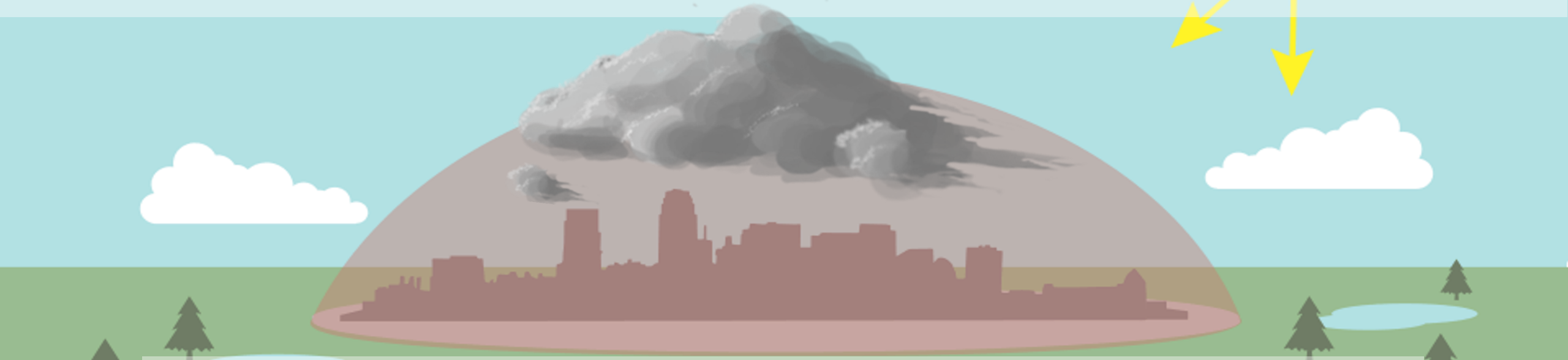
EGU General Assembly 2022

UCL

Land and atmospheric conditions regulating urban heat and dry islands and their impact on convective cloud formation



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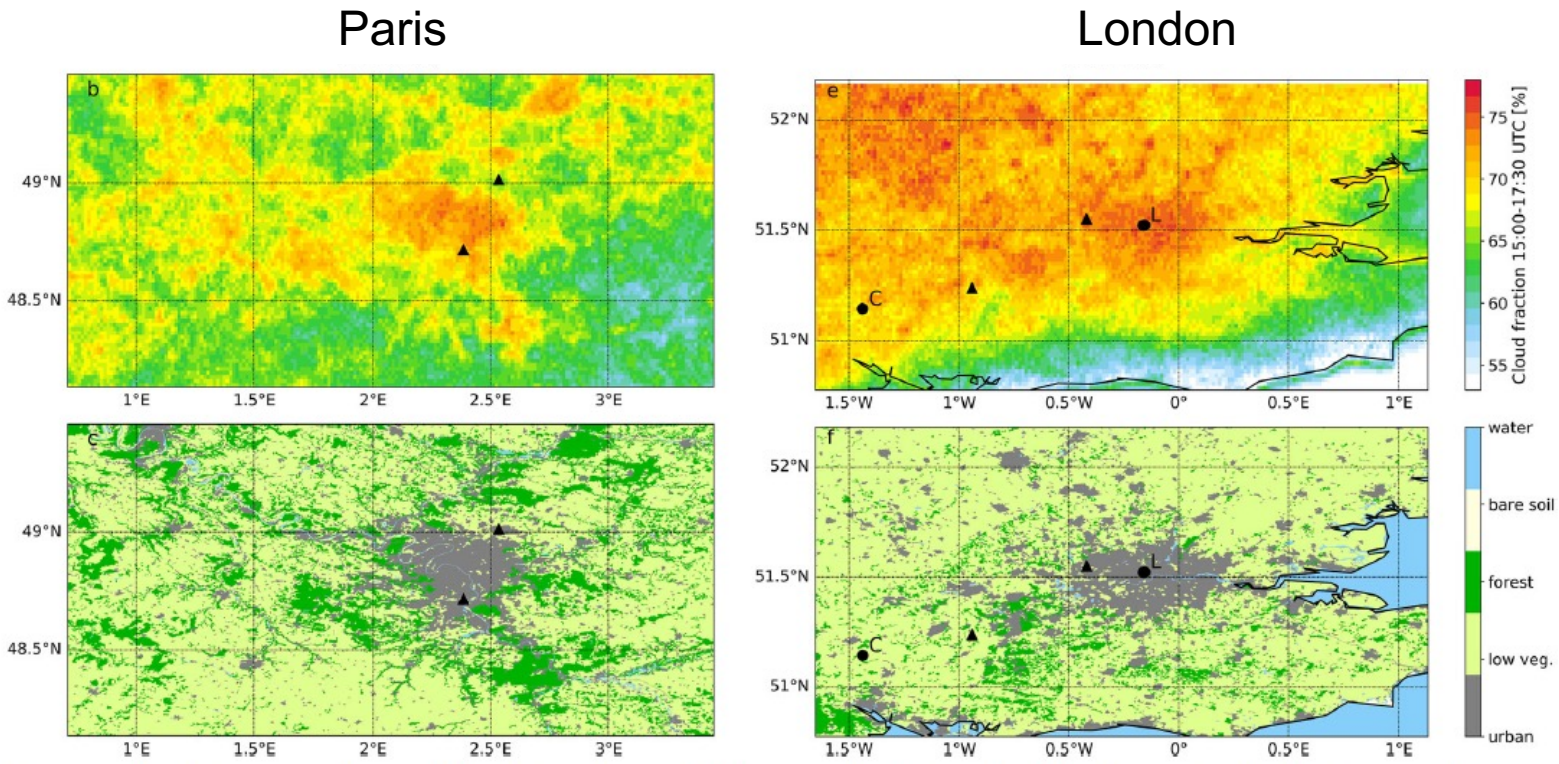
This presentation participates in OSPP

EGU

Outstanding Student & PhD candidate Presentation contest

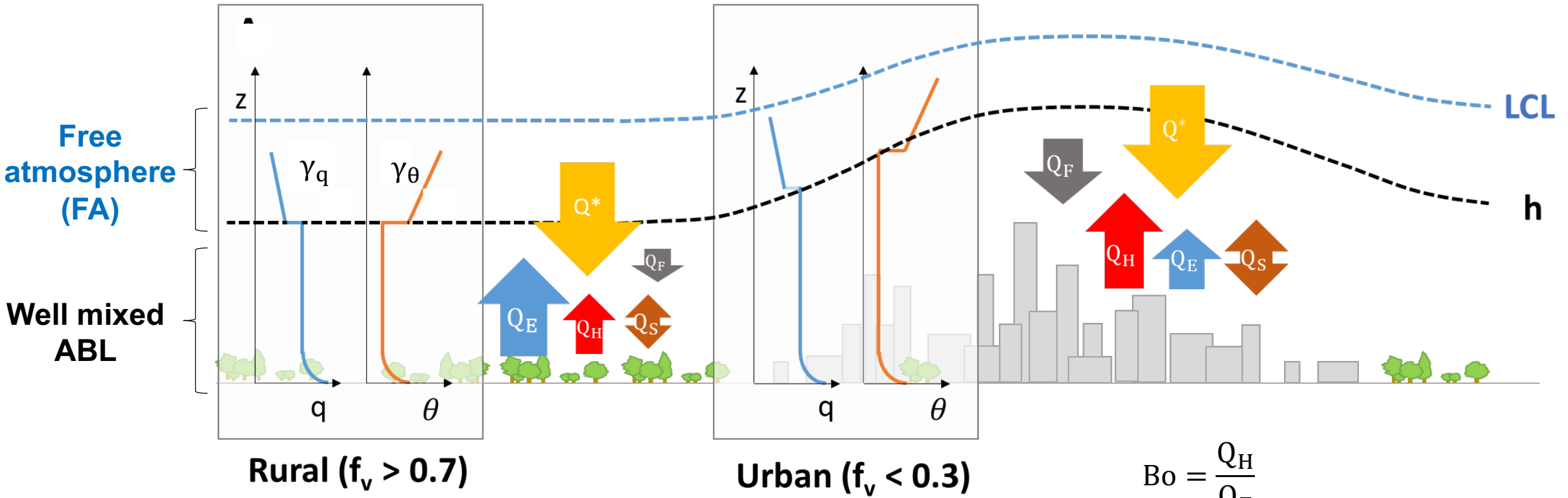
Cities create their own clouds?

- **Hypothesis:** Despite **drying**, **urban warming** enhances **convective cloud formation** over cities, potentially intensifying convective storm
- **Objective:** Understand how urban surfaces and atmospheric conditions impact urban warming, drying, and cloud formation using a mechanistic model



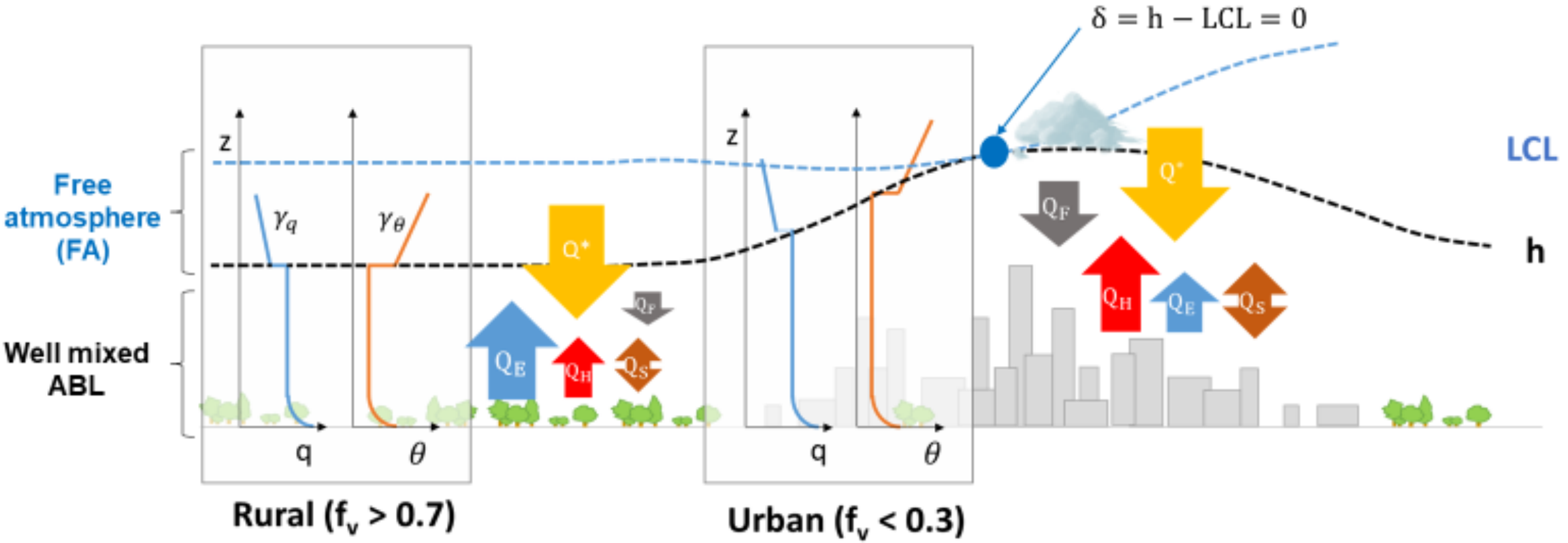
Afternoon mean cloud fraction in Paris(b) and London(e), land cover in Paris (c) and London (f) (Theeuwes et al., 2019)

Conceptual Model



$$Bo = \frac{Q_H}{Q_E}$$

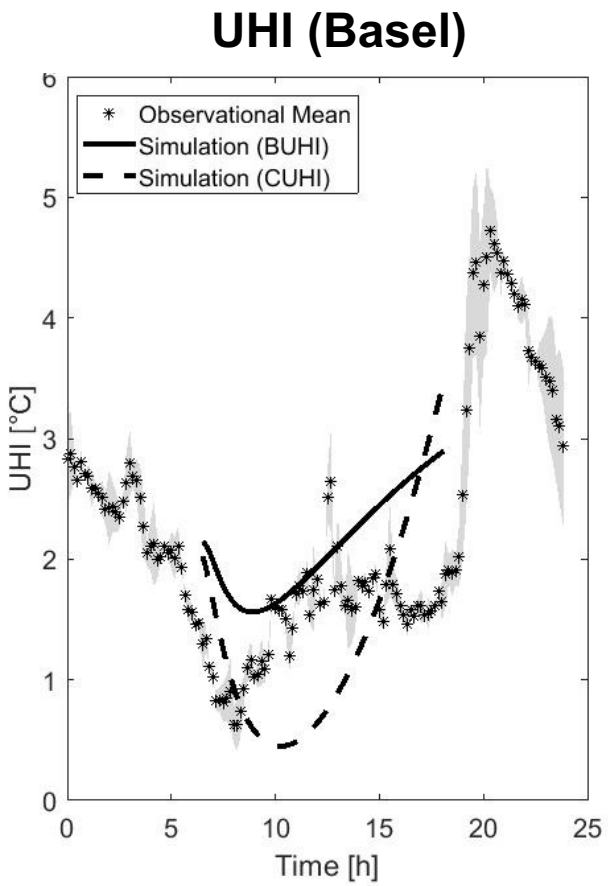
Conceptual model

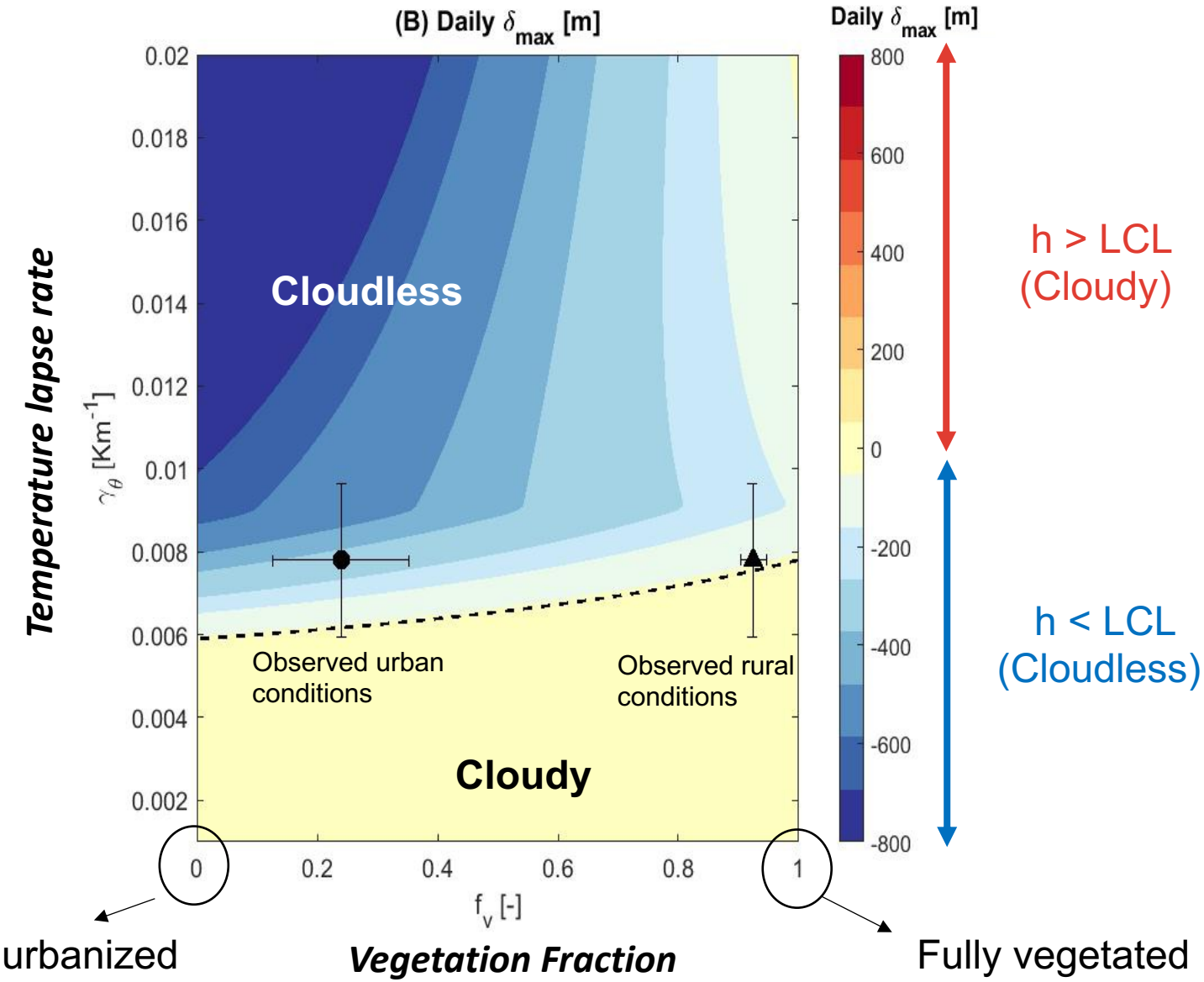


Governing Equations

	Governing Equations	Analytical Solutions
Surface Energy Balance:	$Q^* + Q_F = Q_H + Q_E + \Delta Q_S + \Delta Q_A$	/
ABL height, *h*:	$\frac{dh}{dt} = \frac{(1+2\beta)Q_H}{\rho c_p \gamma_\theta h}$	$h(t) = \frac{1}{t_0}\left[h_0^2 t_0^2 + \frac{2(1+2\beta)Bo \cdot t(Q_m t(A_1-1)(t-3t_0) + 3A_2 Q_m (t-2t_0) + 3Q_F t_0^2 - 3t_0^2(Q_F - A_3))}{3\rho c_p \gamma_\theta (Bo+1)}\right]^{\frac{1}{2}}$
ABL temperature, θ:	$\rho c_p h \frac{d\theta}{dt} = \mathrm{Q}_H + \rho c_p(\theta_f - \theta)\frac{dh}{dt}$	$\theta(t) = \gamma_\theta \frac{1+\beta}{1+2\beta} h(t) + \theta_{f0}$
ABL humidity, *q*:	$\rho h \frac{dq}{dt} = \frac{\mathrm{Q_E}}{\lambda} + \rho\,(q_f - q)\frac{dh}{dt}$	$q(t) = \gamma_q' h(t) + q_{f0}$
LCL height:	$LCL = \frac{R \cdot \theta}{g M_a} \cdot \ln[\frac{P_s}{P_{LCL}}]$	$LCL(t) = \frac{R \cdot \theta(t)}{g M_a} \cdot \ln[\frac{P_s}{P_{LCL}(t)}]$

Result


UHI (Basel)
Observational Mean
Simulation (BUHI)
Simulation (CUHI)
UHI [°C]
Time [h]


(B) Daily δ_{max} [m]
Daily δ_{max} [m]
Temperature lapse rate
γ_θ [Km^{-1}]
Cloudless
Cloudy
Observed urban conditions
Observed rural conditions
f_v [-]
Vegetation Fraction
Fully urbanized
Fully vegetated
h > LCL (Cloudy)
h < LCL (Cloudless)

Thank you for your attention!

Question?