

## ***Authors' responses to reviewers' comments on the manuscript os-2012-107***

**' The effect of various vertical discretization schemes and horizontal diffusion parameterisation on the performance of a 3-D ocean model: the Black Sea case study'**  
by G. Shapiro, M. Luneva, J. Pickering and D. Storkey.

### **Referee 1.**

**Comment.** *The literature on vertical grid systems is far more extensive than is suggested in the present manuscript... Recently, adaptive coordinate systems were suggested (e.g. Hofmeister et al. 2010) and should not have been ignored by the Authors of the present study.*

**Response.** A new paragraph is added on page 3 lines 18-27, citing additional grid systems, including those suggested by the referee. Three new literature references added to the reference list.

**Comment.** *The article by Luneva and Holt (2010) is referred to in the core of the text, but is missing in the bibliography.*

**Response.** The reference is now added: Luneva, M. and J. Holt, 2010. Physical shelf processes operating in the NOCL Arctic Ocean model.

<http://www.whoi.edu/files/whoi-server.do?id=77125&pt=2&p=83808>

**Comment.** *'...there are seemingly confusing statements about diffusivity and viscosity.... Authors of this study use Griffies and Hallberg (2000) is confusing, if not simply wrong.'*

**Response.** We are grateful to the referee for pointing this out. Of course, Griffies and Hallberg (2000) discussed viscosity rather than diffusivity. Despite turbulent diffusion and viscosity are similar processes, the values of coefficients are different, with Prandtl number (a ratio of viscosity to thermal diffusivity) typically taken to be equal 5. Corrections are now made throughout the manuscript.

**Comment.** *It should be made clear that condition (1) on page 3646, i.e. the "hydrostatic consistency" condition, is not directly to the truncation error of the scheme used.*

**Response.** This is correct, the truncation error of the scheme used is only one component contributing to the hydrostatic inconsistency. Clarification made on p3 line 15-16.

Minor errors and misprints are now corrected where appropriate.

Note. While paper by Haney (1991) is frequently cited, it is not the original paper on hydrostatic inconsistency. We refer to an earlier paper by Rousseau and Pham (1971) to give them a proper credit for their important work.

### **Referee 2.**

**Comment.** *'.. SCO model has a lateral diffusion which acts along s=const surfaces. In this case over bottom slope this lateral diffusion makes a considerable contribution to the vertical diffusion. Mainly for this reason the maximum values of spurious currents for SCO is much greater than one for ZCO model'.*

**Response.** We use a standard facility of NEMO to rotate the horizontal diffusion/viscosity operators from sigma- to z-level. This rotation removes the effect of contamination of a relatively small vertical diffusion/viscosity by large values of their horizontal counterparts. Clarification is added on page 5 lines 19-22.

**Comment..'** ...the numerical diffusion inherent to the TVD scheme makes a considerable contribution to the lateral diffusion along  $s=\text{const}$  surfaces in SCO model. The authors should take into account the above reasons.'

**Response.** Yes this is a known effect of a TVD scheme for all non-z-level grids considered in the paper, not only SCO. This effect is discussed in the original manuscript on page 10, first para.

Minor comments are implemented and misprints are corrected.