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

Anonymous Referee #2

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General Comments: This study by Statnaia et al. examines the predictability of the February 2018 SSW by investigating the tropospheric conditions prior to the onset using the 51-member ensemble forecast of the ECMWF. In particular they focus on the role of tropospheric wave activity in the 10-14 days before the observed SSW date. They find that the Ural High region is particularly important for the onset of this SSW via the development of a blocking anticyclone in agreement with a recent study. This anticyclone was contributed to by the MJO phase 6-7, although this latter section is somewhat speculative in its nature. The paper is mostly well-written, although the English could do with some improvement (there are many places where the wrong article ['a' or 'the'] are used). Overall I find the paper quite interesting and thus warrants publication in WCD. My comments are all rather minor and hence my recommendation

is publication with minor revisions.

Specific Comments:

Lines 95-98; to clarify, you only use forecasts that are initialized on 1st February? Have you examined any forecasts initialized before (and also after) this? If so, can you say something about them? How poor was the prediction skill of such forecasts? What is the 'fraction' mentioned in the two cited papers?

Line 116; 1) 'used to localize regions on wave activity sources and sinks' → '. . .is used to identify localized regions of wave-activity sources and sinks.' 2) In this diagnostic did you calculate for stationary waves? i.e., did you average the u,v,T etc in time prior to calculating the deviations from the zonal mean? Such a calculation is important as this diagnostic is only suitable for stationary waves. For transient waves, as is more appropriate here for synoptic-scale features, the flux of Takaya and Nakamura (2001) would be more apt.

Line 162; how many ensemble members actually maintained the easterlies for the period that ERAI shows?

Line 165; are these GPH anomalies that are shown? In section 2 you mention that GPH is only shown as anomalies, although this figure does not make it clear. Further on lone 167, you mention the 4-6th February GPH fields but they are not shown in figure 3. It would be useful to include them or at least state that they are not shown if that is the case.

Lines 188-190; Such a relationship between wave1 and wave2 with one increasing and the other decreasing in amplitudes suggests some kind of wave-wave interaction occurring, i.e., wave2 grows at the expense of wave1 and vice versa. To diagnose this would be beyond the scope of this paper as it involves the enstrophy budget. However, a sentence on this may be useful as well as a suitable reference such as Smith (1983).

Line 199; What exactly is the ensemble spread shown here? The difference between

the max and min ensemble members? i.e., the best and worst ensemble members? Or between the EN+ and EN- groups?

Figure 6; The contours are too dense to be able to make out the values of the spread shown by the shading, especially in panel a. Can you decrease the number of contours in all panels?

Lines 227-228; I wonder if the Europe/Siberia sector can be considered as preconditioning the vortex prior to the reversal. Indeed, the North Atlantic sector appears to be the final straw with massive amplification just before the onset, but the Europe/Siberia sector is maximized a week or so before. Have you checked which wavenumbers dominate the flux in this figure? From figure 4 I would hazard a guess at wave-1, but it would be good to find out for sure.

Figure 9; what are the lines for? Presumably to show the blocking ridges and troughs. Please refer to them in the text and describe what they show in the caption; they could be useful in helping to explain to the reader. Further, figure 9b I find hard to understand what is going on. The features described on lines 258-265 are very difficult to see and as such I am not sure that I would agree with their characterization. For instance, the maximums in v'^2 on Feb 6th and 7th centered at 0E are characterized as two different events, but they could well be the same event. The max in v'^2 that is 80deg further downstream is characterized as part of the red-box event, but I find it rather unlikely that the feature would have travelled 80deg in one day. I find panel a much more believable and to me provides the necessary information that I would want to know; I would consider removing panel b entirely or at least making it clearer in the text exactly how you are tracking the features.

Figure 11; Can you include the u contours on this plot to show how the winds and wave propagation are related. Further, the panels of the composite EN+ and EN- would be helpful to see how overall, the best and worst ensemble members capture the horizontal wave propagation compared to ERAI.

C3

Figure A2; over how many days are these trajectories run?

Line 318; Why is the central date here cast as February 7th? The central date in ERAI was 12th February throughout the earlier manuscript. Is this chosen as the period before which the vortex started being displaced and then splitting?

Line 332 and 339; how sensitive are the results in figure 14 to different lag stages? Given the previous comment, this can be important. Why exactly are lags 5-9 days before February 7th chosen? Figure 14; it is somewhat unclear from the caption and text exactly what this figure is showing. The contours are the 'climatological' response to every MJO phase 6-7 event, delayed by 5-9 days, in the ~20 years of data? Then the shading represents the GPH anomalies just for the period 5-7th February for this one SSW event? Hence if the shading projects onto the contours then one could say there is constructive interference? Please clarify.

Line 361; I would say that the EN- composite actually captures the global pattern pretty well in ERAI and EN+. It is the difference over the Urals/East Asia that is most pronounced as the observed wave-2 pattern is instead a wave-1 via a connection of the ridges.

Summary; Please include references to figure numbers throughout.

Technical Comments:

Line 40; add 'a' before 'negative phase of the. . .'

Line 101; what does EN stand for here? It is a little confusing as it can be easily mixed up with the El Nino phase (indeed initially I thought that was what it meant until I got to figure 2). Can you use a more appropriate acronym?

line 225; 'third' → 'sector'

Line 255; 'cost' → 'coast'

Line 397; The sentence starting 'Here we also' does not make sense written as it.

C4

Please change to make clear.

Lines 413-414; Rewrite sentence as 'the composite analysis provides evidence, albeit indecisive, that teleconnections. . .'

References: Smith 1983, Observations of wave-wave interactions in the stratosphere. JAS.