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Glider fleet-based, multi-parameter observations in the tropical Northeast Atlantic

Torsten Kanzow (1), Gerd Krahmann (1), Johannes Karstensen (1), Thomas Ohde (2), Andreas Funk (1), and Mario Müller (1)

(1) Leibniz-Institut für Meereswissenschaften, Chrstian-Albrechts-Universität Kiel, Ozeanzirkulation und Klimadynamik, Kiel, Germany (tkanzow@ifm-geomar.de), (2) Leibniz-Institut für Ostseeforschung Warnemünde, Rostock, Germany (thomas.ohde@io-warnemuende.de)

Mesoscale and sub-meoscale processes play a fundamental role in the redistribution of heat, salt, and marine biomass. Mesoscale eddies carry waters with different properties from their surroundings, and sub-mesoscale (SMS) processes act to extract properties and energy from the mesoscale flow field and transfer them to scales where mixing occurs. In particular, the SMS physical forcing can lead to biological and chemical responses as time scales of SMS motions and phytoplankton growth coincide.

Physical-biogeochemical SMS coupling has mostly been studied near ocean margins and ocean frontal systems. We report first results from an open-ocean study carried out north of the archipelago of Cape Verde, employing simultaneous observations from 5 gliders. Each glider recorded temperature, salinity, chlorophyll, dissolved oxygen and turbidity for the duration of 49 days in Spring 2010. A 45 by 45 km wide area was sampled using butterfly shaped courses, to optimize the coverage of the whole area and the intercalibration of the gliders. The aims of the experiment include (i) the quantification of the SMS variability in the recorded parameters in both the surface mixed layer and the thermocline including the upper part of the oxygen minimum zone (OMZ) and (ii) the demonstration of the coupling between physical processes (lateral and vertical advection) and biogeochemical processes (phytoplankton biomass, oxygen production/consumption, fertilization by Saharan dust).

During deployment period the gliders traveled about 3800 km and performed more than 3000 dives. Over the course of the experiment the gliders observed significant variability in form of gradual seasonal changes of thermohaline properties, internal waves, and meso-scale features that appeared to drift by with the background current. Below the mixed layer, changes in oxygen, and salinity imply spatio-temporal variability of the ratio of North to South Atlantic waters. In addition, pronounced SMS variability is found, which might be important for the vertical fluxes of nutrients and oxygen between the OMZ and the mixed layer. An analysis of the scale-dependence of the different parameters is shown. We have further implemented the methodology of Merkelbach et al. (2010), to derive profiles of vertical velocities from the gliders' dives. The relation between the vertical velocities and the internal wave field is presented. The oxygen measurements revealed a shallow lense of extremely low oxygen – significant lower than that within the OMZ - which is thought to originate from the African continental slope. The glider measurements appear to be sensitive to the deposition of dust in the ocean because there are indications for the correspondence between glider-derived turbidity and satellite-inferred aerosol optical depth. While beyond the scope of the present study, the combination of turbidity and chlorophyll measurements might thus open the opportunity to study the effect of fertilization by Saharan dust on primary production in the tropical North Atlantic. In this respect, a comparison between glider and satellite-derived chlorophyll fluorescence will also be presented.