Ocean Sci. Discuss., 4, S26–S28, 2007
www.ocean-sci-discuss.net/4/S26/2007/

Ocean Science Discussions

Interactive comment on “Climatological mean distribution of specific entropy in the oceans” *by* Z. Gan et al.

Anonymous Referee #2

Received and published: 22 February 2007

The authors use Feistels’ representation of the seawater Gibbs function, together with temperature and salinity data from the World Ocean Atlas 2001 to plot the distribution of entropy in the ocean. They show that the entropy primarily varies with potential temperature and is only weakly affected by salinity.

1.1 As a technical report it is fine, it is of interest to see these things and there may be a case for providing similar plots of other thermodynamic variables - all of which can be derived from the Gibbs function. However these are usually the things that are seen in an atlas, not a scientific paper. For a scientific paper, we really need more, something that gives some real insight into how the ocean behaves or why it behaves in the way it does.

1.2 In fact the authors have tried to do this by emphasising the importance of entropy. Unfortunately in doing this they have misunderstood a particularly bad oceanographic convention - the use of the word "isentropic" as a shorthand referring to "surfaces of constant potential density".

The problem arose because the usage was borrowed from the atmospheric community. In the case of the atmosphere, if the small effect of water vapour is ignored, surfaces of constant potential temperature, potential density and entropy all coincide - so the above shorthand is valid.

In the ocean this is not the case and as a result the surfaces are known to intersect. Unfortunately Montgomery (1938), having realised there was a problem, ignored it - or rather justified his continuing use of the term on the grounds that particles following surfaces of potential density kept their own unchanged entropy. In fact this is not true, entropy is only conserved if any changes are adiabatic. Conversely adiabatic movement in any direction will conserve entropy of the water particles. Later authors have followed Montgomery and this has led to the confusion in the present paper.

Anyway quite a lot of the paper is spent re-discovering that isentropic surfaces do not follow surfaces of constant potential density or McDougall's neutral surfaces and this really does not justify a paper.

1.3 My other problem as a reviewer is that I do not see how the paper can be rescued. Physically the most important thing about entropy is its rate of change with time. This is in contrast with other thermodynamic quantities such as the speed of sound, which gives us the SOFAR channel of the ocean, or the pressure distribution, which determines geostrophic currents. I suppose entropy may be used as a passive tracer but the core layer type analysis is hardly used any more.

If anyone does know how the entropy distribution may have a more active role please write in.

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Interactive Comment

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1.4 The one aspect that might be worth following up is to ask questions along the lines of "why does salinity have a strong effect on density and only a little effect on the entropy?" and to extend the question to cover other thermodynamic variables. The authors start doing this with Eqn. (4) but the derivation is confusing (why for example are there two temperature variables) and after reading the section I do not understand why the salinity effect is so small. Maybe we have to go back to the molecular structure of sea water.

Other points

2.1 The use of different colour scales on related figures (the entropy scales in Figs. 1a, 1b, 2a and 2b all differ) should be avoided.

Interactive comment on Ocean Sci. Discuss., 4, 129, 2007.