



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*)

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

3. Results

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

1. Introduction

2. Materials & Methods

3. Results

4. Conclusion

Richards' equation
Ross solution

Diffusive wave equation
Hayami method

Hydrology

Partition
runoff /
infiltration

Runoff
propagation

Pesticide fate

Reactive
transport in
soil

Extraction
into runoff

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)

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

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Richards' equation
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Diffusive wave equation
Hayami method

Hydrology

Partition runoff / infiltration

Runoff propagation

Pesticide fate

Reactive transport in soil

Extraction into runoff

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

Convection-diffusion equation

Degradation rate

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- Decrease with a decrease in soil water content

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Study area : a vineyard field in the south of France

1. Introduction

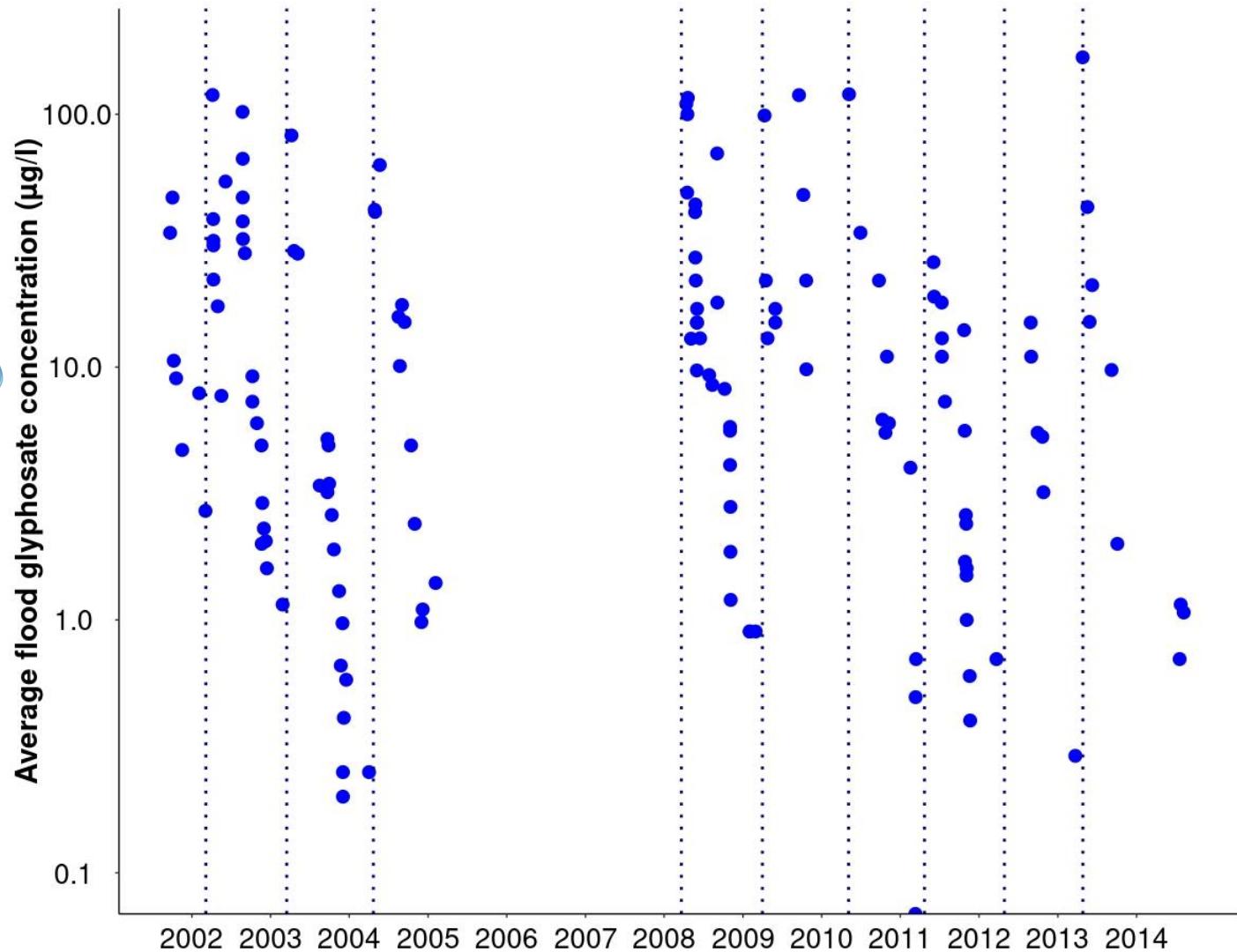


2. Materials &
Methods

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

Average flood glyphosate concentration ($\mu\text{g/l}$)

100.0
10.0
1.0
0.1

Calibration period Validation period

3. Results



4. Conclusion

To assess global model performance

Statistical criteria

NSE

Nash Sutcliffe efficiency

PBIAS (%)

Percent bias

Variables of interest

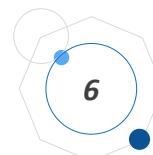
C

flood concentration *log(flood concentration)*

logC

To assess performance in simulating
intra-annual variability

Analysis of error structure



Results

1. Introduction



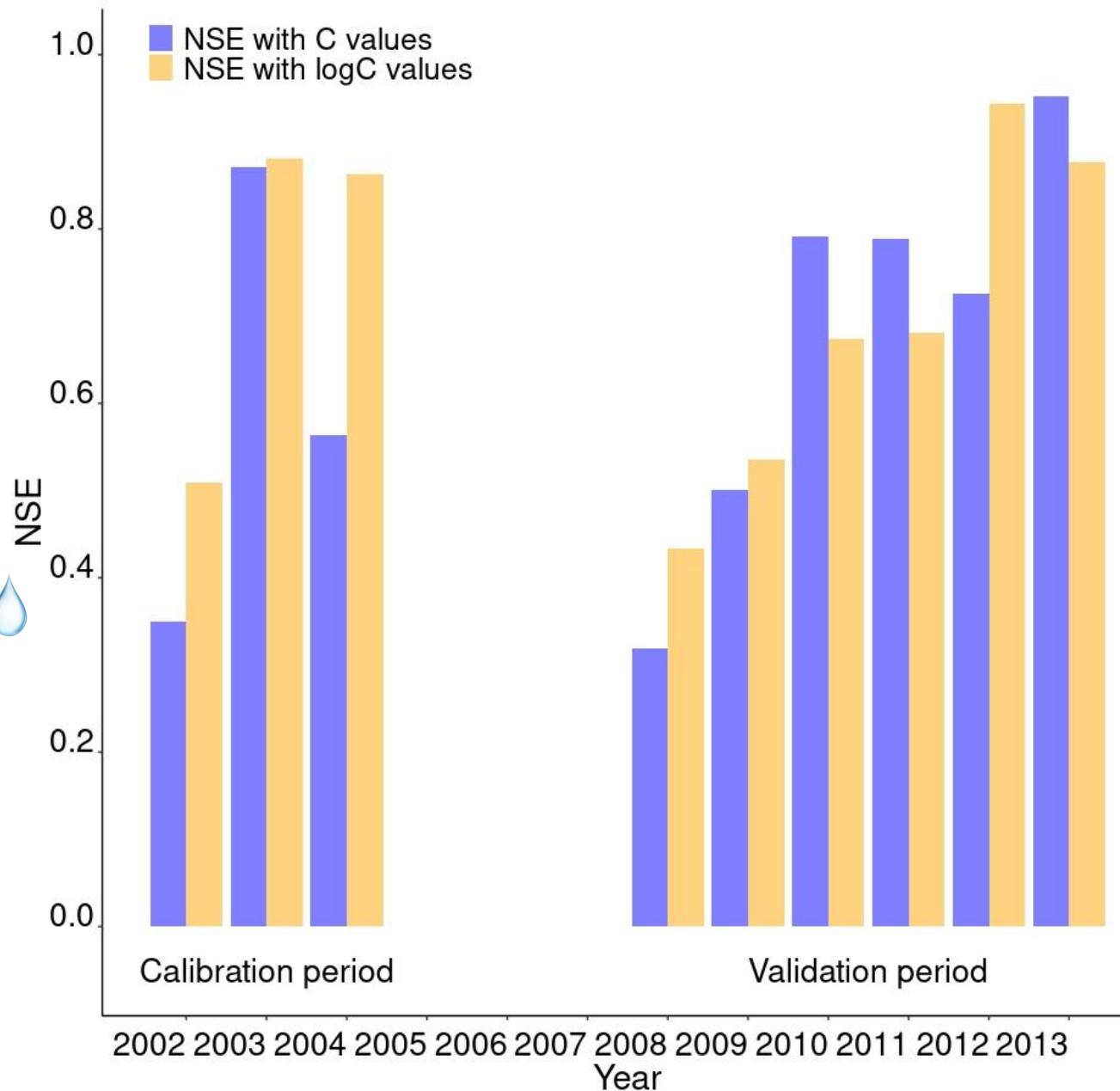
2. Materials & Methods



3. Results



4. Conclusion



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

1. Introduction



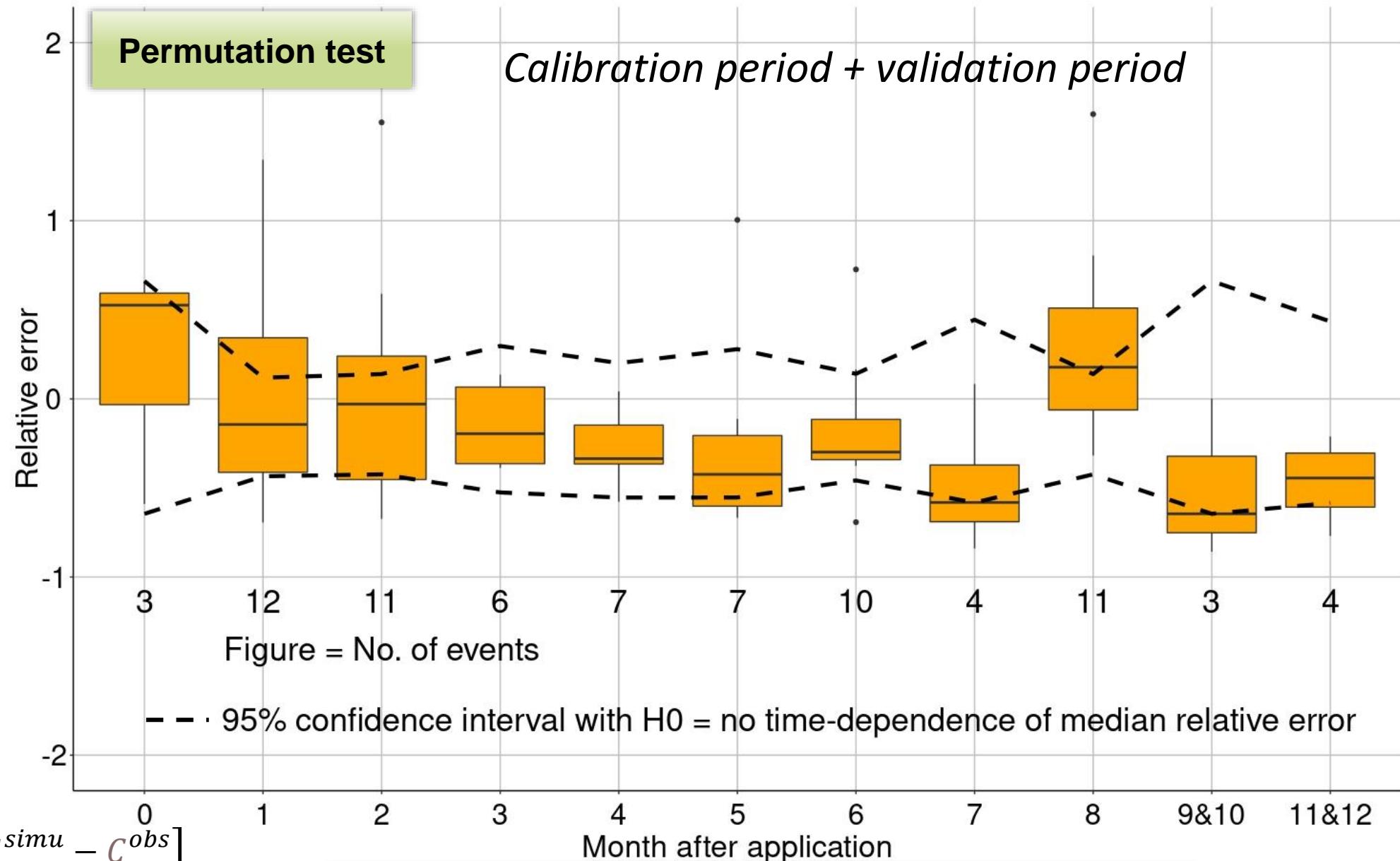
2. Materials & Methods



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

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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