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Claire Lauvernet, Laure-An Gatel, Claudio Paniconi, Matteo Camporese, Anna Botto, Arthur Vidard, Maëlle Nodet

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

C. Lauvernet1, L. Gatel2, C. Paniconi2, M. Camporese3, Anna Botto3, A. Vidard4, M. Nodet5

1 INRS-ETE, Université du Québec, Canada – 2 Univ. of Padova, Italy – 3 Inria, France – 4 Univ. Grenoble Alpes & INRIA, France

Abstract: Physically-based models represent detailed surface/subsurface transfer, but the required spatial information does not allow their operational use.

▶ In situ data on pesticides in a catchment are usually rare and not continuous in time and space.
▶ Satellite images well describe data in space, but only water related, and at limited time frequency.

The ADIMAP project aims to exploit these 3 types of information (model, in situ data, images) with data assimilation methods adapted to image data, in order to improve pesticide fluxes simulation and estimates of hydrological parameters. This paper discusses the proposed methodology as well as the available study site data and modeling components.

CATHY-Pesticide Hydrological model

Coupled surface/subsurface flow and transport [1-7]

▶ Richards eq. for variably saturated porous media:
  \( S_m \frac{\partial \theta}{\partial t} + \frac{\partial Q}{\partial t} = \nabla \cdot \left( K \nabla \psi \right) + q_w \)

▶ 1D diffusive wave equation at surface:
  \( \frac{\partial Q}{\partial t} + c_0 \frac{\partial Q}{\partial x} = D_c \frac{\partial^2 Q}{\partial t^2} + q_s \)

▶ Advection – dispersion equation:
  \( \frac{\partial C}{\partial t} = \nabla (D_c \nabla C) - \nabla (\nabla c) + R \)

▶ Linear adsorption and first order decay
  \( K_d = C_i \frac{dt}{dx} = -\lambda C \)

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

Assimilation of images

▶ Usually, remote sensing data and sequences are under-used, though their content in information is very high (shapes evolution, correlations,...)
▶ HR Images would also help to identify the landscape elements (grass strips, hedges, ...)
▶ In classical approaches: uncorrelated noise, diagonal error covariance matrices
▶ How to provide observation error covariance matrices adapted to spatially correlated errors? [2]
▶ Focusing on the observations operator description, and distances definition in the DA scheme


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