QBO influence on the ozone distribution in the extra-tropical stratosphere

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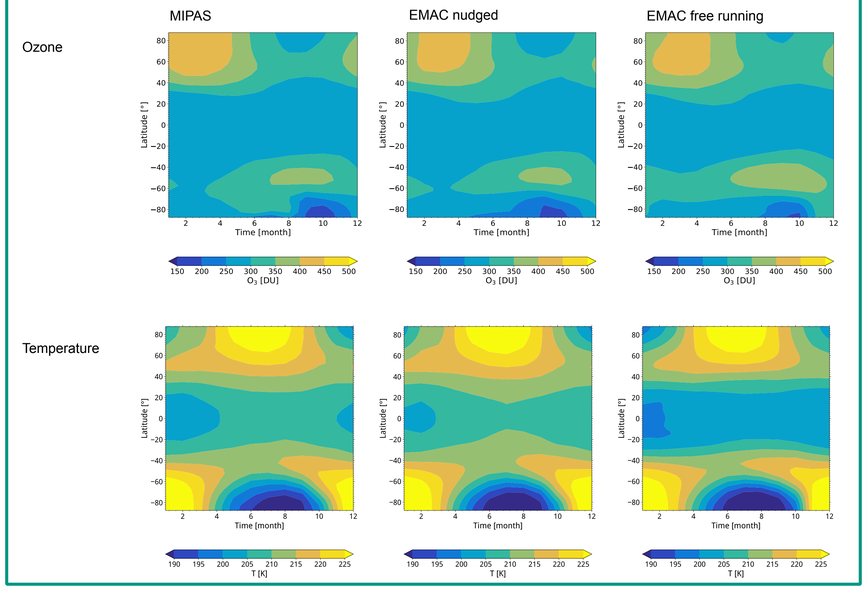
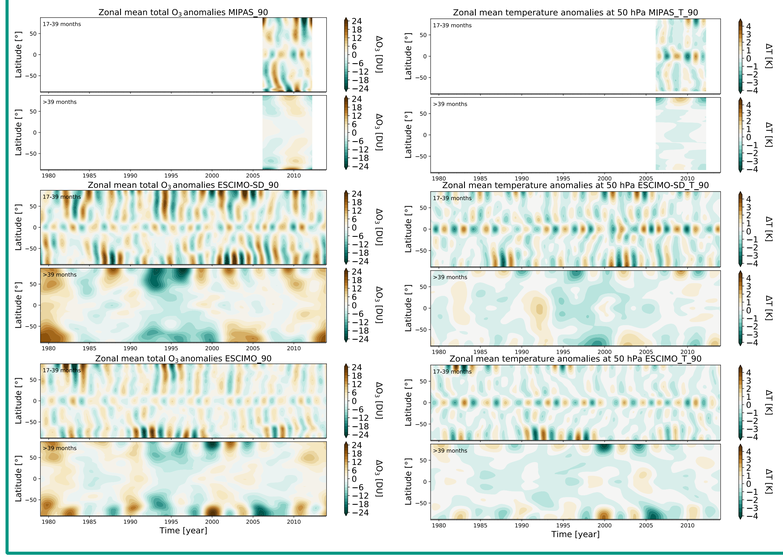
Motivation

To study the influence of the quasi-biennial oscillation (QBO) on the inter-annual ozone variability in the tropics and extra-tropics we are using band-pass Fourier filtering to extract QBO-ozone signatures from model data with a particular focus on height resolved ozone anomalies that we construct as QBO total ozone maximum and minimum averages. By comparing the observational evidence with free-running (with a nudged QBO) and nudged (using ERA interim) EMAC (ECHAM5/ MESSY Atmospheric Chemisty) model data with T42L47 resolution, we are able to characterise the models performance with respect to chemical and dynamical processes and increase our confidence and the description of QBO related processes. With this diagnostic we improve our understanding of the physical mechanisms that contribute to ozone variability and how an 'ozone change signal' can migrate from the tropics to the extra-tropics. Understanding the main mechanisms involved in this signal transfer lays the foundation for improved trend detection on decadal time scales.

1. Annual cycle in the total column O_3

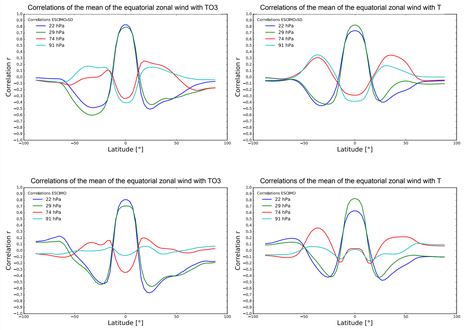


2. Time series of filtered (QBO and >39 months) Δ total column O_3 and temperature for data from MIPAS, nudged EMAC and free running EMAC



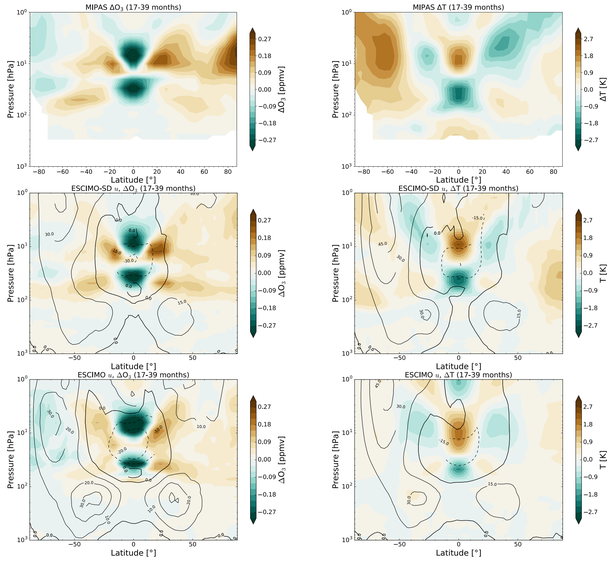
The maxima and minima of ozone and temperature are determined for the tropical QBO. At those positions altitude sections are determined with ozone mixing ratios and temperature to generate a mean state in a composite plot (3).

3. Height dependent correlations for ozone and temperature

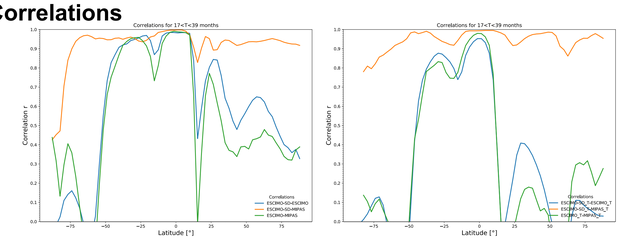


Correlation of the mean of the equatorial zonal wind $u_{Eq}(p)$ with the total ozone column anomaly, ΔTO3 (left) and the temperature anomaly ΔT (right) for nudged EMAC (top), free running EMAC (bottom)

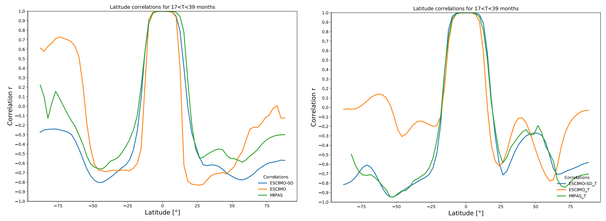
4. Composites of EMAC (ESCIMO, ESCIMOSD) and MIPAS O_3 (left) and 50 hPa temperature (right) QBO minimum



5. Correlations



Correlations of total column ozone anomalies (left) and 50 hPa temperature anomalies (right) of the different datasets against latitude.



Correlations of the equatorial total ozone column anomalies (left) and the 50 hPa temperature anomaly (right) time series with the equatorial ozone and equatorial temperature anomaly time series at all latitudes, respectively, for nudged EMAC (blue), free running EMAC (orange) and MIPAS (green) data.

6. Summary

1. Annual cycle of ozone/T shows good agreement between datasets.
2. Influence of the wind QBO on ozone and temperature is clearly observed in the EMAC model.
3. Ozone maxima and minima extend to 12 to 15°N/S.
4. Quadrupole-like structure of the ozone field.
5. The observed structures in ozone and temperature are related to the residual circulation and the dynamically and chemically controlled regimes of ozone.

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