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Evidence for the long-term climate model predicted-stratospheric circulation changes in the ERA5 reanalysis over 1960-2020

Mohamadou Diallo[1], Roland Eichinger[2], Fernando Iglesias-Suarez[3], and Felix Ploeger[1]
[1]Institute of Energy and Climate Research, Stratosphere (IEK-7), Forschungszentrum Jülich, 52 425 Jülich, Germany
[2]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany,
[3]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany,

The recent release of the long-term ERA5 reanalysis data spanning from 1950 to present offers new opportunities for analysing trends and variability of stratospheric dynamics. For the first time, a 60 year period (1960-2020) can be analysed in reanalysis data and compared with chemistry-climate model simulations. The analyses of stratospheric circulation trends and seasonalities over this long time period can help us to better understand the long-term evolution of the Brewer-Dobson circulation (BDC), and the related inter-model differences and model dependencies. Therefore, this way an improved credibility in future projections of the BDC can be obtained.
We find that the global trend patterns of the temperature, zonal wind and residual vertical velocity agrees well between ERA5 and the multi model mean. However, differences occur in the width and altitude of the maximum trend. The tropical upwelling mass flux time series in the lower stratosphere of models and reanalysis disagrees at the beginning of the period, but they converge after around 1980. The agreement of the time series increases with altitude, where the QBO dominates the signal. Moreover, we find a generally good agreement in the zonal wind trends, although some differences are detected in the subtropical jet strength and upward shift, as well as in the polar vortex region where the models exhibit larger changes than ERA5. Another striking difference is the temperature trend in the tropical upper troposphere/lower stratosphere, where models show a more extended warming trend into the lower stratosphere. In this presentation, we show these results, put them in relation to what had been shown in previous studies for other time periods and discuss possible explanations for the differences as well as implications for the further evolution of the BDC.