ONE Planet Doctoral Training Partnership

Natural Environment Research Council

Project title: Can we reverse climate change by changes in carbon capture enzymes?

Ref: OP2413

Keywords: Photosynthesis, Carbon capture, Gene editing

One Planet Research Theme:
Climate & Climate Change ☒ | Earth System Processes ☐ | Anthropocene ☒ | Environmental Informatics ☒

Lead Supervisor:
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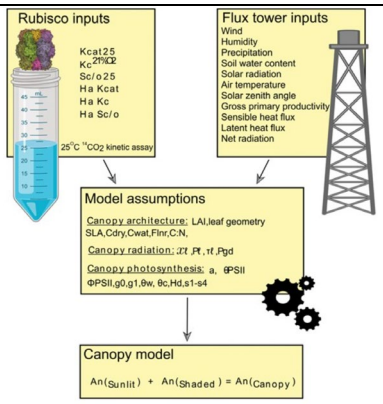
Key Research Gaps and Questions:
Enzymes fixing CO_2 in plants and algae are often non-optimal for current and future climate conditions resulting in negative outcomes such as food shortages or coral bleaching. Can we find/swap/engineer better enzymes for natural & artificial carbon sequestration using current and predicted climate data in combination with data on enzyme kinetics? How to modify genes encoding these enzymes inside chloroplasts which are protected by multiple membranes and cell walls? Would changes in enzymes change the course of climate change?



Project Description: Rising CO_2 concentration in the atmosphere and oceans is among the major drivers of current **climate change** and a threat to humanity as we know it. Photosynthetic organisms (plants, algae and cyanobacteria) are fixing inorganic carbon using several enzymes: most terrestrial plants use Rubisco as a primary carboxylase to fix CO_2, whyle c.10% of terrestrial plants and majority of algae and cyanobacteria use phosphoenolpyruvate carboxylase (PEPC) and/or carbonic anhydrase (CA) for primary carbon fixation in the form of bicarbonate. Recently graduated ONE Planet PhD student successfully used data from **environmental bioinformatics** for modelling impact of climate change on Rubisco performance in key crops and for enzyme kinetic predictions (Iqbal et al., 2021; 2023). This project will build on that foundation.

The main **aims** of this project are (i) to further use the combination of environmental data and climate models to predict better carbon capture enzymes for key aquatic and terrestrial phototrophs (algae including coral symbionts, ecosystem forming tree species and crops) in future climates; (ii) to implement predicted changes in the carbon capture enzymes within selected algal and plant species using gene editing and a recently developed chloroplast gene delivery system (V.N. Kozhevnikov, Northumbria University).

This research will improve our understanding of photosynthetic carbon fixation under different climate scenarious and inform human-assisted carbon sequestration, which could mitigate negative effects of climate change.

Prerequisites: enthusiasm and an ability to undertake independent research; at least a 2:1 honours degree in biology or chemistry. Coding in R and/or Python is an advantage.

For more information, please contact Dr Maxim Kapralov (maxim.kapralov@ncl.ac.uk).

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