

3 PhD and 2 MSc funded positions on Mineral Dust and Climate Change at High Latitudes

The Université de Montréal (Departments of Geography and Chemistry), the Université de Sherbrooke (Department of Applied Geomatics), and the Université Laval (Department of Civil and Water Engineering) jointly offer a total of three PhD and two MSc positions in a fully funded project centred around the emissions of mineral dust from mountainous terrain led by James King at UdeM (<https://draeolus.com/>).

The overarching goal of the project is to investigate the influence of mineral dust emitted from within mountainous regions on surrounding ecosystems through a series of projects that culminate in providing results to better understand the ecological impacts and radiative impacts of mineral dust, as well as to increase the current capacity to model the changes in landscape and emissions under future climate change scenarios.

Field campaigns will be conducted within the Ä'äy Chù (Slims River) Valley, which flows into Łù'àn Mân (Kluane Lake), in southwestern Yukon in the summer of 2020 and 2021. The Ä'äy Chù is a proglacial river supplied by the summer melt of the Kaskawulsh Glacier, part of the St. Elias Mountain Glacier system. This region has been substantially altered within the last 300 years by natural changes and anthropogenic climatic changes. Recent glacier retreat has led to a change in its drainage direction (river capture), diverting it towards the Gulf of Alaska and reducing the lake level, resulting in the rapid exposure of deltaic sediments and extended periods of dust emissions. This recent history and potential further environmental changes to come, makes the region an excellent natural laboratory for investigating the impact of dust storms under past and future climates.

Studying in Quebec and specifically Montréal has many financial, academic, and cultural advantages including: A unique cultural comprehension of science being at a Francophone institution; Université de Montréal is ranked among the top three francophone universities in the world and among Canada's top three research universities; Montréal was recently named world's best student city, due in part to relatively low costs of living; And thanks to a historically strong student movement, tuition fees for students are substantially lower than other Canadian Universities (\$2,900 vs the Canadian average of \$6700; with non-resident tuition parity waivers).

All funded positions are to be applied for through the respective contact given below in the form of a letter of motivation (1-2 page), a curriculum vitae, unofficial transcripts, and contact information for two references. Deadline for applications is March 31.

PhD projects:

Dust emission and wind climatology (King (UdeM) & Nadeau (Laval))

Understanding mountain wind mechanisms is essential to anticipate major dust emission episodes in the Slims River Valley. Mountain winds are either thermally driven, that is they are produced by temperature differences within the mountains, or they are dynamically-forced due

Faculté des Arts et des Sciences
Département de géographie

to the large-scale synoptic pressure gradients. One of the objectives of this thesis will be to better understand how upper-level forcing and thermally-driven circulations behave to drive dust emissions and how these events affect dust emission mechanics. An approach will include field campaigns with micrometeorology and aerosol monitoring, exploration of re-analysis data, and modelling of combined processes to inform high-latitude dust processes. Questions related to this project should be directed to James King (js.king@umontreal.ca).

Remote sensing of mineral aerosols (O'Neill (Sherbrooke))

A key component of the project will be to employ (i) temporal, ground-based remote sensing retrievals from AERONET (both high frequency, extinction-based products at the event level and weekly to monthly averages of lower frequency extinction & sky radiance inversions), and (ii) satellite-based radiance images and AOD (aerosol optical depth) spatial retrievals to arrive at a robust characterization of spatio-temporal dust columnar properties that can be compared with model simulations at the event (diurnal to multi-day) level and climatological-scale (weekly- to monthly-binned) levels. Questions related to this project should be directed to Norm O'Neill (Norman.T.ONeill@USherbrooke.ca)

Assessment of the role of dust in past and modern ecosystems (Talbot (UdeM))

Dust can be enriched in elements critical to ecosystem productivity such as nitrogen and phosphorus. In the context of a recent increase in dust emission and deposition in and around the pro-glacier valley/lake system, a Ph.D. project will aim to elucidate the impact of past and present dust deposition on the structure and functions of terrestrial and freshwater ecosystems. This will be done using a mix of paleoecological reconstructions, remote sensing, and field-based approaches. Questions related to this project should be directed to Julie Talbot (j.talbot@umontreal.ca).

MSc projects:

Physico-chemical characterization of high latitude dust (Hayes (UdeM))

The student will carry out research to characterize the chemical and microphysical properties of the emitted mineral dust aerosols. These measurements will then be used to understand the impacts of dust storms on air quality as well as on ecosystems in this region. The student will also assist with developing quantitative models of dust optical properties needed for improving predictions of direct climate forcing and for evaluating remote sensing of aerosols. Measurement methods utilized to analyze field samples will include ICP-MS, ICP-AES, XRD as well as arsenic speciation by liquid chromatography. Questions related to this project should be directed to Patrick Hayes (patrick.hayes@umontreal.ca).

Impact of climate change on traditional subsistence activities (Herrmann (UdeM))

For the Kluane First Nation, local weather and ecological conditions plays a key role in traditional subsistence activities (fishing, hunting, trapping gathering). There is rising concern among the Kluane First Nation about dust emissions as they pose challenges to their livelihood, health and

Faculté des Arts et des Sciences
Département de géographie

culture. The student will work with the local community and document local observations of changes in weather / wind conditions and related dust emissions and their impacts on traditional food resources (contaminants in country food, etc.) and land-based activities. Methods includes Indigenous methodologies, interviews, and participatory mapping. Questions related to this project should be directed to Thora Herrmann (thora.martina.herrmann@umontreal.ca).



Photo: Marie Cadieux, 2018

Jill Bachelder (MSc student in chemistry) taking soil samples in the Ä'äy Chù