Supporting information for "The role of the stratospheric state in upward wave flux prior to Sudden Stratospheric Warmings: a SNAPSI analysis"

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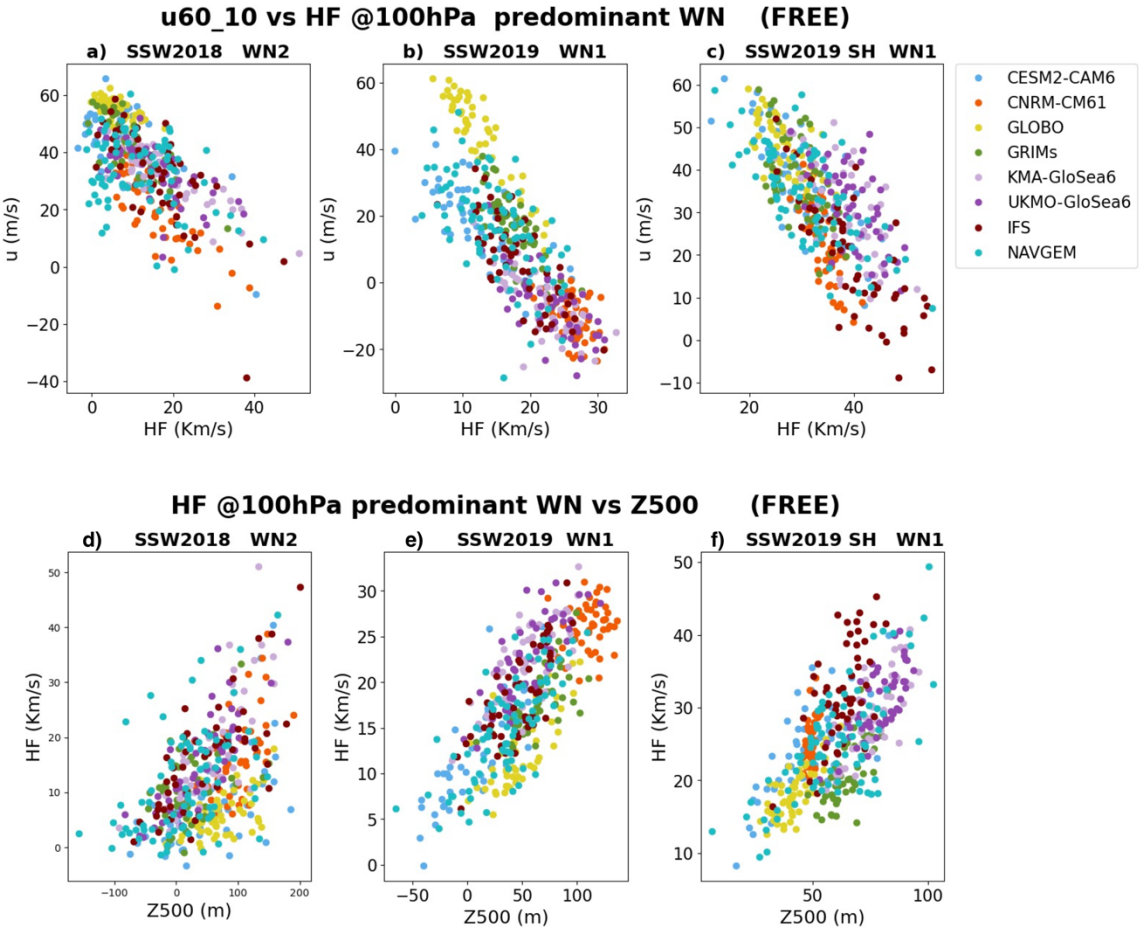

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Figure S1. Scatter plots of (a)-(c) u60_10 (m/s) averaged during the SSW onset date vs heat flux at 100hPa (K m/s) for the predominant wavenumber and averaged during the burst of tropospheric wave activity associated with each SSW. (d) – (f) Same as (a)-(c) but for the heat flux at 100hPa (K m/s) vs the combined Z500 anomalies (m) of the corresponding tropospheric precursors. In all plots each dot represents a single ensemble member. The variables represented in both plots follow a linear relationship.

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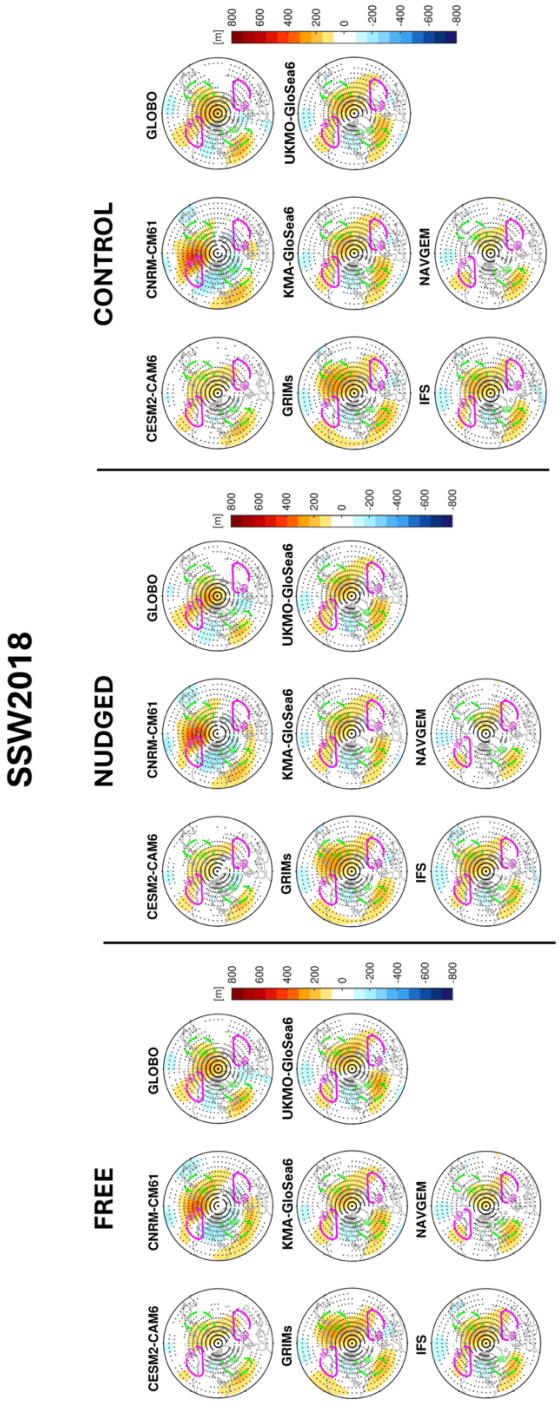

Figure S2. Composite maps of Z500 anomalies (m) for the period 3rd-13th February 2018 for the (a) FREE, (b) NUDGED and (c) CONTROL experiments. The magenta solid (green dashed) contours show the ERA5 climatological WN2 component of Z500 at ± 80 m. The WN2 spatial pattern in all experiments appears rotated relative to the climatological WN2 wave patterns. The stratospheric state does not seem to highly influence the tropospheric circulation prior to the SSW2018.

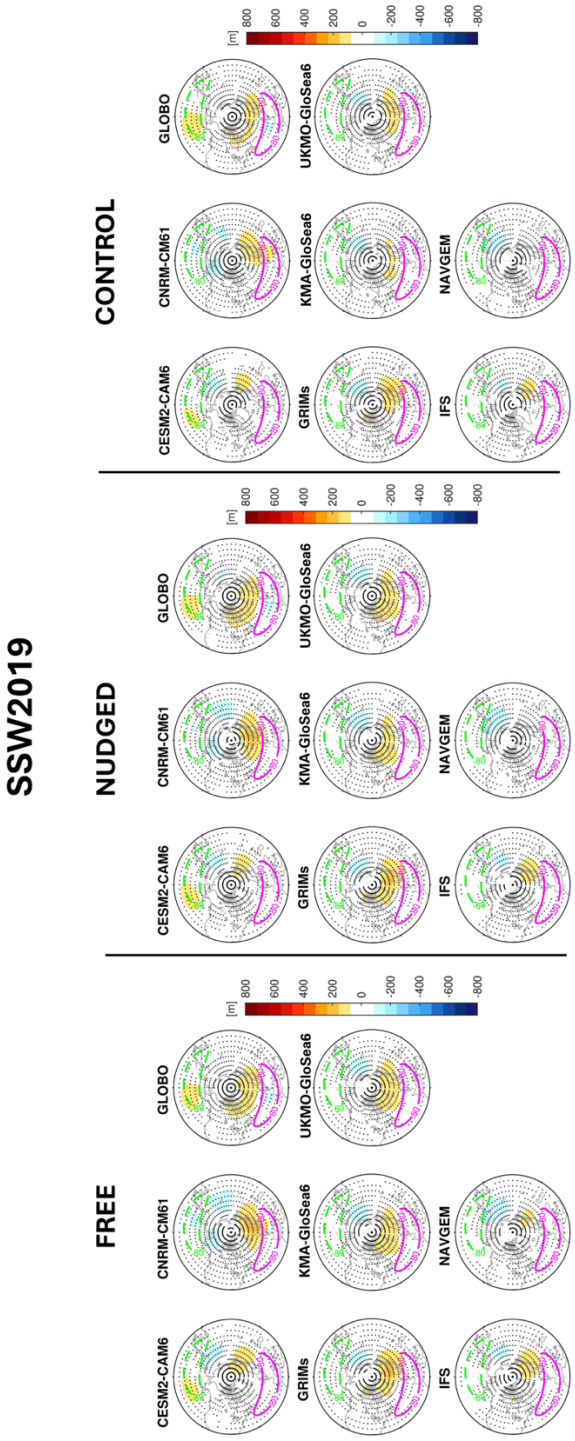

Figure S3. Same as Figure S2 but for the period 18th-30th December 2018. The red solid (green dashed) contours show the ERA5 climatological WN1 component of Z500 at ± 80 m. The patterns are very similar to those shown in Fig.6 associated with a vortex deceleration.

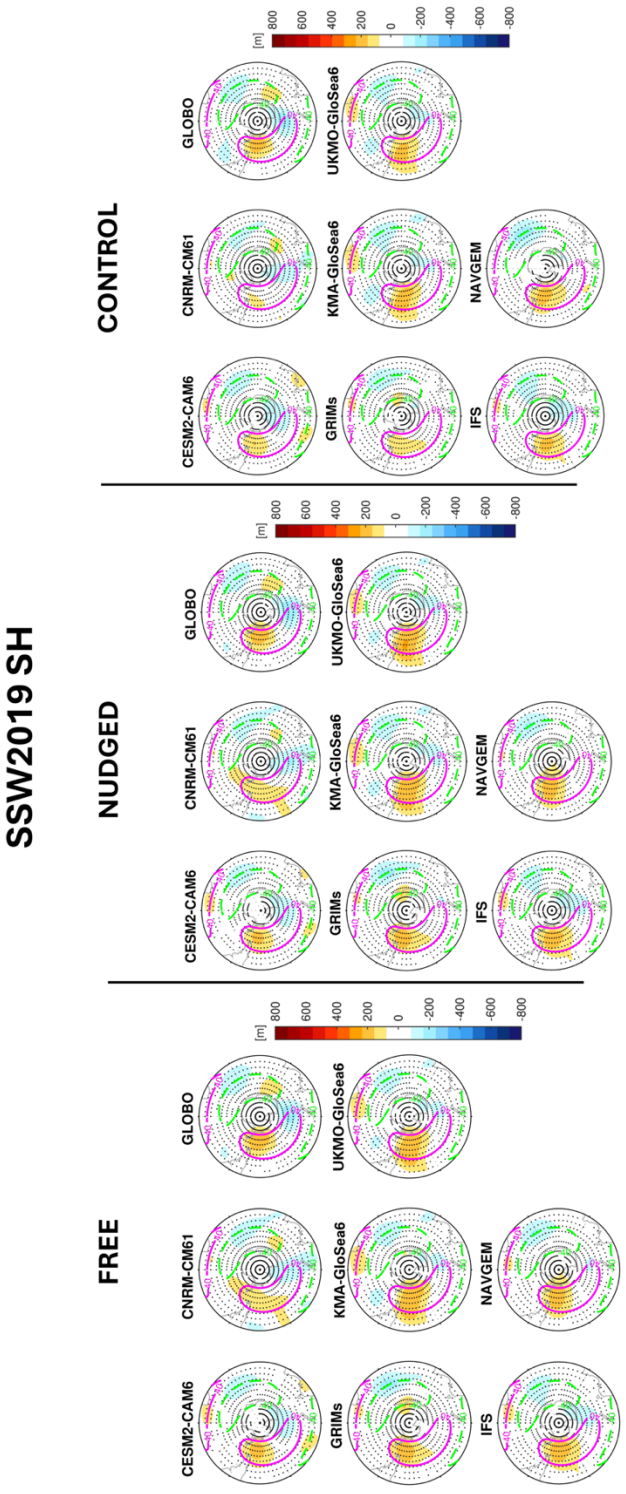

Figure S4. Same as Figure S3 but for 1st - 10th September 2019. Similar conclusions are derived to those of SSW2019 (Figure S3).

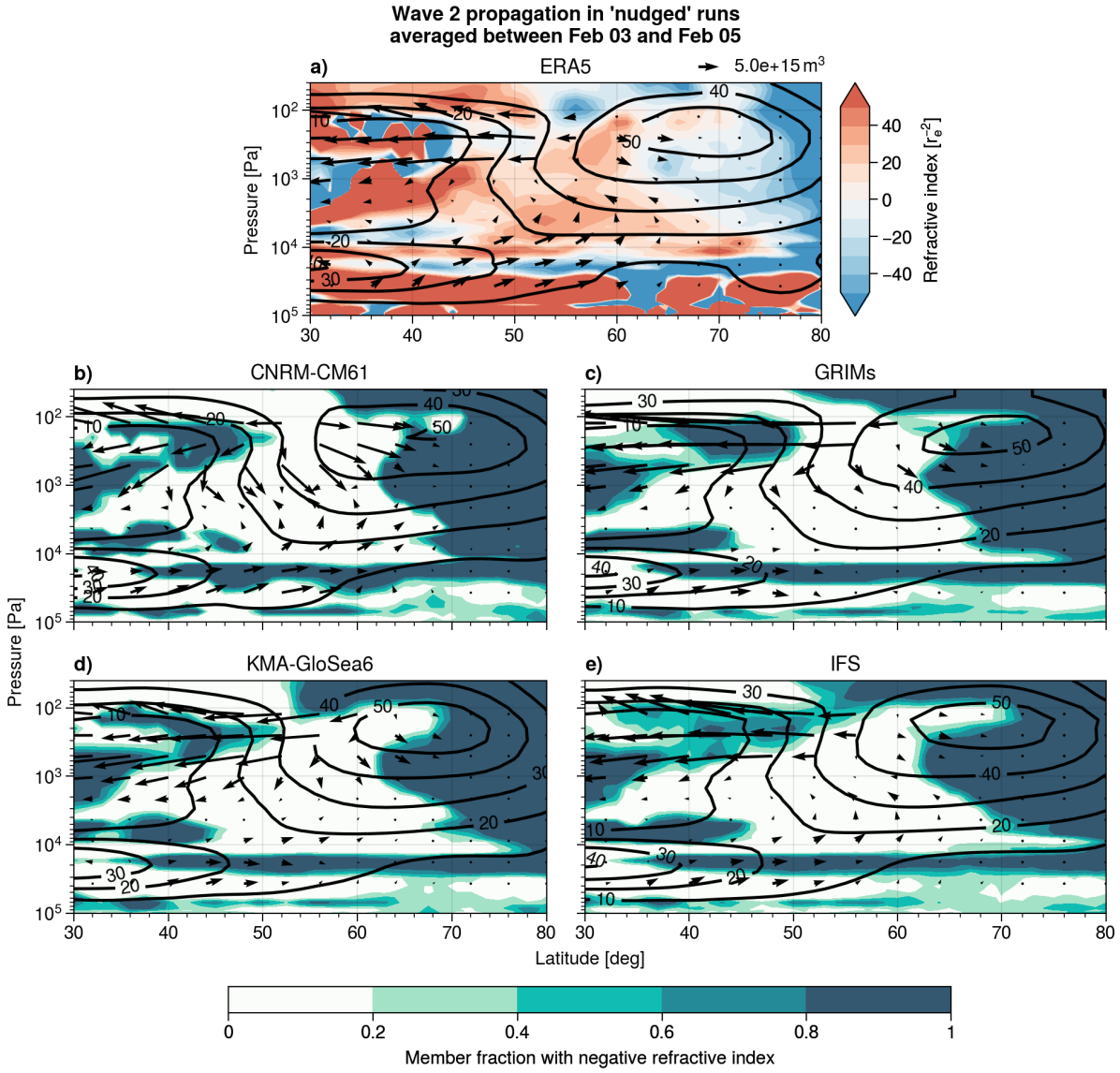

Figure S5. (a) Eliassen-Palm flux (arrows, m^3) and n^2 (shading, a^{-2}) for the WN2 wave component and zonal mean zonal wind (black contours) for 3rd-5th February 2018 in ERA5. (b)-(e) Same as (a) but for the NUDGED experiment of CNRM-CM6-1, GRIMs, KMA-GloSea6, and IFS. In (b)-(e) shading indicates the member fraction of negative n^2 instead of n^2. Unlike FREE experiments (Fig. 12), all systems show a region of low probability of negative n^2 between 55º-70ºN, which favors the poleward wave propagation in the upper stratosphere.

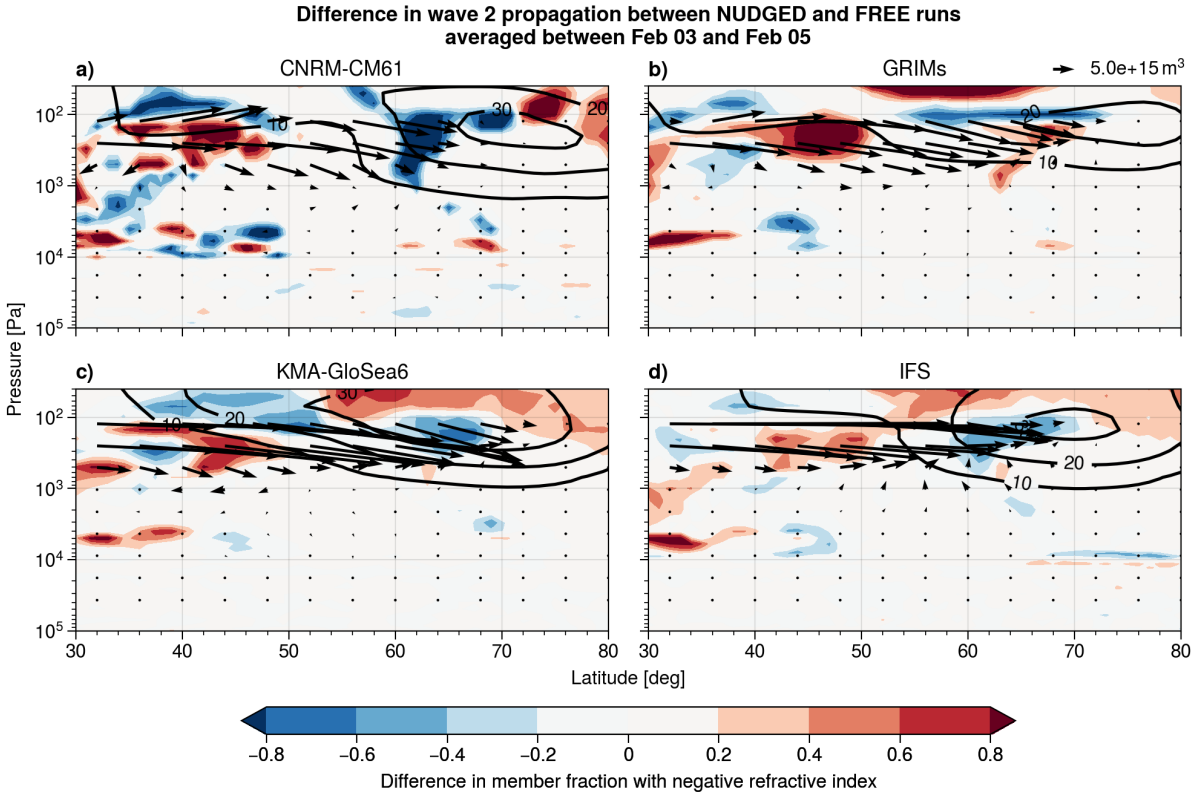

Figure S6. NUDGED-minus-FREE difference of Eliassen-Palm flux (arrows, m^3) and member fraction of negative n^2 (shading) and zonal mean zonal wind (black contours) for 3rd-5th February 2018 in (a) CNRM-CM6-1, (b) GRIMs, (c) KMA-GloSea6 and (d) IFS. The difference plots highlight the enhanced poleward wave propagation in NUDGED with respect to FREE.

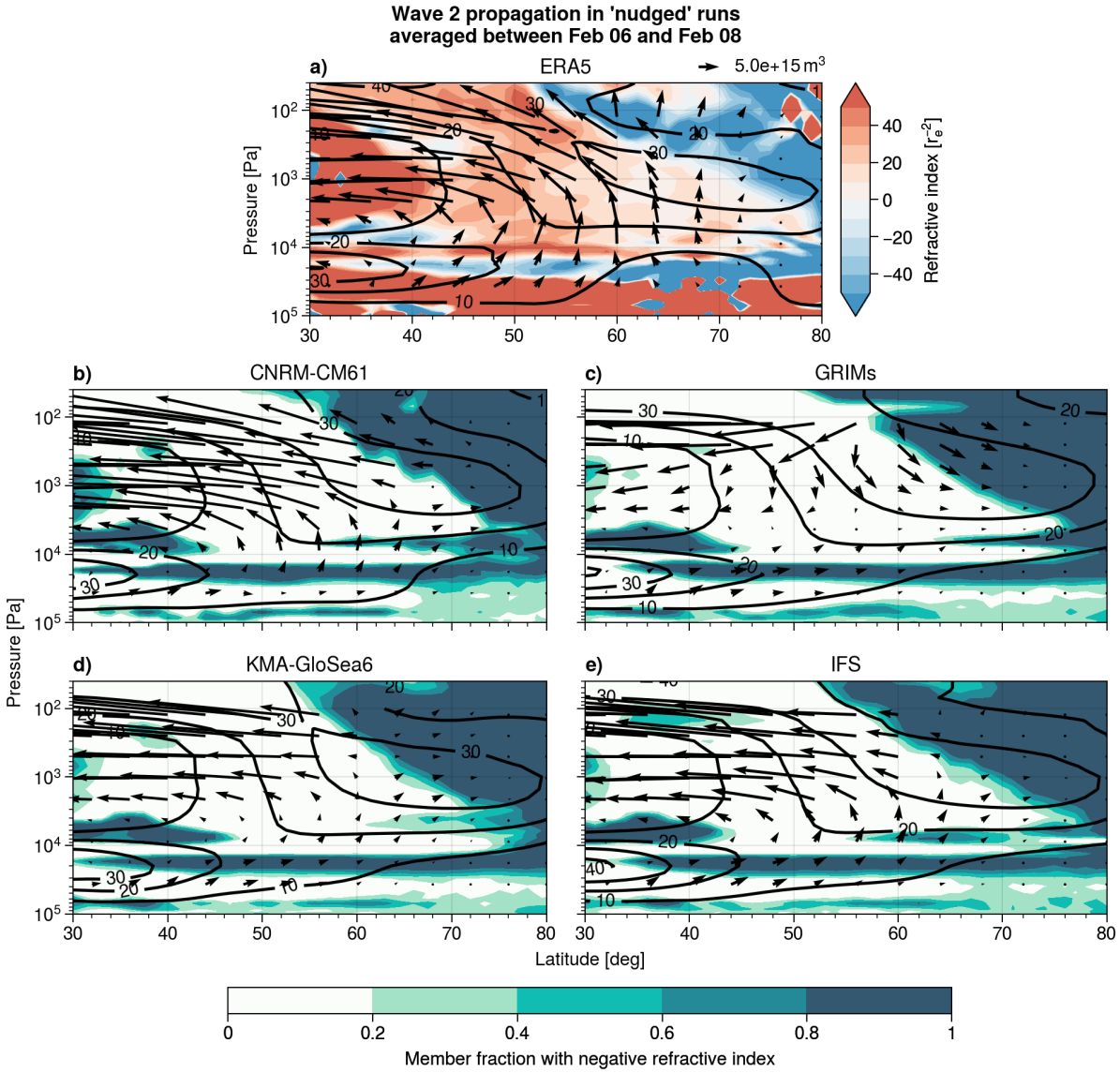

Figure S7. Same as Figure S5 but for 6th-8th February 2018.

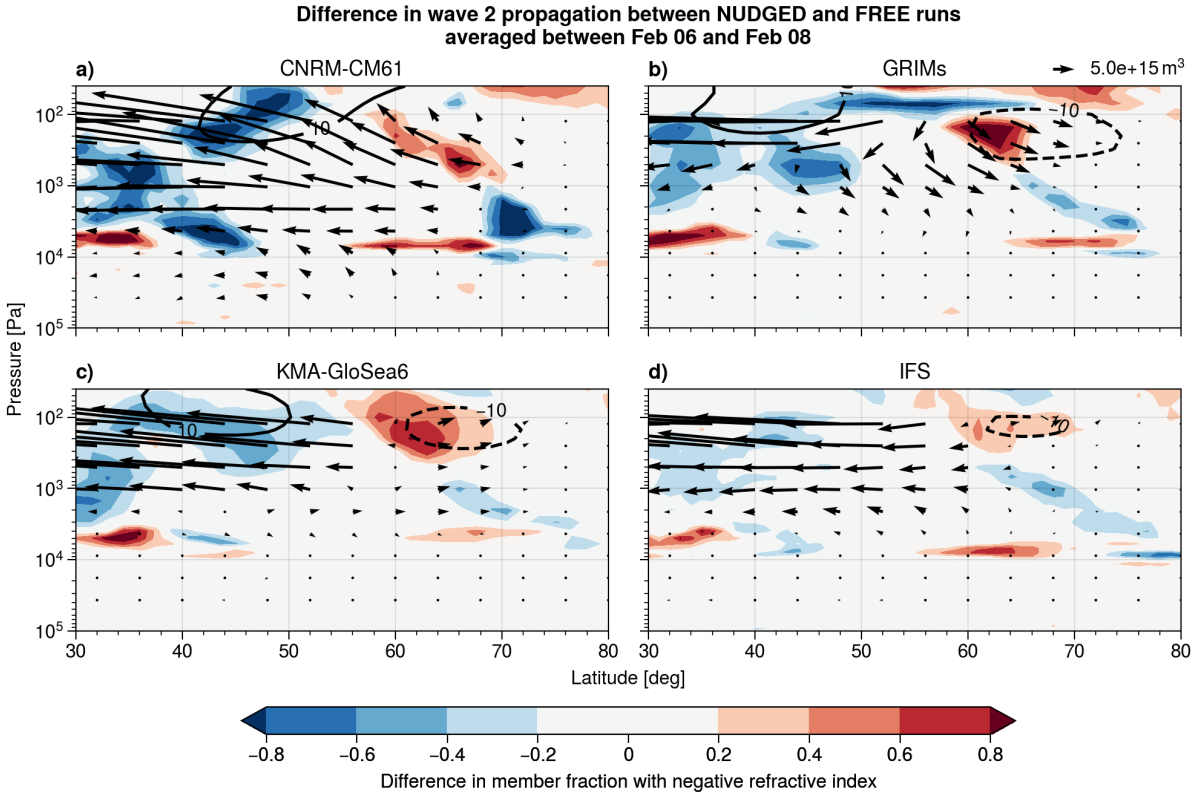

Figure S8. Same as Figure S6 but for 6th-8th February 2018.