

Statistical analyses of the meteorological observation and numerical weather forecasting datasets to understand severe dust events and extreme wind speed in Iran

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論 文 名 :

Title: Statistical analyses of the meteorological observation and numerical weather forecasting datasets to understand severe dust events and extreme wind speed in Iran

(イランにおける強風と砂塵事象を解明するための気象観測データと数値気象解析データの統計解析)

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論 文 内 容 の 要 旨

Thesis Summary

Understanding the fundamental mechanisms of sand and dust transports is crucial for grasping the diverse causes and impacts of dust events in Iran, which occur in various forms such as suspended dust, rising dust, and dust storms. These events exhibit distinct characteristics and frequencies across different regions in the entire regions of Iran. By understanding the frequency of different dust events in various regions, we can quantify the impact of dust events on buildings, transportation, and human beings. In addition, predicting dust storms requires accurate estimation of weather conditions such as wind speed distributions. Improving our understanding of wind dynamics is crucial for refining predictions and mitigating the impacts of dust storms. Therefore, this thesis deals with both meteorological observation and numerical weather forecasting datasets. The meteorological datasets were employed to quantify the present status of the dust events in Iran over last ten years in terms of the occurrence frequency, strength, types, and spatial distributions of the dust events. Accordingly, to clarify the effect of strong wind speeds on the dust events, numerical weather forecasting was employed to predict wind speed distributions throughout a year. By scrutinizing the meteorological datasets and weather forecasting wind distributions, this thesis clarifies the spatial distributions of the dust events and wind speeds in the entire regions of Iran. The summaries of the thesis are as follows:

In Chapter 1, we introduced the research background, declared the research gap and purpose, outlined the thesis structure, and provided fundamental preliminary information essential for this research.

Chapter 2 explores the environmental dynamics of the dry belt region, particularly focusing on the Middle East. It discusses the climatic and anthropogenic parameters influencing sand and dust storms. The chapter highlights Iran's

susceptibility to dust events due to its geographical conditions and examines the impact of dry lake beds on dust generation. Additionally, it discusses predictive modeling of dust storms and their impact on various sectors, emphasizing the importance of proactive measures in mitigating adverse effects.

Chapter 3 explores an extensive examination of sand and dust storms within the geographical context of Iran. The primary objective is to comprehensively analyze the occurrence patterns, spatial distribution, and long-term trends of these atmospheric phenomena. The chapter meticulously examines the frequency and duration of dust events across Iran based on the analysis of long-term meteorological datasets. By categorizing dust events into three main types—suspended dust, rising dust, and dust storms—the chapter clarifies the varying characteristics and prevalence of each category. This categorization aids in understanding the spatial and temporal distribution of dust events, offering insights into the regions most affected and the severity of these events. Furthermore, by uncovering seasonal patterns and trends in the frequency and duration of dust events across different seasons, the chapter explores long-term trends of dust events, utilizing historical data to discern patterns and changes over time.

Chapter 4 provides a comprehensive analysis of the prediction accuracy of wind speeds using both numerical weather forecasting (NWF) and statistical models across various stations in Iran. This chapter describes the methodology employed to investigate wind patterns in Iran. It begins by explaining the study region, providing comprehensive details regarding the implementation of the NWF model. Furthermore, it introduces a statistical model, namely the Gram-Charlier series (GCS) model, aimed at refining the approximation of wind speed probability density functions (PDFs). Moreover, this chapter scrutinizes the relationship between fundamental statistics for both the numerical weather model and observational outputs for estimating extreme wind speeds. Subsequently, the analysis proceeds to compare PDFs at specific stations, thereby accentuating the applicability of the statistical GCS model prediction of extreme wind values using the mentioned model. Thereby, assessing the effectiveness and utility of the GCS model in this context.

Chapter 5 offers concise summaries of the key findings and results from each preceding chapter, accompanied by insights into potential future research directions for further exploration and development.