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An analysis of flow distortion in a multipath sonic anemometer

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Sonic anemometers provide point observations of the three-dimensional velocity field at high sampling rates and are crucial instruments for understanding and quantifying the fluxes of momentum, energy and scalars between the atmosphere and Earth's surface. Since the beginning of sonic anemometry 50 years ago, the characterization of flow distortion, i.e. how the instrument structure alters the flow, has been an ongoing research topic. Multi-path sonic anemometry provides a new opportunity to research and understand flow distortion on the vertical velocity component, since several positions in the small measurement volume can be measured simultaneously. In this work, we use data from a flat terrain measurement campaign in 2020, in which several sonic anemometers were mounted on 4m towers placed 4m apart. The analysis is focused on the Multipath Class-A sonic anemometer (Metek GmbH, Germany), which provides vertical velocity observations from three vertical paths 120 degrees and 0.1m apart. Vertical velocities are also calculated from several combinations of the tilted paths. We investigate how the vertical velocity component is altered depending on wind direction relative to different parts of the instrument structure. We demonstrate that by an optimal combination of the different paths, the vertical velocity variance and fluxes can be significantly enhanced. We also show spectra, and especially look at the high frequency end of the spectrum, where the relative behaviour of the velocity components is known from fundamental turbulence theory. Further, the relative importance of transducer shadowing and pressure-induced blockage effects is discussed.