

Supplement of: QBO-induced anomalous transport in the  
Northern Hemisphere stratosphere: the exceptional  
2018/2019 late boreal winter

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# 1 Time series at 15 hPa

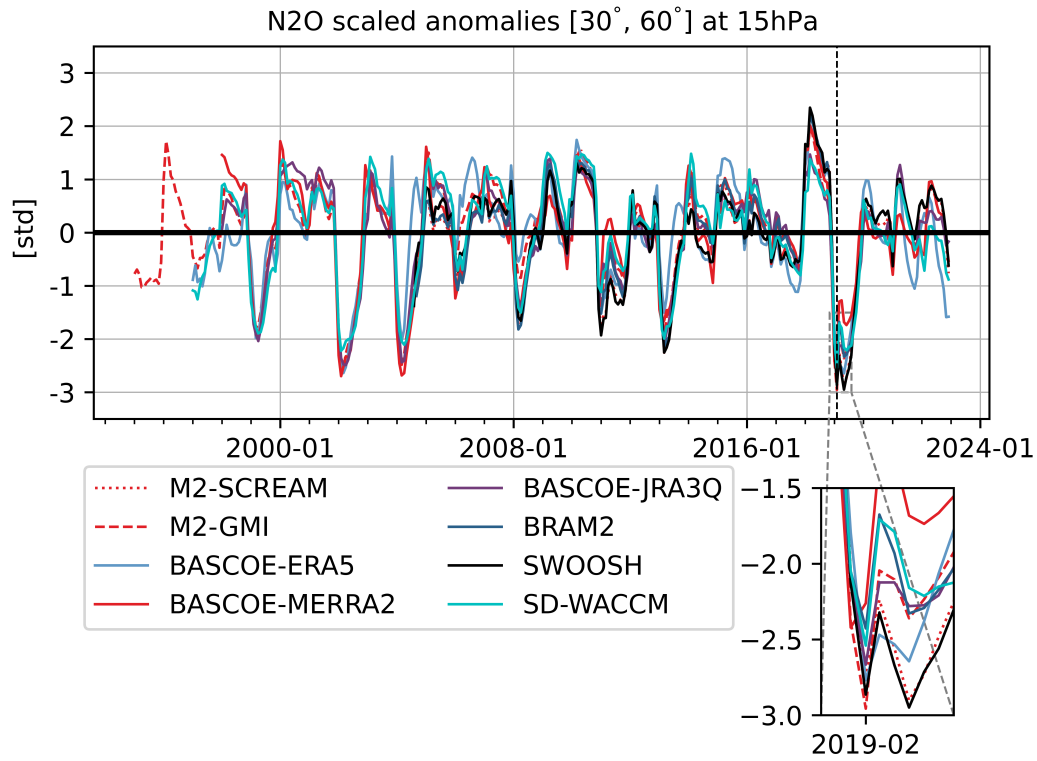


Figure S1: Same as Fig. 2, but at 15 hPa.

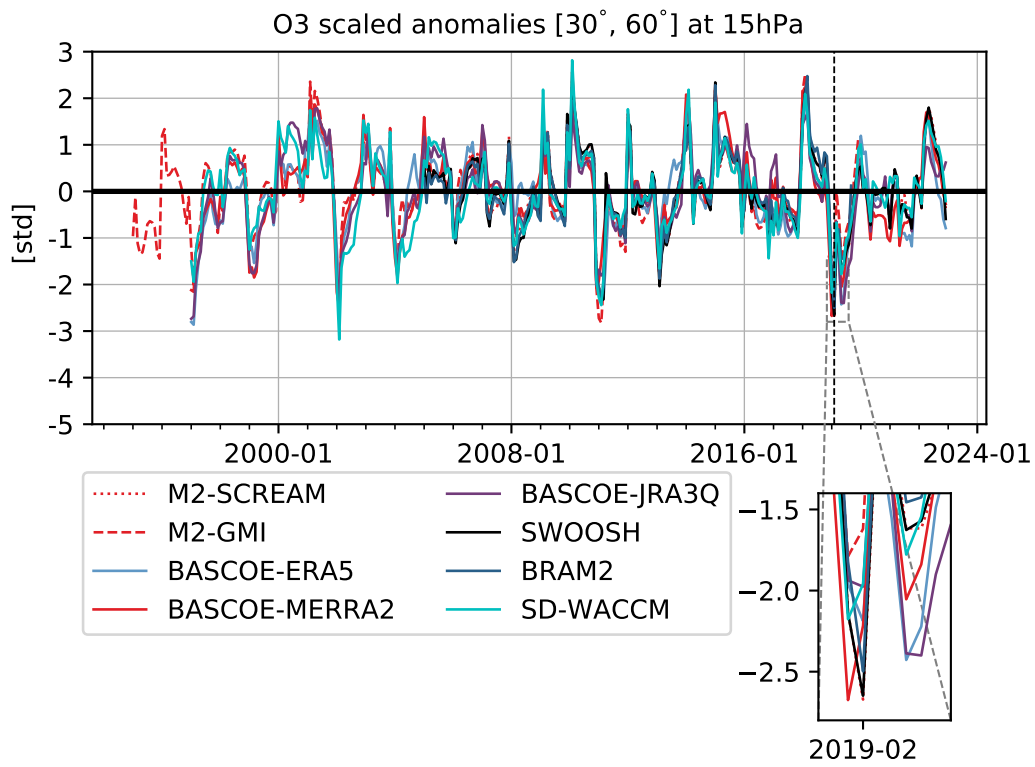


Figure S2: Same as Fig. 3, but at 15 hPa.

## 2 Time series of N2O TEM terms

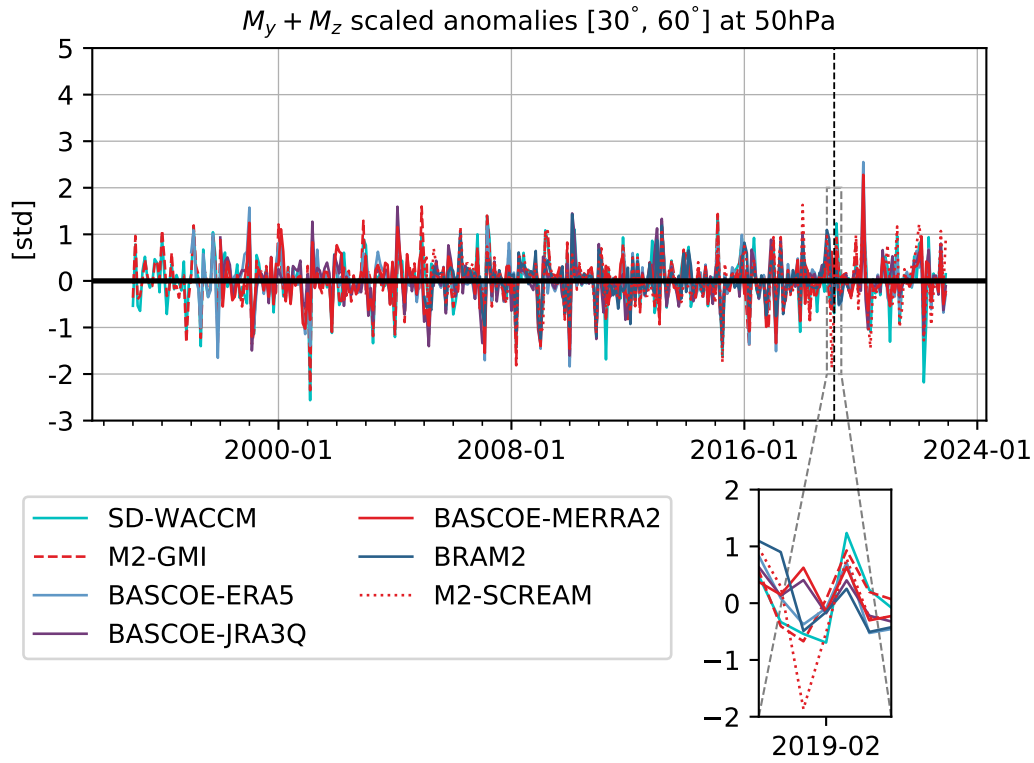


Figure S3: As Fig. 4, but for  $M_y + M_z$ .

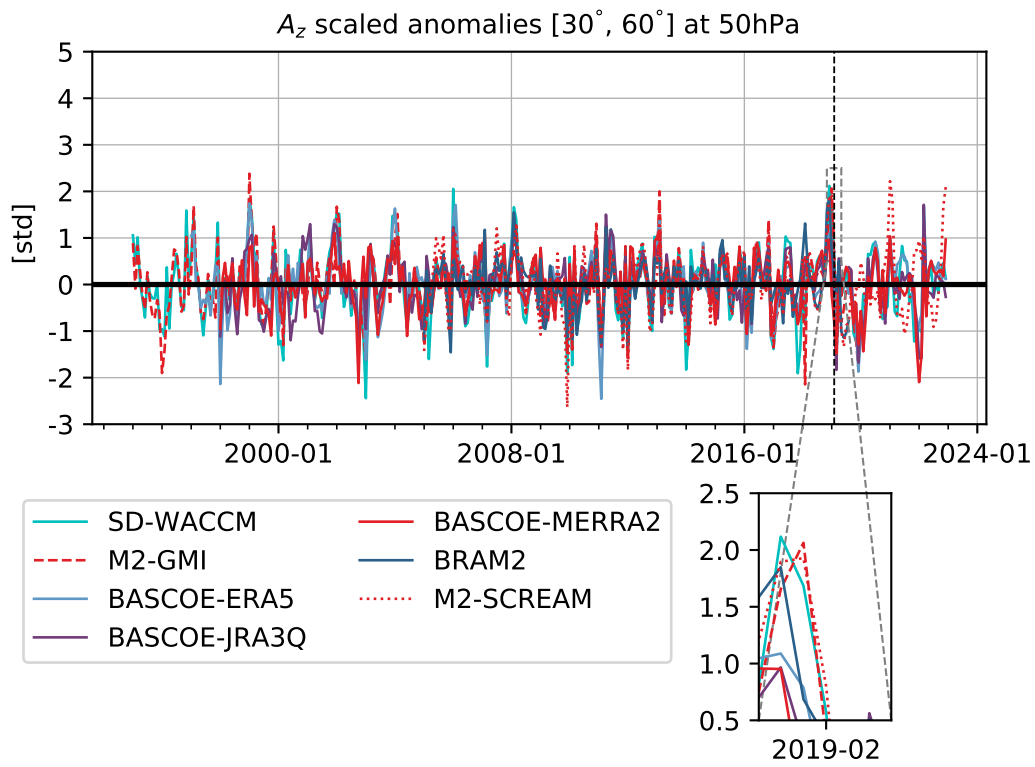


Figure S4: As Fig. 4, but for  $A_z$ .

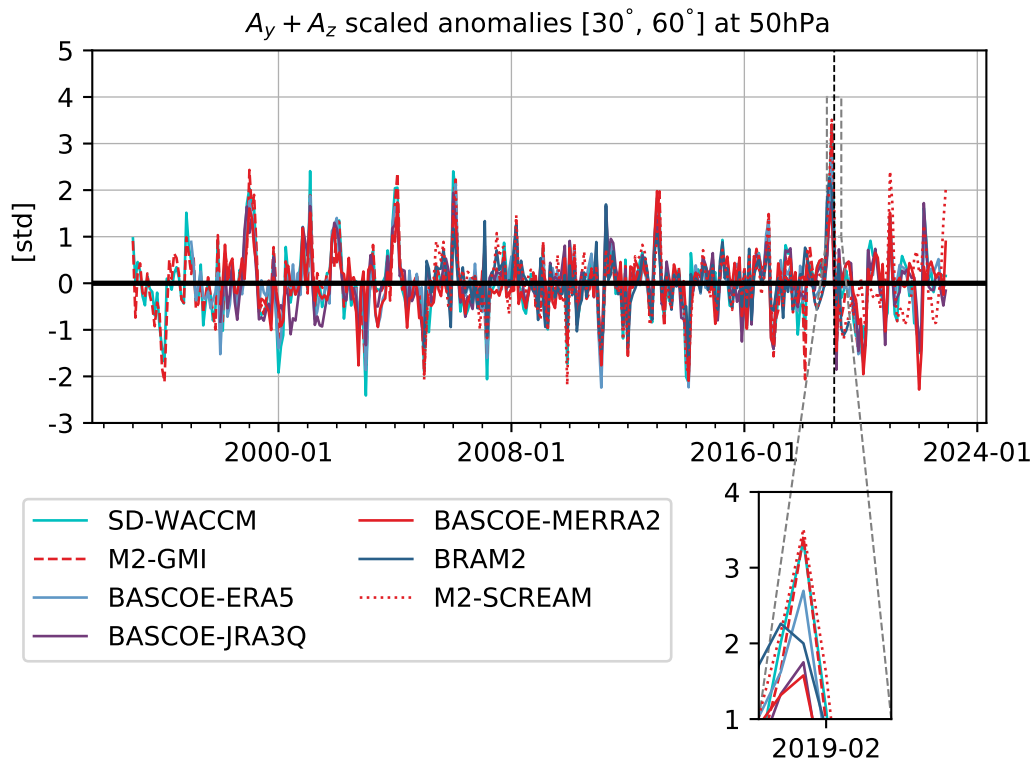


Figure S5: As Fig. 4, but for  $A_y + A_z$ .

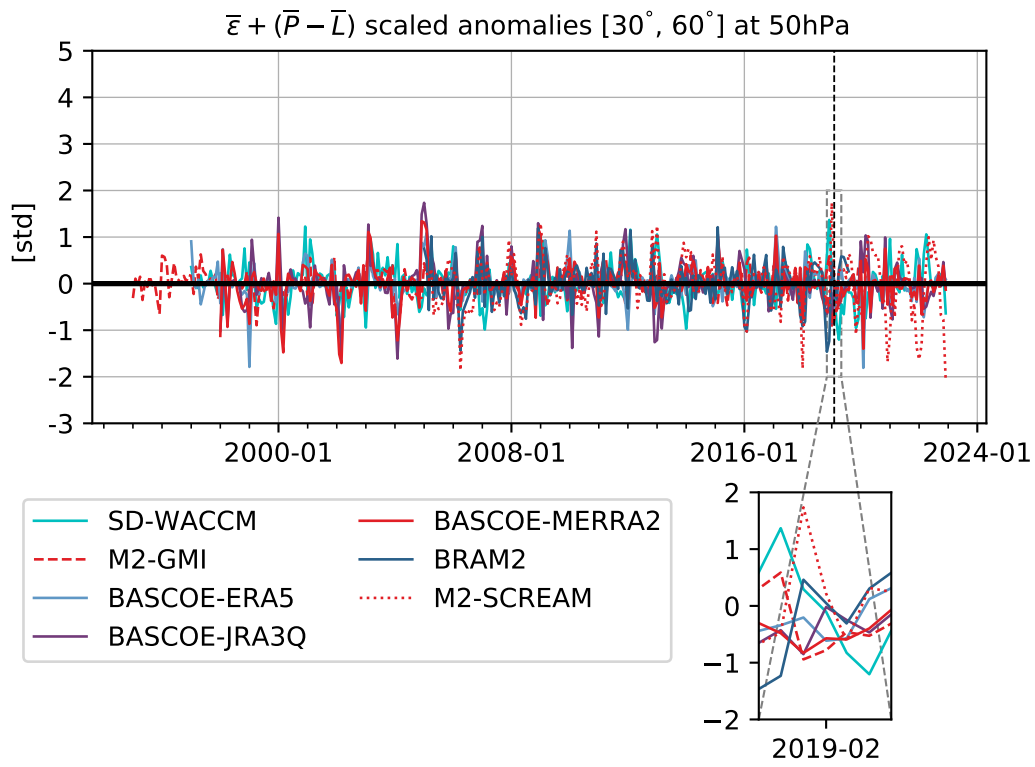


Figure S6: As Fig. 4, but for  $\epsilon + (P - L)$ .

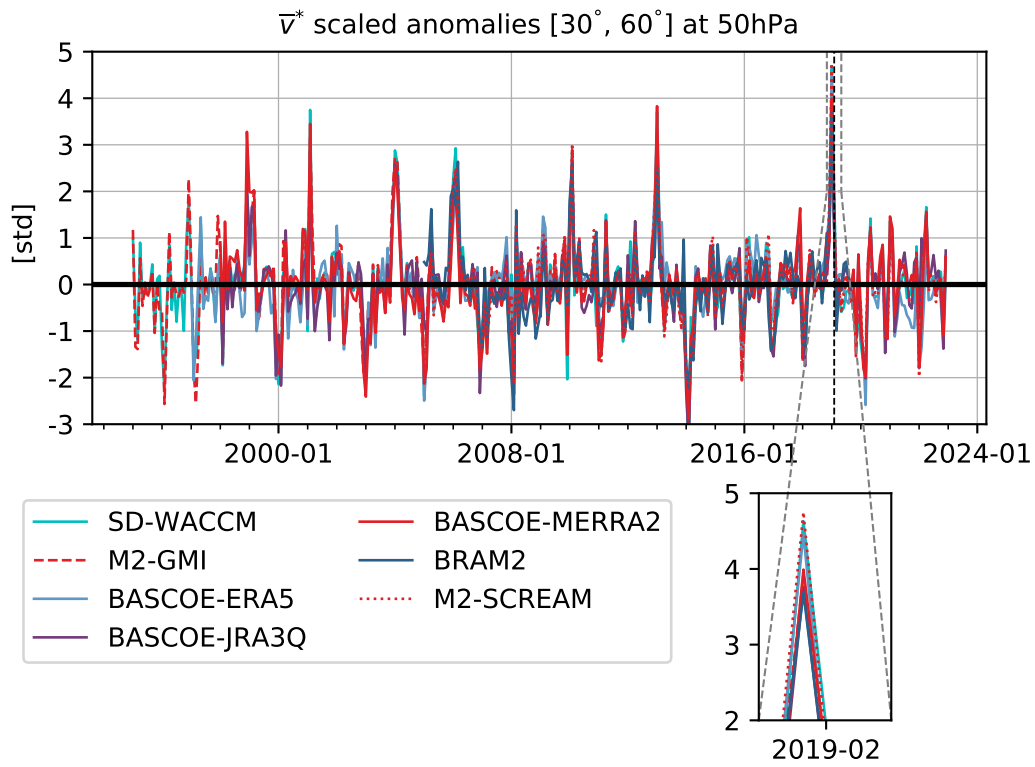


Figure S7: As Fig. 4, but for  $\bar{v}^*$ .

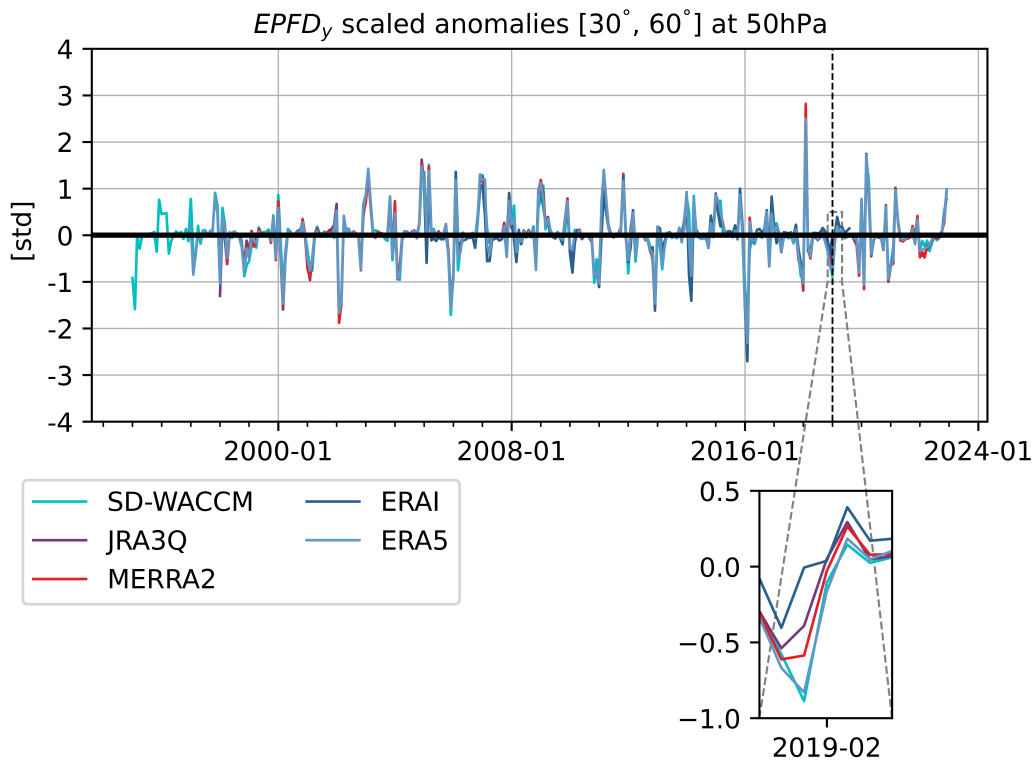


Figure S8: As Fig. 4, but for  $-EPFD_y$ .

### 3 Zonal wind

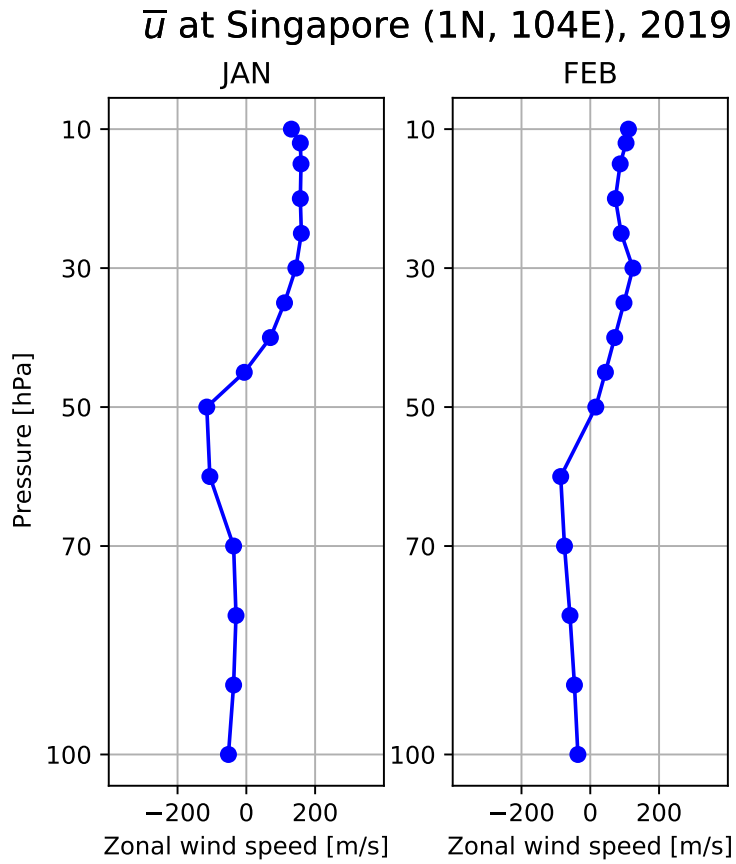


Figure S9: Vertical profiles of zonal wind speed [m/s] measured at Singapore for January 2019 (left) and February 2019 (right).

$\bar{u}$  at Singapore (1N, 104E), 2021

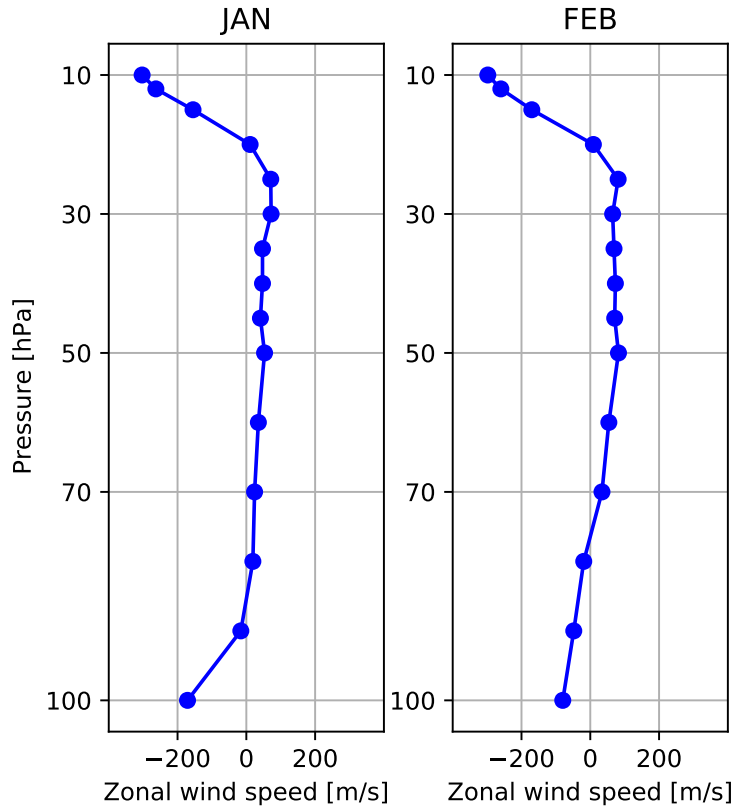


Figure S10: Vertical profiles of zonal wind speed [m/s] measured at Singapore for January 2021 (left) and February 2021 (right).

## 4 N<sub>2</sub>O anomalies in previous Februaries

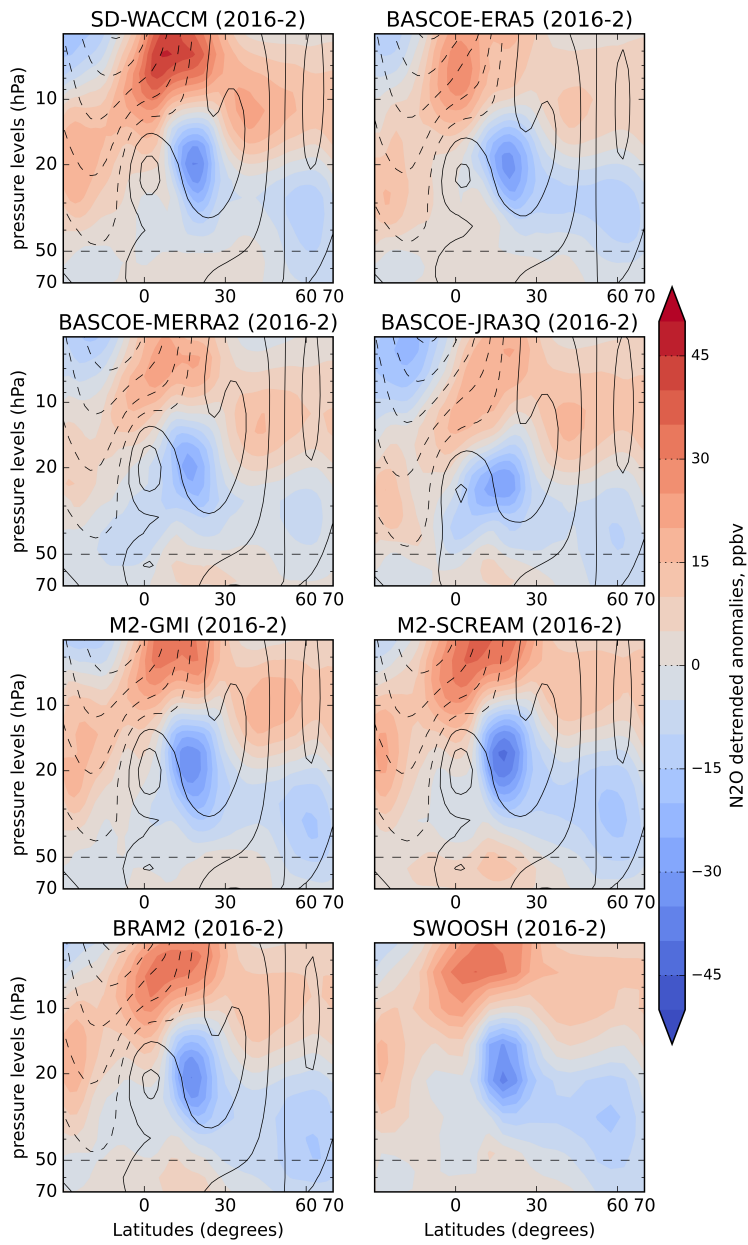


Figure S11: As Fig. 6, but for February 2016

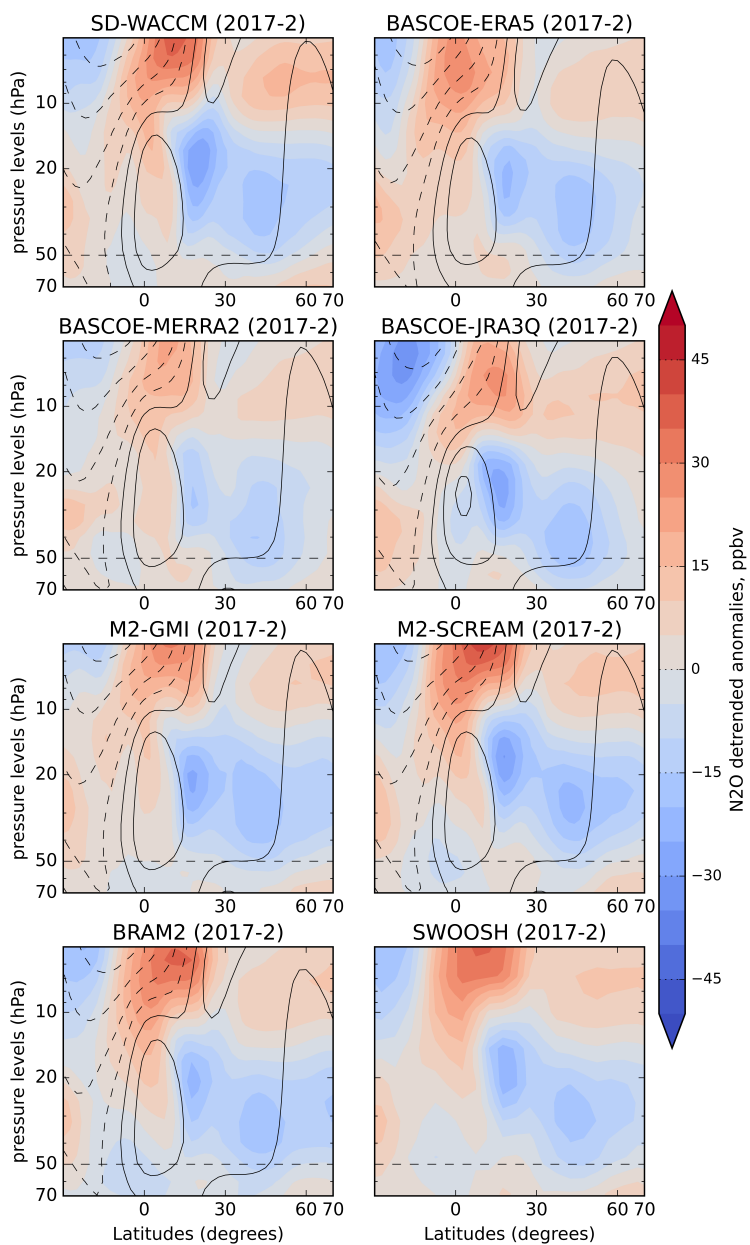


Figure S12: As Fig. 6, but for February 2017

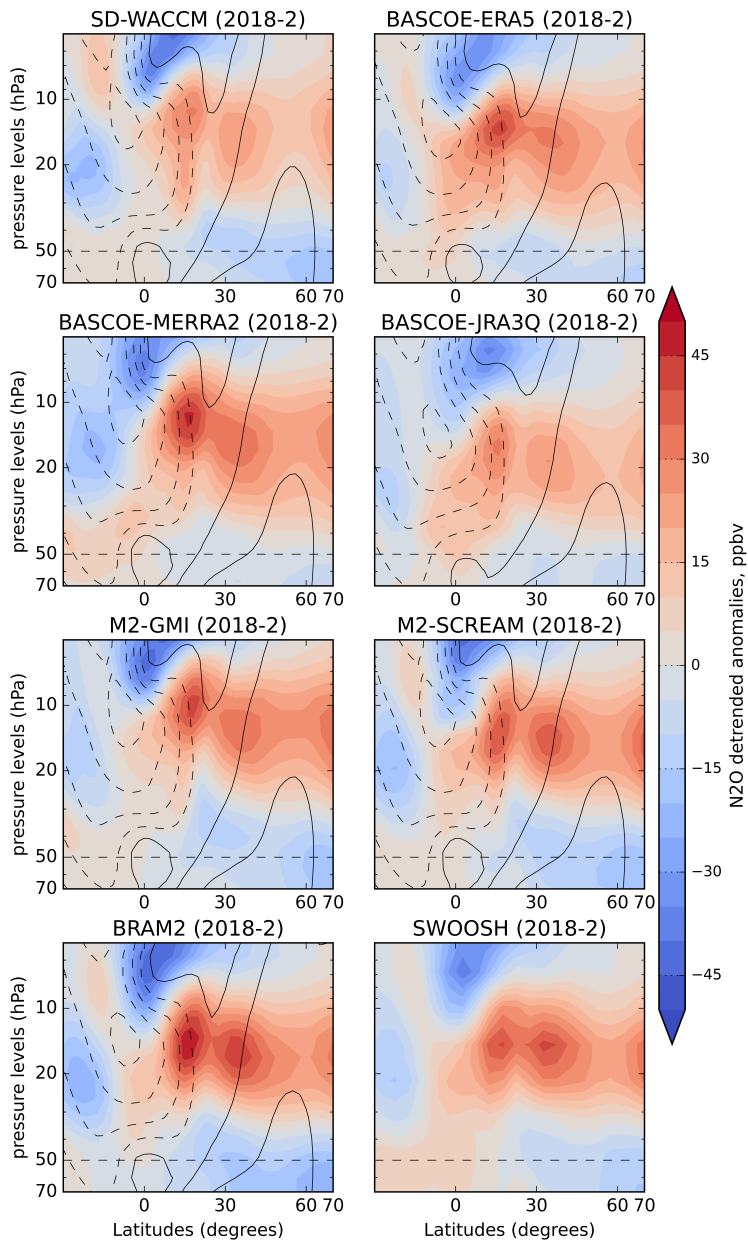


Figure S13: As Fig. 6, but for February 2018

## 5 N<sub>2</sub>O anomalies in W-QBO phase

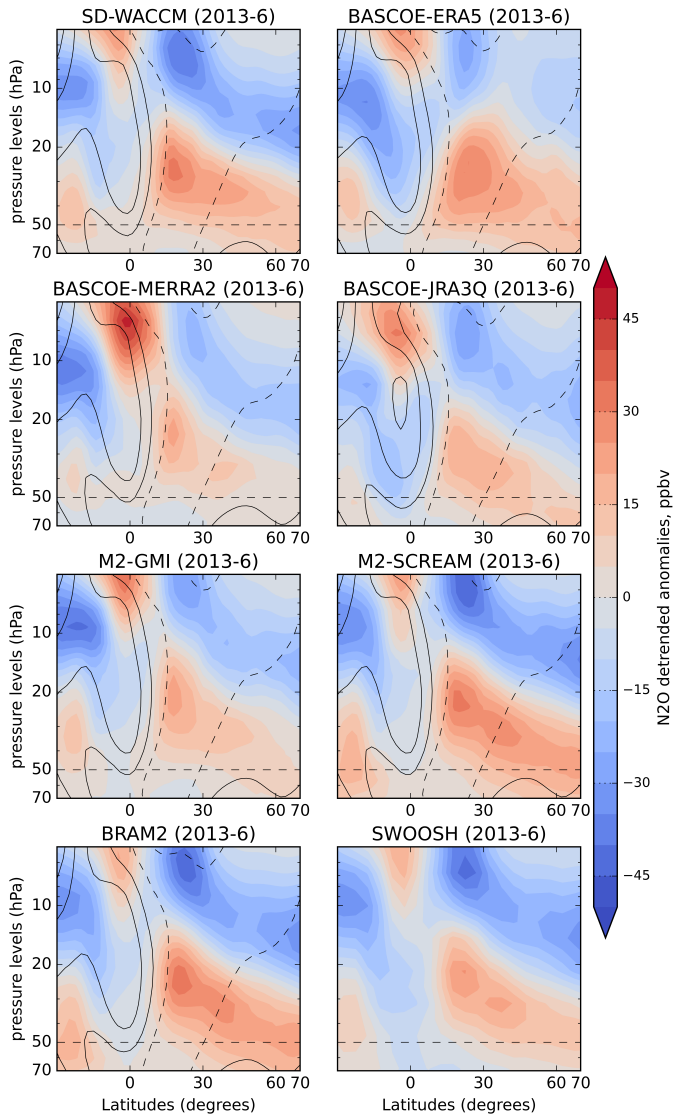


Figure S14: As Fig. 6, but for June 2013.

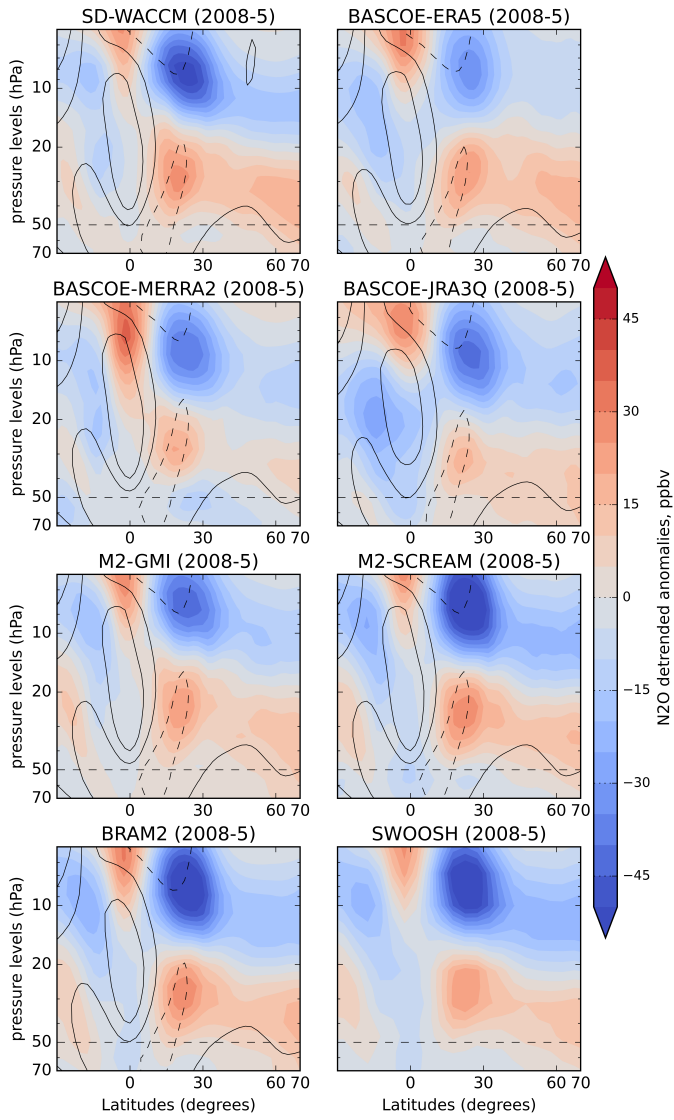


Figure S15: As Fig. 6, but for May 2008.

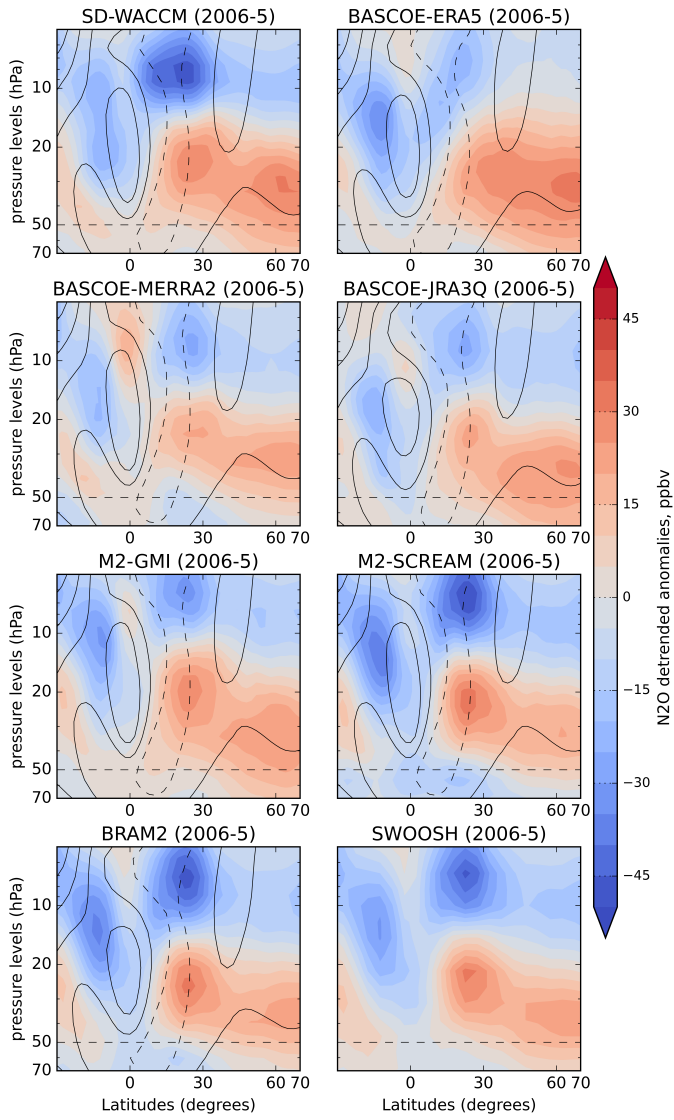


Figure S16: As Fig. 6, but for May 2006.

## 6 Seasonal variations of the zonal wind

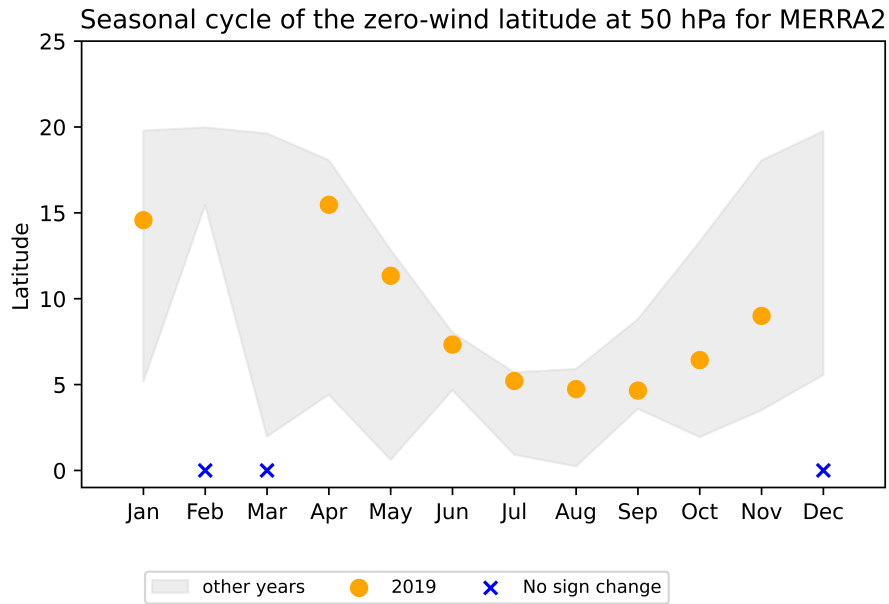


Figure S17: As Fig. 9, but for MERRA2.

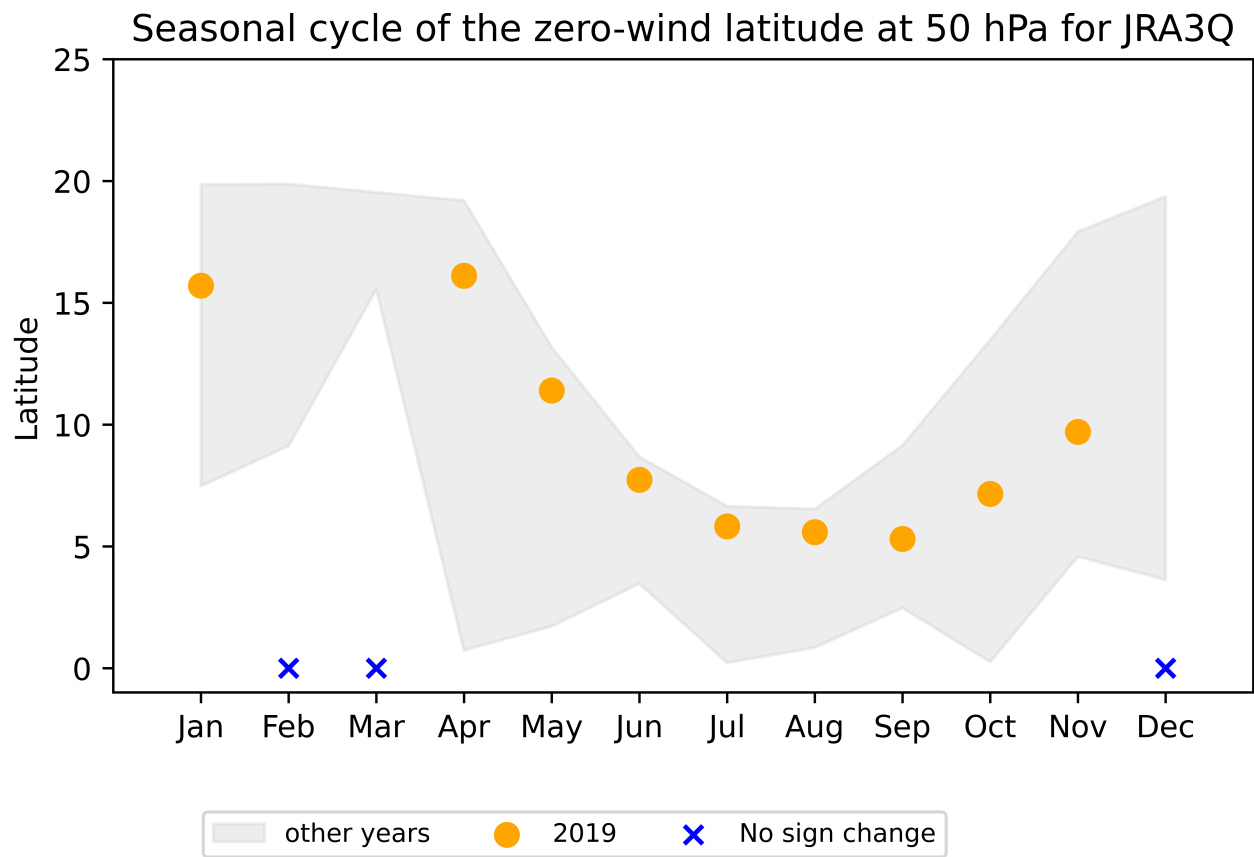


Figure S18: As Fig. 9, but for JRA3Q.

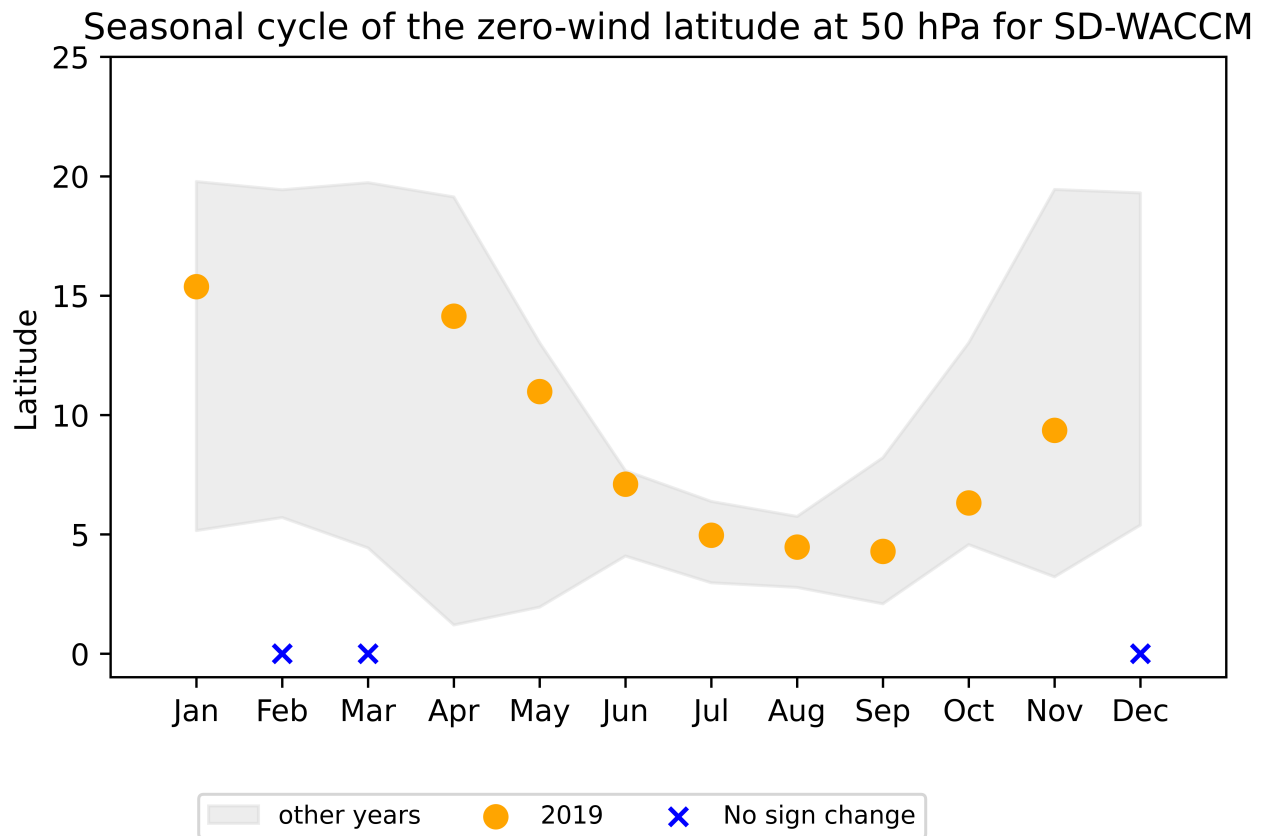


Figure S19: As Fig. 9, but for SD-WACCM.

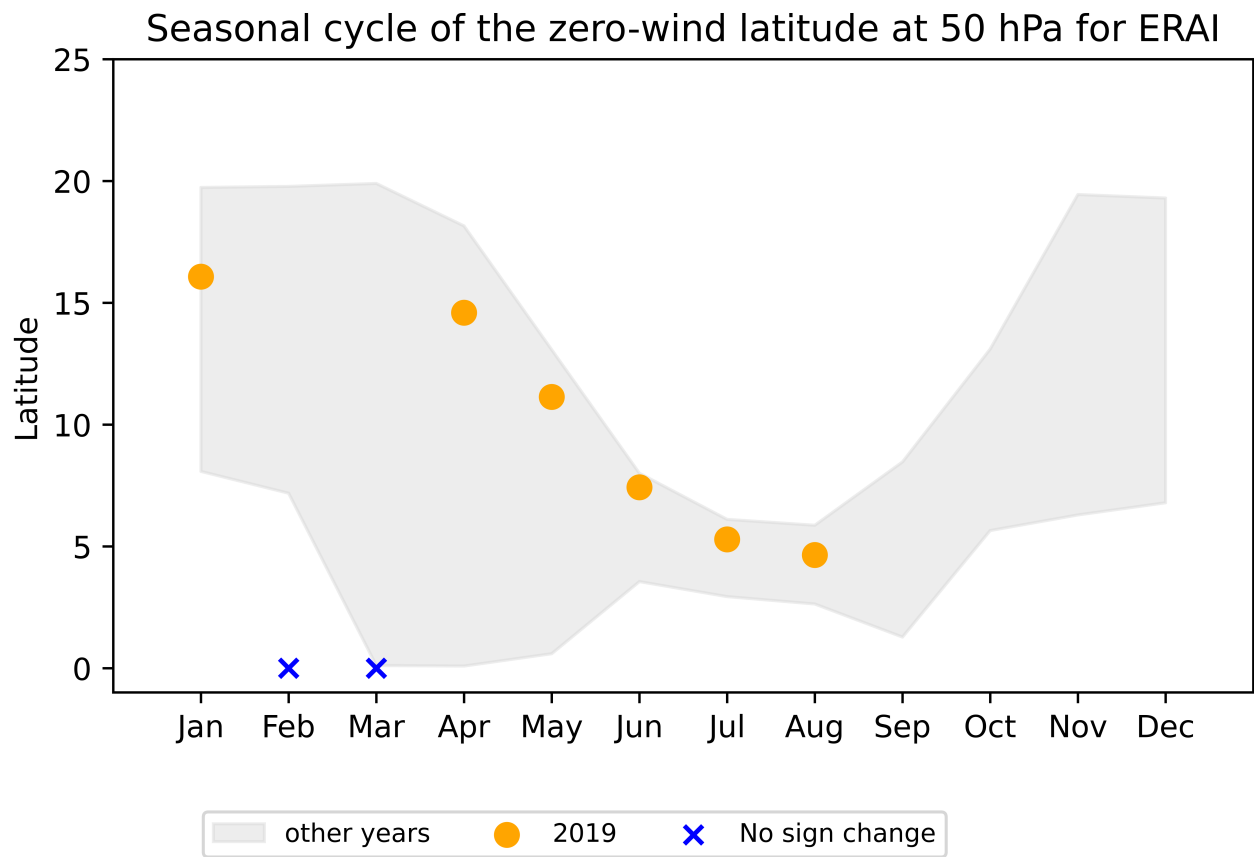


Figure S20: As Fig. 9, but for ERAI.

## 7 Anomalies of meridional component of the horizontal wind

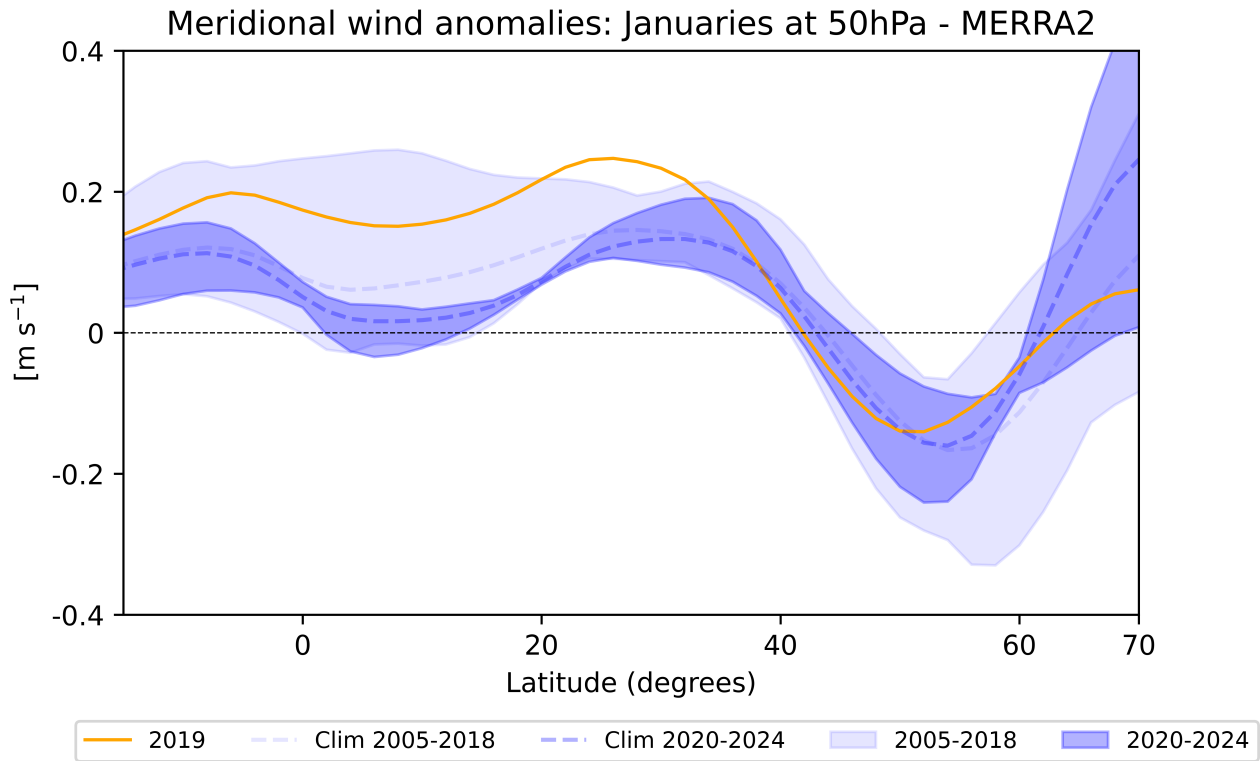


Figure S21: As Fig. 10, but for MERRA2.

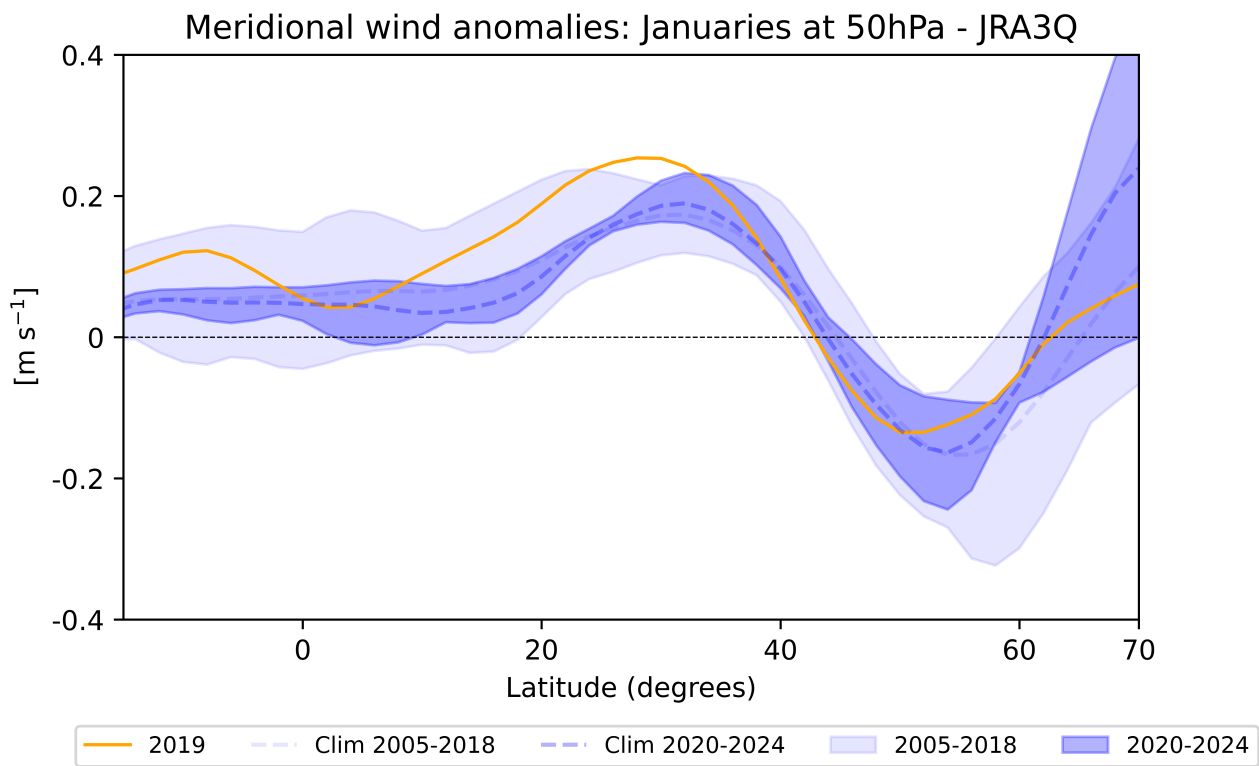


Figure S22: As Fig. 10, but for JRA3Q.

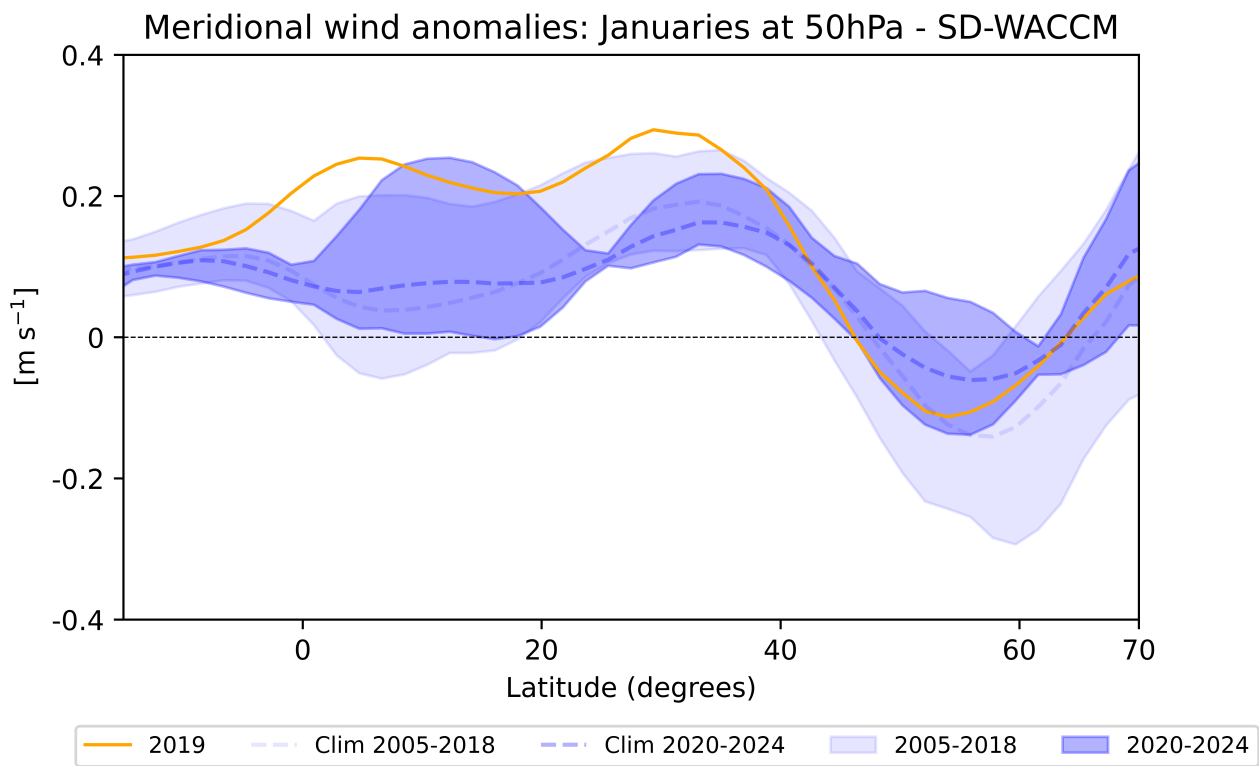


Figure S23: As Fig. 10, but for SD-WACCM.

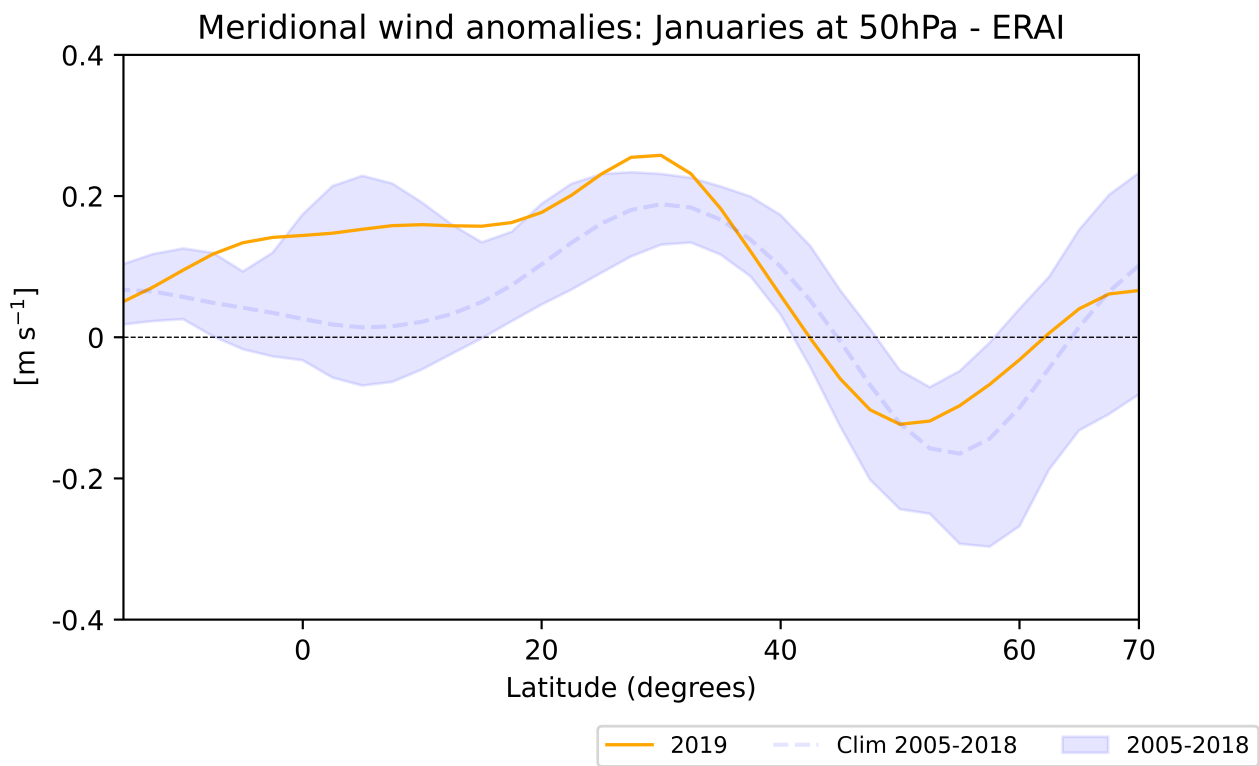


Figure S24: As Fig. 10, but for ERAI.