Mixing Diagrams

- References:

- Principle:
  o Boundary layer evolution, including entrainment rates at the top of the PBL, can be diagnosed from surface flux measurements and the evolution of near-surface temperature and humidity, assuming a well-mixed boundary layer using sub-diurnal data spanning the daylight hours.
  o Change in PBL moisture or heat content during the day is estimated by:

\[ \Delta q_{\text{PBL}} = \frac{LH}{\rho_{\text{PBL}}} \frac{H_{\text{PBL}}}{\Delta t} - \frac{SH}{\rho_{\text{PBL}}} \frac{H_{\text{PBL}}}{\Delta t}, \]

- Lateral advection:

\[ -\lambda_{\text{V}} \int_{\text{PBL}} \mathbf{V} \cdot \nabla q \, \Delta t - c_p \int_{\text{PBL}} \mathbf{V} \cdot \nabla \theta \, \Delta t, \]

- Entrainment (estimated as residual of terms above)

- Data needs:
  o Need near surface met from around/after sunrise and between peak PBL depth and PBL collapse at sunset.
  o Need mean surface fluxes during the period.
  o Need mean PBL depth during the period.

- Observational data sources:
  o Biggest constraint is surface flux measurements and estimates of PBL depth (LCL-based estimates are not very accurate).
  o ARM/CART, field campaigns, can conflate FLUXNET with nearest radiosondes.

- Caveats:
  o Advection can be tricky.
  o 2-meter \( T \) and \( q \) used as an approximation for the PBL mean of these quantities (assumes perfect mixing) and can exacerbate estimates of the residual vector as a result.

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