The potential impacts of climate change on ecosystem carbon storage across contrasting tree-lines in the Peruvian Andes and the European Arctic

Supervisors

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Project description

Rationale

Climate change is already having considerable effects on terrestrial ecosystems. Ecosystems at high latitudes and high altitudes are experiencing more rapid warming than other regions of the world. This is leading to a clear altitudinal treeline advance in many areas, with potentially important consequences for ecosystem carbon storage, but the effects are likely to be very different in contrasting systems. In the Andes, colonisation of high-altitude puna grassland by trees is likely to increase carbon storage both in soils and the whole ecosystem[1]. However, in the European Arctic, carbon losses from soils have been shown to more than compensate for carbon gains in tree biomass, when dwarf shrub tundra is colonised by birch forest[2]. We currently lack mechanistic understanding of why changes in these different treelines can have such contrasting effects on soil and ecosystem carbon storage.

Increased supply of carbon to the soil (litter and inputs from roots) following tree colonisation, can result in increased soil organic matter formation but could also promote the decomposition of existing soil organic matter (SOM), with 'priming effects' - enhanced decomposition of SOM in response to increasing plant-carbon inputs - potentially very important in controlling the pattern observed in the European Arctic[2]. The extent to which the magnitude of these priming effects is controlled by the plant species involved, and their associated microbial communities, versus the type of organic matter stored in the soils in not known. Addressing this question would represent a major advance in understanding how plant-soil interactions will control ecosystem carbon storage responses to global change.

Research plan

The student will travel to and collect soils from two contrasting tree-line transitions in the Peruvian Andes and the European Arctic:

Controlled experiments will be used to address the following key question:

"Is the magnitude of any priming effect caused by treeline advance controlled by the chemistry of the SOM present or the tree species involved in the colonisation? "

The specific objectives will be:

1. To examine whether contrasting plant communities create SOM which is more or less vulnerable to priming
2. To examine whether contrasting plant species have different abilities to stimulate the decomposition of SOM

The research will make extensive use of isotopic tracers, trace gas instrumentation, and plant-soil biogeochemical and microbial analyses.

References

[1]Whitaker *et al* (2014) *Journal of Ecology*, **102**, 1058-1071.

[2]Hartley *et al* (2012) *Nature Climate Change*, **2**, 875-879.

Image 1: Tropical forests in the Andes

Image 2: Swedish Arctic Landscape