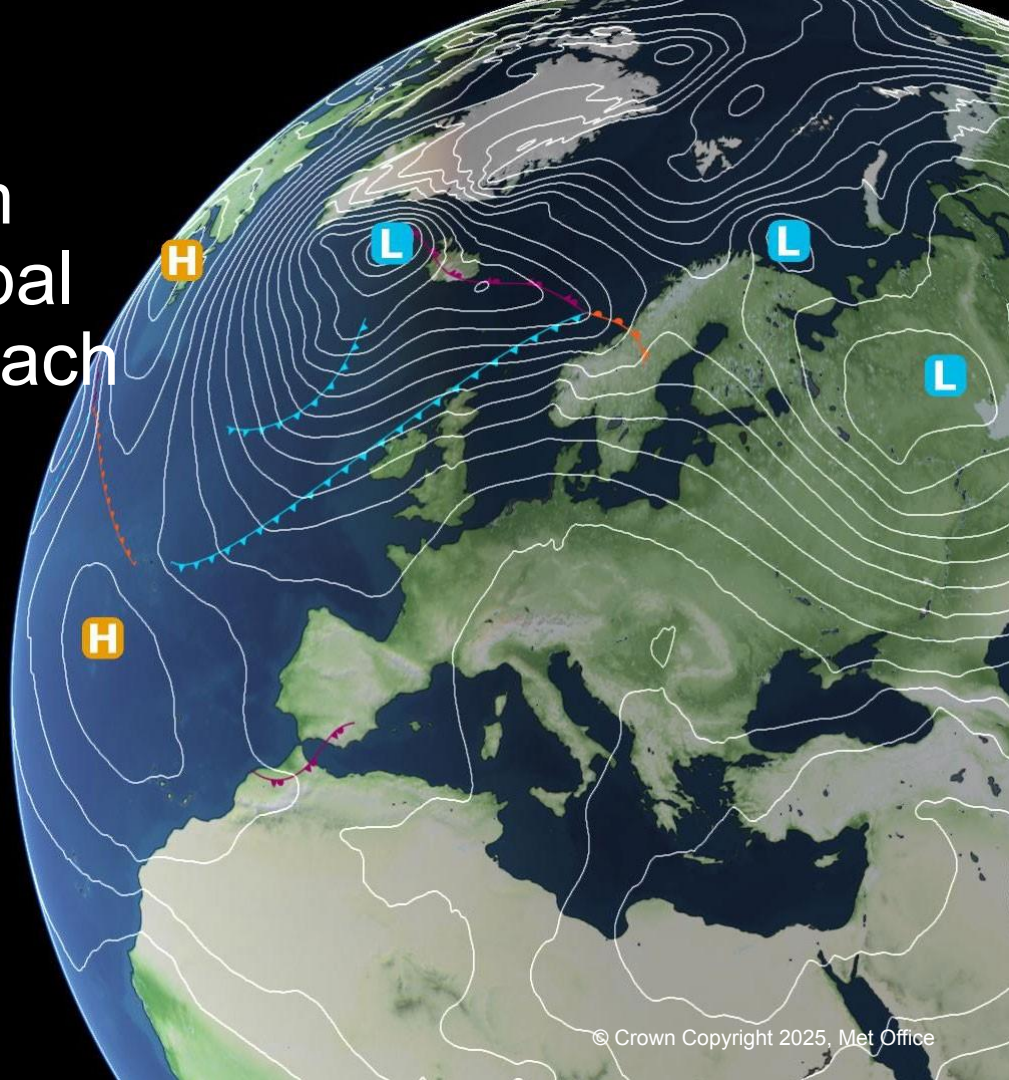


# Met Office and Momentum Partnership seamless global model development approach

Charline Marzin  
GC Programme Manager  
Met Office

Seamless Global Modelling workshop  
Bristol, 3-6 June



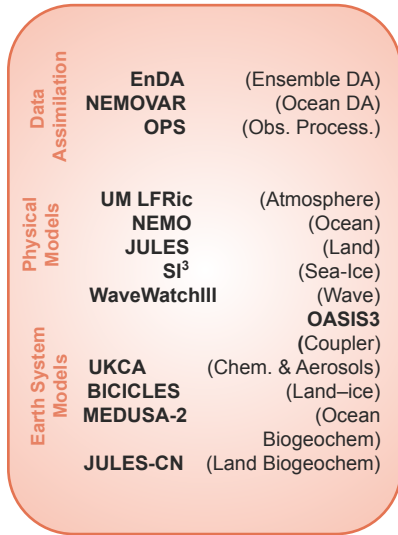
# Seamless strategy evolution

- Building the Unified Model code base. Cullen, Meteor. Mag, 1993
- 2000s more and more model evaluation across timescales
- 2010: Creation of Met Office Foundation Science between Weather and Climate and GMED team (Seamless Global Model Development and Evaluation). Walters et al, GMD 2011 <https://doi.org/10.5194/gmd-4-919-2011> Brown et al. ,2012. <https://doi.org/10.1175/BAMS-D-12-00018.1>
- 2011-2016 INTEGRATE project first attempt at global coupled seamless configuration development, GC2 release Williams et al, GMD 2015 <http://dx.doi.org/10.5194/gmdd-8-521-2015> Walters et al, GMD 2017. <https://www.geosci-model-dev.net/10/1487/2017/>
- 2018 Creation of the GC Programme (Global Coupled configuration), governance, seamless requirements, partnerships
- 2021: Implementation of Coupled NWP with GC4 configuration
- 2023 GC5 release: full implementation of seamless coupled model development framework

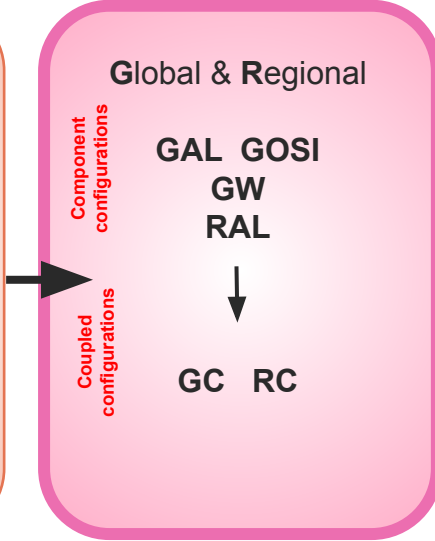
# Seamless Environmental Prediction Frameworks

...to develop underpinning seamless global and regional model frameworks for use in ensemble predictions/projections across weather and climate timescales

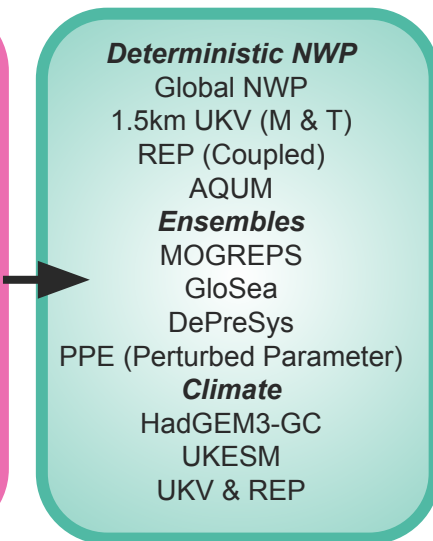
## Research, Codes & Component Models



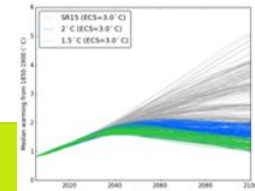
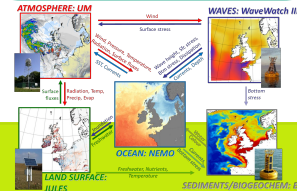
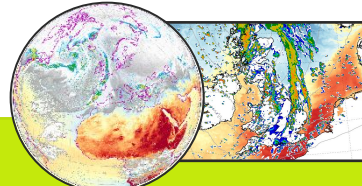
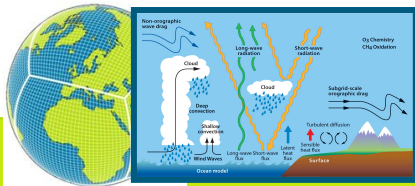
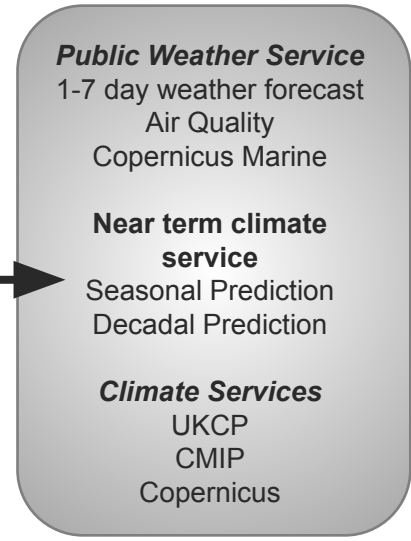
## Seamless Science Configurations

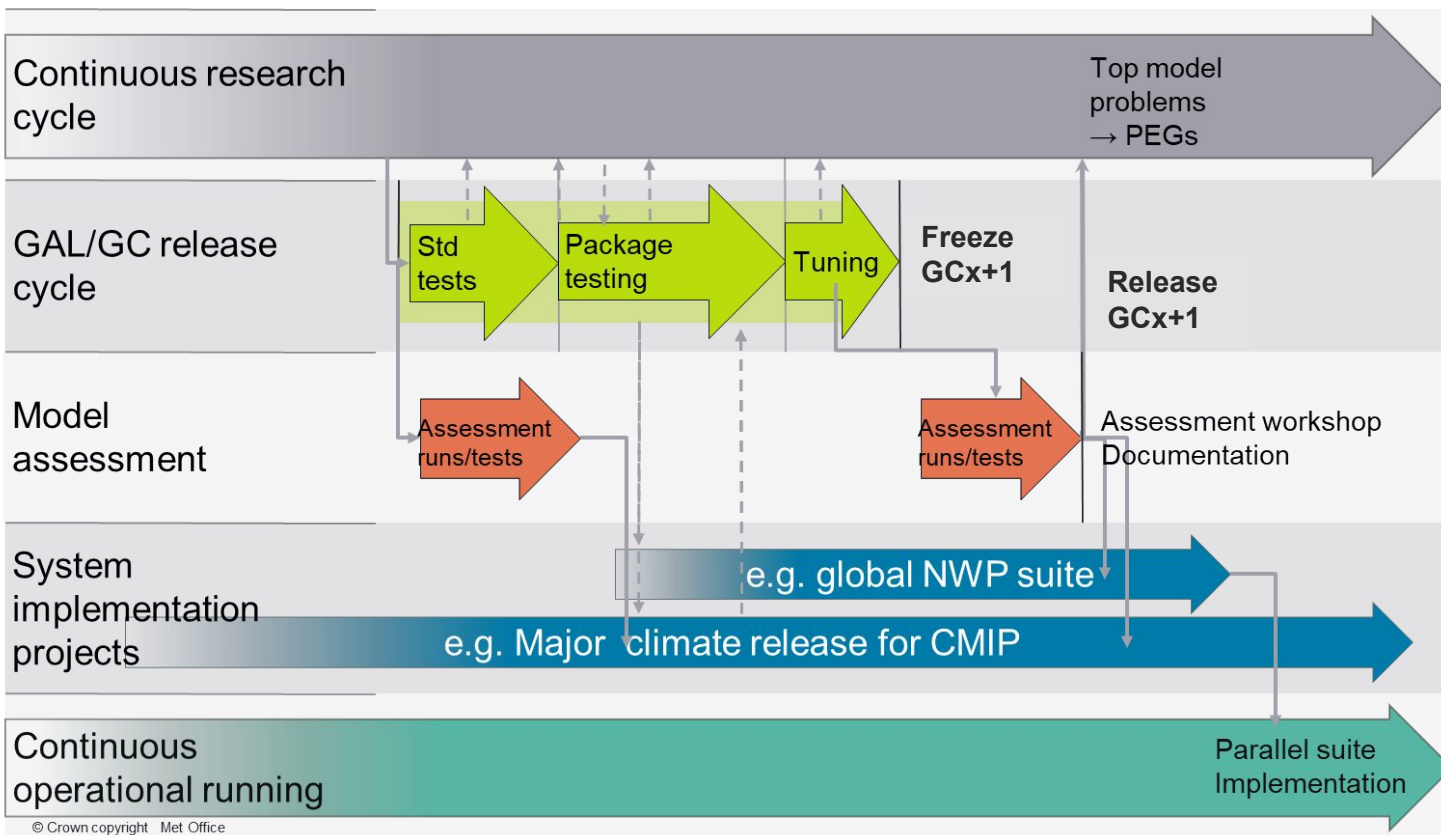


## Seamless Prediction & Projection Systems



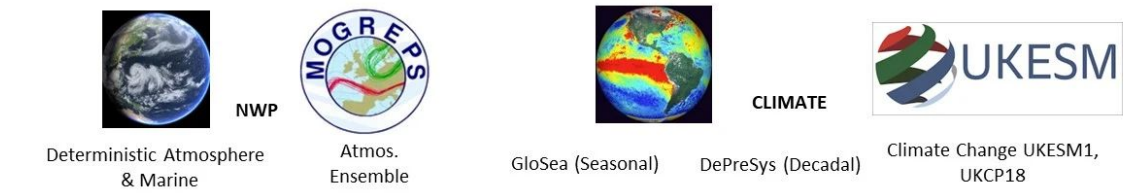
## Weather & Climate Services





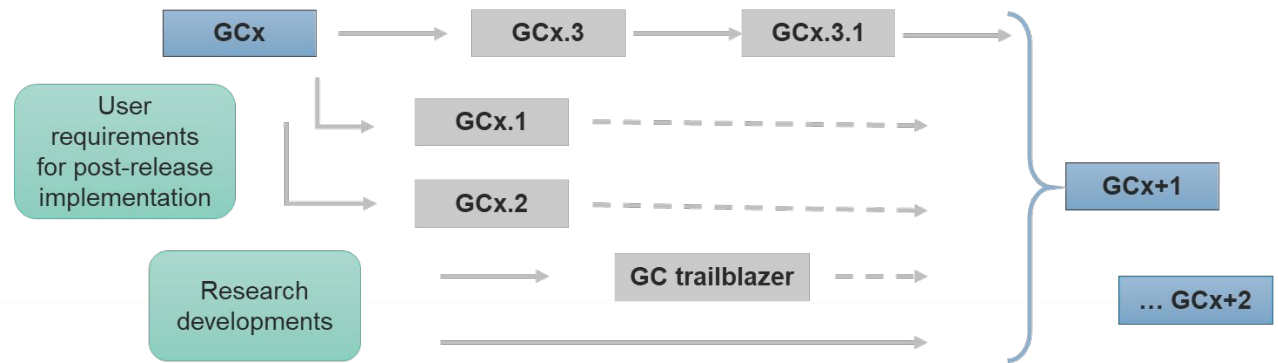
# Global Seamless Physical Model

# A pragmatic seamless approach



- Traceable seamless trunk developed in partnership
- Scientific robustness
- Agility: branches and research configurations
- Central development, infrastructure and support

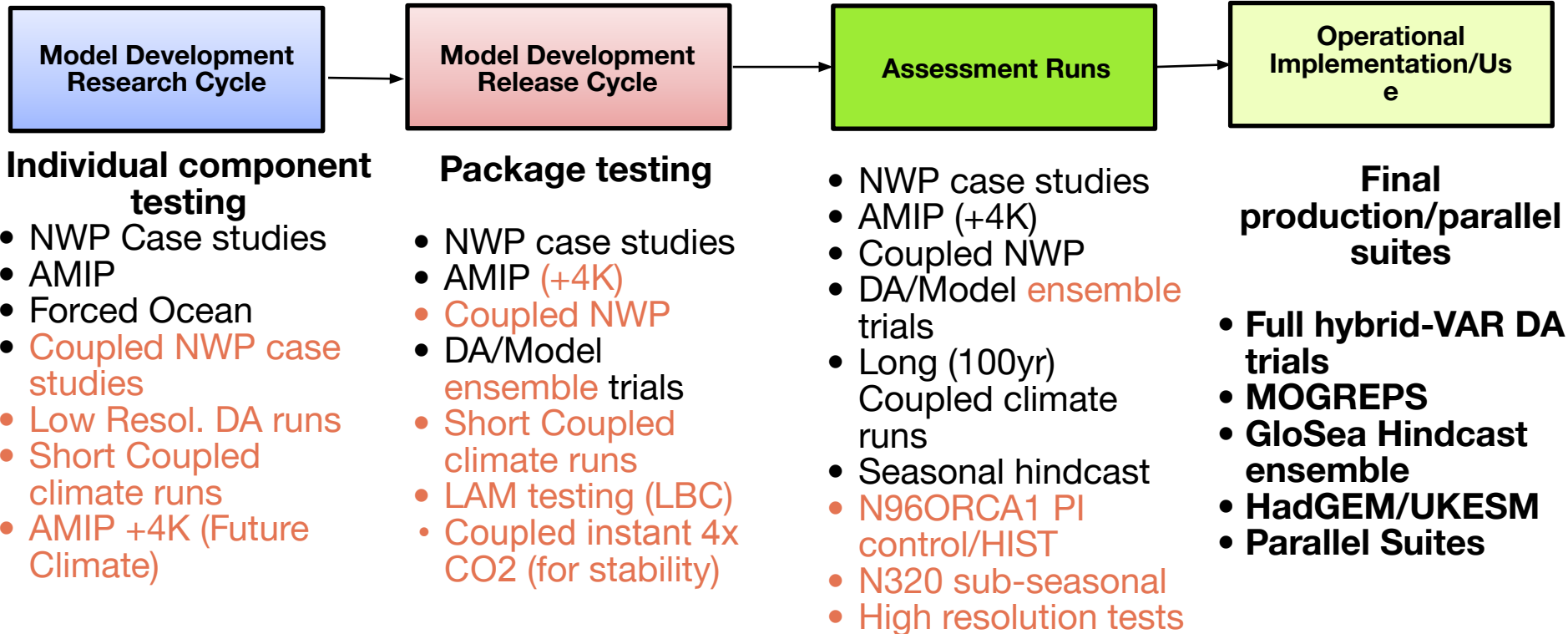
Example release / implementation cycle






# GC seamless testing framework

**Extended** and ambitious testing for GC5,  
leveraging all partnerships



# GC5 (GAL9 GOSI9) achievements

 Met Office GC5 Release (Global Coupled model configuration)

## Science developments since GC4

- New sea ice model SI<sup>3</sup>
- Southern Ocean improvements
- Significant changes to most areas of parametrisation: convection, clouds, microphysics, drag
- Extensive testing for both weather forecasting and climate predictions
- Developed in partnership



## How will GC5 be used?

- NWP and seasonal operational implementation, 2024 (PS47)
- Baseline for UKESM and next set of climate projections
- Baseline for LFRic implementation, next generation modelling system



## Performance improvements

- Southern Ocean temperature
- Sea ice area and volume
- Precipitation over land, diurnal cycle, monsoons

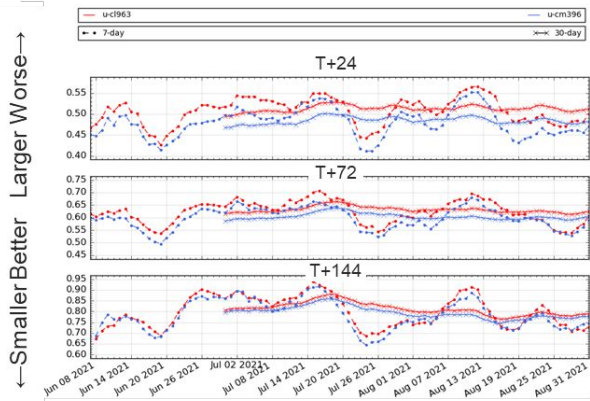
- Near surface wind speed
- Tropical cyclones
- NWP: improved forecast accuracy

- GC5.1 high resolution branch for NWP implementation
- GC5-central climate sensitivity for certain climate applications

# Seamless model development: GC5 release

## GC5rc2 vs GC4

Timeseries of Global 24 hrly SEEPS\*

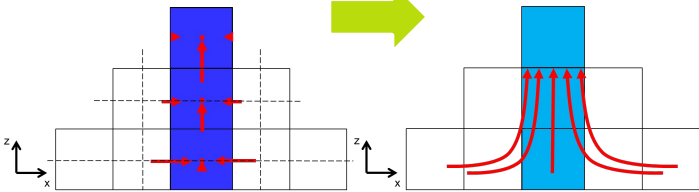


### GC5 target applications:

- Basis of climate configurations for CMIP7 & next UK climate projections
- Planned NWP & seasonal forecast system upgrades on next HPC GEN1
- Baseline for development of next generation models (GungHo/LFRic)

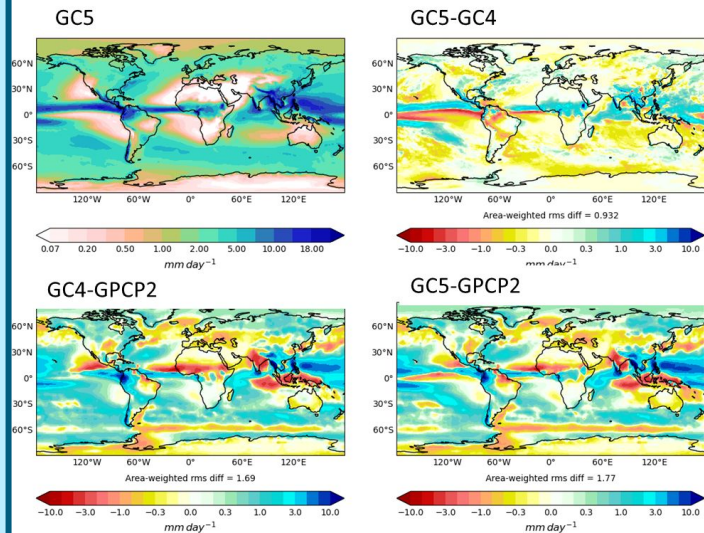
**GC5 includes major changes to convection, large-scale cloud, sea-ice, ocean mixing (& climate calendar).**

Poorly resolved semi-Lagrangian advection



“Fountain buster”

### JJA precip, N216ORCA0.25

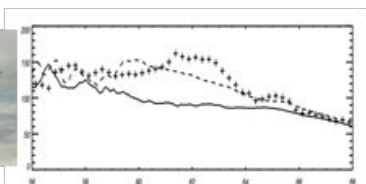
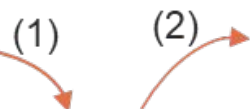
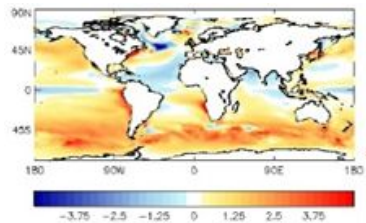


# Met Office Seamless Process-oriented evaluation

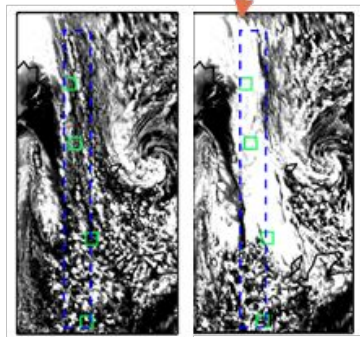
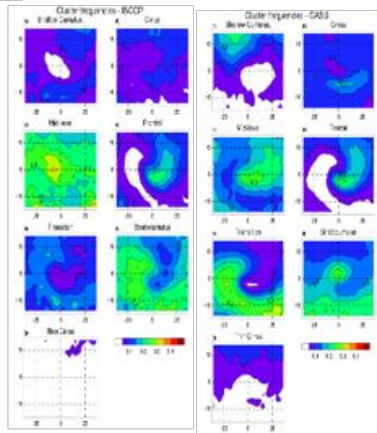
Definition of top model problems for systematic and critical errors

-> model development projects and Priority Evaluation Groups to tackle them and track sources

## Southern Ocean PEG

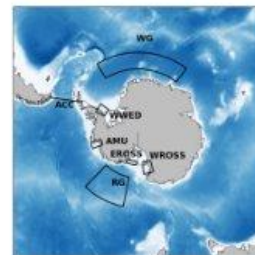
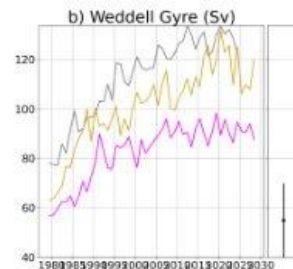
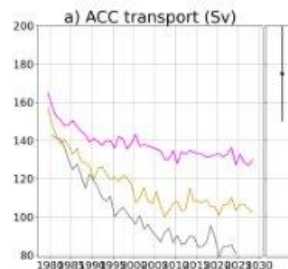


Example from the PEG addressing the Southern Ocean warm bias. (1) Detailed diagnostics revealed a lack of closed-cell cloud in the cold sector of cyclones. (2) The CONSTRAN field campaign off Scotland revealed the problem was in situations when the BL was shear dominated and (3) an improvement to the BL scheme to address this was developed.



(3)

Further Ocean developments, Dave Storkey, Guiavarch et al. 2024



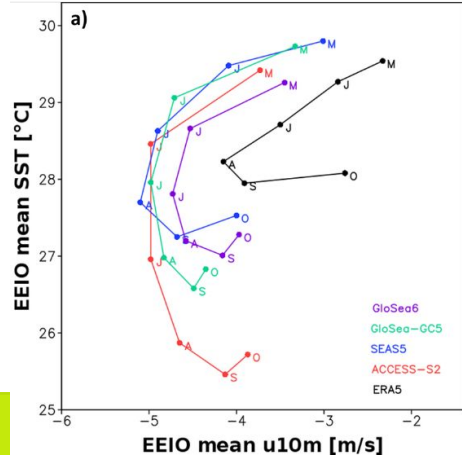
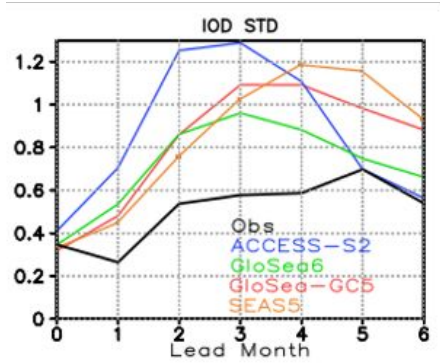
— GC5 G08p7 no SO package  
— GC5 G08p7  
— GC5 G08p7 new bathy

Hyder et al. 2018

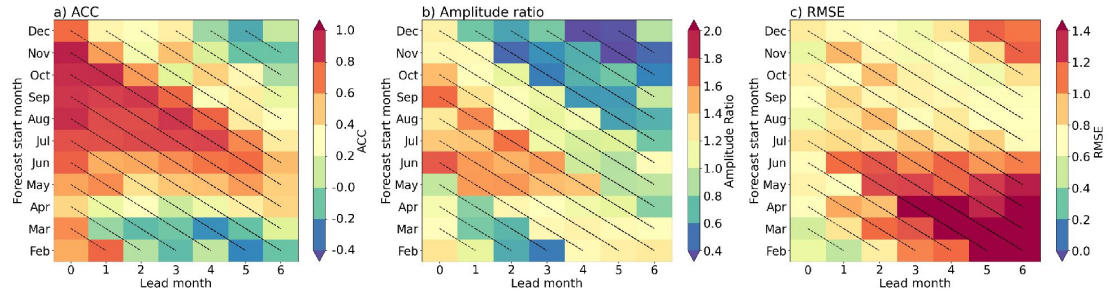
# Met Office Seamless Process-oriented evaluation

Seasonal hindcasts, Hudson et al 2024

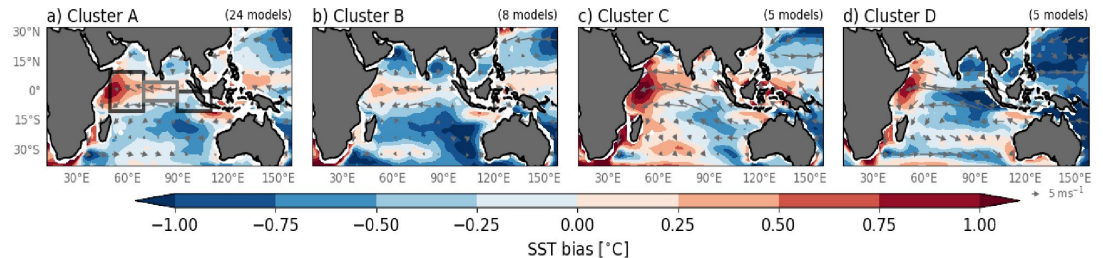
Indo-Pacific PEG, investigating systematic errors over the Indian Ocean impacting teleconnections and skill



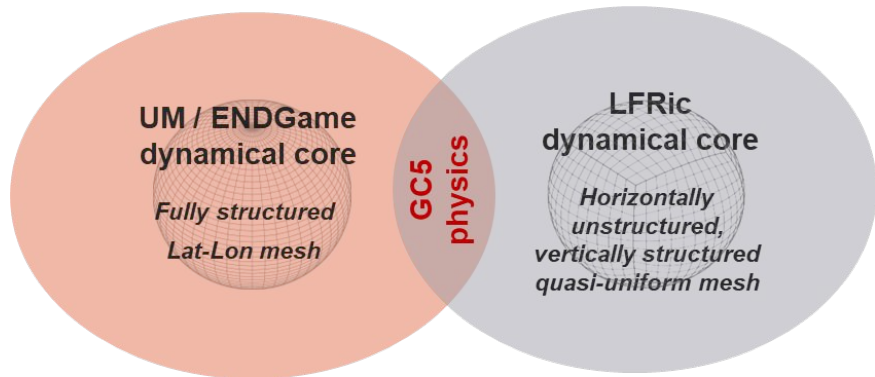
GloSea6 IOD skill Marimel Gler



SST bias in CMIP6 models Marimel Gler



# Move to Next Generation Modelling System



## Seamless Acceptance criteria

### General

Ready to start GC6

Any significant change should be understood

### NWP

Less than 2% degradation

Stable  
Resolution dependence checked

No significant degradation to variability

### S2S/Climate

No broken key processes for mean climate, variability and teleconnections

Acceptable changes to TOA radiation balance and fluxes

No unphysical changes to climate feedbacks



Lewis Fry Richardson  
(1881–1953)

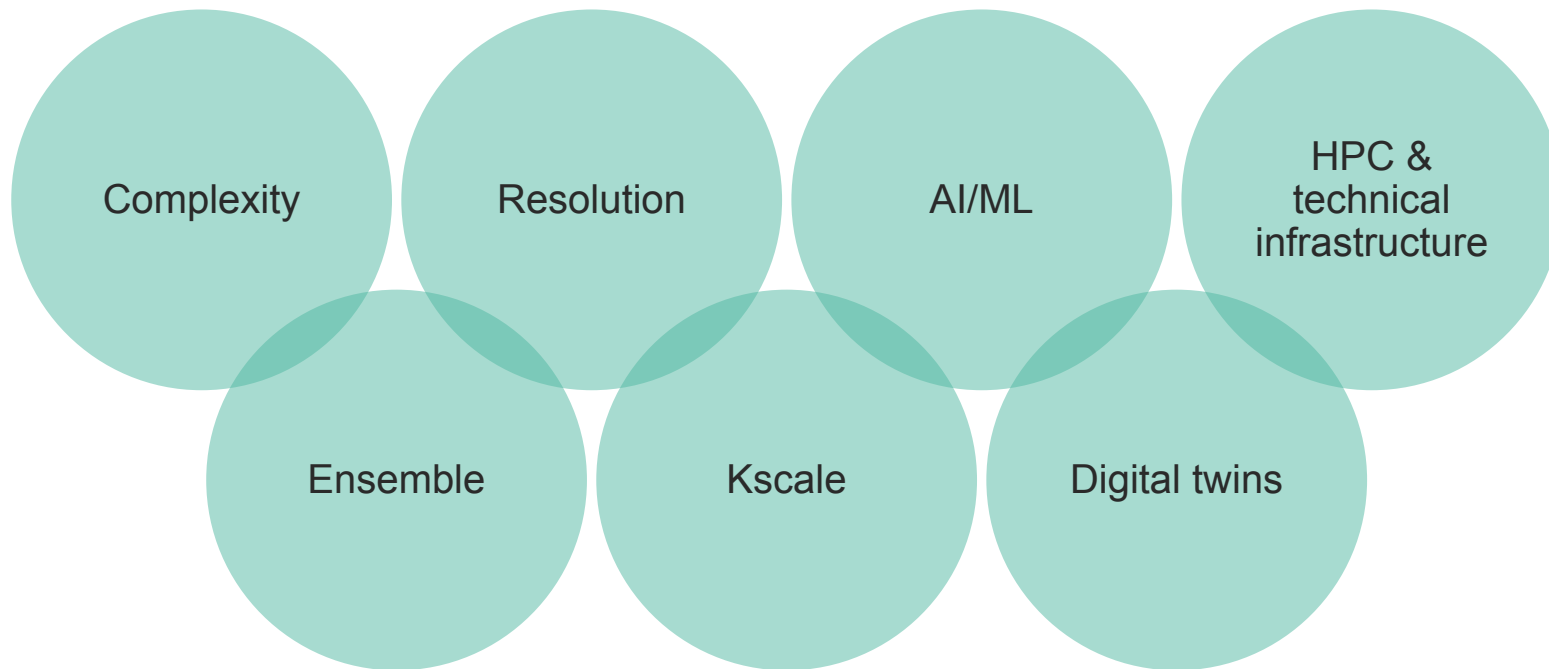


## Momentum

The Unified Earth Environment  
Prediction Framework

- Next GC6 release early 2027
- Further science pull through with GC7 2028/2029, unified scale aware physics

# Upcoming/ongoing challenges



***How to adapt and optimise the seamless model development framework to meet those challenges and rapidly evolving user requirements?***

Thank you, any questions?