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Review of the article

"The NASA Aerosol Wind Profiler Doppler Wind Lidar, Part I: Instrument Description and Airborne Demonstration"

submitted by Bedka et al.

(AMT)

Review Summary

The manuscript "The NASA Aerosol Wind Profiler Doppler Wind Lidar, Part I: Instrument Description and Airborne Demonstration" by Bedka et al. presents a comprehensive overview of coherent-detection Doppler wind lidar systems that have recently been developed by NASA, in particular the Aerosol Wind Profiler (AWP), to demonstrate the readiness of this technology for space applications. Together with descriptions of the hardware of the respective systems, the wind retrieval method used is also explained and demonstrated by means of first airborne measurements performed in 2024. The paper is well structured and readable and is therefore recommended for publication after revision according to the minor comments given below.

Comments:

- **Line 19:** Is Part II already submitted? Could you provide a reference here?
- **Line 22:** Community Needs for 3-D Winds: In this section, it is nicely demonstrated how important 3-D wind measurements (from space) are and which instruments are currently available. Although you discuss DWLs in the observing section in the following section, I think you could already mention Aeolus here, as it indeed demonstrated the community need for 3-D winds (although only 1 LOS was measured) and showed that these needs can be fulfilled with a lidar. This could maybe provide a very good bridge to the following Section 1.2.
- **Line 85:** Although this is obvious for "Aeolus people," it might be worth briefly explaining what is meant by "Rayleigh" winds and "Mie" winds.
- **Line 94:** "an interferometer": I would prefer to write "different kinds of interferometers." Aeolus used more than one (FPI and Fizeau). Furthermore, Michelson and Mach-Zehnder interferometers are typically used as well (although there is no need to mention the different interferometers). I just think it is good to use the plural here.
- **Line 98:** Rew et al. 2025 should probably be Yew et al. 2025.
- **Line 106:** I agree with the advantages of CDWLs that are mentioned. However, I am missing the most significant disadvantage: the need for "enough" aerosols in the atmosphere. Direct-detection systems (Aeolus) always have a signal (in the absence of cloud blocking), whereas CDWLs can sometimes suffer from really clear air. Although this is mostly avoided by the high pulse energy of the NASA systems, it can still happen, as you show, e.g., in Fig. 11 (15 s average, 19:00 to 20:00 UTC, 4–6 km). I would prefer if this point were mentioned in this context, just for the sake of completeness.
- **Line 123:** I like this section, as it shows the development, or rather the evolution, of NASA CDWLs, which always comes together with airborne testing. In this context, it would be nice to briefly mention (maybe only in one sentence) the few other existing airborne instruments. You already mentioned the DLR 2-µm system, which now has a successor (HEDWIG) with a recent AMTD paper, as well as the LIVE lidar by the French colleagues, as recently published in AMTD by Cezard et al. I do not think that it is mandatory that this is mentioned, but for the sake of completeness, I think it would be helpful to demonstrate that there are only a

handful of airborne wind lidars and that it is therefore very important that this work is being done at NASA.

- **Fig. 2:** Very nice sketch. What do the crossed arrows mean for the pump laser light? Is it randomly polarized?
- **Line 213:** Why did you choose CFC as the optical bench material? Only because of weight considerations, or do you see other benefits?
- **Line 217:** 3.6 m resonator length. It is impressive that you can get this resonator aligned and keep it stable even during aircraft operation. But is this really the concept that you would follow for a spaceborne system? Do you really need such a long resonator to achieve the needed pulse specifications? It would be nice if you could clarify this in one further sentence.
- **Line 227:** Related to the point above: you mention the tip-tilt mirror that can be used for alignment modifications (or the auto-alignment). Just out of curiosity, how often have you had to realign during aircraft operations?
- **Line 271:** I like the discussion of the TFOM. As I was always wondering how the TFOM can be translated into achievable coverage, I wanted to ask if you have ever investigated this issue. E.g., by changing/doubling the pulse energy during a flight and investigating how the data coverage changes under otherwise equal conditions (similarly to what you did for different averaging times).
- **Line 303:** Why did you not use the Fibertek laser for your work?
- **Line 334:** Rew et al. should be Yew et al.
- **Line 392:** Auto-alignment system: Related to the point above, I would like to know how often the auto-alignment is performed. Is this done continuously? What is the update rate? Further, as I am not too familiar with the principle of the WDM: Can you be sure that the BPLO at 1.55 µm has exactly the same alignment as the 2-µm light in the resonator? It is really elegant to always have a BPLO signal available for optimizing the Tx/Rx paths.
- **Line 444:** For a space system, one wants to reduce components and risk, but for airborne operation, it might be beneficial to operate a double-wedge scanner, allowing much higher flexibility in beam pointing (also for, e.g., compensating for aircraft attitude).
- **Line 465:** Scan strategy: You measure at 2 LOS, which is principally sufficient to retrieve the two wind components u and v (assuming w to be constant within the 12 s). I am wondering if you have ever investigated whether this measurement strategy leads to a larger representativeness error. Gasch et al., for instance, used an LES simulator to show that measuring with 5 LOS provides an optimum for airborne operation. Have you tested this and measured with more LOS?
- **Line 499:** Retrieval:
    - Do you also perform some kind of noise-whitening procedure based on the signal measured below ground to correct for the nonlinear frequency characteristics of the detection chain?
    - You average the spectra for each range bin. Do you correct the individual spectra for the jitter of the outgoing laser pulse, or is there no need to do so because the laser/AOM is so stable? Have you analyzed your reference signal on a pulse-to-pulse level?
- **Fig. 11:** I am not sure if I fully understand how you arrive at this figure. According to the text, you measure with a 15 s stare at each LOS. So I do understand how you reach a 15 s averaging time by using 7.5 s from LOS 1 and 7.5 s from LOS 2. But how do you do it for the 0.25 s averaging time? Do you use again the end of LOS 1 and the beginning of LOS 2, but throw away all the other signal?
- **Line 799:** Integration duration from 0.25 s to 15 s. Again, I think it would be helpful to clarify what you mean here. Do you integrate over 0.25 s but then use the mean within the 15-

second stare time, or do you just use 0.25 s and throw away the rest of the 15-second measurement?

- **Line 845:** “Affordably built.” Could you be more precise here? Just to get a feeling for which potential space program this could fall into.