

# **Impact du changement climatique sur les ressources en eau**

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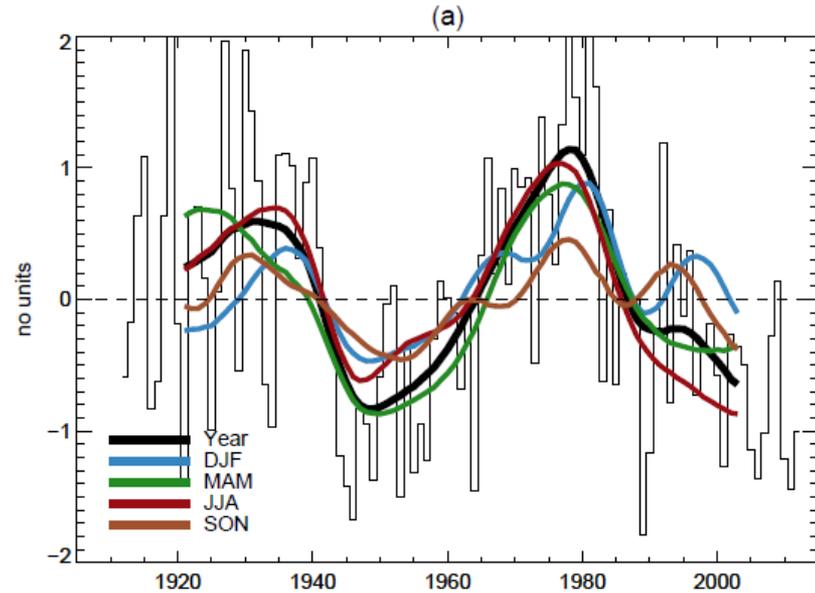


## Multi-decadal river flow variations in France

J. Boé<sup>1</sup> and F. Habets<sup>2</sup>

<sup>1</sup>Sciences de l'Univers au CERFACS, URA1875, CNRS/CERFACS, Toulouse, France

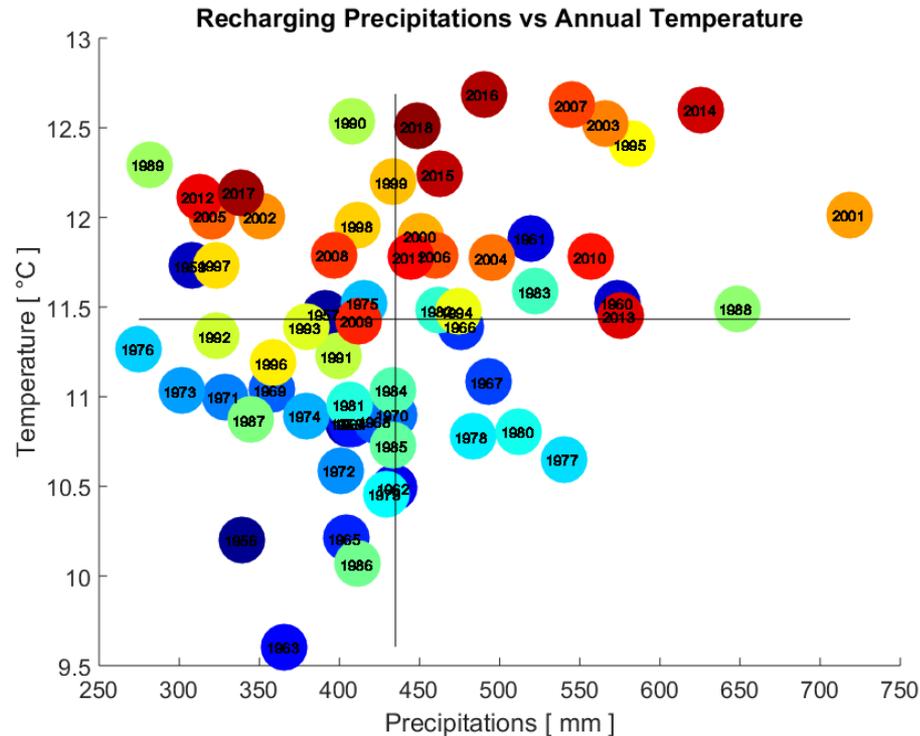
<sup>2</sup>UMR 7619 METIS, CNRS UPMC, Paris, France



**Fig. 2.** (a) Standardized (undretrended) river flows of the Gave d'Ossau at Oloron-Sainte-Marie (Oloron-Ste-Croix). Bars: annual means. Thick lines: low-pass-filtered seasonal and annual series.

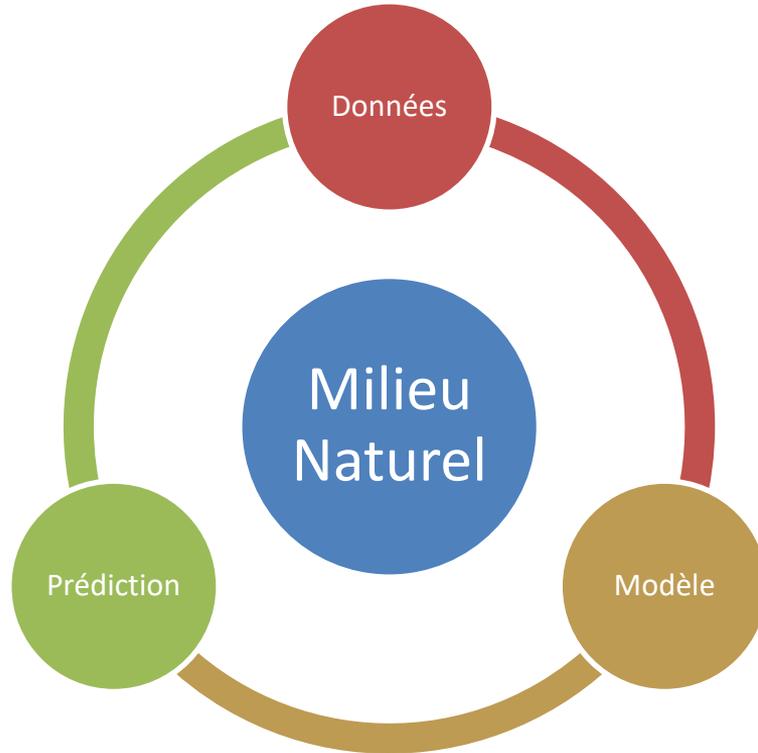
# Evolutions Climatiques

Analyses rétrospective et prospective des paramètres climatiques déterminants pour le cycle hydrologique



Moyennes Octobre-Avril sur 10 stations de Bretagne + Nantes, La Hagu (Laurent Longuevergne)

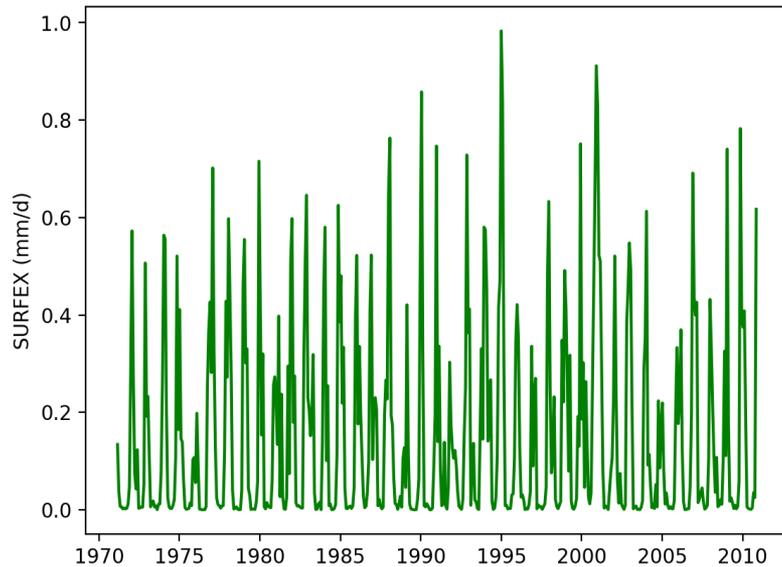
# Quelle démarche scientifique?



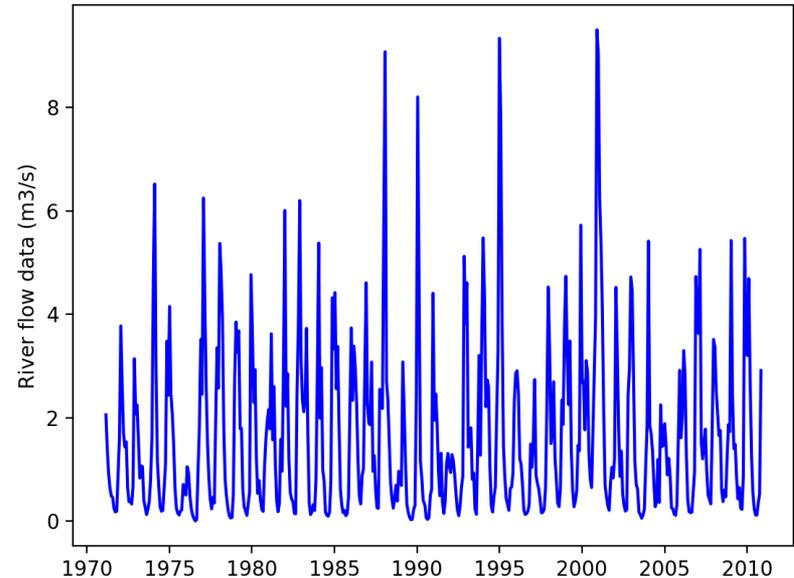
# Démarche à partir d'un objectif

## *Effet du changement climatique sur les ressources en eau*

Quelle évolution des débits de rivière à 50-100 ans?



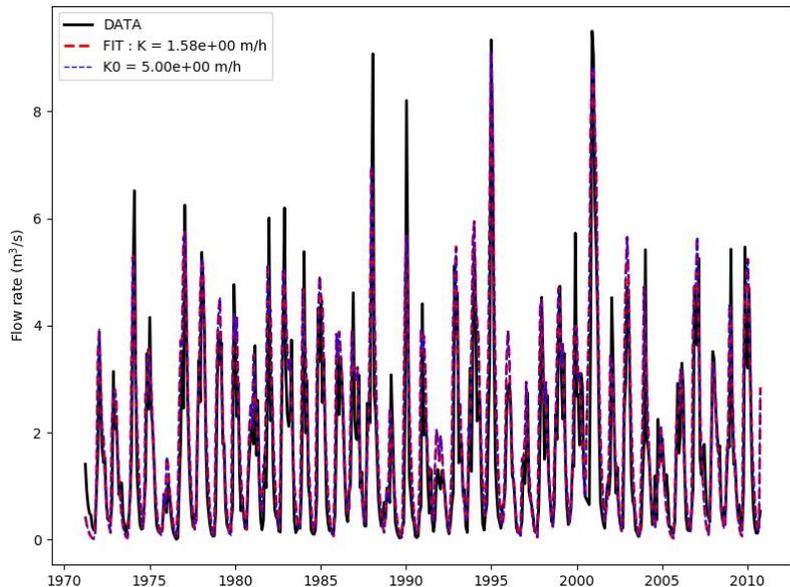
recharge (surfex)



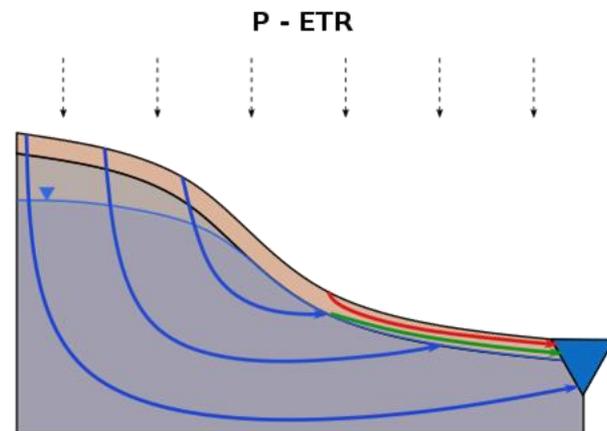
débit

# Démarche à partir d'un objectif

## *Effet du changement climatique sur les ressources en eau*



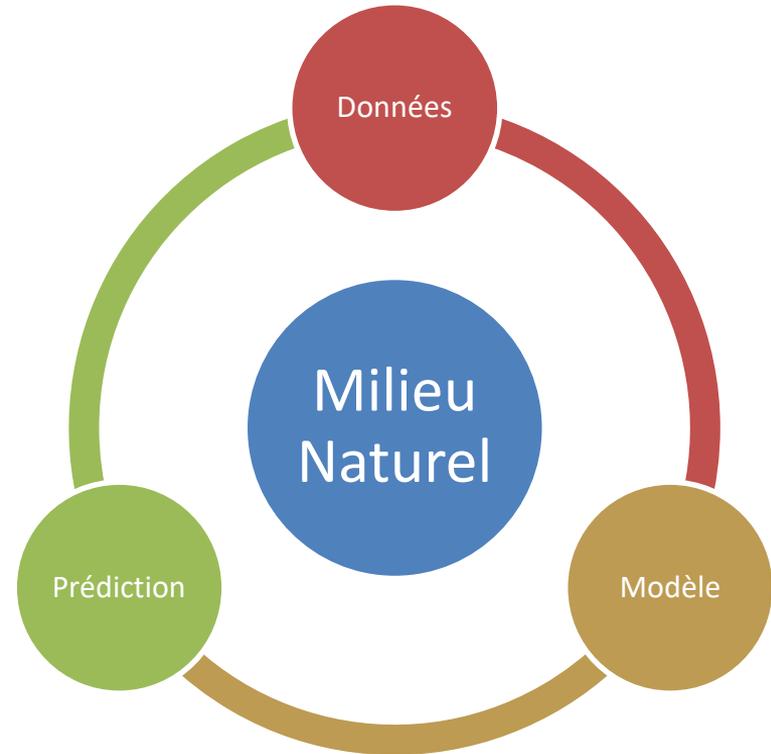
**WINTER**



Thèse de Quentin Courtois (2016-2019)

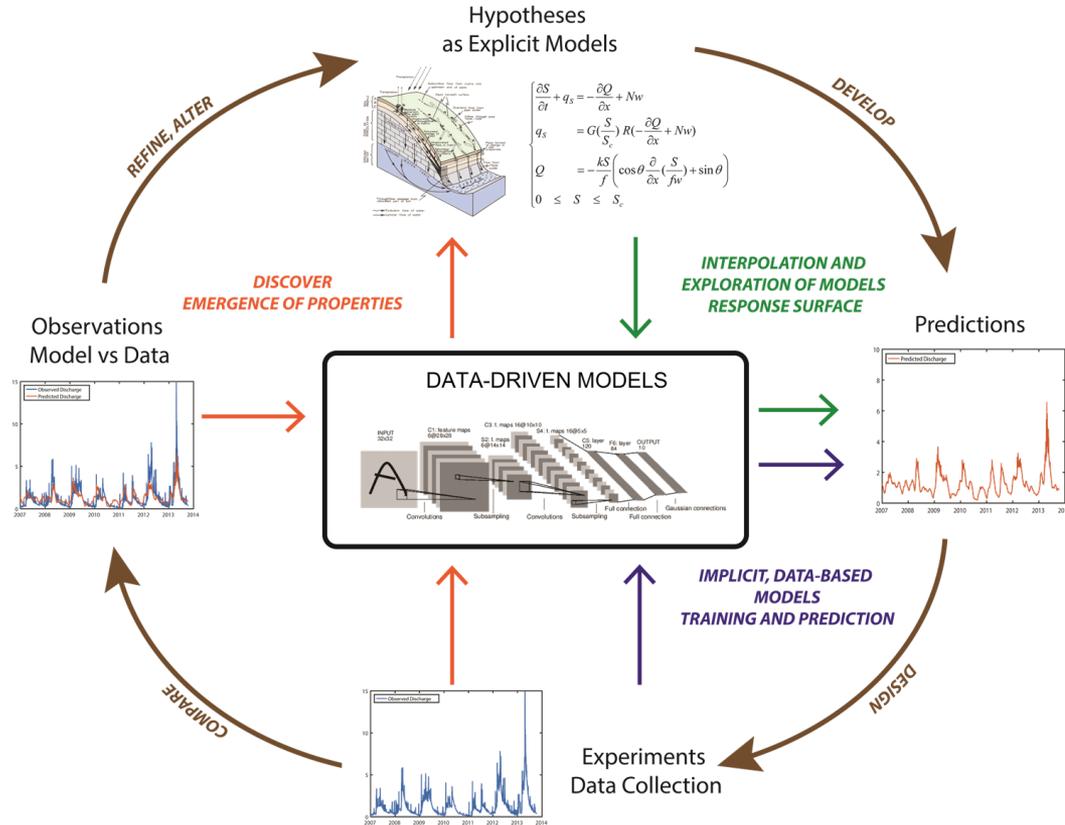
# La place de la modélisation dans la démarche scientifique

- Cohérence données-modèles-objectifs
- Construction commune des démarches
- Stratégie de connaissance des territoires
- Gestion intégrée de l'eau: qualité et quantité
- Des modèles pour un milieu naturel: incertitudes, maintenance, adaptation



# Une stratégie, Des modèles

## Les nouvelles méthodes d'apprentissage (IA)



# Du modèle au système

The screenshot displays the Eclipse Platform interface for a farming model simulation. The main workspace shows a diagram of farm activities and resources. The diagram includes a tractor, people, and a crop field. The activities are defined in the central workspace:

- activity LABOUR from 1 jan to 28 feb using 1 Tractor and 1 People
- activity SEMIS from 15 mar to 15 apr [ after LABOUR && no rain since 3 days && tempe ] using 1 Tractor and 2 People
- activity IRRIGATION weekly from 15 jun to 15 aug after SEMIS using 1 Tractor and 1 People
- activity FERTILISATION from 15 mar to 15 jun [ after SEMIS is done since 30 days && no rain since 1 days ] using 1 Tractor and 1 People
- activity RECOLTE from 1 sept to 30 sept [ grain is "mature" && after SEMIS ] using 1 Tractor and 2 People

The diagram also shows a tractor, people, and a crop field. The crop field is divided into three sections: 10ha - 4 fields, 10ha - 2 fields, and 10ha - 10 fields. The tractor is labeled "Massey Ferguson 1". The people are labeled "John" and "Henry". The crop field is labeled "Crop". The tractor is labeled "Tractor" and "People". The crop field is labeled "Crop". The tractor is labeled "Tractor" and "People". The crop field is labeled "Crop".

The Properties panel on the right shows the following values:

Property	Value
A	110.00065
B	110.00205
Culture	Culture wheat
Ed	111.85
Emax	110.94
K	110.5
Lmax	116.5

The Climate Data table shows the following values:

Day	Rain (mm)	Temperature (°C)	Ray (Joules/cm²)
apr 7	50	10.4	690.0
apr 8	0.0	10.4	790.0
apr 9	0.0	11.0	790.0
apr 10	19.0	11.4	230.0
apr 11	0.0	9.0	700.0
apr 12	2.0	10.7	810.0
apr 13	0.0	9.7	810.0

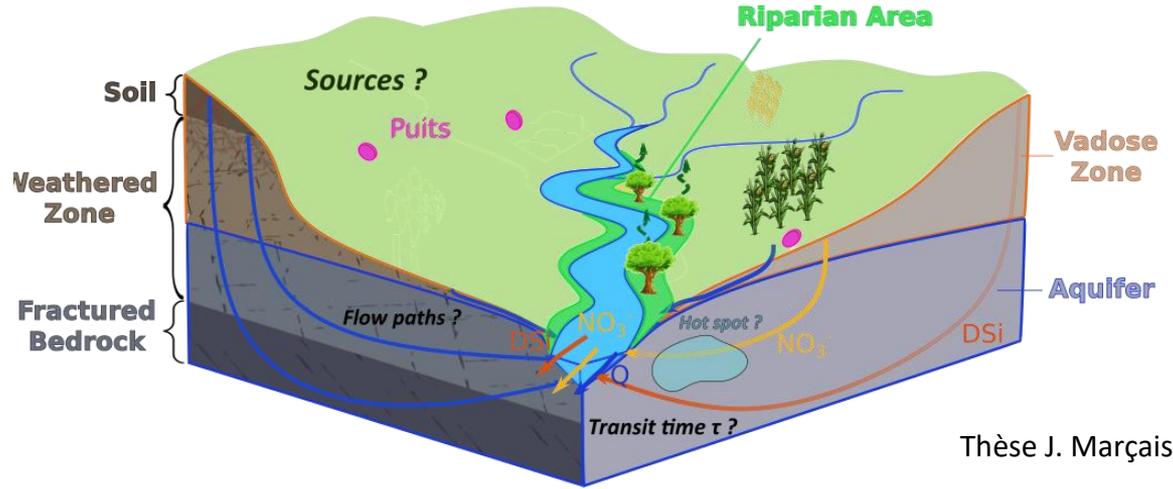
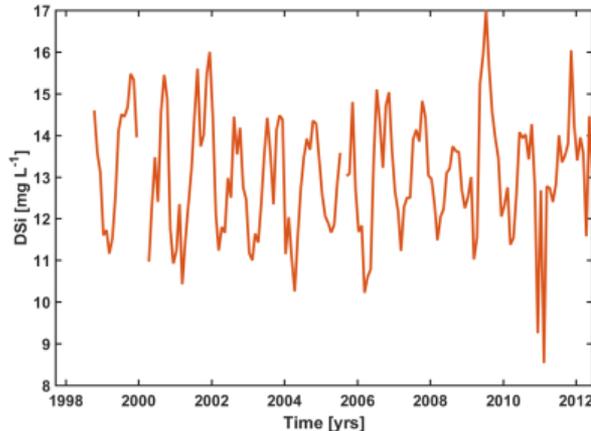
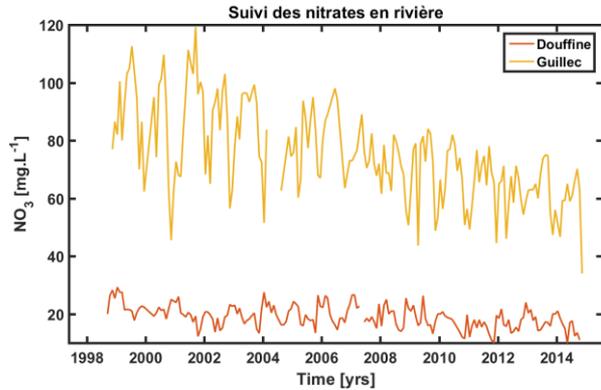
Benoit Combemale

<https://github.com/gemoc/farmingmodeling>

# Démarche à partir de données

## Transfert et dégradation des nitrates dans les aquifères

Ecoflux



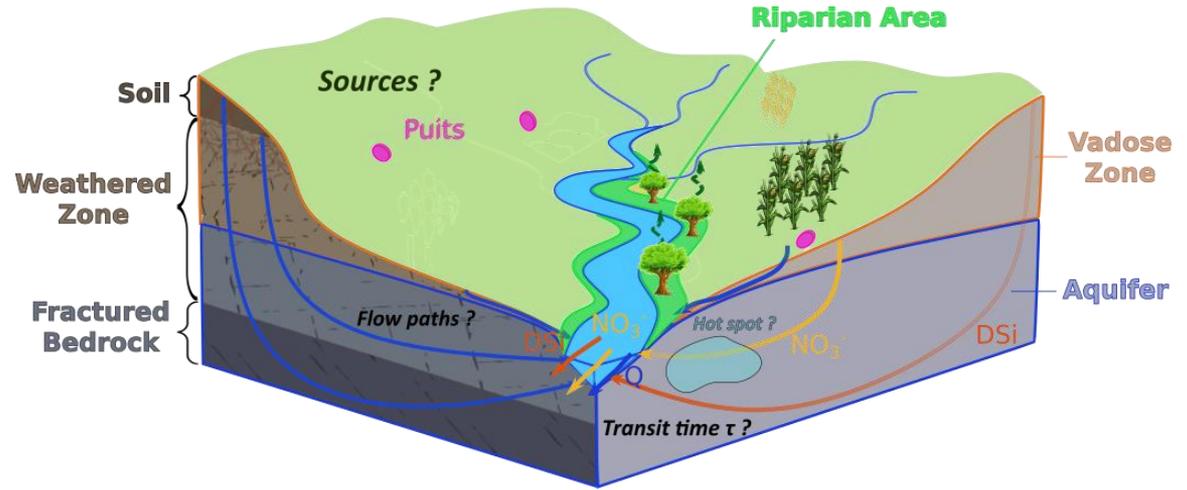
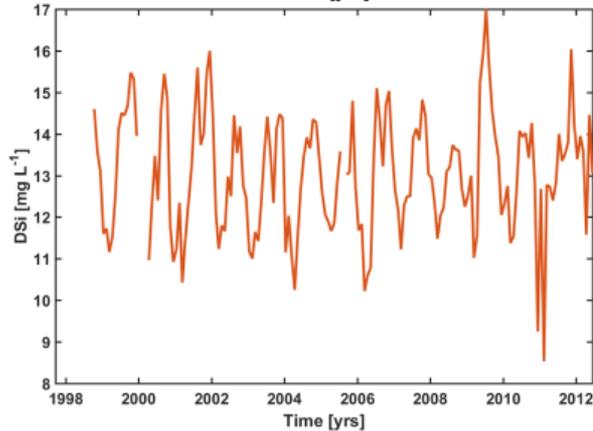
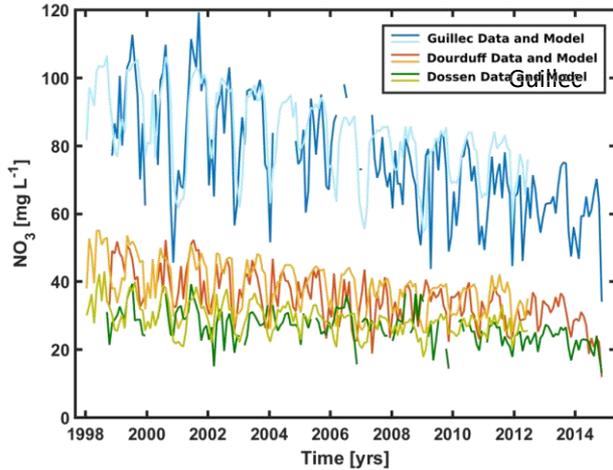
Thèse J. Marçais



$$\begin{cases} q_S(x_S, t) = -\frac{\partial Q}{\partial x}(x_S, t) + N(t)w(x_S) & q_S(x_S, t) \\ \frac{\partial S}{\partial t}(x_S, t) = 0 & \\ Q(x_S, t) = -\frac{kS_c(x_S)}{f} \left( \cos \theta \frac{\partial}{\partial x} \left( \frac{S_c}{fW} \right) (x_S, t) + \sin \theta \right) & \\ S(x_S, t) = S_c(x_S) \text{ and } -\frac{\partial Q}{\partial x}(x_S, t) + N(t)w(x_S) \geq 0 & . \end{cases}$$

# Démarche à partir de données

## Transfert et dégradation des nitrates dans les aquifères

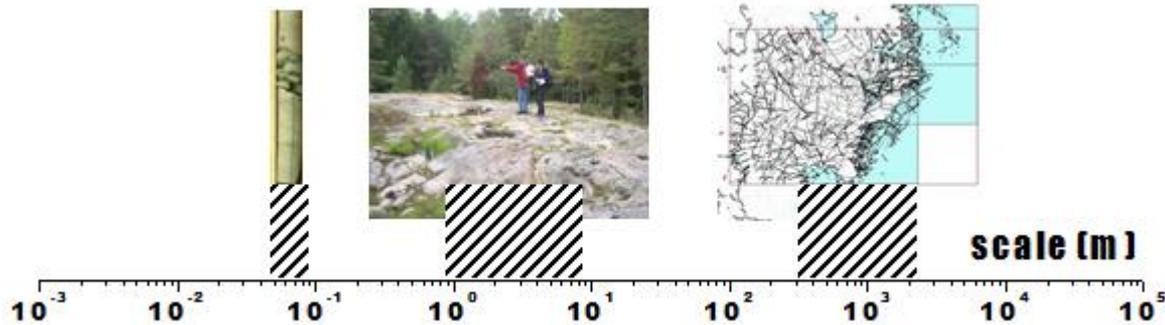


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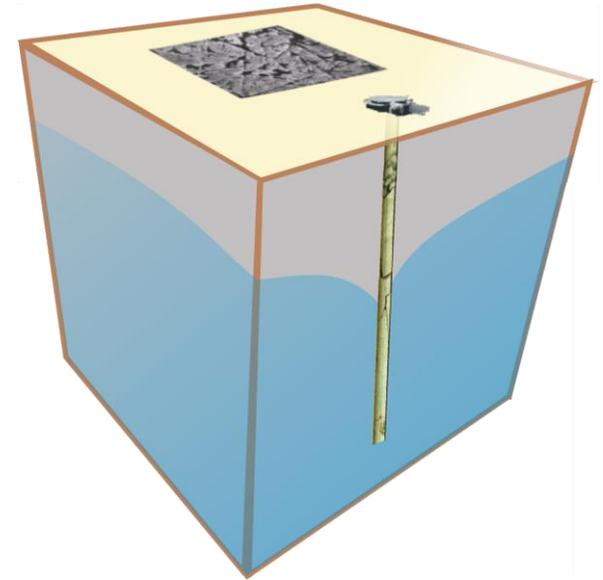
# Démarche à partir de modèles

## *Reconstruction des milieux souterrains (socle)*

### Données



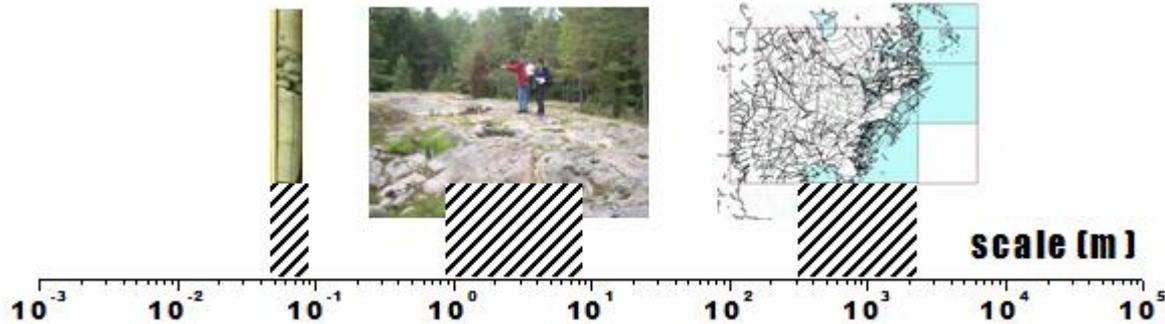
### Milieu Fracturé



# Démarche à partir de modèles

## *Reconstruction des milieux souterrains (socle)*

Données



Modèle

