THE DESIGN AND INITIAL TESTING OF AN X-BAND DOPPLER RADAR FOR MONITORING HAZARDOUS WINDS FOR RAILROAD SYSTEM

P13A.15

Wataru Kato 1), Hiroto Suzuki 1), Makoto Shimamura 1),
Kenichi Kusunoki 2), and Taiichi Hayashi 3)

1. Introduction

On Japanese railroads, wind conditions affect operating efficiency, infrastructure, and safe passage of people and freight. For instance, strong winds cause regional delays or shutdowns, and especially hazardous crosswinds may lead to overturn of railcars. However sonic/cup anemometers densely cover on the railroads for operations through some wind speed thresholds (e.g., winds in excess of 25 or 30 ms^{-1}), localized but hazardous wind phenomena are difficult to detect with the present system.

In Japan, along the Sea of Japan side, severe storms occur frequently especially in winter season. The use of Doppler radar data for these storms, and associated hazardous wind phenomena such as tornadoes, downbursts, and gusty winds, is an important requirement. In order to assess the utility of Doppler radar for use in operational railroad systems, the East Japan Railway Company installed a X-band Doppler radar on the rooftop of the building of the Amarume Station (Yamagata Pref., Japan, Fig.1). In this presentation, we will introduce some key characteristics of this radar and an example of observations.

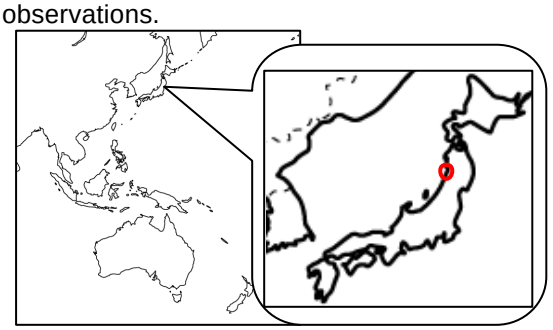

Fig.1 Observation along The Sea of Japan

1) East Japan Railway Company, Research and Development Center of JR East Group, Disaster Prevention Research Laboratory, Saitama, JAPAN, w-katou@jreast.co.jp
2) Meteorological Research Institute
3) Kyoto University

2 About this radar

2.1 Observation Range

This X-band Doppler radar is on the rooftop of the building of the Amarume Station. It has a 30-km observation range, the height of the center of the antenna is about 8 meters from surface. From here, we can observe all over the Sho-nai plain (Fig.2, 3).

It is operated in a PPI mode and we began this observation in 4° elevation to observe phenomenon at the bottom of thunder cloud in winter above the Sea of Japan.

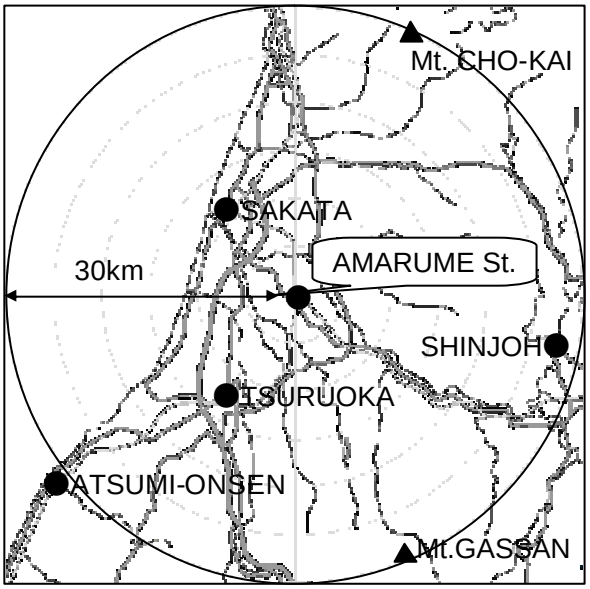

Fig.2 Range of Observation from The Amarume Station

Fig.3 The Radar on The Station

2.2 System

2.2.1 Spec

This radar's main spec is as follows.

Diameter of Antenna	1.2m (Fig.4)
Rotation Speed	2rpm（PPI Only）
Elevation	Fixed in 0-90° (Variable with manual)
Frequency	X-band（9770MHz）
Output	Max 40kW
Pulse Width	0.5μsec
Range of Observation	30km
Distance Resolution	Min 30m
Azimuth Resolution	0.7°
Beam Width	2.0°
Processing Item	Mean Velocity, Speed dispersion
Observable Max Speed	±27m/s （Dual PRF 1200/900Hz）
Power Source	single-phase AC100V
Capacity	Under 2.0kVA
Weight	Under 300kg

Fig.4 180° Parabola Antenna

2.2.2 Remote Control and Observation with Network

This radar site in Amarume is unmanned, we are observing and controlling from remote offices at Niigata and Oomiya via network (Fig.5). This network system is constituted with 40Mbps ADSL, fixed IP service and Storage server on Web.

Because observed raw data are large size, we cannot get them through this network. They are deposited in a storage device in Amarume. But a network server in Amarume uploads processed PNG type picture files to a Storage Server on Web, we can watch observed real time and past data as pictures from offices.

We can also watch working statuses of this radar and control (Turn On/Off of Power and Start/Stop of Observation) from offices (Fig.6). If some abnormality happens to it, observation automatically stops, and a notice e-mail is sent to registered e-mail addresses.

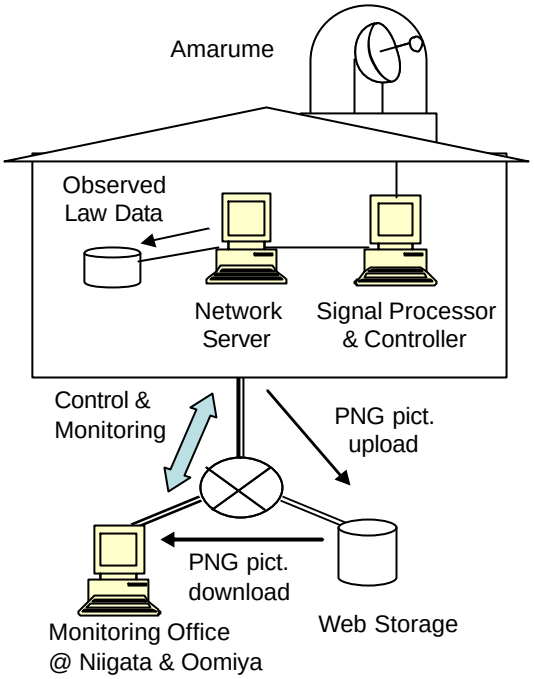

Fig.5 Network for remote Observation

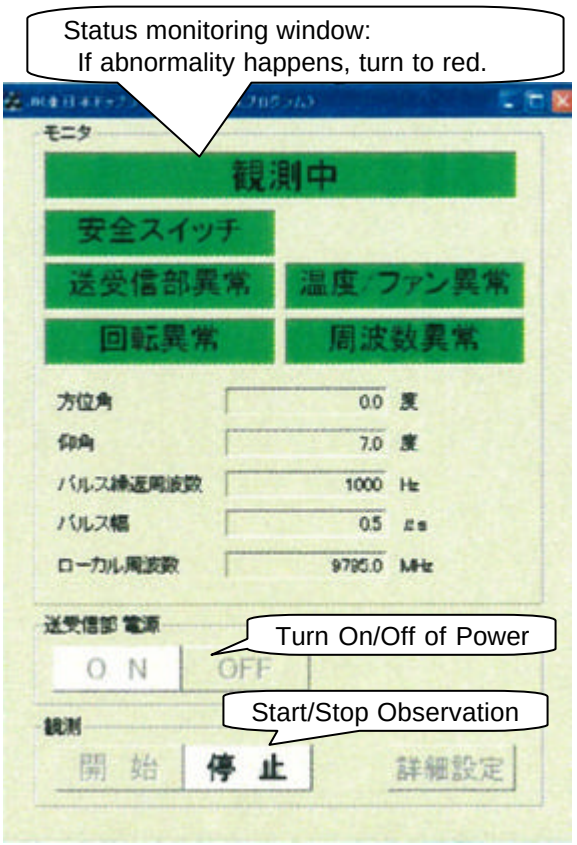

Fig.6 Status Monitoring & Control Window at Remote Office

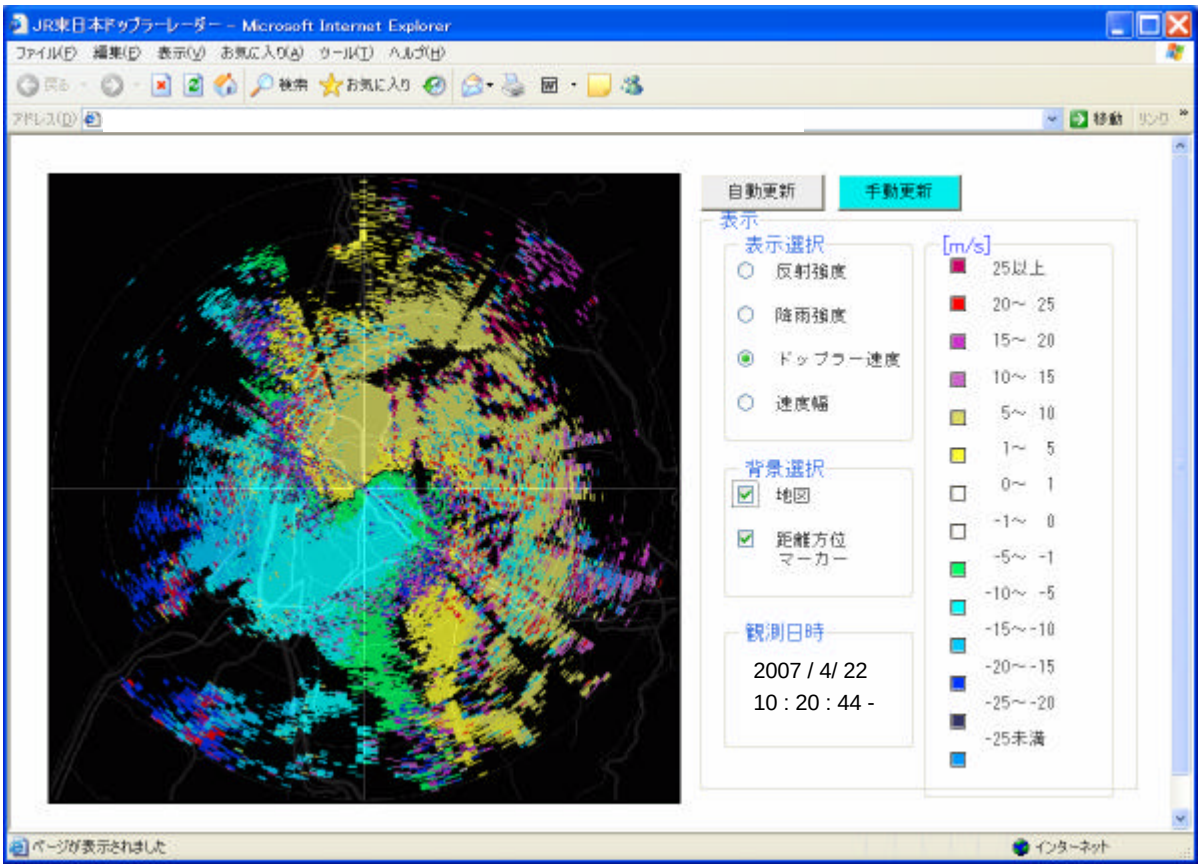

Fig.7 Example of Observed Picture (22nd April 2007 10:20:44)

3. Example of Observation Case

We started this observation at March 1st 2007. One example of past observation is above (Fig.7). In this case, a low pressure with stationary front passed near the site (Fig.8). Although precise analysis is not done yet, we will begin analyzing some weather disturbances in near future.

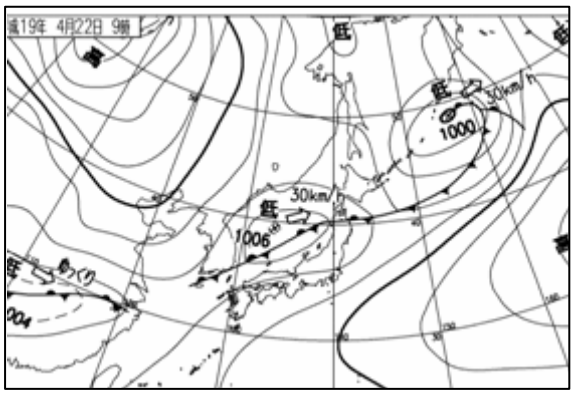

Fig.8 Weather Chart of 22nd April 2007 9:00 JST (Japan Meteorological Agency)

4. Purpose of Future

Except of some scheduled stops or happening case, 24 hours continuous observation is carried on. But no analysis begin yet, we are now discussing about collaboration with some research organizations.

Through example analyses, we want to examine a judgment standard to catch hazardous wind phenomena such as tornadoes, downbursts, and gusty wind, and assess a possibility of application of a Doppler radar to a railroad operation control.

In addition, we are going to carry on this observation in this summer to assess that possibility against not only winter weather phenomena, but also local heavy rains in rainy season and summer.