The PRISM Support Initiative, COSMOS and OASIS4

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… 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

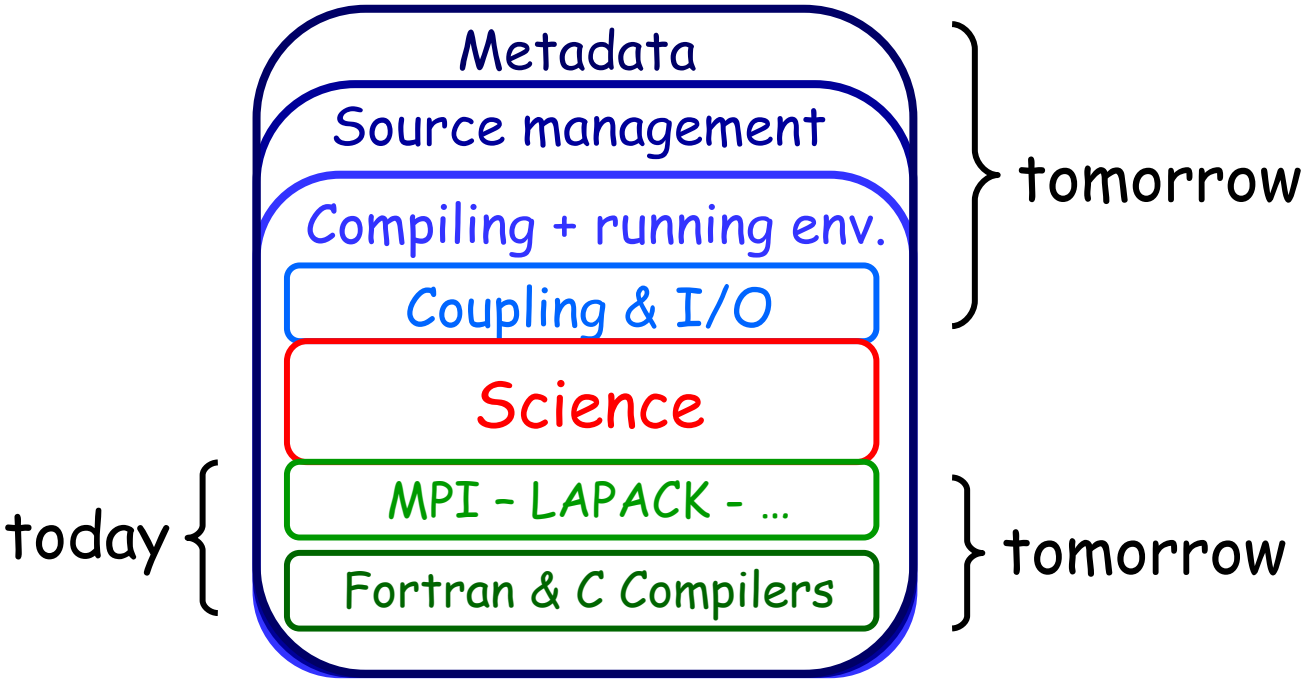
    CERFACS
    CNRS
    CGAM
    UK MetOffice
    MPI-M&D
    NEC-CCRLE
    ECMWF

  - 9 associated partners

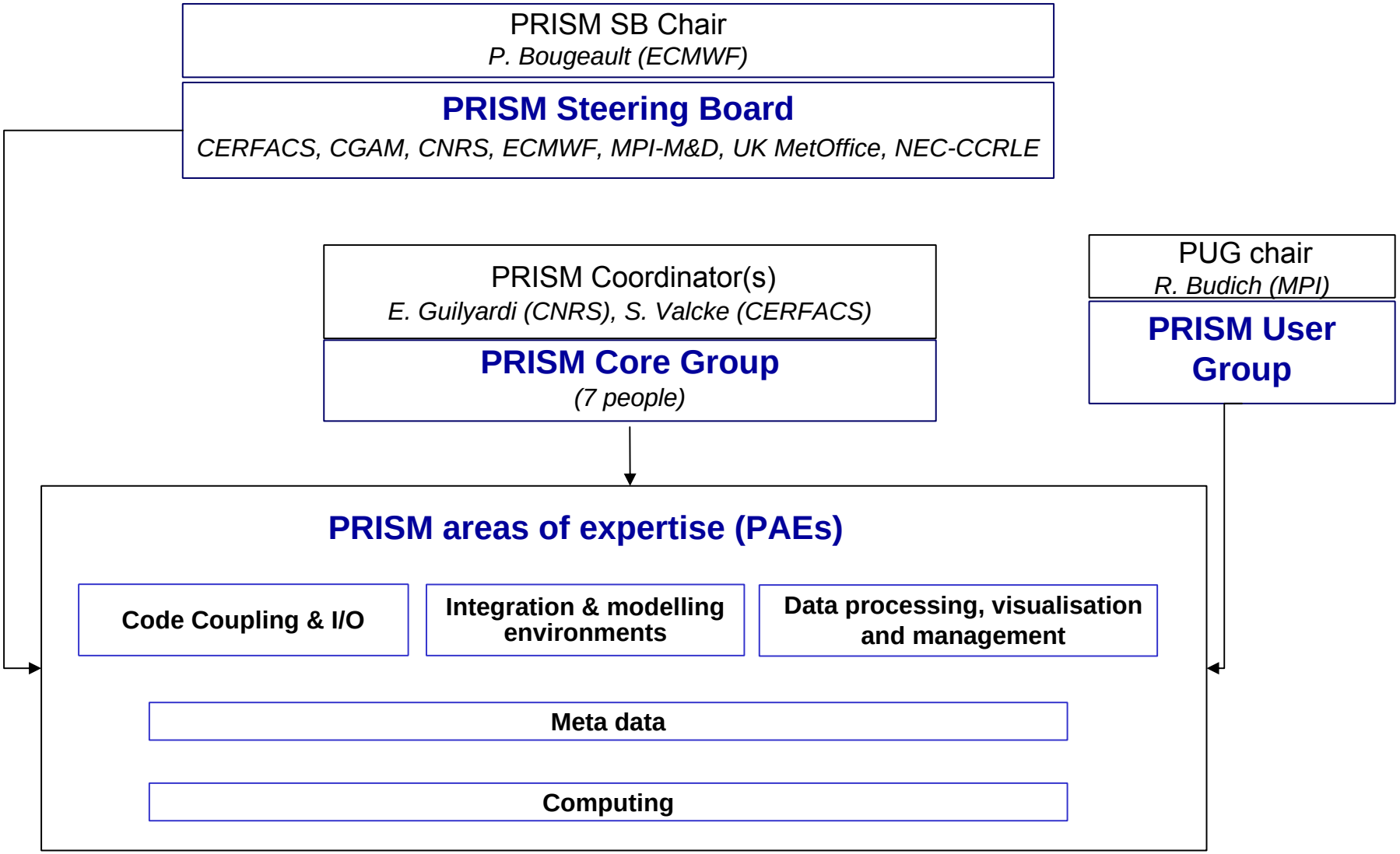
    CSC
    IPSL
    Météo-France
    SMHI
    MPI-M
    CRAY
    SUN
    SGI
    NEC-HPCE

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)***

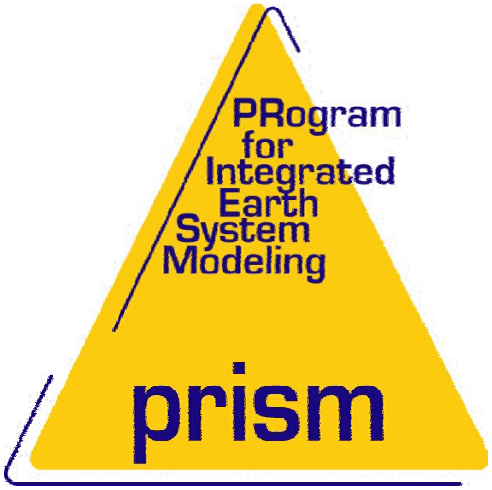
- keep computer vendors informed about climate community requirements
- keep Earth system modellers informed about computing evolutions
- computing aspects important for Earth system modelling:
  - file IO
  - algorithmic developments
  - portability (parallel and vector systems)

PRISM Areas of Expertise

PAE Meta-data *Leader: L. Steenman-Clark (CGAM)*

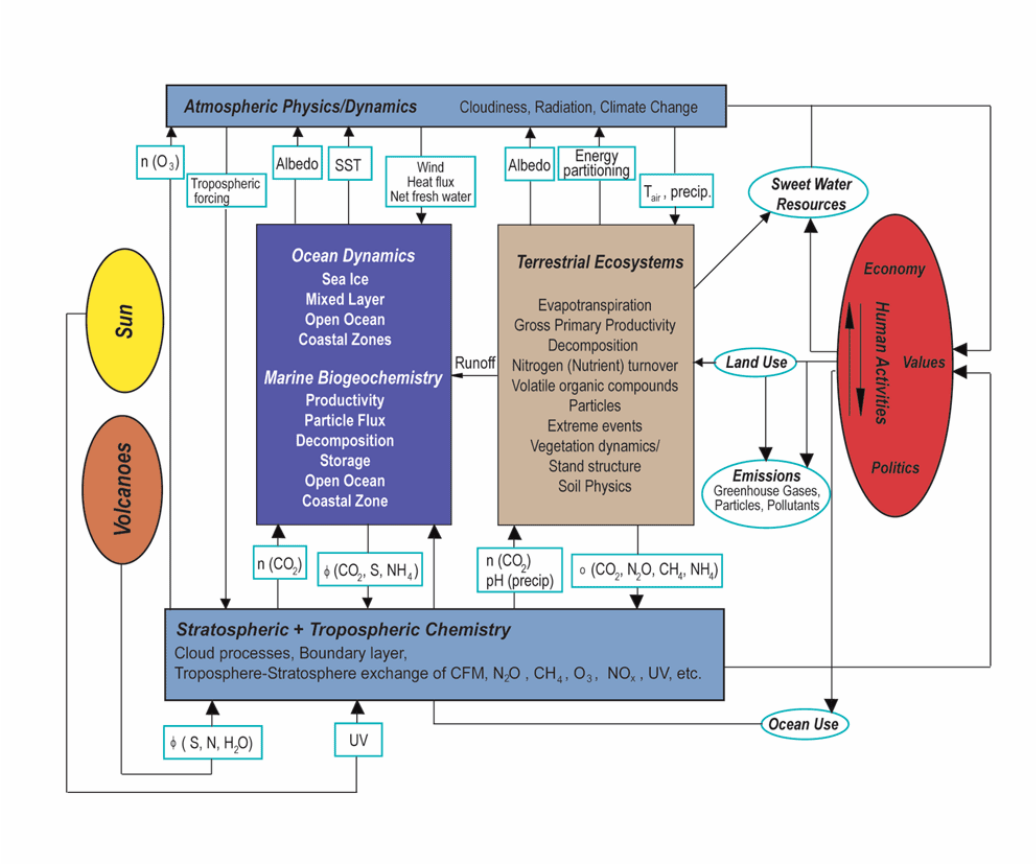
- meta-data: data about data, models, runs, ...
  … a hot topic in the last few years
  - exchange and use of data
  - interchangeability of Earth system models or modelling components
- forum to discuss, develop, and coordinate metadata issues:
  - Numerical Model Metadata (U. of Reading): numerical 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)

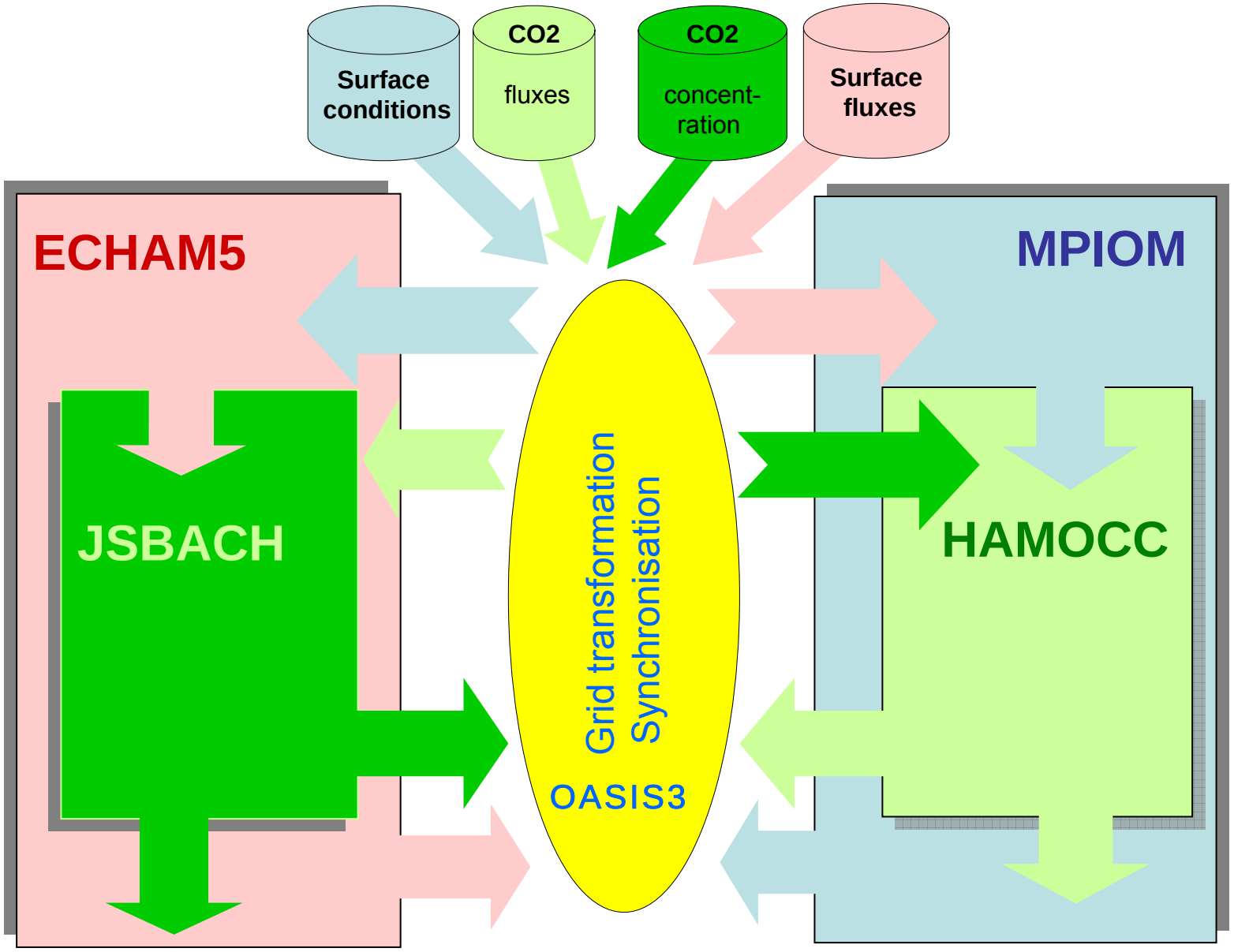
- cosmos-as, cosmos-aob, cosmos-asob, cosmos-aso, cosmos-ob
- PRISM SCE, PRISM SRE, OASIS3

a = atmosphere

s = land surface model

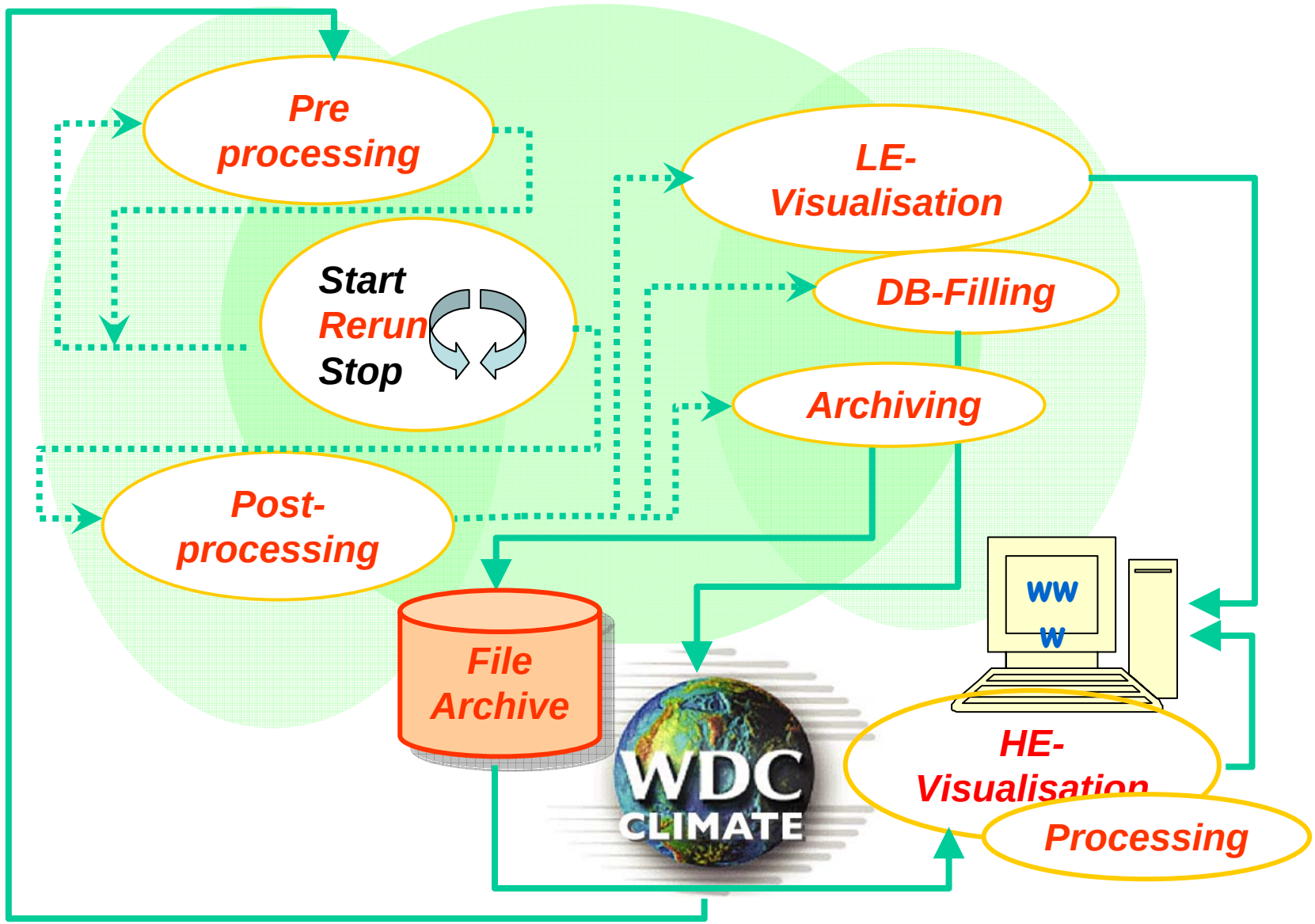
o = ocean

b = ocean biogeochemistry


Surface conditions
CO2 fluxes
CO2 concent-ration
Surface fluxes
ECHAM5
JSBACH
Grid transformation
Synchronisation
OASIS3
MPIOM
HAMOCC

cosmos-asob

SRE


Pre processing
Start
Rerun
Stop
LE-Visualisation
DB-Filling
Archiving
Post-processing
File Archive
WDC CLIMATE
ww w
HE-Visualisation
Processing

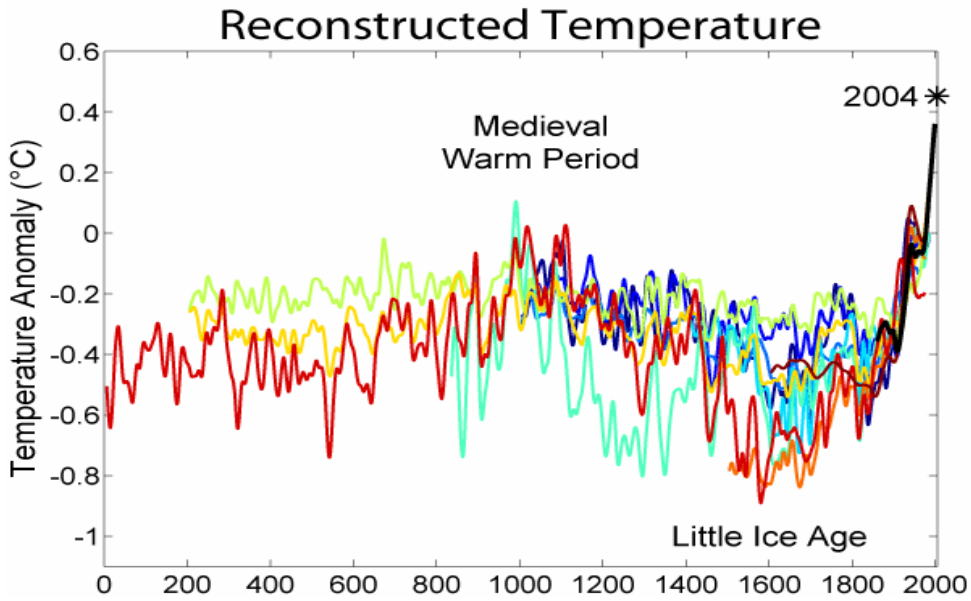
COSMOS Prototype experiments

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?



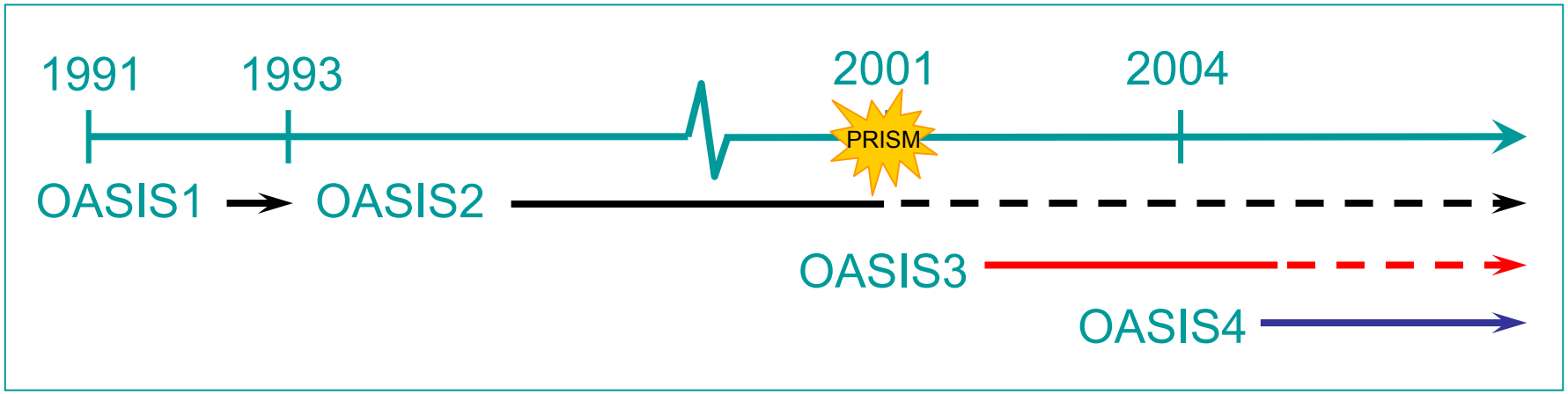
COSMOS contact points

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 – OPAmed

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)	ECHAM5 - NEMO (OPA9-LIM)
NCAS / U. Reading (UK)	ECHAM4 - ORCA2, HADAM3-ORCA2
SMHI (Sweden)	RCA - RCO
NERSC (Norway)	ARPEGE - MICOM
KNMI (Netherlands)	ECHAM5 - TM5/MPI-OM
INGV (Italy)	ECHAM5 - MPI-OM
ENEA (Italy)	MITgcm - REGgcm
JAMSTEC (Japan)	ECHAM5(T106) - ORCA ½°
IAP-CAS (China)	AGCM - LSM
BMRC (Australia)	BAM3 - MOM2, BAM5 - MOM2, TCLAPS-MOM
CSIRO (Australia)	Sea Ice code - MOM4
RPN-Environment Canada (Canada)	MEC - GOM
UQAM (Canada)	GEM - RCO
U. Mississippi (USA)	MM5 - HYCOM
IRI (USA)	ECHAM5 - MOM3
JPL (USA)	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

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)

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OASIS4: general remarks

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

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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

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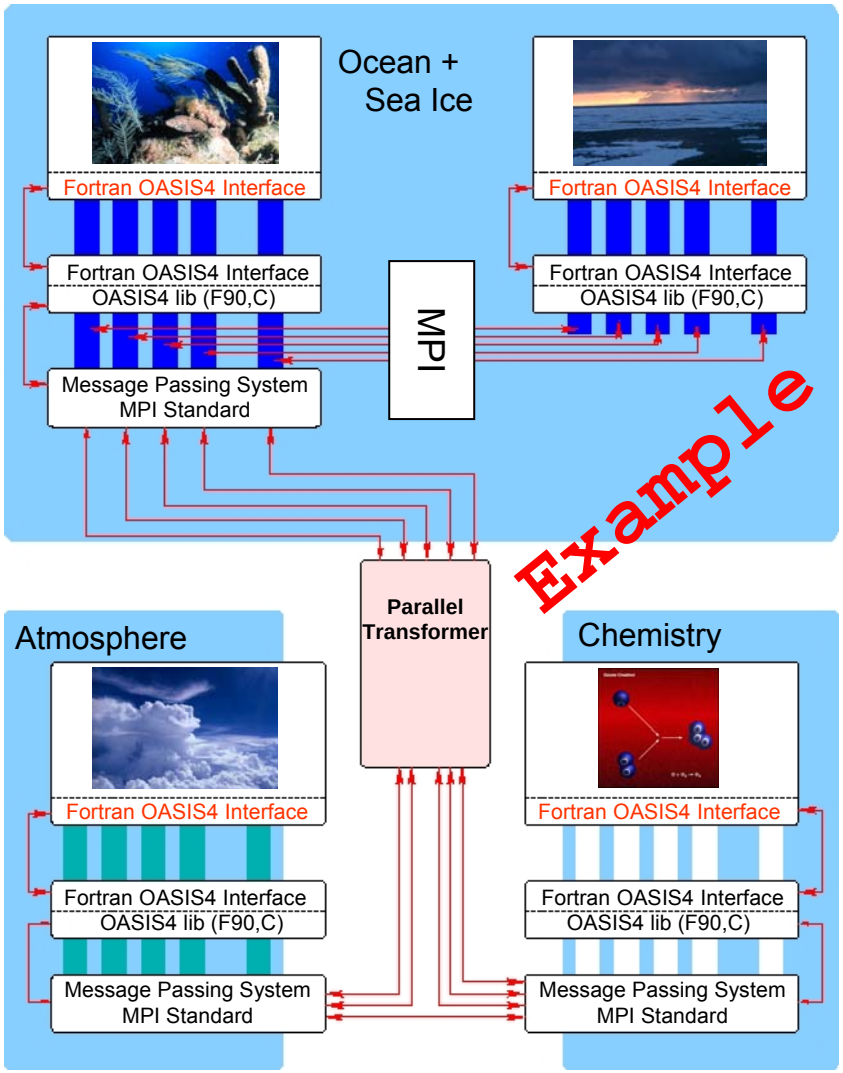
OASIS4 model configuration



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/combination

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”, …)

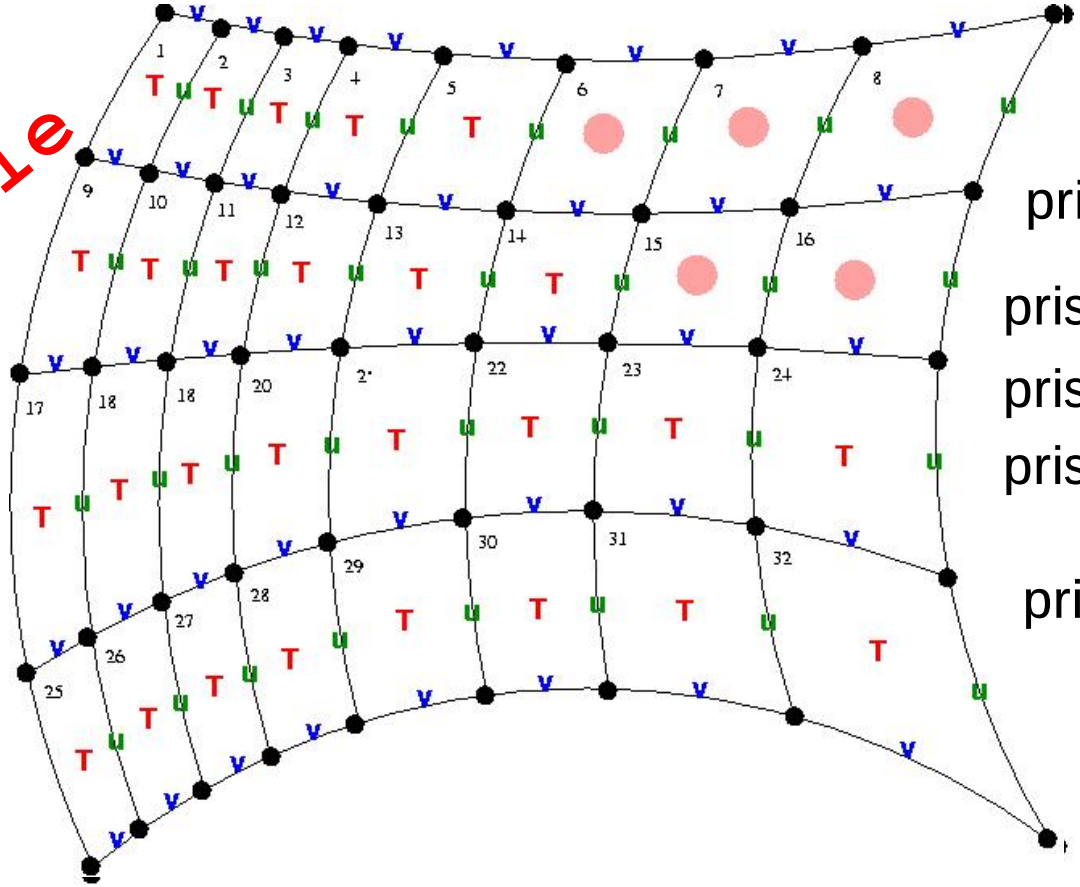
- Placement of scalar points and mask on the grid

  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