We thank the reviewer for their thorough review of this manuscript and bringing up an important detail about the nature of the HSRL-2 viewing geometry. We provide a response to this comment in blue font.

Reviewer comment:

The authors have addressed all my comments and provided clear explanations or amendments to previously overlooked aspects. This study can be accepted with following minor remarks applied. Once the authors have provided clarified version of the methodology, it becomes clear that they are applying surface reflectance-wind parametrizations for a nadir or a near-nadir system, but it is not clearly articulated.

Comment about difference between nadir and non-nadir lidar systems to the authors: If you use nadir system, in this case, this (1) should be clearly stated in the methodology. What is the incidence angle of their HSRL system? Also, if it's nadir or near nadir, (2) the introduction and methodology should shortly mention that this logical rationale you provide through methodology and results holds true for near-nadir and nadir systems. I think a reader should be clearly informed that you are talking about near nadir or nadir system and a minor red flag should be raised over the non-nadir systems. My formulation is as following, but you can include this rationale in any form in your study. "At nadir and near-nadir incidence angles, most contribution of lidar surface signal comes from ocean surface [these Josset et al. studies that you mentioned], which makes it possible to introduce relatively simplified models of sea surface reflectance. However, Li et al. [2010] had demonstrated that at the higher incidence angle lidar systems (> 15o), the sensitivity of lidar backscatter signal from ocean surface would rapidly decrease at such highly non nadir incidences being shifted towards subsurface contribution. More recent lidar study based on highly non-nadir (~37o) Aeolus UV HSRL lidar [Labzovskii et al., 2023] indirectly confirmed this phenomenon by showing low agreement between passive remote sensing reflectivity and Aeolus surface reflectivity parameters particularly only over water surfaces such as oceans. Thus, an opportunity to retrieve ocean surface winds using lidar ocean backscattering has been shown effective only for nadir or near-nadir lidar systems such as x incidence angle of HSRL system we analyze." There are more studies on this topic, but these two references including our recently published study on this should be enough to raise flag about non-nadir HSRL lidar systems for a reader. It's up to you to include these comments or not though.

Li et al. [2010] - DOI: 10.1175/2009JTECHA1302.1
Labzovskii et al. [2023] - https://doi.org/10.1038/s41598-023-44525-5

Response:

Thank you for bringing up this important point. We agree that the HSRL-2 nadir-viewing geometry should have been more carefully explained and how this affects the use of surface reflectance – wind speed parameterizations. We have made the following additions to articulate these points.

Abstract:

> Original: "The HSRL-2 can directly measure vertically resolved aerosol backscatter and extinction profiles without additional constraints or assumptions, enabling the instrument to accurately derive atmospheric attenuation and directly determine surface reflectance (i.e., surface backscatter)."
>
> Modified: "The HSRL-2 is a nadir-viewing lidar that can directly measure vertically resolved aerosol backscatter and extinction profiles without additional constraints or assumptions, enabling the instrument to accurately derive atmospheric attenuation and directly determine surface reflectance (i.e., surface backscatter)."

Introduction:

> Added: "Note that the HSRL-2 operates at a nadir-viewing geometry, which is detailed more in Sect. 2.4. At nadir or near-nadir incidence angles, the surface contribution of the lidar surface backscatter signal is the largest and is therefore sensitive to changes in wind speed (Josset et al., 2008; Josset et al., 2010a; Josset et al., 2010b), making it possible to introduce relatively simplified models of sea surface reflectance. However, Li et al. (2010) demonstrated that at the higher incidence angle lidar systems (> 15°), the sensitivity of the lidar surface signal would rapidly decrease as these highly non-nadir incidences shift the signal towards a subsurface contribution rather than a surface one. A more recent lidar study based on the highly non-nadir (~37°) Aeolus UV HSRL lidar (Labzovskii et al., 2023) indirectly confirms this phenomenon by showing low agreement between passive remote sensing reflectivity and Aeolus surface reflectivity parameters over water surfaces such as oceans. For these reasons, an opportunity to retrieve ocean surface wind speeds using lidar ocean backscattering has been shown to be effective only for nadir or near-nadir lidar systems such as the HSRL-2."

Methods (Sect. 2.4):

> Added: "As noted in the Introduction, the HSRL-2 is operated in a nadir-only viewing geometry (i.e., not scanning). However, there is a small offset from this nadir incidence angle due to the pitch and roll angles of the King Air aircraft. This offset angle is measured by the Applanix INS and is then used in Eq. 2 to derive the wave-slope variance. The median pitch and roll angles depend on the flight conditions (e.g., wind and fuel loads), but ranged from 2 - 5° for pitch and < 1° for roll during ACTIVATE flights. The surface wind speed data are screened to limit the pitch and roll to less than ± 3° from the median values, resulting in HSRL-2 incidence angles of < 3° for roll and < 8° for pitch. This screening effectively selects cases where the aircraft is flying straight and level legs."