September 2025

PISCES

Basic information on the model

PISCES

- PISCES is a standard biogeochemical and plankton ecosystem model of varying complexity
    - Mostly PFT framework but with some trait-based formalism (size, lability, …)
    - Upper trophic levels (above mesozooplankton) are not explicitly modeled

- PISCES should be coupled to an OGCM:

NEMO

CROCO

- PISCES is using explicit temporal integration in the ocean
    - Sediment module used implicit integration (Rosenbrock schemes)

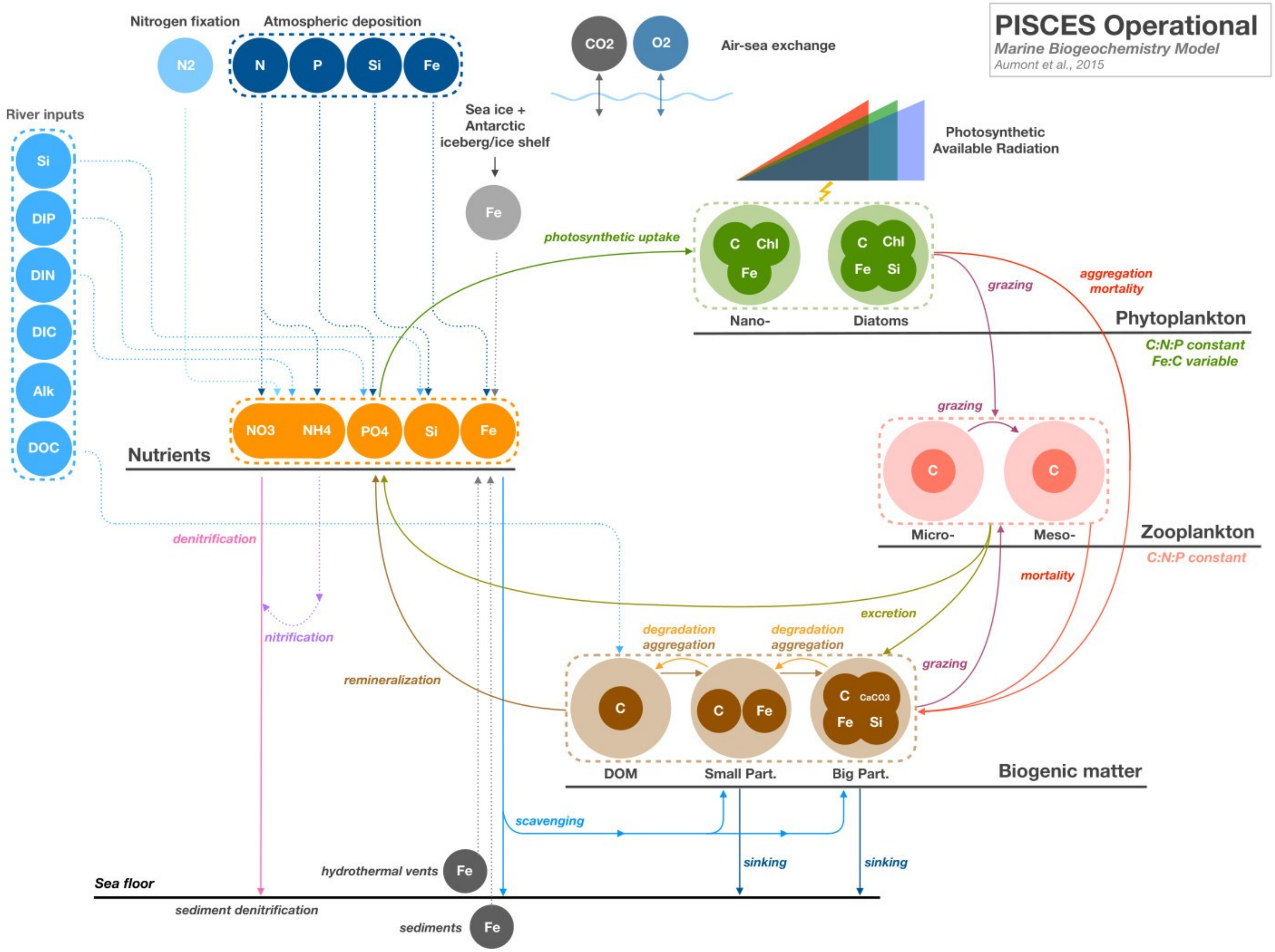
- PISCES is coded in Fortran 90

- Works only in 1D-V and 3D (no 0D or 2D version)

PISCES-std vs. PISCES-QUOTA

`ln_p4z = .true.`

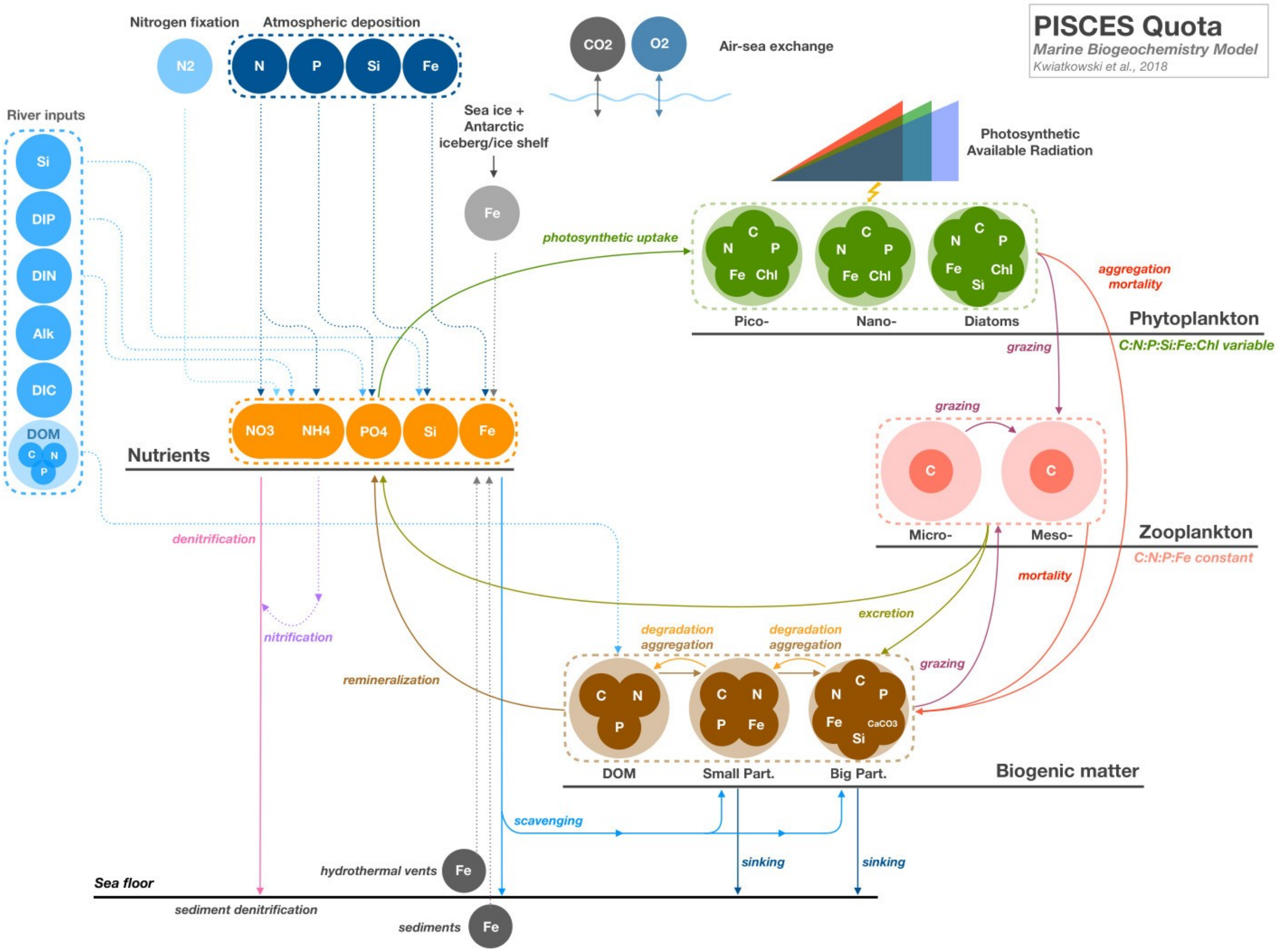
PISCES-std (24/25 tracers)



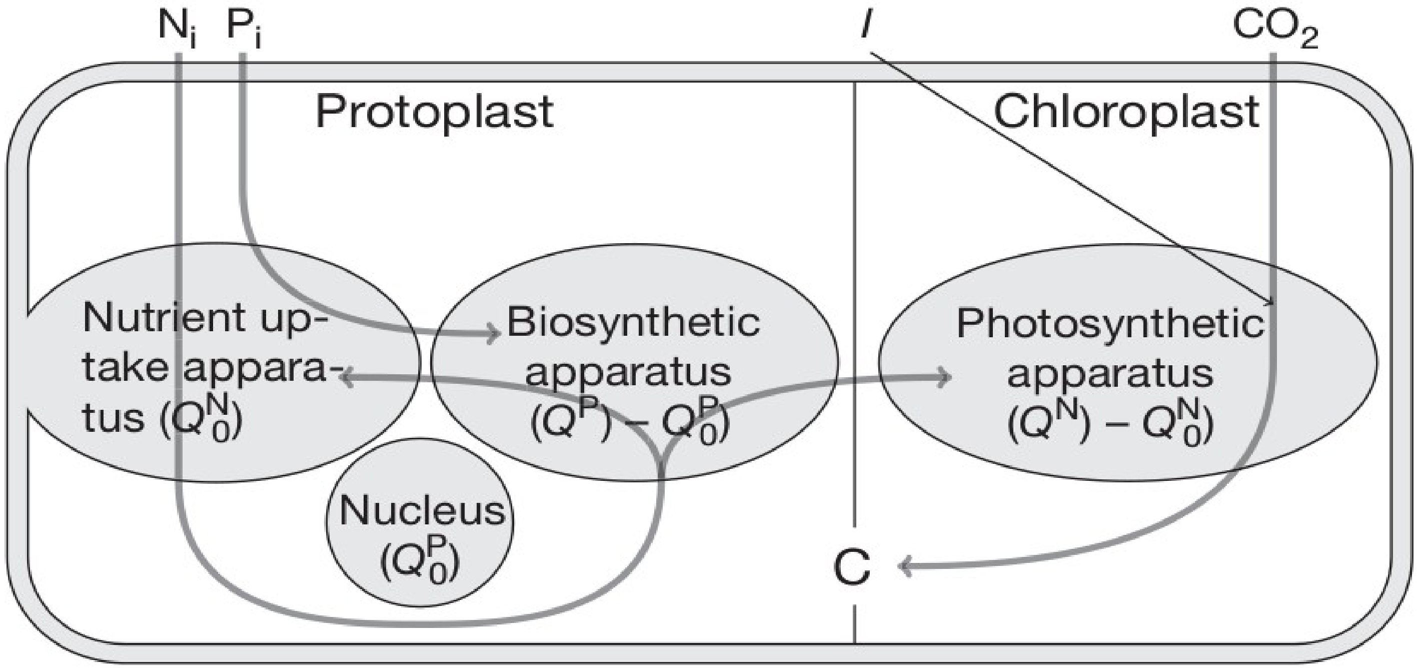
PISCES-std vs. PISCES-QUOTA

```
ln_p5z = .true.
```

PISCES-QUOTA (39/40 tracers)



PISCES-QUOTA



- Several adaptations of that model when embedded in PISCES:
  - Maximum quotas in P depends on the physiological status of the cells
  - Iron physiology has been added
  - Chlorophyll regulation has been modified

From Pahlow and Oschlies (2009)

Chlorophyll distribution

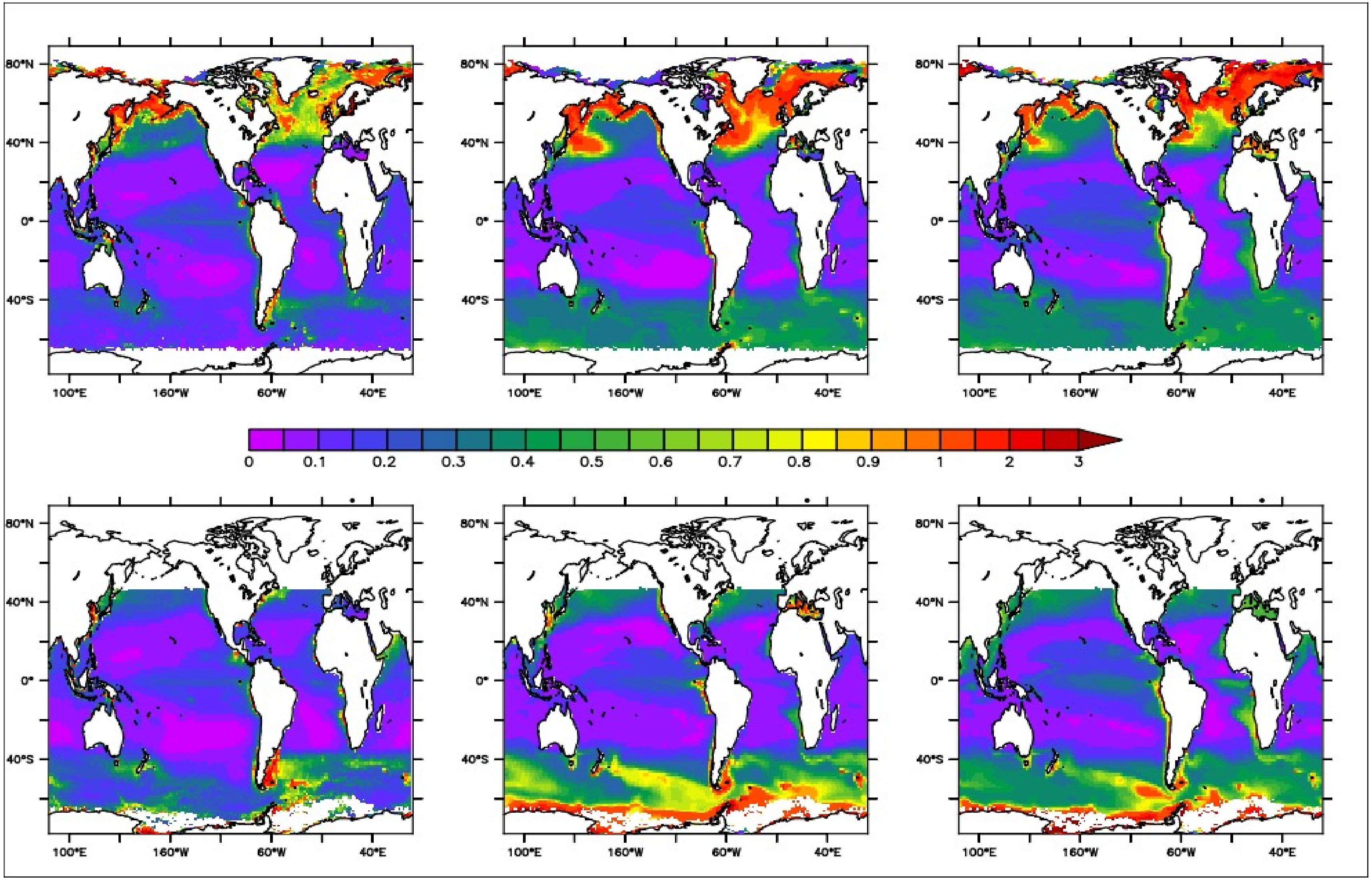
Satellite

PISCES-v2

PISCES-QUOTA

AMJ

NDJ

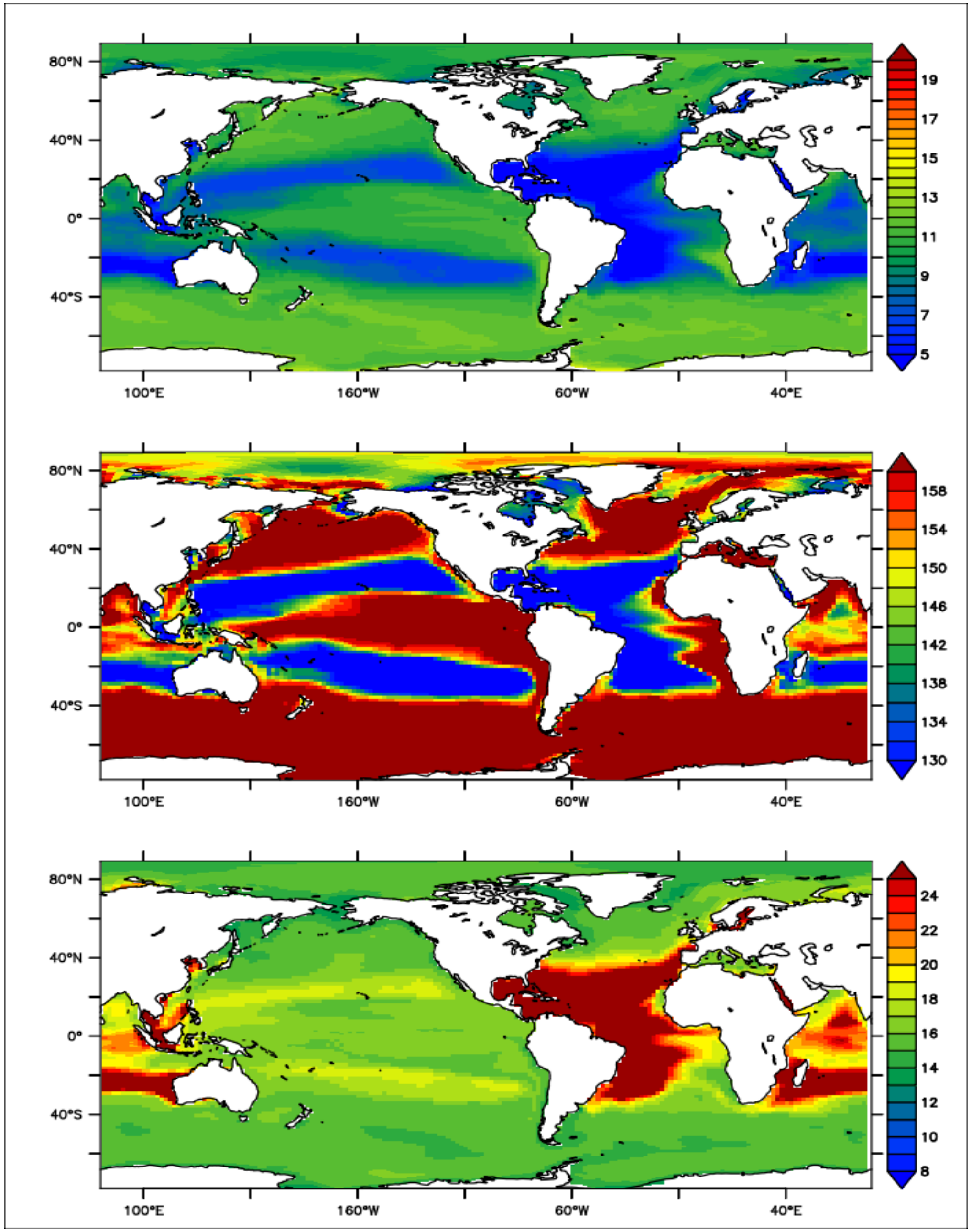


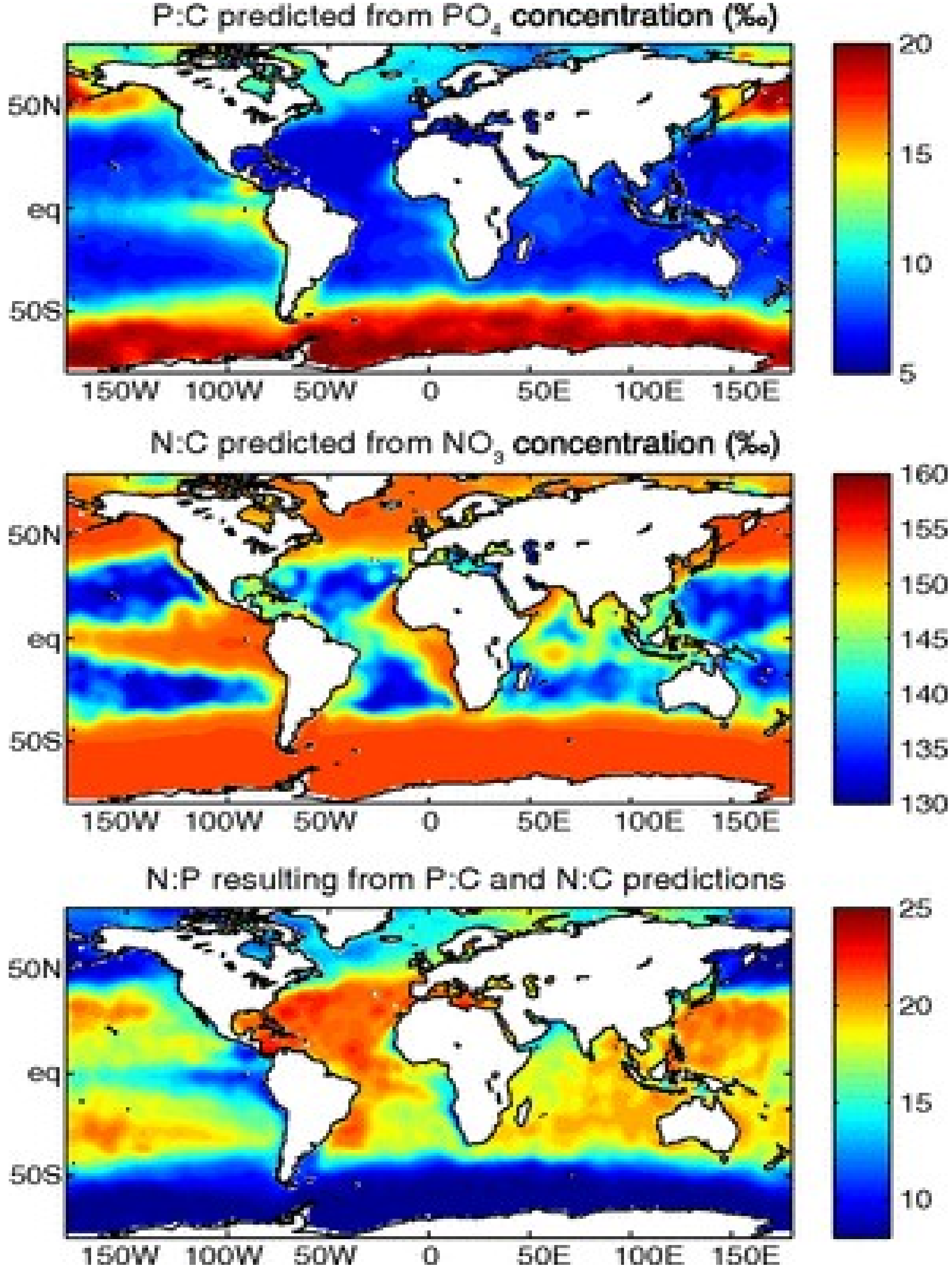
C/N/P ratios

P/C

N/C

N/P




P:C predicted from PO_4 concentration (‰)

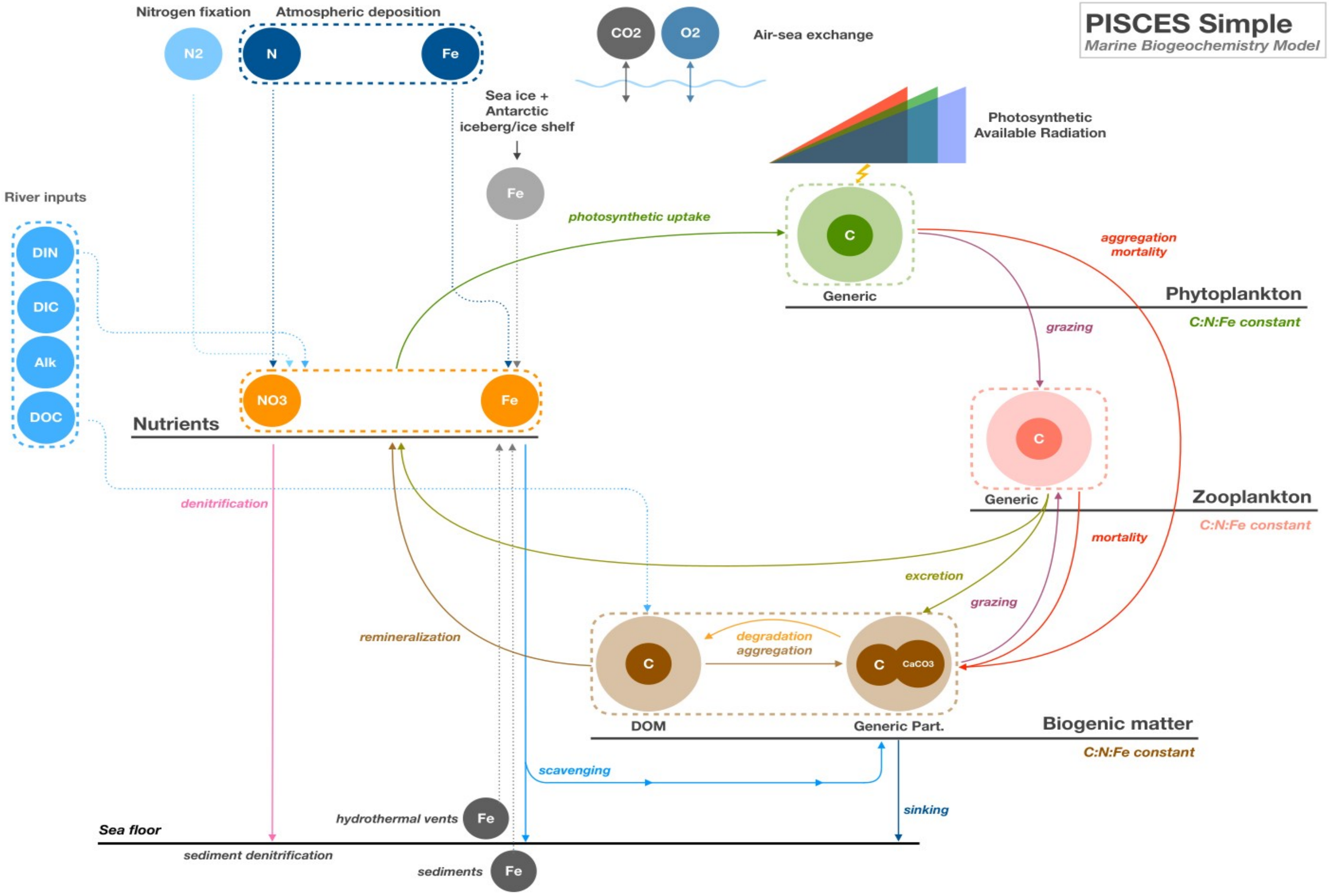
N:C predicted from NO_3 concentration (‰)

N:P resulting from P:C and N:C predictions

PISCES-simple vs. PISCES-STD

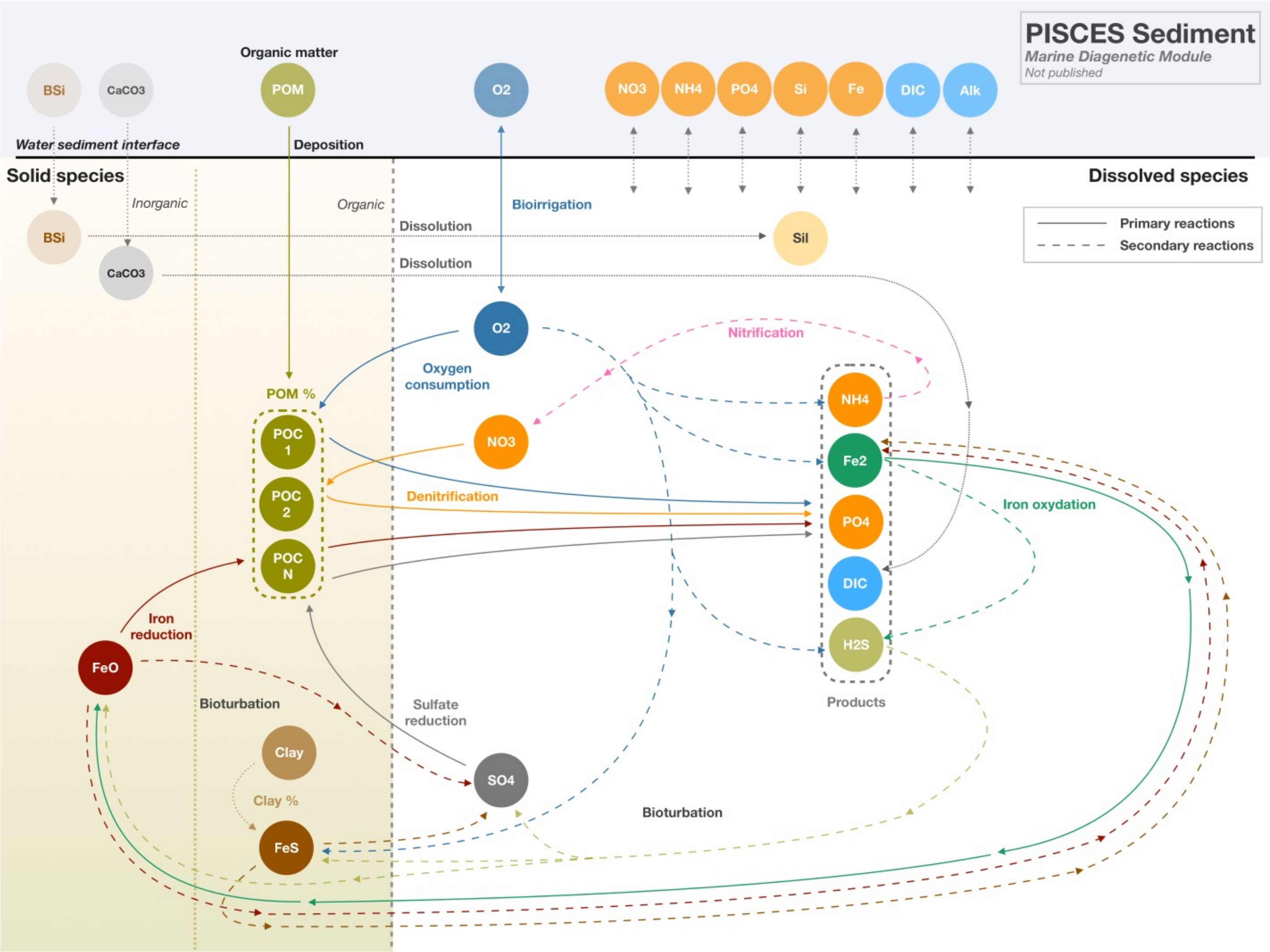
```
ln_p2z = .true.
```

PISCES-Simple (9 tracers)

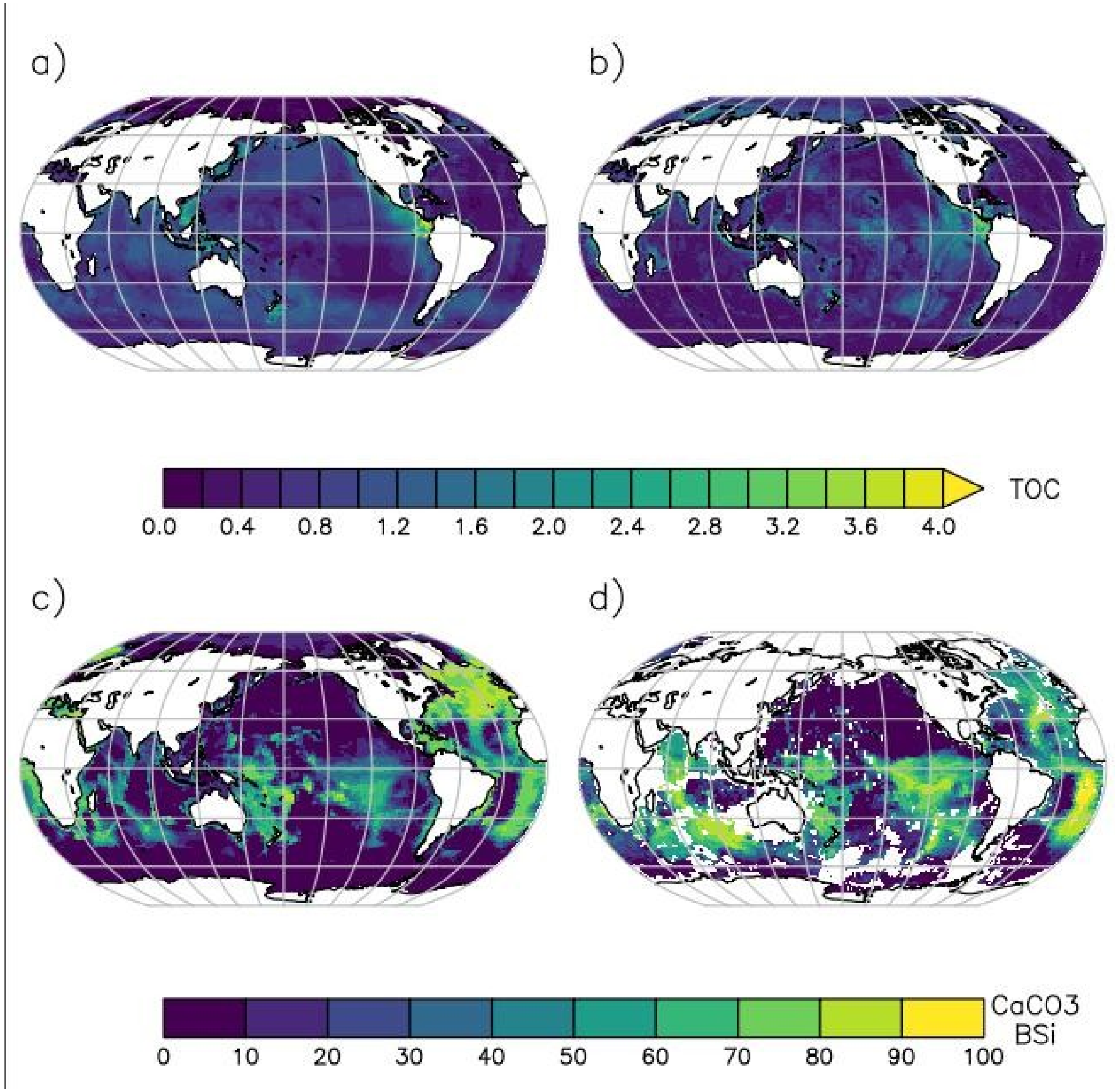


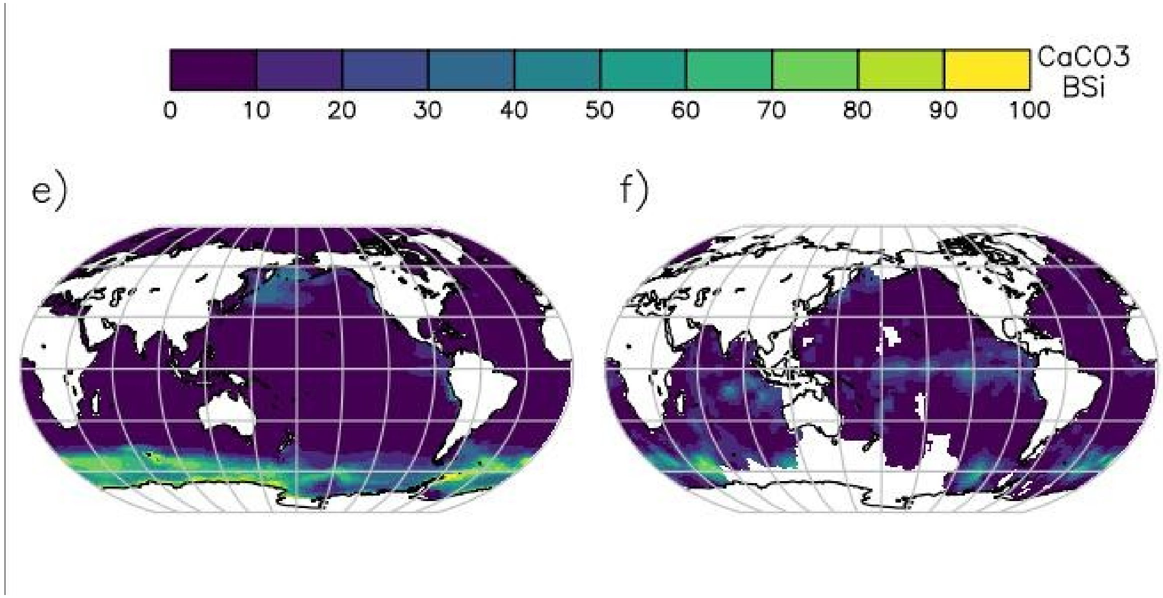
PISCES-Sediment

Can be used online/offline/standalone

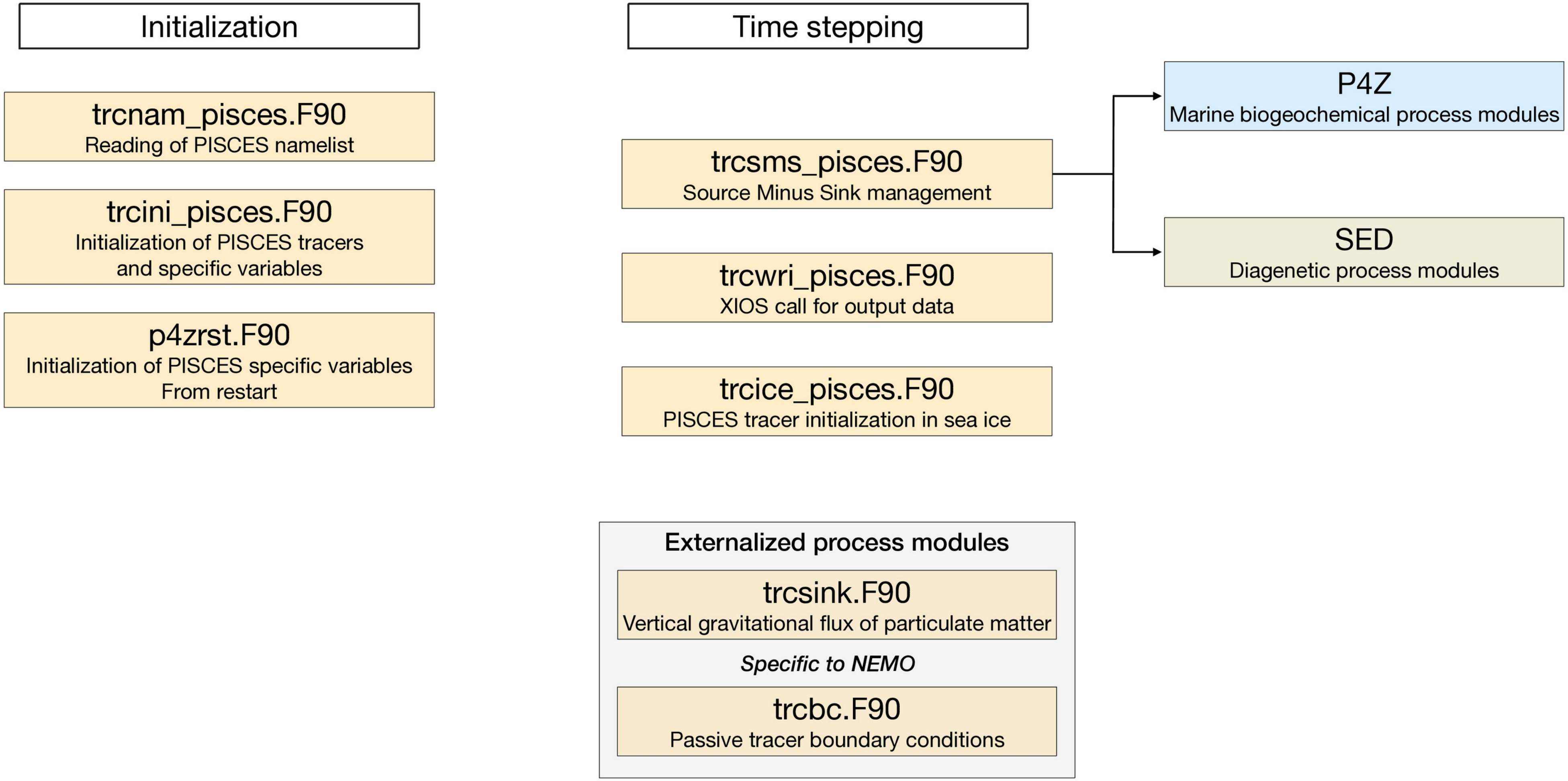


Solid composition of the upper sediments





Code structure - Main



Initialization

trcnam_pisces.F90
Reading of PISCES namelist

trcini_pisces.F90
Initialization of PISCES tracers
and specific variables

p4zrst.F90
Initialization of PISCES specific variables
From restart

Time stepping

trcsms_pisces.F90
Source Minus Sink management

P4Z
Marine biogeochemical process modules

SED
Diagenetic process modules

trcwri_pisces.F90
XIOS call for output data

trcice_pisces.F90
PISCES tracer initialization in sea ice

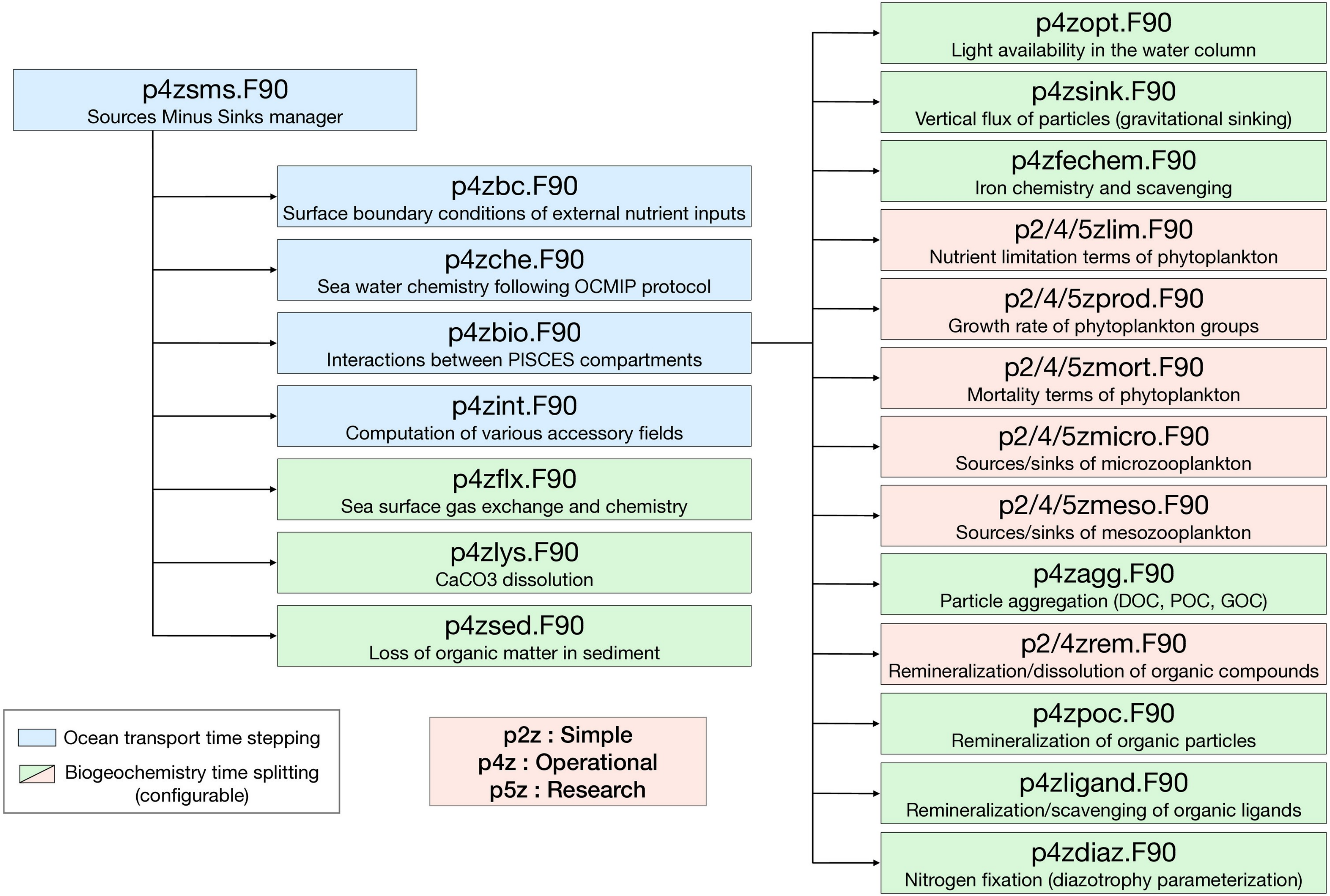
Externalized process modules

trcsink.F90
Vertical gravitational flux of particulate matter

Specific to NEMO

trcbc.F90
Passive tracer boundary conditions

Code structure - SMS



p4zsms.F90
Sources Minus Sinks manager

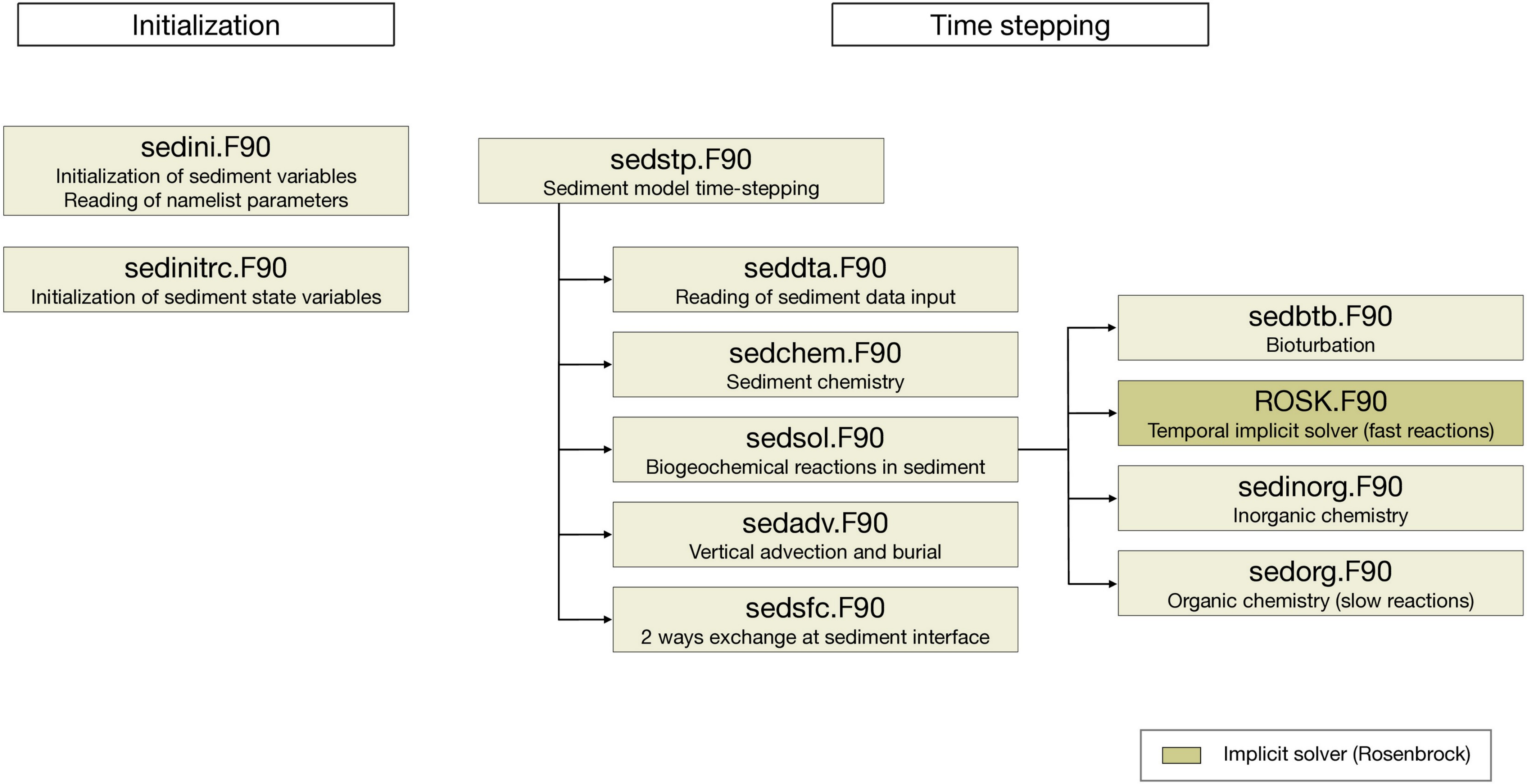
- **p4zbc.F90**
Surface boundary conditions of external nutrient inputs
- **p4zche.F90**
Sea water chemistry following OCMIP protocol
- **p4zbio.F90**
Interactions between PISCES compartments
  - **p4zopt.F90**
Light availability in the water column
  - **p4zsink.F90**
Vertical flux of particles (gravitational sinking)
  - **p4zfechem.F90**
Iron chemistry and scavenging
  - **p2/4/5zlim.F90**
Nutrient limitation terms of phytoplankton
  - **p2/4/5zprod.F90**
Growth rate of phytoplankton groups
  - **p2/4/5zmort.F90**
Mortality terms of phytoplankton
  - **p2/4/5zmicro.F90**
Sources/sinks of microzooplankton
  - **p2/4/5zmeso.F90**
Sources/sinks of mesozooplankton
  - **p4zagg.F90**
Particle aggregation (DOC, POC, GOC)
  - **p2/4zrem.F90**
Remineralization/dissolution of organic compounds
  - **p4zpoc.F90**
Remineralization of organic particles
  - **p4zligand.F90**
Remineralization/scavenging of organic ligands
  - **p4zdiaz.F90**
Nitrogen fixation (diazotrophy parameterization)
- **p4zint.F90**
Computation of various accessory fields
- **p4zflx.F90**
Sea surface gas exchange and chemistry
- **p4zlys.F90**
CaCO3 dissolution
- **p4zsed.F90**
Loss of organic matter in sediment

🟦 Ocean transport time stepping

▨ Biogeochemistry time splitting (configurable)

p2z : Simple
p4z : Operational
p5z : Research

Code structure – Diagenetic module



Initialization

sedini.F90
Initialization of sediment variables
Reading of namelist parameters

sedinitrc.F90
Initialization of sediment state variables

Time stepping

sedstp.F90
Sediment model time-stepping

- **seddta.F90** – Reading of sediment data input
- **sedchem.F90** – Sediment chemistry
- **sedsol.F90** – Biogeochemical reactions in sediment
  - **sedbtb.F90** – Bioturbation
  - **ROSK.F90** – Temporal implicit solver (fast reactions)
  - **sedinorg.F90** – Inorganic chemistry
  - **sedorg.F90** – Organic chemistry (slow reactions)
- **sedadv.F90** – Vertical advection and burial
- **sedsfc.F90** – 2 ways exchange at sediment interface

🟨 Implicit solver (Rosenbrock)