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Interactive comment on "Impact of the Indonesian throughflow on Agulhas leakage" *by* D. Le Bars et al.

D. Le Bars et al.

dewi.lebars@gmail.com

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We thank referee number 2 for his useful comments on our manuscript.

"The candid discussion of the weakest points of the POP model builds confidence on the strength of the analysis. Unfortunately this discussion is a bit shallow and disorganized. For example, we learn in section 5 (the discussion of HIM), that the magnitude of the percentage of water retroflected in POP is insensitive to the opening of the ITF. Shouldn't this have been mentioned in section 4 (the POP section)?"

That could have been. However, we would prefer to introduce the retroflection index in section 5 together with the HIM model. This index was until now only used in idealized models, for this reason we think it fits better in the HIM section than in the POP section

that is more focused on the description of the results rather than the understanding of the physics.

"The fact that the retroflection index remains more or less constant does not mean that the ITF has no impact on the interocean exchange. More water is transferred when the ITF is open because the AC transport is larger. It just means that the Agulhas retroflection is insensitive to variations of its transport, which seems to be a bit surprising in light of previous theoretical work (e.g., de Ruijter et al.)"

It is certainly surprising that the question of the impact of an additional transport of water coming from the Pacific on the Agulhas retroflection has never been studied before. We show here that it is a different experiment than changing the strength or pattern of the wind stress as has been studied in many previous papers. Opening of the ITF gateway is a qualitative difference with the earlier studies: the domain becomes multiply connected. The ITF has to return to the Pacific along an as yet unknown pathway that involves the Agulhas Retroflection.

"It would be interesting to include in the discussion the results of an extreme case e.g., one in which the ITF is increased to a substantially larger value (50 Sv?)."

That would be interesting indeed. However, running a global model at high resolution like POP (i.e. on a grid 3600 x 2400 x 42) for seventy years takes a few million CPU hours (on an IBM Power6). Unfortunately, we do not have the additional resources to perform further simulations.

"There are some points of the POP discussion that I don't understand. In page 363 it is stated that the ITF is increased by 13 Sv, yet the MC flow increases in 15 Sv and the SEMC flow in 13 Sv. How an inflow of 13 Sv produces a change of 18 Sv?"

As stated in the manuscript the net flow between the Pacific and the Indian Ocean is increased by 13 Sv, +15 Sv of Indonesian Throughflow and -2 Sv of Tasman leakage. If the Tasman leakage is not able to make it as far north as the SEMC then the increase

of SEMC (+3Sv) and Mozambique Channel (+15Sv) transport is only 3Sv more than the ITF increase. A possible reason for this difference is the possible strengthening of the inertial recirculation at the east of Madagascar, if our section is not large enough we could then catch the southward part of the flow and not the northward part that happens more offshore. Another important impact of the Indonesian Throughflow is to strengthen the "Leeuwin Current system", part of this system is the South Indian Ocean Counter Current (Siedler et al. 2006, Palastanga et al. 2007) that flows north eastward just south of Madagascar. It is difficult when integrating the SEMC to make the separation with the South Indian Ocean Counter Current, an offshore deviation of this current due to the opening of the Indonesian Throughflow would lead to increase transport in the SEMC section. We will discuss this issue in the revised manuscript.

"This article suggests that the cold path of the meridional overturning circulation is more important than the warm path. That is, that the entrainment of Agulhas eddies into the South Atlantic is largely irrelevant to the MOC. The authors note that of the 13 Sv injected by the ITF only 4 are outflowed to the South Atlantic. I therefore surmise that the remainder is advected eastward by the ACC and retrained through the Drake Passage (the cold path). This conclusion should be highlighted."

We did not analyze the results concerning the Atlantic Meridional Overturning Circulation (AMOC) because seventy years is not long enough for the sinking in the north Atlantic to reach a new equilibrium. The ITF is certainly important for the temperature and salinity fields in the Atlantic. What we see is that closing the ITF leads to a decrease of the Agulhas leakage transport but also to an increase of its salinity because the ITF water leads to a freshening of the Indian Ocean. Furthermore the fresh anomaly generated in the Pacific in the closed ITF simulation propagates slowly eastward and influences the properties of the cold water path. The influence on the AMOC is therefore quite complex and intriguing but outside the scope of this paper.

"I'm not particularly impressed by the analysis of HIM and the linear model. These models do not represent a logical progression of the POP analysis. It is impossible, for

example, to compare the results of a flat-bottomed model, two-layer, highly idealized model (HIM) with the results of the highly realistic POP simulation. "

It is indeed not possible to compare quantitatively the results of HIM and POP. However HIM is able to reproduce the constant retroflection index when the ITF is open/closed. This shows that our result is not dependent on bottom topography or on the details of the stratification. For this reason we think that including the HIM results adds in understanding the physical mechanisms that play a role in the answer of the Agulhas retroflection to the ITF forcing.

"Like the first reviewer, I am not impressed by the discussion of the linear model either."

In the revised manuscript we will deepen the analyses of the HIM results and a comparison with the low resolution barotropic model of Le Bars et al. (2012) will be included. The description of the linear model will be moved to an appendix and only the main results will be mentioned in the main text.

"Summary: I enjoyed reading this article. I think, however, that it needs of a sharper focus. The discussion about the results of HIM should be deleted or, at the very least, should be expanded to conciliate the differences between the highly idealized and realistic simulations. A new simulation with POP and a larger ITF discharge is suggeste. The results of the analytica model should be eliminated."

As said above, even if HIM is not a state of the art model, we think that its results are essential in the understanding of the physics. A new simulation with POP is not possible because of the enormous computing resources necessary. The analytical model will be moved to an annex.

"Small points: - Perhaps it should be noted that two POP simulations are not started from dynamically equivalent. Both POP simulations are initialized with a simulation in which the Indonesian Passages are open. The model with the closed Indonesian Passage therefore is not in dynamical equilibrium at the beginning of its simulation

while the one with the open IP it is in dynamical equilibrium. "

Yes, we will make this point clear at the end of section 2.1

"- I would suggest to reduce the number of acronyms. It seems that each current or geographical accident in the Indian Ocean is given an acronym to purposely distress those, that like me, have a bad memory. "

We will remove the acronyms that are not often used, TL, MC, SEC, NBC and BC will be replaced respectively by Tasman leakage, Mozambique Channel, South East Madagascar Current and north Brazil Current and Brazil Current.

"- I don't see why the authors cannot change the winds in POP."

Technically changing the wind forcing is possible in POP but as said above we do not have enough computing resources to run many sensitivity experiments with high resolution at global scale.

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