

Interactive
Comment

***Interactive comment on* “Detection of low bottom water oxygen concentrations in the North Sea; implications for monitoring and assessment of ecosystem health” by N. Greenwood et al.**

N. Greenwood et al.

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Received and published: 15 December 2009

We would like to thank the reviewers for their constructive comments which will improve the paper. We shall address the issues they raised during the revision of our manuscript. In particular: 1. The authors should better define what they mean with “low” oxygen concentration. In their case, neither of the sites showed particularly low oxygen levels compared to many other marine environments. Also, the duration of the “low” oxygen period was restricted to seasonal scales. There is no evidence of a longer scale (multi annual) depletion of oxygen at these sites. The authors should treat this aspect better in their ms.

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The factors governing oxygen concentration are now dealt with more thoroughly in the introduction. The seasonal nature of oxygen depletion will be emphasised and put into context of scales of other low oxygen observations (permanent, seasonal, episodic, diel eg Kemp et al., 2009). A wider comparison of the lowest values of oxygen observed at our sites will be made with other sites world wide. By including these comparisons the relation of the low oxygen in this situation is now placed in a wider context resulting in a clearer definition of what constitutes low oxygen.

2. A better, more thorough, discussion of reasons for the observed oxygen changes, and differences between sites causing these changes. The physical ventilation / advection processes are mentioned, but their importance appears underexplored. Greenwood et al. should improve the discussion of this mechanism.

The advection at each site is now better quantified using the ADCP measurements. The nature and scale of advection processes at the study sites is given in more detail along with the potential impact on oxygen concentration. The role of advection in influencing oxygen concentrations will be included in the introduction.

3. I think the discussion is well written, however there are a lot of points coming across and that makes it difficult to follow. The discussion on the potential mechanisms for oxygen depletion may be better followed with the use of a diagram /flow chart showing the influence on the various factors(temp, remineralisation of organic matter and suspended matter). This could also be a good way to show the differences in sites.

A summary diagram is now included which shows the contribution of each factor on the observed oxygen depletion at each site.

4. Secondly the authors discuss the need for modeling future scenarios, but I would like to see a bit more on the discussion of any other papers which may have linked a disturbance to the depletion of DO in the Oyster banks. I agree with authors that this most likely due to natural forces, but more discussion on the potential impacts (if any have been shown or modelled) is warranted.

The amount of literature exploring the nature of oxygen depletion at the Oyster Grounds is extremely limited although we have now added an extra reference not previously mentioned, de Wilde et al. (1984). Previous studies have emphasised that the site would be susceptible to impacts from anthropogenic forcing rather than stating that it is due to anthropogenic forcing. Physical disturbance through trawling however does occur at these sites, predominately at Oyster Grounds. Estimates of the quantity of sediment disturbed during trawling will be given to indicate the potential impact it may have. The site is also not impacted by the Rhine plume so although anthropogenic nutrient input may occur via atmospheric sources (Jickells, 1995) it is expected that impacts due to climate change may be more important in the future as is outlined in the text.

References P.A.W.J. de Wilde, E.M. Berghuis and A. Kok. Structure and energy demand of the benthic community of the Oyster Ground, central North Sea, Neth. J. Sea Res. 18, 143-159, 1984. Jickells, T.D., Atmospheric inputs of metals and nutrients to the oceans: their magnitude and effects. Marine Chemistry, (1995). 48: 199-214. W. M. Kemp, J. M. Testa, D. J. Conley, D. Gilbert, and J. D. Hagy. Coastal hypoxia responses to remediation. Biogeosciences Discuss., 6, 6889-6948, 2009

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