Coupling 'Lab-on-Chip' Nitrate and Phosphate Sensors with Seagliders for year long monitoring of the North Sea

ANTONY BIRCHILL[1], ALEX BEATON[1], JOHN WALK[1], ROBIN PASCAL[1], MATTHEW MOWLEM[1], JAN KASIER[2], TOM HULL[2], CHARLOTTE WILLIAMS[3], MATTHEW PALMER[3]

[1]Ocean Technology and Engineering Group, National Oceanography Centre, Southampton, U.K., SO14 3ZH, anchill@noc.ac.uk

[2]Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, Norwich Research Park, Norwich NR4 7TJ.

[3]Marine Physics and Ocean Climate, National Oceanography Centre, Liverpool, U.K., L3 5DA.

Coupling *in situ* sensors with autonomous platforms allows for investigations of marine systems on temporal and spatial scales that are otherwise impossible. Here we couple microfluidic 'Lab-on-Chip' (LoC) analysers developed by the Ocean Technology and Engineering Group at the National Oceanography Centre with Seagliders. Repeat deployments of up to 2.5 months' duration allowed for autonomous observations of total oxidised nitrogen (TON; sum of nitrate and nitrite) and phosphate concentrations along a 50 km transect in the North Sea over a period of 1 year (2018-19) as part of the AlterEco (http://altereco.ac.uk/) programme.

The LoC sensors use the classic Griess and molybdenum blue spectrophotometric assays for the detection of TON and phosphate, respectively. The results from five TON sensor deployments capture dynamic seasonal cycling of nitrogen as well as spatial variability in TON concentrations. We observe surface drawdown of TON during the spring bloom, with surface concentrations reaching growth-limiting levels (<0.1 µM) during summer months. During dark winter months we observe a gradual TON concentration increase, reflecting mixing with high-nutrient water types and remineralisation.

In addition, we integrated a LoC phosphate sensor with a Seaglider for the first time. We observed surface depletion during summer as well as decreasing concentrations with distance from the coast.

The North Sea, like many shelf systems, is under increasing anthropogenic pressure, including nutrient inputs causing eutrophication. The results of this programme demonstrate the viability of emerging autonomous technology to provide cost effective data collection at the temporal and spatial coverage needed to assess the health of shelf systems, including in low-income countries.