

The thoughtful comments given by the second reviewer Kristopher M. Bedka (Reviewer 2, <https://doi.org/10.5194/egusphere-2026-4731-RC2>) are highly appreciated. They are well-conceived and constructive, thus, contribute essentially to an improvement of the paper manuscript. We worked through each of them and revised the manuscript accordingly. Below the answers to each comment are given, where the answers are indicated in blue color, and the resulting changes in the manuscript are highlighted in green color.

Reviewer 2: <https://doi.org/10.5194/egusphere-2026-4731-RC2>

Summary and Comment

This paper describes a new airborne Doppler wind lidar system developed at DLR called HEDWIG, retrieval algorithms applied to its data, and a brief demonstration of data from its first flight campaign NAWDIC. The system has high repetition rate and moderate low pulse energy, placing its TFOM in the middle of current airborne wind lidar system. HEDWIG features a novel Rissly prism scanning mechanism that enables a diversity of beam orientations for both vertical and horizontal wind profiling. HEDWIG performs 360° conical scanning with relatively short dwell times per azimuth for horizontal wind profiling, with longer dwell times interspersed for direct measurement of vertical motions. The instrument installation and pointing is calibrated with land and ocean surface returns, demonstrating very low uncertainty. An example of 2 hours of flight data is shown to provide an initial demonstration of instrument performance.

The paper is extremely well written and concise. I have no critiques or comments about the writeup, which is very rare for me, so kudos to the authors for such a well-constructed and written paper. My only comment / concern is that I am not able to interpret the data shown in Figure 6 as well as I had hoped. One of the primary strengths of a heterodyne system is its ability to detect extremely high precision and resolution winds from boundary layer and clear sky aerosol returns. I look at the top three panels Figure 6 and I see what only looks to be to be returns from mid- to upper-tropospheric cloud. I see that the dwells for off-nadir LOS were just 1 second, providing 750 pulses for integration, which could be limited backscatter sensitivity. I think showing a satellite image and corresponding data from the WALES HSRL would be informative to characterize the scene being measured by HEDWIG. I look at panels d and e and I see quite strong SNR from the nadir measurements (which have longer dwells, better backscatter sensitivity and greater depth of successful retrieval) throughout the mid- to upper-troposphere. The character of the returns looks to me like there is abundant cloud cover. I also some indication of clouds atop the PBL from -20 to -28 longitude, which may have obscured the PBL. But all this is speculative and hard to interpret from the curtain plots. Addition of the MTG FCI imagery and WALES would allow us to see “the truth”, to see the depth of the PBL (if detectable at all given cloud cover), and assess the backscatter sensitivity off-nadir beams with short dwells. I understand that future algorithm work will merge data from successive scans which should fill in some gaps in the profiles. This will be critical for future applications that require a deep layer of wind measurement from cloud free backscatter signal.

I also see mentions of assessment of data quality with independent wind measurements. Were dropsondes being released from the HALO aircraft? This will enable us to get a picture of measurement precision after the surface return calibration. It would be informative to see at least one comparison against an independent wind measurement in this paper so we can get an initial perspective of the wind measurement precision, which will be later augmented with a larger sample of comparisons.

Thanks a lot for this very thoughtful assessment of our HEDWIG paper manuscript. After reading your evaluation in detail, we realized that a few important information still was missing in order to fully understand the presented work. Due to the fact that a HEDWIG performance paper is currently in preparation, we will keep the particular performance discussion for the later one. However, we addressed the main concerns raised in your comment and revised the manuscript accordingly, as discussed below.

Data coverage and measurements in aerosol-poor atmosphere

During the integration of HEDWIG into the HALO aircraft, we experienced damage to the pump laser unit, which could only be repaired two days before our departure for the NAWDIC campaign. Due to this time constraint, we were unable to perform further ground-based tests to verify the instrument alignment before the campaign.

During the first airborne measurements, we found that HEDWIG was operating properly, but with reduced sensitivity. A subsequent analysis identified an imperfect alignment of the heterodyne detection path as the likely cause of this reduced sensitivity. As a result, HEDWIG predominantly provided valid wind retrievals from optically thin cloud layers and regions with enhanced aerosol backscatter, such as the planetary boundary layer. In contrast, clear-air conditions with only weak aerosol backscatter did not provide sufficiently high SNR for reliable wind retrievals with HEDWIG during NAWDIC.

As this is an important finding for the interpretation of the airborne measurements, we have added the following paragraph to Section 4 of the manuscript:

It should be noted that the sensitivity demonstrated during the first airborne measurements performed during NAWDIC was lower than initially expected from the transmitter performance. A subsequent analysis of the HEDWIG receiver revealed a small misalignment in the heterodyne detection path, which reduced the effective receiver sensitivity compared to the nominal instrument performance. Consequently, the measurements acquired during NAWDIC predominantly provide valid wind retrievals from optically thin cloud layers and enhanced aerosol backscatter in the planetary boundary layer, whereas reliable retrievals under background aerosol conditions were not yet achieved. This sensitivity limitation is therefore not considered representative of the final instrument performance. The receiver alignment has since been identified as an important aspect for further optimization, and its improvement is expected to increase the sensitivity to weak aerosol backscatter and thereby extend the range of atmospheric conditions accessible to HEDWIG.

Further validation data:

We agree that comparisons with independent observations would provide valuable information on the performance of the HEDWIG wind retrieval. During NAWDIC, several independent observations suitable for such comparisons were obtained. Dropsondes were deployed from HALO during the campaign, several ground-based lidar systems operated by KIT were overflown, and coordinated flights were conducted with the

AIRFLOWS wind lidar. These measurements provide complementary independent observations that can be used to assess the HEDWIG wind retrieval under different atmospheric conditions.

A comprehensive comparison of these datasets, however, requires a sufficiently large number of suitable collocations and careful consideration of the different spatial and temporal sampling characteristics of the individual instruments. We therefore consider such an analysis beyond the scope of the present instrument-focused paper. We have clarified this point in the manuscript and will address the independent observations from NAWDIC, including the dropsondes, ground-based lidar measurements, and the coordinated AIRFLOWS flight, in a dedicated follow-up study focusing on the comprehensive validation and performance assessment of HEDWIG.

For further clarification, the following paragraph was added to the manuscript at the beginning of Section 4:

Although there is a large data set available from the NAWDIC campaign, the purpose of this paper is not to provide a comprehensive validation and error assessment of the HEDWIG instrument, but rather to demonstrate the performance and measurement capabilities of HEDWIG under realistic airborne conditions. Accordingly, the measurements presented in this section provide a first assessment of the HEDWIG measurement capabilities during the NAWDIC campaign. The campaign also provided several opportunities for independent validation and intercomparison, including dropsonde measurements released from HALO, overflights of ground-based lidar systems operated by KIT, and coordinated flights with the AIRFLOWS wind lidar aboard the TU Braunschweig Cessna aircraft. These complementary observations provide a valuable basis for assessing the HEDWIG wind retrieval under different atmospheric conditions. A detailed comparison of these datasets, together with the complete NAWDIC dataset, will be presented in a dedicated follow-up study focusing on the comprehensive validation and performance assessment of HEDWIG.