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Atmospheric Measurement Techniques Discussions

Interactive comment on "The Polar 5 airborne measurement of turbulence and methane fluxes during the AirMeth campaigns" *by* Jörg Hartmann et al.

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We thank reviewer 2 for the review and for the helpful and constructive comments. We took nearly all of them into account in preparing a revised version of our manuscript. The specific comments are answered in the following:

RC2: 1. General comments .... All equations show a "-" instead of "=".

The files uploaded to the copernicus site passed the copernicus validation checks. When downloading the pdf, all equations are printed correctly. We cannot reproduce

that effect. What kind of pdf-viewer did the reviewer use ? The technical editor should look into that issue.

RC2: 2. Instrumentation

No action required.

RC2: 3. Calibration of TAS The assumption of the wind changing by less than 0.25 m/s should be addressed more detailed. Which time period is considered? It is unlikely that the wind remains constant over the leg distance of the more than 150 km (first data in table 1). The derivation of equation (2) is missing. I understand this value not as ground speed but corrected speed in aircraft longitudinal direction. So the label of the value v_g is confusing. It might be easier to perform an addition of the two vectors V_g and V (as in equation (1)) to get the reference speed for the TAS calibration. The accuracy of this method is highly depending on the constancy of the wind. A constant change during the two legs seems to stay undetected as this could not be found in the differences of mean values in table 1. Each leg should be analysed separately with respect to time. A standard deviation per leg would be helpful to address this point. Equation (5) implies that the total pressure is measured correctly by the 5-hole probe and the error is only occurs in the static port of this probe. This is not a valid assumption for this kind of probe unless the flow angle at the probe is zero. As the flow angle at the probe is not mentioned a typical calibration curve of the 5-hole probe should be taken into account. The requirements to speed constancy are not mentioned at all. In principle the wind measurement should be independent of TAS but problems might arise by the fact that two legs are averages separately. What happens if one leg is flown at a different speed? The authors should address this point. It is not mentioned whether the computed values for wind and their differences in table 1 are obtained before calibration or thereafter. The major question is the constancy of the wind during the whole roundtrip. What is the influence of a change in the wind over time and how *can it be detected and eliminated?*

The calibration method does not require a wind changing less than 0.25 m/s for each of the out- and return-flight manoeuvres. We rather argue that with the multitude of such manoeuvres possible wind changes between out- and return flight are randomly distributed and their influence on the eventual calibration parameter is considerably reduced due to the averaging process.

We now more explicitely show the derivation of Equation (2) and rephrased the entire derivation of the reference true airspeed. Please refer to the revised manuscript. We also changed several symbols especially that referring to the reference true airspeed.

The accuracy of this method ist not highly dependent on the wind being constant for each individual pair of return track manoeuvres, as we use a large number of those manoeuvres to find the calibration parameters. There are some manoeuvres (e.g. #1, #4 and #14, we added a sequential numbering in table 1 in the revised version of the manuscript) where the wind changes by about -0.6 m/s or -0.8 m/s between out and return flight. Most manoeuvres, however, have a wind change of about $\pm$0.2 m/s and the average of all changes is -0.11 m/s.

The reviewer correctly pointed out a deficiency in our correction of the static pressure measurements. We now include the probe's error as a function of probe angle as found by wind tunnel tests of an identical model. For most situations of level flights this correction term, however, is very small.

The out- and return flights have been flown at the same manually controlled airspeed. The actual differences in airspeed between both legs are very small. We now include the true airspeed in Table 2, the list of parameters for each separate flight leg.

The computed values listed in Table 1 (and also those in the new Table 2) are calculated after the calibration. This is now mentioned in the table headings.

RC2: 4. Angle of attack calibration The method of angle of attack calibration is described in detail with sufficient explanations. The results are good especially as the flight condi- tions at low level over open sea are ideal. The comparison with the second method is very helpful und shows the effectiveness of both approaches.

No action required.

RC2: 5. Angel of sideslip calibration The derivation of equation (11) is missing. For the sideslip angle calibration the same principle problem occurs as for the TAS calibration: a change of wind and / or TAS over time. An increased wind on one leg will lead to an increased residual error of the sideslip angle. This problem cannot be solved by this method unless the wind and TAS remain constant.

We added further to the derivation of Equation (11) (now Equation 13). The reviewer correctly pointed out, that for a single pair of out- and retur-flights no distinction can be made between a change of wind and a possible misalignment of the probe. However, with a large number of return manoeuvres in different situation and on different days we can assume that possible wind changes are randomly distributed, and thus wind contribution to the average of all residuals (the beta misalignments) should vanish. We further explained this in the revised version of the manuscript.

RC2: 6. Static pressure precision The assessment of static pressure precision can only refer to a relative accuracy of the measurement. This is not addressed clearly. It is an interesting approach based on statistical methods.

This is true. Offset errors in the static pressure cannot be detected by this method. We added this comment in the revised manuscript.

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