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Mode S and ADS-B as a Source of Clear-Air Turbulence Measurements

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Clear-Air Turbulence (CAT) beside being the most common cause for aviation incidents in the cruise phase for commercial aircraft is a complex physical phenomenon. CAT is an effect of various underlying physical mechanisms such as different kinds of hydrodynamic instabilities, large scale forcing. In order to properly understand and correctly forecast it one needs significant amount of observation data. Up to date the best available observations are the in-situ EDR (from eddy dissipation rate - a measure of turbulence intensity). Those observations are reported every $\sim$1min of flight (roughly every 15km). Yet they are limited by the willingness of the airlines to cooperate. However there is a class of data that has greater availability.

In the present paper we propose and discuss three methods of processing Mode S/ADS-B messages into viable turbulence measurements. The Mode S/ADS-B messages are unrestricted navigational data broadcast by most of the commercial aircraft. The unique characteristic of this data is a very high temporal resolution. This allows to employ processing which results in obtaining turbulence information characterized by spatial resolution comparable with the best available data sources. Using Mode S/ADS-B data increases significantly the number of airplanes that are supplying the observations.

The first method uses either the very high resolution altitude information available in ADS-B an further employs the WMO algorithm to calculate the EDR estimate. This method is potentially hugely dependent on the aircraft type. However the ADS-B data are broadcast globally. The second method utilizes the wind measurements contained in the Mode S EHS and uses the structure function estimates in order to calculate EDR. The third method is based on the threshold crossing statistics.

The paper is largely based on the results of the methods application to the data coming from DELICAT flight campaign that took place in 2013. The reference Mode-S/ADS-B data are supplied by the KNMI.