Answers to anonymous referee #1

We thank the reviewer #1 for his remarks, which encouraged us to reconsider our approach of presenting our results. His/Her comments leads to clarifications and adjustments of some paragraphs. In particular we reformulated the introduction to clarify, that our intensions are not the comparison of various initilisation techniques nor historical forecasts (hindcasts), but the introduction of the Modini-wind-forcing method for Max Planck Institute Earth System Model (MPI-ESM).

1. We totally agree with the reviewer, and there is no need to comment on this.

2. In this paragraph, the reviewer lists the following aspects, which we would like to address separately:

   a) *The diversity of approaches for initialisation of General Circulation Models (GCMs) should be listed in the introduction.*
   Many thanks to the reviewer for this suggestion. We added a short paragraph in the introduction, citing the suggested article of Servonnat et al. (2014), and mentioning commonly applied techniques. However, it is not the purpose of this paper to review or, indeed, assess different initialisation techniques or their performance. Rather our aim is to present a particular partial coupling technique applied to the MPI-ESM and to assess the ability of the partial coupled model to reproduce the observed variability of the climate system, a necessary prerequisite for any respectable initialisation technique. This is already is a significant task in itself. That the technique has potential as an initialisation technique for decadal forecasts has already been demonstrated by Ding et al. (2013).

   b) *No sensitivity of the technique is explored. No in depth discussion versus other techniques is given.*
   We think this depends on what the reviewer means by exploring the sensitivity of the technique and providing in depth discussion versus other techniques. If he/she means by carrying out decadal hindcasts using different initialisation techniques and comparing the performance of MODINI against these other techniques then we fear this is way beyond the scope of the present paper. Our aim is simply to assess the ability of MODINI to reproduce the observed climate variability, not to assess its merits (or demerits) compared to other techniques as an initialisation technique. However, Modini does have the virtue of simplicity (it is easy to implement) and, as we think we show, it does have skill. Of course not every aspect of the observed climate system is reproduced, especially in the North Atlantic sector, where some constraint on the surface buoyancy forcing is clearly required, as noted now at the very end of the main text.

3. In the new version we have added some material to try and explain the underlying physics. For example, we now refer (in Section 3.1.1) to Figure 3 of Kirtman and Shukla (2002) and note the importance of the teleconnections from the tropical Pacific. We think this is an important conclusion - especially since the teleconnections from the tropical Pacific actually give us some skill in the atmosphere and, in turn, with Sea Surface Temperature (SST) that is driven by the atmosphere (e.g. in the case of the Pacific Decadal Oscillation (PDO)). However, the reviewer is correct,

that we did not elaborate on our choice of climate indices. We simply picked very prominent and well known ones, we tried to cover both hemispheres, we analysed oceanic, atmospheric, and sea-ice variables, and we used spatial maps and time series. We added the missing parts of this background at the beginning of section 3.

4. We agree with the reviewer, that the wind stress constrains the SST much more in the tropics than elsewhere and that teleconnections most likely explain a large fraction of the skill in the reconstructions elsewhere (see response above). However, the main focus of this manuscript is the discussion of the Modini-wind-forcing technique in MPI-ESM and its merits for reproducing historical climate events.
The reviewer also notes, that the Modini-wind forcing concept is limited, as we do not nudge SST and/or Sea Surface Salinity (SSS) in higher latitudes. This is correct, but beyond the scope of this manuscript which deliberately deals with wind-forcing only. However, we added a sentence at the end of the conclusions, where we point out this additional approach as a possible future research area.

5. The reviewer proposes to use longer records for the forcing. However, we decided for this study to focus only on the satellite-era (that is post 1979) for which we have two of the best reanalysis products available (National Centers for Environmental Prediction, Climate Forecast System Reanalysis (NCEPcsfr) and ERA-Interim reanalysis (ERAI)). Of course, it is true that the reliability of our statistics is limited by the fact that we working with only about 30 years of data and this is a problem for interdecadal modes of variability such as the PDO. However, we are careful to describe our statistics in detail. In particular, we define the expressions used for the statistical significance in footnote 1 and provide exact correlation coefficients whereever possible. We use the so called *vague terms* to make the meaning of numbers easier to understand. It is also the case that different wind reanalysis products do not agree in space and time, an issue noted in the Summary and Conclusions section. This is the reason we computed wind stress using two different reanalysis products rather than relying on only one. However, testing the robustness of the wind products from reanalysis data sets is not the focus of this study. We note, however, that according to recent studies, dealing with the sparsely observed Arctic ocean (Jakobson et al., 2012; Lindsay et al., 2014), reanalysis products agree in general well with observations that have not been assimilated in the reanalyses.

6. Just to clarify this: We do not use any *nudging* technique for the applied wind forcing. Instead we replace the modelled wind stress seen by the ocean model by observations. We agree that the coupling frequency is important, as has been demonstrated for the case of inertial oscillations by Jochum et al. (2012), and that this impacts the surface mixed layer, as discussed in the second paragraph of Section 3.1.

7. The reviewer is correct, that we do not perform any hindcasts in this manuscript. This is way beyond the scope of this manuscript. We mention in the conclusions, that this will be the subject to further studies.

Answers to anonymous referee #2

We thank the reviewer for his/her very positive comments and we are pleased that the reviewer enjoyed reading our manuscript.

1. We now make reference to Figure 3 in Kirtman and Shukla (2002) when referring to the correlation map (Figure 1) and mention the *interactive coupled ensemble technique* in the introduction, too.
2. The fully coupled MPI-ESM (named Coupled Model Intercomparison Project Phase 5 (CMIP5) in our manuscript) shows fluctuations that are in general slightly larger than the observed El Niño Southern Oscillation (ENSO) signals (Figure 1eC). Hence, it is not surprising, that the Modini-MPI-ESM ENSO signal is slightly enhanced, too. We added a sentence to Section 3.1.2. referring to the larger amplitudes.
3. We removed the parenthesis and added a statement that the wind-driven part of the Atlantic Meridional Overturning Circulation (AMOC) is largely unpredictable, because it arises from the weather noise.
4. We checked for autocorrelation by estimating the correlation for first differences, too. We added this information to footnote 1 on page 5553.
5. Corrected
6. We are not sure, what the reviewer means with *add labels for the regions*. On the right side the regions are already named.
7. We added a statement for this.
8. Adjusted
9. Corrected

Acronyms

AMOC Atlantic Meridional Overturning Circulation
CMIP5 Coupled Model Intercomparison Project Phase 5
ENSO El Niño Southern Oscillation
ERAI ERA-Interim reanalysis
GCM General Circulation Model
Modini Model initialisation by partially coupled spin-up
MPI-ESM Max Planck Institute Earth System Model
NCEPcsfr National Centers for Environmental Prediction, Climate Forecast System Reanalysis
PDO Pacific Decadal Oscillation
SST Sea Surface Temperature
SSS Sea Surface Salinity

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