

Analysis of the occurrence time of downbursts and the overall situation.

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Downburst is a meteorological phenomenon in which a strong downdraft generated in a cumulonimbus cloud hits the ground [1]. The three main strengthening factors of downburst are listed below: the first is the cooling effect of the atmosphere due to the latent heat associated with the evaporation of raindrops. As the lower layer of the atmosphere dries out, the height of the cloud base increases, and raindrops are more likely to evaporate when they pass below the cloud base height. As a result, the surrounding atmosphere is cooled, and the downdraft is enhanced. When the lower layer of the atmosphere is humid, precipitation particles are difficult to evaporate, and precipitation particles are carried downward into the atmosphere, forming a downward flow. The third effect is to strengthen the flow of relatively dry winds in the middle atmosphere from the side and merge with the downward flow inside cumulonimbus clouds. These are phenomena that occur when atmospheric conditions are unstable or during the formation and development process of cumulonimbus clouds [1]. In this study, we analyzed the occurrence time and environmental field of downburst in Japan by focusing on the stability of the atmosphere.

We examined the time at which downburst occurred for 195 cases (from 1991 to 2024) in which the phenomenon is distinguished as "downburst" from the database of gusty winds such as tornadoes published by the Japan Meteorological Agency [2]. It was shown that the number of confirmed occurrences of downburst was high in the late afternoon (from 14:00 to 18:59) during the warm season (from June to August), and a similar trend was reported by Muramatsu et al. (2012) [3].

Next, based on the surface weather map [4] from 2002 to 2024, we identified the environmental field, which is the cause of atmospheric instability on the day of downburst generation.

As a result of classifying the frequency of occurrence of accompany meteorological phenomena at the time of downburst occurrence by time of day (from 00:00 to 13:59, from 14:00 to 18:59, from 19:00 to 23:59), stagnant fronts were the most common cause of occurrence, accounting for about 33% (60 cases) of the total number of confirmed occurrences in downburst. In addition, the occurrence of the downburst by Pacific High and typhoon was concentrated from 14:00 to 18:59.

Convective available potential energy (CAPE), which is one of the indicators for estimating atmospheric stability, was calculated for 8 cases in which downburst occurred within 2 hours after radiosonde observations which are conducted twice a day (9:00 and 21:00 JST). The atmosphere was unstable just before the formation of the downburst.

In this study, we extracted downbursts in Japan and analyzed the number of confirmed occurrences by time zone, environmental field, and atmospheric stability. As a result, it was found that downburst occurs frequently in the afternoon of from June to August, and they are often caused by stagnant fronts. It was quantitatively shown that the atmospheric condition immediately before the formation of downburst was unstable. In the future, we will conduct an analysis with the aim of clarifying the factors that cause downburst in the afternoon.

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