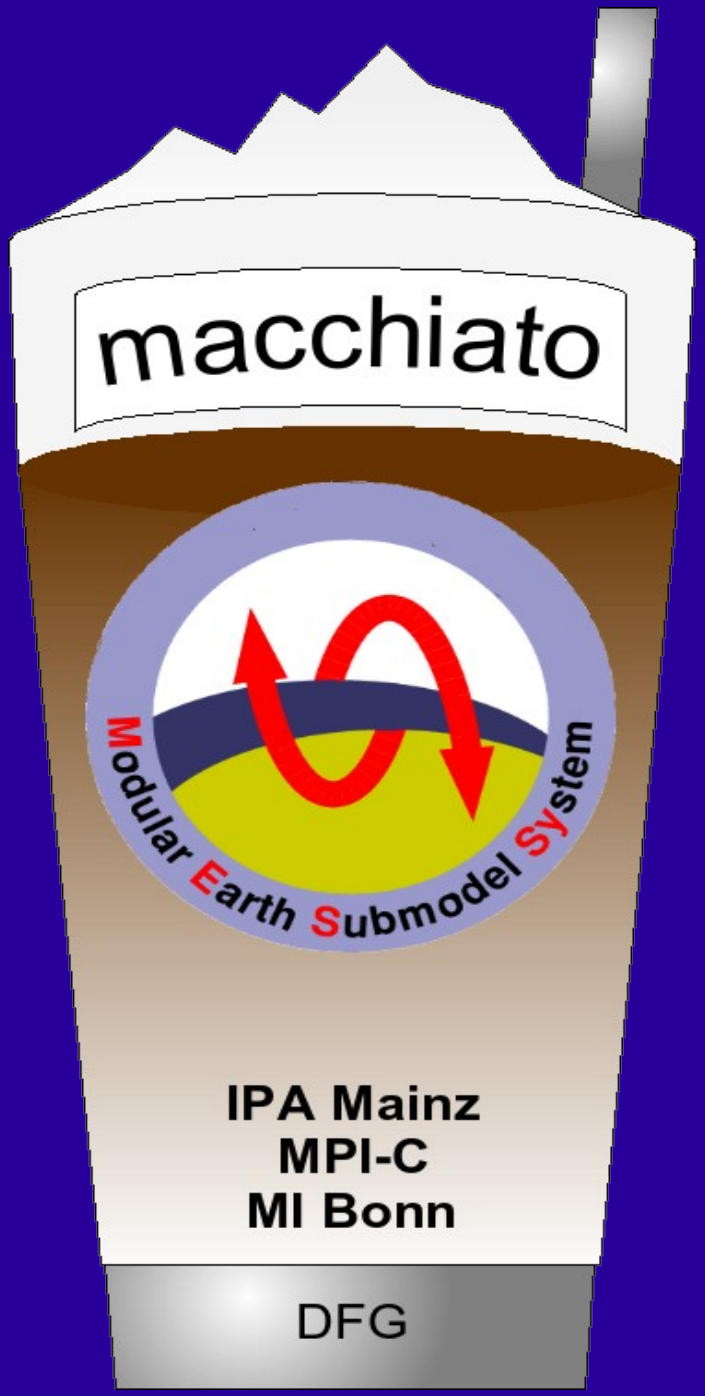

Modeling of atmospheric chemistry and transport from global to local scales

Astrid Kerkweg
Institute for Atmospheric Physics
University of Mainz, Germany

COSMO-User-Seminar
Langen, March 10, 2009

http://www.staff.uni-mainz.de/kerkweg/MACCHIATO

The MACCHIATO Project
STARTING POINT

- ECHAM5/MESSy
  - global general circulation model
  - grid space > 100 km
  - chemistry

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  - local
  - influenced by local effects (e.g. orography)

The MACCHIATO Project
STARTING POINT

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  - global general circulation model
  - grid space > 100 km
  - chemistry
- Measurements
  - local
  - influenced by local effects (e.g. orography)

=> a dynamical regional model including chemistry is required

The MACCHIATO Project
STARTING POINT

- regional model: COSMO

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STARTING POINT

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- chemistry: MESSy (= Modular Earth Submodel System)

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STARTING POINT

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consistent chemistry?

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consistent chemistry? Build model chain!

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consistent chemistry? Build model chain!

ECHAM5/MESSy => COSMO/MESSy

=> COSMO/MESSy => COSMO/MESSy

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ECHAM5 – MESSy - COSMO

- "zooming" option for Atmospheric Chemistry GCM

  for field-campaign planning and analysis
- COSMO with gas-phase (and aerosol) chemistry

  for regional chemical weather forecast
- consistent model system on different scales

  (global – regional – local) for process studies
- Impact of climate change on specific regions (downscaling)
- supported model system (community effort ...)

The MACCHIATO Project

OUTLINE

1. Motivation
2. What is MESSy?
3. Status of COSMO/MESSy
4. Online Coupling
5. Summary and Outlook

The MACCHIATO Project
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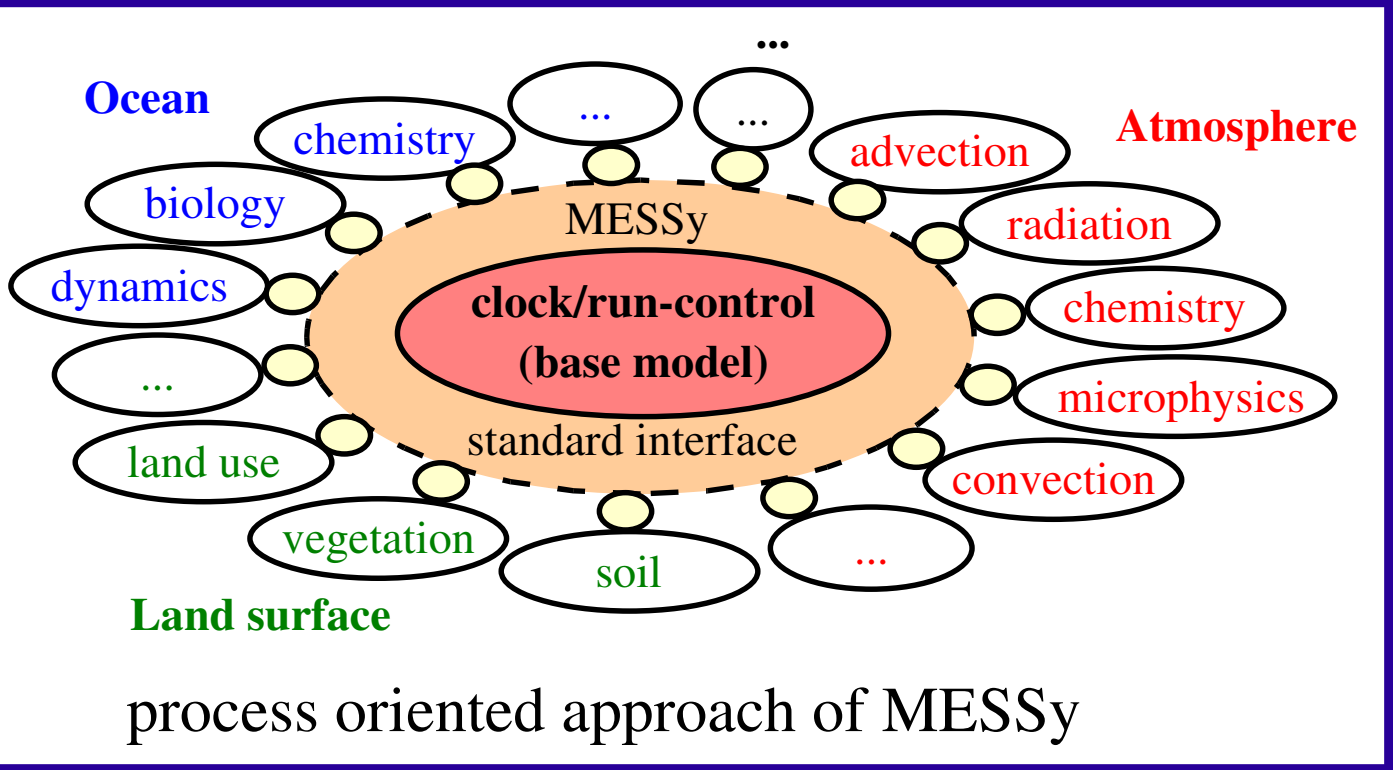
What is MESSy ?

- Interface with infrastructure to couple 'processes' (= submodels) to a base model (e.g. a GCM or COSMO)
- Set of processes coded as switchable submodels
- Coding standard



process oriented approach of MESSy

transparent control of feedback mechanisms

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MESSy submodels

MESSy1.1

AIRSEA
CLOUD
CONVECT
CVTRANS
DRYDEP
EMDEP
H2O
HETCHEM
JVAL
LNOX
M7
MECCA
OFFLEM
ONLEM
PHOTO
PSC
PTRAC
QBO
RAD4ALL
SCAV
SEDI
TNUDGE
TROPOP

TRACER
- FAMILY
- PDEF

NCREGRID

MESSy1.2

D14CO
EQSAM
GM7
MADE
MMFORCE

MESSy1.3

TIMEPOS
RAD4ALL_FUBRAD

MESSy1.4

SPE

MESSy1.5

VAHR
SPACENOX

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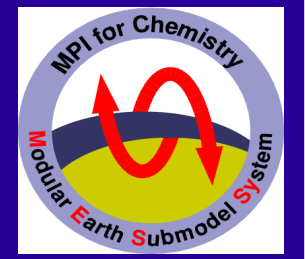
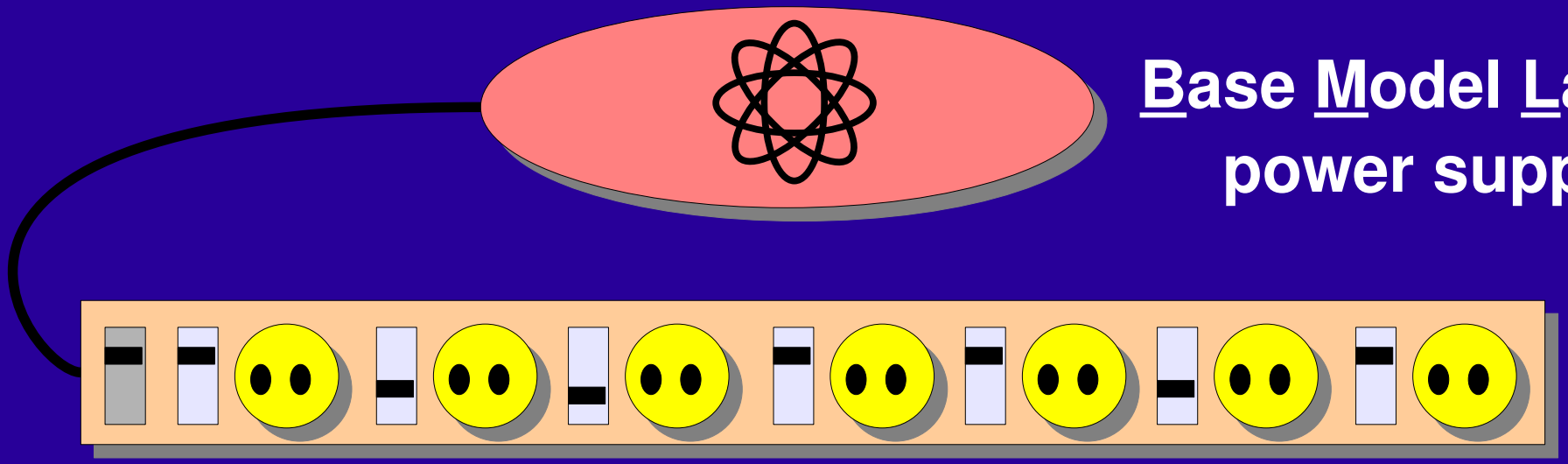
The MESSy interface





Base Model Layer: power supply

Base Model Interface Layer: multiple socket outlet

Submodel Interface Layer: connector

Submodel Core Layer: the machinery ...

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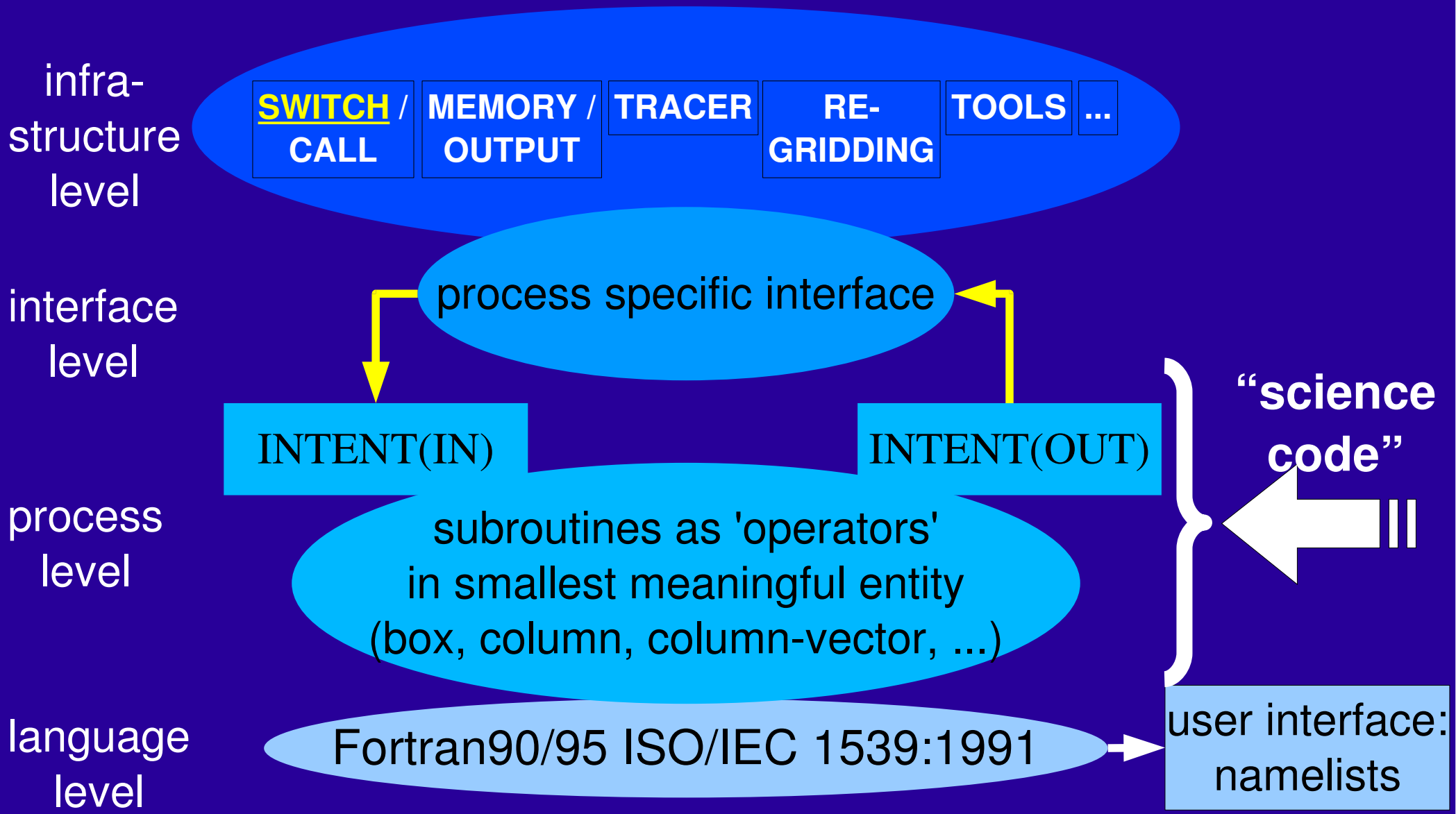
The MESSy interface

Standardisation on the lowest possible level ...



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OUTLINE

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STATUS OF COSMO/MESSy

The infrastructure submodels are implemented:

- SWITCH/CONTROL
- TIMER
- CHANNEL / memory management
  - → COSMO memory allocation via CHANNEL
  - → COSMO output via CHANNEL
  - → COSMO restart via CHANNEL

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Status of COSMO/MESSy

- **TRACER:**
  - **transport of tracers (horizontal/vertical diffusion, advection, ...)**
  - **convection not (yet) implemented**
  - **ongoing work: integration not yet mass conserving**

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Online Coupling

Challenges in regional chemistry modeling:

- Boundary condition updates required more often than for pure meteorological models (e.g. photochemistry)
- exchange of much more fields required (chemical species)

The MACCHIATO Project
Online Coupling

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The MACCHIATO Project
Online Coupling

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- Boundary condition updates required more often than for pure meteorological models (e.g. photochemistry)
- exchange of much more fields required (chemical species)

=> the data amount (number of files and size of files) becomes huge

=> ONLINE COUPLING of model instances

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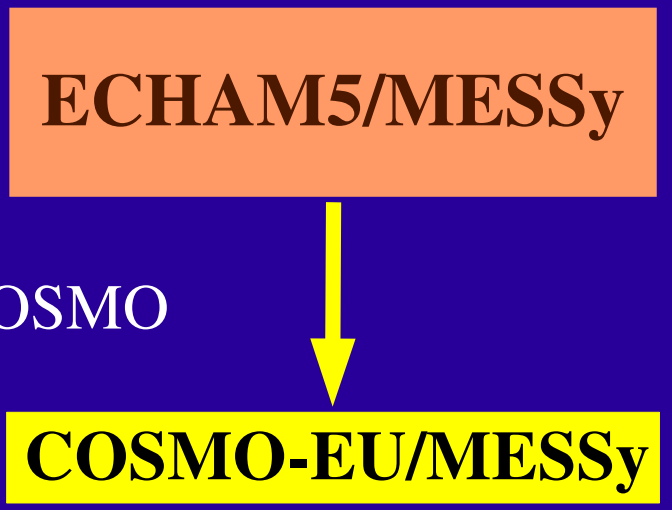
Online Coupling

ECHAM5/MESSy

The MACCHIATO Project

Online Coupling

Online data exchange ECHAM5 -> COSMO



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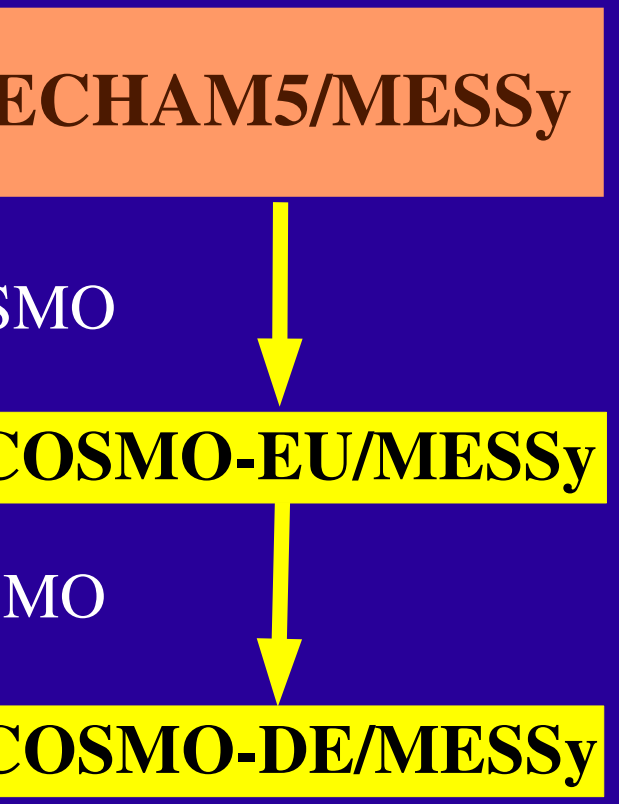
Online Coupling

Online data exchange ECHAM5 -> COSMO

Online data exchange COSMO -> COSMO



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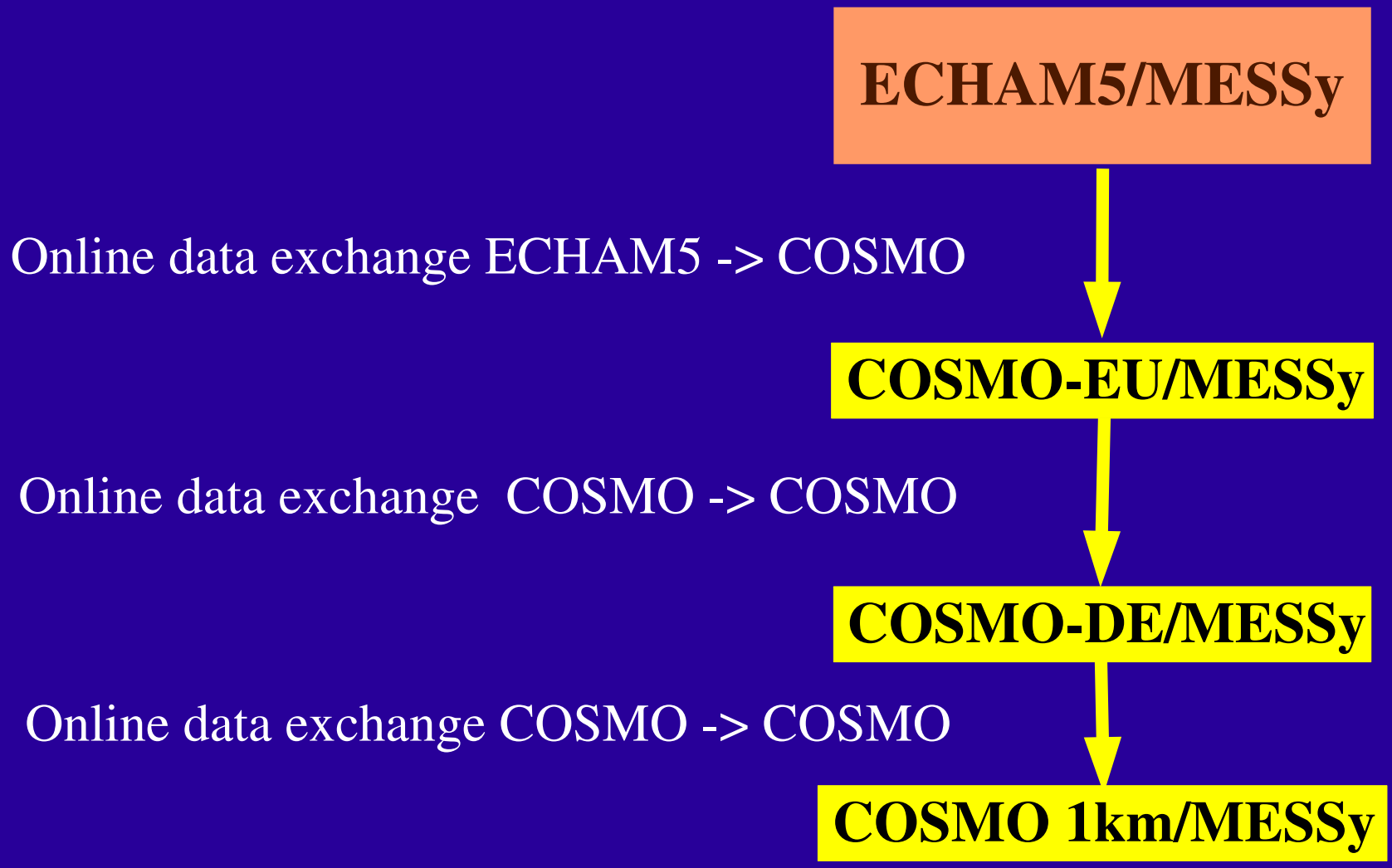
Online Coupling



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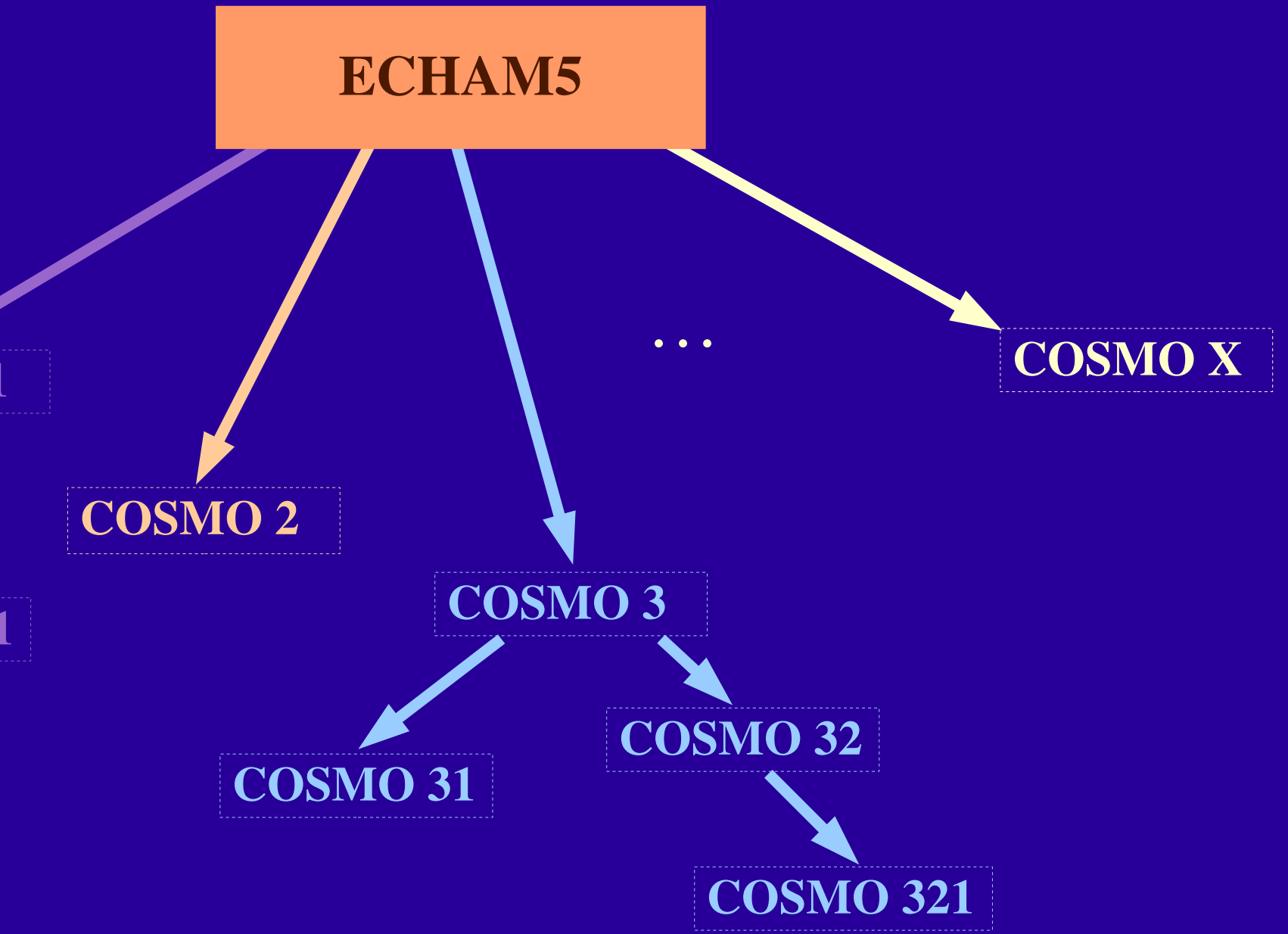
Online Coupling



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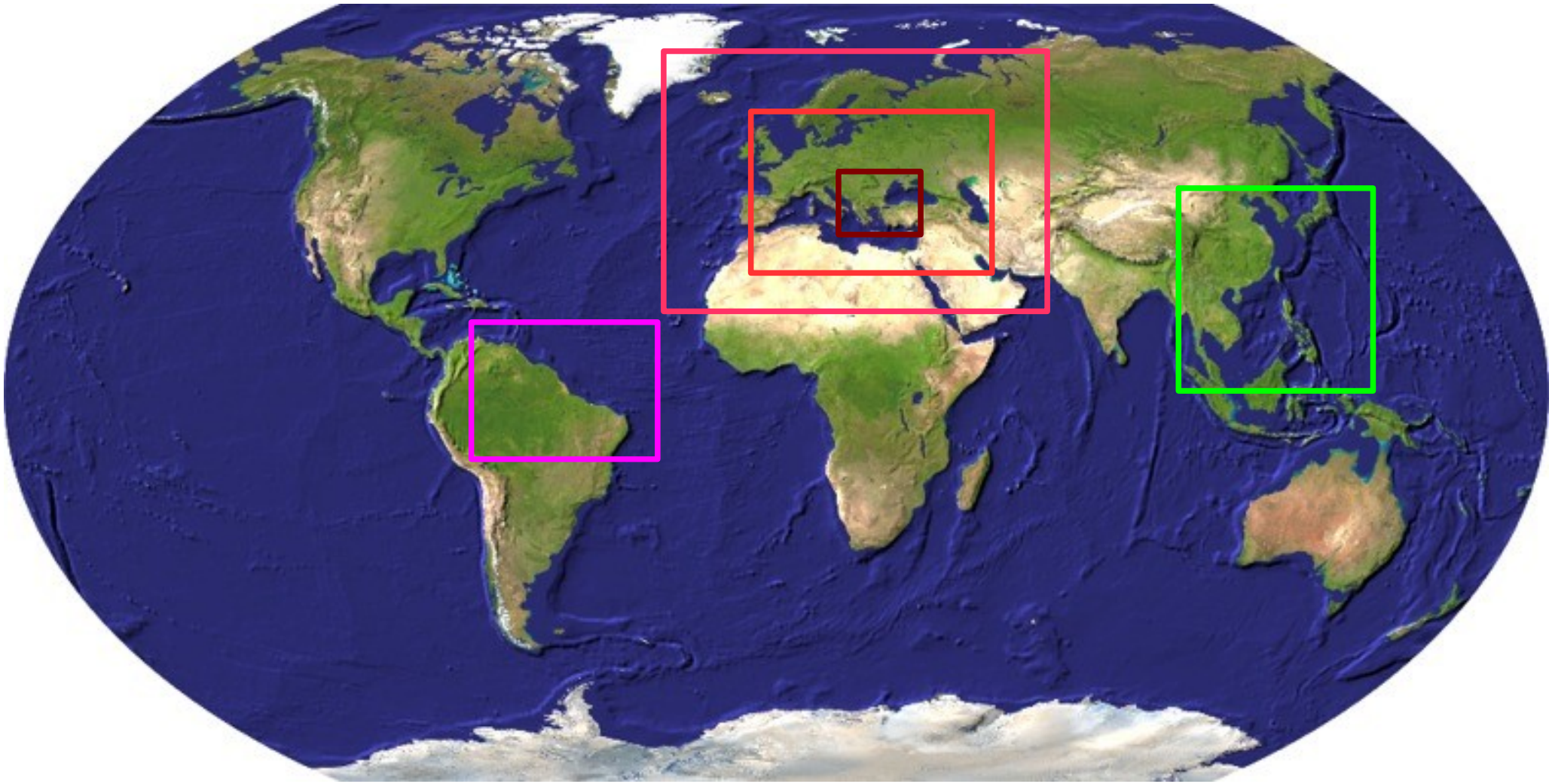
The vision of "ONLINE-COUPLING"



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The MACCHIATO Project

Summary

- MACCHIATO as a project contains a lot of model development.

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- The model chain ECHAM5/MESSy => COSMO/MESSy => COSMO/MESSy => ... will provide a tool for consistently calculating atmospheric chemistry across all scales

The MACCHIATO Project

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- MACCHIATO as a project contains a lot of model development.
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- MESSy provides the possibility to add processes and diagnostic tools to COSMO without changing COSMO after the MESSy interface is include once.

The MACCHIATO Project

Summary

- MACCHIATO as a project contains a lot of model development.
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- MESSy provides the possibility to add processes and diagnostic tools to COSMO without changing COSMO after the MESSy interface is include once.
- Output of variables not included in the grib tables of COSMO is possible via the MESSy interface.

The MACCHIATO Project

Summary and Outlook

Technical Workpackages:

- **MESSy infrastructure in COSMO: COSMO/MESSy**

The MACCHIATO Project

Summary and Outlook

Technical Workpackages:

- **MESSy infrastructure in COSMO: COSMO/MESSy** **done**

The MACCHIATO Project

Summary and Outlook

Technical Workpackages:

- **MESSy infrastructure in COSMO: COSMO/MESSy** **done**
- **Tracer transport in COSMO**

The MACCHIATO Project

Summary and Outlook

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The MACCHIATO Project

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The MACCHIATO Project

Summary and Outlook

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- **MESSy infrastructure in COSMO: COSMO/MESSy** **done**
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The MACCHIATO Project

Summary and Outlook

Technical Workpackages:

- MESSy infrastructure in COSMO: COSMO/MESSy done
- Tracer transport in COSMO work in progress
- Coupling of chemistry in COSMO/MESSy future
- 1-way on-line coupling of COSMO/MESSy to ECHAM5/MESSy

The MACCHIATO Project

Summary and Outlook

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Summary and Outlook

Scientific Workpackages:

The MACCHIATO Project

Summary and Outlook

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- Meteorological evaluation of COSMO/MESSy

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Summary and Outlook

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Summary and Outlook

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  - The performance of COSMO/MESSy will be evaluated with observations of chemically passive tracers (e.g. CO)

The MACCHIATO Project

Summary and Outlook

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The MACCHIATO Project

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- Investigation of the dynamical and chemical aspects of chemical plumes

The MACCHIATO Project

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- Investigation of the dynamical and chemical aspects of chemical plumes

- Case study of regional air pollution with the COSMO/MESSy

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Thank you for listening !

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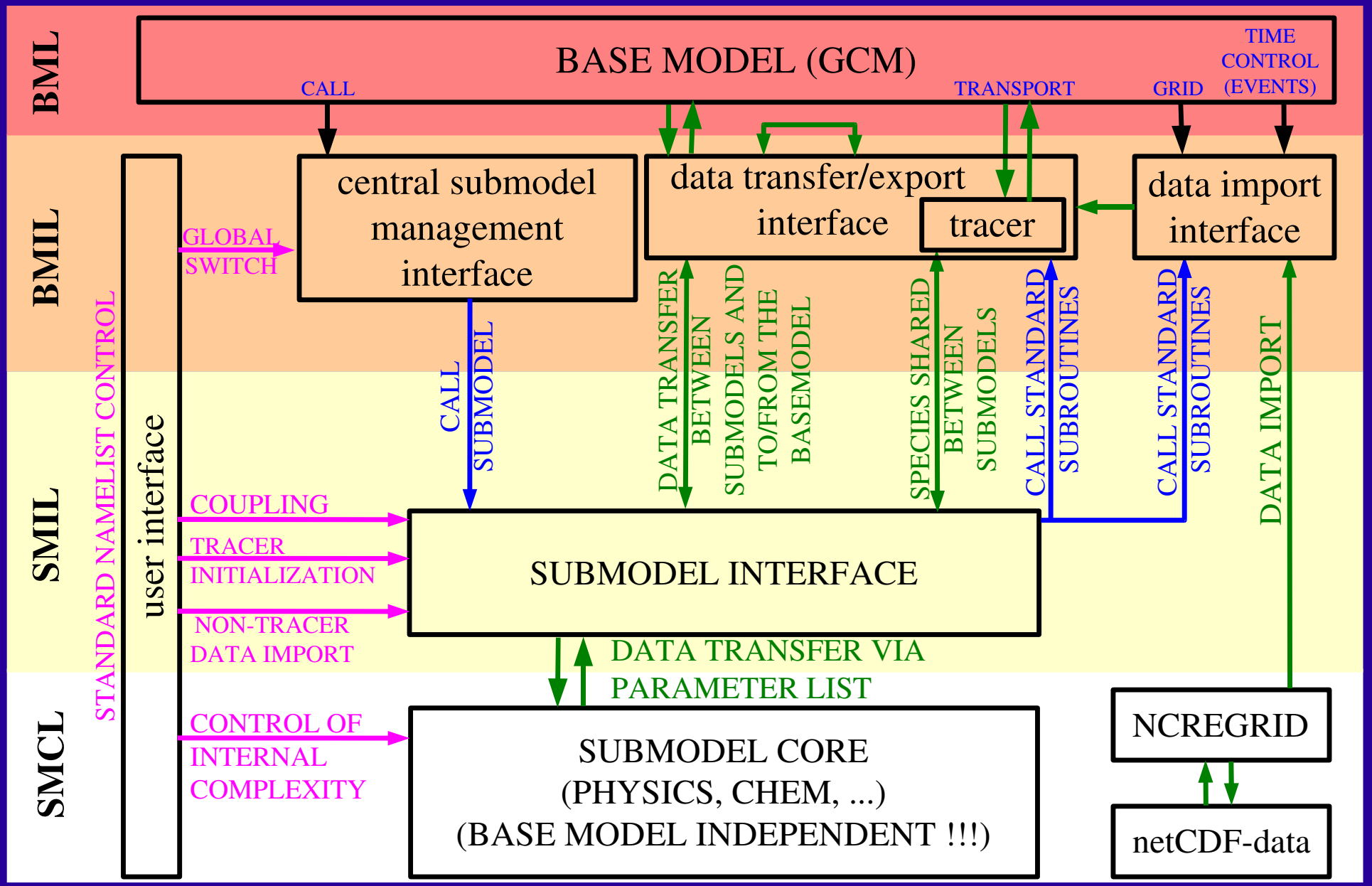
The MESSy interface



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Status of Online Coupling

- meteorological online coupling of ECHAM5/MESSy -> COSMO/MESSy “nearly finished”
- chemical online coupling of ECHAM5/MESSy -> COSMO/MESSy prepared but not yet tested
- meteorological and chemical online coupling of COSMO/MESSy -> COSMO/MESSy prepared but not yet tested