The partial pressure of carbon dioxide (pCO_2) in surface seawater is an important biogeochemical variable because, together with the pCO_2 in the atmosphere, it determines the direction of air-sea carbon dioxide exchange. Large-scale observations of pCO_2 are facilitated by Ships-of-Opportunity (SOOP-CO_2) equipped with underway measuring instruments. The need for expanding the observation capacity and the challenges involving the sustainability and maintenance of traditional equilibrator systems led the community towards developing simpler and more autonomous systems.

Here we performed a comparison between a membrane-based sensor and a showerhead equilibration sensor installed on two SOOP-CO_2 between 2013 and 2018. We identified time- and space-adequate crossovers in the Skagerrak Strait, where the two ship routes often crossed.

We found a mean total difference of 1.5 ± 10.6 µatm and a root mean square error of 11 µatm. The pCO_2 values recorded by the two instruments showed a strong linear correlation with a coefficient of 0.91 and a slope of 1.07 (±0.14), despite the dynamic nature of the environment and the difficulty of comparing measurements from two different vessels. The membrane-based sensor was integrated with a FerryBox system on a ship with a high sampling frequency in the study area.

We showed the strength of having a sensor-based network with a high spatial coverage that can be validated against conventional SOOP-CO_2 methods. Proving the validity of membrane-based sensors in coastal and continental shelf seas and using the higher frequency measurements they provide can enable a thorough characterisation of pCO_2 variability in these dynamic environments.