Cseep as a stoichiometric tool to distinguish a seep signal from the natural variability.

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Abstract

For Carbon Capture and Storage technologies to be classified as a climate change mitigation option, an efficient, safe and enduring storage needs to be verified through site-specific monitoring programs, which is required by the international and national regulations. In the case of offshore geological storage, the high spatiotemporal natural variability hinders the interpretation of leakage signal above background measurements. Therefore, the characterization of the spatiotemporal natural variability through baseline studies is required when designing an efficient monitoring program.

We present in this poster a stoichiometric technique called for the Cseep method, which we developed for the determination of excess CO\textsubscript{2} in the water column. The technique takes advantage of the fact that the production and consumption of seawater CO\textsubscript{2} by natural process can be modeled/computed from non-CO\textsubscript{2} variables that are not impacted by CO\textsubscript{2} leakage. For instance, biological production of CO\textsubscript{2} is always associated with a certain amount of oxygen consumption and nutrient production while CO\textsubscript{2} leakage has no specific effect on oxygen and nutrient levels in ambient bottom waters. The Cseep method was originally demonstrated using discrete sampling from natural submarine vents in the Norwegian Sea and highly accurate desktop instrumentation for Dissolved Inorganic Carbon and Total Alkalinity (Botnen et al., 2015). Here, we will show how to optimize the method for variables that can be measured at high frequency and in an autonomous mode. Furthermore, we will consider the most important sources for uncertainty when computing the Cseep tracer including changes in the air-sea CO\textsubscript{2} fluxes; changes in the Redfield ratios used to estimate the biological-mediated changes in CO\textsubscript{2}; and changes in water masses between the reference station and the monitored area. The results will be used to assess the effect of measurement variables on the performance of the Cseep method.

\begin{equation}
C_m = C_b + \Delta C
\end{equation}

\begin{equation}
\Delta C = \Delta C_{bio} + \Delta C_{ase} + \Delta C_{mix} + \Delta C_{seep}
\end{equation}

\[R_{\text{NC}}(P_0-P_m)\]

\[R_{\text{NS}}(A_{T0}-A_{Tm})\]

\[a \Delta S_m + b\]

\[K_j \Delta p CO_2\]

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$C_m$: measured concentration; $C_b$: nearly constant theoretical background concentration; $\Delta C$: fluctuations due to natural processes and due to leakage; $\Delta C_{bio}$: impact of biological activity modeled from nutrients; $\Delta C_{ase}$: impact of air-sea exchange, to be eliminated by difference; $\Delta C_{mix}$: impact of mixing between water masses estimated from salinity changes.
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References: