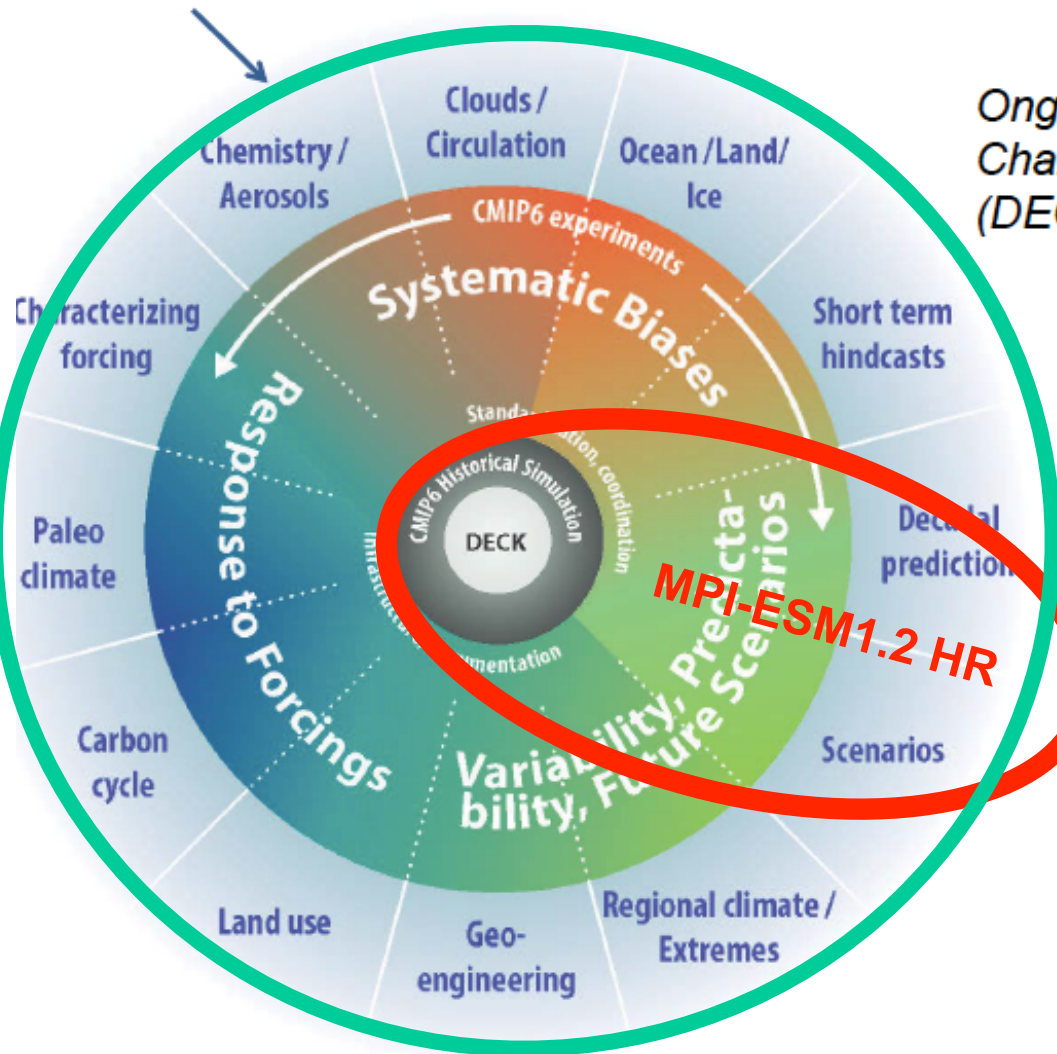# MPI-ESM 1.2 in CMIP6

Matthias Bittner
Karl-Hermann Wieners, Johann Jungclaus, Thorsten Mauritsen,
Monika Esch, Tatiana Ilyina, Irene Stemler, Helmuth Haak, Luis
Kornblueh, Marco Giorgetta, Michael Botzet, Wolfgang Mueller,
Kameshwar Rao Modali, Christian Reick, Reiner Schnur, Julia
Pongratz, Thomas Raddatz, Hauke Schmidt, Claudia Timmreck
et al.,

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CMIP6-Endorsed Model Intercomparison Projects (MIPs)

CMIP

The World Climate Research Programme's
Coupled Model Intercomparison Project

Ongoing Diagnosis, Evaluation, and Characterization of Klima (DECK) Experiments

DECK (entry card for CMIP)
i.   AMIP simulation (~1979-2014)
ii. Pre-industrial control simulation
iii. 1%/yr CO_2 increase
iv. Abrupt $4xCO_2$ run

CMIP6 Historical Simulation (entry card for CMIP6)
v.   Historical simulation using CMIP6 forcings (1850-2014)

(DECK & CMIP6 Historical Simulation to be run **for each model configuration** *used in the subsequent CMIP6-Endorsed MIPs)*

MPI-ESM1.2 LR

Note: *The themes in the outer circle of the figure might be slightly revised at the end of the MIP endorsement process*

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MPI-ESM1.2

	MPI-ESM1.2-LR	MPI-ESM1.2-HR	MPI-ESM1.2-XR*
Atmosphere	ECHAM6.3		
	T63 (1.9° x 1.9°) 47 vertical levels to 0.01 hPa	T127 (1.0° x 1.0°) 95 vertical levels to 0.01 hPa	T255 (0.5° x 0.5°) 95 vertical levels to 0.01 hPa
Ocean	MPIOM1.63		
	GR1.5 (1.5° x 1.5°) 40 levels	TP04 (0.4° x 0.4°) 40 levels	
Additional components	**Land:** JSBACH3.20 including dynamic vegetation + Carbon- and Nitrogencycle **Ocean-Biogeochemistry:** HAMOCC	**Land:** JSBACH3.20 without dynamic vegetation, Carbon- and Nitrogencycle **Ocean-Biogeochemistry:** HAMOCC	

*MPI-ESM1.2-XR is part of HighResMIP and will not perform the full DECK simulations.

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Changes of the MPI-ESM1.2 compared to CMIP5

ECHAM6.3:

- Monte-Carlo independent column approximation (McICA) radiation scheme [option: spectral sampling in time].

- Bug fixes for energy conservation in atmospheric physics.

- treatment of aerosol radiation and aerosol-cloud interactions using the simple plume approach (MACv2-SP).

- Bug fix for cloud cover scheme.

- Activated stratocumulus parameterisation.

JSBACH:

- improved hydrology and soil model based on 5-pool model YASSO

- Implementation of Land Nitrogen Cycle

HAMOCC:

- sinking velocity as function of depth

- Prognostic nitrogen fixers.

ALL COMPONENTS:

- Additional diagnostics implemented to serve the CMIP6 output requirements.

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Implementation of forcing data

The recommended forcing data sets for CMIP6 have all been prepared and tested in the MPI-ESM1.2. The MPI-ESM1.2-HR and LR have been tuned based on the forcing datasets to best match our understanding of the 20th century.

DECK:

- We will not be using stratospheric background aerosols in the DECK (except of AMIP).

Historical:

- Because we will use dynamic vegetation only in the LR model, the land use forcing is different for LR and HR.

- Because we already started historical with the HR, we use the forcing dataset v6.1.1 constantly for this model.

- The newest forcing dataset release (v6.2) will be used for the LR model.

MPI-ESM1.2 Current status

LR (ECHAM6.3 T63L47 MPIOM1.65 GR15/L40) :

- Model development finished (tuned set-up using the CMIP6 piControl forcing).
- Needed retuning compared to CMIP5.
- Test historical simulation to ensure good representation of 20th century.
- runs by default *with* Dynamic Vegetation
- daily coupling
- will be used for many MIPs
- Performance: 70yrs/day on 32 nodes

- Version with interactive Carbon cycle is in preparation.

MPI-ESM1.2 Current status

HR (ECHAM6.3 T127L95 MPIOM1.65 TP04/L40) :

- Model development finished (tuned set-up using the CMIP6 piControl forcing).

- 500 year piControl finished.

- 5 members of historical simulation finished.

- runs *without* DynVeg.

- hourly coupling.

- will be the base model for MiKlip-II forecast system, DCPP, BMBF CMIP6 project with DKRZ.

- Performance: 18yrs/day on 108 nodes.

MPI-ESM1.2 Current status

XR (ECHAM6.3 T255L95 MPIOM1.65 TP04/L40) :

- Model development finished (tuned set-up using the CMIP6 piControl forcing).
- No full DECK planned.
- 1950 spin-up finished.
- Extended AMIP finished
- 1950 control simulation and historical currently running.
- runs *without* DynVeg.
- hourly coupling.
- Used in PRIMAVERA and HighResMIP.
- Performance: 6yrs/day on 256 nodes.
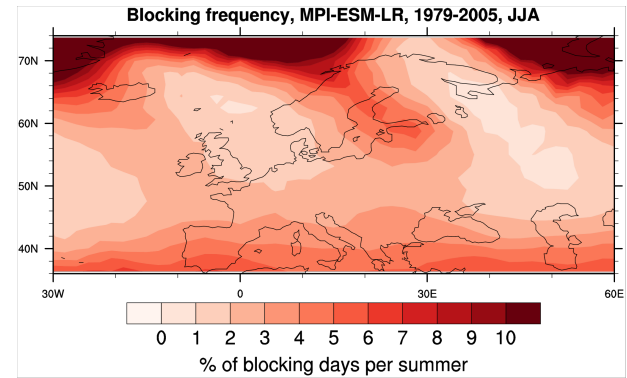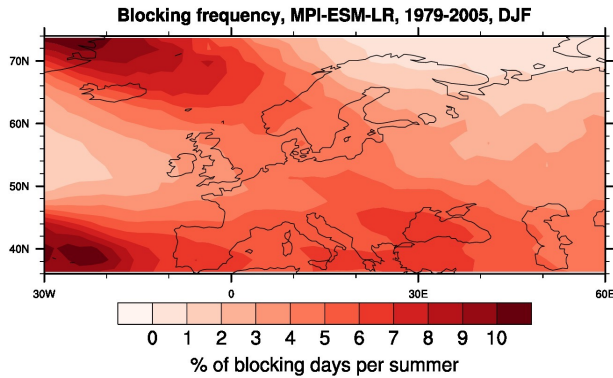
MPI-ESM1.2

Resolution matters: HR vs. LR

ERA Interim

LR bias

HR bias

Variance of geopotential height at 500hPa
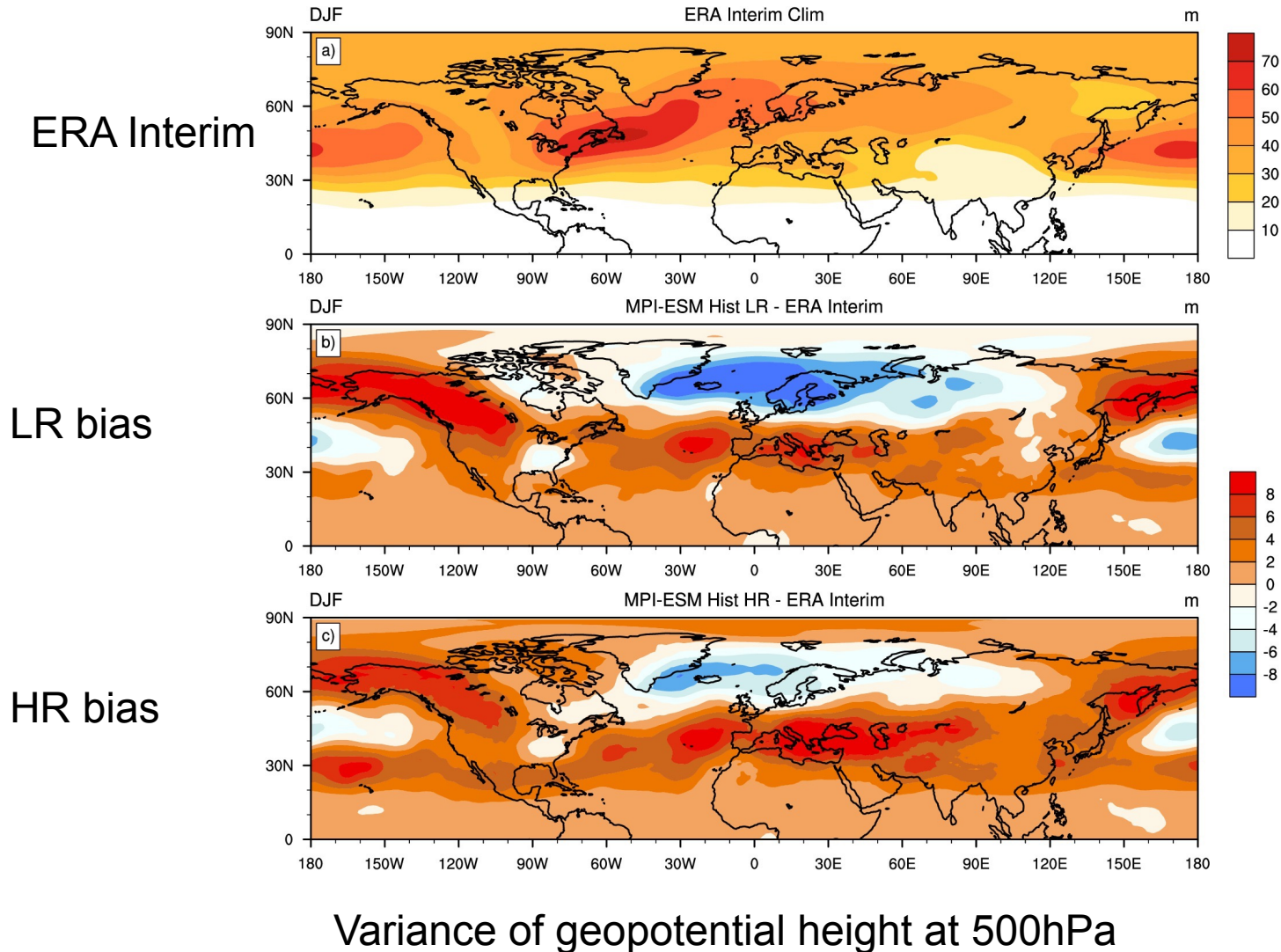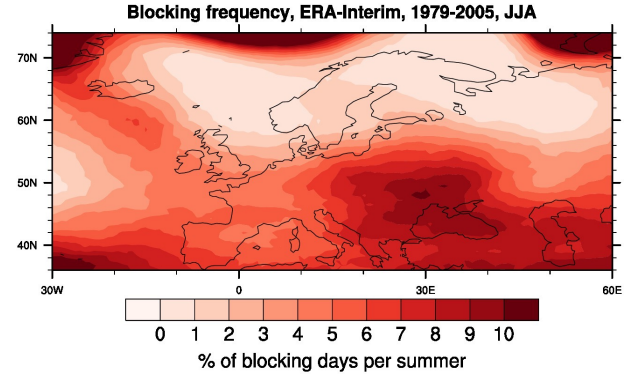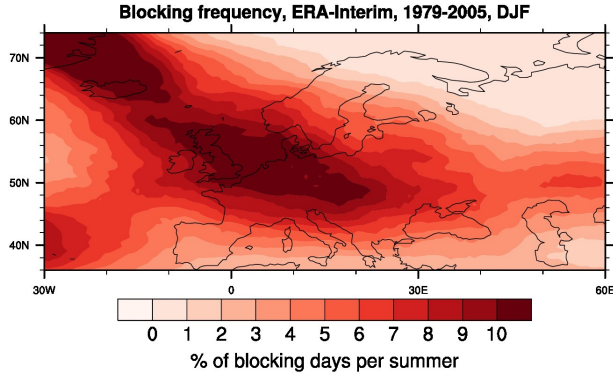
WINTER　　MPI-ESM1.2　　SUMMER
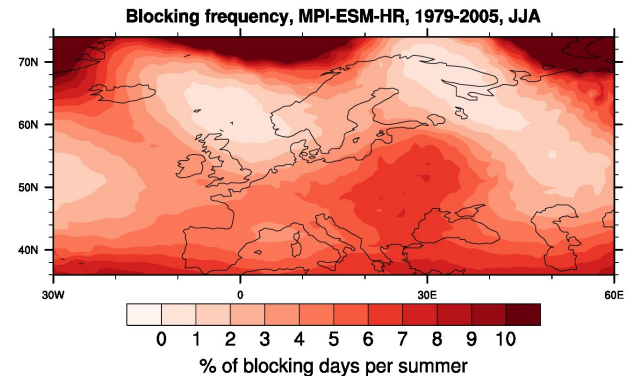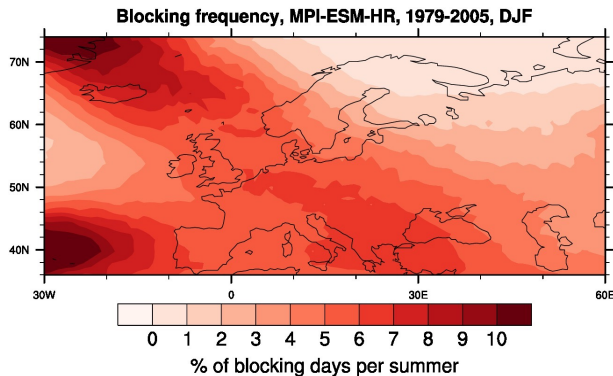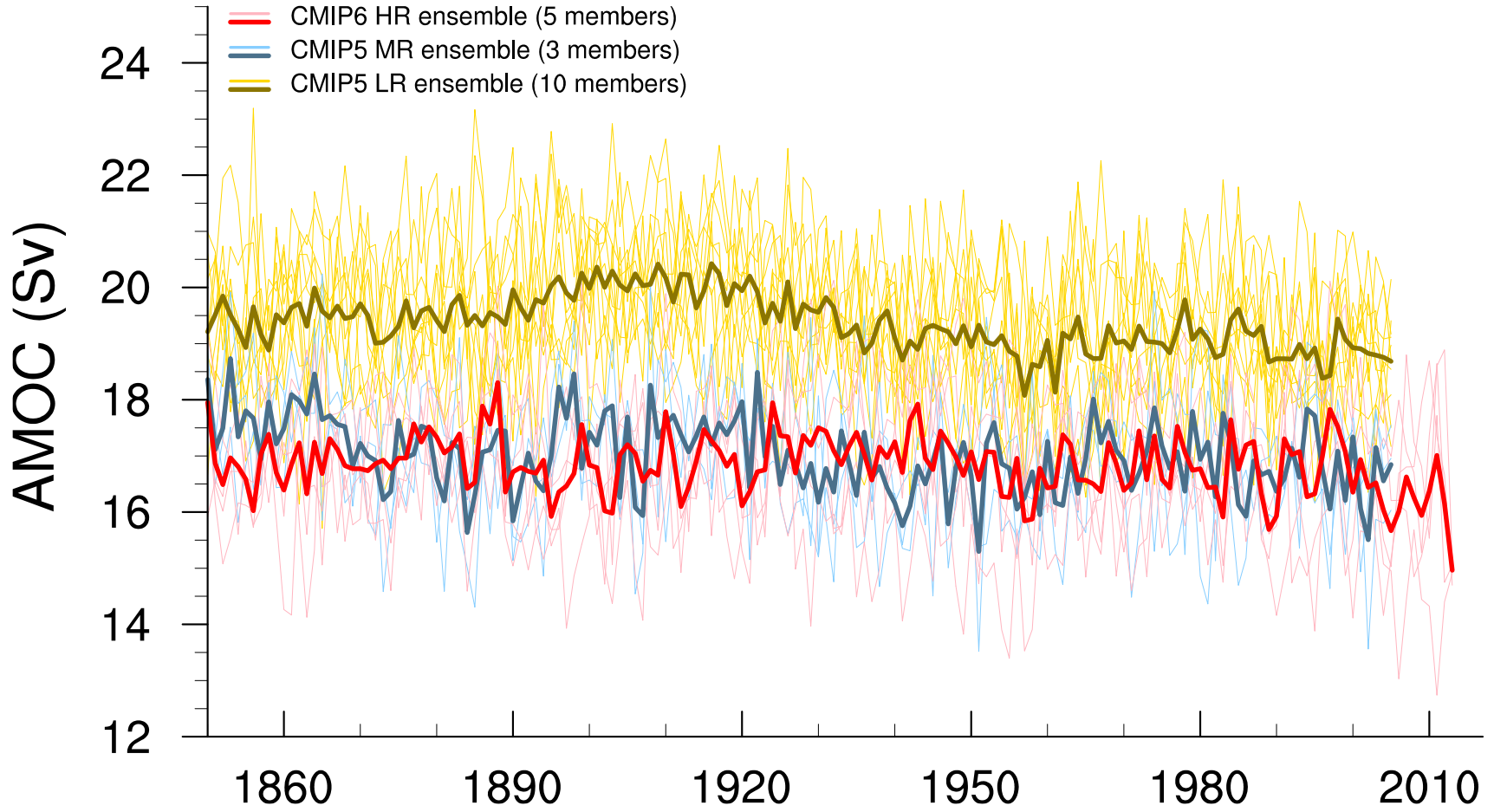

% of blocking days per season

MPI-ESM1.2-HR

Global Mean Surface Temperature Anomalies
from 1961-1990 average

Legend:
- HadCRUT4
- CMIP6 HR ensemble (5 members)
- CMIP5 MR ensemble (3 members)
- CMIP5 LR ensemble (10 members)

Y-axis: Temp. Anomaly (°C)

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Summary

Development of MPI-ESM1.2 for CMIP6 has been finalized and released. Tuning with respect to the CMIP6 forcing dataset has been completed.

PiControl and historical simulations have been finished with the MPI-ESM1.2-HR.

We will use slightly different forcing for the HR and LR model (which will be indicated by the ripf identifier).

The higher resolution of MPI-ESM1.2-HR compared to the LR model shows considerable improvements, especially in atmospheric dynamics.

Historical simulations show good agreement with observations and show some improvements compared to the CMIP5 model and forcing.

Future work:
Finalizing the post-processing scripts to ensure CMIP6 data request requirements.

Future developments will focus on finalizing ICON-ESM.

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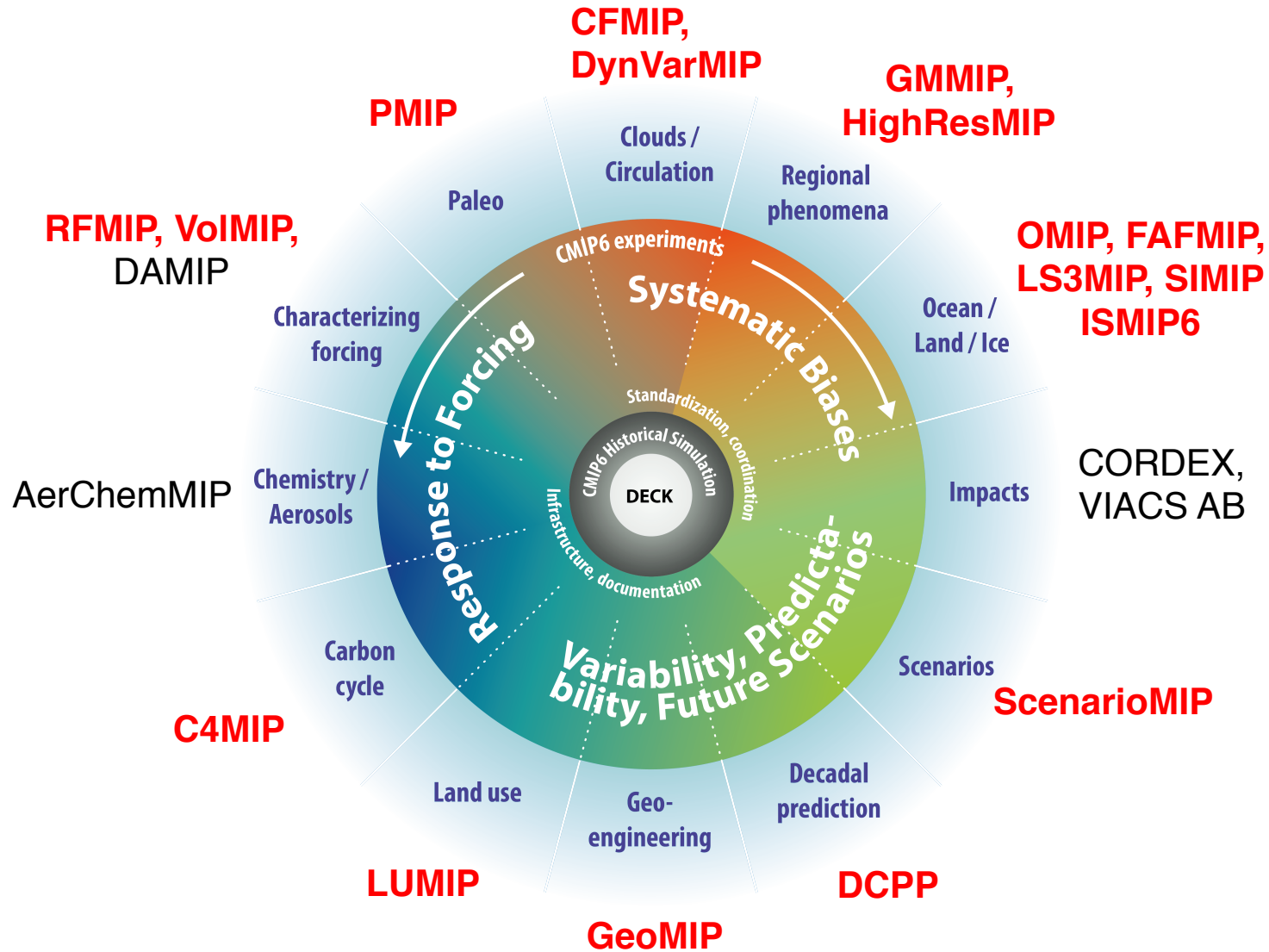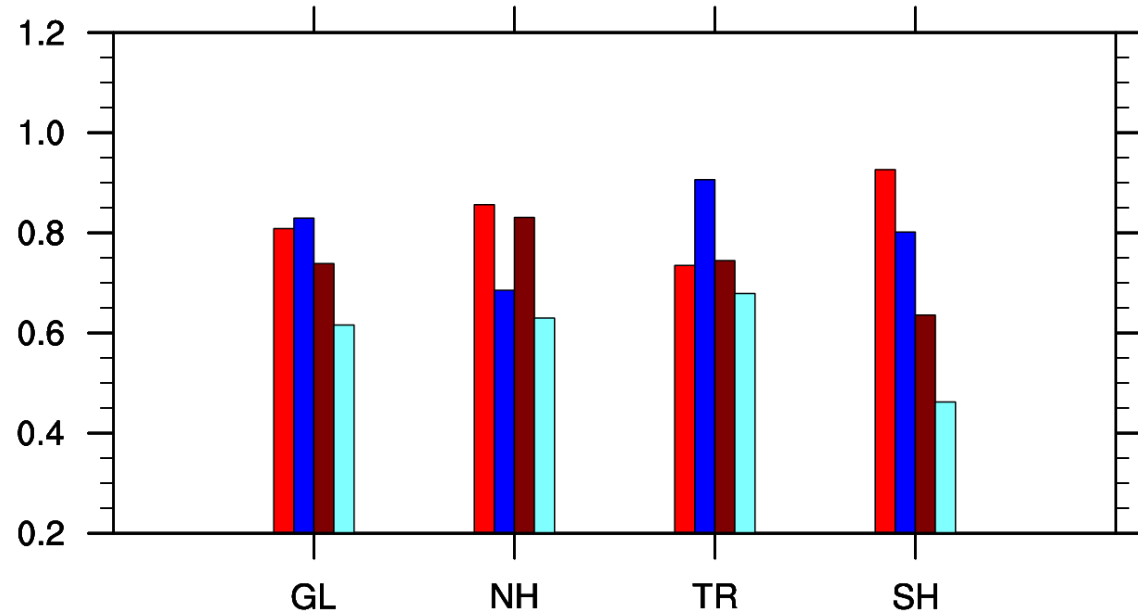Future developments will focus on finalizing ICON-ESM.

Thank You!

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BACKUP

MIPs @ MPI-M

MPI-ESM1.2

From ECHAM5 to ECHAM6.3

Biases(ANN) related to echam5.5 (1979-1999) bias

GL: Global
NH: Northern Hemisphere
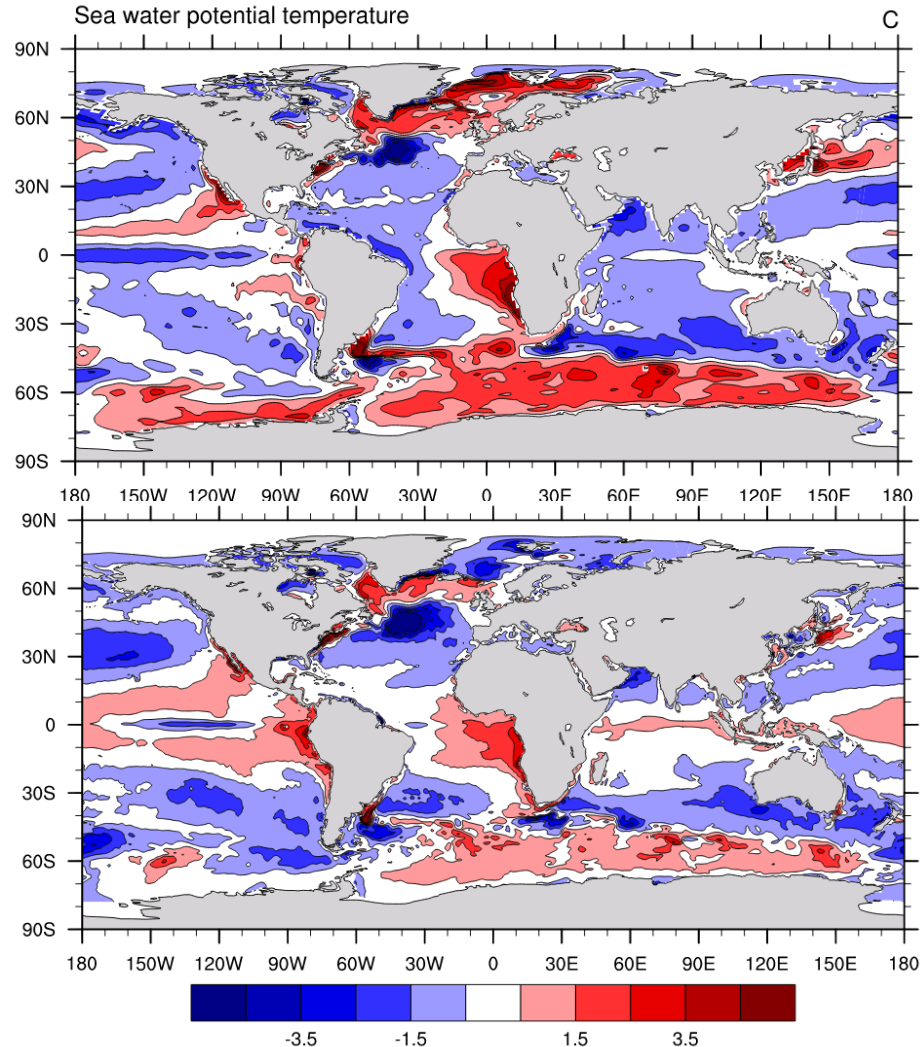SH: Southern Hemisphere
TR: Tropics

Global

	GL	NH	TR	SH	
	0.62	0.63	0.68	0.46	echam6.3 (T127L95) (1979-2008)
	0.74	0.83	0.74	0.64	echam6.3 (1979-2008)
	0.83	0.69	0.91	0.80	echam6.2 (1979-2008)
	0.81	0.86	0.73	0.93	echam6.1 (1979-2008)

MPI-ESM1.2

Resolution matters: but notorious biases remain

Data-Levitus Anomaly, 1979-2003, surface

LR bias

HR bias

Sea surface temperature bias
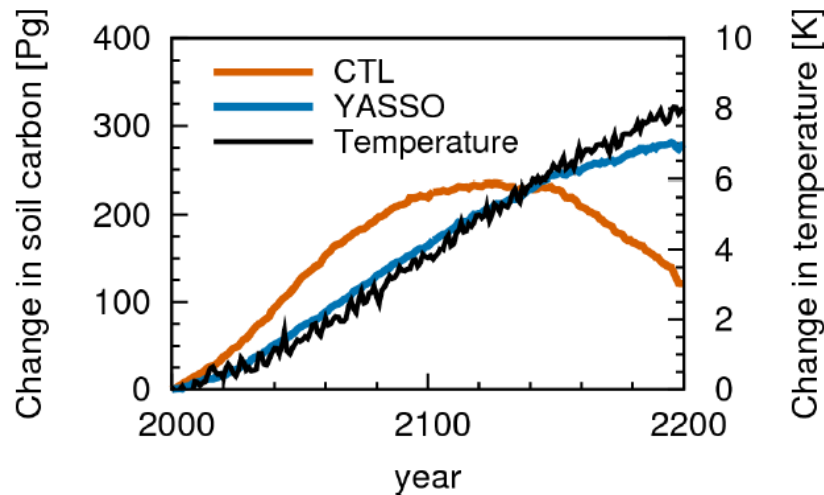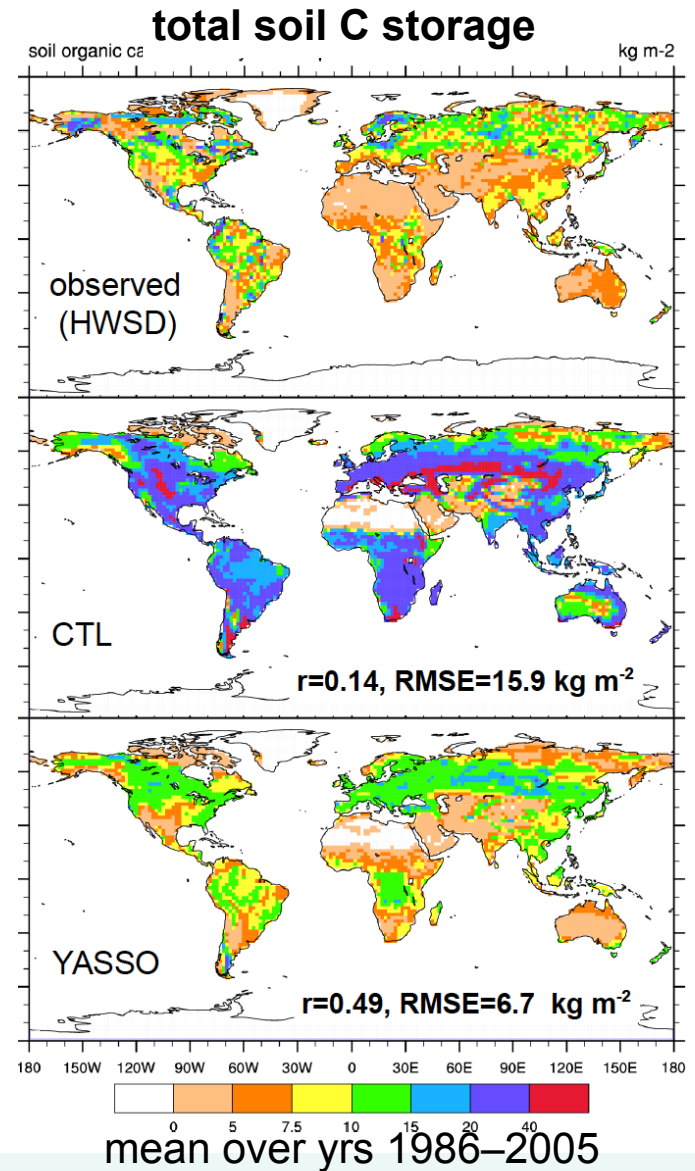
MPI-ESM1.2

Land biogeochemistry:

New components:

- improved hydrology and soil model based on 5-pool model YASSO

6.2 Projected change in SOC (rcp8.5)

CTL: CMIP5 version of JSBACH
YASSO: JSBACH with YASSO by Lieski et al.

total soil C storage

mean over yrs 1986–2005

Goll et al., GBC, 2015

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MPI-ESM1.2

Ocean biogeochemistry:

New components:

- Sinking velocity as function of depth
- Prognostic nitrogen fixers

organic sediment

const wpoc

wpoc(z)

2018   K. Seiter et al. / Deep-Sea Research I 51 (2004) 2001–2026

TOC [wt%]

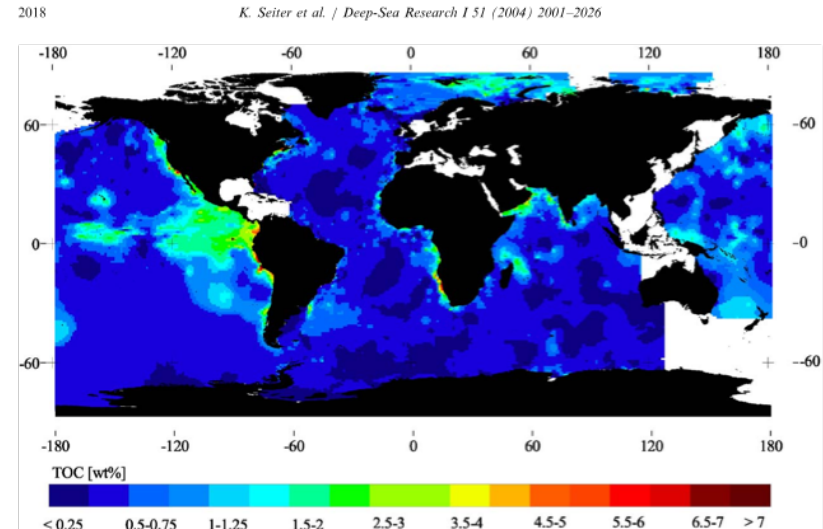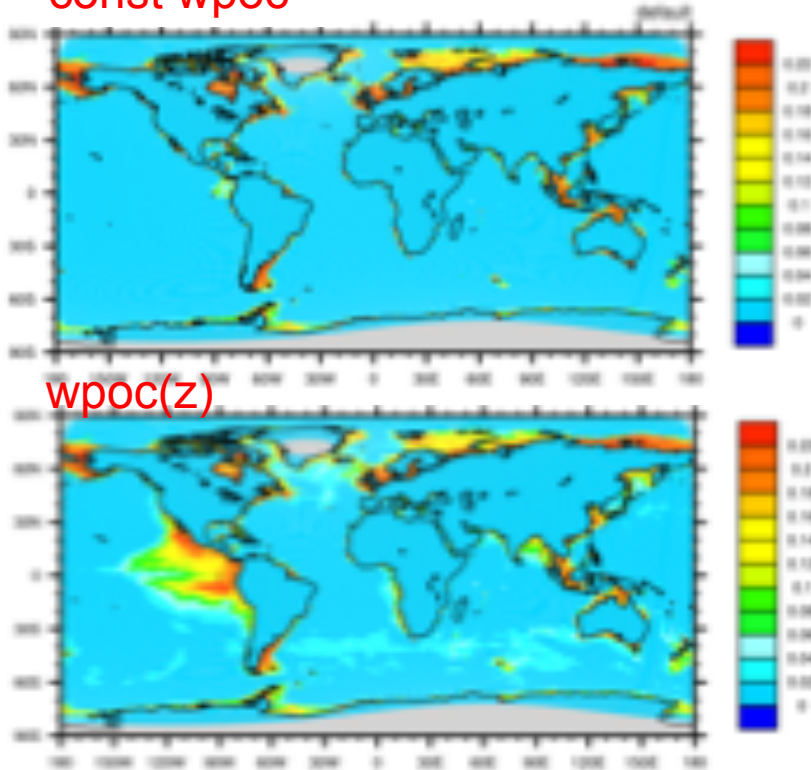| < 0.25 | 0.5-0.75 | 1-1.25 | 1.5-2 | 2.5-3 | 3.5-4 | 4.5-5 | 5.5-6 | 6.5-7 | > 7 |

Fig. 11. Global distribution pattern of the TOC content in surface sediments (<5 cm sediment depth).

MIP-related projects

MIP	Project(s)
Historical:	DKRZ-BMBF
SCENARIOS:	DKRZ-BMBF
DCPP:	BMBF MiKlip
C4MIP:	EU H2020 CRESCENDO
FAFMIP:	DFG SPP Sea Level
GeoMIP:	DFG SPP1689, CELARIT
HighResMIP:	H2020 PRIMAVERA
ISMIP6:	BMBF-PalMod
LS3MIP:	EU H2020 CRESCENDO
LUMIP:	EU H2020 CRESCENDO
PMIP:	BMBF PalMod / JPI: PACMEDY
RFMIP:	EU FP7 BACCHUS
VolMIP:	BMBF MiKlip

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