



esiwace

CENTRE OF EXCELLENCE IN SIMULATION OF WEATHER
AND CLIMATE IN EUROPE

Joachim Biercamp
(Deutsches Klimarechenzentrum (DKRZ))

& the ESIWACE partners

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MISSION:

**Join weather and climate communities
to provide support, training, services
for efficient Earth System Modelling *)
using High Performance Computing**

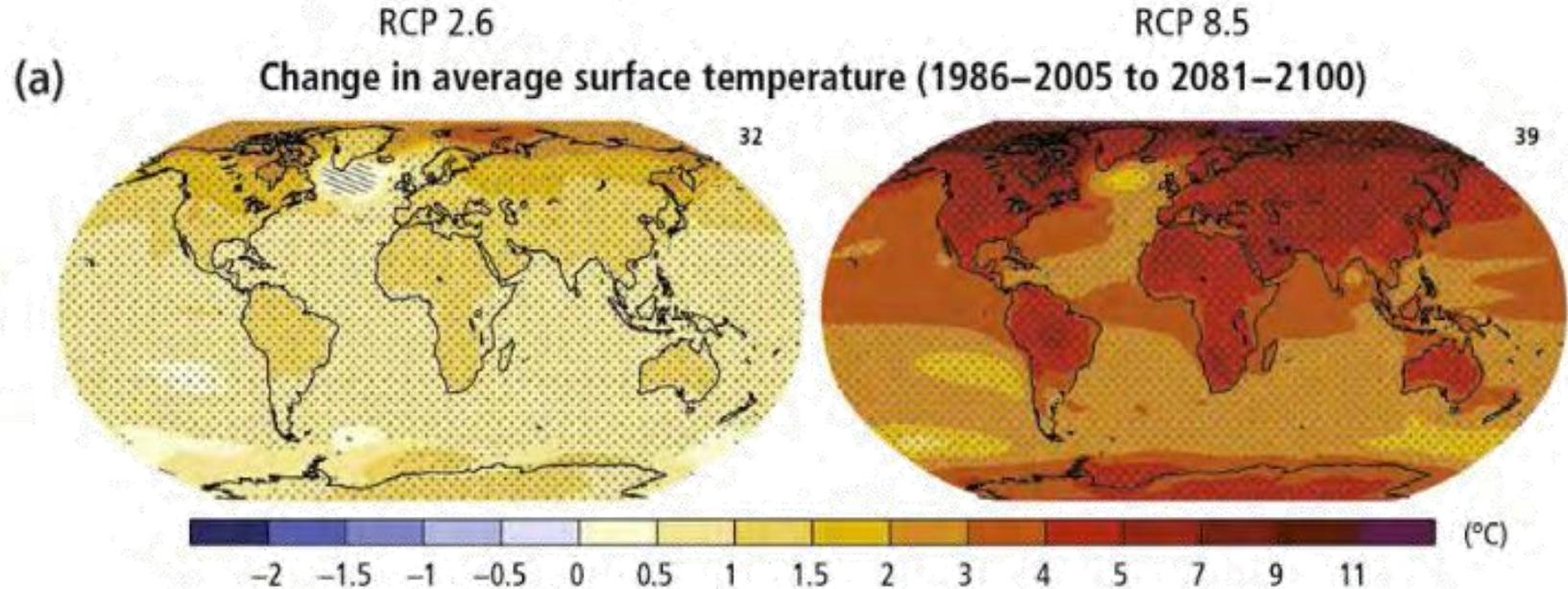
*) We are using the term „Earth System Modelling“ (ESM) as short for „Earth System Modelling for weather and climate science“.



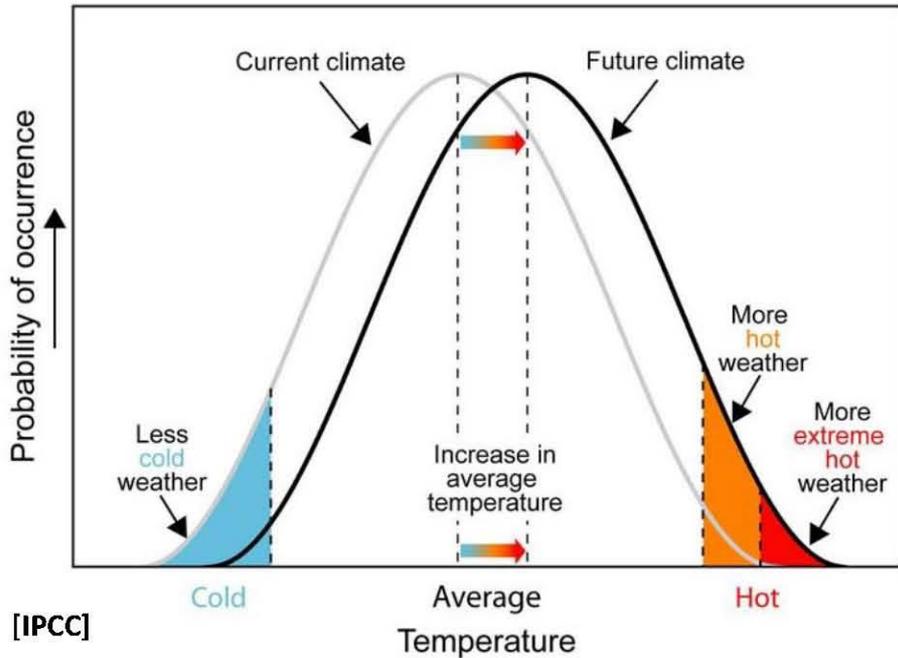
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Rational



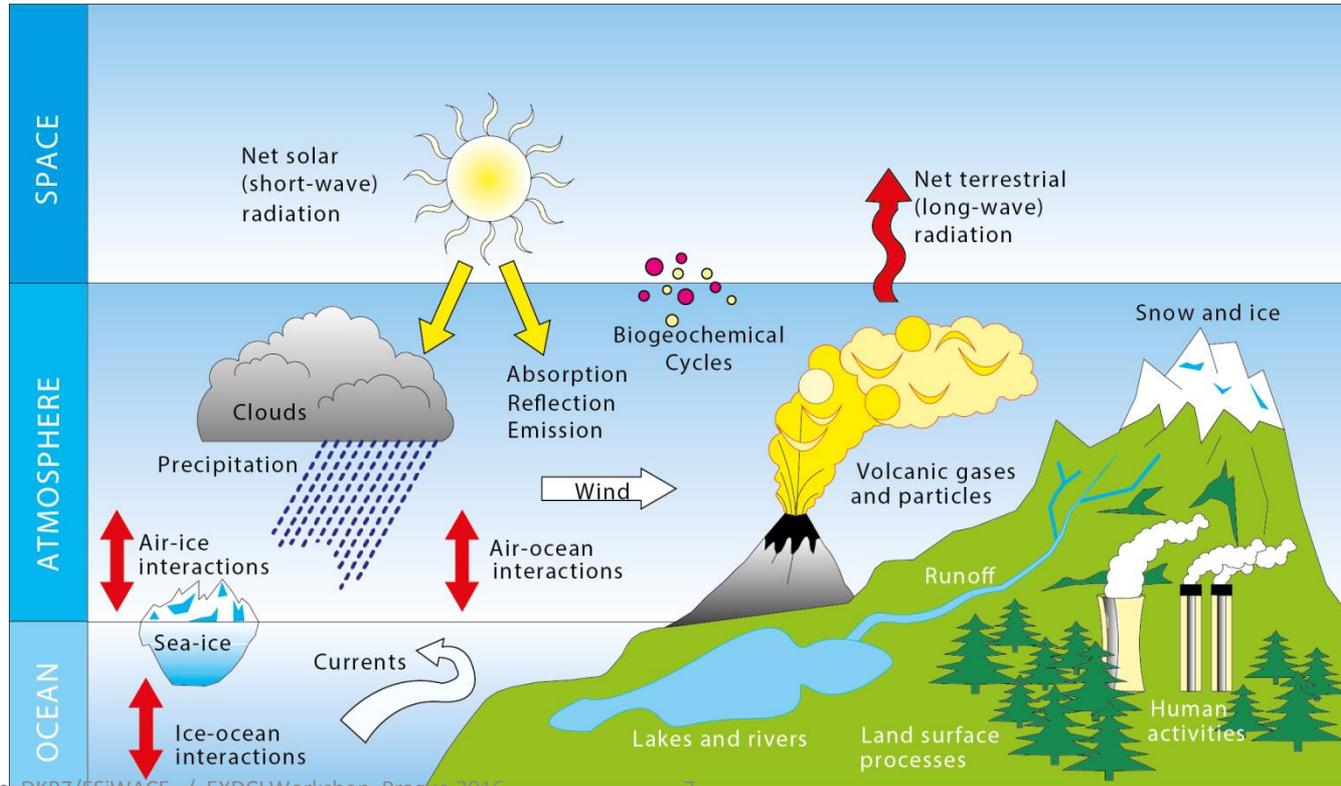
Changing the climate changes weather



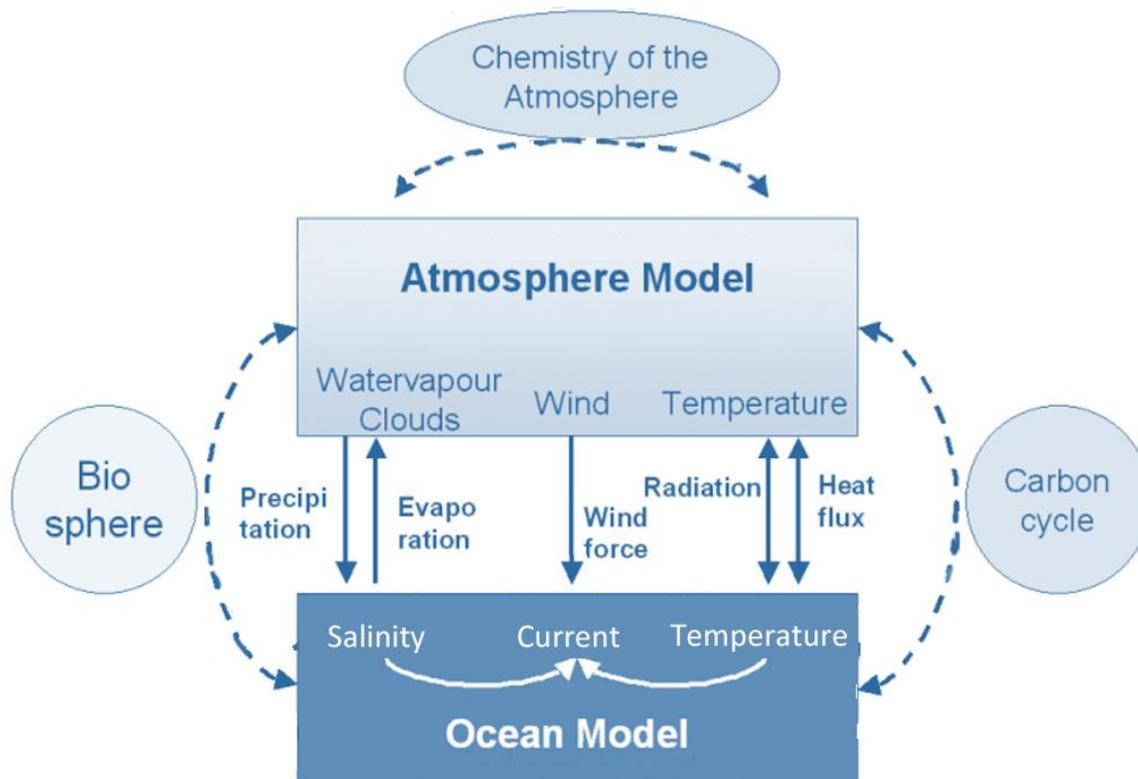
[IPCC]

Application

The “Earth System” as seen by climate and weather modelers

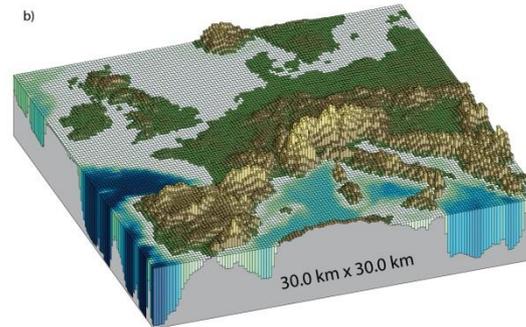
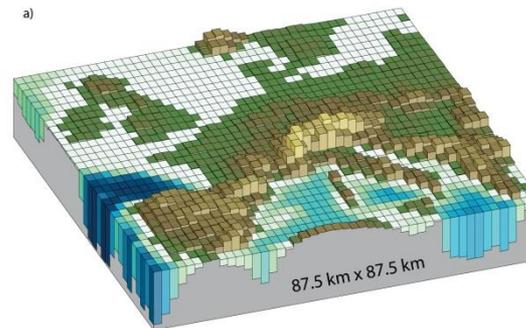
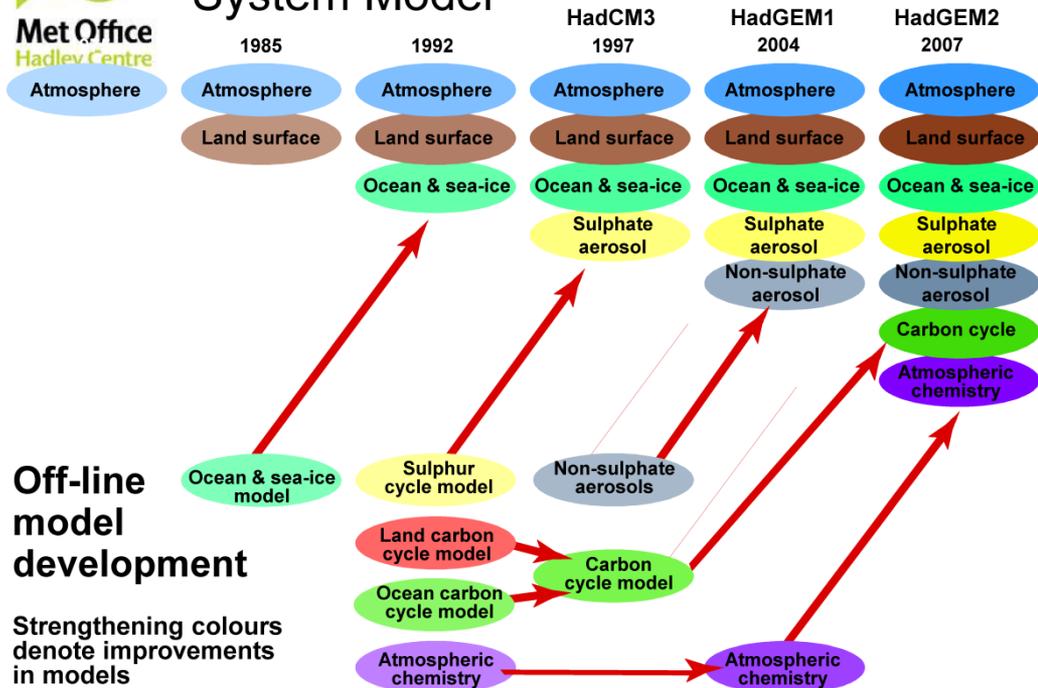


The “Earth System” as seen by climate and weather modelers





Development of the Hadley Centre Earth System Model



© Intergovernmental Panel on Climate Change
From Fifth Assessment report. Climate Change 2013:
The Physical Science Basis, Chapter 1, Fig. 1-14



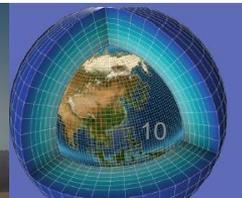
Grand challenge: towards global 1 km climate models (resolve convective clouds)

Recommendations:

(From: Infrastructure Strategy for the European Earth System Modelling Community - 2012-2022)



- 1) Access to world-class HPC for climate - « **tailored** » up to « **dedicated** »
- 2) Develop the next generation of climate models
- 3) Set up data infrastructure (global and regional models) for large range of users from impact community
- 4) Improve physical network (e.g. link national archives)
- 5) Strengthen European expertise and networking



The expertise

Weather



Met Office



Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Climate



Max-Planck-Institut
für Meteorologie



Institut
Pierre
Simon
Laplace



Centro euro-Mediterraneo
sul Cambiamenti Climatici



National Centre for
Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

HPC



DKRZ
DEUTSCHES
KLIMARECHENZENTRUM



CERFACS



Science & Technology
Facilities Council



BSC



ICHEC
Irish Centre for High-End Computing



Climate Modelling:

- Six of the seven European Models used for climate projection (IPCC reports) are developed and supported by members of the consortium

Numerical Weather Prediction:

- Major European NWP systems are represented by members of the consortium

HPC:

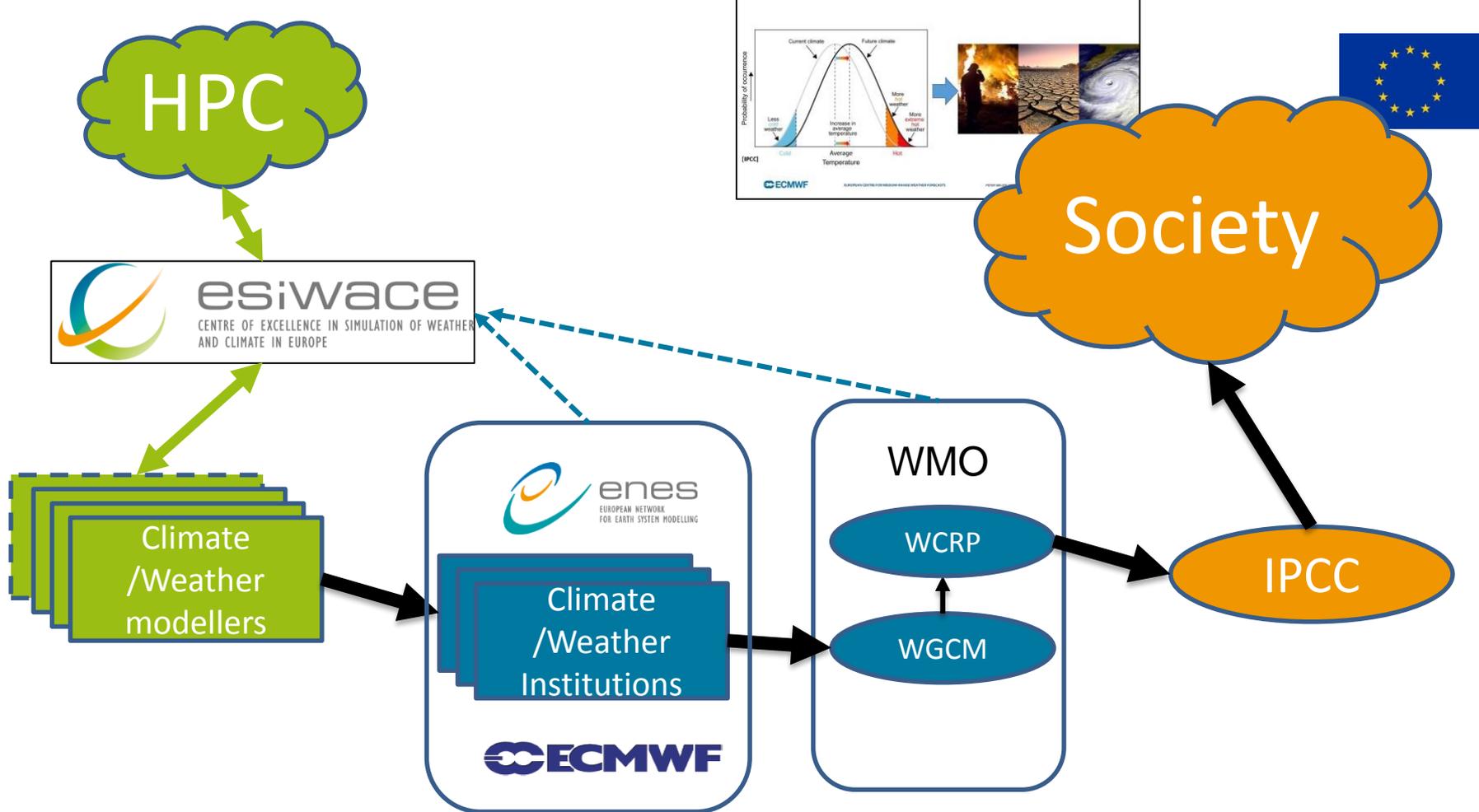
- Significant HPC resources (~ 20 PFLOPS, 100 PBYTE Disk) dedicated to Climate & Weather are operated by members of the consortium

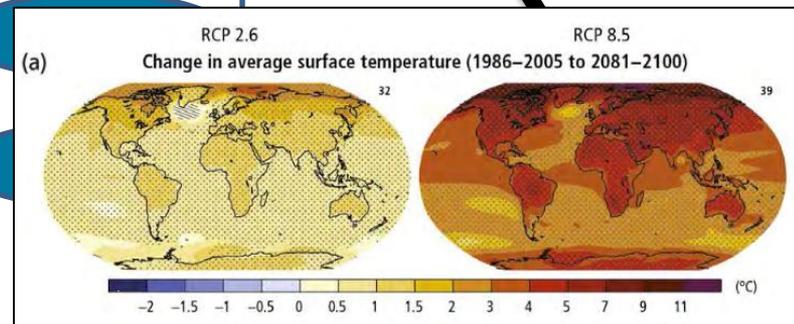
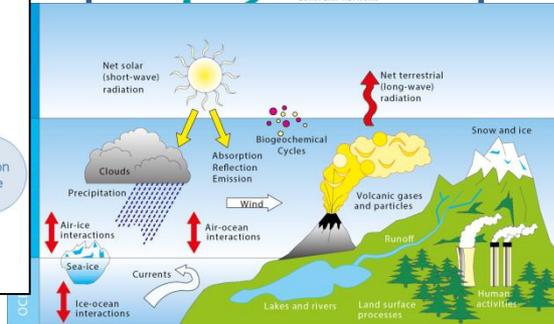
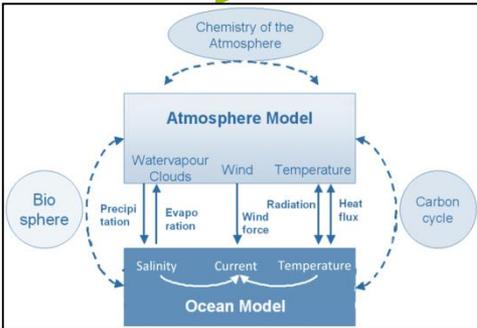
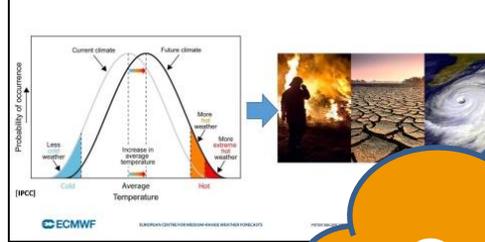
cPPP:

- Three industry partners within the consortium are core members of ETP4HPC



Who are the users



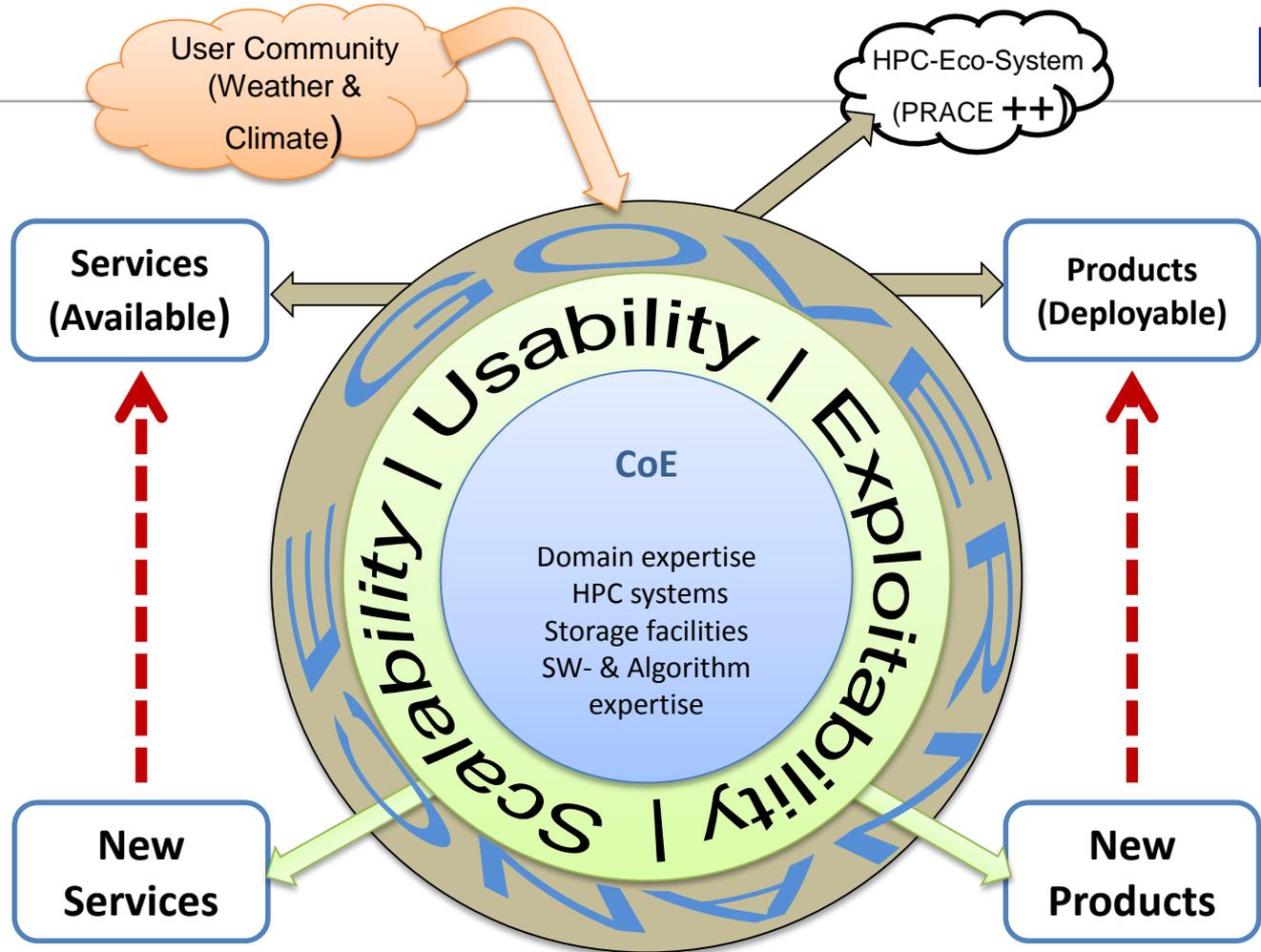




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Services



1. Direct Services (= support) -> www.esiwace.eu



The screenshot shows the website's navigation menu with the following items: IN SHORT, RESULTS, EVENTS, SERVICES, and CONTEXT. The 'SERVICES' menu item is highlighted, and a dropdown menu is open, listing the following support services: Support for Cylc, Support for OpenIFS, Support for NEMO, and Support for OASIS3-MCT. The background of the website features a server room with blue lighting and a grid of colorful lights.

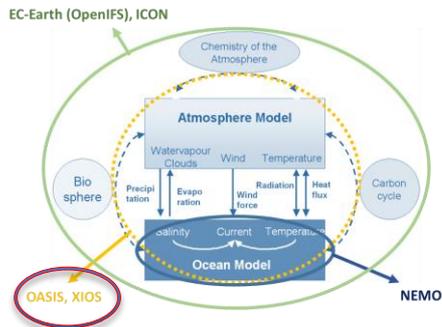
IN SHORT RESULTS EVENTS **SERVICES** CONTEXT

- Support for Cylc
- Support for OpenIFS
- Support for NEMO
- Support for OASIS3-MCT

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User services

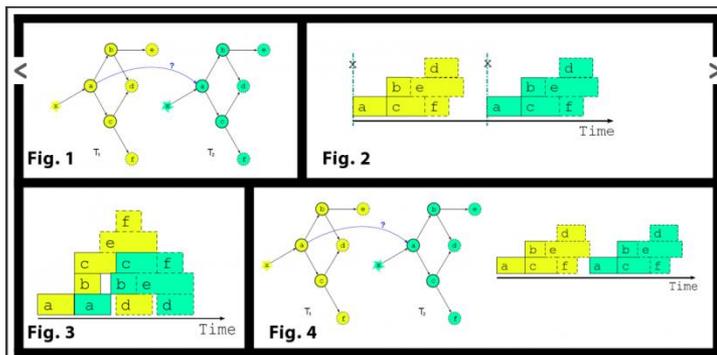
- Code access under version control
- Tutorial, training, best practices
- On-line forums
- Bug fixes
- User-driven evolutions (governance - link with WP1)

- ✧ Software developed by CERFACS since 1991 with CNRS since 2006
- ✧ Ensures coupling exchanges between the component codes of climate models
- ✧ Used by ~70 groups in the world, with ~40 groups in Europe, and in 5 of the 7 European ESMs in CMIP5

OASIS optimization (months 12-24)

- Performance analysis and improvement
- Multi-threading and/or thread-safe

CYLC is a meta-scheduler world-leading to better manage the dependencies of the many interdependent tasks that make up computer simulations of weather and climate.



Support approach

- Phase 1:
 - Support evaluation and decision making
 - Bespoke and personal interaction offered
- Phase 2:
 - Training and advice
 - Assume local first-level support
 - Responsive to feedback
- Leading to further software development

ESM System Software Stack & ESM end-to-end workflow recommendations

- methodology for maintaining a portable HPC system software stack for ESM application
 - enable portability of complex climate modelling experiments (multi model, multi member ensembles)
- ➔ Enable efficient usability of Prace-typ infrastructures for Earth System Modeling**

Business model for storing and exploiting high volume climate data

- Create models to reduce the design space/understand expected performance
- Identifying beneficial storage architecture candidates for the entire workflow.

New storage layout for Earth system data

- Overcome performance limitations of shared I/O during simulation workflows from multiple PEs.
- Address performance issues for alternatives to traditional parallel file systems
- Achieve performance portability (with no changes to applications)

COMMUNITY BUILDING / ENHANCING COMMUNITY CAPACITY IN HPC

- **HPC task force**
 - Coordinate HPC related activities of the modeling groups and interaction with industry (-> cPPP)
- **HPC-Workshops**
 - ENES Series on HPC for Climate (<https://www.esiwace.eu/events/4th-hpc-ws>)
 - ECMWF Series on HPC for Meteorology
- **Other events**
 - ISC16, Frankfurt: Session on climate and weather coordinated by Thomas Ludwig
 - PASC16, Lausanne: “Climate&Weather contributions” coordinated by Peter Bauer



Toulouse April 2016

„HPC ecosystem
meets
Earth System
Modeling“

~ 100 participants
from 4 continents

INTEGRATION:

ESiWACE will drive a longer term strategy and vision aiming at getting adequate recognition of the requirements of Earth-System-Modelers in the evolving hpc-ecosystem

- by fostering integration of weather & climate
- by exploiting synergies between that community and the HPC ecosystem
- by exploring and filling gaps (ETP4HPC -> SRA)

→ **“Business model” to be developed with industry partners**

NEXT STEP:

Contribute actively to the Extreme Scale Demonstrator discussion (and also to the upcoming co-design proposals)

To achieve a quantum leap in science performance, we need:

- Global coupled & uncoupled simulations at **1 km** spatial resolution; as ensembles to characterize forecast uncertainty
 - Weather forecasts: target O (10 days per hour wallclock)
 - Climate predictions: target O (100 days per hour wallclock)
- } E (2-5 exaFLOP)

→ **EsD applications:**

- Full-sized 1 km models
- Tailor-made, cost-driving model components (to be highly optimized and made scalable) for both computing and data handling

... to be provided by **ESiWACE (CoE) and ESCAPE, NextGenIO and others (FET)**

Thank you

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