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# Continuous ship of opportunity based measurement of CH4 and CO2 in surface waters of the Baltic Sea using off-axis integrated cavity output spectroscopy (ICOS)

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Methane is an atmospheric trace gas which directly or indirectly influences the climate on earth to a significant degree. It is the most important greenhouse gas after water vapor and carbon dioxide. As a natural source for atmospheric methane, oceans play only a modest role in the global methane budget, but a great part of that (up to 75%) is emitted from estuaries and coastal areas. Recent studies have shown that estuarine methane emissions may be underestimated as there is a lack of data and considerably uncertainty about many estuaries around the world due to missing measurements of oceanic methane [Bange 2006]. The lack of data can be explained by the methodical limits of continuously measuring methane in surface waters, which until now has been limited to gas chromatography.
Here we present a new system which allows to measure methane and carbon dioxide concentrations in surface waters autonomously and continually using ships of opportunity. The analytical setup consists of a CH4/CO2-Analyzer (MCA; Los Gatos Research) joint with an already established equilibrator. The analyzer uses off-axis integrated cavity output spectroscopy (ICOS) and combines a highly specific band laser with a set of strongly reflective mirrors to obtain an effective laser path length of several kilometers. This allows detecting methane and carbon dioxide with high precision and frequency.
The system was installed in November 2009 on the cargo ship Finnmaid (Finnpartner) that commutes regularly between Travemünde (Germany) and Helsinki (Finnland) with the aim to foster our understanding of processes, seasonality and emission rates of methane in the Baltic Sea. The Baltic is a brackish inland sea with an average depths of 52m located in Northern Europe and connected with the North Sea through the Skagerrak and Kattegat. Various sills limit the inflow of saltwater from the North Sea, which, together with a positive freshwater balance, results in a surface salinity gradient from 17psu in the west (Belt sea) to 3psu in the north east (Bothnian Bay).
From the first 10 days of recording surface water methane and carbon dioxide concentrations first patterns can be derived. Carbon dioxide concentrations correlate well with the data obtained by the existing state of the art system of B. Schneider (IOW) running in parallel based on a LICOR CO2 detector [Schneider et al. 2006]. Methane concentration data show large regional differences with remarkable features, especially in shallow regions. Whereas the concentration in the open water of the Gotland Sea maintain background (i.e. close to equilibrium with the atmosphere) concentrations of around 3.8 nM methane, concentrations in near shore regions reach up to 16.8 nM. Additionally, spatial coherences can be seen in the methane data according to the distance to the shore line. At the EGU further processes, which influence changes in methane concentrations will be observed and discussed based on data generated during the upcoming four months.