The PRISM Software Infrastructure:
Achievements and Next Steps
Outline

• Introduction: Background and Drivers
• PRISM Software Infrastructure
  – Requirements & Ideas
  – Overview
  – Availability
• Future Work
Introduction: Background
Introduction: Background

→ Earth system modeling expertise widely distributed
  → Geographically
  → By subject
Introduction: Background

The development of climate models over the last 25 years showing how the different components are first developed separately and later coupled into comprehensive climate models (IPCC WG1, 2001)
Introduction: Background

**Earth system modeling expertise widely distributed**
- **Scientific motivation:**
  - facilitate sharing of scientific expertise
  - the sharing of models
- **Technical motivation**
  - the technical challenges are large compared with available resource
Introduction: Background

The Earth System
Unifying the Models

Climate / Weather Models

Ocean Models

Atmosphere Models

Land Surface Models

Terrestrial Biosphere Models

Hydrology Process Models

Water Cycle

Carbon Cycle

The Predictive Earth System

Natural Hazard Prediction

Solid Earth Models

Megaflops
Gigaflops
Teraflops
Petaflops

"Courtesy of the Jet Propulsion Laboratory, California Institute of Technology"
Introduction: Background

Earth system modeling expertise widely distributed

- Scientific motivation: facilitate sharing of scientific expertise
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Introduction: Background

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  - facilitate sharing of scientific expertise
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→ Need to keep scientific diversity

"Courtesy of the Jet Propulsion Laboratory, California Institute of Technology"
Introduction: ... and Drivers
Introduction: ... and Drivers

Earth system modeling expertise widely distributed
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→ Need to keep scientific diversity

→ At the same time increase efficiency
  → Scientific
  → Technical
PRISM: Requirements & Ideas

- Program for integrated Earth System Modelling
  - 22 partners
  - 3 Years, from Dec 2001 - Nov 2004
  - 5 Mill. funding, FP5 of the EC
  - Coordinators: G. Brasseur and G. Komen

To make life of Earth System Modellers easier
PRISM: Requirements & Ideas

« Share Earth System Modelling software infrastructure across community »

• Methods:
  • Share development, maintenance and support
  • Gain performance, coop with manufacturers
  • Standardize modeling software environment
  • Alleviate use of different climate component models
Software structure of an Earth System Model

Running environment

Coupling infrastructure

Scientific core

Supporting software

Share
PRISM: The long term view

Towards standard ESM support library(ies)

Today
- Earth System model (Science + support + environment)
- Fortran Compiler
- Hardware

Tomorrow
- Climate science work
- Earth System model (Science)
- Standard support Library (incl. Env.)
- Fortran Compiler
- Hardware

Modeller
IT expert
PRISM: The People

Reinhard Budich - MPI, Hamburg
Andrea Carril - INGV, Bologna
Mick Carter - Hadley Center, Exeter
Patrice Constanza - MPI/M&D, Hamburg
Jérome Cuny - UCL, Louvain-la-Neuve
Damien Declat - CERFACS, Toulouse
Ralf Döscher - SMHI, Stockholm
Thierry Fichefet - UCL, Louvain-la-Neuve
Marie-Alice Foujols - IPSL, Paris
Veronika Gayler - MPI/M&D, Hamburg

Eric Guilyardi - CGAM, Reading and LSCE
Rosalyn Hatcher - Hadley Center, Exeter
Miles Kastowsky - MPI/BCG, Iena
Luis Komblueh - MPI, Hamburg
Claes Larsson - ECMWF, Reading
Stefanie Legutke - MPI/M&D, Hamburg
Corinne Le Quéré - MPI/BCG, Iena
Angelo Mangili - CSCS, Zurich
Anne de Montety - UCL, Louvain-la-Neuve
Serge Planton - Météo-France, Toulouse
Jan Polcher - LMD/IPSL, Paris
René Redler, NEC CCRLE, Sankt Augustin
Martin Stendel - DMI, Copenhagen
Sophie Valcke - CERFACS, Toulouse
Peter van Velthoven - KNMI, De Bilt
Reiner Vogelsang - SGI, Grasbrunn
Nils Wedi - ECMWF, Reading
PRISM: An Overview

Expected Benefits:

- Easier to assemble ESMs based on community models
  - High performance ESM software
    - Developed by dedicated IT experts
    - Available to institutes/teams at low cost
  - To help scientists to focus on science
  - To help keep scientific diversity
    ⇒ Higher scientific output
    ⇒ Survival of smaller groups

- Increased scientific exchanges through shared infrastructure

- Computer manufacturers help to
  - Gain efficiency (porting, optimization) on their platforms
  - Next generation platforms influenced by ESM needs
  - Easier procurements and benchmarking
  - Reduced computing costs
PRISM: Framework Shells

- Outer shells
- Standard Running Environment
- Standard Compile Environment
- PSMILE (coupling and I/O)
- Scientific core
- Inner shell
- Historic I/O
- Platforms A, B, C
PRISM: Adapting Earth System Component Models

PRISM Model Interface Library
Potential Model IO Description
Levels of adaptation

User Interface

PSMILe + PMIOD

SRE
SCE
Configuration Management and Deployment

SCE

User Interface

Driver

Transf.

disks

Binary executables

SRE
Data Processing and Visualization

PRISM Archive, Data Processing and Visualisation Architecture

Graphical User Interface
- Job definition including diagnostic and archive requirements

Low-End Data Access and Visualisation Interface
- Remote Access

High-End Data Access and Visualisation Interface (04b5, 04b7)
- Visualisation Packages (04a5, 04a7) - Low and high end visualisation

Coupled Model
- Made up of individual models and the coupler, includes "integrated data processing" of data and persistent data interface for outputs

Run Shell Data Processing

Archive Interface (04a4)

IO Library (04a1, 04a3)
- Output of data, input of ancillaries, etc.

Data Repository
- Active archive

Job Flow and Run Shell (SMS)

Shared Processing Library
- For
  - Post processing toolkit
  - Run Shell Data Processor
## Demonstration experiments

### Platforms

<table>
<thead>
<tr>
<th>Platform</th>
<th>NEC SX6</th>
<th>SGI IRIX64</th>
<th>Fujitsu VP5800</th>
<th>IBM Power 4</th>
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</thead>
<tbody>
<tr>
<td>Assembled</td>
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<tr>
<td>Coupled models</td>
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<td>OASIS3 toy coupled models</td>
<td>Andrea Carli by INGV</td>
<td>Peter van Velthoven and Primo Altamade by KNMI + Reiner Vossiek by DWD</td>
<td>Serge Planat and Karine Maynard by MeteoFrance + Jean Laterns by FSG</td>
<td>Luis Kambalov by MPI-MET</td>
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<tr>
<td>ECHAM5 + MPI-OM</td>
<td>Andrea Carli by INGV</td>
<td>Peter van Velthoven and Odile de Marteau by KNMI + Reiner Vossiek by DWD</td>
<td>Jean Laterns by FSG + Andrea Carli by INGV</td>
<td>Luis Kambalov and Noel Kastenside by MPI-MET + Hanne Theilade by MPI-MET + Nina Weidt by EUCORE + Angelo Manghi and Francesco Berressem by ESCC (OPEN HOUSE)</td>
</tr>
<tr>
<td>ECHAM5 - ORCA-LIM (ice-ocean turned on)</td>
<td>Andrea Carli by INGV</td>
<td>Thomas Schimansky by NGR + Serge Planat by MétéoFrance</td>
<td>No human resources</td>
<td>Serge Planat and Karine Maynard by MétéoFrance + Sophie Woycke by GERBEACR + Claire Levy by IRSL + Jean Laterns by FSG</td>
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<td>HadAM3 (SRES) + ORCA-LIM (ice-ocean turned off)</td>
<td>Jeff Gise by GCMAM</td>
<td>No human resources</td>
<td>Jean Laterns by FSG + Armand Côté by UOMM</td>
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PRISM: Availability

• PRISM has delivered
  - A tool box
  - A network of expertise and
  - Demonstration runs

• Community acceptance is growing
## PRISM: Availability

### PRISM software:
- Coupler
- Interface libraries
- SCE, SRE
- Vis.- and anal.-tools
- ...

### PRISM Framework:
- PRISM software +
- Component Models
- Graphical User Interface
- ...

... will be available under an Open Source License for Earth System research purposes

... will be available under the resp. licenses of the components for Earth System research purposes at no cost within Europe

... Maintained by CERFACS, ECMWF, IPSL, MetOffice, MPI-Met, Manufacturers, and others
Collaboration

- **ESMF** (supporting software, PMIOD, MOM4)
- **FLUME** (PRISM framework)
- PCMDI (visualisation, PMIOD)
- CF group (CF names)
- NERC (BADC & CGAM) (data, PMIOD)
- M&D, MPI (data)
- Earth Simulator (install PRISM system V.0)
Future Work

- Key need for sustainment:
  - Tool box needs to be
    - Maintained
    - Developed
    - Kept open for new features
  - Network of expertise

- Key need for development:
  - Tool box needs to be extended for
    - Assimilation
    - Data Management
    - Further Modularisation
    - ...

Institutional Funding

Third Party Funding
PRISM: Sustainment

Distributed Team needs to
1. **Co-ordinate**
   - Improvement
   - Maintenance
   - User support

   Of/for current PRISM framework for the benefit of the Earth system modelling community

2. **Support**
   - Adaptation of more component models to PRISM technical standards
   - Installation of PRISM framework at additional computing sites
   - Usage of PRISM framework

3. **Prepare for the future**
   - Seek additional funding
   - Propose evolution, adaptation and development strategies

   • avoid divergence
   • organize benefits from PRISM communities expertise
PRISM: Sustainment

• Tasks for the Team:
  – Management
    • Coordination
    • Interface to Community, Outreach
    • Funds
  – Technical
    • Productise framework
    • Maintenance, improvement and QC
    • ß-Testing
    • Services (Repository, Users, Training etc.)
PISM: Sustainment

• What it takes:
  - Up to 7 people in first phase
  - Consortium Agreement
    • (3 yrs, renewal 1 yr)
  - Management structure
    • Avoid prevalence of single institution
    • Ensure involvement of user community
    • Usage of existing structures where possible

• Available already:
  - Interest from many institutions
    • CERFACS, ECMWF, Met Office, M&D, NCAS, NEC-CCRLE, CNRS, IBM, SGI, Fujitsu, MPI, Météo-France, UCL, INGV, SMHI, KNMI, University of Berlin
  - Commitment from some ...
PRISM: Sustainment

• Next steps:
  – Meeting this week in Paris for further discussion
  – Consideration of new applications for funding
The End

- Thank you!
- Questions?

http://prism.enes.org
budich@dkrz.de
Prozess - Sicht

Collect & Install
Web Portal
CVS, PRISM Sites

Parameterize & Compile
Prepare Experiment
Scripts / PrepIFS

Post - process & Visualize
Low-and High-End Graphics Packages;
Common data model

Execute & Control
Standard Scripting Environment
SMS: Schedule, Monitor, Supervise

Comp. Models
& Compiler

SCE