Dear editor,

We sincerely thank all the reviewers for their reviews of our paper. The aim of this letter is to detail how we addressed their comments in our manuscript.

Reviewer comments for
"Modelling turbulent vertical mixing using a 1-D version of NEMO"
G. Reffray, R. Bourdalle-Badie, and C. Calone

General comments

A comparison of two types of turbulent closure is presented using a 1D configuration of the NEMO ocean model: the one-equation TKE model of Gaspar et al. (1990) and the two equation models encompassed by the GLS framework of Umlauf and Burchard (2003) are considered.

A brief explanation of the model primitive equations in a 1D context and then a summary of the main differences between the two types of turbulent closure are given. The performance and numerical behaviour of these closures are assessed in an idealized Kato-Phillips (1969) test case and a realistic test case based on observations from OS PAPA. The numerical behaviour is explored through the use of two vertical grid discretizations (31 and 75 levels), three time step sizes (360s, 1200s and 3600s) and an 'ideal' spatiotemporal discretization (1000 levels and a 36s time step).

The results present a very useful insight into the comparative performance and numerical behaviour of two similar types of statistical turbulent closure, for a range of spatial and temporal discretizations. Furthermore, the results are easily and directly reproducible by virtue of the configuration being immediately available from the NEMO repository. The derivation of NEMO1D from the full 3D domain also allows the performance of the discussed turbulent closures to be applicable to users of the full 3D NEMO model.

I am generally happy with the content of the manuscript but have a few minor revisions that I think should be addressed before publication.

Specific comments

1. I think that the description of the turbulent closures in section 2.2 needs to more clearly contrast the differences between the two types of closure:

> 2.2- I think it would be better to introduce the two types of closure presented in the paper at the end of this section, so that in each subsection the treatment by both closures of the solution for k, l, Cμ and C'μ can be compared

To follow the recommendations of both reviewers, we have modified the plan. We hope that the description of each turbulent model is now clearer.

> 2.2.2- The principal difference between the two types of closure presented is that the length scale of the former is an algebraic formulation, while the latter uses a prognostic differential equation to calculate a length scale-related quantity. Often these types of closure are referred

to as one and two-equation models (see for example Burchard et al., 2008). I think the clarity of this section would benefit from a concise summary of this key difference at some point.

The section has been clarified and we have followed your recommendations. The suggested reference has also been included in the text.

2.2.3- I think this section should more specifically be about the determination of $C\mu$ and $C'\mu$, contrasted with their constant values in the TKE model (for the TKE scheme I don't think they are defined elsewhere in the manuscript other than in table 1)

The section devoted to the stability functions has been rewritten with a subsection for the TKE model and one other for GLS models.

2.2.4- $C\mu0$ is missing a defined value here, and I think the reasons for the difference in its value between the models should be briefly described. I'm not sure Pr belongs in this section either- it is not a constant and might be better placed in 2.2.3 since it appears in the TKE model definition of $C\mu'$

The definition of $C\mu0$ has been highlighted as being the limit value of the stability function inside the logarithmic boundary layer. Moreover, the value of $C\mu0$ depends only on the stability function choice and so the value must be the same for all GLS closures considered in this study. By consequence, corrections have been carried out in Table 1. Moreover, the stability functions have also been corrected according with the model description (division per the factor $C\mu0^3$).
The note on the definition of Pr is relevant and the definition has been naturally moved to the stability functions section devoted to the TKE model.

2. I think some caution is needed when describing "realistic" values of Hp (P5262, line 17) in section 2.2.5 for the TKE model without explaining why the 0.5m to 30m profile is realistic. I think this must either be physically justified or else not described as "realistic"

We agree with you and the sentence has been modified:
"In most cases, H_p varies as a function of the latitude (0.5 m at the equator to a maximum of 30 m at the middle latitudes)".

3. At the end of section 2.3 the purpose of the paper is described as providing "feedback on different turbulent closures available in NEMO". However the KPP and simpler models are not considered; rather the "Algebraic Stress Models" of NEMO are put forward. This is acknowledged in section 6, but I feel that a brief explanation of this choice of turbulent closures from those available in NEMO would be useful.

This point has been highlighted at the beginning of the description of the turbulent model. We have explained that only one or two-equation models are studied in this paper.

4. An interesting result from section 4.3 is that there is a sensitivity to the time step to varying degrees for all closures (figures 3a-c), but this is not really acknowledged. It would be interesting to hear some thoughts on why this might be the case.

The same remark has also been done by the other reviewer.

We agree that this lack of robustness of the schemes is very worrying. Unfortunately, we do not have an accurate understanding of the numerical phenomenon. This point is also under discussion on the GOTM forum but without clear explanation: https://groups.google.com/forum/#!topic/gotm-users/dOpd4waVvtc*. Supplementary tests (not shown here) have shown us that we can improve the results with k-kl and k-ω by modifying the background values but the dependence of the time-step is not totally removed.*

5. It would be useful for the paper to deliver a recommendation on which of the presented turbulence closures should be used, particularly as the OS PAPA test case is presented as a readily available configuration: what is the turbulence closure used by PAPA1D and why? This could be presented as a brief discussion item in section 6.

Recommendations on the choice of the turbulent model have been added in the conclusion as suggested by both reviewers.

6. Figure 10 is too small to clearly interpret

We have increased the size of this figure.

Technical corrections/suggestions

All modifications have been taken into account and are carried out directly in the text.