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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 # 3

This study uses ROMS / NEMO ocean circulation models and a Lagrangian particle tracking routine to study transport of water around southern South America (1) between the deep ocean to coastal regions and (2) between the Pacific and Atlantic coasts. The study represents a considerable amount of effort on the part of the authors and they have done a good job thoroughly exploring the models. I think the paper could be benefited by a few additional considerations.

1. **In the Introduction the authors discuss the importance of this region from ecological, economic (fisheries) and climate perspectives. They argue that a better understanding of the ocean circulation in this region would be useful, particularly in the context of the movement of larval/juvenile fishes. However, the authors never really come back to this idea in the Discussion or Conclusions. It would be helpful to know how their findings are useful in that regard.**
   Thanks for pointing out this omission. We now inserted the following statement at the end of Section 5 (line 423 in the revised manuscript):

   Despite the significant morphological and dynamical differences between the southern Humboldt Current and Patagonia LMEs a number of biogeographical studies based on a variety of species and different methodology have suggested *that south of 43° S both regions share similar biological and environmental characteristics and belong to the Magelleanic Province (e.g. Boschi, 2000a, b; Sullivan Sealey and Bustamante, 1999; Spalding et al., 2007 and references therein). However, the causes of this relatively strong ecological connectivity are unknown. Our results suggest the connectivity is mediated by a well-defined flux from the Pacific to the Atlantic, which may facilitate the dispersion of holoplanktonic species and planktonic larvae of benthic species, as well as fish larvae towards the Atlantic.*

2. **Additionally, I wonder how sensitive your results are to use of monthly averaged velocity fields. An earlier study examining the sensitivity of transport predictions to the spatial and temporal resolution of ocean circulation model output found quite large differences between daily snapshots and monthly averages at 1/12 (0.08) degree resolution (https://royalsocietypublishing.org/doi/pdf/10.1098/rsif.2012.0979). For instance, the daily snapshots better represented the movement of oceanographic drifters and the 30day averages tended to over-predict offshore transport (movement from the continental shelf to oceanic waters), but the overall distances traveled were reduced. Though most of the focus of that paper was in a western boundary current region, effects were also apparent in an eastern boundary current. I would feel more confident about the results if the transport predictions were either compared to some in situ Lagrangian measurement of ocean movement (e.g., drifters from NOAA's Global Drifter Database that contains 30+ years of drifter tracks, https://www.aoml.noaa.gov/phod/gdp/index.php) and/or to compare results to model output with daily (or better) temporal resolution. For this type of analysis you could consider only a subset of the years/results to compare. In my view all you need to do is to identify for the reader what type of bias (if any) they are looking at.**

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Discussion paper

The reviewer poses an interesting question regarding the spatio-temporal resolution of the ocean model that we employed to feed the particle tracking algorithm. Putman and He (2013) used HYCOM model outputs to explore resolution effects on particle tracking experiments in the North Atlantic. Better results were obtained with 1/12 spatial resolution and one-day temporal sampling. The CMM output has in principle adequate spatial resolution but otherwise is only available at a maximum frequency of 10 days (10day-average). Note that tidal forcing precludes the use of daily snapshots (unless the temporal sampling is set at hourly values, something requiring huge storage facilities). Putman and He (2013) also indicate that the resolution of the model output required to appropriately simulate organism movement depends on the question being addressed and the dominant physical factors influencing ocean dynamics over the regions and timescales of interest. In this regard, it is important to note that our geographical area differs from the one analyzed in Putman and He (2013). The SCHS is very narrow and located on an eastern boundary while the PS is extremely wide, is bounded by a very stable western boundary current and is forced by large tides (not included in HYCOM) and steady westerly winds. Altimetry analysis has shown that this is a region (particularly the shelf) of very low eddy variability [see for example and Goñi et al, (2011), their Fig. 9 for the PS and Meredith (2016), his Fig.2, for the entire region). CMM maximum temporal resolution is 10-day average. We made additional exploratory experiments with CMM comparing trajectories forced with 30-day (30D) averages and 10-day (10D) averages. We selected years 1992 and 1998 which show two extremes of the SAM cycle (Fig. 10). Some indication of higher drifter velocities in 10D can be seen near the surface. The overall pattern of particle dispersal for 10D, however, is very similar to 30D both for SCHS and PS (see Fig. 1 to 4 attached). The reviewer also points to a comparison between real and computational float trajectories. A qualitative comparison was included in Fig. 6 (real trajectories were plotted in light green). Speed of virtual floats for some selected trajectories around CHS are ≈10% less than oceanographic drifters (not shown). A more quantitative (statistical) analysis however is precluded by the small number of real floats present in our study area (many of them got stalled in the Chilean fjord system). Some of the drawbacks of poor sampling can be alleviated with multiple releases and long term tracking (Putman and He, 2013). The release of particles every 30 days (not just a single day) the long-term span of our tracking experiments and the ensemble average of the results (see Fig. 6 of the manuscript) ensures a more robust interpretation of particle dispersion between the HLME and the PLME. Therefore, although we expect a reduced influence of high frequency input on our preliminary particle tracking results, the only way to proper asses and quantify this effect would be to perform a dedicated series of experiments (including model-model intercomparison), something that is beyond the scope of our study.

Following the reviewer advice a paragraph on this matters was included in the revised manuscript (page 13, line 242):

Putman and He (2013) used HYCOM model outputs to explore resolution effects on particle tracking experiments in the North Atlantic. Comparison with oceanographic drifters released in the Gulf Stream System indicated that daily snapshots better represented the real trajectories while 30-day averages tended to under-predict speeds (although not direction). Numerical experiments of particle dispersal also indicated a bias towards higher cross-shelf transport when using low resolution model outputs. Overall, however, their results were very dependent on particle release location and the associated dynamical characteristics of the regional ocean circulation (i.e., releases in the South Atlantic Bight were scarcely affected by temporal resolution). In this regard, it is important to note that our geographical area differs from the one analyzed in Putman and He (2013). The SCHS is very narrow and located on an eastern boundary while the PS is extremely wide, bounded by a very stable western boundary current

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Discussion paper

and is forced by large tides (not included in HYCOM) and steady westerly winds. Altimetry analysis has shown that this is a region (particularly the shelf) of very low eddy variability [see for example and Goñi et al, (2008), their Fig. 9 for the PS and Meredith (2016), his Fig.2, for the entire region]. CMM maximum temporal resolution is 10-day average. We made additional exploratory experiments comparing trajectories forced with 30-day (30D) averages and 10-day (10D) averages. Some indication of higher drifter velocities in 10D can be seen near the surface. The overall pattern of particle dispersal for 10D, however, is very similar to 30D both for SCHS and PS (not shown).

Surface drifters' trajectories, extracted from the Coriolis database (http://www.coriolis.eu.org/) were compared against the above described simulated trajectories (green lines in Fig. 6). Eighty-nine trajectories flowing on the HLME/PLME or through the northern Drake Passage, were recorded between 1980 and 2017. Among them, 33 drifters flowed onto the HLME or the PLME shelf. However, most drifters either ended washing ashore in the numerous fjords of southern Chile, or were released directly in the PLME, and therefore are not useful to portray the exchange between the two shelves. Only two drifters went through the Drake Passage and penetrated the PS briefly, before reaching the ME. Three additional drifters directly entered the ME after flowing through the Drake Passage. Even though the observational dataset is small and precludes a quantitative statistical analysis, the observed and simulated trajectories are in good qualitative agreement as no drifters flowing through the Drake Passage south of the SAF entered the embayment. This supports our conclusion about the Pacific origin of the PS water masses.

Some of the drawbacks of poor sampling can be alleviated with multiple releases and long term tracking (Putman and He, 2013). The release of particles every 30 days (not just a single day) the long-term span of our tracking experiments and the ensemble average of the results (Fig. 6) ensures a more robust interpretation of particle dispersion between the HLME and the PLME. Therefore, although *we expect some influence of high frequency input on our preliminary particle tracking results, the only way to proper asses and quantify this effect would be to perform a dedicated series of experiments, something that is beyond the scope of our study.*

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