Ocean Sci. Discuss., 11, C423–C425, 2014
www.ocean-sci-discuss.net/11/C423/2014/

Ocean Science
Discussions
Open Access

Interactive comment on "The shallow meridional overturning circulation of the South China Sea" *by* N. Zhang et al.

C. W. Hughes (Referee)

cwh@liv.ac.uk

Received and published: 27 May 2014

This paper requires a very large amount of work in order to be of publishable quality.

The authors diagnose various quantities related to the overturning of the South China Sea, and show that wind stress plays a major role in the shallow overturning in one ocean model. This is fine, as far as it goes. However, there are two major problems:

A) The shallow MOC is of little interest in itself. The reason for the current level of interest in the North Atlantic MOC is that this reflects a large-scale ocean mode responsible for significant heat transport. The MOC in the South China Sea may or may not be a good proxy for some interesting aspects of its circulation, but it would make much more sense to first investigate the three-dimensional circulation of the sea and its role in cycling and exchanging water mass properties of interest. If the MOC plays a significant role in these processes, then it becomes an interesting diagnostic, but it is of little interest for its own sake in a relatively small, and partially open region of the ocean.

B) The presentation suffers from many problems, as detailed below:

1) The authors initially consider diagnostics from two ocean models, but quickly discard one of them without looking at how and why the models differ.

2) The primary diagnostic - the meridional overturning streamfunction - is of dubious value in an unbounded region, for which there is no meaning to the vertical component of the visualised "flow" at latitudes which are not closed. A better diagnostic would be the same, but integrated from the bottom up, rather than from top down, as this at least does represent a genuine streamfunction for the integrated flow below the depth of connections to the wider ocean. However, much more useful would be a clear description of the three-dimensional circulation. The authors make a good case for a northward Ekman flux accounting for much of the integrated flow in the mixed layer. A good question would be, how does that flow return to the south? Is it in boundary currents or throughout the interior? What is the role of any recirculation through connections to the wider ocean? Is there a net change of density (temperature, salinity) associated with that recirculation, and if so, where does it occur. Such questions should be straightforward to answer with the full ocean model fields.

3) The calculation of subduction rate (section 4.2.2) moves from the MOC in z-coordinates, to the water mass formation associated with flow through the mixed-layer base (which is not at constant z). However, the formulation in terms of a linear vorticity balance is dubious in the presence of bottom friction and nonlinear vorticity, and there is no need for such an idealised formulation when the full model fields are available - simply calculate the flow through the chosen surface. Incidentally, the v in (3) is supposed to represent the geostrophic velocity only, not any v associated with the Ekman

OSD
11, C423–C425, 2014

Interactive Comment

layer. No attempt is made to account for the fact that the MOC in z-coordinates is not directly relevant to this quantity. I also find it strange that subduction into the interior is considered, but entrainment back into the mixed layer (negative subduction) is set to zero.

4) The manuscript switches back and forth between annual mean budgets and seasonally varying components, occasionally using diagnostics from one to explain features of the other. This is very confusing. The two should be kept as separate as possible, with the seasonal variation only influencing the annual mean through explicitly calculated rectification of non-linear terms (in the transport within a particular density class, for example, where velocity and density may be correlated over a seasonal cycle).

5) The relative roles of Ekman pumping and coastal upwelling/downwelling are not made clear. How much of the upwelling and downwelling required to balance the northward Ekman transport is supplied by interior Ekman pumping, and how much by coastal upwelling and downwelling? This is a section in which the switching between annual mean and seasonal cycle is particularly confusing.

6) Section 5, comparing the results with the Indian Ocean, seems quite disconnected from the rest. The only real connection I can see is that the Indian Ocean also has a surface Ekman layer, and even that is more notable for its different behaviour than for its similarity, as the Indian Ocean Ekman layer straddles the equator.

These problems, especially in the light of the central issue of why the MOC might be of interest in the first place, are great enough that any acceptable paper would effectively be a new paper on a different subject, hence my recommendation to reject for OS.

Interactive comment on Ocean Sci. Discuss., 11, 1191, 2014.