L'Érosion **É**olienne Laboratorie (LÉÉ group)

Research Program Summary

Atmospheric mineral aerosols (dust) generated by wind-blown transport from natural and anthropogenic sources is an important component of the Earth system and plays an essential role in the global radiation budget, biogeochemical cycles, and atmospheric dynamics. Currently most dust emission schemes used within global circulation models are based on theoretical models parameterized and corrected with highly idealized laboratory results, leading to simulated emissions that poorly represent actual dust production rates. This has led to the erroneous simplification of the wind-blown transport process that can benefit from a new approach to characterize dust emissions. Specifically, the quantity of dust emission flux away from the surface can only be crudely estimated because of a mismatch of theory and instrumentation. Most flux-based theory require steady-state conditions for which dust storms do not exist, resulting in time-averaged point measurements extrapolated over large areas. Additionally, although mass conservation is maintained, biased rates of flux occur for minerals from the source material leading to preferential enrichment of particular minerals, not yet accounted for in the dust emission process.

This proposal therefore seeks to target two key aspects that can greatly improve current dust emission schemes by challenging these two current paradigms: 1) the flux of dust from the surface is spatially and temporally consistent (with wind velocity and supply) across different sources, and 2) particle size and mineralogy distributions are conserved through the transport process. These objectives will be achieved by undertaking the following tasks:

1) Evaluate the change in particle size distribution and associated mineralogy of particles as a result from the transport process.

   Currently, only the mass of transported material is conserved between transport modes despite a large range of differing source material. Additionally, minerals within the mobile grains have contrasting radiative and highly variable biological properties, while no research has investigated the bias through the transport process. Using a laboratory wind tunnel a series of natural and fabricated soil types will be subjected to a range of transport conditions to quantify the changes in size distribution from the parent soil size distribution. Additional analysis of the transported and parent soil material will generate mineralogy distributions that are a critical component of the radiative budget in long-range transport models. Both results will be evaluated against a compilation of existing dust emission models.

2) Accurate measurements of dust emission fluxes from a variety of supply-limited and supply-unlimited surfaces

   A novel measurement of dust emission fluxes is proposed using eddy covariance to provide a more reliable estimate than the more traditional, yet still not well used, gradient method. A series of comparative studies utilizing these two approaches over a range of surfaces with a new field campaign will provide the first such set of data leading to a redefinition of standard procedures for measuring dust emissions in addition to contributing to the improvement of dust emission modeling. Dust emission flux model will be articulated to summarize the measurements based on the dependent variables found and will be tested against the performance of existing models.

The proposed research will benefit a large range of benefactors ranging from other scientific disciplines concerned with climate change forecasting, global terrestrial and oceanic productivity, landscape development, and paleoclimate. This proposed research will also increase the ability for forecasting dust storms, improving the timing and severity of visibility and associated transport hazard systems within Canadian prairies and other arid zones.