# Thermodynamic-statistical Analysis of Thunderstorms in Iran

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## 1. Introduction

Ascent rainfall mechanism is "one of the most important factors in leading to various rainfall behaviors in different regions, such as various atmospheric precipitation seen in different time scales" (Masoompour, Miri, Zolfaghari, & Yarahmadi, 2013, p. 299). In fact, some of them can be called atmospheric phenomena due to their special nature. One of these atmospheric phenomena is thunderstorm. Not only this storm and its accompanying phenomena like lightening, tornado, hail, strong winds, and heavy precipitation (see Changnon, 1925, 2001), but also atmospheric hazard phenomena in aviation, such asturbulence, frost, and wind shear (Tajbakhsh et al., 2009) cause remarkable damage to human and natural environments. Therefore, recognizing the features of these phenomena has been attracting the attention of researchers.

## 2. Theoretical Framework

As a part of weather, thunderstorms are considered as "key elements of the cycle of water and electricity in atmosphere" (Jalali, Rasoli, & Sari Saraf, 2006, p. 20). Generally, researchers believe that extreme instability of air is the result of the convection in lower levels of atmosphere and the assistance of high levels with appropriate humidity. In fact, the necessary conditions to make convection are the main reasons for thunderstorms. There are three required conditions for the occurrence of convection, including static instability, humidity of lower levels of atmosphere, and lifting mechanism near the surface. In fact, the combination of instability, humidity, and convergence in lower levels of atmosphere play an important role in probable thunderstorms.

## 3. Methodology

This study aims at recognizing the thunderstorms of Iran using instability indices. Using the archive of National Meteorology Organization, hourly data and atmospheric phenomena of 14 synoptic stations with radiosonde were gathered. They are 19-year data used to find statistic features. The previously mentioned collected data were processed in time scales of year, season, and month. High atmosphere data (radiosonde data), available in the website of Wyoming University, were applied to investigate thermodynamic features of thunderstorms. Thermodynamic conditions were examined

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by CAPE, LI, TT, SI, and KI and skew-T chart drawing in the environment of RAOB environment.

**4. Results and Discussion**

The frequency of thunderstorm occurrence in Iran revealed that 1107 occurrences of thunderstorm were recorded with different codes during the studied period. Of the selected stations, Kermanshah and Booshehr stations with 160 occurrences and Yazd station with 17 occurrences have the maximum and minimum occurrences, respectively.. Comparing the occurrences of this phenomenon during 2 decades (1991-1999 & 2000-2009), it became clear that 601 occurrences were recorded in the selected stations during the first decade, whereas these occurrences decreased to 506 cases during the second decade. Seasonal scale showed that northern half of the country (Tehran, Kermanshah, Mashhad, Tabriz, & Isfahan) has the most occurrences during spring while southwest stations (Ahvaz & Booshehr) have them during fall. Furthermore, southeast and south stations (Birjand, Zabol, & Bandar-e-Abbas) recorded these occurrences mostly during winter. Precipitation status of these thunderstorms confirmed that group precipitation of (0-5 mm) has maximum frequency while the group precipitation of (5-10 mm) has minimum frequency among the selected stations. Instability scale showed that such thunderstorms with this extensive CAPE (more than 2500) have not been recorded. Moreover, the values of convergence indices TT and KI mark the possibility of convergence occurrence for a majority of the stations. Instability indices of LI and SI also suggest the limited instability of the thunderstorms.

**5. Conclusion and Suggestions**

According to the findings of statistic processes in yearly, monthly, and hourly scales, it is safe to say that the occurrence of this phenomenon does not follow specific rule throughout the country and has various temporal and spatial changes. Seasonal scale showed maximum occurrence during spring (39%) and minimum occurrence during summer (7%). Like seasonal scale, monthly scale similarly suggest the maximum occurrence for April and May and the minimum occurrence for August.

Hourly scale shows the maximum occurrence both at noon and after the maximum sun radiation. However, the minimum occurrence is in the morning at 6:00 which reveals the least amount of energy for the earth surface. Frequency of thunderstorms during 2 decades (1991- 1999 & 2000- 2009) confirmed that except Tehran, the storms of second decade have decreasing process as compared with the storms in the first decade. The calculation of convection potential making the thunderstorms for the samples shows that the values of convective indices (i.e. SI, LI) and instability indices (i.e. SI, LI, CAPE) are moderate or little simultaneous with the occurrence of this phenomenon.

**Key Words**: Convection, Instability indices, Precipitation, RAOB.

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