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Design and preliminary test of a X-band polarimetric radar for gust detection system for safe railway operation

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On Japan railroads, wind conditions affect operating efficiency, infrastructure, and safe passage of people and freight. Strong and gusty winds cause regional delays or shutdowns, and particularly hazardous crosswinds may lead to overturn of railcars. Therefore, cup anemometers densely cover along the railroads for operations through some thresholds of wind speed (e.g., winds in excess of 25 m s-1 or 30 m s-1). However, small-scale localized but strong gusty winds such as tornadoes, downbursts, and gustfronts are difficult to detect with the present system.
To detect those hazardous wind phenomena, Doppler radars that observe wind movement in a large area can be used. The East Japan Railway Company installed a X-band Doppler radar on the rooftop of the building of the Amarume Station (Yamagata Pref., Japan), located in the regions along the side of the Sea of Japan where strong gusty wind associated with severe storms occur frequently in winter season. The observation has been conducted since March 2007 to develop a gust detection method using the radar data, and the applicability of that to train operation decisions has been assessed. In the studies using the radar, most of the observed severe storms were found to generate over the Sea of Japan and landed the coast. Time and space resolution of Doppler radars is an important requirement for the good performance of gust detections.
Based on those results, the East Japan Railway Company installed a new X-band polarimetric radar at a location closer to the coast than the Amarume Station, to improve the accuracy of detecting gusts. The radar has a 60-km observation range. Its antenna is 1.2 m in diameter, resulting in a beamwidth of 1.2 deg. It has high sampling resolutions in azimuthal and range direction (0.7 deg. and 75 m). Since it is aimed to predict ground-level wind gusts successfully, the radar is operated in a PPI mode with 4 rpm at a low-elevation angle to provide Doppler velocity fields as close to the ground as possible. In this presentation, we will introduce the characteristics of the new X-band polarimetric radar and an example of observations.