# Resubmission of wcd-2021-84: Differences in the Sub-seasonal Predictability of Extreme Stratospheric Events

Dear Co-Editor Yang Zhang,

On behalf of all authors I would like to submit the revised version of the original article "Differences in the Sub-seasonal Predictability of Extreme Stratospheric Events" including an annotated manuscript and a modified version of the manuscript. To address the concerns of referee 2, we have included comments on nonlinear processes in SSW prediction (Lines 446-454) and have included the two suggested references in Line 450.

Once again, thank you very much for your time in reviewing our manuscript.

Best regards,
Rachel Wu

**Reviewer 2** Specific comments.

1) Line 436: the split SSW event in 2009 has been studied in depth by Gray et al. (2020; 2022). Using controlled modelling simulations, they showed that event involved a series of build-up of acceleration events and nonlinear wave-wave interactions. It is worth citing these more recent papers here. These papers suggest that one of the potential reasons for the limited success in model predicting SSWs is nonlinear processes in the equatorial upper stratosphere during early winter.

Gray, L.J., Brown, M.J., Knight, J. et al. Forecasting extreme stratospheric polar vortex events. Nat Commun 11, 4630 (2020). https://doi.org/10.1038/s41467-020-18299-7.

Gray, L.J., Lu, H., Brown, M.J., Knight, J.R. and Andrews, M.B. (2022), Mechanisms of influence of the Semi-Annual Oscillation on stratospheric sudden warmings. Q J R Meteorol Soc, 148: 1223-1241. https://doi.org/10.1002/qj.4256

Thank you for your comment. We now added the discussion on the nonlinear processes in Lines 447-455 and included the two suggested references.

Lines 446-454: "Furthermore, vortex preconditioning may also be an important factor in determining predictability. For example, certain geometrical configurations of the initial state of the vortex might be more susceptible to vertical wave propagation and weak breaking (Albers and Birner, 2014; Matthewman and Esler, 2011; Esler and Matthewman, 2011). Remote precursors from the tropical stratosphere (Garfinkel et al., 2018; Gray et al., 2020, 2022), the tropical troposphere (Domeisen et al., 2015; Garfinkel and Schwartz, 2017), and the extratropical troposphere (Martius et al.,2009; Karpechko et al., 2018; White et al., 2019; Peings, 2019) can also further enhance predictability on sub-seasonal to seasonal timescales. As such, one might want to investigate how the 2009 and 2018 split SSW events differ from other deceleration events in terms of their preconditioning processes, and to see whether the mechanisms, in particular the nonlinear processes, associated with the two events are well represented in the model."