Introduction to NorESM

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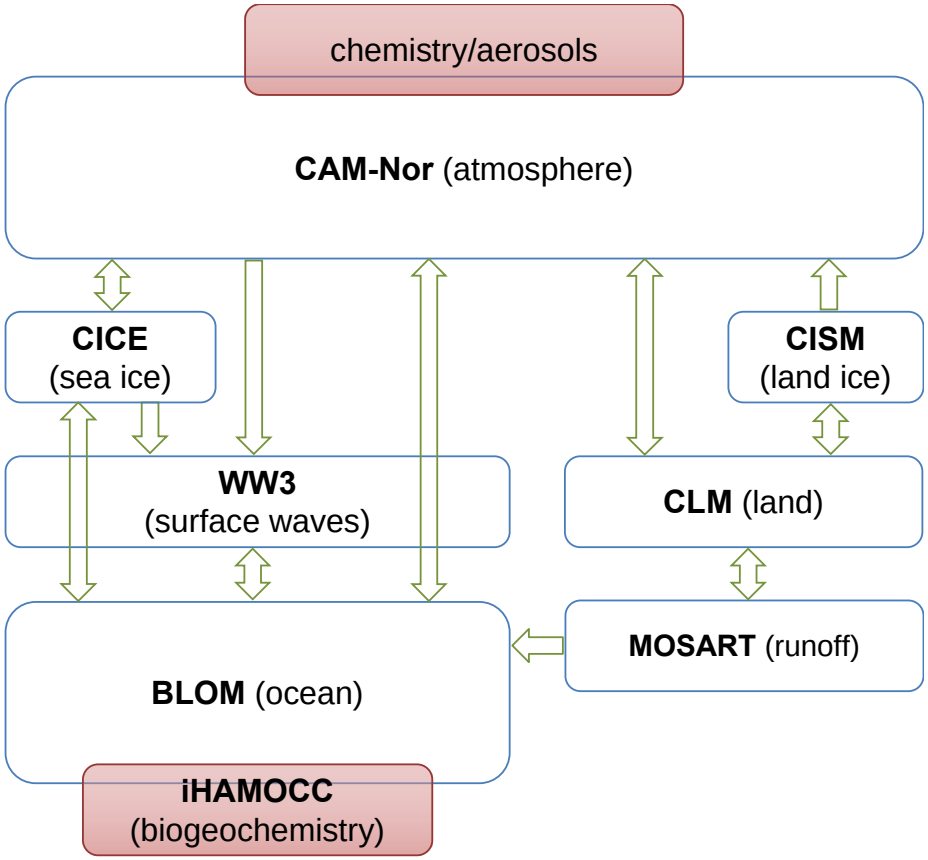
[3] University of Bergen

Outline

- NorESM overview and differences to CESM
- Some dynamical and physical characteristics
- Scientific updates in NorESM2 compared to NorESM1
- CMIP6 status
- NorESM infrastructure
- Plans for further NorESM development

Norwegian Earth System Model (NorESM)



Based on Community Earth System Model (CESM) of NCAR, Boulder, USA.

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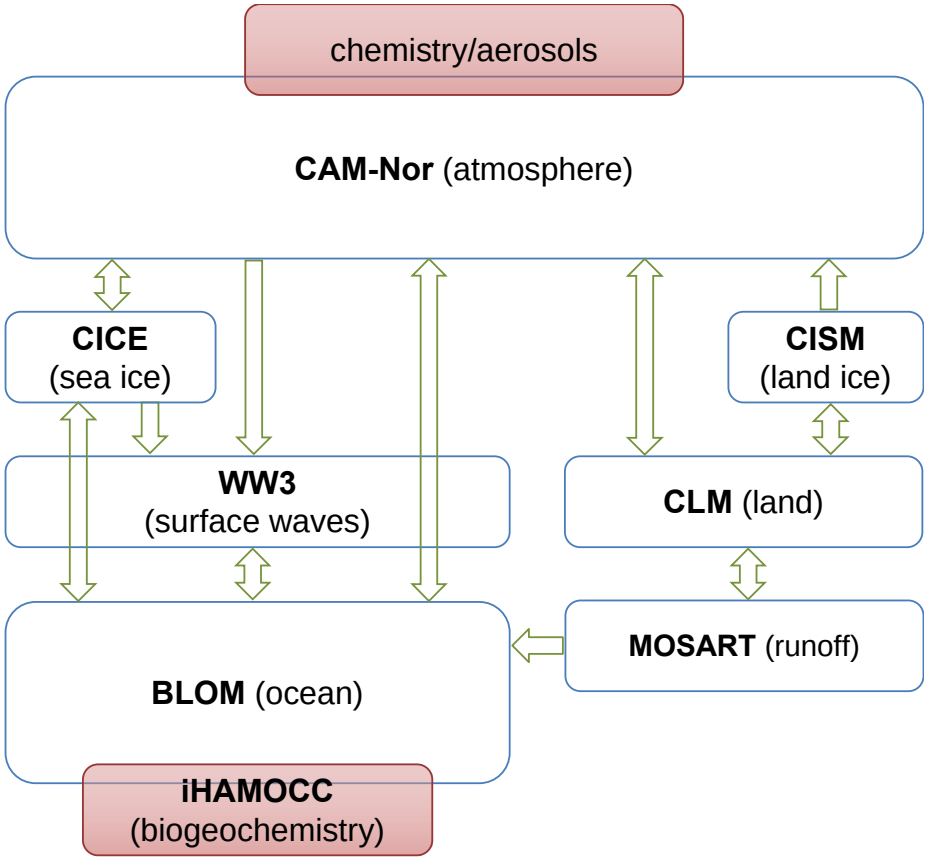

Consortium:

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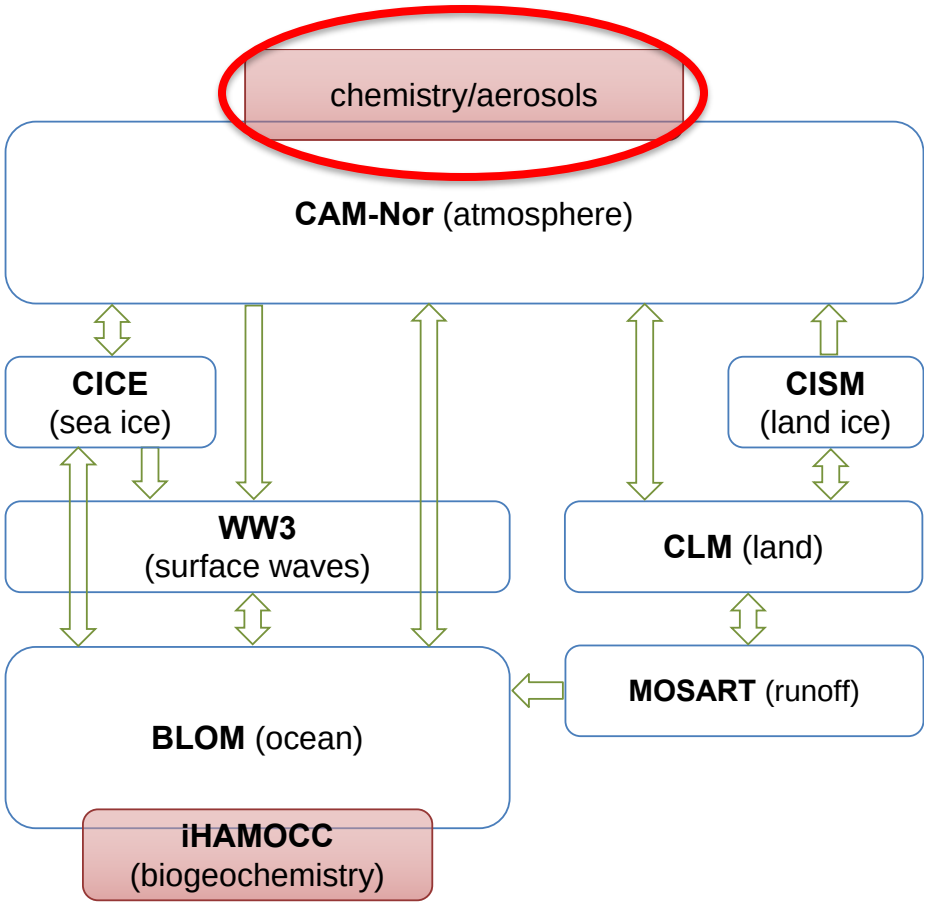

Specific NorESM additions to CESM:

- Atmospheric chemistry/aerosol/cloud module

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Norwegian Meteorological Institute

Oslo

INES

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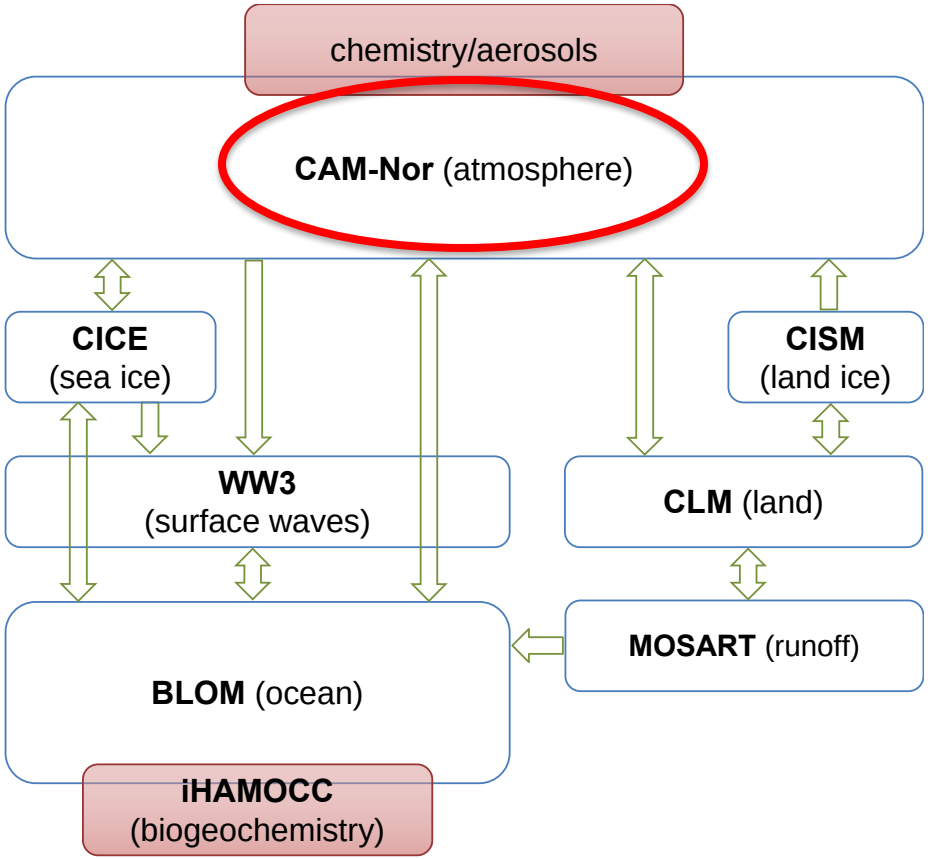

Specific NorESM additions to CESM:

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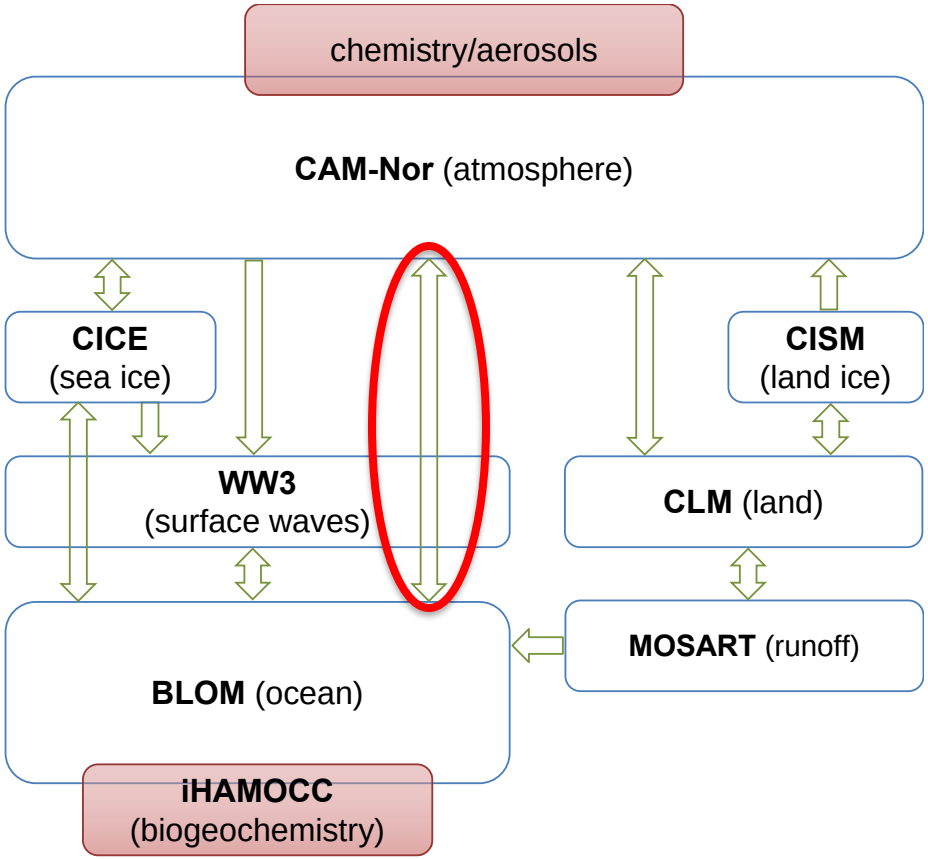

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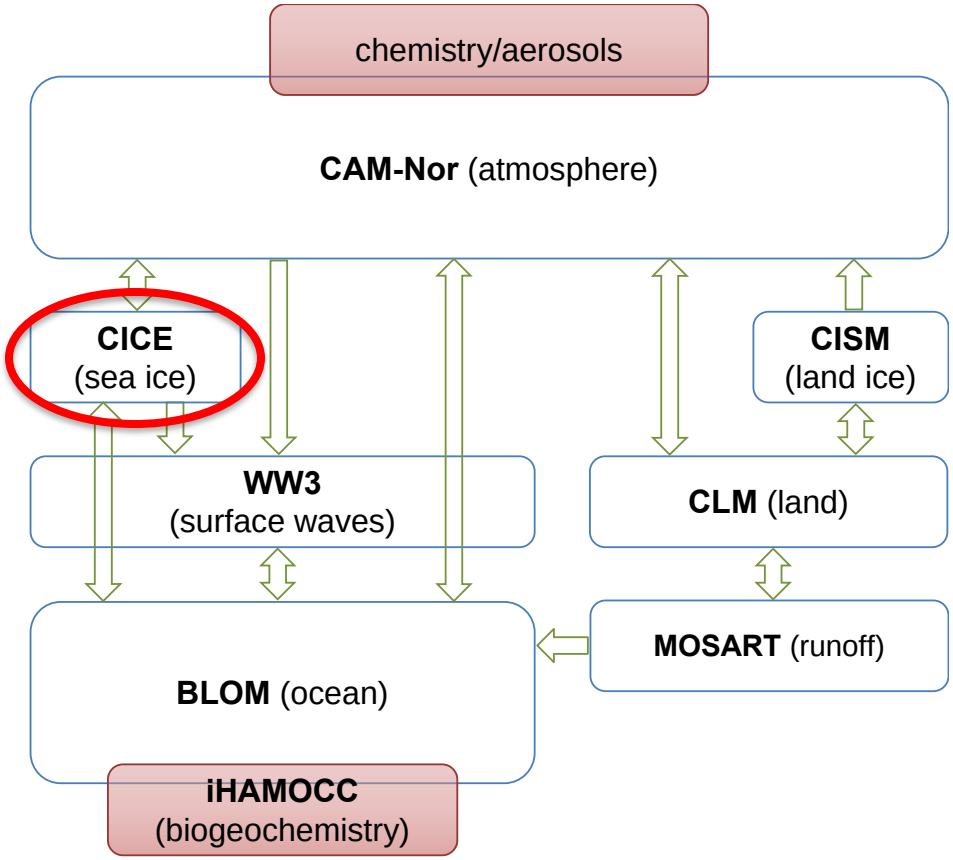

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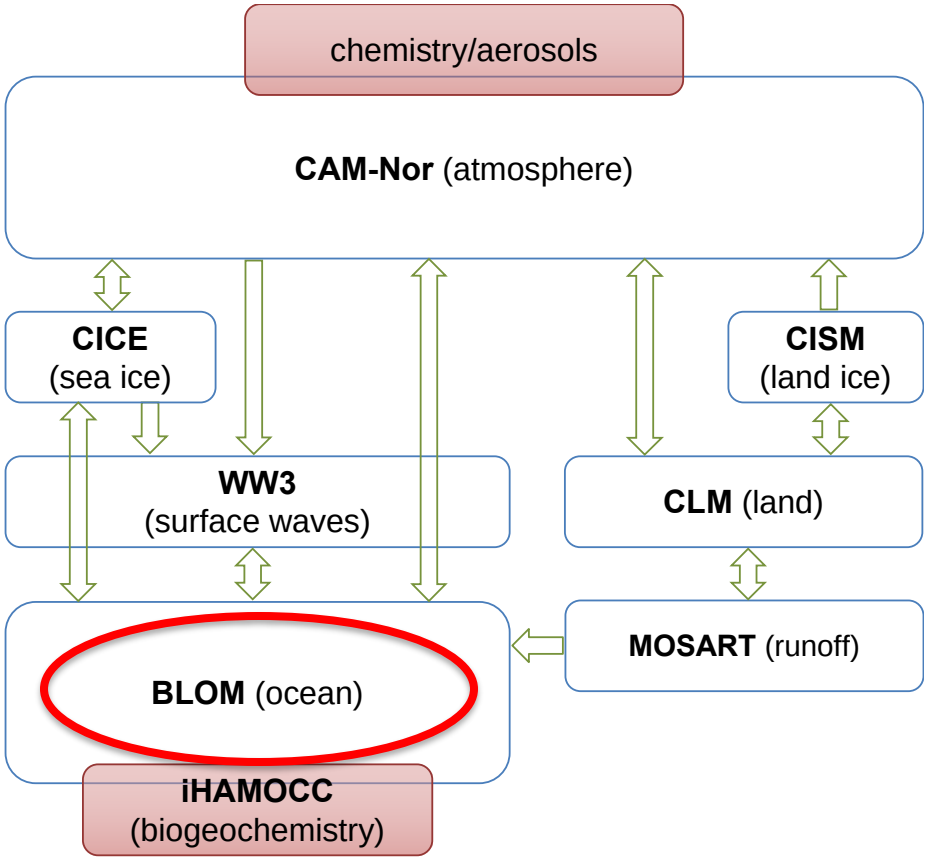

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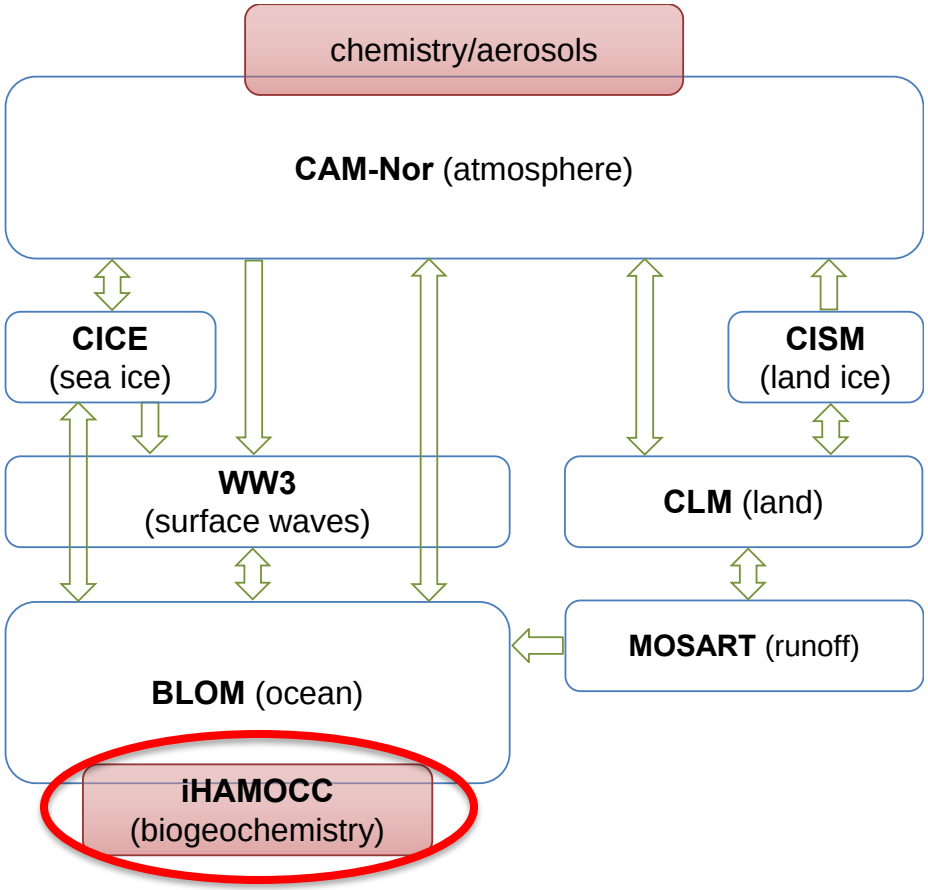
Norwegian Earth System Model (NorESM)



Specific NorESM additions to CESM:

- Atmospheric chemistry/aerosol/cloud module
- Atmospheric dynamics/physics: Improved conservation of energy and angular momentum
- Parameterization of turbulent air-sea fluxes
- Wind drift of snow
- Ocean component with isopycnic vertical coordinate
- Hamburg Model of Ocean Carbon Cycle (HAMOCC) adopted for use with isopycnic ocean model and further developed

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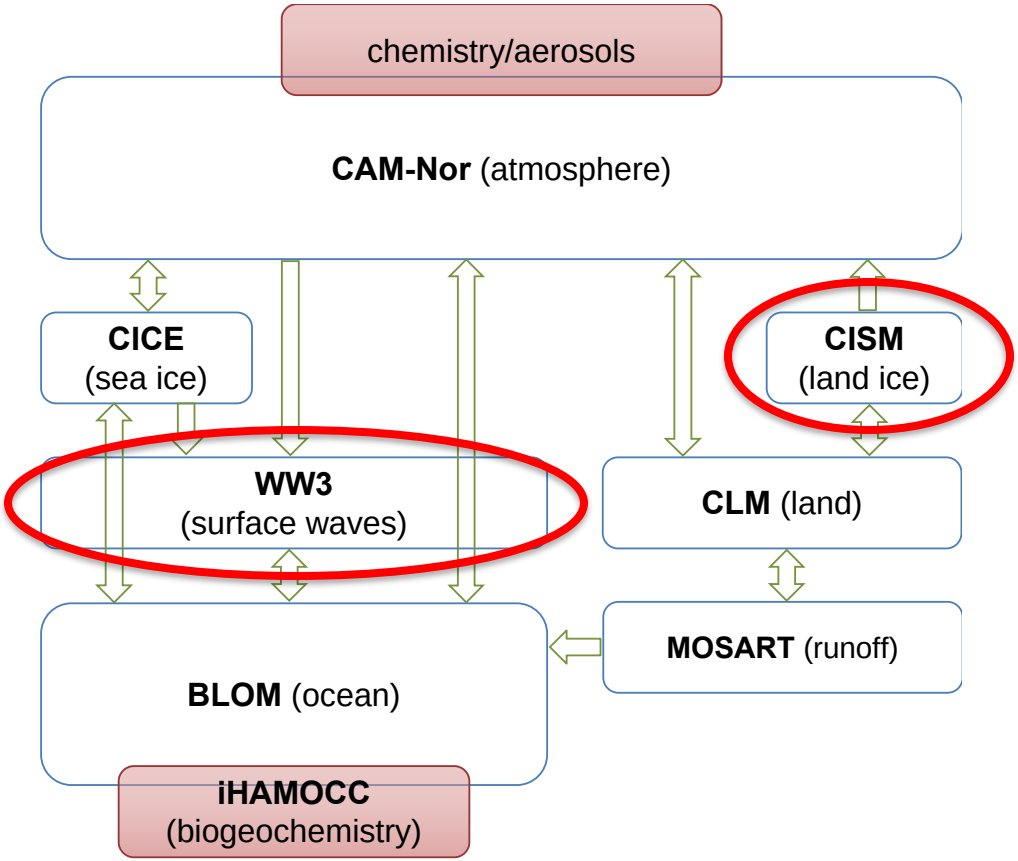
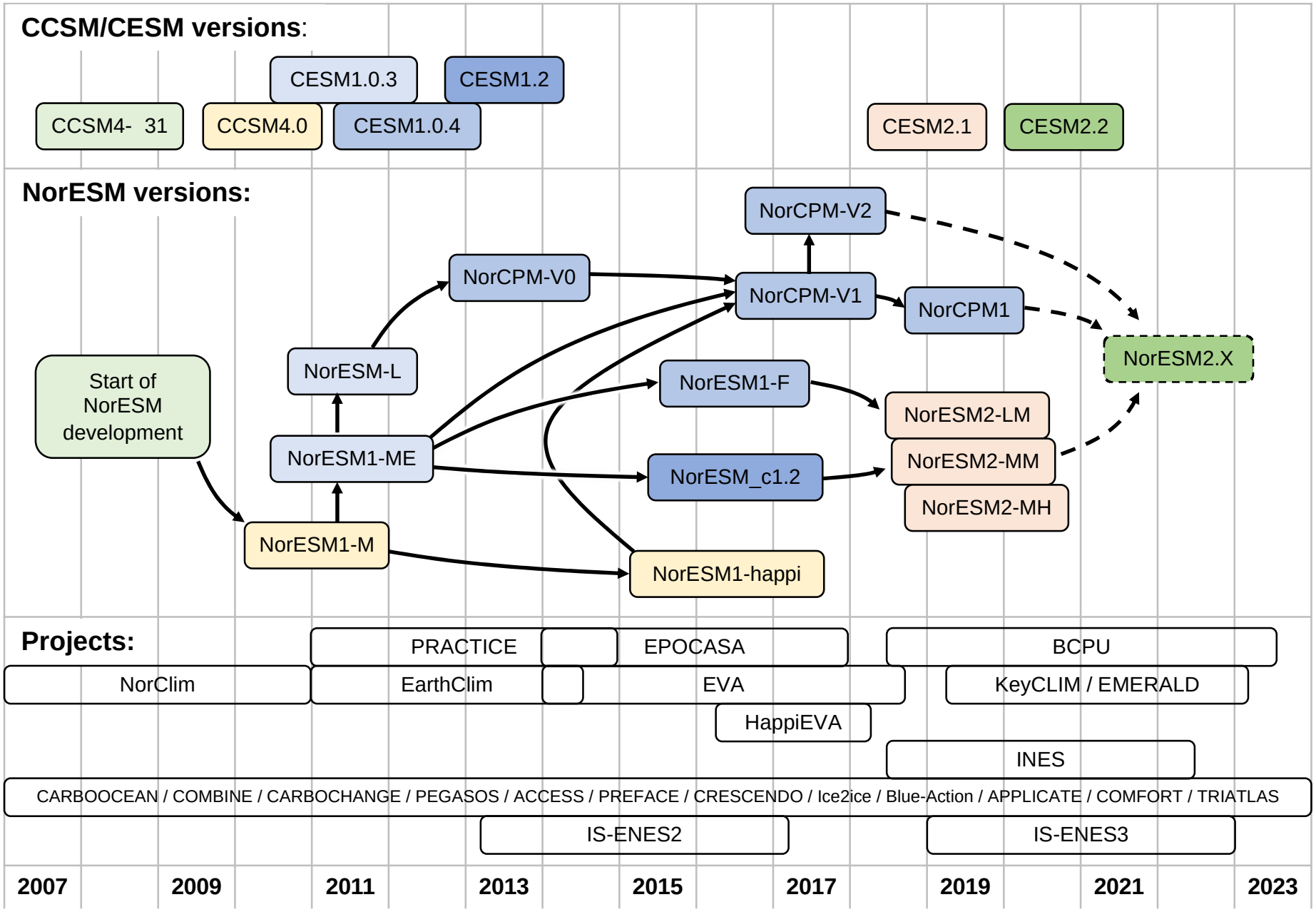


NorESM2.X / NorESM3

CISM – land ice is available in experimental versions of NorESM2

WW3 – ongoing work to include surface waves as a model component

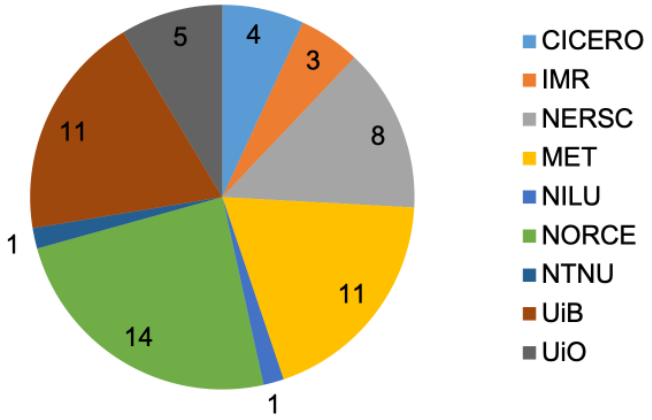
NorESM genealogy



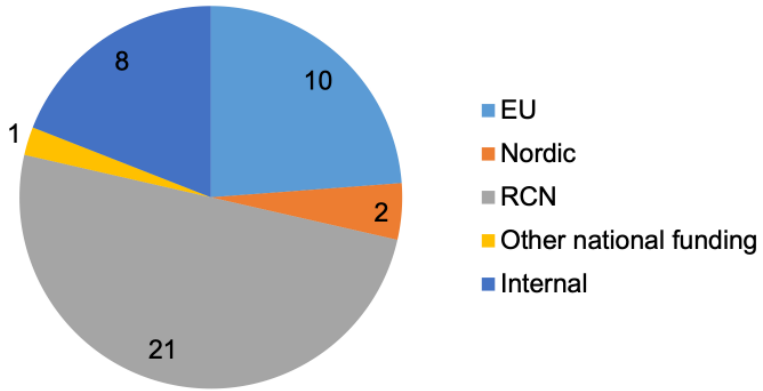
Users and developers of NorESM

- Based on a survey from February 2021.
- In total 58 national users and developers of NorESM in 2020.

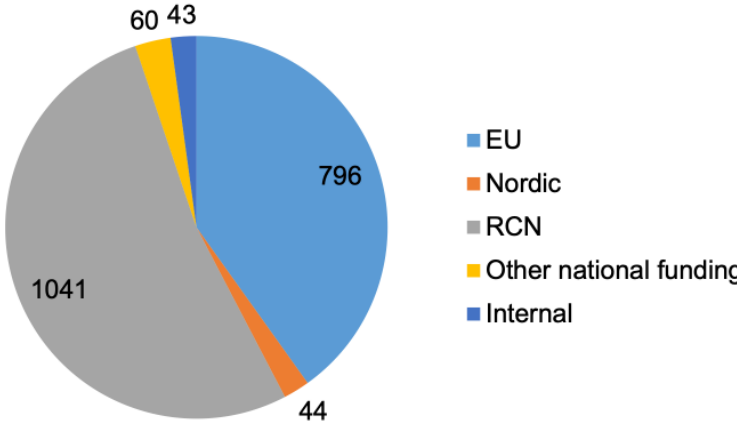
National users



Number of projects

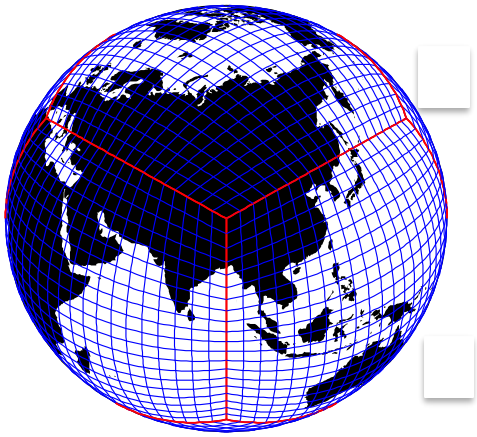


Total grant size (MNOK)

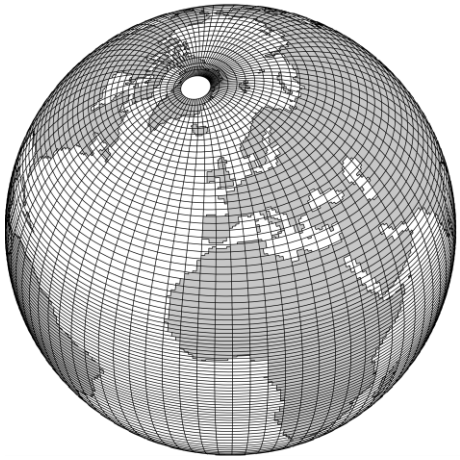


Component discretization

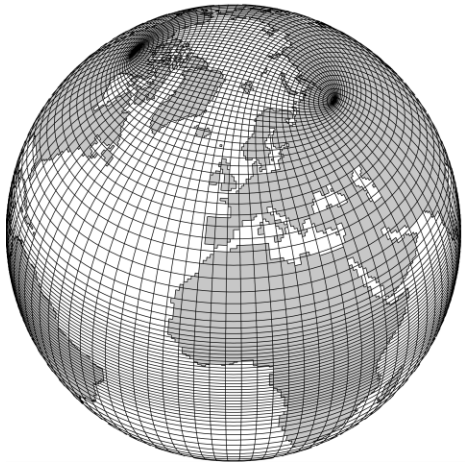
CAM finite volume



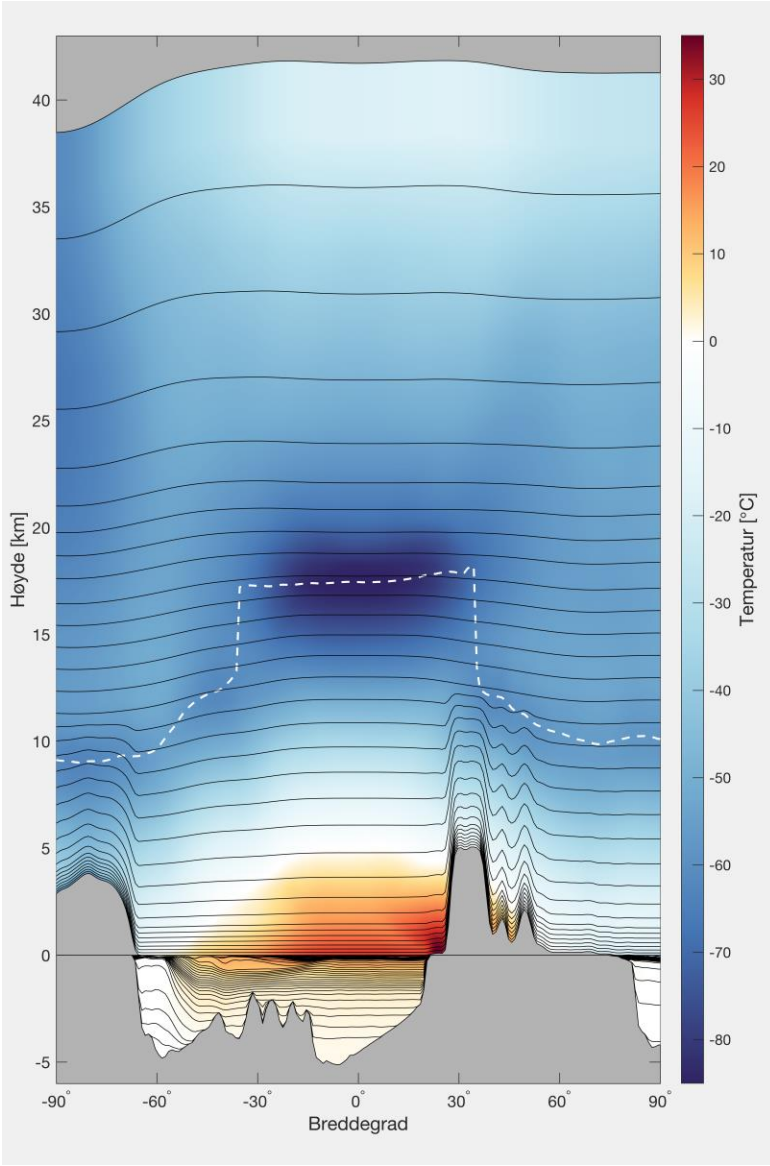
CAM spectral element



BLOM/CICE bipolar

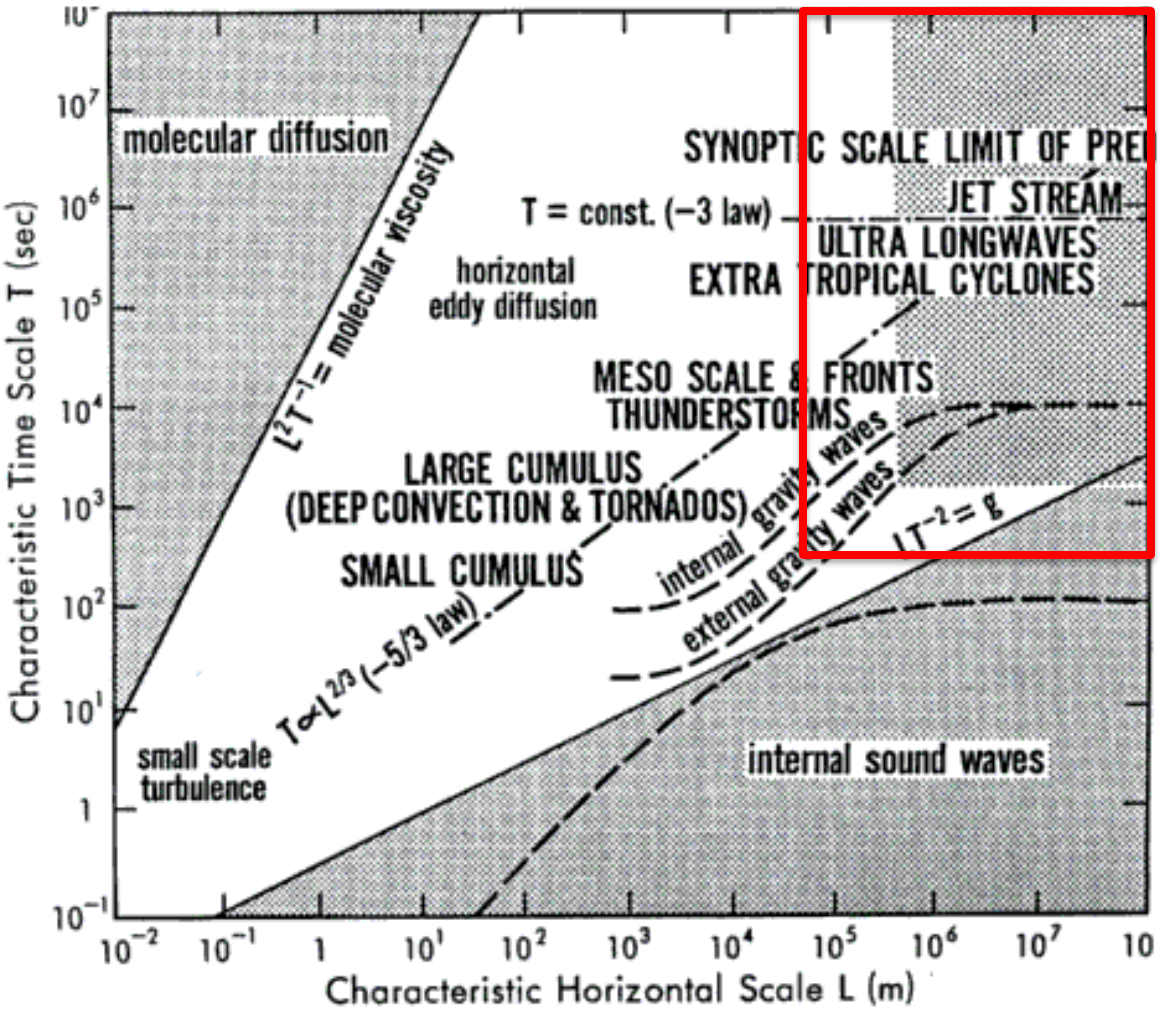


BLOM/CICE tripolar



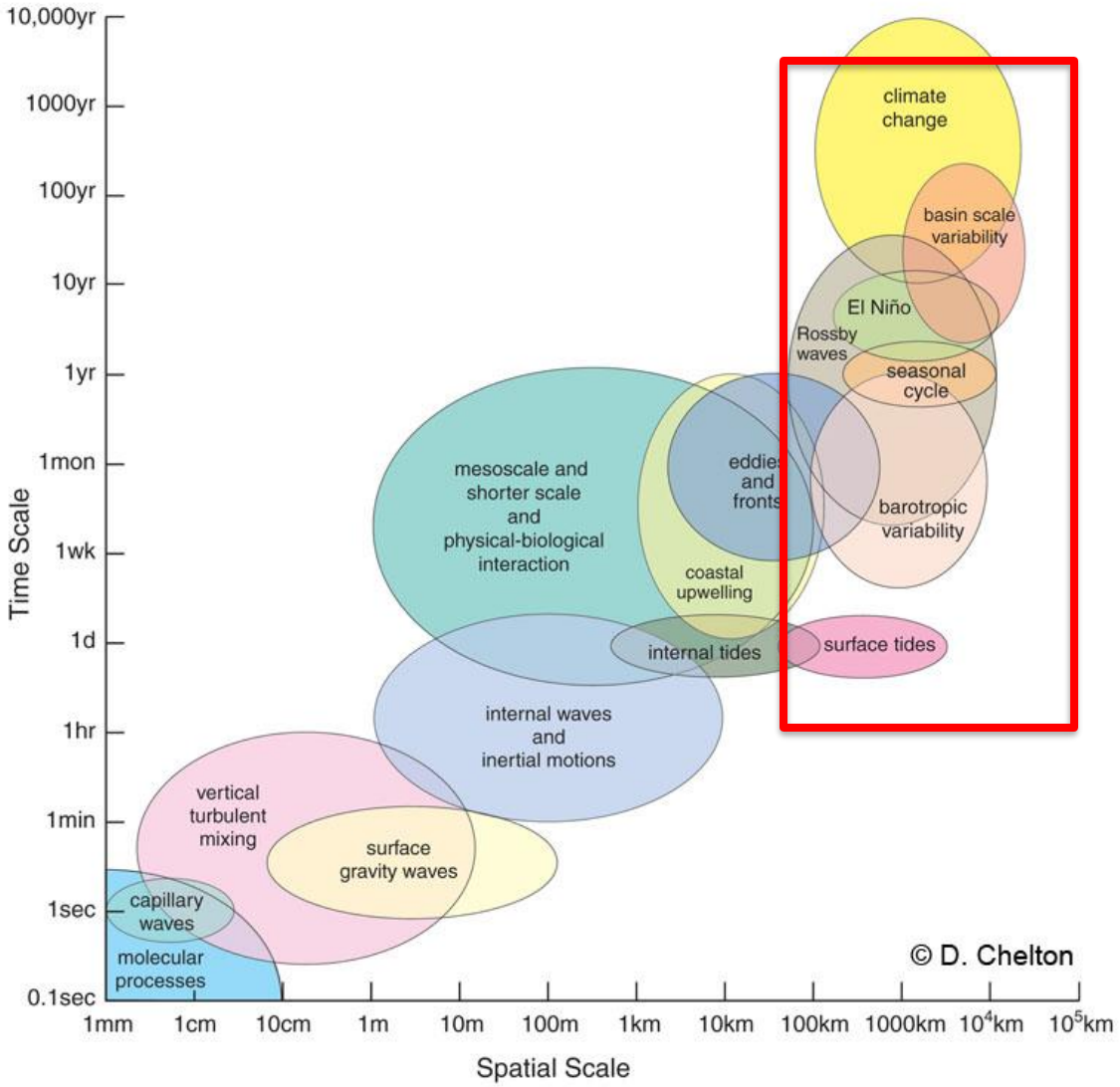
April temperature of NorESM2 along 87.5°E

Spatial and temporal scales of the atmosphere

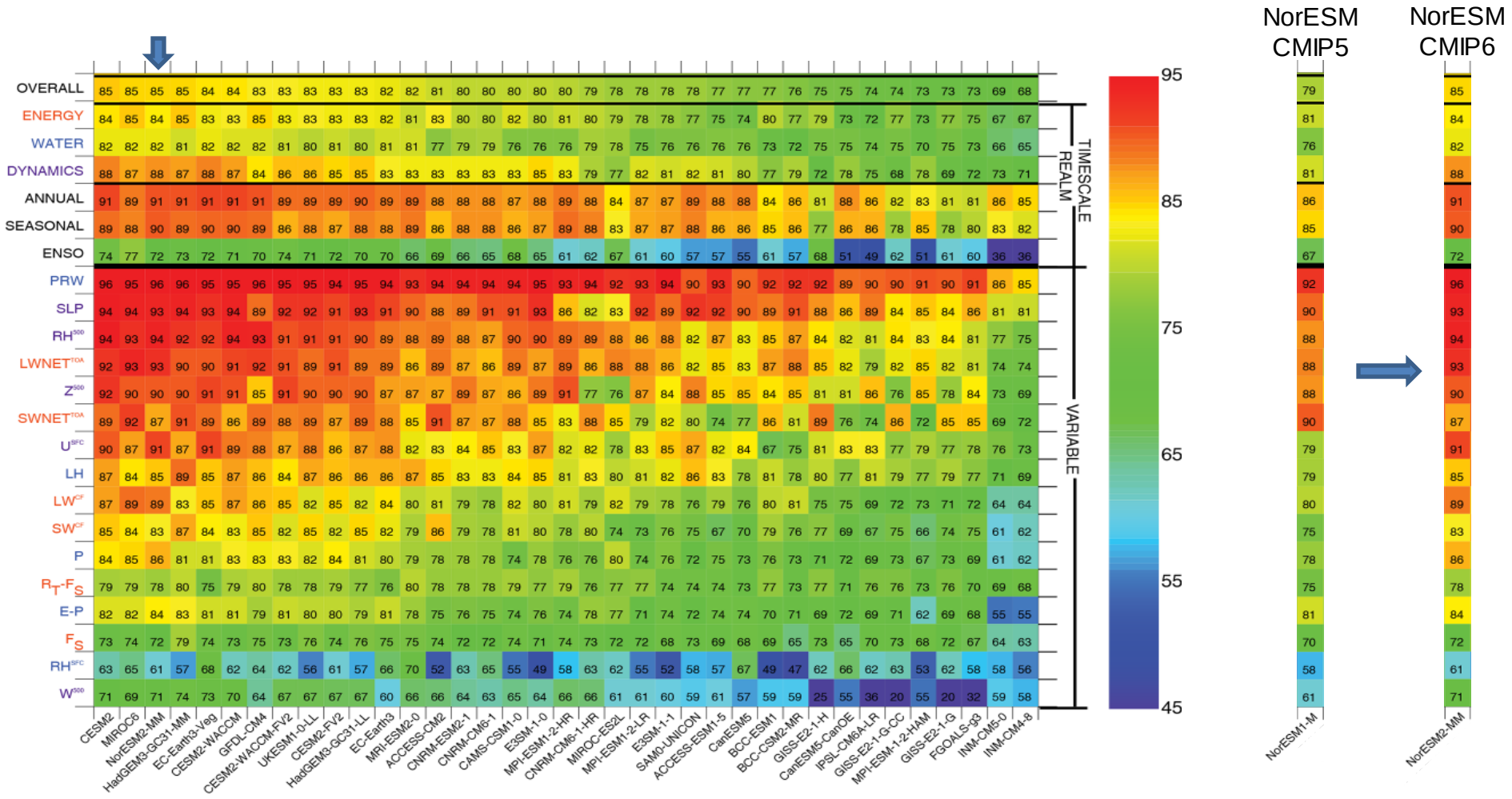


Courtesy: Smagorinsky (1974).

Spatial and temporal scales of the ocean



CESM2/NorESM2 developments



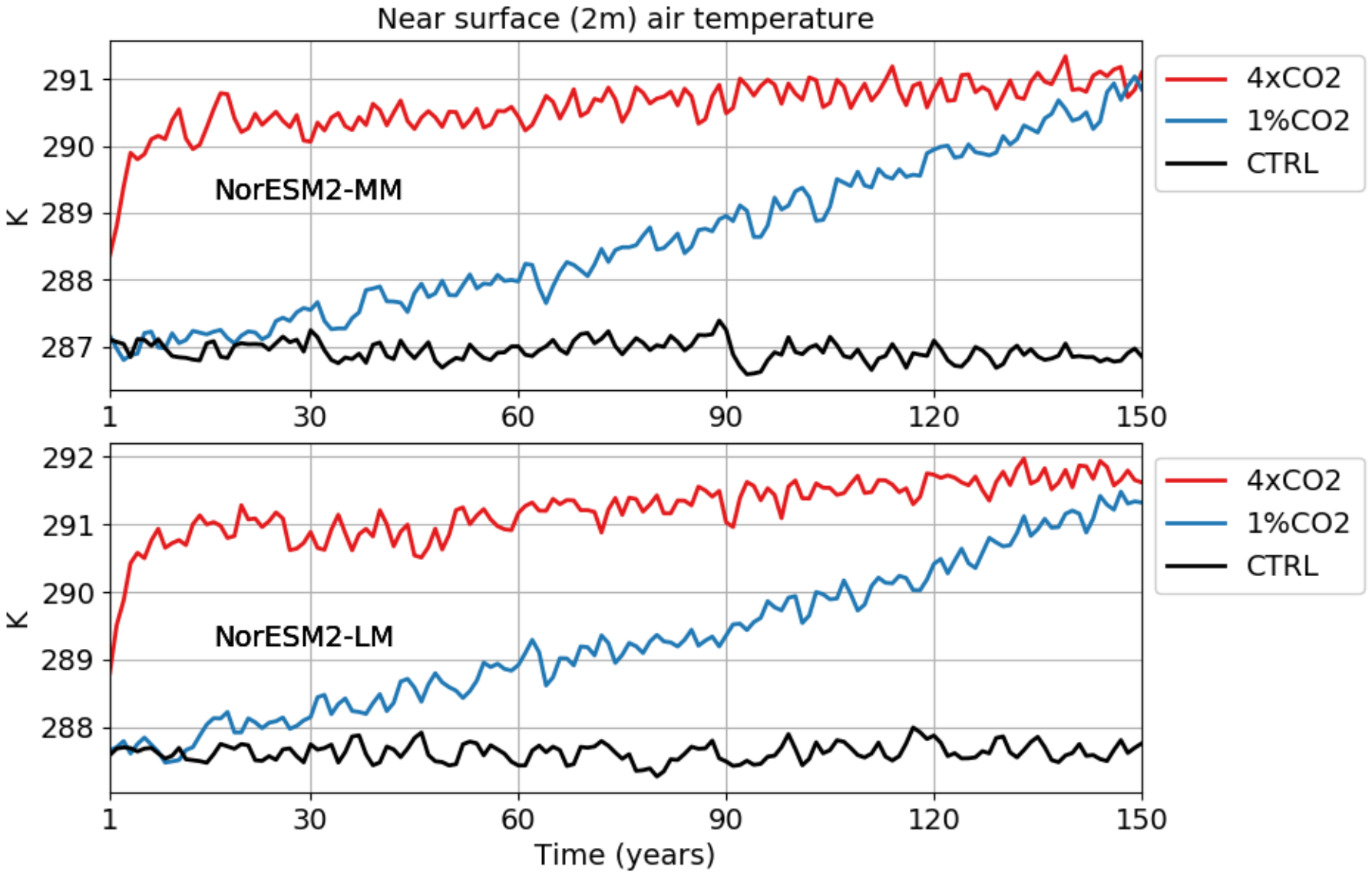
Courtesy: Fasullo (2020).

CMIP6 status

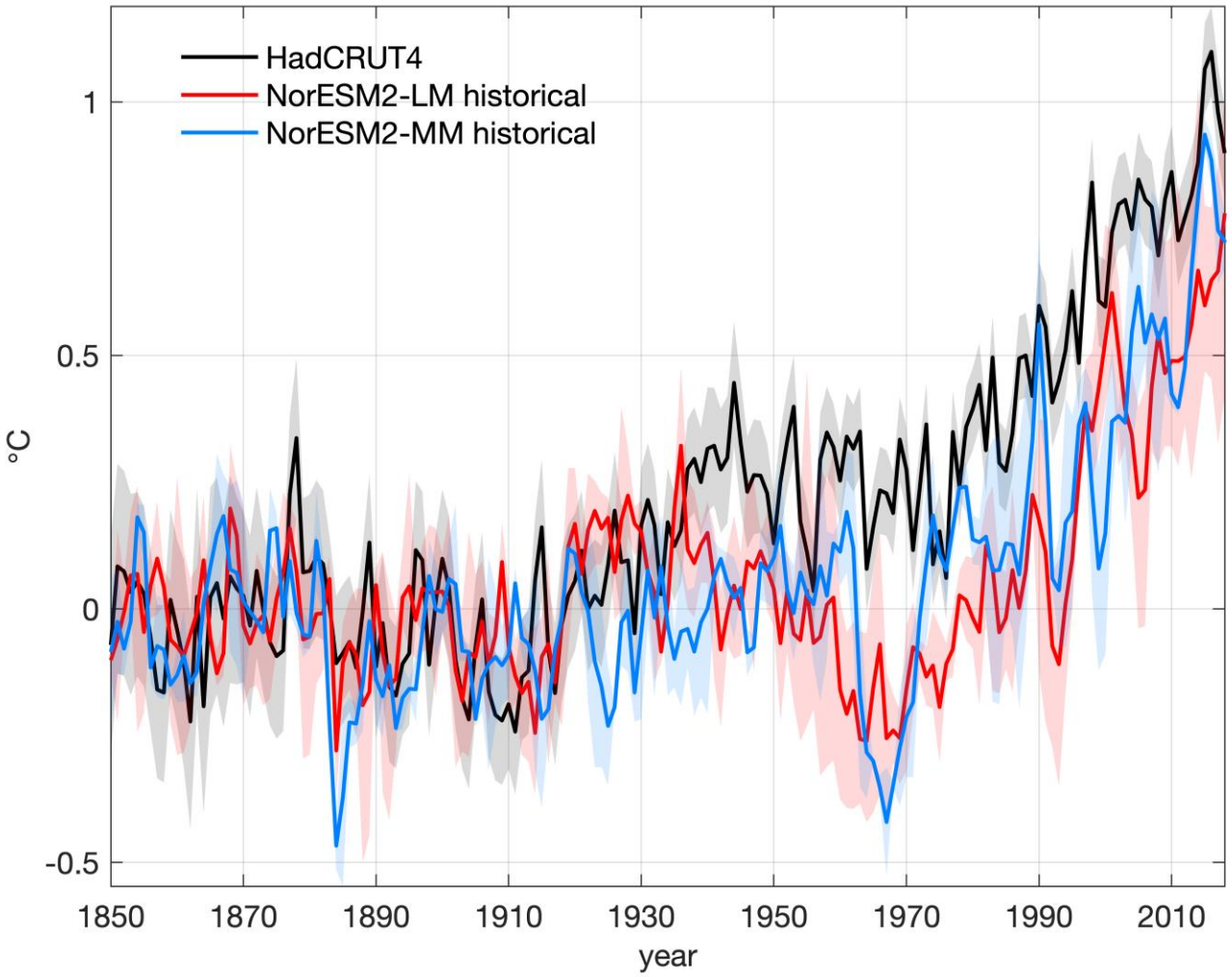
- Through ESGF there are currently **86** NorESM2-LM, **12** NorESM2-MM, **8** NorCPM1 and **4** NorESM1-F experiments available.
- The various NorESM configurations have contributed to the following MIPS:
  - **NorESM2-LM:** AerChemMIP, C4MIP, CDRMIP, CFMIP, CMIP, DAMIP, LUMIP, OMIP, PAMIP, PMIP, RFMIP, ScenarioMIP.
  - **NorESM2-MM:** AerChemMIP, CMIP, RFMIP, ScenarioMIP.
  - **NorCPM1:** CMIP, DCPP.
  - **NorESM1-F:** CMIP, PMIP.

- For development and production **200 million CPU hours** have been used and **3 PB** of data produced.

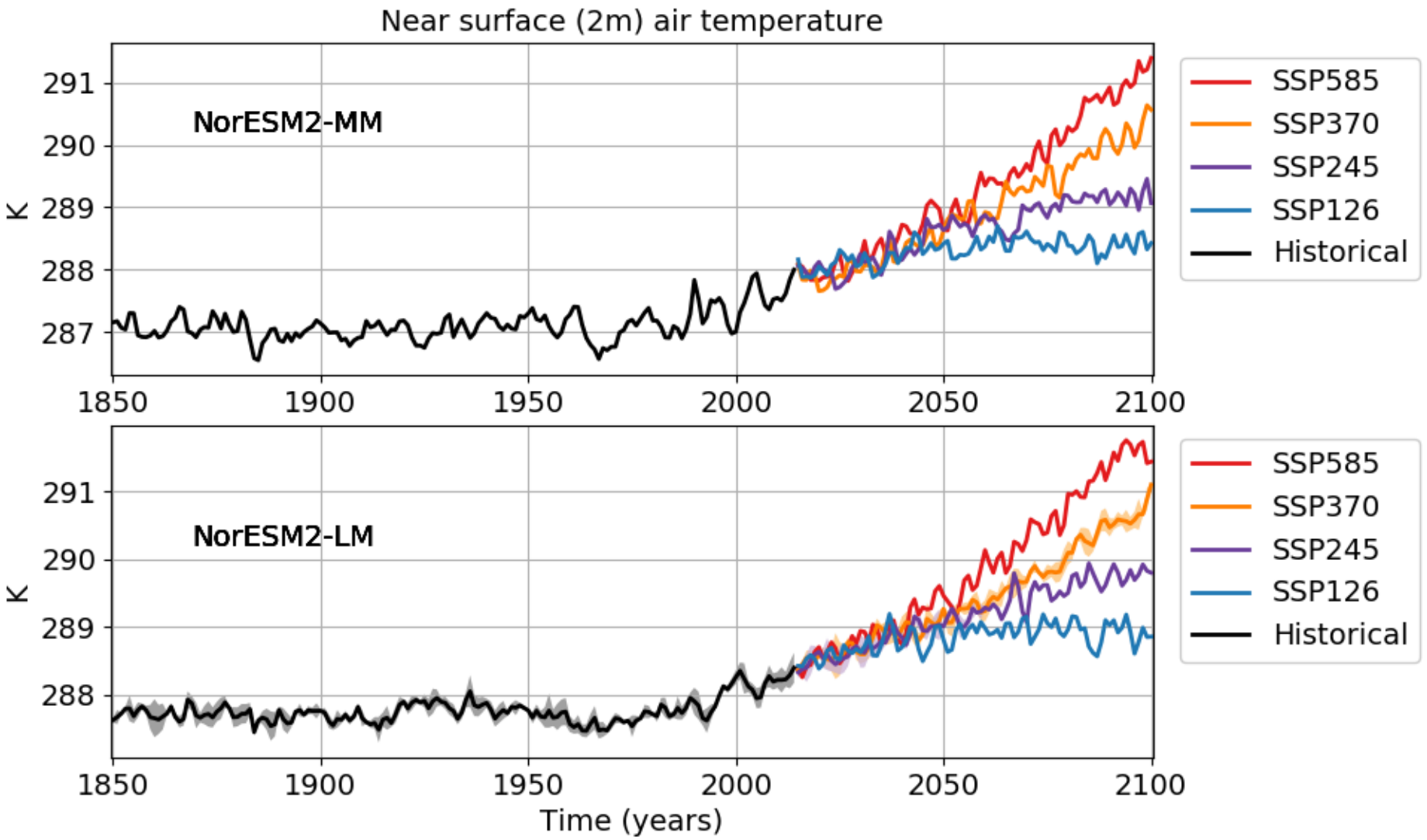
NorESM2 DECK simulations



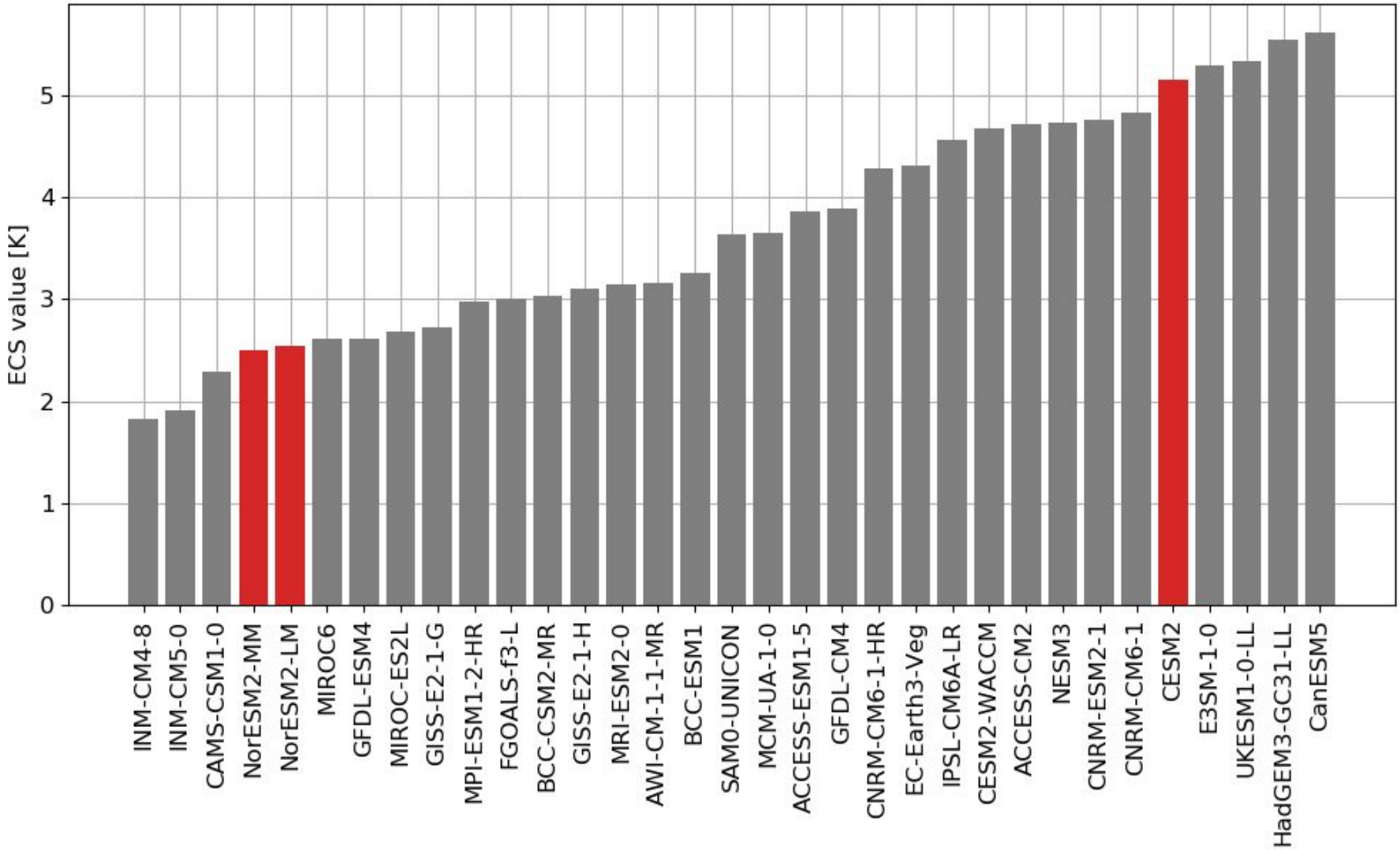
NorESM2 historical simulations



NorESM2 historical and scenario simulations

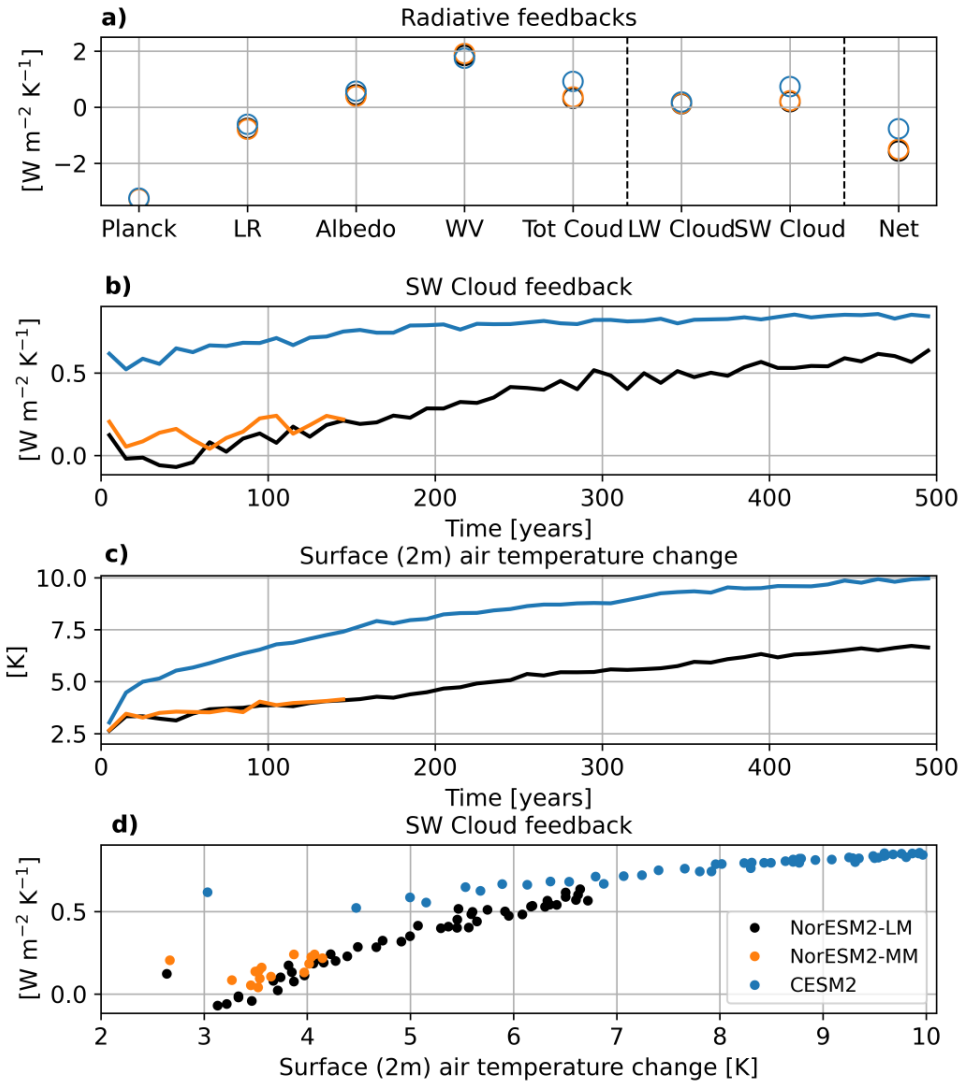


CMIP6 equilibrium climate sensitivity



CMIP6 equilibrium climate sensitivity

- Very different transient climate sensitivity between NorESM2 and CESM2.
- Caused by different depth distribution of heating in the Southern Ocean, subsequently impacting SST, clouds and radiation.



Courtesy: Gjermundsen et al., (2021)

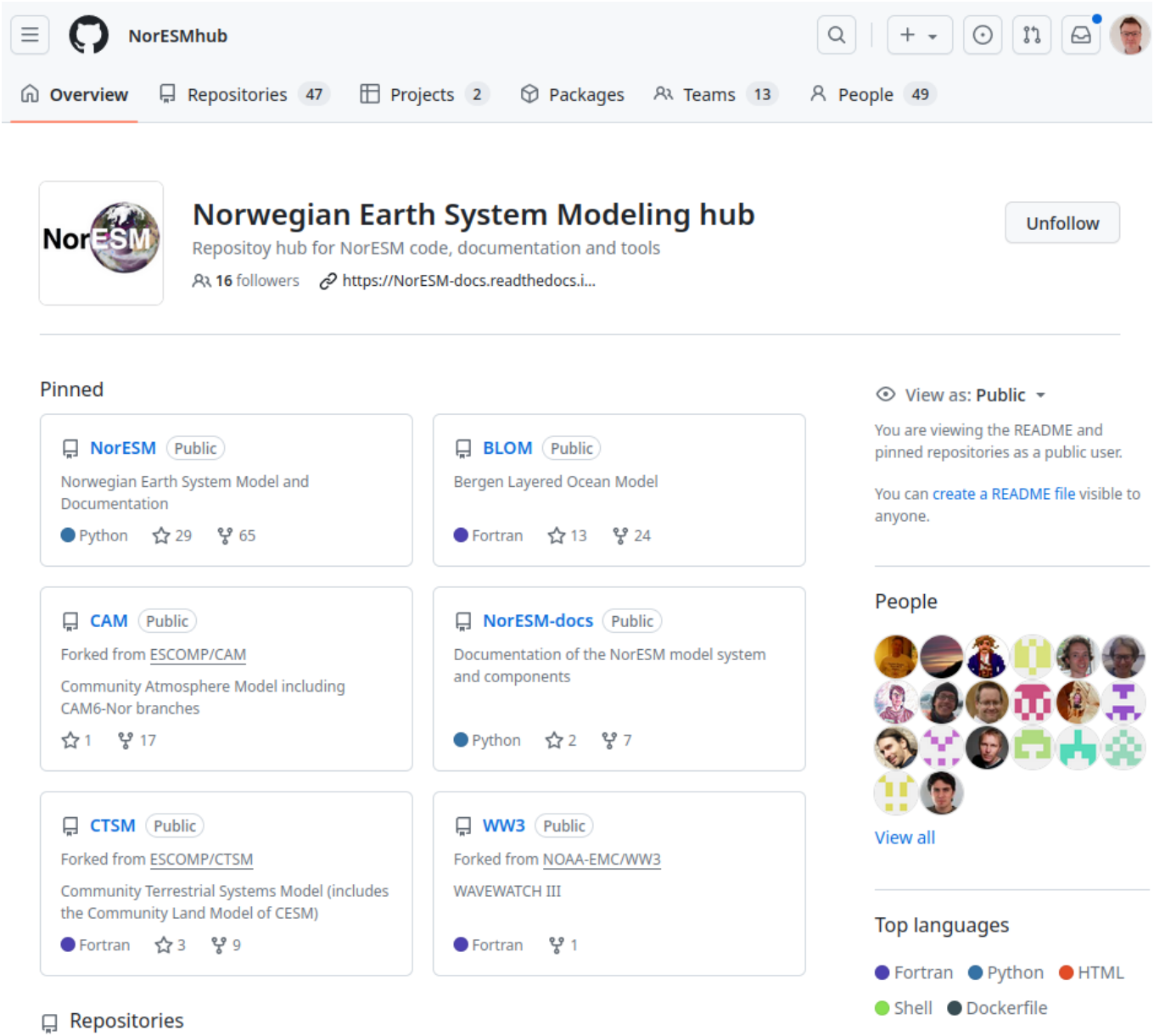
NorESM infrastructure

- Repository hub for NorESM code, documentation and tools: https://github.com/NorESMhub

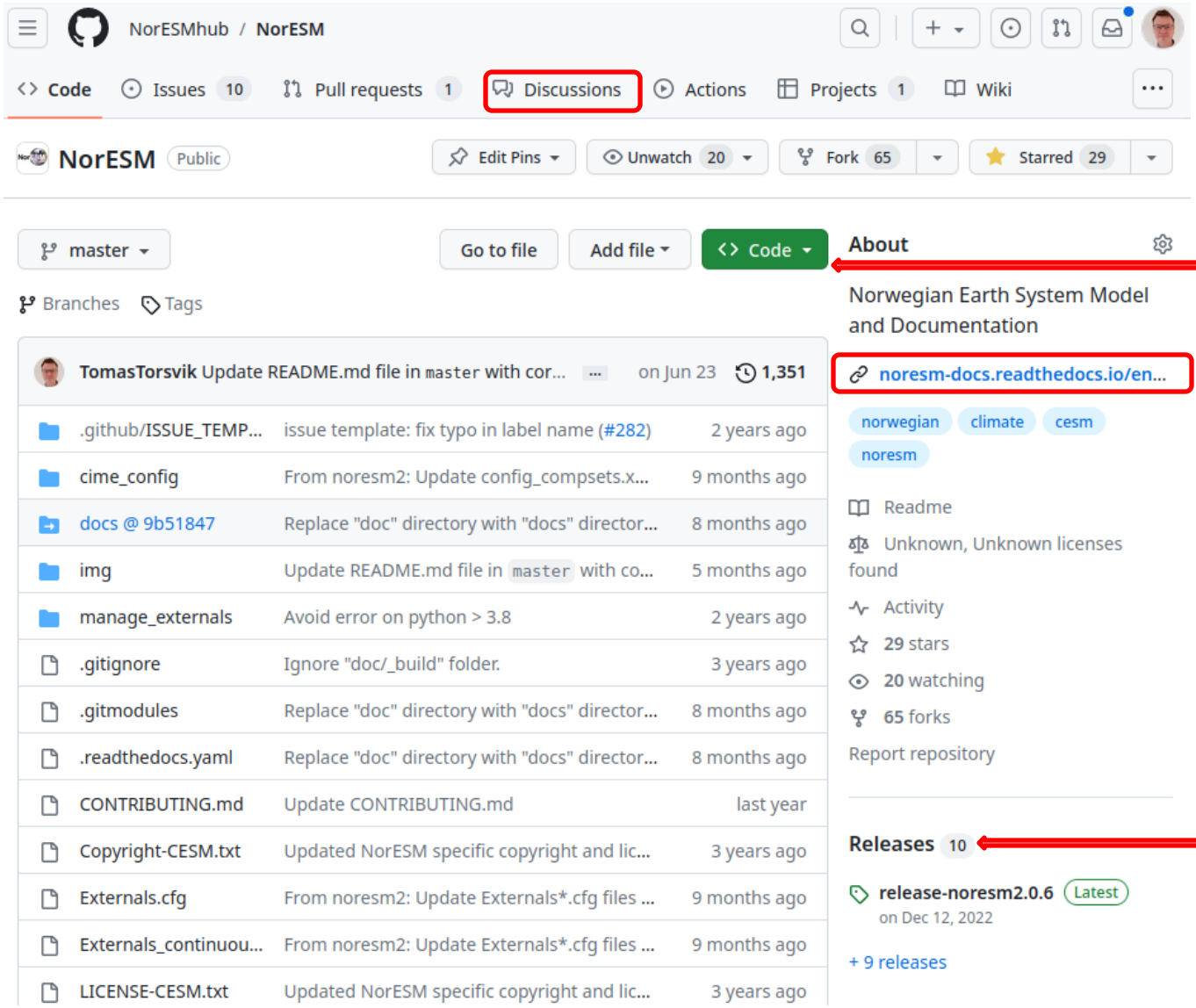
- NorESM2 User's Guide: https://noresm-docs.readthedocs.io

- Time-invariant location of NorESM input data: https://www.noresm.org/inputdata

GitHub: NorESMhub



GitHub: NorESM

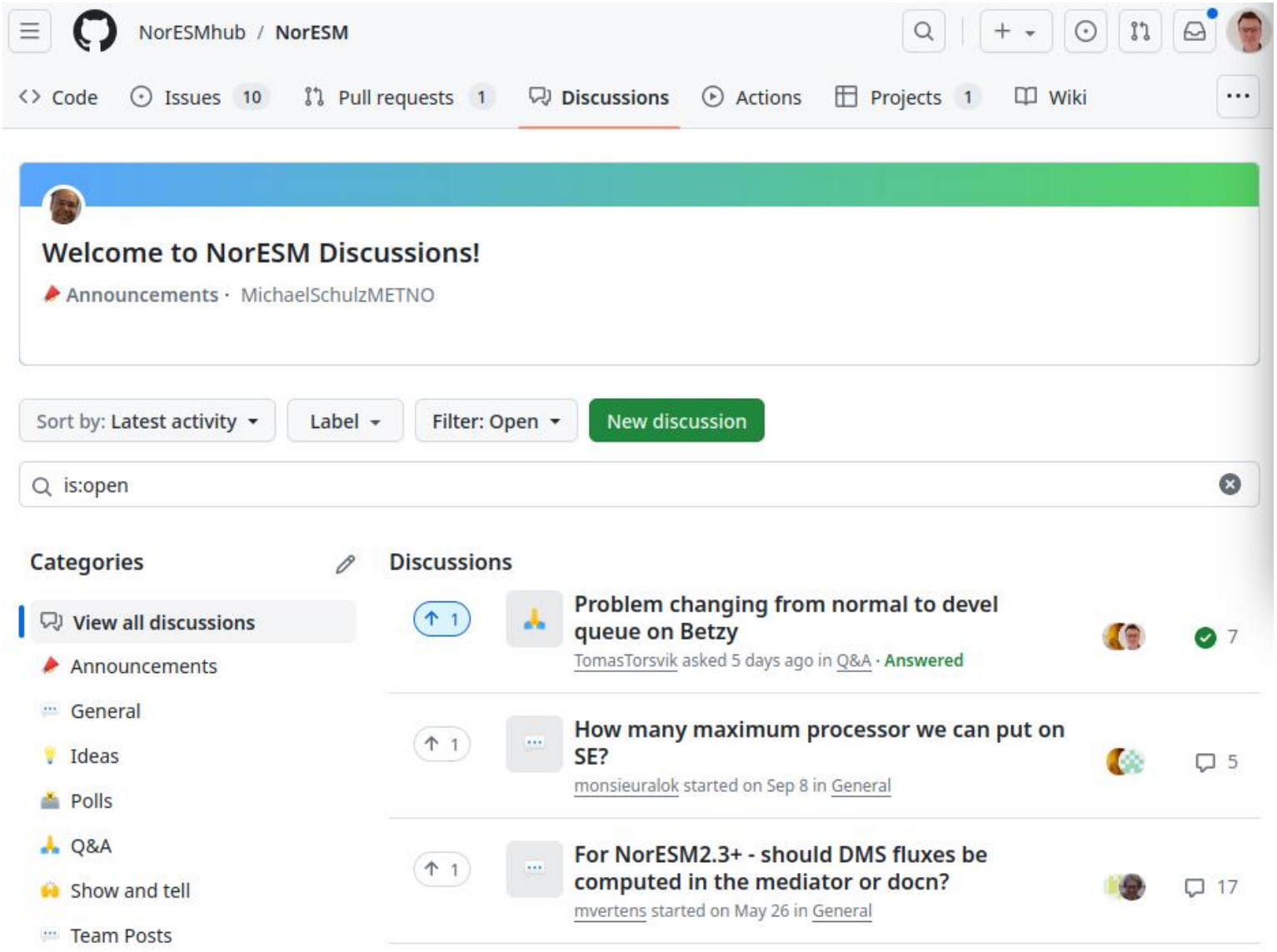
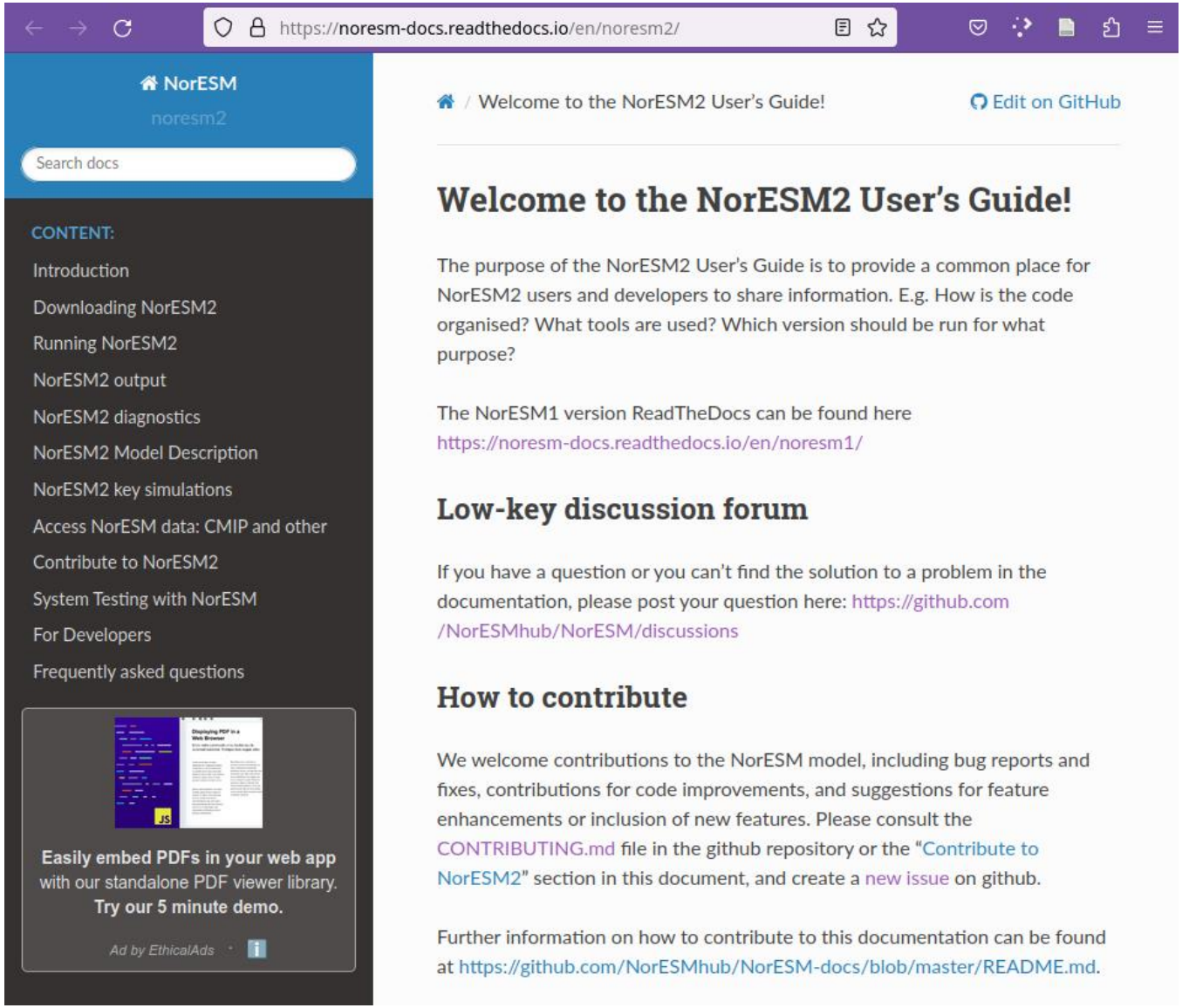


Link to download source code

Link to NorESM documentation

List of code releases, i.e. NorESM versions

GitHub: NorESM discussions page



ReadTheDocs: NorESM documentation