

Models

The Multi-Hydro platform

Abdellah ICHIBA (HMCo-ENPC)

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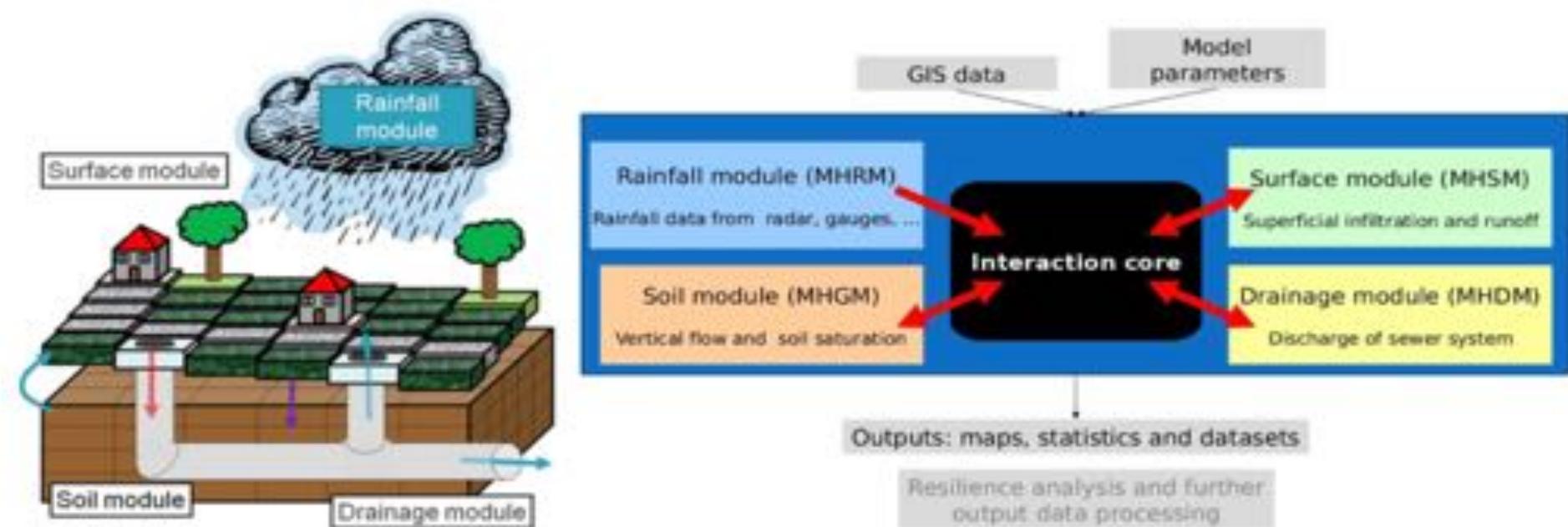


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Multi-Hydro Platform

A **coupling Core** between four modules. Each represents a portion of the water cycle in the urban environment :

- The Rainfall module
 - The Surface module
 - The Drainage module
 - The Sol module
- Fully distributed
 - Physically based model



Multi-Hydro Platform

- **Physically based** (No calibration needed)
- Takes into account the **high heterogeneity** of urban catchment
- Detailed **information available at small scale**
- **High Flexibility to change the spatial resolution**
- **Sewer Overflow computed**

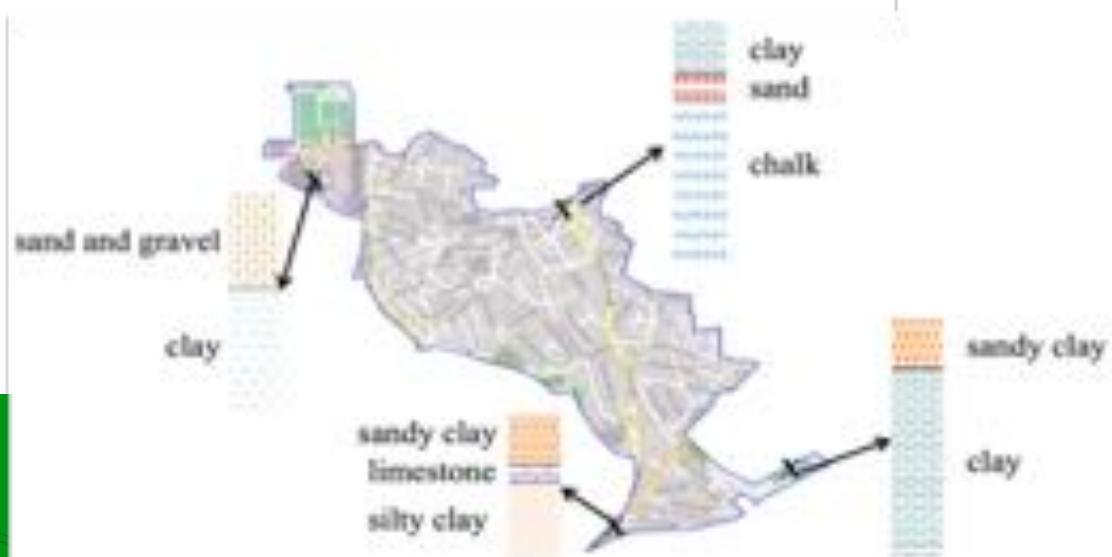
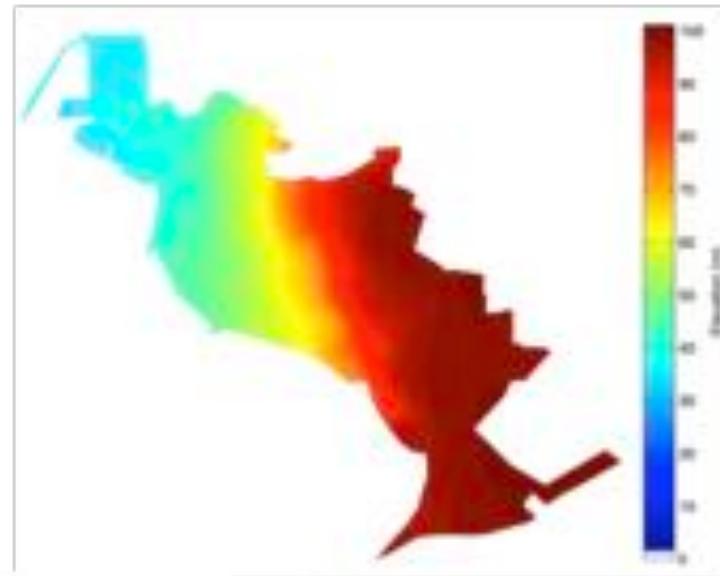


- **Conceptual based (calibration needed to force the model)**
- **Uniform properties** at the sub-catchment scale
- **Information only available at sub-catchment outlet**
- **Very difficult to change the spatial resolution**
- Sewer Overflow not considered



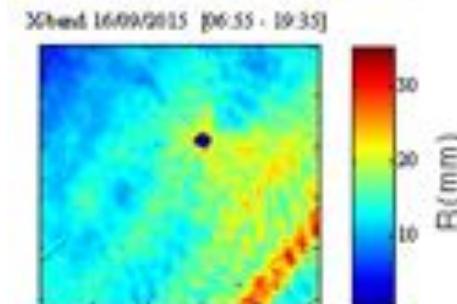
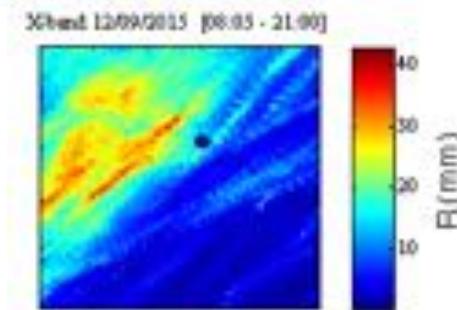
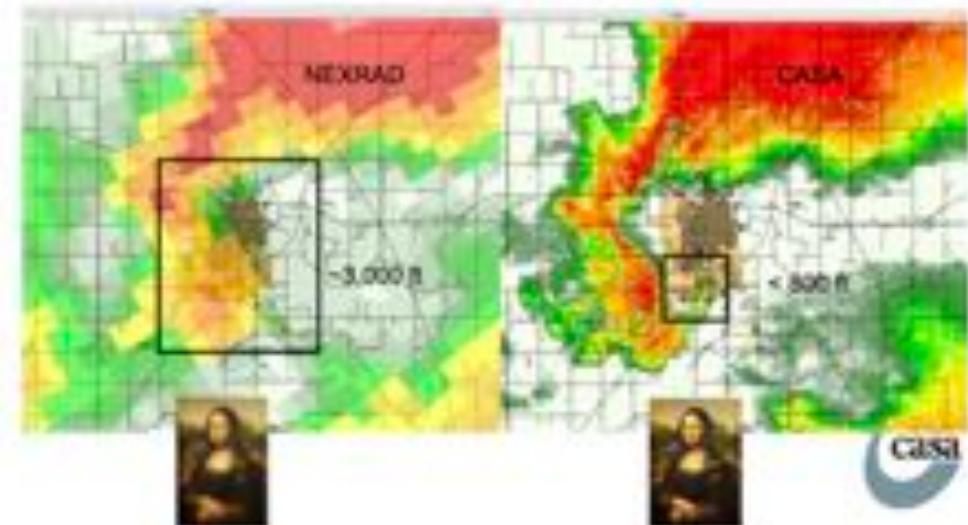
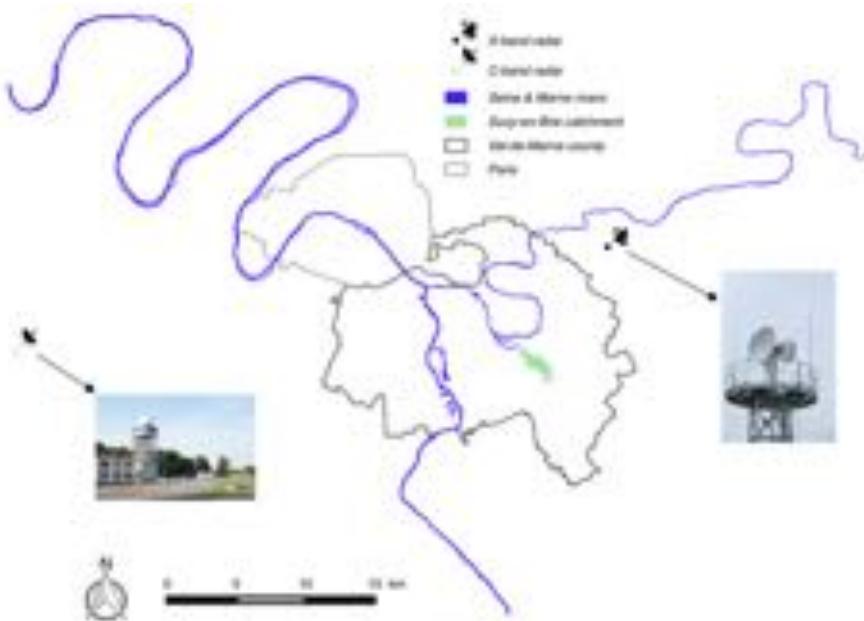
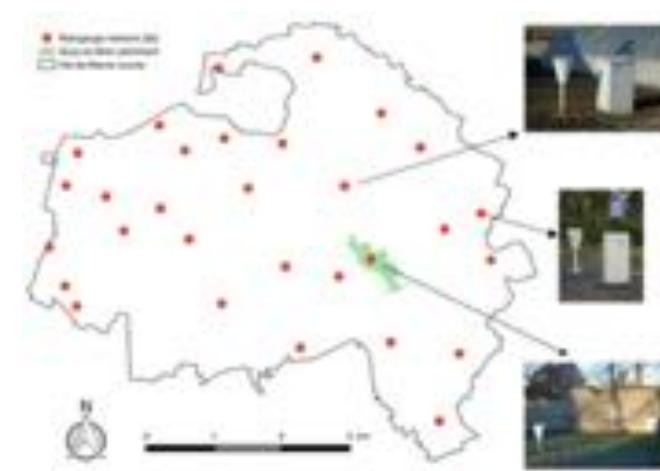
Multi-Hydro Platform

The modelling approach : Full consideration of the urban catchment heterogeneity



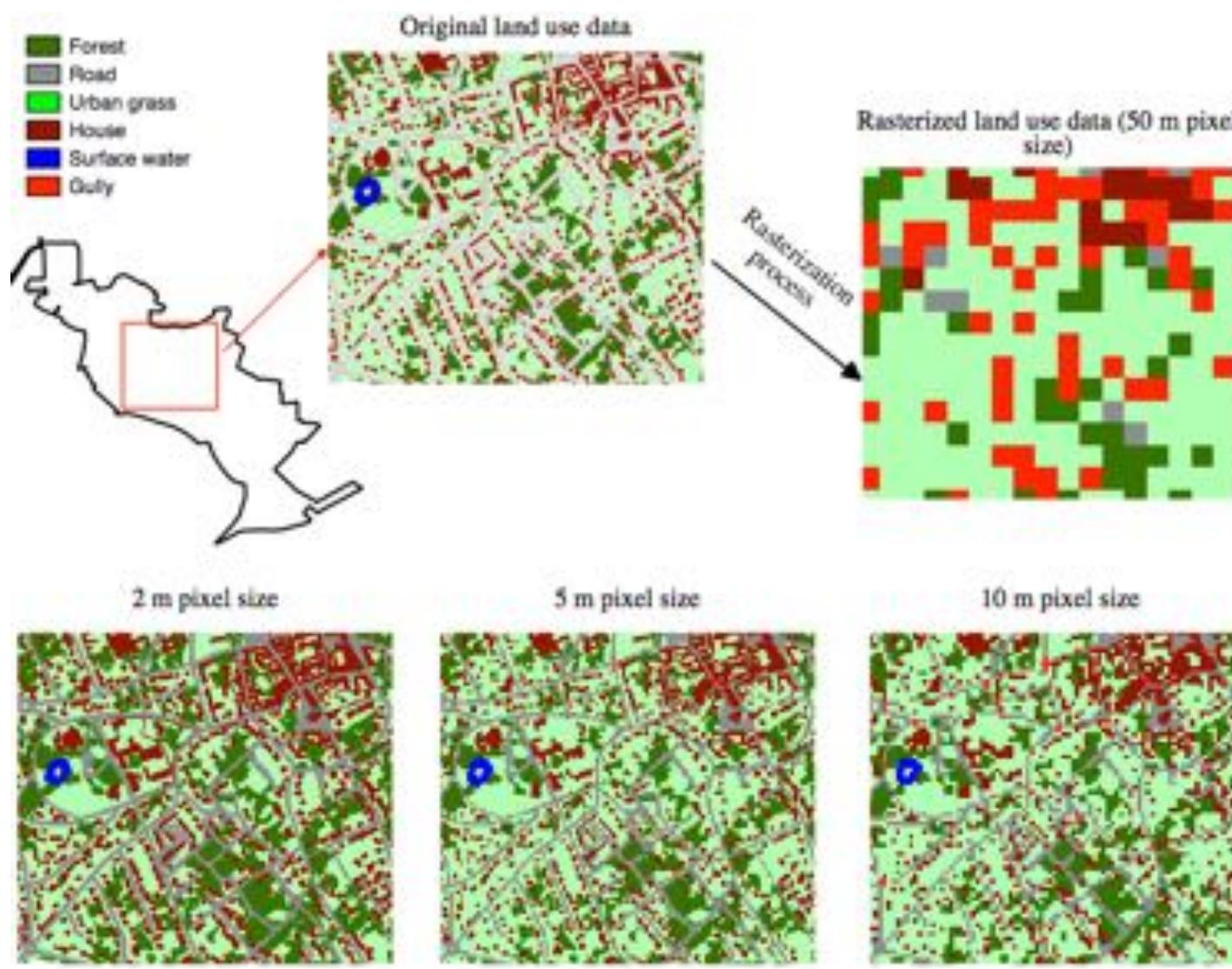
Multi-Hydro Platform

The modelling approach : Full consideration of the rainfall spatio-temporal variability



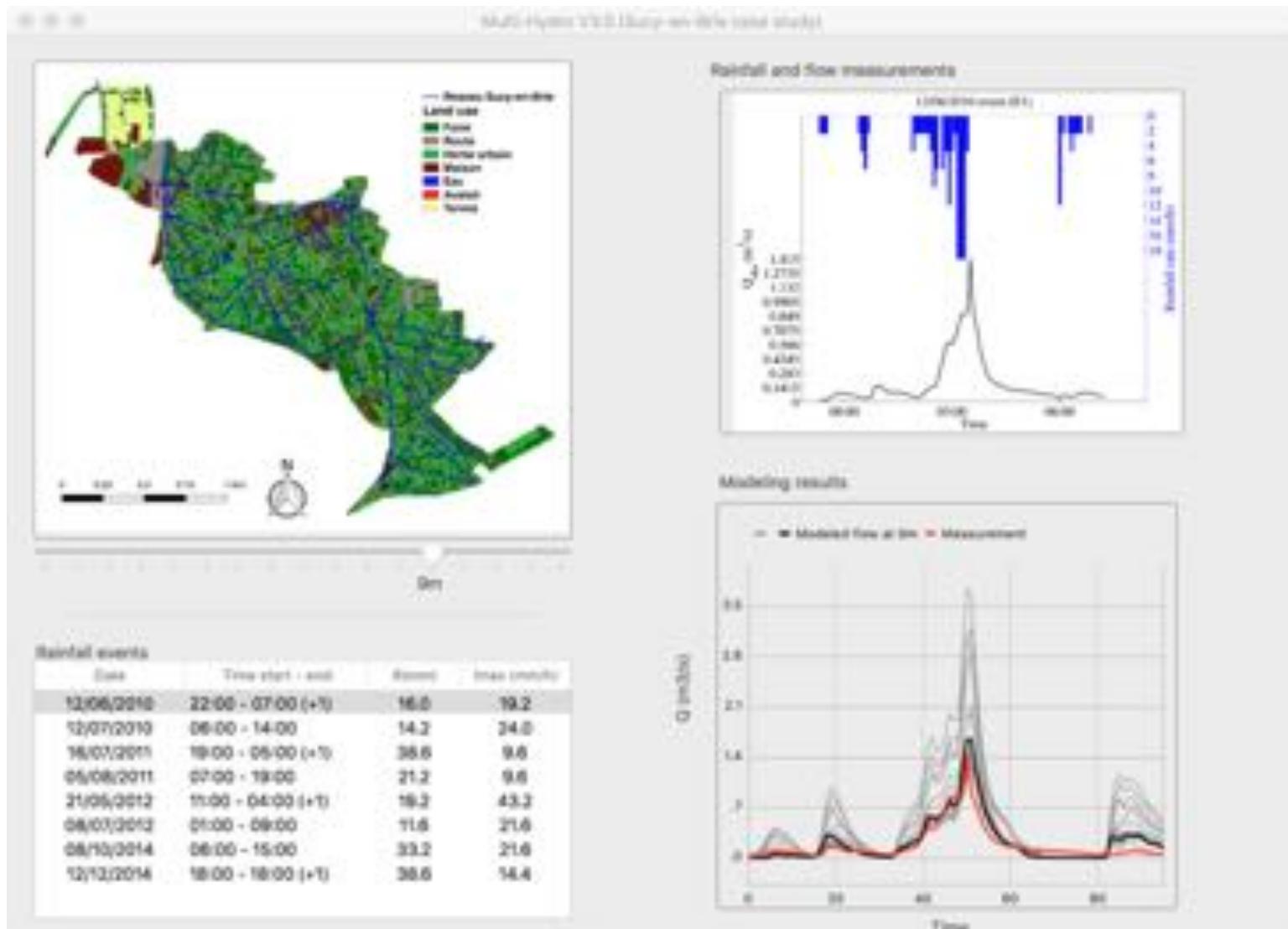
Multi-Hydro Platform

The modelling approach : Grid-based model with one unique land use class for each pixel

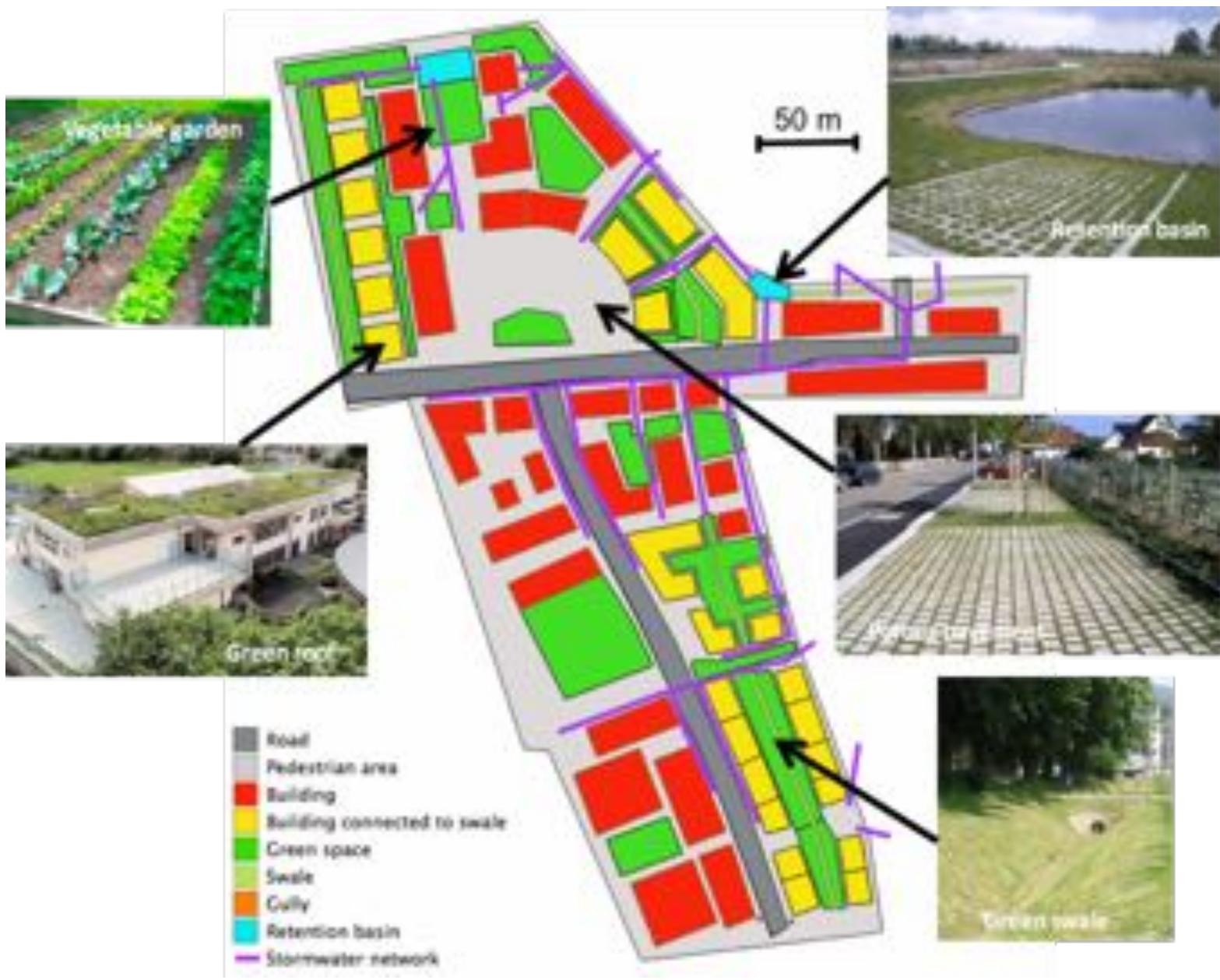


Multi-Hydro Platform

Sucy-en-Brie case study : assessing the effect of scale



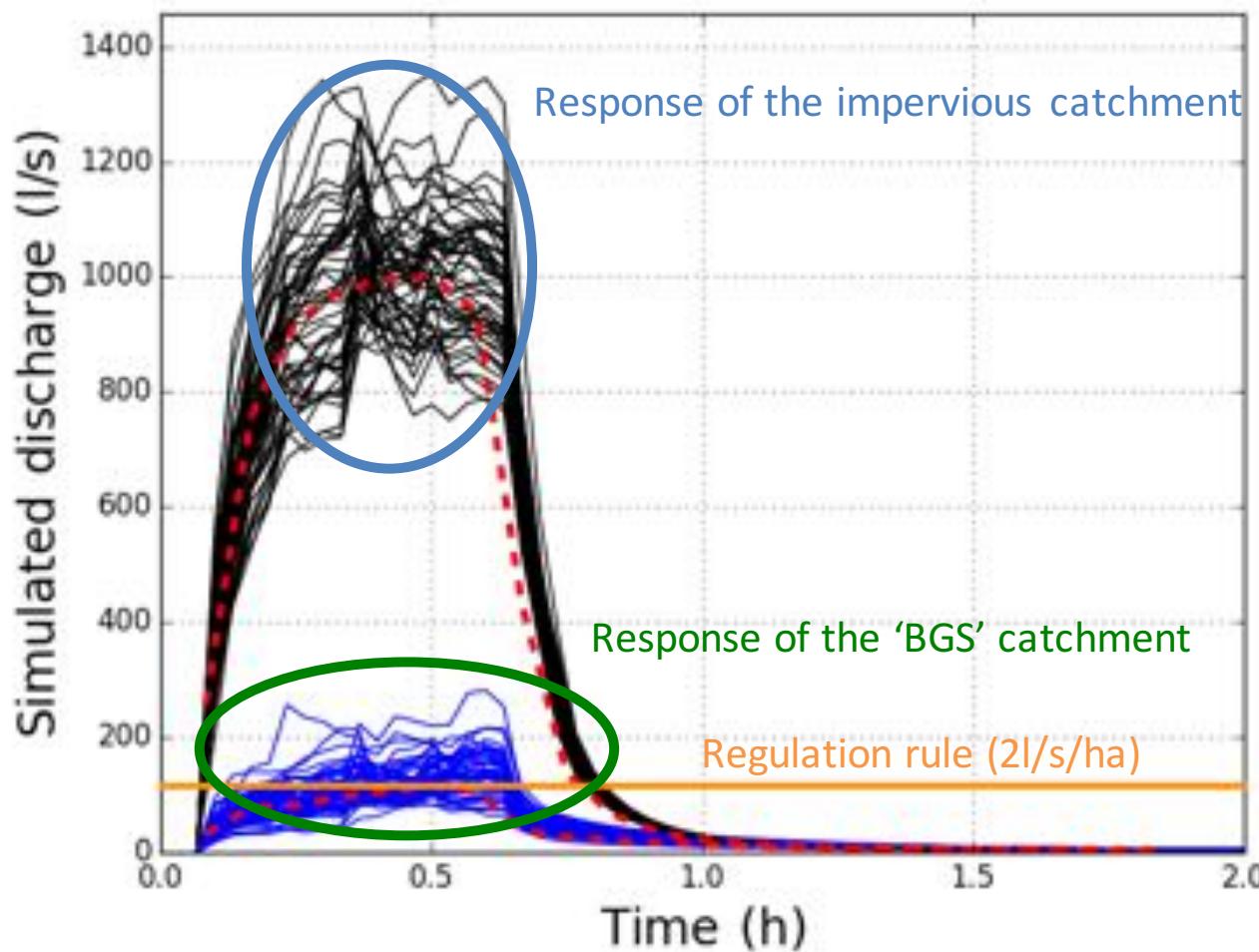
Multi-Hydro Platform



Multi-Hydro Platform

Use of Multi-Hydro to assess BGS as tools to solve stormwater management issues

Use of 50 downscaled rainfall scenarios: Duration = 30 minutes, T= 5 years



Models SOLENE-microclimat

Marjorie Musy (Cerema Nantes)



Direction territoriale Ouest



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SOLENE-microclimat

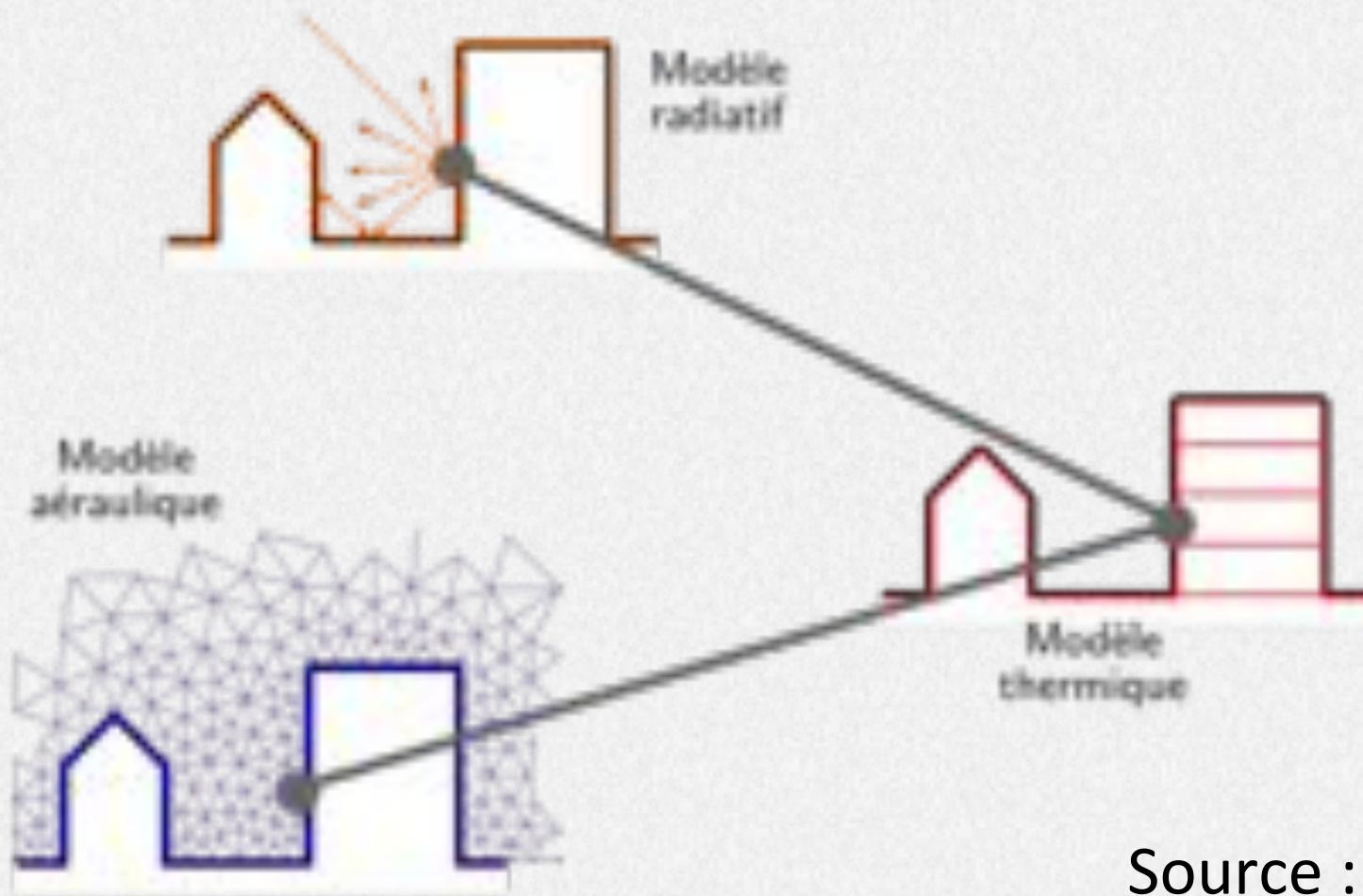
- Principe du modèle
- Types d' application
- Historique
- Modèles
- Types de résultats
- Limites
- Bibiographie



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SOLENE-microclimat

Qu'est-ce que Solene-microclimat ?



Source : L. Malys

SOLENE-microclimat

Les types d'applications

SOLENE

Solenne-microclimat

Indicateurs morphologiques

Ensoleillement

Lumière

Thermique

Micro-climatologie et confort extérieur

Adaptation climatique

Consommation énergétique des bâtiments et confort intérieur



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SOLENE-microclimat

Histoire

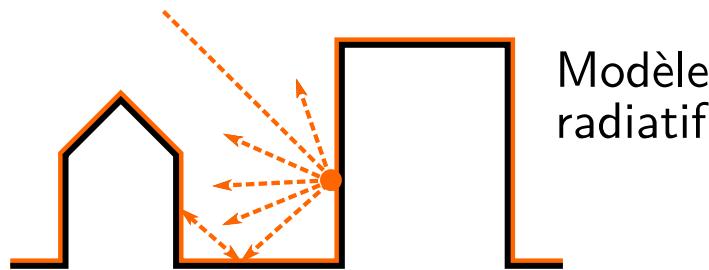
- Des développements initiaux : SOLENE (D. Groleau, F. Miguet, C. Marenne et al.)
- Des thèses : Solene-microclimat (direction C. Inard et M. Musy)
- De la ré-ingénierie de SOLENE (T. Leduc et al.)
- Des applications (VegDUD, Tipee, EVA...)



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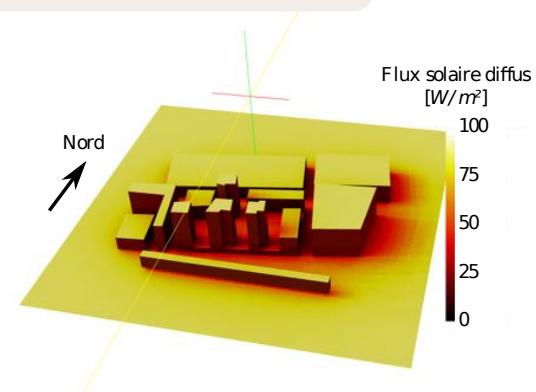
SOLENE-microclimat

Les modèles : 1 – Modèle radiatif



Solene

- Rayonnement solaire direct et diffus (ciel discréte)
- Interreflexions solaires (méthode des radiosités)
- Bilan de rayonnement infrarouge



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SOLENE-microclimat

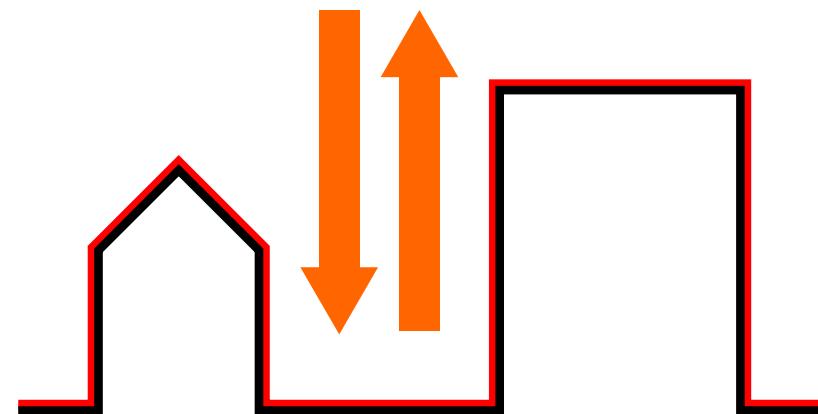
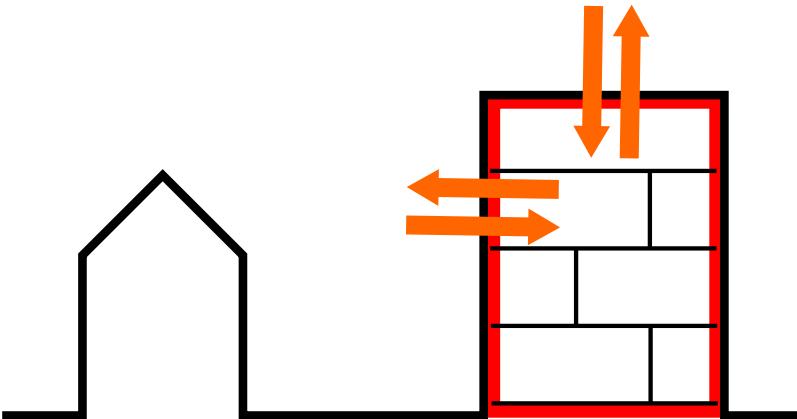
Les modèles : 2 – Modèle thermique

Modèle thermique de bâtiment

- Pas de représentation explicite de l'environnement
- Bilan thermique de surface simplifié à l'extérieur du bâtiment
- Centré sur les systèmes de chauffage et de climatisation

Modélisation microclimatique

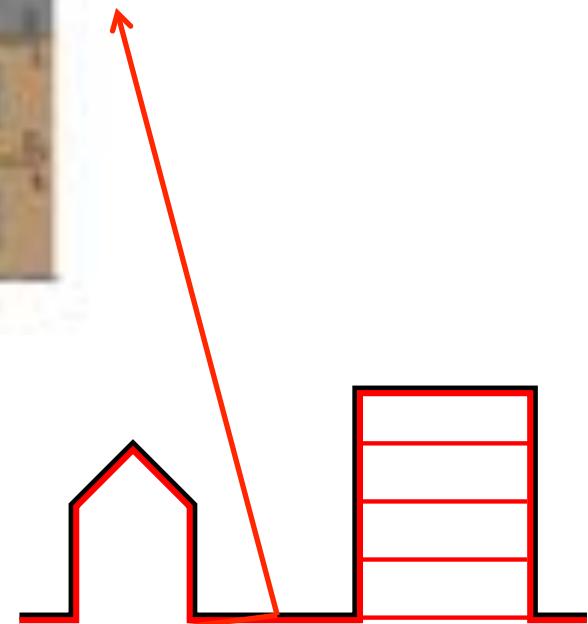
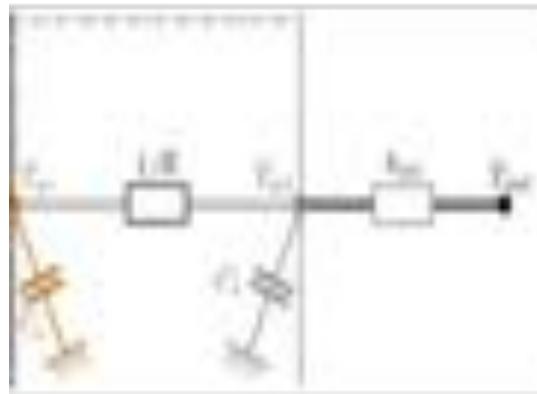
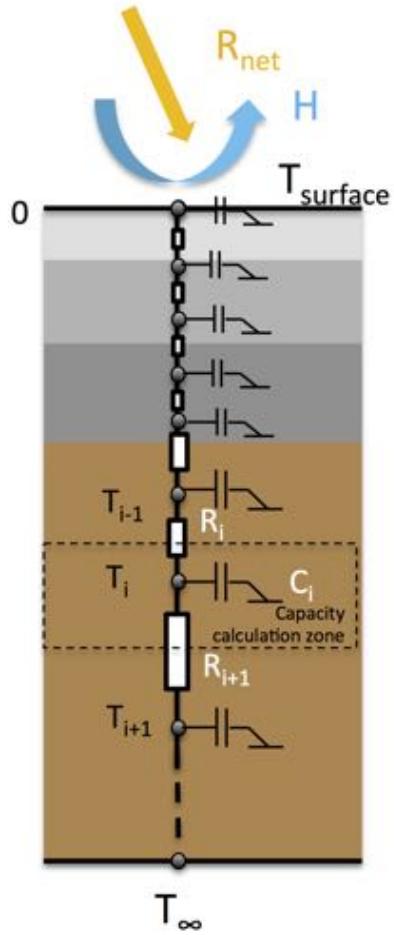
- Pas de représentation explicite de l'intérieur des bâtiments
- Pas de bilan énergétique des bâtiments
- Flux convectifs forcés ou température intérieure fixée



SOLENE-microclimat

Modèle de sol

J. Bouyer



Modèle
thermique

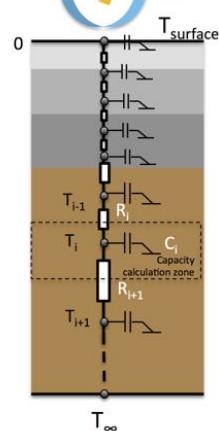
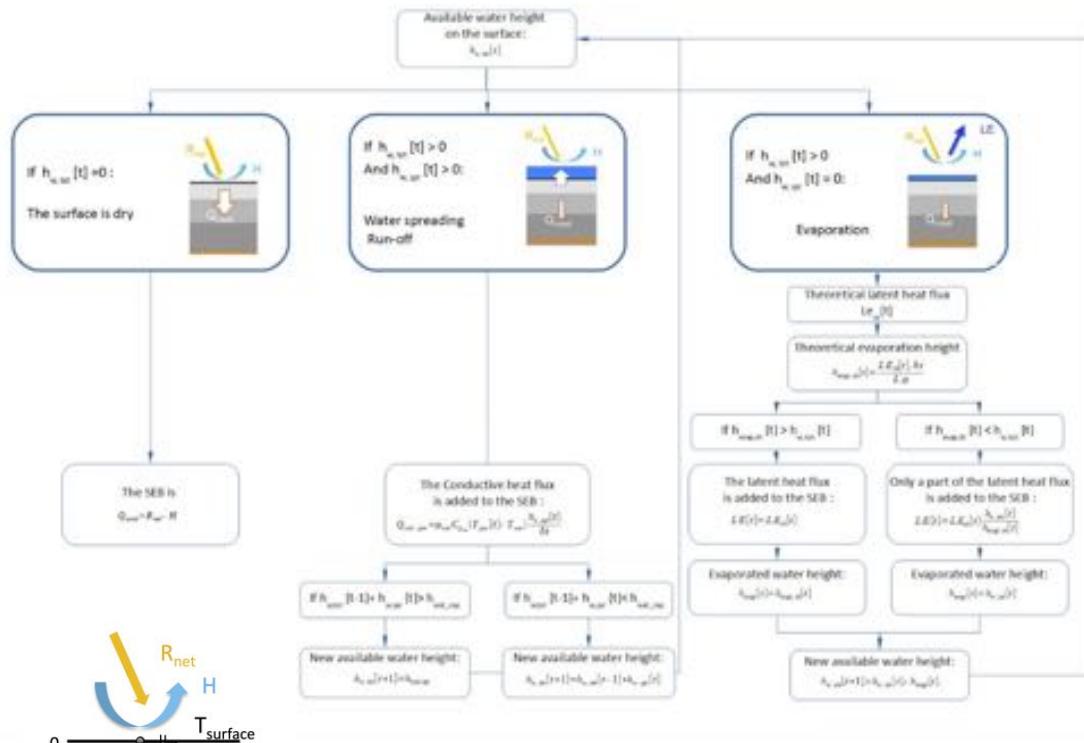


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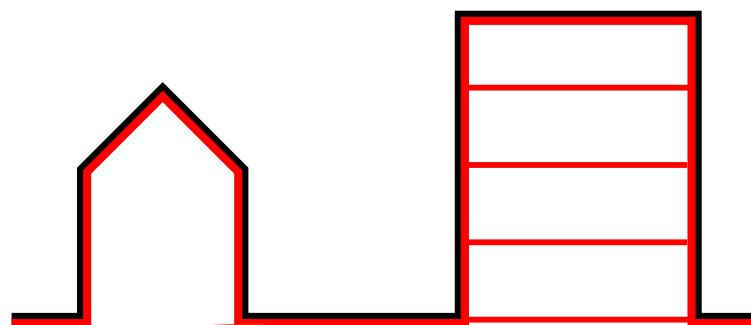
M-A Azam

SOLENE-microclimat

Humidification du sol



M-A Azam

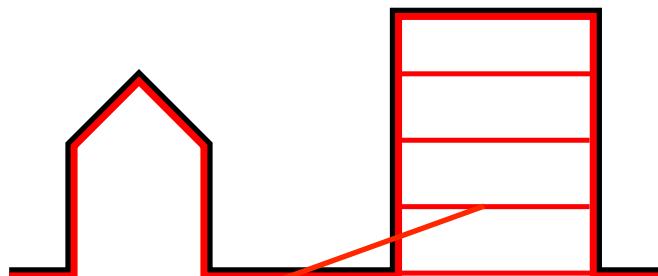
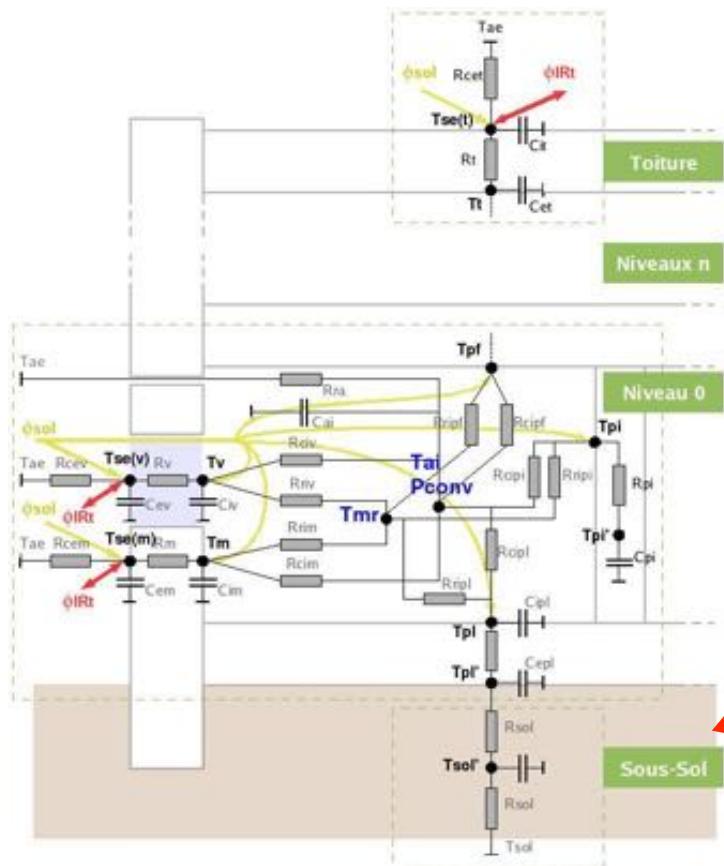


Modèle thermique

SOLENE-microclimat

Solene [Bouyer, 2009]

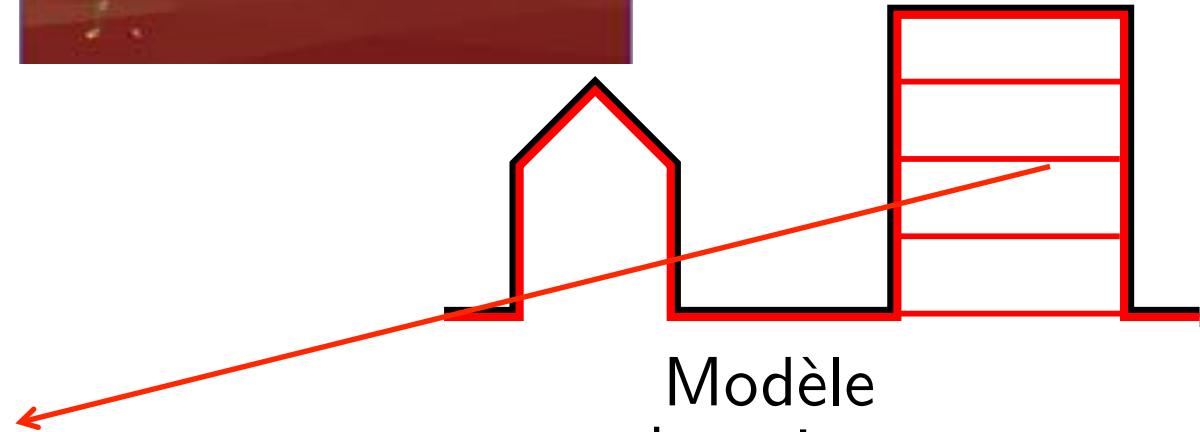
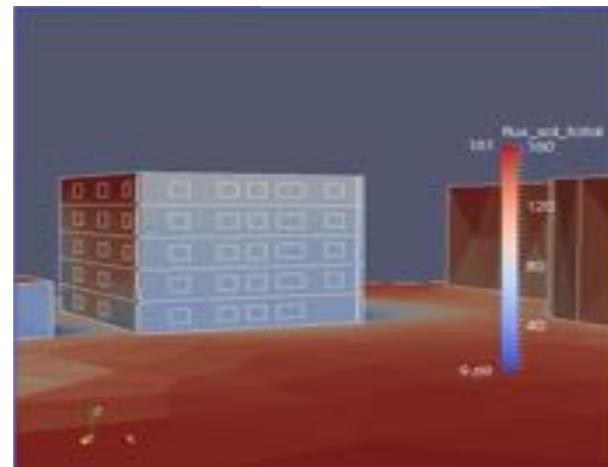
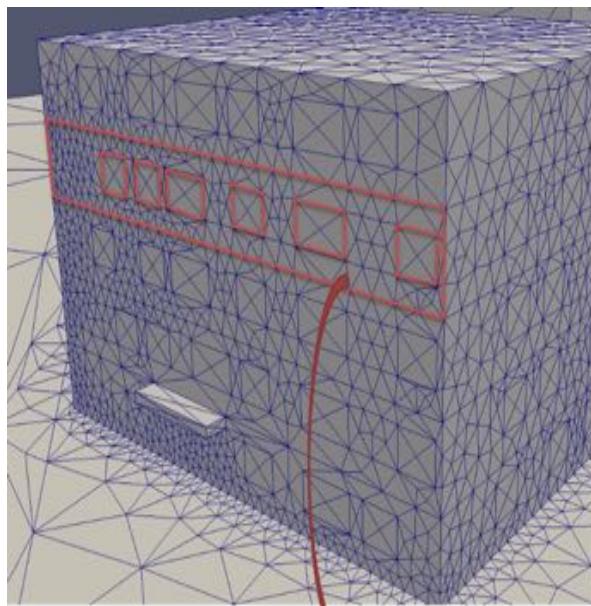
- Modèle de paroi R2C
- Modèle thermique multizone (une zone par étage)
- Conditions aux limites extérieures discrétisées



Modèle
thermique

SOLENE-microclimat

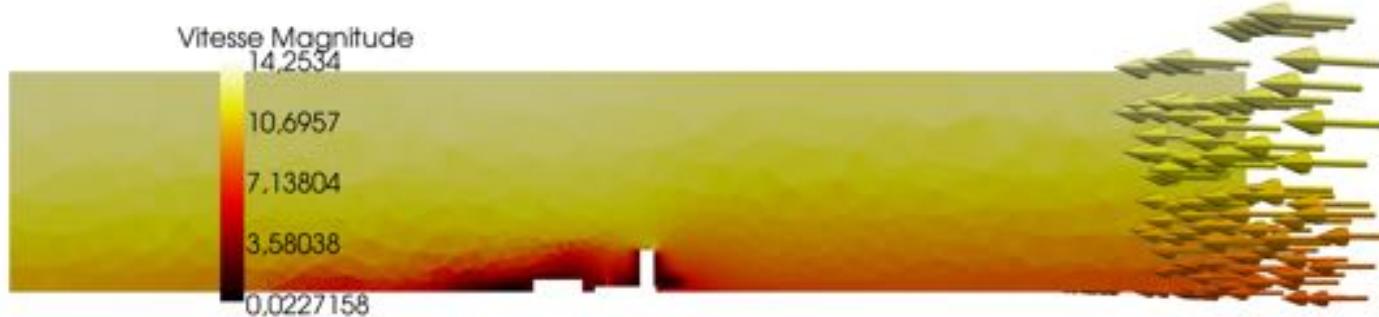
Modèle de bâtiment différences finies et plusieurs nœuds internes par étage (Rodler 2017)



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SOLENE-microclimat

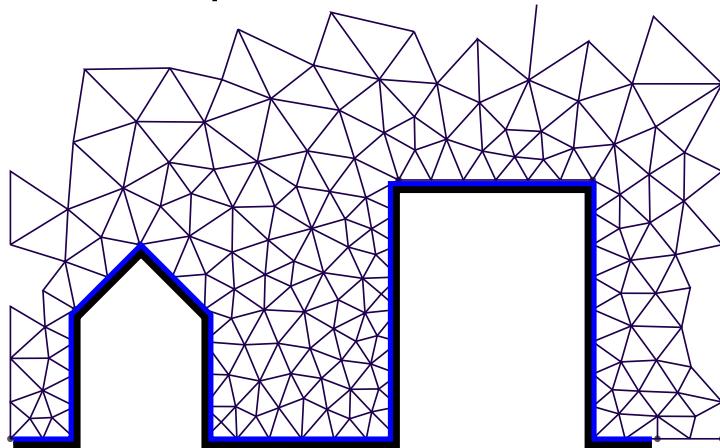
Les modèles : 3 – Modèle aérodynamique



Modèle
aéraulique

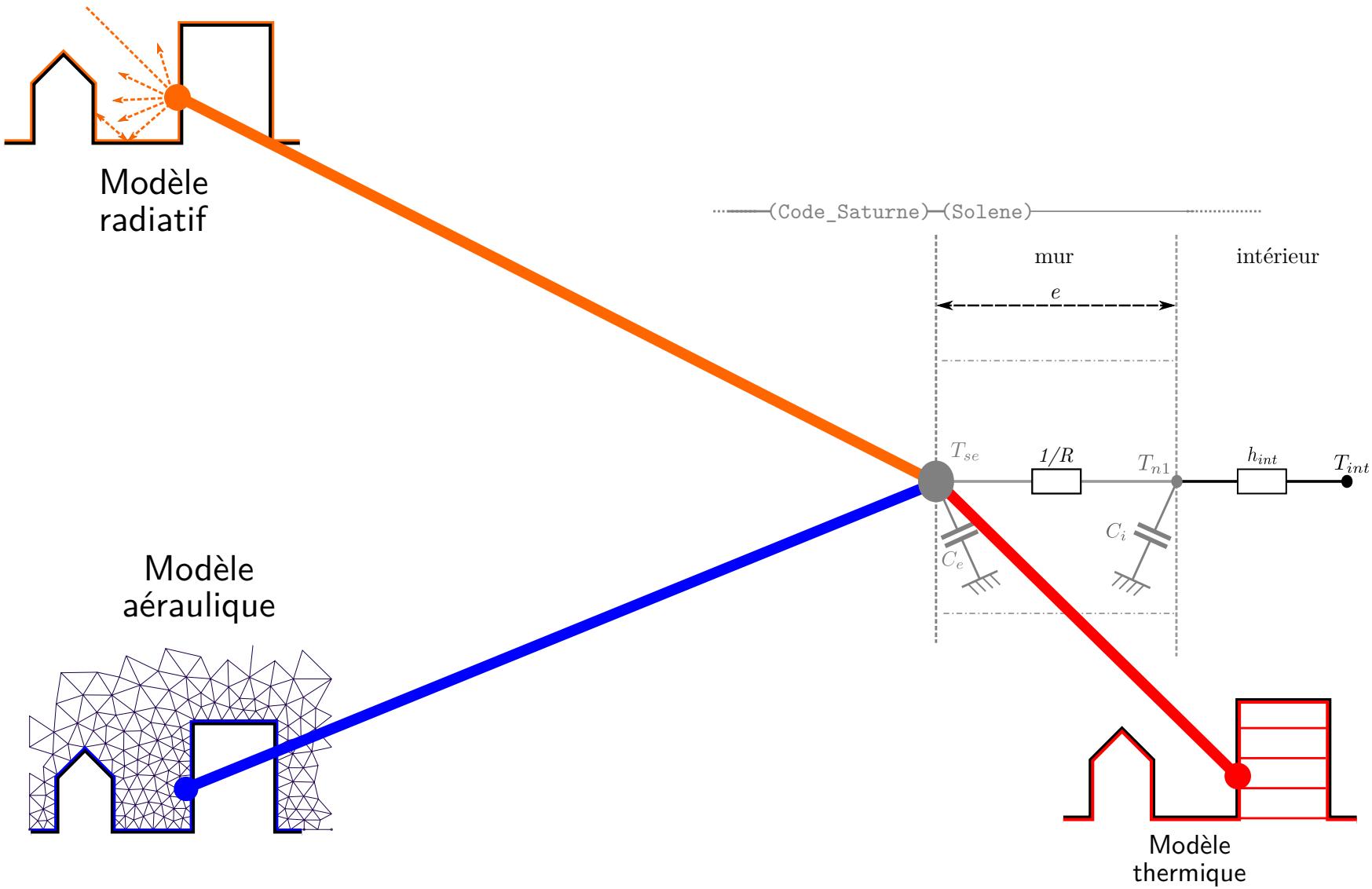
Code_Saturne

- Technique de la veine numérique
- Méthode RANS, modèle de turbulence k-epsilon
- Transport de la température et de l'humidité

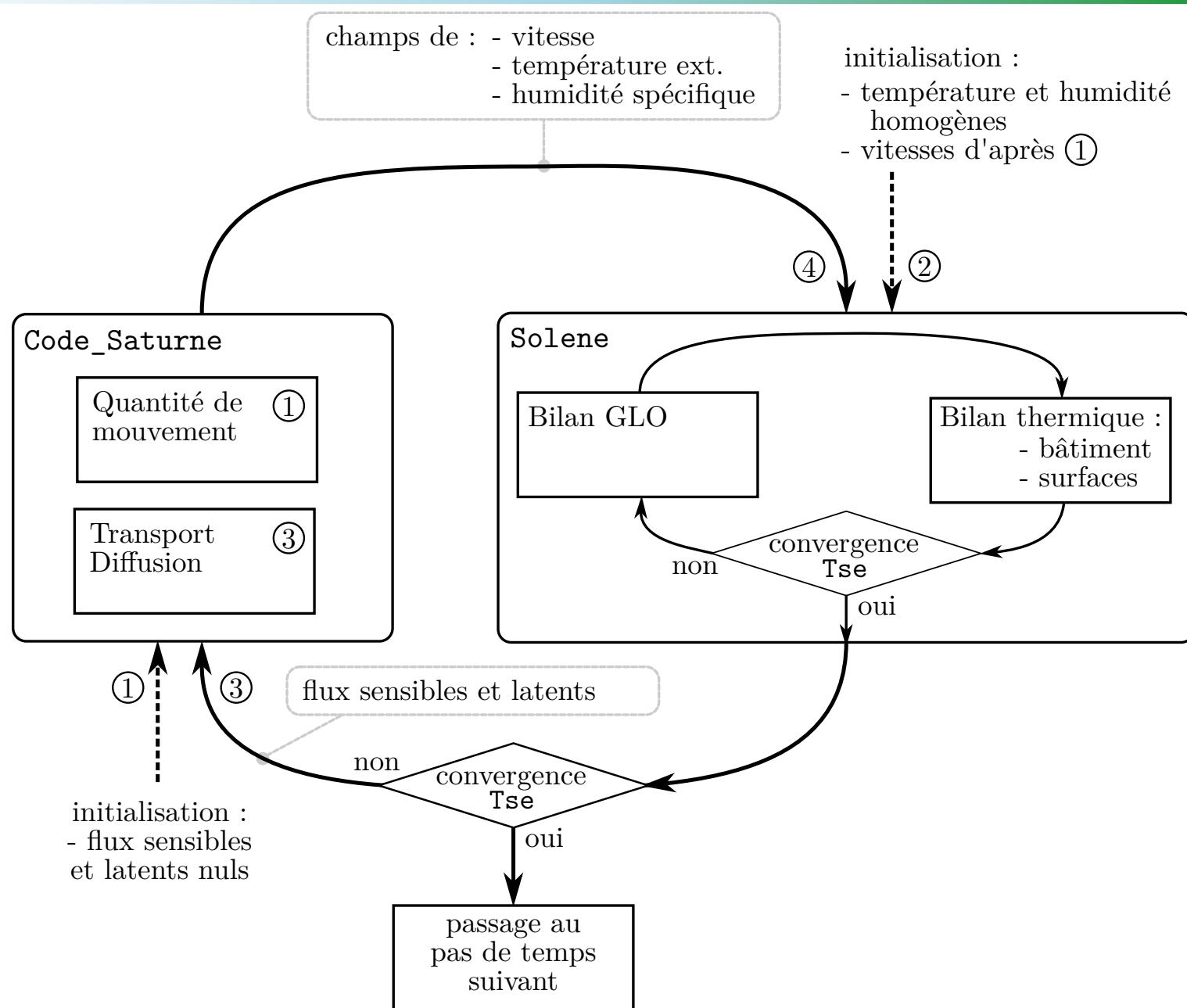


SOLENE-microclimat

Les modèles : 4 – Le Couplage



SOLENE-microclimat



SOLENE-microclimat

Les modèles : Modules ajoutés

Bassins d'eau (M. Robitu)

Arbres (M. Robitu)

Sols naturels (J. Bouyer / L. Malys)

Toitures et façades végétales (L. Malys)

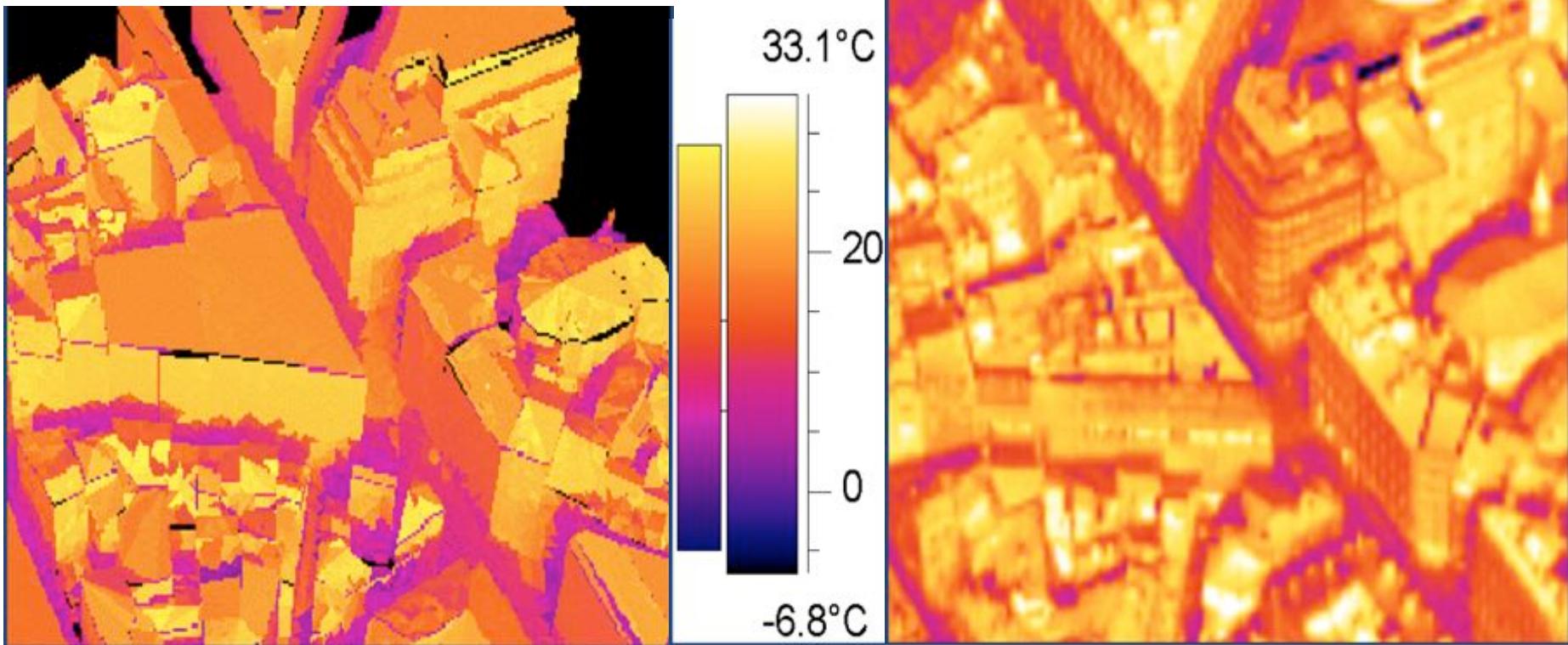
Sols imperméables détaillés + arrosage (M-H Azam)



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SOLENE-microclimat

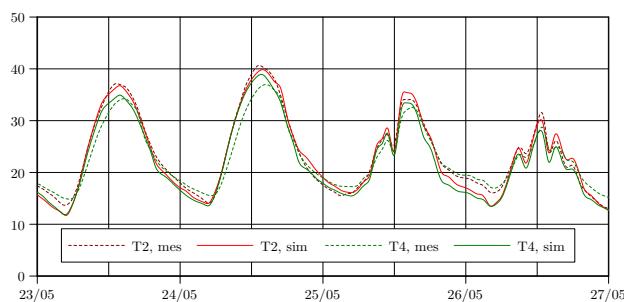
Les modèles : Eléments de validation



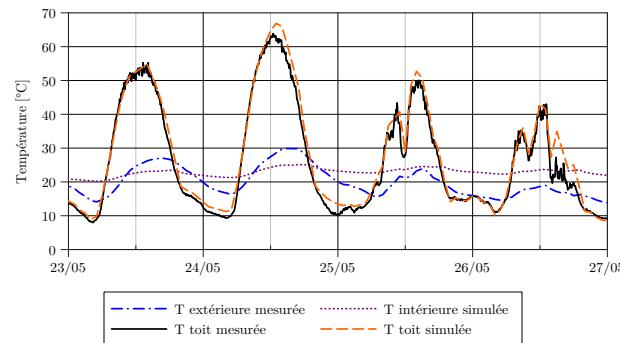
Comparaison avec la mesure de la caméra aéroportée (Capitol Toulouse), Source : A. Hénon

SOLENE-microclimat

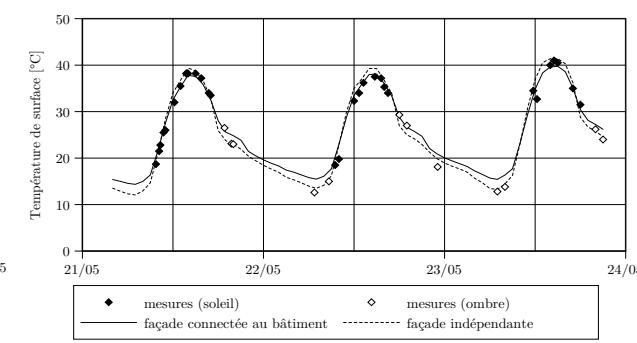
Les modèles : Eléments de validation



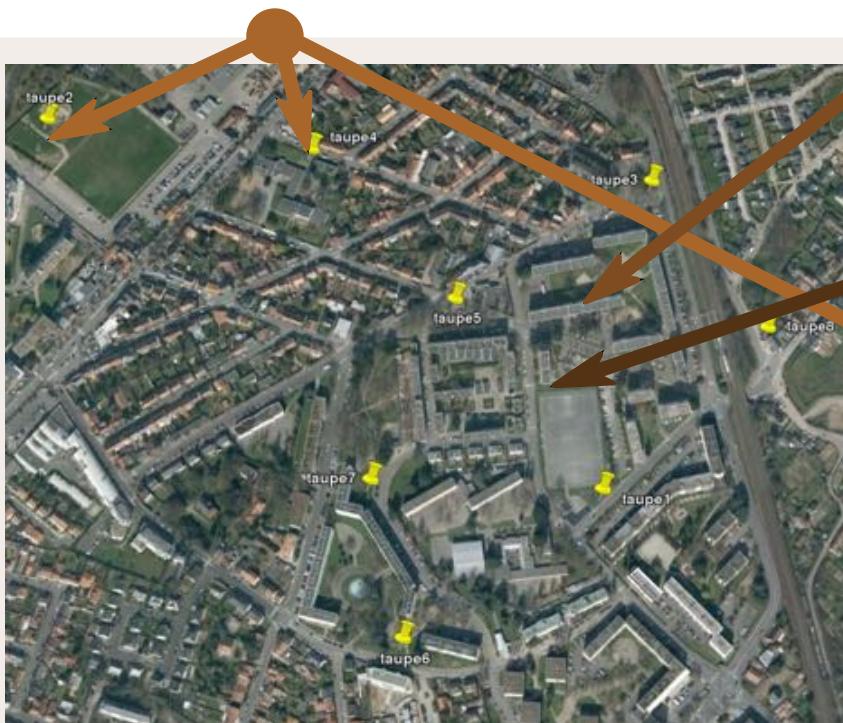
Modèle de sol



Modèle de toit

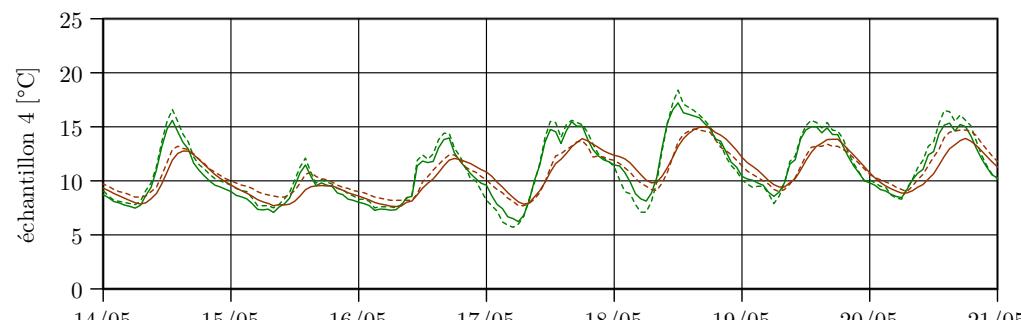
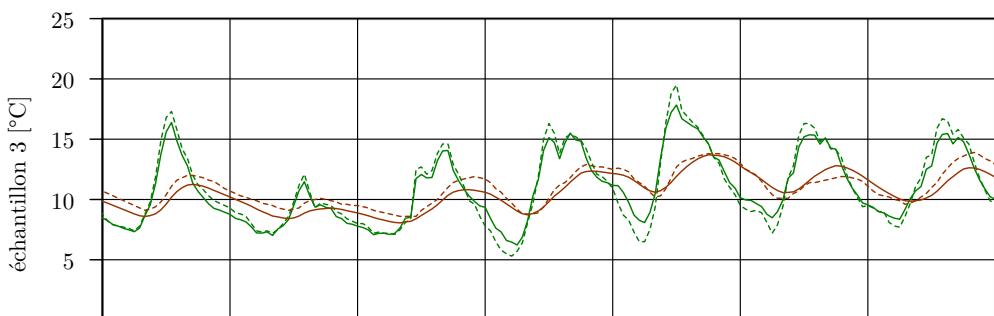
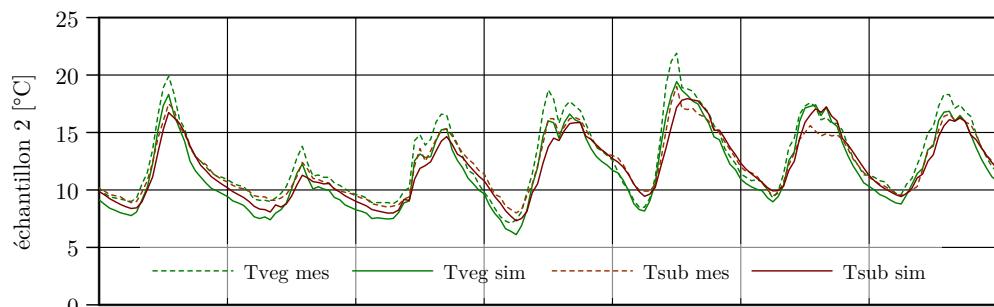


Modèle de façade



Comparaison avec les mesures de FLUXSAP 2010 (Nantes) Source : L. Malys

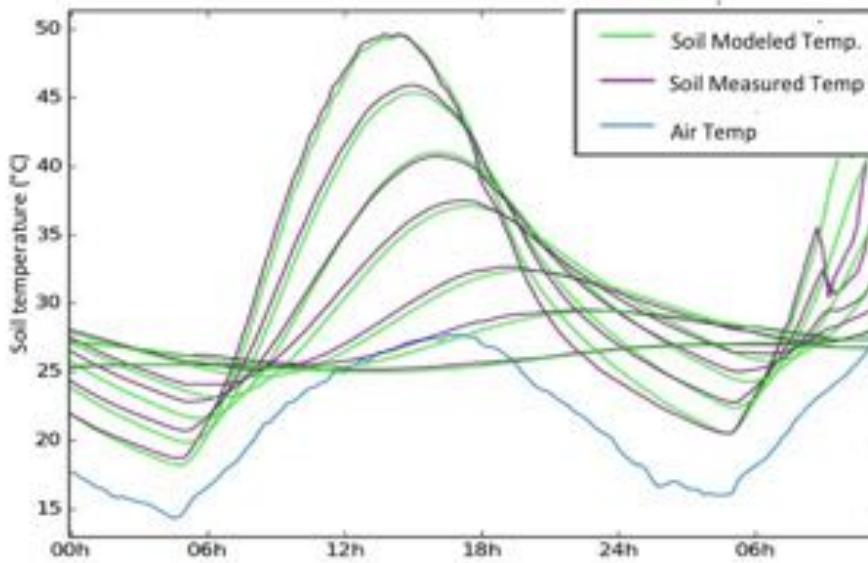
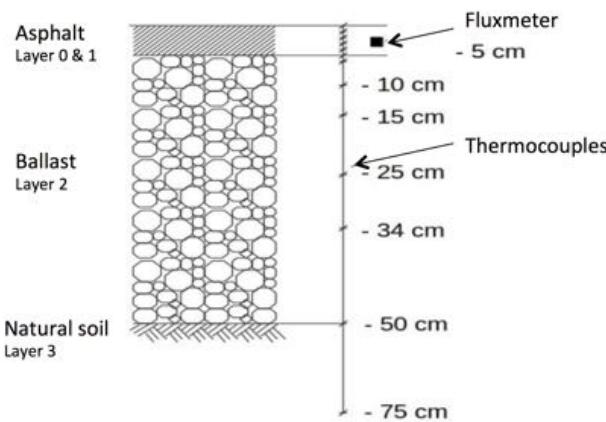
SOLENE-microclimat



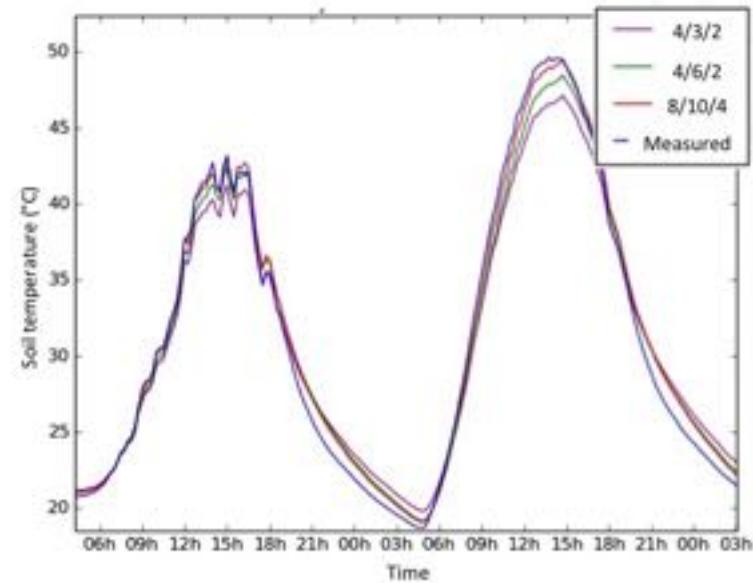
Comparaison avec les mesures
de l'HEPIA (Génève) Source :
L. Malys

SOLENE-microclimat

- Meteorological data
- ↗↘ Sonic Anemometer (1 and 2 m)
- Net Radiometer at 1 m
- Pyranometer at 1 m



Sol (campagne ROSURE) Période sèche



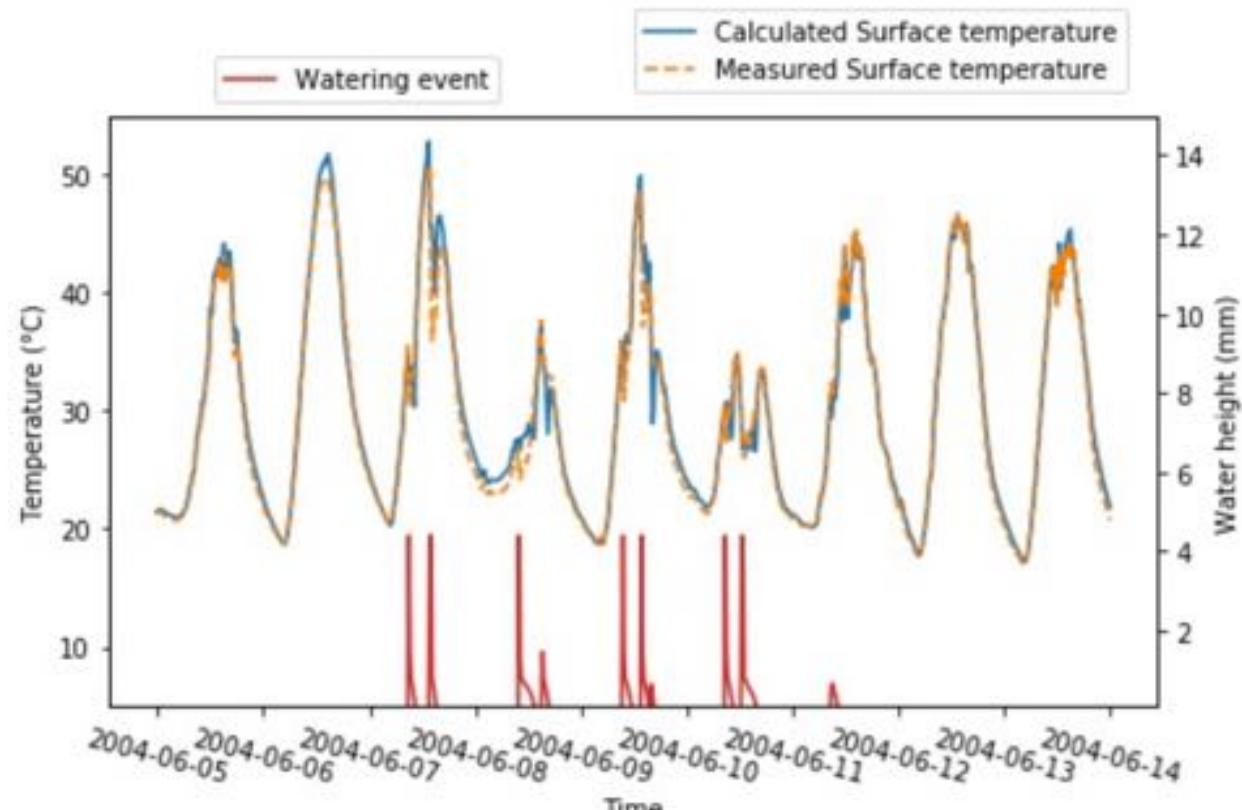
Avec différents nombres de noeuds

SOLENE-microclimat



Sol (campagne ROSURE)
Arrosage

Avec différents
nombres de noeuds



SOLENE-microclimat

Limites

Réflexions diffuses uniquement

Calcul énergétique pour un seul bâtiment

Taille de la zone de calcul limitée

Situations de convection naturelle (pas de vent) impossible



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SOLENE-microclimat

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Groleau, D. and P.G. Mestayer, 2012, Urban morphology influence on urban albedo - a revisit with the Solene model, *Boundary-Layer Meteorology*, 147 (2), 301-327

Hénon, A., P.G. Mestayer, D. Groleau, J. Voogt, 2011, High resolution thermo-radiative modeling of an urban fragment in Marseilles city center during the UBL-ESCOMPTE campaign, *Building and Environment*, 46, 1747-1764.

Hénon, A., P.G. Mestayer, J.P. Lagouarde, J.A. Voogt, 2012, An urban neighborhood temperature and energy study from the CAPITOUL experiment with the Solene model. Part 1: analysis of flux contributions, *Theoretical and Applied Climatology*, 110, 177-196

Hénon, A., P.G. Mestayer, J.P. Lagouarde, J.A. Voogt, 2012, An urban neighborhood temperature and energy study from the CAPITOUL experiment with the Solene model. Part 2: influence of building surface heterogeneities, *Theoretical and Applied Climatology*, 110, 197-208

Malys, Laurent, Marjorie Musy, et Christian Inard. « A hydrothermal model to assess the impact of green walls on urban microclimate and building energy consumption ». *Building and Environment* 73, n° 0 (2014): 187-97.



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SOLENE-microclimat

Azam, Marie-Hélène, Benjamin Morille, Jérémy Bernard, Marjorie Musy, et Fabrice Rodriguez. « A new urban soil model for SOLENE-microclimat: review, sensitivity analysis and validation on a car park ». *Urban Climate* In press (2017).

Bernabé, Anne, Marjorie Musy, Hervé Andrieu, et Isabelle Calmet. « Radiative properties of the urban fabric derived from surface form analysis: A simplified solar balance model ». *Solar Energy* 122 (2015): 156-68. <https://doi.org/10.1016/j.solener.2015.08.031>.

Gros, Adrien, Emmanuel Bozonnet, Marjorie Musy, et Christian Inard. « Simulation tools to assess microclimate and building energy - a case study on the design of a new district ». *Energy and Buildings* 114 (2016)

Malys, Laurent, Marjorie Musy, et Christian Inard. . « Direct and Indirect Impacts of Vegetation on Building Comfort: A Comparative Study of Lawns, Green Walls and Green Roofs ». *Energies* 9, n° 1 (2016): 32.

Malys, Laurent, Marjorie Musy, et Christian Inard. . « Microclimate and building energy consumption: Study of different coupling methods ». *Advances in Building Energy Research*, 2015.

Morille, Benjamin, Marjorie Musy, et Laurent Malys. « Preliminary study of the impact of urban greenery types on energy consumption of building at a district scale: academic study on a canyon street in Nantes (France) weather conditions. » *Energy and Buildings* 114 (2016): 275-82.



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