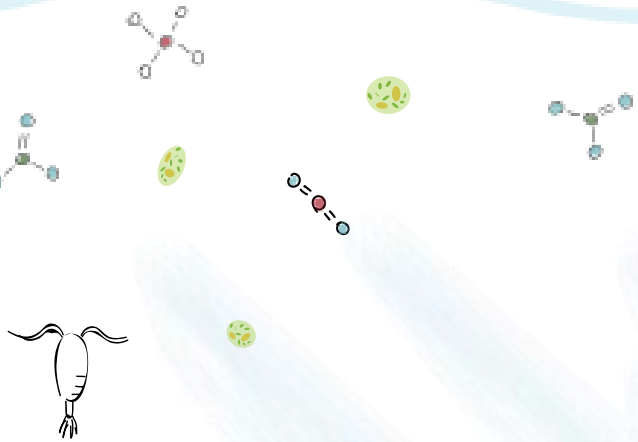


Reactive Transport in the Hydrosphere

Department of Earth Sciences, Faculty of Geosciences, Utrecht University

Lecturers: Lubos Polerecky and Karline Soetaert

Illustrations, narration and video editing: Renee Hageman
Additional contributions: Dries Bonte, University Ghent
Audio effects: mixkit.co

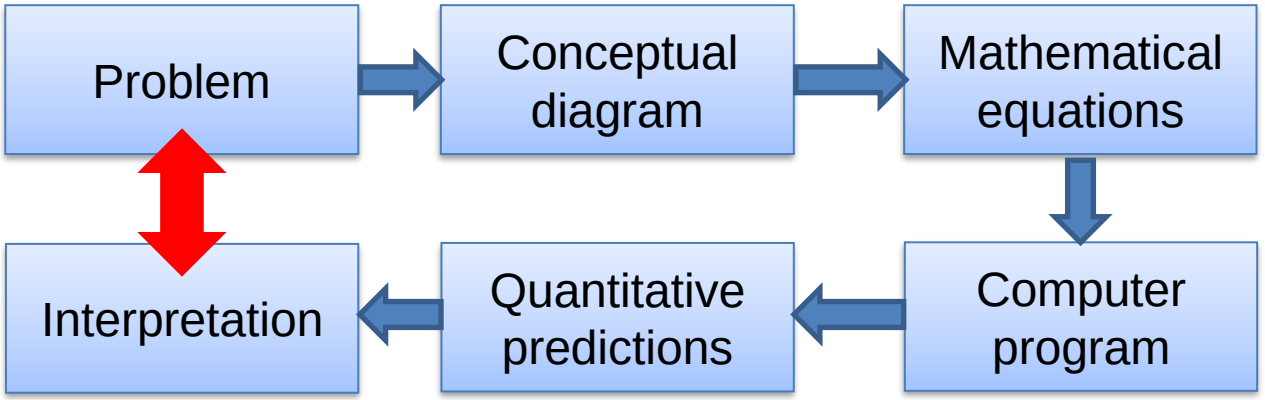
Universiteit Utrecht

GHENT UNIVERSITY

Course philosophy and focus

- develop an **appreciation** for the importance of **mathematics** and **computational** approaches to answer fundamental and applied questions in **biogeochemistry**

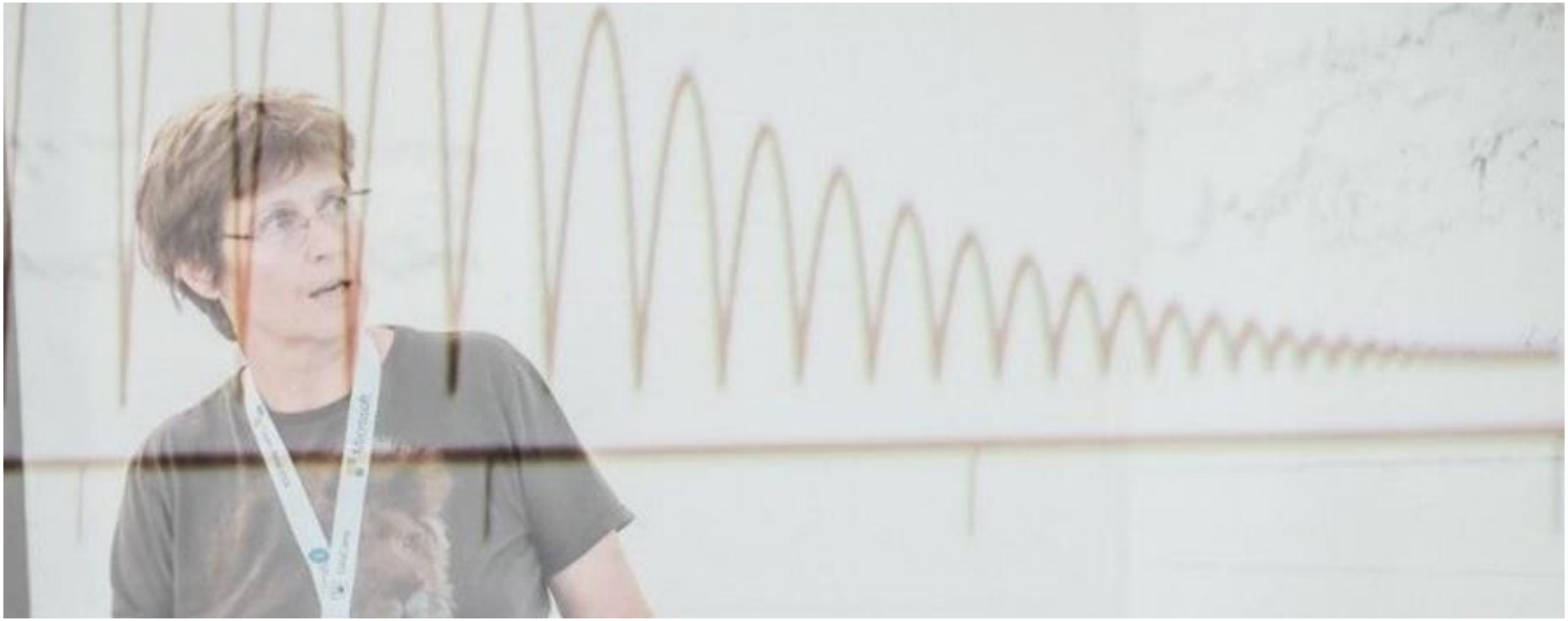
- teach you how to make models "from scratch" by following **a systematic and logical approach**



We will use **R** as our coding platform

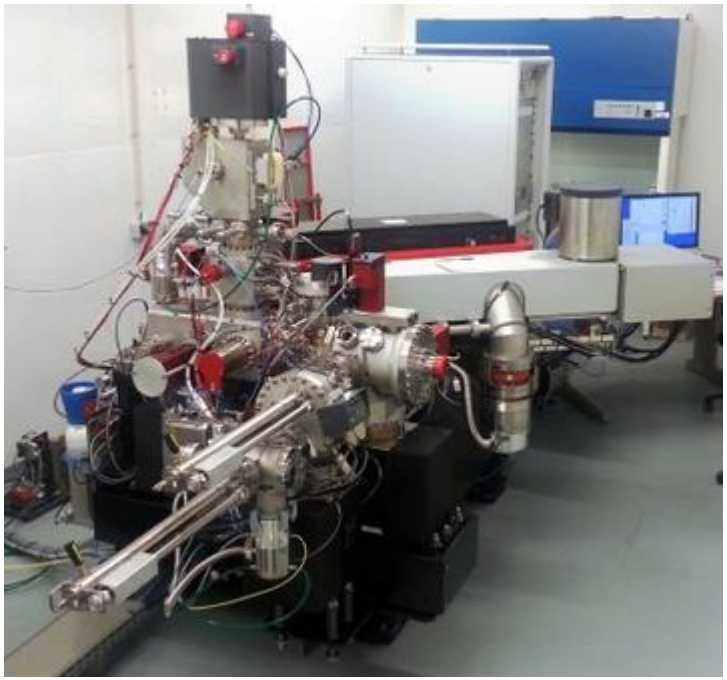
Prof. Dr. Karline Soetaert (k.e.r.soetaert@uu.nl)
Ghent University / Utrecht University / NIOZ Yerseke

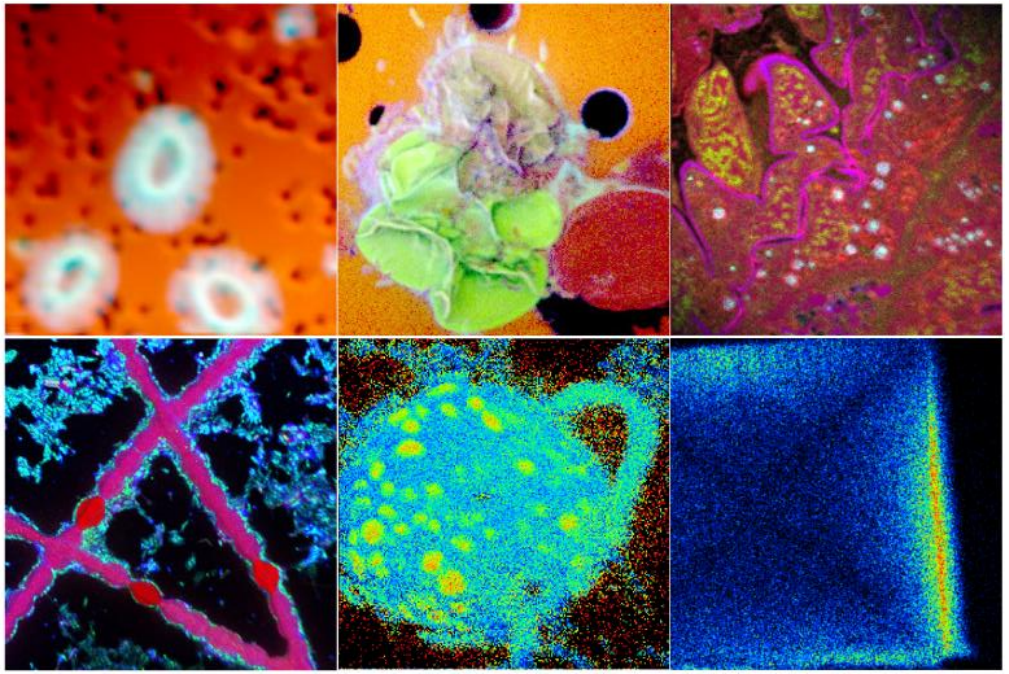
- **Biologist** and **computer** scientist
- Modeling of **ecological** and **biogeochemical processes** in marine environments



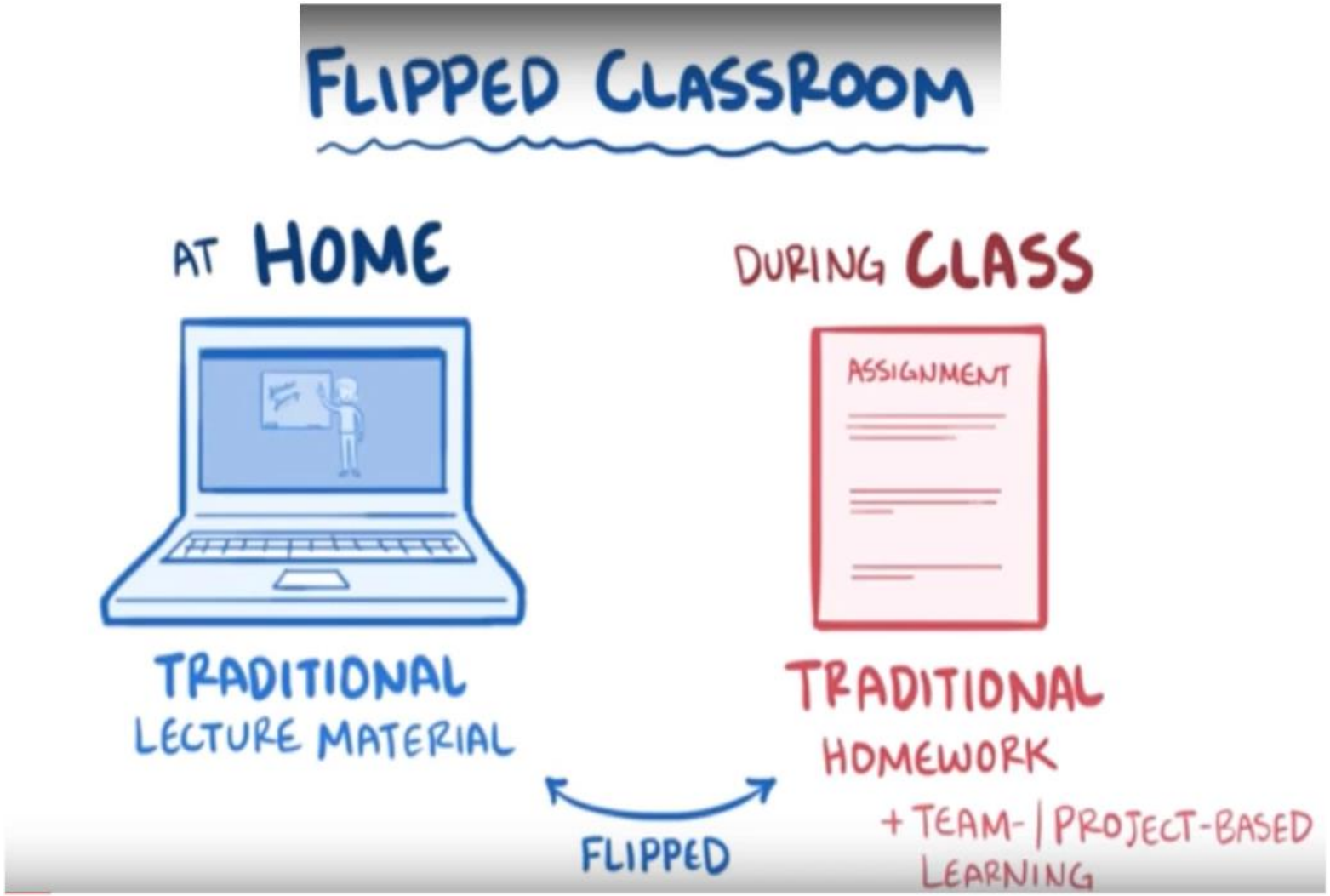
Dr. Lubos Polerecky (l.polerecky@uu.nl)
Utrecht University / Head of the UU nanoSIMS facility

- **Physicist** & **Engineer**, multidisciplinary research (Earth Sciences, a bit of Life & Material sciences)
- Models to **interpret** nanoSIMS data and **embed** them in a wider biogeochemical context

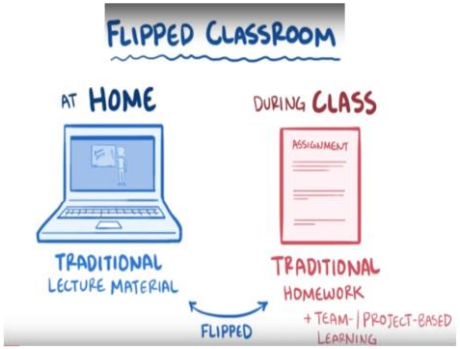




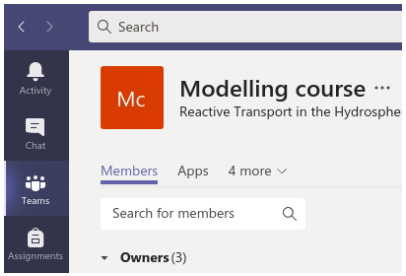
Course format



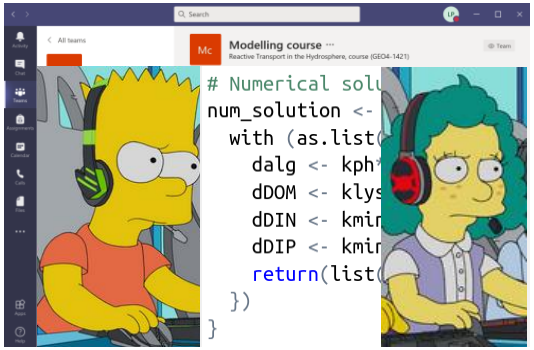
Course format



- **Learn basic concepts and theory** by watching videos
  - take **notes**
  - **think** about what you have learned
  - note **questions**



- **Class discussions** (~30 min)
  - **prepare yourself** well ahead



- **Work in groups** (3-4 students) to **solve problems**
  - Put theory into practice, hands-on experience
  - we will visit your group to answer questions and provide hints

This year: contact via **Teams**

To pass the course

- Final grade at least 5.5, and mid-term exam grade at least 5.5 (one resit).

- **Homework** assignment (after 4 weeks: 1x written report, 15%)
- **Mid-term exam** (after 5 weeks: 3 hrs, 40%)
- **Final project** (end: written report, 25%; oral presentation + discussion, 20%)

  Evaluated as a **group effort:**

  - one report + one presentation per group
  - each group member will receive the same grade

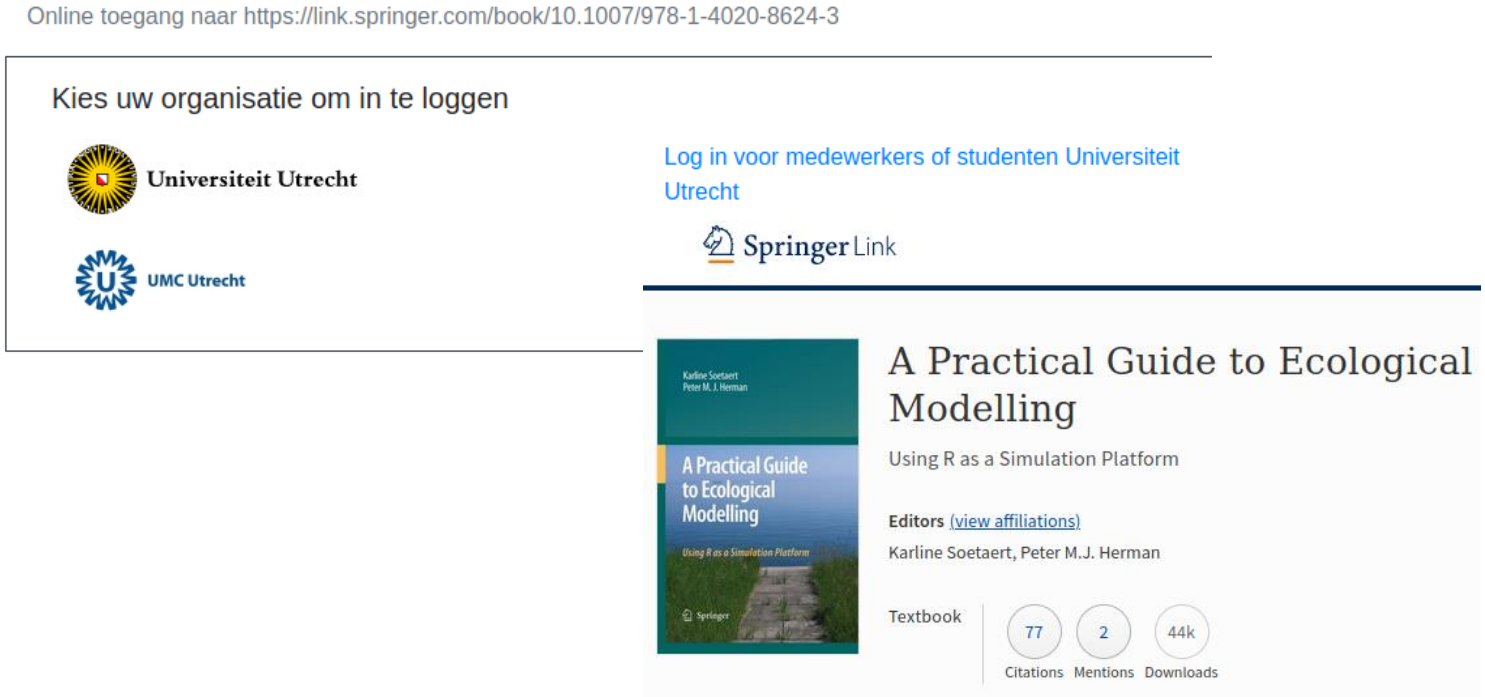
Work ethics:

- This is **not a competition**
- **Collaborate** within groups
- **Reach out** to other groups
- Best learning if you **try to explain** your ideas **to someone else**.

Get the textbook as an e-book

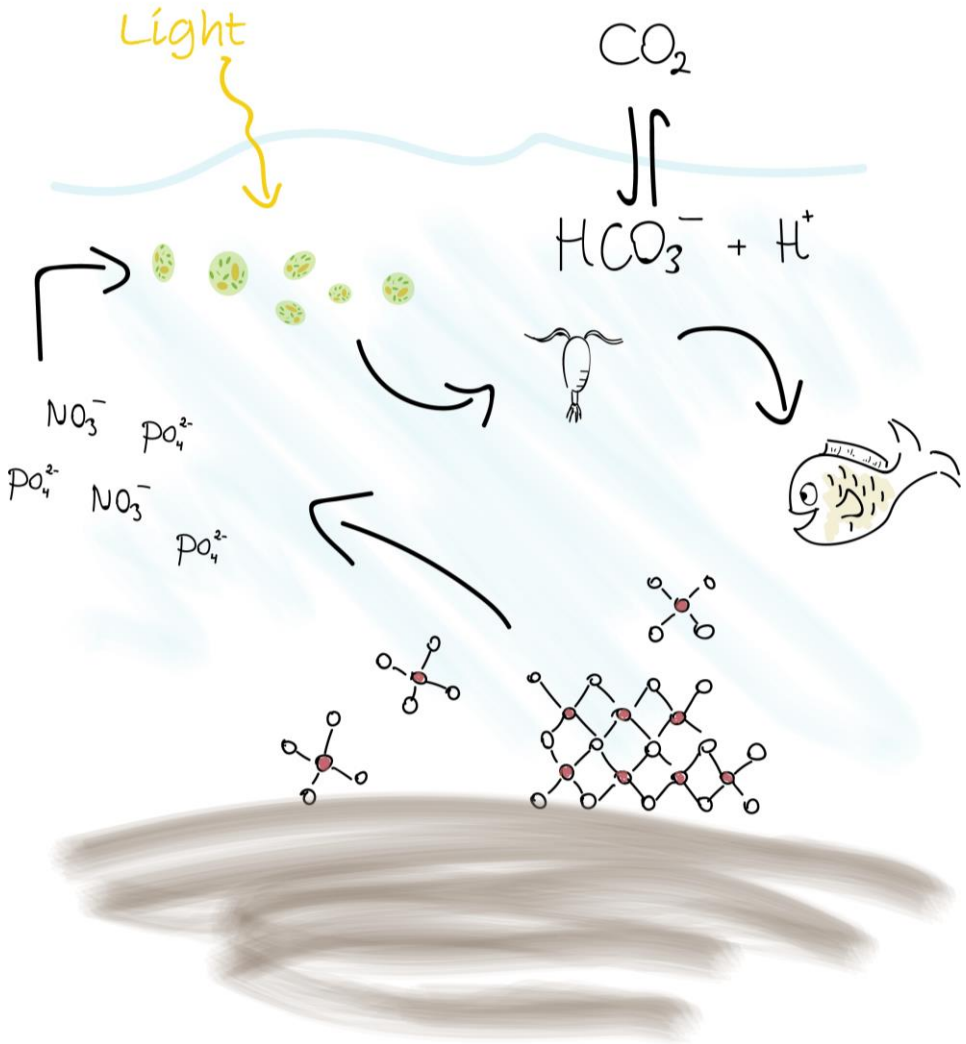
Available from **Springer** using your Solid-ID

https://link.springer.com/book/10.1007/978-1-4020-8624-3



Additional material as **handouts** – via Blackboard

What kind of models are we going to study in this course?



Biogeochemical models

- Ecological **interactions** (predator - prey)
- Organic matter **production**
- Organic matter **mineralization**
- Mineral **dissolution/formation**
- Cycling of **C coupled to N, Fe, S, P**, etc.

What kind of models are we going to study in this course?

Biogeochemical models

Mechanistic mathematical models:

- Processes (mechanisms) described mathematically
- Formally and numerically precise (describing mass balance)
- Model predictions can be directly compared with experimental data

Subject of inquiry:

- Exchange of mass and energy
- Variation in time and space

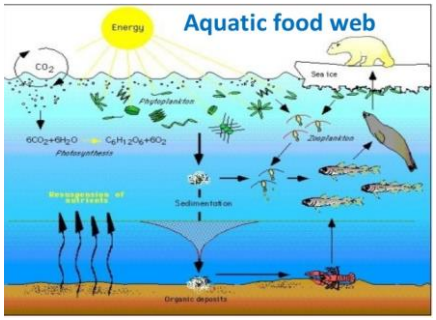
Studied systems:

1. Rivers
2. Sediments
3. Aquifers
4. Lakes & Oceans
5. Earth

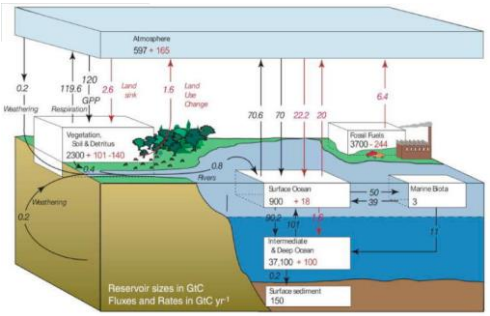
What kind of models are we going to study in this course?

Start of the course: **box-models**

Ecological interactions

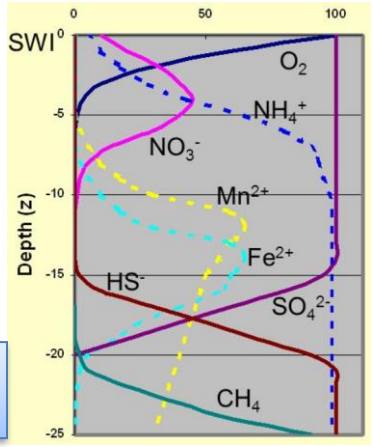


Global element cycles

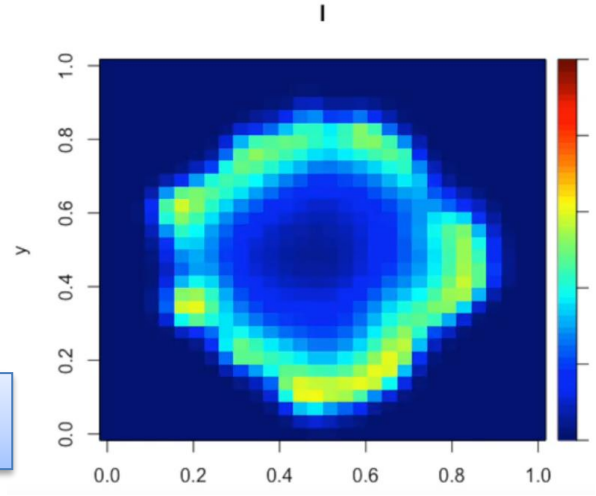


0D

Subsequently: **include spatial context**



1D

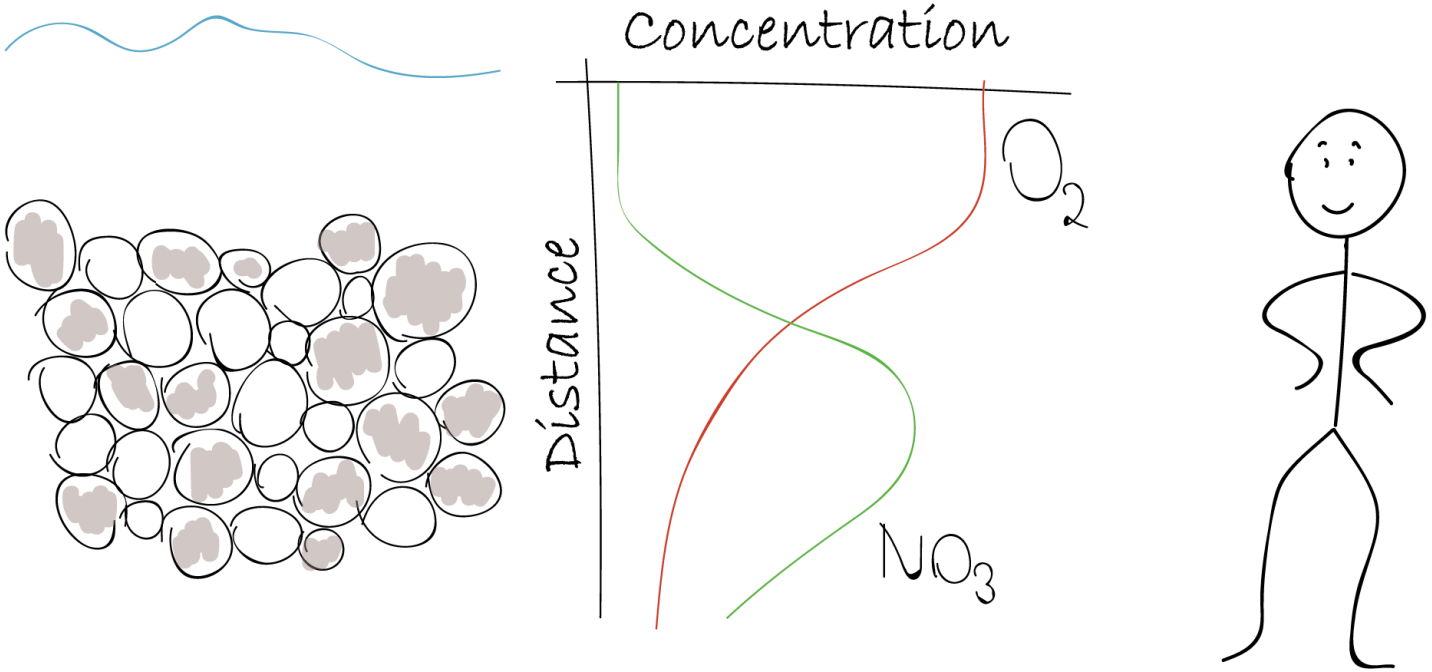


2D

What kind of models are we going to study in this course?

Sedimentologist's view

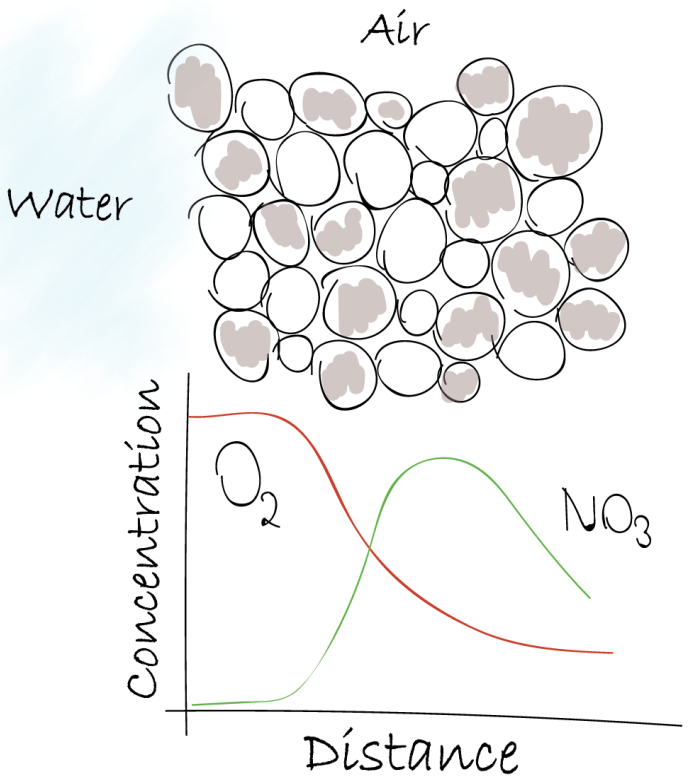
"Sediment setting"

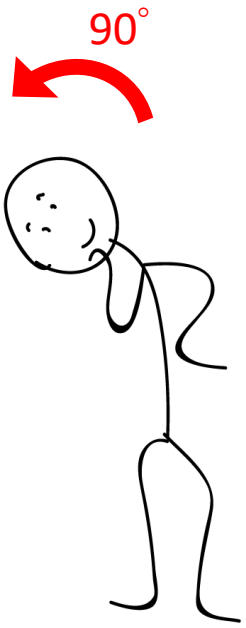


What kind of models are we going to study in this course?

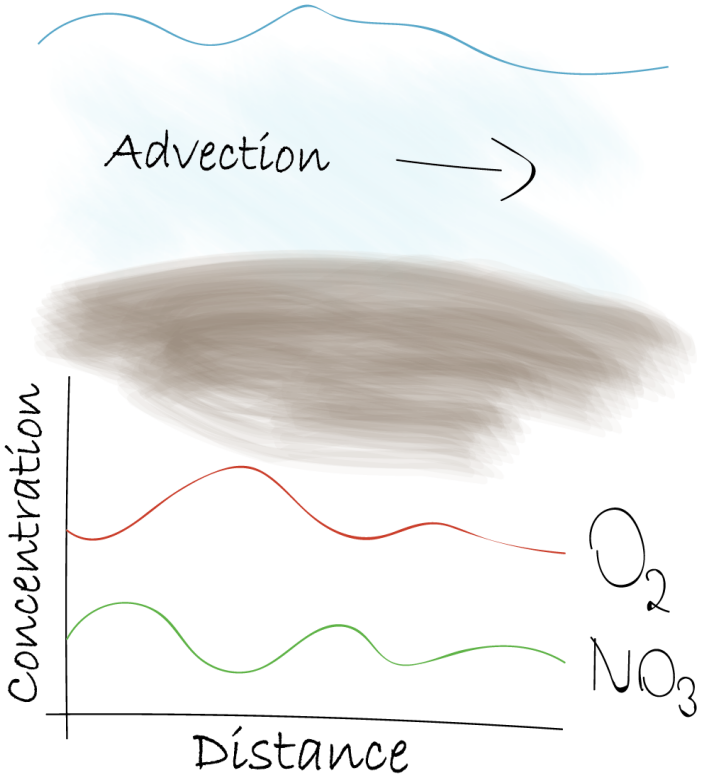
Hydrologist's view

"Aquifer setting"



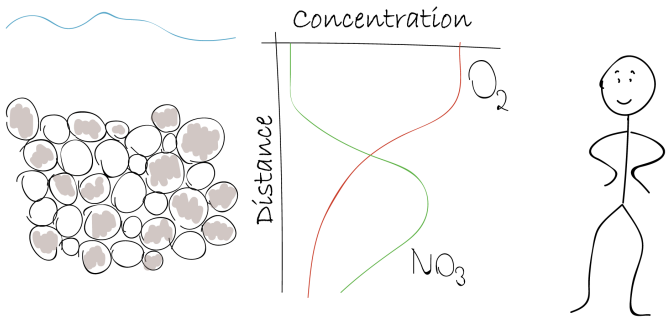


"River setting"

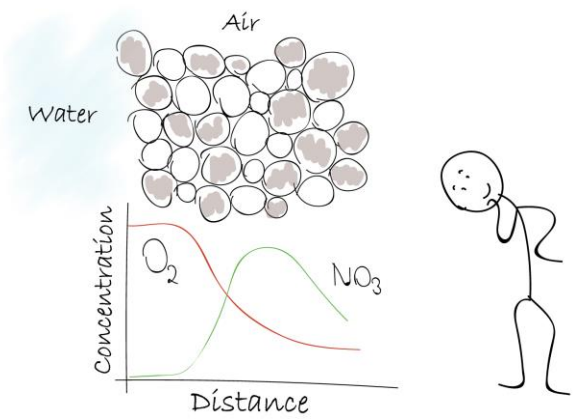


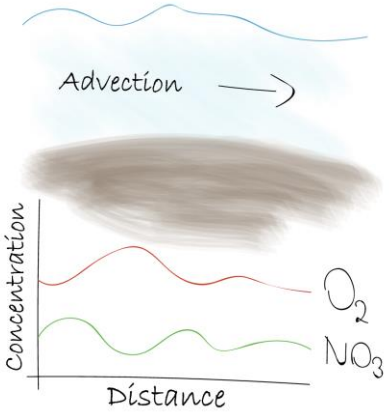
What kind of models are we going to study in this course?

Sedimentologist's view



Hydrologist's view





Equations will be the same!

Final projects:

develop a model (**from scratch**) for one of the following topics

Formation of CH_4 bubbles in marine sediments

C+S cycling

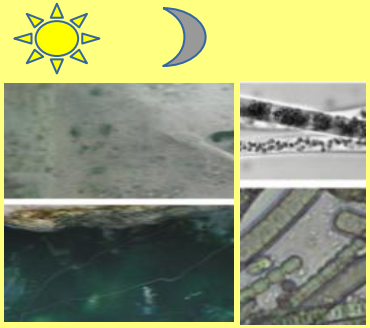
Algal blooms due to eutrophication

C+N+P cycling

Role of iron reduction in C-org mineralization

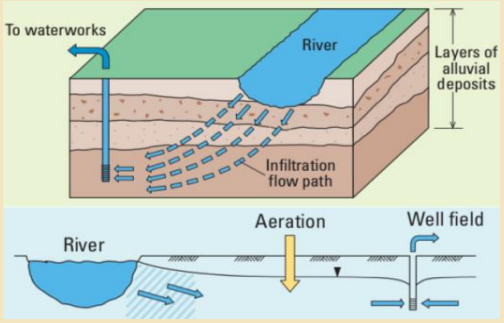
C+Fe cycling

Light vs. chemical energy utilization



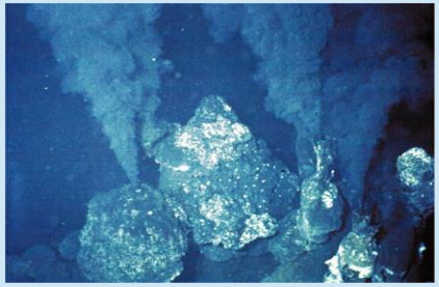
C+S cycling

River bank filtration



C+N cycling

Sub-seafloor $CaCO_3$ precipitation driven by AOM



C+S cycling

Main tasks given

You can expand further as you wish.