Variation of boundary-layer wind spectra with height

This study revisits the height dependence of the wind speed power spectrum from the synoptic scale to the spectral gap. Measurements from cup anemometers and sonics at heights of 15 m to 244 m are used. The measurements are from one land site, one coastal land-based site and three offshore sites in the mid-latitudes. There are two new findings. The first finding addresses the diurnal peak in the power spectrum. Our analysis suggests that there are two sources that contribute to the diurnal peak. One is related to surface-driven processes and another one is related to pressure perturbation from the atmospheric tide. The second finding regards the height dependence of the general spectrum. We describe the dependence through a so-called effective roughness, which is calculated from wind spectra and represents the energy removal at different frequencies, and thus surface conditions in the footprint areas. The generalizable spectral properties of winds presented herein may prove useful for validating numerical models.