Tracking nutrients in the Southern North Sea

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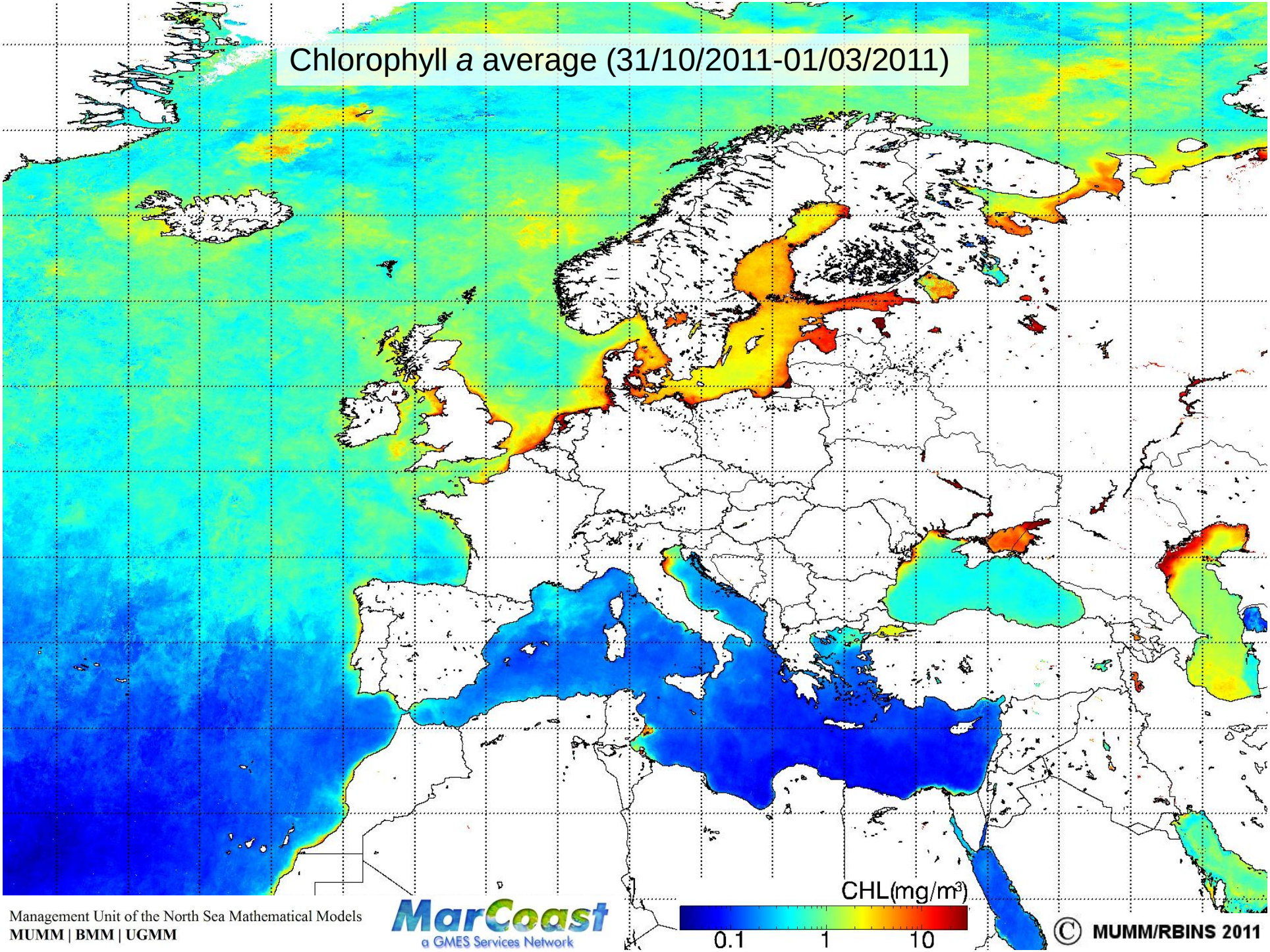
JONSMOD meeting, 12th May 2014, Brussels (Belgium)



Management Unit of the North Sea Mathematical Models
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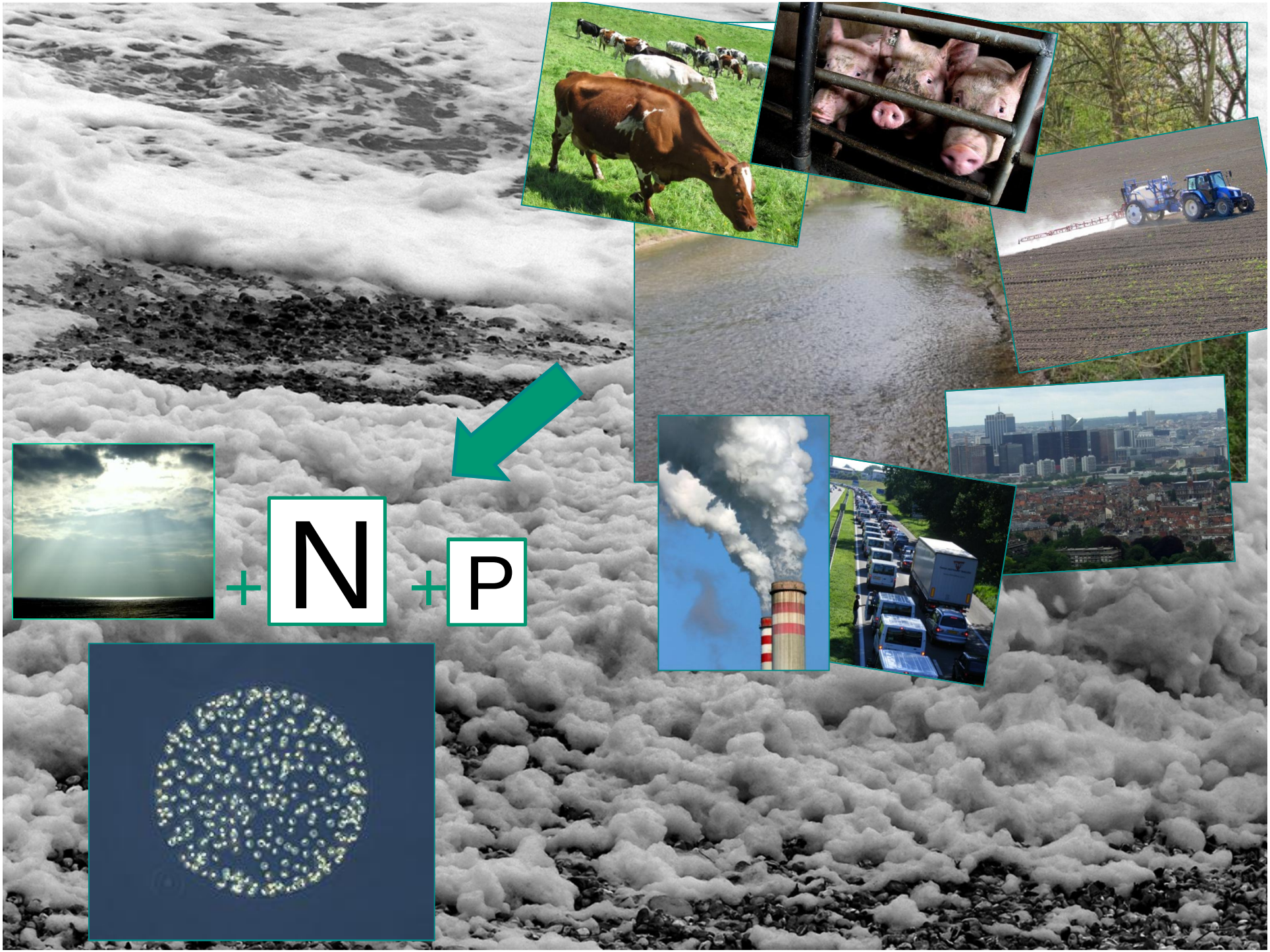
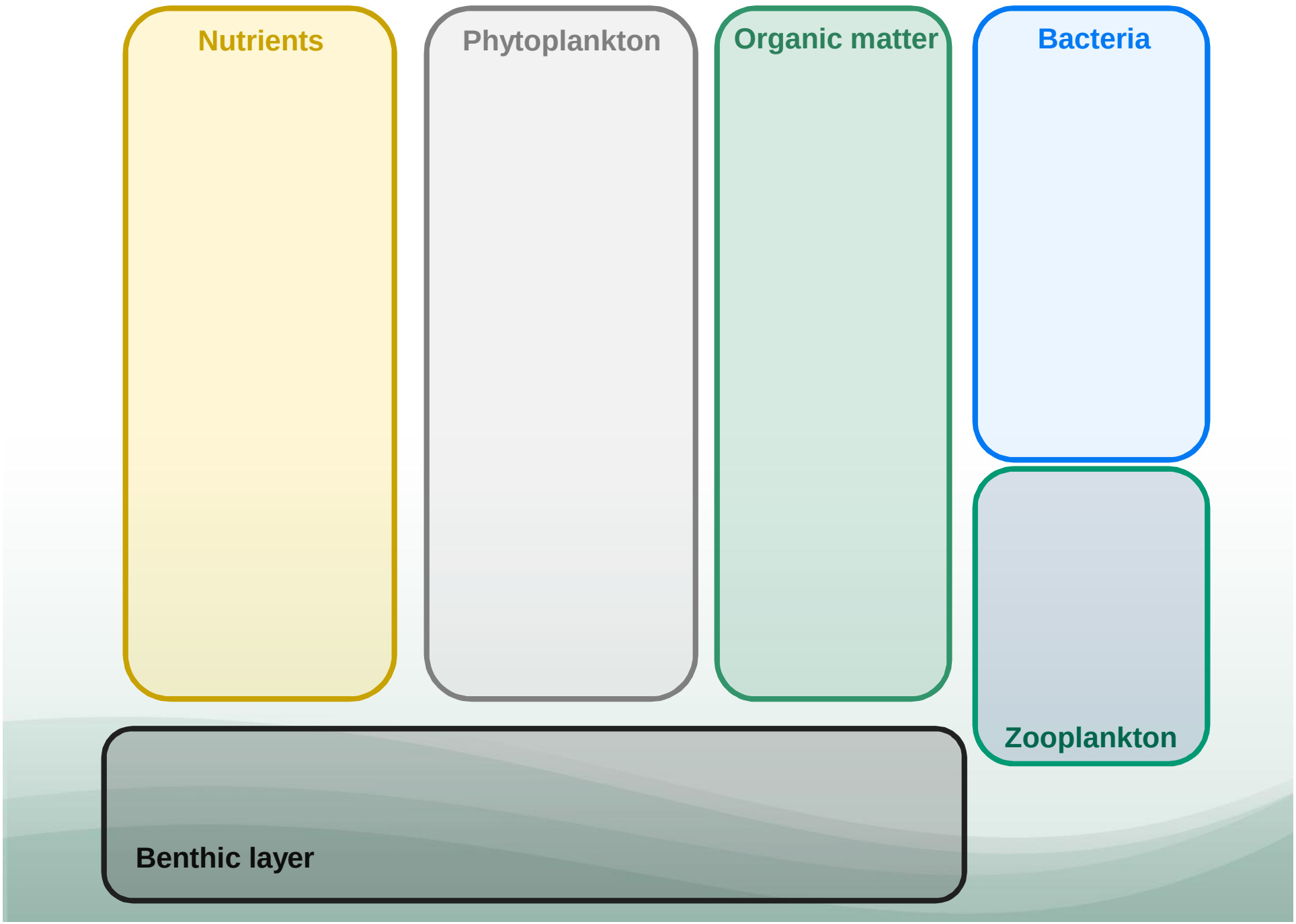
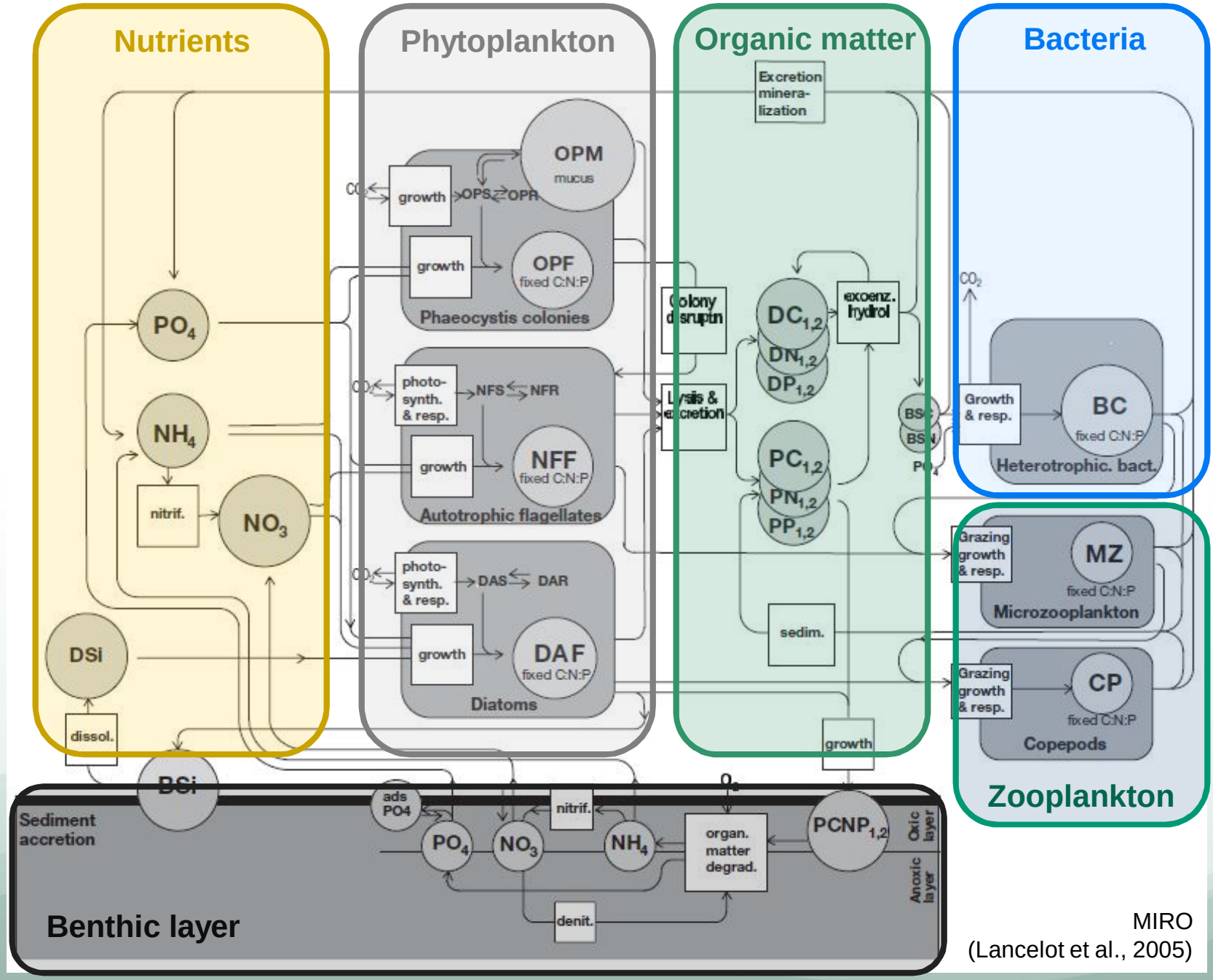
MarCoast
a GMES Services Network


+ N + P


Nutrients
Phytoplankton
Organic matter
Bacteria
Zooplankton
Benthic layer



MIRO
(Lancelot et al., 2005)

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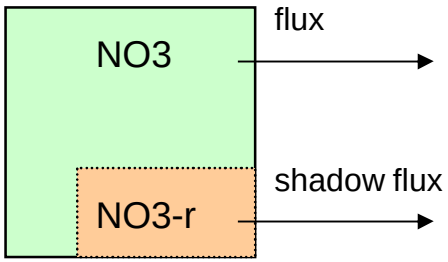
Menesguen's tagging technique

Principle of the Method

1) New state variables are added
   NO3-r
   NH4-r
   all organic N species –r



2) Shadow fluxes are computed on the basis of

- Real fluxes for corresponding untagged state variables
- Proportion of tagged / untagged variable in the grid cell (e.g. NO3-r/NO3)

3) Tagged variables are inputted via specific sources (e.g. River, ocean, atmosphere)

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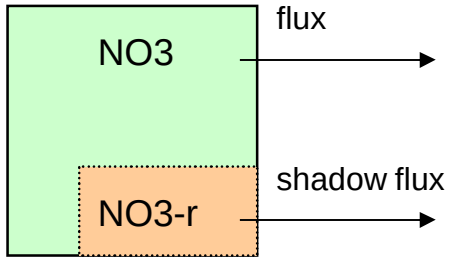
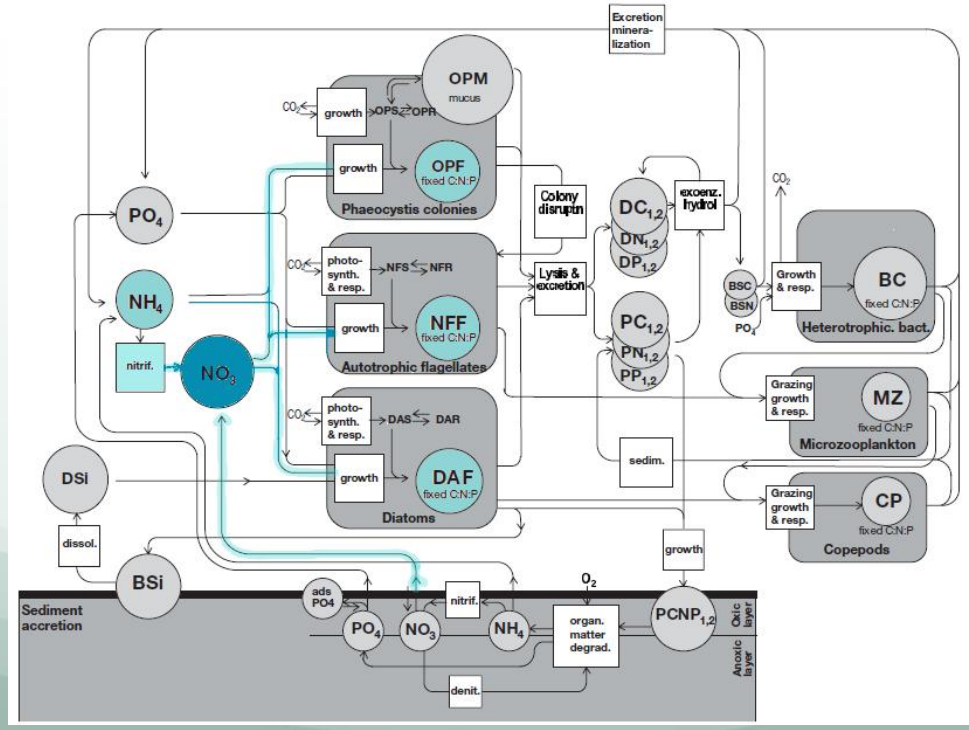
Adaptation of Menesguen's tagging technique to MIRO&CO

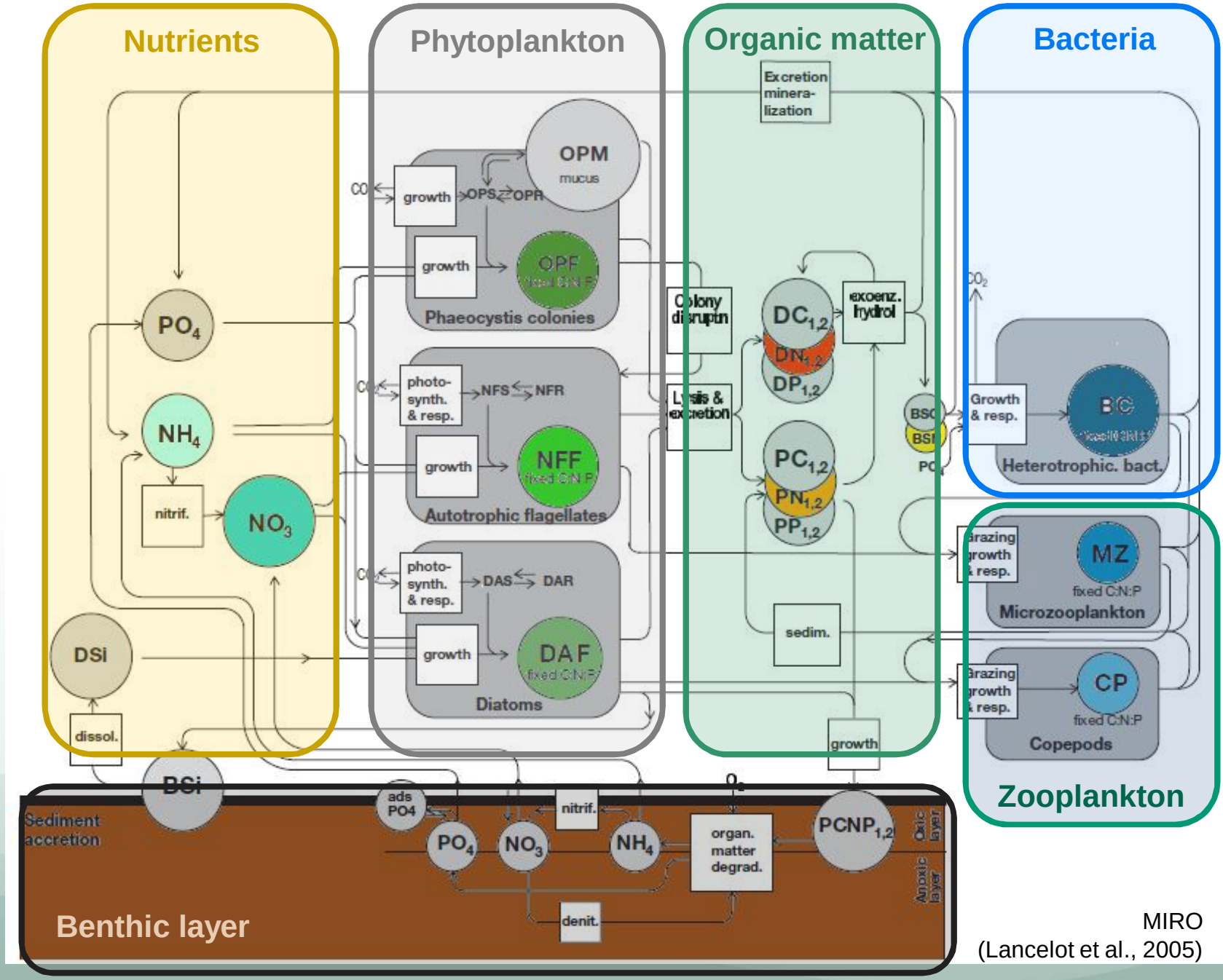
$$\frac{dNO3}{dt} = nitrification - uptake_{NO3}{}^{PHY} + \frac{1}{Z} J_{NO3}{}^{sed}$$



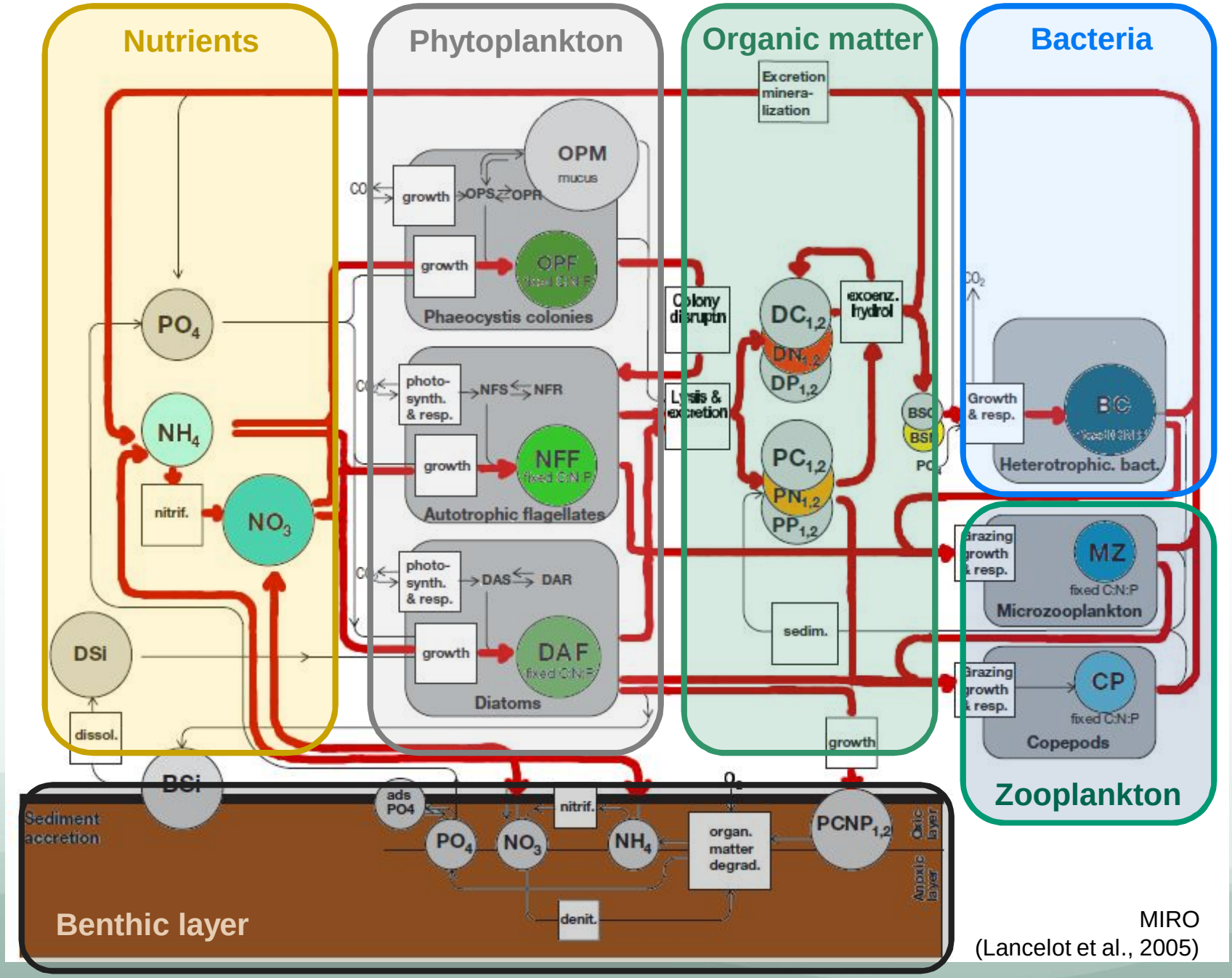
$$\frac{d(NO3\_r)}{dt} = nitrification\, Y_{jNH4} - uptake_{NO3}{}^{PHY}\, Y_{jNO3} + \frac{1}{Z}(J_{NO3}{}^{sed-}\, Y_{jNO3} + J_{NO3}{}^{sed+}\, Y_{jsed})$$

Where $Y_{jNH4} = NH4\_r / NH4$
$Y_{jNO3} = N03\_r / N03$
Y_{jsed} = sed_r / sed





MIRO
(Lancelot et al., 2005)



MIRO
(Lancelot et al., 2005)

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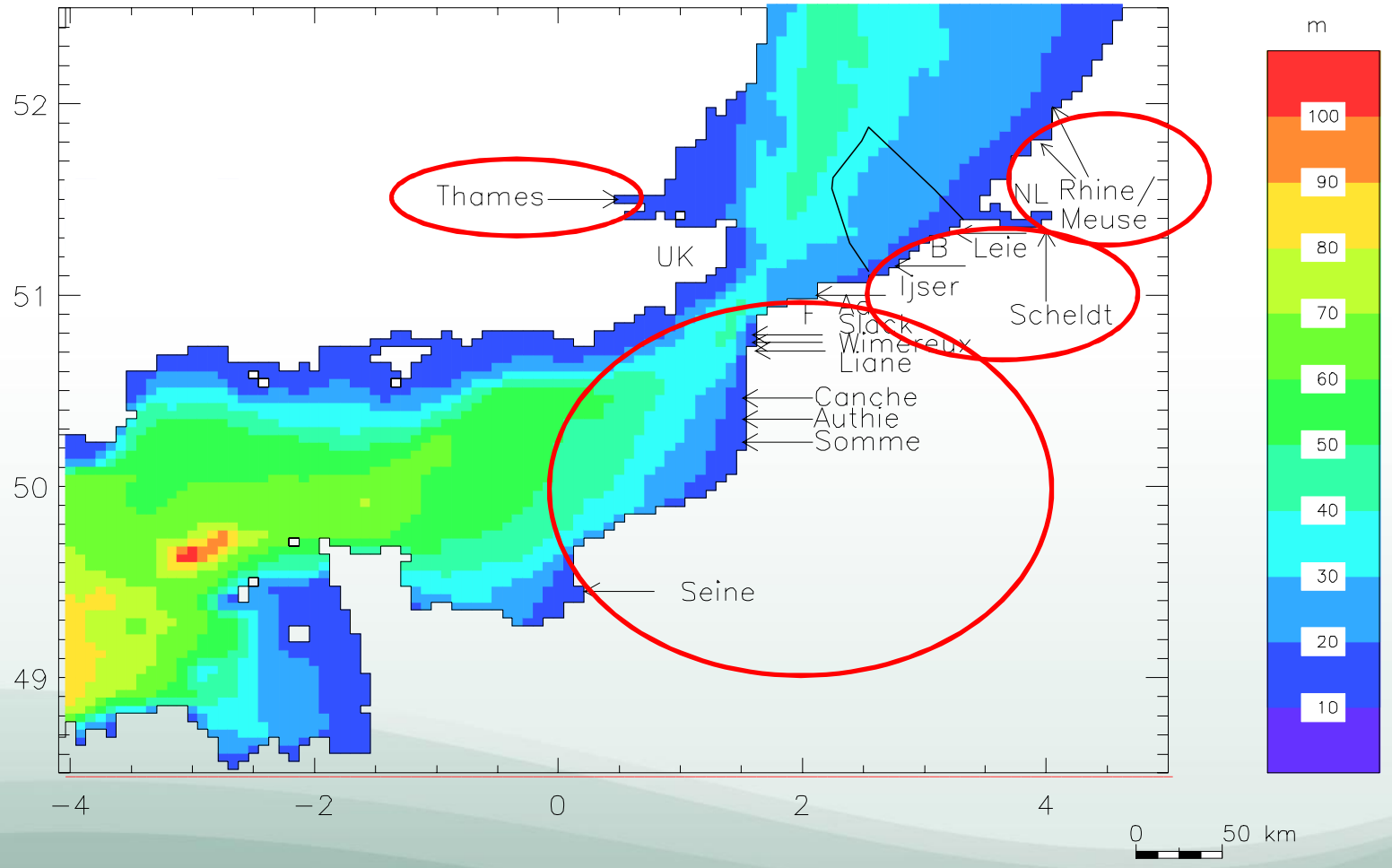
Nitrogen sources



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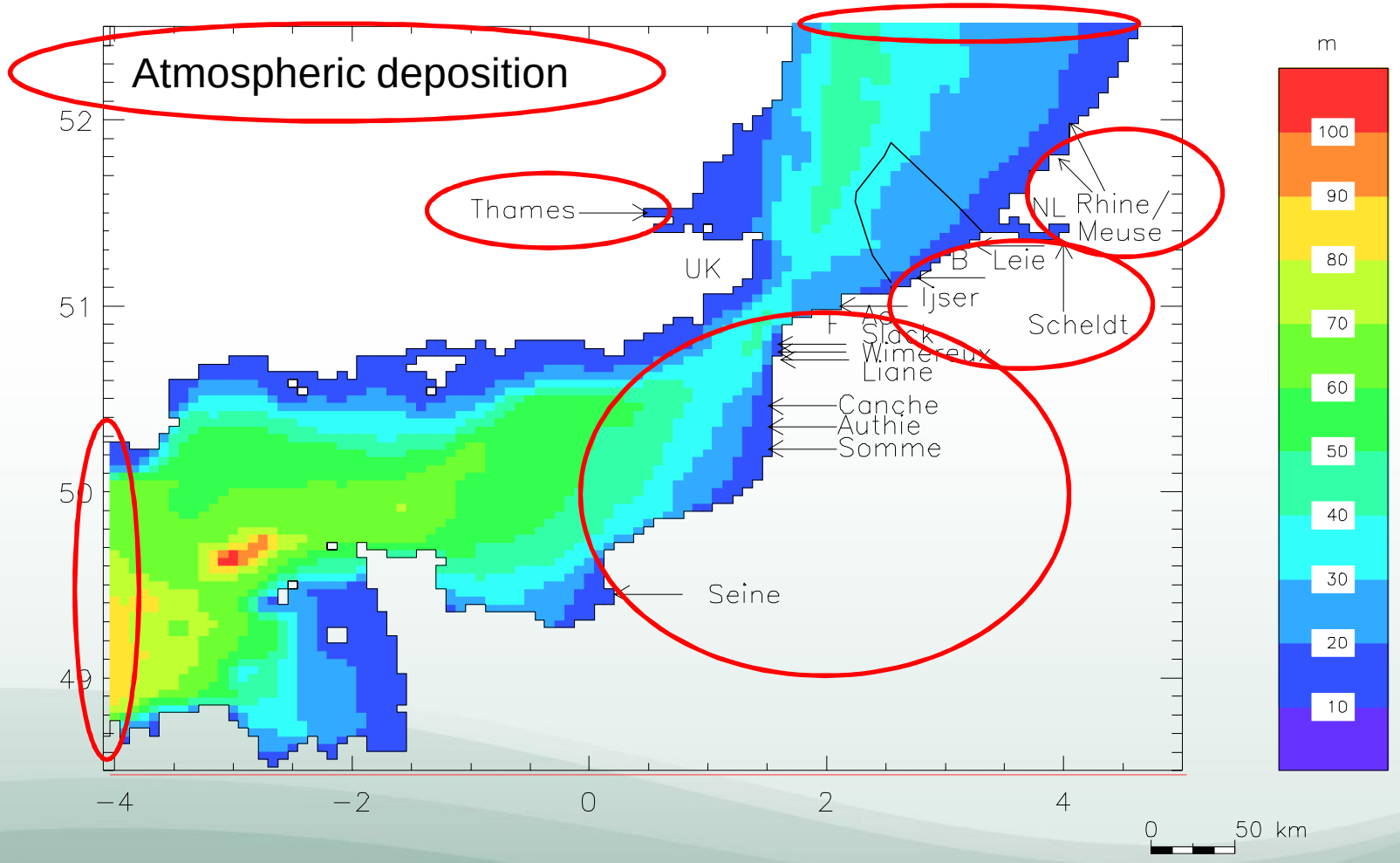
Nitrogen sources



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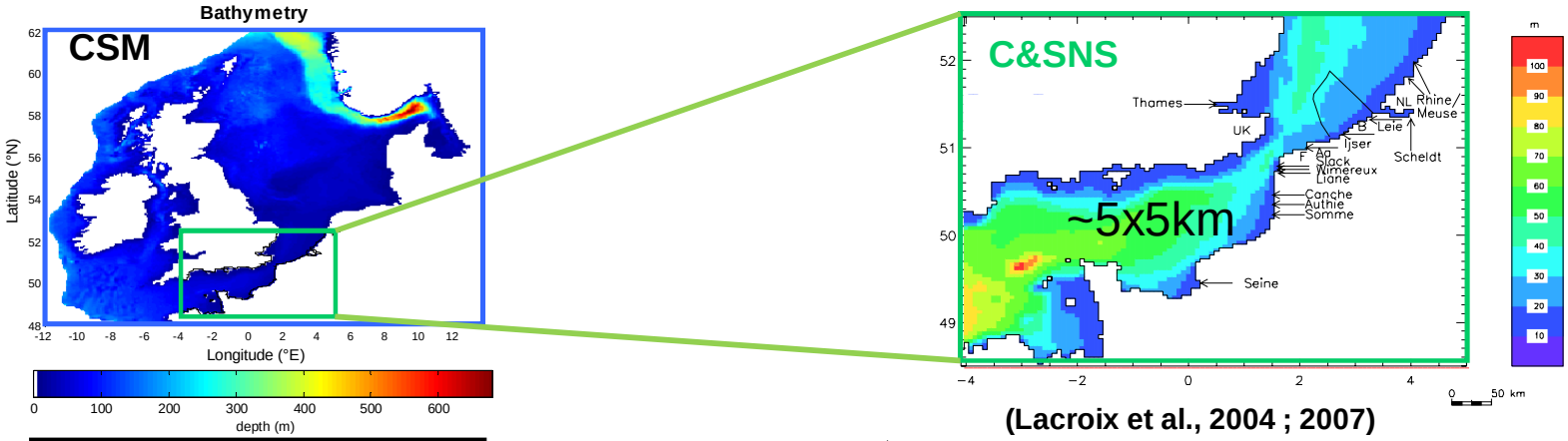
MIRO&CO: implementation



(Lacroix et al., 2004 ; 2007)

Continental Shelf Model (CSM) COHERENS 2D
Resolution ~5km
Dt: 20 sec
1999-2007, CPU: ~ 1 week/y

Open BC
-2D: U, ζ (1hr)
- S,nutrients: ICES clim.
T, biol.: grad 0

Channel & South. North Sea (C&SNS)
MIRO&CO-3D [COHERENS & MIRO]
Resolution ~5km
Dt_{2D}: 60 sec, Dt_{3D}: 15 min
1999-2007

Forcing

Wind and atm. Pressure (UKMO – 6h)
Precip, cloud, rel. humidity, air temperature … (UKMO – 6h)
Actual river discharge (daily)

River loads (~monthly)
SST (from BSH; weekly),
GSR (computed from UKMO cloud fields)
TSM 'Recolour' (daily climato) 2003-2006

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Test cases

1. All sources are tagged
   tagged results = non-tagged results?
2. One source at a time is tagged
   sum of all sources = non-tagged?
3. No tagged source

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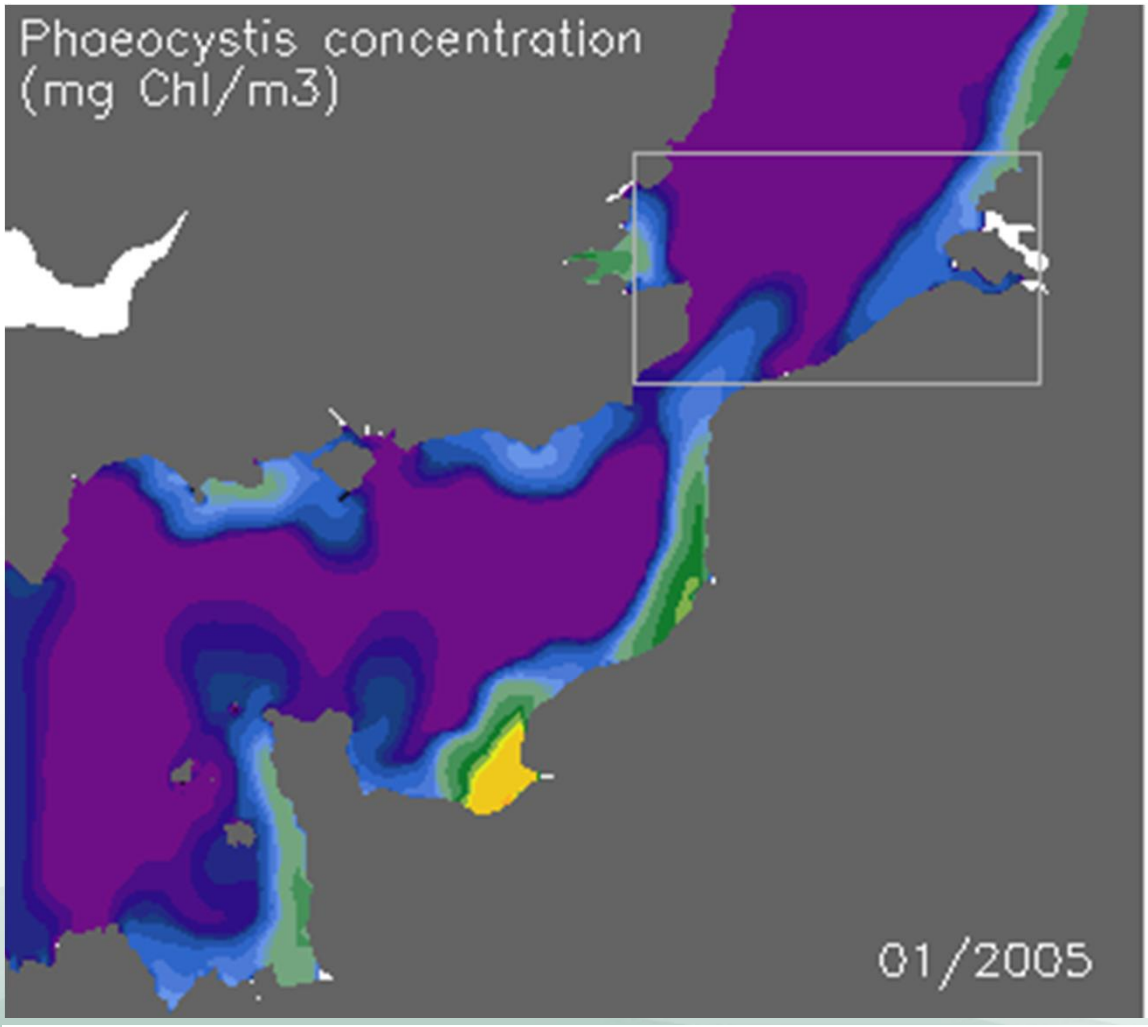
Tracking method results



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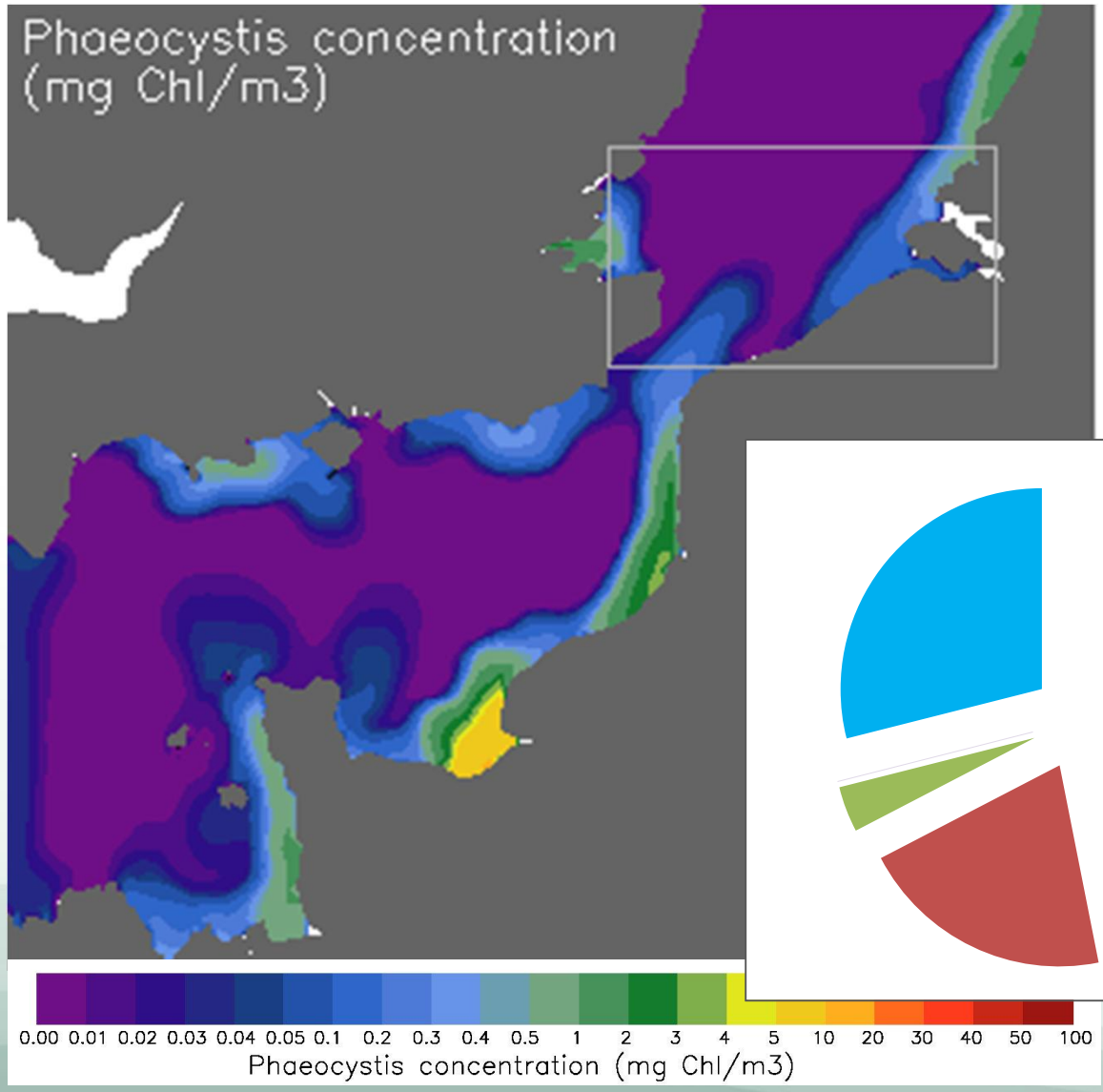
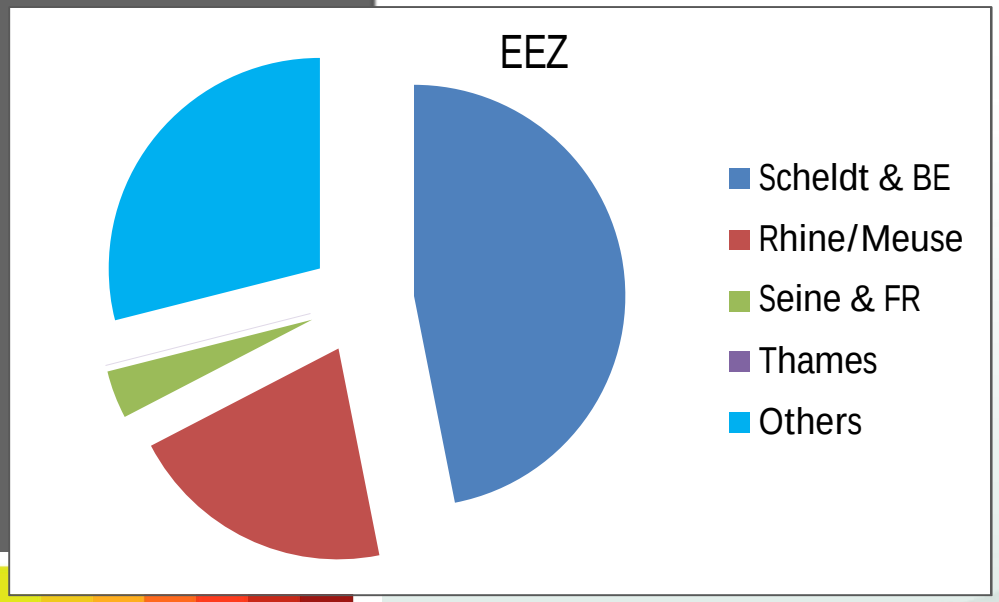
Tracking method results



Tagged from Rhine and Meuse



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Menesguen's tracking method

- useful to track nutrients in the sea and trace back their source (ocean, atmosphere, river)
- Could be applied to other nutrients / contaminants

BUT :

- expensive in computation time
- model dependent

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The EMoSEM project

Objective

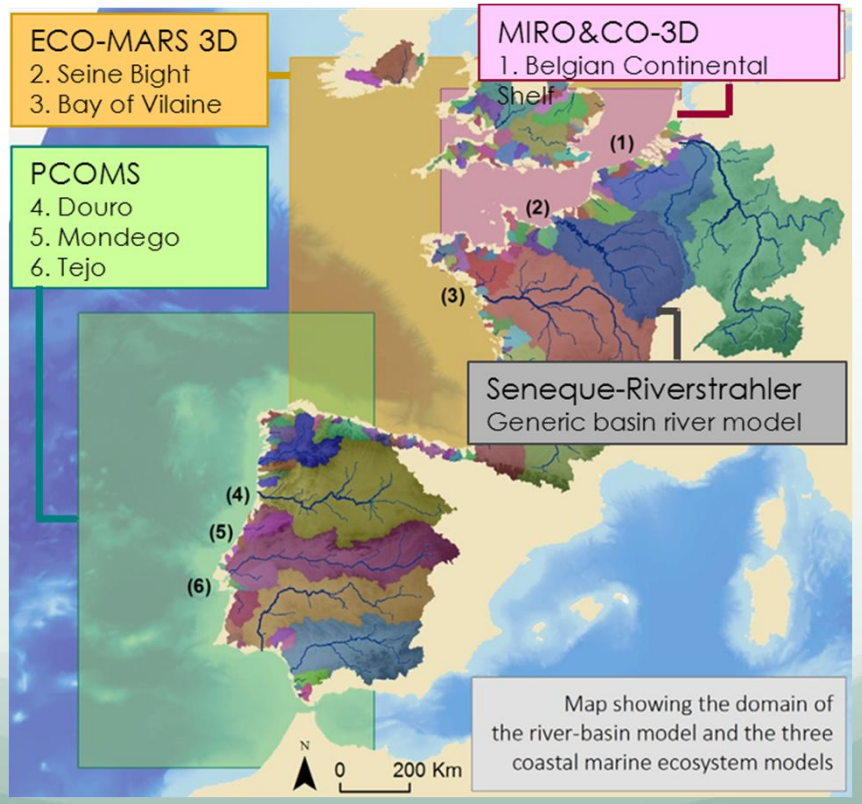
To develop and combine the state-of-the-art **modelling tools** describing the river-ocean continuum in the NEA continental seas

→ **to link** the eutrophication nuisances in specific marine regions to anthropogenic inputs,

→ and **trace back** their sources up to the watersheds.

Partners

RBINS, ULB, UPMC, IFREMER, IMAR, UHAM, DELTARES, CEFAS (collaborators)



Map showing the domain of the river-basin model and the three coastal marine ecosystem models

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The EMoSEM project

Methodology

1. **Improvement** of the marine ecological models and implementation of a **tracking method**
2. Development of a generic **watershed model** for the NEA rivers
3. **Coupling** of the marine ecological models with the river model

→ Run the **standard** simulations with tracking

→ Run **pristine-like** scenario for scaling the current status

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umar
Cefas
Universität Hamburg
Deltares
Enabling Delta Life

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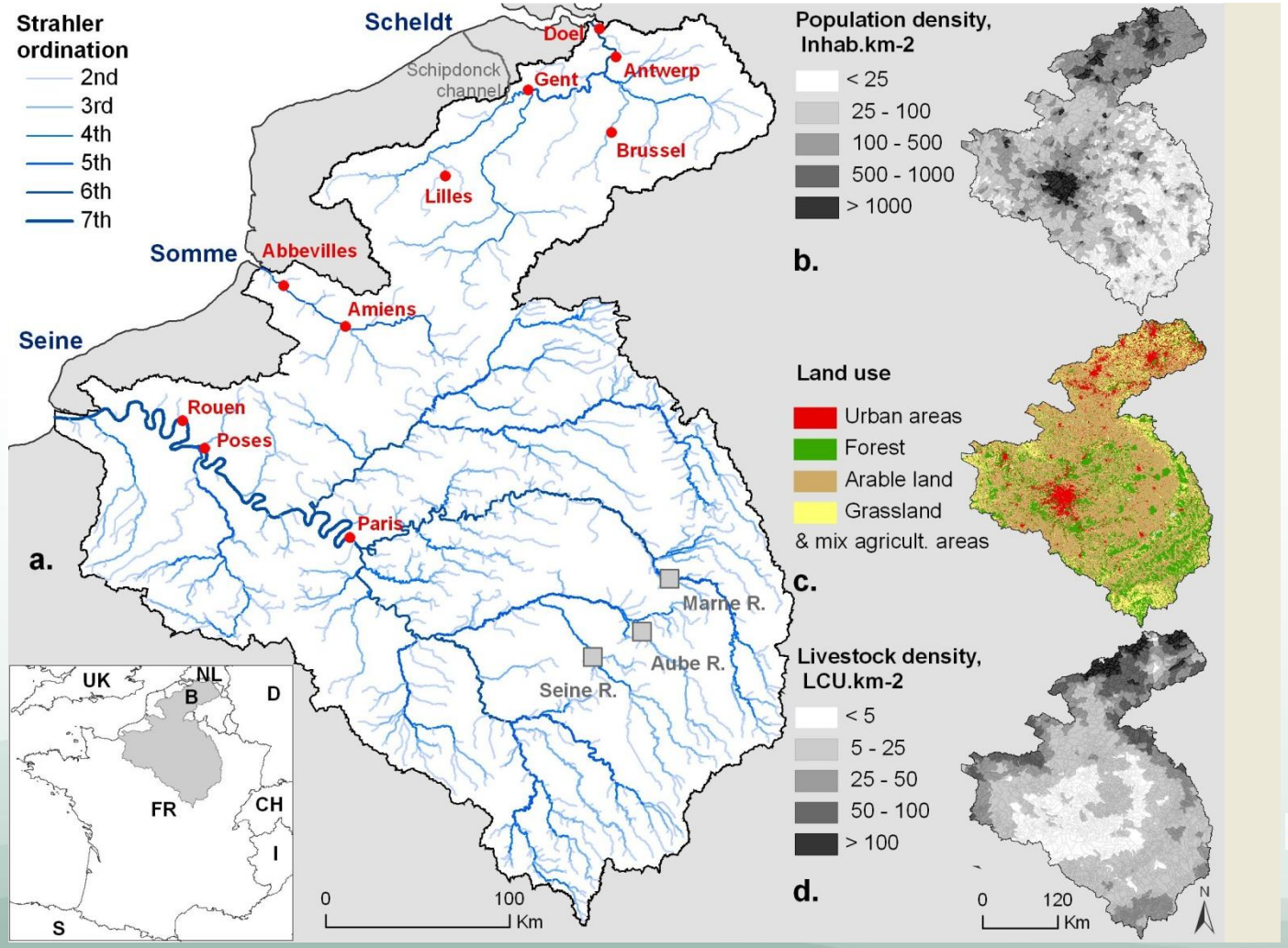
The EMoSEM project



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→ Run the **standard** simulations with tracking

→ Run **pristine-like** scenario for scaling the current status

→ Run **realistic nutrient reduction** scenarios applied to the rivers and scale their effect on the ecosystem

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The EMoSEM project

Expected outcome

- Innovative ecological **indicators**
- **Description** of eutrophication problems and their **causes**
- **Comparison** of the current eutrophication status with “pristine-like” status
- **Realistic future scenarios** for watershed management and impacts at sea

The EMoSEM outcome will be transferred to Member States responsible of the WFD and MSFD in their national domain and to the OSPAR commission.

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Thank you!

http://www2.mumm.ac.be/emosem