

Interactive comment on “The GEOVIDE cruise in May–June 2014 reveals an intense Meridional Overturning Circulation over a cold and fresh subpolar North Atlantic” by Patricia Zunino et al.

Anonymous Referee #1

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One of the main findings in this paper is that despite the ongoing cooling/freshening anomaly in the SPNA, the authors measure stronger heat transport across the OVIDE section during the GEOVIDE cruise in May–June 2014. The authors further conclude by strongly stating that air-sea (heat and freshwater) fluxes were the dominant factor for the observed changes and that ocean circulation played a minor role.

The authors seem to have ignored the fact that the subpolar gyre (SPG) cooling/freshening is part of a decadal trend most likely initiated by ocean advection and circulation. There are evidence that the SPG temperature and salinity reversed already in 2005 (e.g. Robson et al. 2016, Nature Geoscience), and that the NAO shifted more

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to the positive state later on around 2011. The 2014 cooling/freshening thus may have been enhanced by air-sea fluxes (not locally formed), but it is important to keep in mind that the cooling as well as the freshening did not start in 2014 as the authors mention. It was well underway!

Nevertheless, I think the paper is good and taking into account what I have mentioned above as well as my comments below will help improve the paper, which I recommend for publication after these issues have been resolved.

Major comments

I think the authors need to focus on the 2014 event as being part of the (multi-)decadal cooling/freshening rather than the instigator of it. A robust discussion along these lines is therefore strongly recommended.

Furthermore, I wonder also how the authors reconcile the fact that there are numerous studies (see e.g. Robson et al. 2017, Clim Dyn, and references therein) demonstrating that the western SPG is dominated by surface fluxes, while the eastern SPG is dominated by ocean advection.

How do you explain the large-scale salinity anomaly in Fig. 8 that spans both the the SPNA and the region of the Gulf Stream? there is very little discussed about this basin-scale feature.

Comments

I think the calculations and results are straightforward, but I have some comments that can help to further improve the paper:

Using the inverse model the authors and thereby identify all main flows, and show that the ship-ADCP velocities are largely similar, at least in structure, to those based on the inverse modelling. I suggest to compare your transport numbers, whenever possible, to other studies for a complete picture.

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Weaker NAC during 2014 is an interesting finding. The top-to-bottom transport of $0\pm 6\text{Sv}$ as compared to the $11\pm 4\text{ Sv}$ estimated by D2016 is large. I believe it is possible to show this large-scale shift from altimetry along the eddy-blockage and the doubling of the intensity of the SAF, which the authors are briefly mentioning in lines 404-412. Please elaborate also on the transfer of transport from the northern to the central branch, it is not clear to me how this occur!

Furthermore, as the authors mention (lines 520-527), they expected an expansion of the SPG. Could you better discuss what the displacement of the SAF actually means?

The green box in Fig. 9 seems very large to me to be considered as the eastern North Atlantic. It is rather peculiar that in the net freshwater field you are averaging over an area that almost symmetrically includes positive and negative net FW.

The eddy part of the paper is clear, although full of details, it completes the picture well. It is however not easy from a visualization point view to see the eddies and the colors in the figure. Suggest to improve this and make it as clear as possible to the readers, perhaps similar to Fig. 6 of D2016.

Consider adding a reference to a recent paper by Rossby et al. (2017, JGR) on the fluxes across 59.5N . Their MOC transport estimate is in line with yours.

Minor comments

Please replace 'Hydrological' with 'Hydrographic' throughout.

Figure 1 is busy and therefore making an effort to explain all the signs is important. For example, you should indicate what the stars represent early on. You may also want to add the names of the different NAC branches here.

lines 251: Please keep it consistent with the decimal throughout the paper.

The bathymetry can hardly be seen in the AVISO figures.

lines 505: Define the SPG acronym. And no need for the SPG acronym in the last

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paragraph of the discussion.

Caption Fig. 9; It is not clear in the text that the anomalies are for 2014.

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