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Interactive comment on "On the origin of the mesospheric quasi-stationary planetary waves in the unusual Arctic winter 2015/16" *by* Vivien Matthias and Manfred Ern

Anonymous Referee #1

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Comments on "On the origin of the mesospheric quasi-stationary planetary waves in the unusual Arctic winter 2015/16" by Vivien Matthias and Manfred Ern

This paper presents a detailed investigation of the spatial distribution and the propagation features of the SPW1 and SPW2 observed during the boreal mid winter of 2015/2016 that was characterized by an unusually strong polar night jet (PNJ). The both satellite temperature MLS/Aura and SABER/TIMED data for the period of time between 21 Dec 2015 and 20 Jan 2016 have been used for studying the characteristics of the SPWs and the GW drag respectively. The authors found extraordinary large SPWs in the subtropical mesosphere as the SPW1 dominates from late December

2015 to early January 2016 (named as Period I) while the SPW2 dominates from early January until mid January 2016 (called as Period II). Moreover, the authors found also the amplification of the SPW1 in the Period I and the SPW2 in the Period 2 respectively in the polar mesosphere. These results actually defined the basic object of the study that is to define the origin of the observed mesospheric subtropical and polar SPWs. By using all possible data analysis methods: (i) two-dimensional least squares method for determining the SPW amplitudes and phases; (ii) calculation of the geostrophic winds for estimation of the propagation conditions of the SPWs; (iii) diagnostic analysis (calculations of: the refractive index squared n2; the Eliassen-Palm flux (EPF) vectors and their divergence, and the meridional potential vorticity gradient) for distinguishing regions of wave propagation from wave evanescence, defining the direction and strength of SPW propagation, the interaction of the SPWs with the mean flow and the condition for barotropic and/or baroclinic instabilities respectively; (iv) longitude distribution of the GW drag. By the synergy of the all above mentioned analysis methods and satellite data sets, the authors found clear evidences for the origin of the both subtropical SPWs (they propagate from the mid-latitude stratosphere) and polar SPWs (generated in situ by longitudinally variable GW drag and by instabilities) in the mesosphere and in the two periods. Additionally, the authors considered also a possible contribution of the unusually strong SPWs in the subtropical mesosphere to the disruption of the QBO in the same winter as well as the impact of the strong El Niño on the enhancement of the PNJ.

I find this paper very interesting and useful particularly for colleagues working on the PW coupling processes. The clarification of the area that is crucial for the upward propagation of the SPWs into the subtropical mesosphere is an important new result. The topic of the paper is certainly appropriate for the journal. It is written very clearly and presents informative figures of high quality. The abstract adequately presents the obtained in the paper results. Therefore I suggest the publication of this paper after addressing only two very minor comments mentioned below.

(i) P. 7: It is written: ". . .. as wave (a) which propagates from the stratosphere over the stratopause region (wave (b)). . .. . .", or "In other words the SPW 1 generated in the lower stratosphere could be propagated upward in midlatitudes until the upper stratosphere." Similar statements have for the SPW2 as well in p. 8. Yes, the SPW phase analysis and EPF vectors indicate vertical and equatorward propagations however the presence of the waves (a) and (b) from Figures 2 and 3 represents actually the typical double-peak altitude structure of the SPWs in the field of the temperature. This issue is reported by Pancheva et al. (2009; please, see Figure 9 there) and is a consequence of the hydrostatic equation (Sassi et al., 2002). Moreover, this double-peak altitude structure is valid not only for the SPWs but for all PWs in the field of the temperature; for example, Pancheva et al. (2016) showed this feature for the quasi-2-day waves.

(ii) I have some doubt about wave (d) from Fig. 3 that it is in situ generated. I think that the waves (c) and (d) represent the above mentioned double-peak altitude structure of the SPW2 in the field of the temperature. This could be checked by considering the SPW2 but in the field of the geopotential height; the latter should have a single peak maximum situated at an altitude coinciding approximately with the altitude of the minimum between the double-peak structures in the temperature. Both the phase structure and EPF vectors southward from 60°N show vertical and equatorward propagation of the SPW2; wave (d) is also above the region where n2 is negative.. I agree that EPF vectors are not large at altitude of 80 km but below and above this altitude they are quite large. I think also that the barotropic and/or baroclinic as well as the GW drag may additionally strengthen the northern part of wave (d).

Typos: The text of Figure 7: Latitude-time. . .. should be Longitude-time. . ..

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