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Comparison of the impact and fate of leaked CO_2 and CH_4 bubbles from the seabed on the near field waters within the North Sea.

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Simulating the formation, dynamics and dissolution of various gas bubbles, such as methane (CH_4) and carbon dioxide (CO_2) in seawater allows the physiochemical impact on the marine environment to be measured. This study develops both an individual bubble model to determine the bubble fate; along with a small scale, two phase, three dimensional LES numerical plume model to measure the impact on the waters from a bubble leakage from natural reservoir vents and potential storage sites within the North Sea.

The objective is to predict the effect that these leaks have on the local marine environment. Both models and sub-models are calibrated using either laboratory or in-situ experimental data for each gas, such as shrinking rate and rising velocity. Implementing fluid properties and seasonal data from the potential CO_2 leakage and CH_4 venting location sites, such as temperatures, salinity, currents and leakage depths, allow accurate tuning of the model. Recent temperature and salinity profiles within the North Sea local to the potential sites are recorded [1], where circulation models provide a prediction of the local ocean currents [2] and seepage rates are taken based on observational data.

Sub-models are implemented that predict the momentum through drag forces and mass transfer through convective transportation from the bubbles to the seawater allowing the prediction of the velocity and shrinking rate of the individual bubble and the two phase model allows the dynamics and concentration of dissolved gas solution in seawater to be predicted. Correlations for these are presented based on experimental data from Bigalke et al. [3, 4] among others.

Case studies for both gasses will provide preliminary results that can be compared with observational data in terms of both plume and individual dynamics verifying the validity of the model findings that can be extended into mesoscale, regional and global scales to see the true effect on the environment. Findings show that CH_4 is far less soluble than CO_2 and rises higher into the waters; as such there is a greater effect on the marine environment from the dissolved CO_2, but a large risk from the CH_4 bubbles rising into the atmosphere.

References:

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