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To cite this version:

HAL Id: hal-02608128
https://hal.inrae.fr/hal-02608128
Submitted on 16 May 2020

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Assimilation of image data into a spatialized water and pesticide flux model

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Abstract: Physically-based models represent detailed surface/subsurface transfer, but the required spatial information does not allow their operational use. Therefore, images are used as a source of additional information. The ADIMAP project aims to exploit these 3 types of information (model, in situ data, images) to deduce the state of the system in order to improve pesticide fluxes simulation and estimates of hydrological parameters. This poster discusses the proposed methodology as well as the available study site data and modeling components.

The Morcille study site (Beaujolais)

- Small watershed (8.8 km²)
- 70% of vineyard
- High risk of pesticide contamination
- Steep slopes > 25%
- Permeable sandy soils
- Continental climate with Mediterranean influence
- Research on pesticides since 1985
- River quality and flow monitored between 2006 and 2011.

Reactive solute transport on a short event

- Dynamics are reproduced, but significant delay
- Sensitivity Analysis showed high influence of hydrodynamic characteristics on solute transfer outputs [see Gatel pres. on Wednesday Session 43!]
  ⇒ Need to reduce uncertainty
  ⇒ Need to better parameterize CATHY spatialized hydrodynamic characteristics

DA for pesticide transfer modeling

Modeling pesticide transfer in a watershed is particularly complex:
- Very high heterogeneity of the system
- Many processes in interaction
- Few information on physico-chemical interactions of molecules
- Lack of data deep in the soil
  → research focuses on development of modeling in function of chosen processes to describe
  → DA would improve input parameters characterization and pesticide transfer understanding.

Hypothesis:

Assimilating hydrological variables will improve the pesticide fluxes simulations and the input parameters estimates.
⇒ Coupled Data Assimilation

Model setup on a simplified hillslope

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Zone 1 (mean, SD)</th>
<th>Zone 2 (mean, SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K_e</td>
<td>m s⁻¹</td>
<td>(1.819, 0.169)</td>
<td>(1.952, 0.169)</td>
</tr>
<tr>
<td>h</td>
<td>m</td>
<td>(0.540, 0.064)</td>
<td>(0.420, 0.045)</td>
</tr>
<tr>
<td>n</td>
<td>-</td>
<td>(0.15, 0.0375)</td>
<td>-</td>
</tr>
<tr>
<td>m</td>
<td>cm⁻¹</td>
<td>(1.46, 0.146)</td>
<td>(1.52, 0.152)</td>
</tr>
<tr>
<td>K</td>
<td>m² s⁻¹</td>
<td>(0.032, 0.0065)</td>
<td>(0.13, 0.033)</td>
</tr>
<tr>
<td>K</td>
<td>m² s⁻¹</td>
<td>(27.5, 31)</td>
<td>(5.1, 1.2)</td>
</tr>
<tr>
<td>K</td>
<td>m² s⁻¹</td>
<td>(45.1, 30)</td>
<td>(1.98, 1.33)</td>
</tr>
<tr>
<td>K</td>
<td>m² s⁻¹</td>
<td>(30, 10)</td>
<td>-</td>
</tr>
<tr>
<td>K</td>
<td>m² s⁻¹</td>
<td>(0.0025, 0.0015)</td>
<td>-</td>
</tr>
</tbody>
</table>

4DVar

\[ J(x) = \frac{1}{2} \| x - x_0 \|_2^2 + \frac{1}{2} \| H(x_{mod}) - y \|_2^2 \]

with B and R background and observation error covariance matrices

- would allow testing more situations to help estimate the input parameters for the hydrological part of CATHY
- Would reduce uncertainty for the pesticides transfer part
- No need for expensive MC estimation, long as the adjoint model coded.


This study was funded by INSU LEFE/MANU in the project ADIMAP.