Atmos. Meas. Tech. Discuss., 8, C4479–C4482, 2015
www.atmos-meas-tech-discuss.net/8/C4479/2015/

Atmospheric Measurement Techniques Discussions
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Interactive comment on "Retrieving clear-air turbulence information from regular commercial aircraft using Mode-S and ADS-B broadcast" *by* J. M. Kopeć et al.

Anonymous Referee #1

Received and published: 23 December 2015

Review of "Retrieving clear-air turbulence information from regular commercial aircraft using Mode-S and ADS-B broadcast" by Kopec et al.

This paper provides some initial feasibility studies of the use of Mode-S and ADS-B data streams to infer turbulence experienced by commercial aircraft transmitting those messages. Unfortunately the data available for verification was very limited, and robust results could not be obtained. Still, the paper provides a basis for which future, more detailed studies could be performed to better assess the reliability of the techniques. I recommend therefore that the paper be accepted for final publication, subject to addressing some minor comments listed below.

Minor comments 1. Title: First, the proposed techniques to infer turbulence is not limited to clear-air sources, and in fact they cannot distinguish between encounters in clear air vs in cloud or turbulence due to mountain waves. So the "clear-air" qualifier could be removed. Second, "ADS-B" is an acronym for "Automatic Dependent Surveillance – Broadcast", thus the last word in the title "broadcast" is redundant and could be removed.

2. Similarly in the abstract and introduction it is implied that the turbulence inference techniques would be useful for identifying region of turbulence in the "upper troposphere", but many commercial flights, especially in winter, would cruise in the lower stratosphere, so the techniques could be applied to turbulence encounters in the upper troposphere-lower stratosphere (i.e., the UTLS).

3. Abstract: "can be considered a new and valid source". It is not clear from this study that "valid" is an appropriate descriptor. And the technique, if proved feasible, does not really "measure" turbulence, it can only infer its presence.

4. Introduction, lines 27-28. It is stated that "EDR is still not an industry standard". In fact, EDR is the atmospheric turbulence metric required by the International Civil Aviation Organization (ICAO 2001) for routine turbulence reporting, and will likely become the Aircraft Meteorological Data Relay (AMDAR) standard for turbulence reporting as well.

5. Introduction, p. 11820 lines 15-16. The proposed technique would have a "spatial resolution of approximately 25 km which is comparable to the in situ EDR data." Current implementations of in situ EDR data provide reports over one-minute of cruise, which for typical airspeeds amounts to about 12-13 km, twice the resolution of the suggested techniques.

6. Section 2.1 lists the flights used for calibration of the proposed techniques. These were all summertime cases, and may not be "CAT" at all, but may be related to convection. Calibration for CAT cases may in fact not be included in these data sets.

7. Section 2.2 describes the processing of the data. Here actual Mode-S data was missing and the data from the DELICAT flights had to be processed to mimic what the Mode-S data transmissions would have provided. This may or may not be satisfactory and leaves some question about the integrity of the results.

8. Section 3 describes methods to infer turbulence from three different techniques. The first and third methods produce estimates of the vertical component of EDR, while the second provides an estimate of the longitudinal component of EDR. In the stably stratified shear flow environment of the UTLS it is not clear the horizontal and vertical component should be the same. Indeed there is ample evidence that they are not the same from field campaigns (e.g., Schumann et al. JGR 1995; Kennedy and Shapiro MWR 1975; Lilly et al. JAM 1974; Sharman and Frehlich AIAA paper 2003-194 2003).

9. The results section 4 discusses the findings relative to an estimated moderate turbulence threshold for small business jets provided in Sharman et al. 2014. However when I look at Fig. 6 in that paper there is a lot of scatter in the data used to define thresholds, so too much emphasis should not be placed on deviations from this number.

10. I think the conclusions as stated are fair, and that probably much more work needs to be done using more data in all seasons to better assess the feasibility and reliability of the proposed approaches. Another approach besides using methods independently is perhaps to use a synthesis of Mode-S and ADS-B inferences in some sort of ensemble-like or fuzzy-logic framework to provide more robust results. Operationally it is important to provide high reliability at the larger EDR vales. Inconsistency at low values, e.g. 0.08 vs 0.12, is probably less operationally significant, at least for commercial aircraft. In this regard the approach used by Krozel and Sharman ("Remote detection of turbulence via ADS-B", AIAA Guidance, Navigation, and Control Conf., Kissimmee, FL, Jan., 2015) where only significant ADS-B altitude deviations were used to infer turbulence might be operationally more reliable. One problem in that study was the lack of aircraft that were actually outfitted with ADS-B. Full implementation is not expected

until 2020. Also the authors should be aware that there is a proposal to incorporate a field for in situ edr measurements in the ADS-B data stream (see RTCA DO-260B, Appendix V). However manufacturers of ADS-B have not yet implemented this, and it would likely be some years before it would happen.

11. The English needs some reworking here and there, but for the most part is understandable.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 11817, 2015.