n02 Atmospheric and Polar Consortium: Select highlights

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1. Atmospheric and Polar Consortium
2. Computational ecosystem
3. High Resolution Climate Modelling (HRCM)
4. NERC National Capability - CANARI
5. British Antarctic Survey (BAS)

Atmospheric and Polar Consortium

- 171 active users (2023-2024)
- 22 institutions

NERC funded

- National Capability
- Regular grants
- NCAS, BAS, CEH, NOC, PLM

EU funded, Welcome Trust, Marie Curie...

Atmospheric and Polar Consortium

- Climate/Weather (production)
  - Earth System (UKESM)
  - Global/Regional modelling
  - Land Surface, Vegetation, Ice, Sea Ice
  - Atmospheric Chemistry and Aerosols
  - Extreme weather, storms, flooding
  - Paleoclimate
  - Coupled Model Intercomparison Project (CMIP)

- Model development/Next Generation models
  - Resolution, Fidelity, IO
  - Portability, Performance
  - Work flow

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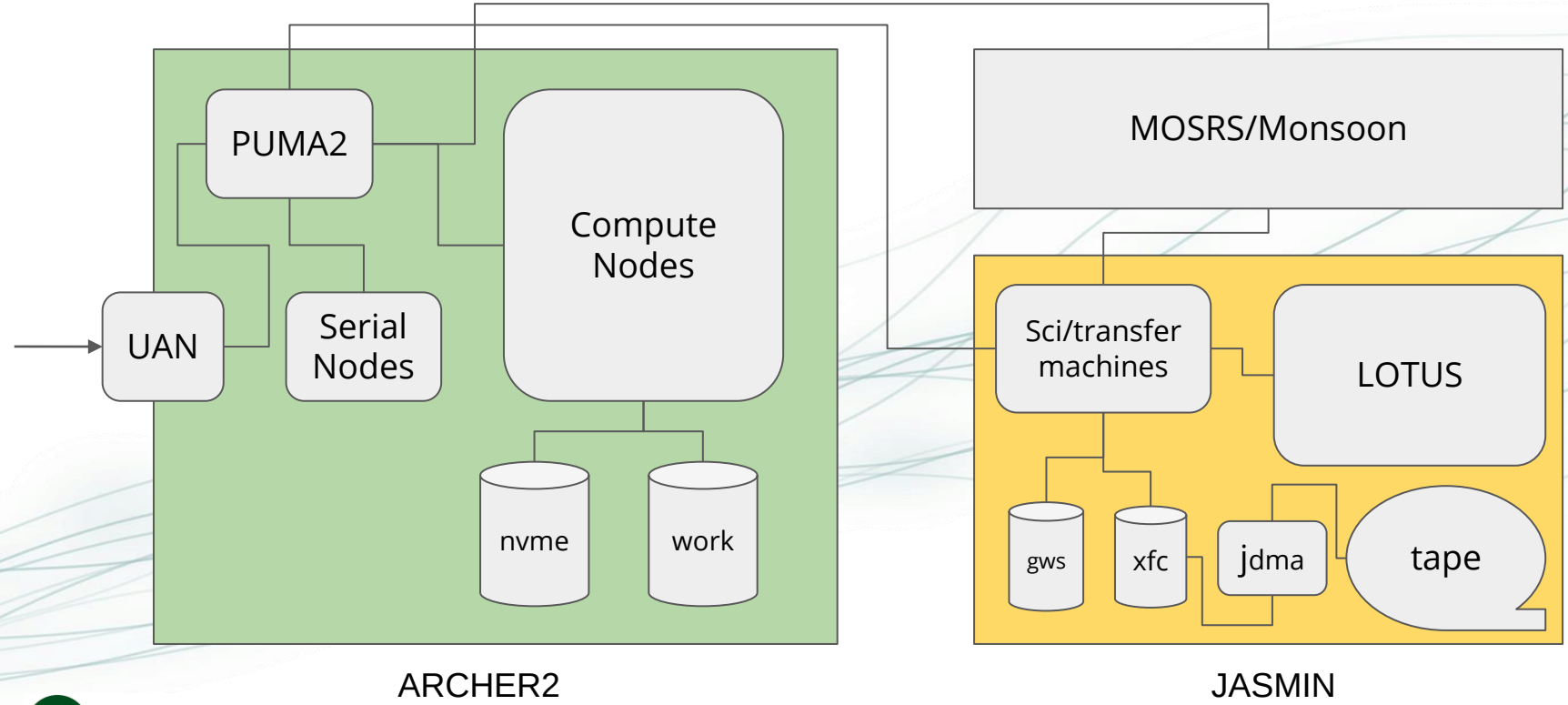
Computational ecosystem

Models

- Unified Model (Atmos, NEMO, JULES, CICE, SI3, OASIS, ...)
    - LFRic (next generation of the MO model)
- MITgcm (MIT General Circulation Model)
- ICON (ICOsahedral Nonhydrostatic weather and and climate model)
- WRF (Weather Research and Forecasting Model)
    - MPAS (Model for Prediction across Scales)
- CESM (Community Earth System Model)
- MONC (Met Office NERC Cloud Model)

Computational ecosystem (UM/Workflow)



High Resolution Climate Modelling

P. L. Vidale et al

1. long simulations span climate time scale
2. Global Storm Resolving Models (GSRMs) offer unprecedented levels of process fidelity

100km

Increasing Resolution

2-5km

Century-scale re-analyses and traditional climate simulations 300 yrs

«The CTO environment»

What is the role of climate variability and change?

HighResMIP climate 100 yrs

How are CTO interannual variability and intensity changing?

Seasonal predictions 20 yrs

«Black Swans»

Have we missed rare, albeit plausible and dangerous events?

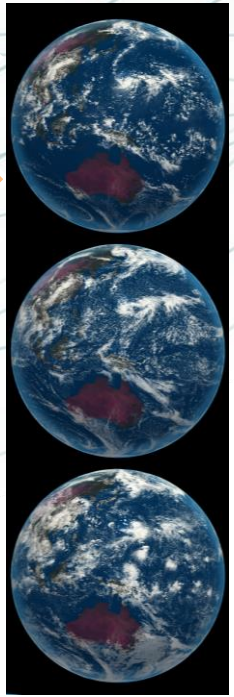
GSRMs 30 yrs

How is CTO genesis changing? What is the true range of possible intensities?

RCMs

«Process studies»

What are the roles of dynamics (regional circulation) and thermodynamics (Sea Surface Temperatures)



What are CTOs and why should we care?

We imagine: Tropical Cyclones (TCs, hurricanes, typhoons) live and die in the tropics.

But in reality: since 1950, 3-5 CTOs / year tracked into mid-latitudes, mostly as Post-Tropical Cyclones (PTCs), but at times even as genuine hurricanes. In very simplistic terms:

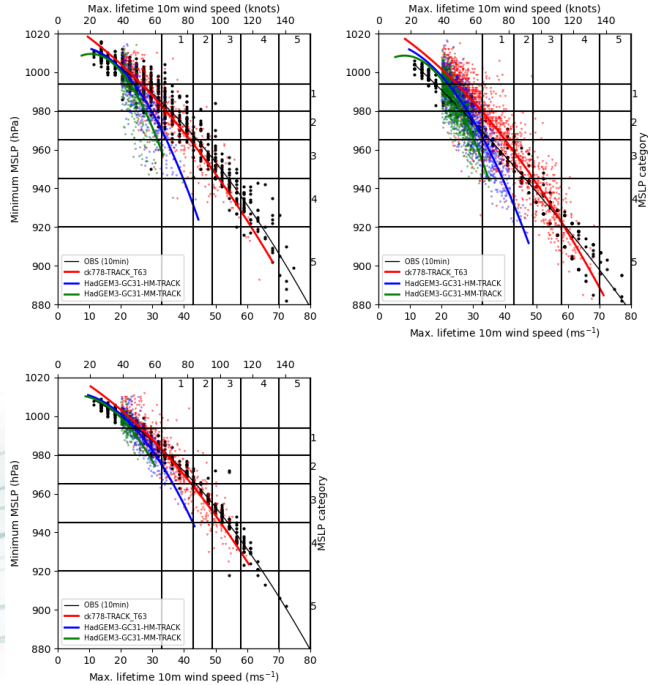
CTOs = TCs + PTCs

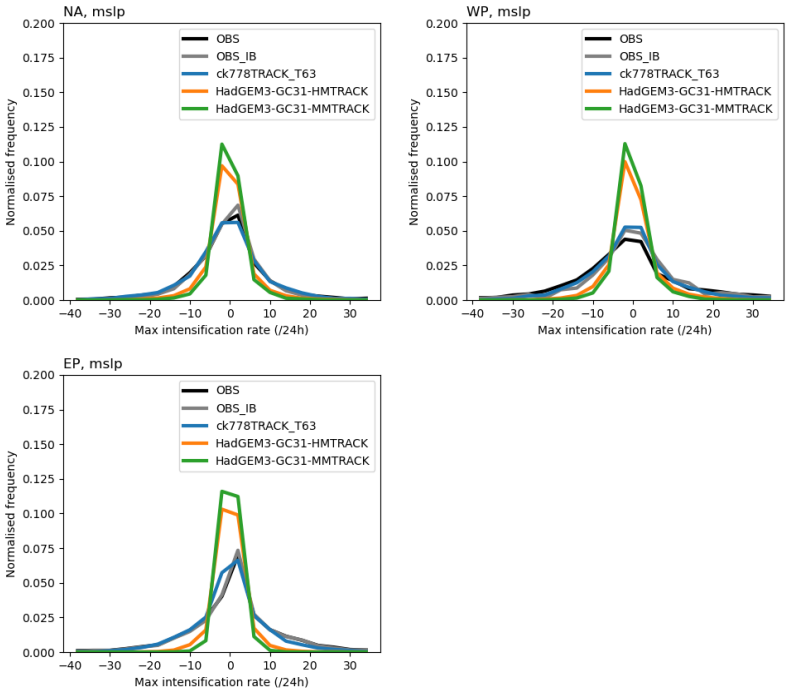
CTOs hazards:

Typical (traditional) TC loss: ~$ 20 billion/hurricane
Worst-known mid-lat CTO loss: $ 40-70 billion for PTC Sandy: impacted New York City, 2012
$ 31-44 billion losses in a single month, Henri+Ida, 2021

P. L. Vidale et al

We have HadGEM3 runs135 years at 10km (3 ensemble members)
Lengthy process these runs extended Sept 2021 – Feb 2023 (stability)





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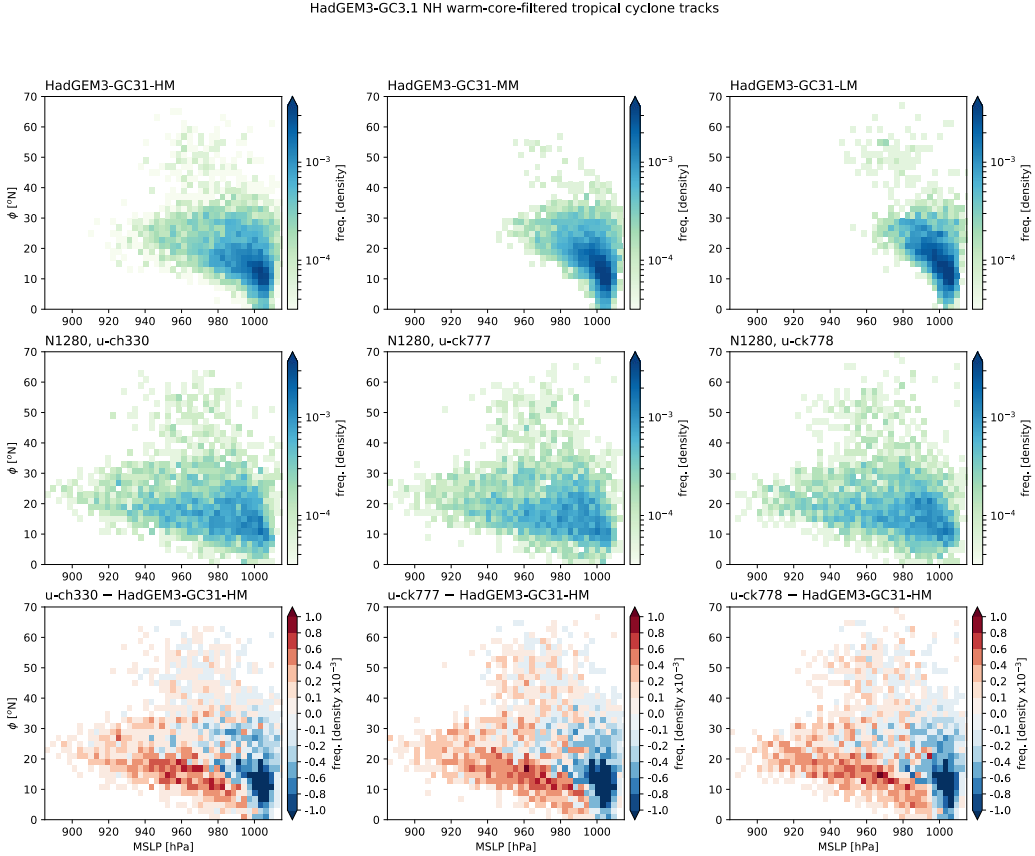

- a realistic relationship between max intensity and its location

- credible intensification rates, which goes with the above

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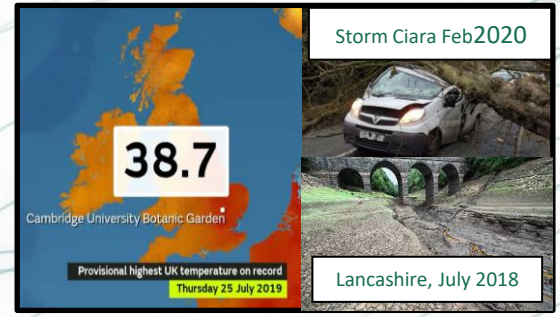
CANARI: Climate Change in the Arctic-North Atlantic Region and Impacts on the UK

A NERC NC Multi-Centre Science Programme

- CANARI PI: Len Shaffrey (NCAS)
- Apr 2022 – Mar 2027
- Further info: canari.ac.uk

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.

- Inland flooding
- High temperatures and health
- Drought and water supply
- Extreme winds and wind damage
- Changes in UK Shelf Seas



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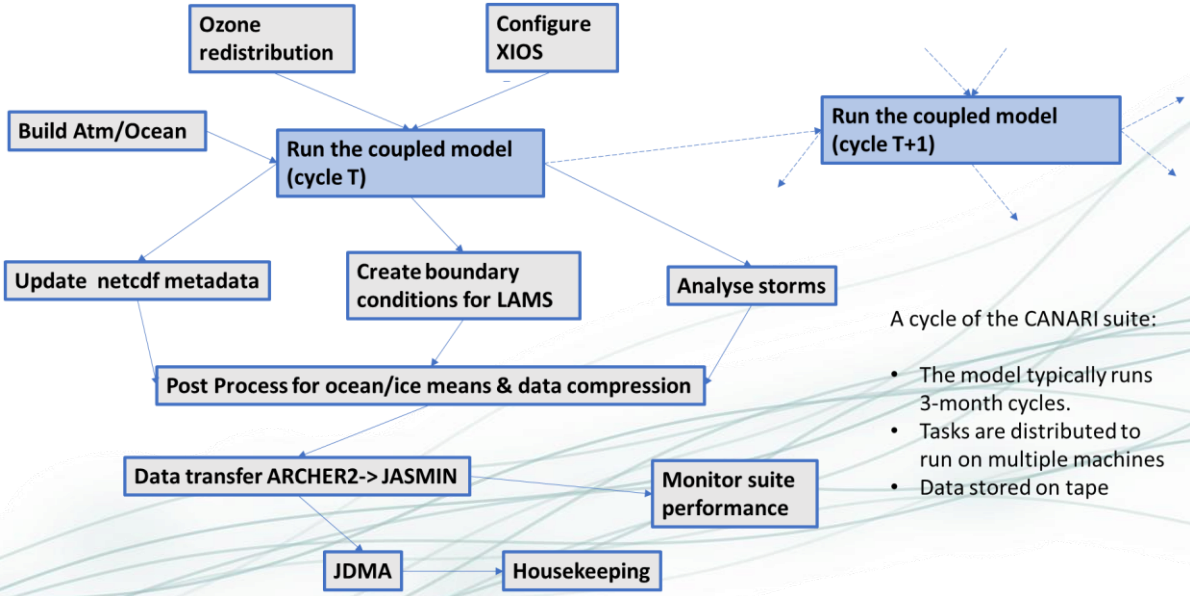
CANARI



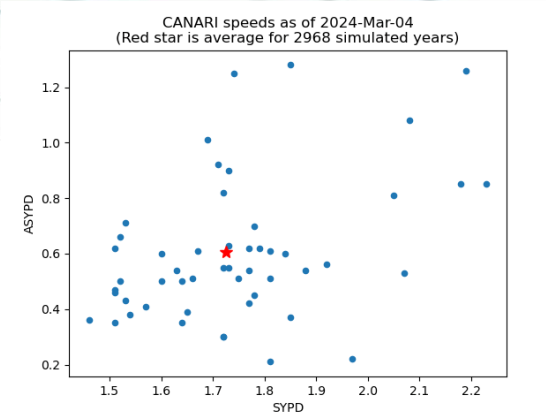
A cycle of the CANARI suite:

- The model typically runs 3-month cycles.
- Tasks are distributed to run on multiple machines
- Data stored on tape

Large Ensemble:

40-member ensemble (N216ORCA025)
CMIP6 (1850-2015) modified after
150 years each member
Began Feb 2023
Target completion end of 2024
13 CANARI volunteers

CANARI will use about 4 million CUs and produce ~5PB of data on JASMIN Elastic Tape



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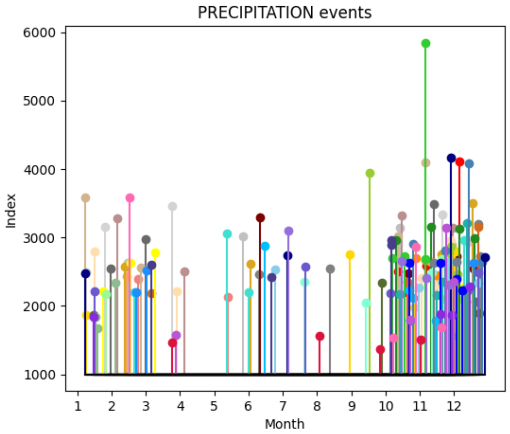

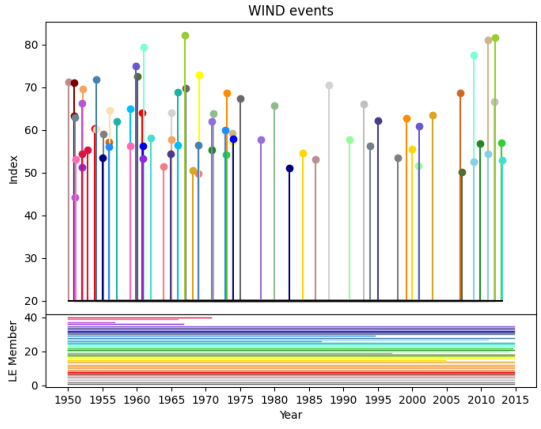

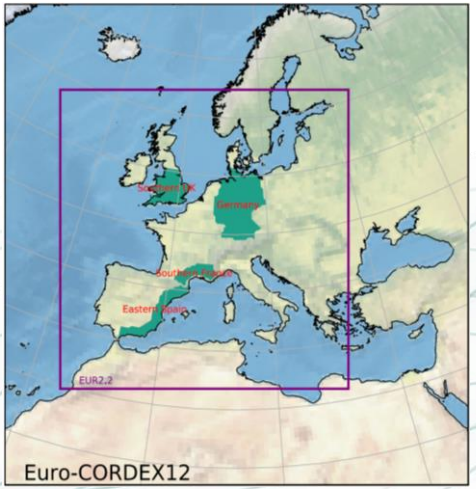

CANARI Large Ensemble

300 extreme storm cases

2.2km Pan-EU Domain

- Storm dynamics
- Extreme wind impacts
- Hydrological modelling

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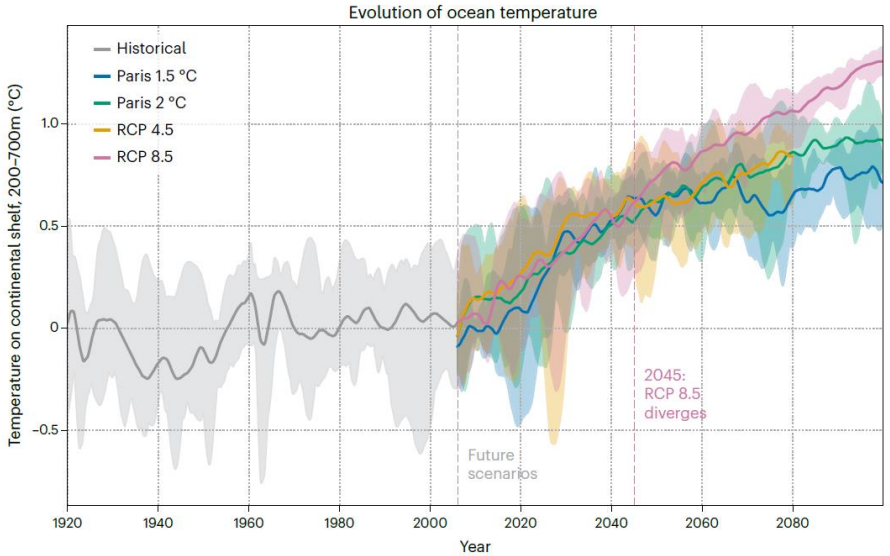
British Antarctic Survey science on ARCHER2

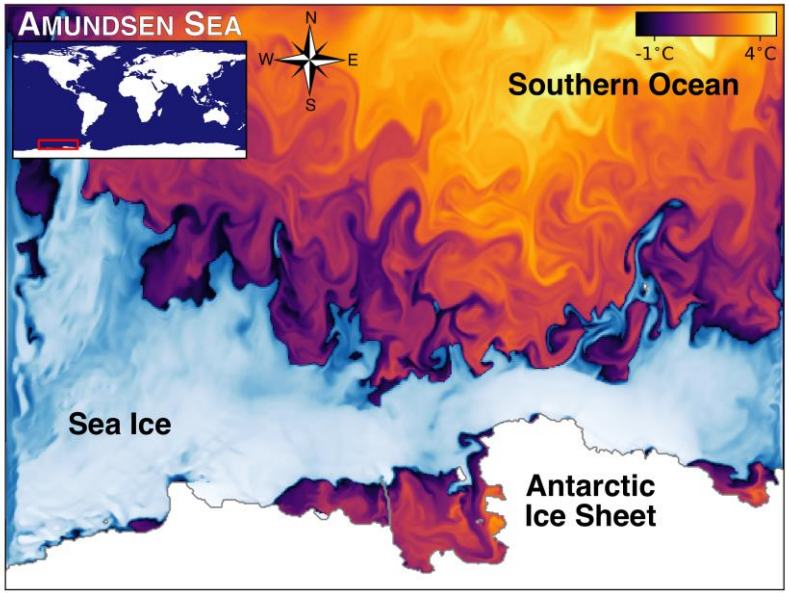
Science aim: understand and predict impacts of climate change on the Antarctic ocean-ice system



Timeseries of simulated Amundsen Sea temperature for five core climate scenarios

- Understand ocean-driven ice shelf melt, both at the regional (Amundsen Sea) and circum-Antarctic scales
- Simulate the impacts of climate change on ocean temperatures, ice shelf melt and sea-level rise
- Modelling tools: regional and circum-Antarctic ocean, sea ice, ice shelf modelling with **MITgcm** and **NEMO-SI3**
- Example: mitigation of greenhouse gases now has limited power to prevent ocean warming that could lead to the collapse of the West Antarctic Ice Sheet (Naughten et al., 2023).

British Antarctic Survey science on ARCHER2



Simulated ocean temperature and sea ice cover in the Amundsen Sea

Science aim: reduce uncertainty of model predictions by investigating and improving model representation of key ocean-ice processes

- Idealised modelling of the ocean-ice shelf boundary layer to develop an improved representation of ice shelf melt processes
- Developing new model representation of iceberg-sea bed interaction, including grounding
- Coupled ocean-ice sheet modelling to understand drivers of historical ice stream retreat and project future retreat
- Modelling tools: **MITgcm**, **NEMO-SI3**, **WAVI**

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Emma Young

British Antarctic Survey science on ARCHER2

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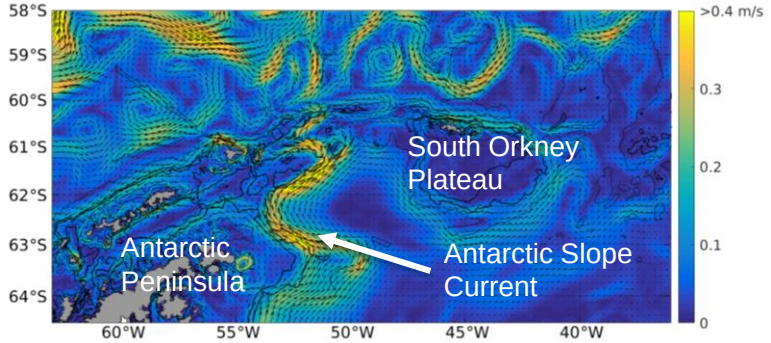

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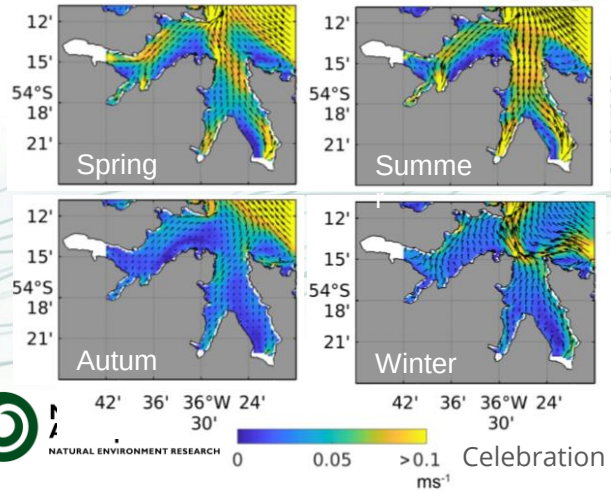

Science aim: understand regional oceanographic variability and impacts on Antarctic ecosystems

- Elucidate the drivers of regional and shelf oceanographic and sea ice variability
- Investigate the impacts of variability on the marine ecosystem, including commercial species, e.g. Antarctic krill, to support ecosystem and stock management
- Modelling tools: **NEMO-SI3**
- Example 1: Antarctic Slope Current restricts transport of krill from the Antarctic Peninsula to the South Orkney Plateau (Young et al., 2023)
- Example 2: subglacial discharge dominates seasonal flow variability in Cumberland Bay, a sub-Antarctic fjord (Zanker et al., 2024)

Thanks

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