

# **Norwegian Earth System Model and data management**

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# Outline

- ▶ **NorESM (Norwegian Earth System Model) Overview**
- ▶ **Data Storage**
- ▶ **CMIP5 archive**

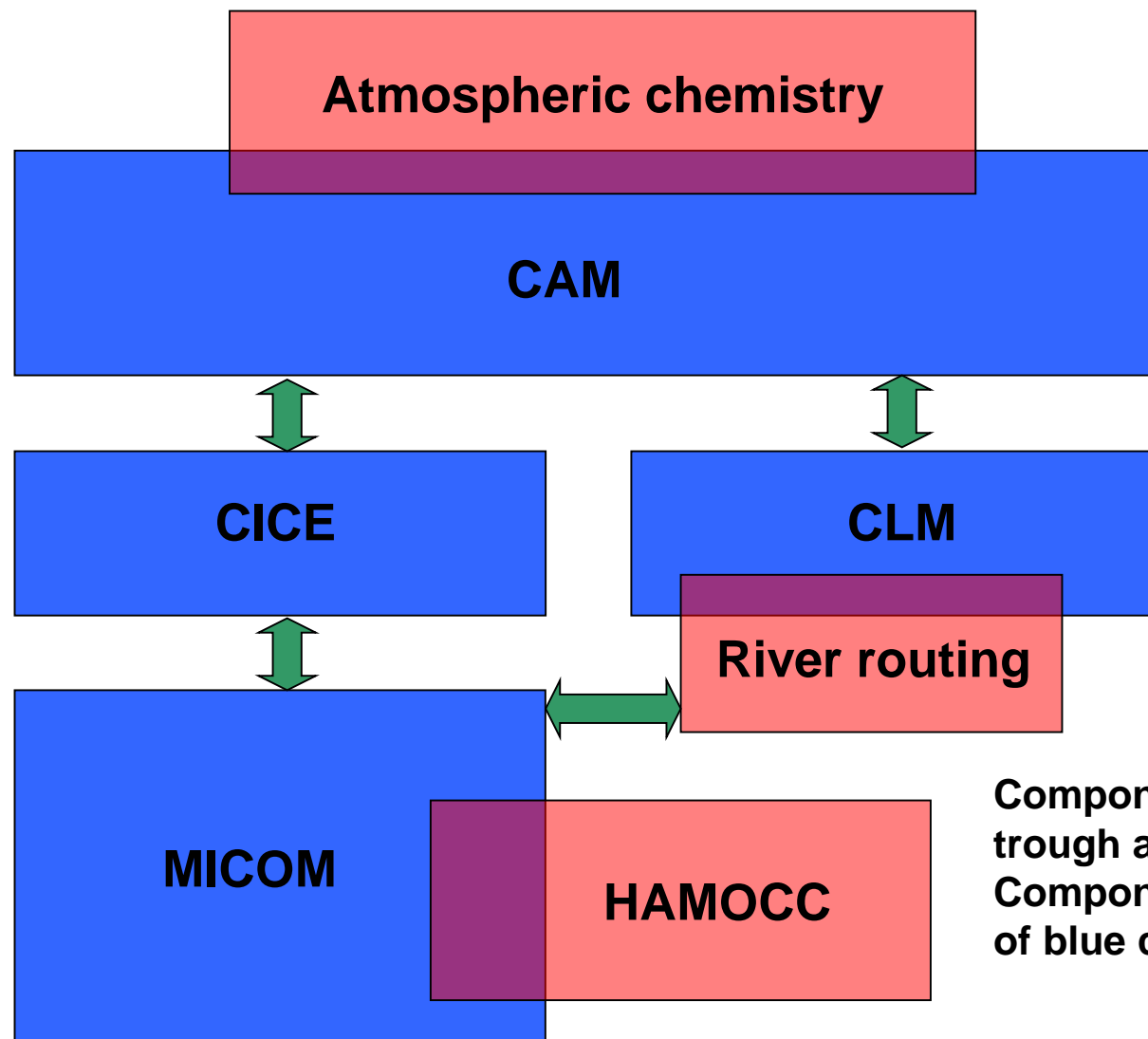
# NorESM framework and model components

- NorESM is based on version 1 of the Community Earth System Model (CESM1) from the University Corporation for Atmospheric Research and National Center for Atmospheric Research, Boulder, USA.

## **Specific NorESM additions to CESM1:**

- Ocean component: NorESM-O, originates from the Miami Isopycnic Coordinate Ocean Model (MICOM) but extensively modified at the Bjerknes Centre.
- Atmospheric chemistry: Chemistry-aerosol-cloud package in CAM4 by University of Oslo and met.no.
- Ocean Carbon Cycle: Hamburg Model of Ocean Carbon Cycle (HAMOCC) adopted for use with an isopycnic ocean model at the Bjerknes Centre.

# NorESM framework and model components



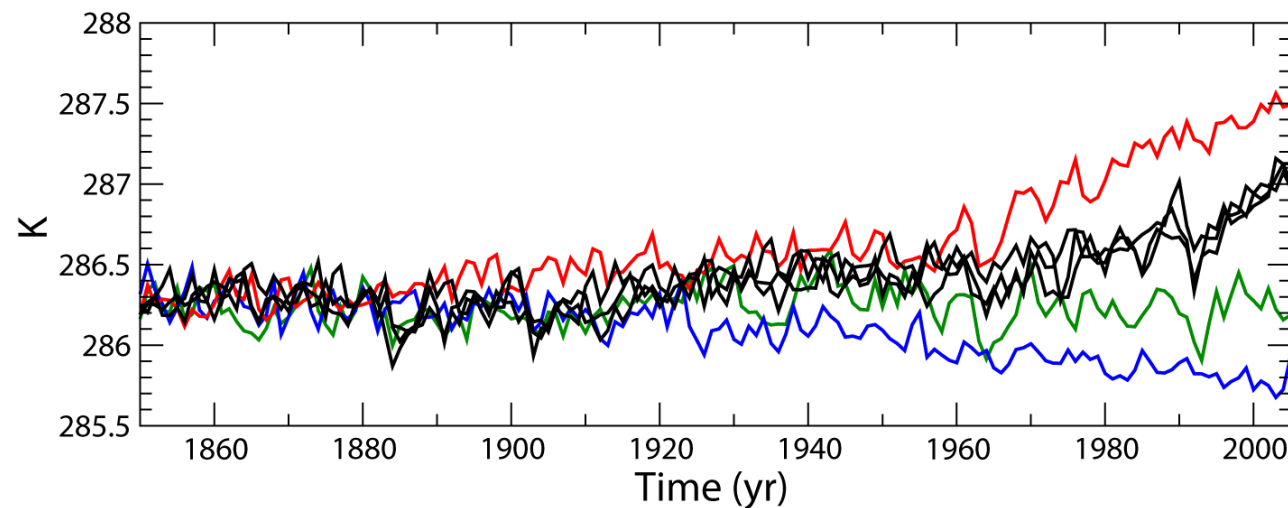
Components in **blue** communicate through a coupling component. Components in **red** are subroutines of blue components.

# NorESM status

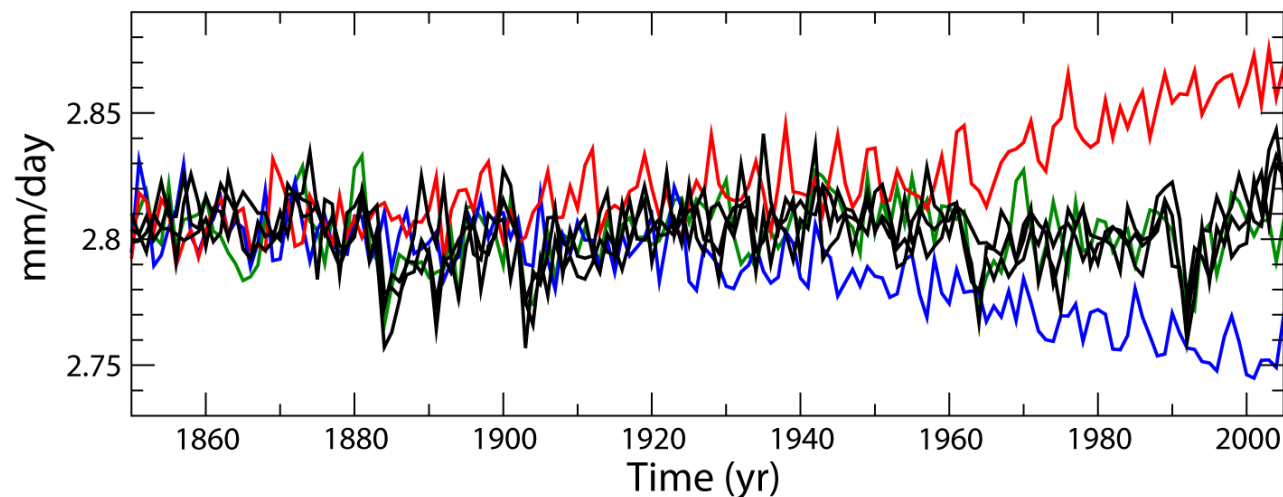
- In June 2011 we most of the NorESM1-M experiments without interactive carbon cycle available to CMIP5. We was the 7<sup>th</sup> modelling center to deliver.
- NorESM1-ME experiments with interactive carbon cycle was also delivered in time to be used in many studies cited in IPCC AR5.
- According to the CMIP5 website (<http://cmip-pcmdi.llnl.gov>), NorESM1-M/NorESM1-ME experiments have been used in more than 160 peer-reviewed publications.
- Completed documentation of the CMIP5 version of NorESM and associated experiments.
- Low resolution configuration of NorESM for millennia scale simulations exists, but work is ongoing to establish an improved low resolution configuration.

# Historic experiments with individual forcing

Near surface air temperature



Precipitation rate



GHG forcing only  
All forcing elements  
Natural forcing only  
Aerosol forcing only

# Tentative schedule for NorESM2 development

- First development version of NorESM2 based on CESM1.2 is configured.
- Frozen model version with respect to dynamical core, physics, physical parameterizations, configuration and parameter tuning (mid-2016).
- Submittal of experiments to CMIP6 (mid-2017).

# Model data Storage – an Example using NorESM

- **Model output is produced on Notur's Computational facilities**
  - Limited typically 1 week
- **For longterm archiving, raw model output is transferred to NorStore**
  - A folder is created for each model experiment
  - Located under NorClim project
  - All members of NorClim group have read access
- **Basic processing can be performed at NorStore and catalogue can be mounted or data can be transferred.**
- **Raw model output is not accepted in CMIP; an advanced post-processing is required to reorganize the data in standardized form**
  - Tools are Fortran based and use Climate Model Output Rewriter (CMOR) library to ensure conformance with the metadata conventions for climate data and forecast (CF conventions)
  - Versioning tool is used that follows Data Reference Syntax (DRS) conventions



# Continue...

- Member of ESGF (Earth System Grid Federation)
- Norwegian ESGF data node <http://noresg.norstore.no>
- Data published to NorStore's Climate Data Node can be accessed via <http://pcmdi9.llnl.gov> Earth System Grid Federation's portals or any of their members node
- Climate model data that contributes to major climate inter-comparison projects are mirrored
- In case of NorESM, DKRZ produces a replica of model data and performs quality control and assigns doi-numbers for data

## **A white paper on data management of climate data in Norway**

### **NorStore services for Environmental and Climate data**

*Øystein Godøy, Benjamin Pfeil, Helge Sagen, Ingo Bethke, Mats Bentsen, Stein Tronstad, Andreas Jaunsen*

# NorESM1-M coupled CMIP5 archived experiments.

Experiment	No.	Tier	Years	Ens. size	Type
Pre-industrial control	3.1	core	450	1	CPL
Historical (1850-2005)	3.2	core	156	1	CPL
Ensemble of historical runs	3.2-E	tier 1	156	2	CPL
RCP4.5 (2006-2100)	4.1	core	95	1	CPL
RCP4.5 (2100-2300)	4.1-L	tier 1	200	1	CPL
RCP8.5 (2006-2100)	4.2	core	95	1	CPL
RCP2.6 (2006-2100)	4.3	tier 1	95	1	CPL
RCP6.0 (2006-2100)	4.4	tier 1	95	1	CPL
1% per year CO2	6.1	core	140	1	CPL
Abrupt 4xCO2	6.3	core	150	1	CPL
Historic with natural forcing only	7.1	tier 1	156	1	CPL
Historic with GHG forcing only	7.2	tier 1	156	1	CPL
Historic with aerosol forcing only	7.3	tier 1	156	1	CPL

**NorESM1-M: Medium resolution  
(atmosphere/land 1.9°×2.5°,  
ocean/sea-ice 1.125° along equator)  
without interactive carbon cycle.**

# NorESM1-M atmosphere only CMIP5 archived experiments.

Experiment	No.	Tier	Years	Ens. size	Type
2030 time-slice	2.1	core	10	1	A
AMIP (1979-2008)	3.3	core	30	1	A
Ensemble of AMIP runs	3.3-E	tier 1	30	3	A
Control SST climatology (from exp 3.1)	6.2a	core	>30	1	A
CO2 forcing	6.2b	core	>30	1	A
Aerosol forcing	6.4	core	>30	1	A
4xCO2 AMIP	6.5	tier 1	30	1	A

# NorESM1-ME CMIP5 archived experiments.

Experiment	No.	Tier	Years	Ens. size	Type
ESM pre-industrial control	5.1	core	>250	1	ESM
ESM historical	5.2	core	156	1	ESM
ESM RCP8.5 (2006-2100)	5.3	core	95	1	ESM
ESM fixed climate 1	5.4-1	tier 1	140	1	ESM
ESM fixed climate 2	5.4-2	tier 1	251	1	ESM
ESM feedback 1	5.5-1	tier 2	140	1	ESM
ESM feedback 2	5.5-2	tier 2	251	1	ESM

**NorESM1-ME: Medium resolution  
including interactive carbon cycle.**

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# Thanks