Response Referee 2

We thank the referee 2 for his positive review and comments. Below, we provide point-by-point responses to the referee comments (red text).

The manuscript presents a coupled ocean-atmosphere simulation of Last Glacial Maximum (LGM) climate and water and calcite isotopic distribution, using the intermediate complexity model iLOVECLIM.

The main goal of this paper is to evaluate the simulation using a compilation of several temperature and oxygen isotopes datasets. This paper does not present any new idea or conclusion, does not directly address any science question. Rather, it presents a new tool that could be potentially used in the future to address science questions. It deserves to be published to the extent that it is one of the first attempts to simulate the LGM climate with water isotopes in both atmospheric and oceanic components.

The paper is well written, the results are presented clearly, the figures are nice. I have only a few minor comments.

- I don't think the title is well chosen. I don't understand how the paper helps to constrain the LGM climate. The paper is rather an evaluation of the iLOVECLIM simulation. The use of this evaluation to constrain the LGM climate is not clear. Either the title should be modified, or the "constrain" part should be clarified in the text.

This paper is indeed an evaluation of the iLOVECLIM simulation for the LGM climate. However it also helps to constrain the LGM climate as mentionned in the abstract and developed in the text: *"Our data-model comparison for calcite d18O allows investigating the large discrepancies with respect to glacial temperatures recorded by different microfossil proxies in the North Atlantic region. The results argue for a strong mean annual cooling between the LGM and present (> 6 C), supporting the foraminifera transfer function reconstruction but in disagreement with alkenones and dinocyst reconstructions"* and *"Explanations for the observed North Indian Ocean enrichment in d18Osw at the LGM could be (1) a contraction of the Indian subtropical gyre and reduction of Agulhas leakage salty water (Caley et al., 2011a) and/or (2) an overall reduction of the hydrological cycle over the western and northern Asian region, in agreement with numerous Indo-Asian monsoonal reconstructions (Schultz et al., 1998; Iwamoto and Inouchi, 2007; Cheng et al., 2009; Guo et al., 2009; Caley et al., 2011b, c; Chabangborn et al., 2013). Also interesting is the low calcite 18O anomaly observed in the China Sea (Figs. 8 and 10). This signal cannot be explained by a temperature effect as we observe a cooling more important in the China Sea in comparison to the North Indian Ocean (Figs. 6 and 10). Therefore, we hypothesize an important decrease of the d18Osw, a pattern exhibited in our model (Fig. 10c). The cause for such important decrease of the d18Osw is not completely clear because the monsoon in East Asia is rather reduced during the LGM (Iwamoto and Inouchi, 2007; Cheng et al., 2009; Guo et al., 2009). Nonetheless, some studies argue for substantial precipitation during the LGM in South China sea (Sun et al., 2000; Colin et al., 2010; Chabangborn et al., 2013). Indeed, part of the explanation could reside in the negative d18O anomaly observed in precipitation over the China Sea (Fig. 1)."* And *"Spatial differences in term of δ18Osw anomaly can be observed, suggesting that changes are not homogenous in the deep ocean. This* *is in agreement with reconstructions derived from pore fluids in deep-sea sediments (Adkins et al., 2002; Schrag et al., 2002; Malone et al., 2004) (Fig. 12A)".*

We change the title of the paper in the revised version for: "Oxygen stable isotopes during the Last Glacial Maximum climate: perspectives from data-model (iLOVECLIM) comparison."

- p108 l7-9: precise "with isotopes in both components".

Added in the revised version.

- fig 1, 2 and 3: the color scales look saturated, especially in the red. I hope this is not to hide irrealistically high deltaO18 values. I think the color scales should be adapted to remove any suspicion.

No the apparent saturation in the red for figure 1, 2 and 3 is not to hide unrealistically high deltaO18 values. For all the figures in the manuscript, the scale has been calculated statistically and therefore allows an optimal representation of data contrary to a conventional linear scale. Furthermore, for Figure 2 and 3, graphs of regression between data and model are presented and therefore remove any suspicion concerning the agreement or disagreement between data and model results. The results were also resumed in the Table 1. We have now added the reason for the scale in the legend of figure 1 and refer to it in subsequent figures as follow: *"The color scale we used is based on the distribution of the values in the dataset used: 95% of the proxy data are meant to be appropriately represented in that color scale. It is centred around the mean of the dataset, hence red means heavier values than the mean and blue values lighter than the mean of the dataset."*

- section 3.1.2, table 2, fig 5 on speleothems: more speleothem data could be added in the tropics and subtropics. Many more tropical speleothems than listed here show a depletion during LGM (e.g. Cruz et al, 2009). I expect including more tropical speleothems will highlight the fact that iLOVECLIM, like most GCMs, is too enriched during the LGM in the tropics. If the case, this should be pointed out and previous papers showing this bias should be cited.

We have tried to compile all the available speleothems records covering both the LGM and late Holocene time interval. There is indeed two more records (Rio Grande do Norte and Santana Cave) in south America than can be added in our compilation (Cruz et al., 2009). We are thankful to the reviewer to have brought these additional records to our attention. They have been included in the revised version (Table 1) and are now discussed in the text. Indeed, iLOVECLIM is too enriched in south America in comparison with these new data. We agree with the reviewers that the failure to simulate lower d18Op in South America is common to other GCMs (Werner et al., 2001; Jouzel et al., 2000; Risi et al., 2010). Whether the reason for that enrichment is the same in all model with such different complexities is not evident however. To understand fully the processes behind these d18Op changes would require an in-depth comparison of the models that has not been attempted so far.

We added in the revised version in lines 352-359: *"Considering the error bars on the data (Table 1), we observe overall positive calcite δ18O anomalies except for Solufar cave and South American caves (Fig. 5). For South America, there is a failure in iLOVECLIM to simulate lower δ18Op (Figure 1) as also* *observed in other GCMs (Werner et al., 2001; Jouzel et al., 2000; Risi et al., 2010). Whether the reason for that enrichment is the same in all models with such different complexities is not evident however. To understand fully the processes behind these δ18Op changes would require an in-depth comparisons of the models which has never been attempted so far."*