

General comments

The manuscript presents an analysis of dissolved oxygen data from CTD casts made along a repeat transect in the Celtic Sea during 2014 and 2015. The authors construct a simple budget to quantify the processes controlling the summer bottom dissolved oxygen inventory in both years. They extend their analysis of the present-day data to consider the impact of climate change through a 2°C temperature increase on each of the quantified budget terms. They also consider the potential impact of the variability in annual storminess on the bottom dissolved oxygen budget. The findings are a useful contribution to understanding processes influencing ocean deoxygenation in the North West European Shelf.

The authors make good use of relevant literature to parameterise their analysis and to set their work in context of other studies. Whilst the cited literature isn't extensive and the introduction is relatively short, it provides sufficient context for the study and helps to make the manuscript clear to read.

The manuscript is clearly written with a good standard of English. It is well structured, making it easy to follow the analysis of the data and presentation of results. The authors clearly tabulate their results and make good use of suitable figures which are all discussed in the text.

I recommend accepting the paper with minor revisions as described below.

Specific comments

Line 71: Further information about the DO sensor calibration is needed – the current text is brief, particularly as this is the main data set being analysed.

- Provide details of the oxygen sensors on the CTD rosette. How were the data processed to correct for sensor lag?
- Please provide some further information about the nature of the calibration e.g. number of data points, was a simple offset applied, or a regression? How many data points and over what temperature/salinity range? Were the Winkler DO samples collected on the same CTD casts as the data being presented?
- Is the +/- 3 uM, the uncertainty in the discrete DO samples, or in the calibrated DO sensor data?
- Presumably it is the CTD DO data which are analysed, rather than the Winkler DO data? Make this clear if so.
- Were the samples used to calibrate the DO sensor collected on the same CTD profiles being analysed?

Line 85: there is mention of the subsurface chlorophyll maximum but there is no mention of how chlorophyll is measured. Is it from a fluorometer? If so, how is this calibrated to derive mg m^{-3} from fluorescence units?

Line 86: Whilst the depth over which 'bottom water' is calculated is explained later in the paper, it would be useful to provide the information in the methods section so that the reader has this context early on in the paper.

Line 106: Given the impact of the choice of K_z value on the value calculated for diapycnal mixing and the large impact it has on the resulting calculation of oxygen consumption rate, could the authors consider a sensitivity analysis to quantify this. Given the oxygen budget is relatively simple, some discussion of the uncertainties this may introduce/assumptions made and their impact would be valuable.

Figure 5: Is the kriging introducing artefacts due to the length of the gaps between some of the surveys? e.g. the low dissolved oxygen at approximately 25m in late August 2014 which is not coincident with a survey and follows immediately after the high oxygen concentration at the same depth earlier in August.

Minor comments:

Line 45: 'In the semi-enclosed North Sea, bottom-water DO saturation commonly drops to 75–80% of saturation values in summer'. This is the case for stratified waters in the North Sea but monitoring data show that bottom dissolved oxygen concentrations in the well mixed southern North Sea remain at 100%. Please clarify this statement.

Line 62: Figure 1 isn't currently labelled with a and b but the text refers to Figure 1a

Line 65: 'During the stratified period, typically from spring to late autumn, the BML are separated from surface waters by a thermocline' – 'the BML is separated...'

Line 81: There is a one sentence paragraph which should be combined with the text in the following paragraph.

Figure 2:

- Split the legend text into what refers to Fig. 2a and Fig. 2b. Explain what Δz and $\Delta[\text{O}_2]$ are.
- The oxygen profile plot and the legend text show DO with units of μM but the analysis in the paper uses units of mmol m^{-3} . Change the units on Figure 2 and the legend to match the text in the paper.

Line 125: '...using measurements from muddy and sandy sediments, comparable to those at CCS, collected during...'. It would be good to make it clear that these sediment

sites are in the same region as your study e.g. ‘..collected in the area of interest and comparable to those at CCS...’

Line 138: ‘The horizontal diffusive flux, F_{diff} , was calculated using a horizontal eddy diffusivity KH in the range 20 to 100 $m^2 s^{-1}$...’. Was a single value used, if so what? Or were a range of values used - it is unclear here.

Figure 3:

- The y axes both show the location of CS2 but this is not shown in Figure 1. Amend Figure 1 to show CS2 or remove from the y axis of these plots if not discussed.
- The legend shows DO with unit of $mmol m^{-3}$ but the scale bar units in Fig 3b shows μM - change to $mmol m^{-3}$.
- I would suggest adding values along the scale bars for both temperature difference and bottom DO so the reader can more easily see what value a colour represents - currently the reader needs to work out the intervals which particularly hinders interpretation of the DO plot given the wide range of colours across the scale.
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Figure 5: Figure 3 shows a CTD cast at CCS in March 2014 (as well as other sites along the transect). Is this included in Figure 5 plots? I can't see a dotted line on the left of each plot.

Line 203: ‘In both summers DO concentrations declined...’ clarify that bottom DO concentrations declined...

Line 219: Did you have a method to automatically detect the base of the thermocline based on temperature or density? I couldn't see it in the methods.

Line 230: ‘...sbottom..’ – delete the ‘s’

Line 248: ‘...background diffusivity) suggests a...’ – delete the ‘)’

Line 270: ‘Horizontal eddy diffusion was assessed using a simple 1D model with DO concentration at CCS given an initial Gaussian distribution similar to the CTD observations, with a local maximum in DO concentration set to 10 $mmol m^{-3}$ above the background.’ This is method information and I think should appear in section 2.5

Line 310: ‘Thus, the November bottom water DO inventory will be bias low.’ Suggest changing this to ‘.....will be biased to lower values.’

Line 311: ‘...would instead by 34 $mmol m^{-2} d^{-1}$,’ – change ‘by’ to ‘be’

Line 357: I think the variable Q_{10} should be explained to the reader.

Line 372: What source of wind data are you using for the 1960-2020 analysis? Is it ERA5 reanalysis? In the methods section you describe using this for the 2014 and 2015 analysis, but it is not mentioned in this analysis. Please clarify and also add the source to the legend for Figure 8.

Line 392: ‘...Changes in DO because of reduced solubility in a warmer...’ – suggest changing ‘because of’ to ‘due to’.