

# Measure and simulate turbulent fluxes over heterogeneous surface: MOSAI



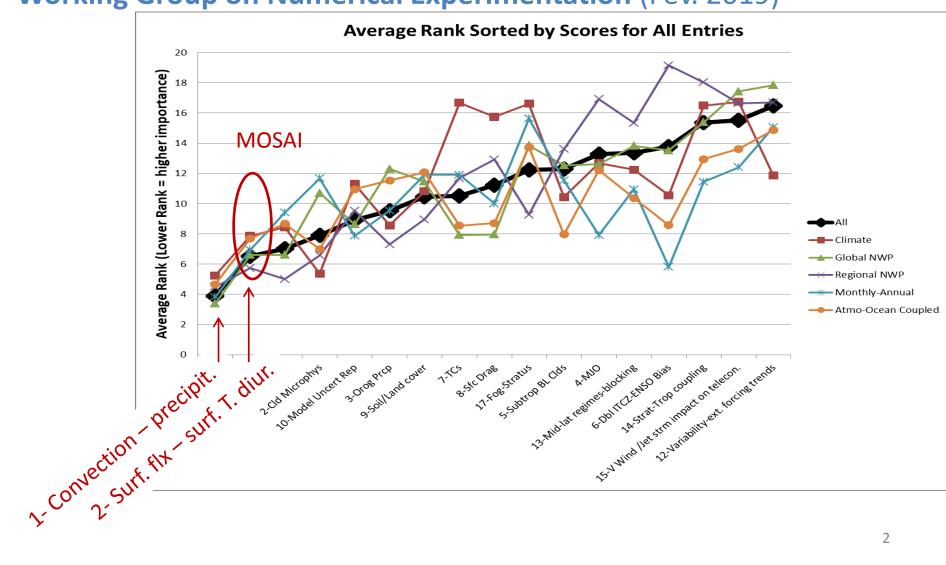
### Fabienne Lohou

LOTHON M., BASTIN S., BRUT A., CANUT G., CHERUY F., COHARD J.-M., COUVREUX F., DARROZES J., DUPONT J.-C., FERNANDEZ R., JOME M., LAFONT S., ROEHRIG R., ROMÁN-CASCÓN C., ZOUZOUA M., and MOSAI team

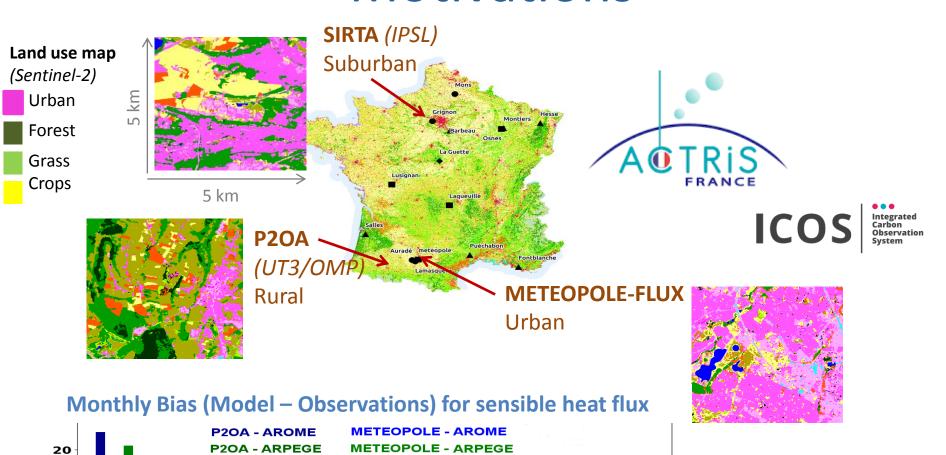


### Motivations

### Working Group on Numerical Experimentation (Fev. 2019)



### **Motivations**



10

Bias h[Wm<sup>-2</sup>] **0** 

-20

-30

-40

m

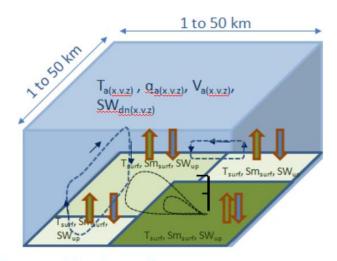
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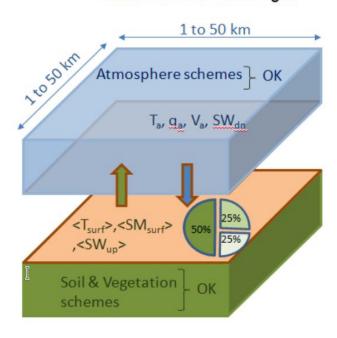
# **MOSAI** Objectives

### Observations at model grid scale



WP1: uncertainty and horizontal representativeness of L-A exchanges measured over heterogeneous landscape

### Climate or NWP model grid



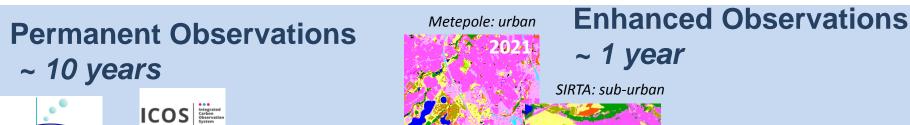
WP3: Improvement of the L-A models coupling

WP2: Model evaluation using long-term measurements

# Outline

- Motivations
- Objectives
- Strategy
- 2023 field experiment
- Some ongoing works for each objective
  - O1: Representativity
  - O2: New methods for model evaluation
  - O3: Improving surface/atmosphere coupling

# **MOSAI Strategy**





**SURFACE HETEROGENEITY** 

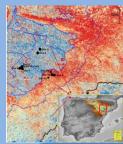
P2OA: rural

P2OA SOP

Roughness Transition

**Intensive Observations** 





VERTICAL STRUCTURE

**Numerical Models** 

Méso-NH/ SURFEX; LES WRF / ORCHIDEE; Régional AROME / SURFEX; Regional

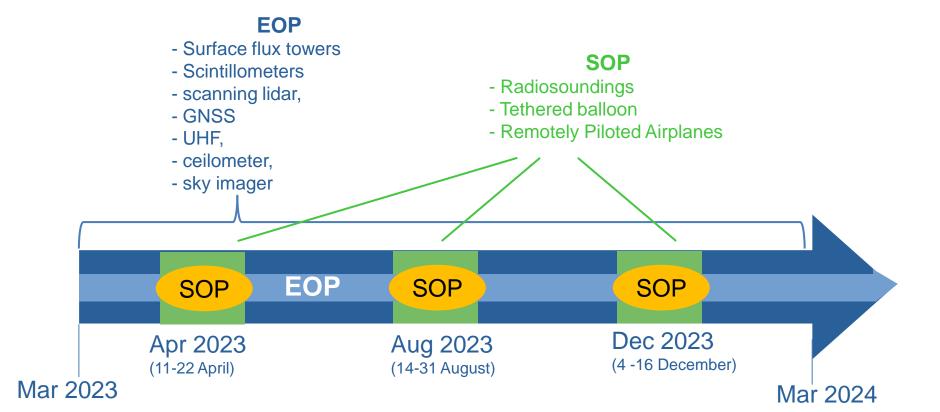
ARPEGE / SURFEX; Cimate LMDZ / ORCHIDEE; Climate DYNAMICO / ORCHIDEE; Climate

# Field campaign at P2OA



### Main objective:

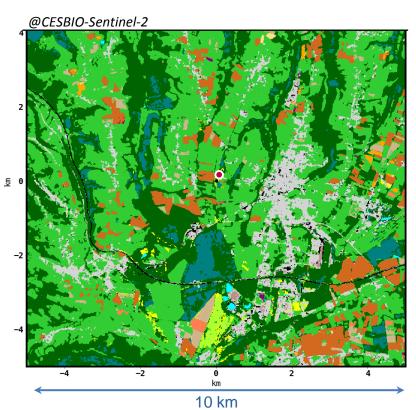
- Characterize the representativity of the P2OA 60 m tower relatively to the heterogeneous landscape
- Document the vertical structure
- Investigate the impact of a roughness transition



### P2OA EOP: Surface heterogeneity

### **Deployment of flux stations:**

- Prairies
- Deciduous forest
- Summer crops
- Urban in Lannemezan
- Winter crops
- Conifer forest / mixt forest



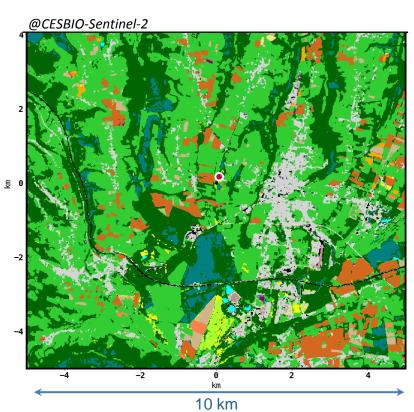


4 km

### P2OA EOP: Surface heterogeneity

### **Deployment of flux stations:**

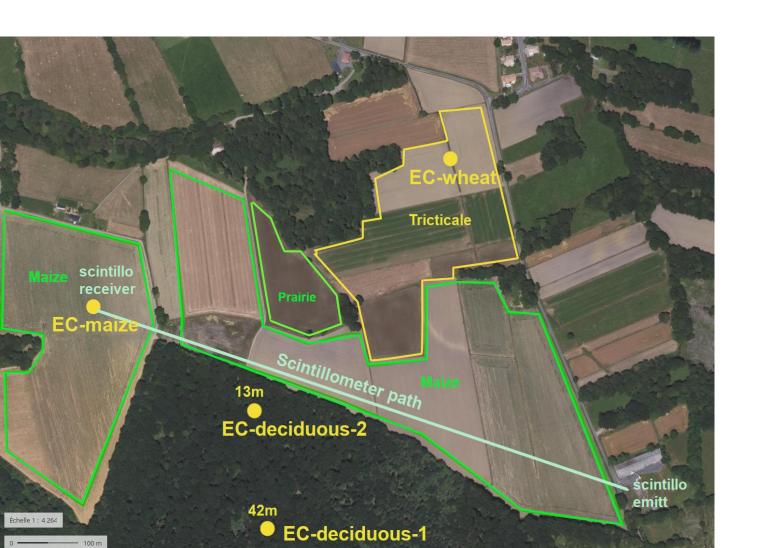
- Prairies
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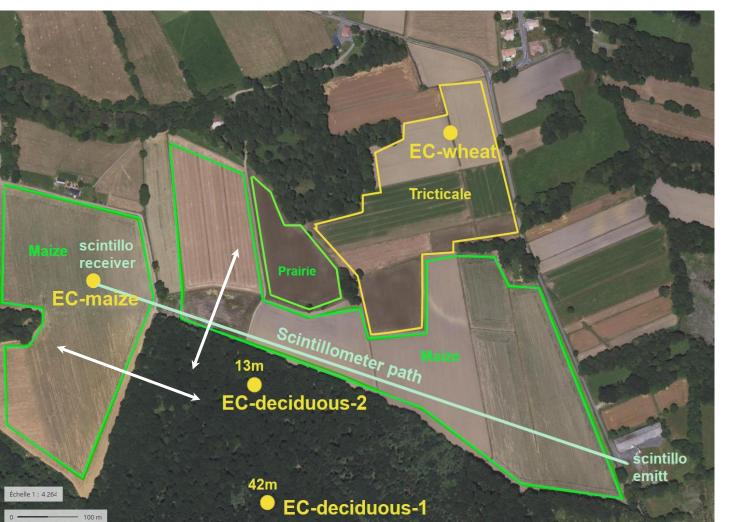
4 km

# P2OA EOP: Exploring a specific transition



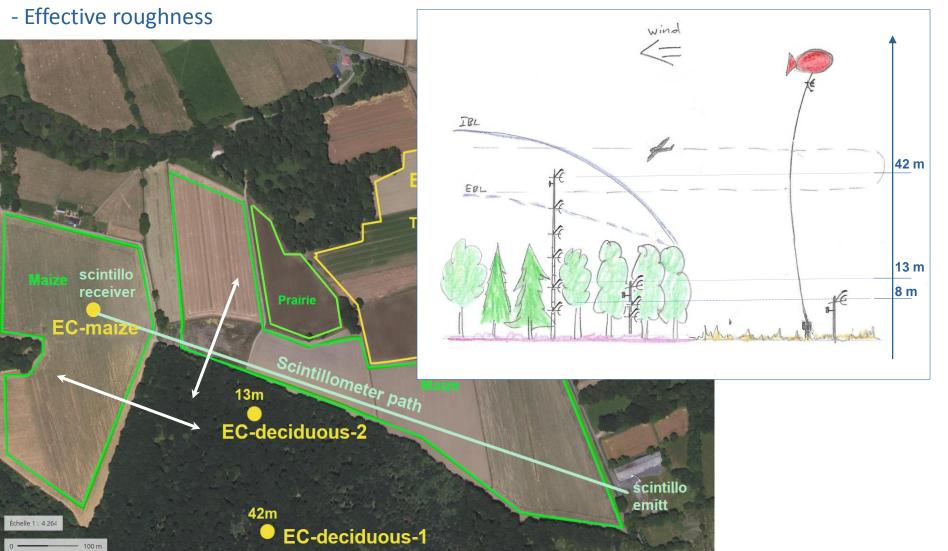
### P2OA EOP: Exploring a specific transition

- -Vertical structure across the transition
- Impact on fluxes and influence of atmospheric structures within canopees
- Effective roughness



### P2OA EOP: Exploring a specific transition

- -Vertical structure across the transition
- Impact on fluxes and influence of atmospheric structures within canopees



# O1- Representativity

How to evaluate the representativity of reference long-term surface flux measurements in an heterogeneous landscape?

### See Poster from Mathilde Jomé (LAERO)!

Based on Meteopole EOP (2021)

- Surface heterogeneity indicators
- Link between

surface energy budget residual and flux heterogeneity

### How to evaluate the representativity of reference long-term surface flux measurements in an heterogeneous landscape

### INTRODUCTION AND AIMS

An accurate evaluation of land-atmosphere (L-A) exchanges and their representation are needed for weather and climate forecasts. A survey on systematic s established that the modelling of surface fluxes is the second most important issue, highlighting the importance of improving the representation of the surface atmosphere interactions in the models. Large biases in the models are still pointed out in the epresentation of surface-atmosphere flux when compared to observations

The Models and Observation for Surface-Atmosphere Interactions (MOSAI) project (https://mosai.aeris-data.fr/) aims at reducing those biases

one family of indicators linked to the surface fluxes measurement errors and bias
 the other linked to the horizontal representativeness of the local measured

scientific objective of this project and concerns the investigation and determination of the uncertainty and representativeness of L-A exchanges meas



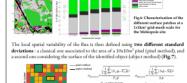


### \*Local spatial variability of the flux

An object identification algorithm (Naida Villefranque, thesis) (Fig. 5) was pplied to land-use maps (CESBIO) to identify and characterise the differen urface patches (Fig.6). For a 1x1km<sup>2</sup>

nted by patches larger than 41m.

SURFACE HETEROGENEITY INDICATORS



We use a simple two-dimensional parar the Flux Footprint Prediction3 and the use-land maps contribution to the measured fluxes (Fig.8).

### NON-CLOSURE AND HETEROGENEITY

Many recent studies have focused on the SEB non-closure issue that turned out to be multifactorial<sup>4,5</sup>. Surface heterogeneity is one of these factors and therefore, we investigate the potential existence of a relationship between the non-closure of the SEB and the heterogeneity of the surface using the two heterogeneity indicators previously defined for the Météopole instrumented site.

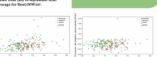
TAKE HOME MESSAGE

SEB (expected)

larger SEB non-closure observed for larger local spatial variability of the H flux (to be confirmed)

Normalized SEB non-closure = Rest-[H+LE+G]





### PERSPECTIVES:

- repeat this study considering the stability of the atmosphere
- studying the horizontal representativeness of these fluxes in the heteror

### REFERENCES:

Mauder, M., Foken, T. & Cuzart, J. Sartace-fivergy-fisions Cicare over Limit: A Review-Soundary-Layer Melecord 177, 396–430 (2020), https://doi.org/10.1007 K. Wilson et al.: Energy Blanco cicare at PLOSMET alex. Agric. For. Melecord., 113 (1-4) (2002).

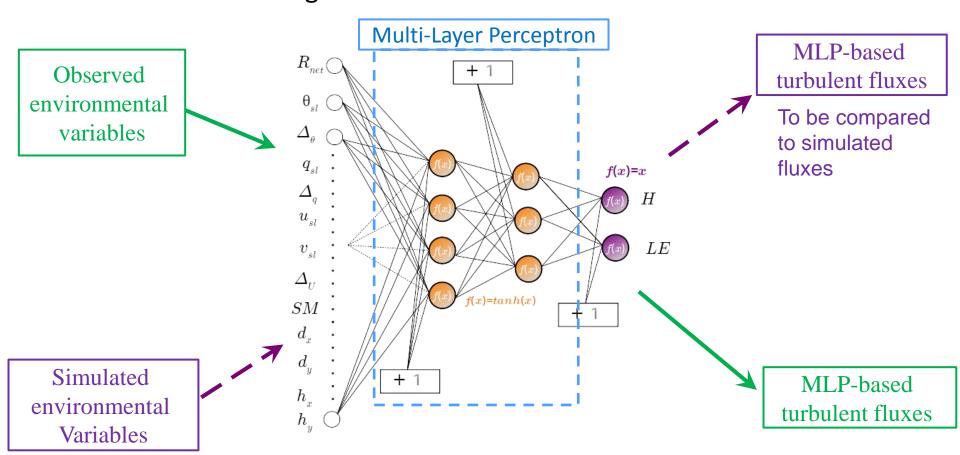


### O2 - New methods for model evaluation

Using neural network to estimate model bias

By Maurin Zouzoua, Sophie Bastin, Marjolaine Chiriaco (LATMOS)

Objective: Make a "fair" model/obs comparison, by freeing from differences in environmental forcings.



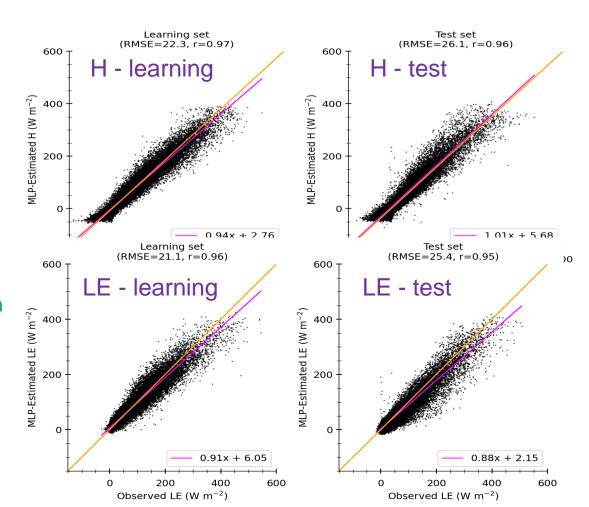
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Observational data from Meteopole, Toulouse (Jun 2012 - Dec 2021)

- Trained MLP performs well
- Difficulties for H estimation in strongly stable surface layer
- Difficulties in cases of large LE

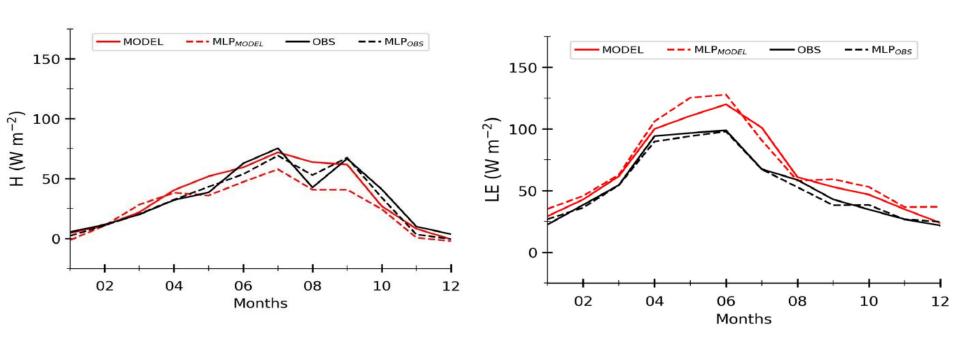


### O2 - New methods for model evaluation

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By Maurin Zouzoua, Sophie Bastin, Marjolaine Chiriaco (LATMOS)

### Preliminary results !!!

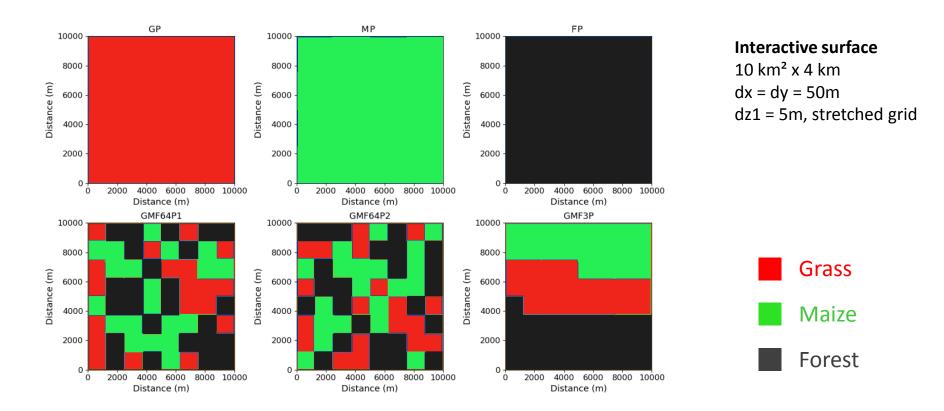


# O3: Improving surface/atmosphere coupling

Impact of surface heterogeneity on the boundary layer flow and nearsurface turbulent exchanges in an LES framework.

by Royston Fernandez, Fleur Couvreux, CNRM

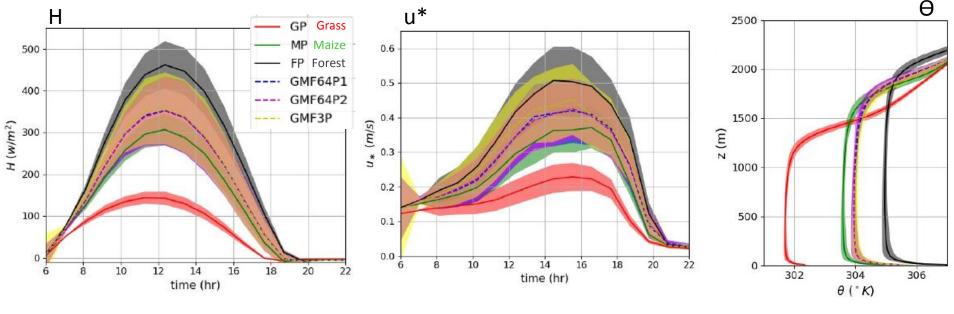
### MesoNH/SURFEX coupled LES



**Objectives** 

# O3: Improving surface/atmosphere coupling

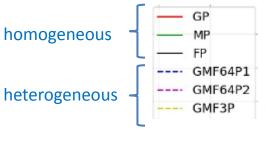
Impact of surface heterogeneity on the boundary layer flow and nearsurface turbulent exchanges in an LES framework.



- Heterogeneity slightly increases mean flux and roughness (larger than the weighted average)
- Near surface wind is more influenced
- BL slightly deeper, but remains well homogeneous, and independent of patch size and distribution

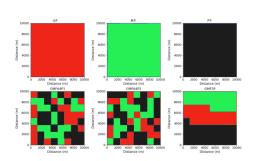
# O3: Improving surface/atmosphere coupling

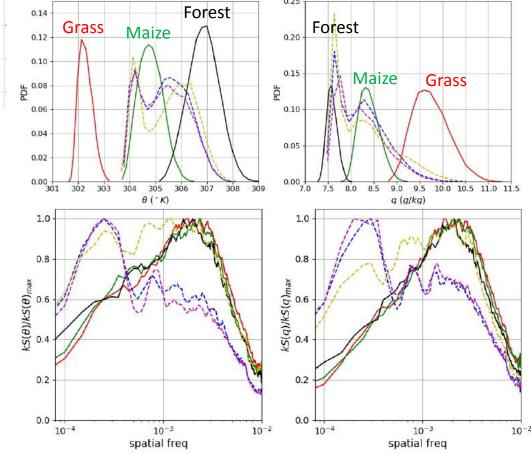
Impact of surface heterogeneity on the boundary layer flow and nearsurface turbulent exchanges in an LES framework.



Heterogeneity induces Bimodal distributions and excess of energy at larger scales

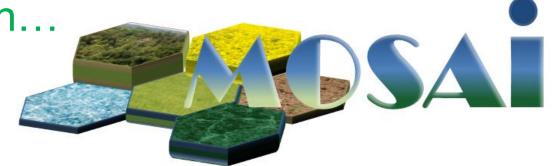
→ due to **secondary circulations** 





More to come soon...

# Thank you!



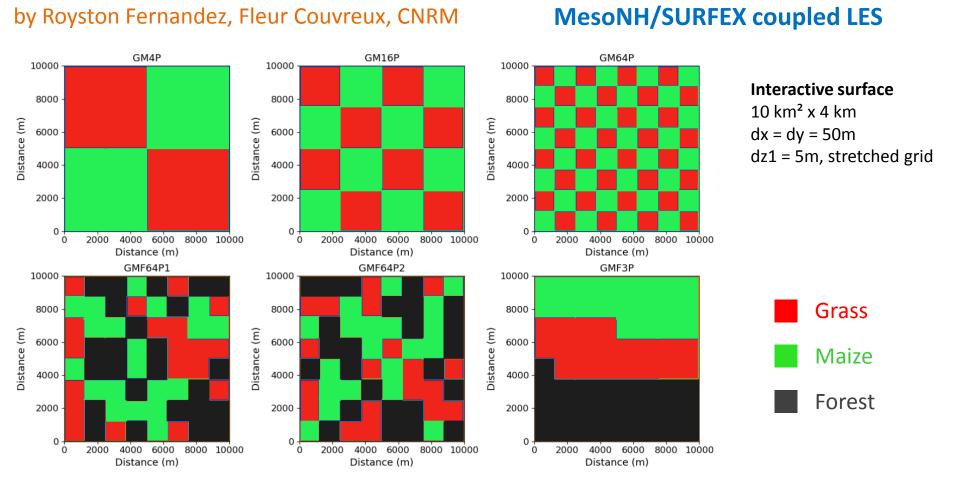
### Web site & Data base:

https://mosai.aeris-data.fr/



# O3: Improving surface/atmosphere coupling

Impact of surface heterogeneity on the boundary layer flow and nearsurface turbulent exchanges in an LES framework.



**Motivations** 

## O3: Improving surface/atmosphere coupling

Impact of surface heterogeneity on the boundary layer flow and nearsurface turbulent exchanges in an LES framework.

