Quasibiennial modulation of the Southern Hemisphere tropopause

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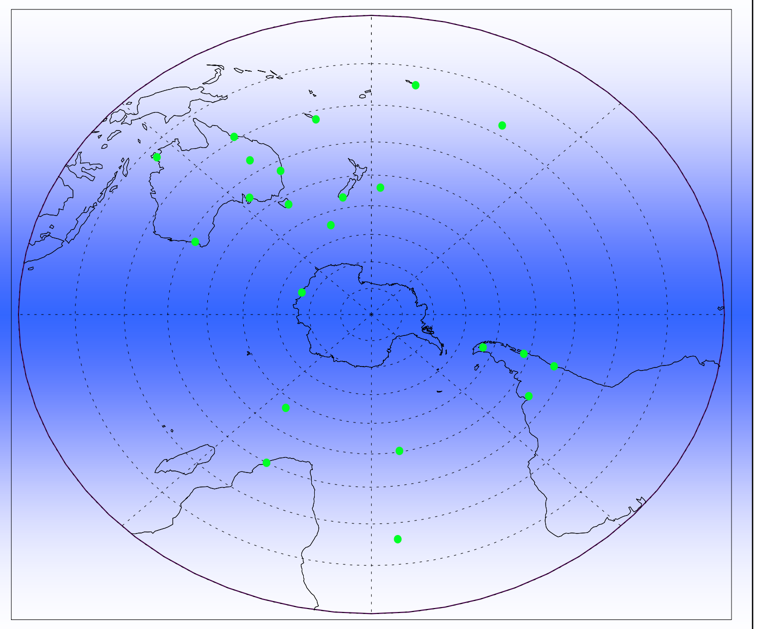
Data and method

The equatorial Quasibiennial Oscillation (QBO) is known to influence tropopause characteristics over the whole globe.

In the present analysis, we compare the modulation exerted by the QBO over the southern hemisphere tropopause characteristics using different data sources:

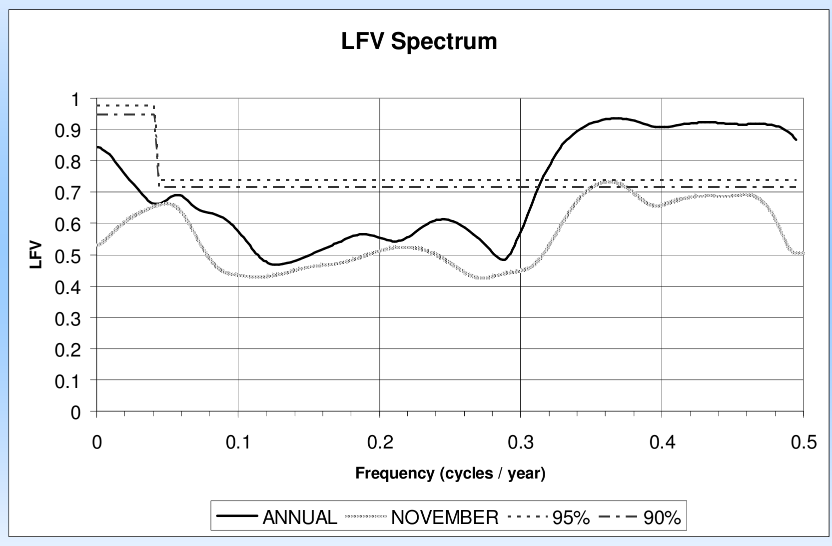
- ERA-40 reanalyzed data from the European Centre for Medium-Range Weather Forecasts (ECMWF).
- Data from a set of 22 observatories included in the Integrated Global Radiosonde Archive (IGRA).
- Ozone data from TOMS for the 1979-1999 period.

The QBO modulation of the tropopause characteristics from these databases is estimated through the application of the multitaper-singular value decomposition method (MTM-SVD) for the 1979-1999 period. QBO modulation of ozone concentration is estimated through the application of the MTM-SVD analysis to ERA-40 ozone data and by compositing TOMS data during the most intense positive and negatives phases of the November QBO.



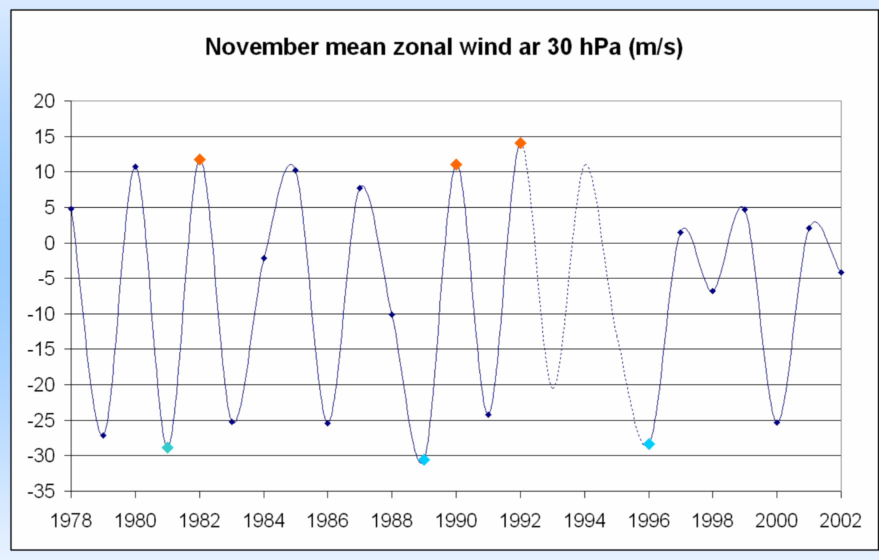
The Quasibiennial Oscillation

A significant band of oscillation is identified in the LFV spectrum of the joint datasets, both at annual and November timescales. This band corresponds to the quasibiennial oscillation of the zonal wind over the equator (QBO).



The QBO signal is more intense in the annual analysis, possibly due to the weak propagation of the equatorial QBO signal towards the Southern Hemisphere.

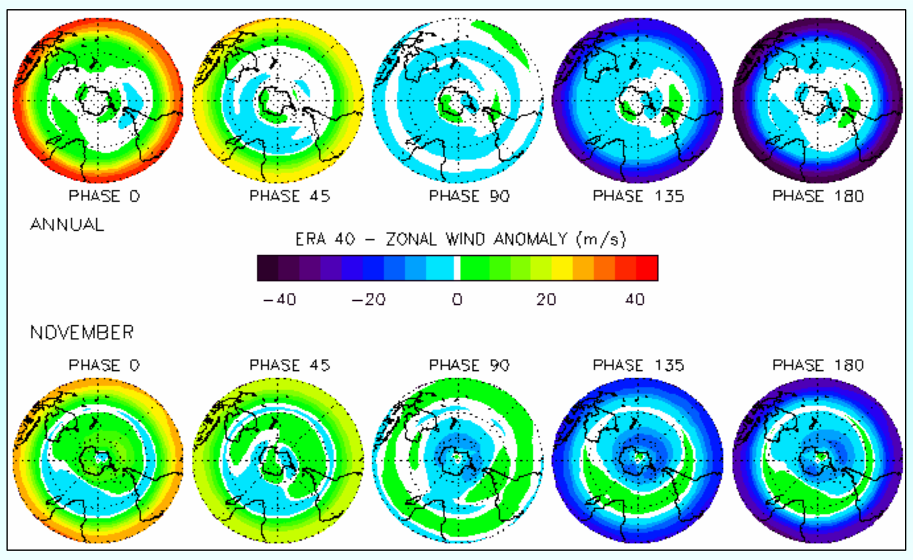
The evolution series of November mean zonal wind at 30 hPa over the equator is characterized, as well, by a quasibiennial oscillation. In the following figure the three most intense positive and negative phases have been marked with a orange and a blue bigger dots.



TOMS data has been used to calculate the composites of total ozone during positive and negative QBO phases. The discontinuous line corresponds to months with no data available from TOMS.

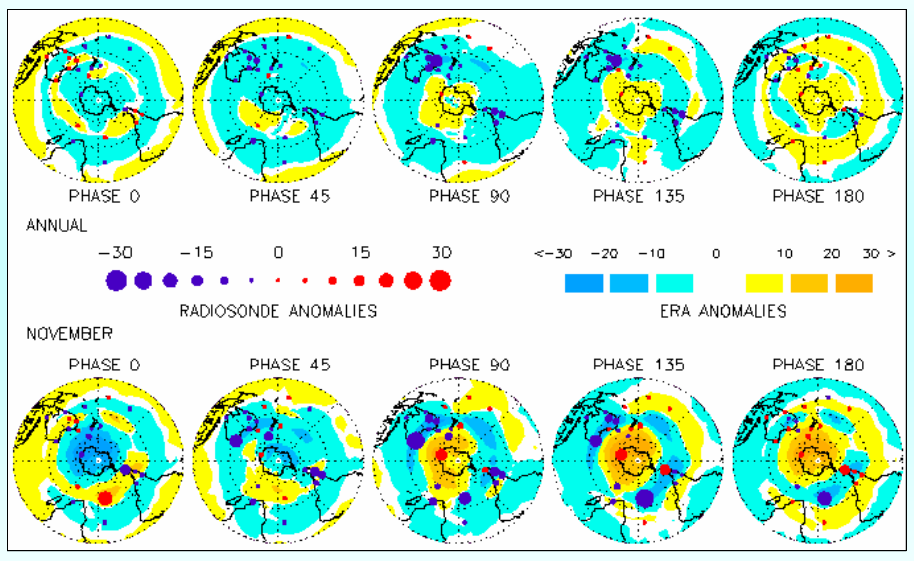
Spatial patterns: tropopause

Evolution of the zonal wind at 30 hPa through half a QBO cycle (approx. 16 months) from a QBO west phase to a QBO east phase.



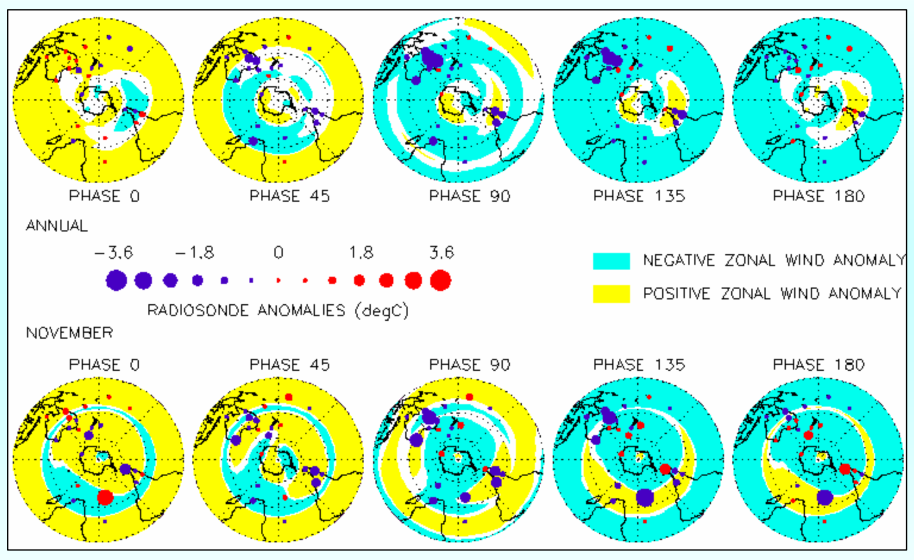
November data evidences the existence of an acceleration of the SH polar vortex in phase with the equatorial QBO during this month.

A good agreement between the evolution of pressure at the tropopause obtained from ERA and from IGRA data is observed in the annual analysis.



The agreement is not so good in the November analysis, particularly over the southernmost areas of South America.

At extratropical latitudes there is a reasonable agreement between an acceleration (deceleration) of the polar vortex and a colder (warmer) tropopause temperature.

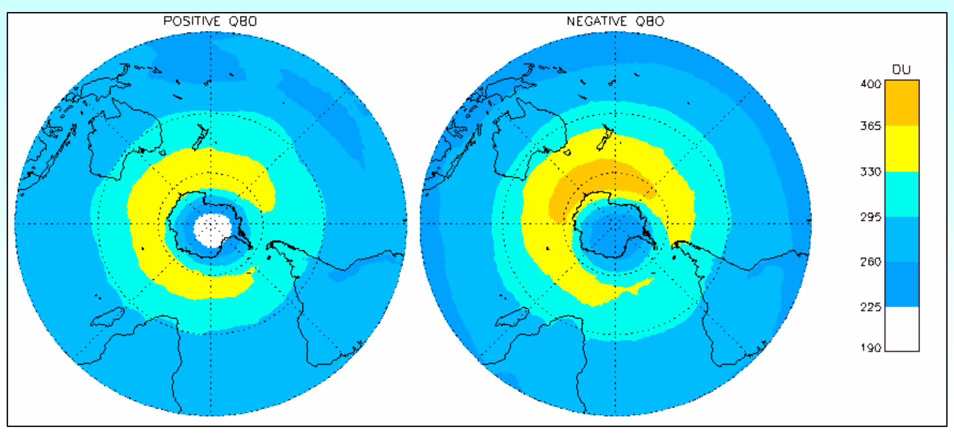


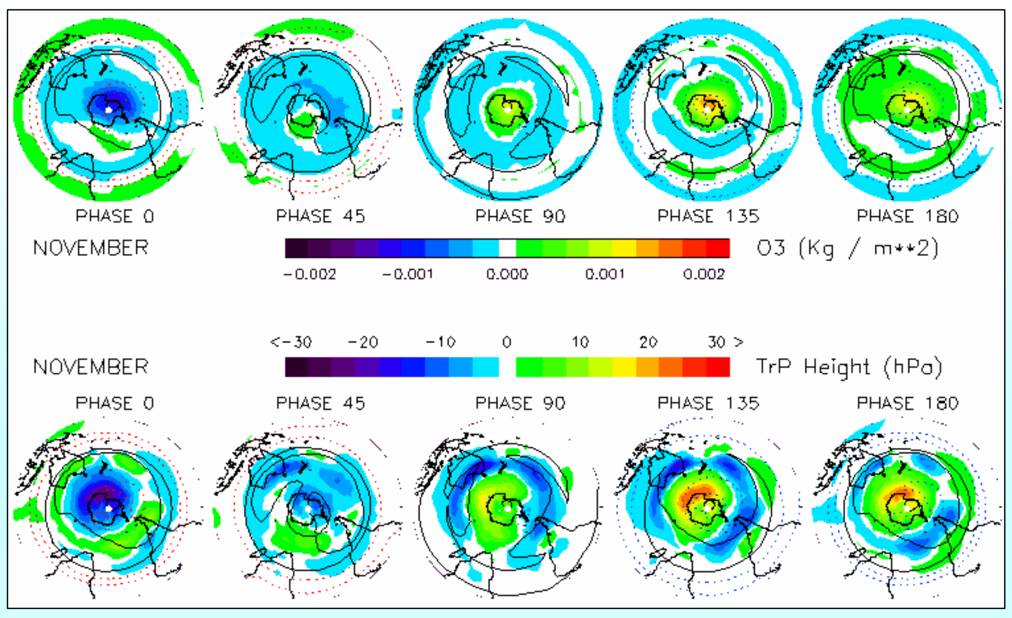
The analysis of November data shows similar results, even when higher values are detected in temperature anomalies.

Spatial patterns: ozone

It has been proposed that the intensity of the Brewer-Dobson circulation can be affected by the QBO. A positive (negative) QBO phase would correspond with a BD circulation less (more) intense. Simultaneously, it would correspond with an acceleration of the polar vortex. Colder (warmer) than normal temperatures at polar latitudes during positive (negative) QBO phases can be explained by an elevation (descent) of air masses over those latitudes and by a decrease (increase) in the ozone concentration.

The composites of TOMS data for intense November QBO phases shows that positive QBO phases are characterized by a general reduction in the total ozone to the south of 55S, while negative phases are characterized by an increase in the total ozone.





The analysis of the ERA data corroborates the previous result. At high latitudes, November evolution of total ozone oscillates from lower than normal presence of ozone during positive QBO phases to higher than normal presence of ozone during negative QBO phases. This evolution is accompanied by an elevation of the polar tropopause (negative pressure anomalies) during positive QBO phases an a descent of the polar tropopause during negative QBO phases.