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Observational Characteristics of East Asian Monsoon during the Summers of 1993 and 1994

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1993, 1994년 여름철 동아시아몬순의 관측 특성

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Abstract: The characteristics of the East Asian summer monsoon circulation associated with the cool and wet summer of 1993 and the warm and dry summer of 1994 are investigated by analyzing the atmospheric circulations features in the upper and lower troposphere and by examining the global SST and associated tropical convective precipitation fields. The negative geopotential height anomalies at 500 hPa and 200 hPa in 1993 over East Asia, the central North Pacific, and the western United States were replaced by positive ones in 1994. In addition, the 200 hPa zonal wind anomaly averaged over the East Asian summer monsoon region is negatively correlated with the Korean summer temperature anomaly. The subtropical jet stream in 1993 was displaced into the central part of Korea well south of its normal position. The western Pacific subtropical high was shifted southward, and the East Asian summer rainfall and temperature was above-normal and below-normal, respectively due to the southwestward extension of a cold and dry polar airmass from the Sea of Okhotsk to the Est Sea. In contrast, the subtropical jet stream in 1994 was displaced well north of its normal position. The abrupt northward shift of the western Pacific subtropical high was accompanied with the rapid northward movement of the rain band of the East Asian summer monsoon rainfall. The anomaly patterns of the East Asia summer rainfall and temperature were opposite to those of 1993. Large sea surface temperature anomalies of opposite signs existed in the tropical Pacific with a mature El Niño in 1993 and a weak La Niña condition in 1994. The role of the anomalous convective precipitation in the western Pacific and the Indian Ocean related with the variations in the low-level cross-equatorial flow along the northwestern periphery of the Australian high and the Mascarene high is probably to influence a large-scale atmospheric circulation over the East Asia during both the years.

Keywords : East Asian summer monsoon circulation, cool and wet summer of 1993. warm and dry summer of 1994

요 약 : 저온 습윤한 1993년 여름철과 고온 건조한 1994년 여름철과 관련된 동아시아에서 대조적인 여름철 몬순순환의 특성을 상, 하층 대류권의 대기순환 특성과 함께 전구 해수온도 및 적도 대류성 강수장을 분석함으로써 조사하였다. 1993년의 경우, 동아시아, 중앙 북태평양 및 미국 서부지역에서 500hPa 면과 200hPa 면의 음의 지위고도 편차가 나타났지만, 1994년의 경우, 이들 지역들에서 양의 편차를 보였다. 1993년의 아열대 제트류는 평년보다 다소 남쪽에 치우쳐져 한반도 북쪽에 위치하였다. 서태평양 아열대 고기압이 남쪽으로 이동하여 동아시아지역에는 평년보다 많은 여름철 강수와 낮은 여름철 기온이 나타났다. 이는 오오츠크해로부터 동해로 저온 습윤한 기단의 확장에 때문으로 판단된다. 대조적으로 1994년의 아열대 제트류는 평년보다 다소 북쪽에 위치하였고, 서태평양 아열대 고기압의 갑작스런 북상은 동아시아 여름철 강수대의 북상을 동반하였다. 따라서, 아시아 여름철 강수 및 기온 편차는 1993년과 반대 양상을 보였다. 적도 태평양상의 해수온 편차에서는, 1993년은 엘니뇨가, 1994년은 라니냐가 각각 나타났다. 오스트레일리아 고기압과 마스카렝 고기압의 북서 연변을 따르는 하층 적도 횡단류와 관련된 서태평양과 인도양에서 이상적인 대류성 강수는 이들 대조적인 동아시아 여름철의 대규모 대기순환에 영향을 준 것으로 판단된다. 또한, 동아시아 여름몬순지역에서 평

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균된 200 hPa 면의 동서바람편차는 한반도 여름 기온편차와 음의 상관을 보였다.

주요어 : 동아시아 여름철 몬순순환, 1993년 여름철의 저온습윤, 1994년 여름철의 고온건조

Introduction

During the early 1990's, strong anomalous summers, especially severe droughts and floods, appeared frequently in the Korean peninsula, the Yangtze River basin and the Huaihe River basin of China and Japan. Moon *et al.* (1998) found that the IAP-L2 AGCM (Institute of Atmospheric Physics-Two Layer Atmospheric General Circulation Model) and the IAP-AOCTGCM (Atmosphere/Ocean Coupled Model) have some predictability for summer droughts and floods in East Asia, especially for the severe cases. To understand the physical mechanism of summer drought over East Asia and to estimate whether the GCM approach is an appropriate tool to climate research in Korea, sensitivity experiments were performed for the 1994 Est Asian summer drought with SST boundary forcing using GEOS GCM (METRI/KMA, 1995).

Recently East Asia had large climatic anomalies such as the cool and wet summer of 1993 and the warm and dry summer of 1994. Some characteristics of the 1993 and 1994 East Asian summer monsoon were investigated by using GMS high cloud amount (Suh, 1995). They showed that the wave activity in the equatorial Pacific is different for the contrasting years, 1993 and 1994.

Moreover, the synoptic patterns of the 1993 and 1994 Changma (the rainy season in Korea) were largely affected by the western Pacific subtropical high, the upper level divergence, and the low-level warm moist southwesterly flow (Rha and Hong, 1995). The unusual evolution of the monsoon associated with the East Asian drought during the summer of 1994 was also investigated by using the GEOS datasets (Park *et al.*, 1995). They found that the abnormal evolution of seasonal cycle associated with sudden jump of the upper level anticyclonic flow over East Asia, played an important role for the absence of Changma in 1994. In Japan also, there have been many reports about the investigations of the 1993 and 1994 East Asian summer monsoon.

The economic and social importance of the 1993 flood and 1994 drought is very clear. For better understanding and long-term climate forecast of rainfall during the rainy season, it is necessary to examine the characteristics of monsoon circulation associated with the extreme climates. Therefore, important goal of this study is to investigate the characteristics of East Asian monsoon circulation over lower and upper troposphere, SSTs and the tropical convective precipitation fields for the 1993 and 1994 abnormal summers.

Data and Methods

Summertime mean rainfall and temperature data of 18 stations in Korea from 1979 to 1994 compiled by KMA. The monthly mean geopotential height and wind in the NCAR/NCEP reanalysis data from 1982 to 1994. The 5-day mean wind data for 1993 and 1994 provided by JMA (Japan Meteorological agency). Global SST anomaly fields for JJA (June-July-August) of 1993 and 1994 from the monthly report on climate system provided by JMA.

In 1993 the large-scale atmospheric circulation anomalies leading to the cool and wet condition in East Asia lasted during the summertime. In 1994 the substantially below-normal rainfall and above-normal temperature occurred in the summer of 1994. The diagnostic method used here is to examine the circulation features and investigate whether the contrasting during these two extreme summers.

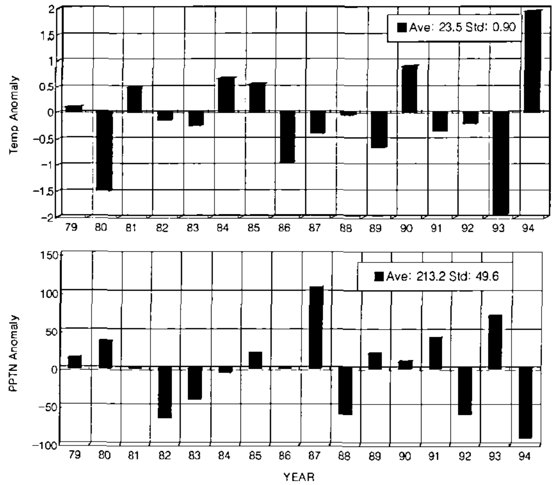

Fig. 1. Interannual variations of the Korean summer (a) temperature and (b) precipitation anomaly during the period of 1979 to 1994.

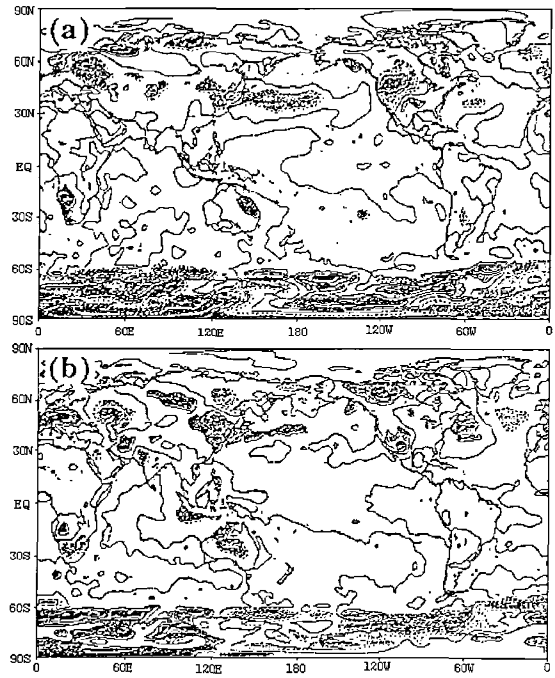

Fig. 2. The distributions of the surface temperature anomaly for the summer of (a) 1993 and (b) 1994.

Results and Discussion

1) Atmospheric circulation anomalies in the mid-latitudes

The interannual variations of the Korean summer temperature and precipitation anomalies during the period of 1979 to 1994. This figure clearly depicts the cool and wetter summer of 1993 and the warm and dry summer of 1994 (Fig. 1)

The surface temperature distribution of these two years. To the south and the north of significantly positive anomalies, the surface temperature reveals negative anomalies in the region from the western Europe to the central North Pacific including East Asia and the western part of North America during the summer of 1993 (Fig. 2a). The anomalous surface temperature features during the summer of 1994 is indeed reversed in sign, not just in East Asia but throughout the western Europe, except for the north region of the Caspian Sea (Fig. 2b)

The latitude-pressure sections of potential temperature and zonal wind at 127.5°E for July 1993 and July 1994. The subtropical jet having th wind speed of over 20m/s in 1993 is seen at about 38°N along 350 K isentrope. Its position is shifted further south than normal, so a cold and dry polar airmass extends southwestward from the Sea of Okhotsk to the East Sea. Due to the further northward shift of the western Pacific subtropical high, the subtropical jet in 1994 is significantly intensified and its position lies at about 47°N along 355 K isentrope. This shift has been linked with the above-normal SST in the warm pool and the association with the stronger convective activity around the Philippines (Huang and Sun, 1992; Kurihara, 1989). This pattern of jet cores is a direct consequence that the strong vertical wind shear throughout the middle and high latitudes related to the strong horizontal temperature gradient based on the thermal wind balance equation. The maximum wind axis tilts slightly northward with height throughout the troposphere. In the lower latitudinal part of the subtropical jet the easterlies appear throughout the upper and lower troposphere over the subtropics due to influence of the outflow form the North Pacific high at the 1000hPa, the subtropical high at the 500hPa level, and the Tibetan high at the 100hPa. It can be indicated from the cross-

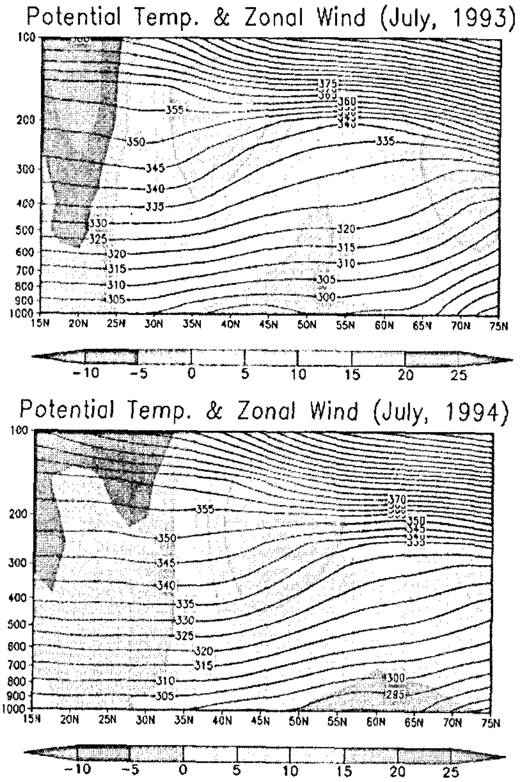

Fig. 3. The latitude-pressure sections of potential temperature and zonal wind at 127.5E for (a) July 1993 and (b) July 1994.

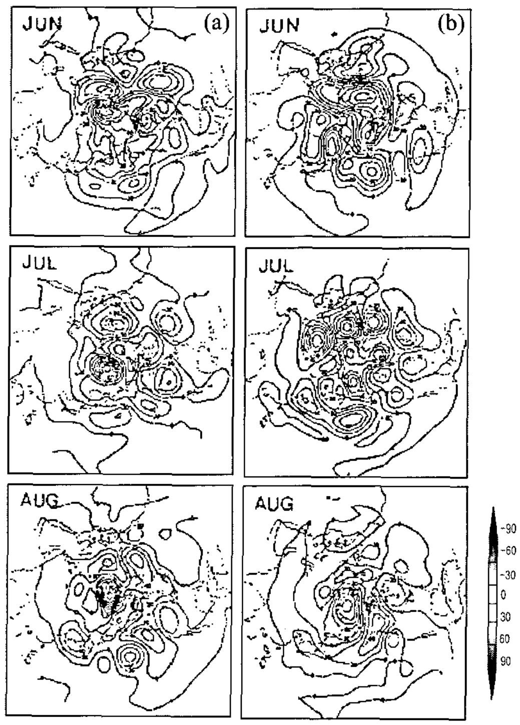

Fig. 4. The distributions of the 500hPa geopotential height anomaly for June, July, and August in (a) 1993 and (b) 1994.

section patterns of zonal wind that the Tibetan high in 1994 is shifted much further northward than in 1993, extending from the subtropics to the midlatitudes (Fig. 3b). In 1993 another maximum wind core. called as the Arctic jet, is clearly seen at about 70°N along 320K isentrope. The latitude-pressure sections of potential temperature and zonal wind in June and August are very similar to the one in July.

The 500hPa geopotential height anomalies in June, July and August for Fig. 4a 1993 and Fig. 4b 1994 over the northern hemisphere. In the cool year, i.e, 1993 for June, larger negative anomalies are located from the eastern Europe to the western United States through East Asia and the central North Pacific In the warm year, that is, 1994 for June, positive height anomalies are dominant from the Mongolia to the Korean peninsula and the central North Pacific, while geopotential heights are below normal in the eastern part of Jan and over the sea of Okhotsk. In the cool year for July, positive height anomalies are broader in extent than in June. The below normal heights are shown in the region from the eastern part of China to the central North Pacific including the Korean peninsula. In the warm year for July, positive anomalies extend from the Tibetan Plateau eastward to the central north Pacific to the south of significantly negative anomalies. The pattern is due to the fact that the western pacific subtropical high ay have shifted northwards. This kind of distribution partly resembles the EU (EUraisan) teleconnection pattern. In the cool year for August, negative height anomalies are dominant over the Korean peninsula and Japan centering over the East Sea. Compared with its intensity in the warm year, the height anomaly over the East Sea in the cool year is more

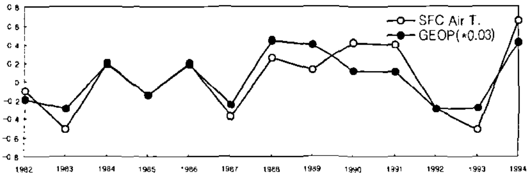

Fig. 5. Interannual variations of the surface temperature and the 500hPa geopotential height anomaly averaged for the area of 30°N-60°N, 100°E-180°E.

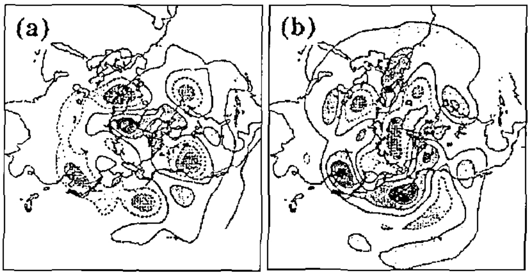

Fig. 6. The distributions of the geopotential height anomaly at 200hPa over the Northern Hemisphere for the summer of (a) 1993 and (b) 1994.

stronger. In the warm year for August, positive height anomalies were noticed around Korean peninsula and Japan with their center located over the Alaska state. In the Siberia region, geopotential height anomalies are below normal. This anomaly pattern partly reflects a positive phase of the West Pacific (WP) teleconnection pattern. Based on the above-mentioned results, we can find that the anomaly of surface temperature is positively correlated with that of the 500hPa geopotential height averaged over the middle in the Pacific and East Asia (30°N~60°N, 100°E~180°E) (Fig. 5). In addition, distinct atmospheric teleconneciton patterns in the 500hPa height field, for example, the Pacific-Japan (P-J) and the East Asia/Pacific (EAP) patterns, have significant impacts in the summertime climate over East Asia and Japan and also North America (Nitta, 1986; Huang and Sun, 1992; Lau and Peng, 1992).

The summer geopotential height anomaly fields at 200hPa over the northern hemisphere. In 1993, geopotential height tends to be below normal around the Korean peninsula, Japan, the central

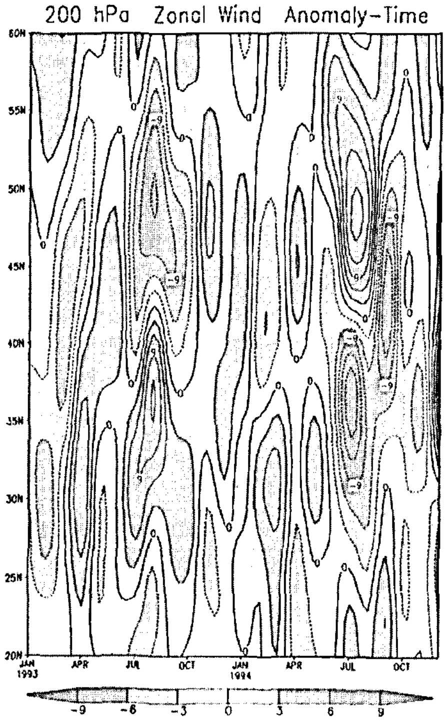

Fig. 7. The latitude-time cross-section of 200hPa zonal wind anomaly at 127.5°E during the period of Jan. 1993 to Dec. 1994.

North Pacific, and the western United States. The anomaly pattern over the East Asia in 1994 becomes almostly opposite to that of 1993. This anomaly pattern may be related to the variations in the strength and position of the Tibetan high with the centers of high cells located around Iran to China. As a result East Asia is covered by positive geopotential anomaly from 500hPa to 200hPa during the warm summer (Fig. 6).

Fig. 7 indicates the latitude-time section of the 200hPa zonal wind anomaly at 127.5°E during the period from Jan. 1993 to Dec. 1994. Throughout August 1993, negative zonal wind anomalies appear to be prominent around 50°N an positive around 36°N. In case of 1994, positive zonal wind anomalies are located around 48°N. Negative anomalies seem to be around 37°N in July and 43°N in September due to the abnormal northward shift of the subtropical jet. This figure also reveals a strong

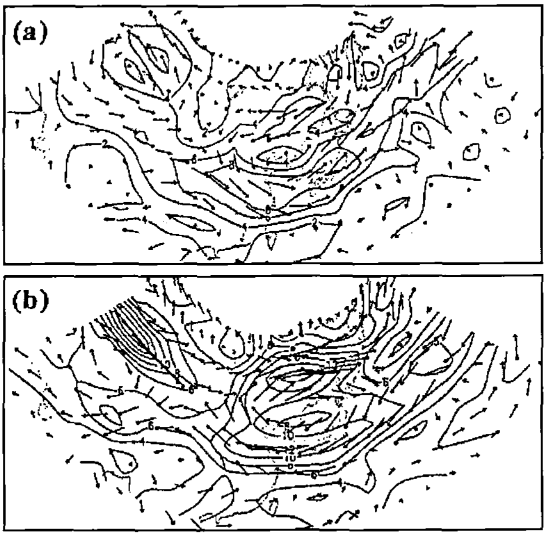

Fig. 8. The 200hPa wind anomalies in (a) 1993 and (b) 1994 during the period of July to August. Isotachs indicate solid lines.

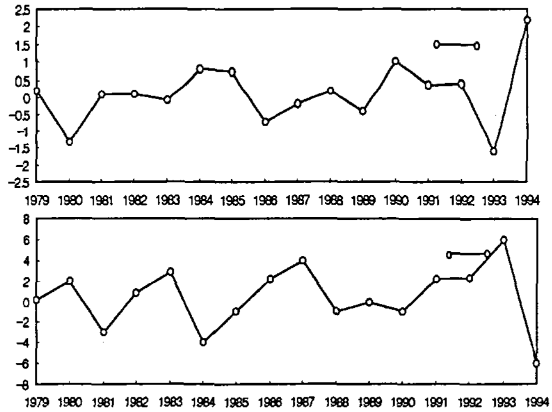

Fig. 9. Interannual variations of (a) the Korean summer temperature anomaly and (b) the 200hPa zonal wind anomaly averaged for the area of 30°N-40°N, 115°E-135°E.

intraseasonal activity in the middle latitude, i.e. near 45°N during two years, although the significant interannual variation is generally observed in the zonal wind of the upper troposphere.

The 200hPa wind anomaly fields in (Fig. 8a) 1993 and (Fig. 8b) 1994 during the period of July to August. In 1993 there is the cyclonic circulation extending from the central China eastward to Japan across the Korean peninsula with its center located over the Liaotung peninsula of China. The southern part of this circulation is more dominant than that of the northern part. The cyclonic circulation in 1993 over the East Asia is replaced by the anticyclonic circulation in 1994. The intensity of a circulation becomes stronger in 1994 than in 1993. This is in a good agreement with the intensity of 200hPa zonal wind anomaly, seen in Fig. 7. It can be concluded from 200hPa zonal wind anomaly averaged over the East Asian summer monsoon region (30°N~40°N, 115°E~135°E) with the Korean summer temperature is presented in Fig. 9. The Korean summer temperature anomalies are negatively correlated with those of the averaged 200hPa zonal wind. On the other hand, the annual variability of precipitation amount over Korea peninsula in summertime is closely related with he north-south migration of th rain belt identified from the 12,400gpm contour of the 200hPa geopotential height field (Lim, 1992).

In order to investigate the evolution behavior of the upper wind fields, 5-day mean wind anomalies at 200hPa in (a) 1993 and (b) 1994 during the period of July to August are showed in Fig. 10. In case of 1993, cyclonic circulation over East Asia is seen during most of the pentads except for 38, 40, 43, and 46th pentads, although its center is a little different as the pentads progress. The strong wind axis can be seen at the southern part of cyclonic circulation on 44 and 45th pentads associated with the abrupt southward shift of subtropical jet. In 1994, all pentads except the 47th pentad have the prominent anticyclonic circulation with its center located over East Asia. It is proposed that the abrupt northward jump of subtropical jet occur during the 42 and 43th pentads with the center of anticyclonic circulation significantly shifted towards East Sea. These results show that the persistent northward or southward jump of subtropical jet is not present during all pentads.

Fig. 11 shows the summertime 850hPa wind anomaly and mixing ratio fields in (a) 1993 and (b) 1994. In 1993, the major axis of moisture tongue extends from the south China northeastward into

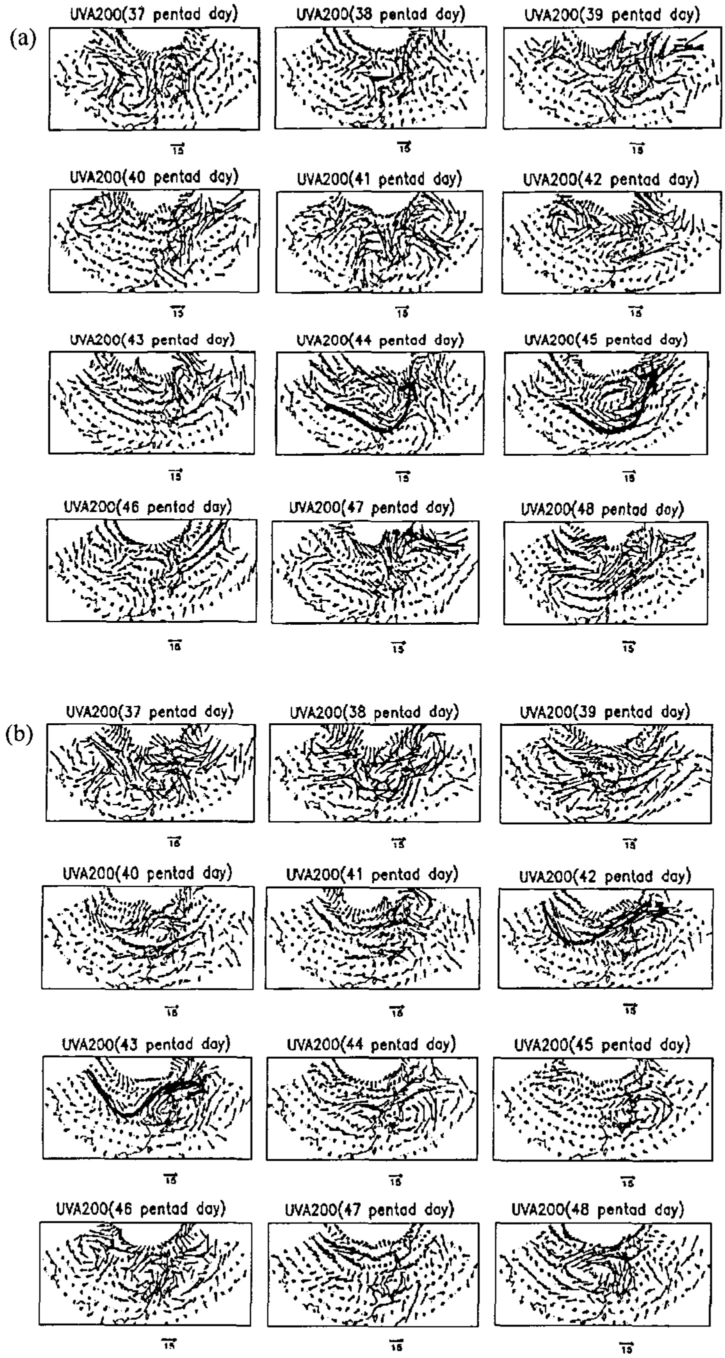

Fig. 10. The 200hPa wind anomalies in (a) 1993 and (b) 1994 during the period of 37th pentad to 47the pentad. A and C indicate anticyclonic circulation and cyclonic circulation, respectively.

the southern part of Japan where the low-level jet becomes stronger than normal. The 850hPa wind anomaly pattern shows a dominant cyclonic circulation around the East Sea which brings abundant moisture transport into the southern part of Korea and Japan from the south China Sea. The wind

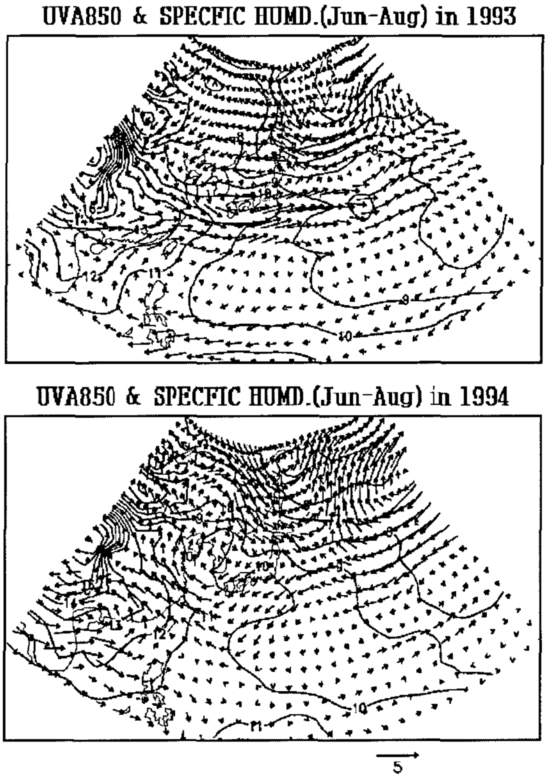

Fig. 11. Anomalous SST fields for JJA 1993 and 1994, relative to 1961-90. The contour interval is 0.5°C. The solid (dashed) lines show positive (negative) anomalies and only zero lines are drawn by thick solid lines.

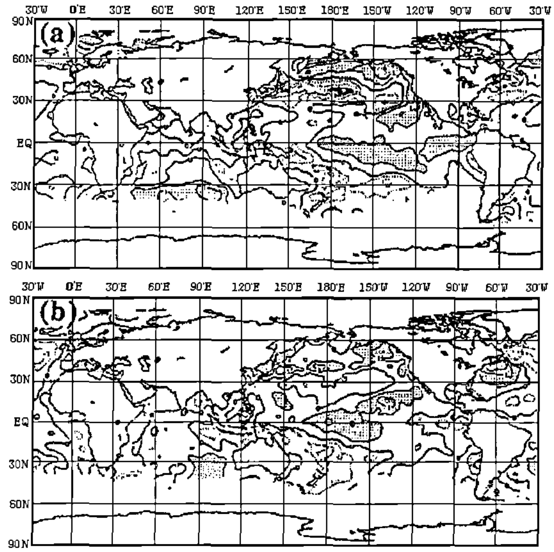

Fig. 12. The distributions of the mixing ratio and the wind anomaly at 850hPa for the summer of (a) 1993 and (b) 1994.

anomaly distribution also shows a strong confluence zone accompanied with the stronger rainy front such as the Changma front in Korea, the Meiyu front in China, and the Baiu front in Japan. This zone is formed from the northwesterlies associated with the intensifying midlatitude vortex over the Korean peninsula, the southwesterlies originating from the Bay of Bengal, and the southerlies along the northwestern periphery of the subtropical anticyclone. As a result, the wet and cool summer of 1993 occurred in East Asia In case of 1994, a well organized moisture zone is largely divided into two parts, one part extends from the East China sea to the northern part of Korea through the entire Yellow Sea and the other one northwestward from the east China sea to the southern part of Japan. The anticyclonic circulation anomaly prevents large amounts of moisture from transporting into East Asia, resulting in reduction of summer rainfall over East Asia. In comparison with two years the distinctive difference appears more dominant in the anomaly flow than in the mixing ratio field. These results imply that the excess or deficit of summer precipitation over the East Asia have a close connection with the circulation features.

2) SST and convective precipitation anomalies in the tropics

The tropical SST anomaly fields for JJA 1993 and 1994 from the monthly report on climate system in JMA are shown in Fig. 12 to understand the response of the atmosphere to SST anomalies. In 1993 the cold SSTs along the central North Pacific are shown by the anomalies of −1.0°C Fig. 12a). The normal SST in 1993 along the equatorial Pacific reveals the mature El Niño. The observed direct atmosphere response can be seen from the convective precipitation anomaly converted form the convective precipitation rate. In 1993 positive convective precipitation anomalies were pronounced near the equator from 150°E to 180°, and

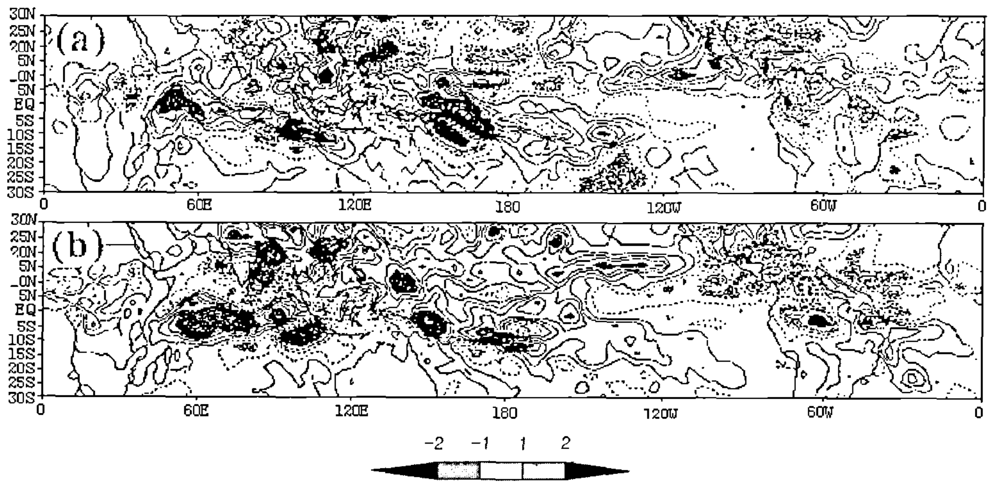

Fig. 13. Anomalous convective precipitation fields for JJA 1993 and 1994, relative 1982-94. The solid (dashed) lines show positive (negative) anomalies.

significantly negative anomalies to the southeast of this region (Fig. 13a). Weak positive anomalies are also seen east of the Africa coast and at the longitude of 105°E over the central Indian Ocean. This pattern has a close connection with variations in the strength of the low-level cross-equatorial flow along the northwestern periphery of the Mascarene high and the Australian high. Positive SST anomalies in 1994 are seen around the Korean peninsula, Japan, and in the western coast of North America and in the central equatorial Pacific (Fig. 12b). The SST anomalies in the equatorial Pacific reveal weak La Niña conditions. The tropical convective precipitation anomalies in 1994 are shown in Fig. 13b. In the central Indian ocean there is a dominant positive precipitation anomaly, which may be explained as a feature associated with a strong outflow from the Mascarene high. This contributes to the pronounced positive precipitation anomaly in the Bay of Bengal associated with a strong southwesterly convergence. The reversal sign over the northwest of Australia is related to a weak cross-equatorial flow from the Australian high. Moreover, the positive precipitation anomaly extends from the south China Sea southwestward to the northeast of Australia with a positive anomaly in the eastern Pacific.

Summary and Concluding Remarks

The aim of this study was to highlight major differences of the atmospheric circulation in the northern hemisphere, particularly, at 500hPa and 200hPa levels and the differences in the global SST distribution and the tropical convective precipitation for JJA of 1993 and 1994.

During the summer of 1993, the lower surface temperature with above-normal precipitation occurred over East Asia, the western Europe, and parts of North America. There was an approximate reversal in the anomalous surface temperature in JJA of 1994 except for the north of Caspian sea. The 500hPa geopotential height anomalies in summertime revealed a reversal pattern over East Asia, the central North Pacific, and the western United States associated with the cool condition in 1993 and the warm condition in 1994. Moreover, it is found that the anomaly of the surface temperature is positively correlated with that of the 500hPa geopotential height averaged over the middle latitude in the Pacific and East Asia. The subtropical jet stream at 200hPa as shift abruptly southward of its usual summer position in 1993 but northward in 1994. The abrupt shift in the jet position significantly occurred during the 44 and 45th pentads in 1993 and 42 and 43rd pentads in 1994, respectively. This upper-tropospheric disturbance provided an environment favorable for unusually northward shift toward East Asia of the western Pacific subtropical high. The geopotential height patterns at 200hPa in these two years are very similar to those at 500hPa. Therefore, East Asia is covered by negative geopotential anomalies from 500hPa to 200hPa in 1993 but positive ein 1994. In the 200hPa wind anomaly field, the cyclonic circulation in 1993 over the East Asia centering at the Liaotung peninsula of China was replaced by the strong anticyclonic circulation in 1994. It is well established that the Korean summer temperature anomalies are negatively correlated with those of the averaged 200hPa zonal wind for the area of 30°N~40°N, 115°E~135°E. In 1993 the major axis of the moisture tongue extending northward from the South China into the southern parts of Korea and Japan was accompanied with the stronger low-level jet. This contributes to substantial moisture transport into East Asia, resulting in the cool and wet summer associated with the heavy rainfall. The cyclonic circulation in 1993 over East Asia was replaced by the anticyclonic circulation in 1994 as revealed by 850hPa wind anomalies. This suppressed large amounts of moisture transport into East Asia.

Large sea surface temperature anomalies of opposite signs existed in the tropical Pacific with a mature El Niño in 1993 and a weak La Niña condition in 1994. The role of the anomalous convective precipitation on the western Pacific and the Indian Ocean induced by variations in the strength of the cross-equatorial flow originating from the Australian high and the Mascarene high is probably to influence a large-scale atmospheric circulations over East Asia in both the years.

The modelling and analytical studies on the physical processes involved in the cool and wet summer in 1993 and the warm and dry summer in 1994 are still needed for the better understanding the mechanism of such extreme climates and for the improvement of its predictability.

References

MRI/KMA, 1995, Simulation of the climate variation with GEOS GCM (I), 100 p (in Korean).

Huang, R.H. and Sun, F., 1992, Impacts of the tropical western Pacific on the East Asian summer monsoon. Journal of the Meteorological Society of Japan, 70(1), 243-256.

Kurihara, K., 1989, A climatological study on the relationship between the Japanese summer western and the subtropical high in the western North Pacific. Geophysical Magazine, 43(1), 43-103.

Lau, K.M. and L. Peng, 1992, Dynamics of atmospheric teleconnection during northern summer. Journal of Climate, 5(2), 140-158.

Lim, G.H., 1992, Annual march of total precipitation over Korea Peninsula and the general circulations during the northern hemisphere summertime. Journal of Korean Meteorological Society, 28(3), 269-282

Lu R., Ryu, C.S., and Dong, B., 2002, Association between the Western North Pacific Monsoon and the South China Sea Monsoon. Advances in Atmospheric Sciences, 19(1), 12-24.

Moon, S.E., Kim, U.J., and Kim, S.H., 1998, Seasonal prediction experiments of the summer drought and flood in East Asia with GCM and atmosphere/ocean coupled GCM. Korean Journal of the Atmospheric Sciences, 1(1), 59-69.

Nitta, T., 1987, Convective activities in the tropical western Pacific and their impacts on the northern hemisphere summer circulation. Journal of the Meteorological Society of Japan, 41, 373-390.

Park, C.K., Schubert, S.D., and Kim, J.W., 1995, On the dynamics of the 1994 East Asian summer drought; An observational study. Proceeding of the International Workshop on the East Asian Monsoon, 29-31 March 1995, Seoul, 138-151.

Rha, D.K. and Hong, Y., 1995, Synoptic characteristics of 1993 and 1994 Changma in Korea. Proceeding of the International Workshop on the East Asian Monsoon, 29-31 March 1995, Seoul, 72-83.

Ryu, C.S., 1998, Interannual variations of summer monsoon rainfall in East Asia and their relations to the atmospheric circulation over the northern hemisphere. Unpublished Ph. D. dissertation, Pusan National University, Pusan, Korea, 137 p.

Ryu, C.S. and Kripalani, R.H., 2002, Intra-seasonal low frequency oscillations of summer Monsoon rainfall in South Korea. Korean Journal of the Atmospheric Sci-

ences, 5(S), 85-91.
Suh, A.S., 1995, On the characteristics of the 1993/1994 East Asian summer monsoon convective activites using GCM high cloud amount, Journal of Korean Society of Remote Sensing, 11(3), 1-21

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2002년 3월 7일 수정원고 접수
2002년 3월 23일 원고 채택