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Ocean Science
Discussions

Interactive comment on "Modelling the variability of the Antarctic Slope Current" *by* P. Mathiot et al.

Anonymous Referee #1

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This paper considers issues of forcing and grid resolution for the proper simulation of the westward flowing Antarctic Slope Current (ASC) around most of Antarctica. The analysis uses a global model with 4 different grid spacing as well as a Southern Ocean model with different surface wind and surface temperature estimates.

Since the focus of this study is on the seasonal variability of the Slope Current, I would recommend that "seasonal" be added to the title before "variability".

The global models are run for the 10 year time period from 1990 to 2000. The regional model is run for the 10 year period 1980 to 1990. Why use different time periods for the two models?

All four of the global simulations have different results for the flow near the Antarctic coast (Figs 3, 4). The 2 degree and 1 degree global simulation are much too coarse to properly represent the Southern Ocean. Even the 0.25 degree model may be too

coarse to represent ACC frontal jets which have widths of 50 km or so which is 2-3 grid points in the model with the finest resolution.

The 0.5 and 0.25 degree global simulations have rather different results along the Indian Ocean sector (Fig 3). How well is the bathymetry of PET represented in these cases? Why are the results so different? Neither one is particularly realistic. Why choose 0.5 degree as the resolution for the Southern Ocean model? Is there any purpose in showing the global model results other than to justify the selection of grid spacing for the Southern Ocean model?

The focus of the analysis is on the transport of the westward flow near the coast and off the shelf break. This transport can develop alongshore changes (Fig 3) only by importing or exporting water from offshore. Basically, this involves the development of local (oceanic) gyres next to the continent. How well do the annual mean streamlines (Fig 5) match with annual average satellite altimetry or mean dynamic topography from climatological hydrographic reconstructions showing such gyres? Is there evidence for these gyres and their seasonal changes in strength?

The main result of the paper, based on the Southern Ocean model, is that stronger winds produce stronger transport near the continent and that colder temperatures produce more summer ice. Further, winds without a seasonal cycle do not produce seasonal changes in the ASC transport.

The second result from the paper is that there are different flow patterns with different model resolution. No surprise that 1 degree and coarser global models do poorly around the Antarctic continent (since much of the flow is bathymetrically controlled and there are small bathymetric features that are important, but not represented by the coarse models). Does the 0.5 degree Southern Ocean model have enough resolution to provide a realistic representation of critical bathymetry and produce a realistic circulation? The annual mean streamfunction (Fig 5) looks ok; do observations tell us what this annual mean pattern should look like?

Ultimately, I am not sure what is new in this paper. Most of the comparisons are between model simulations. It would be important to compare these results against observations as much as possible.

As a further comment, the authors spend too much time describing figures that are included in the paper (for example, most of p. 14). It would be better to point out the important details of the figures and explain how these results illuminate processes in these coastal flows.

I recommend that the paper be returned to the authors for major revisions to focus on the important results that they have obtained by analyzing the simulation results.

Specific questions:

p. 10, fig 3: Model simulations produce half (or less) of the observed ASC transport. Why does orca025 have an increase of transport to the west while the others do not? How well is the PET represented at these various model resolutions?

p. 11: The paper states that the westward flowing ASC is too wide by a factor of 2. Why? Is it just a matter of the wide grid spacing or is something else going on?

p. 13: How can a model with a resolution of 0.5 degree represent a jet with a width of 0.2 degree? It can't. Of course, the jet will be too wide and too slow. Similar comments for current widths on p. 14.

p. 14: Transport values are given in Fig 9 not Fig 8.

p. 14: There is no observational evidence of westward flow (ASC) along the west side of the Antarctic Peninsula. There is some observed (estimated) westward flow at the coast which is driven either by buoyancy (ice melt) or local winds. Since the ACC is at the shelf break in this region and the winds are largely westerlies, I would not expect to see any westward flow (ASC) in this area. So, I don't think this is a failure of the model but a representation of fact (?) that there is no ASC off the west side of the Antarctic Peninsula.

Fig 10: This figure is very hard to understand, particularly the upper panel. With small figures it will be hard to differentiate circles and squares. A better presentation would be to remove the mean for each year and plot monthly variability as a line for each year. Then we can tell the magnitude and variation of these seasonal variations.

fig 11: It is very hard to differentiate the solid dots and the open squares in this figure. Present the results another way.

figs 12, 13: I am not sure that the SSH figures add much to the discussion. Since the flow is geostrophic, these differences basically show the difference in transport.

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