"Oxygen on Argo" – an Observational Quantum Leap in Ocean Biogeochemistry

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Description of the new technology and its importance for science and applications and E-AIMS experiment:

We propose to add dissolved oxygen sensors to the Argo float program in order to determine, on a global scale, seasonal to decadal time scale variations in dissolved oxygen concentrations throughout the upper ocean. Such observations are especially important to document the ocean's current loss of oxygen as a result of ocean warming, but there are many other benefits including estimates of net community and export production, assessment of changes in low oxygen regions, improved estimates of the oceanic uptake of anthropogenic CO_2, improved estimates of ocean ventilation pathways, better monitoring of deep convection events and even constraints and the transfer coefficient for air-sea gas exchange.

In order for an « Oxygen on Argo » programme to be successful the most stringent requirements of float-based sensors have to be met. Oxygen optode sensor technology has matured considerably during recent years and several high-quality sensors are now on the market. In this project we directly compare two prominent examples of oxygen optodes by mounting them pairwise on floats. Two of these have been deployed in the tropical northeast Atlantic Ocean – a region that through its Oxygen Minimum Zone and elevated eddy activity provides an excellent and scientifically most relevant test-bed for a dedicated field study.

Results:

A first dual-oxygen-sensor-float was deployed successfully near 16°N/17°35'W off the coast of Senegal. Until 26 Jan. 2015, the float had acquired 100 profiles featuring high-quality oxygen data from both oxygen sensors. Overall the two data sets agree very well and the small but significant differences are consequences of the technical differences between the sensors. A second, identical float was deployed in November 2014 at 11°N/23°W in the core of the oxygen minimum zone of the North Atlantic. Until 26 Jan. 2015, this float had acquired 17 profiles with high-quality oxygen measurements that confirm the findings from the first float.

Conclusion:

High-quality oxygen measurements can now be made readily with existing technology. The pumped Sea-Bird sensor features a faster response and is therefore capable of better resolving sharp vertical gradients from a profiling platform than the Aanderaa sensor. The unpumped Aanderaa sensor in contrast is capable of measuring in air during each surfacing of the float – an opportunity for in-situ calibration which is not feasible with the current Sea-Bird sensor. After careful analysis of the data we were able to demonstrate that in-air measurements made regularly can indeed be used to in situ calibrate and drift correct optodes over the entire lifetime of a float yielding high accuracy that cannot be achieved otherwise. If further substantiated, this finding will lead to a recommendation to float and sensor manufacturers with respect to « Oxygen on Argo » applications which would help to correct for the small but significant in situ drift that has been documented in the field.

Figures:

Field study with a Sea-Bird NAVIS float with dual oxygen optodes (Aanderaa 4330 + Sea-Bird SBE63): Float trajectory (left) and in-air measurements made in close proximity to the dynamic sea surface (right). These figures show a bias from the surface saturation state which is systematic and can be corrected to yield an accurate calibration.