

Poster Presentation

Theme 1.2: The Contemporary Carbon Cycle - Emerging Approaches and Novel Observation Techniques

Keywords: ocean, CO₂, CH₄, sensors, LOAC**Field deployment of a CO₂, CH₄ and O₂ sensor package for underway measurement across the full river-ocean mixing regime****Canning, Anna Rose* (1,2); Körtzinger, Arne (1); Fietzek, Peer (2)**

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The river-ocean mixing regime represents the interface between inland waters and the ocean, exhibiting strong dynamics for CO₂ and CH₄. Due to a host of biological, chemical and physical processes within this regime, the interface is considered one of the hardest systems to observe accurately. This is of rising importance due to increasing anthropogenic pressures with growing populations, with most pronounced effects within inland waters, estuaries and coastal regions. While direct continuous measurements of $p\text{CO}_2$ and $p\text{CH}_4$ across the full land-ocean aquatic continuum (LOAC) shed light on the two gases sink/source function and variability, observations mainly rely on discrete sampling approaches that use measurements of dissolved inorganic carbon (DIC) and total alkalinity to calculate $p\text{CO}_2$. However, these calculated results were often found to be overestimated due to the unknown contribution to alkalinity by organic components in estuarine and coastal waters. Additionally, manual data collection is time-consuming, with significant human and calculation errors, and without lending itself to autonomous observation approaches. The robust, low-maintenance analytical system presented here is designed for producing long-term LOAC observations. Being able to collect high resolution measurements with as little error and personnel effort as possible, the sensor package will create a more accurate and complete database, in turn being used to close the gap in the carbon budget between the two areas; giving a greater understanding of the carbon cycle in coastal interfaces.

Technical advances have now progressed so far, that being able to limit error within direct measurements is possible, however quantifying across the full LOAC is yet to be achieved. The aim of this study was to create a versatile flow-through system, able to measure $p\text{CO}_2$, $p\text{CH}_4$, O₂, temperature and salinity across their gradients accurately. To achieve this, the HydroC[®]CO₂ FT, HydroC[®]CH₄ FT, HydroFlash O₂ (all KM Contros GmbH, Kiel) and SBE-45 thermosalinograph (Sea-Bird Electronics, USA) were combined into a complete flow-through system, allowing for unified surface water measurements. The HydroC[®]CO₂ and CH₄ use a membrane equilibrator system, measuring the internal gas stream by either a Nondispersive infrared (NDIR) or Tunable Diode Laser Absorption Spectroscopy (TDLAS) detector, respectively. With a sampling speed of 1 Hz, continuous data was collected in various locations from Baltic fjord/river to brackish seas and oceanic waters. For validation purposes, discrete samples for all parameters were collected to check the accuracy of the sensors.

This study has thus far shown that, after years of continuous improvement, membrane-based gas sensor technology has matured to a level that it exceeds the accuracy of $p\text{CO}_2$ calculation methods and approaches that of classical equilibrator-based $p\text{CO}_2$ measurements. With this, the ability to monitor and measure the carbon cycle across the LOAC accurately and with high precision is closer than ever before.

Poster Session (see poster session schedule)