

Supplementary information of “Stratospheric circulation response to stratospheric aerosol injections remains uncertain.” by Mohamadou A. Diallo et al.

1 Individual reanalysis and climate model estimates

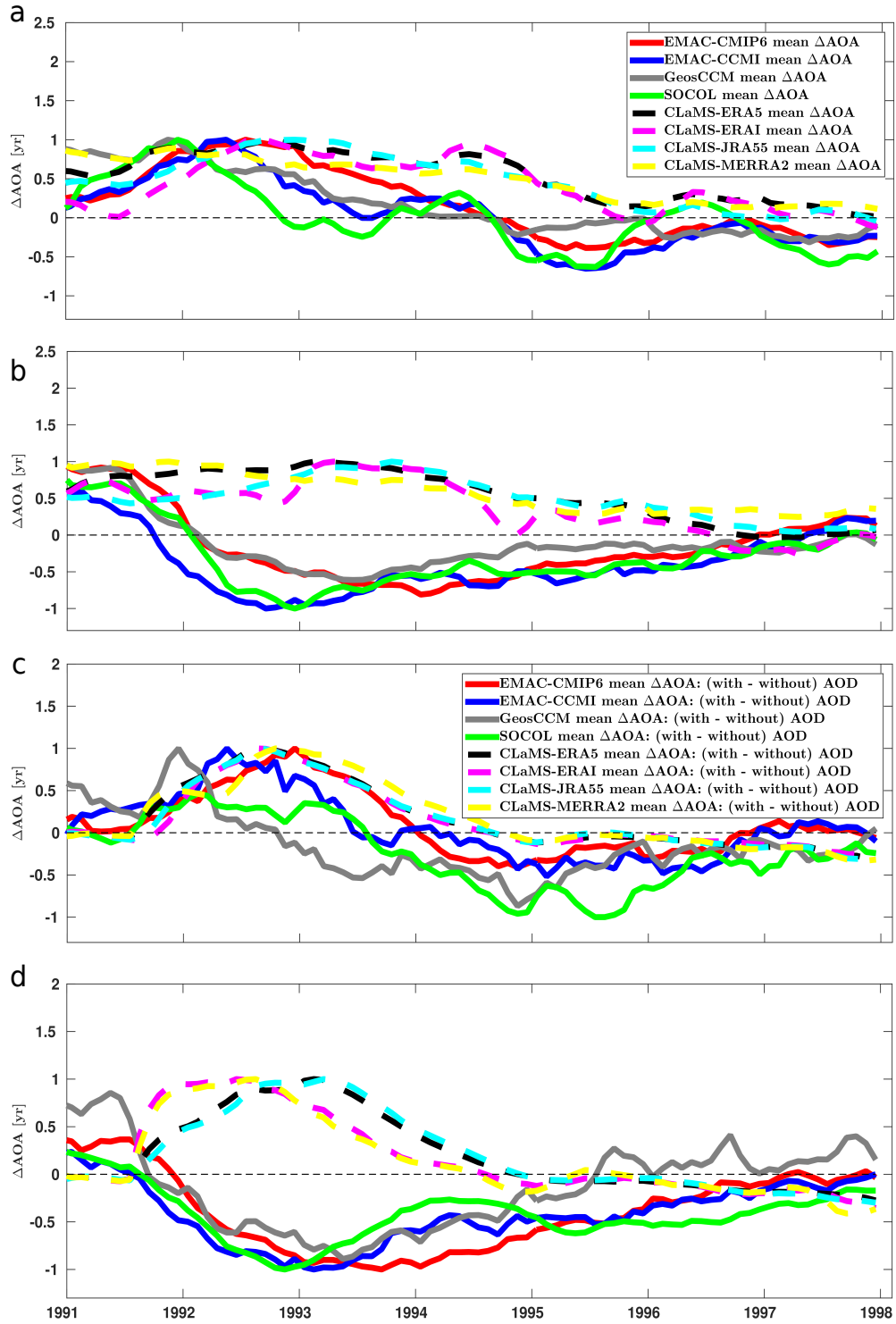


Figure 1: **Impact of the Mt. Pinatubo eruption on the stratospheric circulation.** **a, b** Timeseries of the anomalies of mean age of stratospheric air from each reanalyses and climate models, averaged between 72°S and 72°N in the lower stratosphere (**a** shallow branch, tropopause–21 km) and in the middle/upper stratosphere (**b** deep branch, 22–40 km). **c, d** Impact of the Mt. Pinatubo eruption on mean age of stratospheric air anomalies averaged between 72°S and 72°N from the each reanalyses and climate models calculated by differentiating each simulation including volcanic eruption (“Volcano”) with each simulation without volcanic eruption (“No Volcano”) for the 1991–1998 period and from the reanalyses by differentiating the residual of the multiple regression with and without AOD signal, respectively.

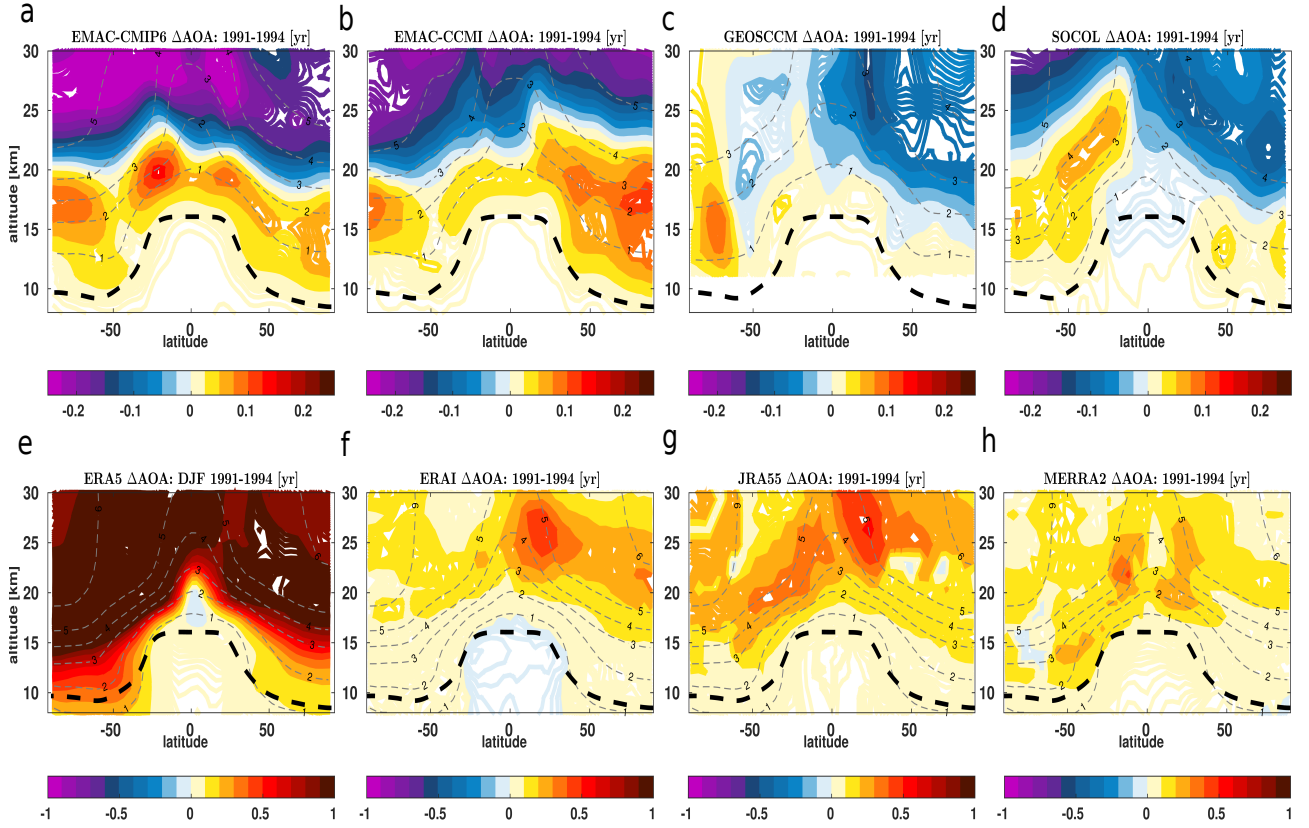


Figure 2: **Zonal mean impact of the Mt. Pinatubo eruption on the stratospheric circulation.** **a–d** Changes in anomalies of mean age of stratospheric air from each individual climate model **a–d** and reanalyses **e–h** estimates, averaged between January 1991 and December 1994. The impact of the Mt. Pinatubo eruption on anomalies of mean age of stratospheric air for each climate model is calculated by differentiating the simulation including volcanic eruption (“Volcano”) with the simulation without volcanic eruption (“No Volcano”) during the 1991–1994 period and for each reanalysis estimate by differentiating the residual of the multiple regression with and without AOD signal, respectively. There is a factor 4 between climate model and reanalysis scales.

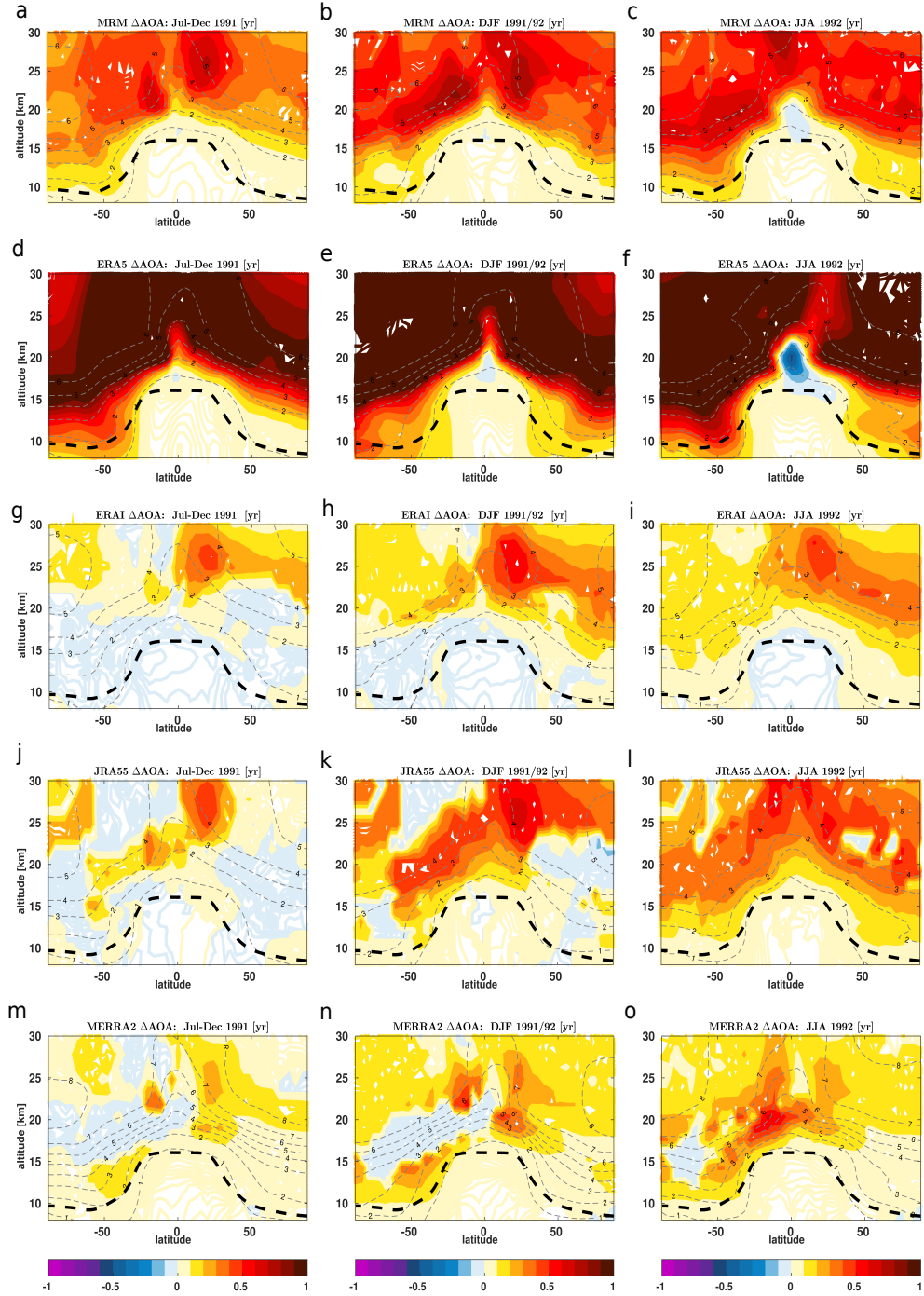


Figure 3: **Time-evolution of the Mt. Pinatubo impact on the stratospheric circulation.** **a–c** Time-varying anomalies of mean age of stratospheric air during the **a** first 6 months (July–December 1991), **b** first boreal winter (December–February 1991/92) and **c** first austral winter (July–August 1992) following the Mt. Pinatubo eruption from multi-reanalysis mean and **d–o** each individual reanalyses. The impact of the Mt. Pinatubo eruption on anomalies of mean age of stratospheric air from each individual reanalysis is calculated by differentiating the residual of the multiple regression with and without AOD signal.

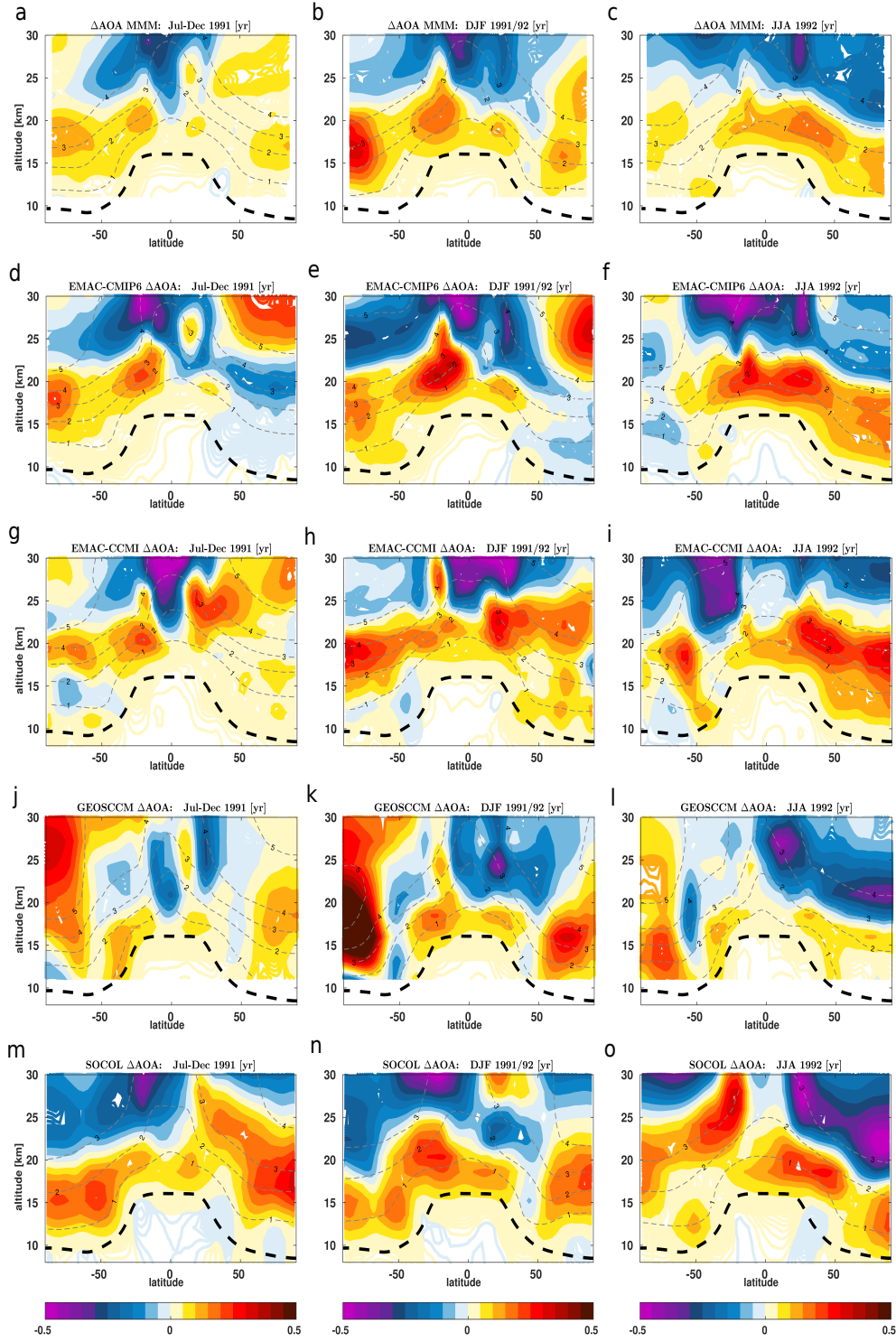


Figure 4: Time-evolution of the Mt. Pinatubo impact on the stratospheric circulation. **a–c** Time-varying anomalies of mean age of stratospheric air during the **a** first 6 months (July–December 1991), **b** first boreal winter (December–February 1991/92) and **c** first austral winter (July–August 1992) following the Mt. Pinatubo eruption from multi-climate model mean and **d–o** from each individual climate model estimates. The impact of the Mt. Pinatubo eruption on mean age of stratospheric air anomalies from the each individual climate model is calculated by differentiating the estimates including volcanic eruption (“Volcano”) with the simulation without volcanic eruption (“No Volcano”).

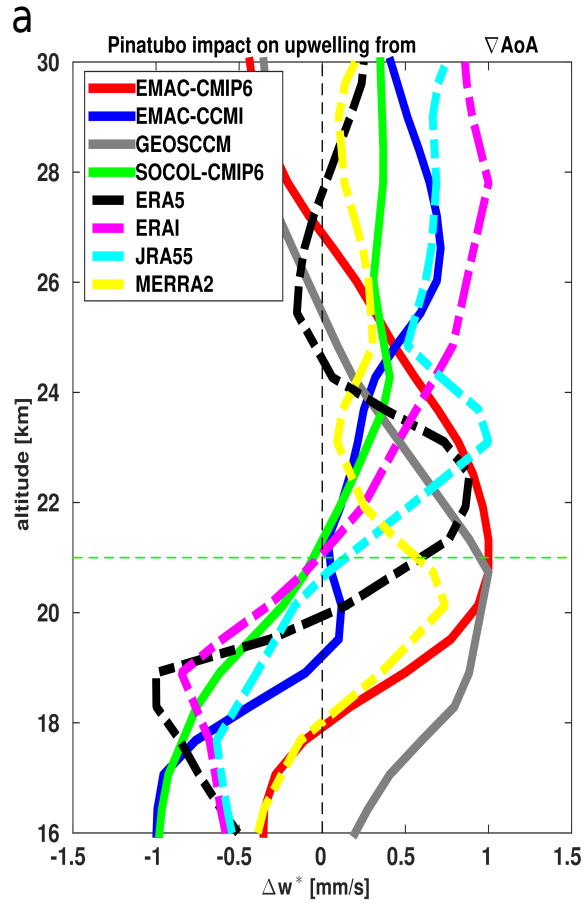


Figure 5: **Impact of the Mt. Pinatubo eruption on tropical upwelling.** Vertical profile of the Mt. Pinatubo eruption impact on the residual vertical velocity (w^*) estimated from the latitudinal gradient formula of mean age of stratospheric air over the January 1991–December 1994 time period for each individual climate models and reanalyses. Horizontal green dashed line indicates the altitude 21 km.

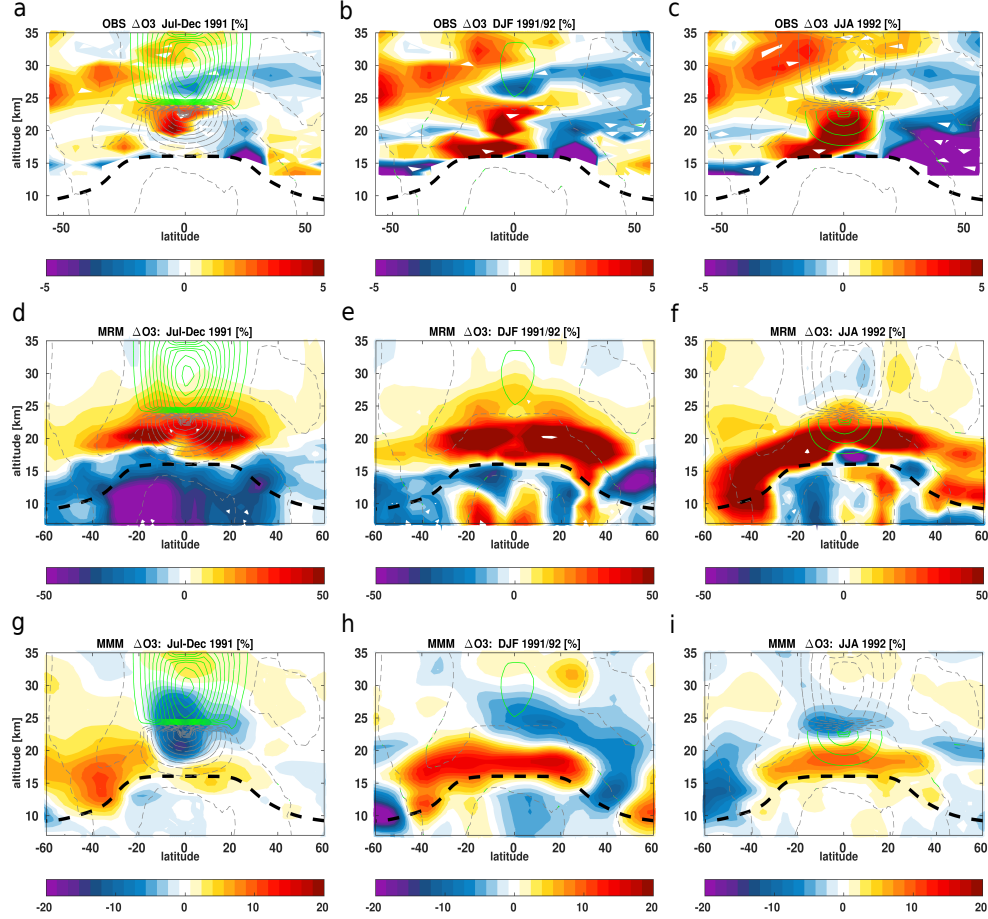


Figure 6: **Time-evolution of the Mt. Pinatubo impact on the stratospheric ozone.** **a–i** Time-varying anomalies of monthly mean stratospheric ozone during the **a** first 6 months (July–December 1991), **b** first boreal winter (December–February 1991/92) and **c** first austral winter (July–August 1992) following the Mt. Pinatubo eruption from merged satellite observations **a–c**, multi-climate model mean **d–f** and multi-reanalysis mean **g–i** estimates. The impact of the Mt. Pinatubo eruption on monthly mean stratospheric ozone anomalies from climate model estimates is calculated by differentiating the simulation including volcanic eruption (“Volcano”) with the simulation without volcanic eruption (“No Volcano”) and from merged satellite observations and reanalyses by differentiating the residual of the multiple regression with and without AOD signal, respectively.

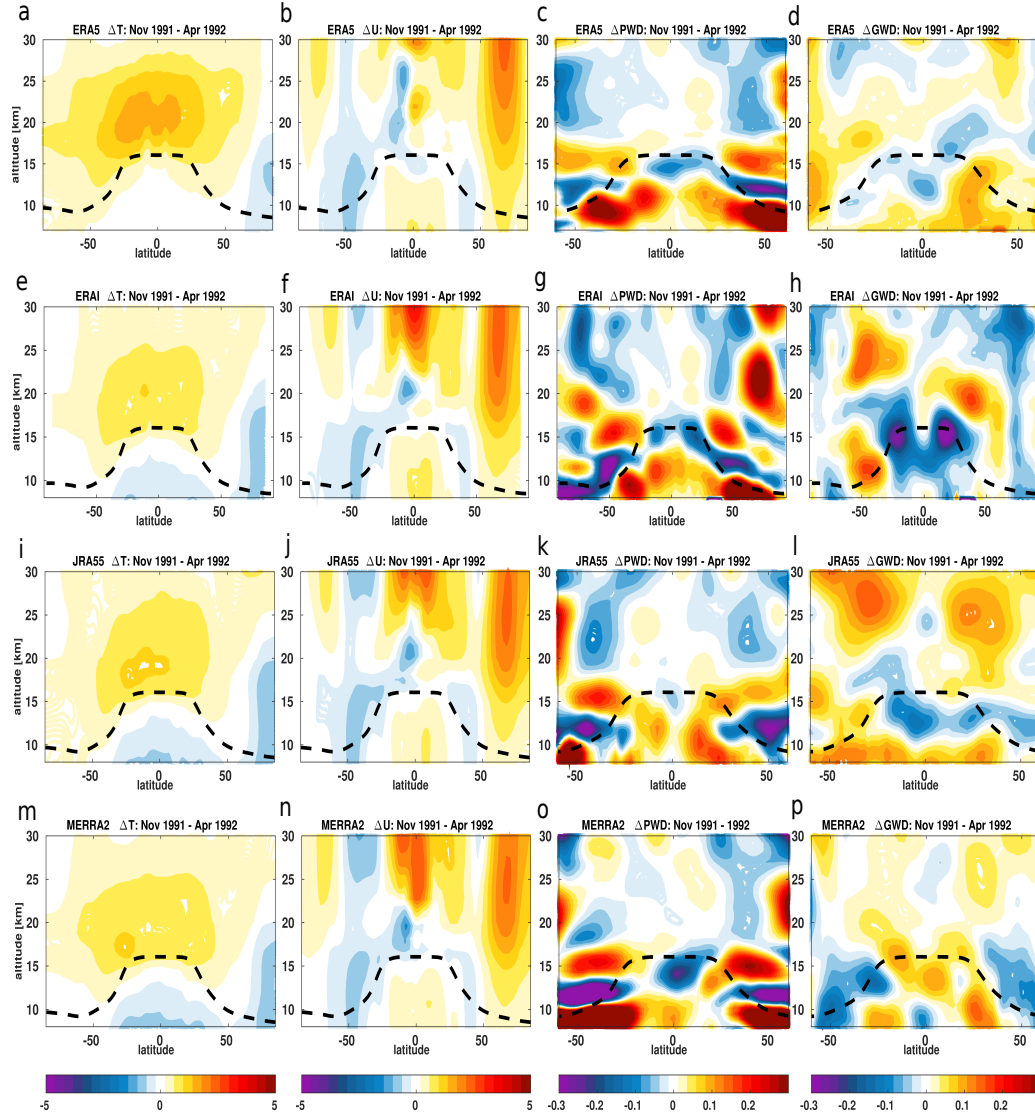


Figure 7: **Mechanism driving the stratospheric circulation response to the Mt. Pinatubo eruption.** Impact of the Mt. Pinatubo on temperature (T) **a, e, i, m**, zonal wind (U) **b, f, j, n**, planetary wave drag (PWD) **c, g, k, o** and gravity wave drag (GWD) **d, h, l, p** from each individual reanalysis during the boreal winter from November 1991–to–April 1992. Bold black dashed–line indicates the tropopause height. Grey thick contour highlights the zero–wind line.

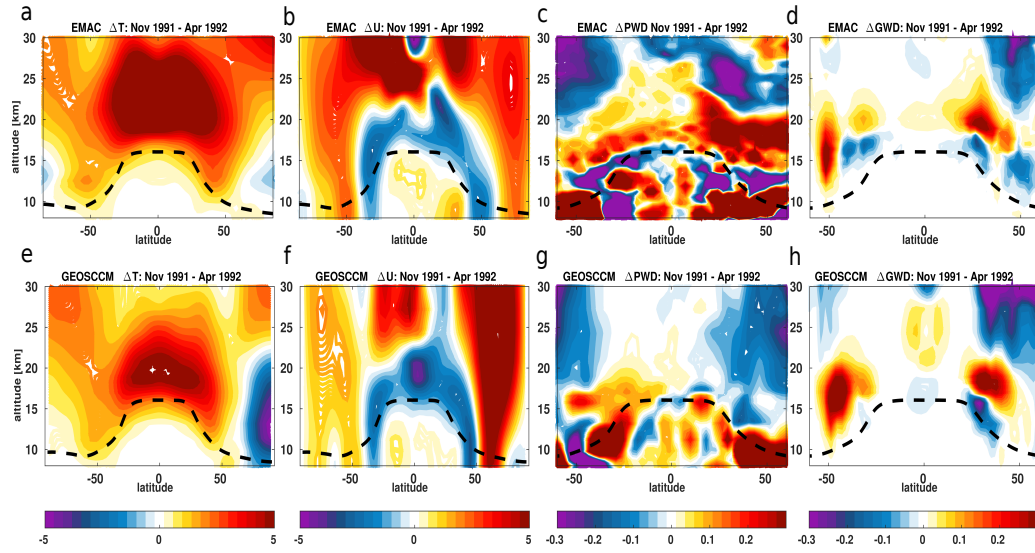


Figure 8: **Mechanism driving the stratospheric circulation response to the Mt. Pinatubo eruption.** Impact of the Mt. Pinatubo on temperature (T) **a, e**, zonal wind (U) **b, f**, planetary wave drag (PWD) **c, g** and gravity wave drag (GWD) **d, h** from each individual climate model estimate during the boreal winter from November 1991–to–April 1992. Bold black dashed–line indicates the tropopause height. Grey thick contour highlights the zero–wind line.