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Variation of some atmospheric circulation factors affecting Vietnam climate

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Abstract. More and more evidence of global climate warming, sea level rise, droughts, floods and climate extremes are recorded. In Vietnam, the manifestation of climate change (CC) is often considered as changing the level and trend of variation of main climatic elements and sea level. However, Vietnam climate influenced by the characteristics of atmospheric circulation in the Earth climate system. This paper presents expression of some characteristics of regional (the expanded East Asia area: 10^0S - 50^0N; 60^0E - 160^0E) atmospheric circulation affecting Vietnam climate, including: surface pressure, zonal circulation indices (Iς); meridional circulation indices (Iλ); Cold front frequency (CF) in the North of Viet Nam. The numbers of tropical cyclone over the East Sea and affecting Vietnam are mentioned in other studies. Changes in atmospheric circulation over the area are reflected by the differences of regional atmospheric circulation characteristics values between the recent period (1991-2007) and the study period (1960-2007) mentioned above.

Keywords: variation, atmosphere circulation, Vietnam climate.

1. Changes in surface pressure

1.1. The annual mean surface pressure

On the map of East Asia expansion, the average surface pressure of the study period (1960-2007) as well as the recent period (1991-2007) are under control of high pressure over the Eurasian continent (HPEA) with 1020hPa in the northwest; low pressure over India (LPI) with below 1010hPa in the Southwest; low pressure Aleusian (LPA) with below 1014hPa in the northeast; the subtropical Pacific high pressure (SPHP) with 1016hPa in the southeast and equatorial low pressure (ELP) with 1010hPa in the south (Figure 1).

The most important change in the recent period compared to the study period is the increase of HPEA intensity, especially in the northeast about 40-50^0N and 100-110^0E. The increase in pressure is up to 2.2hPa in the Northeast and only 0.2 to 0.6hPa in northern Vietnam. In addition, the LPI also increased about 0.2 to 1.0hPa.

1.2. January mean surface pressure

Surface pressure in January (typical month of the winter) of the study period and the recent period as well is controlled by the HPEA with pressure at center over 1034hPa. Pressure gradient is very large in the direction from northwest to southeast.

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During the recent period, the surface pressure increase over the area from 90^0E - 110^0E; 50^0N - 20^0N: The highest value is up to 1hPa over area 45-50^0N, 95-105^0E; on offshore Southeast Philippine Islands the increase is about 0.4 hPa compared to the study period.

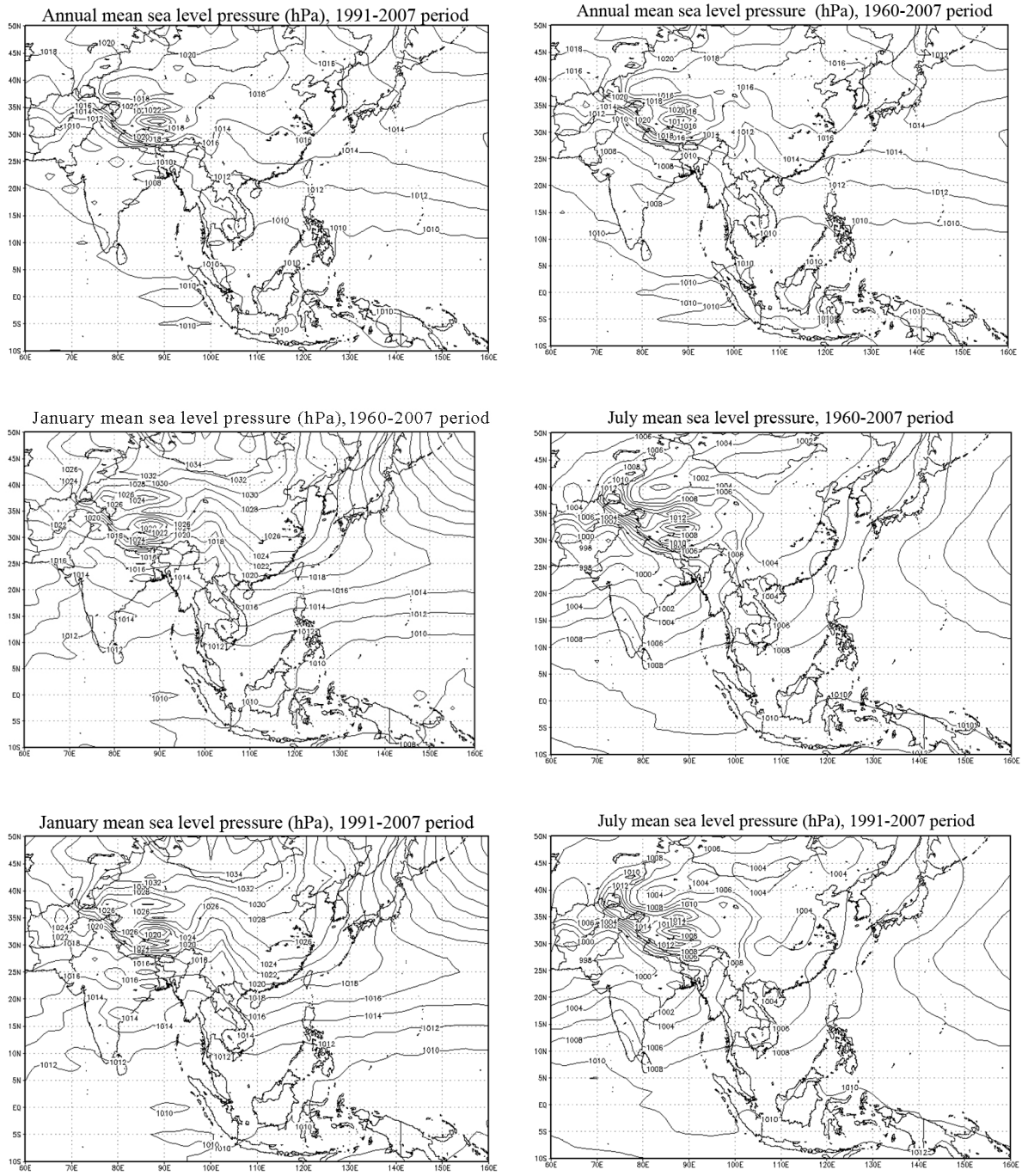

Figure 1. Map of the annual, January and July mean sea level pressure in 1960-2007 and 1991-2007 periods [1].

1.3. Mean surface pressure in July

Mean surface pressure in July (typical month of the summer) of the study period and the recent period is typed by reduced pressure and expansion to the east with pressure at center below 998hPa and develops to the east. Pressure gradient is relatively large on the east-west, between 20-30^{0}N.

In the recent years, the surface pressure increased lightly over mainlands, but decreased over oceans: On the mainland, the increasing rate was up to 3.4 hPa on the area (40-50^{o}N, 90-110^{O}E); and on the ocean, the decreasing rate was about 0.6hPa over 40-45^{o}N, 150-155^{o}E.

2. Variation of circulation indices

2.1. Change of zonal circulation indices

Zonal circulation index is one of circulation characteristics having slight variation. The variation rate of this index is about 18-19% in January and July; about 11-15% in April and October; and about 5% for annual variation.

The zonal circulation index in the recent period (1991-2007) decreased by about 2-5% in the winter, spring, summer and less than 1% in the fall compared to the study period (1960 - 2007).

2.2. Change of meridional circulation indices

Different from zonal circulation index, meridional circulation index is very unstable, especially during the transition months from winter to summer or conversely. Its variation rate is just below 25% in the winter and summer, but up to 68-90% in April and October.

In the recent period, the meridional circulation indices decreased 3.3% in the winter and increased about 59.3%, 17.0%, and 40.0% for the spring, summer and autumn, respectively. The result is that the annual meridional circulation indices increase up 50% (compared to the study period).

3. Variation in the frequency of cold fronts

3.1. Degree of change

In the period 1960-2009, there are 1,375 cold fronts (CF) passed Hanoi, with an annual average of 27.5 of CF: Highest in 1970 with 40 and lowest in 1994 with only 16 CF.

The CF unevenly distributed for the month: From September to June, on average, there is more 1 CF per month and from November to March, there are more 3 CF per month; in contrast, in July and August there is less 1 CF per month on average - this is the time of the CF interruption; in May, there is an year with 9 CF (1976) and also there is an year with only one CF (1993); while in July, CF is rare (1969, 1989).

The CF frequency varied from decade to decades: the most CF in the decade 1971-1980, and relatively little during the decade 1991-2000.

3.2. The trend of change

Trend of CF frequency is evaluated through the regression equation, but it doesn't meet a strict criteria. CF frequency in the recent period (1991 - 2009) accounts for 95% CF in the period 1961-1990. Moreover the record lowest of CF is also in the decade 1991 -2000 of recent period, a record highest of CF is in 1971-1980 decade of previous period.

4. Seasonal changes in temperature

Seasonal temperature change in Viet Nam is mainly the cold season (CS) change in the 4 Northern Climate Zones [2]: Northwest (NW),

Northeast (NE), Red River Delta (RRD) and North of Central Vietnam (NC) concerning the onset, peak and the end of CS. Variations of the cold season are monitored through differences on the frequency of the onset, peak and the end of CS between the period (1961-1990) and the recent period (1991-2007).

4.1. The onset of cold season

In the period 1961 - 1990, the frequency of cold season onset began early (in November) is 37-97% in NW, NE; 6-10% in the RRD, NC and started late (in December, January) is 3-65% in NW, NE; 90-93% in the RRD, NC. In the recent period, the early onset frequency reduces: only 18-94% in NW, NE, 0-10% in the RRD, NC and the late onset is as 6-82% in NW, NE, 90-100% in RRD, NC.

The above results show that over all four Northern Climate Zones, the early onset frequency of CS decreases and vice versa, the frequency of the late onset increases.

4.2. The peak of cold season

In the previous period, the frequency of cold season peak appeared early (in December) as 13-43% in NW, NE; 17-20% in the RRD, NC and appeared later (in February) is 7-17% in NW, NE; 23-30% in the RRD, NC. In the recent period, the early peak frequency is 12-41% in NW, NE; 6-17% in the RRD, NC and the late peak frequency is as 6-18% in NW, NE; 18-47% in RRD, NC.

It is clear that between the previous and recent periods there was no significant difference in the peak of cold seasons.

4.3. The end of cold season

During previous periods, the frequency of cold season end finished early (in January) is 0-3% in NW, NE; 7-17% in the RRD, NC and finished later (in March) is 0-17% in NW; 33-83% in NE; 46-67% in the RRD, NC. In the recent period, the early end frequency of the cold season is as 12-18% in NW, NE; 13-29% in the RRD, NC and the late end frequency is 0-25% in NW, 12-77% in NE; 17-33% in the RRD, NC.

The results indicate that during the recent period, the early end frequency of cold season increases and the late end of cold season decreases compared with the period 1961-1990.

5. Conclusions and recommendations

5.1. Can be obtained the following information on the surface pressure in the recent period:

a) Generally, the annual mean and typical month of seasons surface pressure increased. The highest increasing is up to 3.4 hPa in the summer and 1.0 hPa in the winter. As a result, the maximum of the increase in annual surface pressure is 2.2 hPa.

b) In July, surface pressure increased over continental areas and reduced over oceans; however surface pressure in January steadily increased over both oceans and continents.

c) The increase in surface pressure during the recent relatively large in the northern, relatively few in the south, at most over the region about 45-50^{0}N, 100-110^{0}E.

5.2. In East Asia, the zonal circulation indices are more stable compared to the meridional circulation indices: In the recent period, the zonal indices in seasons did not reduce very much. The meridional index decreases in the winter, but it increase relatively large in spring, summer and autumn compared to the study period.

5.3. Frequency of cold fronts increased during the winter months (XII-II), but decreased in the

months of spring, summer, autumn; the whole-year period the frequency of recent period CF only 95% for the period 1961-1990.

5.4. During the recent period, the late onset and early end frequencies of cold season increases, vice versa, the early onset and late end frequences decrease.

5.5. It is well known that, pressure is as a means of the most subtle monitoring of all weather phenomena in the atmosphere. Thus, changes in surface pressure are certainly as an important agent of climate change. However, until now there are few studies about relationship between change in atmospheric pressure and variation in weather phenomena.

References

[1] Nguyen Van Thang, *Project report on "Study on climate change impacts on natural condition and resources and propose adaptation and mitigation measures for sustainable development in Vietnam"* (Governmental science and technology programme "Environmental protection and hazard prevention", KC08.13/06-10), Vietnam Institute of Meteorology, Hydrology and Environment. Hanoi, 2010 (In Vietnamese).

[2] Nguyen Duc Ngu, Nguyen Trong Hieu, *Climate and climate resource of Vietnam,* Agricultural Publishing House, 2004 (In Vietnamese).