Submitted Abstract

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Abstract

Climate change is altering the elevation range limits of many organisms, often driving upward range shifts. This can have direct eco-physiological effects on species, but also indirect effects that are caused by alterations in the way species interact with one another. Organisms that migrate upwards to track their thermal niche will experience no change in temperature but decreasing air pressure the higher they migrate. This will affect biologically relevant physical parameters such as vapour pressure deficit (VPD), CO2 partial pressure, and gas diffusivity involved in fundamental ecological processes, including evapotranspiration, photosynthetic activity or respiration. Consequently, reduced air pressure poses a potentially novel environmental problem for upwards migrating organisms to solve if they are to persist at high elevation as climate change continues. In this context, the impact of lower atmospheric pressure on upwards migrating plants and their novel associations, are largely unknown. Here, we introduce a new project UPSHIFT that will address this knowledge gap by applying novel experimental approaches to uncover the mechanisms underlying species, community and ecosystem responses to lower air pressure in alpine grasslands. The present contribution focuses on an overview of the experiments that will be carried out. These aim at (i) understanding how upwards migrating plant species react to lower air pressure (ii) assessing how upwards migrating plants perform with novel plant competitors and novel soil organisms, and (iii) evaluating the effect of lower air pressure on the ecosystem water balance. Our experimental approach will integrate a next generation controlled environmental facility to simulate different alpine climate conditions, pot and mesocosm (lysimeter) experiments to disentangle the effects, and field observations to validate the reliability of the obtained results. In particular, UPSHIFT is based on a unique environment simulator (terraXcube https://terraxcube.eurac.edu/) that is able to control different parameters such as barometric pressure, temperature, humidity, concentration of several gases (CO2 and O3) and solar radiation. For all the experiments, a gradient design will be set up at the terraXcube, in which four elevation will be simulated (200-1,500-2,500-4,000 m). During the experiments different ecophysiological, chemical and microbial indicators will be measured to gain insights into fundamental ecological processes. In summary, UPSHIFT is the first attempt to include reduced air pressure to comprehensively anticipate the ecological impacts of climate change in alpine ecosystems.