

Full review of Klingebiel et al., AMT 2017 (based on manuscript version of 14 Feb 2017)

General comments

The study titled “A tandem approach for collocated in-situ measurements of microphysical and radiative cirrus properties” by M. Klingebiel et al. describes how a tandem measurement platform consisting of a research aircraft and a retractable towing sensor shuttle equipped with a CCP and solar radiation instruments can be used to obtain vertical profiles of microphysical and radiative cirrus properties. Spatial cirrus inhomogeneities of properties such as particle size corresponding to the maximum of the particle size distributions were quantified for one case study. Also, it was shown that solar heating rates derived from collocated measurements of the tandem platform lead to more realistic values than those based on single instruments. Finally, the limitations of the tandem platform were listed.

While the approach is unique and worth publishing the quality of the writing needs improvement. Besides assuring a proper English grammatical sentence structure, the task of the main author should be to harmonize different pieces of information to make a coherent story. Especially the abstract would benefit from presenting the information more concisely and in a more logical order. Also, a wrap-up sentence in the abstract summing up the results or their implications is missing. Additionally, you mention ten flights in the abstract which leads to anticipation of results of ten flights which are not fulfilled.

I would suggest the manuscript to be published after minor revision. The authors should address the following points:

Major comments

Line 110-112: You mention that on the original AIRTOSS, the external body cover was used as a mounting point for additional payload. Please explain why this was modified.

Line 114: Air brakes are the red rectangles on the winglets in the back? This becomes clear only later on. – Describe the photo more clearly to a reader who might not know what air brakes are. Also, did you have several different flights during which you employed air brakes with different resistance coefficients to see which lead to the best performance in terms of horizontal flight positioning? Or did you construct the air brakes after flow simulations? ...ok, some of this is answered in Section 2.5 – you can also mention in line 114 that details are explained later. But if you don't, the reader is lost.

Line 137: You mention that several heaters of the CCP were deactivated. – Mention if/how this measure affects the instrument performance?

Line 335-353: This paragraph should be structured and phrased more clearly. For readability, it is better to introduce it like For flight X from Y to Y UTC, with the aircraft flying at XX m altitude and the AIRTOSS being at YYm altitude, cirrus filaments were detected during two sections (at X UTC and Y UTC). ...then go into detail. Instead of starting with details and then giving the big picture in the end. Also, in Fig.7a,b the quantity measured (downward irradiance needs to be added in the y-label). Axis labels and legend font is too small. Do the vertical bars indicate errors or standard deviations? What is the temporal resolution of the measurements?

In Fig. 7c an increased NC (of CCP-CDP and CCP-CIPg) is obvious at 05:35:50UTC – why does the running average only increase a few seconds later. – How is the running average determined?

Line 368-371: In this paragraph you mention that variation in the upward irradiance is mainly due to a lower level stratus cloud. You also state that the upward irradiance varies more strongly in the upper legs while it is less in the lower legs. – Shouldn't the influence of the underlying stratus be affecting the lower leg measurements more than the upper ones? – Please clarify. Also, an additional figure showing a satellite image with overlaid flight track would be good to illustrate the cirrus/stratus situation.

Lines 405-410: This is important! – It should be mentioned more clearly in the abstract. Please emphasize that only collocated irradiance measurements of the Learjet and the AIRTOSS give meaningful heating rates. Also, specify which heating rates are theoretically expected instead of only listing the corresponding references.

Line 407: Here you mention that a cirrus geometrical thickness of more than 200m is too large to allow for positioning of the Learjet above and the AIRTOSS below the cloud layer. Earlier you stated a longer steel wire length – please clarify why the AIRTOSS cannot be positioned below thicker clouds?

Line 427-428: What exactly can you derive by combining microphysical and radiative measurements. You did show several graphs of collocated measurements but it become not quite clear how this knowledge can be used. – Is it possible to validate radiative transfer retrievals of particle size (based on measured radiative properties) with the simultaneously measured particle size distributions? Or how else can the measurements be used for more in-depth cirrus studies?

Line 443-448: Only here you mention that the shown results are taken from a proof-of-concept campaign and that thus the AIRTOSS steel-wire was not extend further. – Please mention that in the very beginning of the manuscript.

Section 2.6: The trace gas measurements seem totally unrelated to the paper in which you are focusing on collocated measurements microphysical and radiative

properties. Unless you convince me how they add to the entire story, I would suggest to remove the parts referring to the trace gas measurements. You only briefly refer to the trace gas measurements again in lines 455-457. – This is not sufficient to justify the inclusion of the trace gas measurement description.

Minor comments

Sometimes you refer to the towing sensor shuttle as AIRTOSS, sometimes as the AIRTOSS. Be consistent and choose if you want to call it a noun or if you want to refer to it as proper name.

Line 4: “detached from” should be extended by “detached from the aircraft via a cable” to illustrate the setup more clearly

Line 6: replace “layer clouds” by the more scientific term “stratiform clouds”

Line 6: motivate why you need “sophisticated numerical flow simulations” - to quantify shattering effects on the CCP?

Line 9-10: move this sentence about the steel cable to line 4 for clarity

Line 13 (and 287): The sentence seems backwards: ice crystals grow from small to large sizes (via diffusional growth/aggregation), thus the sentence should be phrased: ...maximum size in the observed...increases from 30µm to 300µm with decreasing altitude. Also, shouldn't the change in maximum size of the PNSD rather refer to geometrical cloud depth than merely altitude? Please clarify.

Line 16: Remove “consequently” or replace it by “thus”

Line 16: Add “growth” between microphysical and process

Line 17: is the solar downward irradiance on the Learjet measured above/in/below the cirrus?

Line 18: Clarify where the cloud is positioned with respect to the tandem platform to determine heating rates

Line 25: THEIR microphys. Prop. ; warm or cool (plural!)

Line 26-28: rearrange sentence structure to proper English. “Especially the ice particle shape was found to determine ... (e.g., Wendisch ...)”

Line 29: You cannot talk about “such effects” of surface roughness when you haven't previously talked about surface-roughness. – Modify the sentence accordingly.

Line 47: Clarify if the “two helicopter borne platforms” refer to two helicopters flown simultaneously or if not, what kind of platforms you refer to.

Line 54: Replace “speed” by “aircraft velocity”

Line 55: released by means of a steel wire

Line 56: In “the study of” Frey et al....

Line 58: “this” not “his”

Line 60: If the Frey et al. 2009 study is based on the proof-of-concept campaign, it should be mentioned clearly. Also, the proof-of-concept sentence should be moved before line 56. Try to ease the reader into the subject, go from larger picture to more detailed description.

Line 94: What is the limited distance? Give a value.

Line 103: Title of this subsection should be “Specifications of the AIRTOSS”

Line 113: remove comma

Line 121: "of up to 914m"
Line 128: "less than the maximum ..."
Line 137: to save energy
Line 138: explain abbreviation CCP-CDP
Line 139: a voltage
Line 141: no commas
Line 153: mounted on
Line 154: Seems like a word is missing after particle-by-particle data → analysis/algorithm/technique?
Line 158: Specify what you mean by size: maximum dimension?
Line 163: citations should be given in chronological order
Line 172: Again, this last sentence seems like it was added as an afterthought. Consider moving it after the reference to Knollenberg, maybe by combining those two sentences.
Line 178: at the bottom
Line 180: wavelengths
Line 180: irradiance sensor; give reference for horizontal alignment requirement
Line 191: ...symmetric, ... (comma)
Line 194-197: this sentence needs to be simplified or divided into two for clarity. What do you mean by "aiming at their compensation"?
Line 219: As a result, ...
Line 235: Accordingly, ...
Line 272: of less than...
Line 293: growth process
Line 294: water vapor diffusion; the particles don't descent, they sediment
Line 300: explain the term area ratio
Line 304: what orientation was assumed for the falling columnar ice crystal?
Line 304: replace numbers with "estimated terminal fall velocities"
Line 307: Why does aggregation only occur several hours after particle formation at such ice particle number concentration? – Try to present the reader with a good story, instead of with many questions.
Line 326: What do you mean by "undisturbed"? constant?
Line 349: add citation
Line 350: is affected by what? Do you mean "shows variation"?
Line 359: the "in-cloud" inhomogeneities
Line 363: Start the sentence with "to make measurements comparable, ..."
Line 367: Sentence is unclear. Please clarify what the horizontal bars indicate: the standard deviation along individual flight legs or the variability of the radiation along the flight legs?
Line 406: why radiance? I suppose you mean "irradiance"?
Line 420: Is SMART really a sensor?
Line 426: Remove comma
Line 454: Again, the reader wonders: What is the higher sampling rate? – Please mention it and relate to the sampling rate and the sample area of the CCP.