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Short Communication

Linkage between Cyclonic Storms, QBO, Total Ozone and Climate Change

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Abstract

Cyclonic storm frequency exhibits variations of different time scales. If long-term variations of cyclonic storm frequency are properly documented then the epochs of higher and lower frequencies could be foreshadowed much in advance. Ozone has been found to be one of the most important radiative gases in the stratosphere and the upper troposphere, as it is not only able to absorb the incoming solar ultraviolet radiation, but also part of the visible radiation as well as re-emit and absorb the outgoing terrestrial infrared radiation, consequently, changes ozone concentrations affect climate. Keeping the above in view a study has been undertaken to examine the relation between the cyclonic storms, total ozone and QBO (Quasi Biennial Oscillation).

Keywords: Cyclonic storms, QBO, total ozone, climate change.

Introduction

Tropical cyclone activity is influenced by the large-scale environment and so is influenced by various natural modes of Climatic variability. Iinterannual variations in the frequency of cyclonic storms have been documented by several authors[1-4]. On seasonal – to- interannual timescales, the main identifiable factor that influences tropical cyclone activity in most basins is the El Nino- Southern Oscillation (ENSO) phenomenon[5,6]. The stratospheric quasi-biennial oscillation (QBO) affects stratospheric dynamics globally and also has documented impacts on the troposphere, such as on winter temperature in North America, TC activity in the Atlantic and Indian seas[7-12] Several studies have been made using geomagnetic activity as one of the parameters principally to determine its possible effects on several parameters such as pressure change, cyclonic storm activity, ozone changes and atmospheric electricity, seismic activity[13,14]. These studies led one to believe, that, changes in total ozone and geomagnetic activity affects the troposphere phenomena[15,16]. Keeping the above in view in this paper a study has been undertaken to examine the relation between frequency of cyclonic storms, total ozone and quasi biennial oscillation of the equatorial lower stratosphere zonal winds (QBO).

Material and Methods

For the above study utilized the data of 52 years of the frequency of cyclonic storms formed over the Bay of Bengal and Arabian Seas. Cyclonic storm data have been collected from India Meteorology Department (IMD). The mean zonal winds for the 30hPa (QBO), for the above 52-year period have been collected from Free University, Berlin Research group. Total ozone data from 0 to 20N latitude belt for the above 52-year period are collected from the data books Ozone Data for the World and from TOMS, NIMBUS and Earth probe Satellites. In order to investigate the relationship between total ozone variability and frequency of cyclonic storms over Bay of Bengal and Arabian Sea on latitudinal scale, 1-2-1 smoothing was done to ozone values of 0-20N The mean zonal winds are bifurcated into easterly(easterly winds > -5ms-1) and westerly(westerly winds < -5ms-1) phases of QBO. Plots of smoothed values of total ozone, annual frequency of cyclonic storms, mean zonal winds (QBO) are shown figure 1. Plots of westerly zonal winds (QBO) and frequency of cyclonic storms and total ozone at 0-20^0 N latitude belt are shown in figure 1(a). Figure 1(b) shows easterly zonal winds (QBO) and frequency of cyclonic storms and total ozone at 0-20^0N. Table 1 shows correlation coefficient r values between total ozone, mean zonal winds and frequency of cyclonic storms.

Table-1
Correlation r between cyclonic storms, mean zonal winds at 30 hPa (QBO) and total ozone at 0 to 20^0N from 1958-2009

S. No.	Correlation Coefficient r	Westerly QBO	Easterly QBO	QBO
1	Correlation value between zonal winds and Cyclonic storms	+0.22	-0.4	+0.35
2	Correlation value between total ozone and cyclonic storms	+0.1	-0.5	+0.2
3	Correlation value between zonal winds and total ozone	+0.6	+0.5	+0.4

Results and Discussion

From figures 1,1a, 1b it has been observed that formation of cyclonic storms over Indian seas is more in number(r = +0.22) when QBO is in strong westerly phase and less in number (r = -0.4) when QBO in easterly phase. Also from figure 1 noticed decreasing trend in the frequency of cyclonic storms and total ozone during 2008 and 2009 and mean zonal winds have become weak westerly/ strong easterlies.

It is observed from table 1. that total ozone variation at 0 to 20^0N is having an in phase relation with mean zonal wind anomalies r = +0.4). It is also inferred from table 1. that frequency of cyclonic storms and total ozone are having an out of phase relation in the easterly QBO phase (r = -0.5) and also seen from table 1 QBO and total ozone are positively associated and stronger in the westerly phase of QBO (r = +0.6).

Conclusion

There exists a weak but significant relation between the phases of QBO, total ozone and cyclonic storms. QBO westerly phase with an increase in total ozone affects the cyclonic storm activity in the basins of the Indian seas. It is therefore, inferred from the above analysis, that changes in green house gases directly effects the total ozone and mean zonal winds which in turn effecting the climate by reducing formation of cyclonic storms and decreasing the number of cyclonic storms and increasing the intensity of the storms over Indian seas.

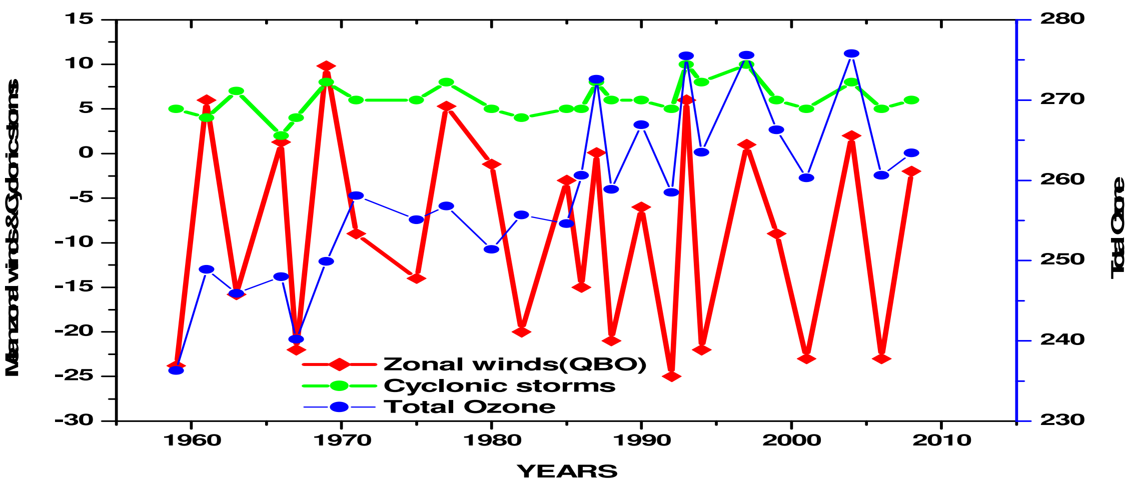

Figure-1
Mean zonal winds at 30hPa, frequency of cyclonic storms over Bay of Bengal and Arabian Sea and total ozone at 0 to 20N from 1958-2009

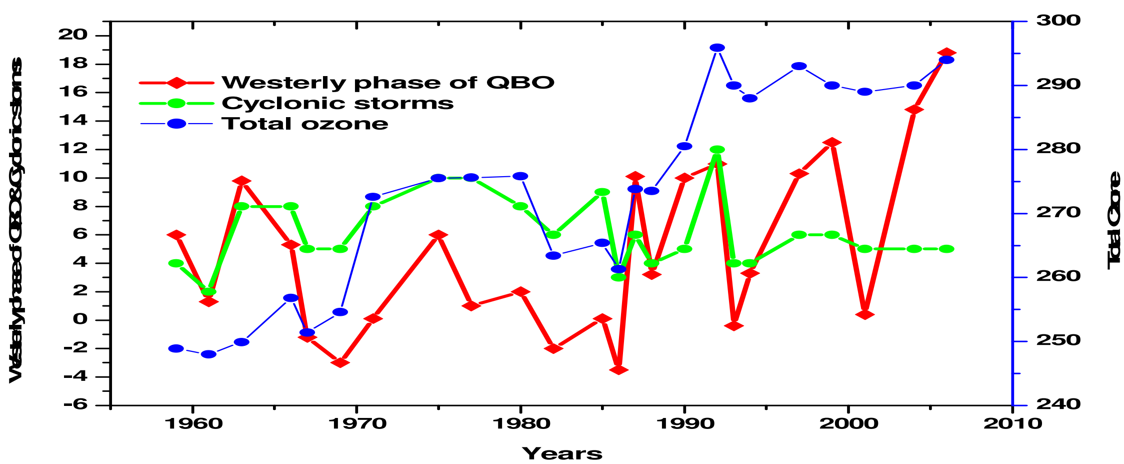

Figure-1a
Westerly mean zonal winds (QBO) and frequency of cyclonic storms and total ozone at 0 to 20N

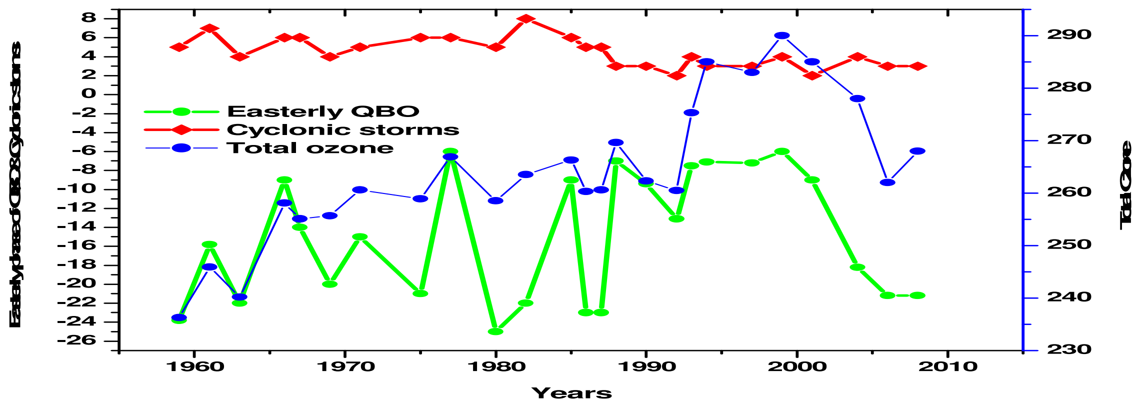

Figure-1b
Easterly mean zonal winds (QBO) and frequency of cyclonic storms and total ozone at 0 to 20N

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