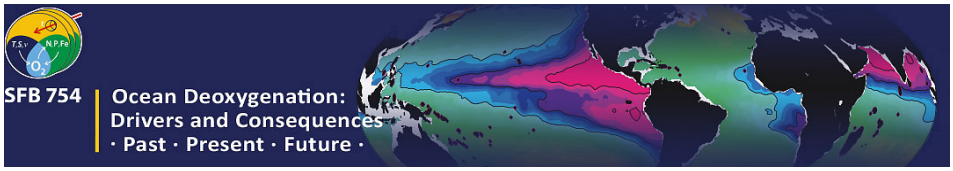

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Oxygen utilisation rate - A poor measure of ocean respiration

Tuesday, 4 September 2018 15:45 (15)

We use a simple 1D model and 3D global ocean biogeochemical models to evaluate the concept of computing the subsurface oceanic oxygen utilization rate (OUR) from the changes of apparent oxygen utilization (AOU) and water age along trajectories on isopycnal surfaces. We find that OUR underestimates globally averaged total oceanic oxygen consumption (respiration) substantially. Most of this difference is observed in the upper 1000m of the ocean, with the discrepancies increasing towards the surface where OUR underestimates oxygen consumption by as much as factor of four.
Hitherto the major problem in the OUR determination has been considered to be the determination of water age, that is the time passed since the last contact of a body of water with the atmosphere, when its oxygen concentration is assumed to have reached equilibrium with air ("saturation"). We find, however, more fundamental and large errors in the concept of OUR itself. AOU from which OUR is calculated is not only the imprint of respiration in the ocean's interior, but the net result of respiration and oxygen supply, i.e. AOU generation and destruction. Similarly, water age is the net result of ageing and age destruction at the surface. Now AOU and water age are subject to advection and diffusive mixing, and only when they are affected by both in the same way does the OUR calculated represent the correct rate of oxygen consumption. This is the case only with uniform respiration rates, when the proportions of AOU and age are not changed by transport. Inhomogenous distributions of respiration yield understimates (when maximum rates occur near the outcrops of isopycnals) or overestimates (when maxima occur far from the outcrops). Given the distribution of respiration on isopycnal surfaces in the ocean (and in the models employed), that is high rates near their northern and southern outcrops and low rates below the oligotrophic gyres as well as rates decreasing with water depth everywhere, underestimates are the rule. Integrating these effects globally in an ocean biogeochemical model we find that AOU-over-age based estimates underestimate true model respiration by a factor of three.

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