

# The Biogeochemical Flux Model

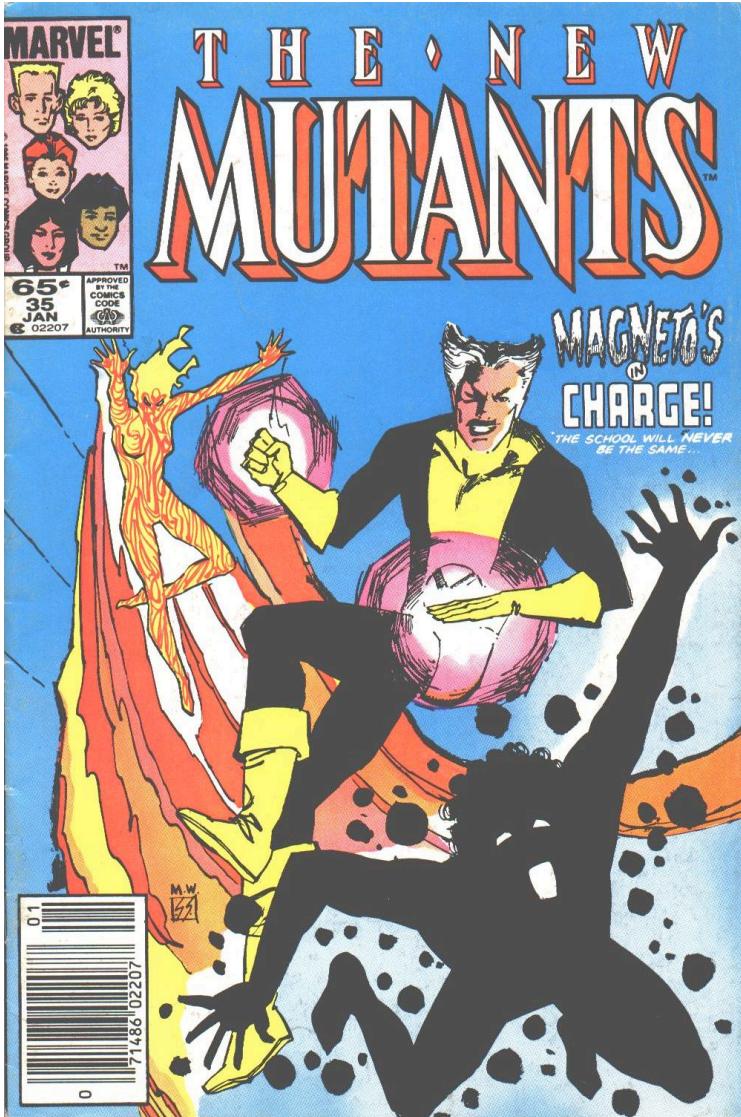
## an Open Source stoichiometric model for marine ecosystems

Marcello Vichi (CMCC-INGV)  
on behalf of the  
BFM System Team



*BFM Release meeting, Bologna March 19 2013*

# Flavours, mutants, clones or (just) evolution?



- Science, like ecosystems, benefits from diversity
- Diversity is organised in functional groups with redundancy, but *what is the “sufficient” level of redundancy for biogeochemical models?*
- **Biogeochemical modelling** is still considered a *problem-oriented* science because of the lack of theories, therefore one is allowed to apply any possible parameterization
- Research groups often produce **new** models with **similar** parameterizations, instead of searching for common features which may increase the knowledge and provide robust predictive mechanisms

# Why a community model?

- Create a community of research groups that share common interests in marine biogeochemistry and ecosystem modelling
- Provide a common environment for the testing of process mechanisms, with unified syntax and semantics.
- Share and distribute consolidated knowledge and tools that are ready to be used by other scientists
- Reduce the effort of exchanging information between different disciplines
- Create a benchmark for the development of new methodologies

# What is the BFM?

- **Extension** of the ERSEM philosophy (*Baretta et al., 1995; Blackford and Radford, 1995*)
- **Stoichiometric** biomass-based model, which describes the biogeochemical cycles of major constituents in the pelagic, benthic and sea ice systems
- **Open Source** code with advanced and flexible coding structure starting from a core of ordinary differential equations
- Designed with the idea of **coupling** with different OGCMs in a partial differential equation system

# Why BFM-V5?

1992-1997: ERSEM I and II (Baretta, Baretta-Bekker et al., Box models in the North Sea)

1996-2000: Dispersion of propagules; ERSEM in regional seas (mostly coupled with POM)

1998-2002: ERSEM III in the OpenSESAME environment (Ruardij, Vichi et al. Baltic and Adriatic)

2002: **BFM was born** with the MFSTEP project: BFM-V2, version used by OGS in the Mediterranean (Lazzari et al., 2012)

2003-2011: BFM-V3 used in the global ocean with OPA8.2 (CMCC-ESM results published in CMIP5 are based on this version)

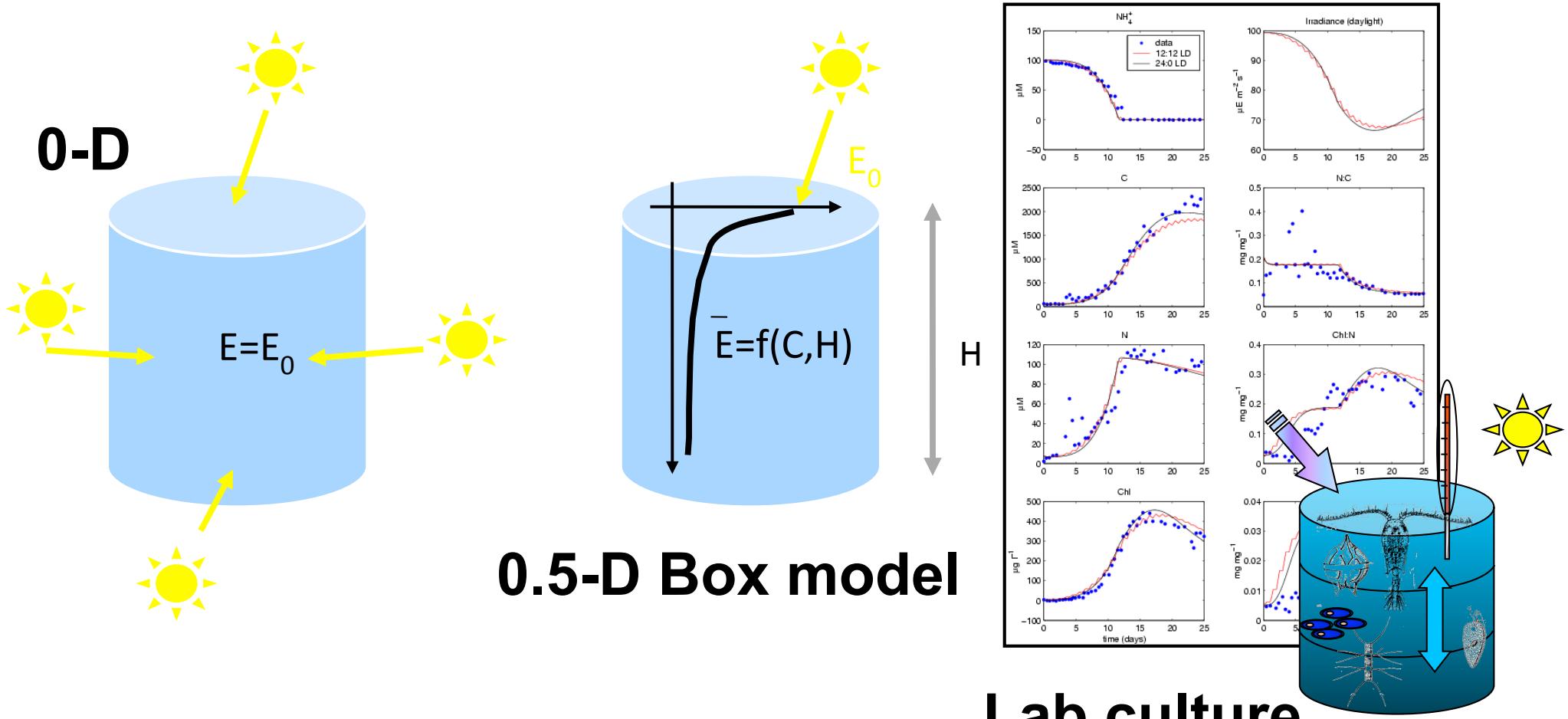
2006-2012: BFM-V4 is a transitional version that has been coupled with different GCM: GOTM-GETM (CEFAS, NIOZ), NEMO 2.3 (INGV, UNIBO)

2011-2012 : the BFM agreement is signed. Towards V5

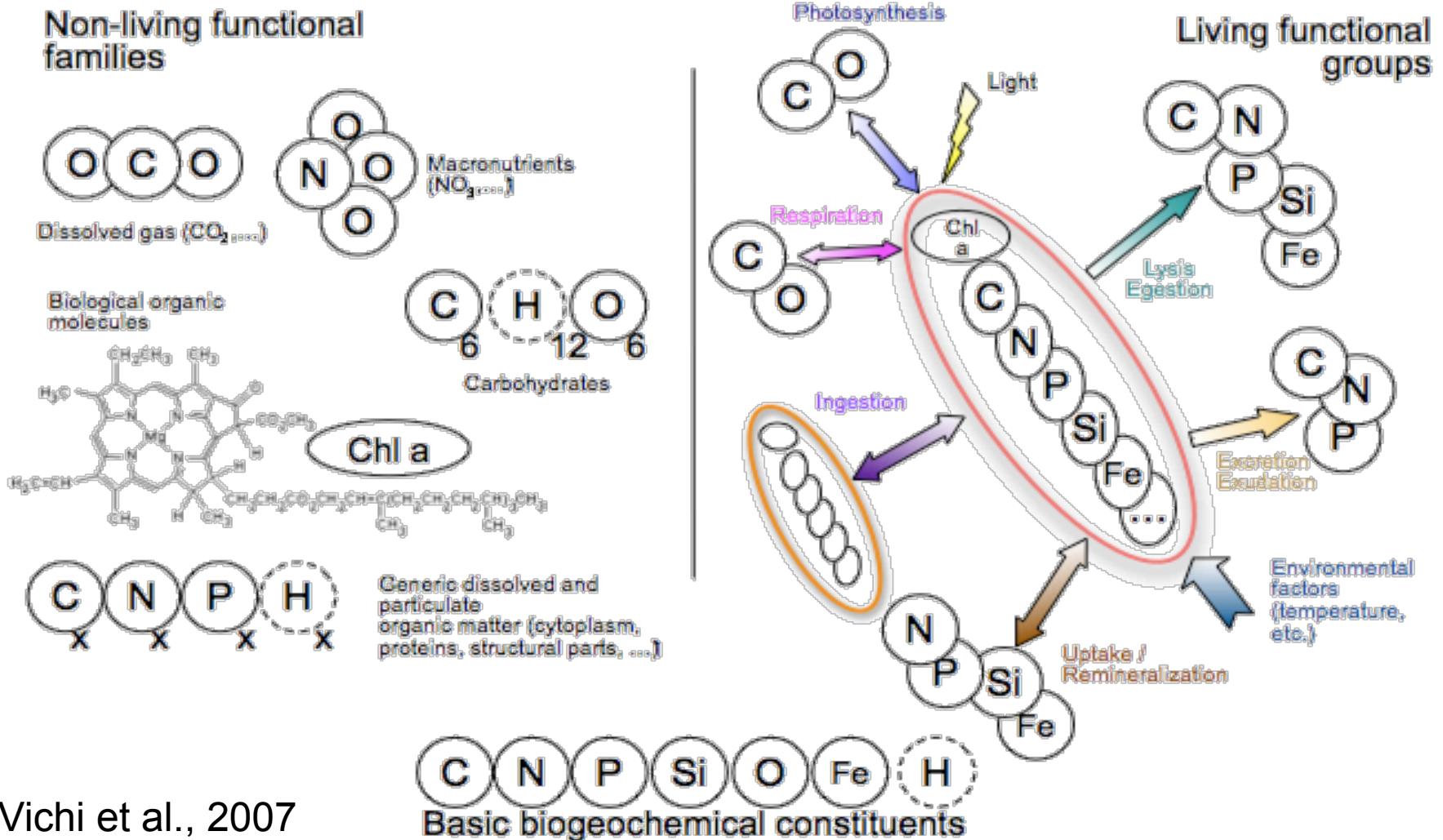
**2013: BFM-V5 is released**

# What you'll find in BFM-V5?

The STANDALONE model: Focus on production/consumption processes

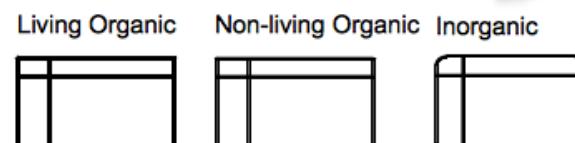
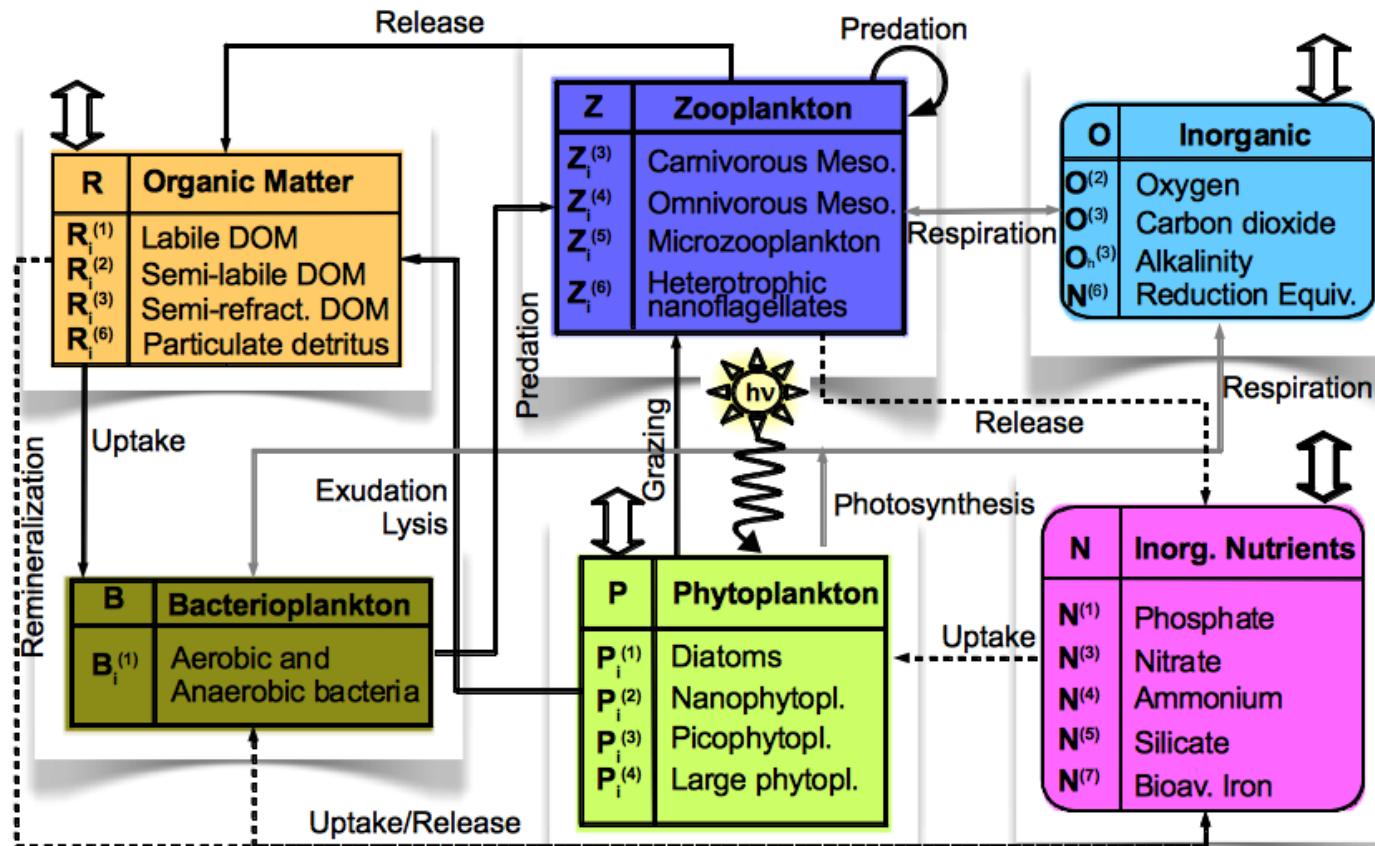


## Stoichiometric Modelling: flexible number of constituents

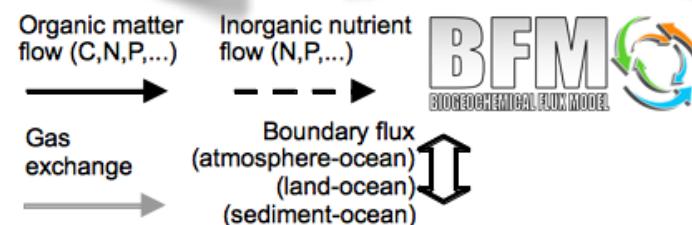


Vichi et al., 2007

## Multivorous food-web and components



© 2013 BFM System Team <http://bfm-community.eu>

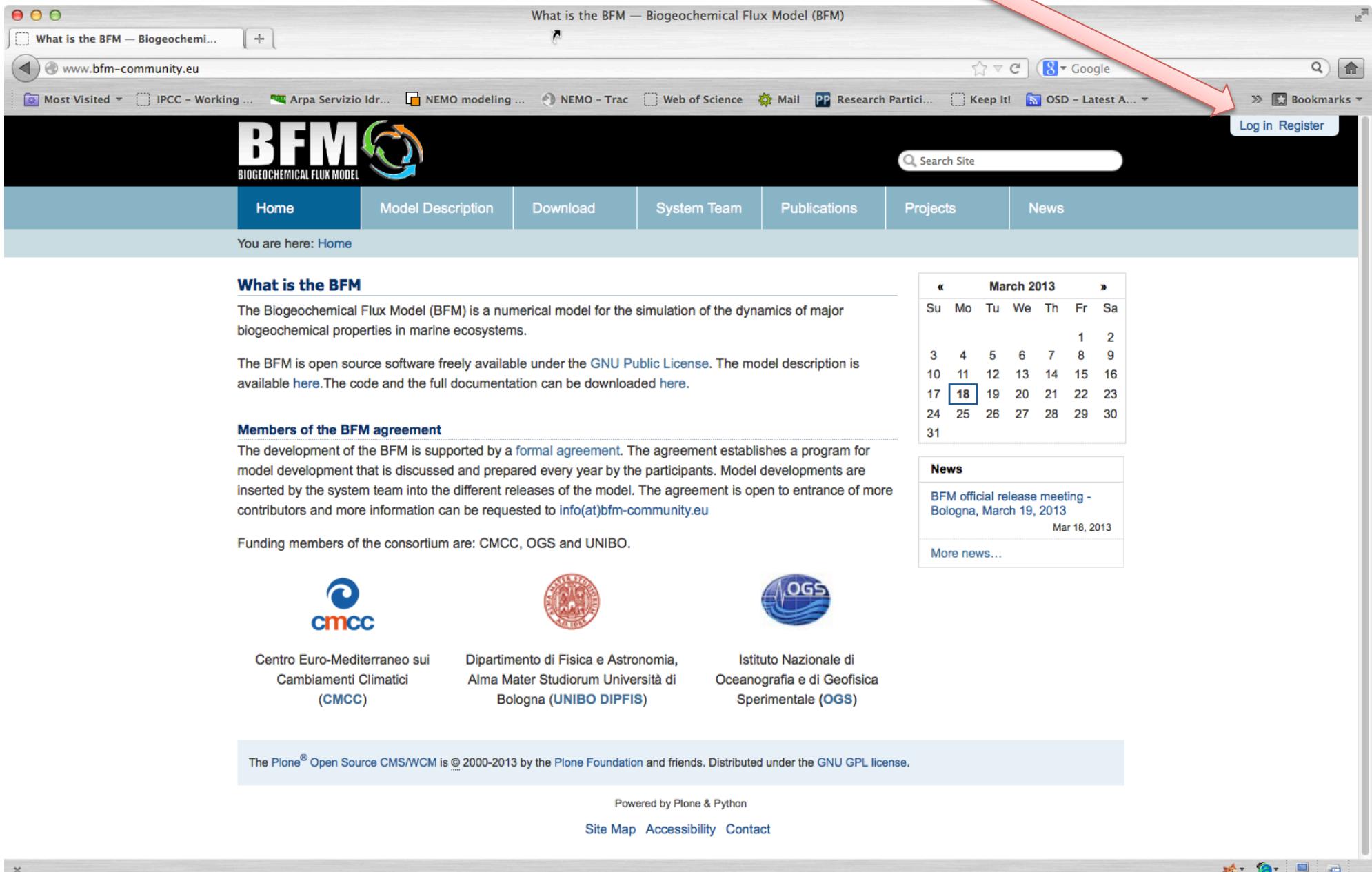


Equation Box 2.3 Bacteria equations

# Modularity and flexibility



# Register here



What is the BFM — Biogeochemical Flux Model (BFM)

www.bfm-community.eu

Most Visited ▾ IPCC – Working ... Arpa Servizio Idr... NEMO modeling ... NEMO – Trac Web of Science Mail PP Research Particip... Keep It! OSD – Latest A... Bookmarks ▾ Log in Register

Search Site

Home Model Description Download System Team Publications Projects News

You are here: Home

**What is the BFM**

The Biogeochemical Flux Model (BFM) is a numerical model for the simulation of the dynamics of major biogeochemical properties in marine ecosystems.

The BFM is open source software freely available under the [GNU Public License](#). The model description is available [here](#). The code and the full documentation can be downloaded [here](#).

**Members of the BFM agreement**

The development of the BFM is supported by a [formal agreement](#). The agreement establishes a program for model development that is discussed and prepared every year by the participants. Model developments are inserted by the system team into the different releases of the model. The agreement is open to entrance of more contributors and more information can be requested to [info\(at\)bfm-community.eu](mailto:info(at)bfm-community.eu)

Funding members of the consortium are: CMCC, OGS and UNIBO.

March 2013						
Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

**News**

BFM official release meeting -  
Bologna, March 19, 2013  
Mar 18, 2013

[More news...](#)

Centro Euro-Mediterraneo sui Cambiamenti Climatici (**CMCC**) Dipartimento di Fisica e Astronomia, Alma Mater Studiorum Università di Bologna (**UNIBO DIPFIS**) Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (**OGS**)

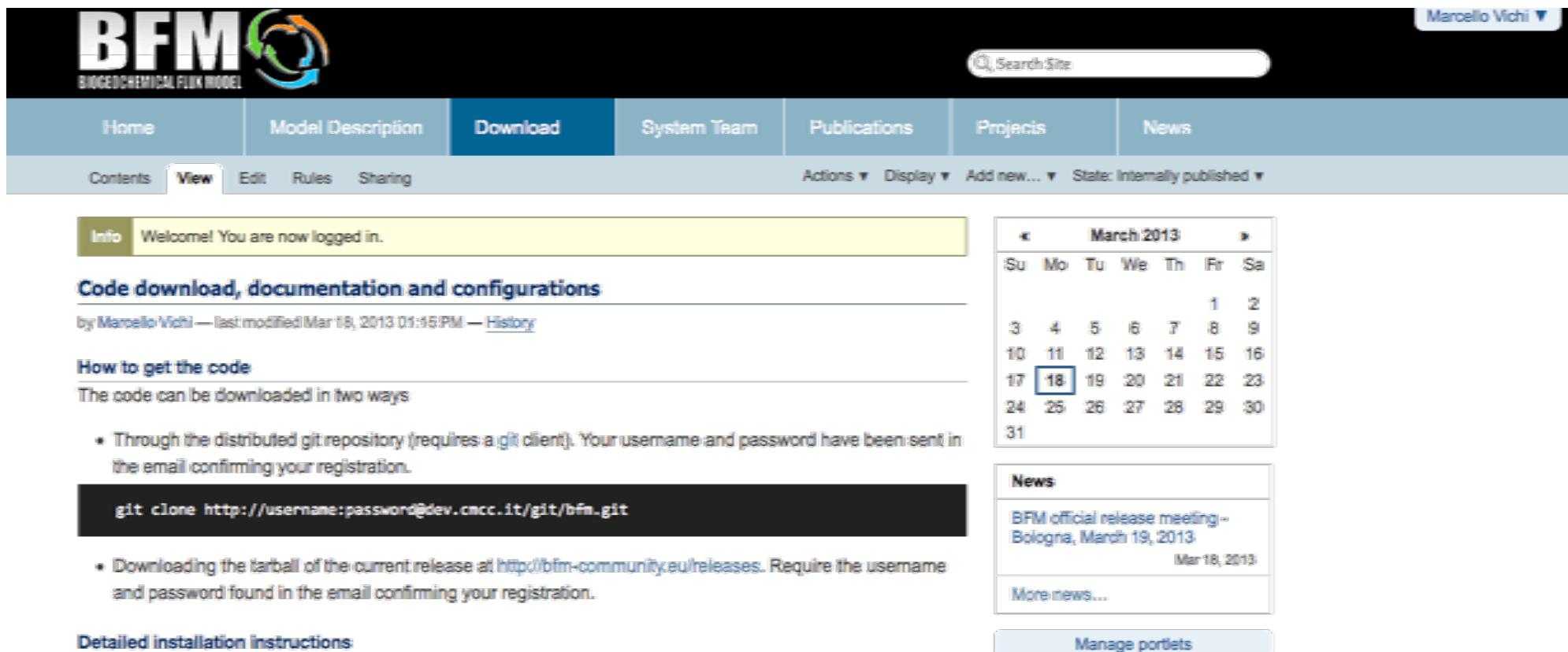
The Plone® Open Source CMS/WCM is © 2000-2013 by the Plone Foundation and friends. Distributed under the [GNU GPL license](#).

Powered by Plone & Python

[Site Map](#) [Accessibility](#) [Contact](#)

# http://www.bfm-community.eu/documentation

Marcello Vichi ▾



The screenshot shows the BFM documentation website. At the top, there's a navigation bar with links for Home, Model Description, Download, System Team, Publications, Projects, and News. Below the navigation is a search bar labeled "Search Site". The main content area has tabs for Contents, View (which is selected), Edit, Rules, and Sharing. It also includes filters for Actions, Display, Add new..., and State: Internally published. A message box says "Info Welcome! You are now logged in." Below this, a section titled "Code download, documentation and configurations" is shown, last modified on March 18, 2013. It includes a "How to get the code" section with instructions for git cloning and downloading tarballs. A calendar for March 2013 highlights March 18th. To the right, there's a "News" sidebar with a link to the official release meeting in Bologna on March 19, 2013.

Info Welcome! You are now logged in.

## Code download, documentation and configurations

by Marcello Vichi — last modified Mar 18, 2013 01:15 PM — [History](#)

### How to get the code

The code can be downloaded in two ways

- Through the distributed git repository (requires a [git](#) client). Your username and password have been sent in the email confirming your registration.  

```
git clone http://username:password@dev.cmcc.it/git/bfm.git
```
- Downloading the tarball of the current release at <http://bfm-community.eu/releases>. Require the username and password found in the email confirming your registration.

### Detailed installation instructions

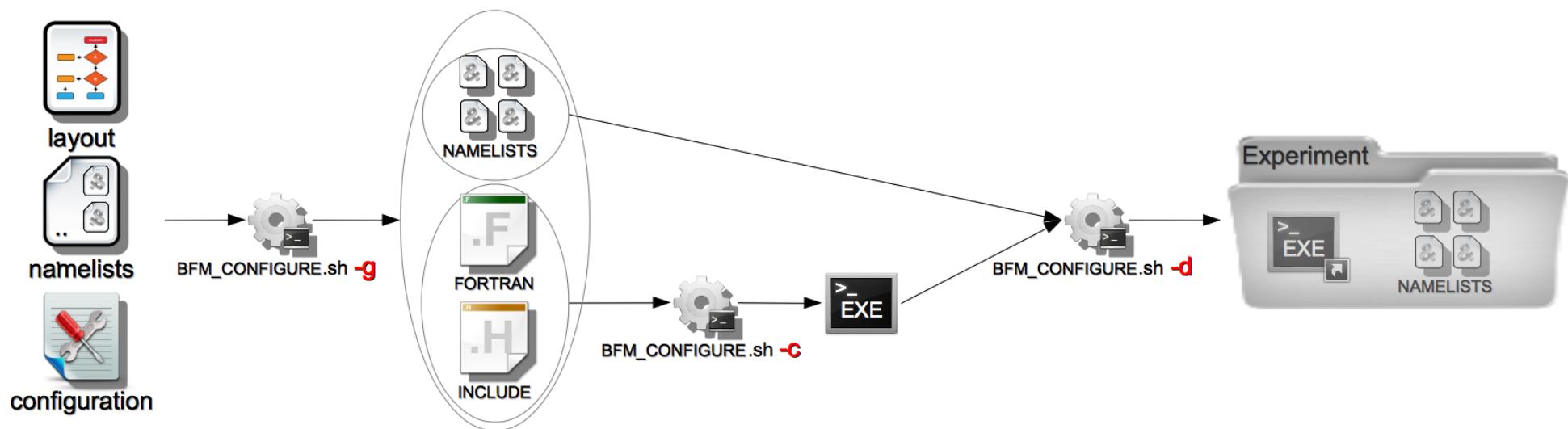
**Supported architectures**

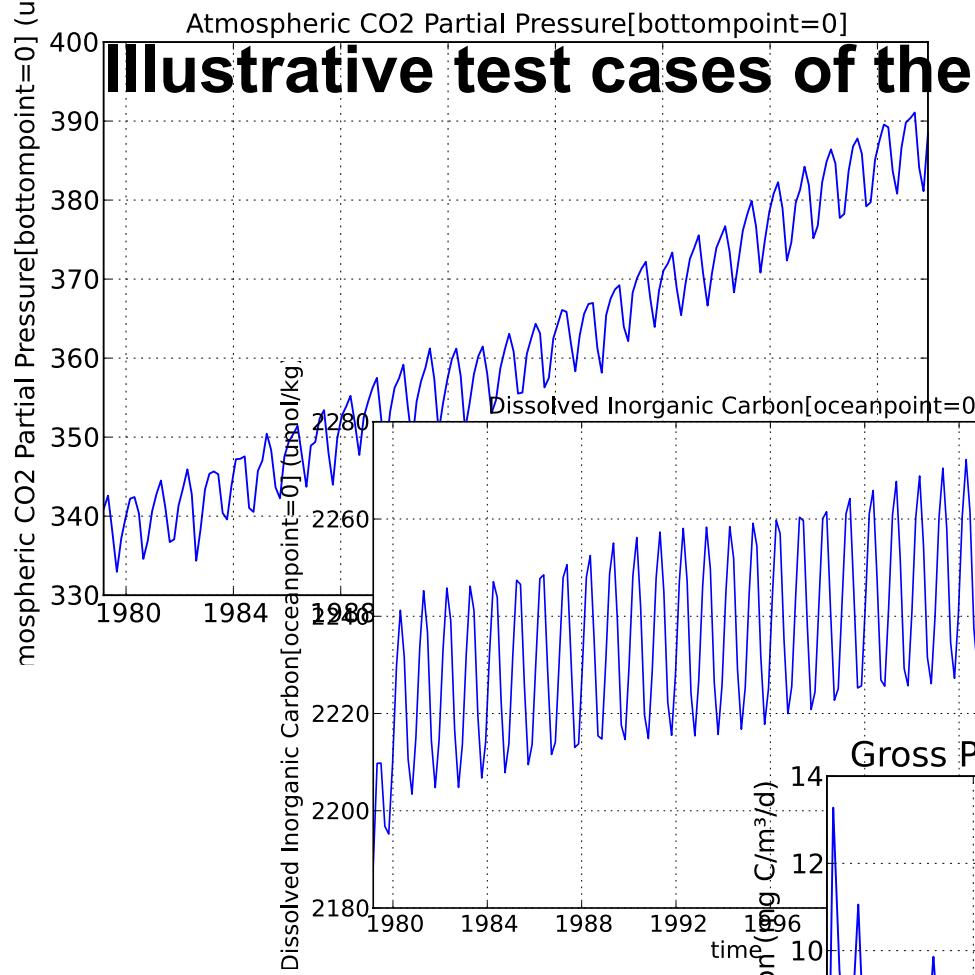
- linux
- Mac OSX (Darwin)
- IBM AIX

**Software requirements**

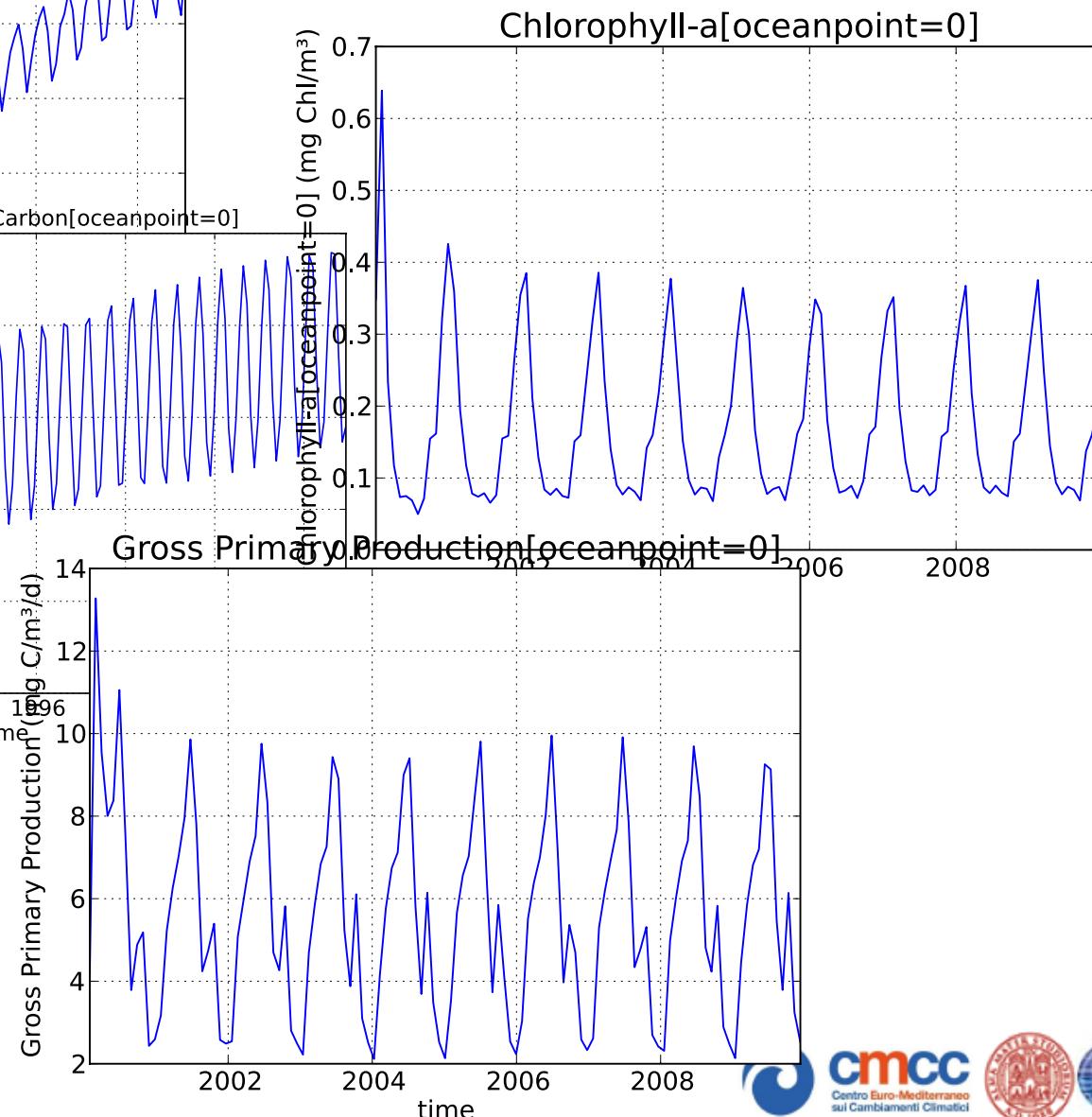
- PERL (version 5.8.2 and above)
- FORTRAN 90/95 compiler. Under linux and Mac OSX the model can be currently compiled with gfortran (version 4.6 or higher) and ifort. For AIX xlf90 is required.
- NetCDF library (<http://www.unidata.ucar.edu/software/netcdf>). It is mandatory that the library has been

# The configuration tool: from different model layouts to experiments



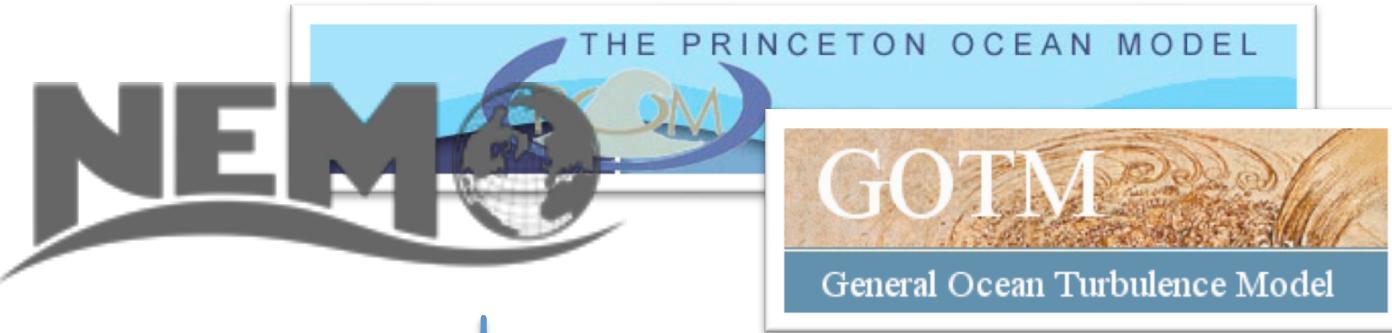


- Simple carbonate equilibrium with increasing atmospheric CO<sub>2</sub>
- Well-mixed “tank” in a temperate sea



# The coupling with transport processes

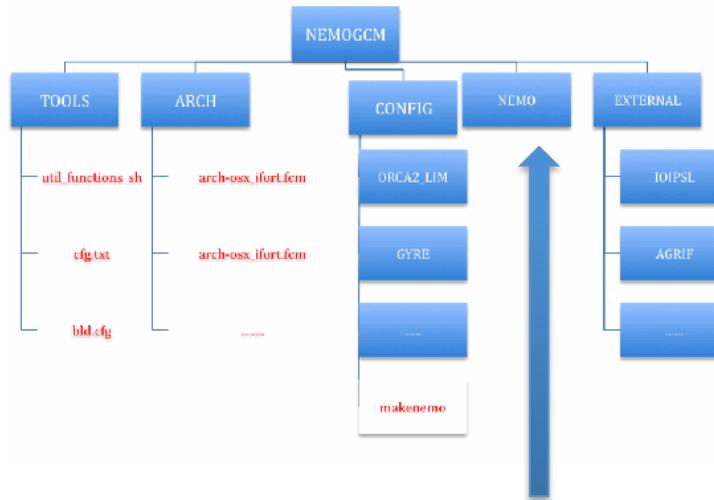
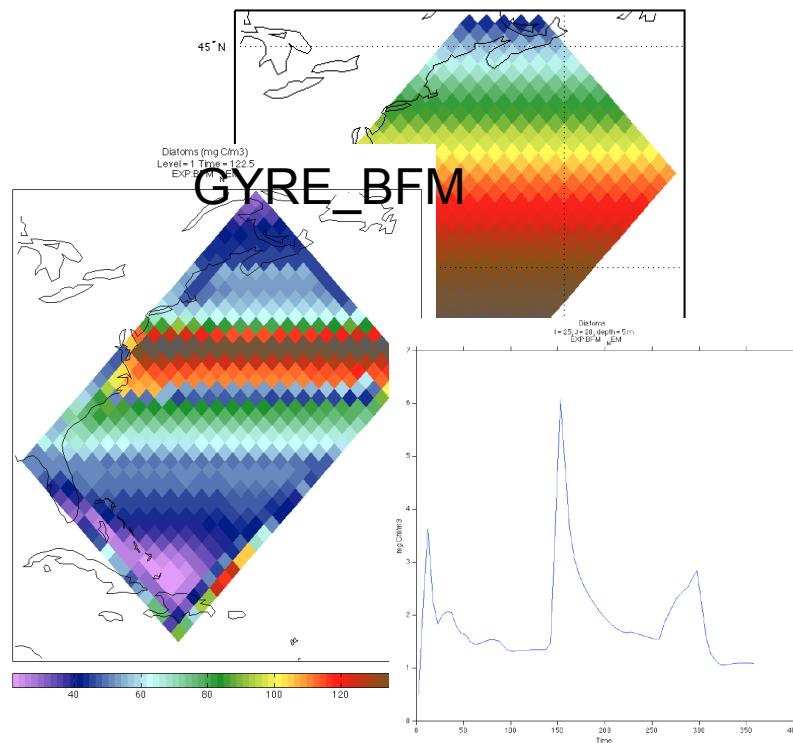
The BFM has been coupled with several General Circulation Models  
 NEMO, POM, OPATM, GOTM-GETM (next talk)



$$\frac{\partial C}{\partial t} = \underbrace{-\mathbf{u}_H \cdot \nabla_H C + \nabla_H \cdot (A_H \nabla_H C)}_{\text{non-local}} - w \underbrace{\frac{\partial C}{\partial z} + \frac{\partial}{\partial z} A_V \frac{\partial C}{\partial z}}_{\text{local (physical)}} - w_C \underbrace{\frac{\partial C}{\partial z}}_{\text{local (biological)}} + \left. \frac{\partial C}{\partial t} \right|_{bio} \quad (1)$$



The coupling with NEMO 3.5 is publicly maintained by BFM and NEMO consortia  
 [still experimental]



The two models are external components and BFM\_configure allows to compile using NEMO tools

## *Credits and acknowledgments*

Support from CMCC, OGS and UNIBO



ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA



The precious help and dedication of the  
System Team members:

Support from EU-FP7 projects:  
MedSeA                            Greenseas



The developers of the ERSEM  
community

Esteban Gutierrez  
Tomas Lovato  
Andrea Russo  
William McKiver  
Paolo Lazzari  
Gianpiero Cossarini