

Synoptic and thermodynamic analysis of heavy precipitation in the Province of Kermanshah from October 27 to 30, 2015

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Extended abstract

Among the natural disasters, floods involve the highest human casualties. The economic damages of flood in developing countries, including Iran, is much more, and its occurrence is very high particularly in the cold months of the year in the west of the country. By studying the synoptic maps of the Earth's surface and the middle and upper levels of the atmosphere, many Earth-surface phenomena such as flood, based on the spatial arrangement of the pressure curves or the height and the location of patterns on these maps, the pattern of daily weather conditions can be controlled and the origin of many of these phenomena can eventually be determined. Precipitation is the major climate phenomenon resulting from the complex interactions of the climate system and it has a complex behavior due to the bond with various components of the climate system. The occurrence of precipitation requires the provision of several conditions. The availability of moisture, deep instability and cooling, are the prerequisites for the occurrence of precipitation. All of these conditions must appear in its strongest state for the occurrence of super heavy rainfalls. The western region of Iran is a suitable area for exacerbating and extending rainfall and sometimes flooding due to the presence of mountains. This is because the role of mountains in capturing air humidity plays a significant role in increasing the atmospheric precipitations. There are two types of approaches in synoptic studies: circulatory to environmental, and environmental to circulatory. In the study of precipitation, the environmental to circulatory classification and approach are used. The reason for this is that, the temporal and spatial variations of rainfall are severe, and the environmental to circulatory method allows the researchers to concentrate on the precipitation and, consequently, on the synoptic patterns which they intend to study. In this study, the heavy and pervasive rainfall in the province of Kermanshah on October 27-30, 2015, was selected and it was attempted to analyze the synoptic and thermodynamic conditions of the occurrence of this torrential rain. In this research, the environmental to circulatory approach was used. To conduct such studies, two databases are required. In this paper, which was conducted with the aim of analyzing the heavy rainfall synoptic situation in Kermanshah province (on October 27-30, 2015), two databases have been used. First, the daily rainfall data from October 25 to 31, 2015 were extracted by referring directly to digital files sent by the stations to the Iranian Meteorological Organization, and then, the high atmospheric variables on the same date were used for synoptic and thermodynamic analysis of the aforementioned precipitation and to see how the synoptic systems entered the region. Data related to the station's level pressure, geopotential height, orbital and

meridional components of wind and moisture at different levels of the atmosphere from the database related to high atmosphere data were obtained from the United States National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Prediction, and National Center for Atmospheric Research (NCEP / NCAR) with a spatial resolution of 2.5 by 2.5 arc degrees. Then, for the synoptic analysis of the aforementioned rainfall, daily maps of the Earth's surface and the levels of 850 and 500 hPa were plotted in the GrADS software. Drawings of these maps were carried out 48 hours prior to the start of the rainfall until the day of full stop. The instability indices KI, LI, SW and SI were also used for the thermodynamic analysis of the high atmosphere data of Kermanshah and obtaining the extent of instability in the study days. In the analysis of the Earth's surface synoptic map on the day of torrential rains, the southern system appears as a low-pressure field and has the highest power in the Red Sea and Sudan region, and the low-pressure current has been drawn to the center of Iran, and extends over a vast area from the east and south of the European high pressure to the west and center of Iran and the conditions of instability are dominant in these areas. The ascending currents have increased because of the intensity of pressure reduction. It seems that the intense pressure gradient between the Sudan's low-pressure and the European high-pressure current is one of the causes of the occurrence of torrential rains during the studied period in the province of Kermanshah. All stations in Kermanshah province have reported rainfalls under this very strong pressure and moisture from the Persian Gulf and Oman Sea. Enhancement of the low level system of the Earth's surface and the downfall of cold weather in high latitudes by polar trough at the level of 500 hpa contributes to the occurrence of atmospheric instability and the onset of rainfall in the west of the country. The trough is located on the eastern Mediterranean in such a way that, its axis at the end of the Mediterranean trough passes over the Red Sea. on the eastern part of this trough's axis (Red Sea descent), there is air turbulence from the west of the Red Sea to the north of the Caspian sea, which causes low pressure of the Earth's surface to be raised to high latitudes. If this trough is strengthened while moving eastward, it will contain thunderstorm, rain and snow, in case of having enough moisture on its way, which is from southwest to the northeast, while passing over the heights. At the beginning of the heavy rainfall, the subtropical jet stream is on North Africa and the polar jet stream is on the areas located on the north of the Caspian and Black Sea. The amount of precipitation increase dramatically as these two jet streams get closer to each other, the polar jet stream changes position to the lower latitudes, and the subtropical jet stream moves towards the northeast. In the study of instability indices, there has been dispersed thunderstorm according to the LI instability index. The probability of dispersed shower on October 28 is very low according to the S1 index and the study area will witness very storms with low intensity on this day according to SW index. According to the KI index, this probability reaches to 60-80% in Kermanshah province on October 28 (peak day of precipitation).

Keywords: Synoptic analysis, Heavy precipitation, Circulatory patterns, Kermanshah province