Planning for a Large Ensemble based on the HadGEM3 climate model

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National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

Outline

- Science context: the CANARI programme
- Basic properties of the Large Ensemble and HadGEM3 model
- Large Ensemble design
    - Scenario
    - Initialisation
    - Output

CANARI: Climate Change in the Arctic-North Atlantic Region and Impacts on the UK

National Capability Multi-Centre Science Programme Aim: Advance understanding of

- the impacts on the UK
- arising from climate variability and change in the Arctic-North Atlantic region,
- with a focus on extreme weather and the potential for rapid and disruptive change.

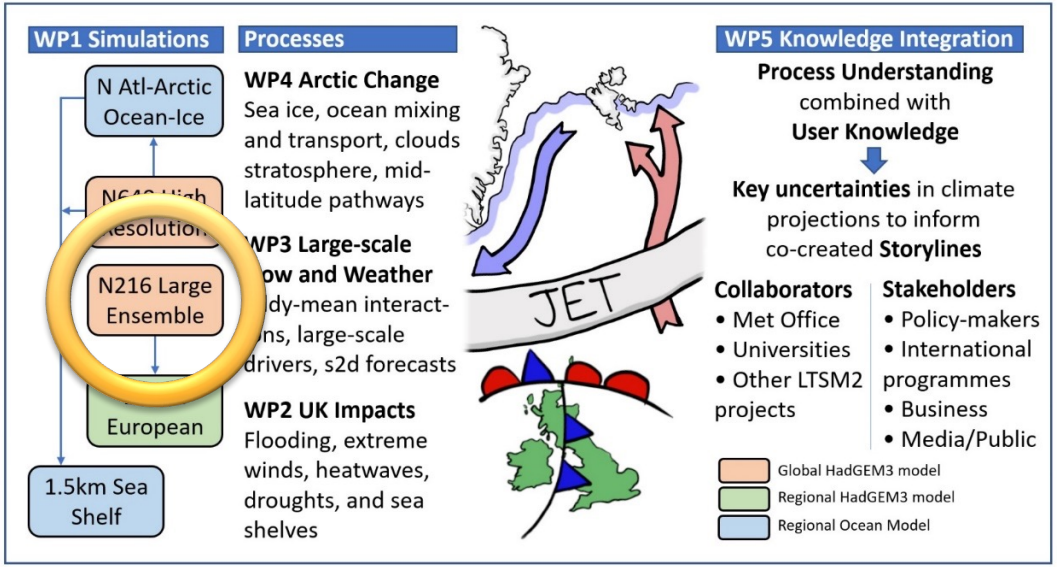
- ➢ Deliver new knowledge about the risks of climate change to the UK
- ➢ Provide the research community with new simulations and tools, including a Large Ensemble or SMILE
- ➢ Engage with users to inform climate adaptation and resilience building

National Centre for Atmospheric Science · UK Centre for Ecology & Hydrology · National Oceanography Centre · British Geological Survey · National Centre for Earth Observation · British Antarctic Survey · Centre for Polar Observation and Modelling · Met Office · Natural Environment Research Council

CANARI: Climate Change in the Arctic-North Atlantic Region and Impacts on the UK

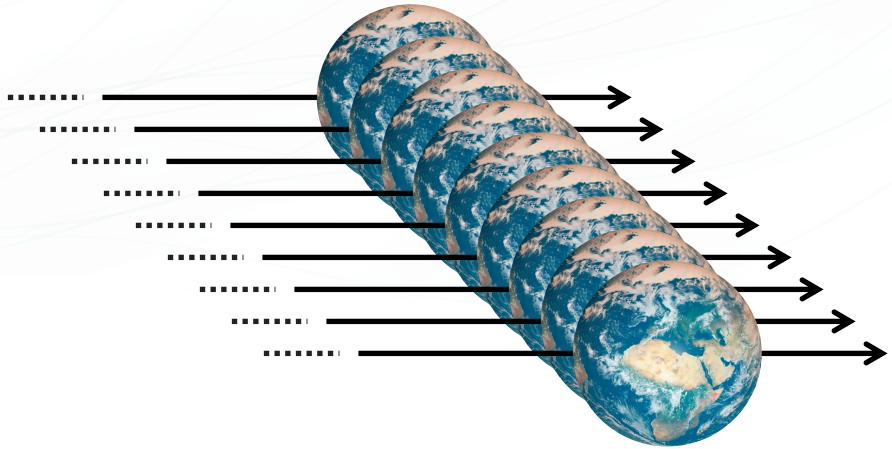
Produce a large ensemble to

- address CANARI science questions, and
- as a community resource more widely.



The CANARI Large Ensemble

- Model
  - HadGEM3-GC3.1, the UK Met Office CMIP6 model
  - N216-ORCA0.25 resolution (~60 km atmosphere at midlatitudes, ¼° ocean)
- Experiments
  - CMIP6 historical (1950 – 2014)
  - CMIP6 all-forcing scenario (2015 – 2100)
- 40 members



The model: HadGEM3-GC3.1

UK Met Office global physical climate model used in CMIP6. EffCS = 5.4 K (Senior et al., JAMES, 2020).

Met Office

The model: HadGEM3-GC3.1

Global Coupled

GC3.1
Williams et al., 2018

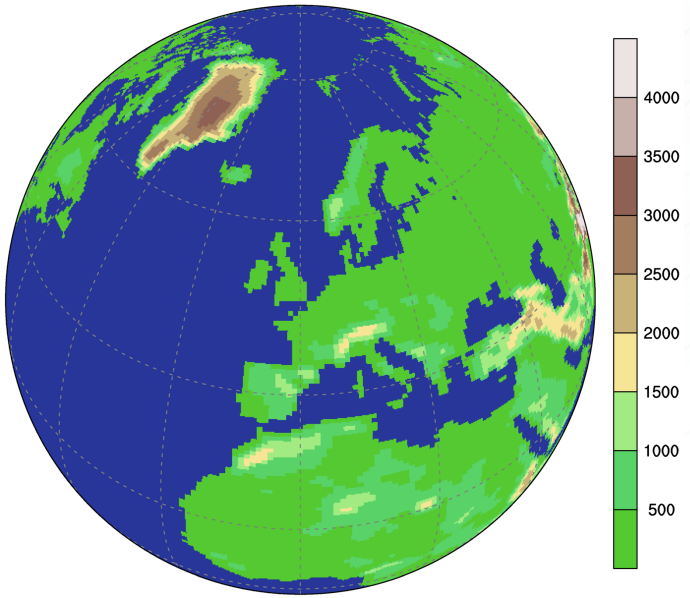
=

Met Office Unified Model™
Global Atmosphere

GA7.1
Walters et al., 2019

+

GC
Sto



Resolutions: N216
(0.83° x 0.5°, ~60 km)

L85 to 85km

Scenario choice: talking points

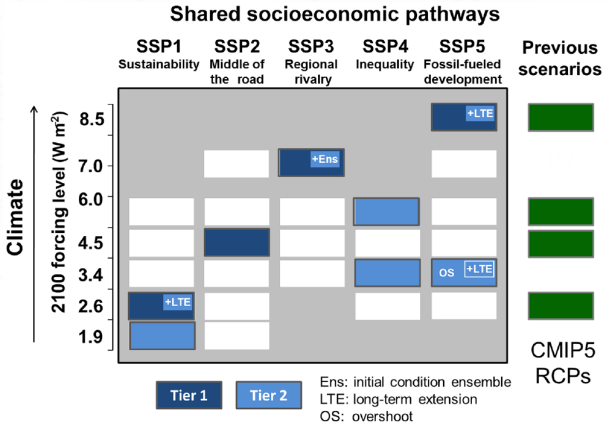
CANARI focus on rapid/disruptive change → strong all-forcing scenario (SSP3-7.0).

SSP3-7.0

SSP3 – Regional Rivalry (High challenges to mitigation and adaptation): resurgent nationalism, focus on national/regional security (food, energy), low international priority for environmental issues

- Slow economic growth
- 2100: 12 bn people, 800 ppm CO_2, 6 Mt black carbon emissions, +/- 700/600 mill. ha cropland/forest

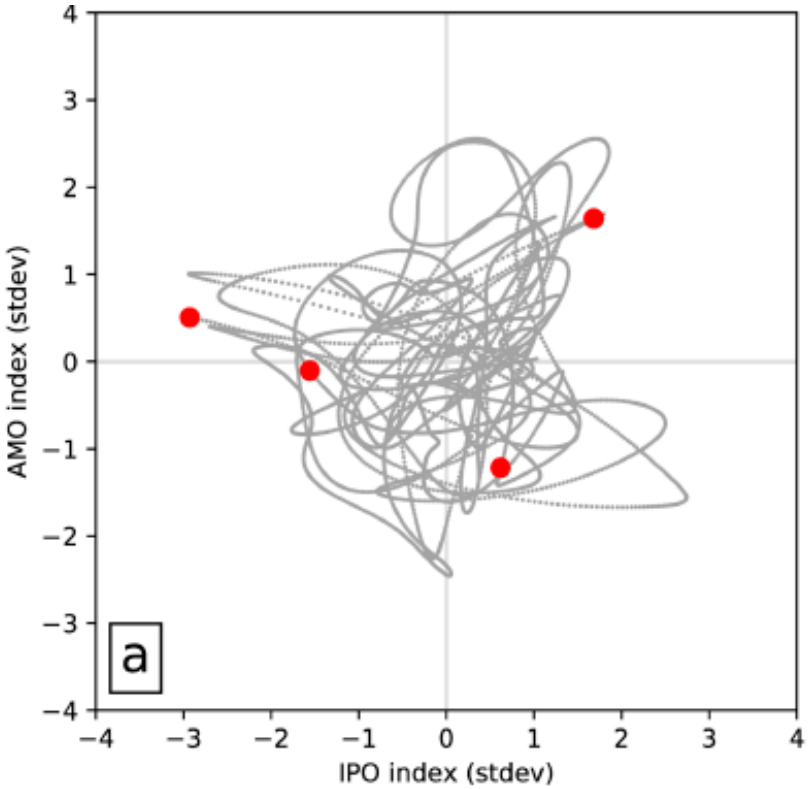
- Baseline for CMIP6 LUMIP, AerChemMIP
- Baseline for both SSP2&3 scenarios with lower forcing



O'Neill et al., GMD, 2016; Riahi et al., GEC, 2016

Initialisation

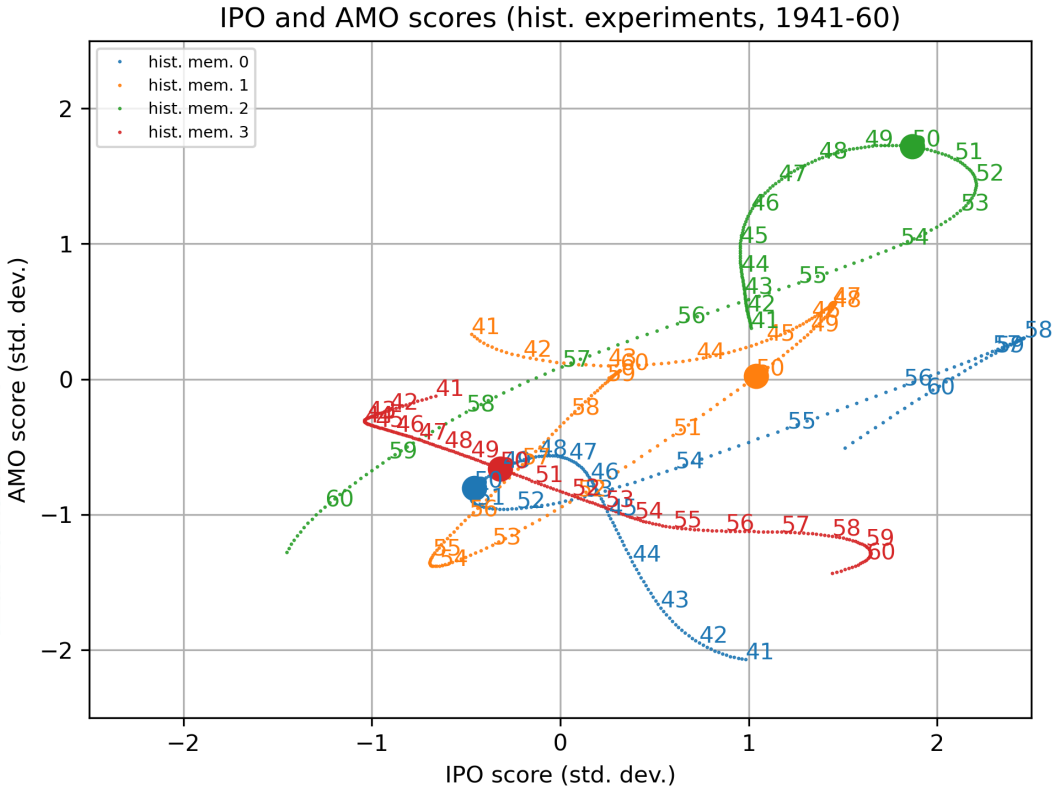
- Hybrid approach, e.g., 8 ‘macro’ x 5 ‘micro’
- Macro: follow method use by Met Office for CMIP6 historical experiments:
  - 1850 pre-industrial control
  - at different positions in IPO:AMO phase space
  - at least 30y apart
- (but we will start the CANARI LE in 1950 …)



Sellar et al., JAMES, 2020

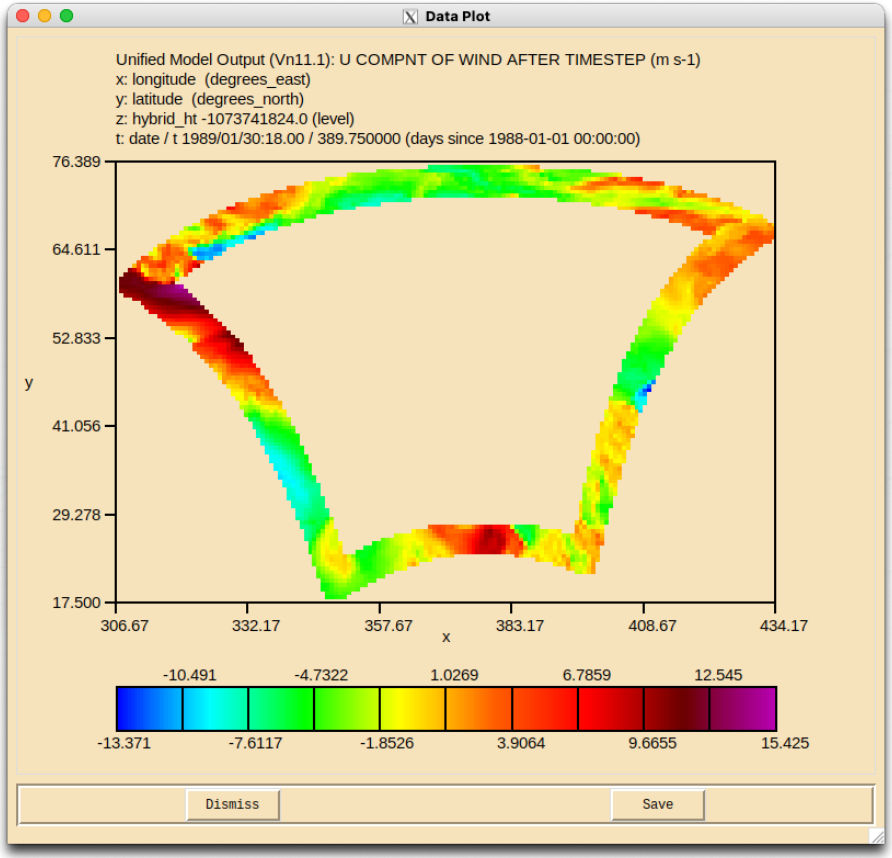
Initialisation

- 4 historical simulations with GC3.1 N216-ORCA0.25 (1850 – 2014)
- Where are these runs in the IPO:AMO space in 1950?
- Another ~4 historical 1850 – 1950 simulations for additional macro initialisation will be run.



Output

- successive reduction of CMIP6 output
- CANARI emphasis on storms / Europe
    - 6h dynamical fields in lower, middle, and upper troposphere
    - Boundary conditions for regional modelling
- Community consultation with a viable suggestion



Summary and status

- UK national multi-centre CANARI science programme started in April 2022. CANARI focuses on extreme weather and potential rapid, disruptive change in the Arctic-North Atlantic region.
- A new Large Ensemble will be created, to address CANARI science questions and as a resource for the community at large
    - HadGEM3-GC3.1 at N216-ORCA0.25 resolution
    - 40 members x 1950 – 2100 simulations
    - CMIP6 historical and strong all-forcing scenario (SSP3-7.0)
    - Hybrid macro-micro initialisation
    - Output to allow for studying weather systems (storms)
- Production planned for 2022 – 2024.