# SIMULATING THE DISPERSION OF MICROPLASTICS IN THE ATMOSPHERE TOWARDS A REMOTE SITE

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## INTRODUCTION

In this work the long-range atmospheric Lagrangian dispersion model MILORD is applied in **backward mode** to **investigate the potential source areas of microplastics (MPs) and the effects of** some key parameters, such as **the settling velocity**, on their atmospheric transport. The case study refers to the work of Allen et al. (2019), where the deposition of microplastics in the remote and pristine site of Bernadouze in the French Pyreenes and their possible atmospheric pathways were investigated.


*The red label represents the Bernadouze meteorological station, the sampled site in Allen et al. (2019) study*

## METHODS

MILORD is a 3-D long-range Lagrangian particle model; dispersion of pollutants or tracers is simulated following the trajectories of virtual particles, each representing a finite mass and/or activity of the substance considered, in a three dimensional wind field. The atmospheric transport is modelled based on the advection due to the wind (*deterministic term*) and the diffusion due to turbulence (*stochastic term*). Depletion of the mass particle by dry and wet deposition and radioactive decay are accounted for by exponential reduction equations. Hereafter the dry deposition equation used in MILORD is reported: the calculation in the backward mode has been modified so that the reverse modelling reconstructs the amount of pollutant that the particle would have lost due to the depletion processes, before reaching the sampled site (receptor).

$$D_{dry} = N_0\left(1 - e^{-\lambda_d \Delta t}\right)$$

$N_0$: Initial pollutant amount

where $\lambda_d$ is the dry deposition coefficient defines as:

$$\lambda_d = \frac{v_d}{H(x, y, t)}$$

$v_d$: deposition velocity

$H(x, y, t)$: Particle height

## RESULTS

To assess the possible influence of the settling velocity on the MPs dry deposition **four different runs following the pathway of a single particle** were performed using four different deposition velocity values, based on the literature (see the Table), for three different periods of the year (November 2017, January and March 2018), and for two resolutions of the ECMWF analyses used in input to MILORD, 0.5°x 0.5° and 0.25°x 0.25°.

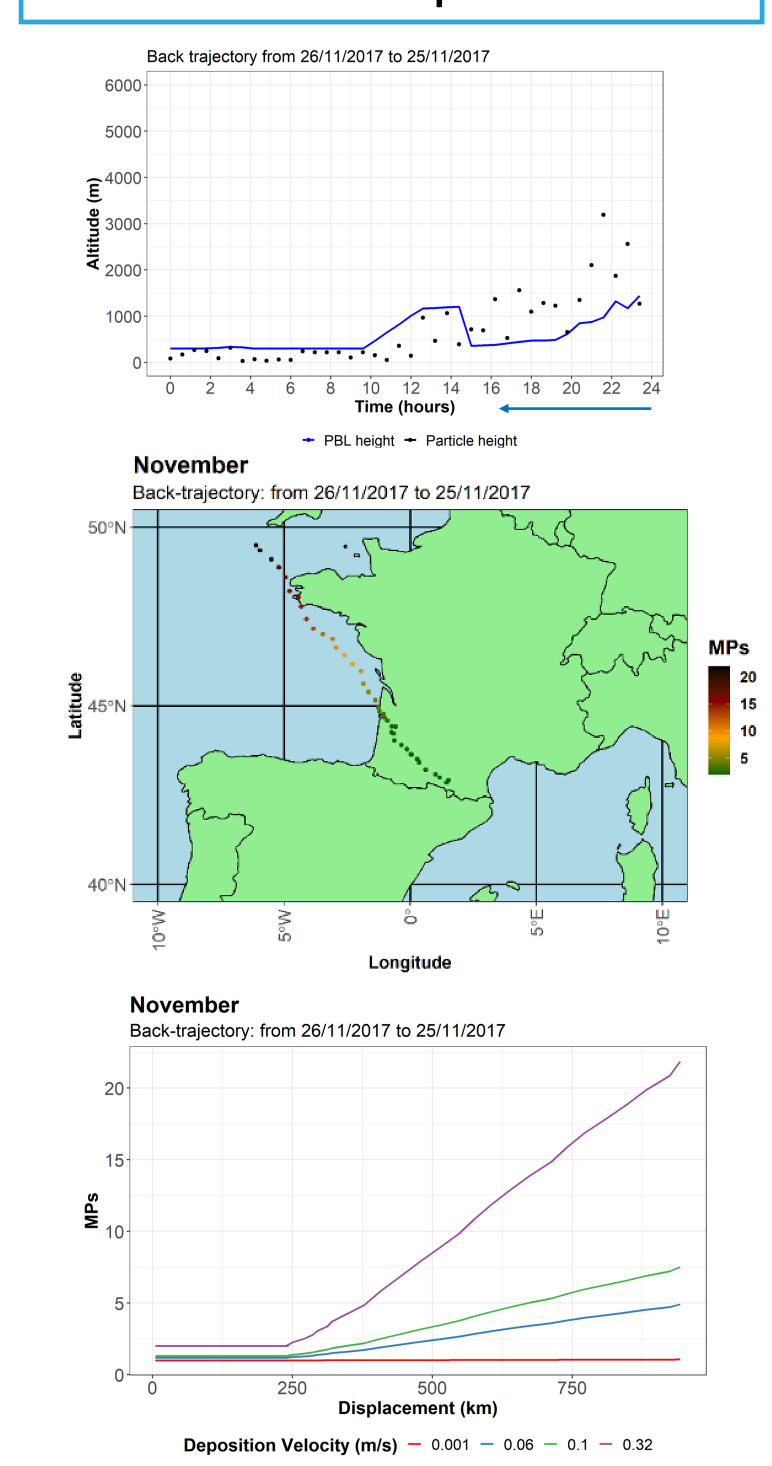
| Settling velocity values reported in literature until 2020 | |
|---|---|
| ***Reference*** | ***Settling Velocity ($ms^{-1}$)*** |
| Allen et al. (2019) | 0.1 |
| Wright et al. (2020) | 0.06 (fibrous MPs); 0.32 (non-fibrous MPs) |
| Trainic et al. (2020) | 0.001 |

For each period and resolution, three graphs are compared:

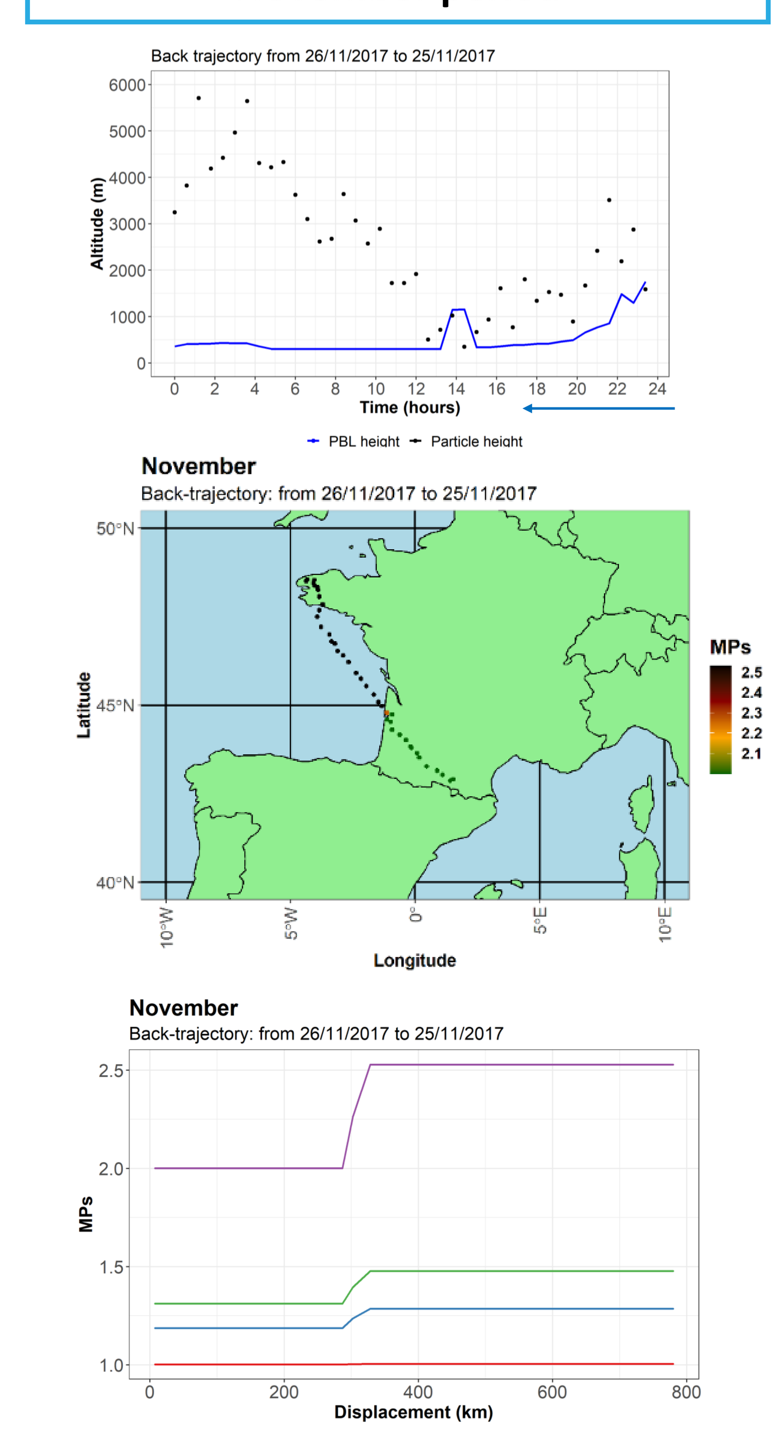
1. The vertical displacement of the particle inside/outside the planetary boundary layer (PBL) as a function of time (backward)
2. The trajectory map, where the colour scale represents the amount of MPs carried by the particle in base-10 logarithmic scale
3. The amount of MPs transported by the particle as a function of the distance it covers, where the lines depict the influence of the settling velocity on the dry deposition

*An example is provided for the case of November*

**0.5°x0.5° Resolution**
**November period**




**0.25°x0.25° Resolution**
**November period**




## DISCUSSION

In this single-particle case, the difference in the MPs amount is due to the fact that when travelling close to the PBL height, even small differences in the value of the wind field and turbulence, determining the displacement of the particle, and in the PBL height daily development, may let the particle move out/in the PBL layer. Only when inside the PBL, the particle gains back the 'dry-deposited' amount in the backward mode, thus leading to potential differences in the particle MPs mass. Concerning the difference in the trajectories, in the Lagrangian modelling approach a great number of particles must be released and traced in order to statistically describe the actual path of the plume. In this sense on average the paths followed by the single particle are in good agreement for the simulations corresponding to two resolutions of the input fields. From the MPs amount, the less likely value for the settling velocity characterizing the long-range transport is found to be 0.32 $ms^{-1}$, since the particle should have started its travel with an improbable high mass of MPs.

## REFERENCES

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Wright S.L., Ulke J., Font A., et al., 2020: *Atmospheric microplastic deposition in an urban environment and an evaluation of transport*, Environ. Int., 136, 105411