

The Influence of Wind Shear, Downdraft and Turbulence
on Aircraft Performance

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Abstract

Wind shear, downdraft and atmospheric turbulence are essential meteorological phenomena which influence the flight performance of an aircraft. Especially in take-off and landing approach this effects may crucially restrict flight safety.

After a short description of the meteorological weather situations most closely associated with variable wind, typical aircraft responses on short scale gusts or turbulence and on large scale variations of the mean wind are discussed.

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1. Introduction

Strong wind shear and downdraft can be of considerable danger to aircraft especially during take-off and landing approach. A number of accidents caused or influenced by variable wind initiated world wide research activities in the area of hazard investigations, wind modeling and the analysis of aircraft flight in variable wind fields.

An important consideration in this investigations is the characterization and simulation of typical wind shear phenomena. The main influences on the shape and structure of wind profiles in the atmospheric boundary layer are surface roughness, stability of the atmosphere and orographic characteristics. This parameters also influence the strength of turbulence in edition to the mean wind speed. In general the turbulent wind profiles are seperated into a large-scale trend and turbulent fluctuations of the wind speed (Fig.1). In some cases gusts are considered as a third category of atmospheric disturbances, witch can be attached to to the turbulent portion or, like in Fig.2, to the variable mean wind.

The aircraft response on large-scale wind shear is quite different. compared with the response on turbulence. While the variation of the mean wind influences the energy state of the aircraft are short-scale gusts and atmospheric turbulence effecting the acceleration terms of the aircraft, i.e. airloads, structural fatigue, passenger and crew comfort and handling qualities.