17B.4 PREDICTION OF INTRASEASONAL VARIABILITY IN TROPICAL CYCLONE ACTIVITY OVER THE WESTERN NORTH PACIFIC OCEAN

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1. INTRODUCTION

Over the western North Pacific Ocean during June-October, a tropical cyclone forms approximately every 6-7 days. However, there are time periods during which tropical cyclones occur more (less) frequently than the climatological average. Because periods with increased or decreased tropical cyclone formations occur over time scales that extend beyond synoptic-scale variability to intraseasonal time scales, it is likely that contributions from a wide range of frequency bands influence tropical cyclone activity. For example, the Madden-Julian Oscillation (MJO) has been suggested to exert significant influence on tropical cyclone activity over several ocean basins (e.g., Maloney and Hartmann 2001). Hartmann et al. (1992) linked 20-25 day oscillations over the western North Pacific, and Chang et al. (1996) identified variability in synoptic-scale wave activity, with tropical cyclone occurrences. To predict tropical cyclone activity over time periods that range from synoptic-scale to intraseasonal, an understanding of the interactions between the dominant time scales is required.

2. ANALYSIS

A wavelet analysis of the variability in 850 hPa circulation over the western North Pacific during June-October 1998 confirmed significant power in frequency intervals between 30-90 days, 10-25 days, and 2-8 days. The influence of the variability in low-level circulation in each frequency range on tropical cyclone activity is examined. Representative patterns of 850 hPa streamfunction and outgoing longwave radiation (OLR) are defined by a singular value decomposition (SVD) analysis. Intraseasonal patterns (Fig. 1a) identify variability associated with a modulation of the Asian and western North Pacific monsoons via well-defined MJO influences. The primary pattern at 10-25 days (Fig. 1b) represents variability in the intensity and orientation of the western North Pacific monsoon trough. Comparison with additional modes (not shown) defines a combination of circulations that propagate northwestward across the Philippine and South China Seas. The leading synoptic-

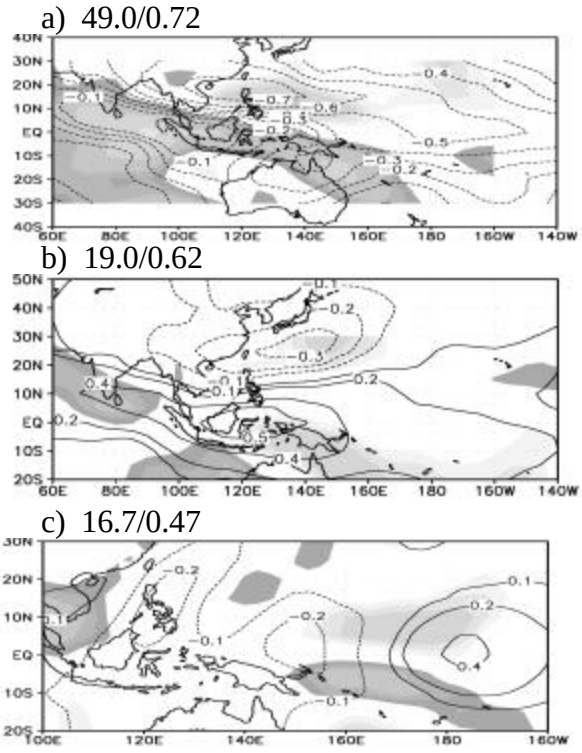

Fig. 1 Leading SVD correlation maps for a) 30-90 day period, b) 10-25 day, and c) 2-8 day 850 hPa streamfunction (contours, negative correlations are dashed) and OLR (shading, dark shading for negative correlations). The first number at the top of each panel defines the percent of covariability in each pattern and the second number defines the correlation between streamfunction and OLR in each panel. Additional patterns lead to assessment of the leading components of circulation variability in each frequency range.

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scale pattern consists of a combination of equatorial mixed Rossby-gravity waves over the central Pacific and northwestward-moving waves over the western North Pacific that are defined by comparison with the second synoptic-scale mode.

The spatial patterns of circulation and OLR covariability are used to define daily circulation indices of 850 hPa zonal winds and 10-25 day and 2-8 day meridional winds (v) Based on the circulation indices from filtered data for each frequency range, a cross-wavelet analysis is used to define periods of significant covariability between circulations in different frequency ranges.

Three years are chosen (Fig. 2) to illustrate the variability associated with the interactions between the circulations on the three time scales and the tropical cyclone activity. During 1979, a significant amount of covariability exists between the 30-90 day zonal wind variability and circulations at 10-25 days and 2-8 days. Consequently, tropical cyclone activity and inactivity appears to be clustered in association with 30-90 day westerly anomalies and the enhanced circulations at shorter time scales. During 1981, a significant amount of covariability exists between the 30-90 day and 10-25 day circulations. However, there is little clustering of tropical cyclone activity or inactivity. No relationship is found between the 30-90 day and 2-8 day circulation, which may be related to the lack of clustering in tropical cyclone activity. During 1987, significant relationships are detected between 30-90 day, 10-25 day, and 2-8 day circulations. This is similar to 1979, except that the amount of significance for the 10-25 day (2-8 day) circulations is less (more) than during 1979. Although some clustering of tropical cyclone activity occurs during 1987, it is less than during 1979, which may be related to the reduced covariability between 30-90 day and 10-25 day circulations.

A large amount of interannual variability is observed in the relationships between circulations at the three primary frequency ranges over the western North Pacific. Examination of periods of significant and reduced interactions will identify important factors that relate to tropical. These factors will comprise the framework for an extended-range prediction scheme of tropical cyclone activity over the western North Pacific.

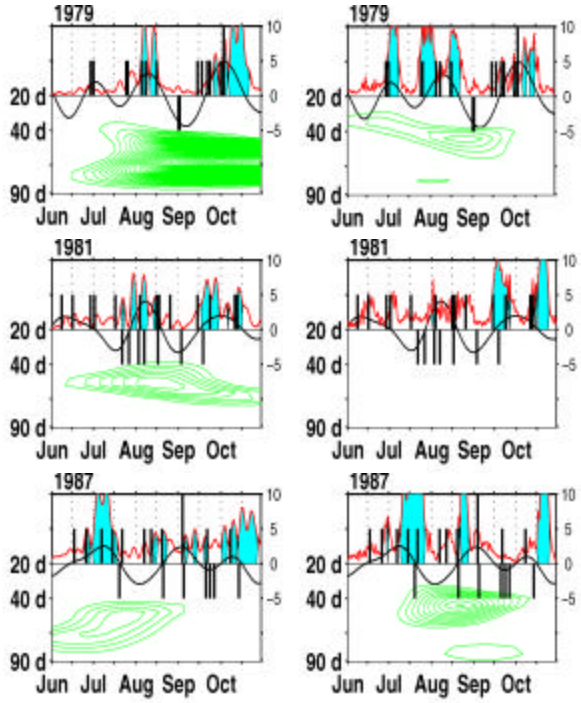

Fig. 2 Time series for selected years of 850 hPa 30-90 day zonal winds averaged between the equator, 10°N and 110°E-150°E, and (left column) 10-25 day v^2, and (right column) 2-8 day v^2 both averaged along a diagonal from the equator, 160°E to 25°N, 120°E. Contours define significant wavelet power between the 30-60 day zonal wind index and the respective v^2 index. The zonal wind and v^2 indices are defined by the left-hand scale. The period associated with the cross-wavelet power is defined by the right-hand scale. Shading of each v^2 index defines periods of significant amplitude. Vertical bars define the formation of a tropical cyclone over the western North Pacific. An upward- (downward-)pointing bar defines formation south (north) of 20°N

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