We thank the anonymous referee for the review. It is a matter of debate that if a manuscript shows "negative results" does not deserve to be published and this has also been discussed in recent time (Knight (2003), Fanelli (2011)). Nevertheless, in this study not only a marked shift of the NAO centers of action is estimated for future scenario, but also potential changes in the distributions of the principal components describing the NAO, changes in correlations and also (now additionally added) transport patterns are shown. Therefore, we strongly believe that this in itself merits publication.

Here below, our replies to the referee's comments.

Replies to Referee's Comments

1. Following the suggestion of both referees, we have significantly improved the analysis of the CO_25 concentration changes between the periods 1980-2010 and 2070-2100. In particular, we have computed the temporal averages of CO_25 winter surface concentrations for high and low NAO events following the criteria written in our reply to referee #1, point-1.

   Moreover, we have computed the regression analysis (Fig. 2 in the reply to referee #1) that will be added in our manuscript.

2. Indeed, differences in tracer concentration due to the NAO could be due to both trends in NAO or changes in the EOF pattern. The computation of changes due to NAO trends contributes to our understanding of temporal concentrations changes by weighing the correlation results due to patterns with the results of the analysis of trends, performed in Section 3.

3. Actually, NAO trend values reported in Fig. 3 of our manuscript are obtained from the PC1 computed for the entire period (150 years), i.e. given the long PC1 we computed the trends in windows sliding along this PC1 series. We will clarify this in Section 3.2 as it was not clear in the original manuscript.

4. As replied to referee #1, the agreement between the coupled simulation and the observations is not expected. In order to avoid any misunderstanding, we have decided to eliminate the analysis considering the "NAO-PC-based index" and Fig. 2 from the manuscript (see also our answer to referee #1, point-4).

5. A climatological timescale (30 years) for the two periods (recent past and future) has been chosen to reduce the interdecadeal variability, as feared by the referee. To corroborate the assertion that the NAO shift is climate induced, rather that due to interdecadal variability, we have chosen different climatological timescales of 30 years for the past and future and computed the decadal EOF1 for both, i.e. 1950-1979, 1960-1989, 1970-1999, 1980-2009 in the past and 2040-2069, 2050-2079, 2060-2089, 2070-2099 in the future. The results in Fig. 1 show differences between the two climatological periods, but they do not between any of the decadal timescale within each period. Thus, we deduce that the changes observed between the past NAO pattern and the future NAO pattern are climate induced and are not simply due to decadal variability. This information will be added to the manuscript and the figures to the electronic supplement.

References

- Knight, Nature 422, 554-555, doi:10.1038/422554a, 2003.
- Fanelli, D.: Negative results are disappearing from most disciplines and countries, Scientometrics 90, 891-904, 2012.

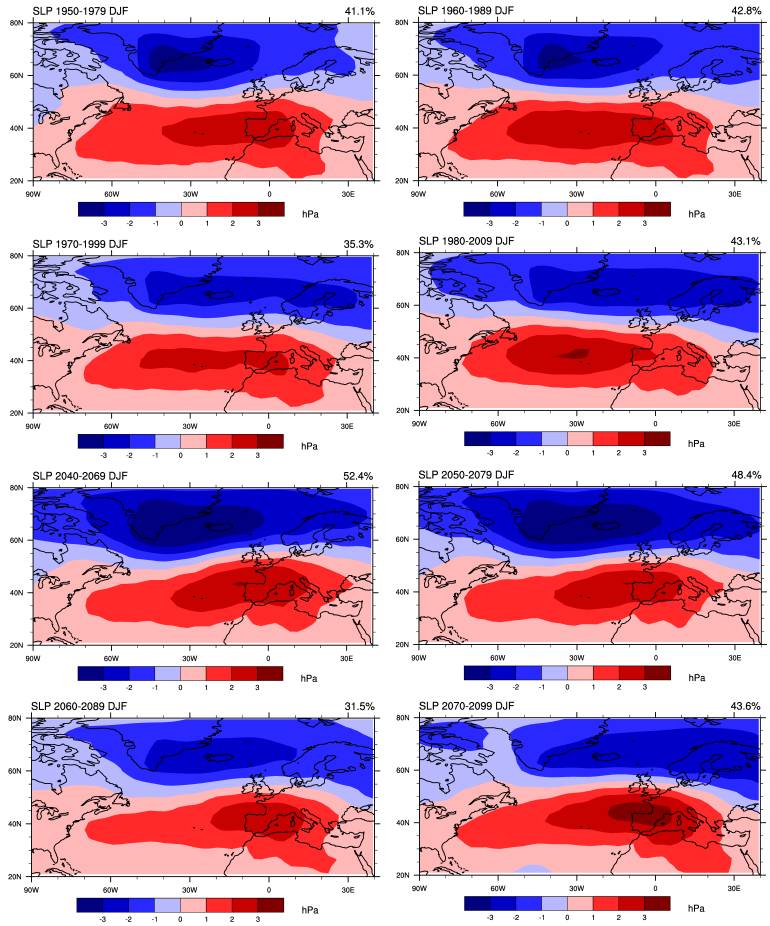

Figure 1: Leading empirical orthogonal function (EOF1) of winter mean sea level pressure (SLP) anomalies of the coupled simulation. From top to bottom and left to right, the leading EOFs correspond to the 30 years periods 1950-1979, 1960-1989, 1970-1999, 1980-2009 (past), and 2040-2069, 2050-2079, 2060-2089, 2070-2099 (future).