Haboob Impacting Air Traffic Operations: Case Study of Khartoum International Airport

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Introduction

Haboob episodes frequency increased during the recent years and affected the air traffic operations significantly during summer. Consequently, the number of flight cancellations and delays raised. This can be attributed to the current location of the airport as it is adjacent to the source area of Haboob, namely El Butana region. Haboob affects the entire state, which includes both the operational and the new airport. Thus, the air traffic operations in the new airport (Not operated yet) will be susceptible to the Haboob effect. The down draught from the Cumulonimbus (CB) clouds is the main trigger of Haboob associated with dry air beneath and loose soil. Therefore, an early warning system should be in place. A new location of alternative airport can be in the southeastern parts of the state.

Case Study Location

Khartoum state lies between latitudes 31.5° to 34° N and longitudes 15° to 15.5° E. It is surrounded by the Blue Nile State in the north-east, the north-west by the Northern State, to the east and southeast by the state of Kassala, Gedaref and Gireida, and in the west by North Kordofan. Location of meteorological station at Khartoum International Airport is 15.60° N and 32.55° E. Its runway located North to South with about 3km long.

Results

Meteorological data from Sudan Meteorological Authority (SMAA) is used to illustrate the Haboob episode on 1st June 2017. This included hourly maximum temperature, relative humidity, horizontal visibility, dew point, clouds and rainfall on hourly bases for the 1st of June 2017. NOAA-HYSPLIT online model is used to construct the forward and backward trajectories, both ensemble and frequency trajectory types were generated. Global Data Assimilation System (GDAS) model output with 0.5-degree resolution is used. R statistical package software is used to produce the graphs.

Discussion

Like the temperature, dew point also fluctuated considerably. Although rainfall preceded the Haboob was light, but it succeeded to improve the visibility at the airport for more than 10 km. Four photos for the Haboob showed its progress. Massive amount of the dust is lifted for more than 1km and transformed westward with strong wind speed exceeded 25 Kts. The northward advancement of Inter-Tropical Convergence Zone (ITCZ) from the east during June allows the development of CB clouds at afternoons. In the absence of moist air beneath the clouds and presence of high air temperature, downdrafts leak place and Haboob occurred if the conditions were appropriate. Forward trajectories and their frequency that produced by NOAA-HYSPLIT online model revealed the relation between Haboob source and the receptor. All the trajectory sourced from El Butana and passed across the airport. The trajectories started from 500m and reached 4km at the deposition area. It is obvious that the main source of the Haboob is El Butana area, which is adjacent to the residential areas where the airport is located. From the plume graph it is clear that the wind direction is perpendicular to the runway. Thus, it increased the risk of landing and takeoff. Analysis of the historical airborne issued and wind shear observed from January 2005 through July 2017 showed high frequency and high probability density around 20 and 5, respectively. The sorted cases of airborne occur and wind shears are rising. The more occurrence of the Haboob since January 2015 showed significant increase during the recent years. Although, the coefficient of determination (R2 = 0.11) is small, but it reflected the increase of Haboob occurrence which possesses adverse impact on the future of air traffic operation at Khartoum International airport. The frequent occurrence of Haboob can be attributed to the anthropogenic effects.

Future Directions

- Dynamical simulation of Haboob using high resolution data for better understanding and set up a prediction model
- Investigation of the source-receptor relationship and identification of the effective distance between them

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References


https://www.noaa.gov/HYSPLIT_traj.php

Four photos show Haboob progress at Khartoum International Airport on Thursday, 1st of June 2017. Photos taken from the video recorded by Mr. Abdelrahman Semeen (Operating weather Forecaster)