Reply on AC5
Anonymous Referee #2

Referee comment on "Gravity disturbance driven ocean circulation" by Peter C. Chu, Ocean Sci. Discuss., https://doi.org/10.5194/os-2022-12-RC6, 2022

In his reply to my review, the author states that "Oceanographers have used the geoid for several decades, but almost no one recognizes that the geoid surface represents the true horizontal". On this important point I disagree. For independent evidence, I refer the author to the book “Ocean Dynamics” by Olbers, Willebrand and Eden and published by Springer. Their Figure 2.9 corresponds exactly to the author’s Figure 1a, showing that they are aware of the geoid. More to the point, they state on page 45 that “It is hence very convenient and useful to use a coordinate system which has phi = constant as one coordinate surface (phi is the geopotential). For orthogonal coordinates, gravity must thus coincide exactly with one coordinate direction, i.e. \(\mathbf{g} = (0,0,-g)\). The geopotential is then dependent on the vertical coordinate \(z\). Referring the potential to the mean surface, i.e. \(\phi(z = 0) = 0\), we have \(\phi(z) = gz\). The geopotential is thus the work which must be applied to lift a unit mass from \(z = 0\) to height \(z\)."

Regarding the Sverdrup/Stommel/Munk problem, the issue is the direction that is used for the vertical. In the coordinate system used by the author, this is not the same as in the coordinate system I describe above, or as used in the standard Sverdrup/Stommel/Munk problem. In the latter, there is no horizontal component of gravity. The different vertical directions lead to different torque balances in the vertical direction.

Regarding the coordinate system used by the World Ocean Atlas, having talked to observationalists, I am assured that they regard horizontal surfaces as coinciding with geopotential surfaces and hence use the coordinate system I describe above.

I am afraid I stand by my original review. The mistake being made by the author is to work in spherical coordinates from the beginning, whereas the coordinate system used by modellers and observationalists is an orthogonal, curvilinear coordinate system in which the vertical direction is perpendicular to geopotential surfaces. As such, I cannot recommend publication of the manuscript. The author could, nevertheless, make a very useful contribution by writing an authoritative manuscript dealing with these issues. But the author needs to be clear about what coordinate system is being used by modelers and observationalists. It is not the coordinate system he uses in his submitted manuscript.