Table S1: Classification of SSWs using ERA5 covering the period 1979–2019. Following Karpechko et al. (2017), a SSW is classified as downward-propagating (dSSW) if (1) the mean NAM index for the period from day 8 to 52 after the central date at the 1000 hPa level (NAM1000) is negative with (2) at least 50 % of the days showing a negative value at 1000 hPa and (3) at least 70 % of the days showing a negative value at the 150 hPa level (NAM150). If at least one of the three criteria is not met, the SSW is classified as non-propagating (nSSW). Compare Table 1 in Karpechko et al. (2017).

Central Date	dSSW/nSSW	(1) NAM1000	(2) daily NAM1000 in %	(3) daily NAM150 in %
22.02.1979	**dSSW**	**-1.2**	**78**	**87**
29.02.1980	**dSSW**	**-0.7**	**80**	**89**
04.03.1981	nSSW	0.3	47	67
04.12.1981	nSSW	-0.7	78	69
24.02.1984	**dSSW**	**-1.1**	**96**	**96**
01.01.1985	**dSSW**	**-1.8**	**100**	**100**
23.01.1987	**dSSW**	**-0.7**	**80**	**100**
08.12.1987	nSSW	0.5	33	58
14.03.1988	nSSW	-0.2	58	44
21.02.1989	nSSW	0.7	16	78
15.12.1998	nSSW	-0.2	51	67
26.02.1999	**dSSW**	**-0.5**	**60**	**96**
20.03.2000	nSSW	0.2	38	22
11.02.2001	**dSSW**	**-0.8**	**71**	**91**
30.12.2001	nSSW	1.1	9	31
18.01.2003	nSSW	-0.0	51	60
05.01.2004	**dSSW**	**-0.8**	**80**	**100**
21.01.2006	**dSSW**	**-0.4**	**62**	**93**
24.02.2007	nSSW	0.3	42	31
22.02.2008	nSSW	-0.0	62	42
24.01.2009	**dSSW**	**-0.7**	**71**	**100**
09.02.2010	**dSSW**	**-0.4**	**60**	**89**
06.01.2013	**dSSW**	**-0.7**	**82**	**100**
12.02.2018	**dSSW**	**-0.7**	**78**	**82**
01.01.2019	**dSSW**	**-0.1**	**62**	**87**

References

A. Y. Karpechko, P. Hitchcock, D. H. Peters, and A. Schneidereit. Predictability of downward propagation of major sudden stratospheric warmings. *Quarterly Journal of the Royal Meteorological Society*, 143:1459–1470, 2017. doi: 10.1002/qj.3017.

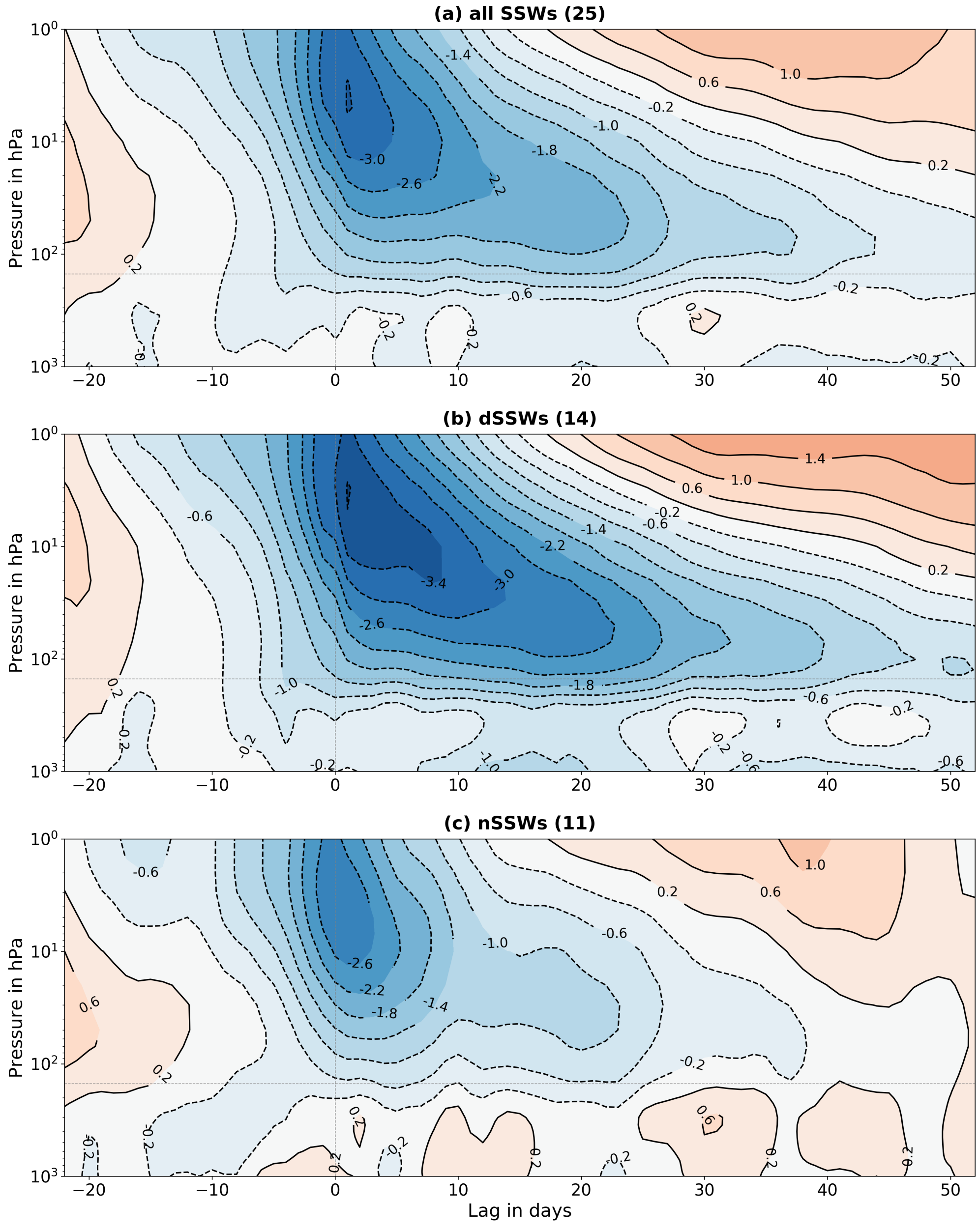

Figure S1: Composite of the temporal evolution of the NAM index averaged over (a) all SSWs, (b) all dSSWs and (c) all nSSWs. The dashed horizontal line indicates the 150 hPa level, the dashed vertical line marks the central date.

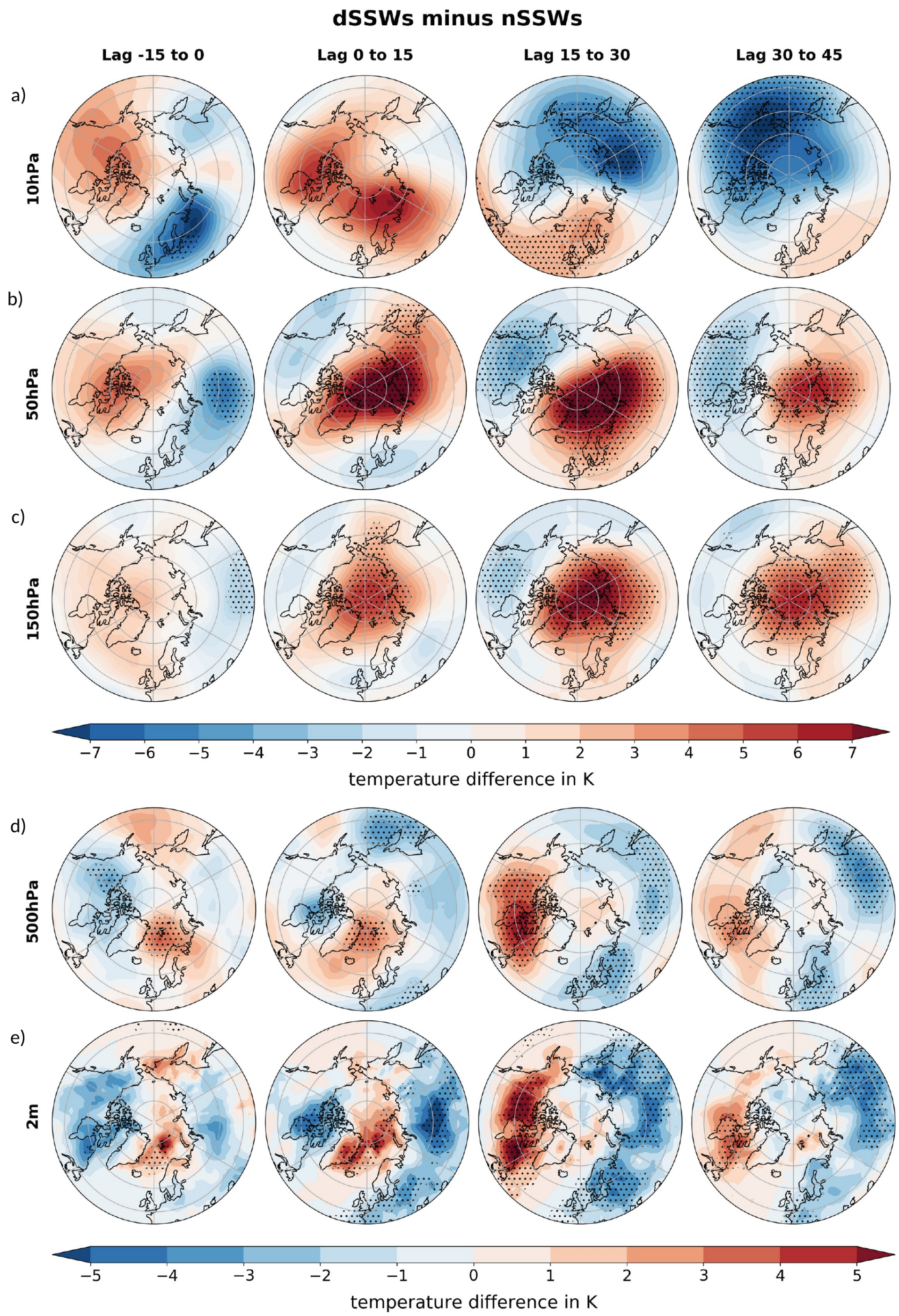

Figure S2: Composite of the differences between dSSWs and nSSWs in the temporal evolution of temperature anomalies averaged over 15-day periods around the central dates on different pressure levels during. The hatching indicates significant differences at the 5 % level between dSSWs and nSSWs.

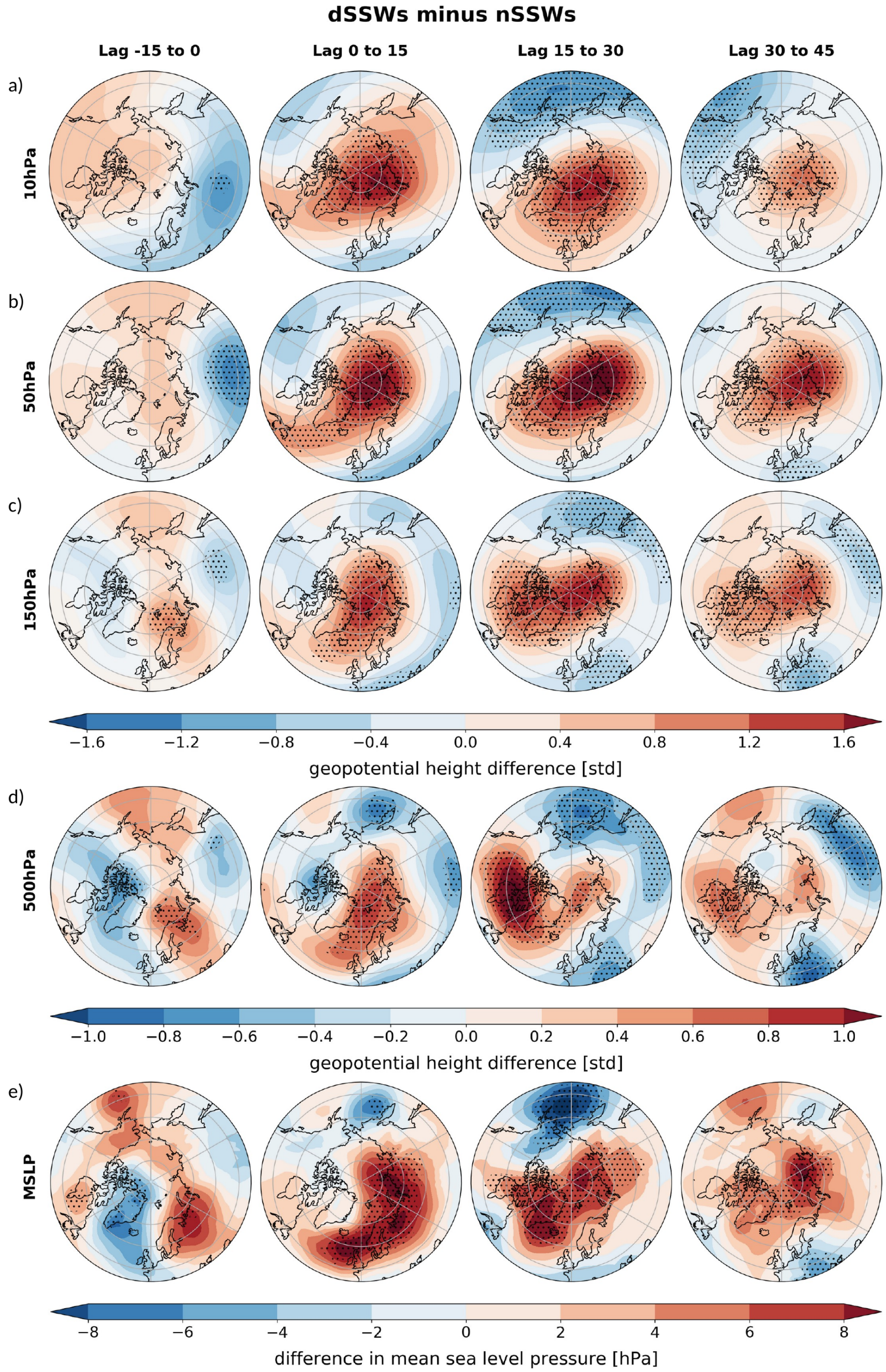

Figure S3: As Figure S2 but for the differences in the temporal evolution of geopotential height anomalies. Again the hatching indicates significant d/nSSW differences at the 5 % level.

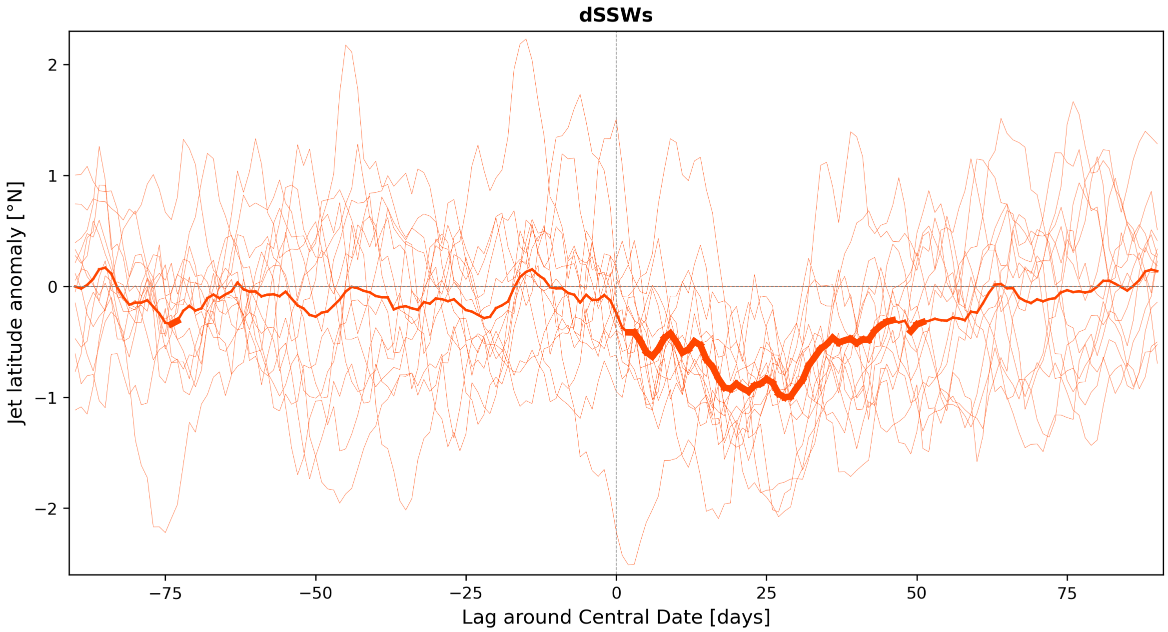

Figure S4: Composite of jet latitude anomalies in °N for different lags around the central date of dSSWs. The solid line shows the composite mean, where a thicker line marks the days with jet latitude anomalies significantly different from the climatology at a 95 % confidence level. Very thin lines show individual dSSW events.

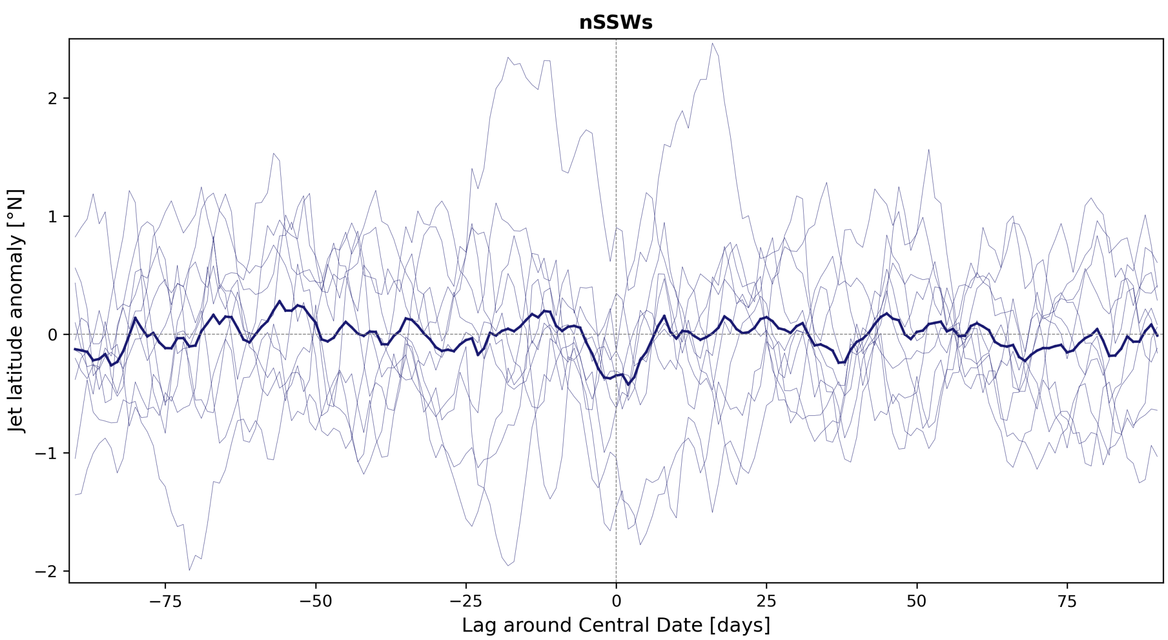

Figure S5: Composite of jet latitude anomalies as in Fig. S4 but for different lags around the central date of nSSWs.

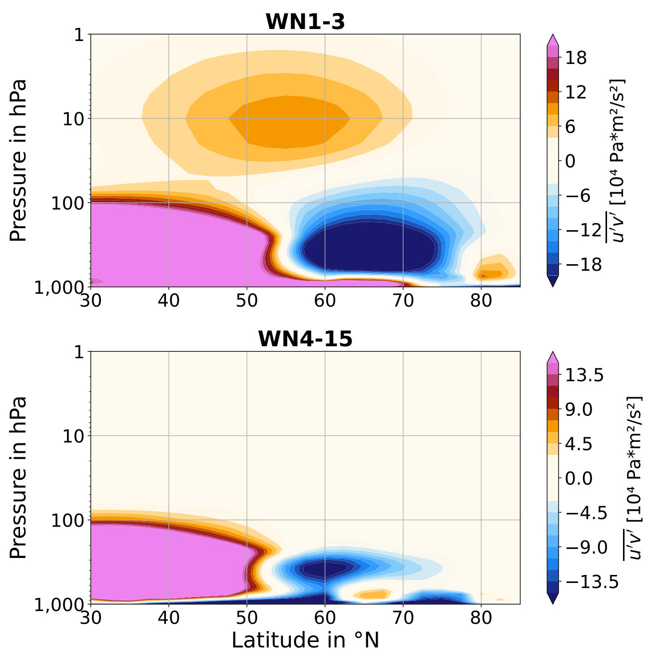

Figure S6: Latitude-height composites of the wintertime (NDJFM) zonal-mean pressure-weighted eddy momentum fluxes for planetary (upper panel) and synoptic-scale (lower panel) waves.

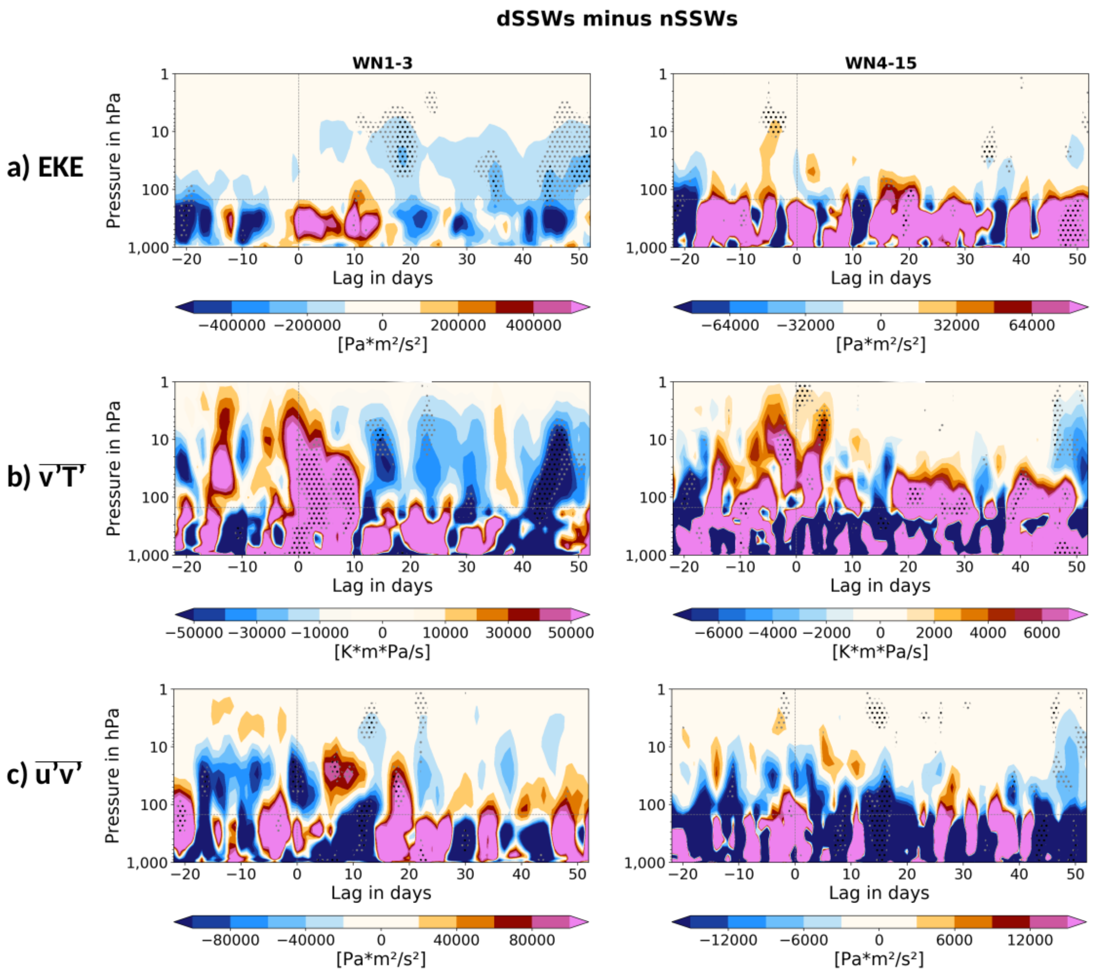

Figure S7: Time-height composites of the temporal evolution of pressure-weighted differences between dSSWs and nSSWs for a) eddy kinetic energy, b) eddy heat fluxes, and c) eddy momentum fluxes averaged over a latitude band covering 50 to 70° N. Left column shows the composites for planetary-scale wave numbers 1 to 3, right column for synoptic-scale wave numbers 4 to 15. Black (gray) hatching indicates significant differences at a 5 % (10 %) level. The dashed horizontal line indicates the 150 hPa level, the dashed vertical line marks the central date.

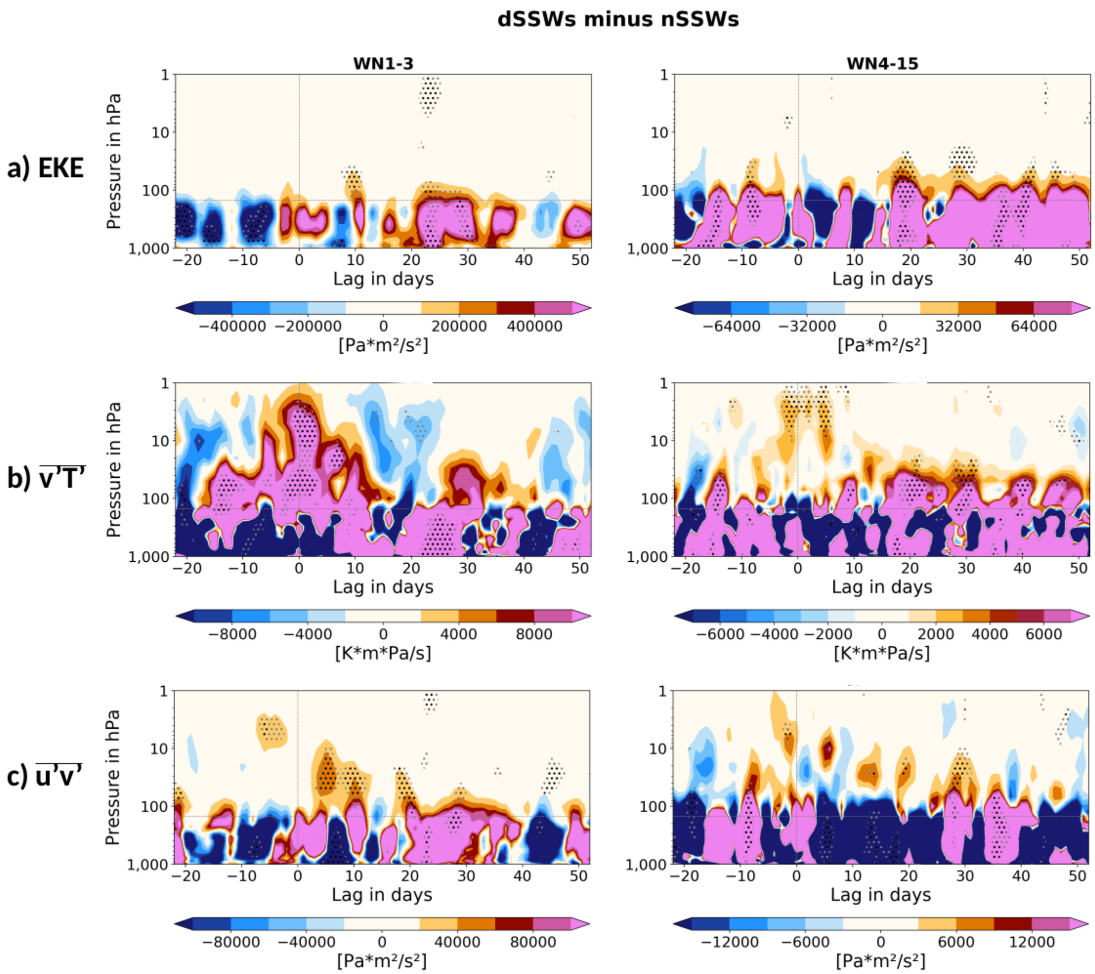

Figure S8: Time-height composites as in Fig. S7 but averaged over a latitude band covering 30 to 47.5° N.