Decarbonizing climate by producing synthetic fuels from seawater – A cartographic study in the Mediterranean Sea

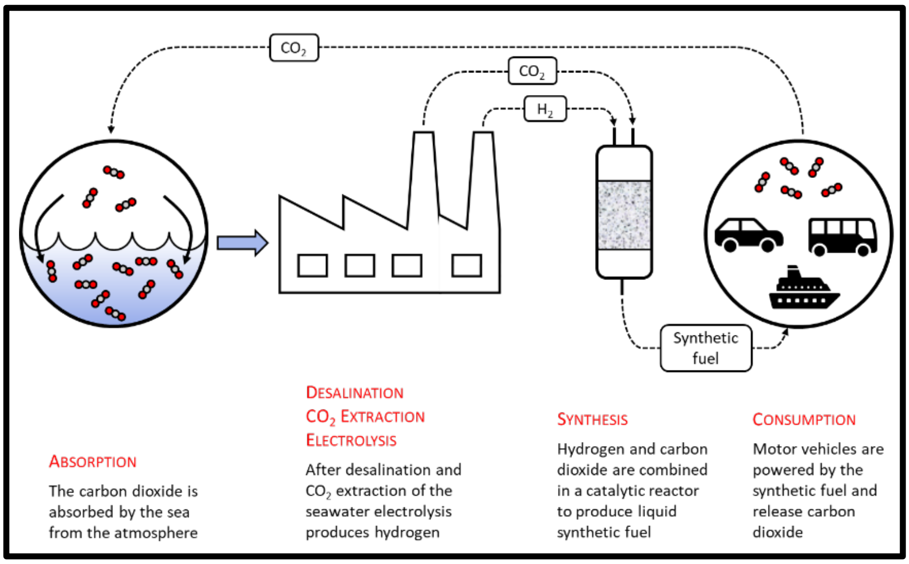
MetMed

Methanol from the Mediterranean Sea

Philippe Drobinski (LMD – philippe.drobinski@lmd.polytechnique.fr), Doug Keller (LMD – douglas.keller@lmd.polytechnique.fr), Cédric Tard (LCM – cedric.tard@polytechnique.edu)

Context

A study recently initiate the idea that a synthetic fuel (methanol, CH_3OH or MeOH) could be produced from CO_2 dissolved in seawater using "photovoltaic-powered solar methanol island".[1] The interest of extracting CO_2 from seawater rather than its direct capture in the atmosphere is simply due to the large difference in concentration (99 g CO_2/m^3 in the ocean vs. 0.79 g CO_2/m^3 in the atmosphere). To summarize briefly this approach, the CO_2 extracted from seawater would be combined in a reactor with dihydrogen (H_2) – produced from electrolysis of desalinated seawater – to give methanol (Scheme 1). The energy required for the different processes would be generated by photovoltaic solar panels. Those devices would be integrated on a floating island located in specific region of the world where insolation and water depth are optimal, with low probability of hurricanes.



Scheme 1 – Decarbonization of the atmosphere by synthetic fuels.

1. Patterson, B. D.; Mo, F.; Borgschulte, A.; Hillestad, M.; Joos, F.; Kristiansen, T.; Sunde, S.; van Bokhoven, J. A. Renewable CO_2 recycling and synthetic fuel production in a marine environment. *Proc. Natl. Acad. Sci. U. S. A.* **2019,** *116*, 12212 (link).

In the frame of the Energy4Climate center, the proposed internship would focus on the cartography of optimal spots to develop such floating islands in the Mediterranean Sea by combining expertise from the LCM chemistry lab and the LMD climate science lab. The model map would ensure high insolation and low probability of weather stress (waves, hurricanes, tsunamis), and could also include local physico-chemical properties (pH, salinity, concentration of metals, etc.). We also need to establish accessibility of such islands to developing countries which will be at the forefront of the consequences of climate change.

Approach

The approach consists of collecting and elaborating on the relevant indicators from a 20-year regional climate simulation in the Mediterranean region, a WRF forced NEMO ocean model in the NEMO-MED12 RegIPSL configuration,[2] and mapping the optimal spots for deploying the floating methanol islands. In addition to the implementation of the existing methodology described in Patterson et al.,[1] the work should also aim at enriching the local oceanic properties which play a role in the system efficiency and analyzing the spatial and temporal variability of the system efficiency.

The intern will have access to the already performed simulations and will have to develop the post-processor. The joint expertise in geophysics and chemistry from the advisors is unique and is key to conduct such original study. Regular joint meetings LMD/LCM will be held in order to take advantage of the multi-disciplinary expertise.

Profile of the M1/M2 student

The internship candidates should be in a Master track with strong background in physics and/or chemistry. Additional training on climate and environment sciences is not mandatory but welcome.

2. RegIPSL MED Wiki (link).