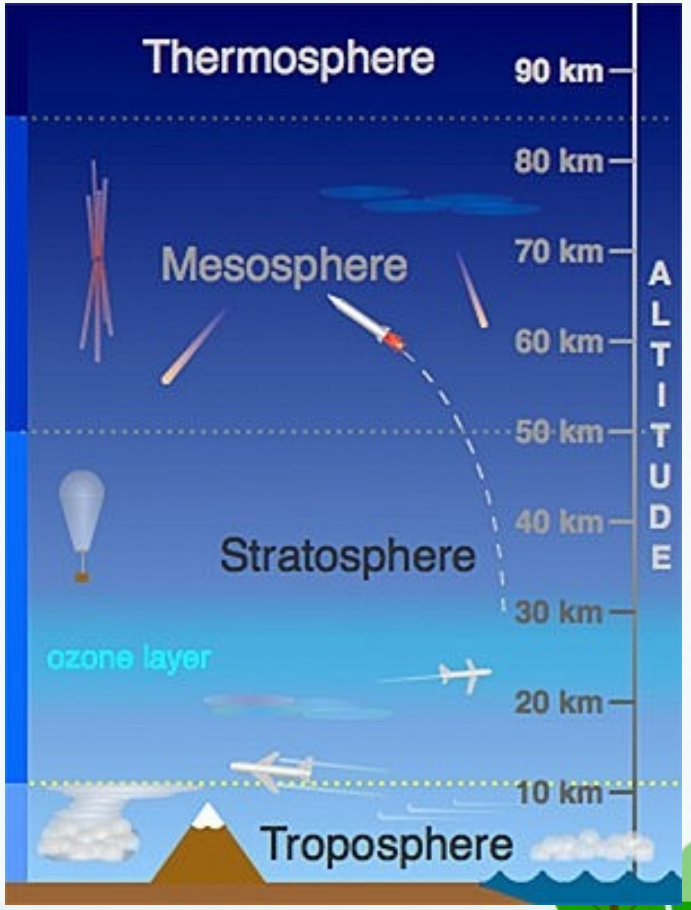
24 Hours in a Perfect Day

(and more)

Antoon van Hooft,
Vincent Heusinkveld, Cedrick Ansorge,
Maurice van Tiggelen, Peter Baas,
Stephane Popinet, and Bas van de Wiel

Recap BGUM 2017

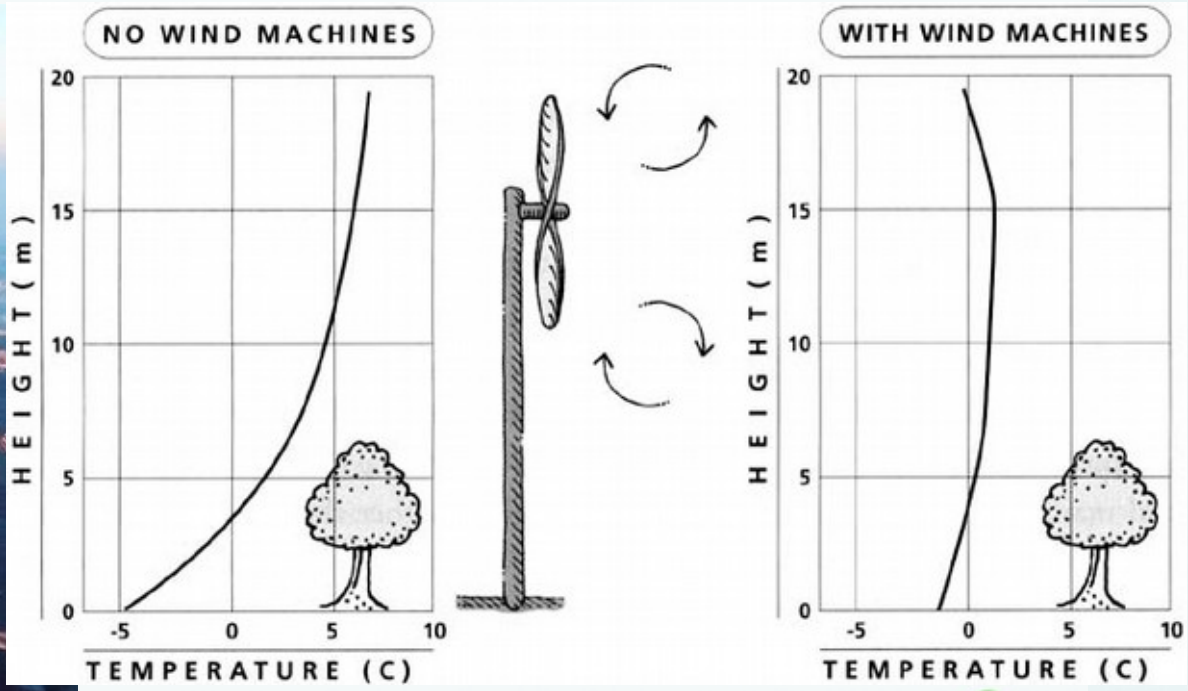
The atmospheric boundary layer



Frost mitigation in Basilisk

Vincent Heusinkveld‘s work:

www.basilisk.fr/sandbox/vheusinkveld/README



Frost mitigation in Basilisk

Vincent Heusinkveld‘s work:

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We watch movies, for details see;

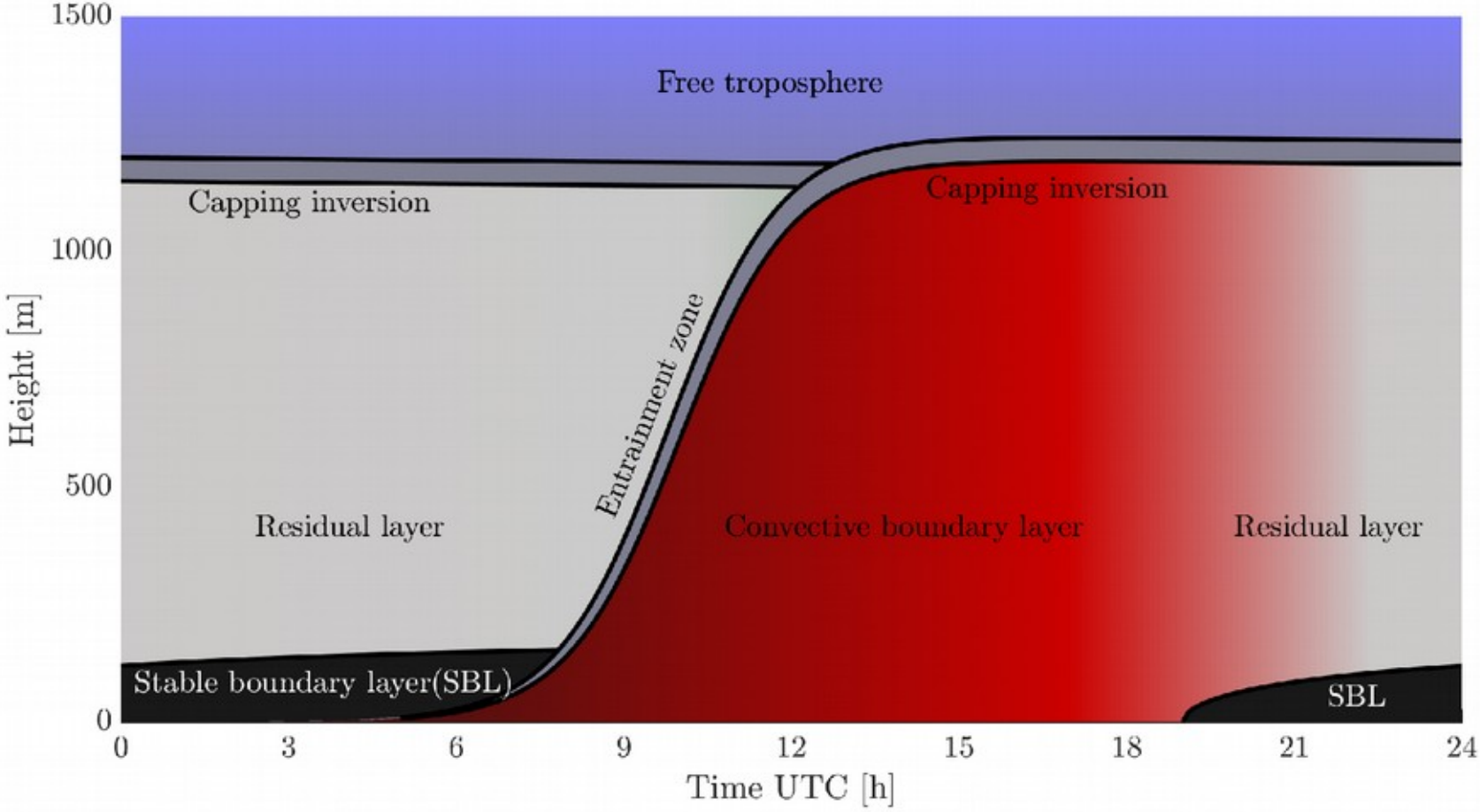
V.W.J. Heusinkveld, J.A. van Hooft, B. Schilderpoort, P. Baas, M ten Veldhuis, B.J.H. van de Wiel.

Towards a physics-based understanding of fruit forst protation using wind machines

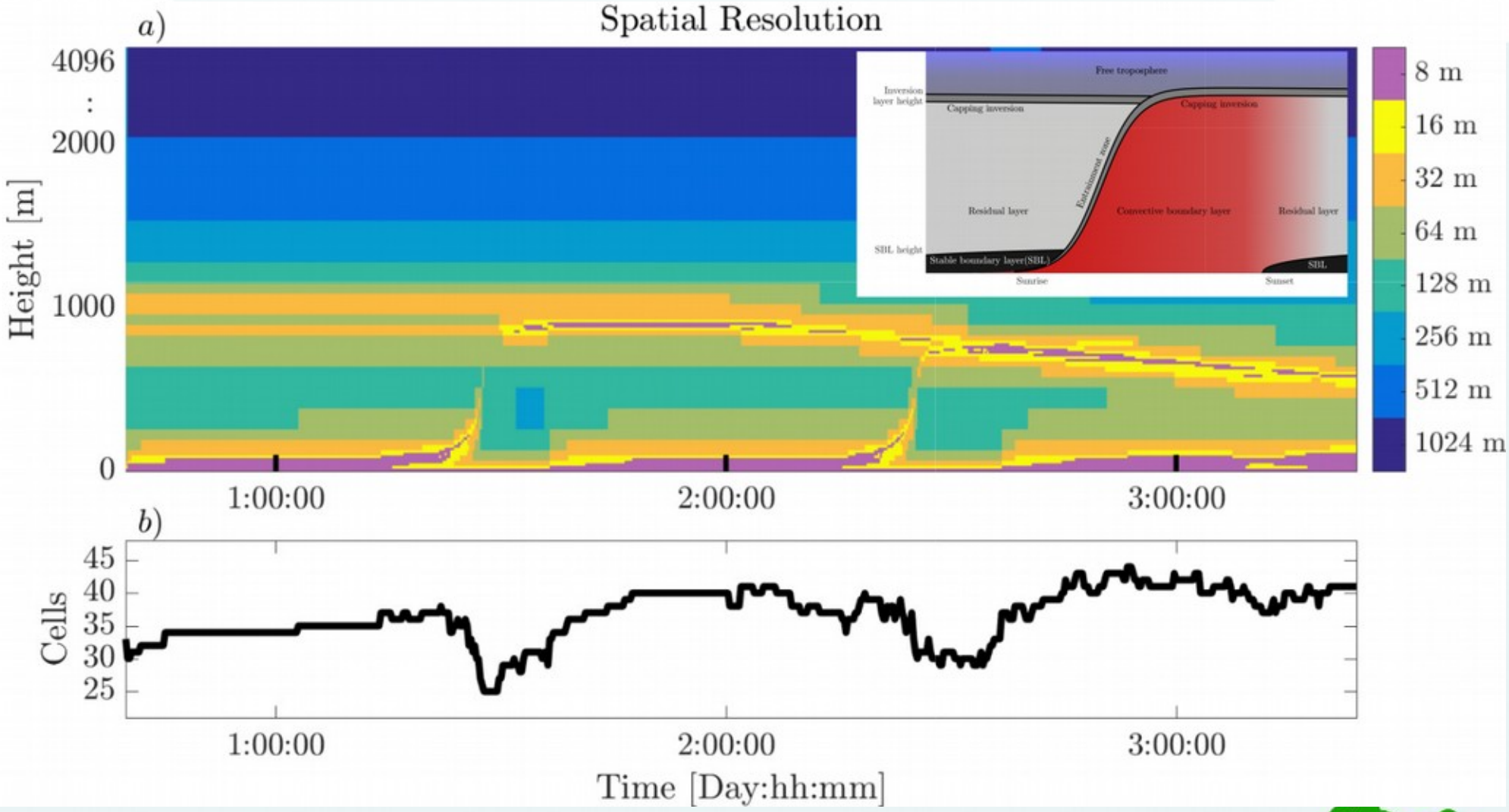
Argicultural and Forest Meteorology (near submission)

The diurnal cycle of the atmospheric boundary layer

The “Stullian” view;

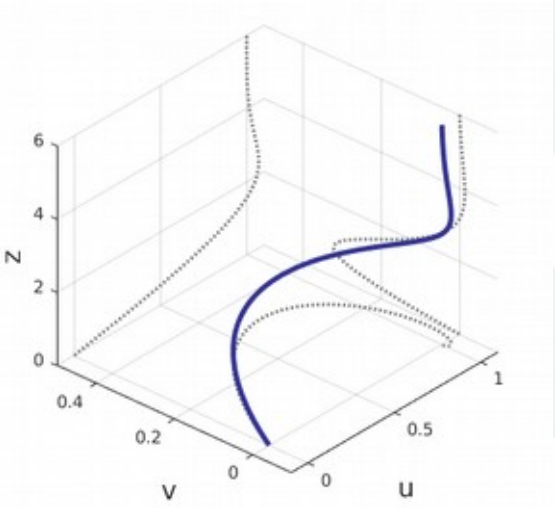


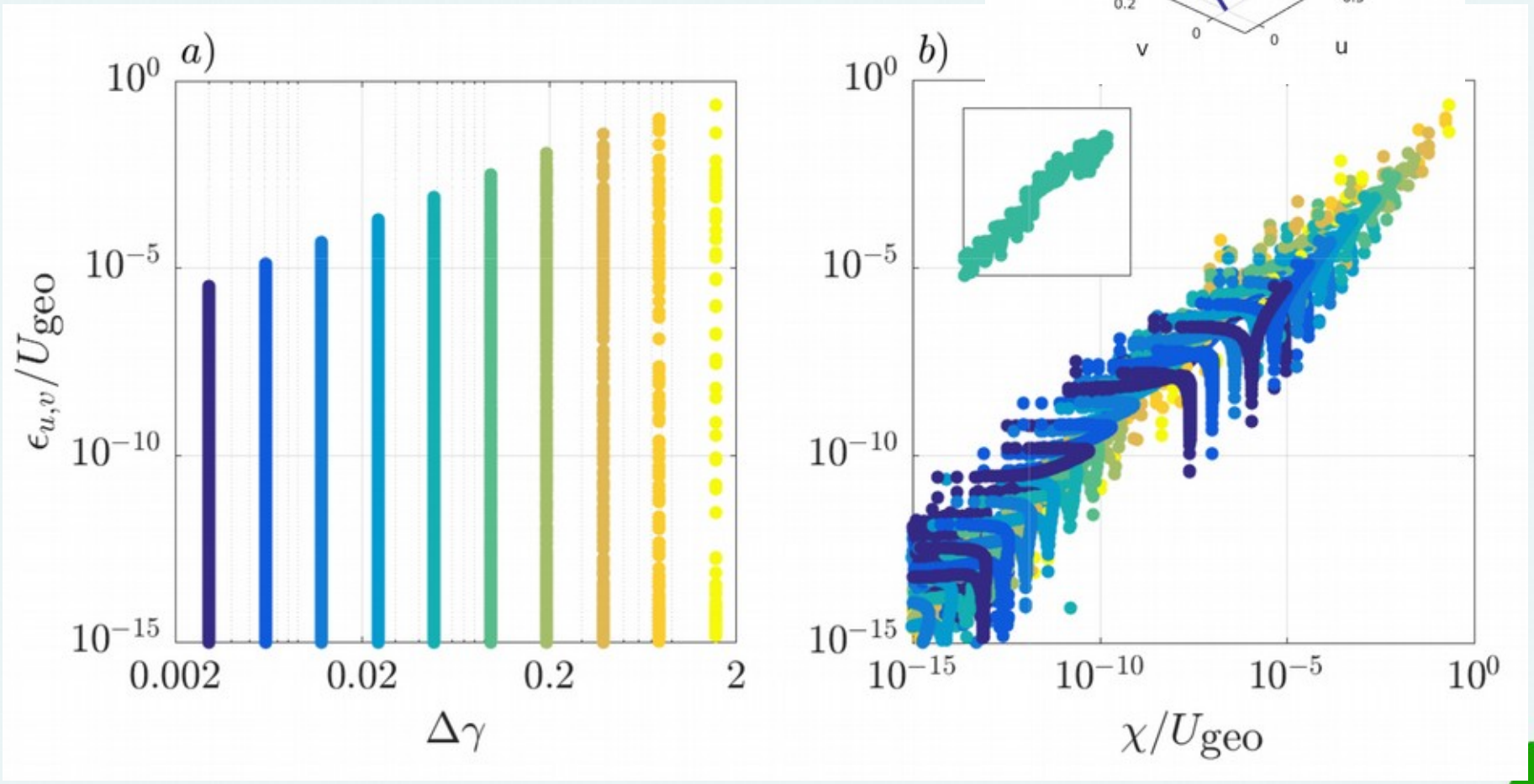
Single-column model



J.A. van Hooft, S. Popinet and B.J.H. van de Wiel (2018),
Adaptive Cartesian Meshes for Atmospheric Single-Column Models
in Geoscientific model development

Wavelet-based error estimator





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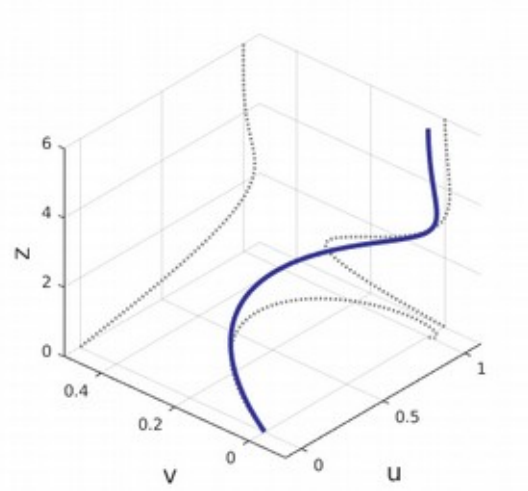

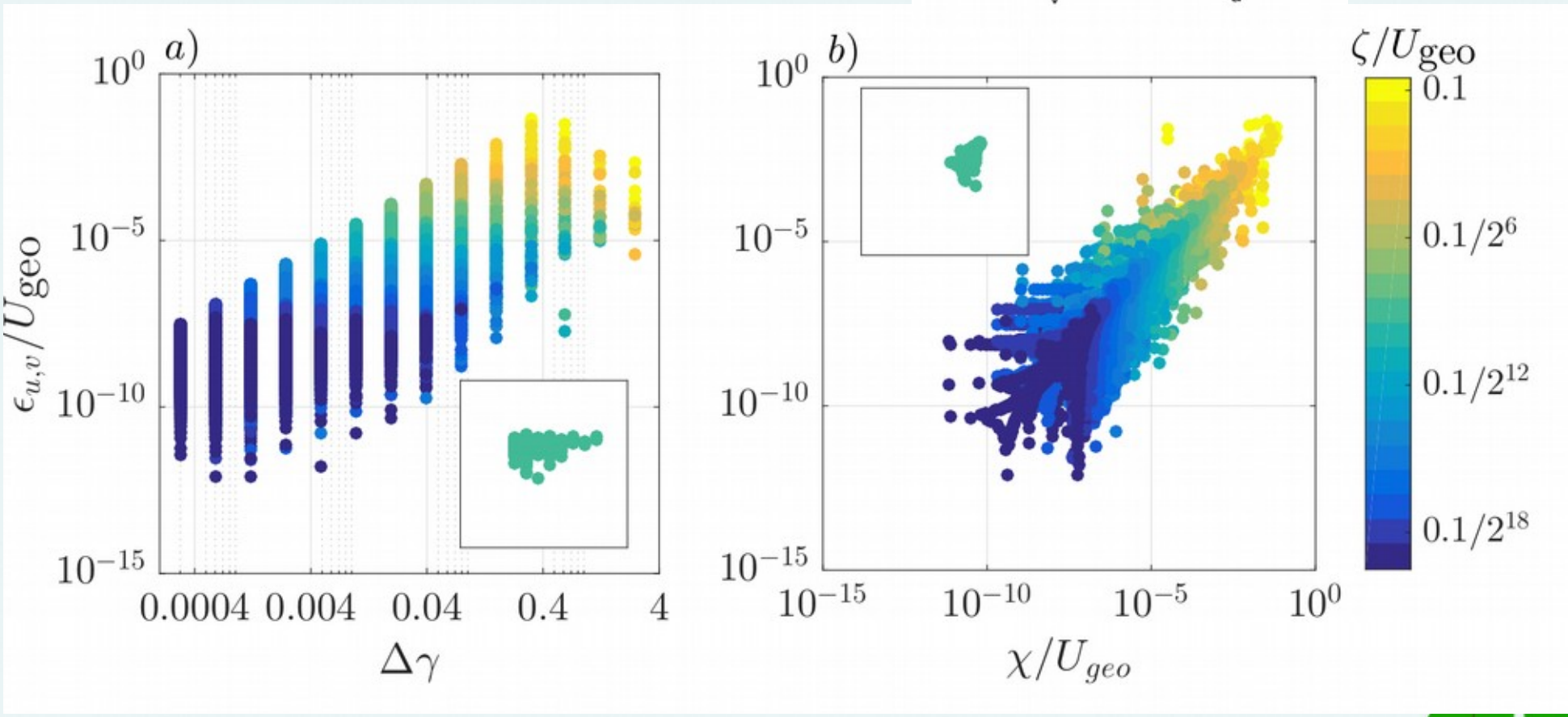

J.A. van Hooft, S. Popinet and B.J.H. van de Wiel (2018),
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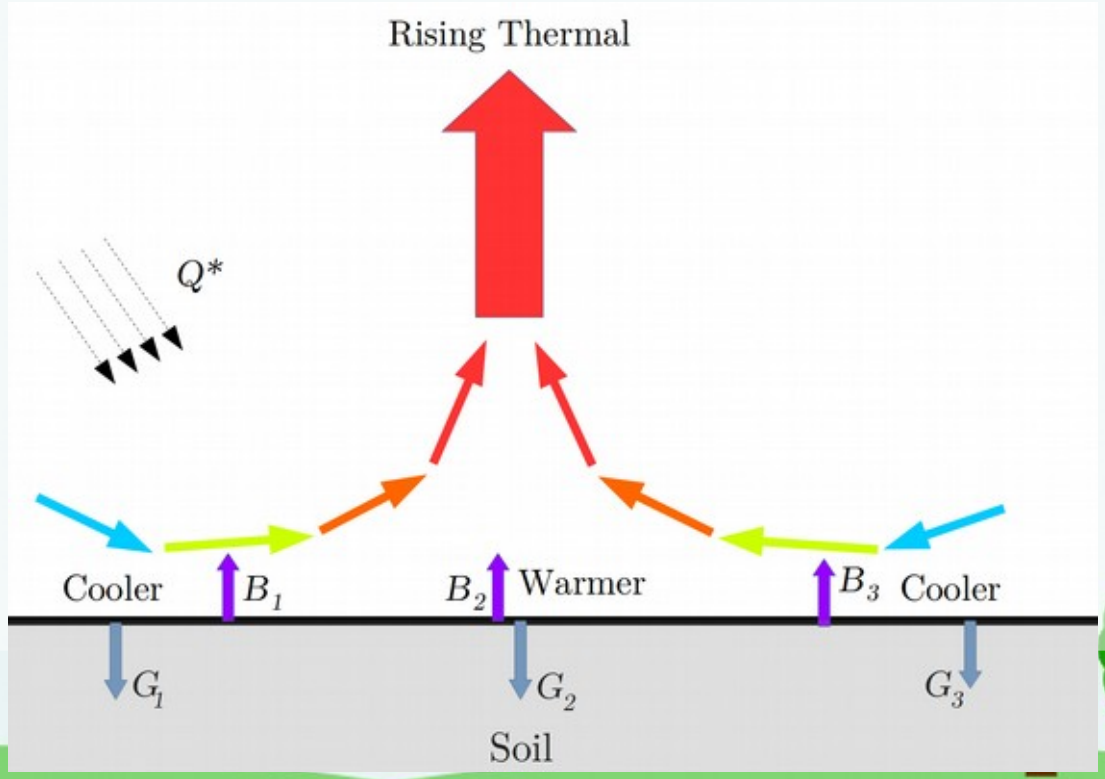
in Geoscientific model development

A simple model of the diurnal cycle

Surface energy balance:

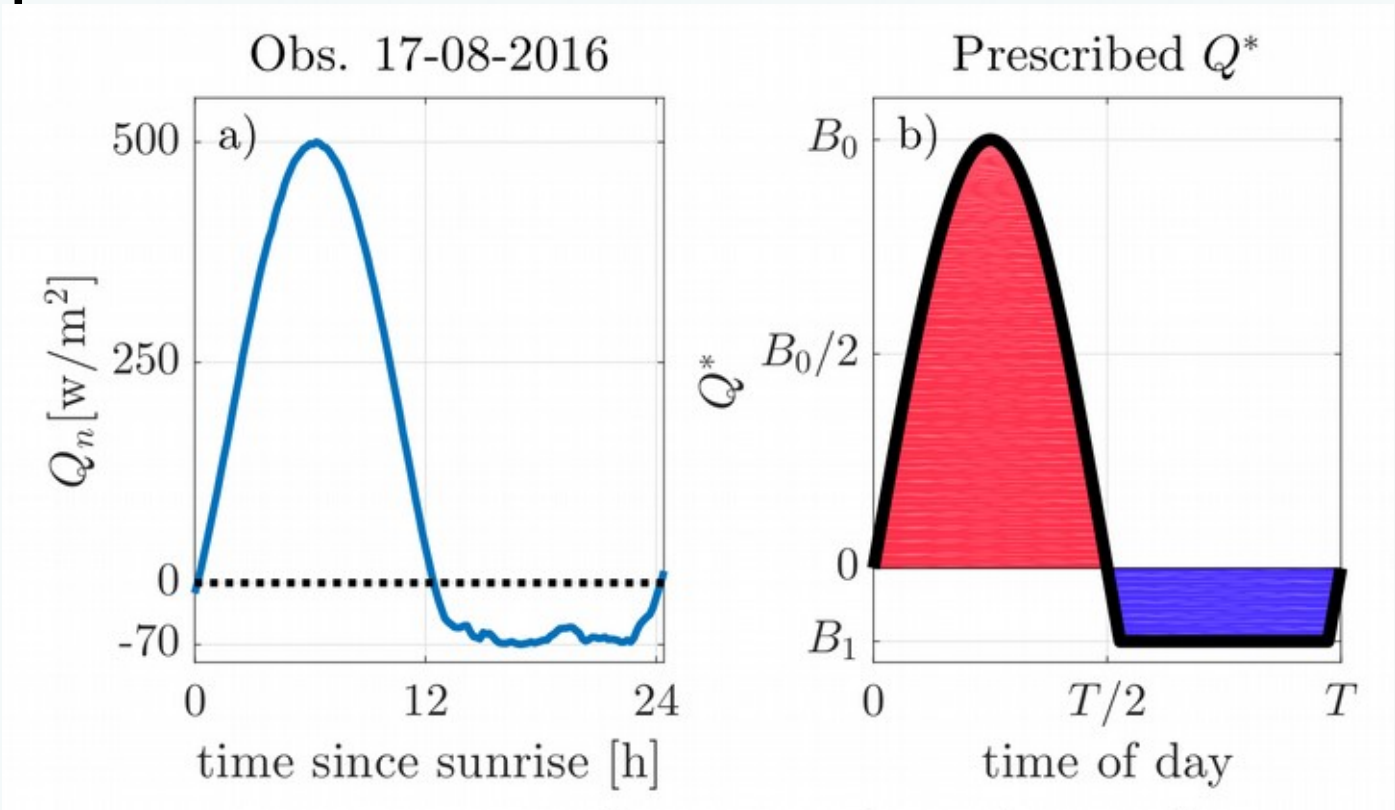
Net radiation = Soil heat flux + Sensible heat flux

$$Q^* = G + B.$$



Net radiative flux

A typical evolution:

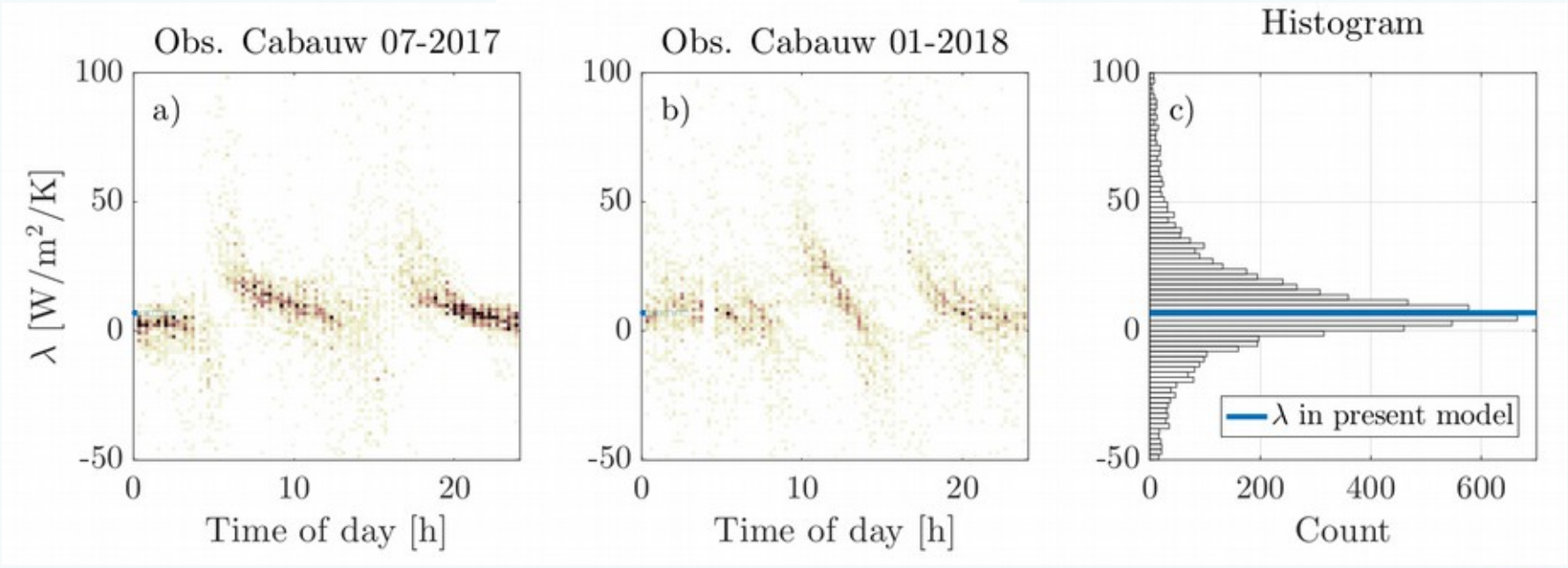


$$Q^* = \max\left[B_0 \sin\left(\frac{2\pi t}{T}\right), B_1\right],$$

Soil heat flux

Negative feedback

$$G = \Lambda(b_{\text{surf}} - b_d),$$



A simple model of the diurnal cycle

Surface energy Balance:

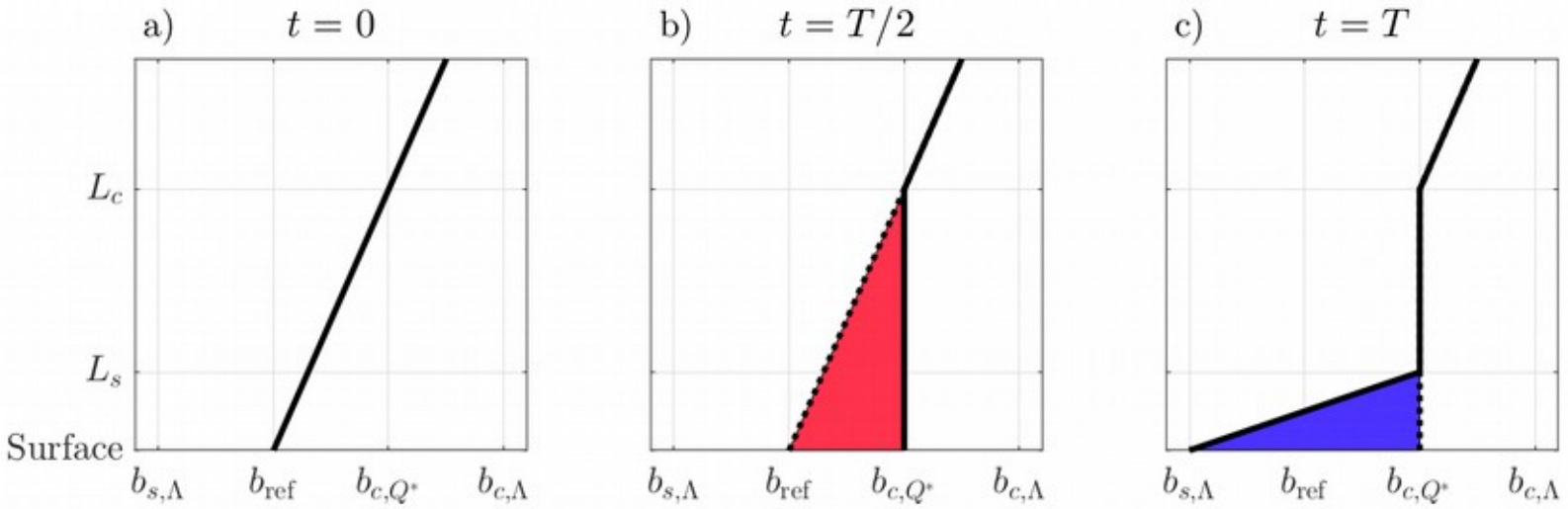
$$Q^* = G + B.$$

Wind forcing with a horizontal pressure gradient and back-ground rotation.

$$\vec{U}_{\text{geo}} = \frac{\hat{\mathbf{k}}}{\rho f} \times \nabla_h P,$$

Initial conditions and apriori analysis

$$b_{t=0}(z) = b_{\text{surf},t=0} + N^2 z,$$



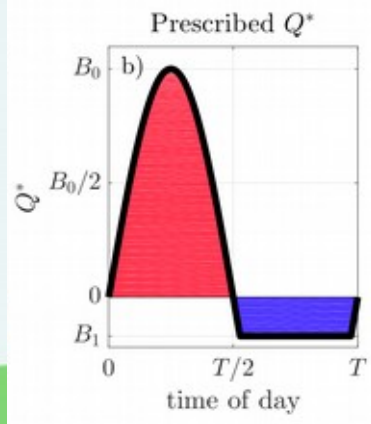
$$U_c = (B_0 L_c)^{1/3}.$$

$$L_c = \sqrt{\frac{2B_0 T}{\pi N^2}},$$

$$b_{c,Q^*} = \sqrt{\frac{2B_0 T N^2}{\pi}}.$$

$$b_{s,\Lambda} = \frac{B_1}{\Lambda}.$$

$$L_s = \frac{B_1 T}{b_{c,Q^*} - b_{s,\Lambda}}.$$



Five Dimensionless groups...

$$\Pi_1 = \frac{B_0}{B_1},$$

$$\Pi_2 = TN,$$

$$\Pi_3 = Tf,$$

$$\Pi_4 = \frac{\sqrt{B_0 T}}{\Lambda},$$

$$\Pi_5 = \frac{U_{\text{geo}}}{U_c}.$$

Symbol	Value	Based on
B_0	1.2×10^{-2} m^{2}s^{-3}	max $(Q_n) \approx 360$ Wm^{-2}
B_1	-0.2×10^{-2} m^{2}s^{-3}	max $(Q_n) \approx -60$ Wm^{-2}
T	24 h	The duration of a day
N	0.025 s^{-1}	0.0175 Km^{-1} with $\theta_{\text{ref}} = 280$ K
f	1.15×10^{-4} s^{-1}	Mid-Latitude / Cabauw
Λ	6×10^{-3} ms^{-1}	$\lambda = 7$ Wm^{-2}K^{-1}, Fig. 1
U_{geo}	$[2 - 15]$ ms^{-1}	van der Linden et al. (2017)
$z_{0,m}$	20 cm	Regional Roughness Cabauw

$$\Pi_1 = -6,$$

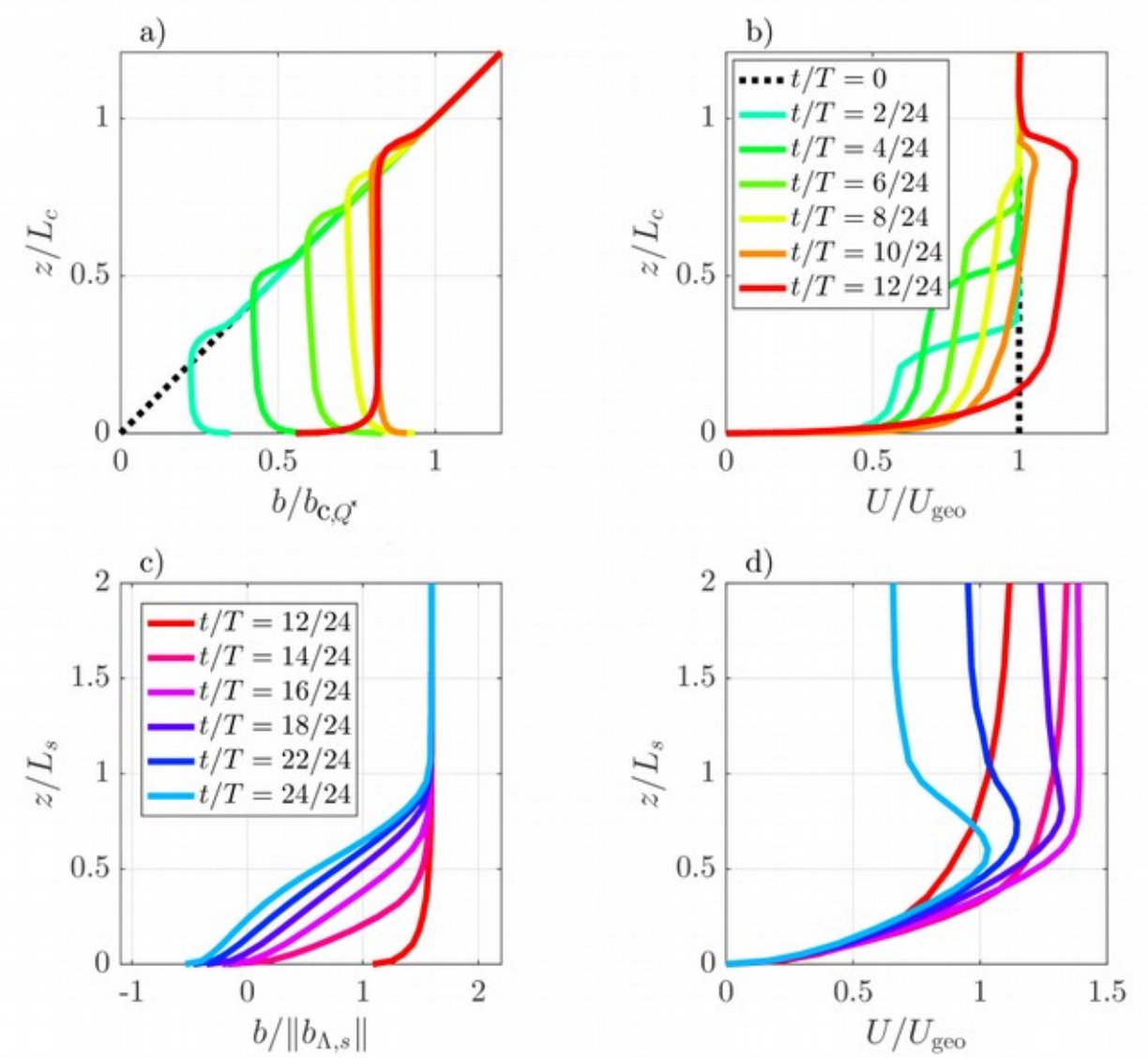
$$\Pi_2 = 2160,$$

$$\Pi_3 = 10,$$

$$\Pi_4 = 5366,$$

$$\Pi_5 = [1 \ldots 5],$$

Results from single-column model



Large-eddy simulation

- For details;

  J.A. van Hooft, Peter Baas, Maurice van Tiggelen, Cedrick Ansorge, Bas J.H. van de Wiel.

  A simple description of the diurnal cycle of the dry atmospheric boundary layer

  Under review for Journal of the Atmospheric Sciences

- Or,

  www.basilisk.fr/sandbox/Antoonvh/README

- The movie concludes this presentation

See: https://vimeo.com/292329175