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Revised estimates of the ocean energy cycle and the key role of the western boundary in the APE to KE conversion due to high latitude cooling

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The ocean energy cycle is a key aspect of the ocean circulation, and has been traditionally framed in terms of Lorenz (1955) theory of available potential energy. However, the latest available observational estimate of the ocean energy cycle is due to Oort and Peixoto (1994) and is now very dated. Moreover, the latter estimate relies on the so-called Lorenz quasi-geostrophic approximation, which is known to be very inaccurate. Oort and Peixoto also neglected the internal energy contribution to the total available potential energy, which is now understood to be far from negligible, and to account for up to 40 percent of the total APE. The purpose of this work is to revisit observational estimates of the ocean energy cycle by taking advantage of a newly developed APE framework, as well as of the many new available observational products for temperature, salinity and surface buoyancy fluxes. In contrast to previous frameworks, our APE framework (Tailleux, 2013) relies on a physically well defined local APE definition, which is valid for a binary Boussinesq or fully compressible fluid with an arbitrary nonlinear equation of state. As part of our approach, we also developed a new fast and accurate way to construct Lorenz reference state of minimum potential energy, based on using the joint probability distribution function for temperature and salinity. Results will be presented for a variety of observational products, as well as for the $ECCO_2$ ocean state estimate. The role of the deep western boundary as the place where the APE created by high latitude is converted into kinetic energy (KE) as part of driving the Atlantic meridional overturning circulation will be emphasized.

References: Tailleux, R., 2013: Available potential energy density for a multicomponent Boussinesq fluid with arbitrary nonlinear equation of state.J. Fluid Mech., 735,499-518.
Sijp, W., J.M.Gregory, R. Tailleux, P. Spence, 2012: The key role of the western boundary in linking the AMOC strength to the North South pressure gradient. J. Phys. Oceanogr., 42, 628-643.