REPLY

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It is true that the airplane observations quoted by Panofsky *et al.* (1977) do not fit the hypothetical curves as well as do the tower data. In fact, the curves were fitted originally to the tower data only. The airplane observations were added later to show that they did not differ 'significantly' from the curves.

There is a question to what extent the airplane observations were made in the surface layer. We would define the surface layer as the lowest 10% of the planetary boundary layer, rather than as a layer of fixed depth. Under neutral conditions, u_*, the friction velocity, decreases by only about 12% in such a surface layer, and more slowly in a convective layer. Thus only one of the aircraft observations used definitely fell outside of the surface layer; yet this point does not depart significantly from the line.

The difference between the behaviour of σ_u and σ_w can be explained as follows: the planetary boundary layer contains eddies of all sizes, with the larger containing most of the energy. But close to the ground, air trajectories due to the 'large' eddies are nearly horizontal, and therefore contribute significantly to the fluctuations of the horizontal, *but not of the vertical*, wind components.

Thus Kaimal's spectra of wind speeds (1978) show that low frequencies scale with the height of the lowest inversion (z_i), and only the high frequencies (with little energy) follow Monin–Obukhov scaling. Thus the reason why σ/u_* for the horizontal velocity components scales with z_i/L is that the fraction of variance scaling with z/L is so small.

In contrast, the spectra of vertical components contain very little energy in the large eddies. Probably, the very lowest frequencies of the vertical velocity spectrum should indeed scale with z_i/L; but since these contain such a small fraction of the total energy, for practical purposes σ_w/u_* scales as z/L.

References

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