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Interactive comment on "Estimating carbonate parameters from hydrographic data for the intermediate and deep waters of the Southern Hemisphere Oceans" *by* H. C. Bostock et al.

Anonymous Referee #2

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Summary: This paper undertakes an empirical analysis to better diagnose and predict Dissolved Inorganic Carbon (DIC) and alkalinity (ALK) within intermediate waters in the Southern Ocean. It's important to explore these empirical relationships, since CO2 data-limitations hinder our understanding of Southern ocean acidification and biogeochemistry. The paper analyses a large amount of data in order to provide a useful relationship for these carbonate properties using only temperature, salinity and oxygen data. With ARGO floats now deployed with oxygen sensors, the ability to diagnose these carbonate parameters using such an algorithm will be important. I would recommend publication after some minor/moderate revisions.

Anthropogenic correction: The authors neglect the influences of anthropogenic CO2

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on the DIC data-set, stating that the signal is small (5-10umol/kg) in comparison to the natural variability. Although the signal is small, it can't be discounted completely for two reasons. Firstly, moving along a given isopycnal surface, there are non-linear changes from anthropogenic CO2 as the isopycnal moves towards outcropping in the Southern ocean. So when applying a linear regression along an isopycnal, there will be a non-linear bias ranging from near 0 (in the sub-tropical interior) up to 10 along the same isopycnal near the outcropping at the surface ocean. This could introduce a bias when regressing the data. Secondly, since alkalinity has no anthropogenic CO2 signal while DIC does, when calculating the carbonate properties, there will be a non-linear bias when looking at patterns. So I recommend expanding on the anthropogenic CO2 correction by testing why you can neglect it or indeed include a simple correction. How could you do this? The total anthropogenic signal is available through GLODAP via the C* method. As a test of how important the anthropogenic signal is, the authors could apply a scaling factor to the C* numbers so that the distribution is similar, but the magnitude is similar to the decadal scale changes expected from your data-set. Then you can have a look at the corrected DIC to see if including the anthropogenic CO2 signal is insignificant or not. If it is important, then you could normalize the DIC measurements to a given year, by calculating the change in DIC overusing CFC's observations and the TTD method (Waugh et al., 2006). Why this correction is important is that the technique can then be applied in the future with a more recent DIC data-sets (>2013), which can then give us the ability to quantify change in carbonate properties between the two time-frames. However, even with the current data-set, I think the authors could look at decadal changes, which brings me to another point.

Decadal changes: The other query I have for the authors, is why they lumped all the data together in the first place? They range from 1993 to 2008, which is quite a large spread. I realize that geographically, the data is sparse, but by looking along isopycnals corrects for geographic sparsity biases. It would therefore be wonderful if the authors could separate the data in time-frames for a 1990s algorithm and 2000's algorithm, to see what changes occur? Furthermore, the authors could also apply their regression

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technique to the 1960s/70s data-set in the Southern Ocean of Eltanin and GEOSECS and apply a residual analysis to see the decadal anthropogenic CO2 signal like some people have done for ACO2 (see Matear and McNeil, 2003)? Bringing in a temporal component of this work would really boost its value. In its current form, by using all data over a 15-year period without an anthropogenic correction, it limits that ability for it to be used in the future by the community.

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