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Crowdsourcing the urban wind climate from private weather stations

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Most urban meteorological research is hindered by a stringent scarcity of observations in the urban fabric. The highly heterogeneous composition of cities causes a microclimate that varies from street to street, requiring a dense network of observations to capture the full scale of the urban system, or to validate the models attempting to resolve these fine scales. However, urban observations are hard to come by: standard WMO stations are only situated in undisturbed (i.e. natural) areas, and maintaining dense urban networks is expensive, prone to vandalism and often obstructed by regulations. Urban measurement campaigns are therefore often small, whether in time (a few months of intensive data collection) or in space (measuring single streets). Over the past years, crowdsourcing has risen as a successful methodology to obtain urban citizen science data which circumvents the scarcity issue. This is partly due to the increase in ownership of Private Weather Stations (PWS) by weather enthusiasts. These stations are affordable, well-designed, easy to operate and of sufficient quality to measure the climate in one's own street. The Netatmo station is a prominent type of PWS, which automatically uploads the meteorological measurements to the company's own website, combining the data of all its stations into a weather map. Though NetAtmo stations have been validated against established reference observations of temperature, whether they can reliably measure urban wind remains unknown. The urban wind climate is highly variable, more so than heat, due to the influence of street orientation, building height and obstructions (e.g. trees) which can drastically alter the wind between two streets.

This study uses 2 years of urban wind data collected by over 80 PWS obtained from Netatmo and the Weather Underground platform, situated in and around Amsterdam, the Netherlands. The PWS data is compared to data obtained from 22 urban reference stations of known quality, maintained by the Meteorology & Air Quality section of Wageningen University as part of the Amsterdam Atmospheric Monitoring Supersite. These stations serve as a benchmark against which the PWS will be compared, in terms of Weibull distributions of wind, as well as the effect of canyon morphology and Local Climate Zone on the wind behaviour as measured by the stations. A Netatmo station has been installed on the weather field of Wageningen University to compare the measurements against the data of the sonic anemometer. For the urban stations, an extensive Quality Assurance procedure is set up to filter the PWS data and to ensure robust results. Preliminary findings suggest that the NetAtmo station underestimates the actual wind speed, and that this bias increases with increasing wind speed, though variability of the wind field is well-captured.