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下部対流圏レーダーで観測された大気境界層の平均像と季節変動について
Averaged images and seasonal variation of atmospheric boundary layer observed by Lower Troposphere Radar

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The atmospheric boundary layer (ABL) is defined as an atmospheric layer in which the turbulence flow generated by the effects of friction of the ground dominates. ABL is one of the most important atmospheric layers that has direct influence on our life, and has the different feature in each region by topographic effects. Therefore, it is very important to measure the atmospheric motion of ABL in each region, however, the atmospheric motion of ABL has not been fully investigated because of its immense complexity.

One of powerful tools for exploring ABL is Lower Troposphere Radar (LTR) developed by Kyoto University. LTR radiates the pulse-modulated radio wave with the center frequency of 1.35GHz and can detect the turbulence with spatial scale of about 10 cm. Based on the information of echo power and Doppler shift of received signal, we can know the turbulence structure constant and back ground 3 dimensions wind velocity from a few hundred meters to about 10 km in altitude, respectively. In addition, the spectral width of received signals gives us the information of intensity of vorticity. The range resolution which is decided by the pulse width of radio wave is a few hundred meters and the temporal resolution is a few minutes. There is no other observing tool which can realize so highly resolved observation of ABL.

We analyzed LTR data obtained at Shigaraki MU observatory in Japan from 2000 to 2006. In order to investigate the averaged images of ABL under clear air condition, the daily average of wind velocity, echo power and spectral width were calculated by using the data obtained in the case of clear sky. As the results, it is clarified that the altitude of top of ABL reaches 1 km in winter and more than 2 km in the condition of summer. In daytime, the obtained averaged images show the turbulence structure constant is strongest at around the top of ABL and a region where large spectral width is observed exists under the region where the strong turbulence structure constant is observed. In addition, we found that the downward flow with the velocity of a few 10 cm/s grew up and was maintained in daytime ABL. This downward flow was observed in all seasons, however, seemed to be strongest in summer. Moreover, we also found that upward flow was almost always observed after ABL dissipated at sunset.

In order to explore the relationship between the information obtained by LTR and physical state of atmosphere, we compared the LTR data with radiosonde data which was obtained at Shigaraki MU observatory. As the results, it was shown that there are a lot of cases showing the altitude dependency of turbulence structure constant agrees roughly with that of mixing ratio. In the result obtained at about 11:45 (JST) on August 15 in 2001, the turbulence structure constant and mixing ratio had peaks at around the top of ABL (~2km), in addition, the potential temperature became high locally at this altitude. The downward and upward flows seemed to be generated at the altitude, which implies the downward flow observed in daytime ABL is generated by condensation of water vapor.

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