Multi-sources data assimilation in a spatialized model of water and pesticide transfers

Emilie Rouzies, Claire Lauvernet, Arthur Vidard

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Emilie Rouzies[(1)], Claire Lauvernet[(1)], Arthur Vidard[(2)]

(1) Riverly, INRAE Lyon-Villeurbanne
(2) AIRSEA, Inria Grenoble

Introduction

The PESHMELBA model

Development of the **PESHMELBA** model (Rouzies et al. 2019) to simulate pesticide transfers and fate on small agricultural catchments

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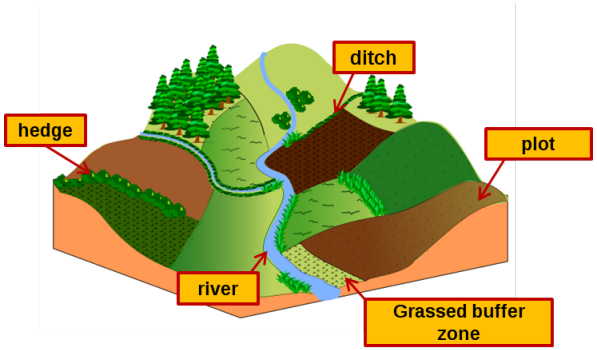

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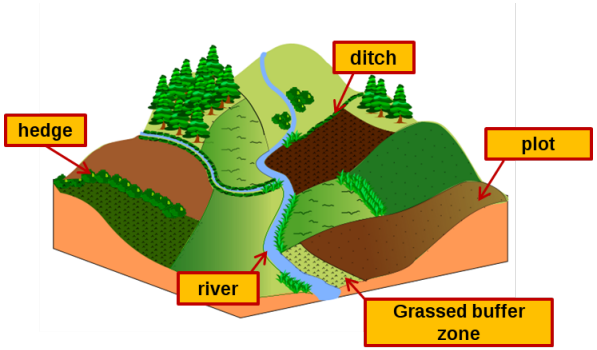
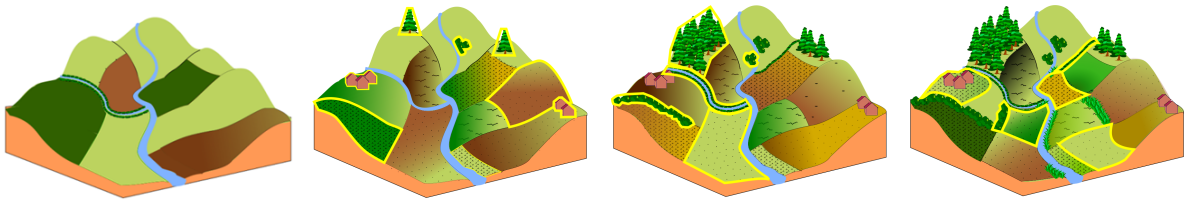


- ✓ Modular structure to explore landscape management scenarios



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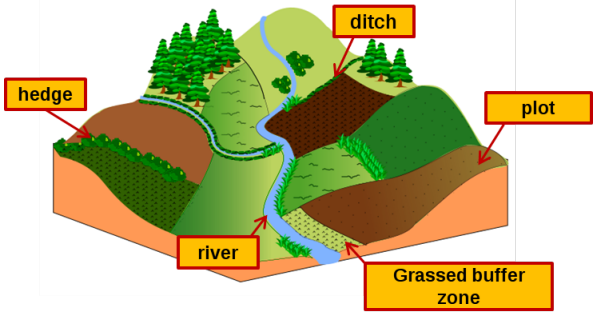

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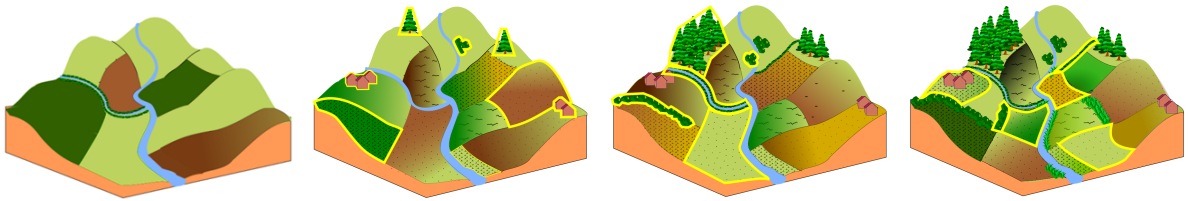

- ✓ Spatialized, process-oriented model : water transfers on surface and subsurface + pesticide advection, adsorption and degradation

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PhD Objectives

We have a dream that one day PESHMELBA will be used as a decision-making tool to set up management scenarios and to identify an optimal landscape configuration for pesticide transfer mitigation.

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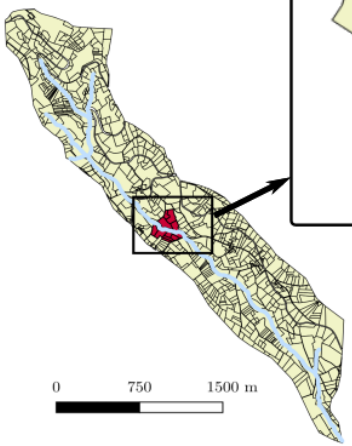
PhD objectives

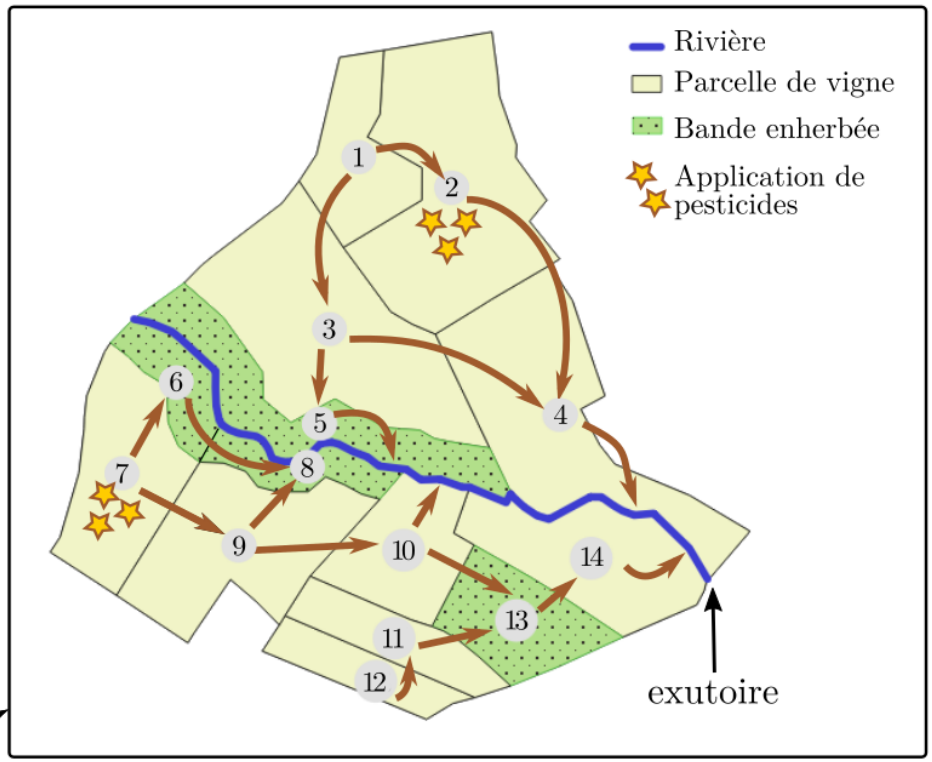
1. Quantify: performing an **uncertainty analysis** and a **sensitivity analysis** of the model

2. Reduce: performing **data assimilation** to integrate different sources of data: soil moisture images, ERT measurements and in-situ data of pesticide concentration

Case study

First attempt of DA in the PESHMELBA model: let's keep it simple...but realistic! (types of landscape elements, number of parameters, climate conditions...)





Panorama du bassin versant de la Morcille (Crédit photo: INRAE)

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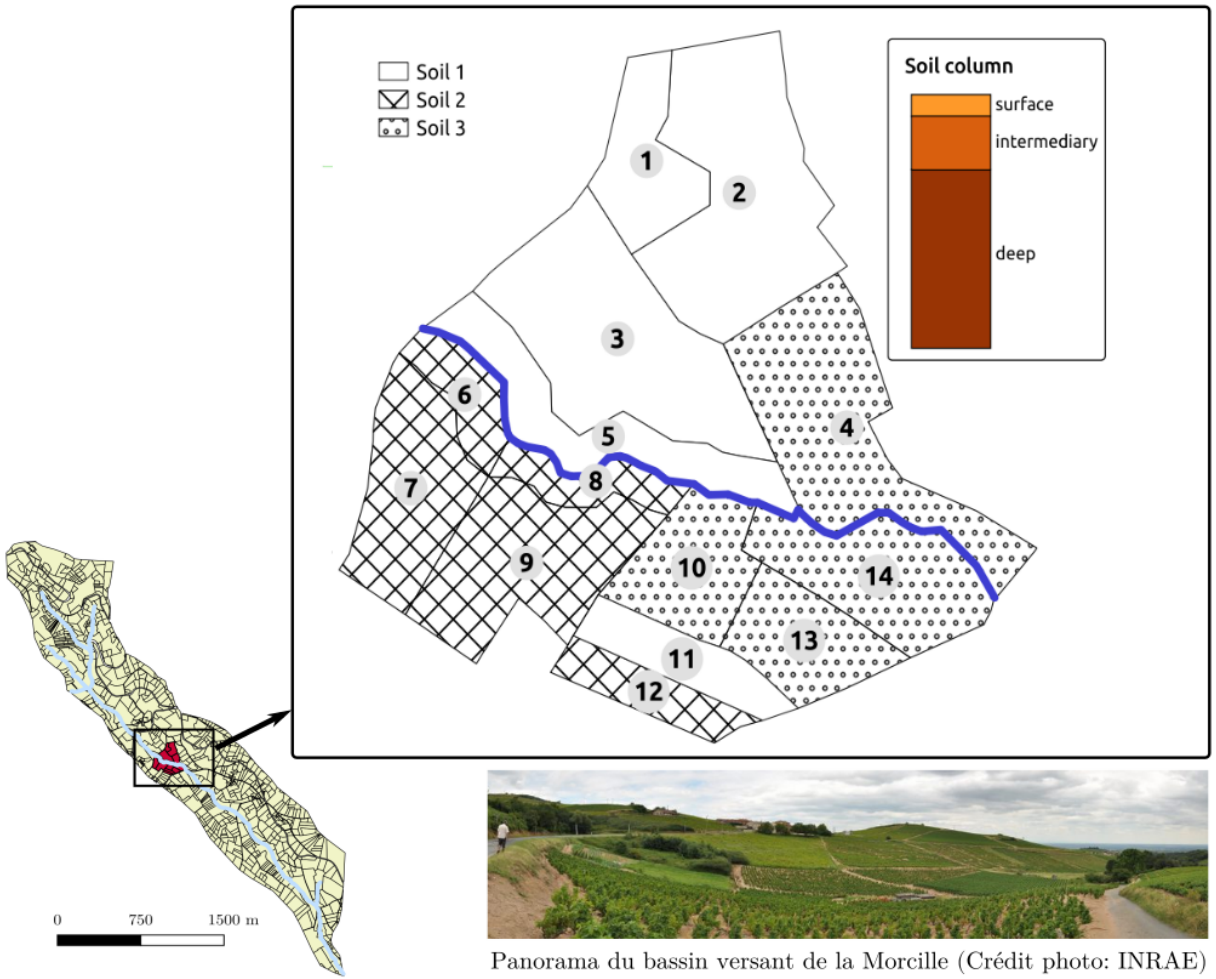

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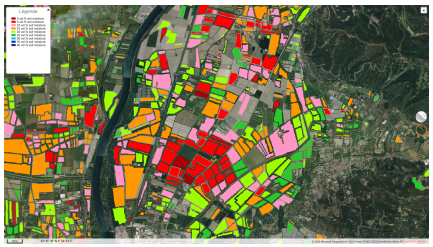
Which observations are available ?

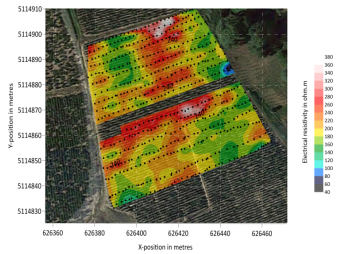
Surface moisture images



- ✓ Surface moisture images got from the synergic use of Sentinel-1 and Sentinel-2 data (El Hajj et al. 2017)
- ✓ One observation of mean moisture in the top 5 cm per landscape element per time step
- ✓ Freq. of observation: 144h, obs. error : assumed Gaussian, std $\sim$ 0.02 cm^3cm^{-3} (⚠ may highly differ on vineyard!)

In-situ moisture profiles

- ✓ Moisture profiles from EMI measurements or probe.
- ✓ Assumption : 2m-moisture profile on some landscape elements, obs. error : assumed Gaussian, std $\sim$ 0.02 cm^3cm^{-3}

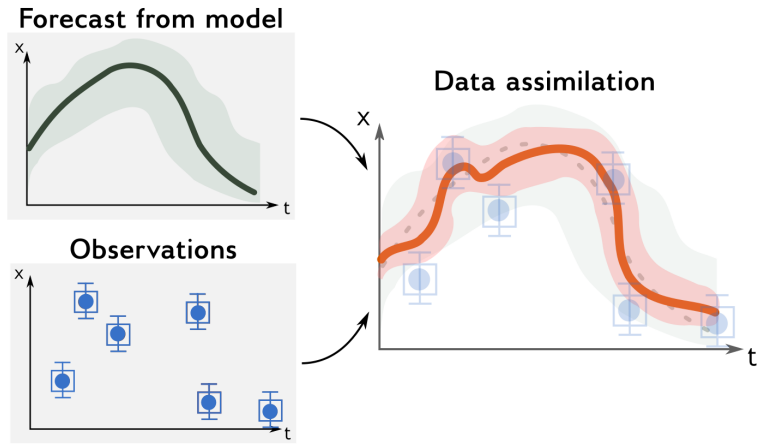


Data assimilation

Data Assimilation

"Approximation of the true state of a physical system at a given time by combining time-distributed observations with a dynamic model in an optimal way"

(Asch et al. 2016)



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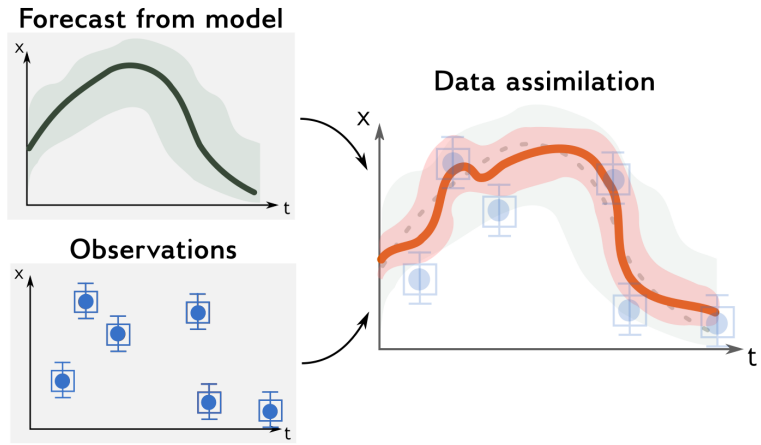

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- ✓ Improve estimation of pesticide export at the outlet
- ✓ Estimate input parameters (θ_{sat}) that would be set for the exploration of landscape management scenarios

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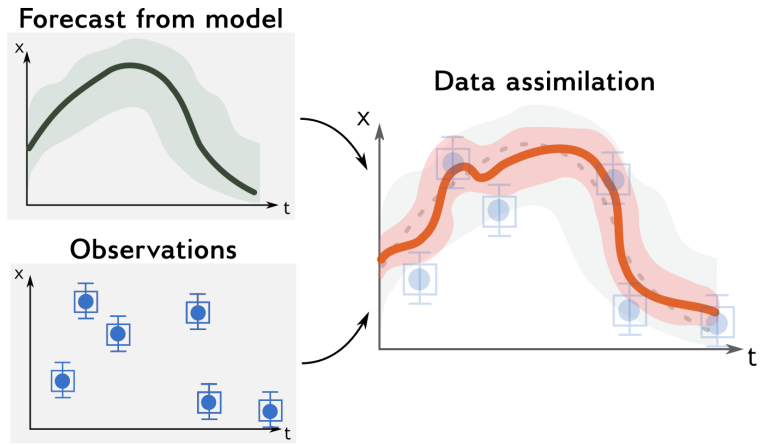

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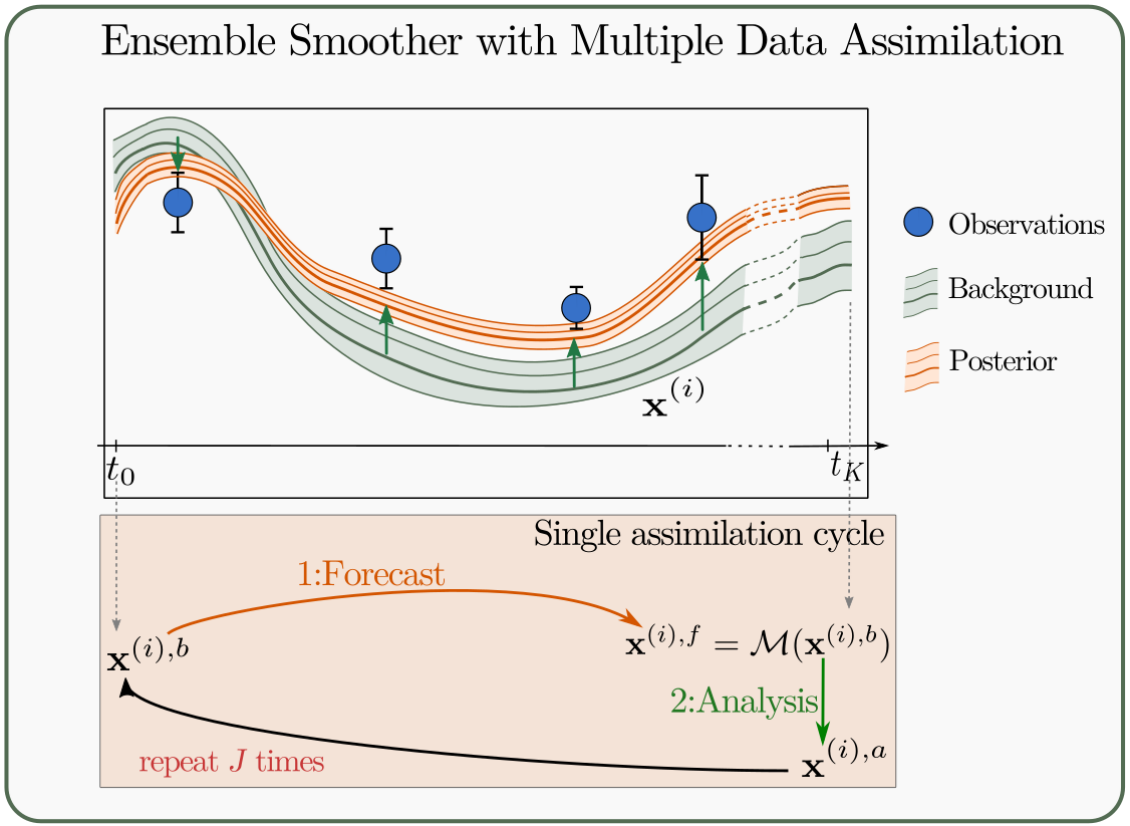
$\Rightarrow$ **Joint-estimation** abilities are investigated

DA method

Ensemble Smoother with Multiple Data Assimilation (Emerick and Reynolds 2013)

- ✓ Ensemble method that inherits from Kalman Filter
- ✓ Iterative smoother well suited to parameter estimation problems in non linear contexts



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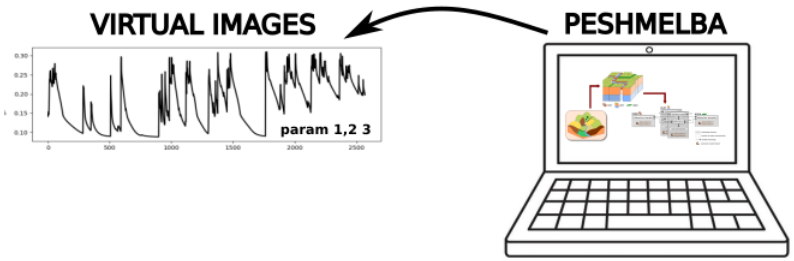

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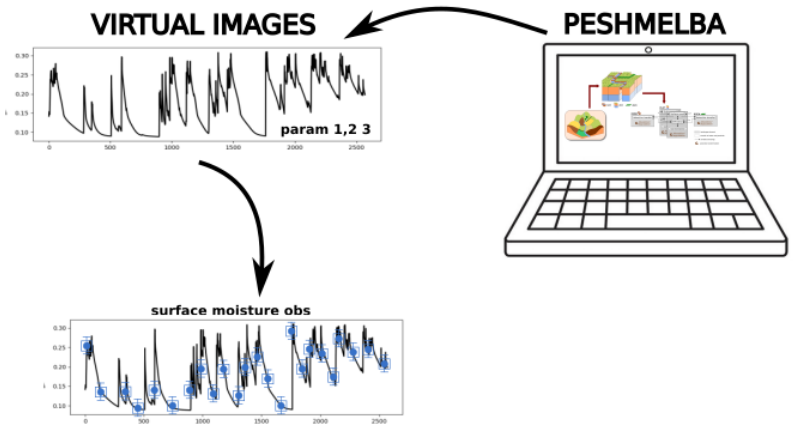

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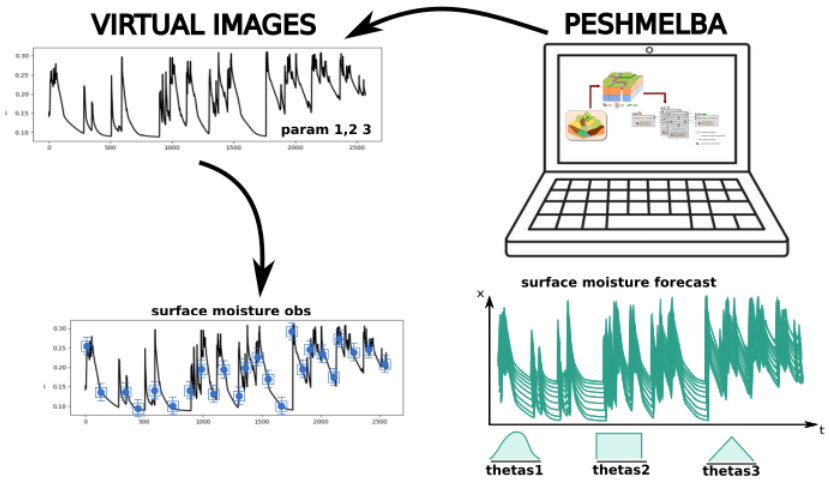

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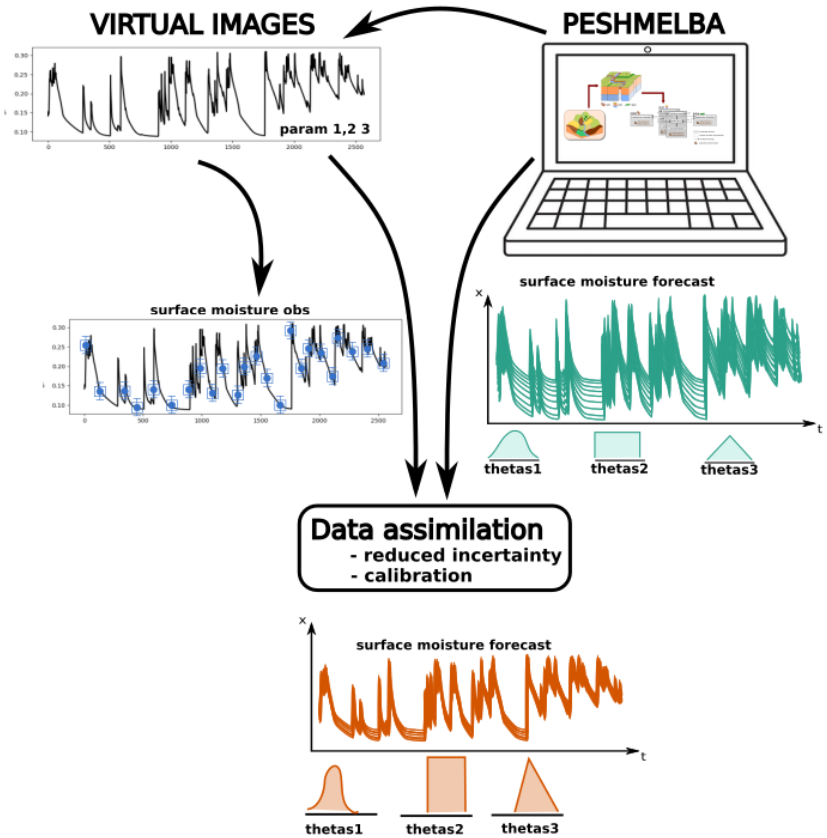

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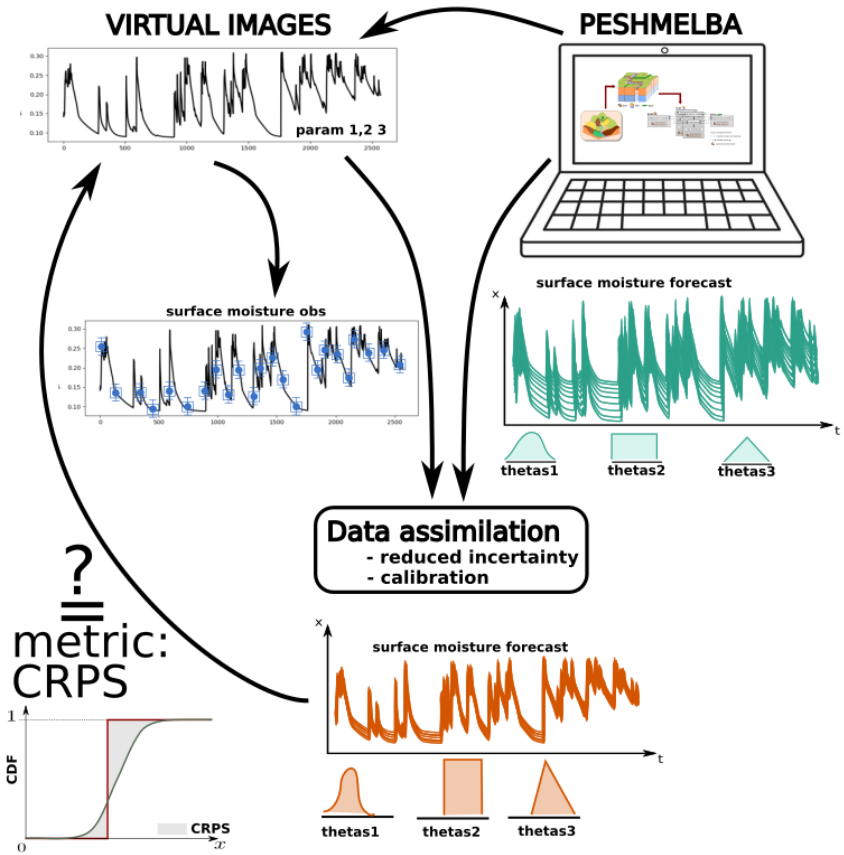

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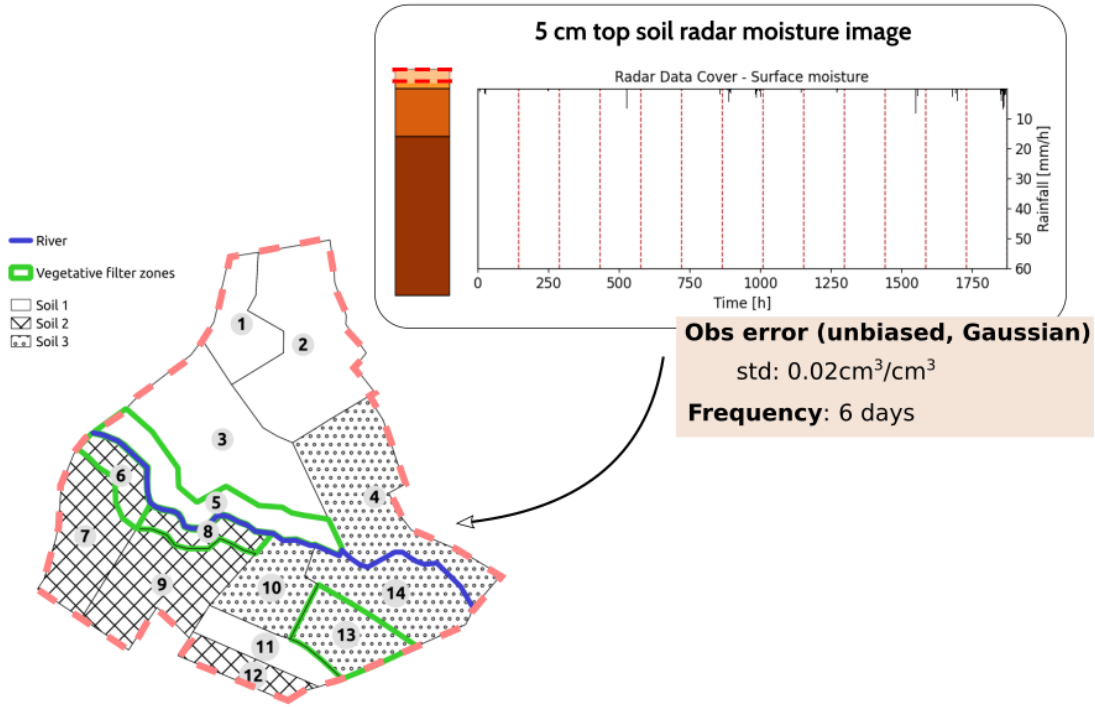

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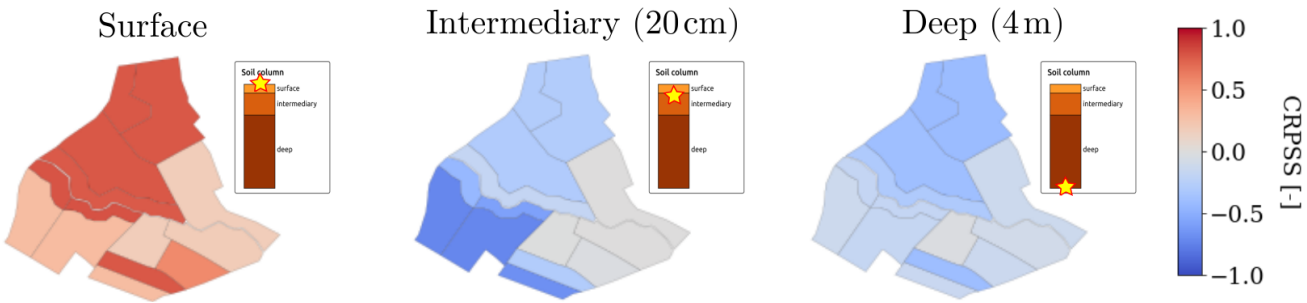

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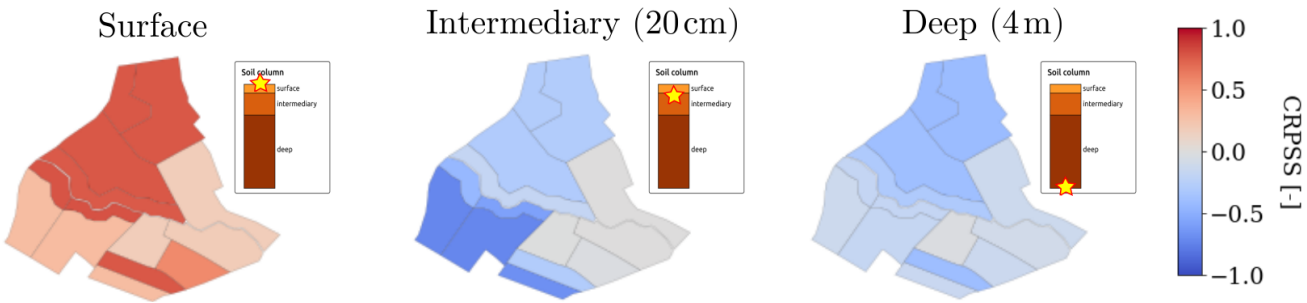

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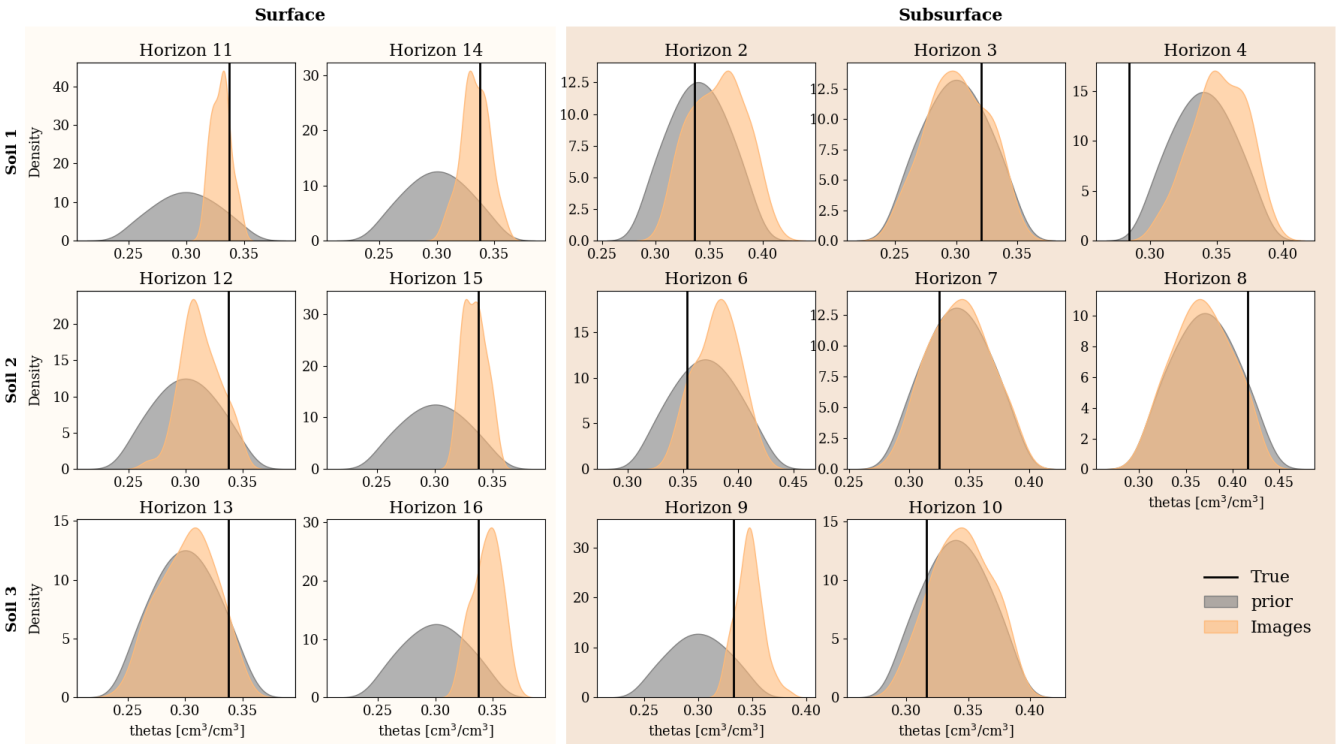

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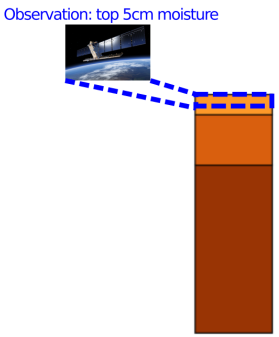

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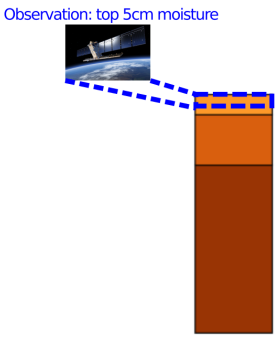

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✓ Good correction of surface moisture and surface parameters

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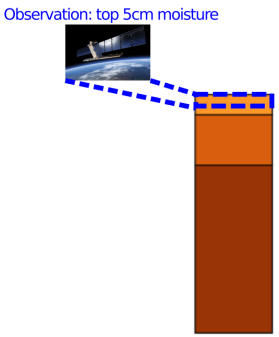

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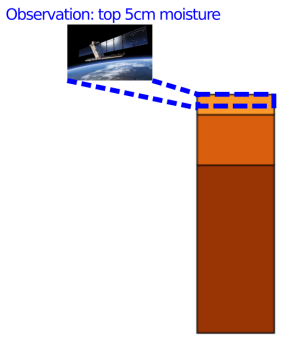

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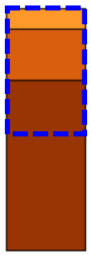
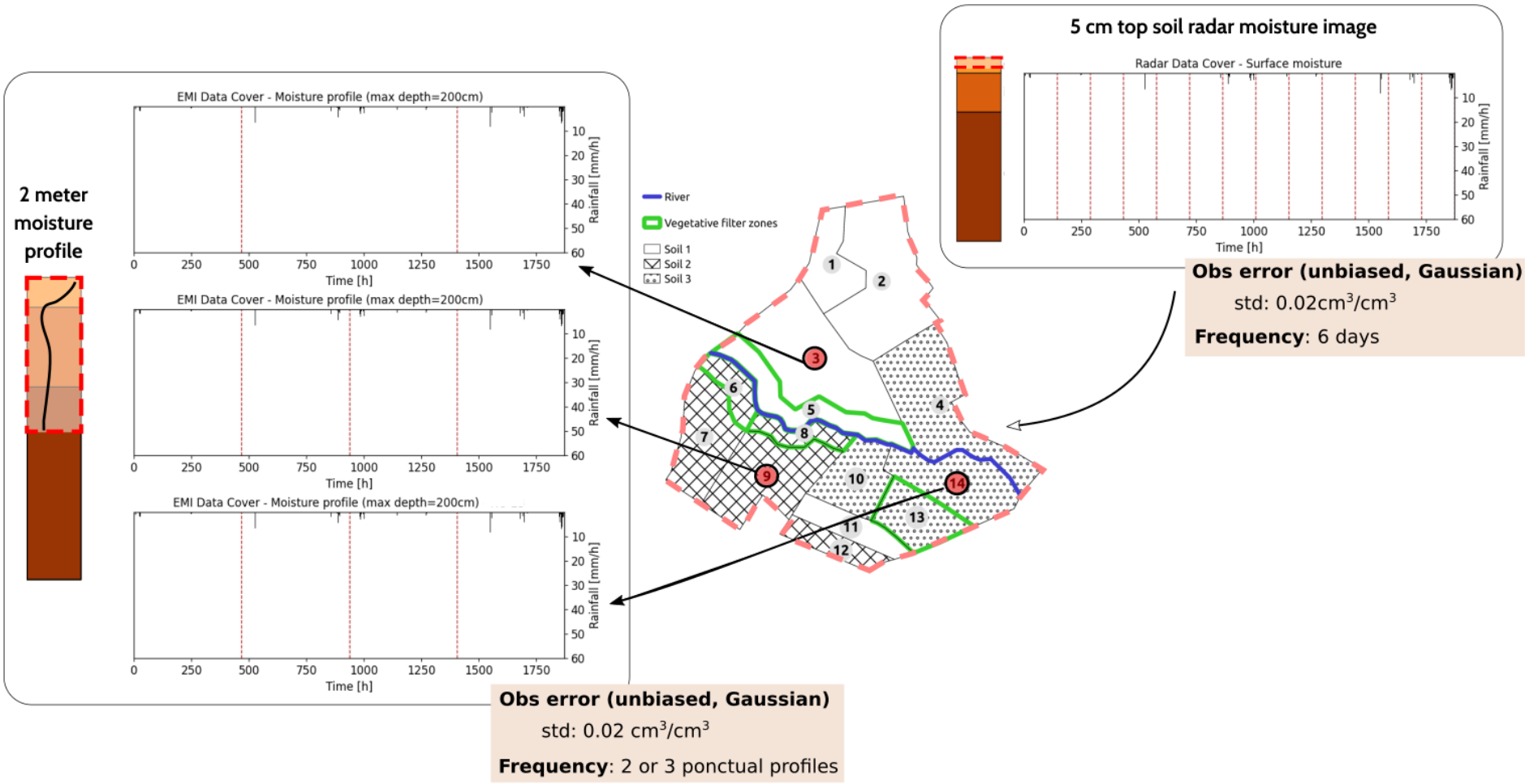
⇒ Solution ? Integrate subsurface observations : point vertical profiles of moisture



Results - Surface images + vertical profiles



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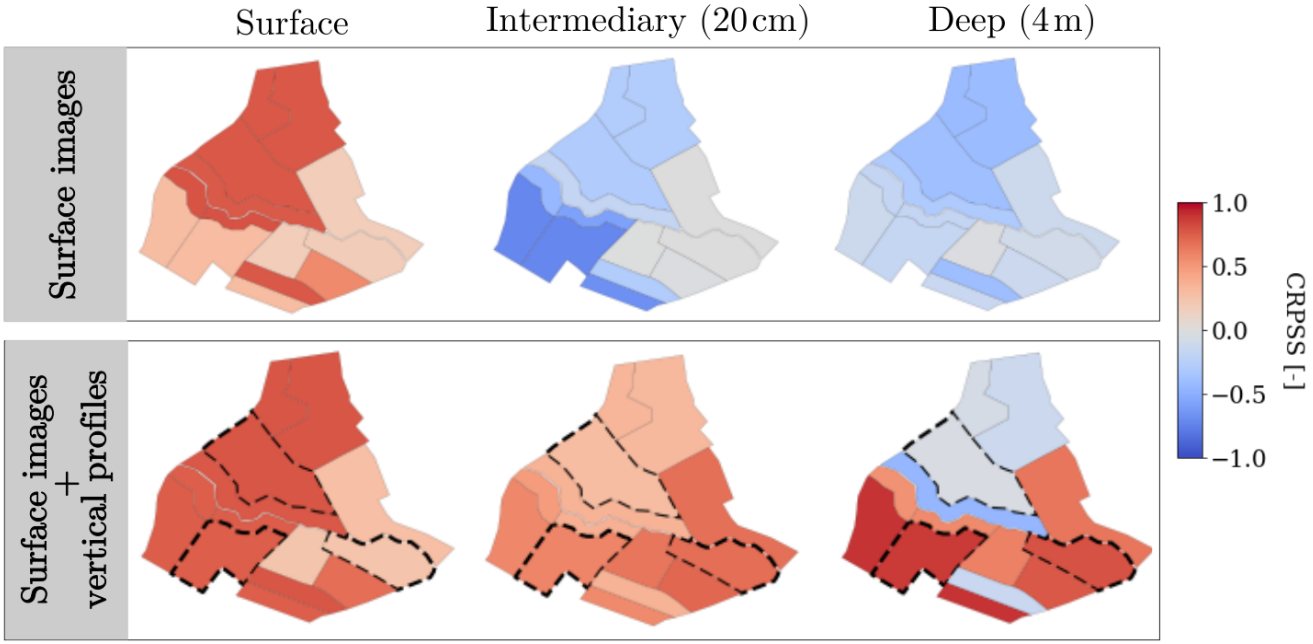

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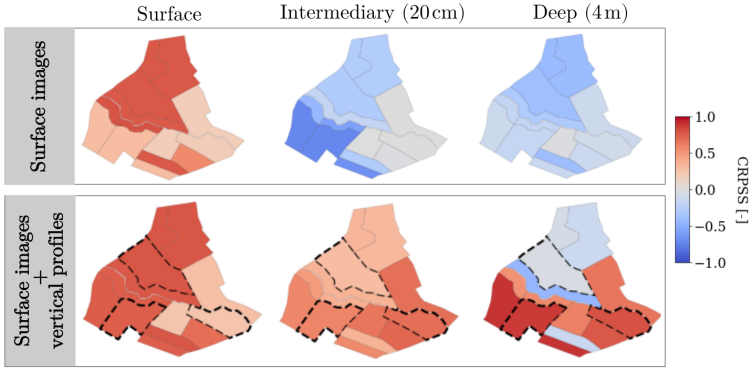

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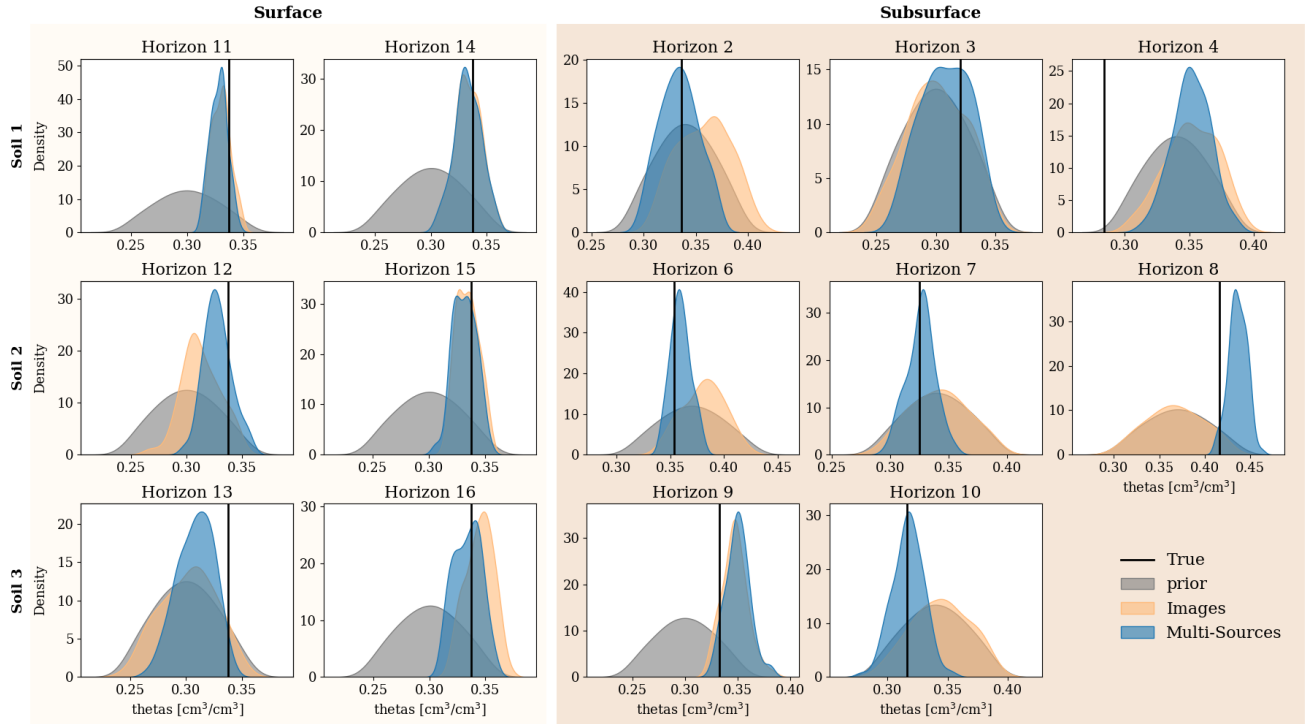

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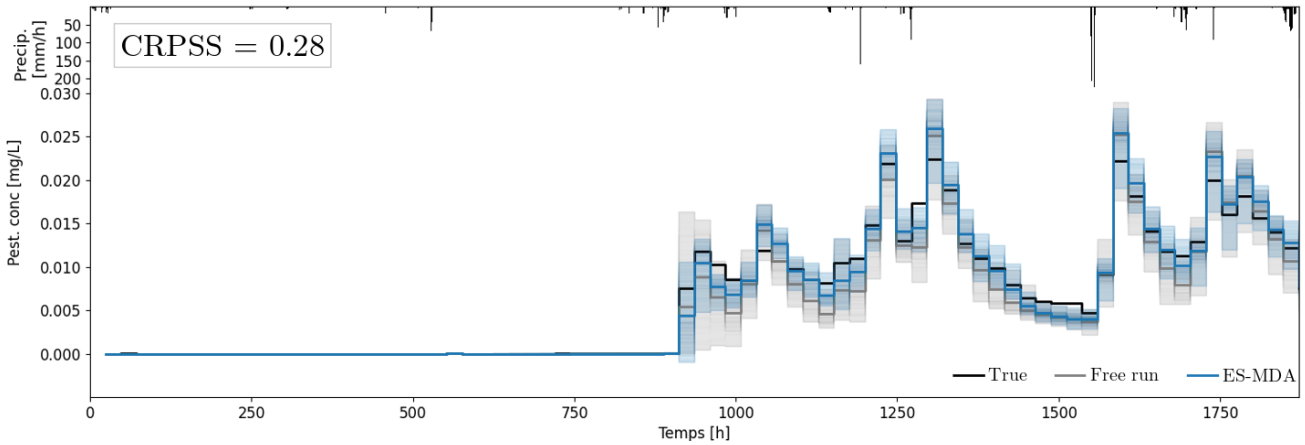

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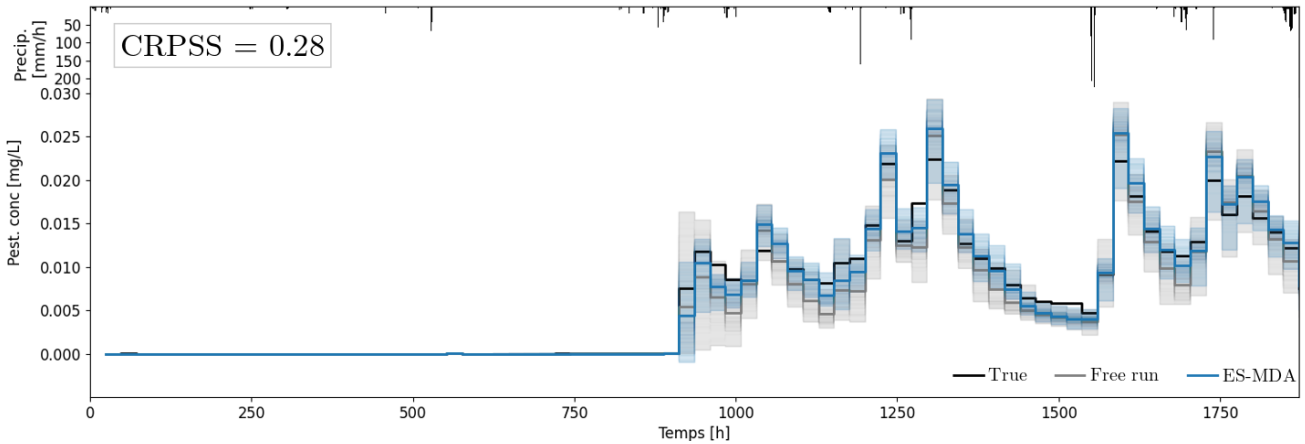

Strongy-coupled DA assimilation efficiently corrects pest. concentration.

Conclusion

- DA framework set for the first time in PESHMELBA
- Twin experiments provide answers to the question : *What can be estimated from which data ?*
- Next step : set a DA framework on a real catchment : many challenges ! (get data, characterize real observation errors, handle high computation cost...)