Relative humidity tendency

- References:
  - Ek, M. B., and A. A. M. Holtslag, 2004: Influence of soil moisture on boundary layer cloud development. *J. Hydrometeor.*, **5**, 86-99.
  - Gentine, P., A. A. M. Holtslag, F. D'Andrea and M. Ek, 2013: Surface and atmospheric controls on the onset of moist convection over land. *J. Hydrometeor.*, **14**, 1443-1461, doi: 10.1175/JHM-D-12-0137.1.
- Principle:
  - Rate of change of relative humidity at the top of a growing boundary layer determines time to cloud formation, and depends on properties of the boundary layer itself, the free atmosphere and the surface (namely EF and "non-evaporative terms"). From an initial RH, the tendency can be integrated to determine if/when clouds will form.
  - Critical EF above which the PBL will moisten instead of dry: $EF_C = \frac{1+2\omega}{1+2\omega+B_{inv}} < 1$, where $B_{inv} = -c_P\Gamma_\theta / \lambda_V\Gamma_q$ is the inverse Bowen ratio at the top of the boundary layer, and ω is an entrainment ratio between PBL top and surface ≅0.2 (is this just α-1?).
  - Increasing specific humidity will not lead to cloud if RH_{PBLH} is not increasing. Dry vs. wet soil advantage regime transitions occur when dRH_{PBLH} /dET=0, but this cannot be solved analytically as RH_{PBLH} is highly non-linear in ET. In Gentine et al. (2013) it is solved numerically.
- Data needs:
  - A full set of surface and profile data are needed including surface fluxes to calculate analytically. There should be a way to approximate the relationships in Fig 5 (and other figures of Gentine et al. 2013) with simple functions of EF and Γ_θ, B_{inv}, etc., that best fit the curves.
- Observational data sources:
  - Profiles and fluxes together.
- Caveats:
  - Comes with many built-in assumptions, lack of easy analytical solutions – a full shakedown with model output might uncover holes.

Supported by NASA/MAP Grant: NNX13AQ21G