Understanding the Differences in the Sub-seasonal Predictability of Extreme Stratospheric Events

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1 Introduction

Extreme stratospheric events such as sudden stratospheric warming events (SSW) and strong vortex events are often the focus of predictability studies due to their downward impacts on surface weather. The predictability of events differ strongly between events and the reasons are not resolved.

2 Methodology

We extend the definitions of extreme stratospheric events (such as sudden stratospheric warmings (SSW) and strong vortex events) by identifying 10-day wind acceleration and deceleration events (Fig. 1):

$$\Delta\overline{u} = \overline{u}(t=9) - \overline{u}(t=0)$$

$\overline{u}$ = zonal mean zonal wind at 60N, 10hPa [m/s]
$\Delta\overline{u}$ = wind change / event magnitude
t = time [days]

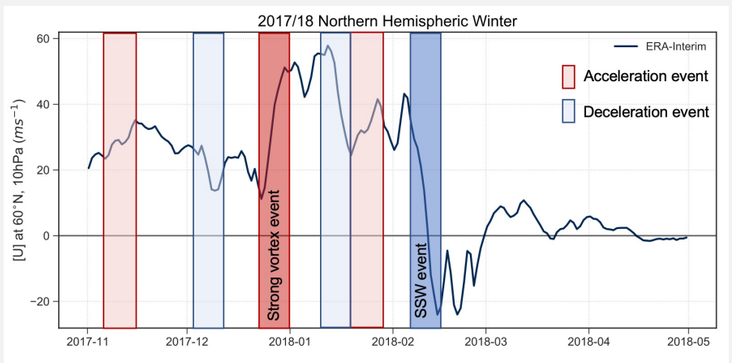

Fig.1 Zonal mean zonal wind (u) for the 2017/18 NH winter. Red and blue shading denotes the identified wind acceleration and deceleration events, respectively. The darkened red and blue correspond to a strong vortex event and SSW event.

3 Results

Wind deceleration events are found to be less predictable than acceleration events (Fig. 2). When plotting the skill of hindcasts against the observed event magnitude (Fig. 3), acceleration and deceleration events show the same predictability dependence on event magnitude. Very strong SSW events (2009 and 2018 split events) retain large errors even at short lead times. The model has limitations in producing extremely strong wave activity (Fig. 4).

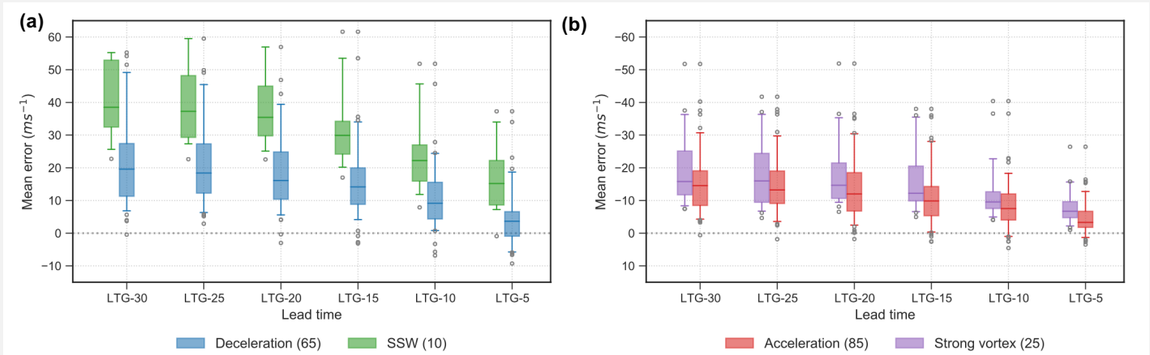

Fig.2 Mean error in event magnitude (Δu) for **(a)** deceleration events (blue), SSW events (green), **(b)** acceleration events (red) and strong vortex events (purple) at different lead times.

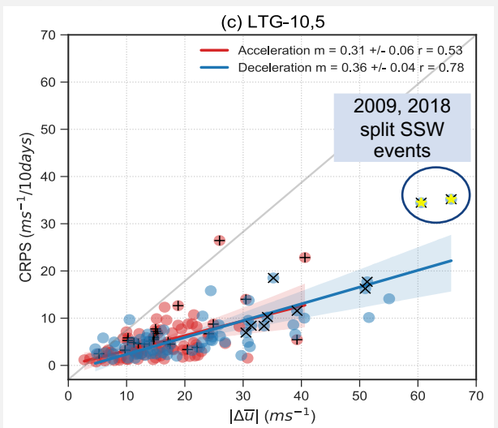

Fig.3 Probabilistic error of Δu for the acceleration (red) and deceleration (blue) events plotted against their observed absolute magnitude ($|\Delta u|$).

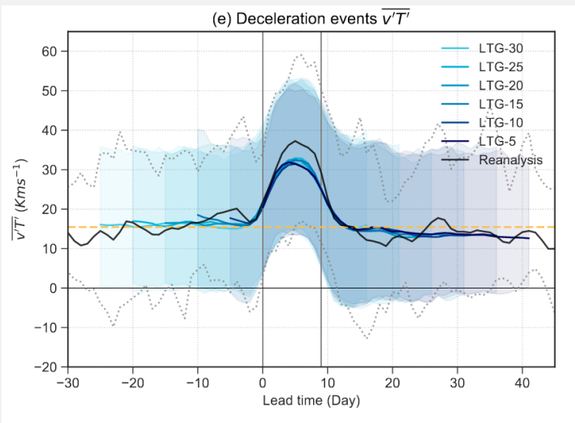

Fig.4 Temporal evolution of eddy heat flux ($\overline{v'T'}$) at 100hPa for strong deceleration events identified in the model at different lead times.

4 Conclusion

- Extreme stratospheric events show a close to linear dependence of predictability on event magnitude
- Very strong magnitude events deviate from this linear relationship, and are even less predictable (e.g. 2009 and 2018 SSW events)
- The ECMWF model shows limitations in producing extremely strong wave activity, which might be associated with nonlinear processes

5 Datasets

- Hindcasts of the ECMWF model from the sub-seasonal-to-seasonal (S2S) database (Vitart et al., 2017)
- Nov to Mar 1998/99 – 2017/18
- ERA-I reanalysis