ABSTRACT

Severe thunderstorms are important weather phenomena which impact on various facets of national activity like civil and defense operation, particularly aviation, space vehicle launching and agriculture in addition to its damage potential to life and properties. One of the most important events in the thunderstorms is the "Downburst". Downbursts occur when a column of descending air reaches the ground and bursts out violently. This downward motion abruptly changes direction and produces a peak wind speed close to the ground. A synoptic, or atmospheric boundary layer (ABL) wind however does not reach its maximum wind speed until much higher above the earth's surface. It is believed that downburst is generated when the moist buoyant air moving upward can no longer be sustained above and subsides into downdraft. Downbursts can be wet (accompanying rain) or dry and are further classified as either microburst or macroburst depending on their horizontal extent of damage. In India severe thunderstorms over the Gangetic West Bengal and Assam, known as "Kalbaishakhi" and "Bordoisila" respectively are very much destructive. In this work an attempt has been made to simulate the dry downburst wind physically and numerically. Impinging jet model of the downburst is used for both the physical and numerical simulations. Two CFD codes are developed for the numerical simulation based on the vorticity-stream function approach and vorticity-vector potential approach using a Large Eddy Simulation (LES) technique. The primary objectives of the present work are to investigate the flow dynamics of the downburst wind due to the variation of the cloud height, Reynolds number, jet rotation and surface roughness. The numerical results are compared with the experimental results obtained from the physical microburst simulator and also with the available full scale data. Very good agreement is observed.

Key Words/Phrases: Wind engineering, Thunderstorm downburst, Dry microburst, LES, Macro-flow dynamics, Physical simulation, Impinging jet model, swirling jet, Stream function-vorticity approach, Vorticity-vector potential approach.