

Supporting Information for "Stratospheric water vapor and ozone response to different QBO disruption events in 2016 and 2020"

Mohamadou Diallo¹, Felix Ploeger^{1,2}, Michaela I. Hegglin³, Manfred Ern¹,
Jens-Uwe Grooß¹, Sergey Khaykin⁴ and Martin Riese^{1,2}

¹Institute of Energy and Climate Research, Stratosphere (IEK-7), Forschungszentrum Jülich, 52 425 Jülich, Germany.

²Institute for Atmospheric and Environmental Research, University of Wuppertal, Wuppertal, Germany.

³Department of Meteorology, University of Reading, Reading, UK.

⁴Laboratoire Atmosphères, Milieux, Observations Spatiales, UMR CNRS 8190, IPSL, Sorbonne Univ./UVSQ, Guyancourt, France.

Additional Supporting Information

1. Figures S1 to S5

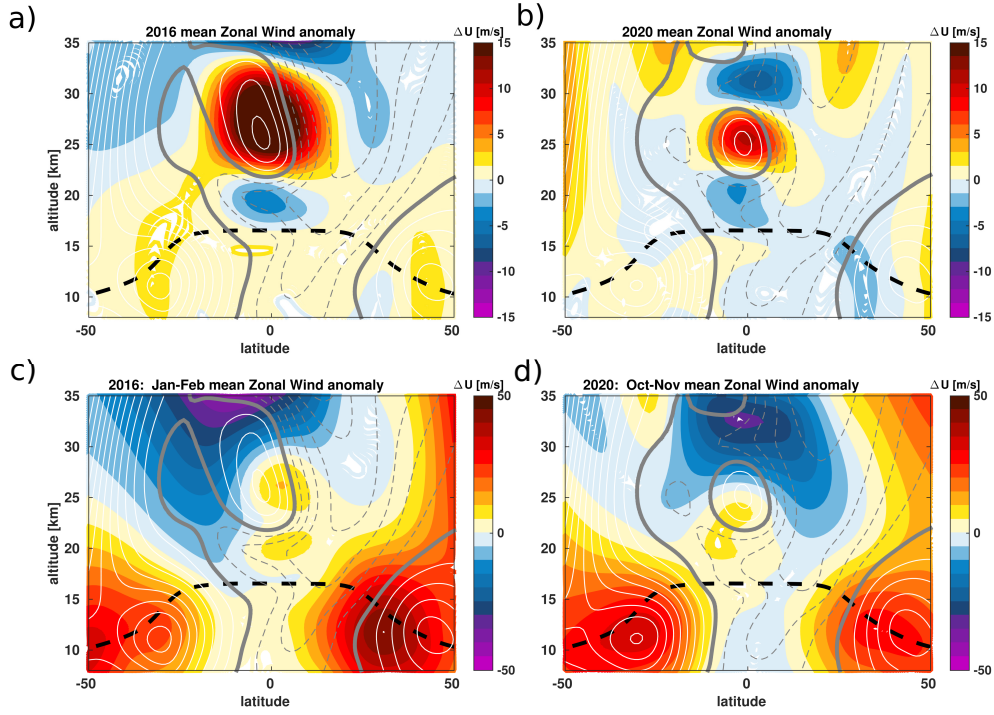


Figure S1. zonal mean deseasonalized zonal wind (**a**, **b**) and the QBO disruption onsets (**c**, **d**) from the ERA5 reanalysis for the years 2016 (**a**, **c**) and 2020 (**b**, **c**) period as a function of latitude and altitude. The black dashed horizontal line indicates the tropopause from ERA5. Monthly mean zonal mean wind component, u (m s^{-1}), from ERA5 is overlaid as solid white (westerly) and dashed gray (easterly) lines.

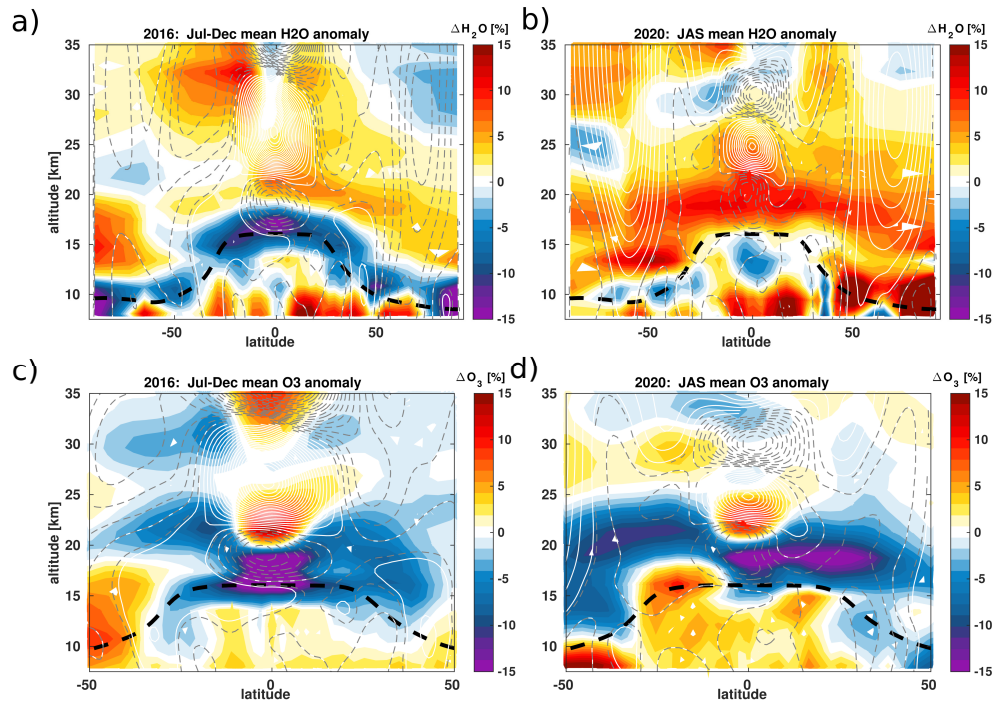


Figure S2. zonal mean deseasonalized stratospheric H_2O (a, b) and O_3 (c, d) anomalies from MLS satellite observations for the years 2016 (a, c) and 2020 (b, c) period in percent change from long-term monthly means as a function of time and altitude. The black dashed horizontal line indicates the tropopause from ERA5. Monthly mean zonal mean wind component, u (m s^{-1}), from ERA5 is overlaid as solid white (westerly) and dashed gray (easterly) lines.

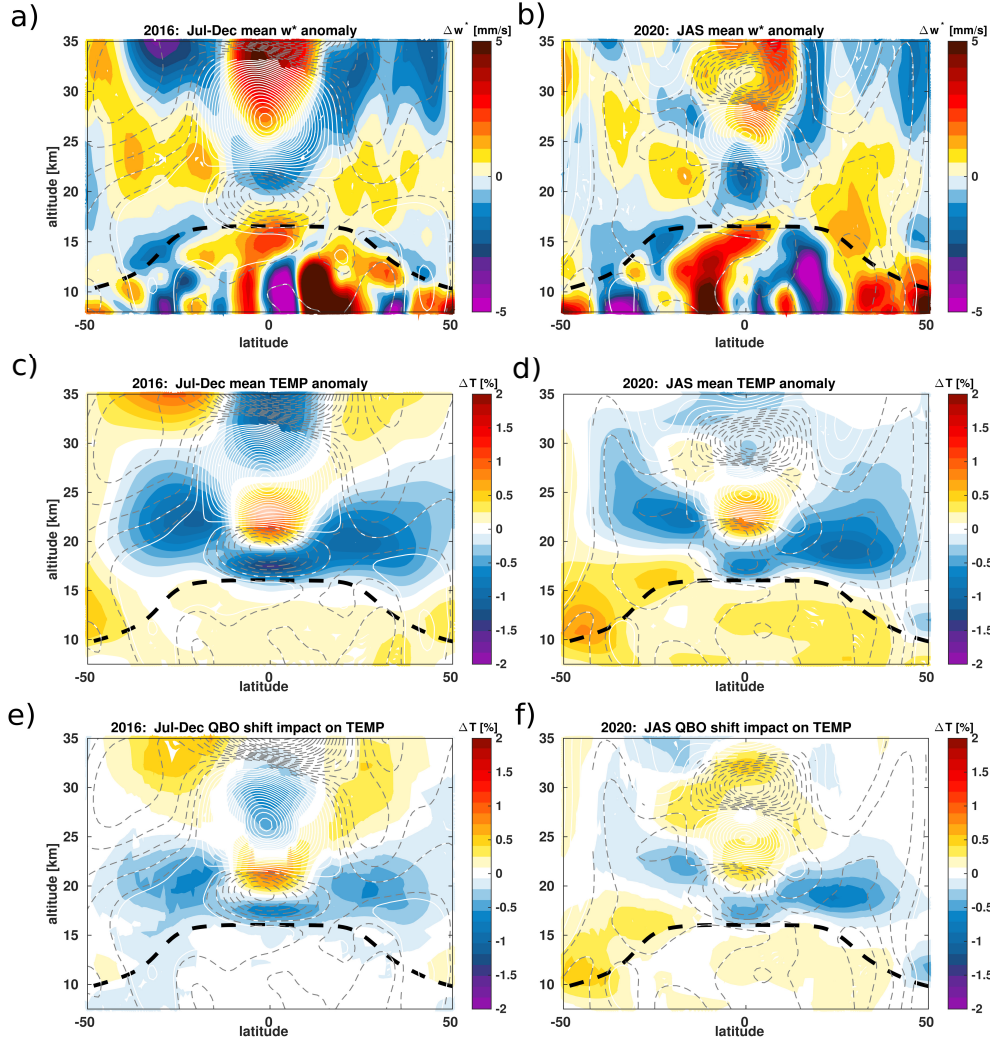


Figure S3. zonal mean residual vertical velocity ($\overline{w^*}$) (a, b) and temperature anomalies (c, d) together with the impact of QBO disruptions on the tropical temperature anomalies (e, f) derived from the multiple regression fit for the years 2016 and 2020. The black dashed horizontal line indicates the tropopause from ERA5. Monthly mean zonal mean wind component, u (m s^{-1}), from ERA5 is overlaid as solid white (westerly) and dashed gray (easterly) lines.

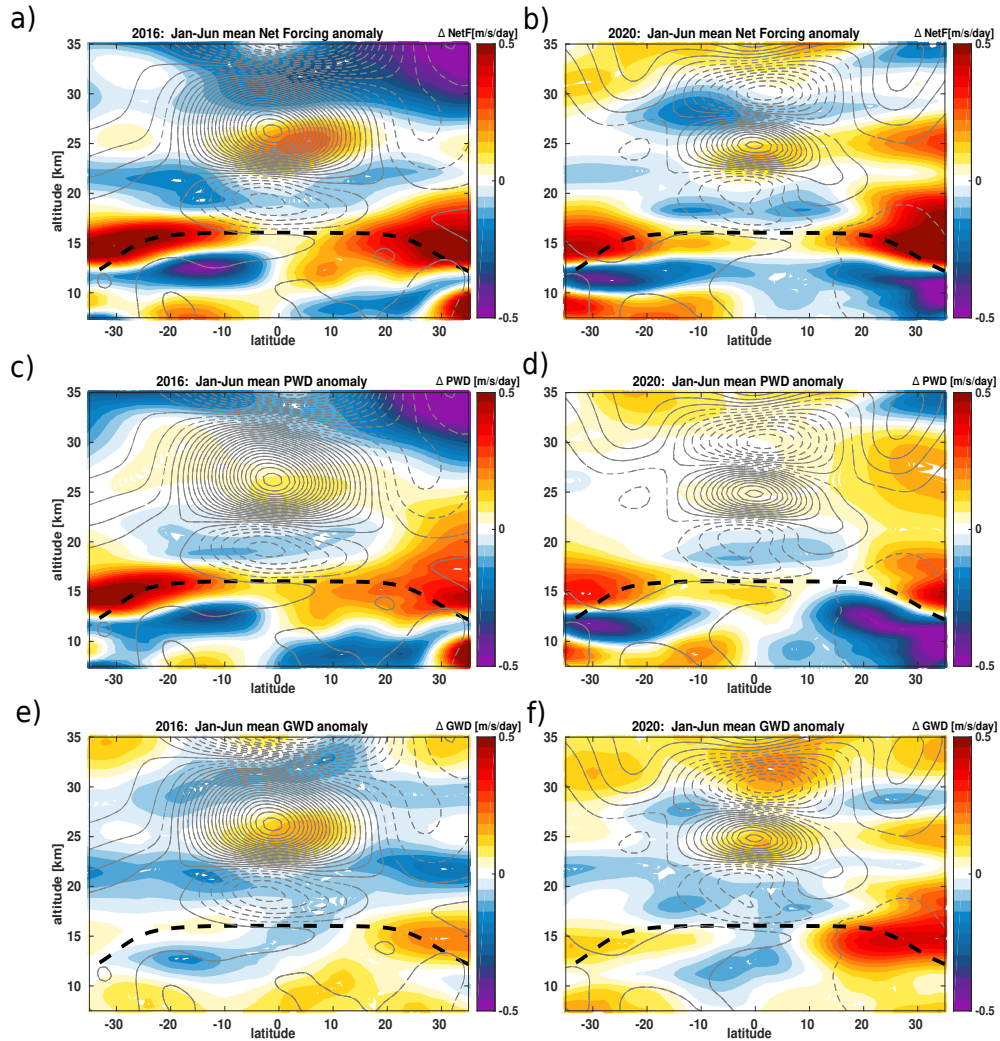


Figure S4. zonal mean monthly mean net wave forcing (**a, b**), planetary wave drag (PWD) (**c, d**) and gravity wave drag (GWD) (**e, f**) anomalies from the ERA5 reanalysis for the years 2016 (**a, c, e**) and 2020 (**b, d, f**) as a function of latitude and altitude. The black dashed horizontal line indicates the tropopause from ERA5. Monthly mean zonal mean wind component, u (m s^{-1}), from ERA5 is overlaid as solid gray (westerly) and dashed gray (easterly) lines.

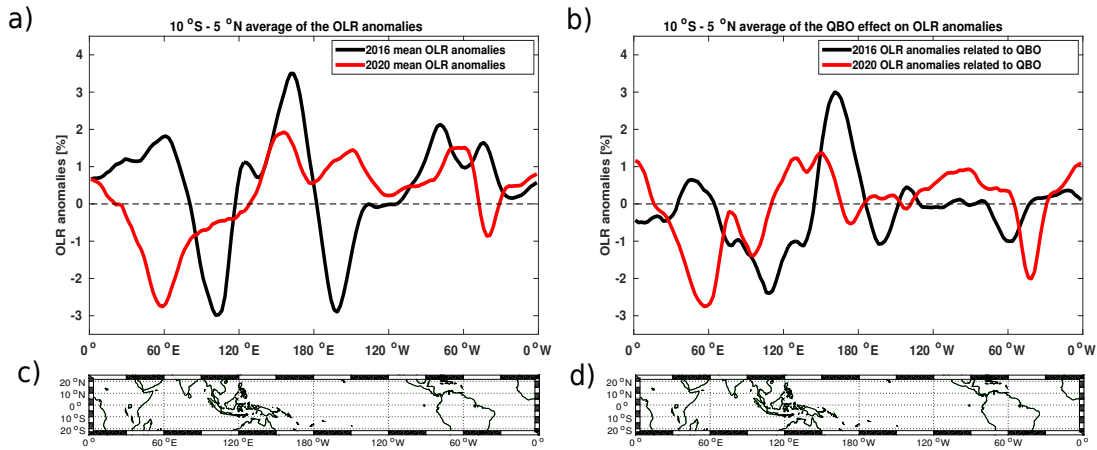


Figure S5. Longitudinal variations of the monthly mean Outgoing Longwave Radiation (OLR) anomalies (a) averaged between 20°S–20°S together with the 2016 and 2020 QBO effect (b) associated with the convective activity derived from the multiple regression fit. The lowermost panels (c, d) shows the QBO index at 50 *hPa* in red.