In the current version of the manuscript, Qiu et al. have reported their work on studies of the sporadic sodium layer (Nas), one of the most active research areas in the upper atmosphere subject. They have introduced this subject concisely in the abstract section, for example, the definition of Nas and the possible mechanisms (e.g., ion-molecule chemistry mechanism and recombination with electrons) as well as Nas relationship with waves.

Then the authors have introduced the solitary wave theory and has applied it to try to explain the fine structure of mesospheric Nas observed by a narrow band lidar at Andes Lidar Observatory. In section 2, the authors have described the solitary wave theory but they have assumed that the particle density changes with time is constant, which is probably wrong in particular for the sporadic Na layer for this study. Actually I am quite struggled to understand the sections 2 and 3 but it looks that using the solitary wave fitting method clearly matches the observation data better than after they have selected Nas cases. Based on this and their Figure 4, the authors then conclude that "this solitary wave theory could possibly explain some characteristics of Nas".

The authors have also warned that "it is worth noting that the numerical simulation of the higher-order KdV equation is probably only suitable for explaining the events similar to the selected case" and "In contrast, the other events with shorter durations and cloud-like shapes are less consistent with the higher-order simulation results. This discrepancy also implies 30 that the NaS with different characteristics may have different fine structures." This is quite confusing and there is not clear conclusions and convincing results from the current work. It also depends on the method the authors have applied to do the data analysis (for example, they have applied the gaussian fit
first for the lidar measurements dataset then subtract it then use the anomaly to do the analysis, see their method in Page 5).

It looks the Gaussian fit used in the Equation 12 is not suitable for the Nas layer (Shown in the Figure 2c). Is that the reason to apply the solitary fitting for the density anomaly? If so, the caption (measured data) in the Figure 2d is misleading because it is the Na density difference from Lidar and Gaussian fit.

If you choose to different Guassian fit (for example, super Gaussian fit function), will the result be different?

Somehow, I am lost in understanding how to obtain the equation (21).

There are also many assumptions and it is very hard to judge and is unclear if they are reasonable or not.

For example, For the equation (2), why Na "could possible be regarded as the input of sodium sources from Na+ through chemical reactions"?

Again, why the authors assume the same airmasses (conservation of particle number) in Equation (2) to let dn/dt equals zero?

This mean the production and loss term of Na is always the same. Is this applicable for Nas layer?

Why the authors only consider "the dispersion term of a surface wave in incompressible shallow fluid" in equation (8) and how this equation (8) is derived?

Does this mean that only one single Nas layer can be done in the current method?

However, from the Lidar observations, it looks that the peak Nas layer occurs at different altitude (here just shows one case 2015-02-02 used in the Table 1, see the figure at http://lidar.erau.edu/data/nalidar/plots/2015/20150202_Dmerge_15min_0.5km_90s_20p.jpg)

What is the value of "the fluid depth h" used for different cases because this is required to calculate the depth of wave d?

My other major concern is the lack of the explanation for sporadic Na Layer formation in the current version of the manuscript, which seems to me it still unclear why solitary wave causes the sporadic Na layer.

If we look at one case used in the current manuscript, for example their Figure 3, there is strong correlation of Nas layer (Figure 3a) with zonal mean wind shear in Figure3f where Richardson number is calculated from the Equation 36, which has the zonal mean wind changes with altitude from the lidar data.

Of course, this suggests that atmospheric waves are related to the Nas formation, but how the authors can attribute it to solitary waves, instead of gravity waves or tidal waves etc..

This may be not true because the authors have not applied a similar analysis for the the neutral Na data without Nas layer.

To be specified, what the results will look like if the authors apply the same method to the
neutral Na data excluding Nas layer? I understand that may be tough since there are some criteria to be met (for example, set the Na concentration and layer depth).

My other major concern is the lack of the explanation for sporadic Na Layer formation in the current version of the manuscript, which seems to me it still unclear why solitary wave causes the sporadic Na layer. If we look at one case used in the current manuscript, for example their Figure 3, there is strong correlation of Nas layer (Figure 3a) with zonal mean wind shear in Figure3f where Richardson number is calculated from the Equation 36, which has the zonal mean wind changes with altitude from the lidar data. Of course, this suggests that atmospheric waves are related to the Nas formation, but how the authors can attribute it to solitary waves, instead of gravity waves or tidal waves etc.. This may be not true because the authors have not applied a similar analysis for the neutral Na data without Nas layer. To be specified, what the results will look like if the authors apply the same method to the neutral Na data excluding Nas layer? I understand that may be tough since there are some criteria to be met (for example, set the Na concentration and layer depth). If the result using the neutral Na data by ignoring Nas is similar as presented in the current manuscript, then that would indicate the current conclusion is wrong.

It has been also widely accepted ion–molecule chemistry in plasma layers is the major mechanism for producing Nas layers at different latitudes, which based on the work from Cox and Plane (1998) (i.e., downward motion of sporadic plasma layer Es as a source of Nas formation by neutralized Na+ via an ion–molecule mechanism). This has been tested and supported from the observations including Na lidar measurements from different locations. Can you do a similar to see if this mechanism won't explain the Nas layer occurs over Ande station?