present results.

Author Response: The circulation patterns of the Caspian Sea are extremely diverse and all of the main features cannot be considered in detail within one paper. In this particular study we aim to investigate the very possibility of modeling the long-term variability of the sea thermohaline circulation as well as the role of various factors of its formation. Nonetheless, we agree that some of the results discussed in the paper could be better explained by visualizing the circulation obtained in the model. Thus, we have added section “4 Surface circulation” containing 2D-plots of surface currents, temperature and salinity, useful for understanding the behavior of space-averaged parameters, discussed in further sections. Section “5 Model validation” was also added, which provides additional analysis along with verification of the model results. As for possible more extreme changes, in our opinion the paper does not present sufficient basis for such forecasts, but could be considered as another step towards profound understanding of climate change impact on lakes and isolated seas.

Changes in manuscript: Sections “4 Surface circulation” and “5 Model validation” were added.

3. Referee Comment: Similarly the roles of down-slope convection processes not represented in the model could be further discussed, from the points of view on short-term and climatic response, to elucidate issues in model development and prediction in the future. Other fine-scale processes such as fronts and upwelling could also be important in the climate sense although they are often considered to be short-term, as also shown earlier by the authors, and they could be emphasized in their presentation and the discussion.

Author Response: The role of down-slope convection was not investigated in the paper: its neglecting was only suggested as a possible reason of accumulating model error in the abyssal waters of the sea. To clarify why this process is not well represented in the model a short explanation was added. Fine-scale processes such as fronts and upwelling play, indeed, an important role in the Caspian thermohaline regime, including in the long-term. To cover this subject a bit more some of the main circulation patterns are additionally presented in section “4 Surface circulation”. However, in-depth discussion of their influence is also beyond the scope of the paper.

Changes in manuscript: A short elucidation of the model design with respect to down-slope convection was added in section “6.2 Middle Caspian”. Section “4 Surface circulation” was added to better consider some of the fine-scale processes: upwelling, frontal intrusions, jet currents.

4. Referee Comment: A minor note: The 6 year low-passed time-series plotted in red in Fig.2a-h is shifted by 6 years - which is the window length. If the low-pass should be centered there would be only a loss of 3 year at the beginning and end of the filtered series (and even this could be partially recovered by adjusting length near the ends). The accordingly corrected low-passed series should be presented in this Figure.

Author Response: Indeed, this is a good idea. The 6 year low-passed time-series plotted in red in fig.2 was replaced by a 5-year centered moving average, which eliminated phase shift.

Changes in manuscript: Figure 2 was changed.

5. Referee Comment: In order to help the authors with style and written language, editing changes are proposed on the pdf, which the authors could choose to adopt.

Author Response: The proposed textual changes were adopted. Thank you very much!

Changes in manuscript: Numerous textual changes, suggested by the referee, were made, without any substantial changes with respect to the paper contents.

Please also note the supplement to this comment:
https://www.ocean-sci-discuss.net/os-2018-128/os-2018-128-AC3-supplement.zip

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