Response to anonymous referee #2

Referee #2 find the manuscript well structured, concise and self-consistent and the method well described. Her/his main concern is about the choice of the various data sets used in the article. Each of the comments concerning this specific point are first answered:

• Page 1317, line 14: what is the EN3 dataset? I could not find any information about it in the Ingleby and Huddleston paper. Why not use data provided in the World Ocean Database? Can you indicate how many profiles satisfy the mentioned conditions (1500 depth, T and S both measured)?
Sorry, I made a shortcut. The Ingleby and Huddleston paper mentions the ENSEMBLES project from which the EN3 dataset is one of the version. The following url has been added to the paper: http://www.metoffice.gov.uk/hadobs/en3/. The World Ocean Database is the primary source of data for the EN3 dataset. The EN3 dataset has the advantage to also include other data sources (GTSPP, Argo, ASBO) and to provide quality controlled profiles. We have discovered that the WOD on the standard levels are very well qualified but that many outliers still remain in the WOD on the observed levels.
357 445 profiles satisfy the conditions: 1500 depth, T and S both measured. This information is added to the text.

• P 1317, l 21: concerning the CORA3.1: is there a duplicate detection in order to avoid common data in CORA3.1 and EN3?
There is no duplicate detection between the CORA3.1 and EN3 dataset since the two datasets are not used together, they are used for different purposes. The EN3 dataset is only used to compute the statistics needed for the method and then the CORA3.1 dataset is used to be combined with the synthetic fields. We have chosen to use the CORA3.1 dataset to be combined with the synthetic fields since this dataset offers a better content for the recent years.

• For the statistics between subsurface and surface fields, it is stated that only the profiles valid up to 1500 m depth are selected. Hence I would expect the maps showing the correlations (Fig1, Fig4) to be limited to the regions where the bottom is deeper than 1500m.
In fact, the covariances are computed locally on a global 1° horizontal grid using all observations available in a radius of influence around each grid point (see text P 1320, l 12) that is why we are able to compute the statistics in regions where the bottom is lower than 1500 m. Those statistics are thus calculated using nearby profiles. This is an approximation given the large scale structure of this statistics.

• P 1318: ARIVO climatology: there are numerous global climatologies available. Is your choice of ARIVO driven by its time coverage (2002-2007)?
Yes the choice of ARIVO is driven by its time coverage consistent with the Argo period and more consistent with the actual period compared to the WOA for example.

• P 1322: l 18: it would be relevant to have a explanation or a hypothesis for the existence of this tongue of negative values.
Ref to ¨P 1321: the salinity field responds as a passive tracer in most part of the ocean and follows what the temperature field is doing in response to the external forcing (heat flux, wind,…). An increase of T will be associated to an increase of DH and a decrease of S (consistent with the negative correlation coefficients). The shape of the tongue should then be consistent with the different fronts present in the area. The sentence: "Any small variation of the salinity field in this area will thus have a significant impact on the sea level" has been deleted and the following sentence has been added to the text: "It is again related to what is observed for temperature and should be consistent with the different fronts present in the area"

• Figure 10: instead of plotting the temperature fields, why not directly represent the anomalies with respect to OVIDE 2008 cruise? This would make the improvements provided by the combined estimate easier to identify.
Figure 10 is replaced with the anomalies with respect to OVIDE 2008 cruise.

• P 1332: the authors mention the possibility to use Sea Surface Salinity. Do the actual accuracy of the measurements by SMOS or Aquarius will allow you to significantly improve the quality of the reconstructions?
A test using a synthetic SSS field has been performed as part of a MyOcean R&D project called MESCLA (see Buongiorno Nardelli et al. 2012, OSD, this issue) and it shows a positive impact of SSS on the reconstruction of salinity at depth. No test has been yet performed using observed SSS from SMOS or Aquarius and thus it is difficult to strictly answer the reviewer question. We nevertheless have to say that we think that the actual accuracy of the SMOS products is not sufficient but a real test should be performed.

Each of the comments concerning the technical corrections is now answered:

Figure 1: the values of the correlation coefficients are supposed to be between -1 and 1, so should do the scale.
The color scale ranges from -1 to 1, every 0.1, as it is indicated on the legend. The very first and very last colors are not used and are then deleted.

Figure 2:
• the horizontal and vertical labels are not easy to read. Of course I could zoom in the pdf, but even doing that it's still hard.
• as the vertical axis are the same for all the subfigures, maybe it is sufficient to have the labels only on the left-hand subfigures. Same for the horizontal axis.
Also, to increase the
• Colors cale: same comment as figure 1: why does it go beyond -1 and 1?
Horizontal and vertical labels have been set bigger as requested.
We will also ask Ocean Science team to increase the size of the figures, if possible.
The color scale ranges from -1 to 1. The very first and very last colors are not used and are then deleted.

Figure 3:
• same comments as for Fig.2.
• Fig. 3 does not appear in the text.
Horizontal and vertical labels have been set bigger as requested.
The color scale ranges from -1 to 1. The very first and very last colors are not used and are then deleted.
That is true that Fig. 3 does not appear in the text – in fact, a complete paragraph is missing in the pdf version – We did not noticed … thank you for that!
The paragraph is:
As the vertical structure of the ocean varies with seasons, seasonal estimates of the covariances are used in the linear regression method. Major differences between seasonal and annual estimates are found for the covariances between SST and the vertical thermal structure in direct relation to the variation of the mixed layer depth. High correlations are found down to 400-m and even down to 1500-m at mid-latitudes during winter seasons of the Northern and Southern Hemisphere where the mixed layer is the deepest (Figure 3). The tropics display small changes between seasons.

Figure 11: labels not easy to read

Fig 11 and Fig 12 have been recomputed, as for Fig 2 and Fig 3

P 1318; L 20: for the 2002 to 2008 periods –> period
Corrected

P 1325; L 1: showed is correct but very rare compared to 'shown'
Corrected

P 1326; L 8: the 'm' for meters is missing
Corrected

P 1327; L 13: the in situ T and S sectionS
Corrected

P 1327; L 14: only in situ observations
Corrected

P 1327; L 20: this number increases
Corrected

P 1329; L2: 1500 meterS. Also, for consistence within the text, use 'm' instead of meters.
Corrected everywhere

P 1329; L2: 500 mr –> m
Corrected

P 1329; L7: previous Argo: do you mean before Argo?
Yes, the word previous has been replaced by before

P 1329; L8: 17-years: the - is not necessary
Corrected

P 1329; L10: the observed signals
Corrected

P 1330; L8: T/S profiles observations –> T/S profile observations
Corrected

P 1330; L13: showed rare compared to 'shown'
Corrected

P 1330; L20: Hemisphere: here with upper case, while lower case on the previous Page
Changed everywhere with lower case letters