

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

**Anonymous Referee #1**

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### **general comments**

This study investigates the lower tropospheric forcing of the major sudden stratospheric warming (MSSW), taking place in February 2018, and its predictability, using S2S database of the ECMWF. The main focus lies on two points: i) under which tropospheric conditions or forcings does the major warming occur (with a focus on the amplification of wave two in the stratosphere)?, and ii) why do some forecasts fail to predict the warming (within a time period of  $\pm 1$  day)? Two clusters are formed emphasizing the different evolution of the polar vortex within the forecast period. MSSW 2018 occurred under an amplification of planetary wave 2 which is mainly connected with anticyclones over Alaska and the Ural Mountains. A connection is drawn to the strong MJO phase 6

C1

roughly two weeks before the onset. The anticyclone over the Ural mountains evolves and maintains under the forcing of wave trains modified by the strong MJO phase. This scale interaction starting to diverge within the ensemble over the North Atlantic sector. It is suggested that the missing MJO response towards the Northern Hemisphere and the modification of the synoptic scale wave trains is likely the cause.

The paper is well written and clearly structured. It is the starting point to investigate which kind of processes belong to a systematic model bias and which are due to internal variability putting forward the S2S prediction system. Therefore I think the paper is worth for publishing after the authors have addressed the specific points below.

### **specific comments**

#### *Data and Methods*

- Which resolution (spatial and temporal) is used for the ECMWF ensemble forecast?
- Were the data evaluated on 12-hourly basis or daily mean basis?
- Geopotential height anomalies are calculated with respect to different time periods for ERA-Interim (1980-2010) and forecast ensemble (hindcasts: 1997-2017). Could we expect different anomalies only due to the different time periods? Have trends been removed?
- Wave activity flux calculations can be used for different time scales spanning from e.g. 10 years down to 5-day mean averages. The investigated "quasi-stationary waves" changes under different temporal averaging. Which kind of temporal averaging is used for defining the prime quantities in the WAF calculations?

C2

- The MJO phase space is obtained by an EOF analysis of the combined fields. Long time scales should be filtered out before the index is calculated. Is a temporal filter applied to the forecast data for calculating the MJO index based on anomalies? Is it necessary for 46-day forecasts?

#### *Stratospheric forecasts*

- line 141: The fluctuations of the easterlies after the MSSW onset are very interesting. Are these fluctuations a result of the vascillation cycles (Holton and Mass, 1976)? The ensemble members do not capture these vascillations? Is the tropospheric forcing maybe not steady within the ensemble in contrast to ERA-In?
- line 199-203: Figure 5 shows forecast spread at 50 hPa? Why is 50 hPa selected instead of 10 hPa (Figures before)?
- Fig. 5 and Fig.6 show ensemble spread at 50 hPa and as a cross section at 50°N, respectively. The ensemble spread is in Fig.5c above 0.3 at 50°N at 50 hPa. Why is this not visible in Fig.6c?
- In Fig. 6 the ensemble spread is gradually decreasing with height and remains below 0.1 above 150 hPa for the selected 3 dates. Why is the ensemble spread decreasing with height and remains low even if the forecast time proceeds?

#### *Tropospheric waves*

- Figure 9 shows the temporal evolution of the geopotential height at 250 hPa and the squared meridional wind component at the same level. Would a Hovmöller plot of the squared meridional wind component averaged between 40°N-65°N enhance the visibility of the wave trains (like e.g. Glatt et al., 2011)? The usage of the square of anomalous meridional wind provides an alternative (e.g. Chang, 1993).

C3

- The description of the coloured lines or coloured rectangles are missing in the captions of Figure 9 and Figure 10. A possible connection can be drawn in the paragraph starting at line 250. Is the contour interval in Fig.10 a,b the same as in Fig.9b?

#### **technical corrections**

- line 94: please, remove blank after "forecast"

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C4