Weather Clim. Dynam. Discuss.,
https://doi.org/10.5194/wcd-2020-17-RC3, 2020

Interactive comment on "Mechanisms and predictability of Sudden Stratospheric Warming in winter 2018" *by* Irina A. Statnaia et al.

Anonymous Referee #3

Received and published: 10 June 2020

The present manuscript analyses the sudden stratospheric warming that took place in mid-February 2018 (SSW2018). In particular, the study focuses on the tropospheric forcing of this phenomenon by examining its predictability based on the ECMWF ensemble forecast of the S2S initiative. The SSW2018 is found to be preceded by an amplification of wavenumber 2 wave activity in the stratosphere that is linked to the occurrence of a blocking in the Ural Mountains region. The authors also investigate the role of the record-breaking Madden Julian Oscillation (MJO) phase 6 in triggering the SSW event. The results show that this phenomenon might help, although its influence does not seem to be decisive.

The manuscript is well-written and the analysis is interesting. Thus, my recommendation is publication after having performed some minor changes.

Specific comments:

L42-43: I think the clearest example of the interdecadal variability of SSW is the 2000s decade when there was an SSW in almost every winter and the 1990s decade with a very low frequency of SSWs.

L57: Please note that some studies such as de la Cámara et al (2019) have also shown that it is not always necessary to have an enhancement of tropospheric waves for the occurrence of an SSW.

L70: This was also shown by Ayarzagüena et al. (2018).

L110-112: Is the data detrended?

L115-123: Instead of the wave activity flux by Plumb (1985), I would suggest using the wave activity flux by Takaya and Nakamura (2001). This flux is defined for the case of a zonally varying basic flow, which, I think, is more appropriate in this study. The basic state in the Northern Hemisphere in winter shows inhomogeneities that can modulate the propagation of Rossby wave packets. Takaya and Nakamura's flux only focuses on the wave activity associated with Rossby wave packets, as the wavy anomalies are considered to be embedded in the basic flow that includes the climatological planetary waves. Actually, this flux was used by different authors to study tropospheric forcing of SSWs such as the event of January 2006 (Nishii et al. 2009) or the SSWs of 2009 and 2010 (Ayarzagüena et al., 2011).

L147-157: This evolution of the polar night jet (PNJ) is typical of split-vortex SSWs (S SSWs) (Charlton and Polvani, 2007). Before these events, the PNJ typically shifts poleward and then, the vortex splits into two pieces. Albers and Birner (2014) also show that the polar vortex before S SSWs tends to be constrained around the pole and has little vertical tilt. I think some comment about that could be added.

L205-207 and figure 6: it is difficult for me to identify the regions with large ensemble-forecast spread.

L217-229: I agree with the authors that there are some bursts of wave activity in the troposphere before the occurrence of SSW2018. I also agree on the enhancement of wave activity in the stratosphere, particularly in the North Atlantic sector. However, I have the impression that apart from the tropospheric forcing there is a self-amplification of the wave activity in the stratosphere. These results would be also consistent with the characteristics of wave activity during S SSWs highlighted by previous studies. For instance, Plumb (1981) and Albers and Birner (2014) indicate that it is typical for S SSWs that an initial vortex structure close to its resonant point can split the vortex with only a small increase in tropospheric wave forcing. I would suggest adding some comments about that in the text.

L241-245: When split into three regions, the correlation coefficient between the vertical component of the WAF forecasts on 4–11 February and U10 forecasts on 12 February is not statistically significant in the troposphere. Do you know why?

L257-265: I must confess I find it difficult to see the propagation of synoptic structures in Figure 9b. In this sense, I am not 100% sure that the anomalies of v250ˆ2 on 8 February around 80°E are related to the anomalies over the Eastern Atlantic at the beginning of February, as the red box in figure 9b seems to indicate. There are already some anomalies at high latitudes in Eurasia on 6 February that seem to intensify in the following days. A similar evolution is detected in Figure 10a for EN+ members, but in EN- members you have a very similar pattern over the North Atlantic on 3-6 February, but the development of the anomalies over the Eurasia is missing.

L321: please add “the”

L397: we have also shown

L397-399: please rewrite this sentence.

L419: Domeisen et al. 2019a or b?

Figure 14, caption: It is not 100% clear for me what you are showing in contours. Is it

the geopotential height anomalies for all MJO phase 6 in the whole period of study? I understood so, but it would be great if you indicate it more clearly in the text.

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