

Interactive comment on “Formation of a bottomside secondary sodium layer associated with the passage of multiple mesospheric frontal systems” by Viswanathan Lakshmi Narayanan et al.

Anonymous Referee #2

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This paper studies the formation mechanism of the secondary Na peak that appears within the altitude range of the main Na layer but below the main peak and near the bottomside of the main layer. The data quality (both lidar and airglow imager near Tromsø) is high, and the analyses connecting the lidar-observed secondary Na peak below its main layer peak with the OH-imager-observed mesospheric bore event are extensive. The topic is interesting to the middle atmosphere science community. On this aspect, the paper is worth considering for publication in ACP after extensive reviews and revisions.

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However, there are three major issues with the current manuscript: 1) The paper title is misleading or improper, 2) its Abstract reads badly with the first sentence distract people's attention, and 3) its Introduction contains misunderstanding of metal layer sciences.

All these issues likely stem from authors' misunderstanding of the meteoric metal layers. The main Na layer ranges from ~ 75 to 110 km, and the layer (below 85 km) they reported here is well within the main Na layer. Therefore, it is NOT an extra layer to the main layer, but an extra peak to the main layer peak. We have seen many times that Na layers go well below 85 km forming variable peaks during wintertime in the polar region, most likely caused by various wave activity. Therefore, what authors observed isn't new, but their studies of connecting such Na peaks to bore/frontal events are new and worth publishing.

1) Paper title: First, as written above it's not a new Na layer, but it's the secondary Na peak within the main Na layer; second, "in lower altitudes" has a grammar issue – lower than what? Therefore, such a paper title is not acceptable. Authors may consider to change the paper title to "Formation of an extra Na peak below the main layer peak associated with passage of multiple mesospheric frontal system" or something better.

2) Abstract: The first sentence in the Abstract is very misleading and it is frustrating to read it. Your paper is on the secondary Na peak below the main layer peak, but you started with mentioning something that is non-relevant to your subject. Please remove this sentence to avoid misleading readers. Also, change "additional sodium layer" to "additional Na peak".

3) Introduction: There is some lack of understanding of the thermosphere-ionosphere metal (TIMt) layers (mentioned in review paper by Plane et al. (2015)) in the Introduction, including thermosphere-ionosphere Fe and Na (TIFe and TINa) layers that were discovered to reach the altitudes of lower F region (Chu et al., GRL, 2011, 2020; Tsuda et al., GRL, 2015; Raizada et al., 2015; Chu and Yu, 2017). None of these pioneer-

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ing papers were acknowledged. Instead, authors referenced Collins et al. (1996) and Wang et al. (2012), and adapted a bad phrase “double sodium layers”. This “double sodium layers” phrase is improper and misleading, thereby it has been discarded by the field. Therefore, the current paragraph (the 3rd one in Introduction) is totally not acceptable. However, these TIMt layers aren’t the focus of this manuscript, so authors may choose to remove this paragraph entirely and focus on the main Na layer. If authors want to include TIMt layers in the introduction, then they should update their understanding of the TIMt layers and cite proper references:

Chu, X., Nishimura, Y., Xu, Z., Yu, Z., Plane, J. M. C., Gardner, C. S., & Ogawa, Y. (2020). First simultaneous lidar observations of thermosphere’s ionosphere Fe and Na (TFe and TNa) layers at McMurdo (77.84°S, 166.67°E), Antarctica with concurrent measurements of aurora activity, enhanced ionization layers, and converging electric field. *Geophysical Research Letters*, 47, e2020GL090181. <https://doi.org/10.1029/2020GL090181>

Chu, X., Yu, Z., Gardner, C. S., Chen, C., & Fong, W. (2011). Lidar observations of neutral Fe layers and fast gravity waves in the thermosphere (110–155 km) at McMurdo (77.8°S, 166.7°E), Antarctica. *Geophysical Research Letters*, 38, L23807. <https://doi.org/10.1029/2011GL050016>

Raizada, S., Brum, C. M., Tepley, C. A., Lautenbach, J., Friedman, J. S., Mathews, J. D., et al. (2015). First simultaneous measurements of Na and K thermospheric layers along with TILs from Arecibo. *Geophysical Research Letters*, 42, 10,106–10,112. <https://doi.org/10.1002/2015GL066714>

Tsuda, T. T., Chu, X., Nakamura, T., Ejiri, M. K., Kawahara, T. D., Yukimatu, A. S., & Hosokawa, K. (2015). A thermospheric Na layer event observed up to 140 km over Syowa Station (69.0°S, 39.6°E) in Antarctica. *Geophysical Research Letters*, 42, 3647–3653. <https://doi.org/10.1002/2015GL064101>

Chu, X., & Yu, Z. (2017). Formation mechanisms of neutral Fe layers in the

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thermosphere at Antarctica studied with a thermosphere-ionosphere Fe/Fe⁺ (TIFe) model. *Journal of Geophysical Research: Space Physics*, 122, 6812-6848. <https://doi.org/10.1002/2016JA023773>

Considering all these factors above, I rate the paper's scientific significance as "excellent", scientific quality as "fair", and presentation quality as "fair".

Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2020-803>, 2020.

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