SPARC GA 2008 Abstract Id: 00057

Triggering of strong El Nino events as a result of the influence of interaction between Tropical lower stratospheric QBO and the tropospheric dynamics

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4th SPARC General Assembly, 31st August – 5th September 2008, Bologna. Italy

OBJECTIVES

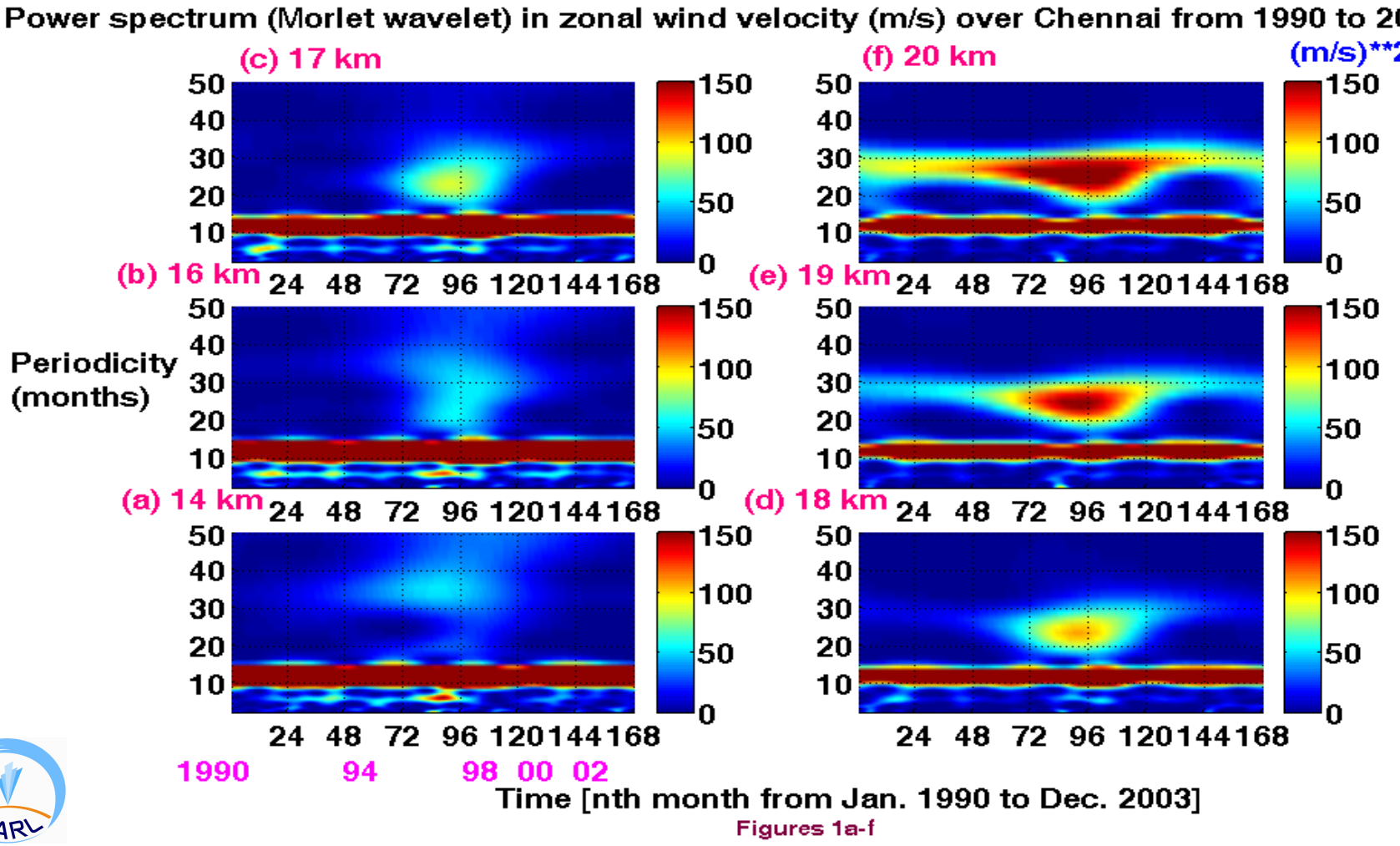
The importance of down penetration to troposphere of equatorial lower stratospheric quasi-biennial oscillation in zonal wind, particularly over the Indian Ocean region, on the triggering of great El Nino events like the ones occurred in the years of 1972-73, 1982-83 and 1997-87 is stressed using zonal wind velocity and intensity of outgoing long wave radiation obtained over both the equatorial Indian and Pacific Oceans.

Data: Monthly averaged zonal wind velocity measured with

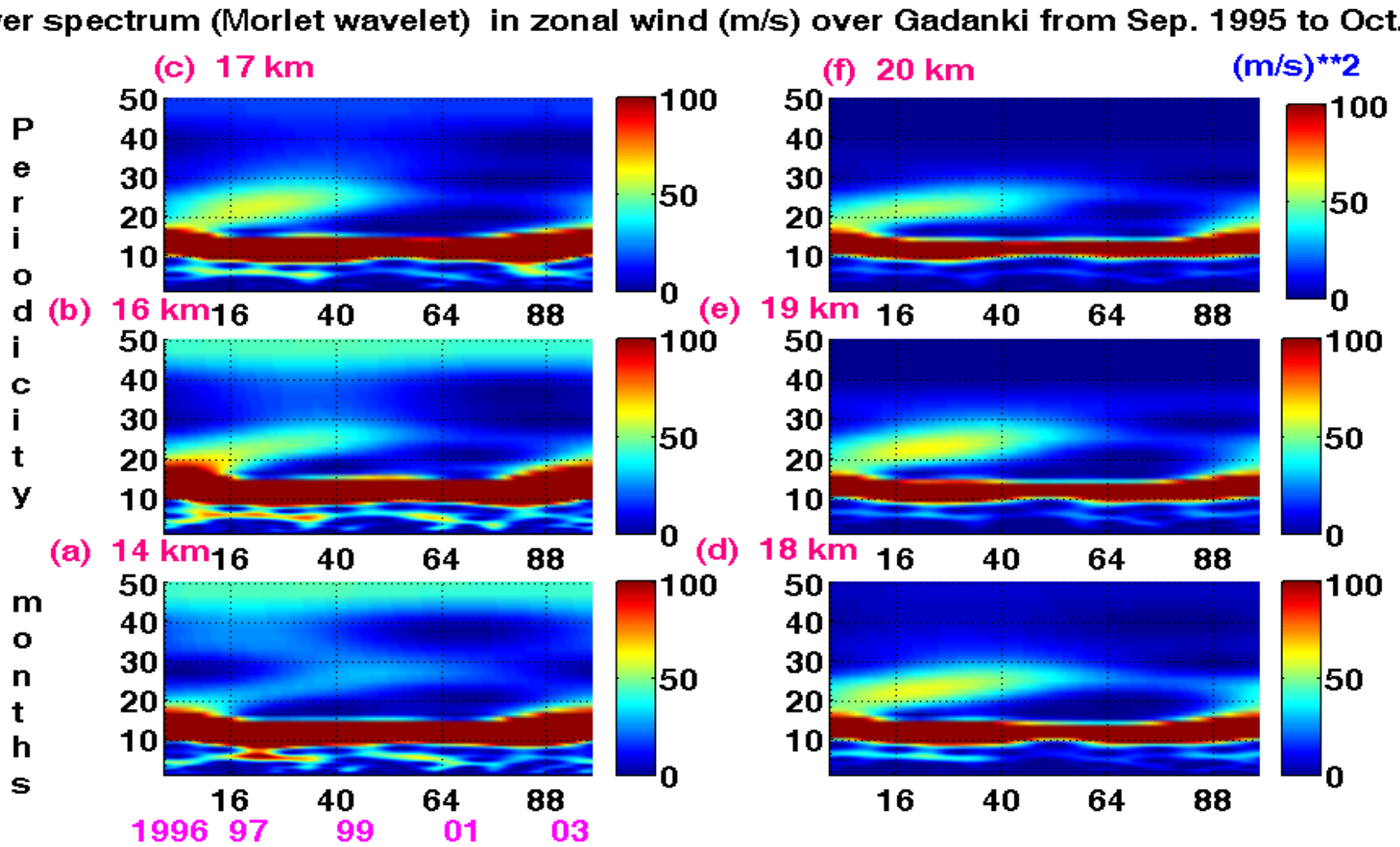
(1) Indian MST radar at Gadanki (13.5°N, 79.2°E) in the heights of 14-20 km during the period of September 1995 to October 2003;

(2) with radiosonde over the near by station (~150 km radial distance towards south) of Chennai (13°N, 80.2°E) during January 1990 to December 2003 and near the heights of 70 hPa (~18 km), 50 hPa (~21 km), 40 hPa (~23 km), 30 hPa (~25 km), 20 hPa (~27 km) and 15 hPa (~29 km) during (1) 1953-67 over Canton Island (2.46°S, 171.43°W), (2) 1967-75 over Gan/Maldives (0.41°S, 73.09°E) and (3) 1975-2001 at Singapore (1.22°N, 103.55°E) is utilized for the present study.

(3) Moreover, using the NCEP-NCAR reanalyses data, zonal wind velocity obtained on the surface, near the tropopause height and in the lower stratosphere, and the intensity of outgoing longwave radiation obtained over both the Indian (10N-10S; 60-160E) and Pacific sectors (10N-10S; 160-260E) are utilized to describe on how the lower stratospheric QBO through down penetration over the Indian Ocean region affects the Walker circulation associated with both the Indian and Pacific ocean sectors.



Figures 1a-f illustrate the time evolution of power spectrum $(m/s)^2$ [Morlet wavelet transform] in zonal wind velocity (m/s) in the heights of 14, 16, 17, 18, 19 and 20 km respectively from January 1990 to December 2003 (x axes) over Chennai, India. Strong spectral power near the periodicity of ~ 24 months (y axes) is seen around the year 1997 /98 (strongest El Nino period of the last century) from 17- 20 km.



Figures 2a-f

Figures 2a-f illustrate the same as in Figures 1a-f except that the period of observation is from September 1995 to October 2003 and the station is Gadanki, India. It may be noted that strong QBO signal occurs around the year 1997 as in Figures 1a-f.

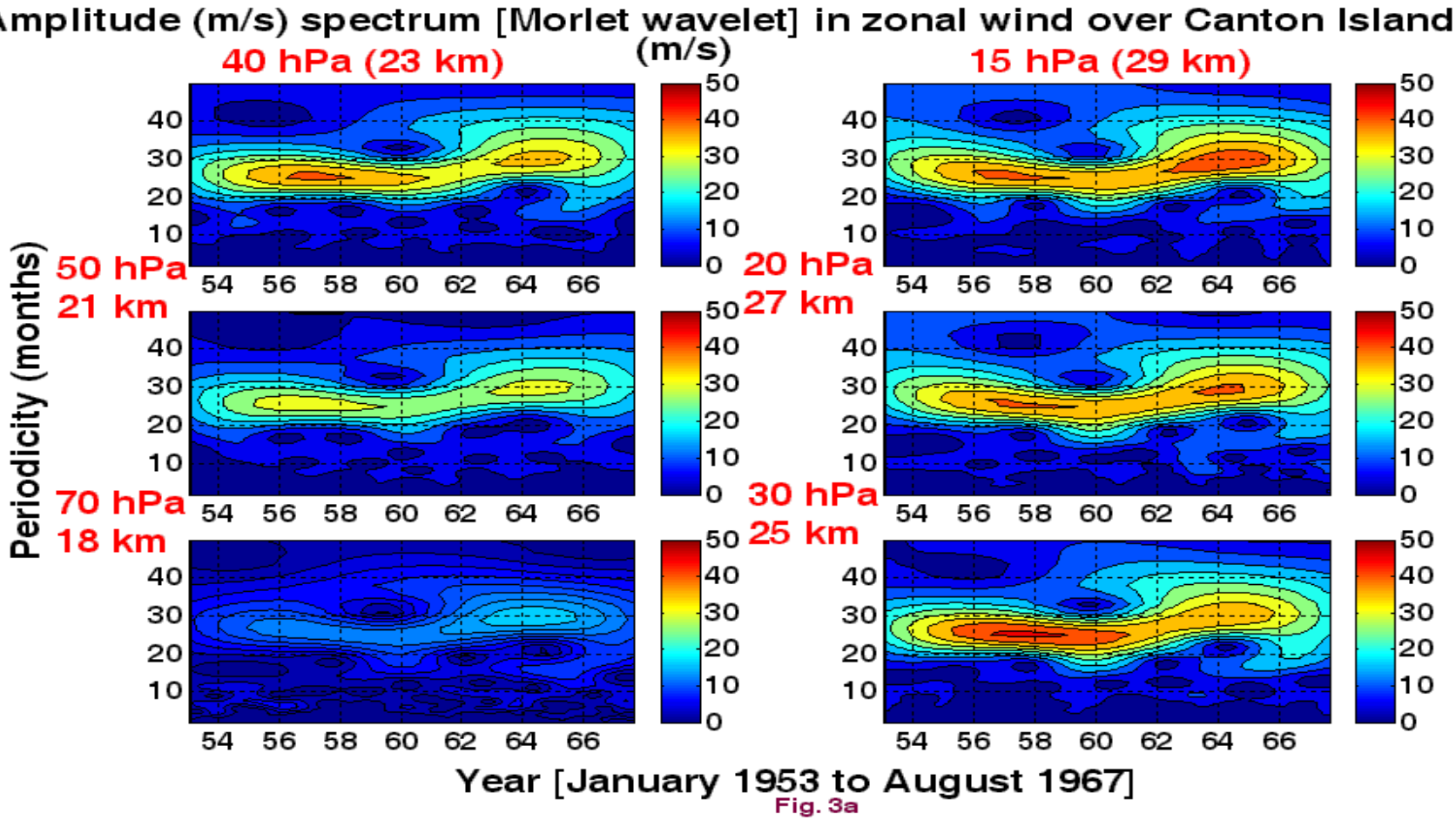


Fig. 3a

Figure 3a show the amplitude spectrum of zonal wind for the height levels of 70 hPa , 50 hPa, 40 hPa, 30 hPa, 20 hPa and 15 hPa respectively for the three tropical stations (1) Canton Island during January 1953 to August 1967, (he strong QBO signals are distinctly seen at 50hPa level in the years around 1957, 1965 which were followed by the successively strong El Ninos of the last century.

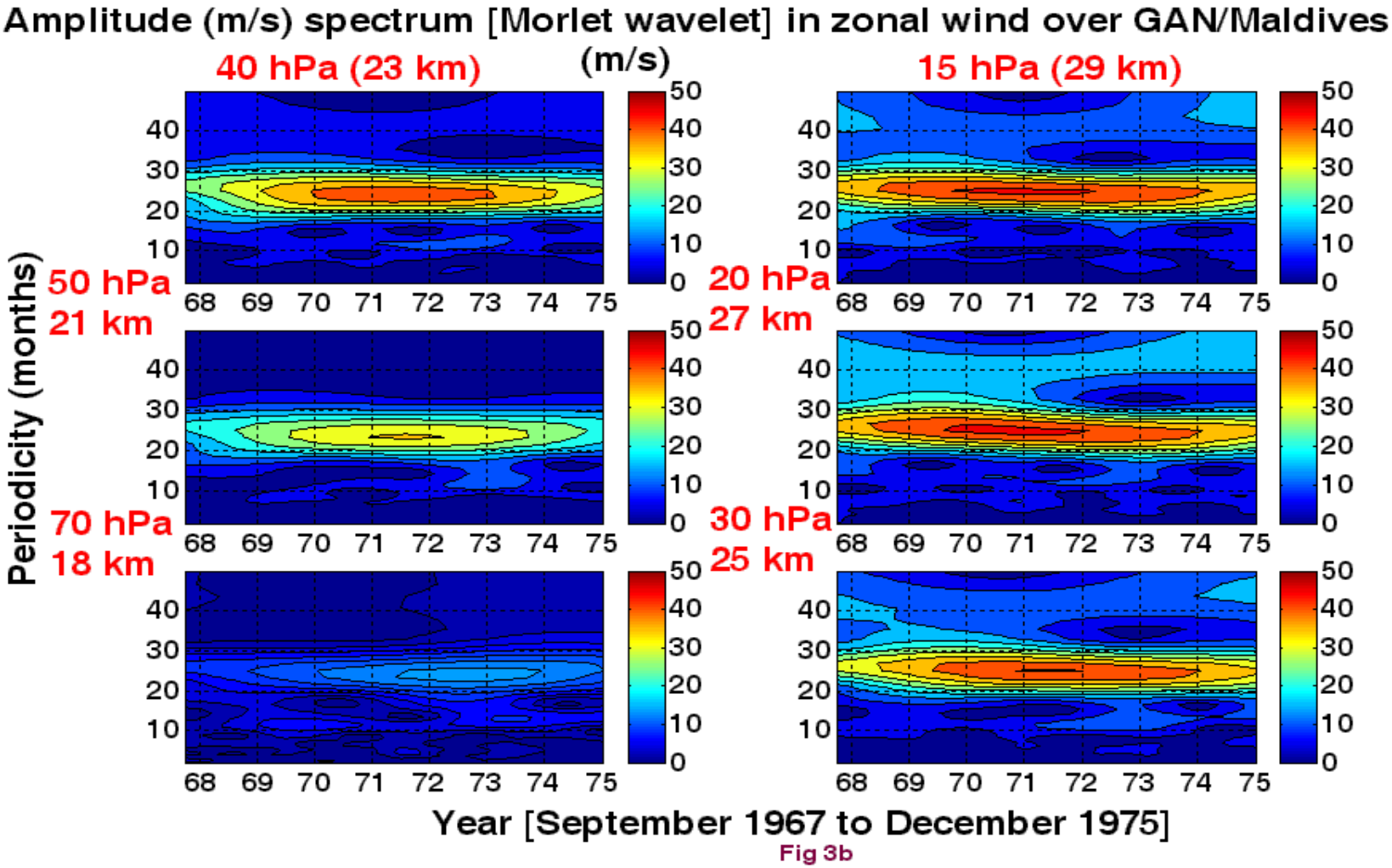


Figure 3b show the amplitude spectrum of zonal wind for the height levels of 70 hPa , 50 hPa, 40 hPa, 30 hPa, 20 hPa and 15 hPa respectively for the three tropical stations (2) Gan/Maledives during September 1968 to December 1975. The strong QBO signals are distinctly seen at 50hPa level in the year around 1971 which was followed by the strong El Nino.

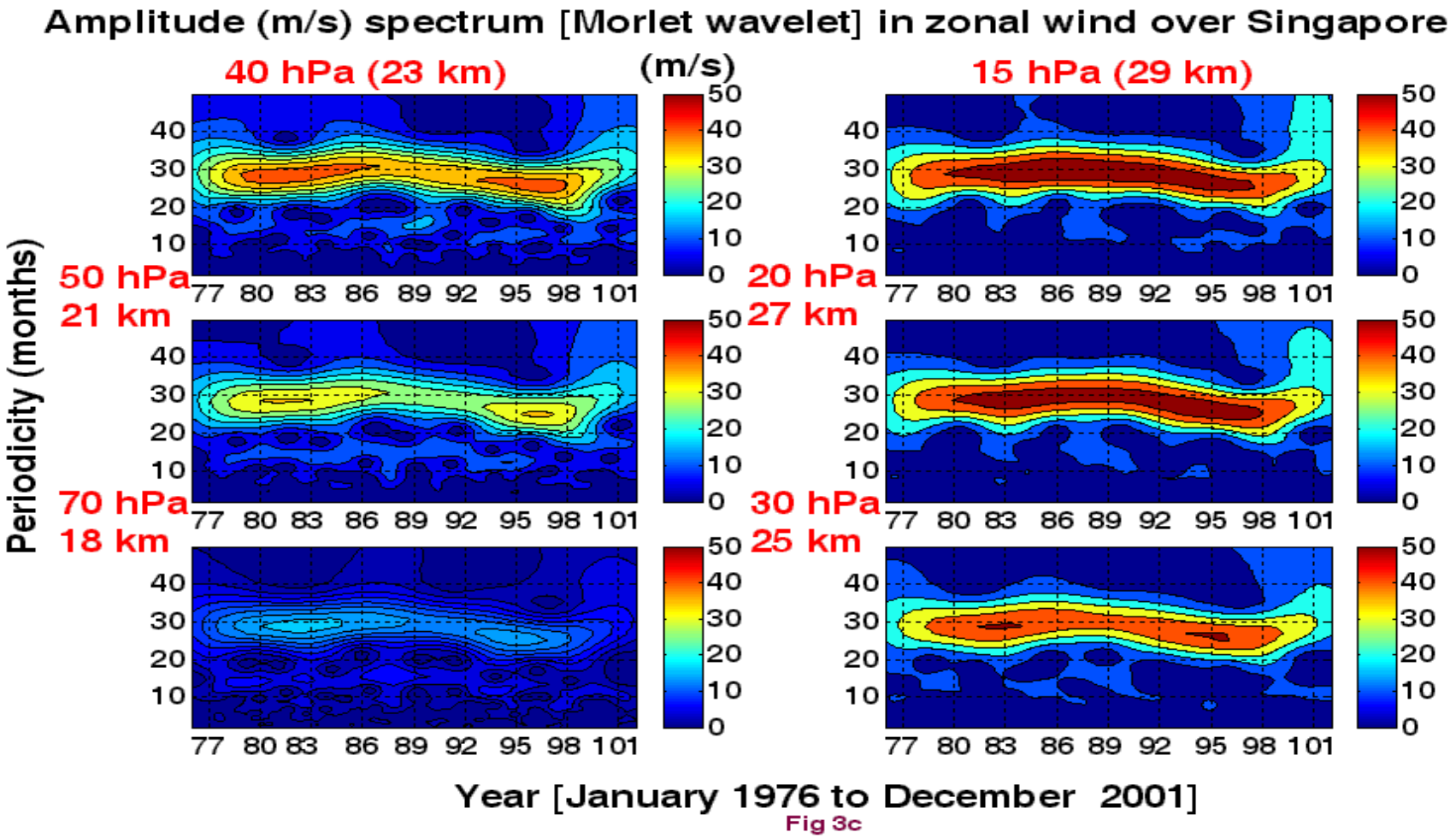


Figure 3c show the amplitude spectrum of zonal wind for the height levels of 70 hPa , 50 hPa, 40 hPa, 30 hPa, 20 hPa and 15 hPa respectively for the three tropical stations (3) Singapore during January 1976 to December 2001. The strong QBO signals are distinctly seen at 50hPa level in the years around 1981 and 1997, which were followed by the successively strongest El Ninos of the last century.

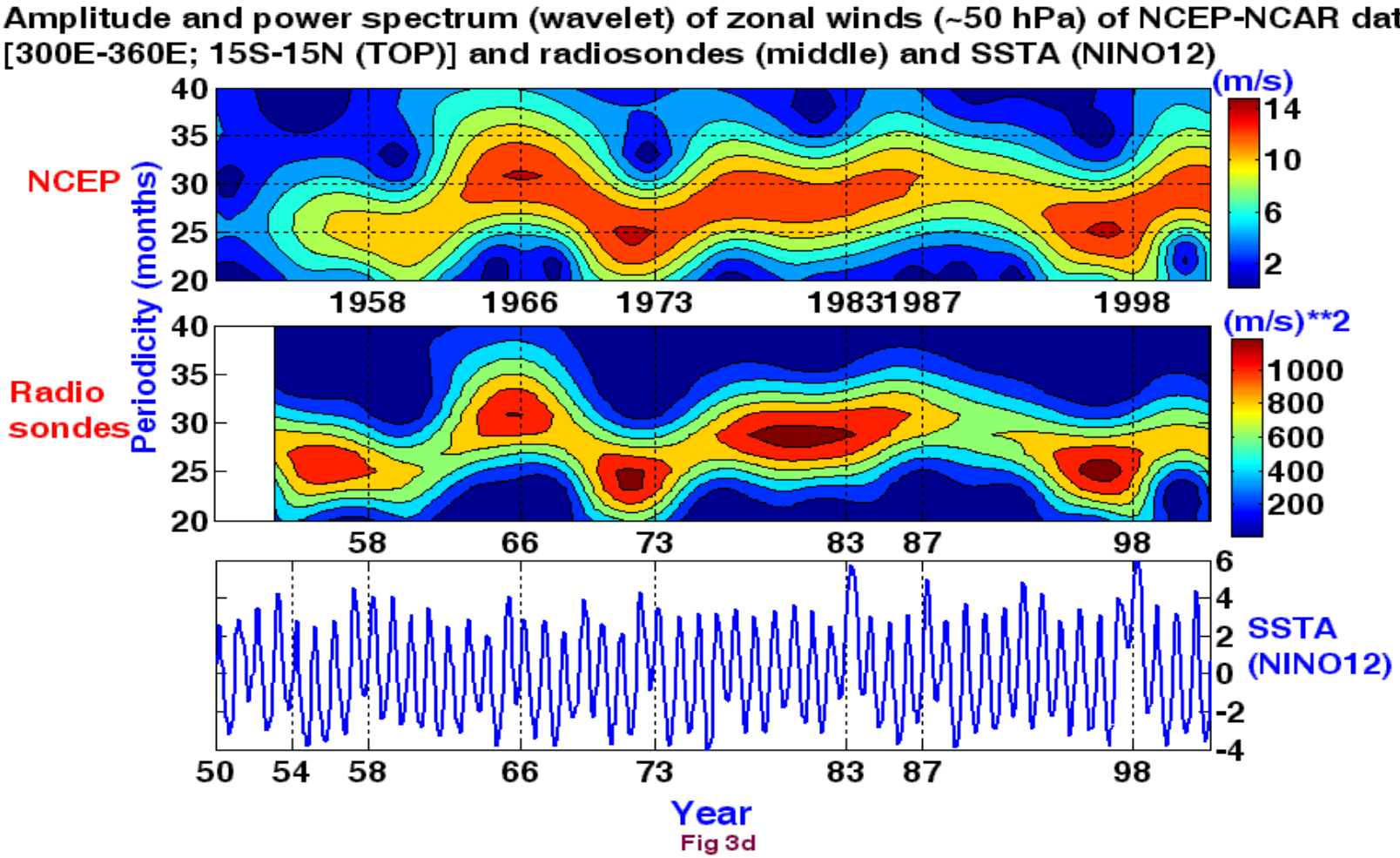


Figure 3d compares the continuous time evolution of the monthly spectral amplitude (m/s) [upper panel, NCEP-NCAR reanalyses data, 20-40 months periodicity range referred from Fig. 3a-c] and power (m/s)2 [middle panel-for the three stations in Figures 3a-c] of zonal wind velocity (m/s) at 50 hPa (~ 21 km) with the time evolution of NINO12-SSTA (°C, lower panel) from January 1950 to December 2001.

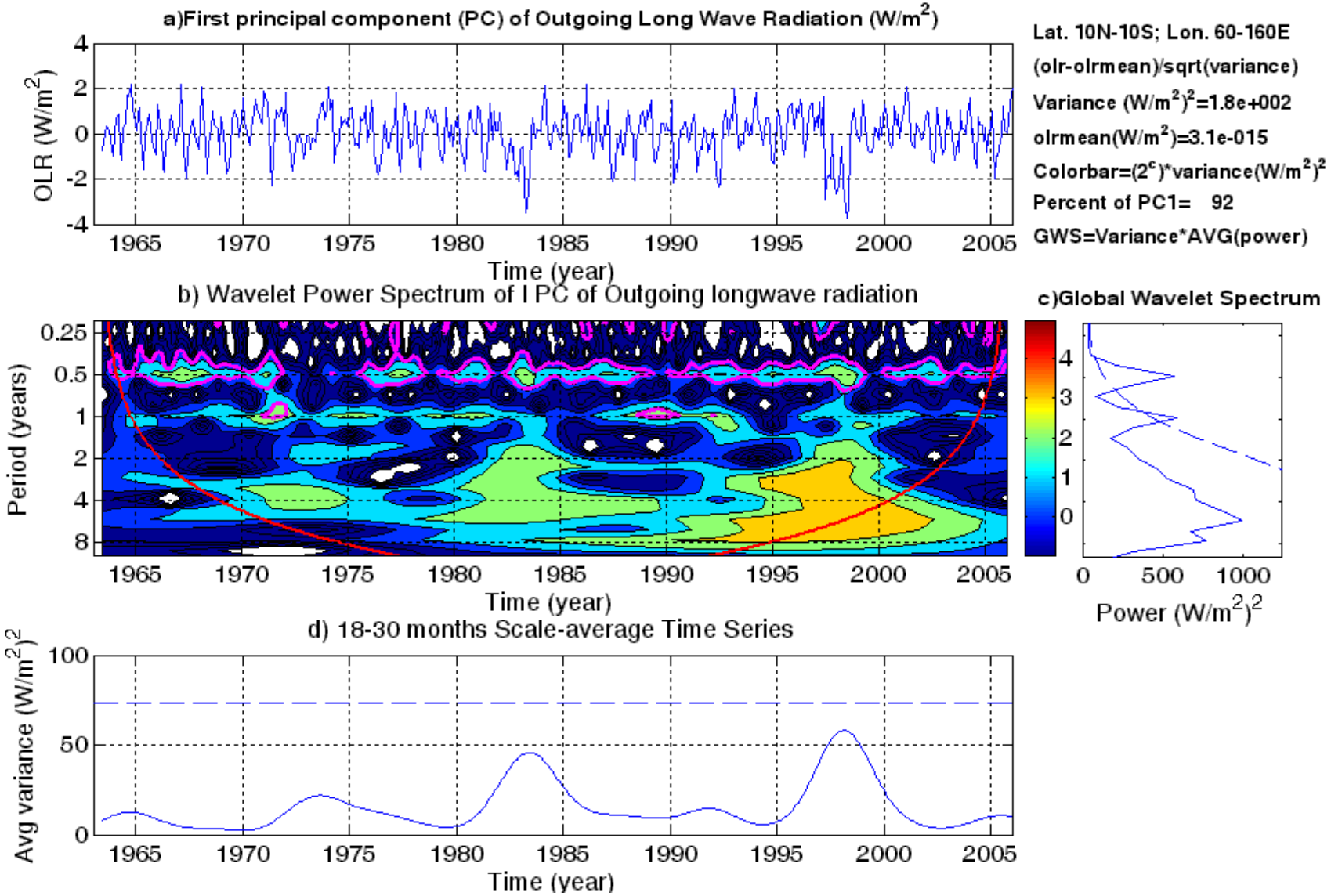


Figure 4 Outgoing long wave radiation (OLR) for the Indian Ocean sector and QBO in OLR is distinctly seen during the three great El Nino years of 1972-73, 1982-83 and 1997-98.

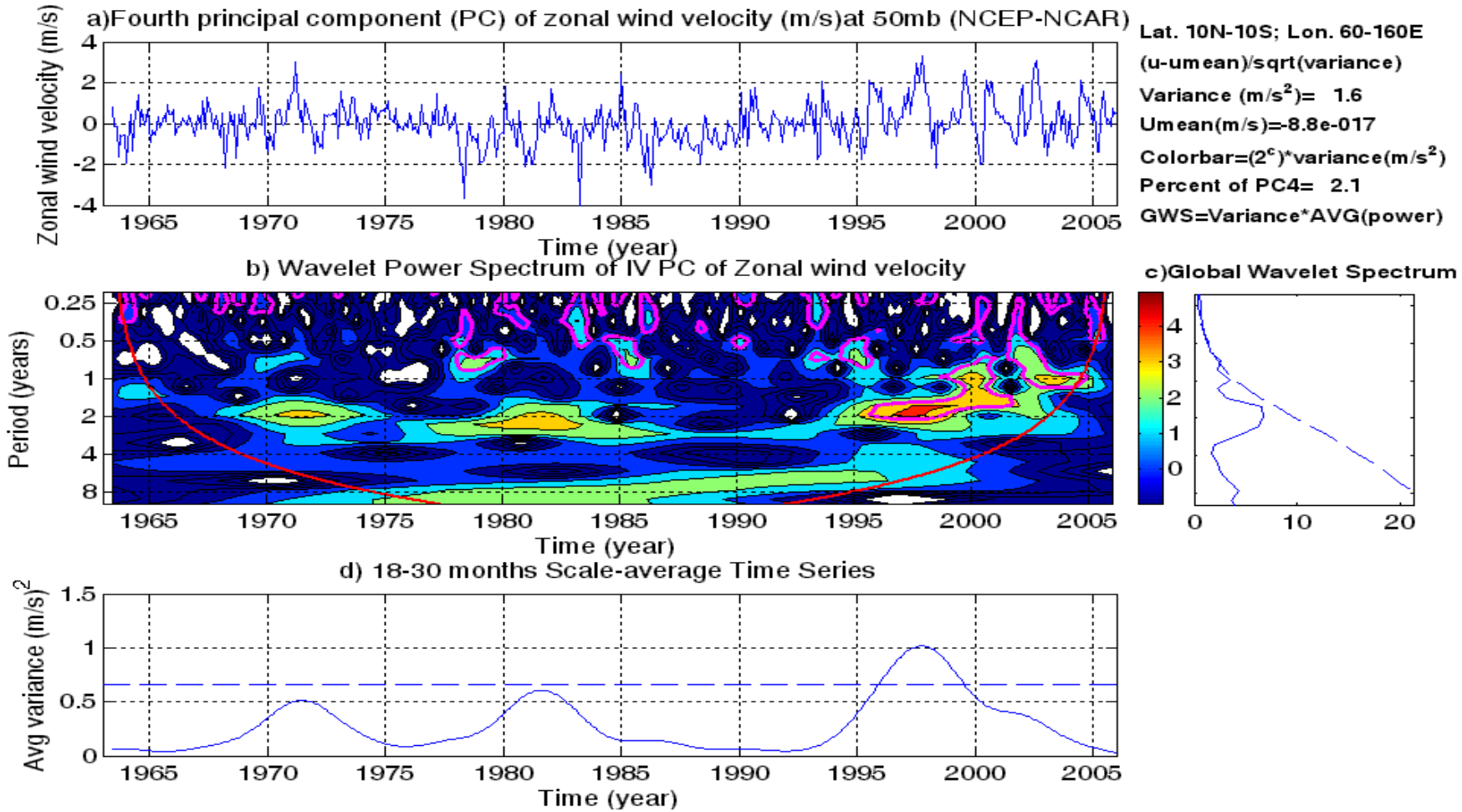


Figure 5a shows the monthly variation of IV PC (top panel) of zonal wind speed anomaly (NCEP-NCAR reanalyses data) in the height of 21 km (averaged over 10N-10S) over the Indian Ocean zone (60-160E) for the years 1963-2005. Fig. 5b shows the corresponding wavelet power spectrum and Fig. 5d shows the corresponding time series of averaged power in the range of 18-20 months periodicity. Fig. 5c shows the global wavelet power spectrum. It is clear that strong QBO occurs distinctly only during the great El Nino years 1972-73, 1982-83 and 1997-98.

Summary

The combined EOF and wavelet analyses of zonal winds (NCEP-NCAR reanalyses data) at ~21 km over the Indian Ocean region have shown that consideration of equatorial lower stratospheric winds is essential to strengthen the forecasting capability of modeling and theoretical studies on great El Nino events like the ones occurred in the years 1972/73, 1982/83 and 1997/98.

Along with NCEP-NCAR reanalyses data, wavelet analyses of monthly averaged zonal wind velocity measured with Indian MST radar (a tropical station in India) at Gadanki (13.5°N, 79.2°E) in the heights of 14-20 km during the period of September 1995 to October 2003; with radiosondes over the near by station (~150 km radial distance towards south) of Chennai (13°N, 80.2°E), India during January 1990 to December 2003 and near the heights of 18, 21, 23, 25, 27, 29 km during (1) 1953-67 over Canton Island (2.46°S, 171.43°W), (2) 1967-75 over Gan/Maldives (0.41°S, 73.09°E) and (3) 1975-2001 at Singapore (1.22°N, 103.55°E) have also indicated that down penetration of equatorial stratospheric QBO below 18 km occurred prior to the triggering of great El Nino events