



## Numerical Study of the Flow Fields in Downburst with Consideration of the Rough Condition on the Ground

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### Abstract

The downburst is an extreme weather condition whose resulting load will affect the stability of the building structures. The characteristic of downbursts is required during the design of buildings. In order to achieve the characteristics of the downbursts, large eddy simulation (LES) is adopted. The method impinging jet is used to reproduce the downbursts, meanwhile smooth and rough ground conditions are examined. The setting of the rough layer of the ground is done by using the immersion boundary method (IBM). After the simulation, the wind field is decomposed into the mean component and the turbulence component. In this paper, the radial wind speed profile and the wind speed time diagram of the simulation experiment are compared with the previous measured data and the simulation results. This paper reveals that the radial wind speed is the key part of the downburst wind speed, and it rapidly increases with height. It is also found that the rough ground will cause the peak radial velocity to move up, which is consistent with the change of the main annular vorticity in vortex cloud image analysis. Finally, the turbulence intensity is found to be relatively small at the position where the radial wind speed is relatively large.

Keywords: Downburst; LES; Wind Field; Numerical Simulation.

### 1. Introduction

The definition of downburst was first proposed by Fujita [1] that in a thunderstorm, a very destructive strong wind will be formed by the divergence of the air from the impact center to the circumferential direction along the surface after the rapid descent of the airflow and impact on the ground. The formation of downburst is closely related to thunderstorm weather. Its source is also one of the manifestations of the sudden release of unstable energy in the atmosphere, but it is not the same as the common wind phenomenon. The downburst is a great threat to the takeoff and landing of all kinds of aircrafts in the field of aerospace. And it is also one of the important factors of thunderstorm wind load in the field of designing building structures. Its impact on human production and life in many areas has gradually become a hot issue of research.

Tornadoes and downburst are extreme weather events in thunderstorms. The former is well-known because of the horrible phenomena and great destructiveness. However, the power of the latter one also cannot be neglected. Many disasters caused by it are not uncommon at home and abroad. Hawers [2] et al. selected and analyzed 94 transmission towers damage cases in Australia. It was found that 90 percent of the damages were caused by downbursts and tornadoes and other extreme weather phenomena. In 1996, a downburst occurred during a thunderstorm in Ontario, Canada. This led to the collapse of 19 transmission towers and the economic losses amounted to more than 1000 million dollars. Due

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