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Atmospheric Measurement Techniques Discussions

Interactive comment on "The Heidelberg Airborne Imaging DOAS Instrument (HAIDI) – a novel Imaging DOAS device for 2-D and 3-D imaging of trace gases and aerosols" *by* S. General et al.

Anonymous Referee #2

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+++ General comments +++

The paper by General et al. presents a new instrument designed for a flexible usage in different aircraft types, combining the pushbroom and whiskbroom method for retrieving spatial information of a variety of species. It gives an overview over existing techniques and previous studies in that field and motivates the usage of such measurements for atmospheric science. The paper includes a discussion of the advantages and disadvantages of the pushbroom and the whiskbroom technique, which are both implemented in the instrument. The main focus of the paper is the technical setup of the instrument, making it suitable as reference for future publications. First results of

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already performed campaigns demonstrate the usability of the instrument.

Therefore, the paper's subject is well within the scope of AMT. In general, the paper is scientifically correct and well written, therefore I recommend a publication after some minor changes.

+++ Specific comments +++

++ structure of Section 1 (Introduction): The introduction gives an overview over existing techniques, instrumentation and measurements (especially airborne), then the new HAIDI system is introduced (with features and benefits for chem. models). Afterwards, again previous studies are mentioned (I-DOAS), than again the advantages of the HAIDI system (with some repetitions). Therefore, I recommend to put the I-DOAS part (Page 2189 Lines 21..26, "I-DOAS instrumentation has ... from cities (Beirle et al., 2011)") somewhere before the presentation of HAIDI.

++ approaches in Section 2.2: The two approaches for vertical profiles you title with "Multiple whiskbroom scanners" (Page 2192 Line 26) and "Pushbroom scanner" (Page 2193 Line 9). In my opinion, the main difference between these approaches is not whiskbroom vs pushbroom, but downward vs forward direction. Therefore, I recommend to title "Multiple downward scanners" and "Forward scanner" instead.

++ Section 3, Page 2208 Line 11,12: "In addition there can be a spatial offset in dependency on the solar zenith and azimuth angles." What do you mean with that sentence?

++ Section 4.3 (HALO setup): You could add a hint to other planned remote sensing instruments onboard HALO, especially the HALO mini-DOAS instrument. What is the current status of the mini-DOAS, and are there plans for comparison or validations between those instruments?

++ Section 6.2 (NO2 emission), Page 2217 Line 6ff: Except a literature reference and that you converted to trop. VCD, you do not tell how you obtained your emission esti-

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mate. Which wind direction and strength did you assume, and where does the information about the wind come from? It also should be mentioned whether the given error estimate already includes the uncertainty of the wind field. Furthermore, a note about the conversion between NO and NO2 should be given.

++ Figure 1 As you mention in the figure's caption, the x- and y-axis represent the spatial dimension. However, the vertical axis in the left figure is not I(lambda) but lambda (which is depicted on the horizontal axis on the right side). Also in the caption, this should be stated clearer, e.g. "..., while the third axis represents the spectral dimension (i.e. the wavelength lambda)". Furthermore, the rainbow color scheme does not harmonize to the lambda axis (red color at small lambda, blue color at large lambda). Please reverse the rainbow colors or reverse the direction of the lambda axes or replace lambda by nu. Additionally I would replace "from a very narrow" by "from one narrow" in the last line of the caption in order to emphasize the 'one' (the width of that one range depends on the filter and therefore isn't necessarily 'very' narrow).

++ variable v_air You use "v_air" as symbol for the aircraft speed relative to ground, introduced on Page 2196 Line 20 as "the aircraft speed". Despite your correct introduction, the symbol "v_air" could be misunderstood as "airspeed" (i.e. the speed of the aircraft relative to the air). Therefore I recommend to use e.g. "v_aircraft" or just "v" instead of "v_air".

+++ Details and technical corrections and suggestions +++

+ several places: "aicrafts" -> "aircraft" (plural of "aircraft" is also "aircraft")

+ Page 2188 Line 12: "Here we report" -> "Here we present" or "give"

+ Page 2189 Line 27: "independent sources" -> "individual sources"

+ Page 2190 Line 16: "to take hyperspectral images" -> "to retrieve hyperspectral images"; "take" sounds like the instrument would directly record 4-dimensional data (3

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spatial, 1 spectral), but actually, the instrument only records 1 spatial an 1 spectral dimension at once.

+ Page 2190 Line 17: "each pixel contains additional spectral information" - additional to what? -> Omit "additional" or reformulate, e.g. "each pixel contains a high-resolved spectrum"

+ Page 2191 Line 4: "Various methods exist" - which other ones beside whiskbroom and pushbroom do you mean?

+ Page 2191 Line 6 to 8: "Both techniques are based on the detection of light dispersed by a prism or grating ...". This applies in general for spectroscopic methods and is not specific to whiskbroom or pushbroom imaging. Therefore, you can omit this sentence or change its begin, e.g. "Like other spectroscopic ..."

+ Page 2191 Line 9: "Each pixel of such a hyperspectral image is in principle a 3-dimensional dataset ..." - I think, you mean 'one spectrum per pixel', which is 1-dimensional. -> Omit "Each pixel of" at the begin of the sentence?

+ Page 2191 Line 13: "... a third spectral one (I(lambda))" -> "... a third spectral one (lambda)"; cf. my comment to Figure 1

+ Page 2192 Line 7: "... HAIDI can operate ... DOAS instruments ..." - Isn't HAIDI the DOAS instrument? -> e.g. "... the HAIDI rack can operate ..."

+ Page 2195 Line 3: "consist" -> "consists"

+ Page 2195 Line 7: "with maximum density" -> "tightly packed" ?

+ Page 2198 Line 1: "technique spectral" -> "technique, spectral" (comma)

+ Page 2198 Line 13: "(31 μm x 190 μm)" -> "(31 x 190 μm)" - 31 is the number of fibres

+ Page 2198 Line 26: "mountings that withstand" -> "mountings, which withstand"

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+ Page 2199 Line 13: "5K) but" -> "5K), but" (comma)

+ Page 2199 Line 14,15: "... also ... at the same time" - redundant, remove "also" or "at the same time"

+ Page 2200 Line 10ff: " ... advantage of producing ... and that ..." - I'm not sure whether this is grammatically correct. Suggestion: "As further advantages, concave holographic gratings produce less stray light than ruled gratings (Palmer and Loewen, 2005), and the zero order of the diffracted light can easily be guided to a light trap with small aperture, because it is also focused."

+ Page 2200 Line 18: "... set from ..." -> "... set to ..."

+ Page 2200 Line 20: "... optical resolution ..." -> "... spectral resolution ..."

+ Page 2201 Line 4: "Apart from ... design the" -> "Apart from ... design, the" (comma)

+ Page 2201 Line 5: "can also generates" -> "can also generate"

+ Page 2201 Line 19: "characteristics" -> "characteristic"

+ Page 2201 Line 25: "(Sect. 3) it" -> "(Sect. 3), it" (comma)

+ Page 2202 Line 4: "ADC" -> "analog-to-digital converter" (you had not introduced the acronym before, and you use this term only here)

+ Page 2202 Line 8: "linearity" -> "nonlinearity"

+ Page 2202 Line 14: "In comparison to" -> "In contrast to"

+ Page 2203 Line 18: "... change due to e.g. ...." -> "... change, for example due to ...."

+ Page 2204 Line 16: put "(Graininger and Ring, 1962)" directly after "a Ring spectrum "

+ Page 2205 Line 26: "varying" -> "various"

+ Page 2206 Line 10: "minus the concentration" -> "minus the integrated concentration"

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+ Page 2206 Line 12: "like e.g." -> remove " e.g."

+ Page 2206 Line 17: "atmosphere instead and are therefore independent" -> "atmosphere and therefore are independent"

+ Page 2206 Line 18: "For this," -> "For this conversion,"

+ Page 2206 Line 25: "In addition" -> "Additionally,"

+ Page 2207 Line 12: "to to" -> "to"

+ Page 2209 Line 21ff: "This selection can be e.g. if ... VCD." -> Reformulate, e.g. "A candidate for such a FRS can be a spectrum taken upwind of an emission source. Also a zero VCD obtained from the forward-telescope is an indicator for a potential FRS."

+ Page 2210 Line 17: "... O4, which has a constant ..." -> "... O4, which has a well-known ..." or "... O4, which has a horizontally constant ..." (with height, O4 concentration decreases)

+ Page 2210 Line 21,22: "... algorithms are ... and uses ..." -> remove singular s in "uses"

+ Page 2210 Line 27: "performance" -> "quality" or "accuracy" or "goodness" ("performance" sounds more like 'efficiency of an algorithm with respect to computational time')

+ Page 2211 Line 10: "However, with ..." -> "With ..."

+ Page 2213 Line 22: "CCD's" -> "CCDs"

+ Page 2216 Line 10: "performed a three" -> remove "a "

+ Page 2216 Line 13: "originate" -> "originates"

+ Page 2218 Line 10: "with the area of Prudhoe Bay" -> "within the area around Prudhoe Bay"

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+ Page 2218 Line 15: "maps the" -> "maps, the" (comma)

+ Page 2219 Line 8: "like e.g." -> remove " e.g."

+ Page 2220 Line 4: "ODEs" -> add "(Ozone Depletion Events)"

———-

+ Page 2232 Table 6: variable "c" not introduced, is it dSCD/(molec/cm^2) ?

+ Page 2242 Fig. 8: For easier orientation, you could number the frames of part (b) with 1..6 or A..F and add markers on top of part (a) indicating the corresponding columns - like you have done it on the right side for indicating the columns.

+ Page 2243 Fig. 9: Probably you can see more details in the graph, if you replace the crosses by simple dots in part (a)-(d).

+ Page 2244 Fig. 10: y-axis: "Noise" -> "RMS of Noise", cf. Fig. 11

+ Page 2248 Fig. 14: "... path is ..." -> "... path inside the absorber is ..."

+ Page 2249 Fig. 15: Perhaps the graph would become clearer if less elevation angles were plotted, and if the colors would be chosen in an intuitive order (e.g. rainbow colors like in Fig. 21).

+ Page 2255 Fig. 21: unit of O4 correct?

+ Page 2256 Fig. 22: "The background shows ... (NASA, 2012)." - Well, I see a nearly homogeneous gray background.

+ Page 2257 Fig. 23: 3rd line: "As can be seen the" -> "As can be seen, the" (comma)

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 2187, 2014.