QBO Features of Tropical Pacific wind Stress Field with the Relation to El Nino

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ABSTRACT

Analysis has been implemented of 1970–1992 tropical Pacific wind stress anomaly and sea surface temperature anomaly (SSTA) datasets, indicating that quasi—biennial oscillation (QBO) of the tropical Pacific WS and SSTA is featured both by a standing and a progressive form, the former emerging in the most intense centers of action and the latter travelling east— or west—ward out of the SSTA sources. Results show that the SSTA is in the warm (cold) phase as zonal component of equatorial wind stress anomaly gets weakened (reinforced) and the QBO of wind stress anomaly is well related to the El Nino cycle.

Key words; Wind stress, Quasi—biennial oscillation (QBO), Equatorial zonal easterly, El Nino cycle

1. INTRODUCTION

As far back as 1969, Bjerknes indicated that the decrease in equatorial trade wind will give rise to a slow rise of Pacific SST, which, in turn, will enfeeble the trade wind, resulting in further intensification of SST, and it is through the interaction that an El Nino eventually be generated, a mechanism for an unsteady sea—air interaction over the tropical Pacific. Based on increased accumulation of observational facts, studies (Rasmusson et al., 1982; Barnett, 1988) reported that a single cold or warm event has its occurrence partially to be phase locked with the annual cycle and partially to be biennial. Spectral analysis (Lau et al., 1988; Rasmusson et al., 1990) demonstrates that tropical SST, sea level pressure, zonal wind and precipitation are marked by two noticeable peaks in power spectra with the principal periods over the range of 3—6 years and the secondary corresponding to the QBO periods. Recent work of Barnett (1991) and Repeleski et al. (1992) indicated that the QBO is indeed part of an ENSO event, located largely over the Indian / Pacific and depending strongly on the annual cycle for genesis. And more evidence shows that the QBO is perhaps a basic mode of ENSO. Interestingly, the tropospheric QBO is assumed to be one of the members of the Southern Oscillation family, particularly the eastern Indian sea level wind QBO in phase locked more closely with the annual cycle, in the context of 1950–1987 Pacific / Indian near sea surface data (Rasmusson, 1982). Accordingly, he proposed a concept of ENSO genesis due to interaction among multiple time scales consisting of biennial oscillation mode, low frequency mode and annual cycle which should be borne out by more observational facts and theoretical efforts, however.

This paper presents the space structure and propagation features of the biennial

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oscillation component for wind stress anomaly in the context of 1970–1992 monthly mean wind stress anomaly and SSTA data over the tropical Pacific, followed by the comparative examination of the relation of the wind stress anomaly to SSTA with regards to QBO, thereby documenting the role of the QBO of wind stress anomaly in an El Nino formation. Section 2 describes the data source and processing. The space structure and propagation features of the QBO of wind stress anomaly are illustrated in Section 3. Section 4 explores the QBO of the wind stress anomaly relative to that of SSTA. Section 5 investigates the role of wind stress anomaly in the El Nino production with the discussion given in the last section.

II. DATA PROCESSING AND SPECTRAL CHARACTERISTICS


First of all, power spectral analysis is performed of the data. The zonal belt is divided into 3 equispaced subbelts: 29–10°N, 10°N–10°S and 10–29°S, followed by a meridional division of the belt into 3 equal parts, too, thus making for 9 regions for the research area, distributed separately over the northern West Pacific, equatorial West Pacific, southern West Pacific, northern Central Pacific, equatorial Central Pacific, southern Central Pacific, etc. Next, regional averaging is done of all the gridded data inside the box to construct a time series for power spectral analysis. Results show that found in the spectrum of the zonal and meridional components of wind stress anomaly for much of the study area are two strong peaks, one being the 3 to 4–year oscillation and the other being QBO (Fig. 1) with the equatorial Central Pacific zonal component wind stress anomaly, $T_x$, showing the strongest QBO power spectrum (figure not shown), which is an indicator of active QBO there. $T_x$ in the equatorial eastern Pacific (figure omitted) has intense signal of 3 to 4–year oscillation and QBO, similar to whose form is the distribution of the SSTA power spectrum, both characterizing essentially the low frequency variation pertinent to the El Nino cycle. For the equatorial western Pacific (figure left out), $T_x$ displays higher frequency oscillation (with the period