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Lagrangian stochastic footprint modelling with wavelet analysis derived flow statistics

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This study aims at testing the sensitivity of a Lagrangian Stochastic footprint model to the input parameters describing the turbulent flow field, with a focus on the within canopy flow processes. A long-term dataset of turbulence measurements within and above a tall spruce canopy is used to extract detailed turbulence statistics as input parameters for the footprint model. This dataset includes a profile of sonic anemometers, which was used to obtain high-frequency time series of turbulent variables and to monitor the turbulent exchange. From these measurements, representative profiles of the input parameters required for the footprint modelling are derived by application of different filters to the original data set. We employed spectral analysis using a wavelet analysis tool to determine the exchange regimes based on the detailed analysis of coherent structures along the vertical profile. The resulting description of the turbulent flow field varies in both the spatial and temporal context, as statistics were derived separately for typical different exchange regimes and wind direction sectors.

Besides using the dataset with detailed characterization of the turbulent flow regimes at the Waldstein Weidenbrunnen site, two additional simpler methods to describe the canopy flow regime will be applied for means of comparison. Firstly, the flow statistics derived from measurements at the Hyytiälä site in Finland, will be used. The forest architecture of the Hyytiälä site differs significantly from that of Waldstein Weidenbrunnen site. Secondly, a model by Massman and Weil to parameterize the profiles of the flow statistics based on profiles of the leaf area index will be employed. The impact of the application of these different descriptions of canopy flow will be tested by comparing size and position of the source areas computed by the footprint model, as well as by the determined composition of land cover types within the source area and their correlation to the measured eddy-covariance fluxes.