Development of Earth System Models at the MPI for Meteorology

RT1 WP1.1

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Original aims for ENSEMBLES

O1.a: Provision of a set of tested Earth System Models for use in the ensemble prediction system.
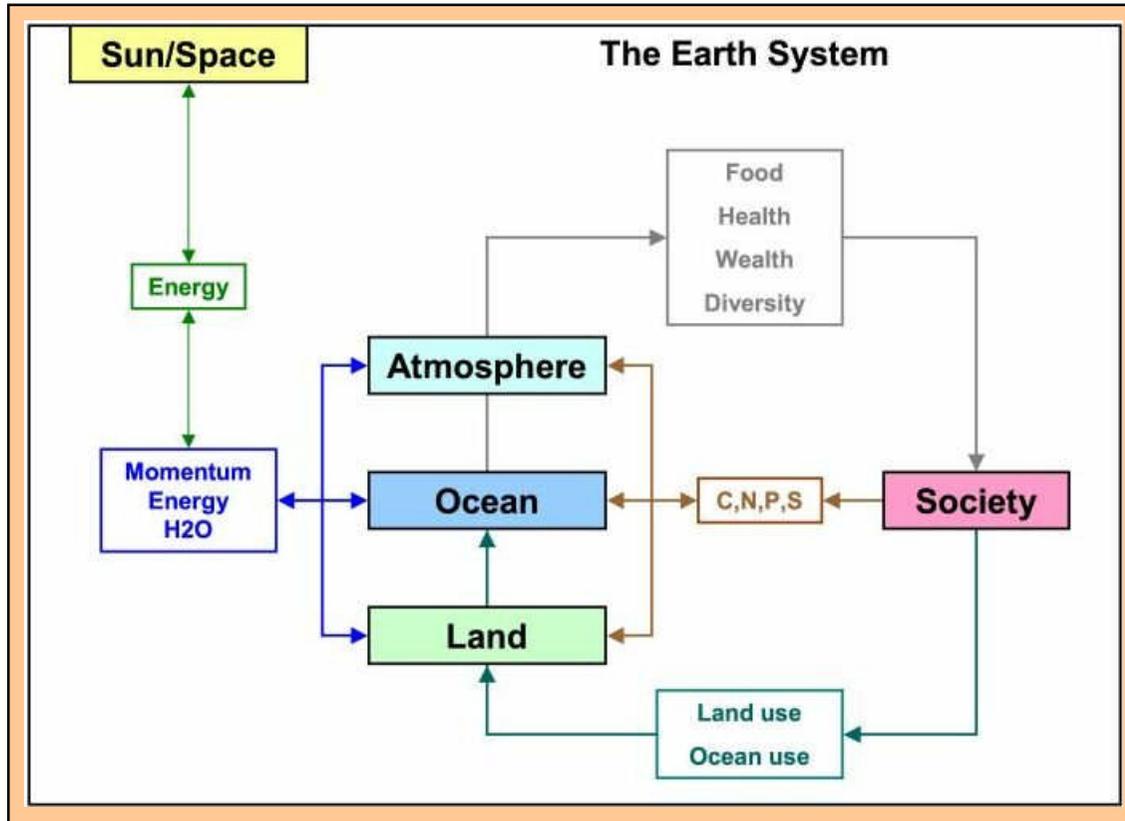
Table 6.8: MPIMET

Existing: Jungclaus et al. (2006), Roeckner et al, (2006)
- ECHAM5 atmosphere
- MPI-OM ocean including sea ice

New:
- ECHAM5 atmosphere
- HAM aerosol module
- MOZART2 atmospheric chemistry
- JSBACH land biosphere
- MPI-OM ocean including sea ice
- HAMOCC ocean biogeochemistry

Conceptual framework

Atmosphere

Dynamics
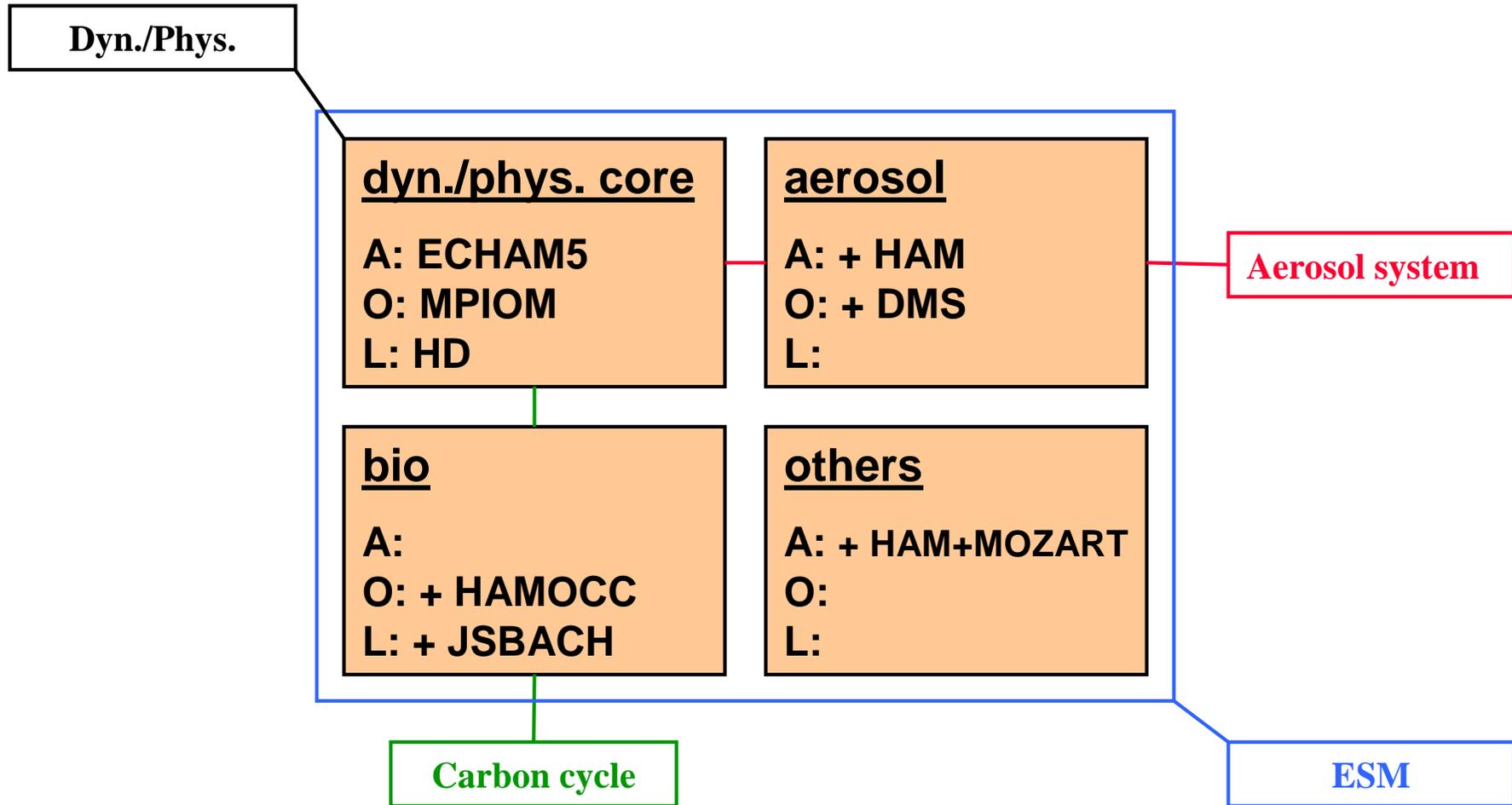Physics
Chemistry
Aerosols

Land

Hydrology
Vegetation

Ocean

Dynamics
Physics
Biogeochem.

Society

Economics
Land use
Ocean use

ESM configurations

dyn./phys. core

A: ECHAM5
O: MPIOM
L: HD

aerosol

A: + HAM
O: + DMS
L:

bio

A:
O: + HAMOCC
L: + JSBACH

others

A: + HAM+MOZART
O:
L:

Aerosol system

Carbon cycle

ESM

Recent developments
1. Physical system

Extension to the middle atmosphere

◆ Dynamical feedback from stratosphere is biased in standard model with top at 10 hPa

◆ Climate effects of major volcanic eruptions

◆ Coupling to (ozone) chemistry

Developments+Testing:

◆ ECHAM5 31 layers to 10 hPa → 47 layers to 0.01 hPa

◆ Identical vertical grid below 100 hPa

◆ Ongoing spin-up integration for pre-industrial conditions

  ▪ ~100 years

  ▪ Drift not yet ended, ca. +0.5K in global mean surface temp.

Recent developments
1. Physical system

◆ Test simulation from an existing troposphere control simulation

◆ No tuning

◆ **Positive temperature drift**

◆ Reduced ice area and volume in NH

Surface air temperature [C]
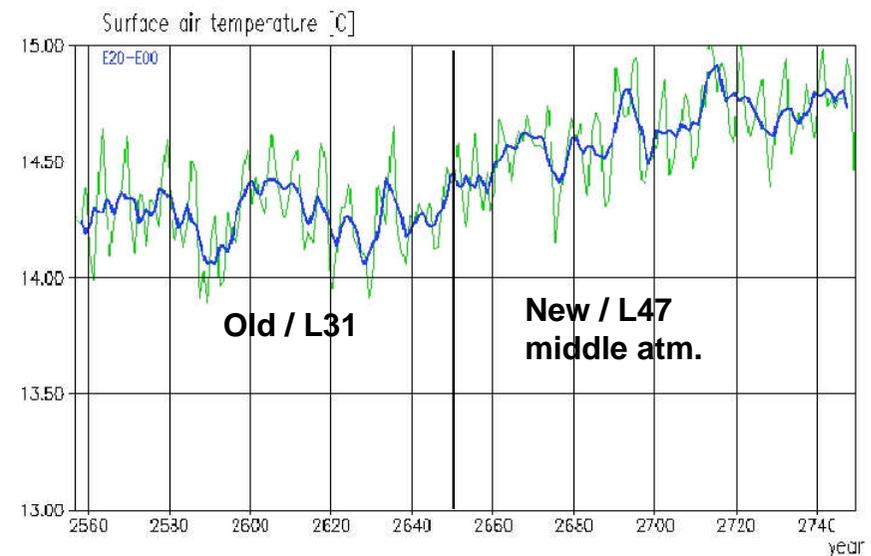
Recent developments
2. Carbon cycle model

Has been used experimentally with prescribed maps of plant functional types for IPCC integrations (not in AR4)

New:

◆ **Coupling of light attenuation in ocean top layers to chlorophyll amounts (Wetzel et al., 2006)**

◆ Technical improvements

Recent developments
2. Carbon cycle model

- light attenuation length scale
  - Blue ocean: 11 m
  - Green ocean: 0 – 25 m / top layer
- Seasonal and regional changes in SW heating and wind stress
- Improvements in El Nino:
  - More peaked Nino3 PDF
  - Smaller amplitude
  - Longer period
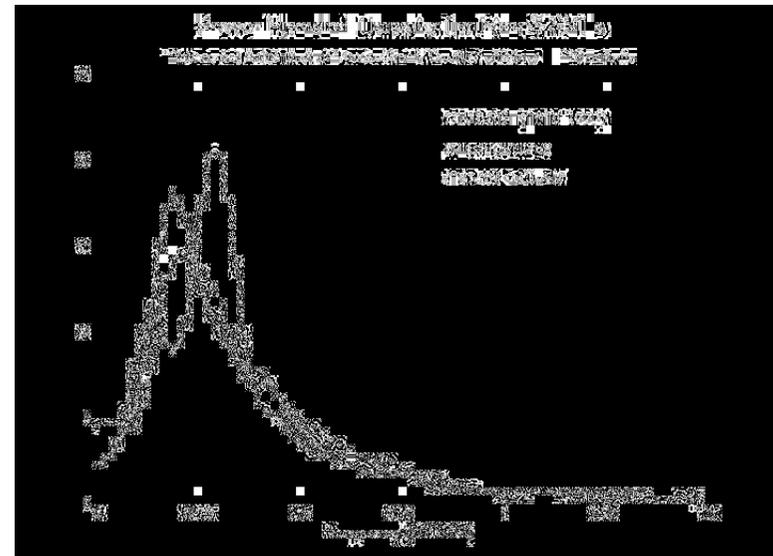
Recent developments
3. Aerosol system

Has been used experimentally for IPCC integrations
(not in AR4), at low vertical resolution (T63 L19)
Deficiencies related to low vertical resolution

New:

◆ higher resolution T63 L31

◆ Technical improvements

Recent developments
4. Chemistry and aerosol+chemistry

Used in RETRO project

Problem:

◆ Too expensive
  8 times more expensive than physical model alone

◆ Necessary emission data not available for
  20C+scenario

→ Not applicable for stream 2

MPIMET models that can be used for stream 2 integrations

Physical system
ECHAM5/MPIOM or
MAECHAM5/MPIOM with middle atmosphere

Aerosol system
ECHAM5-HAM/MPIOM-HAMOCC

Carbon cycle system
ECHAM5-JSBACH/MPIOM-HAMOCC

Horizontal resolution for all models: T63
Vertical resolution L31 (A and C models), L31 or L47 for P model