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Ocean Science Discussions

Interactive comment on "Dynamical Connections between Large Marine Ecosystems of Austral South America based on numerical simulations" *by* Karen Guihou et al.

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Response to Referee # 1

The manuscript titled "Dynamical Connections between Large Marine Ecosystems of Austral South America based on numerical simulations" by Karen Guihou, Alberto R. Piola, Elbio D. Palma, and Maria Paz Chidichimo presents the analysis of a high resolution (1/12) simulation of the area previously done by Combes and Matano (2014a), which is compared with the results from another (1/12) numerical simulation. The connectivity between the Humboldt and the Patagonia Large Marine Ecosystems (HLME and PLME, respectively) are studied using the lagrangian tool ARIANE (Blanke and Reynauld, 1997) by calculating the transport across several defined sections. This is a very interesting article that addresses an area of research that needs more understanding, the connection between both sides of the South American southern coast. There is a very good design of the numerical experiments with ARIANE, and the analysis is details.

1. **a) L107-109: It is described that the domain extends to 81W. However, Fig. 2 has its western boundary at 78W. Please mention this detail to the reader. b) L119: artic – should be Artic**
   Thanks for the observations. The manuscript has been modified accordingly.

2. **A) It is stated that the Drake Passage and Cape Horn Shelf (CHS in manuscript) represent a key region (L212). However, both models have**

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a limited representation of other pathways, namely the Magellan Strait and the Beagle Channel, and thus their impact cannot be understood with the models used. This is mentioned in L389-393, but please discuss further this issue in your analysis and describe a (numerical) solution to address it (not only "higher spatio-temporal resolution" L389).

Although some geomorphological details of Magellan Strait (i.e., western sector, Primera and Segunda Angostura narrows) are crudely represented at 1/12 spatial resolution, transport estimates from CMM are very close to ORCA and the idealized and realistic models of Sassi and Palma (2006). These values are also in good agreement with recent hydrographic estimates (Brun et al, 2019, Estuarine, Coastal and Shelf Science, in revision). Beagle Channel is a very narrow passage ($\approx$ 5km at its narrowest point) connecting the SCHS and the CHS to the south of Tierra del Fuego island that is not represented in CMM nor in ORCA. Information about the magnitude and direction of the ocean currents or the mean transport inside this Channel is presently lacking. A recent analysis based on hydrographic data (Brun et al, 2019, in revision) suggests that though very low salinities are observed at certain locations within the Beagle Channel (e.g. Aguirre et al., Mar. Biol. Res., 2012), these highly diluted waters do not make a noticeable impact on the inter-ocean salinity exchange because they mix with saltier waters before reaching the Le Maire Strait. To properly address the possible importance of this Channel in the interoceanic exchanges we would need to consider a new model with higher resolution, focused on the 50 - 58S latitude band, incorporating continental discharge from glaciers and rivers and a better representation of the coastline and bottom topography (possibly using a nested subdomain or moving to unstructured grids like FVCOM). This effort should be carried out in conjunction with observations at key locations of the channel to properly incorporate the inflow/outflow from the outer ocean and validate model results.

The paragraph addressing this topic has been revised to discuss more extensively which kind of further simulations are needed (page 23 , line 409).

The analysis of 27 years of numerical simulations provided a regional understanding of the long-term exchange between the two large marine ecosystems, and allow assessing the variability of this exchange. Further studies at increased spatio-temporal resolution are clearly needed at some key locations that are under-resolved or absent in CMM and ORCA. In particular, efforts must be made to provide a better representation of the narrowest geomorphological features such as the western sector and the Primera and Segunda Angostura narrows of the Magellan Strait, and the Beagle Channel, a very long and narrow passage (5km) connecting the SCHS and the CHS to the south of Tierra del Fuego island. This task would require the development of a new regional model at higher resolution possibly nested to the 1/12 models or employing unstructured grids. The model should incorporate continental discharge from glaciers and rivers and a better representation of the coastline and bottom topography. At a temporal scale, daily outputs are required to improve the analysis of mesoscale variability, and evaluate their impact on the exchanges described in this study. The combination of such higher spatio-temporal simulations with the current simulations would provide a finer picture of the exchange, and allow quantification of the input from both the small-scale and large-scale circulation. Moreover, such modelling effort should be carried out in conjunction with observations at key locations of the Magellan Strait, Le Maire Strait, Beagle Channel, Cape Horn Shelf and the Malvinas Embayment, which would greatly improve our understanding of the water mass pathways in this complex region.

3. **B) L166-L67: state that the models used are "in good overall agreement" while several of the mean values from Table 1 show a quite large difference between them, particularly for the South Chilean Shelf (SCHS), which, it seems, is poorly represented by both models due to their grid size (1/12), understanding that a model's effective resolution is larger (7-10 dx). Please moderate this optimistic statement comment on the issue.**

The sentence was corrected in the revised version.

4. **C) Table 1 Shows mean, std, min and max values for the calculated transport. I would prefer to see the compared histograms of the calculated transport in both model. This would help to understand if the probability distribution function of the obtained volumes is gaussian and, thus, is adequate to use mean and std values as a statistical descriptors. Authors could also express the agreement for different percentiles for purposes of comparison**
Following the reviewer's advice, we computed the transport histograms (figure 1 attached, new Fig.3 in the revised version) and modified lines 165-173 of the manuscript accordingly (page 6, line 162).
The above described transports are based on the numerical results from CMM. For comparison we have also analyzed the ORCA outputs over the same subregions. Fig. 3 displays the probability distribution of the monthly transport values for both models. The distributions are close to gaussian, the exception being very narrow pathways like the SCHS, the northwestern limit of the CHS, Magellan Strait and Le Maire Strait, especially in ORCA. Main differences between model results are concentrated on the southern sector of the SCHS where ORCA shows lower mean values in cross-shelf and alongshelf transports and decreased temporal variability. Additionally, and in contrast with the CMM results, the main source of waters to SPS1 in ORCA is the Le Maire Strait (0.52Sv), whereas only 0.35Sv enter via the shelf-break. In wider sectors like the CHS, the SPS1 and SPS2 (not shown) the agreement is better both for the mean and the variability.

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