# ANALYSIS OF POSSIBLE RELATIONSHIP BETWEEN QUASI-BIENNIAL OSCILLATION E ANTARCTIC OSCILLATION USING CROSS-WAVELETS

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## RESUMO

A atmosfera é um sistema complexo, que apresenta interações em diferentes escalas temporais e espaciais. Diversos estudos já foram realizados a fim de relacionar eventos que ocorrem em diferentes localidades do globo e ainda assim estão relacionados entre si. Este trabalho busca, através de ondeletas cruzadas, analisar a possível relação entre a Oscilação Quase-Bienal (QBO) e a Oscilação Antártica (AAO), uma vez que essa relação já vem sendo investigada para o Hemisfério Norte (HN), entre a QBO e a Oscilação Ártica (AO; fenômeno correspondente à AAO para o HN). Os resultados das ondeletas cruzadas entre os índices da QBO e da AAO indicam um pico de energia no período de 2 anos, com uma diferença de fase que varia de acordo com o período analisado.

## ABSTRACT

The atmosphere is a complex system, which presents interactions at different temporal and spatial scales. Many studies have already been made in order to relate events occurring in different localities of globe and, nevertheless, are correlated. This study intends to analyze,using cross-wavelets techniques, the possible relationship between the Quasi-Biennial Oscillation (QBO) and the Antarctic Oscillation (AAO), since similar relationship has already been investigated for Northern Hemisphere (NH), between QBO and Arctic Oscillation (AO; NH counterpart of AAO). The results of cross-wavelets between QBO and AAO indices showed a peak of energy in the 2-year period, with a time lag that varies according to analyzed period.

**Key words:**Quasi-Biennial Oscillation, Antarctic Oscillation, Cross-Wavelets.

## 1) INTRODUCTION

The Antarctic Oscillation (AAO; or Southern Hemisphere Annular Mode) is the leading mode of variability of extratropical circulation in Southern Hemisphere. A similar oscillation also occurs at Northern Hemisphere, called Arctic Oscillation (AO; or Northern Hemisphere Annular Mode; Thompson and Wallace, 2000). The AAO refers to a meridional seesaw in atmospheric mass between midlatitudes and high latitudes. On positive (negative) AAO phase, there are positive (negative) pressure anomalies in mid-latitudes and negative (positive) anomalies in high latitudes (Thompson and Wallace, 2000). The Quasi-Biennial Oscillation (QBO) occurs at tropical stratosphere, has a mean period of 28 months and it is characterized by oscillation of equatorial zonal wind between easterlies and westerlies (e.g. Naujokat, 1986). Despite being a tropical phenomenon, somepapers suggest QBO is able to influence extratropics (e.g. Baldwin and Tung, 1994). There are also studies that relate QBO and AO, but little attention was paid to its Southern Hemisphere counterpart (AAO). The goal of this study then was verify a possible relationship between QBO and AAO.

## 2) METHODOLOGY

The QBO and AAO indices were built, respectively, using the monthly data of zonal wind and geopotential of Era-Interim Reanalysis (Dee et al., 2011), considering period from January 1981 to December 2010. AAO index was calculated for four levels (30, 200, 500 and 700 hPa) from the first

EOF (Empirical Orthogonal Function*)* of geopotential height anomaly between 30º-90ºS. This methodology differs of region typically used in literature (20º-90ºS; e.g. Thompson and Wallace, 2000), in order to avoid tropical influence. QBO index was obtained from zonally averaged zonal wind at equator, at 30 hPa (Naujokat, 1986). Cross-wavelets were built from the previous indices (this methodology was based on Grinsted et al., 2004).

## 3) RESULTS

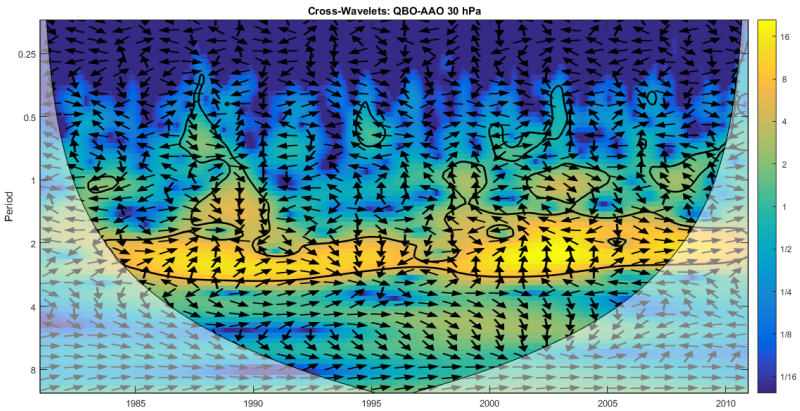


**Figure 1: Cross wavelet transform of the QBO and AAO indices time series. The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows.**

From cross-wavelets obtained between the QBO and AAO index at 30 hPa (Figure 1) can be observed peaks of energy between 1985-1995 and 2000-2005, in the period of 2 years. By analyzing the phase-arrows, phase differences between the QBO and AAO index time series can be seen, with a lag of approximately 18 months in the period 1985-1990, passing to 3 months for 1990-1995 and returning to 18 months for 2000-2005. For cross-wavelets between QBO index and other levels of AAO index, resultsare similar, except not show a peak in 1985-1990 periodand the other two peaks previously observed present less intensity (not shown).

## 4) CONCLUSIONS

The results indicate there is a relationship between these two teleconnections patterns, being more evident for the AAO index at 30 hPa than for others levels. The time lag among indices varies according to analyzed period, being of approximately 18 months, in 1985-1990period, passing to 3 months, for 1990-1995 and returning to 18 months,for 2000-2005.

## 5) REFERENCES

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