



## 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, doi: [10.1175/1525-7541\(2004\)005%3C0086:IOSMOB%3E2.0.CO;2](https://doi.org/10.1175/1525-7541(2004)005%3C0086:IOSMOB%3E2.0.CO;2).
- 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](https://doi.org/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:  $EF_C = \frac{1 + 2W}{1 + 2W + B_{inv}} < 1$ , where  $B_{inv} = -c_p G_q / \omega G_q$  is the inverse Bowen ratio at the top of the boundary layer, and  $\omega$  is an entrainment ratio between PBL top and surface  $\cong 0.2$  (is this simply the Priestley-Taylor coefficient  $\alpha - 1$ ?).
- 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) this 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  $B_{inv}$ , etc., that best fit the curves.

### • Observational data sources:

- Profiles and fluxes together at the same location(s).

### • Caveats:

- Comes with many built-in assumptions (see references). There is a lack of easy analytical solutions – a full shakedown with model output might uncover problems.