Dear Reviewer,

We thank you for your comments and suggustions to improve the manuscript. We have taken the oppurtunity to add several things, some wanted by you some by other reviewers. The main changes in the manuscript are:

- we changed the title to "**EMADDC: high volume, high quality, and timely wind and temperature observations from aircraft surveillance data (Mode-S EHS)**
- We comparison with AMDAR data to the results section
- We included Vector RMS statistics in the results section
- We explain in more detail how the seperate steps for temperature corrections
- We revised the conclusion and added an outlook section
- Lukas Strauss has been added as co-author to give him the credits for inventing the Mach-Indicated Airspeed improvement.

We hope to have answered all remaining questions as good as possible.
Thank you sincerly for your time and effort, Best regards, Siebren de Haan and Co-authors

Answers

General

ok The EMADDC processing of Mode-S messages into meteorological reports is a major and very useful undertaking. I am a user of the EMADDC reports. In places the jargon (eg ASTERIX CAT48 format) is perhaps too prominent. I have made suggestions about this and minor improvements to the English. The text is sprinkled with more commas than I would use. The statistics all use flight level as the vertical coordinate - the equivalent pressure levels should also be given (at least once).

ok I would like to see some discussion of the wider context, both the impact of Mode-S on NWP and the future of Mode-S and what might replace it. Piecing information together from messages designed for another purpose is not how one would design a meteorological observing system.
we included some words on this in the conclusion

ok Also, from my perspective, reports every 4-seconds are overkill. I would hope that, in the longer term it would be replaced by a a better designed aircraft reporting system that provides high resolution data in a single report without the need for heading corrections, rederivation of temperature from Mach number etc.

ok I would like to see some discussion of any moves in that direction, timescale etc and whether it needs a directive from the EU to ensure that such a system becomes widely used over Europe and perhaps elsewhere.

Detailed

ok Title: I would suggest ‘timely’ in place of ‘quickly available’ and possibly moving ‘high volume’ before ‘high quality’ - it is the number of reports that really sets Mode-S apart from other aircraft data sources. What does ‘infrastructure’ mean here? ‘using Mode-S EHS messages’ might be better.

ok L1 ‘Temperature and wind observations from aircraft are regarded of major importance’ I suggest ‘Wind and temperature . . . ’ - the winds are more important.

ok L3 ‘converts it’ - ‘converts them’ (‘data’ is a plural noun)

ok L4 ‘this data’ - ‘these data’

ok L5 ‘To acquire’ - ‘To produce’? ‘the data is’ - ‘the data are’

ok L13 ‘for example its height, and velocity’ ‘its’ should be ‘their’ or can be omitted.

ok L15 ‘aircraft observations form the backbone of the global observing system’ ‘the backbone’ is a bit too stong - ‘an important part’?

ok L19 ‘01/2020 2020’, just ‘2020’

ok L22 ‘The last decade’ - ‘Over the last decade’

ok L25,26 ‘intended heading, airspeed etc.’ - I think ‘intended’ should be deleted (they are reporting actual heading and airspeed)

ok L28 ‘the most of Mode-S’ - ‘most Mode-S’

ok L32,33 ‘observations performed by dedicated aircraft . . . (AMDAR)’ - ‘observations from AMDAR aircraft’ (the acronym was introduced earlier).

ok L35 ‘ECMWF-IFS’ explain acronym (perhaps just ECMWF, need not mention IFS?)

ok L49,50 suggestion: ‘not mandatory; fewer than 5% of aircraft respond to such interrogation requests (Strajnar, 2012) and few countries actively interrogate this register.’

ok L51 2.1 Mode-S EHS Interrogation I think parts of this section could be rewritten more concisely.

ok L59 ‘shall be applied’ - ‘are applied’

ok L75-78 ‘Data can be of ASTERIX CAT48 format, which is mono-radar data . . . ’ I struggle a bit with the jargon and whether it is useful for me and other users to know. It might be better to put the jargon in brackets, perhaps (assuming that I have understood correctly): ‘Data can be from a single radar (in ASTERIRIX CAT48 format) or multiple radars (in CAT62 format, tyically sampled at 4 second intervals; the Mach number is at lower resolution giving derived temperature of lower quality).’

ok L78,79 ‘For this . . . MUAC to develop a solution.’ Perhaps delete the first sentence and replace the second with ‘EMADDC is working with EUROCONTROL MUAC to develop a solution that provides temperature data with consistently good quality.’ Also ‘MUAC’ explain acronym

ok L107 ‘information of’ - ‘information on’

ok L112 ‘Measurements fulfilling one of these checks are discarded’ ‘failing’ better than ‘fulfilling’

ok L115 ‘Output control is necessary to obtain good quality observations.’ Please provide details (or possibly a reference) of the quality control applied. Also some indication of the proportion of ‘bad’ data remaining (1% or 0.1% or whatever), all observing systems have some gross errors. I have recently become aware of some spikes - wind speeds much higher than in the forecast - what might be causing these?
have no clue; might be a decoding issue.

ok Table 1. I think that the ‘frequency’ and ‘reported accuracy’ headings should be swapped, and ‘reported precision’ might be better. Do you know if values are rounded or truncated when they are reported?

ok L135 ‘pressure, at low altitude, is less accurate.’ Why?

ok L136 ‘an improved pressure value that’ insert ‘is calculated’ before ‘that’

ok L198 ‘(minimal 15 days)’ - ‘(at least 15 days)’

ok L231 ‘is outputted’ - ‘is output’ or ‘is written’

ok L236 ‘9.1 Model comparison’ There should be some mention of quality control to remove ‘bad’ observations (radiosondes as well as Mode-S).

ok Table 4. ‘flight level’ - ‘number’ heading is missing ‘bias’ and ‘std.dev’ misplaced

ok L248 ‘9.2 Comparison with Radiosondes observations’ - ‘Radiosonde’ (delete final s)

ok L249 ‘Radiosondes are regarded as the anchor observation for meteorology’ delete ‘the’ (For satellite soundings GNSS-RO are now more important anchor observations than radiosondes.)

ok L250 ‘with some sites launching also at 06 UTC and 18 UTC’ replace ‘some’ with ‘a few’

ok L250,251 ‘Due to budget optimization, the number of launches per day was decreased to one or two.’ Delete? or replace with ‘Due to budget restrictions some radiosondes are only launched once a day.’ WMO GBON regards two launches per day as standard and most, but not all, European radiosondes follow this pattern.

ok L251 ‘Aircraft observations are regarded as replacement to collect upper air observations’ - ‘Aircraft observations are regarded as supplemental upper air observations’

ok L251-251 ‘Aircraft and observations will never be collocated in both space and time, ... avoids the balloon.’ Perhaps just ‘will never be exactly collocated’ and delete the rest of the senteence.

ok L255 ‘of 50 km’ delete ‘of’

ok L255 ‘The table below’ - ‘Table 5’

ok L257 ‘show to have’ - ‘has’

ok L259 ‘the mean difference between aircraft and balloon is small.’ Both Mode-S and radiosondes have slightly stronger mean wind speeds than ‘NWP’, I assume that this is because the NWP fields are on a ~9 km grid, whereas the observations are closer to point measurements and have a contribution to the kinetic energy from scales unresolved by the model.
added some words

ok Table 6. Column headings missing. Caption too brief.

ok L264,265 ‘derived from Mode-S EHS aircraft observations’ ‘reports’ or ‘messages’ better than ‘observations’ here?

ok L269 ‘this heading correction is unique for each aircraft individually’, delete ‘individually’

ok L271,272 ‘although the data is corrected using ECMWF forecast, the data is independent because aforecast lead time of minimal 9 hours is used’ (‘minimal’ - ‘at least’) This is only partially true, if the forecast model used has a bias then this will be reflected with reduced magnitude as a bias in the ‘corrected’ observations, Eyre (2016). Because aircraft heading is not related to forecast values it seems unlikely that the heading correction will cause this type of problem. The temperature and airspeed corrections might be susceptible to problems from model biases. This should be mentioned. Eyre, J.R. (2016), Observation bias correction schemes in data assimilation systems: a theoretical study of some of their properties. Q.J.R. Meteorol. Soc., 142: 2284-2291. https://doi.org/10.1002/qj.2819
we added some words and a reference to the work of John Eyre

ok L283,284 ‘The change in declination is ... close to zero for low latitude regions (middle panel).’ It is confusing having deep red for very small values on this panel - would be better just to use blue scales (white for near zero).

ok Figure A1. define ‘WMM’ or omit. Add note that the contour intervals are different for the three plots.

ok Appendix B. ‘number of observation’ - ‘number of observations’

ok L296 ‘in casu’?

ok L302 ‘1207, E.: Commission’ - ‘European Commission’?

ok L334 ‘Painting, J. D.: WMO AMDAR Reference Manual, WMO-No.958, WMO, Geneva, 2003.’ WMO regards this manual as superseded (although it is still available), see https://community.wmo.int/en/activity-areas/aircraft-based-observations/resources/manuals-and-guides Should the reference be changed? If not is WMO wrong in regarding it as superseded?