

# The PRISM Support Initiative, COSMOS and OASIS4

René Redler

**C&C Research Laboratories, NEC Europe Ltd., Sankt Augustin, Germany**

Sophie Valcke

**CERFACS Toulouse, France**

Helmuth Haak

**MPI M&D, Hamburg, Germany**

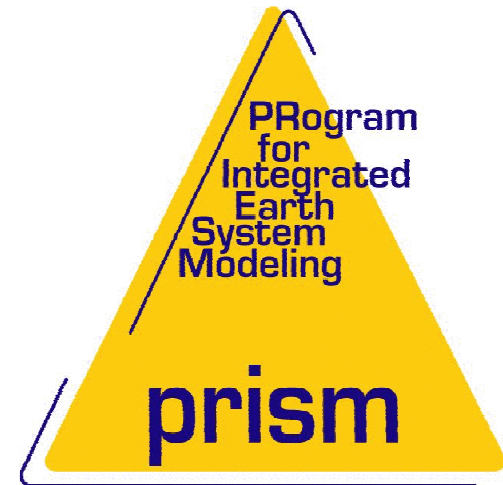
... plus many others contributing to these projects

# PRISM and the PRISM Support Initiative

- 2001-2004: the PRISM EU project
  - FP5 project, 4.8M Euro
  - 22 partners from public and private sector
- 2005-2008: the PRISM Support Initiative (prolongated every 3 years)
  - 7 partners
  - 9 associated partners

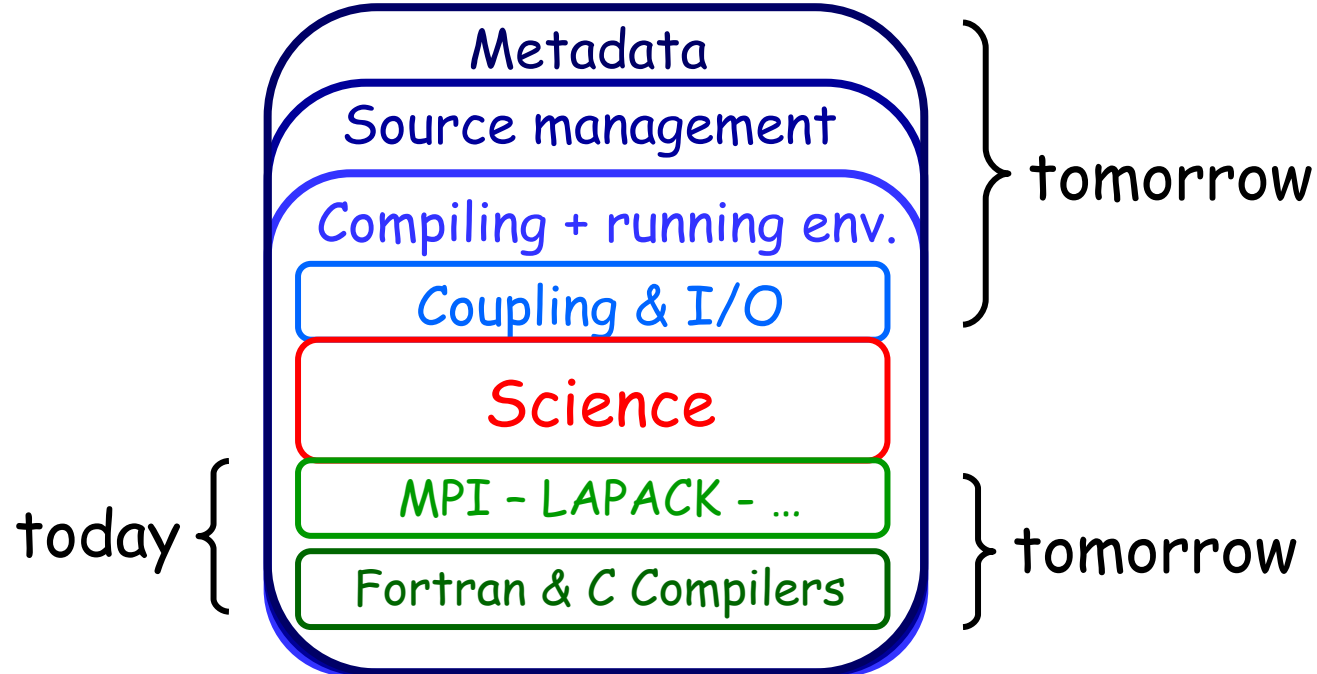
CERFACS  
CNRS  
CGAM  
UK MetOffice  
MPI-M&D  
NEC-CCRLE  
ECMWF

CSC  
IPSL  
Météo-France  
SMHI  
MPI-M  
CRAY  
SUN  
SGI  
NEC-HPCE

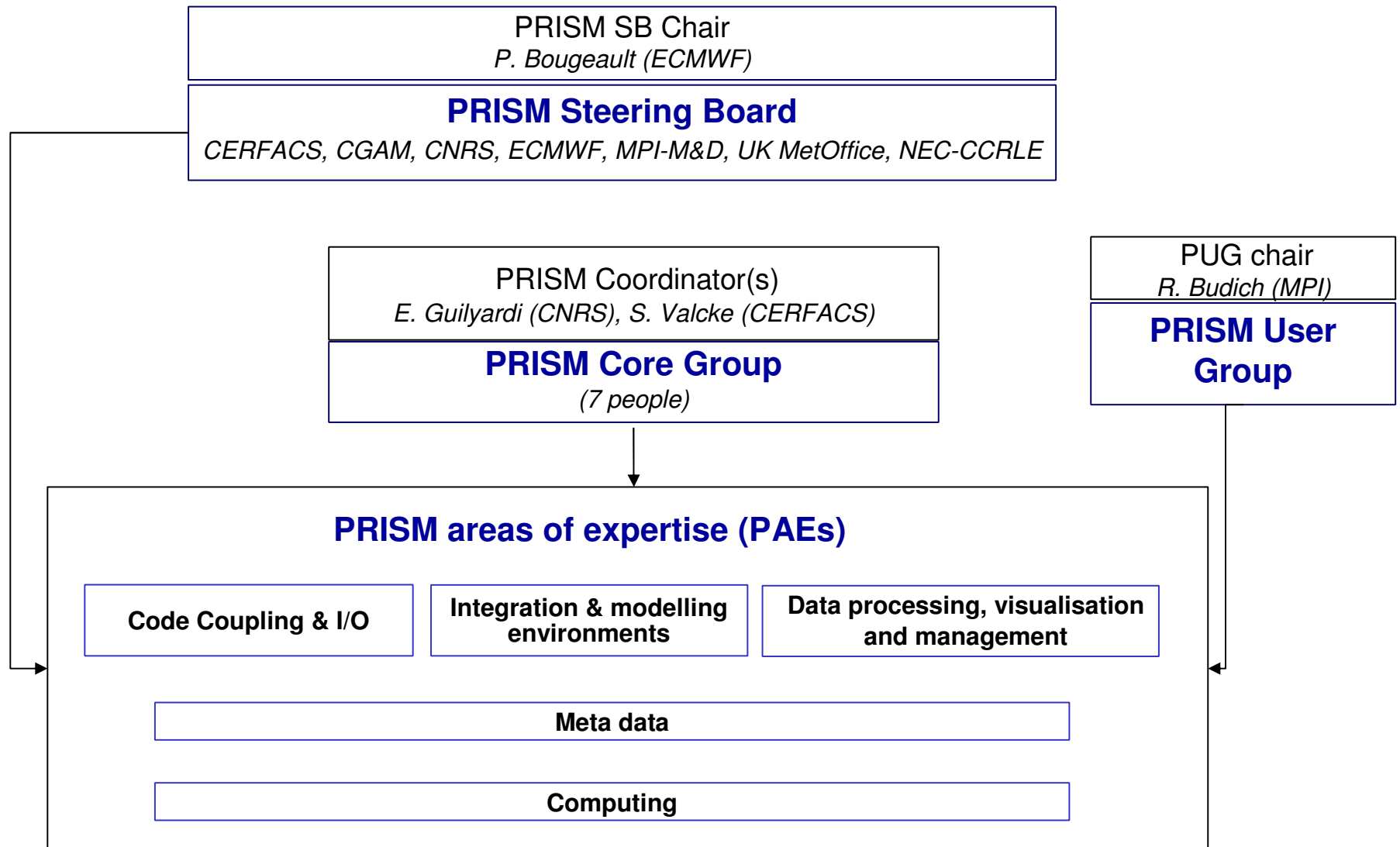


# PRISM: goals

- Increase what Earth system modellers have in common
- Share development and support of these common tools and standards



# PSI: Organisation



# PRISM Areas of Expertise

## PAE Code Coupling and IO

*Leader: S. Valcke (CERFACS)*

- development and support of OASIS3 and OASIS4 couplers
- technology watch on coupling tools developed outside PRISM:
  - PALM coupler (CERFACS)
  - BFG (U. of Manchester)
  - MCT (NCAR)
- relations with projects involving code coupling:
  - UK Met Office FLUME project
  - US ESMF project
  - GENIE project
  - ACCESS

# PRISM Areas of Expertise

## PAE Integration & modelling environments

*Leader: M.Carter (MetOffice)*

- source version control for software development
  - Subversion
- code extraction and compilation
  - FCM (UK MetOffice)
  - PRISM SCE (MPI M&D)
- job configuration & running
  - prepIFS and prepOASIS4 (ECMWF)
  - SMS (ECMWF)
  - PRISM SRE (MPI M&D)

# PRISM Areas of Expertise

## PAE Data processing, visualisation and management

*Leader: M. Lautenschlager (MPI-M&D)*

- data processing, visualization, archiving and exchange for Earth system models
  - NetCDF CF convention
  - CDO (MPI-M)
  - CDAT (PCMDI)
  - CERA-2 data model (World Climate Data Centre, MPI-M&D)
  - MARS (ECMWF)
- networking between geographically distributed archives
  - C3-GRID

# PRISM Areas of Expertise

## PAE Computing

*Leader: M.-A. Foujols (IPSL), R. Redler (NEC-CCRLE)*

- keep computer vendors informed about climate community requirements
- keep Earth system modellers informed about computing evolutions
- computing aspects important for Earth system modelling:
  - file IO
  - algorithmic developments
  - portability (parallel and vector systems)



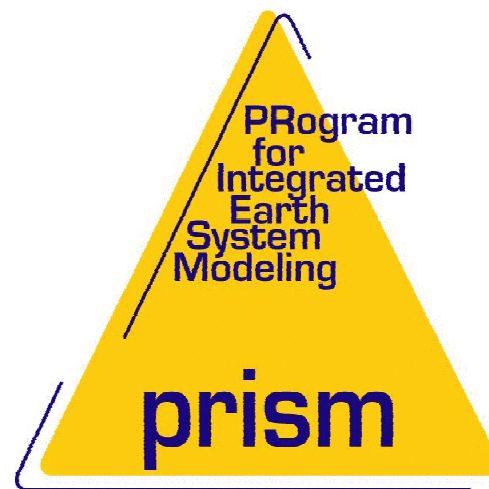
# PRISM Areas of Expertise

## PAE Meta-data

*Leader: L. Steenman-Clark (CGAM)*

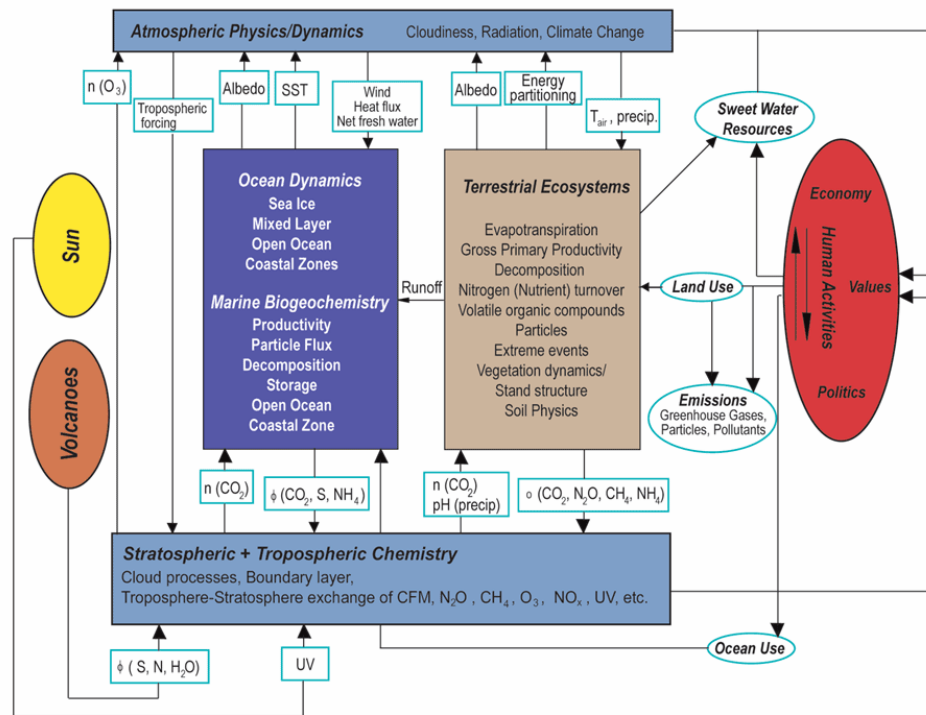
- meta-data: data about data, models, runs, ...
  - ... a hot topic in the last few years
  - exchange and use of data
  - interchangeability of Earth system models or modelling components
  
- forum to discuss, develop, and coordinate metadata issues:
  - Numerical Model Metadata (U. of Reading): numerical code bases, simulations
  - CURATOR project (USA): data, codes, simulations
  - Numerical grid metadata (GFDL, USA): grid
  - NetCDF CF convention (PCMDI and BADC): climate and forecast data files
  - OASIS4 metadata: coupling and IO interface
  - UK Met Office FLUME project: management of model configuration

PRISM website: <http://prism.enes.org/>



# COSMOS: Community Earth System Models

- start in 2003
- join efforts between different research institutes
- towards new scientific goals including modeling of the Earth system



## Targets:

- Integration of knowledge regarding the atmosphere, the ocean, the cryosphere and the biosphere
- Account for the coupling between physical and biogeochemical processes in these components
- Driven by the need to understand large climate variations of the past and to predict future climate changes.

# COSMOS Partners

Appr. 30 Partners from universities, research institutes, industry and other institutions

MPI-MET Hamburg

FMI Helsinki

DKRZ Hamburg

MPI-CHEM Mainz

PMOD/WRC Davos

University Giessen

FZ Juelich

INGV Bologna

FIMR Helsinki

AWI Bremerhaven

UIO Oslo

University Warsaw

FUB Berlin

SMHI Stockholm

PIK Potsdam

DMI Copenhagen

University Helsinki

DLR Wessling

DWD Offenbach

ETH Zuerich

University Karlsruhe

ENEA Rome

BTU Cottbus

NEC HPCE Düsseldorf

NILU Oslo

MPI-BGC Jena

University Köln, ...

COSMOS is open for more partners [see <http://cosmos.enes.org> ]

# COSMOS Organisation

COSMOS is organized in 4 bodies:

**1. Steering committee (SC)**

- general supervision and the planning of resources.

**2. Scientific advisory group (SAG)**

- progress review of working groups

**3. Project coordination**

- Coordination of working groups

**4. Working groups (WGs) [each headed by two co-chairs]**

- development, testing and validation of specific components,

I. Integration

II. Atmosphere: dynamics and physics, chemistry, aerosol

III. Land: hydrology, vegetation, surface exchange

IV. Ocean: dynamics and physics, biogeochemistry

V. Regional modeling

VI. Data: data quality and model validation

VII. Assimilation: methods and tools

# COSMOS Models & Standards

- European **PRISM** project has developed an infrastructure for Earth System Modeling including the coupler **OASIS**.
- Within **COSMOS** a prototype Earth system model is developed based on component models currently available in the participating community.
- **PRISM** structures are used within COSMOS to improve the integration of model components into the system and to avoid multiple developments for identical problems.

# COSMOS model family

## **cosmos-1.0.0** (released Dec. 2006) (IPCC AR4)

- cosmos-a, cosmos-o, cosmos-ao
- PRISM SCE, PRISM SRE, OASIS3

## **cosmos-1.1.0** (under development, release later this year)

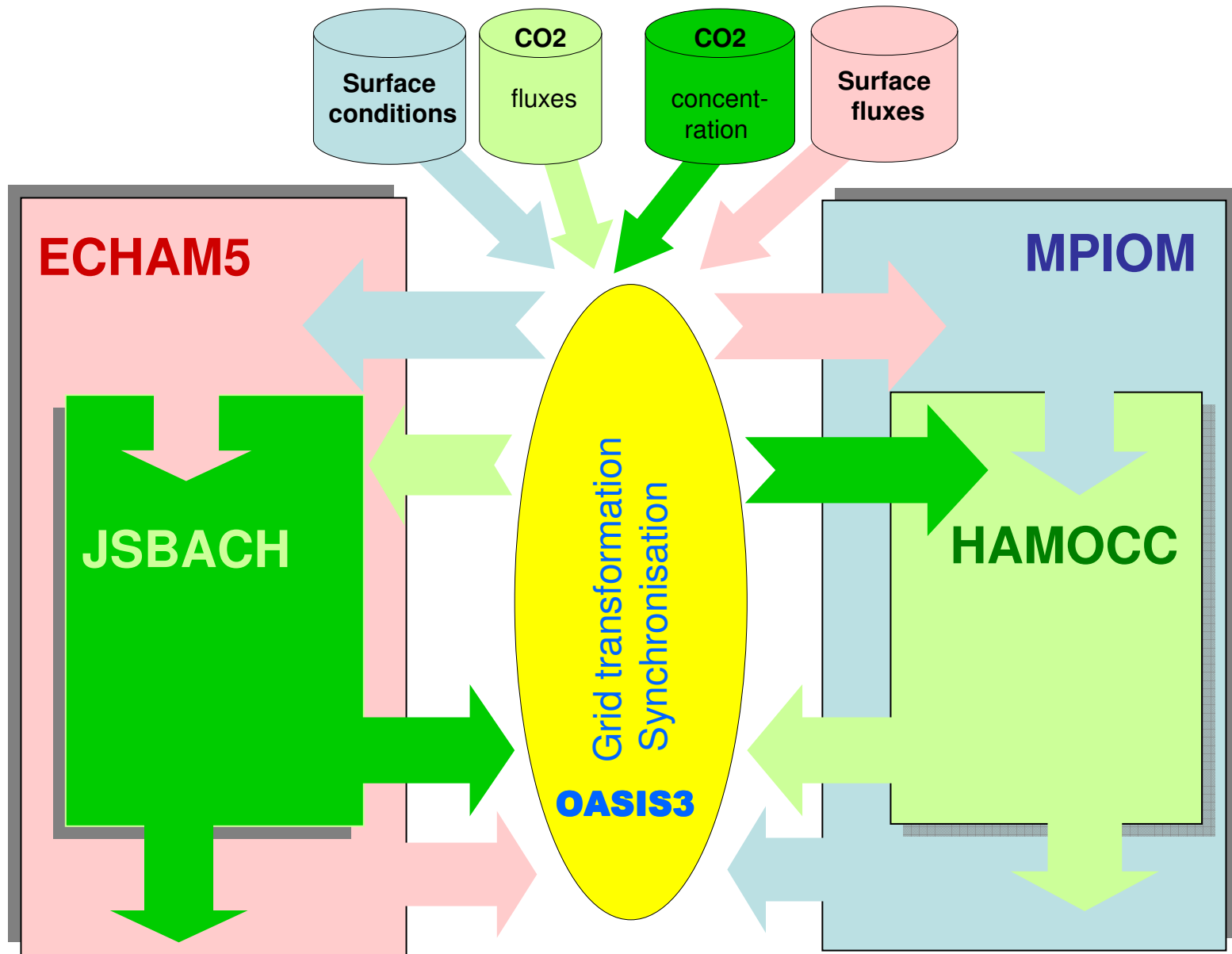
- cosmos-as, cosmos-aob, cosmos-asob, cosmos-aso, cosmos-ob
- PRISM SCE, PRISM SRE, OASIS3

a = atmosphere

s = land surface model

o = ocean

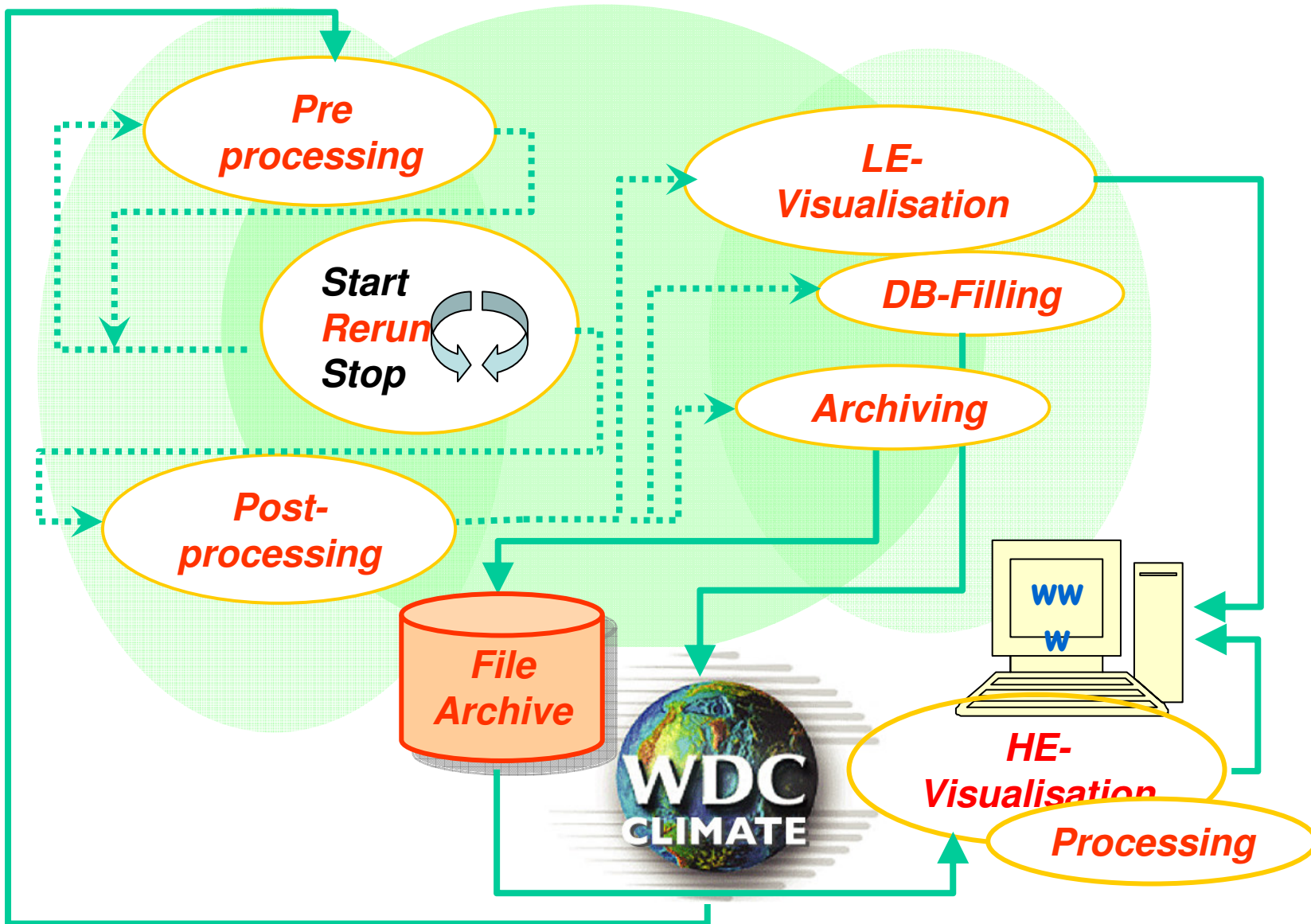
b = ocean biogeochemistry



cosmos-asob



# SRE



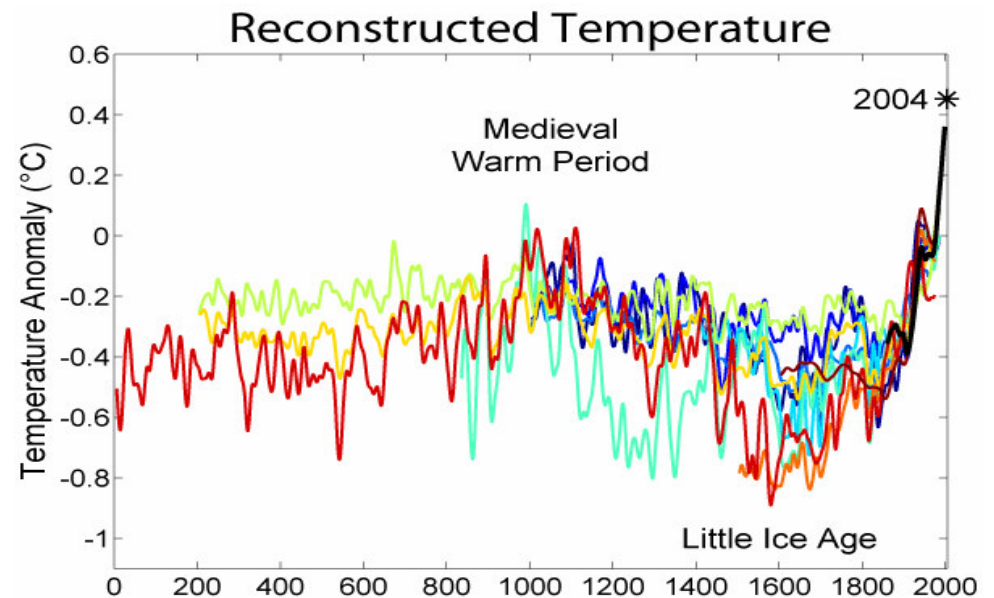
# COSMOS Prototype experiments

## Millennium Project (J. Jungclaus, E. Roeckner)

- Ensemble of 1200 year transient climate experiments with coupled carbon cycle at T63 resolution (cosmos-asob)
- Sensitivity experiments incl. stratosphere (0.1hPa) and reduced “fast” chemistry (ozone, SW bands)

## What drives the century-scale variability?

- solar forcing ?
- volcanism ?
- carbon cycle ?
- internal variability?



# COSMOS contact points

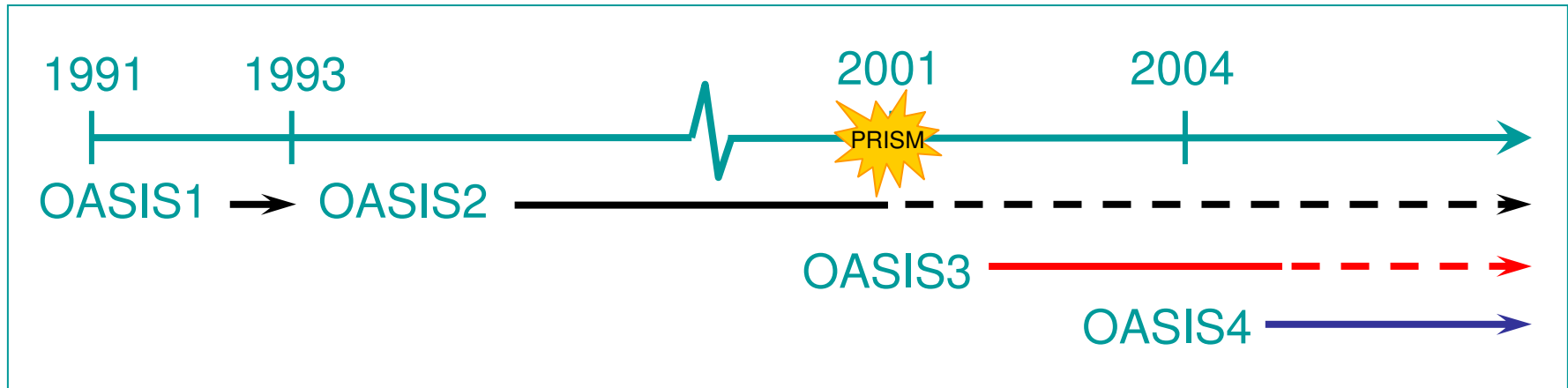
Science: Johann Jungclaus, Erich Roeckner  
Environment: Helmuth Haak, Monika Esch

PRISM SCE and SRE: Stephanie Legutke

# The OASIS coupling software

# OASIS community

OASIS: work started at CERFACS in 1991 to couple existing GCMs



## OASIS1, OASIS2, OASIS3:

low grid resolution, low number of 2D fields, low coupling frequency:

→ flexibility very important, efficiency not so much!

## OASIS4:

high resolution parallel models, massively parallel platforms, 3D fields

→ need to optimise and parallelise the coupler

# OASIS community

## CERFACS (France)

ARPEGE3 - ORCA2-LIM  
ARPEGE4 - NEMO-LIM - TRIP

## METEO-FRANCE (France)

ARPEGE4 - ORCA2  
ARPEGE medias – OPAméd  
ARPEGE3 - OPA8.1 - GELATO

## IPSL- LODYC, LMD, LSCE (France)

LMDz - ORCA2LIM      LMDz - ORCA4

## MERCATOR (France)      (for interpolation only)

## MPI - M&D (Germany)

ECHAM5 - MPI-OM      ECHAM5 - C-HOPE  
PUMA - C-HOPE      EMAD - E-HOPE  
ECHAM5 - E-HOPE

## ECMWF

IFS - CTM (GEMS)      IFS - ORCA2 (MERSEA)

# OASIS community

IFM-GEOMAR (Germany)

NCAS / U. Reading (UK)

SMHI (Sweden)

NERSC (Norway)

KNMI (Netherlands)

INGV (Italy)

ENEA (Italy)

JAMSTEC (Japan)

IAP-CAS (China)

BMRC (Australia)

CSIRO (Australia)

RPN-Environment Canada (Canada)

UQAM (Canada)

U. Mississippi (USA)

IRI (USA)

JPL (USA)

ECHAM5 - NEMO (OPA9-LIM)

ECHAM4 - ORCA2, HADAM3-ORCA2

RCA - RCO

ARPEGE - MICOM

ECHAM5 - TM5/MPI-OM

ECHAM5 - MPI-OM

MITgcm - REGgcm

ECHAM5(T106) - ORCA 1/2°

AGCM - LSM

BAM3 - MOM2, BAM5 - MOM2,

TCLAPS-MOM

Sea Ice code - MOM4

MEC - GOM

GEM - RCO

MM5 - HYCOM

ECHAM5 - MOM3

UCLA-QTCM - Trident-Ind4-Atlantic

# OASIS4 community

## EU project GEMS

- atmospheric dynamic and chemistry coupling
- (see presentation by Johannes Flemming tomorrow 9:00 h)

## SMHI Norrköping

- ocean-atmosphere regional coupling

## UK Met Office

- global ocean-atmosphere coupling (currently prototyping)

## IFM-GEOMAR (Kiel)

- pseudo-models to interpolate high-resolution fields



# OASIS4: general remarks

- Developers: CERFACS, CNRS, NEC CCRLE, NEC HPCE, SGI
- Beta version available (SVN repository)
- Public domain, open source license (LGPL)
- Programming language: Fortran90 and C
- Build upon external libraries and software
  - MPI1 or MPI2
  - NetCDF or parallel NetCDF
  - XMLlib
  - SCRIP interpolation (LANL)
  - mpp\_io (FMS-GFDL)

[oasis4\\_help@lists.enes.org](mailto:oasis4_help@lists.enes.org)

# OASIS4: general remarks

- Flexible, fully parallel and efficient
  - parallel communication
  - parallel interpolation
  - parallel multigrid algorithm for search
- Support for 3D coupling
- Interpolation schemes
  - 2D and 3D nearest neighbour search
  - bi- and trilinear search
  - bicubic search
  - 2D conservative remapping (work in progress)

[oasis4\\_help@lists.enes.org](mailto:oasis4_help@lists.enes.org)

# OASIS4: general remarks

## ➤ Supported grid types

- Block-structured grids
  - Regular grids
  - Horizontally irregular
  - 3D irregular grid
  - Non-geographical grids
- Unstructured grids
  - Gauss-reduced grids

[oasis4\\_help@lists.enes.org](mailto:oasis4_help@lists.enes.org)

# OASIS4: general remarks

## Current developments

- 2D conservative remapping (nearly completed)
- Parallel global search for the interpolation (nearly completed)
- Transformer efficiency
- Full validation of current transformations

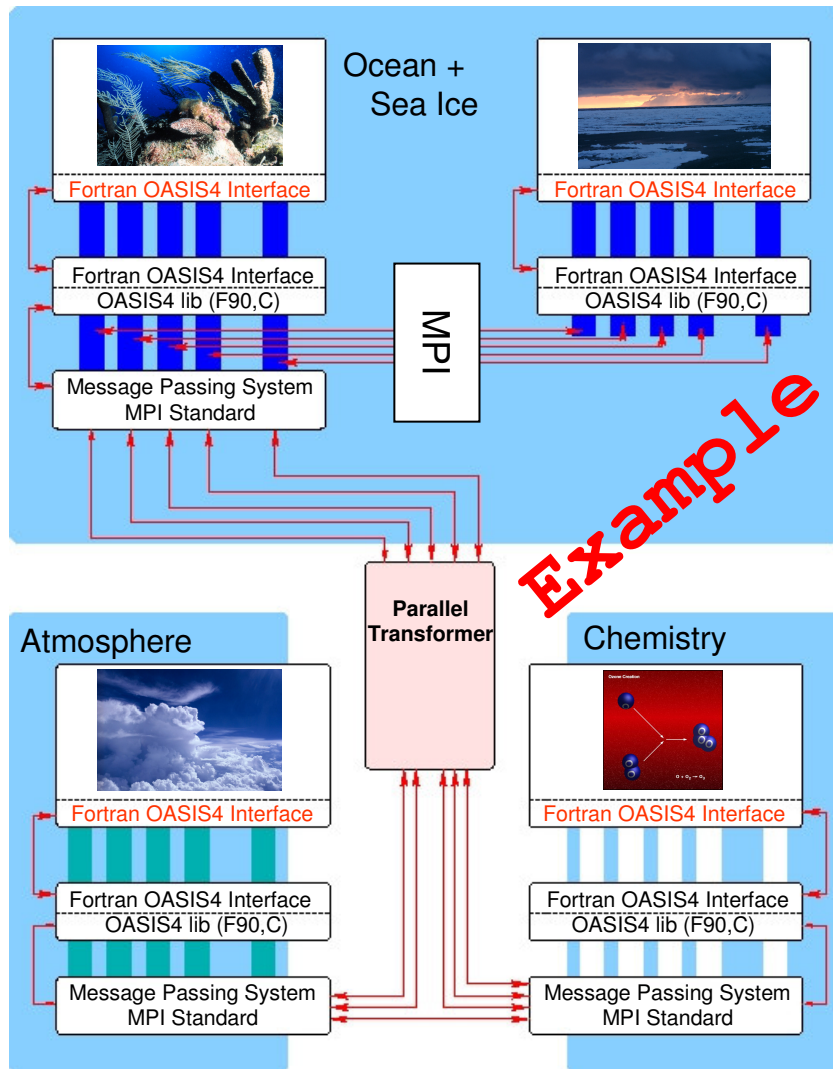
## OASIS4 is regularly tested and run with toy examples

- NEC SX6 and SX8 (NEC SX compilers)
- IBM Power4 (XL Fortran Compiler)
- PC-Linux
  - Portland Group Fortran Compiler Version 6.x
  - Intel Fortran Compiler Version 8.x
  - Absoft Fortran Compiler Version 9.x

## Public version available in 2007

[oasis4\\_help@lists.enes.org](mailto:oasis4_help@lists.enes.org)

# OASIS4 model configuration



Application 1: Ocean Physics and Sea Ice

Application 2: Atmosphere Transport

Application 3: Atmosphere Chemistry

# OASIS4 model configuration

## XML (Extensive Markup Language) input files

### XML schema

- defines the legal content of an XML file
- gives the possibility to check the validity of an XML file

### Specific Coupling Configuration (SCC)

- start date and end date
- applications, components for each application
- host(s), number of processes per host, ranks for each component

### Specific Model Input and Output Configuration (SMIOC) for each component

- grid information: chosen resolution, ...
- coupling fields:
  - name, units, valid min max, numerical type, grid*
  - input and/or output
  - source and/or target (component and/or file)
  - coupling or I/O dates
  - transformations/interpolations/combinations

Linked with international efforts aiming at a standardisation for metadata.

# OASIS4 model adaptation

## ➤ Initialization

call prism\_init\_comp ( **comp\_id**, comp\_name, err )

## ➤ Definition of grid (3D)

call prism\_def\_grid ( **grid\_id**, grid\_name, **comp\_id**, ... )

call prism\_set\_corners ( **grid\_id**, ..., "corner data", ... )

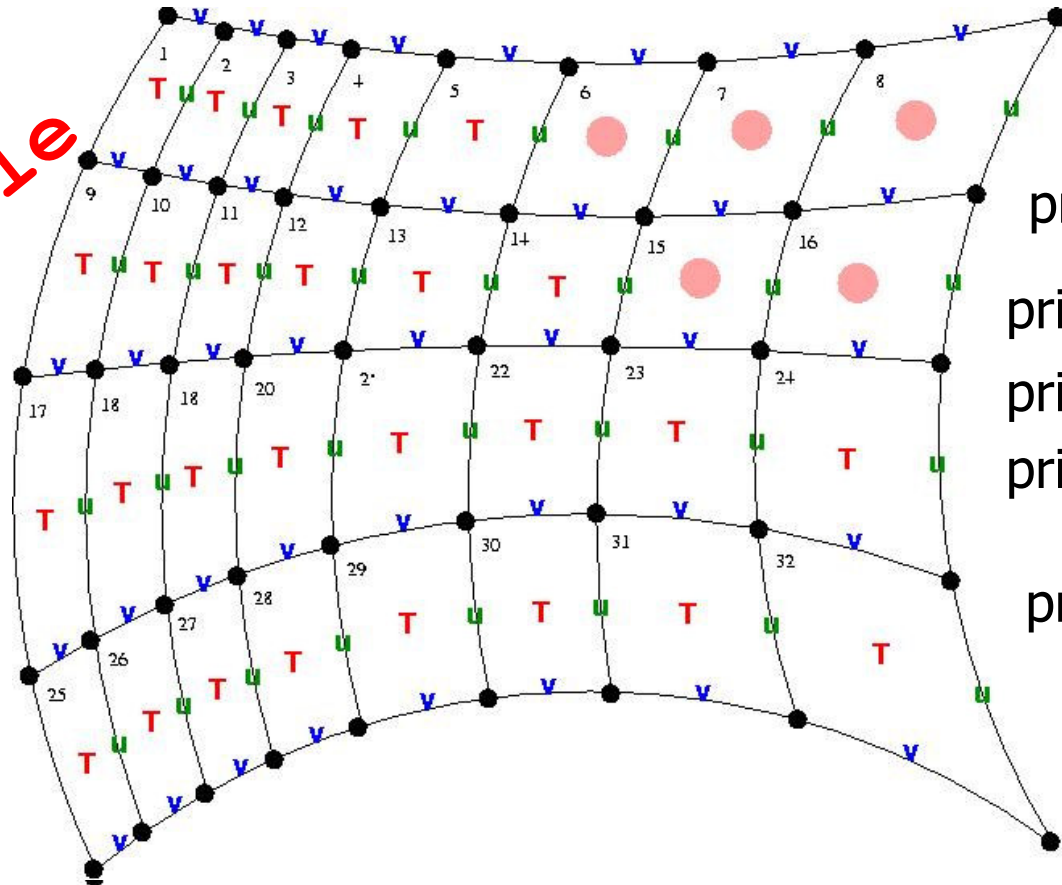
## ➤ Placement of scalar points and mask on the grid

call prism\_set\_points ( **point\_id**, point\_name, **grid\_id**, "point data", ... )

call prism\_set\_mask ( **mask\_id**, **grid\_id**, "mask data", ... )

# OASIS4 model adaptation

**Example**



prism\_def\_grid

prism-set-corners

prism\_set\_points

prism\_set\_points

prism\_set\_points

prism\_set\_mask



# OASIS4 model adaptation

## ➤ Coupling or I/O field declaration

call prism\_def\_var ( **var\_id**, var\_name, **grid\_id**, **point\_id**, **mask\_id**, ... )

## ➤ End of definition

call prism\_enddef (ierror)

## ➤ Coupling or I/O field sending and receiving

- in model time stepping loop

call prism\_put (**var\_id**, date, date\_bounds, DATA, info, ierr)

call prism\_get (**var\_id**, date, date\_bounds, DATA, info, ierr)

- depending on user's specifications in SMIOC:
  - user's defined source or target, component or file (end-point communication)
  - coupling or I/O sending or receiving at appropriate times
  - averaging/accumulation

For further information

<http://prism.enes.org>

<http://cosmos.enes.org>

[http://prism.enes.org/PAEs/coupling\\_IO.php](http://prism.enes.org/PAEs/coupling_IO.php)