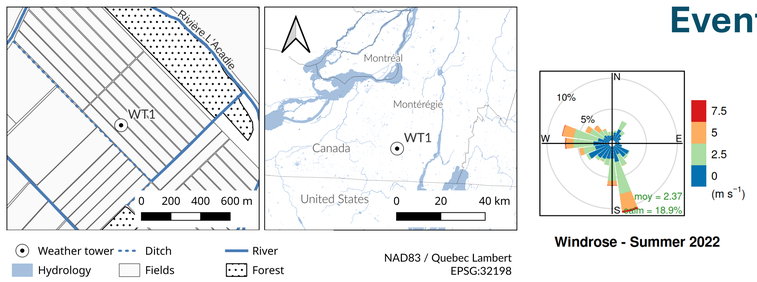
The Challenges of Quantifying Fluxes of Aerosols over Cultivated Peatlands in Southern Quebec

Charles Frenette-Vallières[1*], Jean Caron[1], Daniel Campbell[2], Christophe Libbrecht[1], Alain N. Rousseau[3]
[1]Soil and Agri-Food Engineering, Laval University, Québec, Canada, [*]charles.frenette-vallieres.1@ulaval.ca
[2]Laurentian University, Sudbury, Canada, [3]Institut national de la recherche scientifique, Québec, Canada

1. Introduction

Wind erosion of cultivated histosols is a major problem. Measuring the vertical flux of dust particles from mineral soils is already quite challenging due to the high variability of the diffusive flux of very small particles. On the other end, we know that the chemical composition and organic matter content, among other soil characteristics, may impact significantly these fluxes. Meanwhile, very few studies have attempted to measure and quantify the net dust-emission rate of organic soils. The objectives of this study are to:

1. Quantify the horizontal and vertical dust fluxes;
2. Evaluate the relative importance of suspension on the total mass balance

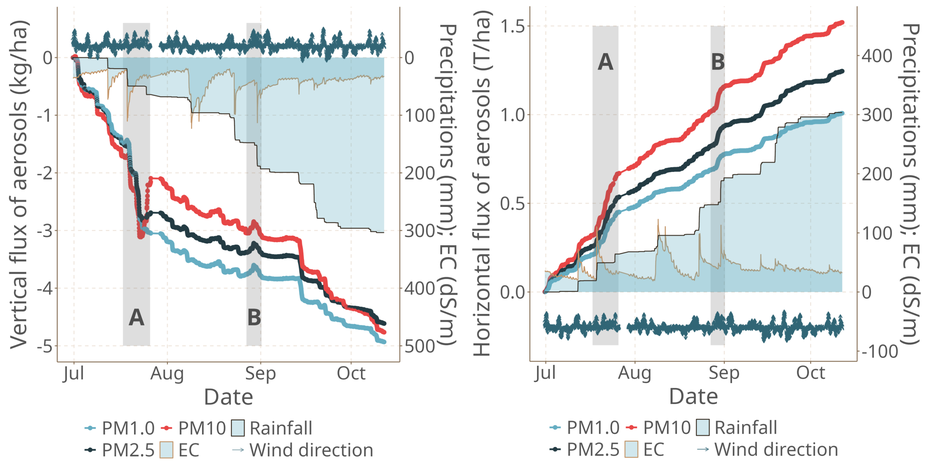


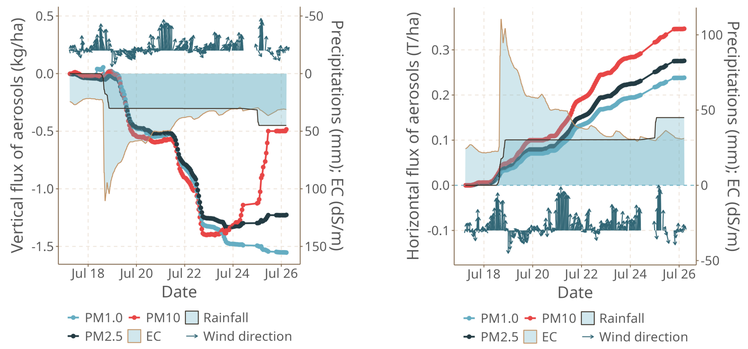
Windrose - Summer 2022

2. Material and methods

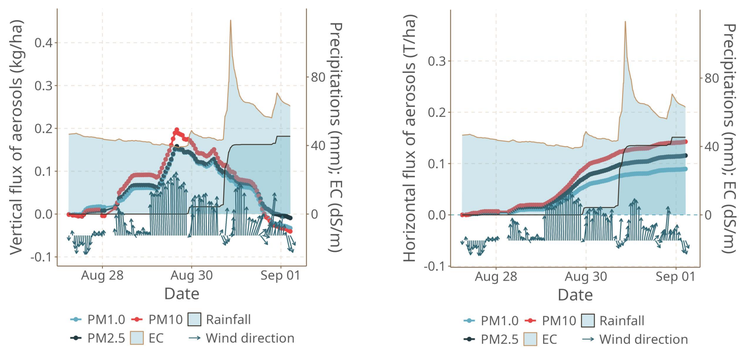
An eddy covariance flux tower was installed between June 30th and October 27th, 2022, on a cultivated histosol located in Sherrington, about 40 km south of Montreal in southern Quebec, Canada. A sonic anemometer (CSAT3B) was mounted at 2m, and low-cost aerosol monitors (PurpleAir II-SD) were installed at heights z1 = 0.5m, z2 = 0.7m, z3 = 1.5m and z4 = 2.15m. Other weather variables were monitored during the experimental period, such as precipitations and soil electric conductivity (EC).
Meanwhile, soil bins were used to measure soil mass and properties at the beginning and at the end of the experiment, and they were used to estimate the observed mass balance.

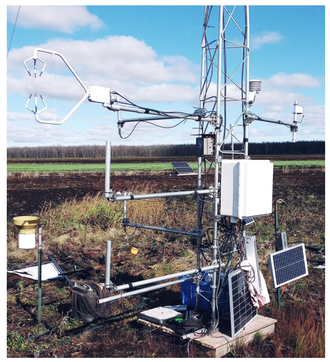
Event A





Event B





3. Results and discussion

Soil losses were estimated at about 34 T ha^{-1}yr^{-1}. This magnitude makes senses as it correspond to about 1.42 cm of peat depth loss over the summer, which is in line with previous experiments in the region. We expect mineralization to induce respiration rates of up to 20 T OM ha^{-1}yr^{-1} for that period and water erosion is estimated at about 0.3 T ha^{-1}yr^{-1}, which leaves **at least 14 T ha^{-1}yr^{-1} that should have been eroded by wind**. However, our attempts to measure aerosols show very small suspension rates, and all previous attempts to directly measure wind erosion losses with classic methods resulted in minimum losses.
Still, our results suggest positive vertical fluxes when strong winds sweep very dry soils and negative fluxes right after rainfall, confirming that the dust can indeed be partly supressed by rain and wet soil conditions. Effectively, **rain and irrigation have the potential to bring dust down to the ground**.
Finally, it is possible that our instrumentation setup could not measure most of the suspended soil particles because of their size. The fibric shape and low density of organic particles suggest that their settling velocity is much lower, therefore larger particles have the potential to remain in suspension. Thus, we recommend to monitor larger particles to characterize wind erosion of organic soils.

4. Conclusion

We were able to quantify vertical and horizontal fluxes of aerosol for PM1.0, PM2.5 and PM10. The vertical fluxes were downward in general, but upward during strong erosive events. Overall, suspension of small particles represented about 2 T/ha for the summer, which was less than expected.

5. References

R Core Team (2024). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.
Carslaw, D. C. and Ropkins, K. (2012) openair – an R package for air quality data analysis. Environmental Modelling & Software. Volume 27-28, 52-61.
Wickham H. et al. (2019). Welcome to the tidyverse. *Journal of Open Source Software*, **4**(43), 1686. doi:10.21105/joss.01686