

Hitchman, M. H., S. Yoden, P. H. Haynes, V. Kumar, and S. Tegtmeier, 2021: An observational history of the direct influence of the stratospheric Quasi-biennial Oscillation on the tropical and subtropical upper troposphere and lower stratosphere. *J. Meteor. Soc. Japan*, **99**, 239-267.

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Plain Language Summary: The history of observational studies regarding the influence of the quasi-biennial oscillation (QBO) on the tropical and subtropical upper troposphere and lower stratosphere (UTLS) is described. The seasonal and geographical variation of QBO westerly (W) minus easterly (E) differences in UTLS temperature, pressure, and zonal wind is presented. Results from the periods 1958-1978 and 1978-2000 using National Centers for Environmental Prediction (NCEP) reanalyses are compared with modern updates using Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA2) data for 1980-2017, and European Centre for Medium Range Weather Forecasting Reanalysis – Interim (ERA-Interim) data for 1979-2018.

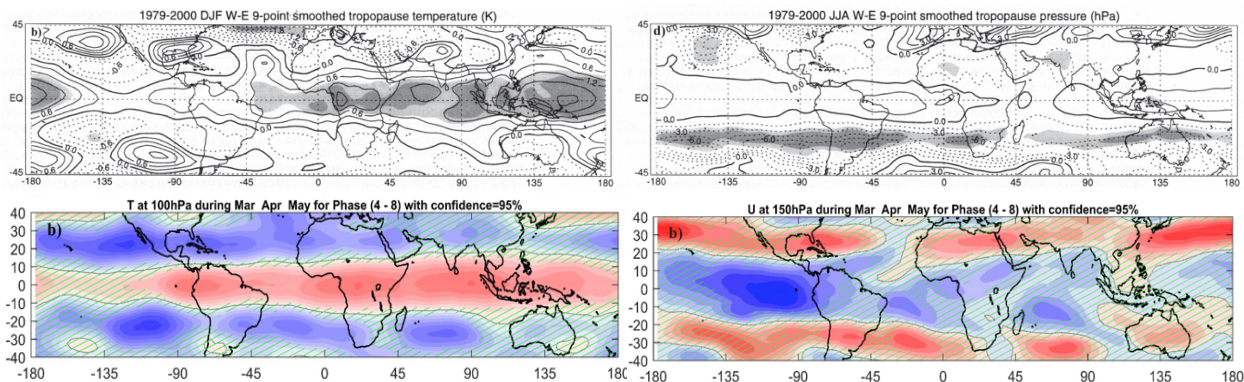


Figure 1. QBO W-E differences in tropopause temperature during DJF (upper left, interval 0.3 K) and tropopause pressure (upper right, interval 1.5 hPa) during JJA for NCEP 1979-2000, and in 100 hPa temperature (lower left, interval 0.25 K, red positive) and 150 hPa zonal wind (lower right, interval 1 m/s, red positive) during MAM for ERA-Interim 1979-2018.

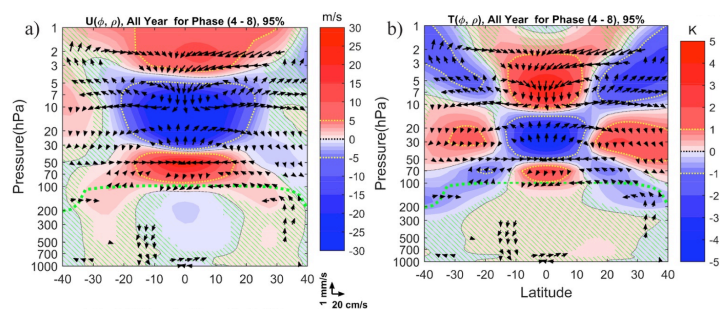


Figure 2. Time mean ERA-Interim QBO W-E differences for a) zonal wind and b) temperature, with superimposed arrows showing QBO W-E differences in the mean meridional circulation (MMC).

- QBO W in lower stratosphere favors warmer tropical UTLS and colder subtropical UTLS
- Agreement among data sets, with larger temperature signal near seasonal convective centers
- Subtropical signal enhanced during MAM in both hemispheres, JJA in SH, and DJF in NH
- Subtropical westerly jets enhanced during QBO W, especially during MAM
- Annual and seasonal depictions of QBO structure in temperature, zonal wind, and MMC