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## ***Interactive comment on “Imprint of external climate forcing on coastal upwelling in past and future climate” by N. Tim et al.***

**N. Tim et al.**

nele.tim@hzg.de

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We thank the reviewer for revising our manuscript. In the following we comment on the main concerns of the reviewer.

**It is interesting to look specifically at upwelling systems because global models still tend to behave rather poorly in these areas, compared to observed data. But doing such an ensemble analysis with 3 members for one forcing is, even though right now state of the art, just not enough to conclude anything substantial.**

The state-of-the-art earth system model of the Max Planck Institute (MPI-ESM) was run three times just changing the initial conditions. Analysing these three with regard to their temporal evolution and their similarities in this aspect, provides a robust tool

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to evaluate whether the external or the internal forcing dominates the upwelling variabilities. Using more than three simulations would not lead to another result. We think that the use of just three simulations is indeed enough for our purposes. The reviewer may be perhaps aiming at identifying the spatial pattern of upwelling that is driven by the external forcing and for this purpose a large number of simulations would indeed filter out the noise and leave a clearer signal. However, our purpose is to test whether the interpretation of single upwelling records (from observations or from proxy data) as driven by external forcing is justified. If, as in our case, two simulations driven by the same external forcing produce different time evolutions of upwelling in terms of long-term trends, it is clear that model results are not compatible with this interpretation. For our purposes, even two simulations would be enough.

**As far as I can see it, the main method hinges on splitting up a certain solution quantity in a part caused by initial conditions and a part caused by the forcing (eq.(1),(2)). The underlying assumption being that the part of forcing for a certain quantity doesn't change when only the initial conditions are changed. And that the time scale of the internal variability of the system is much smaller than the variability due to forcing. Making it possible to set variance terms of the form  $y_i$ ,  $y_f$  to zero. Is this really the case here? In particular regarding the upwelling index. On what time scales does the forcing change?**

The equations show that with two simulations which have the same forcing but different initial conditions the ratio of the variance of the forced component and the variance of the time series is the same as the correlation between both time series. This is true because of the assumption that the variance of the internal components of both time series are uncorrelated. The forcing is externally prescribed and, thus, cannot be influenced by the initial conditions. Correlations are performed after time filtering of 10 years (historical and future) and 30 years (past1000) because we are interested in decadal and multidecadal variabilities and trends. Therefore, forcing variabilities on these and longer time scales are investigated not variabilities of higher frequencies.

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**On another note. These two equations are never mentioned later on. Even though it is clear after a second read through, what was calculated with them. The paper might benefit from mentioning these quantities just after the equations thus removing any possible confusion later on.**

This mathematical description is the base for the whole the statistical analysis used here. This is why we compute the across-simulations correlations. Correlating the three simulations of an ensemble shows us if the external or internal forcing drives the temporal variations. The construction is used in the manuscript whenever correlating simulations of the same ensemble. We will explain this point clearer in the revised version

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Interactive comment on Ocean Sci. Discuss., 12, 2899, 2015.

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