Response to reviewers comments

September 2026

We have addressed all of the points raised by the reviewers (copied here and shown in black text), and include our responses to each point below (in blue text). Where applicable, we also provide the new text (in blue italics).

1 RC1

My only question / concern is related to repeated suggestions that there isn't enough data included here to narrow uncertainty or understand differences between the assorted wind lidars (e.g. Line 150, 219). I see that data is averaged to 1-minute samples, and there are 2-3 days of data included (Line 219). This seems to me to be quite substantial to perform this investigation, especially considering wind profile retrievals from these systems are typically done every 1-2 sec (Line 61). I understand that even though these instruments are pointed in the "same direction", subtle variability with pointing or other instrument artifacts require more averaging. One would think that averaging to 30 sec would be sufficient which would double the samples. You say that data was previously averaged to 30 mins which is extremely long for these types of lidars. But, regardless even at 1 min, you have over 3000 samples across 2+ days which should be plenty. Please comment on this in the response to me and in the text.

The statement that there should be more than sufficient samples to calculate the telescope focus function from a few minutes of data would be true if 1) the atmosphere was unchanging over the sampling period, 2) instrument sensitivity is sufficient, 3) the telescope focus function itself is constant, and 4) there are no other instrument variations. Averaging over a few minutes to half an hour helps to account for atmospheric inhomogeneity (short-lived aerosol plumes) and ensuring sufficient sensitivity. For example, Wei et al. (2025) used 5 minute average time for a comparable method for estimating the telescope focus function. However, Wei also noted that the telescope focus function displayed some dependency on the internal temperature of the instrument. Similar behaviour has been noted for more traditional atmospheric lidars (whether Raman or ALC) where the overlap function is temperature-dependent - the internal optical components or the optical path changes ever so slightly with temperature. The telescope focus function will also depend on the quality of the outgoing beam,

which will also vary slightly with the temperature of the laser and the internal optical components. Unfortunately, the current commercial Doppler lidars do not measure or do not provide all of these measurements, usually only the instrument internal temperature. Therefore, we expect some variability in the telescope focus function itself but do not yet know the timescales over which it varies. An additional factor is that the telescope focus function also responds to a change in the refractive index; since this also varies on timescales longer than the instrument measurement cycle, longer measurement periods are necessary to account for this. Hence, we prefer to be cautious when stating how much data is necessary to obtain a reliable telescope focus function, particularly for operational use.

1.1 Specific comments

Line 100-102, you describe that the data are "normalized" but the approach you use to do this is not provided. Please explain this in the text

Text revised to: *Prior to the calculation of the MSE, both the Doppler lidar and the ALC profiles are normalized by scaling the integrated values of both profiles to equal 1. While the earlier filtering steps should have removed profiles where the scattering properties at the Doppler lidar's and the ALC's wavelength do not have a linear relationship with each other, the absolute values of β' can still be different. The normalization process bypasses a need to obtain a true scaling function between the two instruments and makes it possible to calculate the MSE related to the profile shape.*

Lines 107-111, you describe your fitting procedure based on iterative adjustment of f and D, but according to your equation in line 83, Tf is not modulated by f and D. Please clarify

Equation (3) states that $T_{\mathrm{f}}(R)$ is dependent on the effective receiver area given by $A_e(R)$. The effect receiver area, $A_e(R)$, is then a function of f and D as shown in Equation (2). D and f are constant for a given profile, and hence not displayed as modulating $A_e(R)$; the iterative adjustments are done during the estimation process because these constants are unknown.

Section 3.3, A schematic diagram illustrating the filtering procedure is needed. The text description alone does not provide enough for me to fully understand what it is you're doing and why you need to do it, considering that these lidars are basically sampling the same atmospheres especially when averaged to the long time scales you are using.

A flow chart has been added to illustrate this method, see Figure 1. The text description of the filtering procedure has also been clarified.

Line 139, it is unclear what you mean by how the normalized profiles are

"compared to unity".

Text adjusted to: *the normalised profiles are compared to a theoretical, perfectly homogeneous profile without noise, attenuation, or refractive turbulence, instead of the normalised attenuated backscatter profile from an ALC. This theoretical profile has the same value in each range gate (that value being 1), matching exactly the mean of the normalised Doppler lidar profile.*

Lines 161-163, as noted above you say here that there is a "small amount of data" when in my opinion you have an abundance of data.

See answer given for your main question.

Line 181, artifacts is misspelled

Artefact is the usual spelling in British English. We will leave this for the journal typesetters to modify as necessary to conform to the journal house style.

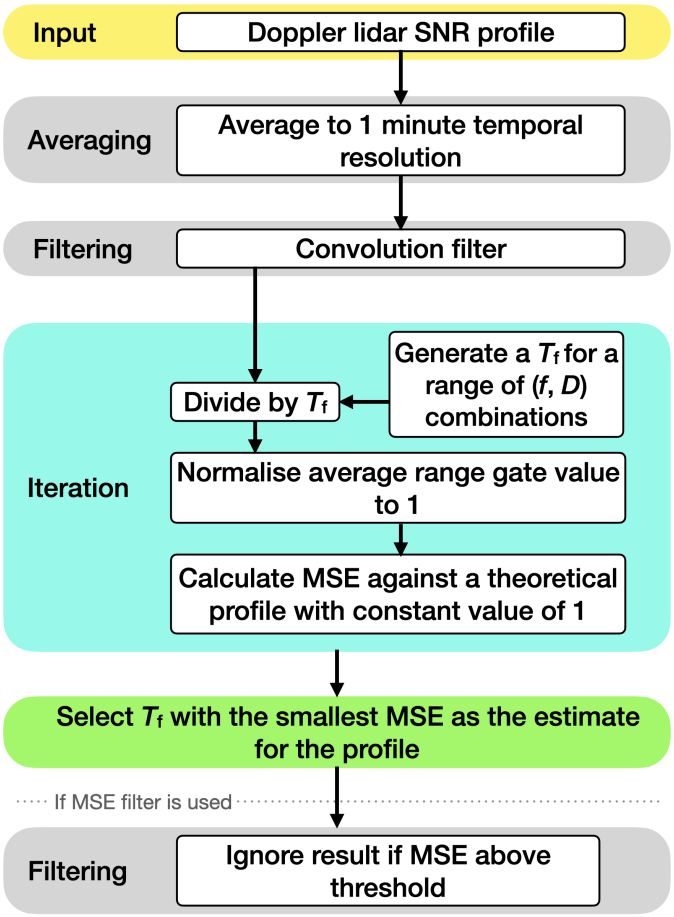

Figure 1: Flow chart summarising the process of estimating f and D from Doppler lidar SNR data with the horizontal method. The last step is only performed if the MSE filter is used.