Heated Condensation Framework

- References:
  - Tawfik, A. B., and P. A. Dirmeyer, 2014: A process-based framework for quantifying the atmospheric preconditioning of surface triggered convection. *Geophys. Res. Lett.*, **41**, 173-178, doi: 10.1002/2013GL057984.
  - Tawfik, A. B., P. A. Dirmeyer, and J. A. Santanello, 2015: The heated condensation framework. Part I: Description and Southern Great Plains case study. *J. Hydrometeor.*, **16**, 1929–1945, doi: 10.1175/JHM-D-14-0117.1.
- Principle:
  - The potential for convection as well as the potential for the land surface via fluxes of heat and moisture to act as a control on the initiation of convection are diagnosed for a given day from morning soundings. They can be monitored throughout the day. There are both threshold and evaluation variables.
    - Threshold variables
      - Buoyant condensation level (BCL): level at which the atmosphere heated from below and well mixed q throughout the constant θ depth reaches saturation.
      - Buoyant mixing potential temperature θ_{BM}: potential temperature at which BCL is reached.
    - Evaluation variables
      - Temperature deficit (θ_{Def}) and specific humidity deficit (q_{Def}) – amount by which well-mixed boundary layer needs to increase in temperature or humidity to reach LCL – multiplication by c_p and λ_v respectively give a comparison of which can trigger clouds and convection with less energy input.
    - Intermediately, as surface temperature is increased, the added heat mixes dry adiabatically up to intersect the temperature profile at the potential mixed level (PML). Humidity is mixed uniformly through the same depth resulting in an average value q_{mix}; this is repeated until the humidity deficit $q_{def} = q_{sat} - q_{mix} \rightarrow 0$.
- Data needs:
  - Requires relatively detailed vertical profiles of T and T_d (or q), as threshold variables are found by incremental increasing of surface temperature and vertical averaging of humidity.
  - Can also specify an evaporative fraction (EF) and increment both temperature and humidity consistent with the proportions of surface heat fluxes in EF.
  - Can be compared to surface heat fluxes to determine whether clouds are likely to be triggered, and how (as with mixing diagrams, advection can be confounding, especially with station data).
- Observational data sources:
  - Ideally suited to radiosondes – best with daytime soundings.
- Caveats:
  - Determines whether location is in surface heat vs moisture flux advantage – compare to the dry vs wet soil advantage of Findell. This can vary as the PML changes (cf. Tawfik et al. 2015).
  - Can generate unrealistic humidity gradients at top of BCL – underestimates entrainment rates at top of boundary layer.

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