University of Savoie Mont Blanc, France

Ph.D. fellowship in alpine soil biogeochemistry

Warming effects on greenhouse gas emissions and stocks of C and nutrients in alpine soils

At high elevations, cold climate, short growing season and poor quality of plant material limit soil microbial activities of soil organic matter (SOM) decomposition, with implications for ecosystem services such as soil carbon sequestration and nutrient cycling (Grigulis et al. 2013; Sundqvist et al., 2013). Consequently, the SOM stock and its ratio of C to N or P nutrients all tend to increase with elevation up to the montane forest belt, reaching a plateau or showing a more complex behavior in subalpine grasslands (Körner, 1998 ; Saenger et al., 2015). This global trend is often linked to soil forming factors (soil parent materials, topography, soil microclimate, vegetation communities and human land-use and management history of soil and vegetation communities; Sjögersten et al., 2011). In these high elevation grasslands warming and changes of management practices (e.g. N fertilization, grazing, mowing) are expected to deeply affect SOM quantity and quality, soil C dynamics and nutrient (N, P) cycling, modifying nutrients availability to microbial and plant communities (e.g. Riggs et al., 2015; Puissant et al. 2017) with potential feedback loops. Additionally, greenhouse gas (GHG) emissions (CO_2, CH_4, N_2O) from warmed soils may increase (Crowther et al., 2016), even though soil C or N loss from warming may be balanced with potentially increasing C and N fixation by autotrophic communities. Yet, how these changes in soil C, N, P stocks and fluxes vary according to the form considered (i.e. labile vs. stable SOM fraction; organic or inorganic form of soil nutrients), and to the short and mid-terms after climate and management changes, remain poorly described in alpine and subalpine grasslands.

This will be assessed in the framework of the TransAlp Project (ANR 2021-25) which aims at understanding, in alpine grasslands, how climate warming and land-use change threaten the structure and dynamics of above- and belowground biodiversity, and their associated ecosystem functions. TransAlp will study short- to long-term effects of these threats by combining transplant experiments covering a decadal time-series of warming responses with a process-based simulation model integrating above- and belowground dynamics. In the transplant experiment, alpine grasslands are exposed to 1.5 °C, 3 °C and 4.5 °C of warming along two elevation gradients, with fertilization and grazing sub-treatments, and soil and vegetation responses will be measured. Expert knowledge and results of the experiment will feed the expansion of the existing vegetation model FATE-HD to integrate key soil tropho-functional groups and interactions between the soil and plant compartment. The project will address the following objectives: (1) Analyse the short- to mid-term effects of experimental warming on plant community functioning, soil physicochemical characteristics and fluxes, and the communities of soil tropho-functional groups (the Ph.D. student will be mainly involved in this part); (2) Identify the ecosystem components and the dynamic processes that are key to understanding soil mediated warming and land-use change effects on Alpine grasslands; (3) Integrate these key ecosystem components and processes in an existing vegetation model and study temporal dynamics and stability of Alpine grasslands under climate and land-use change.

We are looking for a highly motivated candidate to work on a Ph.D. thesis focusing on how alpine grassland soils subject to warming and land-uses changes will respond in terms of soil organic matter quantity and quality, carbon storage capacity, nitrogen and phosphorus retention or loss, and greenhouse gases emissions.

The ideal candidate should be well trained in biogeochemistry and ecology, with field (soil sampling strategy, GHG emissions measurements) and lab skills (soil and water analyses), as well as data analysis skills (statistics on R). Good oral and written communication skills in English are expected. The Ph.D. student will collaborate with the whole TransAlp consortium in microbiology, plant ecology, and modelling to share data, concepts and interpretations of the gathered results to get a more comprehensive understanding of the fate of alpine grasslands under environmental changes. This is a unique opportunity to work with a large and internationally recognized research team.

This Ph.D. thesis will involve intensive field work at two high altitude sites (2100-2500 m a.s.l.) in the French Alps (Lautaret-Galibier Pass and Alpe d'Huez), and lab work at the University of Savoie Mont Blanc and the University of Grenoble Alpes.

The Ph.D. student will be located at the University of Savoie Mont Blanc (Bourget du Lac campus, nearby Chambéry and Aix-les-Bains) in the CARRTEL laboratory under the supervision of Pr. J.C. Clément and Pr. J. Poulenard (EDYTEM laboratory).

The Ph.D. student will also spend some lab and office time at the University of Grenoble in the LECA laboratory where the leader of the TransAlp Project (Dr. T. Münkemüller, CNRS) and its team are located, and where most of the lab work will be done. This will enable regular interactions with the entire research consortium.

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Supervision:

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Please send your application along with a CV and a cover letter (in English) detailing your motivation to all three supervisors.

Deadline: 21 June 2021

Rerferences : Crowther et al. Nature 540, 104-+, (2016) ; Grigulis K. et al. J. Ecol. 101, 47-57, (2013) ; Koerner C. Oecologia 115, 445-459, (1998) ; Puissant J. et al. Biogeochemistry 132, 123-139, (2017) ; Riggs C. E. et al. Biogeochemistry 125, 203-219, (2015) ; Saenger A. et al. Geoderma 241, 279-288, (2015) ; Sjögersten et al., Soil Carbon in sensitive European Ecosystems, 118-148, (2011) ; Sundqvist M. K. et al. Annual Review of Ecology, Evolution, and Systematics 44, 261-280, (2013).