Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2019-16-AC2, 2019

Earth System Dynamics
Discussions

Interactive comment on "Influence of position and strength of westerlies and trades on Agulhas leakage and South Benguela Upwelling" *by* Nele Tim et al.

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Received and published: 17 July 2019

Reviewer #2:

We thank the reviewer for the time and effort invested in reviewing the manuscript and for the useful comments and suggestions. In the following, we list our responses to those comments and describe how we would change the manuscript according to these recommendations.

This article claims to be about the Benguela upwelling region (and Agulhas leakage), but I find it to be mostly on analyses of wind stress strengths and position variability

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in data products and simulations, over historical climates as well as future scenarios. There are many interesting aspects and results in the paper, but I find them to be poorly presented and hard to follow. Often, the results are not explicitly shown in figures. For example an upwelling index is discussed but never shown. "Upwelling" even appears in the title but I think it does not receive much attention. There isnt even a figure that focuses on the Benguela region. The correlation with SST seems interesting, but it is only shown for one simluation. The different simulations, historical and future on top of data products are difficult to follow and receive only individual attention. In the figures often only one simluation or dataset is shown and it is diffiult to get a grip on the comprehensive analysis and consistency, or not, over different historical and future scenarios (exception is table 1). This paper should be rewritten in a more structured way and figures should represent the results of all experiments and datasets, otherwise the number of simulations or time periods should be limited. If not a more quantitative analysis on upwelling and Agulhas leakage (with aspects different than already considered in other papers) is done, the subject is more something like "An analysis of westerly and trade winds strengths and position over the South Atlantic and Indian ocean in historical and future climates"..

To reduce the focus on the Benguela upwelling system we would change the title to "Analysis of position and strength of westerlies and trades and their impact on the Agulhas leakage and the South Benguela Upwelling". The new title emphasizes that we analyze the westerlies and trades with the purpose of detecting changes in the Agulhas leakage and the Benguela upwelling system. To indicate the selected regions in this study, we would add a figure early in the manuscript showing them. Furthermore, we would add the correlation coefficients regarding the Benguela upwelling system in the text and of any other time series correlation if not already mentioned. However, we are a somewhat skeptical about the utility of showing all figures for all data sets. Adding that many subplots would not be beneficial for the manuscript clarity.

Abstract: use present tense in abstract and distinguish what was done in other studies

before and what the present article investigates.

We would change to present tense and distinguish more clearly between our results and results of previous studies.

Please include a figure at the beginning to introduce the broader region, the circulations, winds, processes involved and indicate the areas where you take what kind of averages.

We would include such a figure in the revised manuscript.

page 2, line 28: what do you mean by "parallel" (two lines can be parallel) ? Change wording.

With “parallel” we mean “in conjunction with”. We would change to this wording in the revised manuscript.

page 4, line 10: dependency → variation

We would change it accordingly.

page 4, line 27-30: including the ocean velocities in the wind stress calculations could include a feedback in the coupled climate model simulation, is that important?

In the case of INALT20 it is not relevant because the simulation is not coupled. The wind stress in the coupled millennium simulations is calculated by the coupled model itself, we do not calculate it a posterior.

page 5, line 3-5: Confusing, there are four datasets, but you show only one in Fig 1 ?

We only show one data set in the figure as all data sets show a similar trend and it would not be an improvement to show the others too. We will make the reader more clearly aware of this.

page 6, line 7: contrarily, change word

We would change wording to "The correlations are numerically negative because winds

are positive when directed eastward.“

It is difficult to keep track of the different averaging regions, at first sight it seems confusing, the difference between wind stress trend Fig 1 and 3. Fig 1 there is a decreasing trend, Fig 3 increasing. The wind stress analysis could be presented in a more compact way (combine Fig 1-3 as subpanels in one Figure and describe in caption the specifics.

Figure 1 shows the latitudinal position and figure 3 shows the strength of the wind stress. We would combine both figures in the revised manuscript.

Fig 4 and temperature gradient analysis: I dont think this adds any interesting information. Given the dominance of geostrophy, there is bound to be a correlation between temperature gradients and wind stress. Why is this analysis important at this point?

We added this section to show that the increase in temperature gradient in the past has contributed to the changes in the wind stress. Furthermore, this correlation hints at a possible tendency for future development of the wind systems.

section 3.2: change to variability in past and future climate

We would change it as suggested.

page 9, lines 1-7: what do you mean by "calculated for each century separately"? Why not show the curves? Unclear.

As there has been warmer and colder centuries, we calculate the trend for each century separately to investigate if the wind stress shifted poleward and intensified simultaneously as well as shifted equatorward and weakened. We would add a figure of the trends.

page 10, line 13: "our" analysis

Sure. This is a typo.

page 12, line 18: due to geostrophy, strong SAT gradients are naturally correlated with strong winds, that is not a driving mechanism.

This question is subtle and depends on which data set is being analyzed. In the case of meteorological reanalysis, where the SST are prescribed, the causality can only go from the prescribed SSTs, and therefore SAT over ocean, to the simulated winds. In these cases, one can indeed refer to a driver if a strong statistical link is found. In the case of coupled simulations, the question is not as clear. However, there is a very plausible mechanisms by which temperature gradients drive the geostrophic part of the westerlies through the effect of temperature on density. A mechanism by which zonal winds may physically cause meridional temperature gradients is not as plausible. Nevertheless, we will explain this two situations in the revised version.

Your conclusions are very comprehensive, but a lot of them are never shown explicitly in the results. (The position of the winds is only weakly correlated with South Benguela upwelling intensity, In contrast, the strength of the trades is significantly correlated with Benguela upwelling, with more intense trades being linked to stronger upwelling in South Benguela.. and the whole paragraph).

We would add correlation coefficients in the section 3.3 to support our conclusions and show our results more explicitly. The rest of conclusions in this paragraph can be seen in figure 6.

page 13,line 9-12: these are conclusions from other studies, not from your results

This section is the discussions and conclusions section. Therefore, the compare our results with other studies and put them into context. When referring to other studies, like in this sentences, these studies are cited. We will make the separation between our results and previous finding more clear in the revised manuscript.

page 14,line 13: "This is likely to affect the Benguela upwelling system in several ways,.." why dont you show it here, I thought this is the subject of the paper ?

This is not the content of this paper and has been already published in another paper (as cited in the manuscript). The new title clarifies the subject of the manuscript.

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