The next generation of the Norwegian Earth System Model - NorESM3

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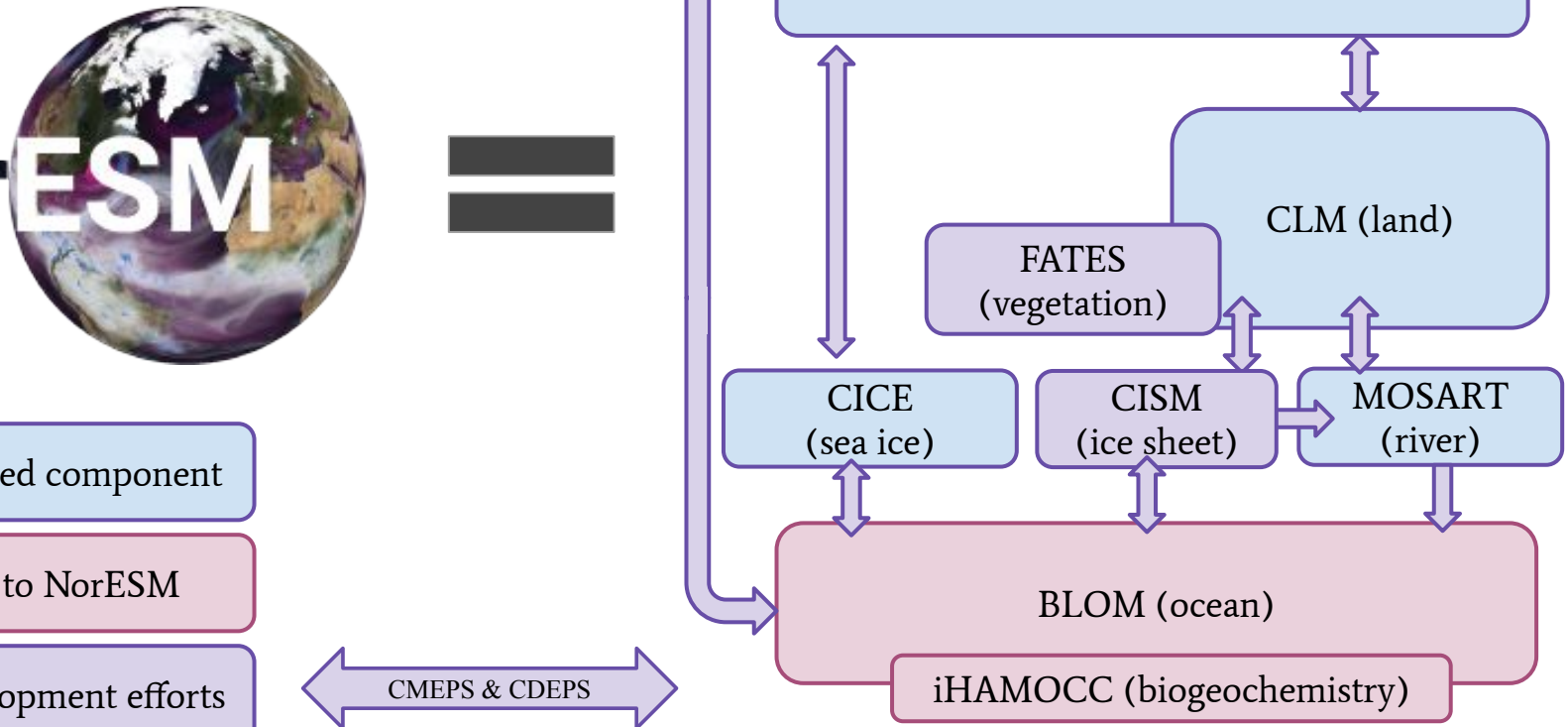
February 4th, 2026 - AMWG presentation

Outline

- What is NorESM
- Towards CMIP7 fast track
- CAM7-Nor
- The impact of model resolution on climate in NorESM3
- Coupled PPEs for calibration
- Nudging refactor

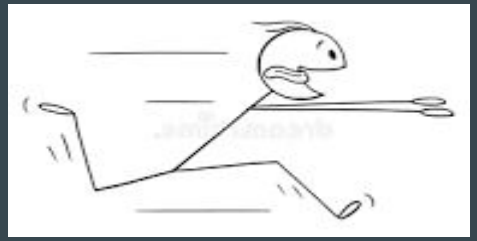
The Norwegian Earth System Model

NorESM =



NorESM3 timeline towards CMIP7

ne16pg3_tn14



CMIP7
FastTrack

ne30pg3_tn14

Planned development

1st of Jan
NorESM3.0 release...
almost there, but not yet...

1st of June
Finalised NorESM3.0 baseline simulations for the user community

Why we chose to do most development with the 2 degree version

ne30pg3_tn14

total pes active : 2176
mpi tasks per node : 128
pe count for cost estimate : 2176

Overall Metrics:
Model Cost: 6983.31 pe-hrs/simulated_year
Model Throughput: 7.48 simulated_years/day

Init Time : 196.939 seconds
Run Time : 57766.324 seconds 31.653 seconds/day
Final Time : 258.615 seconds

ne16pg3_tn14

total pes active : 2036
mpi tasks per node : 128
pe count for cost estimate : 2048

Overall Metrics:
Model Cost: 3377.37 pe-hrs/simulated_year
Model Throughput: 14.55 simulated_years/day

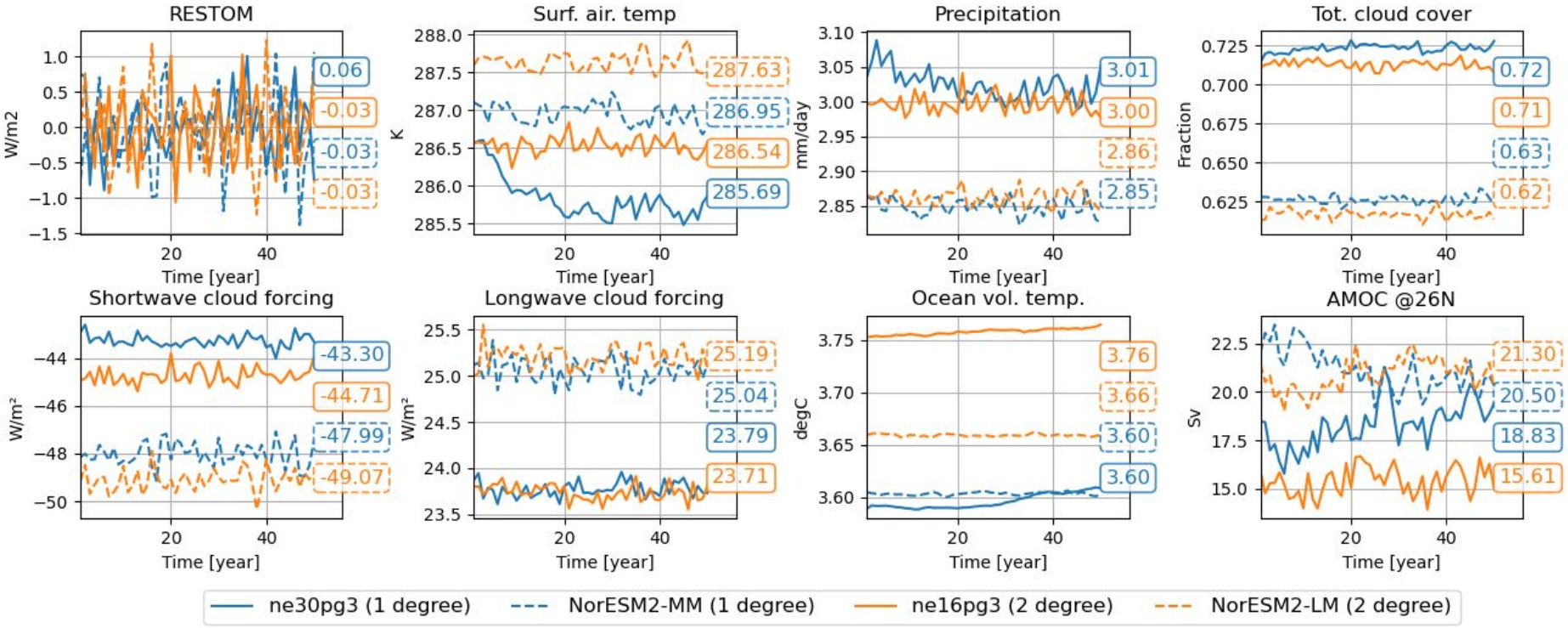
Init Time : 202.837 seconds
Run Time : 59367.820 seconds 16.265 seconds/day
Final Time : 45.184 seconds

CAM7-Nor in NorESM3

Courtesy:
Steve Goldhaber

- Based on **cam6_4_121** but with some bug fixes from later tags (especially from the atmospheric physics sub-component).
- Parameterization sequence is the same as CAM7
- Model uses same vertical coordinate as **CAM-LT** (58 levels)
- Runs with **both ne30pg3 and ne16pg3 grids**
- PUMAS modified to use random-forest ML secondary ice scheme
- **Aerosol / chemistry scheme is Oslo Aero**
- **Radiation scheme is RRTMG**
- Many new diagnostic fields. Some are due to different aerosol scheme or for AEROMIP, others are to meet the needs of the downscaling community

ne16pg3 (orange) vs ne30pge (blue) resolution

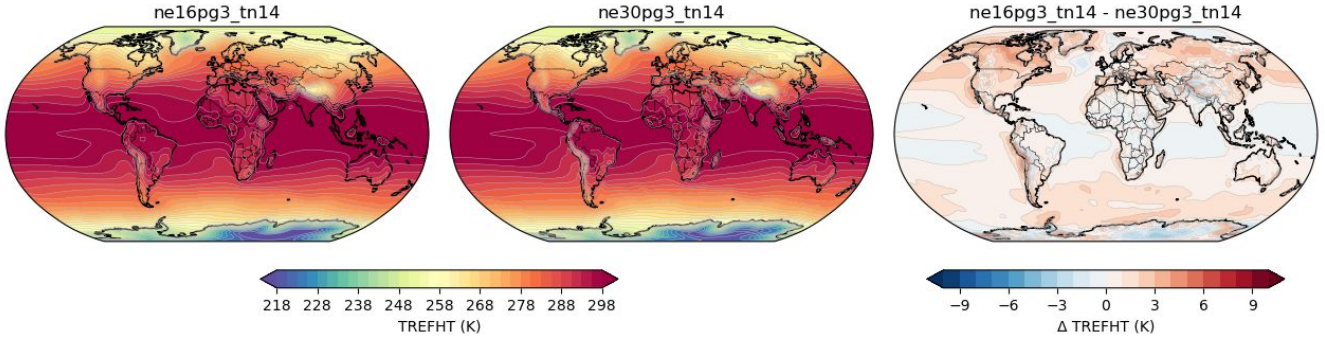


Surface (2m) air temperature (TREFHT)

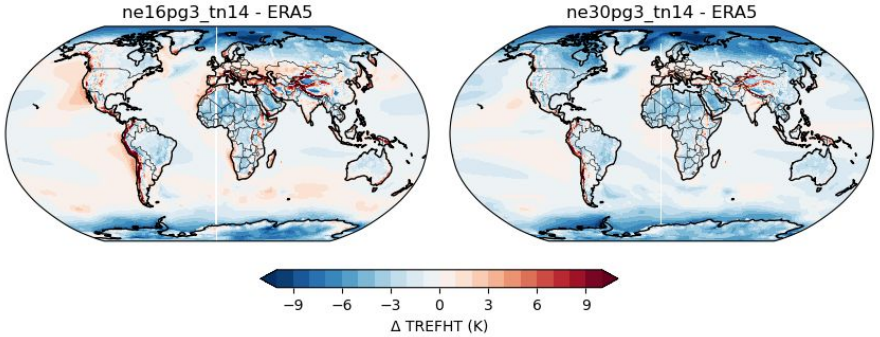
2x2 atmosphere and land

1x1 atmosphere and land

2x2 - 1x1 difference



Difference from ERA5:

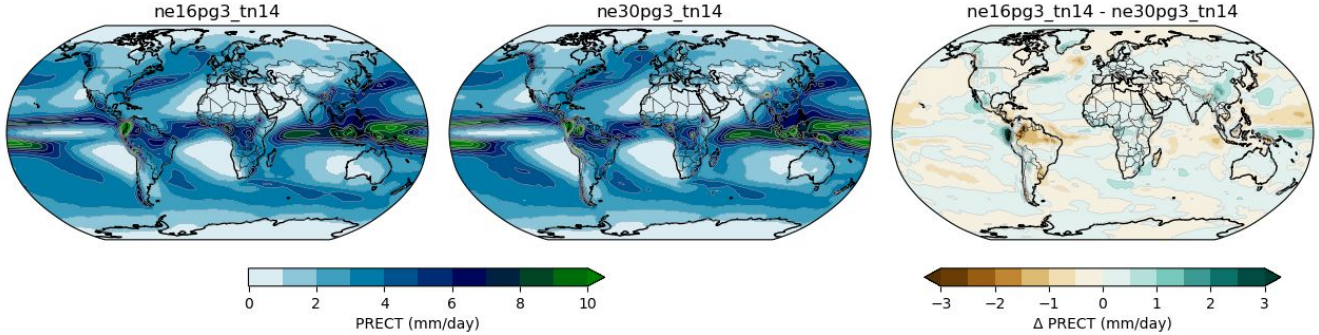


Precipitation (PRECT)

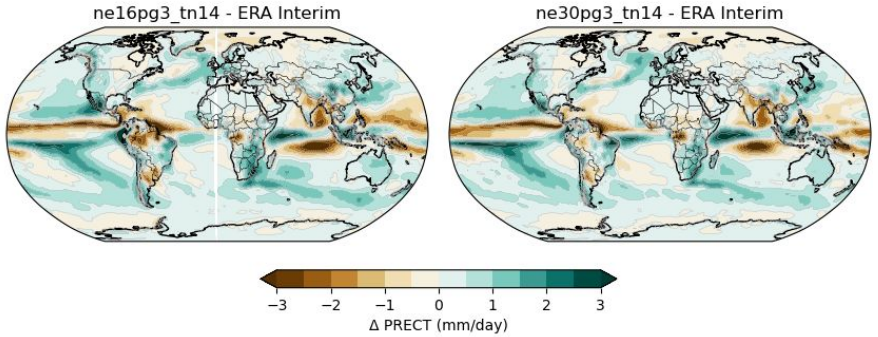
2x2 atmosphere and land

1x1 atmosphere and land

2x2 - 1x1 difference

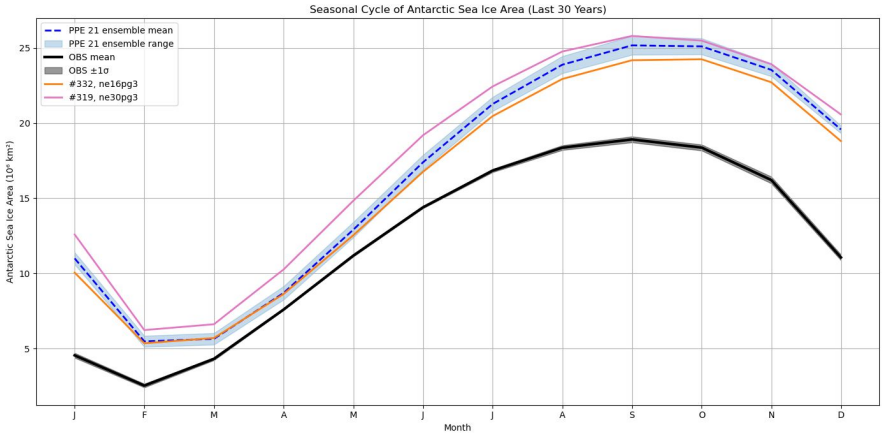


Difference from ERA5:

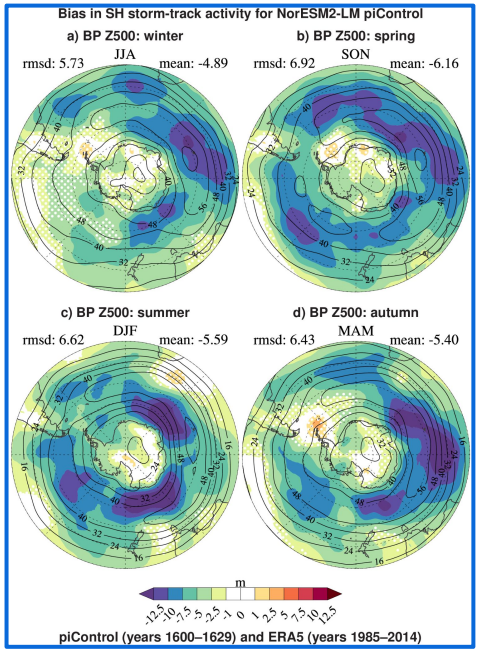


Southern Hemisphere

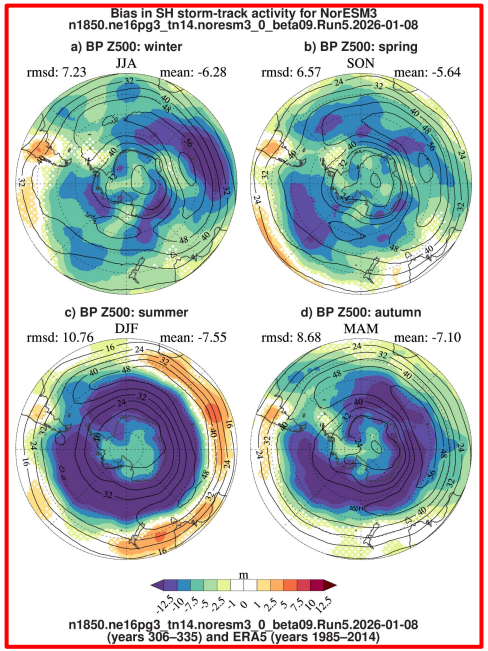
We struggle with very extensive sea ice extent and low storm activity in the Southern hemisphere



NorESM2-LM



NorESM3dev-LM

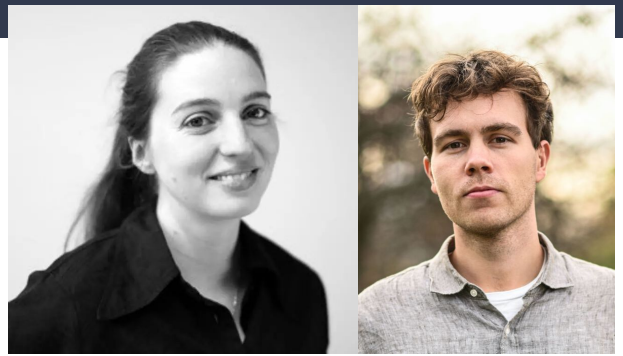


Courtesy: Lise Seland Graff

We use “coupled” PPEs for calibrating NorESM3

Address:

- meridional and land/ocean temperature gradients
- precipitation and latent heating
- sea ice extent and thickness



Courtesy: Marit Sandstad and Herman Fuglestvedt

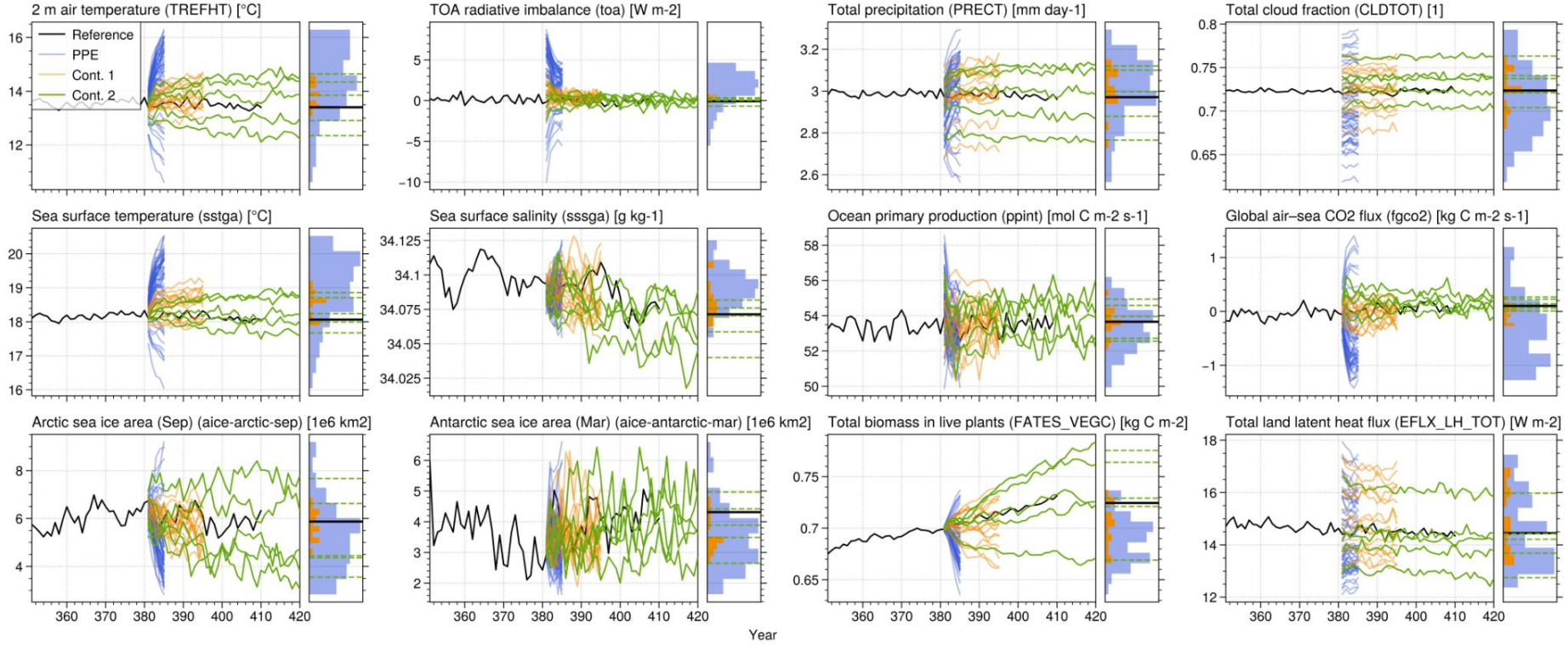
Setup:

- Pre-industrial (1850)
- Perturb parameters in CAM, BLOM (ocn), CLM-FATES (lnd), and CICE
- Latin hypercube: 75 members (5 years)
- Filter for TOA balance: 20 members (15 years) ⇒ 5 members (40 years)

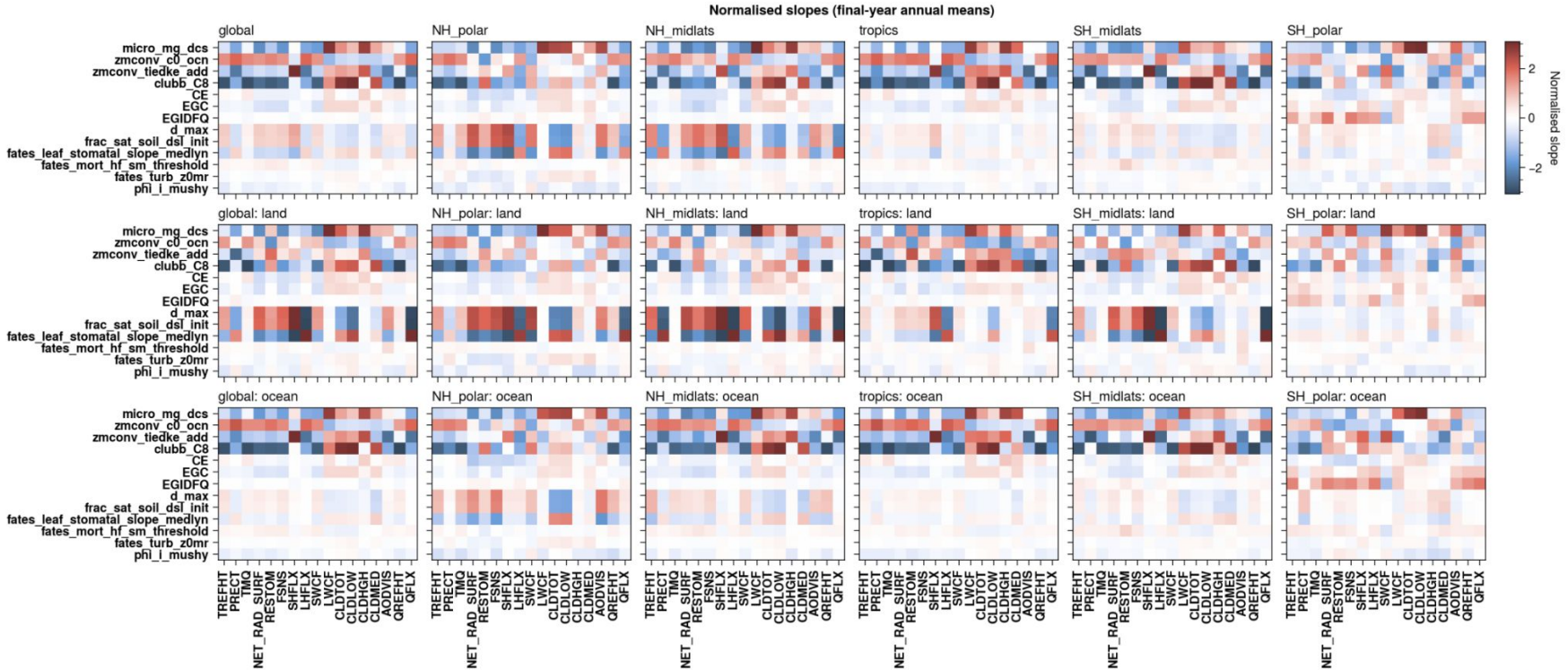
PPE parameters

Component	Parameter	Description
CAM	clubb_C8	Vertical velocity skewness in low+mid clouds
	zmconv_tiedke_add	Convective parcel temperature perturbation
	zmconv_c0_ocn	Convective autoconversion over ocean
	micro_mg_dcs	Autoconversion size threshold ice-snow
BLOM	CE	Efficiency factor of submesoscale restratification
	EGC	Efficiency factor for mesoscale eddy diffusivity
	EGIDFQ	Ratio neutral/thickness eddy diffusivity
CLM	d_max	Maximum dry surface layer (DSL) thickness
	frac_sat_soil_dsl_init	Fractional soil moist. at which DSL initiates
	fates_leaf..._medlyn	Slope of the stomatal conductance model
	fates_mort..._threshold	Soil moisture threshold for drought-induced plant mortality
	fates_turb_z0mr	Roughness length scalar
CICE	phi_i_mushy	Freezing rate under ice

A PPE for calibrating NorESM3



Regional regression slopes



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Component	Parameter	Description
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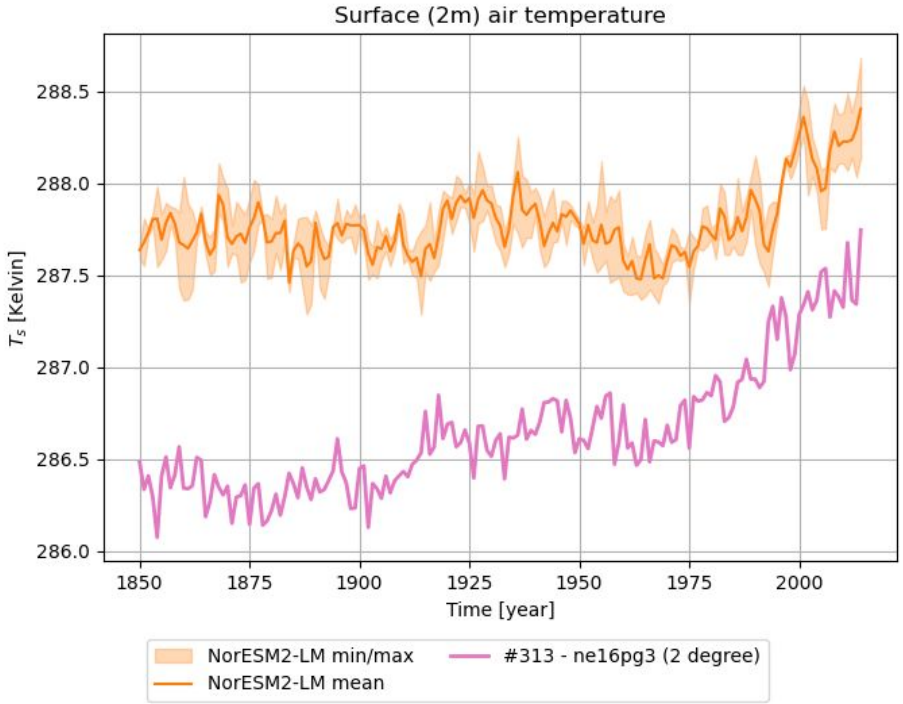
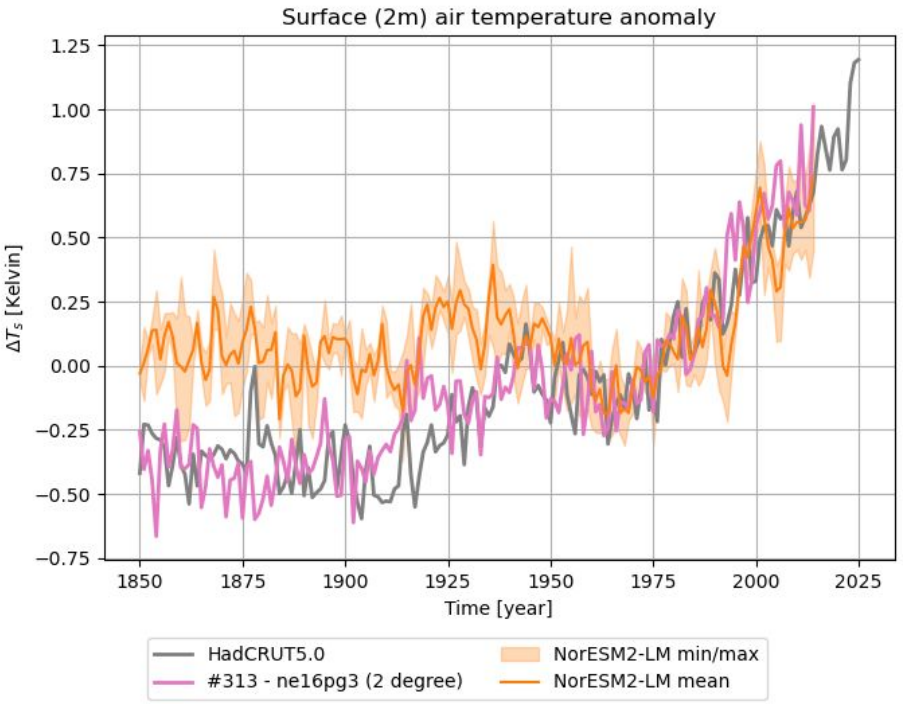
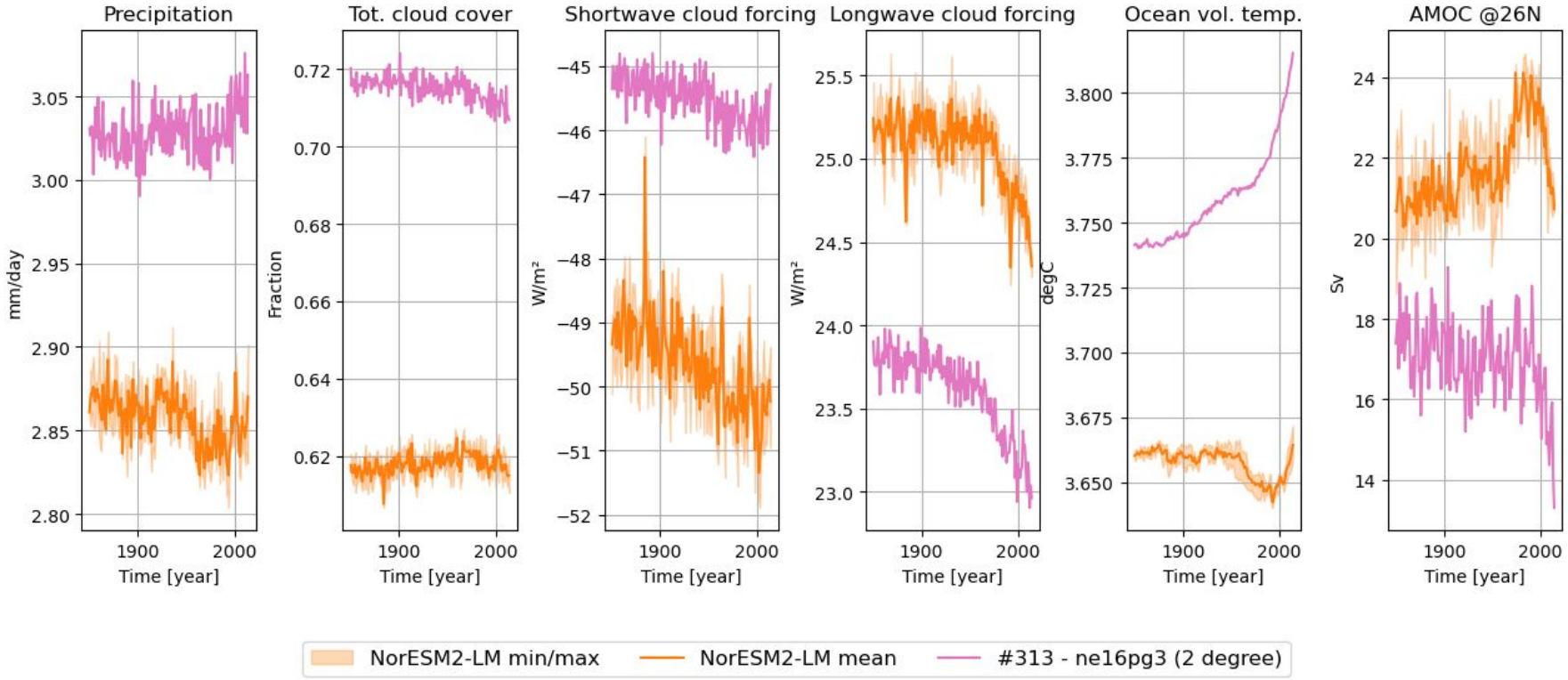
	zmconv_c0_ocn	Convective autoconversion over ocean
	zmconv_c0_lnd	Convective autoconversion over land
	micro_mg_..._lwp_exp	Exponent for autoconversion rate dependence on liquid water path
CLM	d_max	Maximum dry surface layer (DSL) thickness
	frac_sat_soil_dsl_init	Fractional soil moist. at which DSL initiates
CICE	floediam	Floe-size diameter
	ksno	Snow conductivity
	rsnw_fall	Snow grain size for new snow
	drsnw_min	Scaling of dry snow growth

The historical ne16pg3_tn14

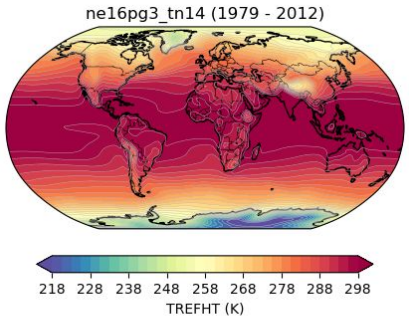
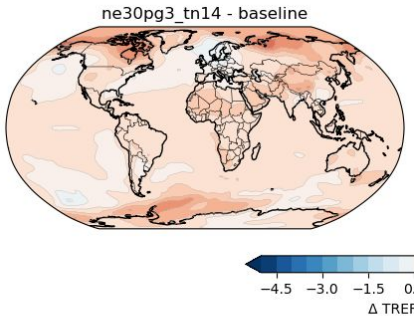
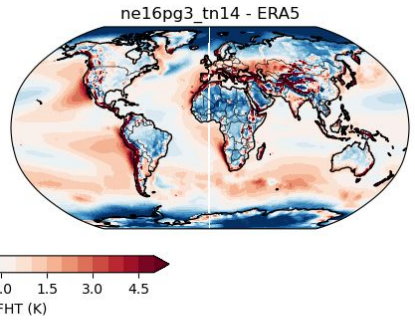
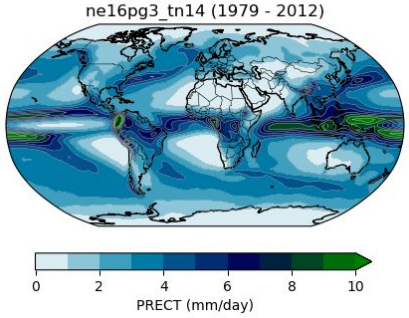
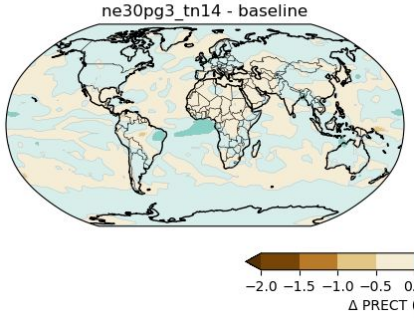
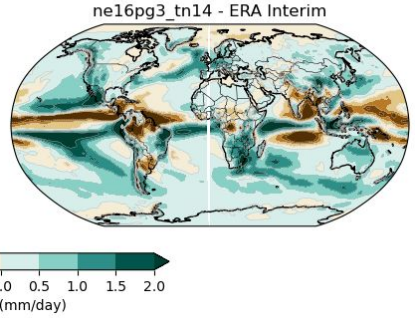




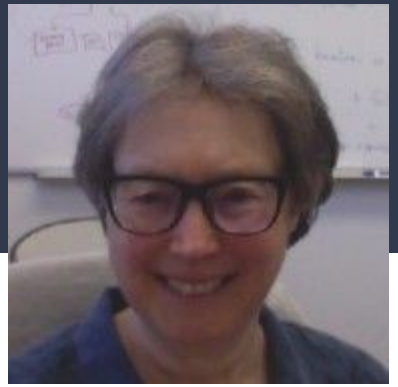
The historical ne16pg3_tn14 (1850 - 2014)



ne16pg3_tn14 - warming patterns and biases (1979 - 2012)

	The historical simulation:	Difference from piControl reference run:	Difference from ERA5:
Temperature:			
Precipitation:			

Nudging refactor



Courtesy:
Mariana Vertenstein

Current capability in ESCOMP/CAM

- separate file for every time interval
- each file must be on the same grid as the model
- this can lead to possibly thousands of files needed for different nudging scenarios

New Capability in NorESMHub/NorESM

- multiple time samples can be put on one file (e.g. monthly data)
- online (CDEPS) regridding from nudging data to model grid (e.g. from FV to SE)
- run time configurable time interpolation and time extrapolation methods
- various validations have already been carried out

Outlook

- We hope to fine tune the CMIP7 versions of NorESM3 in the very near future using results from the PPEs in coupled mode.
- We aim to streamline the workflow—building, running, and analyzing the PPE—so it becomes straightforward for the NorESM community to use.
- NorESMhub: https://github.com/NorESMhub
- NorESM3dev: https://github.com/NorESMhub/noresm3_dev_simulations
- If you have questions, please email me: adag@met.no or adagj@geo.uio.no

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Thank you!