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► **To cite this version:**

Anna Font, Aude Bourin, Corentin Guillou, Cécile Debevec, Nicolas Bonnaire, et al.. Aerosol composition at EMEP remote sites in France: mass balance and de-weathered trends of PM_{2.5} and its main components. EGU 2023 - The 25th European Geosciences Union General Assembly 2023, Apr 2023, Vienne, Austria. 10.5194/egusphere-egu23-940 . hal-04199594

HAL Id: hal-04199594

<https://hal.science/hal-04199594>

Submitted on 8 Sep 2023

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EGU23-940, updated on 07 Sep 2023

<https://doi.org/10.5194/egusphere-egu23-940>

EGU General Assembly 2023

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Aerosol composition at EMEP remote sites in France : mass balance and de-weathered trends of PM_{2.5} and its main components

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Atmospheric particulate matter with an aerodynamic diameter $< 2.5 \mu\text{m}$ (PM_{2.5}) is associated with adverse effects on the climate system, the human health, vegetation and the ecosystems. The World Health Organization (WHO) lowered the guideline limit for PM_{2.5} in autumn 2021 and this is exceeded in many regions including rural and remote areas in mainland Europe. Measurements of the chemical composition of PM_{2.5} is essential to assess the sources which contribute to PM_{2.5} mass concentrations and to further design meaningful policies to tackle sources at their origin.

Here we report 6 years (2014- 2020) of PM_{2.5} mass and chemical speciation at five remote sites across France belonging to the EMEP network (European Monitoring and Evaluation Programme). The seasonal and spatial variability of aerosol composition and source contributions based on the proximity of sources and long-range transport are discussed. Trends in PM_{2.5} and the main components at the five locations were evaluated by means of random-forest modelling coupled with a de-weathering algorithm. This approach is advantageous as resulting trends are driven by changes in emission or atmospheric processes and not by changes in weather conditions and/or long-range transport patterns. Random-forest regression modelling was built using meteorological data, backtrajectory information and temporal variables at each site and quantified the most important factors that explain PM_{2.5} concentrations at remote rural areas in France.

All sites observed statistically significant downward trends in PM_{2.5} at a rate of -4 to -9% year⁻¹ for the period 2014 – 2020. The decrease in PM_{2.5} concentrations was mostly explained by changes in the secondary inorganic species (sulphate, nitrate and ammonium) and not by changes in primary PM_{2.5} emissions. The variability in trends in PM_{2.5} and components observed across the sites is discussed with their implications for policy makers.