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The Role of Regional Atmospheric Circulation over the Middle East on the Occurrence of Summer Dust-storms in Southwest Iran

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Extended Abstract

1- Introduction

In middle and lower troposphere, the main control factor of weather and climate over the Middle East is a local to regional scale thermal forcing including forcing from high mountains. In this regard, regional scale atmospheric circulation associated with surface forcing has an important role in the occurrence of summer dust storms over the area. Southwest of Iran experiences a large number of dust storms every year. Many of them occur in warm period when a series of semi-permanent synoptic systems in lower troposphere control weather and climate in regional scale. In spite of large number of works which have been done during two to three last decades, the main governing mechanisms on the occurrence of dust events over the Middle East are not much clear. Therefore, this study aims to clarify how dust storms occur over southwest of Iran during warm period of the year. In this regard, the research tries to answer to the following questions: What are the most important synoptic patterns of dust storms occurrence in southwest of Iran? What are the main sources of dust for each synoptic pattern? and how regional atmospheric circulation can cause and develop the dust storm events over the area?

2- Methodology

In this research, the structure of regional atmospheric circulation is investigated to explain the causes of summertime dust storms occurrence in southwest of Iran as well as their main sources of dust. The hourly visibility data of eight synoptic stations located in the Khuzestan and Ilam provinces is

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used to extract the widespread dust storms. The study focused on 30 widespread storms is identified in a 6-year period (1998-2003). The NCEP/NCAR reanalysis data and also TOMS aerosol index (AAI) were used to clarify the dynamic and synoptic characteristics of each dust storm for a time from 2 days before storm started until the peak time of the dust storm occurrence in a 6-hour time period. Sea level pressure, geopotential height, vertical velocity, and zonal (U) and meridional (V) wind components at different pressure levels were obtained to determine the synoptic patterns of dust storms. The HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) model is employed to determine the main sources of dust by using a backward trajectory approach.

3- Discussion and Conclusion

The results show that the Arabian High and the Zagros trough play the key role in the formation of regional scale dust storms in the Persian Gulf region and southwest of Iran. Investigating the synoptic patterns of the dust storms, three main synoptic patterns are identified including the Coupling, the Westerly trough, and the High-pressure patterns. In this regard, the Coupling pattern is divided into two sub-category called: Summer and Transitional patterns.

In the Coupling pattern, the horizontal wind shear increases in the lower atmosphere due to the intensification and southward expansion of the Turkmenistan anticyclone, which is associated with the enhanced cyclonic circulation of the Zagros trough. The positive feedback of this procedure in return intensifies both the Zagros trough and the Arabian high and forms a low-level jet so-called Shamal wind in the confluence zone of two pressure systems. Shamal wind plays an important role in the occurrence of the summer dust storms in southwest of Iran. In the Westerly trough pattern, there is seen a strong horizontal wind shear along the latitudes which is associated with the eastward flow from Iraq to the southwest of Iran. This strong horizontal wind shear is the result of the expansion and penetration of a mid-tropospheric trough over the western Middle East as well as formation of cyclonic circulation over northern Iraq and the existence of the Arabian high in the southward of it, instantaneously. In the High pressure pattern, an anticyclone locates over southwest of Iran and the dust transports from west by a low pressure which is located over the west of high pressure system into the study area and then subsides over the region by anticyclone.

The HYSPLIT model outputs show that the main sources of dust for southwest of Iran is a region located over the central-northern part of Iraq and western Syria through northern Saudi Arabia. Investigating the particles trajectory in dust storms reveals that a low-level jet exists over this region, which provides the horizontal dust transportation in a shallow layer and prohibits its vertical dispersion into the middle troposphere. Comparing between the three patterns, it reveals that the High-pressure pattern has the smallest amount of dust transportation in a confined region. It is also found

that the particles in Coupling pattern are traveling through a northwest-southeast direction to reach the study region while the particles in Westerly pattern can move far to the east through a favorable flow pattern.

Using AAI index, it shows that the Coupling pattern experiences the most horizontal expansion of dust over the Middle East. This pattern has also the highest concentration of dust over the area.

Key word:

Dust storms, Arabian high, Zagros trough, Shamal wind, HYSPLIT model, Southwest of Iran