Ocean Sci. Discuss.,
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Ocean Science Discussions

Interactive comment on "A 30-year reconstruction of the Atlantic meridional overturning circulation shows no decline" *by* Emma L. Worthington et al.

Emma L. Worthington et al.

emma.worthington@soton.ac.uk

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Anonymous Referee #2

Interactive comment on Ocean Sci. Discuss., https://doi.org/10.5194/os-2020-71, 2020.

This study presents a new linear regression model to estimate the AMOC strength at 26degN and its two subcomponents, i.e. the upper mid-ocean transport and the Lower North Atlantic Deep Water transport, back to 1981 based on the density anomalies in the western boundary. In particular, the new approach allows the temporal resolution of the time series to be nearly annual, thus sufficiently resolving interannual variability on timescale of âĹij4 years. The main conclusion is that this new AMOC time series does

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not exhibit any significant weakening trend throughout the record. This is an excellent study with a clever method and clear presentation. I only have some minor comments as listed below.

1. L108-110, Figure 2: The rather nontrivial difference between the calculation in this paper and that by Longworth et al. (2011) may suggest a nonstationary relationship between the âĹij400 db temperature and the thermocline transport. Such aspect may have an implication for the reconstruction method employed by the authors, as the multiple regression is trained for the RAPID period and applied to a much longer period. Therefore, the cross-validation approach for training the multiple regression would allow a quantification of uncertainty due to potential nonstationarity. The training period can be broken into âĹij3 segments and the regression coefficients for each segment can be measured by fitting the model to the rest of the time series. Then, the end results such as the Fig. 3 can be constructed by stitching the regressions from all the segments together. The authors tried a cross-checking by testing the model on the latest 21 month RAPID data that were not used in the model training (L163-166). However, a systematic cross-validation would allow a more robust estimate of the uncertainty.

The reviewer is correct in that although the 400 dbar temperature and thermocline transport anomalies exhibit stationary behaviour themselves, the residuals of the regression on them are non-stationary (with stationarity determined using the Augmented Dickey-Fuller. However, the multiple linear regression selected has stationary residuals, although two out of the four exogenous variables are non-stationary.

Following the reviewer's suggestion, we have repeated the cross validation by using the first and last 30% of the original training data to train the model, and the remaining 70% as test data. Although the coefficients differ, each 30%-model gives a Pearson's correlation coefficient of 0.88 between the model-predicted UMO and the observed UMO, higher than the 'full' model (Figures 1 and 2).

Also, used to predict the UMO for the latest 21 month RAPID data, the reduced time

series models give Pearson's correlation coefficients of 0.75 and 0.73 for the models trained on the first and last 30% of the original training data respectively. This compares to r=0.75 for the full model.

Finally, the predictions were also validated against hydrographic data from the period of the RAPID project, and against transatlantic section data from 1981 onward. These results lead us to believe that the multiple linear regression model we develop in this paper is valid for predicting longer time series, and has a realistic estimate of the uncertainty. We will add a brief description of the cross-validation to the manuscript.

2. L146: What is the interpretation for the autocorrelation being significant for a lag of one month?

As autocorrelation is inherent in regression models based on time series, and the RAPID data shows strong seasonality, we would expect to see a relationship between monthly averaged data, in this case between one month and the next but not significantly beyond that. This result is consistent with Smeed et al., 2014, who show the decorrelation length scale associated with the AMOC is 40 days. This last reference and comment will be added to the manuscript.

3. L200: "(Figure 5e), For" <- The comma should be a period.

This will be corrected in the manuscript.

4. L231: "during Longworth et al." -> "by Longworth et al."

This will be corrected in the manuscript.

5. L466: Please correct some of the broken symbols.

These will be corrected in the manuscript.

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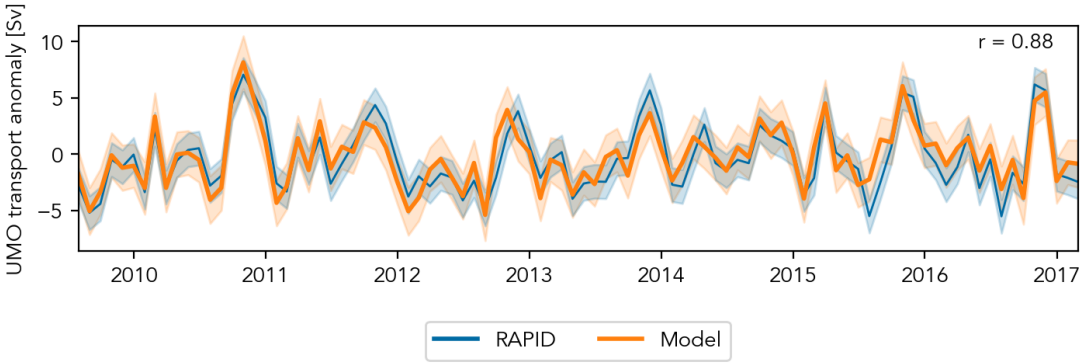

Fig. 1. UMO transport anomaly predicted from last 70% of training data, using model created from first 30% of training data

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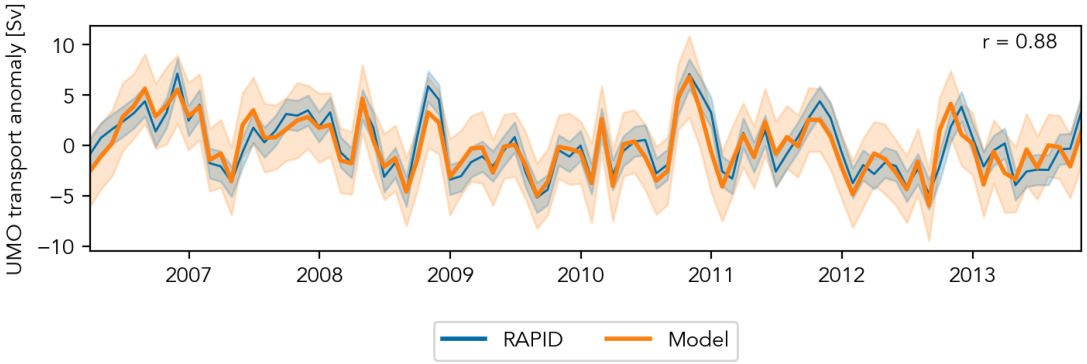

Fig. 2. UMO transport anomaly predicted from first 70% of training data, using model created from last 30% of training data

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