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SEASONAL VARIATIONS OF THE TROPICAL INTRASEASONAL OSCILLATION AND ITS REPRODUCTION IN SAMIL-$R_{42}L_9$

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Abstract: Seasonal variations of the tropical intraseasonal oscillation (ISO) and relationship to seasonal variation of the climate background are studied by using NCEP/NCAR reanalysis data and output of SAMIL-$R_{42}L_9$. Analysis of NCEP data shows that spatial distribution of the tropical ISO has obvious seasonal variations, which are well consistent with the seasonal variation of climate background. The activity of the tropical ISO is, to a great extent, dependent on warm SST, strong convection, zonal western wind, strong precipitation and low-level moisture convergence. Main characteristics of the seasonal variations of the tropical ISO are captured by SAMIL-$R_{42}L_9$. Simulations of seasonal variation of climate background vary greatly with different variables. Results of SAMIL-$R_{42}L_9$ indicate that the seasonal variations of the tropical ISO in dynamical fields are more dependent on climate background than in heating fields and SAMIL-$R_{42}L_9$ cannot represent well the strong dependence of the ISO on the climate background present in NCEP/NCAR reanalysis data. It also suggests that seasonal variations of the ISO do not completely depend on that of climate background.

Key words: tropical intraseasonal oscillation; seasonal variation; climate background; GCM

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1 INTRODUCTION

Seasonal changes are one of the important characteristics of ISO in the tropical atmosphere, which has been studied with many different methods[1-5]. Research results about the seasonal changes of ISO are both consistent and uncertain[6]. It has not been very clear what drives the ISO changes on the seasonal scale. At present, general circulation models have not had ideal simulations of ISO and inability to reproduce the seasonal tendency of ISO is also one of the main drawbacks in most models[7]. For seasonal simulation, most of the analyses treat the tropics as a whole region to study the seasonal difference of ISO intensity[8, 9]. Such difference in intensity is actually related with the seasonal variation of the spatial distribution of ISO, which may be closely linked with the seasonal changes of the mean background[6]. Using the NCEP data and model simulations, this work studies the seasonality of the spatial distribution of ISO, examines model simulations of the relation between the seasonal variation of ISO and the seasonal transition of the climate background, and discusses in what extent the former depends on the latter.

2 MODEL, DATA AND METHODS

The SAMIL-$R_{42}L_9$ model used in this work is a global spectral model for general circulation developed at LASG, Institute of Atmospheric Physics, Chinese Science Academy. The horizontal resolution is R_{42}. The σ -coordinates are used in the vertical with nine layers. Refer to [10] for detailed account of the model. The integration covers the period from Jan. 1, 1978 to Dec. 31, 1989. SST consists of monthly observations. The integration results for the late 11 years are used as

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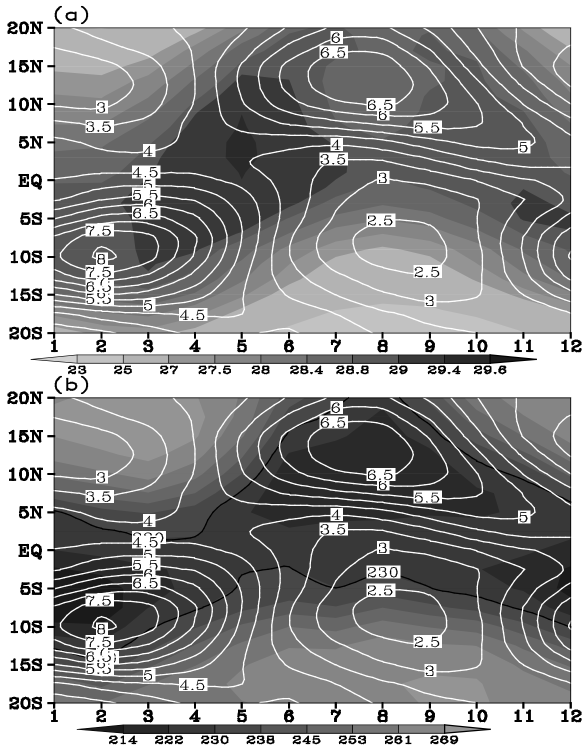
analysis data. For the data in comparison, the daily reanalysis data of NCEP / NCAR and precipitation data of Xie-Arkin[12] are used.

3 ANALYSIS

Fig.1 gives the time – latitude cross-section of the climatic background averaged from 60°E to 180° and intraseasonal (30 – 60 days) wavelet spectral energy of the 850-hPa zonal wind. It is found that the ISO is of significant seasonal variation, being active in areas south of the equator in winter but north of it in summer. It is known from its relationship with the climate background that the seasonal change of ISO is consistent with that of convection in the tropics (Fig.1a & b). The two peaks of ISO in winter and summer correspond well with two simultaneous maxima of the westerly, indicating that the ISO normally takes place in the zone of mean westerly (Fig.1c). Besides, the seasonality of ISO corresponds well with that of precipitation (Fig.1d) when the center of precipitation shifts from the Southern Hemisphere and Northern Hemisphere as the time changes from winter to summer. Two spectral peaks of the intraseasonal oscillation are corresponding to two centers of precipitation. The seasonal change of ISO is also well consistent with that of water vapor flux at low levels (Fig.1e).



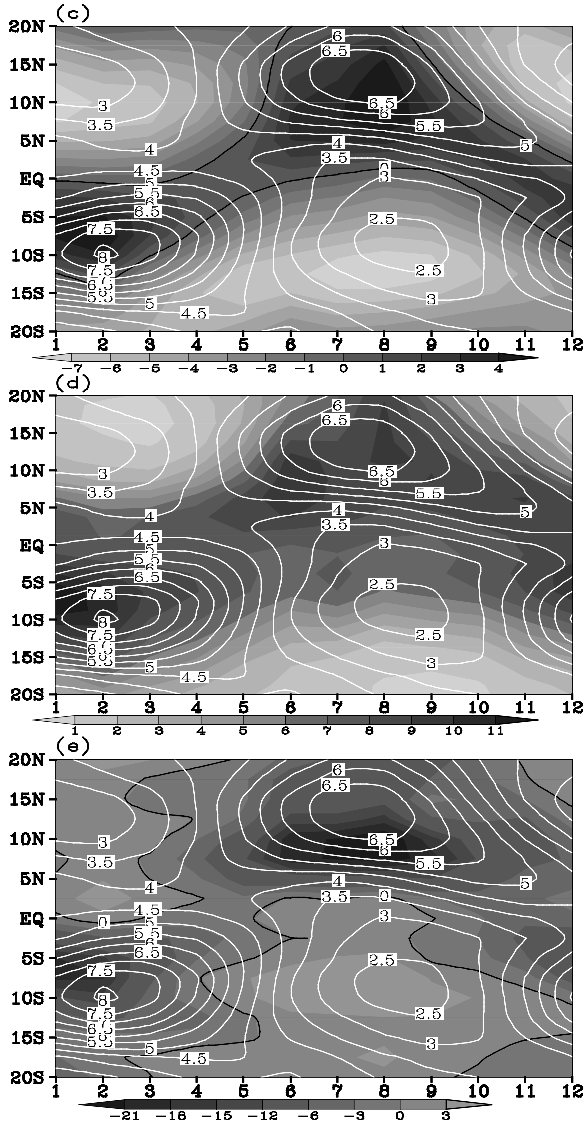
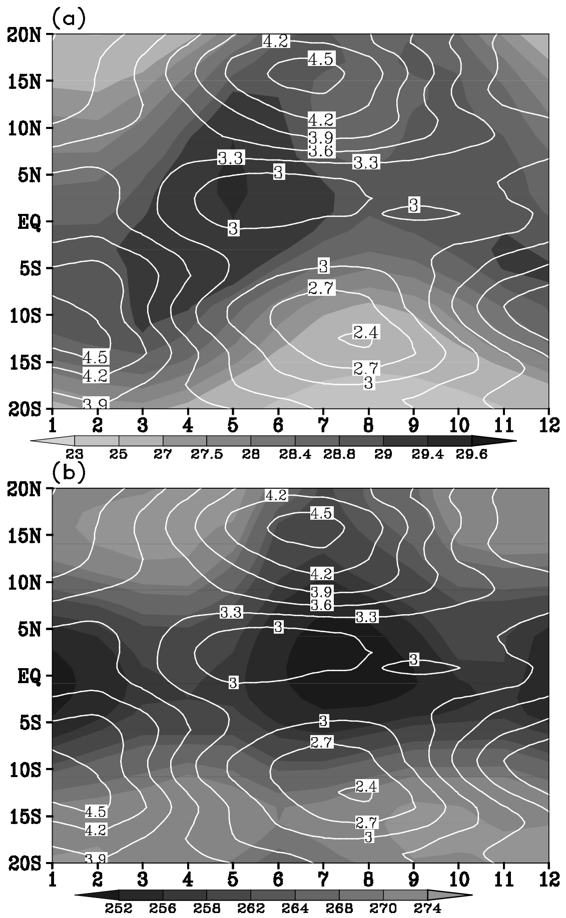


Fig.1 Time (month) – latitude cross-section of the climatic background averaged from 60°E to 180° (shaded) and intraseasonal (30 – 60 days) wavelet spectral energy (white contours) of the 850-hPa zonal wind. The background stands for SST (°C), OLR (w / m^2), 850-hPa zonal wind (m / s), precipitation (mm / day) and divergence of water vapor flux ($gkg^{-1}m^{-1}$). The black contours in 1b stands for the line of OLR being equal to 230 w/m^2. Those in 1c and 1e stand for the zero line of climate background.

4 RELATIONSHIP BETWEEN MODEL-SIMULATED TROPICAL ISO AND SEASONAL CHANGE OF CLIMATE BACKGROUND

As Fig.1, Fig.2 gives the result of SAMIL-$R_{42}L_9$ simulations. The model generally simulates the seasonal shifts of ISO that is consistent with the results of NCEP data. Appearing in winter and summer and being consistent with the ISO spectra, the two centers of convection (OLR, Fig.2b) and precipitation (Fig.2d) around the equator do not show seasonal meridional shifts as clearly as the NCEP data and therefore do not correspond well with the wave spectra of ISO. The simulated 850-hPa zonal wind (Fig.2c) shows obvious seasonal variation but the easterly is stronger than the westerly at all latitudes as compared with the NCEP data; mean westerly is present only in the boreal summer of the Indian Ocean and west Pacific while weak easterly is shown in the westerly zone of austral winter. Significant seasonal changes are also evident in the divergence of water vapor flux at 850 hPa with the maximum convergence of water vapor being in the austral winter and boreal summer, respectively. Compared with the NCEP data, however, their latitudes of location are more towards the equator. It is seen that the amplitude of ISO wave spectra does not correspond well with the mean field of water vapor because the maximum ISO amplitude is not around the area of maximum water vapor convergence (Fig.2e).



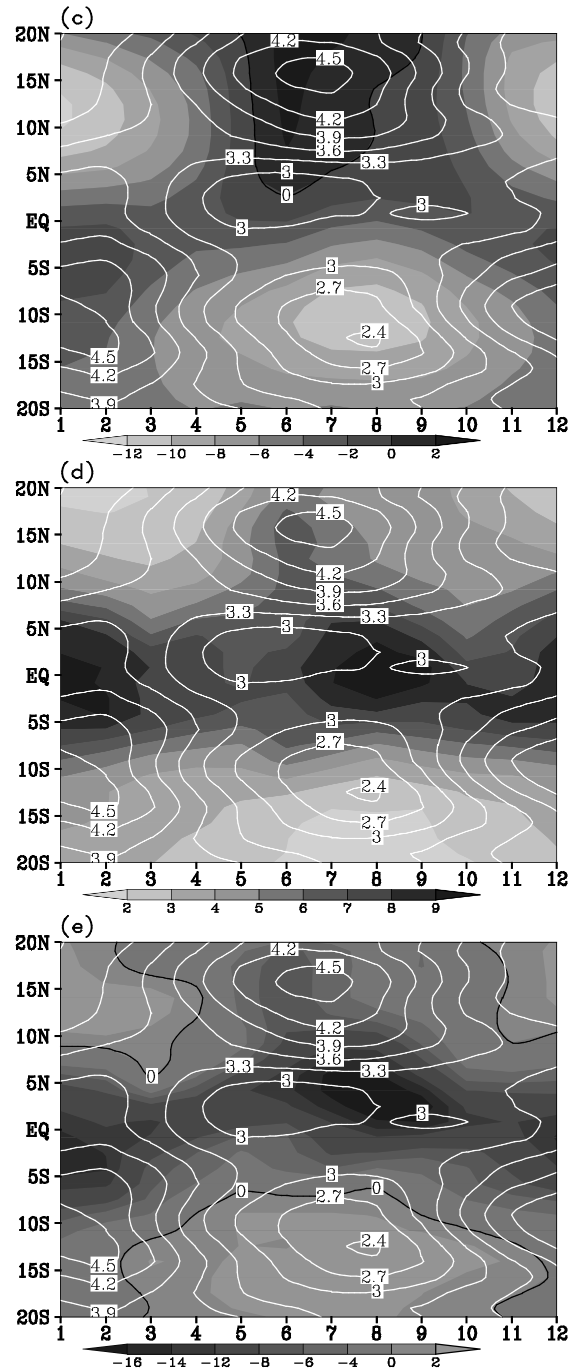


Fig.2 Same as Fig.1 but for the simulation results with SAMIL-$R_{42}L_9$.

It is known from the analysis above that the simulated wave spectra of ISO show significant seasonal change. Large differences are found among individual physical quantities in the simulation of climatic background. Both the 850-hPa zonal wind and water vapor flux show seasonal changes similar to those in the NCEP data but the meridional seasonal change of the mean background differ much from the results of NCEP data to cause the amplitude of ISO spectra not to be entirely consistent with the background. The seasonal variation of convection and precipitation are much less obvious. The above results seem to suggest that the seasonal change of tropical ISO is both associated with the mean climate field and independent from it to some extent. The seasonal change of ISO depends more on the seasonal change of the background of dynamic factors than that of thermodynamic factors.

For the analyses of other aspects, refer to the Chinese edition of the journal.

5 CONCLUSIONS

With the NCEP data and a GCM (SAMIL-$R_{42}L_9$), the seasonality of ISO in the tropical atmosphere and its relationship with mean climate background are studied.

(1) There is significant seasonality in the spatial distribution of ISO, which is highly consistent with that of mean climate background. The ISO in the tropical atmosphere in lower levels depend much on warm SST, strong convection, westerly zone, strong precipitation area and low-level water vapor convergence.

(2) The SAMIL-$R_{42}L_9$ model generally reproduces the seasonal characteristics of ISO spatial distribution. The model results have shown that seasonal change of tropical ISO is both associated with the mean climate field and independent from it to some extent. The seasonal change of ISO depends more on the seasonal change of the background of dynamic factors than that of thermodynamic factors.

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