

Synoptic and dynamic analyses of most pervasive hot day in Iran during 1964 to 2009

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1. Introduction

Hot days are considered as one of the manifestations of extreme temperature. Hot days are very important atmospheric events in terms of losing water resources, large demand for water and energy, and its effect on human comfort. Accordingly, these events could have physical, economic and social consequences. As Bonsal et al (2001) has stated this atmospheric event and the related atmospheric systems might emerge and occur during every month. These kinds of temperature anomalies especially in large scales are in relation with given synoptic systems.

Although many investigations have been carried out on synoptic analyses of hot days around the world, it seems they have been neglected in Iran. For example Nasrallah et al (2004) studied hot waves in warm season over Kuwait during 1958-2000. They assume northward transfer of subtropical jet stream and a ridge emergence in 500 hp are synchronized with hot days. In Iran the studies primarily underlined hot days consequences. For example Brati and Mosavi (2007) studied hot days trend and Farjzadeh and Darand (2010) investigated the relationship between hot days and mortality rate. Yazdan Panah and Alizadeh (2012) had an investigation into probability occurrence of hot days based on Markov chain model.

2. Study Area

In this study, atmospheric conditions during the most pervasive hot day over Iran were investigated; in addition, a new method for hot day identification was applied. To this end, Iran and also an area between 10W to 120E and 0 to 80N were taken as our field study.

3. Materials and Methods

In the present study, in order to investigate synoptic of the most pervasive hot days in Iran, the circulation to environment approach was utilized (Masodian 2005). Accordingly, the following databases were used:

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1- The maximum of daily mean database with 15*15 kilometer resolution during 1963-2009 was used. This database was obtained from 664 synoptic and climatology stations using Krigging interpolation method. Therefore, the database contains 17166*7187 dimensions and every pixel on each day map has its own mean of temperature value.

According to the definition by "The Joint World Meteorological Organization Commission for Climatology", a hot day is a day when the temperature of each pixel in the country and each day is more than 90th percentile of a given pixel and a given day. Therefore, 366 maps of hot day threshold have been created. These maps were hot days criterions. Country experienced the most pervasive hot day in 2004/3/7. In this day, virtually 96.7% of the country experienced temperature which was above the defined threshold temperature.

2- The atmospheric database for the day with the most pervasive hot and also for the period of 1963-2009 which was obtained from NCEP/NCAR contains sea level pressure (SLP), meridian and zonal components of wind, temperature and 500 hp geopotential heights. Synoptic and dynamic analyses were carried out in order to investigate atmospheric situation synchronized with hot day:

- Synoptic analyses of SLP and 500 hp were analyzed to reveal the pressure and the height of atmosphere and their anomalies in 2004/3/7 and also they were compared with those in 1963-2009 mean.

- Dynamic analyses were considered jet stream, advection and front genesis function. The jet stream was investigated in four levels (300,400,500 and 600 hp). Finally, in order to analyze the dynamic – thermodynamic relations of atmosphere, the relationship of vorticity and temperature in aforementioned level has been estimated based on Pearson correlation coefficient.

4. Result and Discussion

The maximum temperature in (2004/3/7) occurred in southeast of the country specified from 39 to 40 degree centigrade, while the minimum temperature specified from 0 to 3 degree centigrade has happened in a small area at north east of Eastern Azerbaijan. There are only small distinct areas that cover 3.3% of the country (Northwest, Caspian coast and in Northeast of the country) where the positive anomalies have not occurred. Generally, most parts of the country experienced positive anomalies and there are also areas in Kerman, Yazd, Semnan And Khorasan Razavi characterized by up to 16 degree centigrade positive anomalies.

Sea level pressure showed two high pressure systems were located in east and west of Iran, meanwhile the polar low came from southward to north of Iran. Therefore, a dramatic pressure gradient in between caused a massive hot advection toward Iran. The pressures anomalies in all over Iran were positive and up to 5 hp were negative through northern part and in small area of Oman sea coast.

In the 500hp level, a two center cut off system was observed on Russia and Iran is located in front of Mediterranean-Red sea trough. This pattern moved air masses from lowest latitude, northeast Africa, toward Iran. Also a ridge on Iran caused a dramatic height gradient due to its adjacency with northern cut off. This condition caused a negative anomaly pattern all over Iran. The anomalies are -550 to -300 meters.

Investigating westerly's jet stream, it revealed that jet stream came to 600 hp in southwest-northeast orientation which was covered northwest of Iran to northeast of Kazakhstan. A vast area of Iran was located in southern mouth quarter in which cyclonic convergent air and dropping pressure level were naturally expectable. Calculating front genesis function, it is clear that there was front genesis potential all over Iran.

All situations mentioned tend to have warm advection in all atmospheric levels toward Iran although there are some reigns characterized by cold advection in which the temperature anomalies are still positive.

The correlation between lowest levels of atmosphere and uppers indicated a strong positive correlation. This indicates a thick atmospheric layer warming limiting heat transfer.

5. Conclusion

The pervasive hot day was due to difference in pressure pattern causing a deep atmospheric front and a high and deep jet stream. There are other patterns such as negative anomalies in atmospheric height, warm advection. Warm convergence in all atmospheric levels tends to decrease spatial temperature difference. Consequently, it caused difficult situation for heat vacation. It is obvious that surveying hot days necessitate thermodynamic as well as dynamic consideration.

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Key Words: Hot Day, Temperature Anomaly, Vorticity, Warm Advection.