Ocean and Sea Ice Modelling at the UK Met Office and NERC centres

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Overview

- Joint Marine Modelling Programme
- Current model configurations
- Current model performance / biases
- Future ocean / sea ice developments
- Interactions with UK research community

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Joint Marine Modelling Programme (JMMP)

- The JMMP is a research programme under the wider Joint Weather and Climate Research Programme (JWCRP; NERC centres and Met Office)

- It delivers global ocean (GO), global sea ice (GSI) and NW shelf region (CO) configurations based on NEMO to operational and academic users

- It is a partnership between Met Office, NOC, BAS and CPOM

- The overall programme is led by Helene Hewitt (MO), with GO led by Bablu Sinha (NOC), GSI led by Ed Blockley (MO), and CO led by Jeff Polton (NOC)

- Total cross-institute effort is approximately 10 people

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Current model configurations

- Global ocean and sea ice configurations (GO6 and GSI8) exist at three resolutions: 1°, 1/4° and 1/12° (Storkey *et al.*, submitted)

- These are being used for short-range forecasts, seasonal to decadal forecasts and CMIP6

- The GO7 version has ice cavities open

- CMIP6 experiments (e.g. Eyring *et al.*, 2016) with two versions of the coupled climate model: GC3 at 1/4° resolution (physics only); and UKESM1 at 1° resolution and including marine biogeochemistry

- NW shelf configurations include CO6 (7 km resolution) and CO7 (1.5 km resolution); both are used for operational forecasts and climate projections

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Global Physical Modelling

Unified Prediction across Timescales

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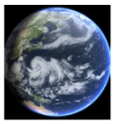
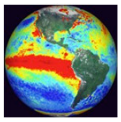
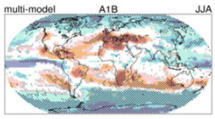
Hours Days Weeks Months Seasons Decades Centuries

1/12° 1/4° 1°







NWP - Atmosphere, Ocean, Waves
Deterministic forecast

MOGREPS (monthly)

GloSea (seasonal)

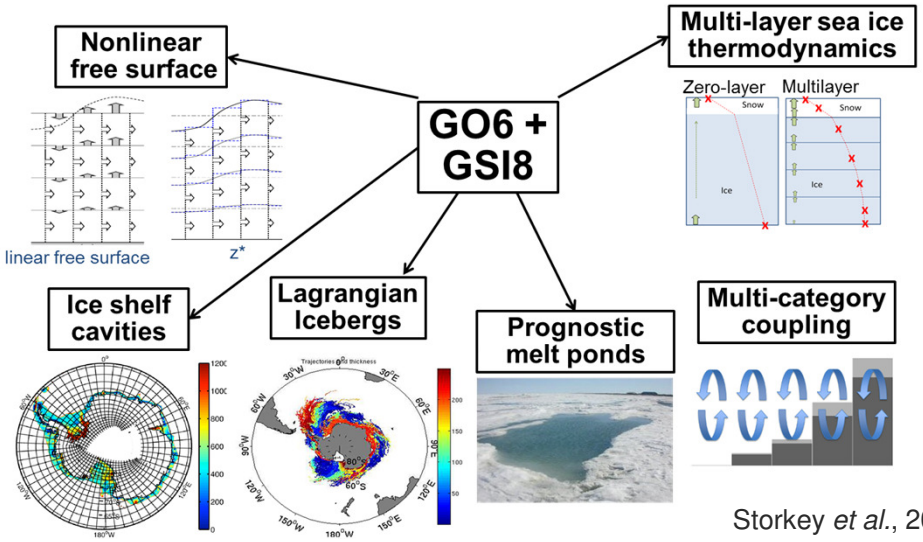
Decadal (…)

Climate Change
UKESM1

Component Models	Coupled AOIL Model
GA7 , GL7, GO6, GSI7/8	GC3.0

Met Office | NERC Science of the Environment | National Oceanography Centre | British Antarctic Survey | cpom

GO6 configuration



Storkey *et al.*, 2018

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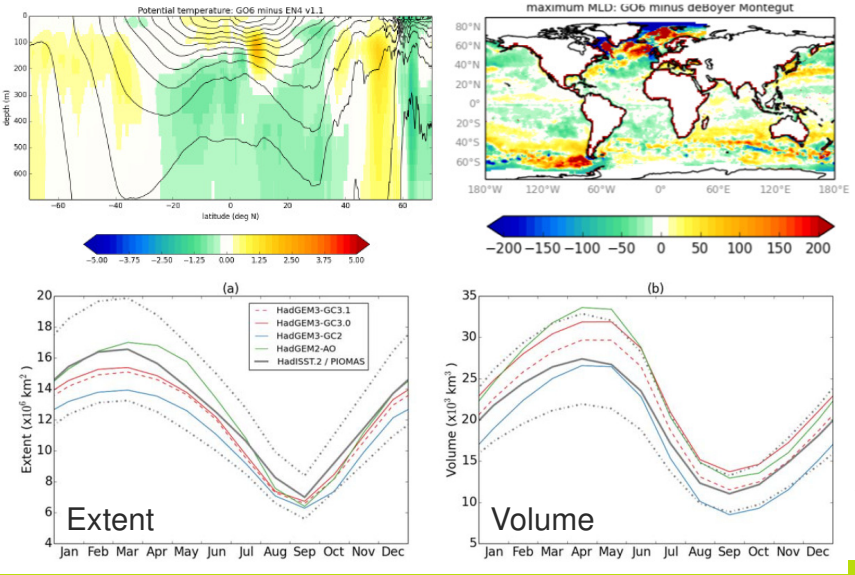
YA15

Ocean and Sea Ice Performance



Ocean biases in GO6

Storkey *et al.*, 2018

Arctic Sea Ice in GC3

Williams *et al.*, 2017

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Future GO, GSI configurations

Current plans for GO8 and GSI9 focus on the following:

1. Upgrade to NEMO vn4
2. Inclusion of OSMOSIS mixed layer (strongly motivated by Southern Ocean warm bias)
3. Improvements to downslope flow at key straits both by JMMP core team (Nordic overflows) and off Antarctic shelf (ORCHESTRA). In both cases, the approach is to change to localised terrain following coordinates to reduce entrainment in downslope flow
4. Move to a new sea ice model (SI^3) plus developments in ice rheology and drag

Longer term plans include better representation of shelf processes in global models – especially important for the shelf-dominated Arctic

Slide 7

YA15 I guess my cue here is to say that the biases are relatively minor, and that they're improved over HadGEM2

Yool, Andrew, 04/01/2019

NEMO sea ice model (SI³)

- Previously the NEMO sea ice community was fragmented:
  - LIM, CICE & GELATO sea ice models used routinely with NEMO ocean model
- New collaboration within Europe to pool resources and develop unified NEMO sea ice model:
  - SI³ = Sea Ice modelling Integrated Initiative
  - Led by NEMO Sea Ice Working Group - Ed Blockley (Met Office) & Martin Vancoppenolle (IPSL) co-chairs
  - To include CICE functionality used by HadGEM3
- SI³ being developed with GO8 for inclusion in GC5 or GC6 (i.e. not immediately for GC4)

NEMO website/code access in 2016

Top 10 number of sessions by countries

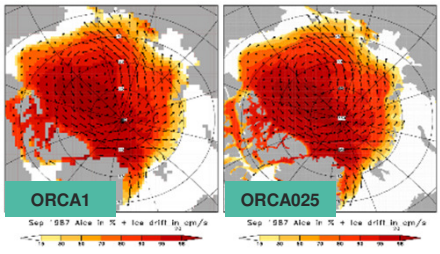
Country	Sessions
France	4,009
United Kingdom	3,378
United States	1,899
Italy	1,635
Canada	1,490
China	1,222
Germany	1,149
India	983
Spain	772
Russia	770

Sea ice drag and rheology

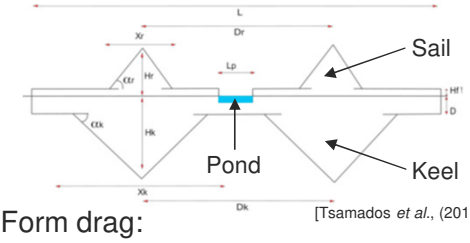
Rheology:

EVP rheology designed to resolve large-scale sea ice dynamics and does not necessarily provide more information with higher resolution.

Trialing the Elastic Anisotropic Plastic (EAP) sea ice rheology within HadGEM3



[Figure courtesy D. Feltham, CPOM]



[Tsamados *et al.*, (2014)]

Form drag:

- Inclusion of sea ice floe edges in atmosphere drag calculation
- Adaption of Lupkes *et al.* (2012) sea ice drag scheme implemented in GL8
- Extended to include ice ridges (sails/keels) & melt pond edges
- Climate: ice-atm and ice-ocn drag will change with the changing ice cover

Interaction with research community

- JMMP plans to make Global (GO), Global Sea Ice (GSI) and Shelf (CO) configurations more accessible to external users

- This will includes output from existing runs (e.g. via webpage or JASMIN) and configurations to run on HPC (e.g. MONSooN, Archer)

- CMIP6 data will be publicly available (ESGF and JASMIN)

- Working with GO and CO configurations means that your research has potential to be relevant to operational applications on a range of timescales

- JMMP is keen to support your work using GO and CO configurations

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