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# Balloon-borne accelerometer observations of atmospheric turbulence

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Turbulence costs the airline industry tens to hundreds of millions of dollars each year, through damage to aircraft and injuries to passengers. Clear-air turbulence (CAT) is particularly problematic, as it is difficult to predict and there is a need for better observations to validate forecast models. Here we describe how specially adapted meteorological radiosondes can observe turbulence using an accelerometer. The radiosonde and balloon act as a pendulum with a moving pivot. The balloon is agitated by turbulence, causing the radiosonde package below to swing. The swinging motions are then measured by the accelerometer. Calibration with a lidar has allowed the variance of the accelerometer to be related to the Eddy Dissipation Rate (EDR), a common meteorological measure of turbulence. A solar radiation sensor is mounted at the top of the package, to determine whether or not the sonde is in cloud. Vertical profiles of meteorological data from the radiosonde, coupled with the turbulence information from the accelerometer, provide a unique dataset of turbulence observations. Here we present some individual case studies showing turbulence observed during different meteorological conditions, as well as an overview of turbulence observed in different conditions from 50 ascents from across the UK and Finland. Results indicate that the main sources of turbulence are the jet stream and convective clouds. However, there are also significant contributions from phenomena such as gravity waves, tropopause folds, and convective caps. Many of these sources are not taken into account in current operational turbulence forecasts for the aviation sector.