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High frequency atmospheric DTS measurements: getting the signal from the noise

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Distributed Temperature Sensing (DTS) is a technique which is able to measure the temperature in a glass fibre optic cable. As the technology has improved, the measurement frequency has become greater, now reaching (nearly) 1 Hz. At this frequency the spatial resolution is 35 cm, with a maximum length of over one kilometre. DTS is increasingly used in atmospheric sciences, with applications ranging from stable boundary layer analysis, Bowen ratio measurements, to studying the 2D structure of surface-layer flows. However, at the highest frequency the measurement noise (standard deviation) is in the order of 0.30 K.

While high frequency DTS measurements show a lot of promise for applications such as turbulence measurements, flux-variance, and surface renewal, the measurement noise is too large to directly apply those methods to DTS data. In this study we discuss the characteristics of the measurement noise, and how to account for it. Methods to filter out part of the noise (when studying the air temperature variance) will also be discussed and demonstrated. Lastly, the influence of the setup and cable types will be discussed, and ways to design a setup which is able to reduce the measurement noise by increasing the placing a higher density of fibre optic cables.