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SUCCESSFUL SIMULATION OF THE TROPICAL WESTERN PACIFIC PRECIPITATION FOR JJA CLOSELY CORRELATED WITH THE TROPICAL SST FOR THE PREVIOUS DJF

Tomoaki Ose*[1], Masato Sugi[2] and Akio Kitoh[1]
1) Meteorological Research Institute, Tsukuba, JAPAN
2) Japan Meteorological Agency (JMA), Tokyo, JAPAN

1. INTRODUCTION

Inter-annual variability of precipitation in the tropical Western Pacific (WP) has been know as one of the key issues for the seasonal prediction over Japan during its winter (DJF) (Ose, 2000) and summer (JJA) (Nitta, 1987). I report the predictability of the tropical precipitation, especially in the tropical WP. Then, I like to show the statistical study on how the successful/unsuccessful simulation of inter-annual precipitation variability is related to SST anomalies.

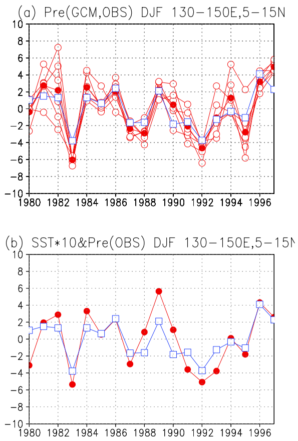
2. MODEL AND EXPERIMENTS

The MRI/JMA AGCM (Shibata et al., 1999) used here is based on the JMA short-term prediction model with some improvements made for a climatic model. Ensemble integrations with six members are made during January 1949 – December 1998 under the observed SST and sea ice (HadISST1). Analysis is focused on the 6-member ensemble average for December-January-February (DJF) and June-July-August (JJA) during 18 years from DJF 1980 (December 1979-February 1980) to DJF 1998 and from JJA 1980 to JJA 19*98. The NCEP2 reanalysis data and Xie-Arkin precipitation data are used for the verification. Note that the WP domain is referred to as (130-150E, 5-15N) for DJF study and (130-150E, 10-20N) for JJA study.

3. RESULTS

3.1 AGCM performance about tropical Western Pacific (WP) precipitation

The inter-annual variability of the tropical WP precipitation is shown in Fig.1a and Fig.2a for each member of the integrations, the ensemble average and the observation. The observed precipitation variability is within the uncertainty estimated from the diversity of six members, almost perfectly for DJF. The ensemble integration for a few of JJA cases misses to capture the observation within their



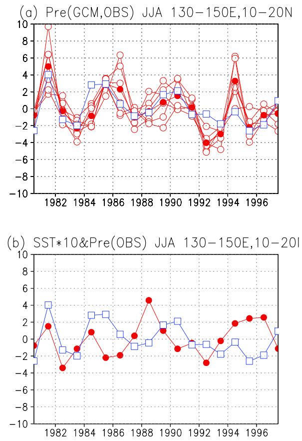


Fig.1 (left) (a) Inter-annual variability of precipitation anomaly in the tropical western Pacific for DJF. Empty circles for AGCM members, filled circles for AGCM average and squares for observation. (b) Observed Inter-annual variability of precipitation and SST anomaly for DJF. Empty circles for precipitation and filled circles for SST.

Fig.2 (right) The same as Fig. 1 except for JJA.

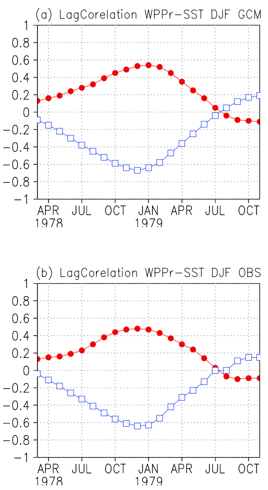
diversity.

The observed tropical WP precipitation has different relationship with SST between DJF and JJA. The WP SST variability is plotted as well as the WP precipitation for DJF

* *Cooresponding author address*: Tomoaki Ose, Climate Prediction Division, Japan Meteorological Agency,, Tokyo, 100-8122; e-mail: t-ose@naps.kishou.go.jp

and JJA in Fig. 1b and Fig. 2b, respectively. The DJF WP precipitation is closely related to the WP SST variability. On the other hand, the JJA WP precipitation is not related to the WP SST.

How about the relationship between the WP precipitation and the El-Niño SST? Fig. 3 shows the lagged correlation of WP precipitation for DJF with WP SST and Niño 3.4 SST in the AGCM simulation (a) and in the observation (b). Fig. 4 is the same but for JJA. First, I like to confirm that the AGCM produces almost the same lagged correlation plots qualitatively and quantitatively. The DJF WP precipitation is well related not only to the WP SST positively but also the El-Niño SST negatively in DJF. These are the simultaneous relationship. For JJA, the WP precipitation is related to the WP SST and the El-Niño SST for the previous DJF, a half year ago. The AGCM simulations get real history only from the observed SST and sea ice. The memory about the previous DJF must be left in other SSTs or sea ice coverage.



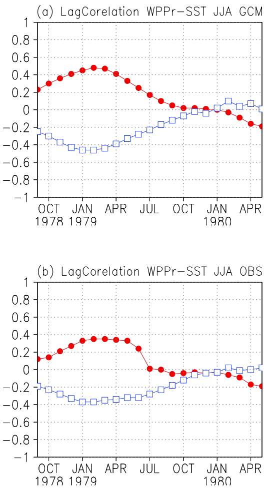


Fig.3 (left) (a) Lagged correlation between AGCM precipitation in the tropical western Pacific for DJF and SST from previous March to next November. Empty circles for Niño 3.4 SST and filled circles for the tropical western Pacific SST. (b) The same as (a) except for observed precipitation.

Fig.4 (right) The same as Fig. 3 except for JJA.

3.2 Why is the JJA WP precipitation related to the El-Niño SST in the previous DJF?

The simultaneous correlation of the WP precipitation with the global SST is shown in Fig. 5 for JJA. Significantly large correlated (> 0.8 or < -0.8) SST area is not found, including the WP SST. This fact indicates that any single SST area does not control the WP precipitation. Relatively large correlations (> 0.6 or < -0.6) are found in the Indian Ocean and the southern off-equatorial Pacific.

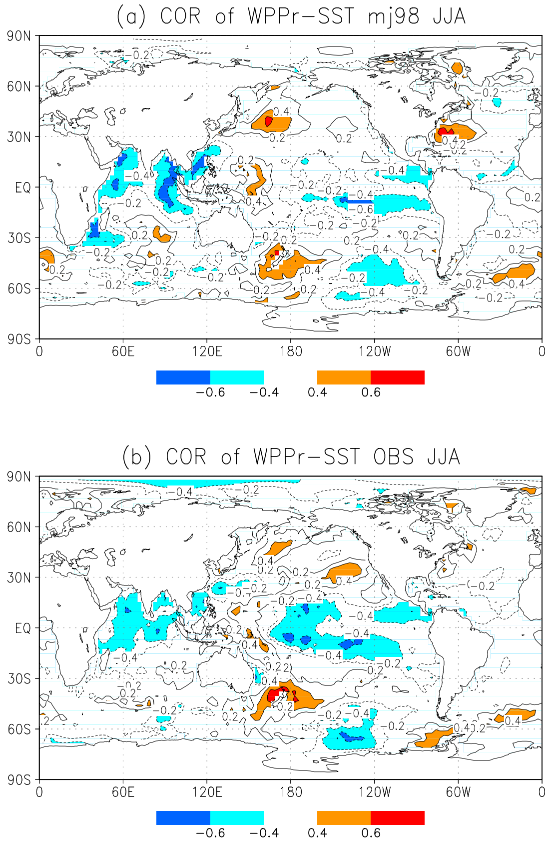


Fig.5 (a) Simultaneous correlation between AGCM precipitation in the tropical western Pacific and other areas for JJA. (b) The same as (a) except for observed precipitation.

Fig. 6 is the regression map of precipitation by the tropical WP precipitation for JJA. The regression pattern for the simulated precipitation is similar to the observed one with some exceptional area in the northern Indian Ocean and the eastern North Pacific. The regressed precipitation for JJA have negative anomaly in the Indian Ocean and the central Pacific around the equator. They are common for the AGCM and the observation. If we connect these negative anomalies of precipitation to the SST anomalies in the Indian Ocean and the southern off-equatorial Pacific, both regional SST and precipitation variability is considered as the cause for the real simulation of the JJA WP precipitation.

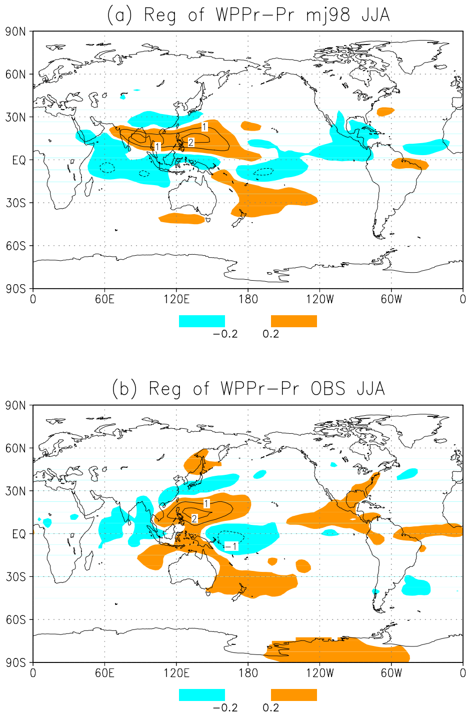


Fig.6 (a) Regressed AGCM precipitation based on precipitation in the tropical western for JJA. (b) The same as (a) except for observed precipitation.

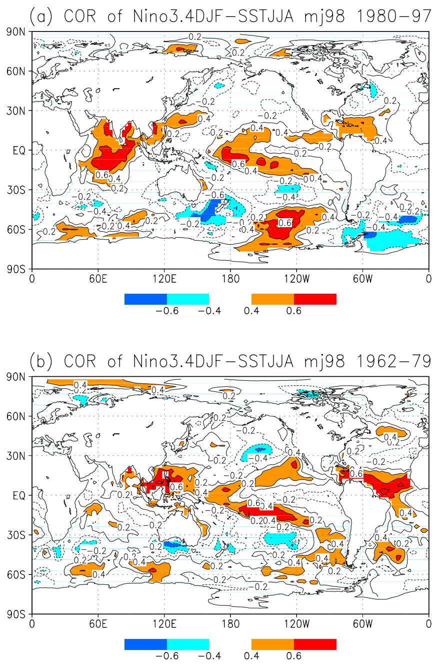


Fig.7 (a) Correlation between Niño 3.4 SST for DJF and the global SST for JJA during 1980-97. (b) The same as (a) except for 1962-1979.

Actually, the JJA SST in the Indian Ocean and the southern off-equatorial Pacific keeps the memory of the DJF Niño 3.4 SST. This relationship is shown in Fig. 7, which is the correlation map between the DJF Niño 3.4 SST and the JJA global SST. The SST regions with the memory of the DJF El-Niño events nearly correspond to the regions where the JJA SST and precipitation variability are highly correlated to the JJA WP precipitation.

3.3 DJF precipitation variability in the eastern Indian Ocean

The regression map of the DJF precipitation by the DJF WP precipitation is shown in Fig. 8. The simulated precipitation successfully captures the characteristics of the observed pattern over most regions. The major exception is the negative anomalies from the maritime continents through the eastern Indian Ocean.

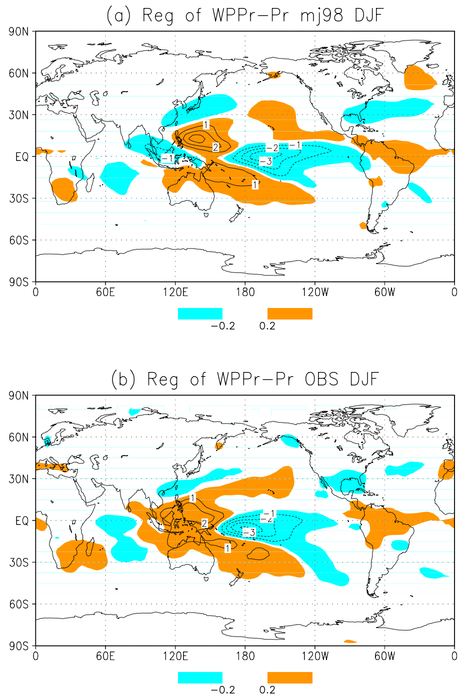


Fig.8 (a) Regressed AGCM precipitation based on precipitation in the tropical western for DJF. (b) The same as (a) except for observed precipitation.

Generally, the precipitation anomalies in the AGCM tend to be positively correlated with the local SST. The correlation between precipitation and local SST at the same place for DJF is shown in Fig. 9. Positive correlations are extended from the WP region through the equatorial Central and Eastern Pacific in the observation. Negative correlations are also found in the observation from the South China Sea and around the maritime continents through the southern Pacific. The AGCM does not seem to reproduce the similar correlation map. Particularly, a large contrast is found from the maritime continents through the eastern Indian.

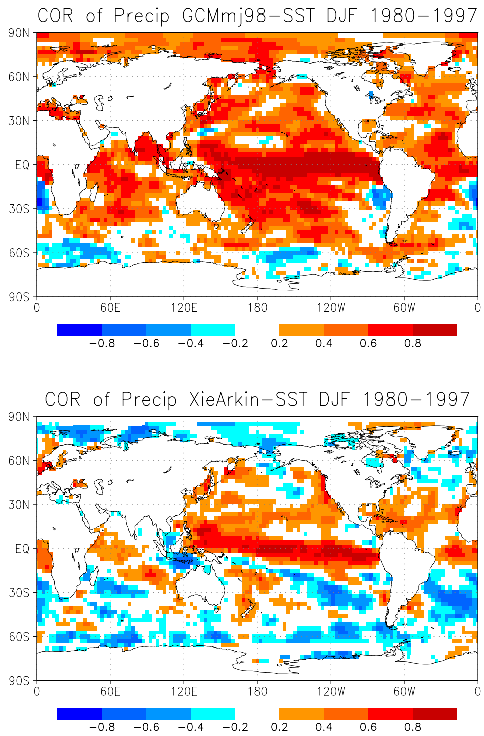


Fig.9 (a) Correlation between AGCM precipitation and SST at the same points for DJF. (b) The same as (a) except for observed precipitation.

4. SUMMARY

The MRI/JMA AGCM (Shibata et al., 1999) integration with the observed SST successfully simulates the variability of the tropical Western Pacific precipitation for both DJF and JJA.

The relationship between the tropical Western Pacific precipitation and the local SST variability is different for DJF and JJA. High correlation is clear for DJF, but almost no correlation for JJA. The tropical Western Pacific precipitation for JJA tends to be related with the El-Niño SST for the previous DJF. The JJA SSTs over the Indian Ocean and the central Pacific off the equator keep the memory of the previous DJF Niño 3.4 SST to some extent. The JJA precipitation over the above two regions may play a role to create the JJA precipitation over the Western Pacific related with the Niño SST for the previous DJF.

The simulated precipitation over the eastern Indian Ocean for DJF is positively related to the local SST anomaly. The observed relationship is opposite. Generally, the inter-annual variability of precipitation in the AGCM tends to be positively related to the local SST variability at each oceanic region on the whole. On the other hand, that local relationship in the observation differs from region to region. The above difference between the AGCM and the observation appears most clearly in the eastern Indian Ocean for DJF. The question about why is left.

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