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Comment

## ***Interactive comment on “Argo data assimilation into HYCOM with an EnOI method in the Atlantic Ocean” by D. Mignac et al.***

### **Anonymous Referee #2**

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This is a well written paper on assimilating Argo data into HYCOM in the Atlantic domain as part of the development of a Brazilian operational oceanography program. There are some ambiguities in the text due to non-native English, but nothing that obscures the meaning. The details of the processes required to assimilating into a complex hybrid coordinate model are well described. The results emphasise the importance of vertical covariances, particularly of the isopycnal depths, in reproducing reasonable results. I recommend publication of the paper after a number of minor revisions have been addressed.

Line 118 I'm not sure whether it's necessary to say  $T, S(z)$  is the observation space, as opposed to  $\Delta p$ . The floats will be measuring pressure  $p$ ,  $T$ , and Conductivity simultaneously so in fact whether you regard  $T(p)$  or  $p(T)$  or indeed Conductivity  $(T, p)$  all

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can be regarded as legitimate observation spaces. Of course projecting to a particular model set of isopycnals will be moving away from Observation space. Just a point for clarity. When model is introduced ~line 165 the boundary conditions in the north and south should be stated. What happens at 50N. Why is the horizontal influence of 150km chosen in line 351? This is a big decision and a reference should be provided preferably. Does this vary with latitude. Does it change near coastlines? I would expect one of the advantages of using HYCOM would be that larger covariances could be used for thickness decorrelations than for z level correlations? Comment? Section 4.2. I found the notation of VLOCDP etc.. very cumbersome and not intuitive at all. Could you not choose shorter and easily expt names? There is some danger of comparing your results to WOA09 as a reference. The Argo data will show the oceans being warmer than the WOA09 climatology especially in upper levels. WoA09 has lots of older data and the upper ocean has been warming so perhaps something more like an Argo climatology would be a better reference. Line ~510 It occurs to be it would have been better to make a map of the vertical displacements instead of Fig 6 since Fig 6 everything looks rather similar Line 544-45 Some discussion of why this is would be appropriate Line 563-64 There is no Argo data to the north here because it is a shelf region and much shallower Line 586. One has to be careful of simply increasing alpha as you may overfit the data. If the model cannot represent the eddies then it may not be best to impose very large data driven changes Line 617-19. Some more discussion of why vertical localisation for T,S is not sop important? Clearly much of what you are seeing is vertical displacements of isopycnals and not changes in the T(S) relation on isopycnals. Line 761 HYCOM+NCODA? Lines 783-86 It should be noted that constraining the current systems near the equator is a very different prospect than constraining them away from the equator because of geostrophy. At the equator the density distribution will adjust to the currents and not the other way round. Away fomr the equator you would hope for a much clearer impact on ocean currents from the assimilation of data. Lines 845-847 The stationarity of the ensemble is a big issue it seems and the real advantages of the ensemble method can only come from allowing

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time evolution, otherwise the you cannot assess different levels of ensemble spread

Minor comments on text below Line 52 equations and therefore 58: produce an “objective analysis”. . . . . output alone (Daley, 1991) 63: long time series of analyses. . . . contribute to a better 68 small volume of 72: only a few decades 75 data down to 2000m. . . . . millennium 77: first time it is (no comma) 84: methods, the ensemble-based. methods use a set of different model 86: One widely used. . . . . from a previous model run. 89: It is already. . . . EnOI method is able 97: evaluated in order to 102: ocean, and 105 two of the 3 state 110: afterwards TE) 115: afterwards XZ). . . . Argo data, and. . that the TE. . . . improvements, in relation to simpler schemes 119: Very little has been. . . . HYCOM with a focus. . . . assimilation system for HYCOM. . . implemented, and realised 124: by XZ. The present . . . developed within the Brazilian 135: In the near 143: discussion and conclusions. 151: transform into z 166: and excluding Indian? Or “indo-pacific” 179: points adjacent to South. . . 120Sv further south to antarctica 185: “1” ? 239: Since Eq(1) 243: and is used 253: and the procedure is repeated for the 258: z levels and the new synthetic observations defined. . . layers, 275: To avoid the . . . . thicknesses occasionally becoming. . . . . is used. If the thickness 296: how sensitive the 304 after a few sensitivity. . . . . cost, and is 338: XZ, as the focus Eq 4 is not easily read 358: correlations for temperature 361: work the 370: As shown by. . . . . elements a few entries 384: surface to 0.05 Eq 8 is confusing 398: has a values close to Line 429 refer to Eq 2 for alpha 430: experiments on a . . . . performed only every 3 days. However 445: “assimilated” rather than “used to validate”?? 478 below 492: correct the 2C. . . shown by the Control 495: represent physical processes. 497: efficient at improving the 505: This increase of the 520: only at the equator, but at all 528: west and it . . . east with a value 532: ocean, and 534: has an even stronger 536 west of the 538: position of the 20CV 543: On the other hand 554: excess over the observational climatology 557 data are assimilated 560: WOA09 by more than??? 571: calculated on a 577: S above 2000m 586: would now be ready 598: was greatly reduced. . . . . 2010 to 31 613: reduces the RMSD values of the Control run by up to 1C and 0.13psu. in the first 615: 1200m to 2000m. . . . . decrease

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RMSD by a further 0.15 623: S was studied. ... 631: Due to the biases of the ?????? better than inaccuracies? 633 layer thickness 641: data above 2000m 650 RMSD in 663 italic "a" 687: vertical constraints by 700: As shown above 703: which in turn generate the pressure distribution.. XZ. ....circulation develop, consistent with 710: originating in 714: velocity increments 725: itself during further integration 746: contribute strongly to the SSH. ....content is positively correlated 752: should this be HC error? By more than 7 762: south of 40S 770:it is displaced further south 775: remains the same....and is not .....SAC near to the surface, 787: signal of the impact 788: as is found 797: assimilation of the.....reduced by less 807: layer thickness 809: layer depths, which .....responsible for the pressure 811 Finally T was 819: Delta P is an 821: improved above 2000m, the maximum 823: 34% and 44% is sufficient accuracy 825: in the upper 828 SSH in the model 840 decreased by 66 842: between more distant 845 and does not 853: evidence that 859: is mainly to 863: key-step in two 866: CPU on 32 2GHz processors

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