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An uncertainty estimate for windprofilers in a turbulent atmosphere

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Doppler wind profilers measure the Doppler-wind-speed along a line of sight or 'beam'. For a profiler standing on the ground this means that its beams must be tilted to get the horizontal component of the wind above. To infer the three components of the wind vector it is necessary to use at least three beams. As beams are tilted the measurements are done at different locations and it must be assumed that the wind at a certain height is everywhere the same. But as the atmosphere is in general more or less turbulent this assumption is not fulfilled and the retrieval inevitable becomes erroneous.

A method is presented to estimate this error. Two main assumptions have to be made: the turbulent field is horizontal homogeneous, and the function describing the turbulent cross correlations is depending only on distance but not direction. The error estimate depends on the Reynolds stress tensor which is estimated from just the vertical wind. The error estimate can be written as a compact matrix equation for any combination of beams. This is used to derive recommendations for scan patterns. A scheme for operational use is presented and estimated errors are validated against measured data.