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Ocean Science Discussions

Interactive comment on "Transport of warm upper circumpolar deep water onto the Western Antarctic Peninsula Continental Shelf" *by* D. G. Martinson

Anonymous Referee #1

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This is an interesting paper that discusses data from a number of moorings on the western Antarctic Peninsula (WAP) continental shelf. The defining feature of that region is the presence of Circumpolar Deep Water (CDW), both Upper (UCDW) and Lower (LCDW) varieties, on the shelf. The analysis described here aims at elucidating the processes that transport UCDW onto the shelf from its source region in the ACC, which tracks the WAP shelf edge. While the paper is generally well structured, with the arguments put forward succinctly and in a logical order, in places there is a lack of clarity about the objectives of the work and the analyses undertaken. I think that some work to address the points listed below would improve the paper:

1) The weakest part of the paper is the introduction, which is restricted to one short paragraph. A brief description of the physical oceanography (water masses, stratification, and circulation) of the region as documented in earlier work would go a long way to addressing some of the questions that follow.

2) In particular it would be helpful to clarify the water mass definitions and justify the exclusion of LCDW from consideration, particularly given that earlier studies of CDW intrusion onto the WAP shelf have identified both UCDW and LCDW intrusions. The derivation of the UCDW fraction shown in Figure 3 could be clarified at this point. I appreciate that it is explained in MSISV08, but it is important for the interpretation of Figure 3. Critically one end-member of the "three water mass mixture" is so dense that it could never contribute directly to the mixture of waters on the shelf. This gives a bias towards high fractions of UCDW. For example, using this system classically-defined LCDW becomes something like 80-90% UCDW and 10-20% DW. However, LCDW is a water mass in its own right and is not formed by mixing between the two end members. Wouldn't it be more appropriate to take WW, UCDW and LCDW as the end members for the shelf waters? That would give generally lower fractions of UCDW. It would not alter the basic pattern, but it would highlight the point that UCDW intrusions may not be the whole story, and that other waters derived from the ACC contribute to the water column over some parts of the shelf.

3) While these may seem like pedantic points, they would contribute important clarification of how this work relates to earlier studies. Without that clarification, the last sentence of the abstract, for example, read like a contradiction to me. Even after a complete first reading of the paper I remained unclear as to whether the findings supported or refuted earlier studies. Apart from the subtleties of the water mass definitions, I missed the meaning of the term "nominal shelf", which occurs twice, almost unnoticed (by this reader) in the paper. This is not a standard term I know of, which is why I missed the critical information that it apparently conveys, but I think it means the expansive, relatively shallow shelf regions outside the deep cross-cutting troughs. This

OSD

8, C963–C966, 2012

is a critical point that needs to be made much more clearly, because much of the interest in the oceanography of the region (from a climate change/sea level perspective) is focussed on the water properties within the troughs, since these lead to the grounding lines of the ice shelves. So many readers will assume that a discussion of the processes that fill the troughs will be part of the paper. In fact they are not. Troughs are only considered as possible sources of water that spreads onto the "nominal shelf". The processes by which the troughs are filled with water from the ACC, and the water masses that fill them, are not discussed.

4) Something that would help is a more in-depth discussion of Figure 3 (presently only mentioned in passing) as background and motivation for the study. The moorings are focussed in the region of high UCDW fraction. This is fair enough as UDCW is slightly warmer and of biologically greater significance (?) than LCDW. However, UCDW is found in mid-water-column, directly below the main pycnocline and well above the seabed, even outside of the troughs. The study was presumably motivated by the desire to understand processes affecting the mid-water column and as a result can give no information on what waters occupy the deeper parts of the shelf, or how they get there. All of this may be self-evident to those more familiar with the WAP and the Pal LTER data (and the underlying motivations for that work), but the paper should be readily accessible to a wider audience. At present the exclusive discussion of UCDW as the dominant water mass everywhere on the shelf might suggest to a non-specialist that the processes discussed could account for all the warm waters on the shelf.

5) In section 3 a large section of the text is devoted to the identification of eddies, while very little is devoted to alternative processes. This is to some extent inevitable, given the relative complexity of the analyses. For example, comparatively simple arguments are used to dismiss processes 2 and 4. However, I did not really follow the discussion of upwelling, and this section really needs some extra clarification. What is meant by a period when "mass balance was approximately achieved"? Is it reasonable to expect that currents are constant over 400 km? When you talk about upwelling you mean

OSD

8, C963–C966, 2012

uniform off-shelf transport in the upper layer and a corresponding uniform on-shelf flow at depth? You are not looking at local convergence/divergence in the near surface flow? But if the currents really were constant over the shelf, wouldn't you see "lagged coherent events in Q(t) across the entire mooring array"? The lack of such events is used to eliminate "shelf-wide flooding" in the following section.

6) Many of the figures would benefit from being reproduced at a bigger scale with larger fonts.

Interactive comment on Ocean Sci. Discuss., 8, 2479, 2011.