Review of egusphere-2025-4803

The authors describe the design of a new Na Doppler lidar system, and the initial observations of Na density, temperature, and vertical winds made with the instrument over Hainan, China (19˚N). The instrument design involves a novel new way to precisely lock the laser to the hyperfine structure of the Na D_2 fluorescence, by employing modulation transfer spectroscopy, and by measuring the frequency chirp induced by the optical pulsed dye amplifier. This latter feature enables the measurement of the absolute radial wind. Until now most groups removed the wind bias caused by amplifier chirp by computing and subtracting long-term means, which is effective for vertical wind observations but not for horizontal winds. In the Abstract it is stated "We present the first lidar-based **characterization of seasonal variations in gravity-wave-induced vertical heat flux, sodium flux**, and associated parameters…". This new lidar and its observations at low latitude (19˚N) are important additions to our ability to observe the mesopause region and could potentially improve our understanding of the influence of gravity waves in this region. However, the current manuscript is deficient in key areas and should be returned to the authors for major revisions.

Measurements of the vertical fluxes of species, heat, and horizontal momentum are rare so new measurements of the Na and heat fluxes are an important contribution to our knowledge wave-induced transport. Although the authors claim in the Abstract to present seasonal variations of Na and heat fluxes, they only presented what I think are annual mean profiles (Figs. 11 & 12). Furthermore, although their powerful lidar (PA=1.2 Wm^2, Δz=61.44 m, Δt=1 min) should be capable of measuring vertical fluxes at high temporal resolution, the data were smoothed to resolutions of Δz=2 km and Δt=30 min, before the computing the vertical fluxes. This is a significant problem, at least for the heat flux, where Guo & Liu (2021) have shown that most of the heat transport is induced by waves with periods less that 1 h, waves which were eliminated from the Hainan dataset by their smoothing procedure. At the very least, the authors need to reprocess their flux data (both heat and Na fluxes) with a temporal resolution of 2.5 or 3 min so that waves with periods of 5-6 min or longer are included. In addition, the authors need to present the seasonal profiles of the Na and heat fluxes as they claimed in the Abstract.

It would be helpful to the scientific community if the authors derive from their monthly mean Na, T, Na flux and heat flux profiles the annual and semi-annual fits and then compare them previous observations. For example, She et al. (2022) https://doi.org/10.1029/2021JD036291 have a nice Figure 1 which shows the annual and semi-annual amplitudes of fits to the T data from Ft. Collins, CO as well as how the mesopause height changes with season. Their Table 3 compares the seasonal temperature variations at

several sites in both hemispheres, including at South Pole. How do the low-latitude Hainan data compare?

Finally, Table 2 in the Hainan paper does not list the Na flux values from SOR and Hefei. Why not? They were clearly provided in the referenced papers. And the data from McMurdo is not included (Chu et al., 2022, https://doi.org/10.1029/2021JD035728).

In summary, the authors have developed an important, improved Na Doppler lidar and collected extensive data covering the calendar year, which potentially will be of considerable interest to the upper atmosphere science community. I strongly encourage the authors to consider the revisions that I have suggested. I recommend the paper be returned for major revisions.