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# Evaluation of the Suitability of the Land Surface Model JULES for Environmental Change Studies in Belgium

Catherine Van den Hoof[1,3], Marc Aubinet[2], Bernard Heinesch[2], Rémy Soubie[3], Caroline Vincke[3]

(1) Belgian Nuclear Research Centre, Belgium
(2) Unité de Physique des Biosystèmes, Faculté Universitaire des Sciences Agronomiques de Gembloux, Belgium
(3) Earth and Life institute, Université Catholique de Louvain, Belgium

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1. Introduction
   - Why interested in environmental change studies?
   - Why using JULES for these studies?
2. Evaluation of JULES against FLUXNET data
   - FLUXNET sites
   - Preliminary results
3. Sources of bias
   - FLUXNET data
   - Model simulations
4. Summary (open question)

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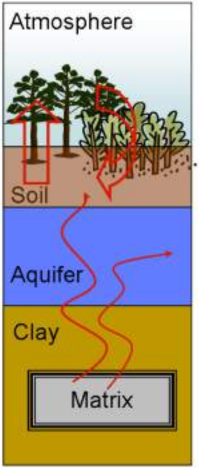
# JULES as Tool for Long Term Safety Assessments




A land surface model is a valuable tool to link together the biosphere and the geosphere. In this study, we want to use it for long term safety assessments of nuclear disposal (SCK-CEN).

The objective is to evaluate the impact of environmental change on the energy, water and carbon fluxes in Belgian ecosystems.

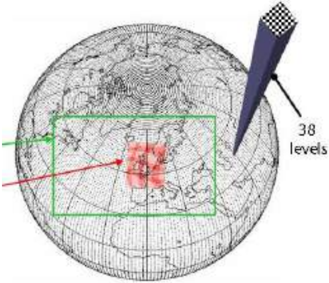
This objective fits well within the work currently carried out at the UCL on the evaluation of forest productivity and water use efficiency on the long term.

# JULES as Tool for Studies at Local Scale

JULES has shown to improve the simulation of global surface climate when included in a climate model, but has been scarcely tested at field site and regional scales in temperate regions.

Evaluation of JULES for Belgian ecosystems:

- Validation against surface flux data
- Sensitivity analysis to the environmental conditions



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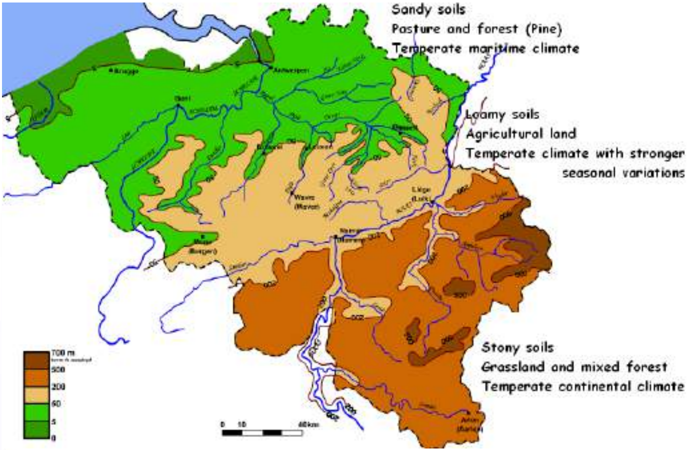
# Type of Ecosystems in Belgium



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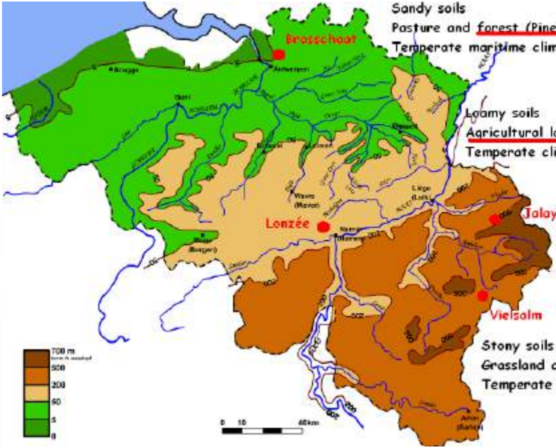
# FLUXNET Sites in Belgium



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# Sites Description

Vielsalm

Brasschaat

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# Ecological, Climatic and Soil Conditions

| | Vielsalm | | Brasschaat | |
|---|---|---|---|---|
| Elevation | 450m | | 16m | |
| | | | | |
| Climate | temperate | | temperate - maritime | |
| Avg. air temp. | 7.5° C | | 10.0° C | |
| Precipitation | 1000mm | | 750mm | |
| | | | | |
| Soil | silt loam | | moderate wet loamy sand | |
| FAO class | distric cambisol (1.5m) | | umbric regosol (1.5 - 2m) | |
| | | | | |
| Landcover | mixed forest | | mixed forest | |
| BL/NL | 50% BL | 50% NL | 30% BL | 70% NL |
| Species | beech (40%) | Douglas (60%) | oak (80%) | pine (80%) |
| LAI | 0 - 5 | 5.5 | 0 - 2.5 | 2.3 |
| Height | 26m | 40m | 17m | 21m |
| Rooting depth | 0.9m | 0.9m | 0.7m | 0.5m |

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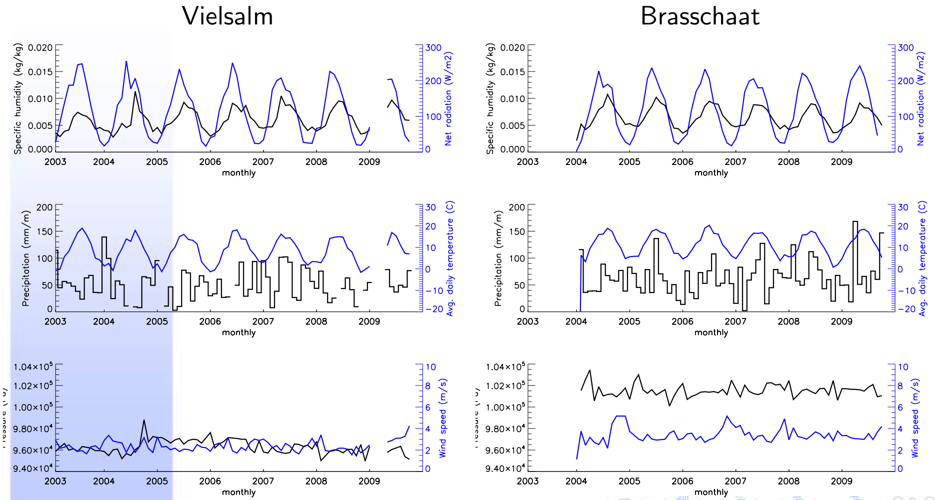
# Meteorological Forcing Data (30min step)



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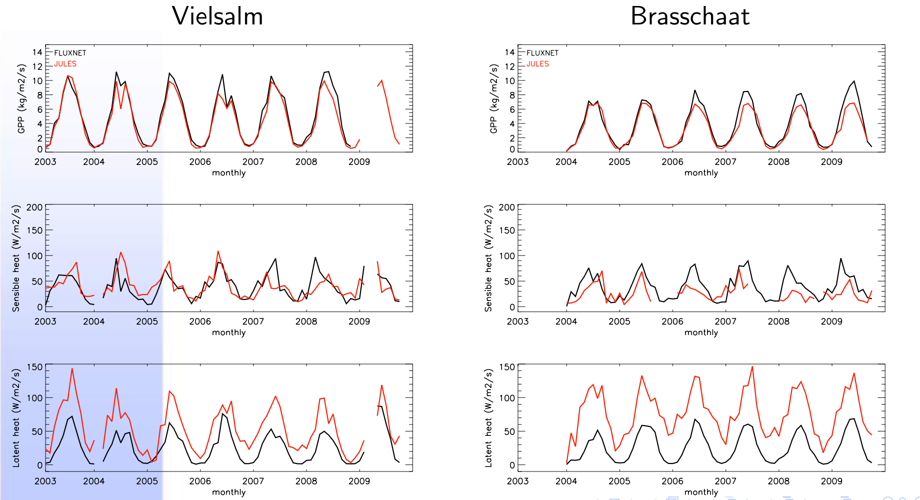
# Simulated vs. Observed Fluxes



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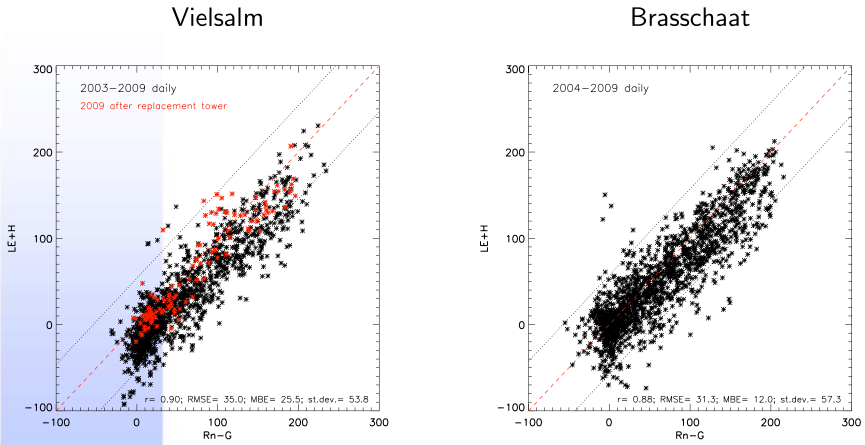
# Energie Balance Closure




Underestimation by 10% of vapour flux at Vielsalm (DeLigne, 2009)

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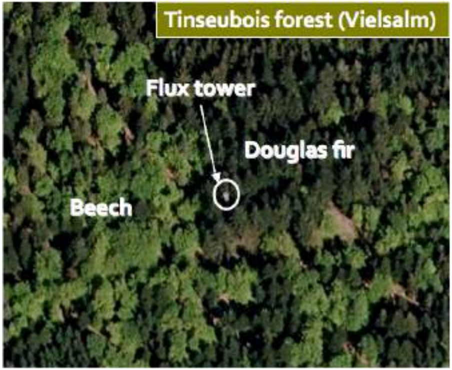
# Footprint




Most important causes of energy closure deficit in heterogeneous terrains is the difference between the footprints of the eddy co-variance system and of the radiometer (Aubinet, 2001)

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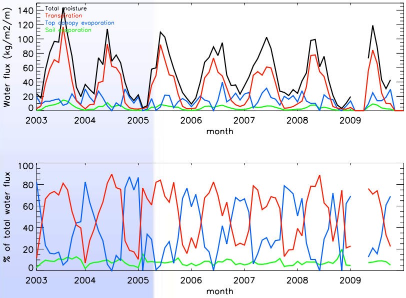
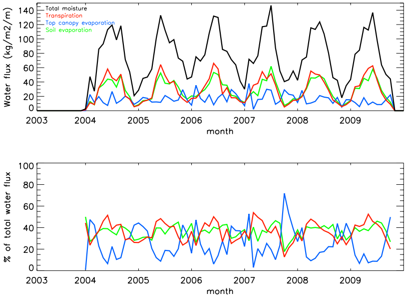
# Moisture Flux Partitioning

## Vielsalm




## Brasschaat



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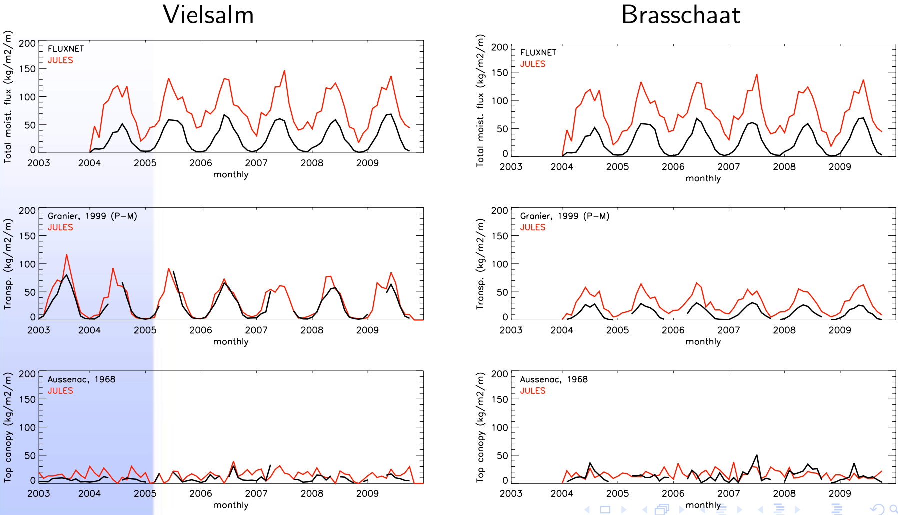
# Evaluation of Flux Components



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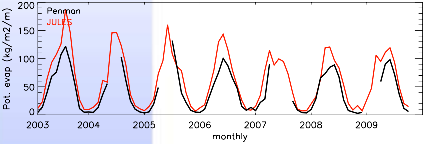
# Simulated Free Water Evaporation

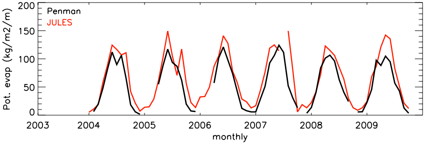
Penman - Monteith:

$$\lambda E T_0 = \frac{s(R_n + G) + \rho C_p \frac{D_a}{r_a}}{s + \gamma(1 + \frac{r_s}{r_a})} \quad (1)$$

Vielsalm




Brasschaat




The evaporation from an open water simulated with (1) is on average 20% lower than the amount simulated with JULES.

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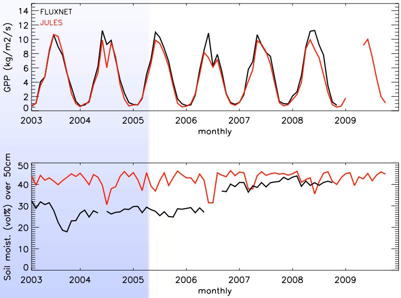
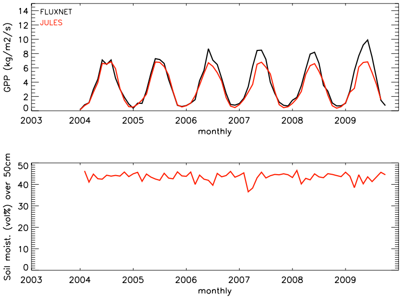
# Soil Hydraulic Properties and Critical/Wilting Points

## Vielsalm




## Brasschaat



# Potential source(s) for these biases

- Fluxnet data:
  - errors in the eddy co-variance measurements
  - sloop terrain
  - footprint, ...
- Model simulations:
  - parameterisation BL-NL
  - aerodynamic and surface (soil, canopy,...) conductances
  - soil hydraulic properties
  - critical/wilting points: transpiration vs. photosynthesis
  - energy available for evapotranspiration
  - understorey tile
  - ...

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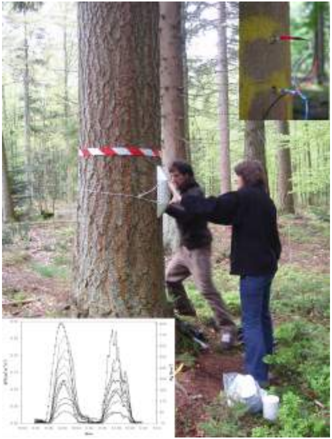
# Detailed Measurements at Vielsalm

- Sap flow (30min)
- LAI (15 days)
- Radial tree growth
- Stomatal conductance
- Soil moisture and
- Hydraulic properties
- Throughfall
- ...



## Open question

How can we explain these biases?