ONE Planet
Doctoral Training Partnership

Natural Environment Research Council

Project title: Environmental biophysics of microalgal migration in snow

Ref: OP2442

Keywords: microalgae, biophysics, snow, global warming

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

Lead Supervisor:
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Key Research Gaps and Questions:

1) How do environmental cues (light, gravity, fluid flow) bias the swimming of algae in snow?
2) How does the spatio-temporal distribution of algae change the optical and thermodynamic properties of the snow?

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Project Description:

Microalgae are photosynthetic microorganisms critical to life on Earth and to global Climate as key players in biogeochemical cycles. They occupy a wide variety of habitats, including snowfields, where they form patches (>100 m^2) on or below the snow surface, and are known to be important terrestial carbon sinks [Gray et al. 2020]. However, key questions, such what environmental conditions lead to the formation of microalgal patches in snow, and how these are affected by climate warming, remain unanswered. In particular, several important species of snow algae are known to swim, but the biophysics of their swimming [Haw & Croze 2012] has not been used to understand microalgal movements in snow.

In this PhD research project, the biophysics of microalgal migration in snow will be studied through a combination mathematical modelling, laboratory and field experiments. The PhD student will develop an experimental setup to microscopically and macroscopically image the movements of swimming microalgae in a slab of snow (artificial and field-sampled), in collaboration with snow physicist Dr M Sandells of Northumbria University (co-supervisor), algal biologist Dr M Davey of the Scottish Association for Marine Science (collaborating partner) and biotech company Xanthella (non-CASE collaborative partner). The student will measure how migrations, and the resulting optical properties of the snow, are affected by light, gravity and flow, as a function of warming temperatures. The student will also adapt existing agent based models (ABM) of swimming algae to predict the distribution of microalgae in snow, comparing these with experiment. The student will gain valuable skills in biophysical imaging of microbial populations (tracking and Differential Dynamic Microscopy). Together with continuum-modelling skills and a grounding in practical microalgal biology, this will provide a broad skill set and cross-disciplinary training.

Prerequisites:
Candidates should hold a first class or 2:1 degree in physics, applied mathematics, engineering or a related subject. Enthusiasm for research, ability to think and work independently, excellent analytical skills, and strong verbal and written communication skills are essential. Experience in modelling, experimentation and knowledge of biology is desirable.

For more information, please contact Dr Otti Croze (otti.croze@newcastle.ac.uk).

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