



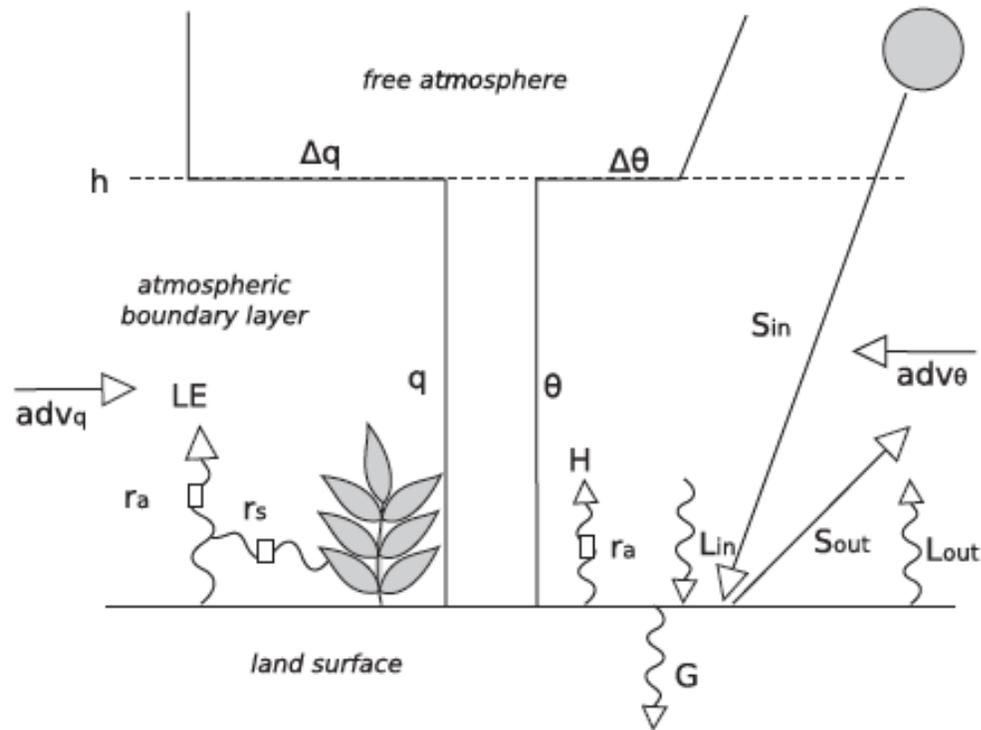
Photo courtesy of Marie Lothon

Evaporation Controlled by Boundary Layer Feedbacks in an Irrigated Semi-Arid Environment: a LIAISE Data and Modeling Study

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Wageningen University, Meteorology and Air Quality
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Research Objectives

CLASS



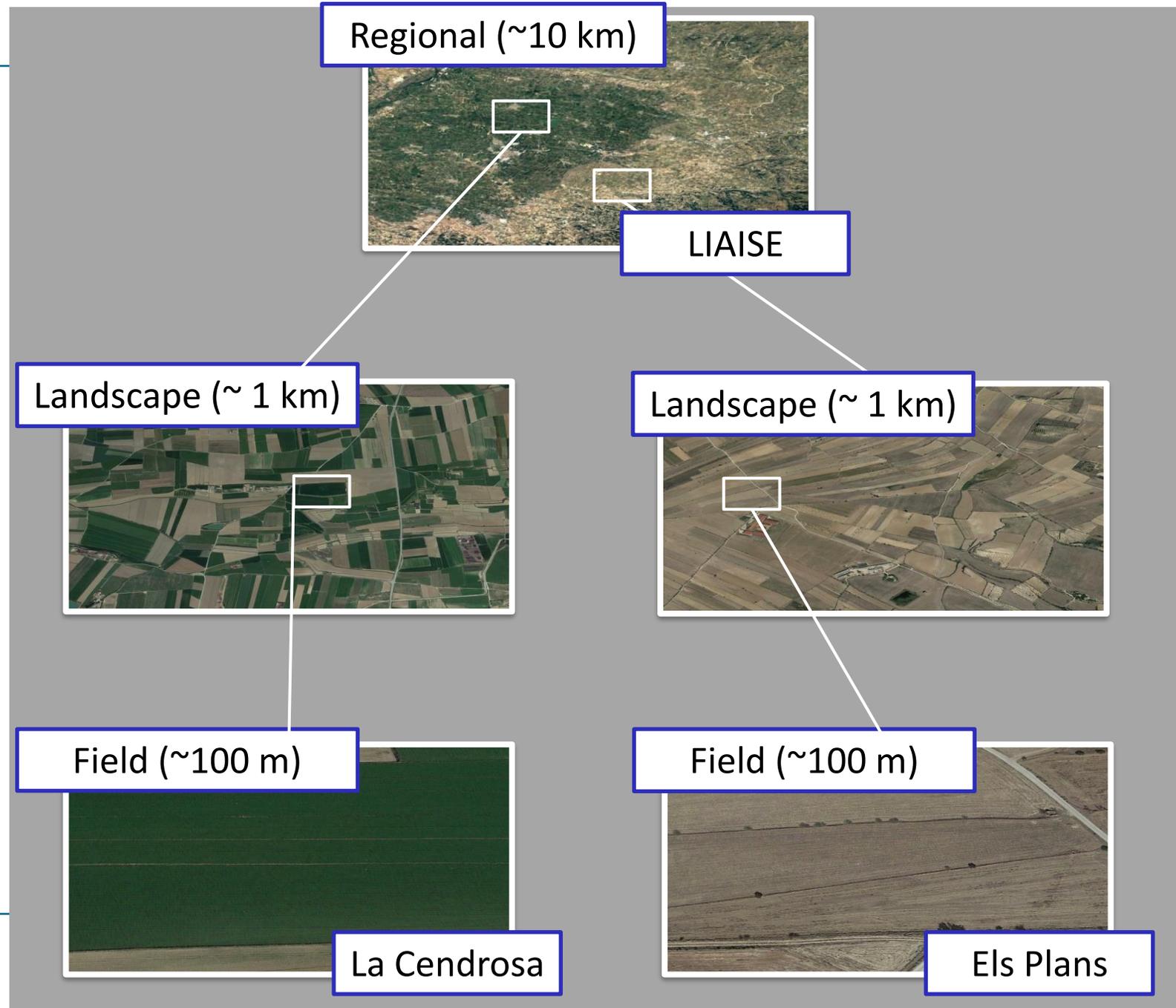
- Research Questions:

1. How do thermal heterogeneities in the LIAISE region impact boundary layer development?
2. How does the boundary layer impact local evaporation at La Cendrosa?

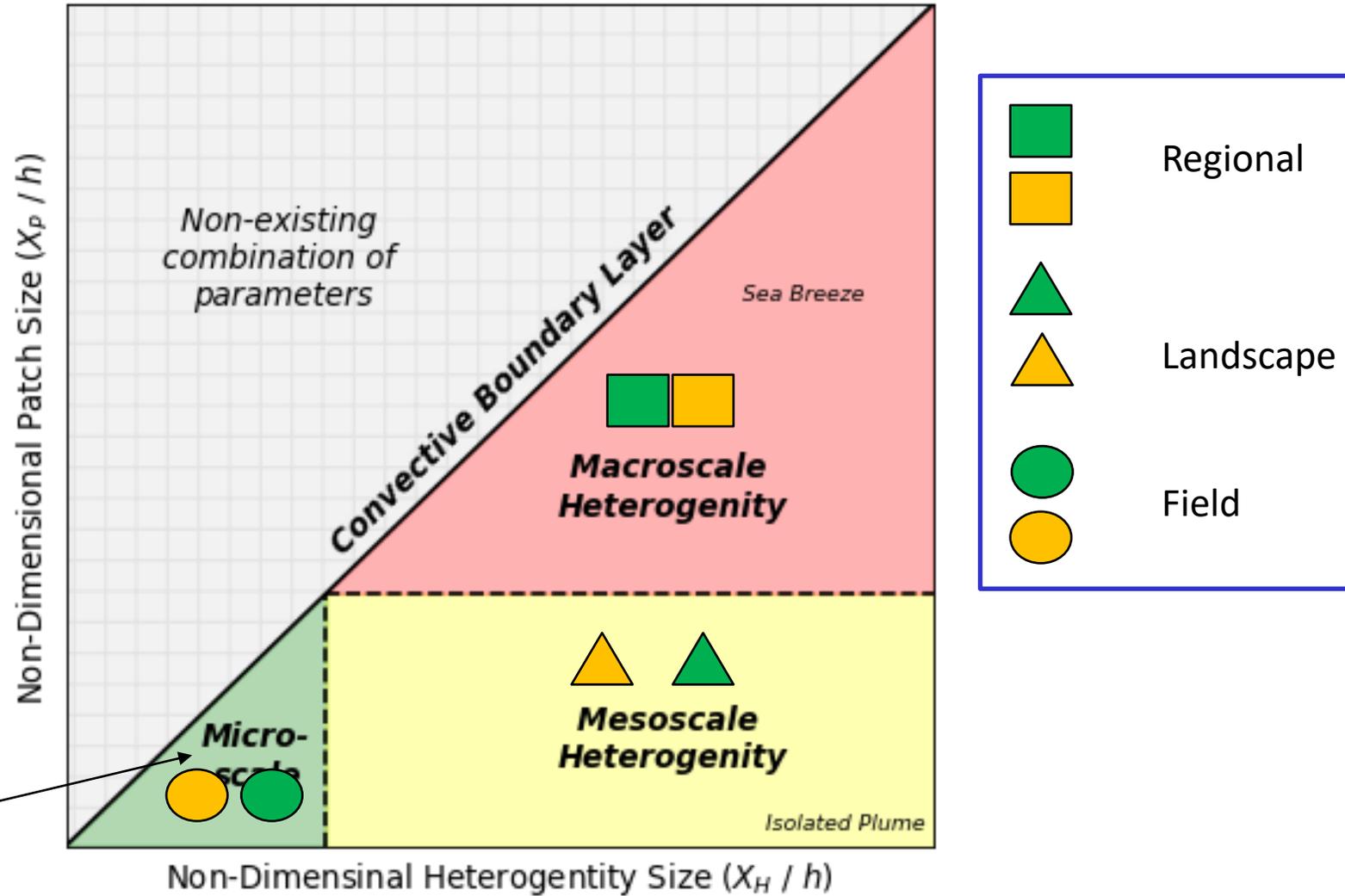
- Modeling Approach:

- 1D Mixed Layer Model: CLASS (Vilà et al, 2015)
- Composite case: “Golden Days” case: 20-22 July 2021

Scale Scheme

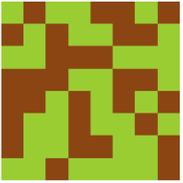
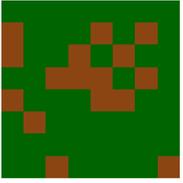
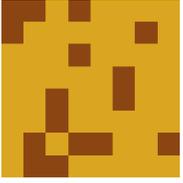


Idealized Heterogenous Scaling

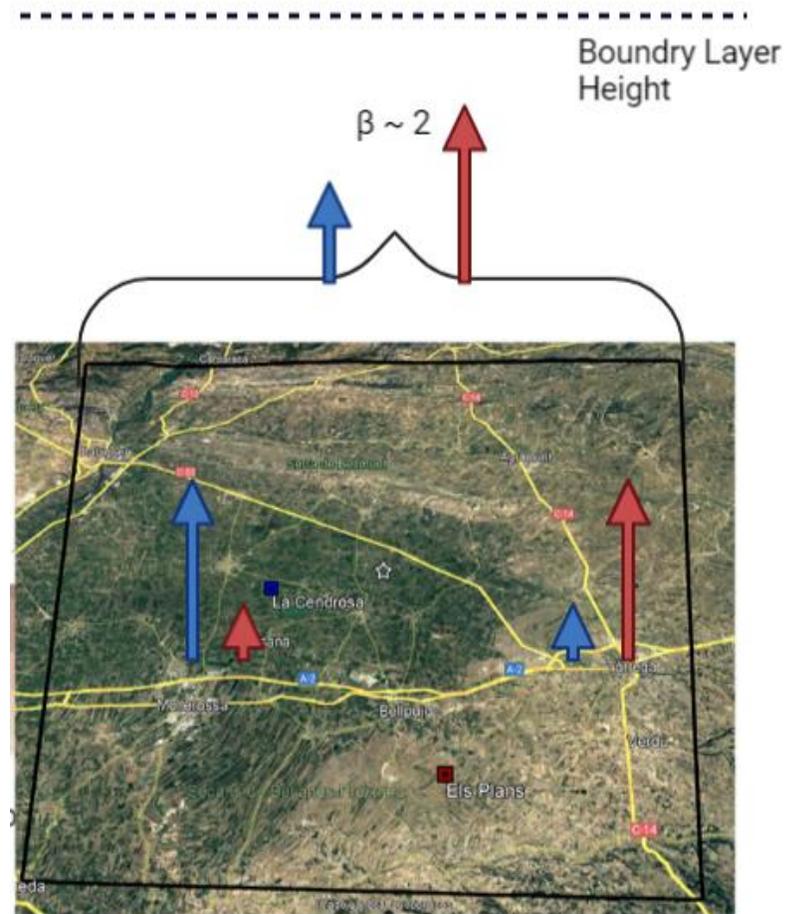


van Heerwaarden et al, 2014

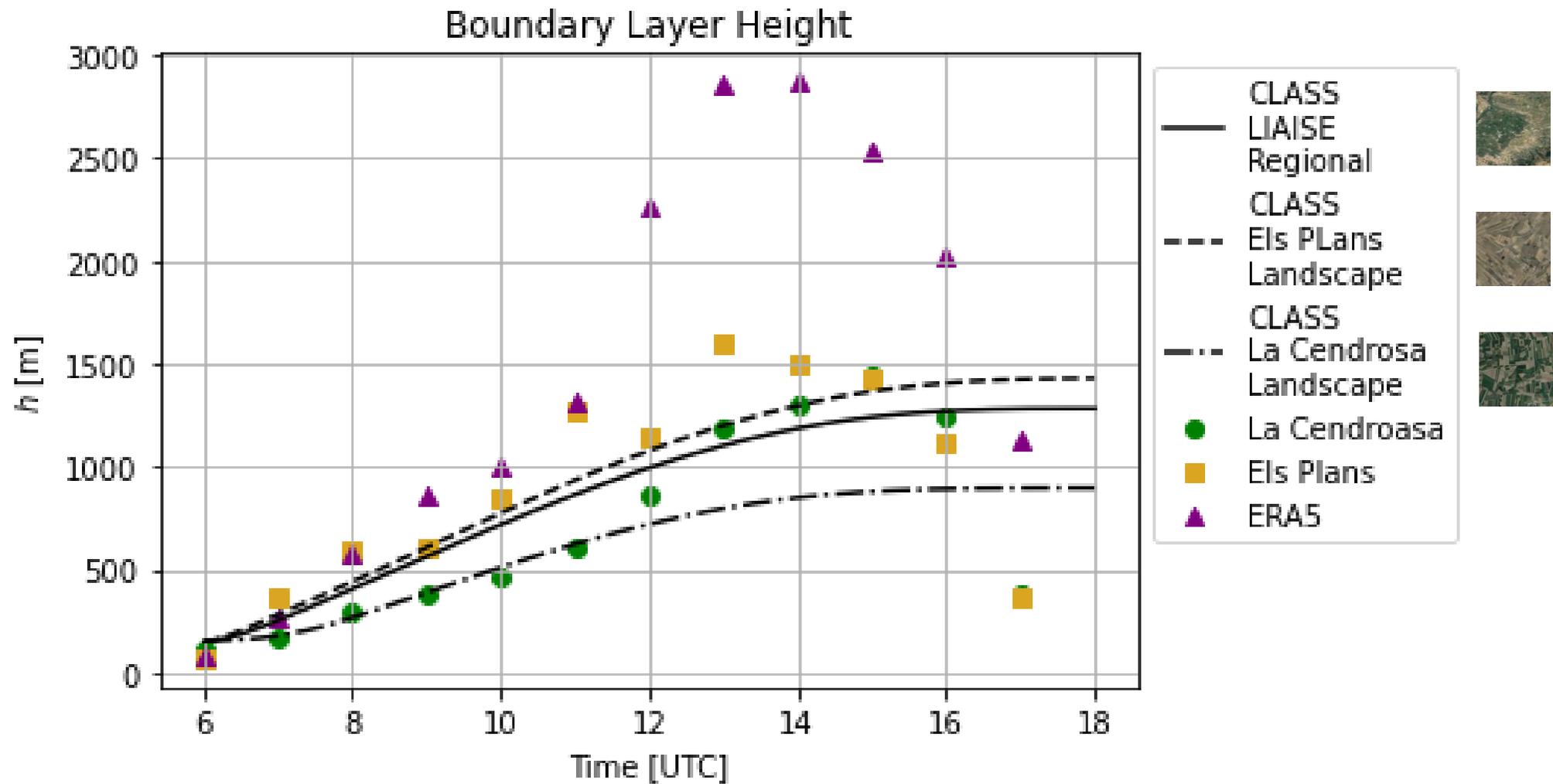


Scale		Scale-View	Model Representation	Model Parameters			Scale Measurements	Target Parameters
				LAI	Vegetative Fraction	Soil Moisture (top layer)		
Regional ($X_H \sim 10$ km)	LIAISE			1.25	0.5	0.2	Radiosondes Aircraft Balloons	$h,$ $\theta, \Delta\theta,$ $q, \Delta q$
	Landscape ($X_H \sim 1$ km)	La Cendrosa			3	0.75	0.2	Aircraft Balloons Scintillometer 50-m fluxes Flux Maps
Els Plans				0.75	0.7	0.2		
Local ($X_H \sim 100$ m)	La Cendrosa			3	1.0	0.21	50-m fluxes Surface Fluxes	H, LE Surface
	Els Plans			0.01	0.1	0.1		

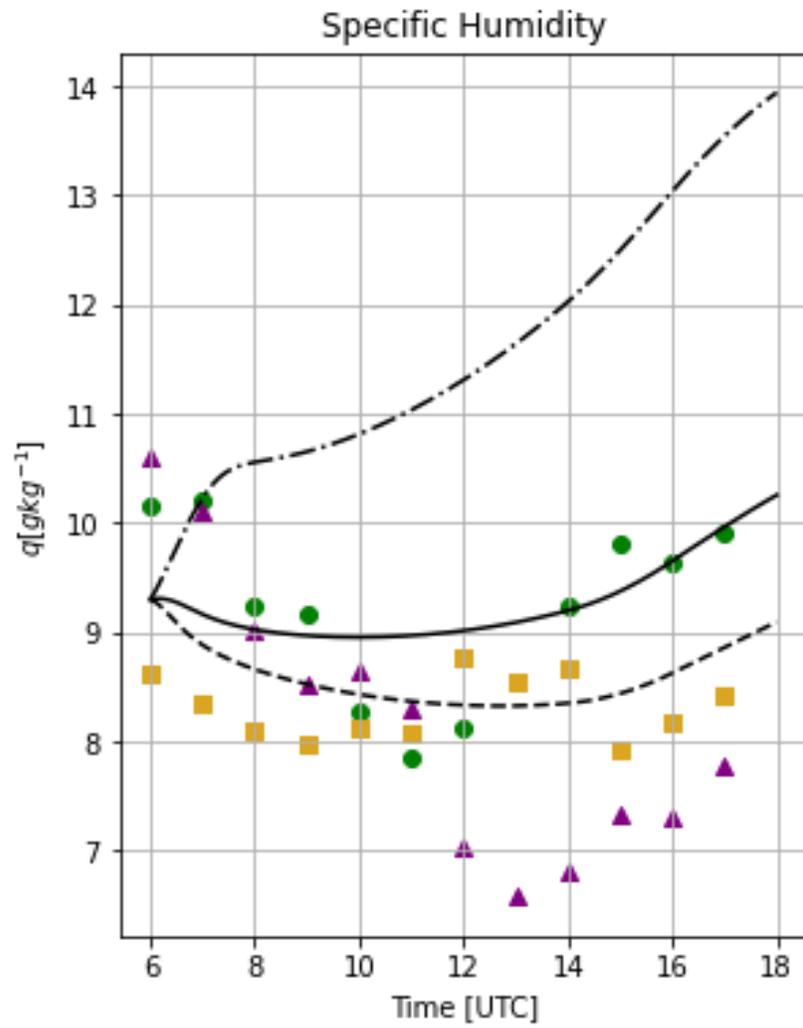
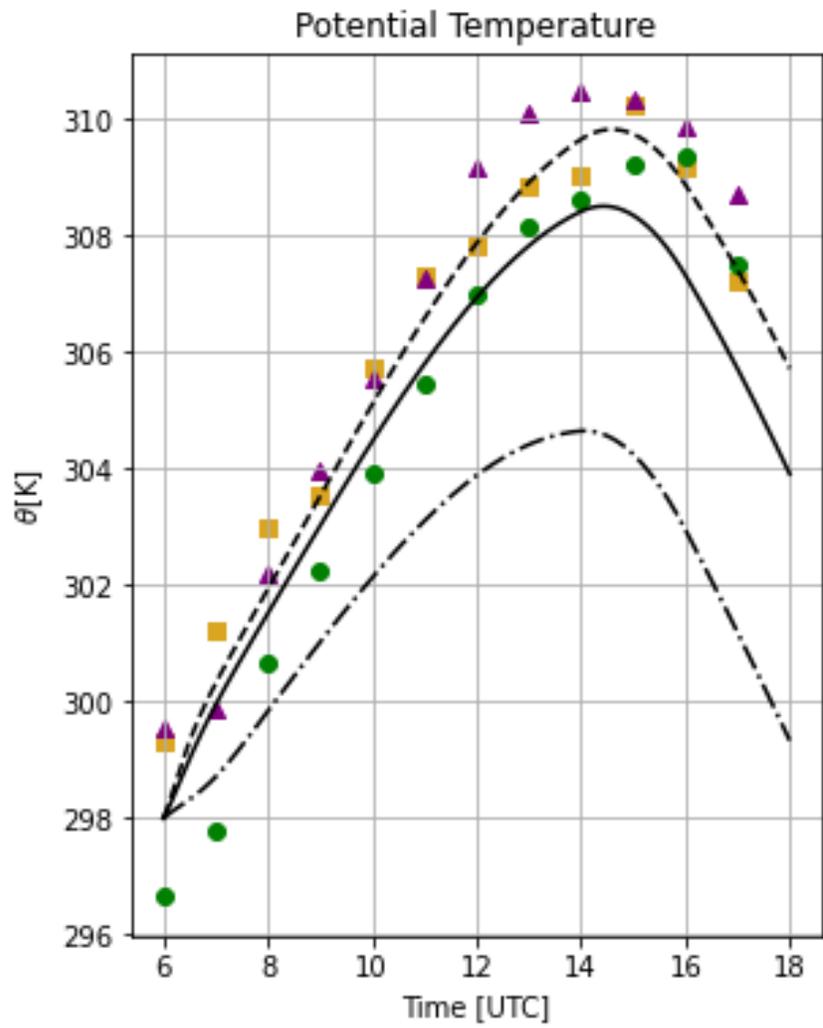
Regional & Landscape Scales



Mixed Layer Results

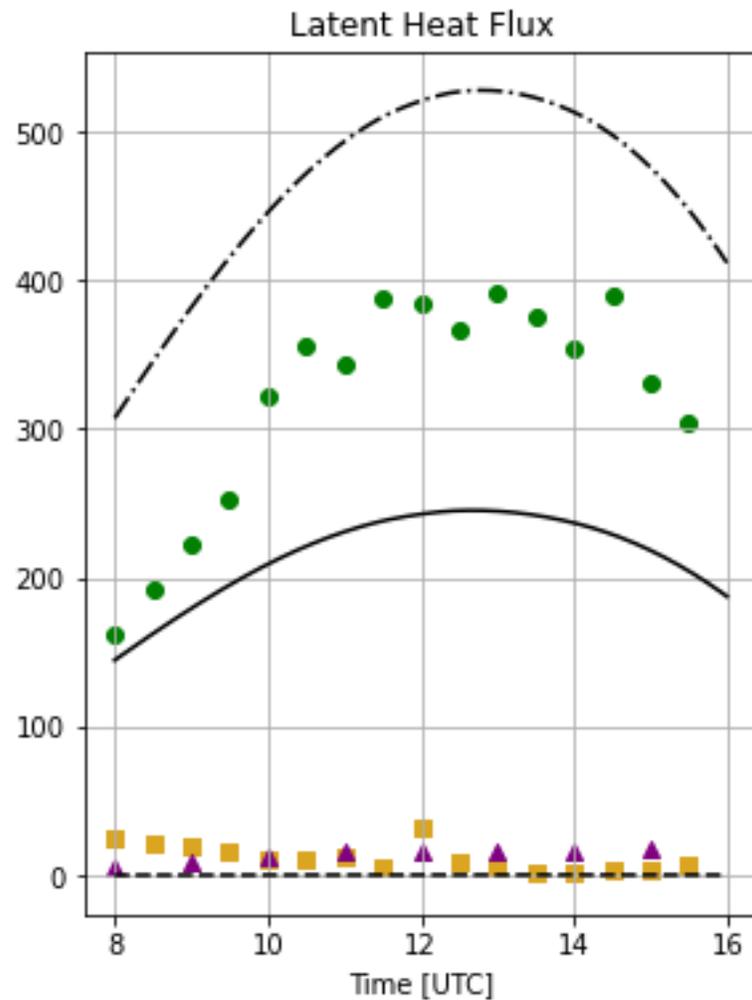
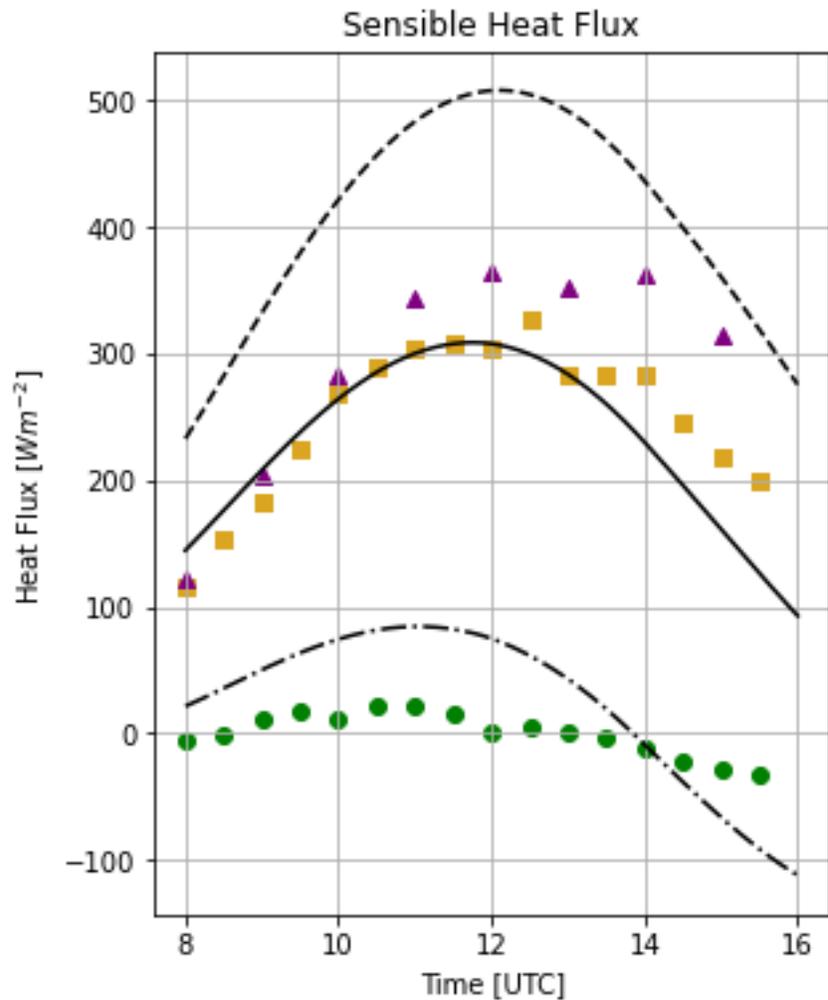
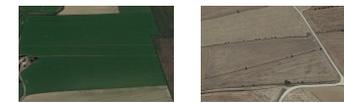


Mixed Layer Results



- CLASS LIAISE Regional 
- CLASS Els Plans Landscape 
- CLASS La Cendrosa Landscape 
- La Cendrosa
- Els Plans
- ▲ ERA5

Local Scale Results



- CLASS Regional
- CLASS Local
- CLASS La Cendrosa Local
- La Cendrosa
- Els Plans
- ERA5



Evapotranspiration Budget Equation

$$\frac{dLE}{dt} =$$

SW_{in}, LW_{in}, α

+ Radiative Forcing

$\frac{d}{dx} (\theta, q)$

+ Boundary Layer Forcing

$w_e, h, \Delta q, \Delta \theta$

H, LE

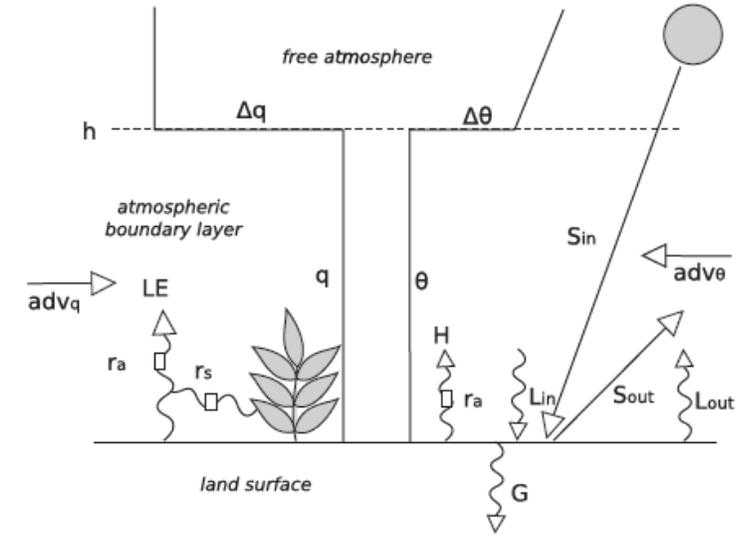
+ Boundary Layer Feedbacks

r_a

- Surface Layer Feedback

LW_{out}, G, r_s

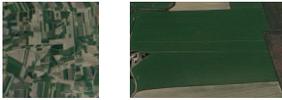
- Land Surface Feedbacks



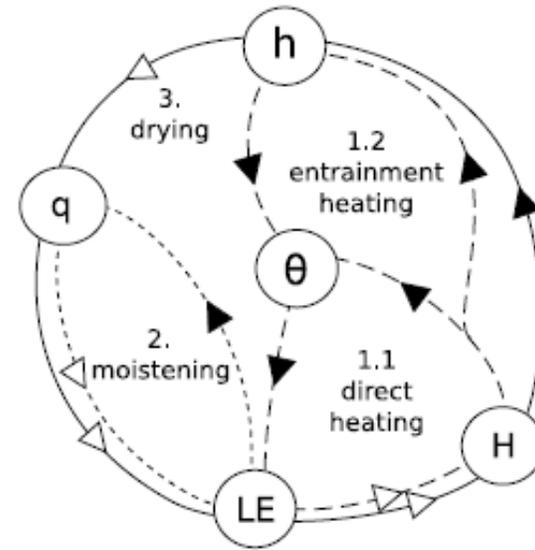
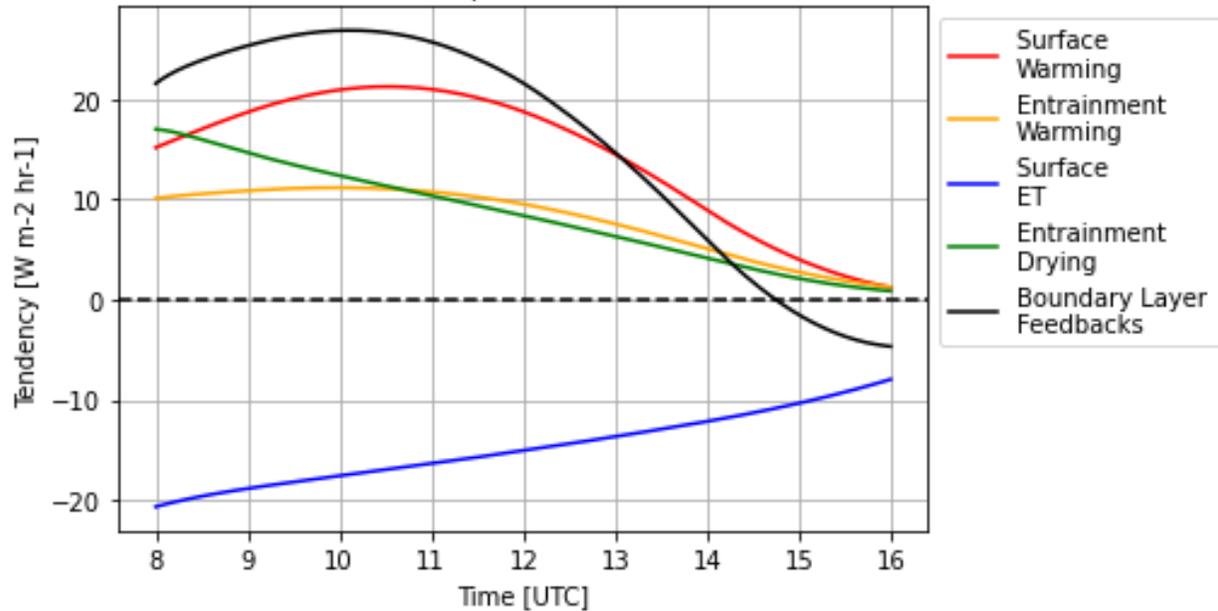
Van Heerwaarden et al, 2010



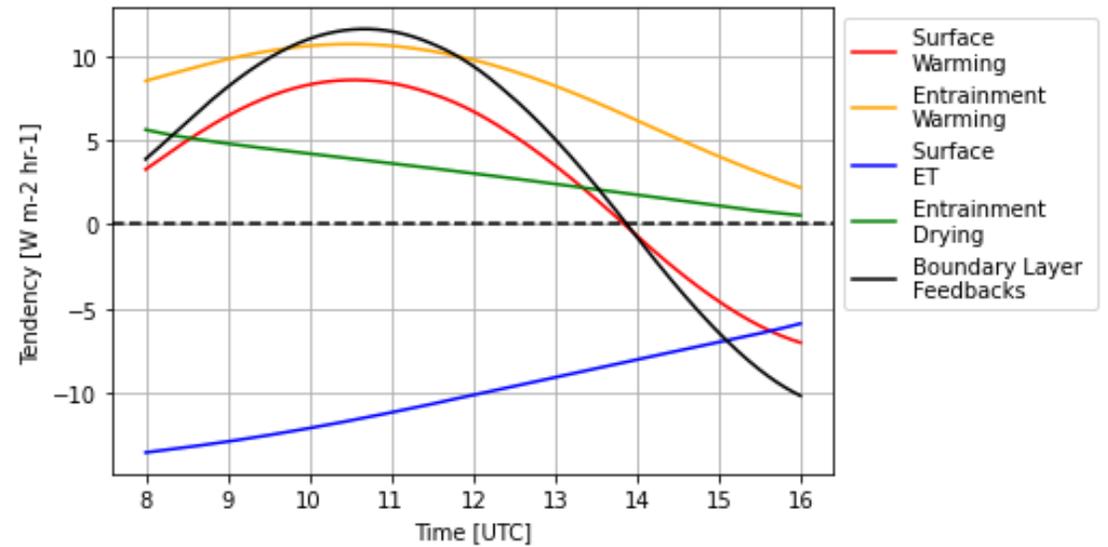
Boundary Layer Feedbacks



Boundary Layer Feedbacks:
Landscape La Cendrosa

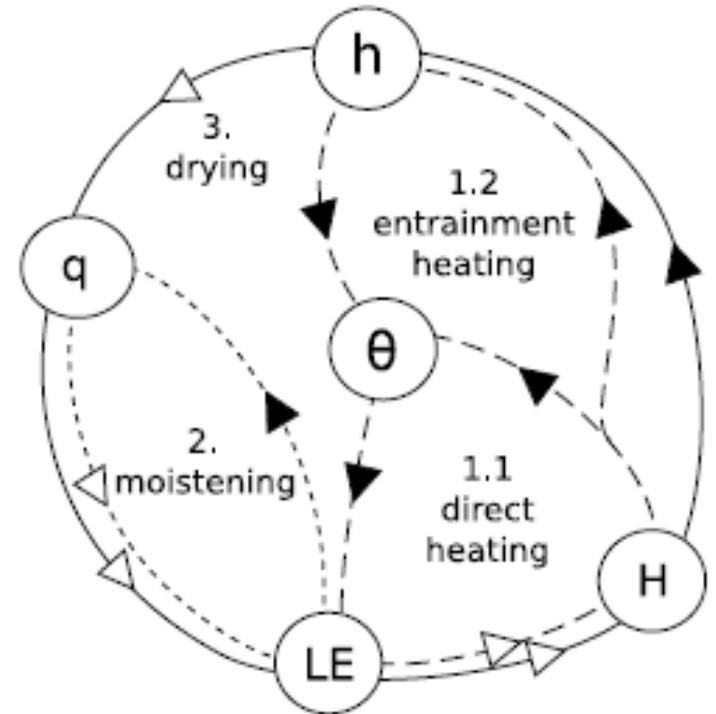


Boundary Layer Feedbacks:
Local La Cendrosa



Summary & Conclusions

- Impact of heterogeneities scale with the relative size of heterogeneity compared to the CBL height
- ERA5 does not do a good job capturing observed boundary layer in LIAISE
- Smaller scales depend more on the input variables, so these results can be improved with more data
- Scale of heterogeneity impacts local evaporation by changing the boundary layer feedbacks on evaporation



References

- van Heerwaarden, C. C., Vilà-Guerau de Arellano, J., Gounou, A., Guichard, F., & Couvreux, F. (2010). Understanding the Daily Cycle of Evapotranspiration: A Method to Quantify the Influence of Forcings and Feedbacks. *Journal of Hydrometeorology*, 11(6), 1405–1422. <https://doi.org/10.1175/2010JHM1272.1>
- van Heerwaarden, C. C., Mellado, J. P., & Lozar, A. D. (2014). Scaling Laws for the Heterogeneously Heated Free Convective Boundary Layer. *Journal of Atmospheric Sciences*, 71(11), 3975–4000. <https://doi.org/10.1175/JAS-D-13-0383.1>
- Vilà-Guerau de Arellano, J., van Heerwaarden, C. C., van Stratum, B. J. H., & van den Dries, K. (2015). *Atmospheric Boundary Layer: Integrating Chemistry and Land Interactions*. Cambridge University Press.

