The Stratospheric Quasi-Biennial Oscillation Influence on Trace Gases at the Earth's Surface

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The quasi-biennial oscillation (QBO) of tropical zonal wind is one of the most important modes of interannual variability in the stratosphere. It is well known that the QBO induces a secondary mean meridional circulation that extends from the tropics into the extratropics and influences the distribution of trace gases throughout the global stratosphere. In this work we show that the QBO variability of stratospheric transport and trace gas distributions extend down into the troposphere, influencing the interannual variability of long-lived trace gas mole fractions through the stratosphere to troposphere mass flux. The QBO variability is seen in surface measurements as well as throughout the stratosphere and troposphere in chemistry-climate model (CCM) simulations of CFC-11, CFC-12 and N_2O. We show that the interannual variability in surface annual growth rates, after long-term changes are removed, is mostly driven by the QBO. Correlations between QBO zonal winds and interannual variability in surface trace gas mole fractions are highly significant in both the measurements and model output. We also show how the emission estimates of the trace gases considered here can be affected by not accounting for QBO-driven variability.

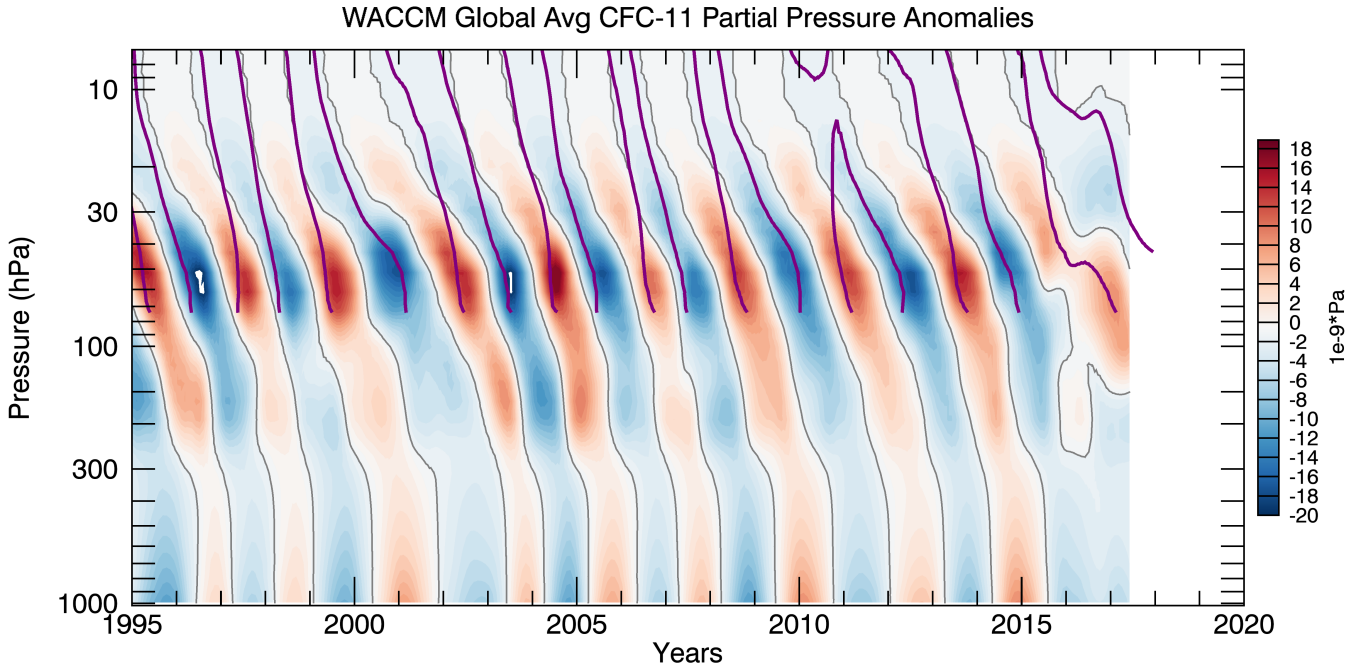

Figure 1. Time series of Whole Atmosphere Community Climate Model (WACCM) global average CFC-11 partial pressure anomalies (orange positive, blue negative) as a function of pressure. The tropical average zonal wind 0 m/s contours are shown in the purple lines for pressures less than 80 hPa. This shows a clear propagation of modeled CFC-11 partial pressure anomalies from the middle stratosphere to the surface.