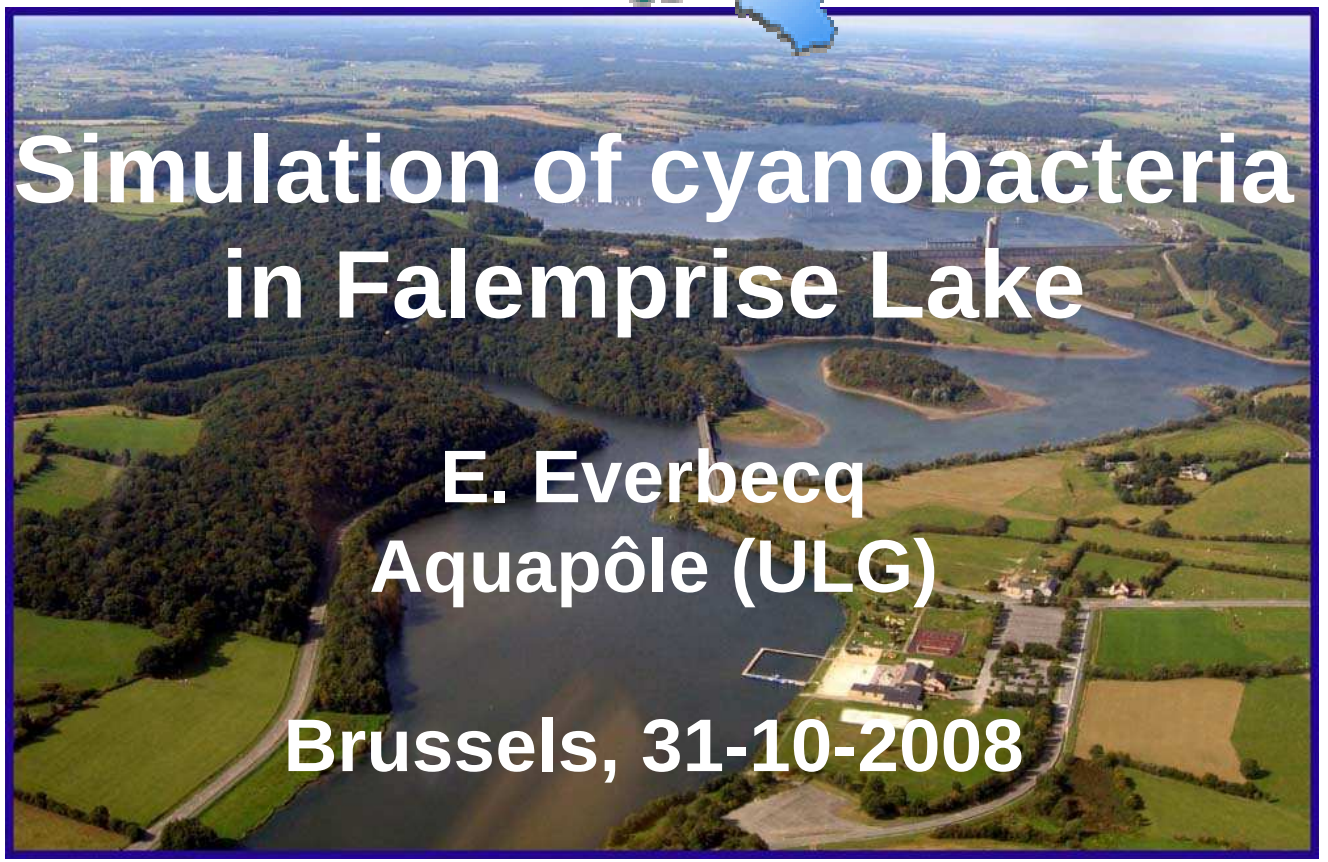
BELGIAN SCIENCE POLICY

B-BLOOMS



Simulation of cyanobacteria in Falemprise Lake

E. Everbecq
Aquapôle (ULG)

Brussels, 31-10-2008

FUNDP NAMUR

UNIVERSITEIT GENT

Vrije Universiteit Brussel

Université de Liège

UNIVERSITY OF DUNDEE

CONTRACT NUMBER
SD/TE/01A

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Historical : deterministic and “physically based” simulations of phytoplankton in rivers and lakes By CEME-Aquapôle, University of Liège

- First simulation of (global) phytoplankton in 1980’s on the Meuse river.

- 1990-1998 : development of a multi-species phytoplankton model : the POTAMON model (for “large rivers” : Meuse, Moselle, ... rivers)

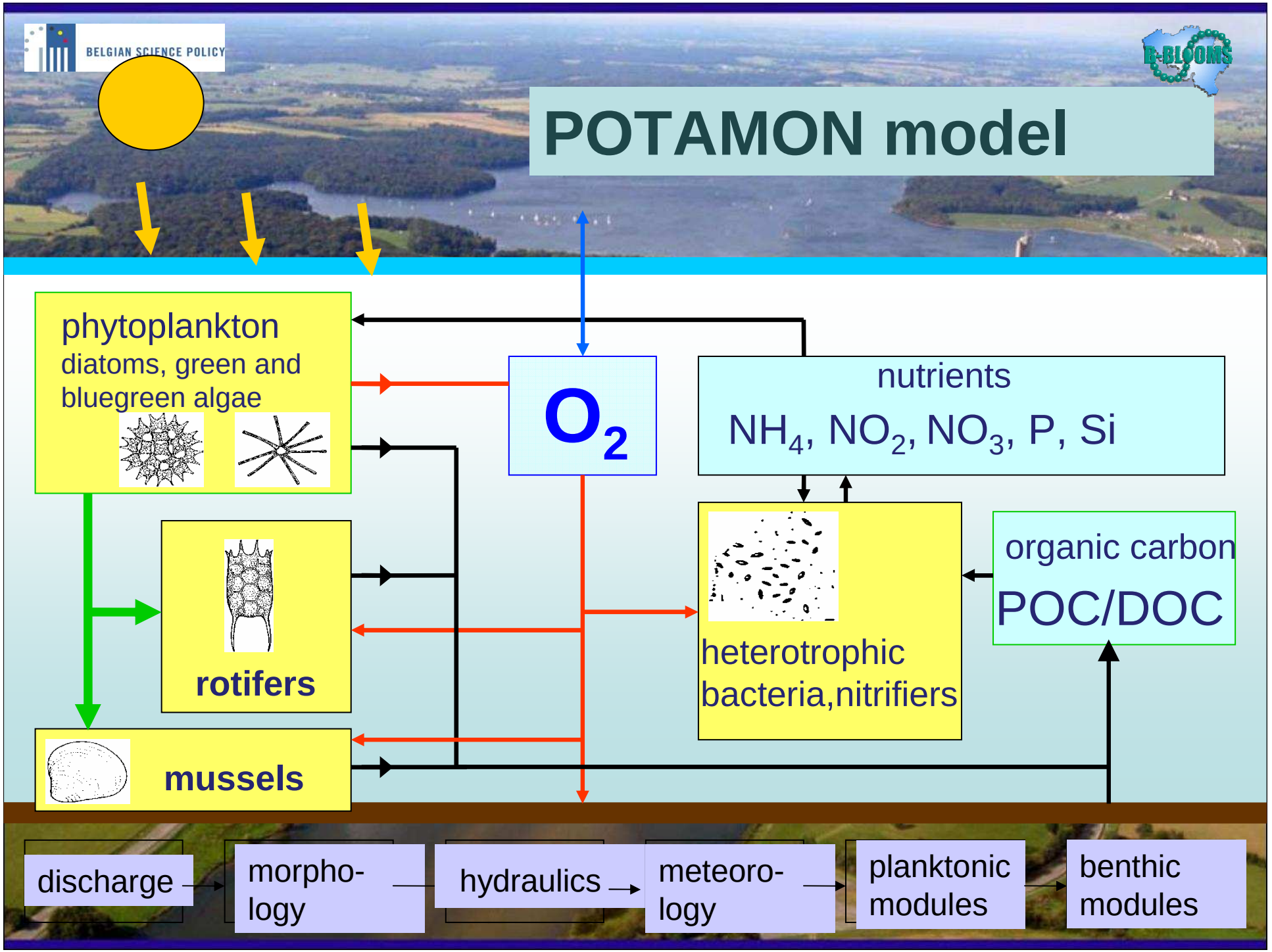
- 1999-2001 : inclusion of the POTAMON model in the integrated river/basin PEGASE model

- 2001-2003 : test of using the PEGASE model to simulate phytoplankton concentration in the Lakes of Eau d’Heure*

- 2001-2003 : test of simulation of cyanobacteria in the Lakes of Eau d’Heure (with an “extension” of the POTAMON/PEGASE models)

- 2007-2008 : use of the existing model (with new calibration) on the Falemprise lake to simulate cyanobacteria (B-BLOOMS2)

* Schéma directeur intégré pour la préservation de la qualité de l’eau et la valorisation écologique des lacs de l’Eau d’Heure dans le cadre du développement touristique et économique du site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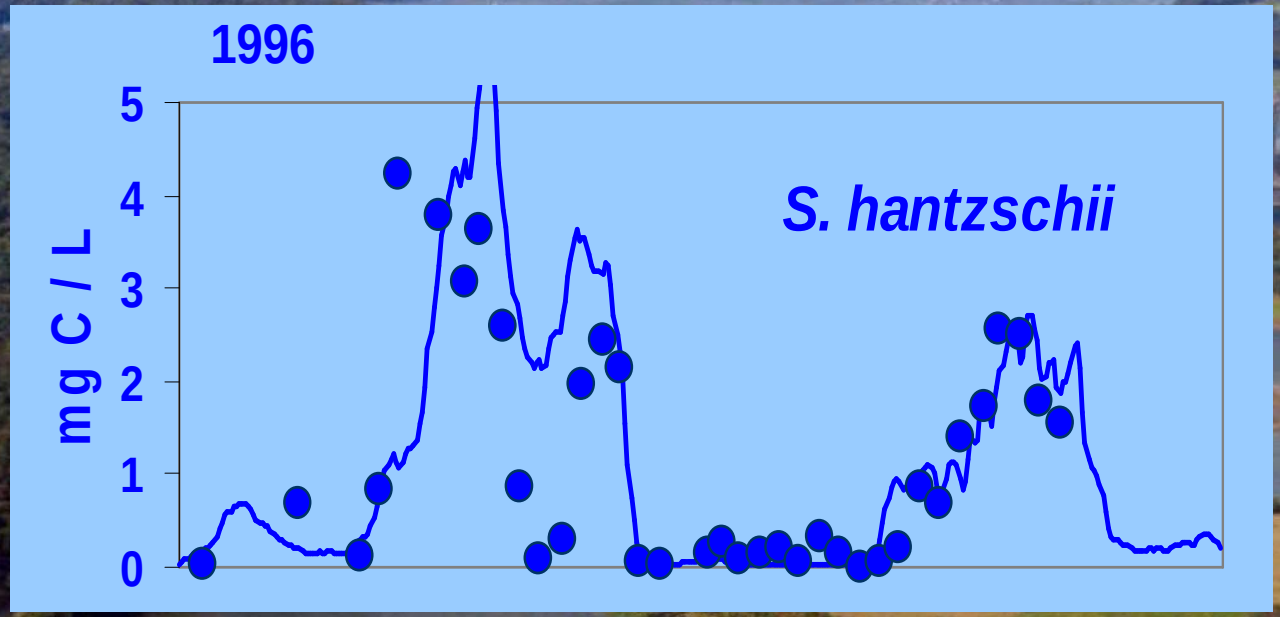
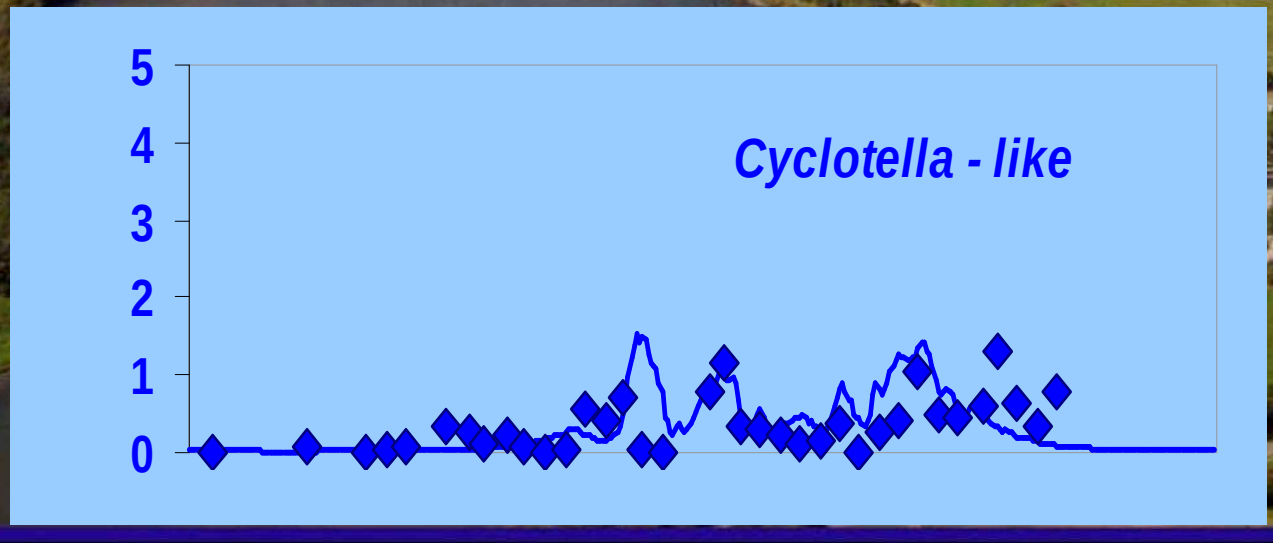
B-BLOOMS
POTAMON model
phytoplankton
diatoms, green and bluegreen algae
O2
nutrients
NH4, NO2, NO3, P, Si
rotifers
heterotrophic bacteria,nitrifiers
organic carbon
POC/DOC
mussels
discharge
morpho-logy
hydraulics
meteoro-logy
planktonic modules
benthic modules

POTAMON model : validation : Meuse River, Jambes

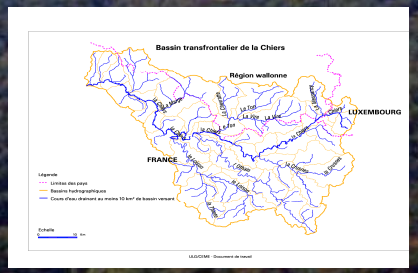




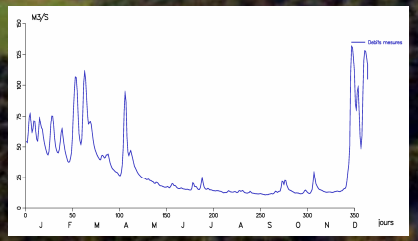
The PEGASE model

PEGASE = Planification Et Gestion de l'ASsainissement des Eaux
Integrated river/basin model, used by water Agencies in Belgium, France, …

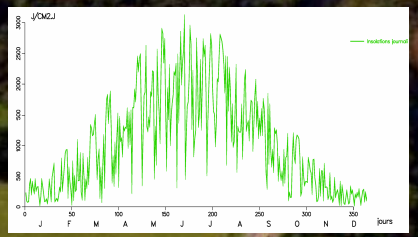
Inputs



Basins
Land use



Hydrographic network



Hydro-meteo

Driving forces / Pressures

PEGASE model

Outputs / results

Pollutant loads to the river network

River flow & veloc.
Water temperature

Biomasses
Ecosystem activity

Water quality
Fluxes

POTAMON/PEGASE phytoplankton model

- **4 → 6 categories of phytoplankton**
  - **Cold water centric diatoms (*Stephanodiscus hantzschii)***
  - ***Small centrics unicellular diatoms (Stephanodiscus*, *Cyclotella*, …)**
  - ***Non-siliceous algae (*Chlorophytes, Cryptophytes, …)**
  - ***Others (large diatoms, cyanobacteria, …)***
- **2 categories of zooplankton (*Brachionus*-like and *Keratella*-like rotifers)**
- **Intra-cellular quotas for N, P, Si**
- **Ability to take into account benthic filters**
- **Extension to lakes :**
  - **Specific numerical method (eulerian in place of lagrangian method)**
  - **Imposition (based on measurements) of the thermocline limit**
- **Extension to cyanobacteria : specific treatment (hphot < hreal)**

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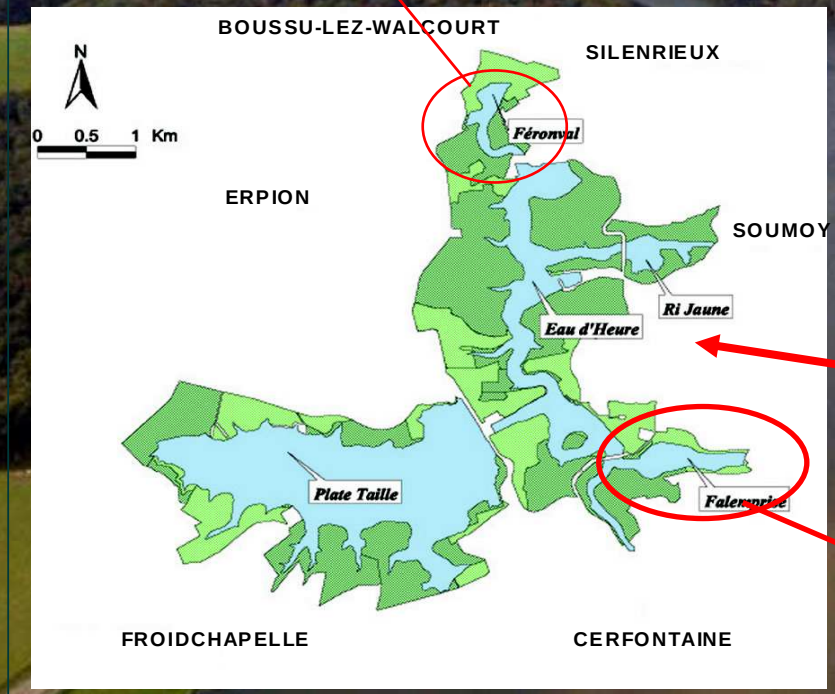
2001-2003 : Eau-Heure Lakes

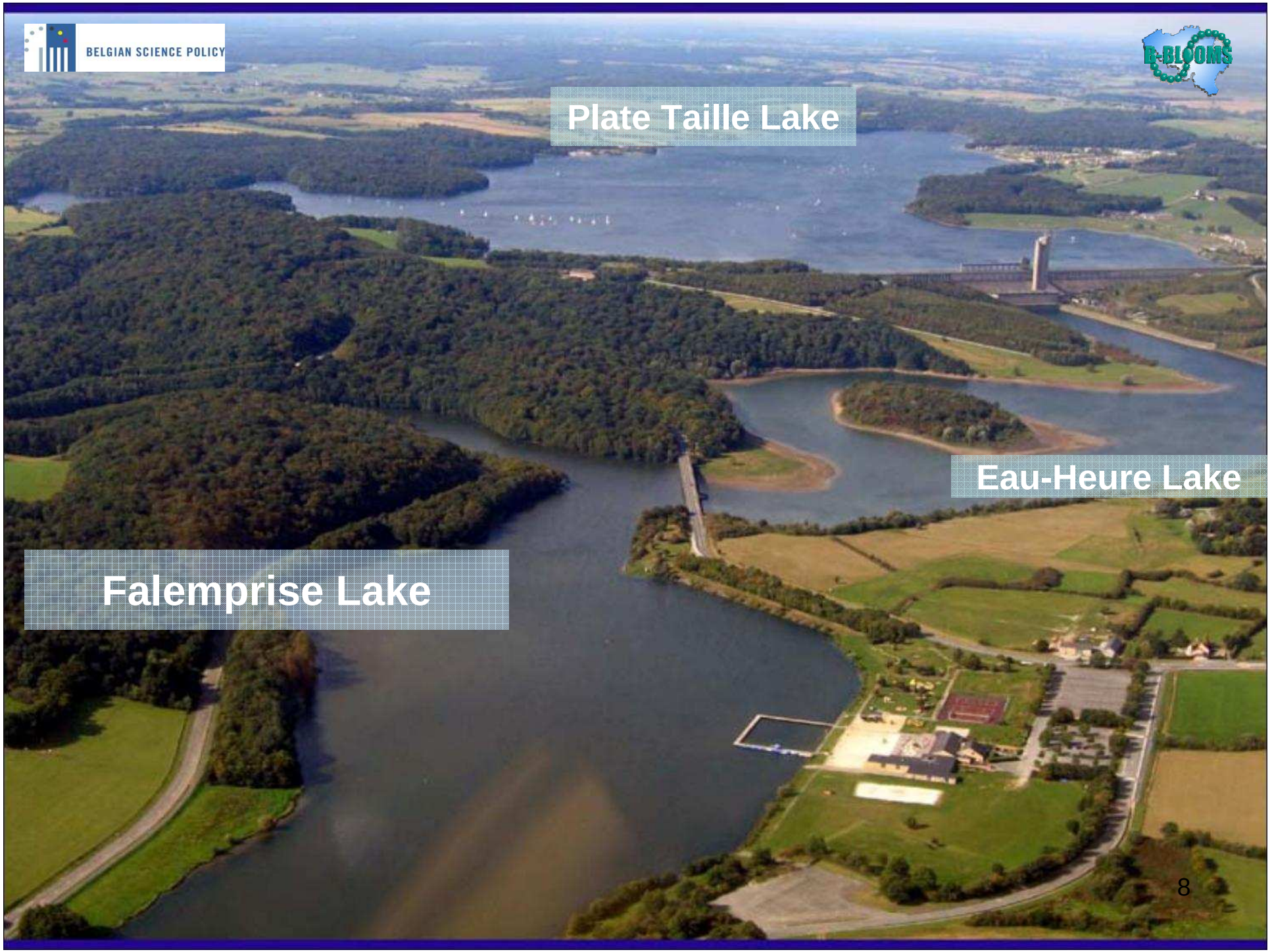
Schéma directeur intégré pour la préservation de la qualité de l'eau et la valorisation écologique des lacs de l'Eau d'Heure dans le cadre du développement touristique et économique du site

Development of an integrated model Simulation of phytoplankton + Cyanobacteria

Féronval lake



Falemprise lake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B-BLOOMS
Plate Taille Lake
Eau-Heure Lake
Falemprise Lake

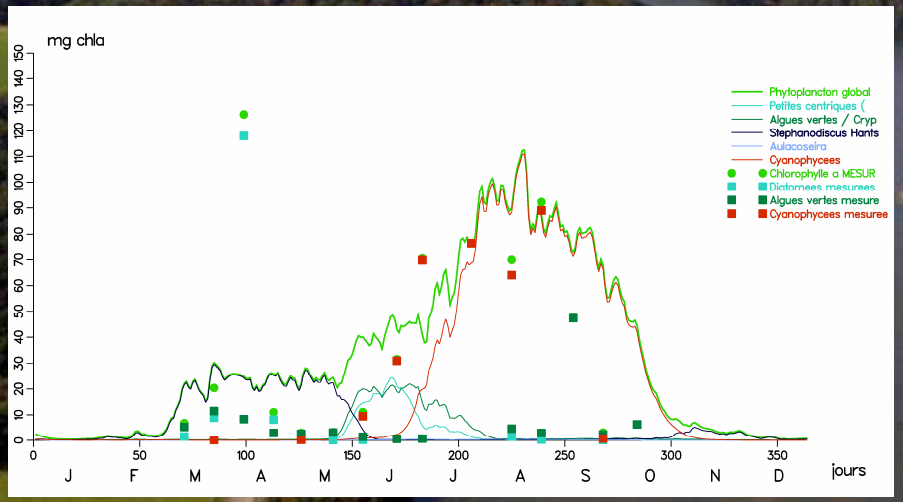
Validation 2002 : phytoplancton

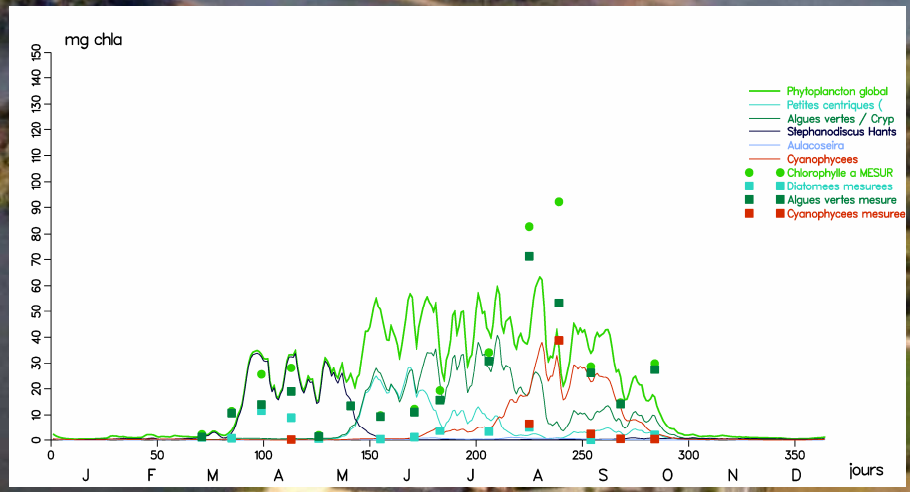
Annual evolution (2002) of phytoplancton concentrations In the Falemprise lake

Annual evolution (2002) of phytoplancton concentrations In the Féronval lake

Measured cyanobacteria concentrations

Computed cyanobacteria concentrations





Constatation :
- ability of the model to represent cyanobacteria for this type of lake

2007 : B-BLOOMS2 project

- **Use of the model applied to Eau d'Heure lakes (which includes Falemprise, the lake monitored in Wallonia) to**
  - **Test and validate the model on the year(s) 2007 and 2008**
  - **Have a finest description of the cyanobacteria**
  - **Develop and test of scenarios for controlling cyanos blooms (P reduction, …)**
  - **NB : due to the few time devoted to this task (2 manmonths) , heavy modifications (like construction of an explicit vertical migration sub-model or deterministic sumulation of the thermocline) are not envisaged in this B-BLOOMS project**

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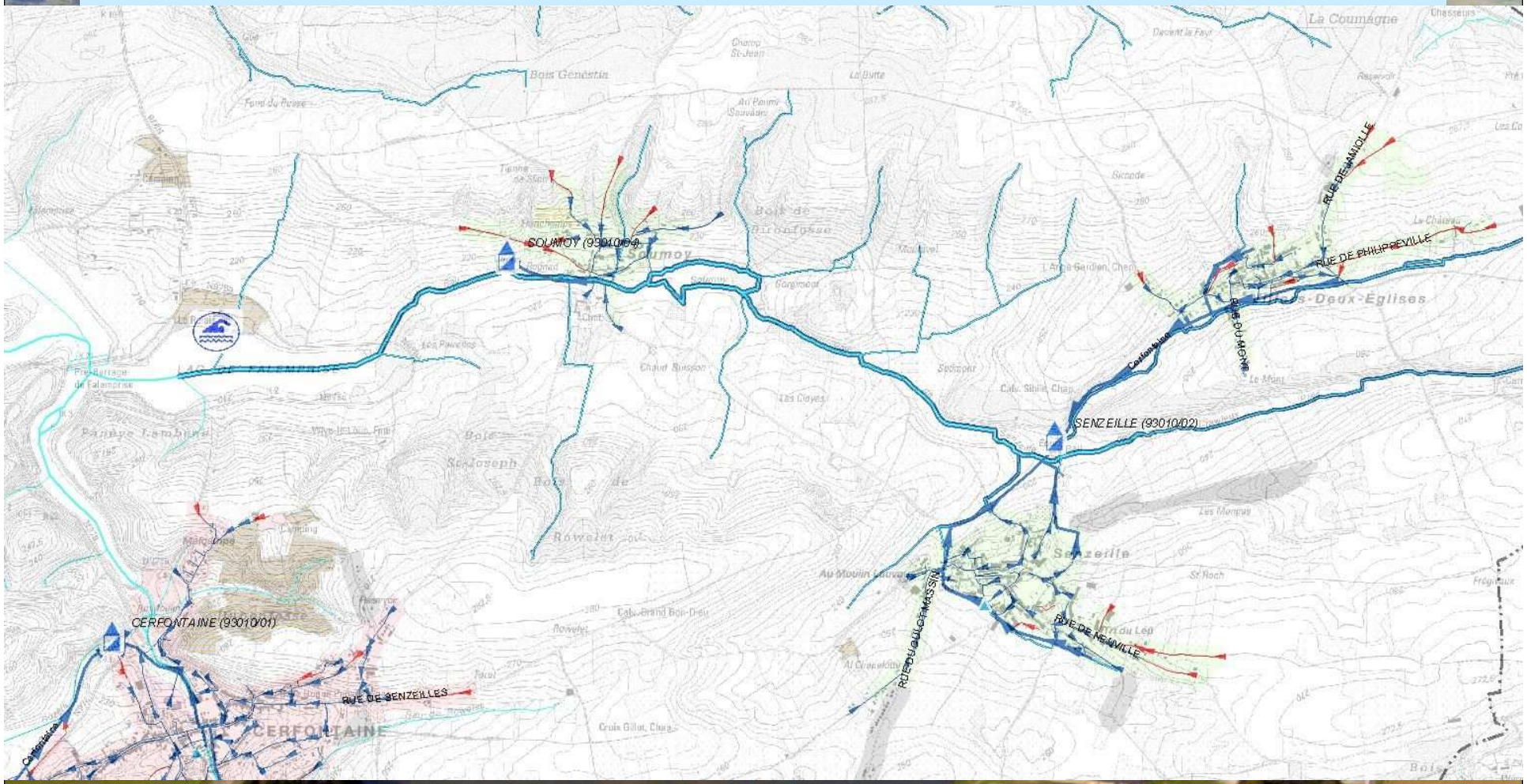
Data necessary for 2007 simulation

- Water discharges (daily values)
  - Collect of 6 measurements stations (MET)
  - Reconstruction of two « virtual » measurement stations
  - Pre-treatment → incorporation into PEGASE
- Water temperatures (daily values)
  - Collect and treatment (interpolation) of data collected during the study
- Insolations (semi-hourly values)
  - Collect of daily data (J/m².day) at the IRM Dourbes Station
  - Calculation of semi-hourly values for each day
- Releases (punctual and diffuse loads)
  - Urban releases : 2 purification plants + sewers systems
  - Diffuse loads : use of semi-statistic input functions

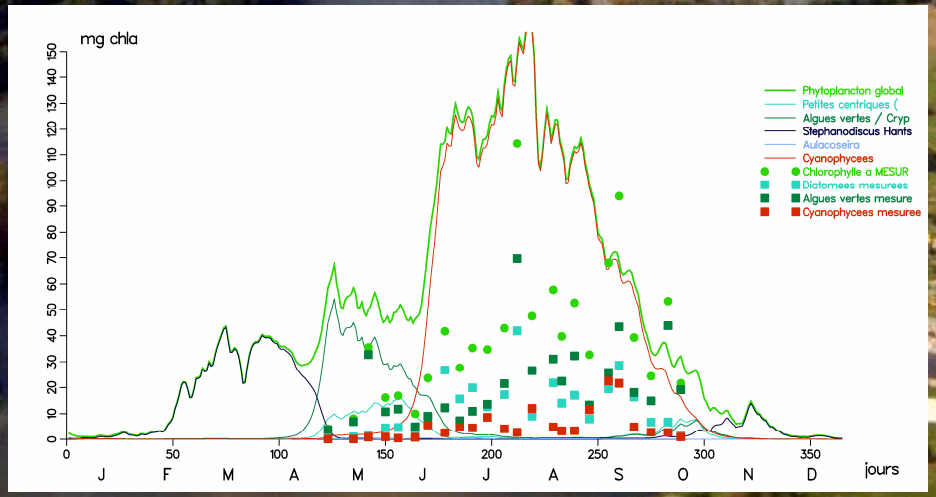
Falemprise basin : releases



- Soumoy (170 I.E , collect rate = 67%) – STEP 1989 (dephosphatation)
- Senzeille (960 I.E, collect rate = 67%) – STEP 2003 (dephosphatation)
- 2015 : collect rate = 90% (Soumoy) and 82% (Senzeille)

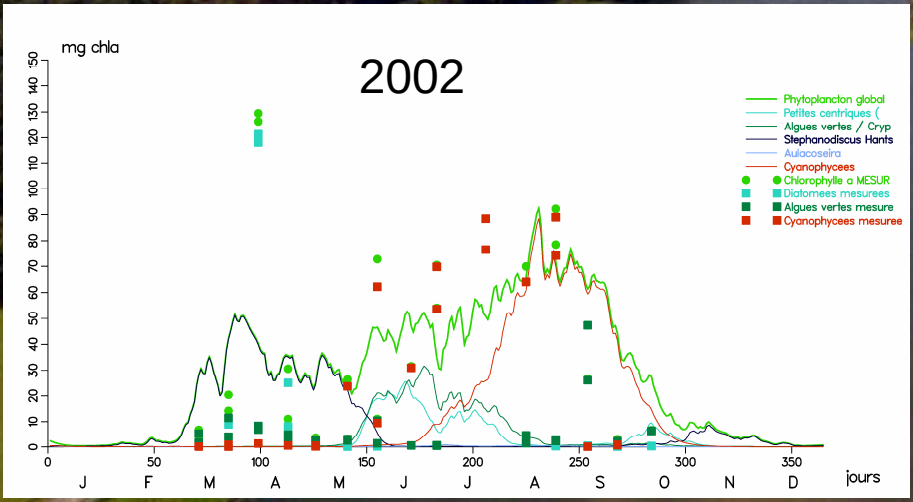
2007 simulation « as it »

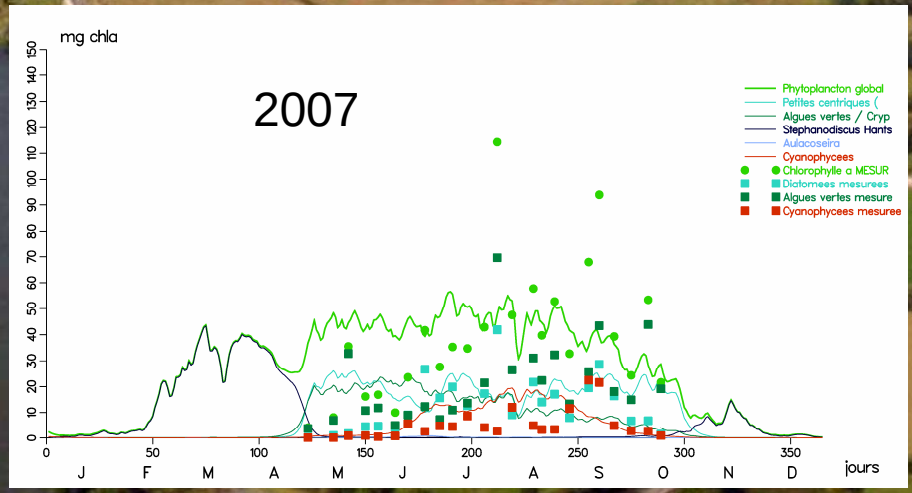
- Simulation 2007 = validation of 2002 simulation
- Constatation : cyanobacteria simulated in Lake Falemprise >> measured concentration
  → NO good validation
- Explanation : phosphorus dependance of cyanobacteria greater than calibrated in 2002 (NB in 2002, more releases of phosphorus)



New 2002 and 2007 simulations with phosphorus correction + minor modifications

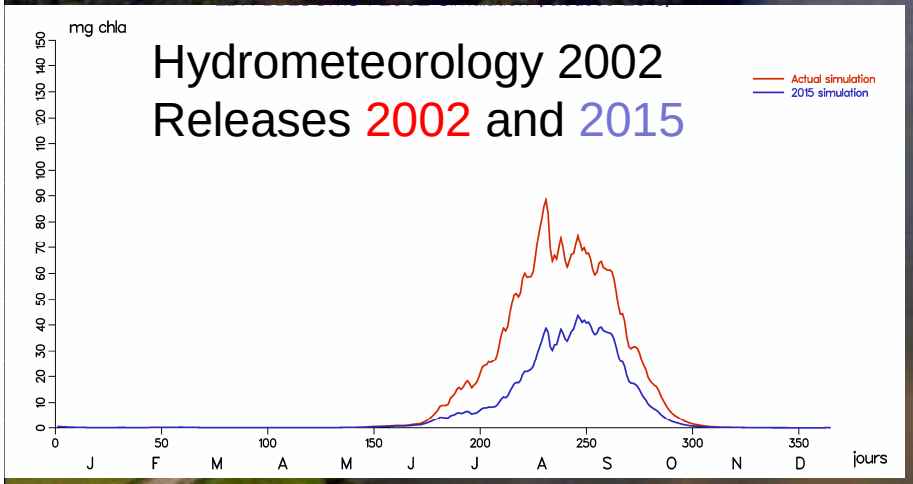
- Constatations
  - better validation for 2007
  - validation for 2002 always consistency
  - Concentrations 2007 < concentrations 2002
    - Phosphorus releases 2002 = 2 x releases 2007
    - Temperatures and insolations 2002 > 2007

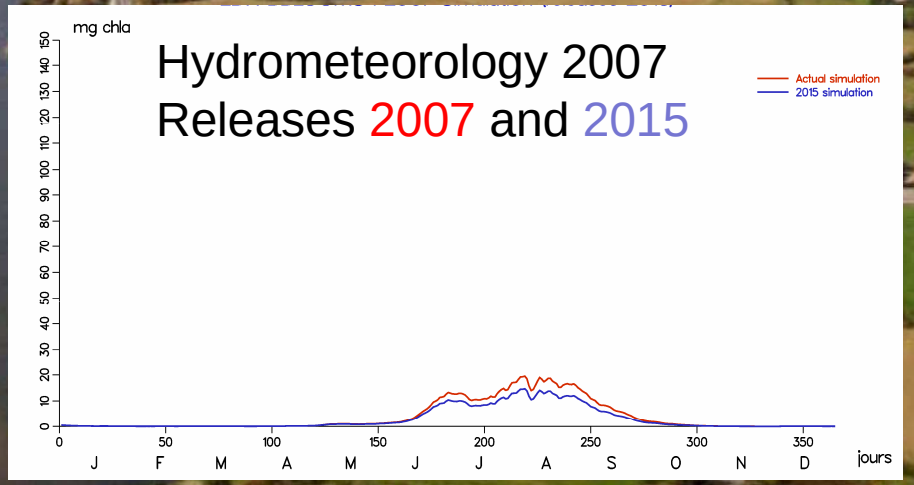




2002 and 2007 simulations with « 2015 releases »

– **constatation : decreasing of concentrations**





Conclusions : deterministic model for cyanobacteria

- **Ability of the (actual) model to simulate cyanobacteria blooms in lakes like Falemprise lake**
- **help to understand ecosystem function and mechanisms of community assembly**
- **numerous applications : surface water management, predictions of effects of environmental changes, reconstruction of the past**

- **Need ? For a more complex « lake » model**
  - **Explicit thermocline determination**
  - **At least bi-layer model**
  - **Explicit vertical migration sub-model**
  - **Sedimentation / resuspension process**
  - **Time to develop it ?**