CHARACTERISTICS OF MICROBURST IN RECENT YEARS AT INCHEON INTERNATIONAL AIRPORT

Jae Won Lee, KMA, Incheon, Korea, Republic of (South);
S. K. KIM, K. Y. BYEN, and J. KIM

1. Introduction

Wind shear and microburst (MBST) is a micro-scale meteorological phenomenon which refers to changes in wind direction and/or speed over a short distance. It can normally occur due to strong temperature inversion or atmospheric density gradients (FAA, 2008). In particular, low-level wind shear has contributed to a significant number of aviation accidents and has given rise to more than 400 deaths in the United States and 1,400 deaths worldwide from 1973 to 1985 (NCAR, 2017).

Incheon International Airport (ICN, RKSI, N37°27'45'', E126°26'21'', elevation 7m) is a maritime airport constructed on a man-made island in 2001. It operates 24-hour unlike the other inland international airports in South Korea. The paper studied the characteristics of occurrence of microburst near ICN. We focused on the Terminal Doppler Weather Radar (TDWR) radial velocity to classify the types of microburst and tried to contribute to the safety of ICN by suggesting a risk-matrix to minimize the damage in the occurrence of microburst.

2. Dataset and method of research for MBST

In ICN, Aeronautical Meteorological Personnel (AMP) is using mostly two ways to observe wind-shear and microburst. One is TDWR(C-band) and the other is Low Level Wind-shear Alert System (LLWAS, altitude around 30meters). If air-traffic controllers or pilots report regarding wind shear to AMP, AMP makes a database about the reports.

In this paper we researched microburst occurrence from 2009 to 2017 and conducted a complete enumeration. For the risk-matrix, we used the TDWR radial velocity images for the analysis.

3. Analysis

3-1. Wind shear Monthly and Seasonal characteristics for recent 3-years

At ICN during December 2015 - November 2018, the frequency of wind shear occurred once in every 22-29 hourly-interval in winter (Dec-Jan-Feb), while an average of 50-100 hour-interval in summer (Jun-Jul-Aug). The incidence of wind shear alarm at ICN occurred relatively in the afternoon. The effect of convection on the solar activity and the phase change of the sea breeze due to the location of the airport on the coast should also be considered. In the autumn of 2016, the period of particularly showing different characteristics showed a high incidence from evening to dawning.

3-2. Microburst Monthly and Seasonal characteristics (2009-2017)

The number of MBST occurrences is increasing year by year. After 2014, MBST observed more than 10 signals/year. In 2018, MBST occurred more than 19 times, which is the highest number in occurrence. In seasonal analyze, MBST normally occurs in summer (32 times).

3-3. Classification according to radial velocity type (radar image characteristic point of view)

Classification by radial velocity can be divided into 4 types:

(1) Low-level jet type: The low-level jet type observed in summer season when the low-level jet-stream analyses near 850hPa. Also, this shape signifies the strong wind around the streak so in the radial velocity image, we could see the velocity folding. The frequency of velocity folding increased just before wind shear occurred. The strongest 10-minute average wind speed recoded mostly higher than 20KT. Wind direction recoded as SE 2 hours before MBST and as SW 1 hour before MBST. It also means low-level jet shape frequently accompany the warm front.

(2) The convergence-divergence type: It is a form where both convergence and divergence appear around the TDWR in autumn season. There was no clear and visible pattern in this type, so the observer should monitor the radial velocity image and LLWAS in real time.

(3) S-type: The S-type does not appear frequently, but when it does, wind shear and MBST were observed with a high probability. If the Zero Isotach

shape makes a clear ‘S’, the higher possibility the microburst occur. S-shape is more likely to occur at atmospheric veering. In this case, wind direction is changed SW into W.

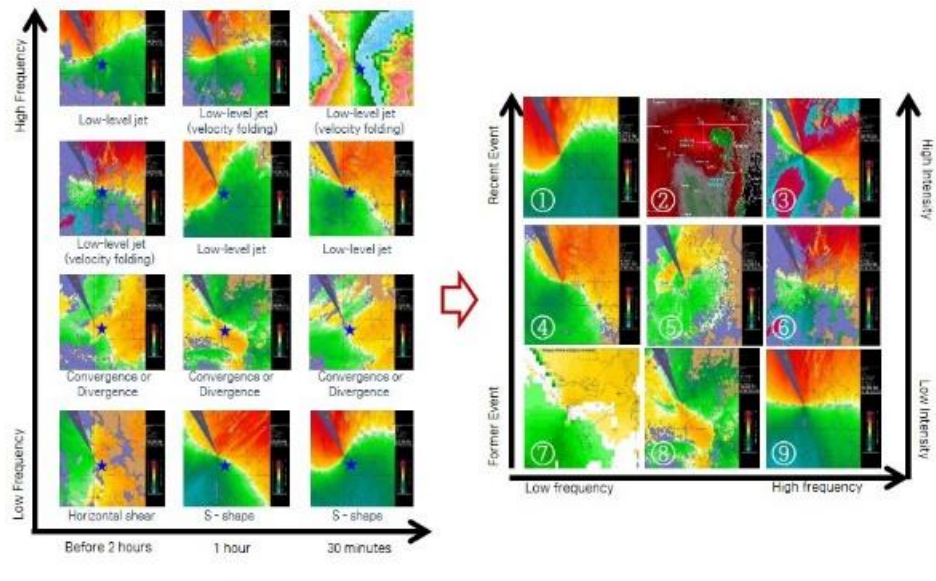
(4) The horizontal-shear type: This type is similar to the low-lever jet type, however, this type never observed in ICN site. The main difference between the low-lever jet type and the horizontal-shear type is the Zero Isotach which is not observed at the low-level jet type, and in this type usually wind speed is not very strong.

3-4 Conduction of risk matrix and the improved risk matrix

In this study we tried to categorize the radial velocity images in the x-axis by time period, 2-hour, 1-hour, and 30-minute before MBST. In the y-axis, we put the types and conducted a proto-type risk matrix (Figure 1-(A)). Verification for the first risk matrix was accomplished using dataset during January-May 2018. In this period MBST observed 12 times, however, 9 of 12 cases were not rain, so radial velocity images were not clear to analyze. In order to improve this problem, a new risk matrix suggested with 3-axises, X, Y and Z. X-axis is frequency of the MBST, Y-axis is observed time and Z-axis is developmental intensity of MBST (Figure 1-(B)). In this risk matrix, ① and ③ are low-level jet type, which has a higher probability of MBST in 1hour, ④ and ⑥ need to monitor to improve to ① and ③. ②, ⑤ and ⑧ recommended monitor the divergence area is mainly observed near TDWR. ⑨ can be developed to ⑥ and ③ so it needs to monitor in real time. ⑦ is not closely linked to MBST.

4. Application to operational now-casting for aviation

In Aviation Meteorological Office (AMO), from June to October 2018, forecasters applied the final risk matrix when the wind shear and MBST observed. The one concern is, TDWR cannot process the radial velocity clearly on no-rain day, so forecasters have difficulties to use the risk-matrix. If it rains, forecasters could detect MBST at least 20 minutes before observation in TDWR and LLWAS. If it is not, however, there were not clear signals on the radial velocity images. When the forecasters decide to warn wind shear and microburst, it is very important to notice even before several minutes these phenomena occur. In this reason, this study to upgrade the risk-matrix should be continued.



(A) (B)

Figure 1. Microburst Risk Matrix with radial velocity patterns: (A) Prototype(dataset during 2009~2017), (B) Improved microburst risk matrix included 2018 data set (② : made by Dr. Kevin Kloesel in University of Oklahoma, 2013 KMA Guest Lecture).