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Ocean Science Discussions

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

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Entropy as an important thermodynamic state function can be considered to provide insight into the physical properties of seawater. Our disputed paper presents a new spatial-temporal distribution of specific entropy in the oceans by using a new Gibbs thermodynamic potential function of seawater, which is proposed by R. Feistel. An important analysis result we demonstrate to the reader is that the distribution of specific entropy is very different from that of potential density or neutral density surfaces in the oceans. By contrast, the distribution of specific entropy is quite similar to that of potential temperature in the oceans. This result is not consistent with the traditional assumption that isopycnal or isoneutral surfaces could be approximately regarded as isentropic surfaces in the physical oceanography. In so far, the assessment of the paper by referee #1 is that "The manuscript is wrong-headed, chasing the false premise

that oceanographers “commonly” assume that a potential density surface is an approximation to an isentropic surface. Oceanographers do not assume this, as far as I know, no one thought they were they the same, so the authors are addressing a non-problem. This manuscript is concerned with dispelling a non-issue” Here, as evidence contributions to this article, the original words of several well-known works will be cited to clarify our manuscript:

1. On Page 7, Section 7.4.2: Horizontal mapping of the well-known textbook “Descriptive Physical Oceanography” By William J. Emery, Lynne D. Talley and George L. Pickard, to be published by Elsevier,2007.See http://www-pord.ucsd.edu/˜ltalley/sio210/pickard_emery/emery_talley_pickard_index.pdf. “Since processes that change density are weak below the surface layer, ocean flow is much more likely to follow surfaces of constant entropy, or isentropic surfaces. (Entropy is conserved if a process is adiabatic, that is, has no change of heat or salt.) This concept was introduced in the 1930s, and closely follows meteorology practice. In the ocean, isentropic surfaces are difficult to determine because of the complicated empirical equation of state (chapter 3). Surfaces of constant potential density (isopycnals) referenced to a nearby pressure (if working close to the sea surface, if working close to 4,000 dbar, etc) are a close approximation to isentropic surfaces. Surfaces of constant neutral density (isoneutrals) have been argued to be almost identical to isentropic surfaces (chapter 3.5.4). Therefore it has become common to map properties on isopycnal (or isoneutral) surfaces. ”

2. On Page 114, Section 6.33: Isentropic analysis of “Descriptive Physical Oceanography-An introduction” By George L. Pickard and William J. Emery. 4th (SI) Enlarged Edition, Pergamon Press, 1982. “horizontal sections, which was introduced for oceanographic use by Montgomery (1938) and referred to as isentropic analysis. He argued that the flow of ocean waters may be expected to occur most easily along surfaces of constant entropy. Because of the complex thermodynamical nature of seawater, it is difficult to determine surfaces of constant entropy as such and Montgomery

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presented arguments to show that surfaces of constant potential density( ) would be a close approximationĚ”

3. On Page 124, Section 6.2: concerning the choice of vertical coordinate of “Fundamentals of Ocean Climate Models” by Stephen M. Griffies, Princeton University Press, 2004 “Figure 6.1 Stylized rendition of an ocean basin, illustrating three fundamental regimes of ocean dynamics critical to the ocean climate system. The surface mixed layer is naturally represented using z-coordinates (or even more naturally with pressure coordinates); the isentropic interior is naturally represented using isopycnal or -coordinates; and the bottom topography is naturally represented using sigma or -coordinates.” From that outlined in the above sections, it is very obvious that we do not chase the false premise and assumption, and we do not attempt to “educate oceanographers” that an isopycnal surface is not the same as an isentropic surface in the ocean.

In addition, we admit that the same manuscript was submitted last year to JGR, and it was rejected from that journal. We have “learnt nothing” from the reviews we received at that time because that comment as the same of the assessment by referee #1 have nothing, such as references, illustrations et al. evidences to rebut our argument, except of a heap of subjective judgments and “education”. Since we believe that the science is objective and it would not be rejected by only a subjective judgment, so we submit it again to the present journal for discussion.

About another assessment of referee #1 “Another basic thermodynamic error that is made in the manuscript is in the introduction where it says that prior to the excellent work of Feistel (2003) specific entropy was only known up to a linear function of salinity because of the complicated thermodynamic nature of seawater. This is incorrect. The fact is that specific entropy is UNKNOWABLE up to a linear function of salinity. ”

We need to say that it is our improper expression in English. In fact, “specific entropy was only known up to a linear function of salinity” should be rewritten as “from the

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same initial empirical data, the entropy of sea water would only be exact within a linear function of salinity" (Original words on pp.18, Fundamentals of Ocean Dynamics by V.M .Kamenkovich, Translated by R.Radok, Elsevier Scientific Publishing Company, New York, 1977)

"Since processes that change its properties are weak below the surface layer, ocean flow is much more likely to follow some constant surface. This surface was identified as the isentropic surface (Entropy is conserved if a process is adiabatic, that is, has no change of heat or salt). (Original words On Page.7, Section 7.4.2: Horizontal mapping, of the well-known textbook "Descriptive Physical Oceanography" By William J. Emery, Lynne D. Talley and George L. Pickard, to be published by Elsevier, 2007.) "The flow of both the atmosphere and ocean is largely along isentropic surfaces, and the realization of this, most easily expressed in isentropic co-ordinates, is of great help in understanding large-scale flows." (Original words on pp.90 of Introduction to Geophysical Fluid Dynamics by geoffrey k.vallis, 2004) The above mention is one of the reasons that physical oceanographers want to concern themselves with specific entropy of sea water. In addition, Entropy as an important state function can be considered to provide insight into the thermodynamic properties of seawater, which is another reason that physical oceanographers should focus an attention on specific entropy in the ocean.

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