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Assessment of the MHYDAS-Pesticide-1.0 model in simulating pesticide concentrations in surface waters at plot-scale continuously over decades

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Assessment of the MHYDAS-Pesticide-1.0 model in simulating pesticide concentrations in surface waters at plot-scale continuously over decades

Guillaume Métayer, Cécile Dagès, Jean – Stéphane Bailly, David Crevoisier, and Marc Voltz

A need to assess model performance to reproduce long-term pesticide contamination of surface water

1. Introduction



Mechanistic model = cost-effective method compared to field studies

2. Materials & Methods

Scarcity of long-term evaluations at field-scale, especially for Mediterranean context
(*e.g. Mudgal et al., 2010, Baffaut et al., 2019*)

3. Results

- Most studies < 1 year (*e.g. Connolly et al., 2001, Malone et al. 2004*)

Poor knowledge about the simulation accuracy of pesticide concentrations in surface water

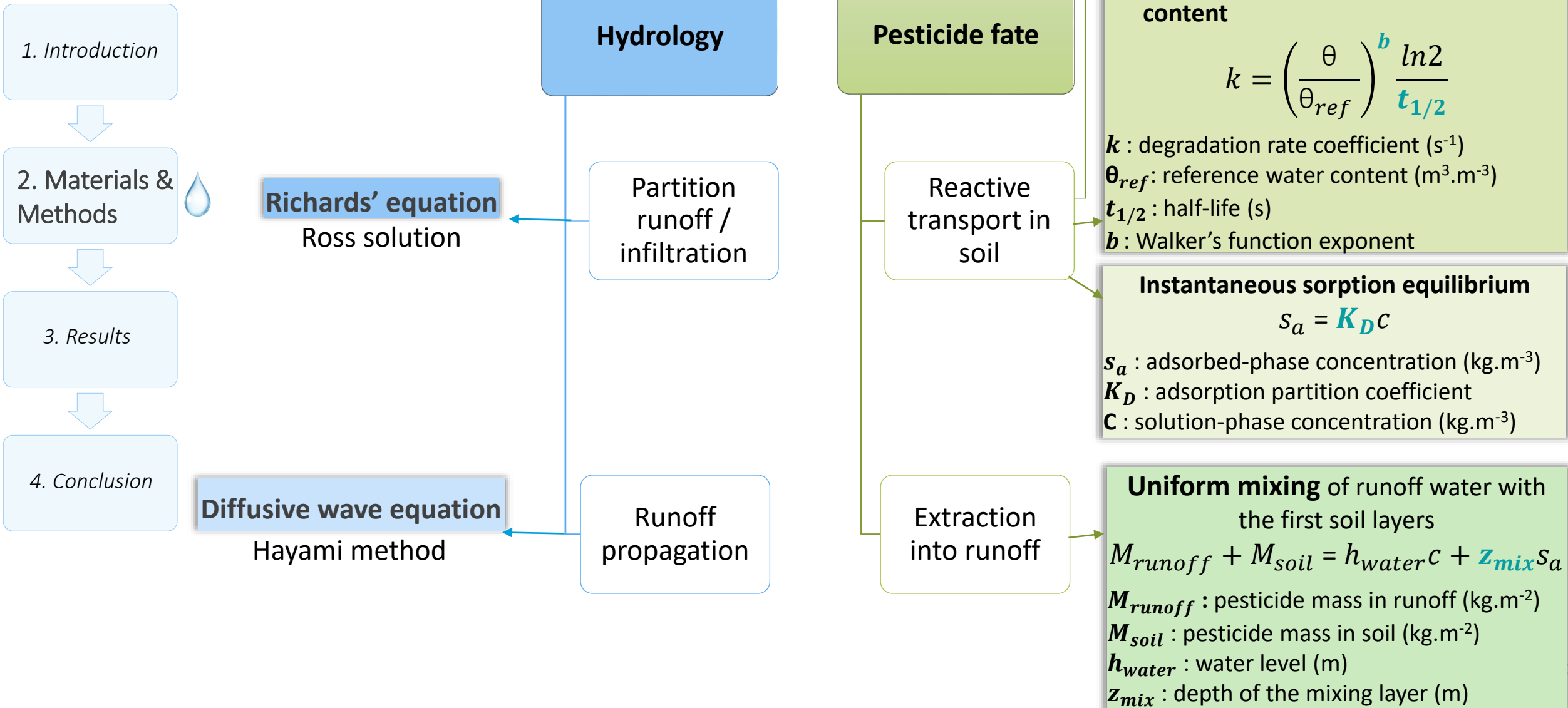
4. Conclusion

Objective of this study :

Assessing the performance of a mechanistic model in **reproducing pesticide concentrations** measured in runoff **at field-scale** on a **multi-year basis**

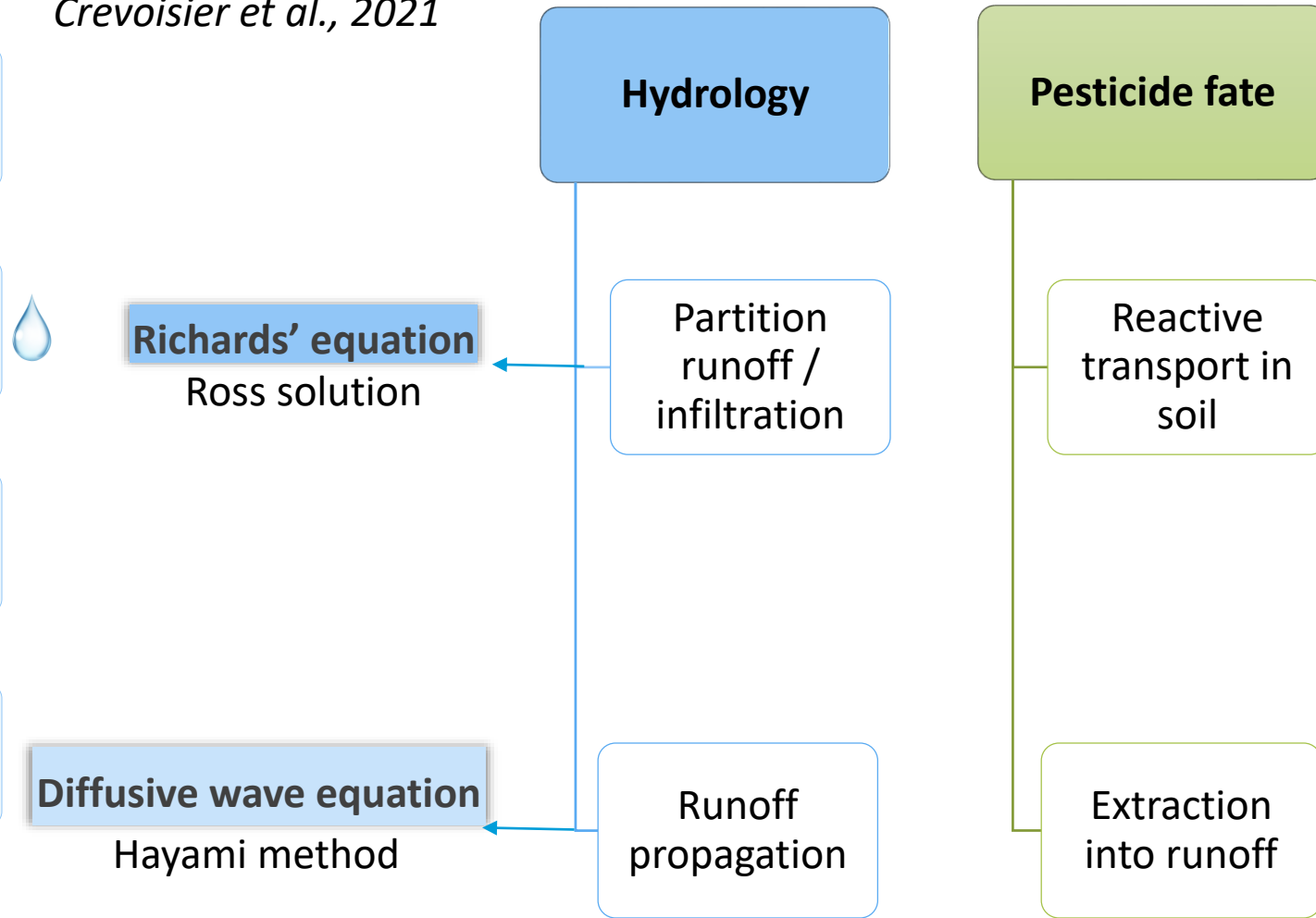
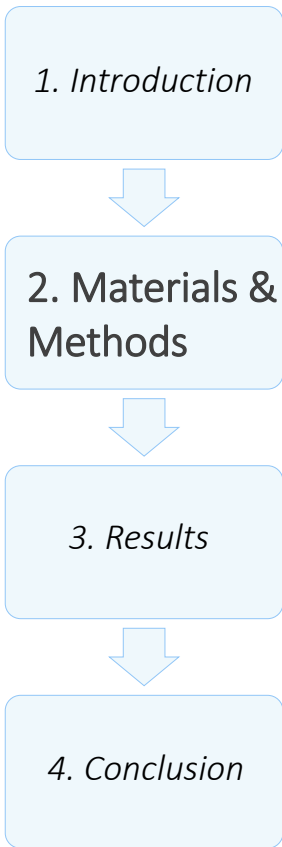
Simulating pesticide concentrations with a standard mechanistic model : MHYDAS-Pesticide-1.0

Crevoisier et al., 2021



Simulating pesticide concentrations with a standard mechanistic model : MHYDAS-Pesticide-1.0

Crevoisier et al., 2021



Convection-diffusion equation

Degradation rate

- First-order kinetics
- Decrease with a decrease in soil water content

$$k = \left(\frac{\theta}{\theta_{ref}} \right)^b \frac{\ln 2}{t_{1/2}}$$

k : degradation rate coefficient (s^{-1})
 θ_{ref} : reference water content ($m^3.m^{-3}$)
 $t_{1/2}$: half-life (s)
 b : Walker's function exponent

Instantaneous sorption equilibrium

$$S_a = K_D C$$

S_a : adsorbed-phase concentration ($kg.m^{-3}$)
 K_D : adsorption partition coefficient
 C : solution-phase concentration ($kg.m^{-3}$)

Uniform mixing of runoff water with the first soil layers

$$M_{runoff} + M_{soil} = h_{water} C + z_{mix} S_a$$

M_{runoff} : pesticide mass in runoff ($kg.m^{-2}$)
 M_{soil} : pesticide mass in soil ($kg.m^{-2}$)
 h_{water} : water level (m)
 z_{mix} : depth of the mixing layer (m)

4 calibrated pesticide parameters : $t_{1/2}$, b , K_D , z_{mix}

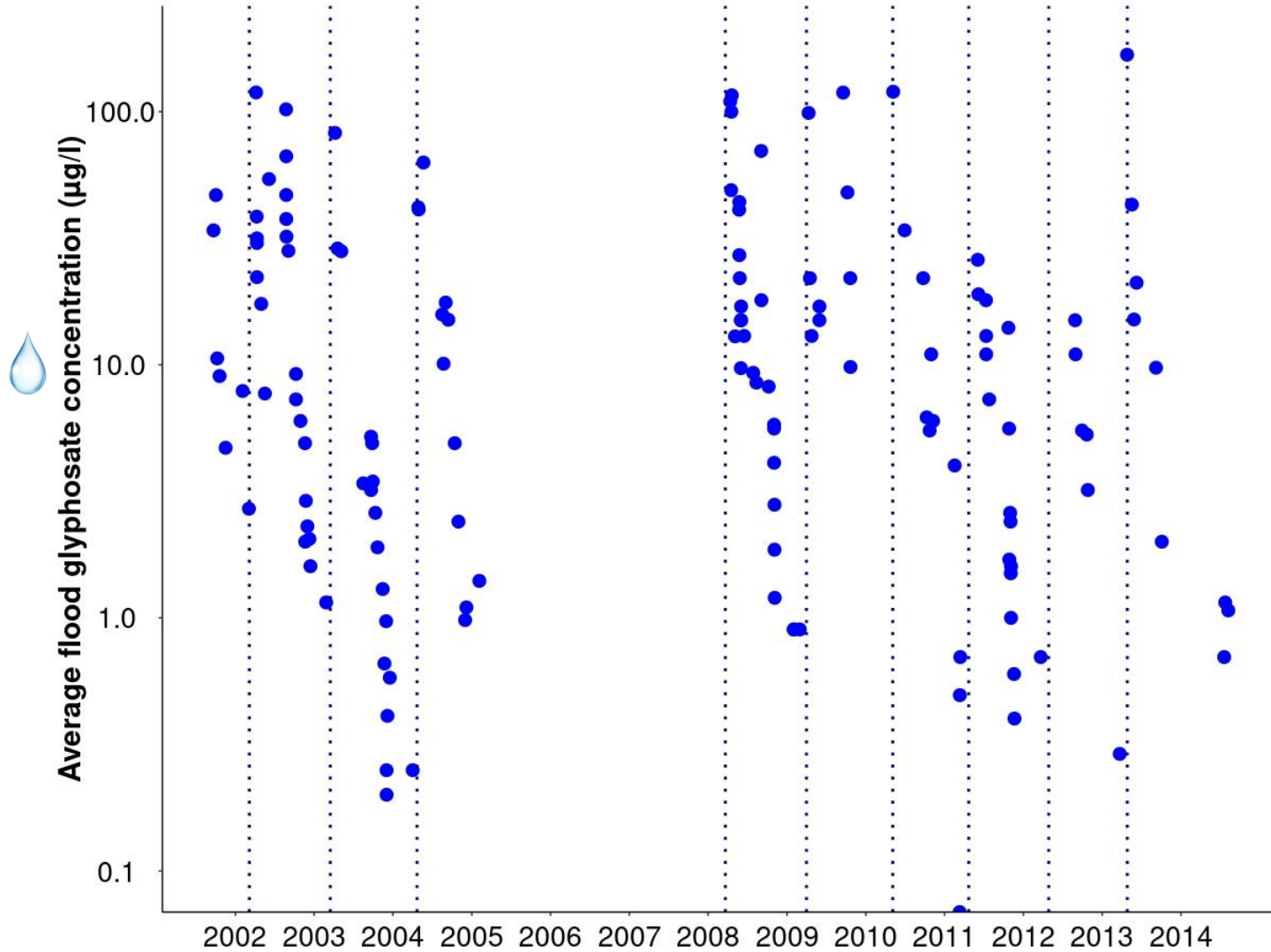
Study area : a vineyard field in the south of France

1. Introduction

2. Materials & Methods

3. Results

4. Conclusion



Outlet measurements :

- Rainfall
- Runoff
- Pesticide concentration

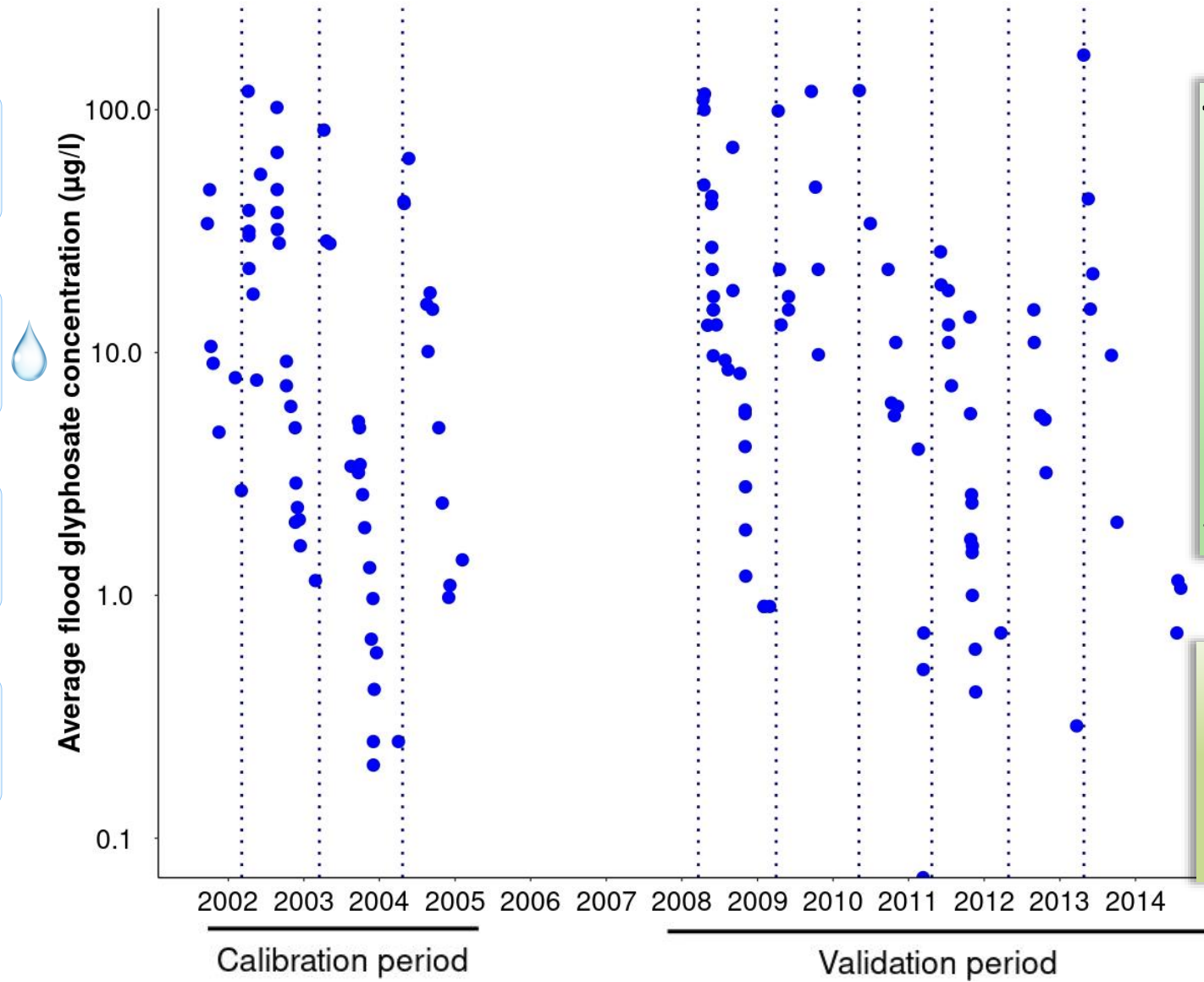


Mediterranean context

High inter and intra-annual hydrological variability

Study area : a vineyard field in the south of France

- 1. Introduction
- 2. Materials & Methods
- 3. Results
- 4. Conclusion



To assess global model performance

Statistical criteria

NSE

Nash Sutcliffe efficiency

PBIAS (%)

Percent bias

Variables of interest

C

flood concentration

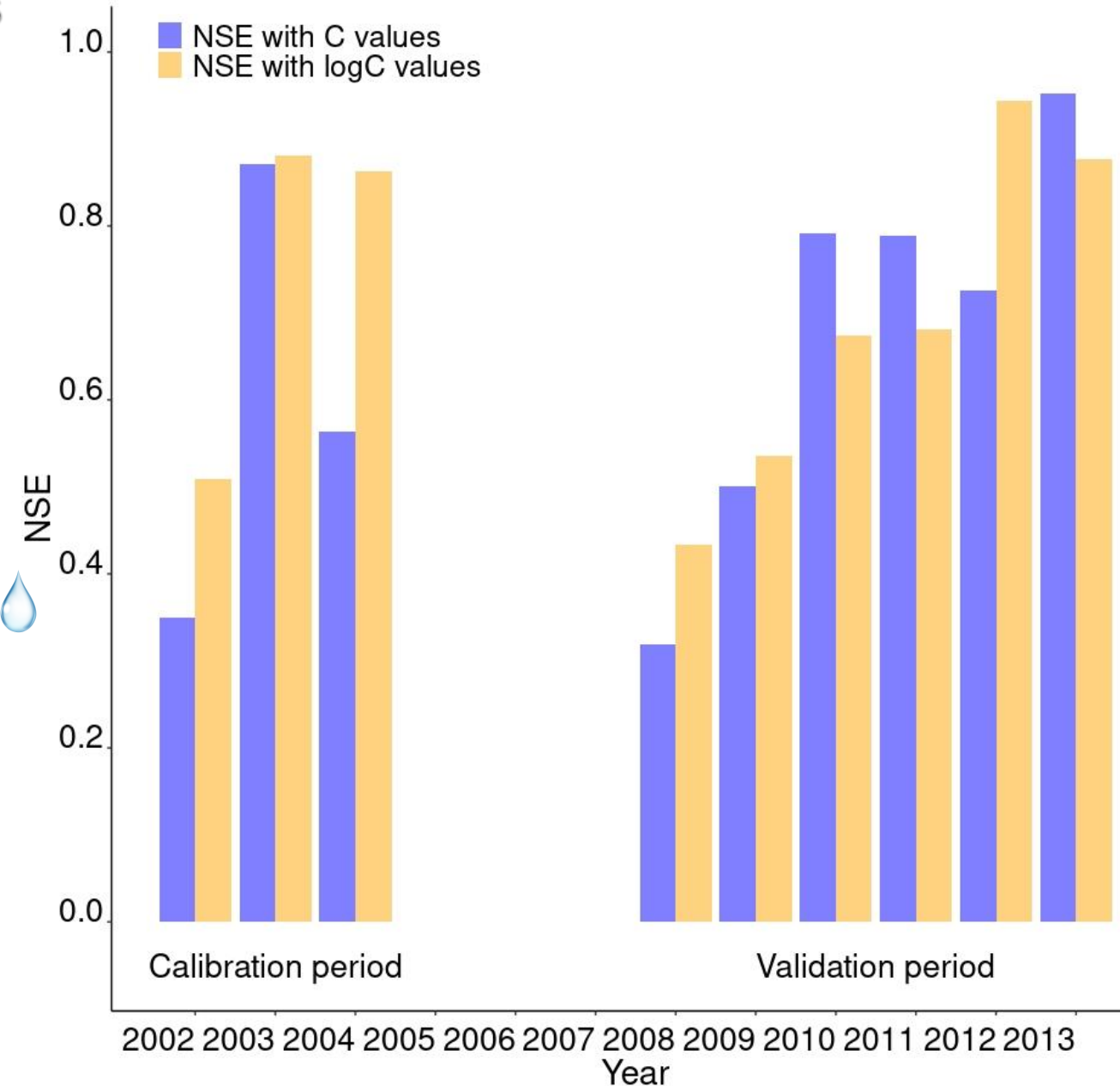
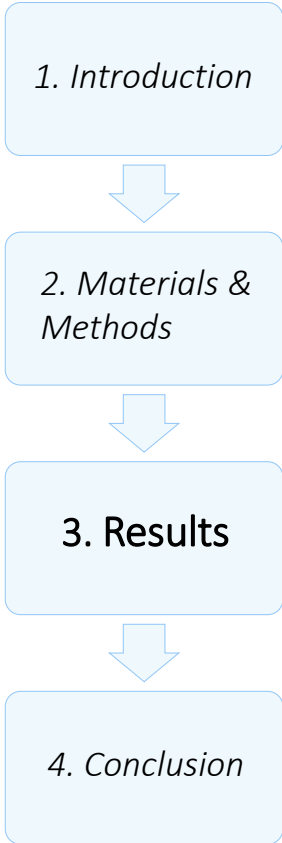
logC

log(flood concentration)

To assess performance in simulating
intra-annual variability

Analysis of error structure

Results



Satisfactory performance for C values and logC values

Calibration period :

- $NSE > 0.65$
- $PBIAS \pm 15\%$

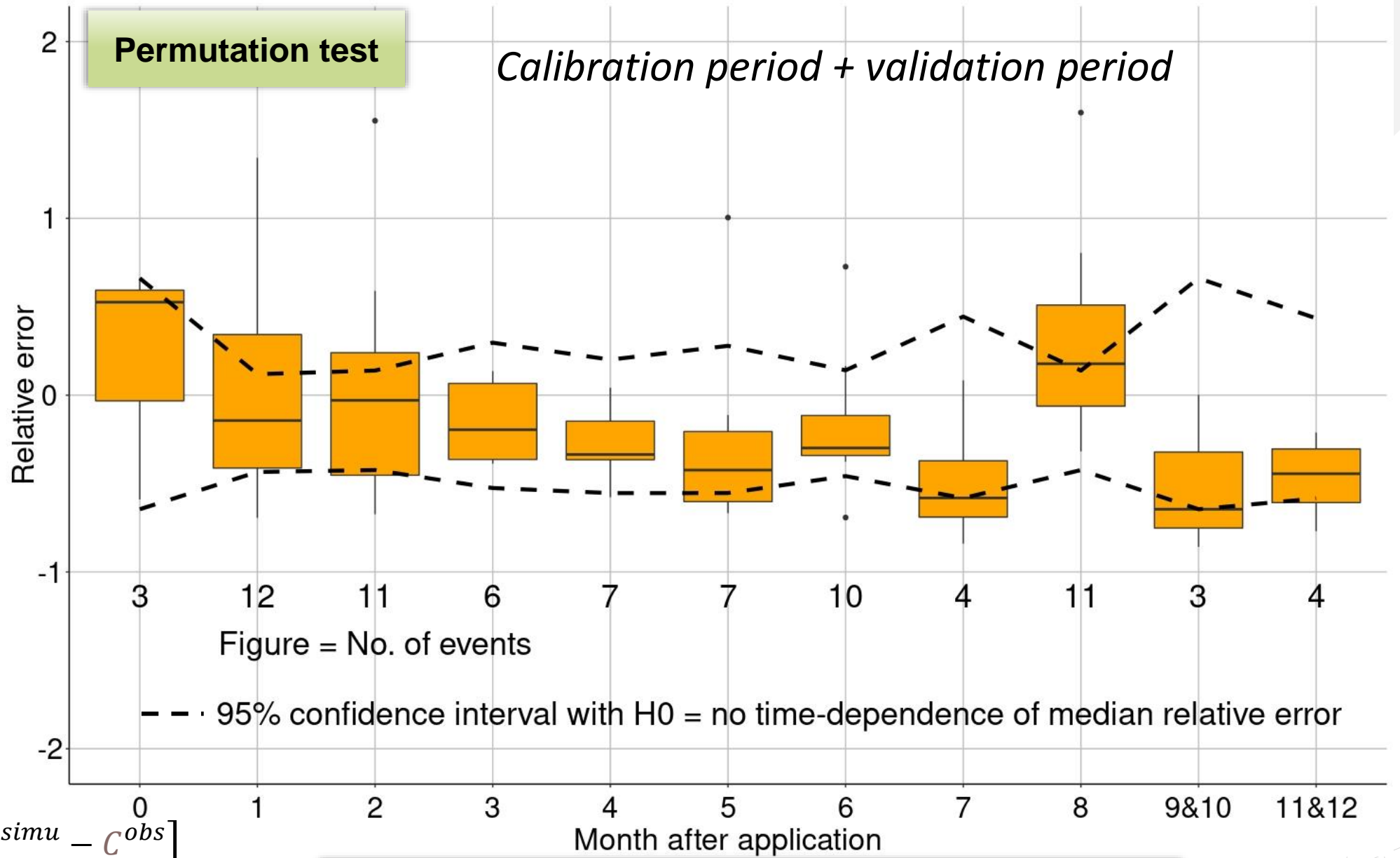
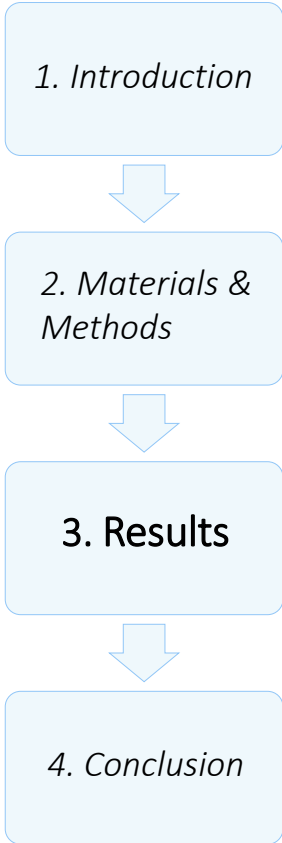
→ « very good » (Moriasi et al., 2015)

Validation period :

- $NSE > 0.5$
- $PBIAS \pm 20\%$

→ « good » (Moriasi et al., 2015)

Results



$$Relative\ error = \left[\frac{C^{simu} - C^{obs}}{C^{obs}} \right]$$

Relative error isn't statistically time-dependent

Conclusions

1. Introduction



2. Materials & Methods



3. Results



4. Conclusion



A **standard mechanistic model** can satisfactorily reproduce **inter and intra-annual variability of pesticide concentrations** in surface water for a **mediterranean context**

Robust calibration achieved with **3 years data**

$t_{1/2}$, K_D , z_{mix} were found to be sensitive to **logC** unlike **Walker's exponent b** despite **expected soil drying effects in Mediterranean contexts**

This work = first MHYDAS-Pesticide-1.0 assessment
Further studies are needed to calibrate the model for other contexts

Thank you for listening

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