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

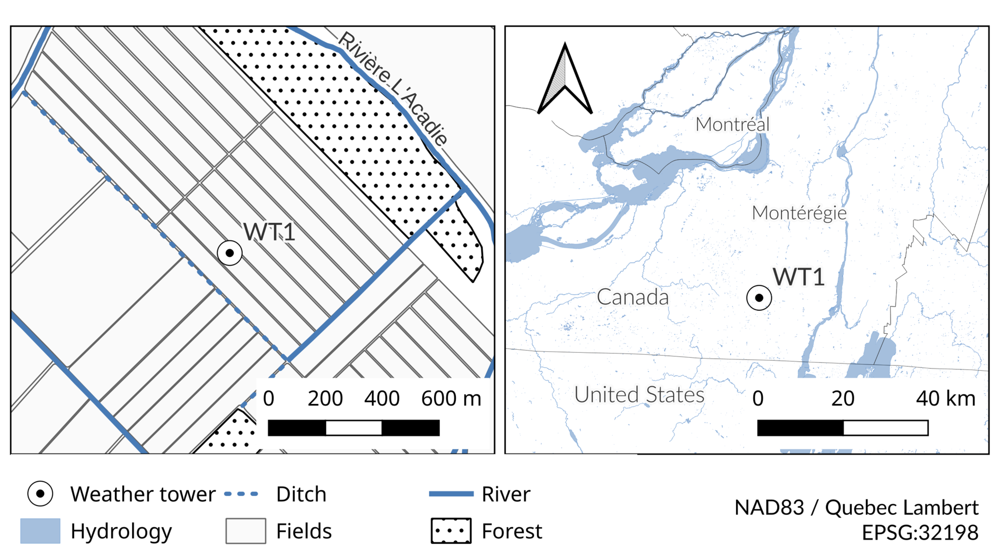
Charles Frenette-Vallières[1*], Jean Caron[1], Daniel Campbell[2], Christophe Libbrecht[1], Alain N. Rousseau[3]
[1]Soil and Agri-Food Engineering, Laval University, Québec, Canada, [*]charles.frenette-vallieres.1@ulaval.ca
[2]Laurentian University, Sudbury, Canada, [3]Institut national de la recherche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

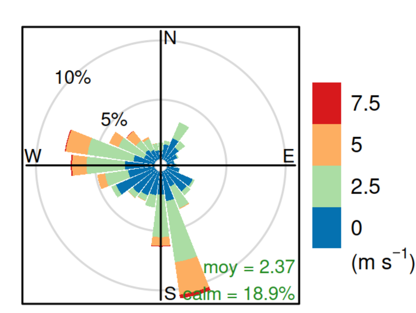
1. Introduction

Wind erosion is a major problem on cultivated histosols. It is already challenging to define the vertical dust flux on mineral soils due to the high variability of the diffusive flux for very small particles, but we also know that the chemical composition and organic matter content, among other parameters, may impact significantly those fluxes. To this day, very few attempted to measure and quantify the net dust-emission rate of organic soils, which is the main objective of this study.

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



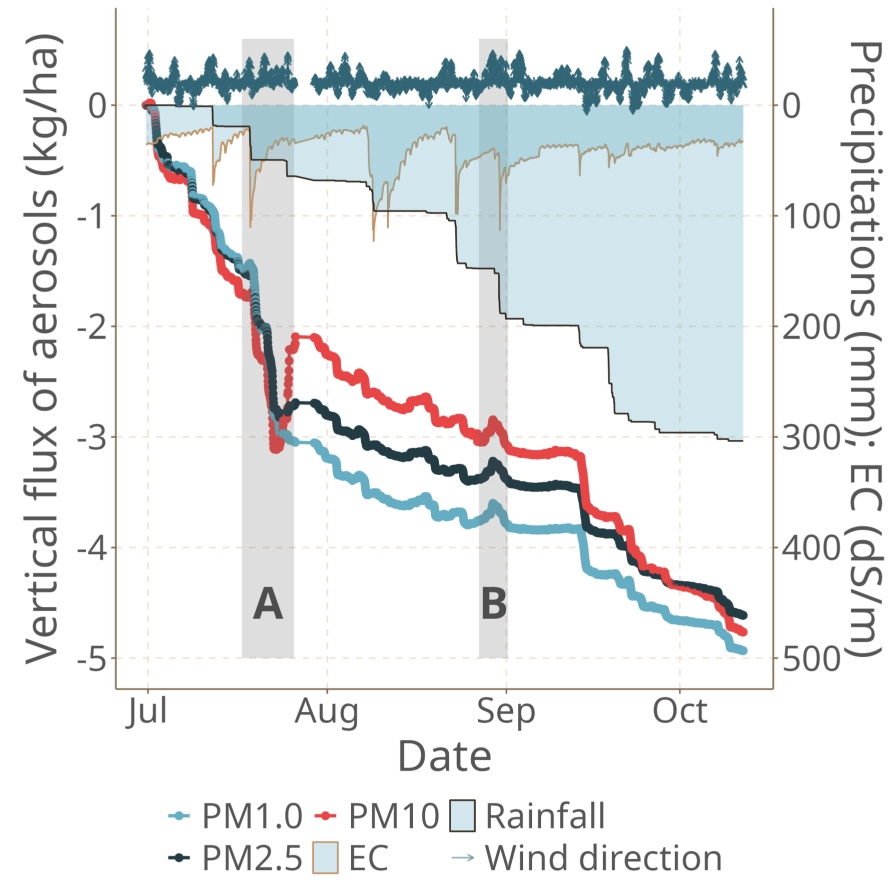


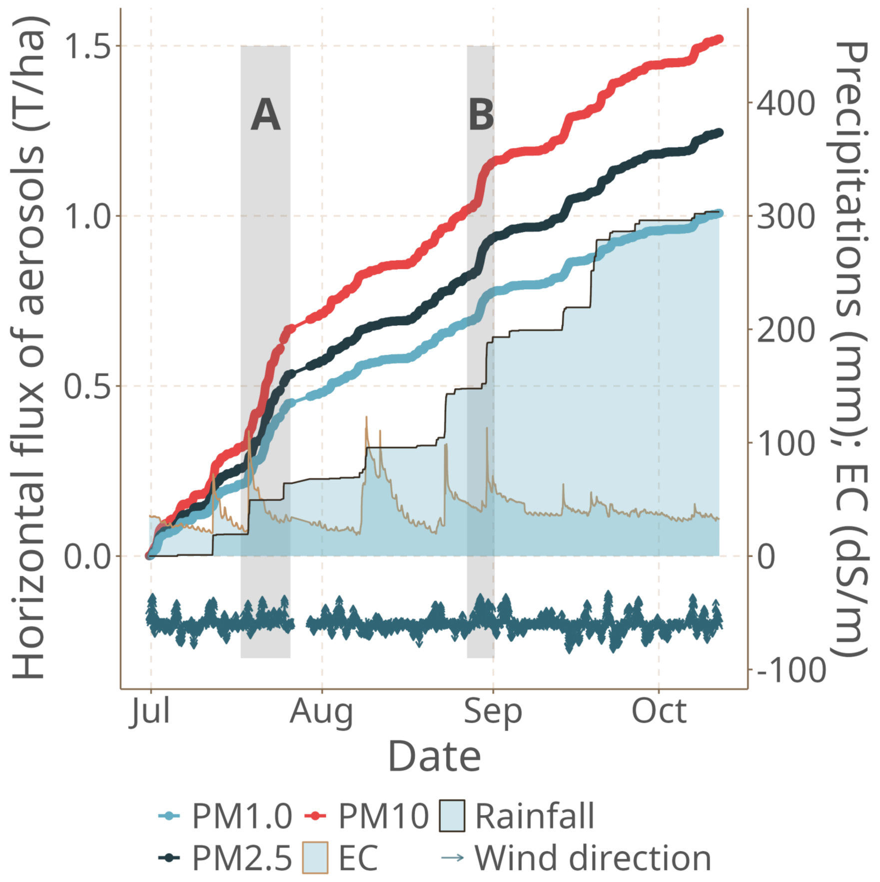
Windrose - Summer 2022

2. Material and methods

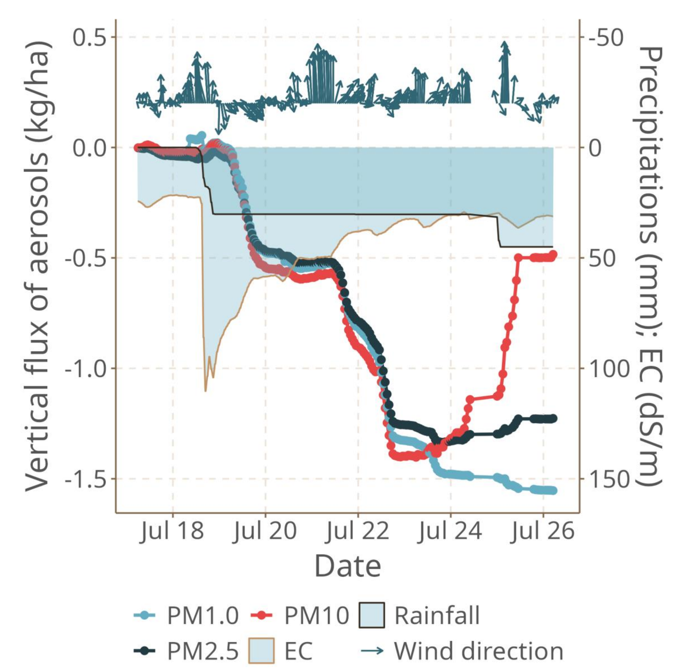
An eddy covariance flux tower was installed between June 30th and October 27th, 2022, on a cultivated histosol located in Sherrington, about 40 km south of Montreal in southern Quebec, Canada. A sonic anemometer (CSAT3B) was mounted at 2m, and low-cost aerosol monitors (PurpleAir II-SD) were installed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

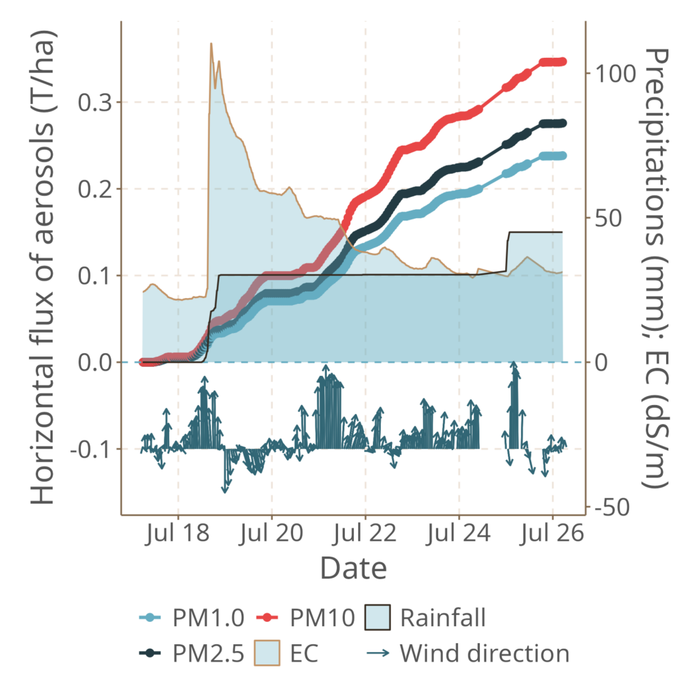
Soil bins were also installed to measure the soil mass and properties at the beginning and at the end of the experiment, and those results were used to approximate the observed mass balance.



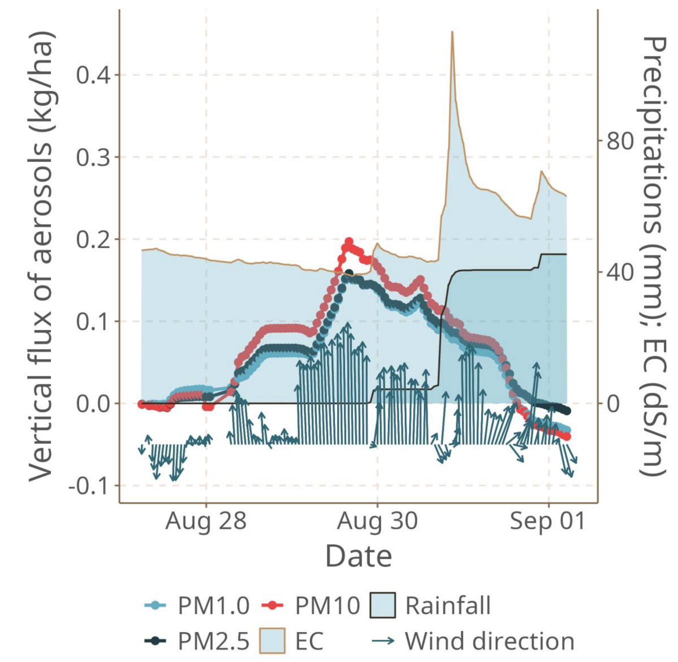


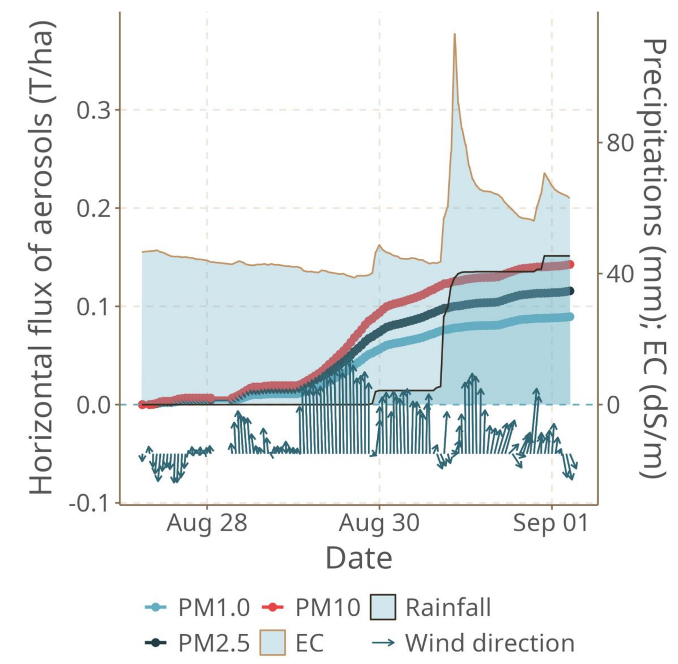
A

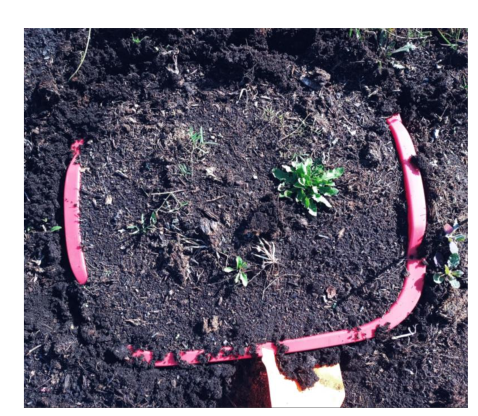




B







3. Results and discussion

The soil bins presented **soil losses of about 34 T ha^{-1}yr^{-1}**. These results seem accurate as it represents about 1.42 cm of peat depth during the summer, which is in accordance with previous experiments in the region. We expect the mineralization to cause respiration rates of up to 20 T OM ha^{-1}yr^{-1} for that period and water erosion represents 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 suspension show very low 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 with strong wind when the soil is very dry, and negative fluxes right after rainfall, which confirms that the dust can indeed be reduced by rain and higher soil water content. Effectively, **rain and irrigation have the potential to bring dust to the ground**.

Finally, it is possible that our instruments could not measure most of the suspension because of their size. The fibric shape and low density of organic particles means that their sedimentation velocity is much lower, therefore larger particles have the potential to be in suspension. In the future, we recommend to monitor those larger particles for 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. In total, 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