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# How to reduce uncertainties in a coupled and spatialized water quality model using data assimilation?

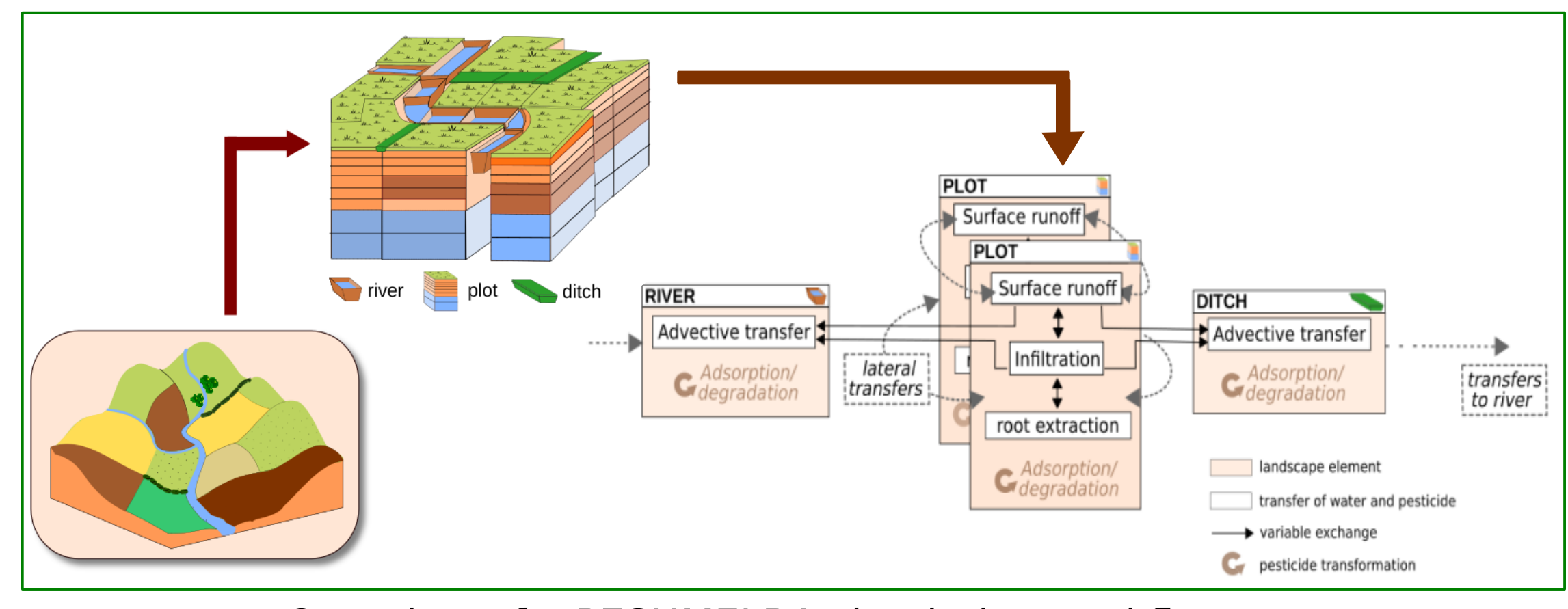
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Uncertainty quantification and reduction is necessary before considering operational use of any pesticide transfer model. In this study, we developed a framework for joint variable-parameter assimilation of satellite surface moisture images in the PESHMELBA model. A fairly simple virtual hillslope inspired from a realistic catchment is set up and data assimilation is performed on twin experiments.

## 1. The PESHMELBA model (Rouzies et al., 2019)

The PESHMELBA model simulates pesticide transfers and fate on small agricultural catchments.

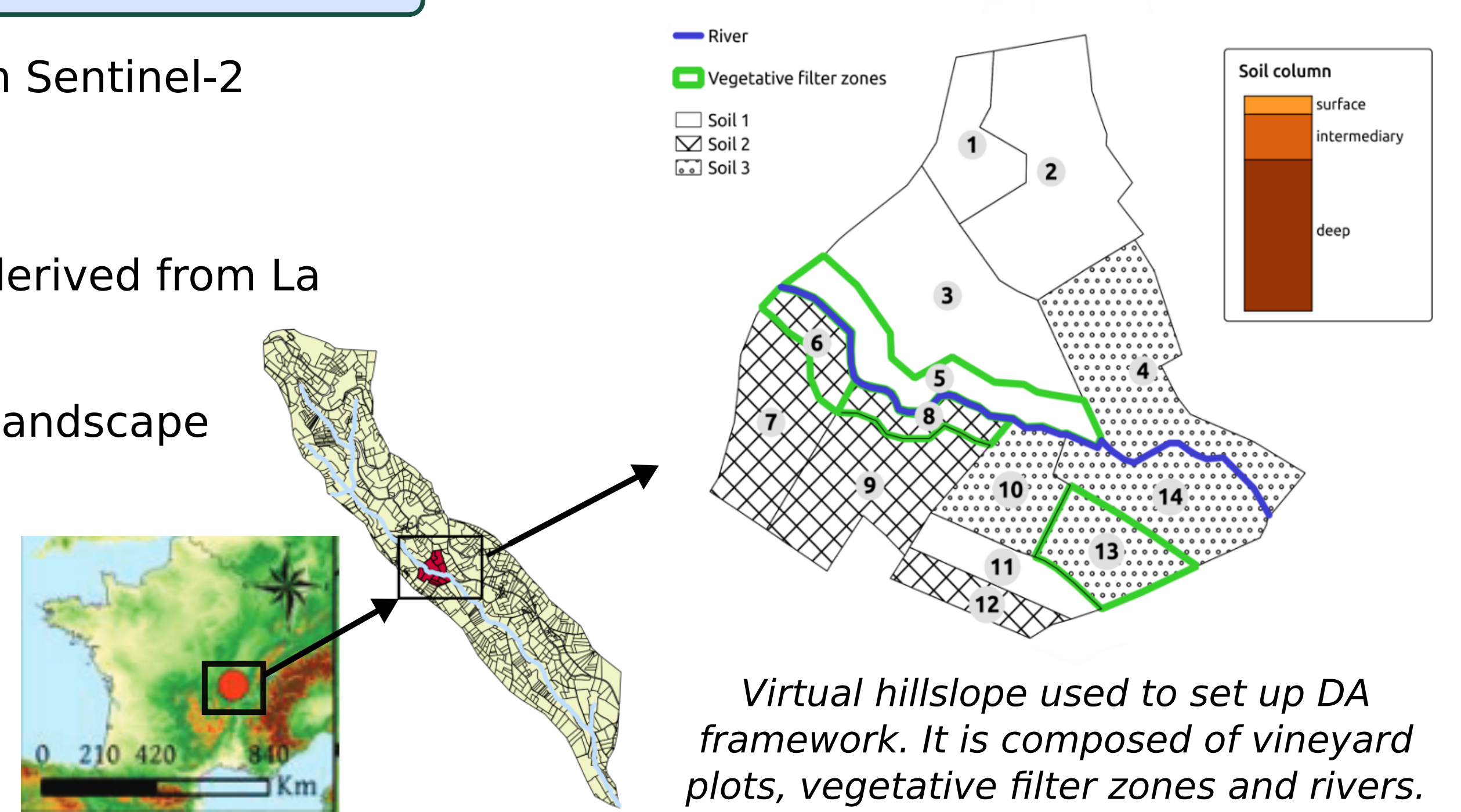
- Explicitly considers the effect of discontinuities (hedges, ditches, rivers, filter zones) and the spatial organisation of the landscape
- Characterized by a modular structure that makes it possible to test different scenarios of agricultural/landscape management practices
- Process-oriented, fully spatialized model.
- One module  $\equiv$  one process or ensemble of processes on a landscape element + coupling within the OpenPALM coupler (Buis et al., 2006)



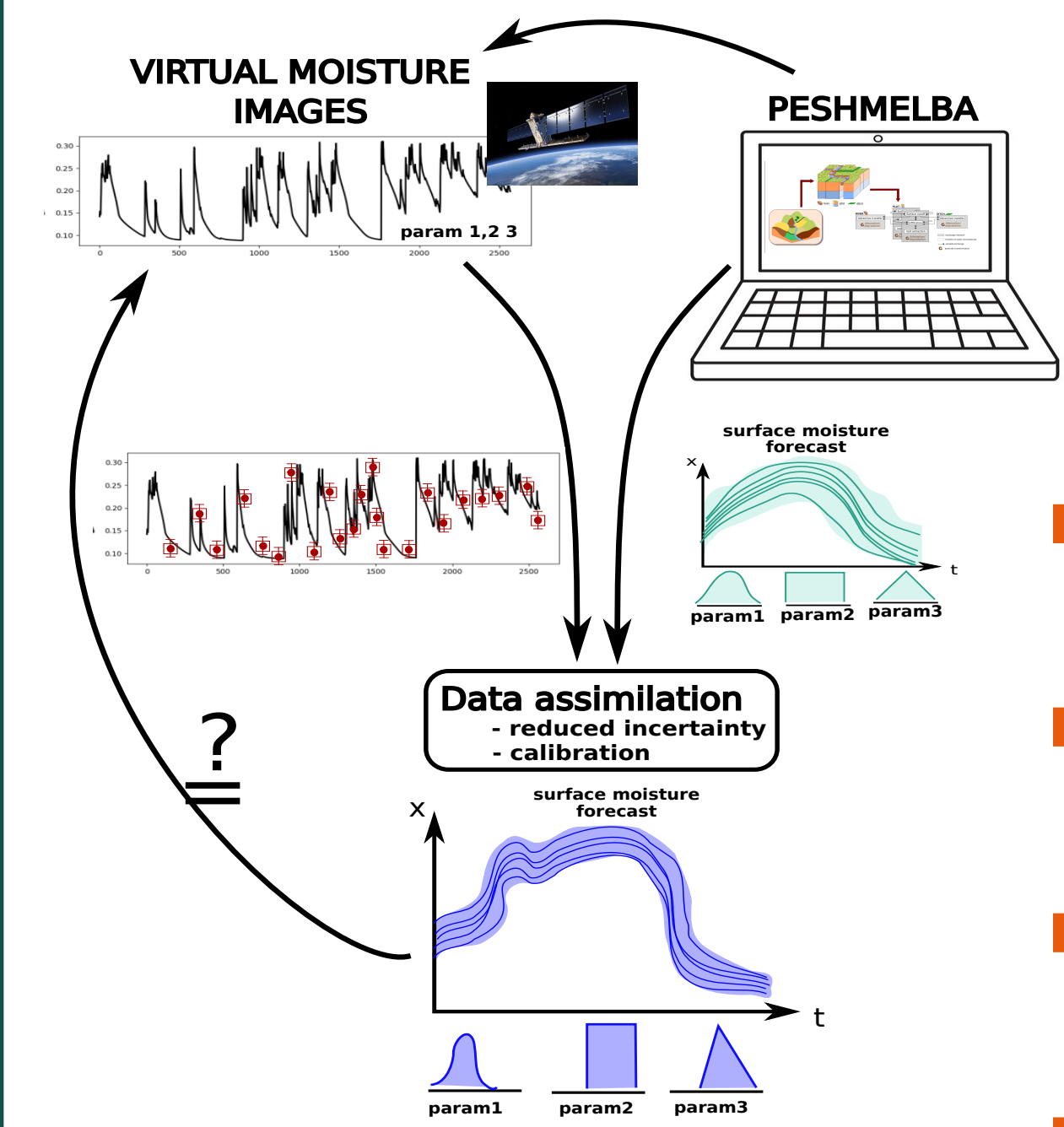
**How to use data assimilation to quantify and reduce uncertainty in this spatialized, highly coupled model ?**

## 2. Data assimilation set-up (twin experiments)

- Available data : surface moisture images from Sentinel-2  
 Frequency : 5 days  
 Obs. error : ~5% (Baghdadi and Zribi, 2016)
- Let's start simple: virtual simplified hillslope derived from La Morcille real catchment (France)
- Even simple: 3 heterogeneous soil types + 3 landscape element types => 145 parameters !



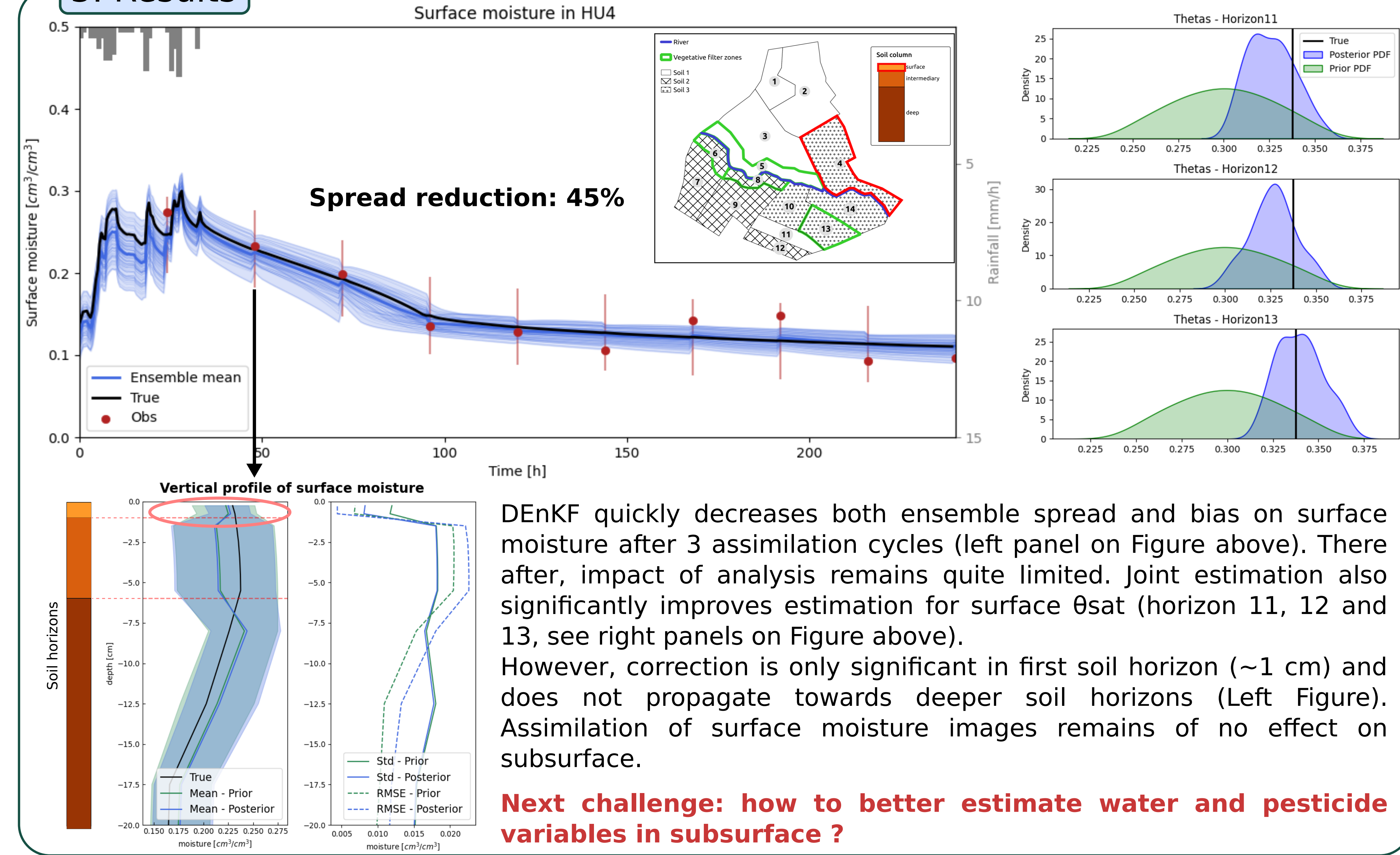
Virtual hillslope used to set up DA framework. It is composed of vineyard plots, vegetative filter zones and rivers.



Twin experiments workflow for assimilating surface moisture images in PESHMELBA

- Twin experiments: virtual moisture images generated from a reference PESHMELBA simulation. First test : one obs. available at each 24h!
- DA method chosen to fit PESHMELBA specificities : Deterministic Ensemble Kalman Filter (DEnKF) (Evensen, 1994). Ensemble size = 100 members
- DA used both to correct moisture in vertical profile and to estimate some input parameters: saturated water content ( $\theta_{sat}$ ) on surface
- Initial ensemble: perturbation of 145 input parameters. Bounds and distributions are set from field measurements, literature review or expert knowledge.

## 3. Results



## 4. Conclusion and next steps

- DEnKF potential to perform joint estimation in the PESHMELBA model is demonstrated using synthetic images. Uncertainty on both surface moisture variables and surface  $\theta_{sat}$  parameters is reduced.
- But this setup does not allow for correcting other components of the model (subsurface moisture, pesticide concentration,...).
- Prospects for improving the process:
  - Smoothing approach instead of filtering approach to better catch the subsurface dynamics
  - Integrating EMI measurements that provide moisture on a vertical profile

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