Norwegian Climate Prediction Model Version 2: New Developments and their impact

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NERSC
STIFTELSEN NANSEN SENTER FOR MILJØ OG FJERNMÅLING
NANSENSENTERET · BERGEN · NORGE

DA-TT/CP-TT workshop at ECMWF, Oct 2026

Bjerknes Climate Prediction Unit

BJERKNES CENTRE for Climate Research

TROND MOHN FOUNDATION

NorESM/NorCPM: Norway's system for all time scales

We produce reanalysis and deliver operational forecasts (national & international)

Paleo-NorCPM

Coupled reanalysis
1860 - present

bcpu.w.uib.no

SIPN
SIPNS

CMIP6(7) DCPP

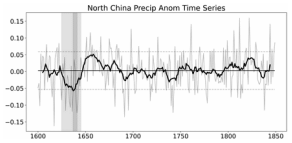
WMO LCDP
C3S2 375

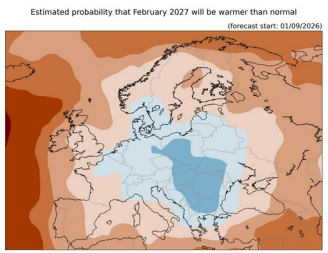
CMIP6 (7) projection

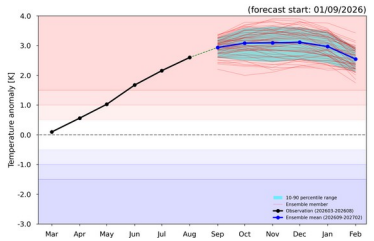
Feb 2027

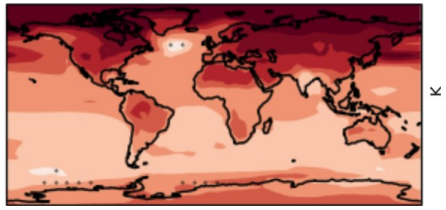
ENSO

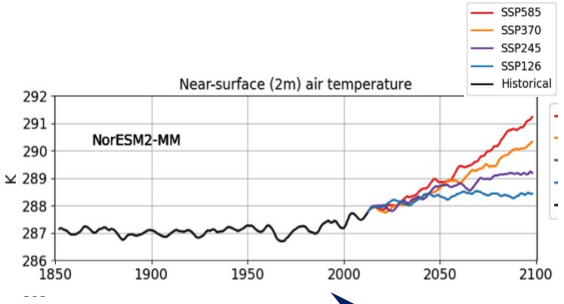
2026-2030











Past climate

Weeks Months Seasons Years Decade Century

Paleo record

Instrumental period

Weather prediction

Seasonal prediction

Decadal prediction

Climate Scenario

Bjerknes Climate Prediction Unit

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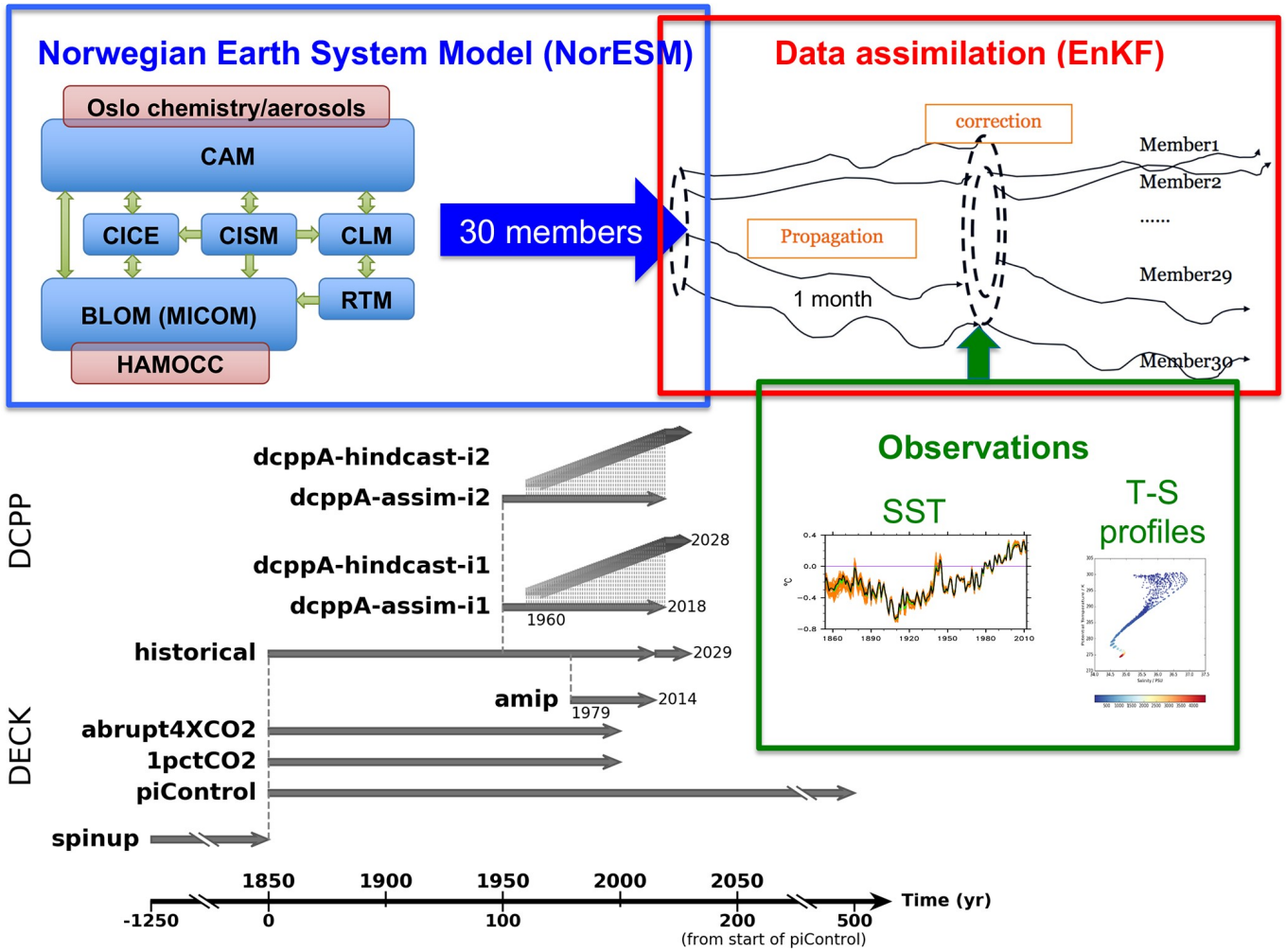
climatefutures

WCRP

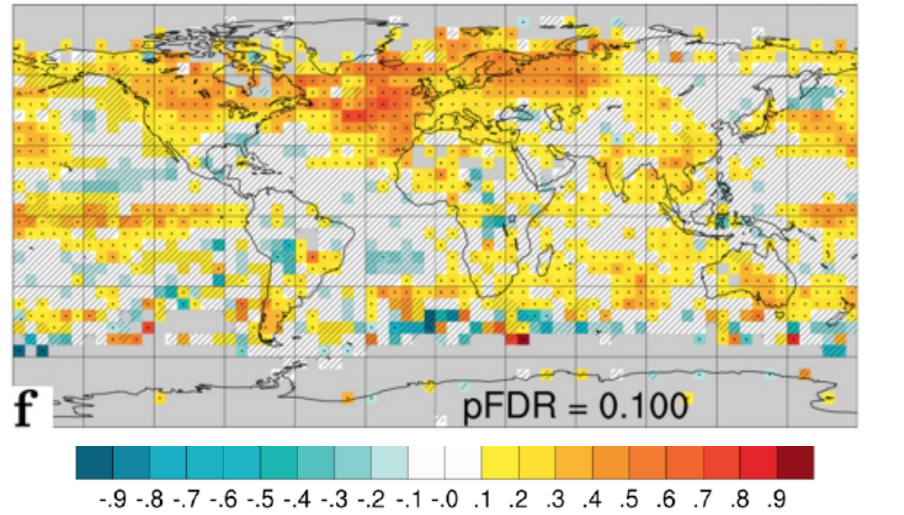
WORLD METEOROLOGICAL ORGANIZATION

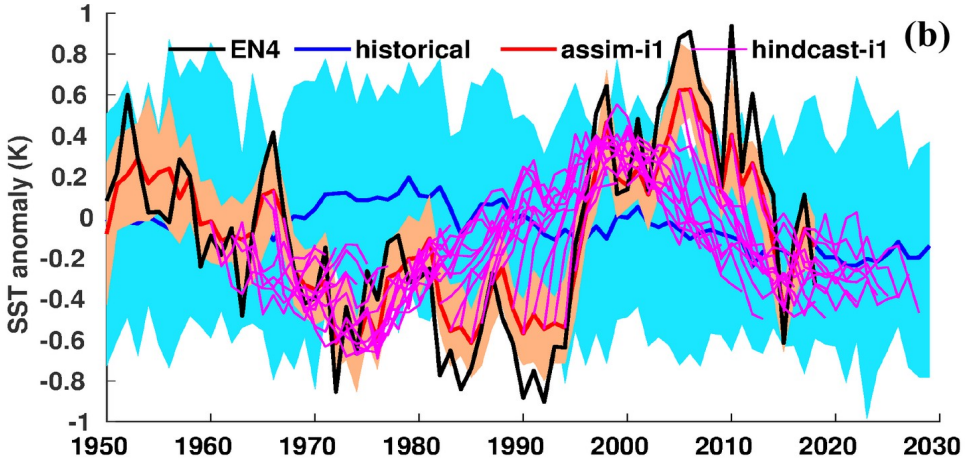
NorCPM1 for CMIP6 DCPP

NorESM1 with ocean initialisation



Residual correlation for SAT 6-9 years lead prediction





Strong prediction drift in the NA SPG region

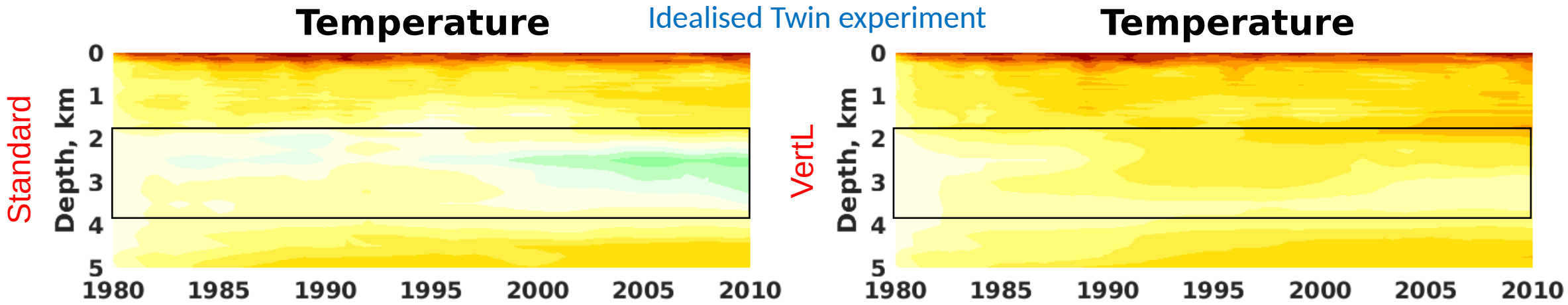
(Bethke et al., 2021)

What will be NorCPM2 for CMIP7 DCPP?

Blue: highlight changes compared to CMIP6

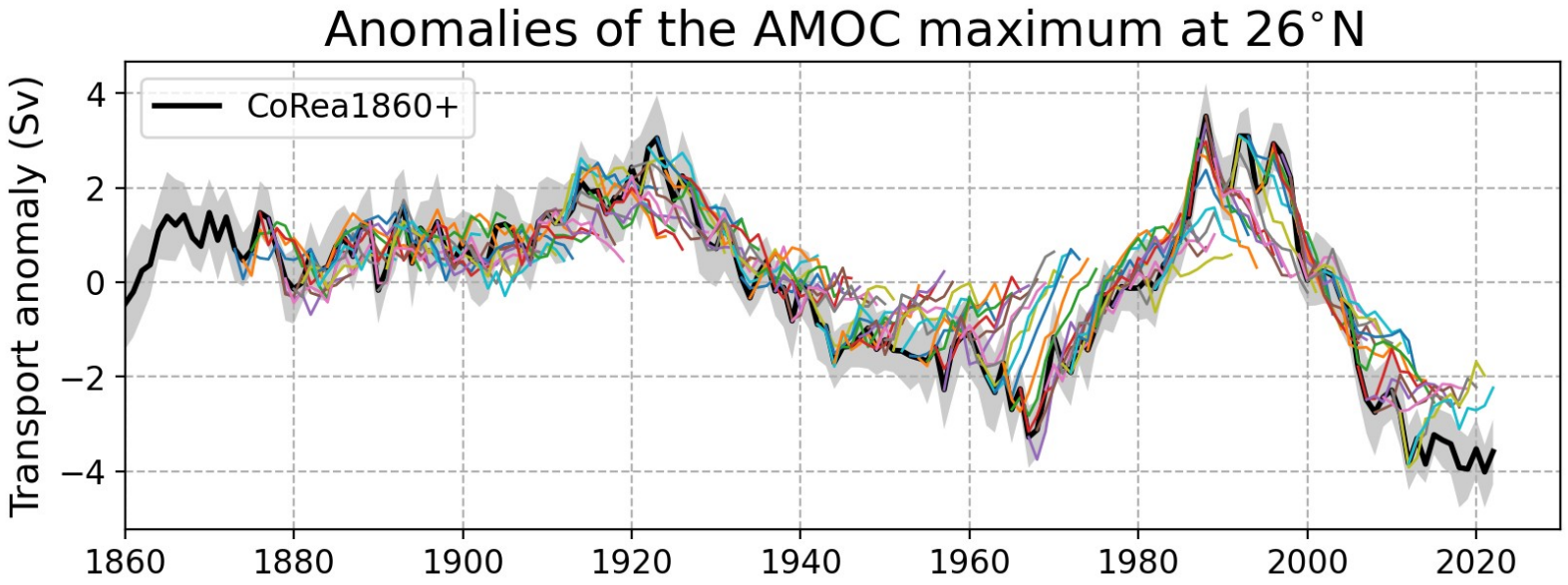
- Use NorESM2-MM (Seland et al., 2020) with CMIP7 forcings
  - 1° in ocean, 1° in atmosphere and improved physics
    - more realistic upper-tropospheric meridional temperature gradients
    - reduced near-surface temperature biases
    - better simulated extratropical storm tracks
    - more reasonable blocking frequency
    - more realistic AMOC mean state (~21 Sv at 26.5°N)
- EnKF with 40 members and hindcasts with 10 members
- Ocean
  - Assimilate T-S profile (CODC, Zhu et al., 2024), and SST (HadISST2+OSTIA, Good et al., 2020)
  - Vertical localisation (Wang et al., 2022)

Isopycnal vertical localisation



Warm colours: improvement Cold colours: degradation

(Wang et al., 2022)

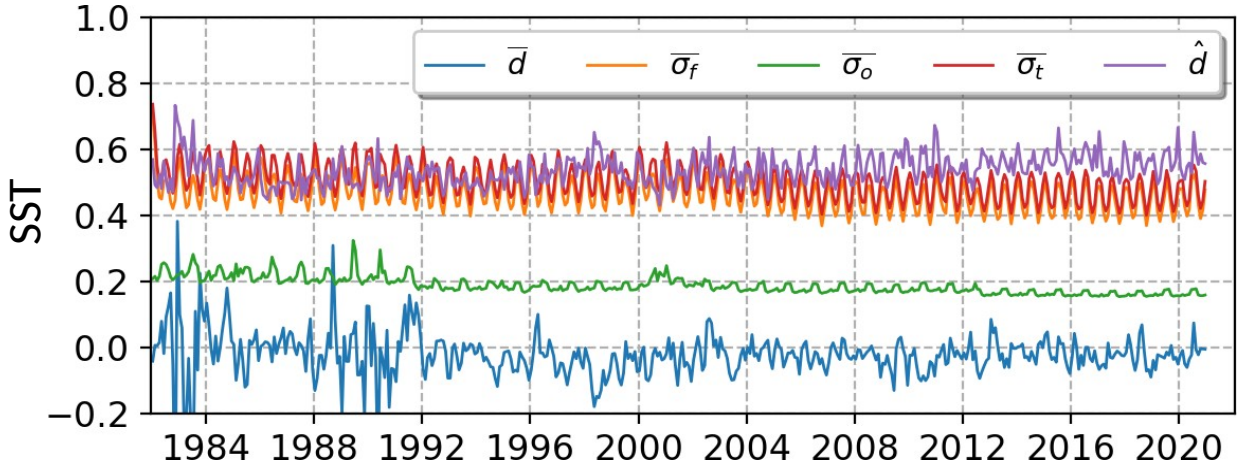


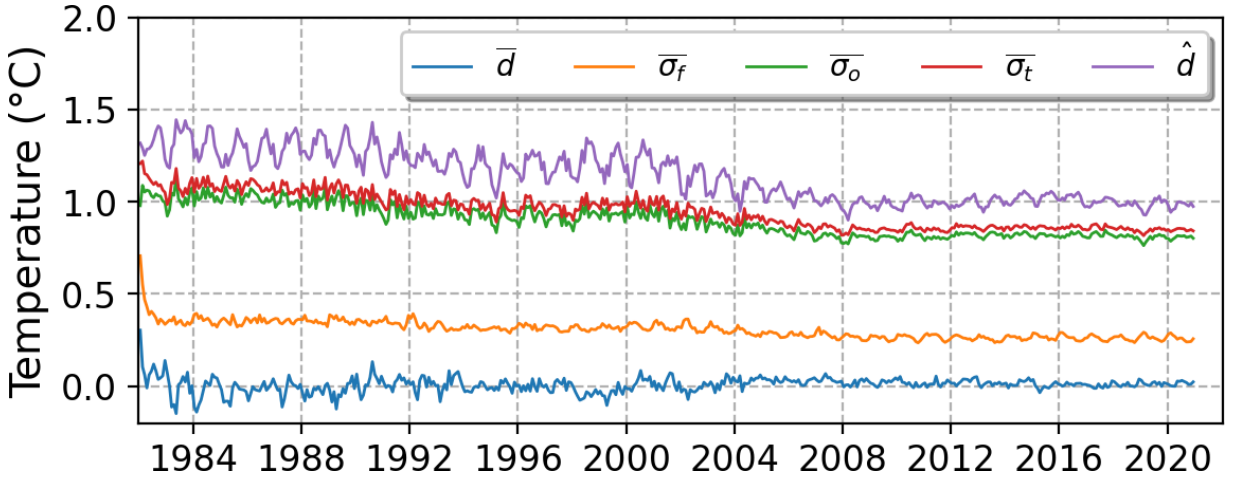
It reduces the degradation in the mid-deep ocean and mitigates hindcast drift.

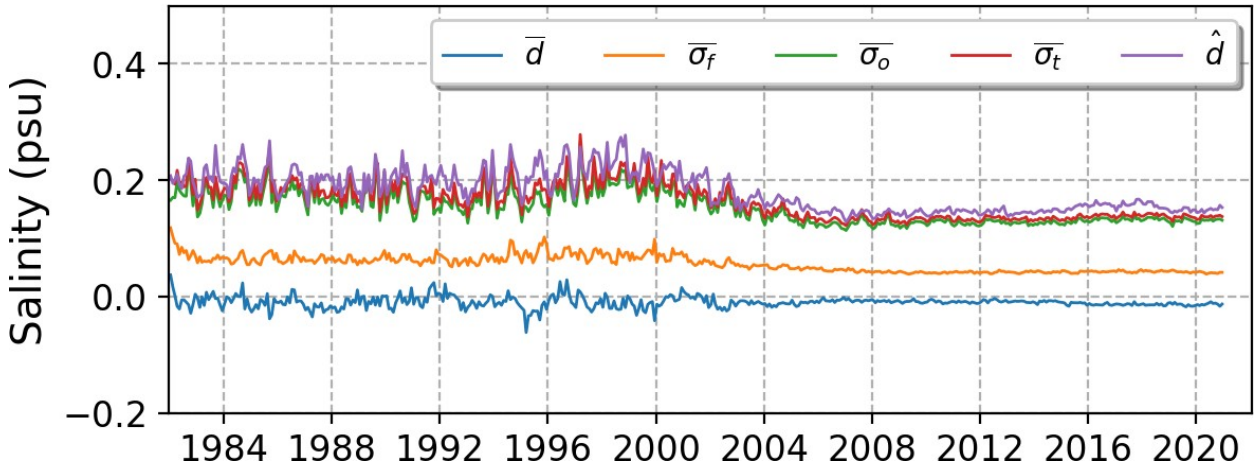
(Wang et al., 2025, in prep)

Monthly SST and TS DA: reanalysis skill

Assimilation statistics







mean difference (bias)
model ensemble spread (model uncertainties)
observation uncertainties
total error (model and obs uncertainties)
RMSE

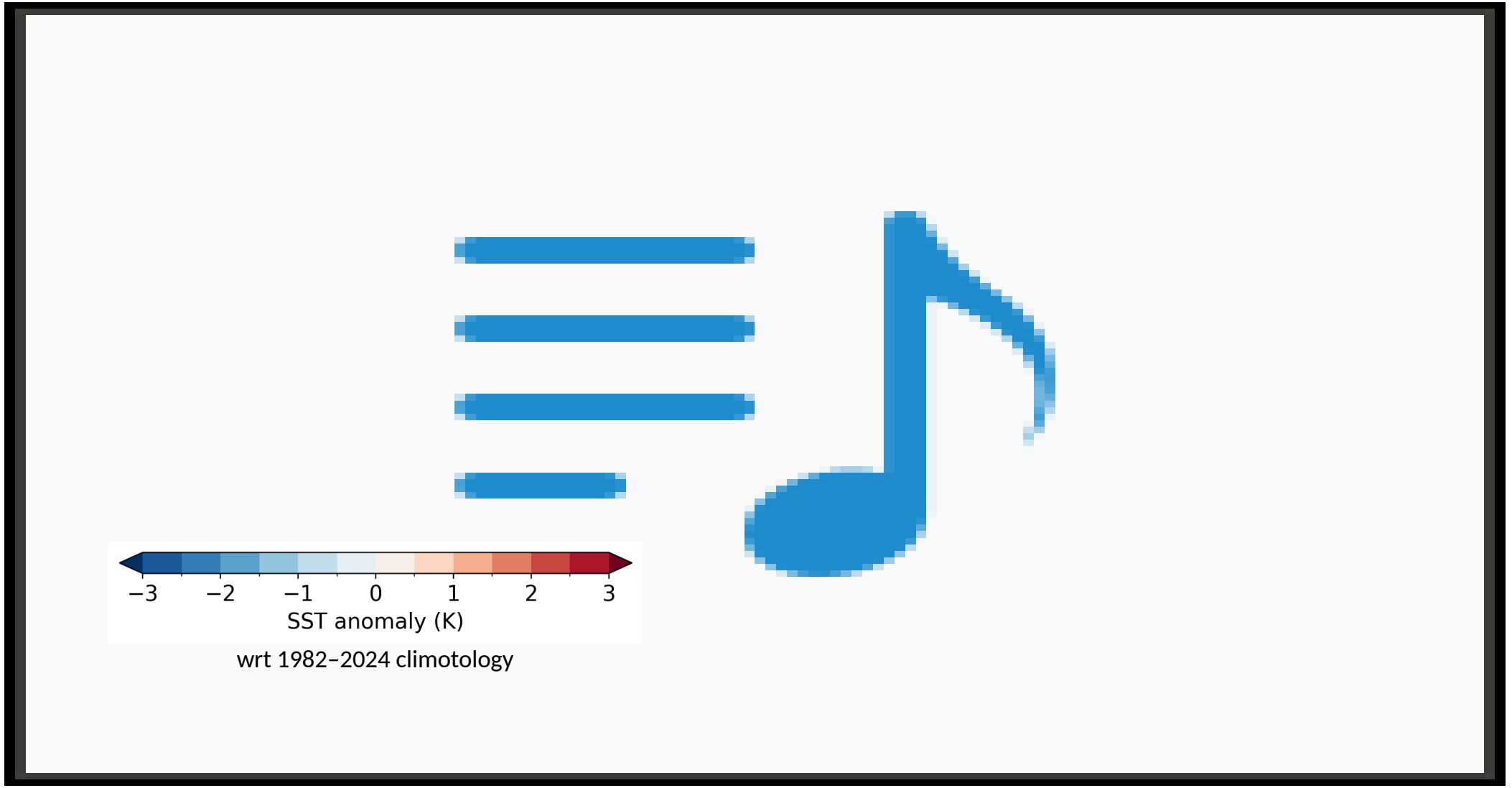
- The system shows stable performance
- The ensemble system has good reliability (total error == RMSE) for SST and salinity profiles

What will be NorCPM2 for CMIP7 DCPP?

Blue: highlight changes compared to CMIP6

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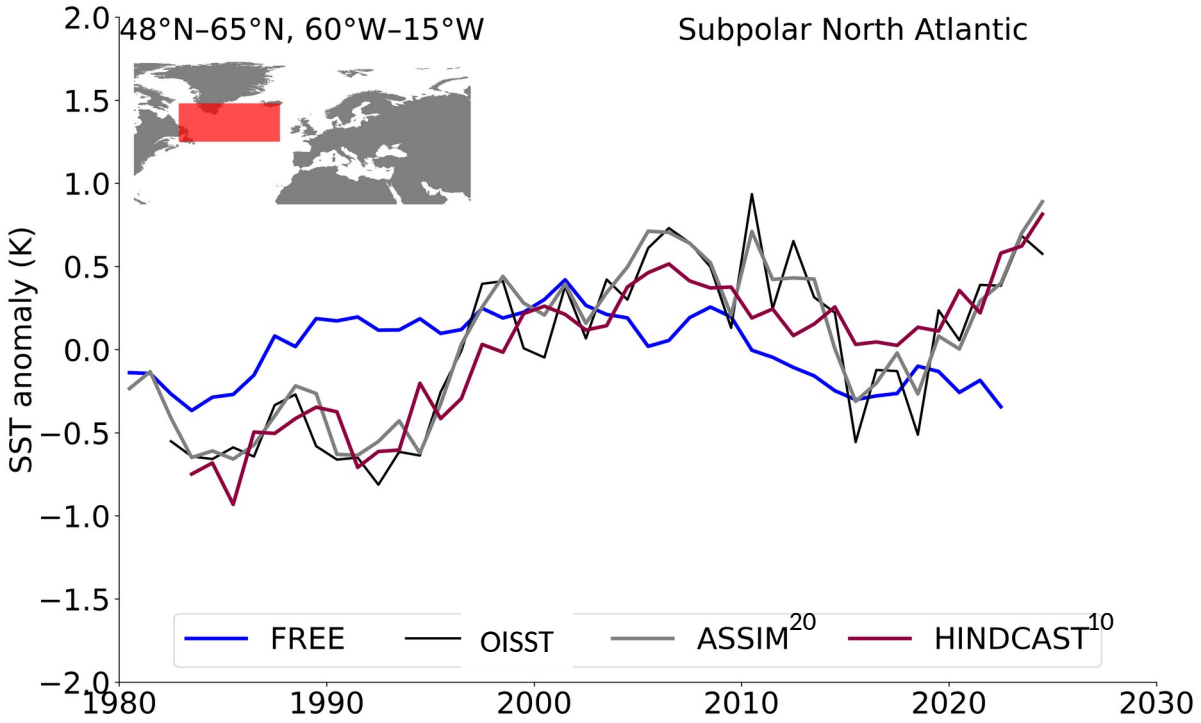
Testing NorCPM2: daily SST in 2022/23, reanalysis

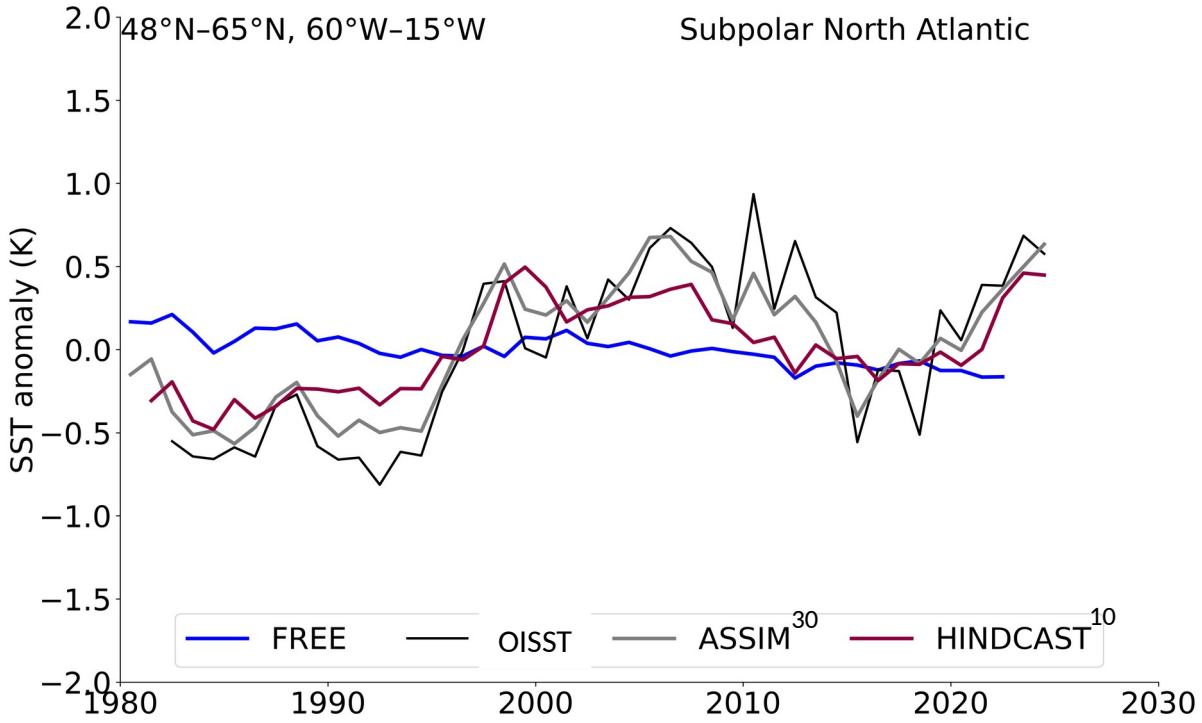


Courtesy of I. Bethke

Subpolar North Atlantic SST prediction

NorCPM1 i1





Annual mean, lead year 1

Courtesy of I. Bethke

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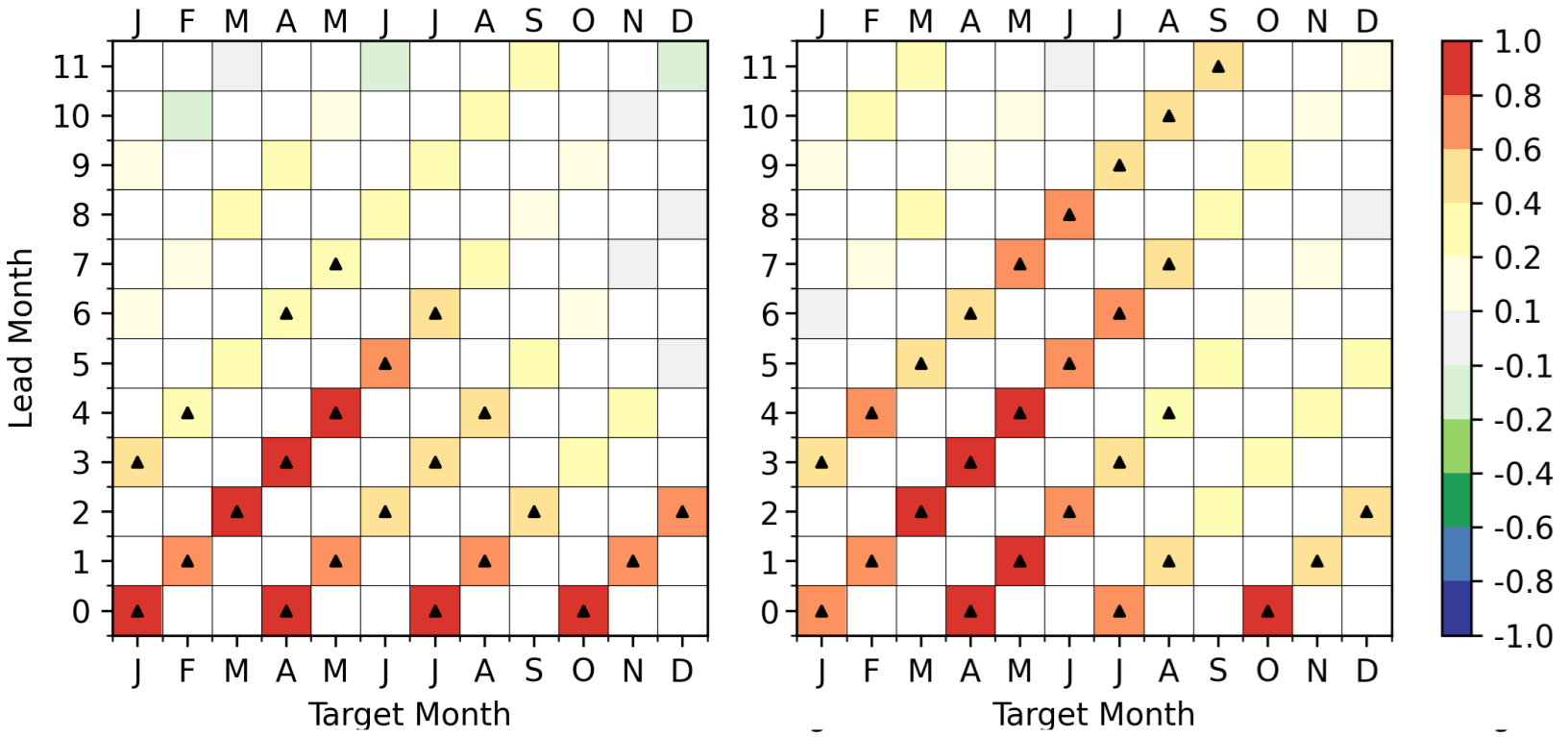
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- Sea initialisation
  - Assimilate SIC from 1982 + SIT from 1993 (Williams et al., 2025; 2026)
- Land initialisation
  - Soil moisture assimilation from 1980 (Nair et al., 2024) è see talk on Friday
- Atmosphere initialisation
  - We will test spectral nudging but likely not ready in time for production

Example of the benefit of sea ice thickness assimilation

It yields improvements in both the Arctic (Williams et al., 2025) and Antarctica (Williams et al., 2026)

An example in the Pan-Antarctic SIE



Without SIT initialisation

With SIT initialisation

Detrended ACC of sea ice extent from seasonal hindcast for the period 1995--2023

(Williams et al., 2026)

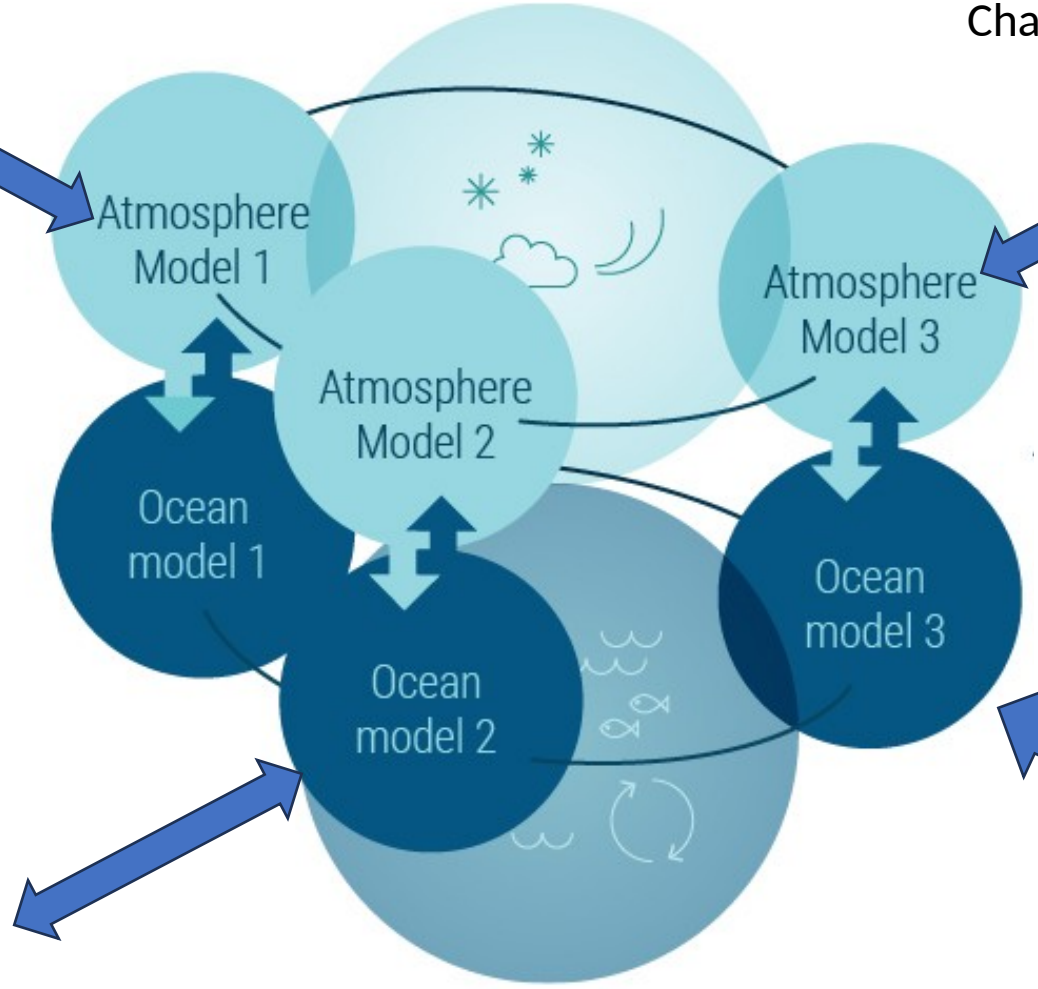
Conclusions

- NorCPM2 (CMIP7 DCPP) features improved model, forcings, observations and assimilation scheme compared to NorCPM1 (CMIP6 DCPP).
- Pilot test over 1982-2020 show reasonably good performance (accuracy, stability, reliability).
- Analysing hindcasts over 1985-2015 demonstrates
- Ongoing tests:
  - Compare assimilation frequency daily, weekly, monthly.

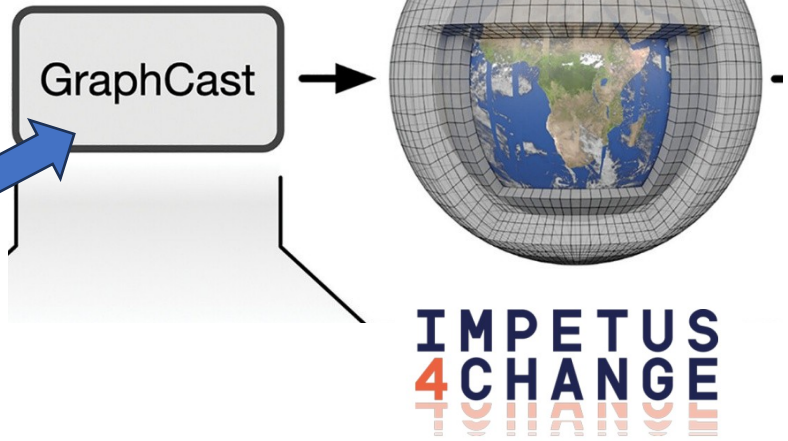
Looking forward to contributing to CMIP7 DCPP!
We expect the dataset (DCPP-A1) to be available in 04/2027.

Supermodelling – Combining AI & dynamical downscaling with Earth System model predictions



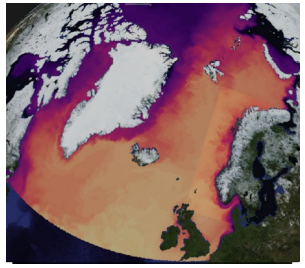


Chapman et al. 2025



TOPAZ

A regional ocean model



SE4CLIM

Schevenhoven et al., 2023

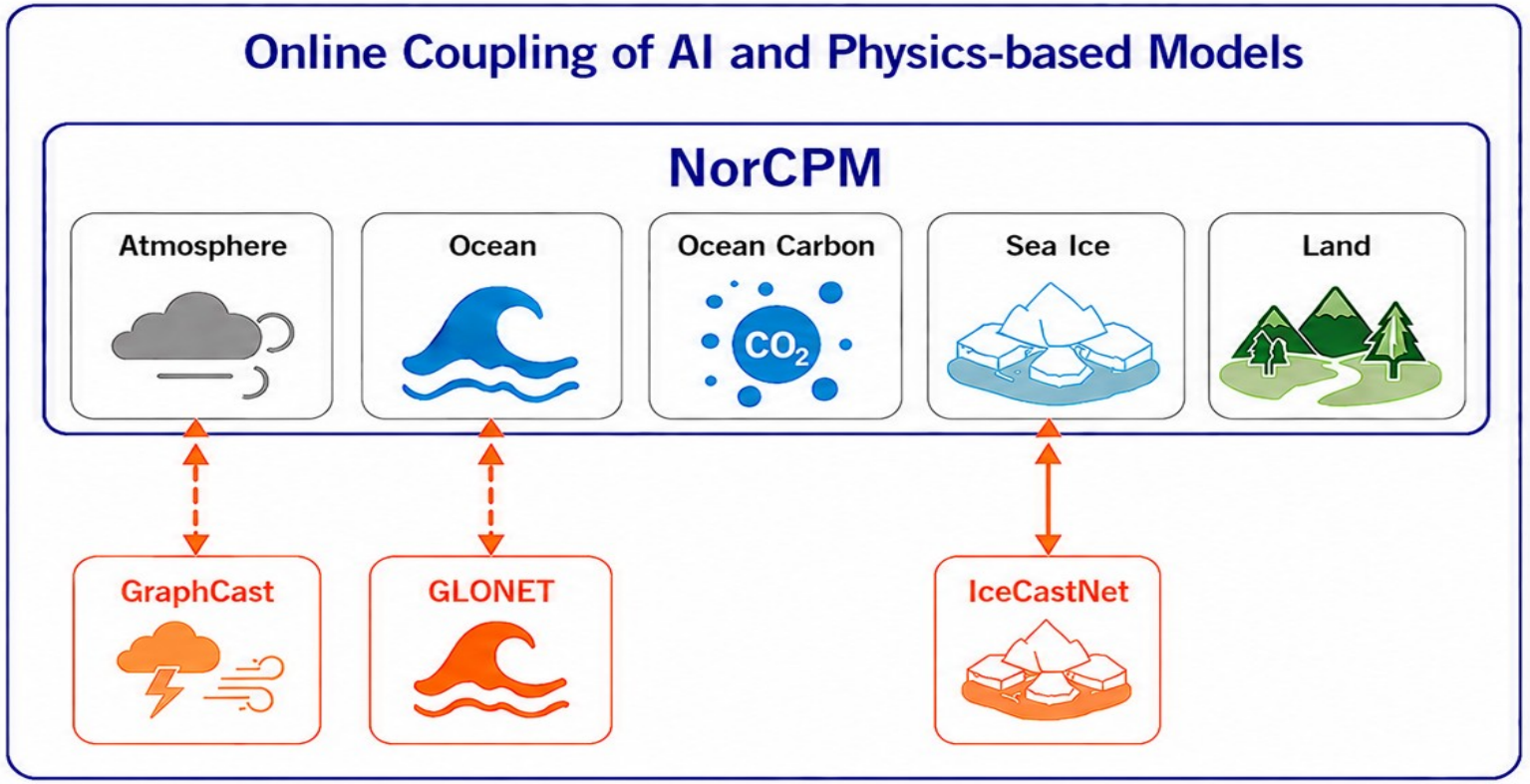
Counillon et al. 2023

GLONET

Mercator's End-to-End Neural Forecasting System



And beyond NorCPM2, building the prototype of AI-NorCPM



AI-NorCPM can resolve small scales (eddies, leads, front) while remaining computationally affordable for global, multi-century simulations (see Poster)