5A.3

SYMMETRY AND ASYMMETRY OF THE ASIAN AND AUSTRALIAN SUMMER MONSOONS

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1. INTRODUCTION

Among the monsoons of the world, the Asian and Australian summer monsoons are the most conspicuous (e.g., Webster et al. 1998). The rainfall amount associated with the preceding Asian summer monsoon has an impact on the succeeding Australian monsoon. Thus there is a significant correlation between the annual rainfall amount over southern Asia and that over northern Australia, when both are measured in the same "monsoon year" (Yasunari 1991) that begins with May of a calendar year and ends in April of the following year. The annual precipitation averaged over the two regions has a high negative correlation with the SST anomaly in the equatorial eastern Pacific Ocean. However, the rainfall amount associated with the preceding Australian summer monsoon has no significant effects on the succeeding Asian summer monsoon rainfall (e.g., Gregory 1991; Joseph et al. 1991) . There is a "communication barrier" between the two regions in boreal spring prior to the onset of the Asian summer monsoon.

2. SPATIAL ASYMMETRY

Although the Asian and Australian summer monsoons share the same ENSO phase in SST within a monsoon year, the difference in land and sea distributions (Asia/Indian Ocean vs Australia/western Pacific) introduces spatial asymmetry between the Asian and Australian monsoons. Clearest manifestations of this asymmetry are the South Asian (or Tibetan) anticyclone and temperature distribution in the upper troposphere in northern summer (Fig. 1). Similar asymmetry in temperature is seen only in the lower troposphere below 700 hPa in the southern summer.

3. ASYMMETRY IN HEAT SOURCE

To gain clearer understanding of how the spatial asymmetry in the two monsoon systems translates to the one-sided time correlation between them, we examine the differences in three-dimensional distributions of heat source (Q_1) and moisture sink (Q_2) associated with the two monsoon systems.

As shown in Fig. 2, for both the Asian and Australian sectors, (sensible) heating over land precedes the intense condensation heating associated with monsoonal rains. Abruptness of spring to early summer heating over the Asian continent has an impact on the resulting circulation patterns well into northern fall. There is clear evidence of sensible heating over dry Australian continent preceding the onset of monsoon rains in northern Australia. However, this heating from the land surface of Australia is much weaker and shallower compared to that resulting from the elevated heat source over the Tibet/Asian continent.

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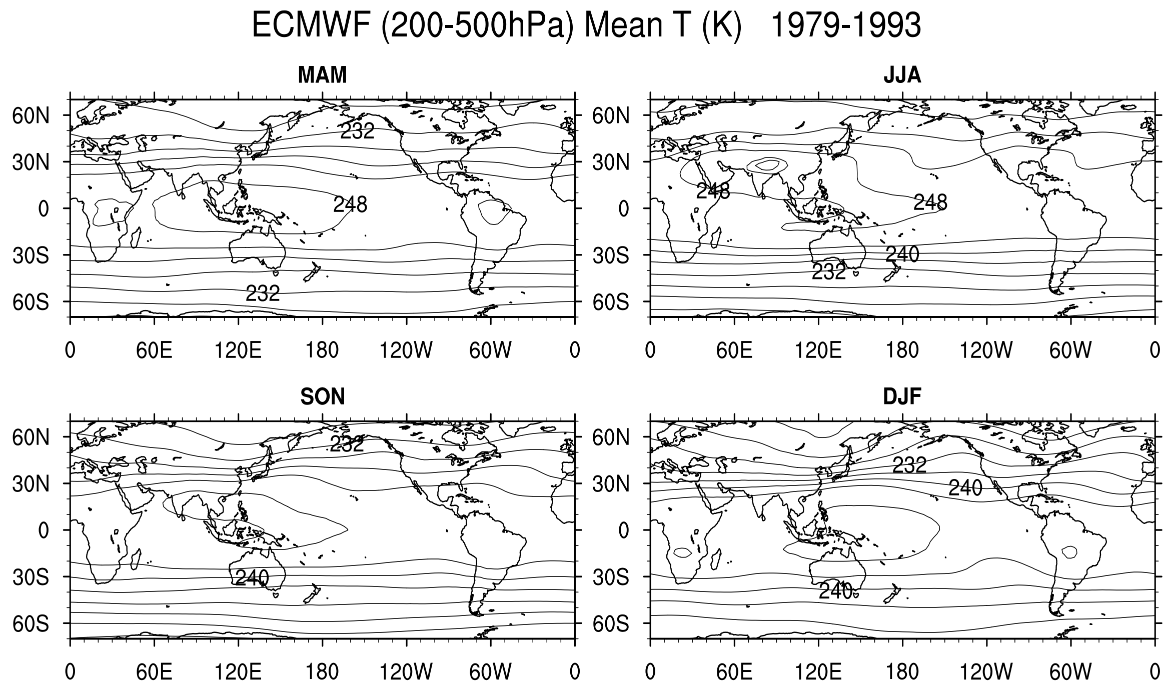

Fig. 1. Mean (200-500 hPa) temperature (K) for 4 seasons (1979-1993).

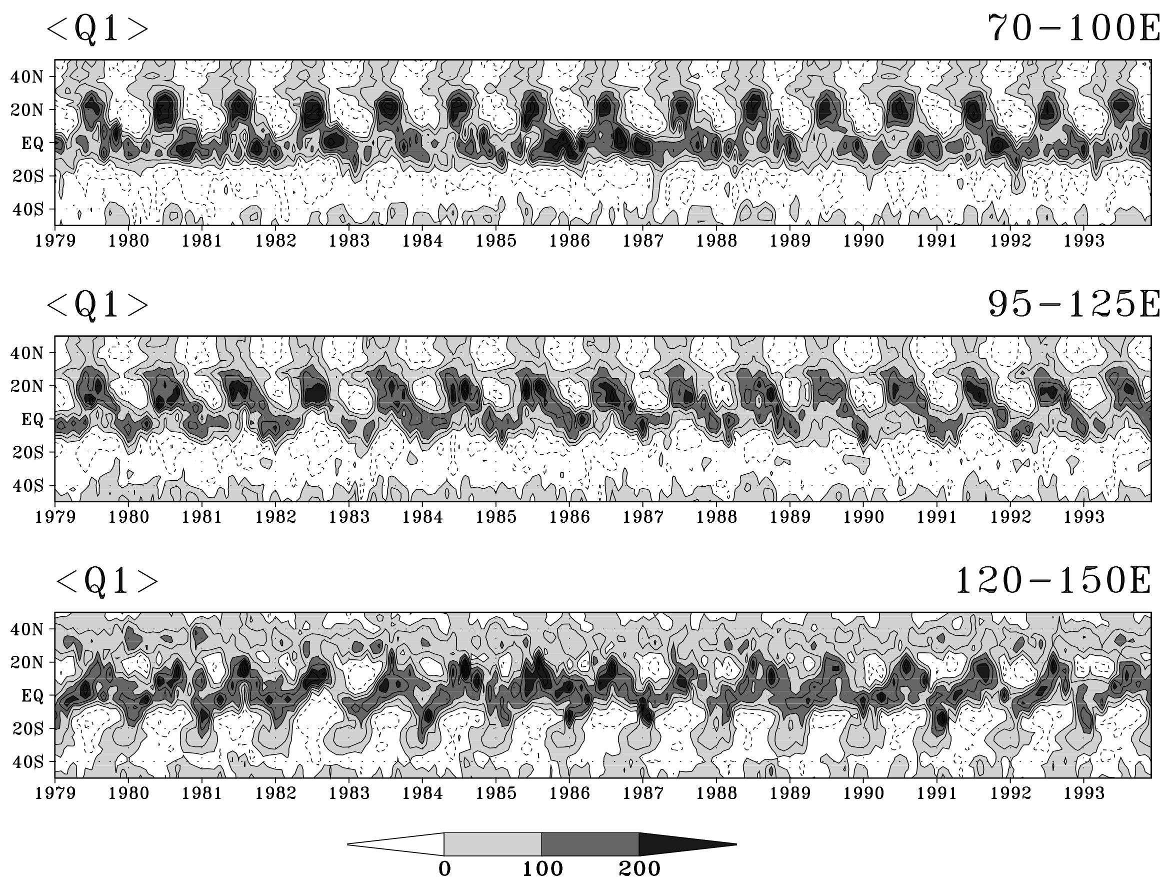

Fig 2. Time-latitude sections of vertically integrated Q_1 ($W\ m^{-2}$) at three longitude belts.