German Contribution to CMIP6

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WGCM-21 Meeting

9-12 October 2016

Exeter, UK

CMIP
The World Climate Research Programme's Coupled Model Intercomparison Project

DLR

CMIP6: Participating Model Groups

	Institution	Country		Institution	Country		Institution	Country
1	**AWI**	**Germany**	12	DOE	USA	23	MRI	Japan
2	BCC	China	13	EC-Earth-Cons	Europe	24	NASA-GISS	USA
3	BNU	China	14	FGOALS	China	25	NCAR	USA
4	CAMS	China	15	FIO-RONM	China	26	NCC	Norway
5	CasESM	China	16	INM	Russia	27	NERC	UK
6	CCCma	Canada	17	INPE	Brazil	28	NIMS-KMA	Republic of Korea
7	CCCR-IITM	India	18	IPSL	France	29	NOAA-GFDL	USA
8	CMCC	Italy	**19**	**MESSY-Cons**	**Germany**	30	NUIST	China
9	CNRM	France	20	MIROC	Japan	31	TaiESM	Taiwan, China
10	CSIR-CSIRO	South Africa	21	MOHC	UK	32	THU	China
11	CSIRO-BOM	Australia	**22**	**MPI-M**	**Germany**	33	Seoul Nat.Uni	Republic of Korea

New in CMIP:

2 new model groups from Germany (AWI, MESSY-Consortium)
4 new model groups from China (CAMS, CasESM, NUIST, THU)
1 new model group from Brazil (INPE)
1 new model group from India (CCCR-IITM)
1 new model group from Taiwan, China (TaiESM)
1 new model group from USA (DOE)
2 new model group from Republic of Korea (NIMS-KMA, SAM0-UNICON)
1 new model group from South Africa / Australia (CSIR-CSIRO)
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⇒ **13 new model groups so far**

More models (>70)
New models
More complex models
Higher resolution models

* Other models can join providing DECK and historical simulations are submitted

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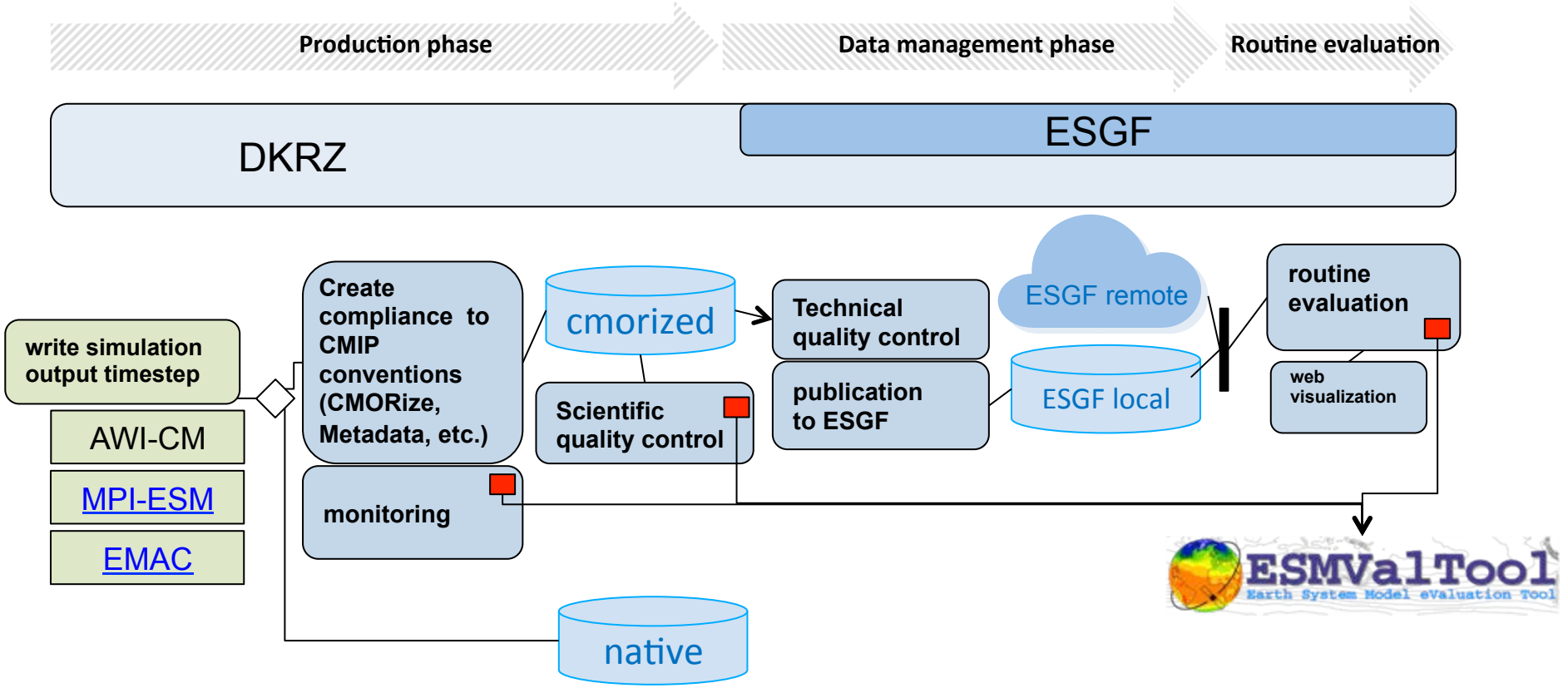
German Contribution to the 21 CMIP6-Endorsed MIPs

Short name of MIP	AWI-CM	EMAC	MPI-ESM
AerChemMIP	0	1	0
C4MIP	0	0	1
CFMIP	0	0	1
DAMIP	0	0	0
DCPP	0	0	1
FAFMIP	0	0	1
GeoMIP	0	0	1
GMMIP	0	0	1
HighResMIP	1	0	1
ISMIP6	0	0	1
LS3MIP	0	0	1
LUMIP	0	0	1
OMIP	1	0	1
PMIP	1	0	1

Short name of MIP	AWI-CM	EMAC	MPI-ESM
RFMIP	0	0	1
ScenarioMIP	0	0	1
VolMIP	0	1	1
CORDEX	1	0	1
DynVar	0	0	1
SIMIP	1	0	1
VIACS AB	0	0	0

All simulations run at DKRZ / ESMValTool is used for quality control (quicklooks, evaluation, comparison to other CMIP Models)*



** BMBF Project CMIP6-DICAD*

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

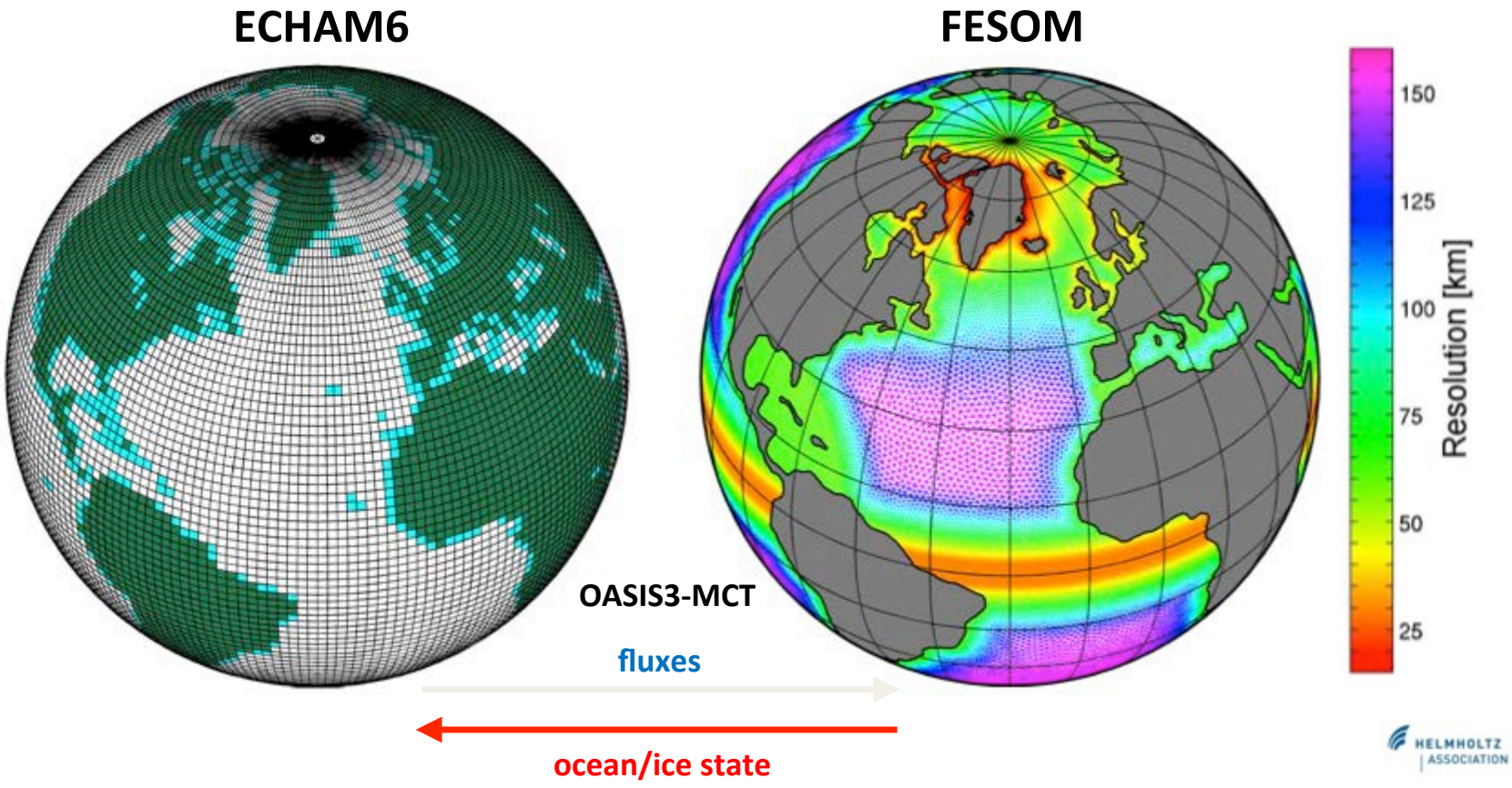
AWI-CM: Contribution to CMIP6

HELMHOLTZ ASSOCIATION

AWI-CM

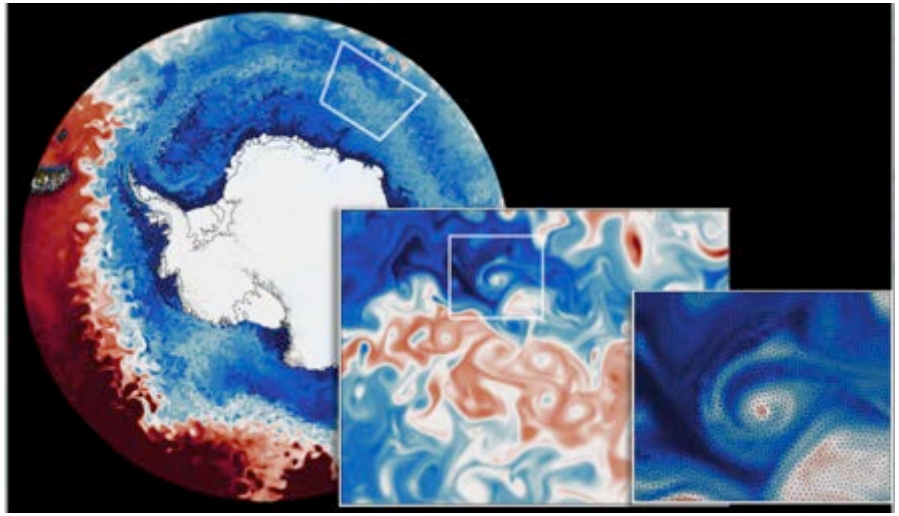
Atmosphere/land component: ECHAM6.3.02p4 including JSBACH developed at Max-Planck-Institute for Meteorology

Ocean/sea ice component: FESOM1.4 (Finite Element Sea Ice Ocean Model) developed at Alfred Wegener Institute for Polar and Marine Research



FESOM

- FESOM implements the idea of using unstructured meshes with variable resolution.
- This mesh flexibility allows to increase resolution in dynamically active regions, while keep a relatively coarse-resolution setup elsewhere.
- FESOM allows global multi-resolution simulations without traditional nesting.
- Excellent scalability characteristics allow to make effective use of massively parallel supercomputers.
- FESOM is also used as the sea ice-ocean component of the AWI Climate Model (AWI-CM), which will contribute to CMIP6.



Status of AWI-CM simulations

LR (nominal resolution: 250 km atmosphere, 50 km ocean)
DECK spin-up simulation running

LR (nominal resolution: 250 km atmosphere, 50 km ocean)
HighResMIP spin-up / control / historical completed and
being submitted to ESGF node at CEDA

MR (nominal resolution: 100 km atmosphere, 25 km ocean)
DECK spin-up simulation running

HR (nominal resolution: 100 km atmosphere, 25 km ocean)
HighResMIP spin-up completed,
HighResMIP control running, HighResMIP historical running

DECK and historical simulations to be submitted to ESGF node at DKRZ
second half of 2018; PMIP and OMIP in 2019.

Feedback / issues

CMIP6 forcing delayed: caused problems with the time line of EU project PRIMAVERA (HighResMIP simulations)

Data request changed frequently until recently: causes problems with consistency since all groups started simulations at different times

Problem particularly pronounced with HighResMIP since simulations had to be started already

ES-DOC questionnaire: not started filling it yet.

CMIP6 simulations with EMAC

Phoebe Graf, Markus Kunze, Patrick Jöckel

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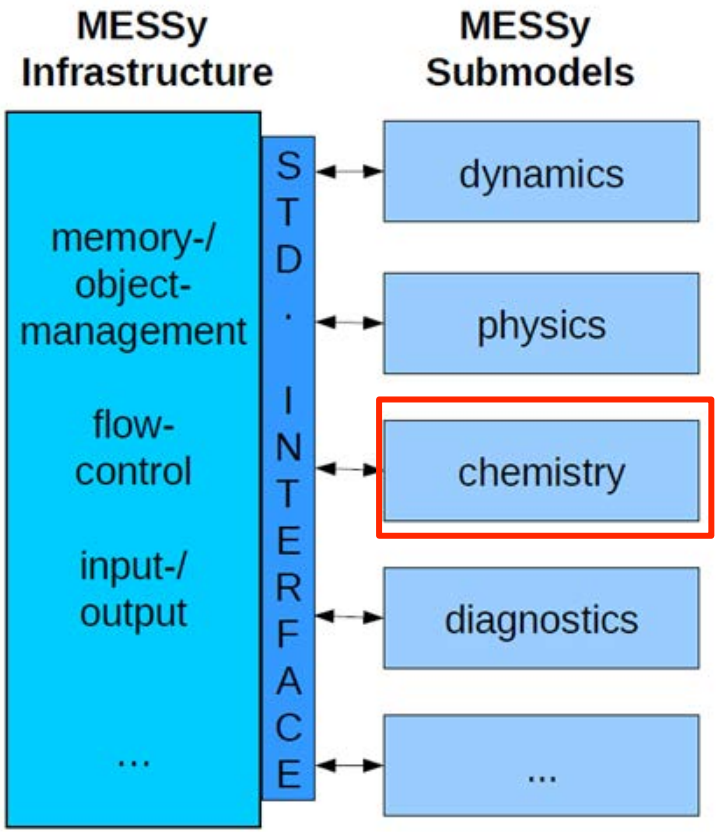
EMAC (ECHAM/MESSy Atmospheric Chemistry model) - one model for many applications



- The Modular Earth Submodel System (MESSy) couples various base models, e.g. ECHAM5, with process & diagnostic submodels.
- Submodels can be switched on / off individually, depending on the application.
- In this project, the focus is on atmospheric chemistry.

EMAC model setup

- resolution T42L47MA (~2.8° x 2.8°, 47 levels up to 0.01 hPa)
- time step 12 min
- DECK, historical and AerChemMIP simulations:
  - free-running with prescribed SSTs/SICs
  - free-running with coupled ocean model MPIOM
- Stratospheric and tropospheric chemistry
  - including NMHC chemistry: C4 + Isoprene
  - ~160 species in ~320 reactions (gas phase & PSC)
  - ~ 90 species in ~ 140 reactions (aqueous phase)
  - additional diagnostic species

Status & Feedback

Experience with CMIP6 forcings? Several updates of the forcings made repeatedly a time consuming preparation of the new data sets necessary and led to an enormous delay in the simulations.

Have you yet started any simulations, and if so which ones? No, but we are just about to start the DECK simulations.

First results from the CMIP6 simulations? Currently not available.

When are you planning to submit model output from the DECK to the ESGF? In 2018.

When are you planning to submit model output from the CMIP6 historical simulations to the ESGF? In 2018.

When are you planning to submit CMIP6-Endorsed MIPs experiments to the ESGF? In 2019.

Have you yet started filling the ES-DOC questionnaire? No, not yet.

Status & Feedback

Any additional feedback to the WGCM and CMIP Panel?

i) No further **updates in forcings** would guarantee that results from models are comparable even if the forcings are not entirely correct.

ii) The **extent of the data request** is huge. We suggest for upcoming CMIPs a strict limitation of the requested variables.

The DKRZ provided a list of the 50 most requested/downloaded CMIP5 variables. It showed almost exclusively the „standard“ variables like temperature, wind fields etc.

iii) As far as possible we try to avoid postprocessing of the model output. Therefore, tailor-made model output is generated online. Any update of the data request forces us to update our model setup and in principle to rerun the simulation. A limitation of the requested variables and a **freeze of the data request** version would help us to stay in time.

Input for WGCM-21 by Max Planck Institute for Meteorology

Overview of CMIP6 models and changes compared to CMIP5

	Atmosphere		Ocean		Additional components
MPI-ESM1.2-LR	ECHAM 6.3	T63 (1.9° x 1.9°) 47 vertical levels to 0.01 hPa	MPIOM1.63	GR1.5 (1.5° x 1.5°) 40 levels	**Land:** JSBACH3.20 <u>including</u> dynamic vegetation + Carbon- and Nitrogencycle **Ocean-Biogeochemistry:** HAMOCC
MPI-ESM1.2-HR		T127 (1.0° x 1.0°) 95 vertical levels to 0.01 hPa		TP04 (0.4° x 0.4°) 40 levels	**Land:** JSBACH3.20 <u>without</u> dynamic vegetation, Carbon- and Nitrogencycle **Ocean-Biogeochemistry:** HAMOCC
MPI-ESM1.2-XR*		T255 (0.5° x 0.5°) 95 vertical levels to 0.01 hPa			
ICON-ESM-LR**	ICON-AES	Icosahedral 160 km 47 vertical levels to 80 km	ICON-OES	Icosahedral 40 km 40 levels	**Land:** JSBACH4.20 **Ocean-Biogeochemistry:** HAMOCC

*MPI-ESM1.2-XR is part of HighResMIP and will not perform the full DECK simulations.
** Formerly registered as MPI-ESM2-LR.

Changes compared to CMIP5:

- MPI-ESM-MR replaced by the MPI-ESM-HR with doubled horizontal resolution in the atmosphere component (from T63 to T127)
- Implementation of new radiation scheme in ECHAM in all model configurations.
- Improvement of energy leakage in all model configurations.
- Additional diagnostics implemented to serve the CMIP6 output requirements.
- Implementation of YASSO as the new JSBACH soil carbon model and implementation of the land nitrogen in JSBACH (both relevant only for MPI-ESM1.2-LR).

- ICON-ESM a completely new coupled GCM not available in CMIP5.

Matthias Bittner / Karl-Hermann Wieners / Bjorn Stevens

Experience with CMIP6 forcing

Overall clear structure of available forcing datasets and googledoc with Forcing Dataset Summary is very helpful. **Input4MIPs** as a central place to download the data is very useful as well.

Some issues:

-**Land Use Dataset** was somewhat delayed which hampered the tuning and starting of the experiments. At the MPI-M, we had some issues with the dataset because in LUHv2 the desert fraction is part of the natural vegetation (which was not the case in LUHv1). However, the relevance of this issue might be model dependent.

-**The stratospheric aerosol dataset** had some issues, due to the fact that in v2 the values below the tropopause should be removed. A climatological tropopause was provided after some discussion. However, at MPI-M we decided to use a climatological tropopause of the model (not observations). This might lead to small difference in the tropopause height in different models.

-**The bug fix for the stratospheric aerosols (v2 to v3)** is a problem. In the first announcement by Paul Durack (email 31st August 2017) it was said that only values from 1971 to 1973 should be changed from v2 to v3. We already started historical simulations with the more expensive HR and XR models, but it might have been possible to rerun the experiments from 1970 onwards. However, in v3 the background aerosols as well as volcanic eruptions in the earlier part of the historical simulations changed as well. Now we decided that we most likely will not repeat the simulations but stick to the v2 version of the stratospheric aerosols. For the simulations with the MPI-ESM1.2LR, we will use v3.

-It is not clear to us when the **forcing datasets for the scenarios** will be provided. The googledoc says August 1st, but for now we could not find them.

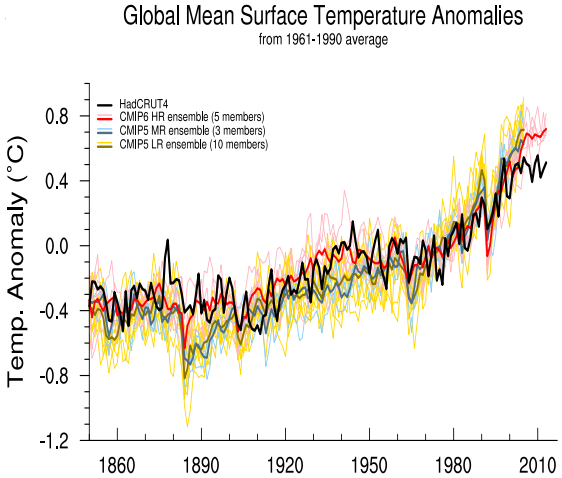
-**AMIP SST and SIC:** Between the version v1.1.0 and v1.1.2 there were conversions for SST between Kelvin and °C and for SIC between fraction (between 0 and 1) and percentage (0 -100). This caused some issues while testing the model. It would be beneficial if for future release, the AMIP data stick to one metric.

Simulations started and first results

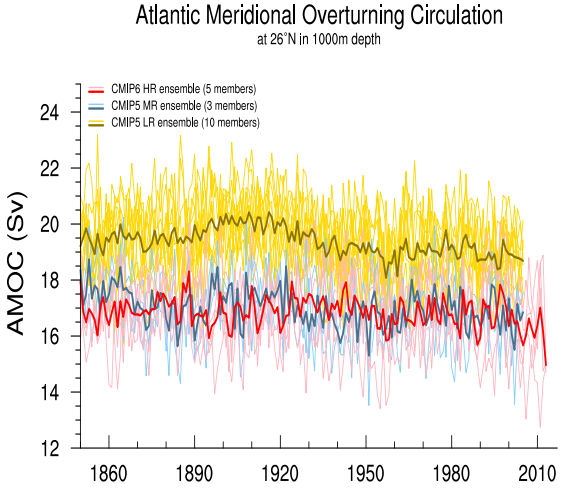
DECK:

MPI-ESM1.2-HR

- piControl (500 years). Additional 500 years will be performed
- Historical simulations (5 members). 5 additional members will be performed



GMST anomalies simulated with the MPI-ESM1.2-HR and CMIP6 forcing data over the historical period are in good agreement with observations (top figure). The cooling after volcanic eruptions as well as the warming in the 1930s are closer to HadCRUT4 compared to the CMIP5 version of the MPI-ESM.



The AMOC shows a realistic magnitude of about 16 Sverdrup, comparable to the CMIP5 MPI-ESM-MR configuration (bottom figure), which has the same resolution in the ocean as the MPI-ESM1.2-HR.

HighResMIP:

MPI-ESM1.2-HR

1950 spin-up
Extended AMIP
Control
Historical

MPI-ESM1.2-XR:

1950 spin-up
Extended AMIP
Control about 30% done
Historical about 15% done

Additional Notes from MPI:

1.The new model also has a treatment of aerosol radiation and aerosol-cloud interactions using the simple plume approach, this should be mentioned

2.The model was tuned to best match our understanding of the 20th century

3.We are not using a background volcanic aerosol in the control, and don't find that making the PiControl sensitive to an evolving understanding of the historical record (let alone bugs) is a step forward.

4.Worries about ES-DOC and double documentation that is not peer reviewed. Last time our model development team was very skeptical about ES-DOCs predecessor, so ES-DOC data provision not a priority for us => Presently no plans to fill out ES-DOC and we would much prefer that WGCM and the CMIP panel first work on improving and adding recommendations for standard elements to the model documentation papers.

5.Planning to submit model output from DECK and historical to ESGF: end of 2017

6.Planning to submit model output from MIPs to ESGF: spring/summer 2018