GEO2310 Meteorology — Exercise 03.04.24
Planetary Boundary Layer, Part 2

1 Surface Energy Balance

(a) Write down the radiation balance and draw an idealized (clear-sky) diurnal cycle. Which factors affect the radiative fluxes (and in which way)?

(b) Write down the surface energy balance and draw an idealized diurnal cycle. Which factors affect the fluxes? What role does the surface type play?

(c) The surface energy balance is in principle a simplified framework. Can you think about what are possible (theoretical) simplifications and which terms may miss in the idealized equation from task b?

(d) The standard way to measure turbulent fluxes is the eddy-covariance method. How are sensible and latent heat flux calculated from eddy-covariance measurements?

(e) At stations without eddy-covariance systems (most of the stations), sensible and latent heat flux can be approximated with a bulk formula. How does the bulk formula for the two fluxes look like?

2 Vertical Structure of the Atmospheric Boundary Layer

(a) Draw vertical profiles of temperature, potential temperature, specific humidity and wind speed for idealized daytime and nighttime conditions. What are the main differences?

(b) The figure shows the diurnal evolution of the atmospheric boundary layer. Explain the characteristics of these layers. Where do we have positive/negative vertical motion? Where would you expect high horizontal wind speeds?

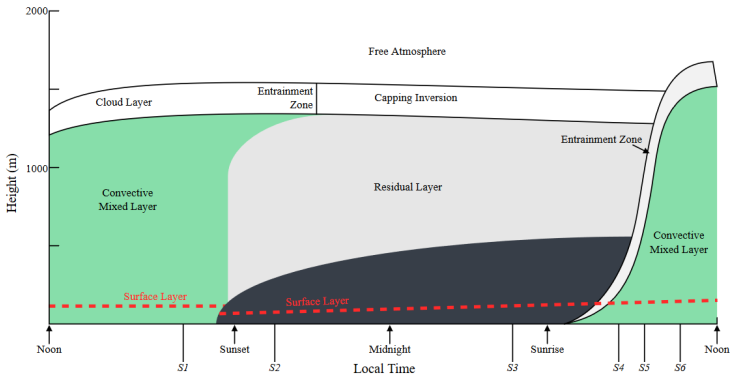

Figure 1: Diurnal cycle of vertical structure of the ABL, source: https://www.weatherhawks.com/.

(c) What are large-scale influence factors on the evolution and characteristics of the boundary layer?

(d) The surface layer is often described using Monin-Obukhov similarity theory (MOST). Explain the idea, assumptions and conclusions of MOST.