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Aviation hazards associated with convectively-induced gravity wave breaking above deep convection: Some influences of environmental flow conditions

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Deep moist convection generates turbulence in the clear-air above and around the cloud. It is recognized that a major source of this turbulence is due to the breaking of convectively-induced gravity waves that are generated as the cloud penetrates the tropopause, and propagate upward into the stratosphere. This convectively-induced turbulence (or CIT) is an important aviation hazard since attempted thunderstorm avoidance by overflying the cloud tops may in fact increase the chances of a turbulence encounter. Improved understanding of the conditions that lead to above cloud turbulence formation may result in better turbulence avoidance guidelines and forecasting capabilities. Results are presented from a series of high-resolution two- and three-dimensional cloud model simulations of a severe thunderstorm to examine the sensitivity of above-cloud turbulence to a variety of background flow conditions, in particular the above-cloud wind shear and stability. It is shown that in the mature stage, gravity wave breaking aloft is the dominate turbulence generation mechanism, and is usually caused by critical level interactions, where the height of the critical level is controlled by the above-cloud wind shear. The strength of the above-cloud wind shear has a strong influence on the occurrence and intensity of above-cloud turbulence, with intermediate shears generating more extensive regions of turbulence, and strong shear conditions producing the most intense turbulence. Also, as expected, more stable situations are less prone to turbulence than less stable situations.