General comments:

The manuscript of Florian Obersteiner and co-authors with the title “A versatile, refrigerant-free cryofocusing-thermodesorption unit for preconcentration of traces gases in air” presents a temperature swing adsorption unit for halogenated trace gases. A basic description of the setup of the developed preconcentration unit was already given in Obersteiner et al. AMT (2016) doi:10.5194/amt-9-179-2016 and other manuscripts of the authors. Nonetheless the present manuscript adds details on the instrument design, optimisation, performance characteristics and application examples. The manuscripts give strengths and weaknesses of the novel design as uneven temperature distribution of the trap or problems in getting reliable temperature data.

Research on trace gases, e.g. halogenated components or GHG isotopologues is very active and the manuscript is therefore timely and of high interest for readers of AMT and potential future users of this technique. I have some concerns on the consistency of the structure of the manuscript, which could be improved as detailed below. In addition, the wording is sometimes colloquial and might be improved. I have a number of suggestions for technical corrections the authors might consider to improve the consistency and readability of the manuscript.

In summary, I suggest publication in Atmospheric Measurement Techniques with minor revisions.

Specific comments:

SI units should be used throughout the manuscript, e.g. “K” instead of “°C” for temperature.

Page 1 Line 25: The term “injection quality” is arbitrary and might be replaced.

Page 4 – 8 Section 2 Instrumentation: The main focus of this section is on the technical description of the preconcentration device including hardware setup and preconcentration procedure. However, details on the hardware are partly missing, partly they are given in section 3 Characterisation. Please give all relevant technical information on components implemented in the preconcentration device including information on model, manufacturers etc. in section 2, where it is mentioned for the first time.

Page 4 Line 7-8: The sentence “A preconcentration system can only be as good as the analytical set-up behind it” is colloquial and might be deleted or rephrased. The overall performance of an analytical system might be either limited by the preconcentration unit or the analyser.

Page 4 Line 13 ff: The title of the section is “loose” and might be change to something like “Setup of the preconcentration device and integration for GC applications”. In this section the preconcentration device is described in detail for the first time and therefore reference to Figure 1 and 2 should be given. Technical information on all components in the preconcentration device with model number, manufacturer etc. should be added.

Page 4 Line 14: Please give details on the applied adsorbents.

Page 4 Line 19: The term “warm column” is imprecise and might be replaced or just deleted as details are given thereafter.

Page 4 Line 20 - 21: Please rephrase the sentence to something like: The system does not involve a separate refocussing procedure as used in other preconcentration systems (Miller et al. 2008) but the analytes are directly purged onto the GC column for further separation.

Page 4 Line 24 - 27: Please give details on the applied MFC. It is unclear how the MFC could be used for large sample volume, could it be: The MFC provides an alternative way to quantify the sample volume. Thereby, operation of the MFC without the downstream reference tank adds flexibility with respect to sample volumes larger than the reference tank.

Page 5 Line 6: The term “in this case” might be rephrased. I assume the two sample loops are not equivalent regarding temperature as one is closer to the Stirling cooler than the other one, which complicates the comparison of temperature data from both loops. How can these temperatures be compared – please comment on this?

Page 5 Line 19 – 22: Please give information on the Stirling cooler used in the presented work.

Page 5 Line 25 – 29: This statement that an “idle time” is needed to reach T_A after desorption is abstract as Figure 3 shows a constant cold plate temperature. From other statements later in the text I assume that at lower cold plate temperatures (e.g. -120°C) heating the trap during desorption affects the cold plate temperature – please comment on this?

Page 5 Line 27 – 28: The sub-sentence “ … is transferred to the coldhead as the sample loop is kept directly inside with only …” might be rephrased.

Page 6 Line 10: Please give a number for the “slightly higher T_A”.

Page 6 Line 4 – 7 and Line 15 – 18: There seems to be a discrepancy between the statements on cooldown time given in Line 4 – 7 (18.6 vs. 8.5 minutes) and in Line 15 – 18 (90 vs. 30 s) for different T_A of -120°C versus -80°C – Please comment?

Page 7 Line 16 ff: Measurement of the trap temperature and thus its control seems to be difficult with a sensor on the trap surface as it is affected by the cold plate. Would it be possible to use the sensor mounted within the second trap to control the temperature of the first although the traps are not identical?

Page 9 section 3: Would a title similar to “performance characteristics” be better?

Page 9 section 3.1: As detailed above to improve readability detailed information on the preconcentration unit (e.g. Stirling cooler, MFC) should be given in section 2 and deleted here. Section 3.1 should mainly contain information on the specific set-up used to determine “performance characteristics” as breakthrough volume etc..

Page 10 Line 19: The wording “stripe the air of nitrogen etc.” should be rephrased.

Page 11 Line 8: In Table 2 the relative response is given in “%” please use consistent terms.

Page 13 – Page 14: Different wording are used to differentiate detrimental contamination effects: sample loop memory, system memory and system contamination. Please unify and simplify the wording and the ways how to test them, if possible beginning of the section 3.3.

Page 14 Line 18: “Concentration in the previous run”

Page 16 Line 3 ff: It would be good to state first what the inter-comparison is based on: The laboratory based instrumentation (GC-TOFMS) is compared to GC-QPMS and GC-MS. As GC-TOFMS and GC-QPMS are based on a similar preconcentration setup, and the preconcentration setup should be tested, it is unclear what we can learn from that.

Page 17 Line 14: Please give details on the argumentation related to the “potential temperature”.