[Coupling metrics to diagnose land-atmosphere interactions]

LCL Deficit

- References:
  - Santanello, J. A., C. D. Peters-Lidard, and S. V. Kumar, 2011: Diagnosing the sensitivity of local land-atmosphere coupling via the soil moisture-boundary layer interaction. *J. Hydrometeor.*, **12**, 766-786, doi: 10.1175/JHM-D-10-05014.1.

- Principle:
  - Difference between lifting condensation level $LCL = (T_{2m} - D_{2m})/(\Gamma - \Gamma_{\mathrm{Dew}})$, and height of the planetary boundary layer (PBLH). It represents the shortfall of a growing boundary layer to reach the level where clouds can form, due to lack of buoyancy from insufficient heating and/or insufficient moisture content. It quantifies as a continuously varying metric that leads up to a threshold occurrence – cloud formation. Can be calculated in meters or millibars, where zero or negative deficit means the PBL penetrated the LCL.

- Data needs:
  - Hourly data is preferable so that the diurnal cycle can be assessed along with timing of necessary support for cloud formation.
  - LCL estimates can be made solely with near surface temperature and humidity data. PBL height is often a diagnostic output of models or can be calculated from vertical profiles of wind speed and temperature (or virtual temperature if moist contributions to critical Richardson number thresholds are considered), or from lidar based on aerosol gradients.

- Observational data sources:
  - Can be calculated from radiosonde profiles or aircraft profiles (AMDAR).

- Caveats:
  - Based in parcel theory, LCL inherently presumes the existence of a perfectly mixed boundary layer whose state is represented by near surface temperature and dew point, or alternately that surface parcels do not mix with the environment as they ascend. Actual cloud base rarely corresponds to LCL, especially early in the morning. This metric works better later as the day goes on.

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