Measurement of turbulent kinetic energy spectrum - Part 1: Convection record method

A novel exact temporal to spatial mapping for point measurements in turbulence has been developed. The spatial record is obtained based on the instantaneous velocity magnitude, \( u = |u| \), creating an exact mapping between the sampling interval, \( \Delta t \), and the spatial record counterpart, \( \Delta s \), through the relation \( \Delta s_n = u \Delta t_n \). \( n \) indicates the sample number in a measurement sequence. Summation of the consecutive streakline elements, \( \Delta s \), corresponding to the convection distance of the fluid, results in a spatial “convection record”. The exact mapping applies to all flows, since it is based on the instantaneous velocity magnitude, thereby incorporating all relevant aspects of the flow dynamics. Even high intensity non-equilibrium spatial records can be measured using this mapping, which is most straightforwardly applied using laser Doppler anemometry measurements. Computer simulated high intensity LDA data demonstrate the technique. The method will also be demonstrated on measurements in a round turbulent jet in part 2.

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