Role of Finite-Amplitude Eddies and Mixing in the Life Cycle of

Stratospheric Sudden Warmings

SANDRO W. LUBIS *, Clare S.Y. Huang, and Noboru Nakamura

Department of Geophysical Sciences, University of Chicago, Chicago, Illinois, USA

*Corresponding author address: Sandro W. Lubis, University of Chicago, 5734 S Ellis Ave, Chicago IL 60637, USA. E-mail: slubis@geomar.de
List of Figures

S1 [S1] Composites of normalized equivalent length $K_{eff}/\kappa$ anomaly as a function of time and equivalent latitude for (left) MERRA2 and (right) CESM1(WACCM), at the 850, 600, 500, and 350 K. The orange solid (dashed) contour lines indicate 95% (99%) significant level based on a 1000-trial Monte Carlo test.

S2 [S2]. As in Figs. 4c-f, but for split and displacement types of SSW events in MERRA2.

S3 [S3]. As in Figs. 4c-f, but for reflective and absorptive types of SSW events in MERRA2.

S4 [S4] As in Fig. 5, but for split and displacement types of SSW events in CESM1(WACCM). The green solid (dashed) contour lines indicate 95% (99%) significant level based on a 1000-trial Monte Carlo test.

S5 [S5] As in Fig. 6, but for reflective and absorptive types of SSW events in CESM1(WACCM). The green solid (dashed) contour lines indicate 95% (99%) significant level based on a 1000-trial Monte Carlo test.

S6 [S7] Time-height composites of Gravity wave drag (GWD) and residual of TEM zonal momentum budget equation (X) during SSWs averaged between 50-70°N in (a-d) 38-yr MERRA2 and (e-f) 100-yr CESM1 (WACCM) simulation. The contour intervals are in logarithmic powers of 2: ± [0.25, 0.5, 1, 2, 4, 8, 16, 32, 64,...] m s$^{-1}$ day$^{-1}$. The green solid (dashed) contour lines indicate 95% (99%) significant level based on a 1000-trial Monte Carlo test.

S7 [S8] As in Fig. 8, but with an additional term of X in the budget analysis.
Fig. 1. [S1] Composites of normalized equivalent length $K_{eff}/\kappa$ anomaly as a function of time and equivalent latitude for (left) MERRA2 and (right) CESM1(WACCM), at the 850, 600, 500, and 350 K. The orange solid (dashed) contour lines indicate 95% (99%) significant level based on a 1000-trial Monte Carlo test.
Fig. 2. [S2]. As in Figs. 4c-f, but for split and displacement types of SSW events in MERRA2.
Fig. 3. [S3]. As in Figs. 4c-f, but for reflective and absorptive types of SSW events in MERRA2.
Fig. 4. [S4] As in Fig. 5, but for split and displacement types of SSW events in CESM1(WACCM). The green solid (dashed) contour lines indicate 95% (99%) significant level based on a 1000-trial Monte Carlo test.
Fig. 5. [S5] As in Fig. 6, but for reflective and absorptive types of SSW events in CESM1(WACCM). The green solid (dashed) contour lines indicate 95% (99%) significant level based on a 1000-trial Monte Carlo test.
Fig. 6. [S6] Time-height composites of Gravity wave drag (GWD) and residual of TEM zonal momentum budget equation (X) during SSWs averaged between 50-70°N in (a-d) 38-yr MERRA2 and (e-f) 100-yr CESM1 (WACCM) simulation. The contour intervals are in logarithmic powers of 2: ± [0.25, 0.5, 1, 2, 4, 8, 16, 32, 64,..] m s$^{-1}$ day$^{-1}$. The green solid (dashed) contour lines indicate 95% (99%) significant level based on a 1000-trial Monte Carlo test.

\[
[X] = [u]_t + \zeta \left( [v] - \rho_0^{-1} \left( \rho_0 \frac{[v^* \theta^*]}{[\theta]} \right) \right) + [u]_z \left( [w] + \frac{1}{a \cos \phi} \left( \cos \phi \frac{[v^* \theta^*]}{[\theta]} \right) \right) - (\rho_o a \cos \phi)^{-1} \nabla \cdot \mathbf{F}.
\]
Fig. 7. [S7] As in Fig. 8, but with an additional term of X in the budget analysis.