Geoengineering the Carbon Cycles in the Ocean

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It is increasingly evident that mitigation technologies and policies alone will likely not be sufficient to reduce the CO_2 concentration in the atmosphere below the levels necessary to avoid the increase of global temperatures above 2 °C. To achieve most of the ≤2◦C scenarios outlined by IPCC, some type of removal of CO_2 from the atmosphere, i.e. Negative Emission Technologies (NETs), will be needed. Only a few NETs are currently being developed, e.g. BECCS or direct air capture, while other processes, which involve large scale interventions in the Earth System, are still cautiously debated, due to inherently complex, and difficult to predict risks.

In this context, the global oceans are being considered as a site for NETs, due to the large available volume for carbon storage; ocean liming, and fertilization are typically discussed as potential solutions to increase the oceanic uptake of atmospheric CO_2.

In this presentation, we will provide a more comprehensive assessment of potential alternatives for ocean NETs (ONETs), with a particular focus on the organic forms of carbon, and their cycles present in the oceans. We consider three concepts for the long term removal of organic carbon in the ocean environments: a) Route 1 attempts to increase the conversion of naturally occuring labile dissolved organic matter (LDOM) to a more recalcitrant form (RDOM); b) Route 2 looks at means to increase sedimentation fluxes of particulate organic matter (POM) and its preservation in the deep-sea sediments; lastly, c) Route 3 considers the import of allochtonous, recalcitrant organic species from externally captured carbon (e.g. biomass) to the ocean RDOM pool.

We will present some initial calculations, and engineering designs related to the three concepts. Finally, the proposed routes will be discussed in terms of their potential for rapid deployment, and large-scale CO_2 removal (e.g. >0.1 GT/annum), while at the same time considering the environmental risks, and economic costs.