Which benefits in the use of a modelling platform ? The VSoil example.

Lafolie F. *INRA, Avignon*

Cousin I. *INRA, Orléans*

Marron P-A. *INRA, Dijon*

Mollier A. *INRA, Bordeaux*

Pot V. *INRA, Grignon*

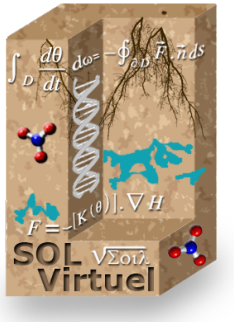
Moitrier Ni. *INRA, Avignon*

Moitrier Na. *INRA, Avignon*

Nouguier C. *INRA, Avignon*

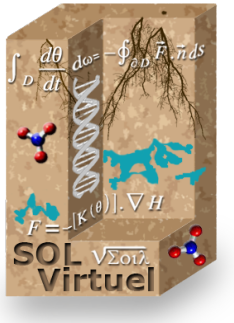
INRA
SCIENCE & IMPACT

Context



- The International Soil Modeling Consortium initiative
- Modeling platforms :
  - Climate, Surface Dynamic, Radioactive Wastes repositories, etc...
- **VSoil** for soil processes modeling at local scale
- What is **VSoil** ?
- Some feedbacks.

Objectives of the Platform



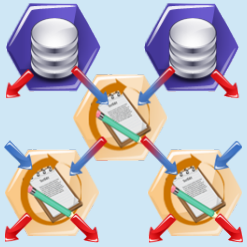
- To share and capitalize on our knowledge and tools.
- To assist in developping models for *existing* or *emerging* processes.
- To facilitate interactions between modelers and people carrying out observations
- To facilitate communication between researchers from various scientific domains.
- To facilitate the exchanges of tools.

Platform architecture

From concepts …

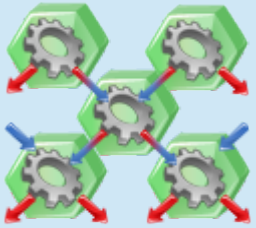
Processes

...linked to form skeletons,



...encoded as modules,

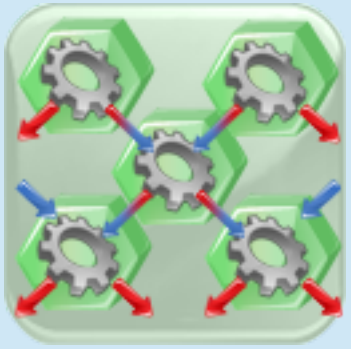
...to create models



...and carry out simulations

vsoil-processes

vsoil-modules



vsoil-models

vsoil-player

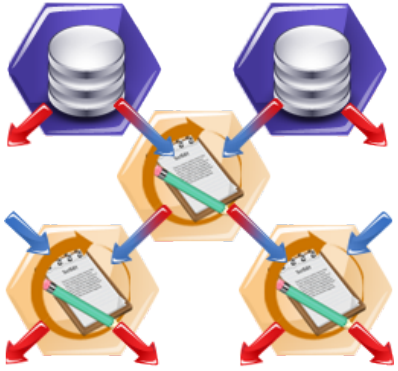
… to softwares

Vsoil Processes

Phenomena are called "*processes*"

External *processes*

Interactions between processes are detected by means of their *inputs* and *outputs*



Processes with their inputs and outputs produce dependency graphs called "**skeletons**"

Lists of variables and processes are opened

Tool to explore platform content

Guide for naming variables

Automatic generation of skeletons

Provides informations useful for coding and assembling.

Vsoil-Modules

A module corresponds to a modeling, a numerical method, etc.. It's a software. A module is attached to a process.

A process can be modeled by several modules.

A module uses some of the inputs of its process and must produce at least one output of its process.

Parameters definition

C++ or FORTRAN2003

Coding assistance

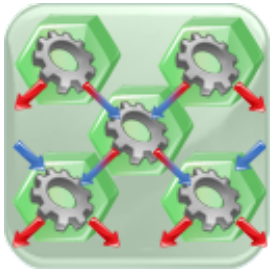
Compiling

Testing

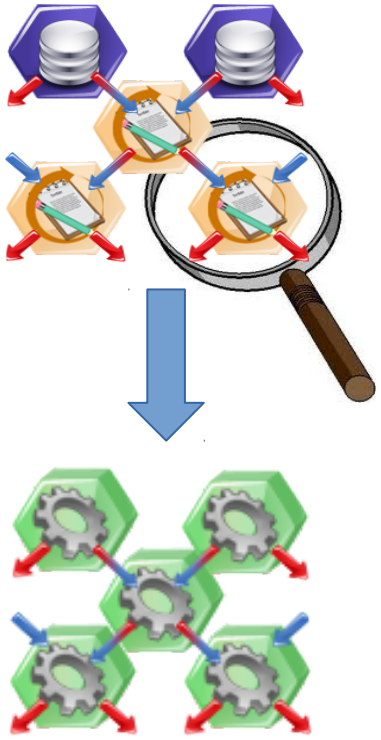
Plots

Not invasive

Vsoil-Models



A model is based on a skeleton



A model is an ordered set of modules

- **Guided module selection**
- **Generation of Main**
- **Generation of GUI**
- **Execution**
- **Visualisation**
- **Saving and archiving**
- **Modification**

Vsoil-Player

Run available models

Visualize previous runs

Compare models and/or runs

Carry out sensitivity analysis

Carry out parameters estimation

A collaborative tool

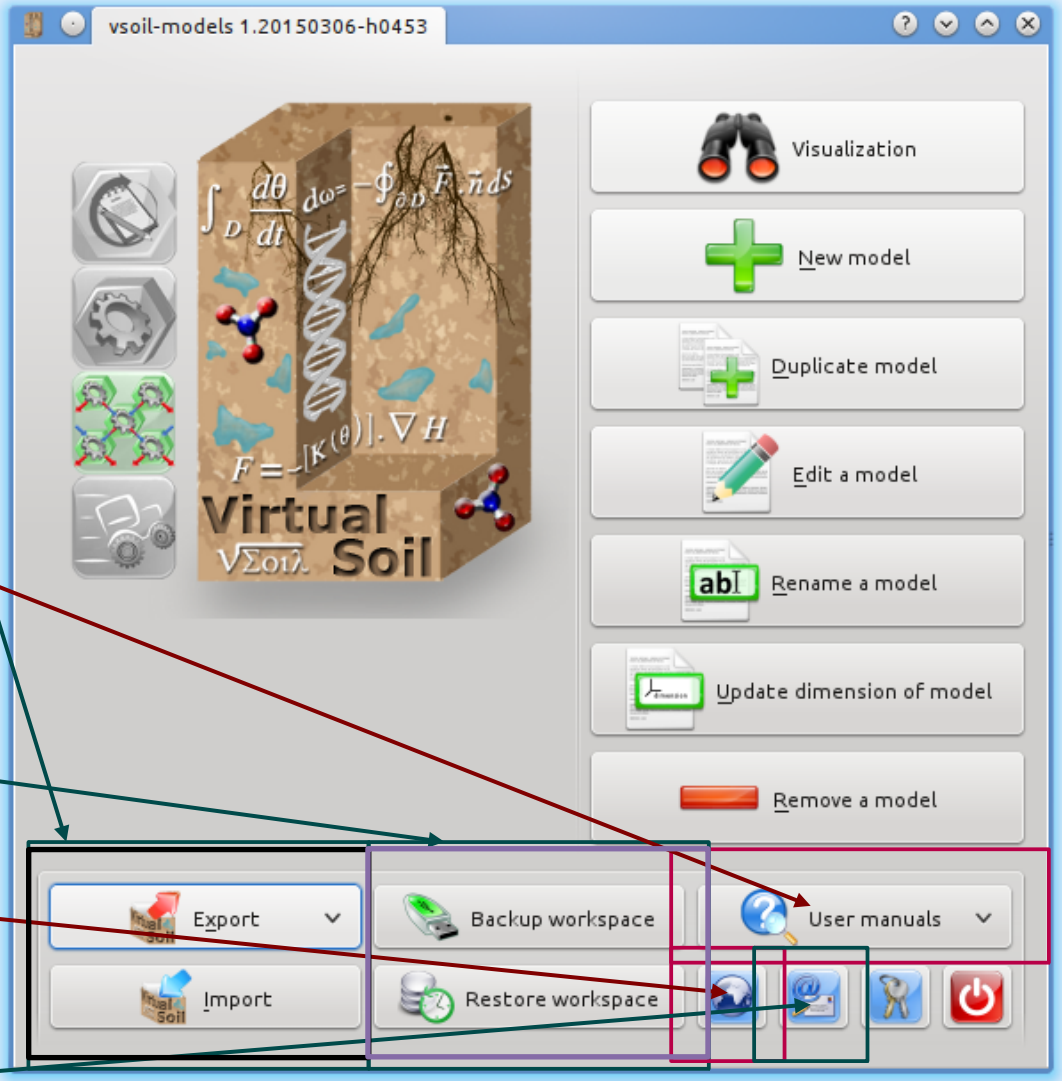
Exchanges of platform objects

In line documentation.

Backups.

Web Site.

Contact and assistance.



Model « Fast Hydro Atmosphere Vegetation Temperature »
FHAVeT

Authors : Anne Julie Tinet et al. Hydrol. Earth Syst. Sci., 19, 969-980,2015

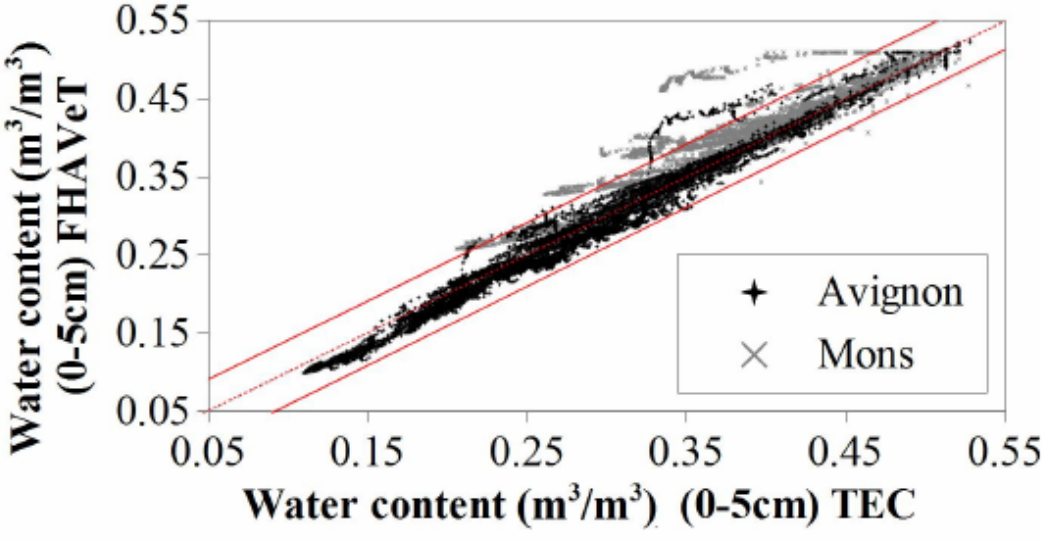
- **Objectives**
  - To develop a model for decision making (irrigation, tillage, etc..)
  - Model should be fast and robust
  - Accounting crop effects on energy balance.
- **Choices**
  - ROSS method for water flow coded within a VSoil module
  - Energy balance coded within a VSoil module
  - Uses soil heat transfert module already available.
  - Weak coupling managed by platform

Comparison with a classical model (TEC)

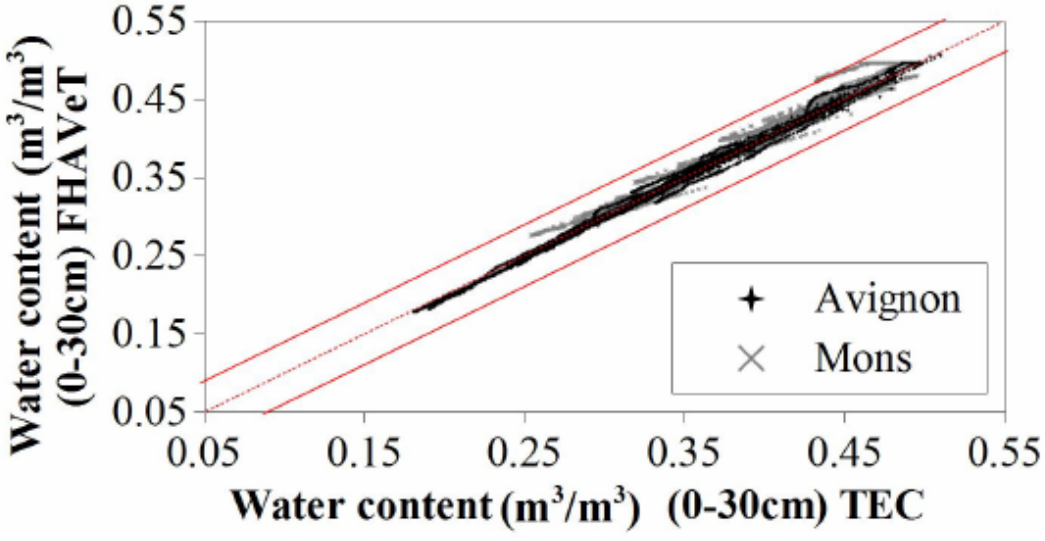
Focus on development of missing modules

Coupling and main program entirely automatic

A first proof of feasability



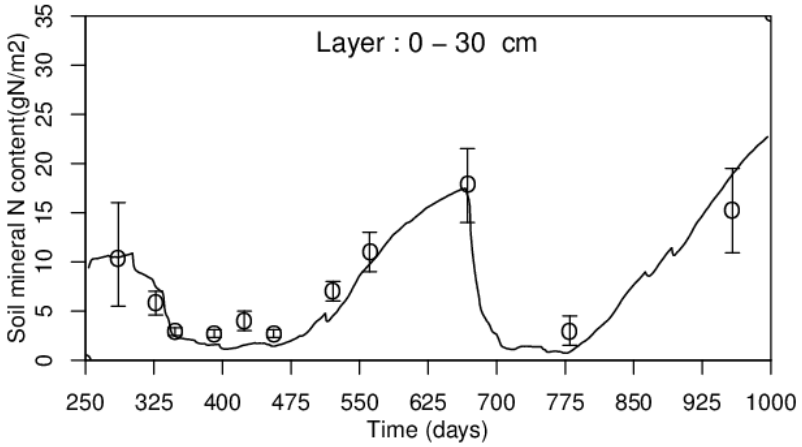
(a) 0-5 cm layer

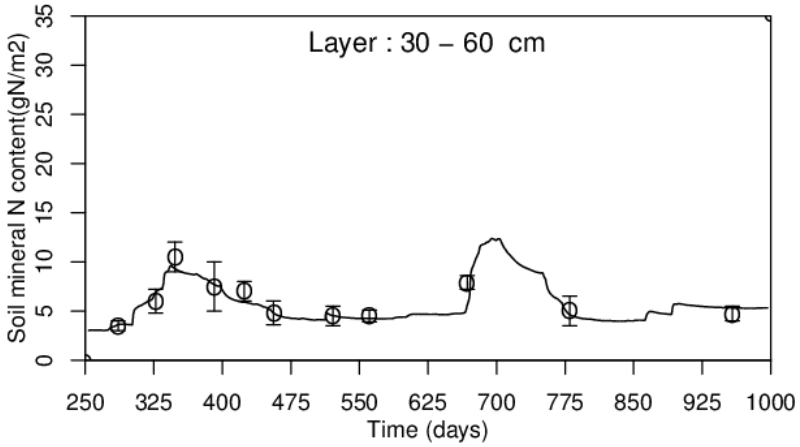


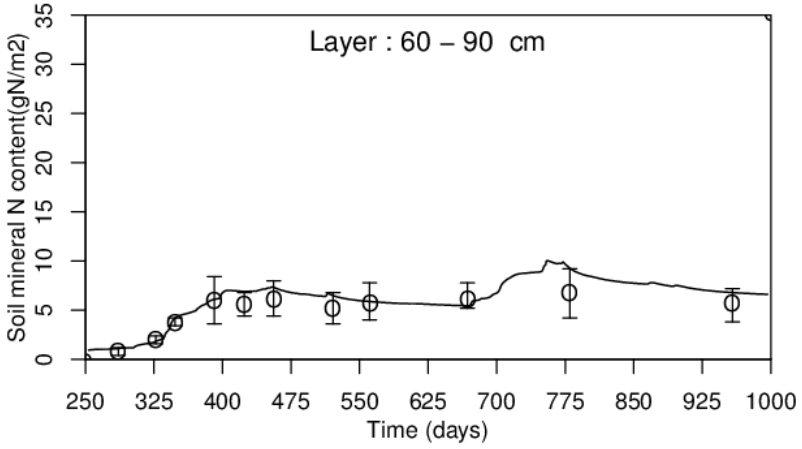
(b) 0-30 cm layer

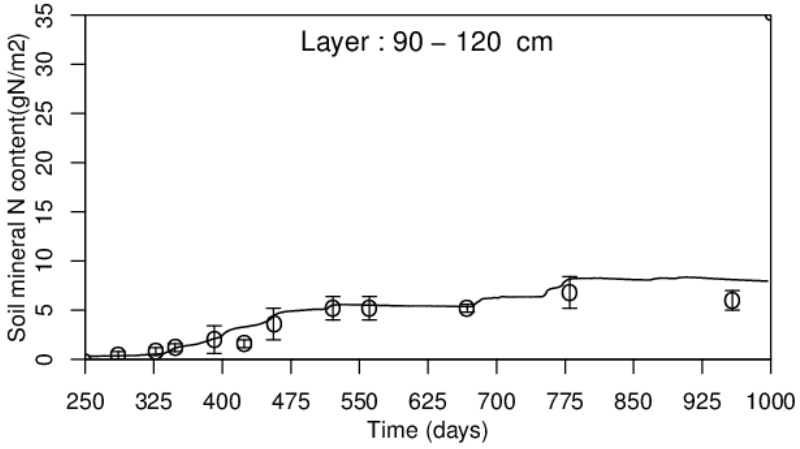
Comparison with an external model and field data

Model constructed using available modules









More examples

- Coupling capilary flow (Richards equation) with macropore flow (KDE) and runoff
- Coupling transport (MIM model) of trace organic contaminant (TOC) and dissolved organic carbon (DOC) with aqueous complexation and kinetic sorption
- Modeling transport of natural or engineered colloids
- Simulation of experiments designed for measuring denitrification and nitrous oxyde emissions

More examples

- Simulation of organic residual products transformations in soils and consequences on nitrogen availability.
- Simulation of HAP fate in soils.
- Development of a model for pedogenesis
- Simulation of NO and NH3 emissions
- Testing of various organic matter modules

What can we learn from these experiences ?

Diversity of users

Autonomy when building

Autonomy when developing

Sensitivity Analysis And visualization

Module re-use

Exchange procedures

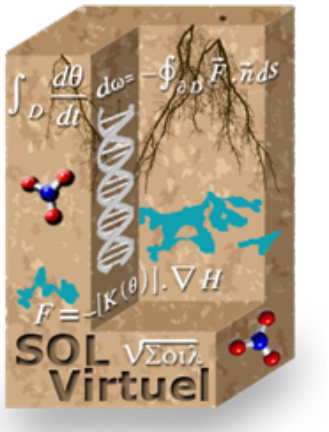
Automatic main_ works

Vsoil-Processes

To summarize…

- **Model builder** and models repository
- Separation between knowledge and calculus
- No intrusion so that the model is readily usable outside the framework
- Benefits of a « development team » that improves potentialities : paralellisation, acces to data bases, access to state of the art methods, …
- To « work » requires collaboration and sharing

Thank you for your attention



https:www6/inra.fr/vsoil