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Interactive comment on "The wind-driven overturning circulation of the World Ocean" *by* K. Döös

Anonymous Referee #1

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Review of "The wind-driven overturning circulation of the World Ocean" by K. Doos.

This paper presents an analytical wind-driven model to describe the meridional overturning circulation in the World Ocean. Its argued that the simple model can describe the key elements of the global MOC.

Since Toggweiler and Samuels (1995), where the authors argue that the Ekman transport across Drake Passage sets the strength of the Atlantic MOC, a host of papers have been published discussing the role of the winds in what previously was called the thermohaline circulation. For instance, Gnanadesikan (1999) attempted a theoretical justification of the Toggweiler and Samuels (1995) idea by deriving a simple relation between the overall transport associated with the MOC, wind-driven upwelling in the Southern Ocean, diapycnal transport through the thermocline and a bolus transport by the eddies. In a series of papers Nof took a slightly different view and argued that the

MOC was set by integral of the windstress along a closed belt that defines the boundary of the Atlantic Ocean, see for instance Nof (2003). An even more fundamental challenge to the concept of thermohaline circulation was presented by Wunsch (2002) and others where energy arguments were used to argue that the fundamental driver of the circulation is the wind field.

The present paper attempts to add to this discussion, especially the line following Toggweiler and Samuels (1995) which stresses the role of the Southern Ocean Ekman transport in the MOC. The author makes use of the ventilated thermocline model of Luyten et al. (1983) to develop a model for the meridional circulation. In Doos (1994) a similar approach was taken to describe the MOC as simulated by the FRAM model. Here, the model is extended further northward and parameter settings are chosen to be comparable with the simulation of the OCCAM model. In my view, the present paper might add a valuable, albeit a not very novel, contribution to the very relevant discussion on the driving of the MOC. In its present form, however, it contains a few obscurities that need to be clarified before publication can be recommended.

Point 1: The author should make more clearly what the added value with respect to Doos (1994) is of this paper. Is this manuscript merely a re-iteration of the ideas of Doos (1994), put in a slightly different model configuration, or is there more to it?

Point 2: The LPS model is not well suited for a reentrant channel. Does the author assume meridional walls all over the Southern Ocean. If so, can he argue that this obviously wrong assumption does not corrupt the whole solution?

Point 3: At page 484 it is stated that the amplitude of the Conveyor belt is set by the Ekman transport across the outcropping line y_{3s}. It is not clear whether this is a result or an assumption, and if it is a result, on which assumptions this is based. In general the Ekman transport across this line can be returned by a) the MOC, b) the Deacon Cell, c) Eddy transports. The latter are not considered, but why should the Deacon Cell be zero at y_{3s}?

OSD
2, S229–S231, 2005

Point 4: It appears to me that the strong impact of the wind in driving the Conveyor Belt in the present model results from the wind being the only free parameter left, all other quantities associated with thermohaline processes have been set, tuned to reproduce the OCCAM results as close as possible. This could be more clearly stated in the abstract and discussion.

Point 5: The author has neglected eddy transports. Yet, it should be simple to incorporate a parameterization for the bolus transport after Gent and McWilliams into this model, see for instance Gnanadesikan (1999). Is the result that this wind-driven model is able to reproduce the MOC-amplitude of the OCCAM model not biased by the neglect of eddy transports?

I will recommend publication after the author has provided an adequate response to the points raised above.

References: Doos (1994), JPO 24, 1281-1293. Gnanadesikan (1999), Science 283, 2077-2079. Luyten et al (1983), JPO 13, 292-309. Toggweiler and Samuels, DSR 42, 477-500. Wunsch (2002), Science 298, 1180-1181.

Interactive comment on Ocean Science Discussions, 2, 473, 2005.