Answer to referee 3 comments for "In-flight emission measurements with an autonomous payload behind a turboprop aircraft"

We would like to thank the reviewer for the suggestions to improve the manuscript. Below, you will find our responses to their comments. The reviewer's comments are written in normal font, and our answers are in italics.

General Comments

The manuscript describes the instruments comprising an autonomous payload for measurement of CO2, NOx, H2O and particles and their initial deployment on a Grob Egrett aircraft to sample the exhaust emissions from a light turboprop aircraft at cruise altitude. The manuscript is well organized and the descriptions and analysis are clear and fairly comprehensive. The topic is certainly relevant for AMT and I recommend it for publication with only minor comments and suggestions for the authors.

We thank the reviewer for this positive assessment and will address the specific comments below.

Minor comments:

L2: perhaps "on the successful first deployment of"
Accepted

L3: could clarify that you are measuring the exhaust of other aircraft
We agree and added this information to the sentence.

L3: perhaps "custom-built and commercially"
We agree and have changed the wording.

L5: "temperatures and pressures"; "performed these first"
We agree and have changed the wording.

L6: suggest "a Piper Cheyenne, a twin-turboprop aircraft powered by…"
We agree and have changed the wording.

L11: suggest omitting ", which is adequate"
We agree and have changed the wording.

L74: "non-CO2 effects from aircraft emissions"
We agree and have changed the wording.

L75: "of the instrument payload for a chase aircraft"; size distribution not included here?
Yes, it is included in the tPM measurements. We revised that sentence to provide a higher level of detail.

L81: Could omit paragraph, or be a little more explicit—"Further" seems vague
We agree and have changed the wording.

L88: "near-field exhaust plume"
We agree and have changed the wording.

L96: omit “specifically” and maybe “accommodate”
We agree and have changed the wording.

Fig 1 caption: “Piper Cheyenne (400LS, registration 30 N92EV)”
Changed. Thank you!

L130: the heated section evaporates the volatile material, the subsequent cooled section is to lower the temperature prior to introduction into the CPC, right?
Yes, but also to condense volatile gaseous material on the tubing walls.

L136: omit the last sentence
We agree and have changed the wording.

Fig 3: “puring” ◊ “”purging”; the pumps associated with the aMCPCs are for the saturator flow, not a sheath flow, correct? The mSEMS does have a sheath flow—pump not shown?
Thank you for pointing this out. There was indeed some incorrect naming. The main pump at the exhaust is responsible for drawing the MCPC sample flows, while the saturator flow pumps only regulate the saturator flow. You are also correct that the sheath flow of the mSEMS is controlled by its own pump. We have updated the schematic accordingly.

L166: “as is shown in Fig. 6.”
Accepted

Fig 5 (and subsequent uncertainty discussion): it would be nice to have a panel that shows the combined uncertainty of the various factors that are shown separately and a discussion of the overall magnitude to conclude section 2.1
Thank you, we included a short summarizing discussion at the end of the section.

L212: “or do not grow large enough”
Accepted

L223: “deposition” would be a better word than “sedimentation”, or you could just say “diffusion to the tubing walls”
Thank you, we changed this!

L226: why do ground-based measurements necessarily require longer inlet lines and residence times?
Not necessarily; it has more of a practical and technical reason, as it is difficult or impossible to place instrumentation near the aircraft engine or plume (it is too hot or too turbulent). Both instruments and operators are subject to safety concerns. On the ground, these instruments are often housed in a measurement container or trailer, rather than being placed directly next to the exhaust. The tubing must bridge that gap. Ground campaigns often compare several instruments or sampling configurations (dilution stages, conditioning, filters). This adds additional tubing length.

L230: is the heating of the sampling line “to avoid significant losses of small particles on the tube walls” mechanism thermophoresis? Or are you preventing ice build-up? How warm? For what length is there a thermal gradient?
Yes, the effect is based on thermophoresis. The sampling line was heated equally over the full length; the exact temperature was, however, not recorded. With additional isolation, we aim

to achieve temperatures around the freezing point, primarily to prevent water vapor from condensing.
Ice buildup is generally captured by an anti-ice installation, which requires more heat at the tip of the inlet where the coldest temperature prevails. We did not account for anti-ice heating and therefore could not fly in supercooled clouds.

L246: inner diameter?
Yes, thank you.

L259: “soot soot”
Thank you.

L362: “referred to as “particle” speed because that is the speed CAPS observes particles to travel? Otherwise “True Air Speed” is the more recognized parameter
The CAPS is technically measuring the true are speed which is referred to as Particle air speed because it is the speed measured at the probe. This is done by a Pitot tube and a pressure sensor. Due to ramp pressure effects at higher speeds, the PAS may be smaller than the TAS. In our case, the PAS is equivalent to the TAS; however, as the TAS measurement of an aircraft has a defined position, there can be slight differences between the measurements.

L375: “in situ” is not hyphenated
Thank you.

L382: “as a dilution”
Thank you, we changed that.

L401: “near-field”; “measurements, as inside contrails and clouds condensation makes water vapor non-conservative.”
Thank you.

L406: Schumann ref in parentheses? Sig figs on molecular seem excessive—actually could omit the number altogether.
Agreed.

L414: “vertical profile”
Thank you.

L421: “example”; “emissions of”
Thank you.

Fig 7: time series of Nnv / Nt would be interesting to see; “near-field” in caption
We agree that the variability of the ratio of N_{nvPM} /N_{tPM} is an interesting aspect. However, we believe that it cannot be assessed on a 1Hz basis, but rather the ratio of the sum of N_{nvPM} to the sum of N_{tPM} over each plume encounter is a better measure. This is reflected in the ratio of EI_{nvPM}/$EI_{tPM,}$ which we now discuss in a supplement added to the article.

L437: “on the order of”
Thank you.

L450: Clause including “slightly aged about one-minute-old” is awkward
Yes, we changed that.

L461: First sentence is unnecessary
Thank you

L465: “low pressure counting”
Disagree. Without the hyphen, 'low' could be read as modifying' pressure counting' as a whole, which is unclear.

L466: not sure what is meant by “corresponding”
It is a bit vague. We changed it to “respective”.

L493: compare to what ground and in-flight measurements? “previous” of …
Agreed, we added “previous”

L543: what is “jet-phase”?
Often referred to as the jet regime. There is no exact definition. It describes the very near-field stage right behind the engine exit, where the hot exhaust jet is dominated by strong turbulence, shear, and rapid mixing with ambient air. In this region, temperatures, pressures, and chemical species are far from ambient, and microphysical processes (soot, ion clusters, sulfur chemistry) are highly dynamic. Kärcher & Yu (2009) define the jet regime as “up to approximately 5 s of plume age past emission”.

L547: “data are archived”
Thank you.

We thank the reviewer for the careful reading and the many detailed comments, which helped us to improve the manuscript.