Variations of 500 hPa flow patterns over Iran and surrounding areas and their relationship with the climate of Iran

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With 11 Figures

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Summary

In order to explore the spatial and temporal variations of 500 hPa flow patterns and their relationship with the climate of Iran, monthly mean geopotential heights for the region 0° E to 70° E and 20° N to 50° N, at 5 degree resolution, were analysed. The study period covered the winter months October to March during the period 1961–90. The monthly height of the 500 hPa level was averaged along each meridian from 25° N to 45° N. The height of the mean monthly pressure pattern was mapped against the study years. The results showed that the characteristics of the 500 hPa flow pattern varied over monthly and annual time scales.

Principal Component Analysis, with S-mode and Varimax rotation, was also used to reduce the gridded data to 5 (6 in October) significant factors. The factor scores for each month were then correlated with monthly Z-scores of precipitation and temperature anomalies over Iran. The results showed that troughs and ridges located close to Iran had more influence on the climate of Iran. Two troughs were identified and named the Caspian and Syrian troughs.

1. Introduction

Westerlies develop three principal troughs in the 500 hPa circulation around the Northern Hemisphere. One is anchored over the Mediterranean Sea (Palmen and Newton, 1969). The spatial orientation and displacement of this trough affects the climate of the Mediterranean area and surrounding regions including Iran (Alijani and Harman, 1985; Jacobite, 1987). Its effect on more distant regions, such as Iran, is mainly through the steering of synoptic systems such as short waves, cyclones, and anticyclones (Alijani, 1979; Steinberger and Yaari, 1996; Zangvil and Druian, 1990; Trigo et al., 1999). Some hemispheric and regional studies have also considered the spatial characteristics of this trough (O’Connor, 1961; Stark, 1965; Klein and Winston, 1958; Harman, 1991).

Most previous studies have been subjective based on manually-drawn charts. However, during recent years, automated studies have become more important. Studying the spatial and temporal characteristics of synoptic systems by automated processes has become routine. Wallace and Gutzler (1981) through a quantitative study of Northern Hemisphere teleconnections proved the existence of the Mediterranean trough, teleconnected with ridges over the eastern Atlantic and Siberia. Movement of synoptic systems has also been the subject of other studies (Blackmon et al., 1984a, 1984b; Fraedrich and Lutz, 1986) which show that lag correlation is a suitable quantitative method to study the movement of synoptic systems.

The effect of the westerly troughs on the climate of Iran has been assessed on several occasions. For example, Alijani (1979) drew cyclone tracks in accordance with the orientation of these
troughs. Others such as Jacobei (1987) and Allesandro, et al. (2000) have used indices such as latitude and longitude or the distance from the trough, to measure precipitation dependence on the trough. Corte-Real et al. (1995) used quantitative approaches to find relationships between 500 hPa flow patterns and surface climatic anomalies in the Mediterranean region.

The main objective of this research is to study the spatial and temporal changes of the 500 hPa flow pattern in relation to the climate of Iran.

2. Data

This study has utilised mean monthly 500 hPa height data for the winter months October to March for the period 1961–90 within the window 20° N to 50° N and 0° E to 70° E at 5° gridded resolution (Fig. 1). These data were kindly provided by the Japanese Meteorological Agency. Monthly precipitation and temperature data for the same period were acquired from the Meteorological Organisation of Iran. Stations with more than 10% missing data were rejected. The selected

![Fig. 1. Map of the study area](image1)

![Fig. 2. Locations of selected surface data stations in Iran](image2)