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Turbulence Characteristics Revealed by MU radar-RASS

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We try to apply Brunt-Vaisala frequency from MU-radar RASS experiment to estimate the turbulent energy dissipation rate in two methods: the spectral width and the echo power method.

Though turbulence energy dissipation rate from both methods have roughly the same order, turbulence energy dissipation rate from the echo power significantly fluctuates, but that from the spectral width does not.

We trust the spectral width method, considering the condition was ideal for spectral width method. Then the echo power method does not show the actual variation. This result strongly suggests that the main factor to determine echo intensities is structures of temperature and moisture.

Turbulence energy dissipation rate is a fundamental parameter to describe the effects of atmospheric turbulence. Since 1980's Doppler radars have been applied to remote-sensing of turbulence, estimating energy dissipation rate from the Doppler spectrum of turbulence echoes Two methods have been proposed to estimate turbulence energy dissipation rate with Doppler radars. One method uses the width of Doppler spectrum as a measure of the turbulence intensity.

In both methods, we need Brunt-Vaisala frequency, which is determined by the vertical structure of atmospheric temperature. In conventional studies, temperature profiles by radiosonde are employed for derivation of Brunt-Vaisala frequency, assuming Brunt-Vaisala frequency does not fluctuate drastically during the interval of balloon launch (3--6 hr).

We have applied the RASS technique to the MU radar to continuously monitor temperature profiles in the troposphere and even in the lower statrosphere with good time and height resolutions. We try to apply Brunt-Vaisala frequency from MU-radar RASS experiment to estimate the turbulent energy dissipation rate.

We use the data-set of the MU radar-RASS campaign during 2--6 on August. During this campaign, we launched a total of 17 radiosondes every 6 hours every day, and obtained profiles of temperature, pressure and humidity in parallel to the MU radar-RASS observation. In this period a horizontal wind was fairly small, since the jet stream was very weak. This result indicates a calm meteorological condition.

First we compared the observed spectral width, the three broadening effects and the corrected spectral width in this campaign. In the most case three broadening effects is small. Then, the corrected spectral width is close to the observed spectral width. We derive turbulence energy dissipation rate from the spectral width, using Brunt-Vaisala frequency from RASS measurements. General structure of turbulence energy dissipation rate by the spectral width method is mainly determined by the observed spectral width, not by Brunt-Vaisala frequency. Some rapid changes of Brunt-Vaisala frequency can be modify turbulence energy dissipation rate slightly.

Next we derive turbulence energy dissipation rate from echo power method. We use Brunt-Vaisala frequency from temperature profiles by RASS, the refractive index gradient from the temperature with RASS and humidity with a radiosonde.

Though turbulence energy dissipation rate from both methods have roughly the same order, turbulence energy dissipation rate from the echo power significantly fluctuates, but that from the spectral width does not.

The derivation method of turbulence energy dissipation rate from the spectral width is the most common method to observe turbulence energy dissipation rate by a Doppler radar, and extensively studied. Moreover, in this campaign, the background meteorological condition is calm and it seems to be an ideal condition for the estimation. So we can trust the spectral width method. Then the echo power method does not show the actual variation of turbulence energy dissipation rate. This result strongly suggests that the main factor to determine echo intensities is structures of temperature and moisture.