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Atmospheric Measurement Techniques Discussions

Interactive comment on "Photoacoustic hygrometer for icing wind tunnel water content measurement: Design, analysis and intercomparison" *by* Benjamin Lang et al.

Anonymous Referee #2

Received and published: 1 October 2020

1 Content

This manuscript describes the instrument design and realization of a photoacoustic water vapor and ice water content instrument for operation in a wind tunnel. Further, die instrument is calibrated to a self build humidity generator and compared to reference instruments in the wind tunnel.

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Discussion paper

2 Overall impression and rating

The overall impression of the manuscript is really good. The analysis is done in a balanced way and all aspects important for an instrument manuscript are considered. The presentation of the manuscript is excellent and nicely to read. It is well organized and the analysis and results are clearly structured and communicated in a very detailed way. In addition, I really like the honest and transparent way of the limitations and error analysis description. I think this manuscript is an excellent contribution to the scientific community. For these reasons, I recommend publication in AMT.

I have only very few comments/questions which should be considered before preparing the final/revised version.

3 Specific comments/questions:

- page 3, lines 23-24, "positioned outside the tunnel and connected by 7 m long heated and thermally insulated PTFE tubing, ":
  PTFE is not the best material for water vapor measurements at very low conditions (<50 ppmv). PTFE behaves similar to a sponge and could contaminate your probed air by outgassing of water vapor especially if you would like to measure strong gradients to low mixing ratios <50ppmv. So if you plan to go to lower mixing ratios, I would recommend to stainless steal as tubing material.

- Figure 1 b):
  I have a general question to the setup of the photoacoustic cell. It looks like there is a dead volume left of the first window after the gas inlet between the window itself and the collimation optic which is not flushed with the actual measurement air. The same is true for the right window. How strong does such dead volumes

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influence your water vapor measurement, if there is a strong difference in humidity between actual probed air (low mixing ratio) and the air within the dead volumes (high mixing ratio)?

- Figure 6 and Section 3.2:
  You described in detail the hygrometer calibration and estimated the uncertainties. I have a questions about the stability of the calibration and the repeatability. Would you get the same calibration function/coefficients, if you would do the same calibration with same PA conditions just the next day or week?. Maybe you can add a short description/discussion about the long term stability of your calibration.

- Page 23, lines 7-9, "Differences (residuals) in background humidities measured by the PA system with the modified BWV inlet and the reference humidity sensor were used to identify measurements exhibiting considerable background humidity offset drift (cf. Fig. 12(a) and (b)),...":
  Do you have any idea, why you measure such background humidity offset drift with your PA instrument ? Is this due to the instrument or more the setup within the wind tunnel. I think it would be good to include some hints or discussion about the reason of the drifts. I mean, if the drifts are from the PA instrument itself, those drifts could also influence your TWC measurement.

4 Technical comments/suggestions:

- Figure 13:
  Is the naming of the boxes FZRA and FZDZ within the figure correct ? I would expert the opposite labeling because you have larger particles (550-650 μm) within FZRA conditions, which should lead to higher CWC values compared to FZDZ

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with smaller particles (100 μm). Or is the number concentration of both particle types so different ?

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