Surface layer model for instantaneous wind speeds designed by deep learning

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parameterizations consider the Monin-Obukhov similarity law for diagnosing momentum transports between the lowest atmosphere and ground. This law was found in the relations between temporally averaged (typically periods of 10 minutes) wind speeds and momentum fluxes. We have suggested that it is inappropriate to apply the law for the parameterization in large eddy simulations in which turbulence fluctuation is involved in resolved wind speed at each grid point. However, we do not know a good alternative to the law.

In this study, we perform a preliminary attempt to apply the deep learning technique for the parameterization. Results of wind tunnel experiments are used for the date to be learned: the relationship between wind speeds and momentums fluxes in a short time scale (1 second, typically) was obtained in the condition with steady external winds and neutral stratification over ten hours.

Nine-tenth of the wind tunnel data for three kinds of different external wind speeds was inputted to the routine of the TensorFlow library. Then the validation is performed by the left of the data. The result shows that diagnoses of the momentum fluxes through the trained network show far better performances than those of the misused Monin-Obukhov law.

If the wind speed is inputted in training, the network overfits the other wind speed that has not been used for the training. It would be better to consider normalize wind speeds for the training to apply a wide range of wind speeds.

Keywords: Surface layer, Deep learning, Surface flux, Monin-Obkuhov law, Law-of-the-wall

