Proc. NIPR Symp. Upper Atmos. Phys., 1, 84–87, 1988

NEUTRAL WIND OBSERVATIONS BY 50 MHz METEOR RADAR AT SYOWA STATION

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Abstract: By using a meteor radar, neutral winds were observed at Syowa Station. The observed neutral wind velocities show noticeable diurnal and semi-diurnal variations. However, the scatter of the data is greater than the amplitudes of these variations. A plausible role of gravity wave in causing this scatter is suggested from a comparison of the meteor winds with the sodium column abundance observed by a laser radar.

1. Introduction

Neutral atmospheric winds at meteor heights were observed at Syowa Station during two years 1984 and 1985, by measuring the doppler frequencies of meteor echoes. The radar system used is a 50 MHz pulsed doppler radar with two antenna beams, one toward magnetic south (GMS beam) and the other toward geographic south (GGS beam). The antenna beams are almost omnidirectional in vertical direction. In the polar region, radar echoes are generated not only by meteors but also by auroras. Therefore it is desirable to eliminate aurora echoes from the data for the detecting neutral winds by meteor observation. A nonlinear least squares method with four parameters is used to determine the decay rate of meteor echoes and the noise level of signals after the disappearance of meteor echoes. The noise level thus determined is useful for the elimination of aurora echoes. Through the processing of observed echo data in this way, altitudes and velocities are calculated for each meteor signal from its decay rate and doppler frequency, respectively. Further statistical analyses were carried out using these data together with the horizontal range data of the echoes.

2. Results and Observations

Figure 1 shows a diurnal scatter plot of observed wind velocities measured by the GMS and GGS antennas for January, 1985. The altitude range of the data in Fig. 1 is limited between 85 and 95 km. It can be observed from Fig. 1 that the wind velocities show diurnal variations, although they exhibit large scatter. At the upper part of Fig. 1, mean wind velocities calculated for every one hour interval are shown by the solid line. This mean wind velocity shows diurnal and semi-diurnal components with a non-zero diurnal mean value. However, the amplitudes of these components are smaller than the scatter in the observed velocities.

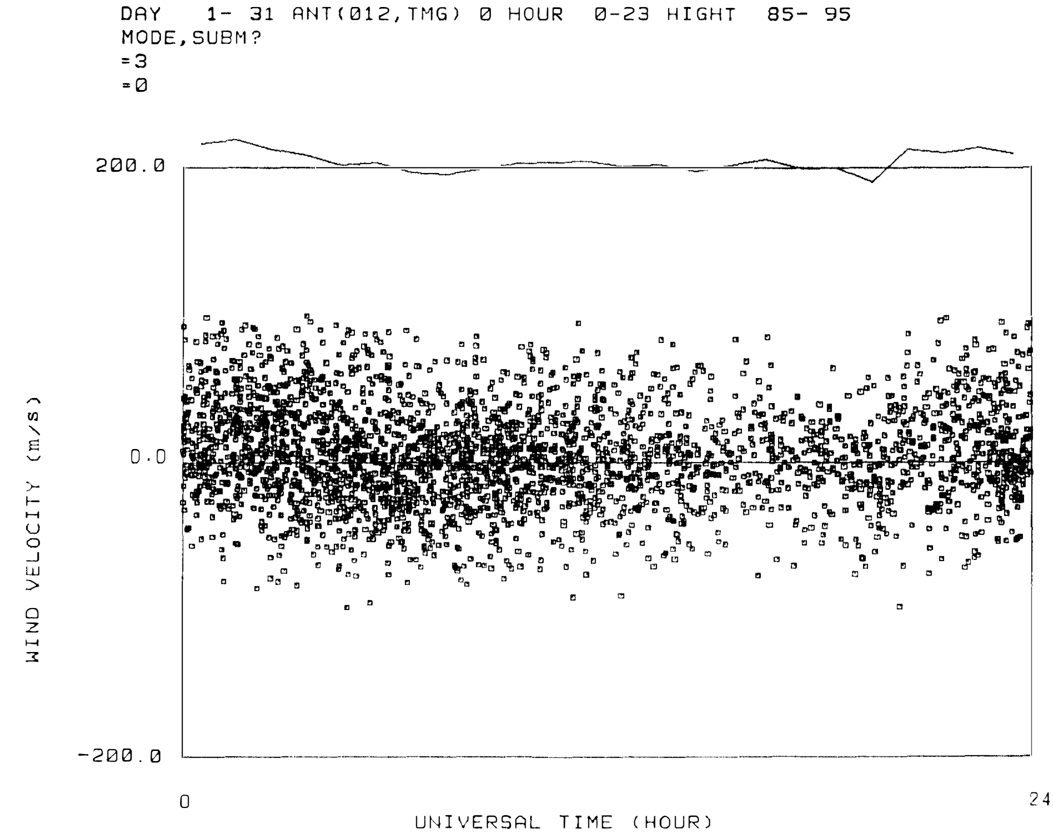

Fig. 1. A diurnal scatter plot of meteor wind velocities.

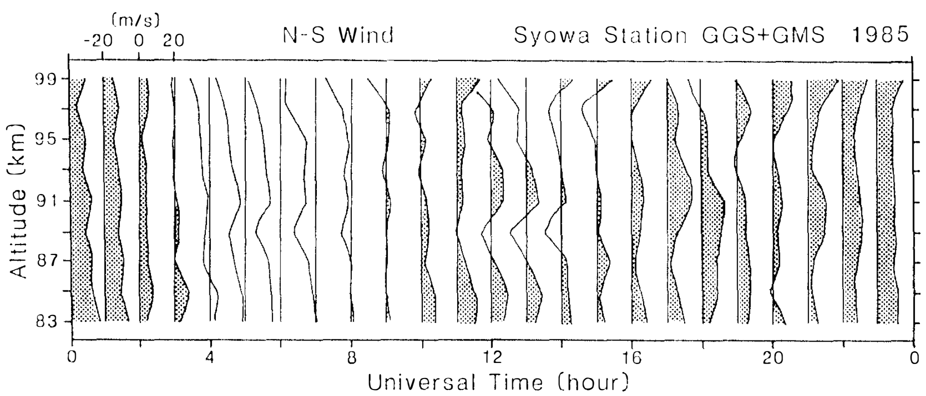

Fig. 2. Altitude-universal time distributions of hourly mean wind velocities.

In Fig. 2, the altitude-universal time distribution of the hourly mean wind velocities is shown for 1985. These velocities roughly correspond to the north-south component of the neutral wind. Local time advances universal time by three hours at Syowa Station. In the evening hours, the altitude profiles of the observed winds show complicated shear structures, while they exhibit monotonic variations during other local times. This tendency is well reflected in the diurnal variation of hourly mean winds shown in Fig. 1, namely the hourly mean wind velocities between 85 and 95 km show irregular variations during evening hours.

As shown in Figs. 1 and 2, the dispersion of the wind velocities is much larger than the amplitudes of the diurnal and seimi-diurnal components or the diurnal mean wind. At the altitudes of meteor observations, the global wind system is strongly controlled by the vertical divergence of gravity wave momentum flux (JAKOBS *et al.*, 1986). Therefore, there is a possibility that a part of wind dispersion shown in Fig. 1 is due to waves or turbulent conditions created by wave breaking. Plausible evidence is shown in Fig. 3 for wave effects on the wind dispersion. In Fig. 3, the results are shown for simultaneous observations of winds by the meteor radar and sodium column abundance by the laser radar. In the bottom diagram of Fig. 3, the variation of the sodium column abundance is shown during the night of May 28–29, 1985. Wave-like fluctuations are observed with a period of about three hours. In the top diagram of Fig. 3, the raw N–S wind velocities observed by the meteor radar during the same time interval are shown by dots. As in Fig. 1, the individual wind velocities show large scattering. In the second diagram of Fig. 3, the wind data are shown after restricting the horizontal meteor range to the region between 110 and 225 km. This restriction is assigned in order to avoid ambiguities due to the horizontal wavelength of gravity waves. In the third diagram, the meteor altitude is also restricted to the height between 85 and 95 km because similar ambiguities can arise from the

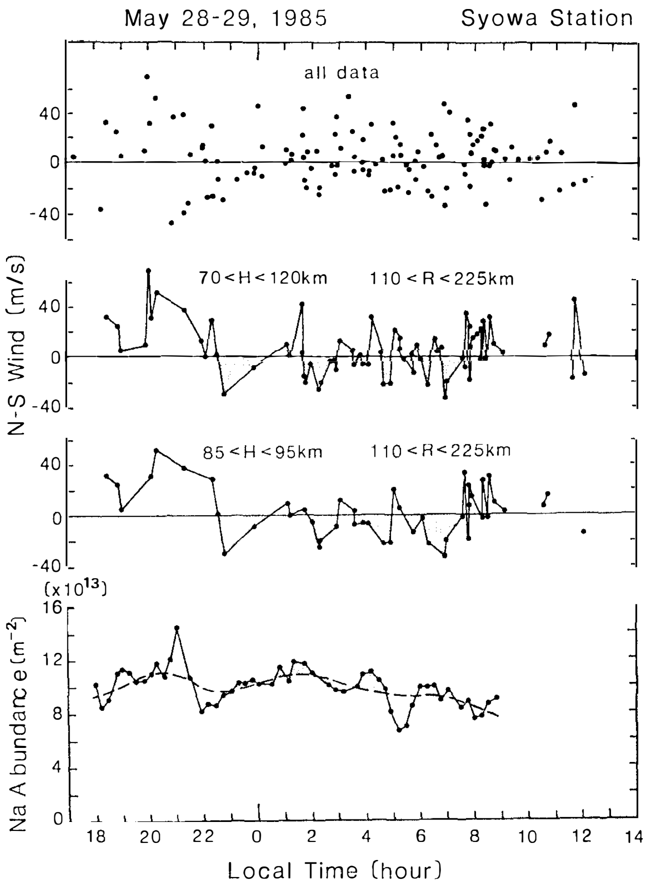

Fig. 3. Simultaneous results for winds by meteor radar and sodium column abundances by laser radar.

vertical wavelength. The final results for the wind velocities in the third diagram exhibit fluctuations similar to those seen in the variation of sodium column abundance. The variations of the two data sets show a tendency of anti-correlation.

Transport effects due to gravity waves connected with chemical effects may be responsible for the variation of the sodium column abundance, although a detailed mechanism is not clear yet. From the data obtained in 1985, similar cases are observed several times, including cases of positive correlations between them. These observations show a plausible role of gravity waves for the scatter in the meteor wind measurements.

3. Conclusion

A plausible role of gravity waves as a cause of the scatter in meteor wind measurements was shown from the analyses of simultaneous observations of meteor radar and laser radar at Syowa Station. It is also shown that meteor winds show noticeable diurnal variations.

Reference

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(Received May 13, 1987; Revised manuscript received August 27, 1987)