# UK plans and recommendations for CMIP6

Catherine Senior

Presentation to WGCM17, Victoria, October 1st, 2013

UK Model Development for CMIP6

2013/4: HadGEM3-GC2 (physical coupled N216(~60km), O(1/4)º)

NEMO+CICE ocean and sea-ice models; 85 atmospheric levels including representation of the stratosphere; ENDGame dynamics, PC2 cloud scheme, increased convective entrainment, new GWD, more frequent calls to radiation, revised surface albedo (MODIS), changed sea-ice roughness,…
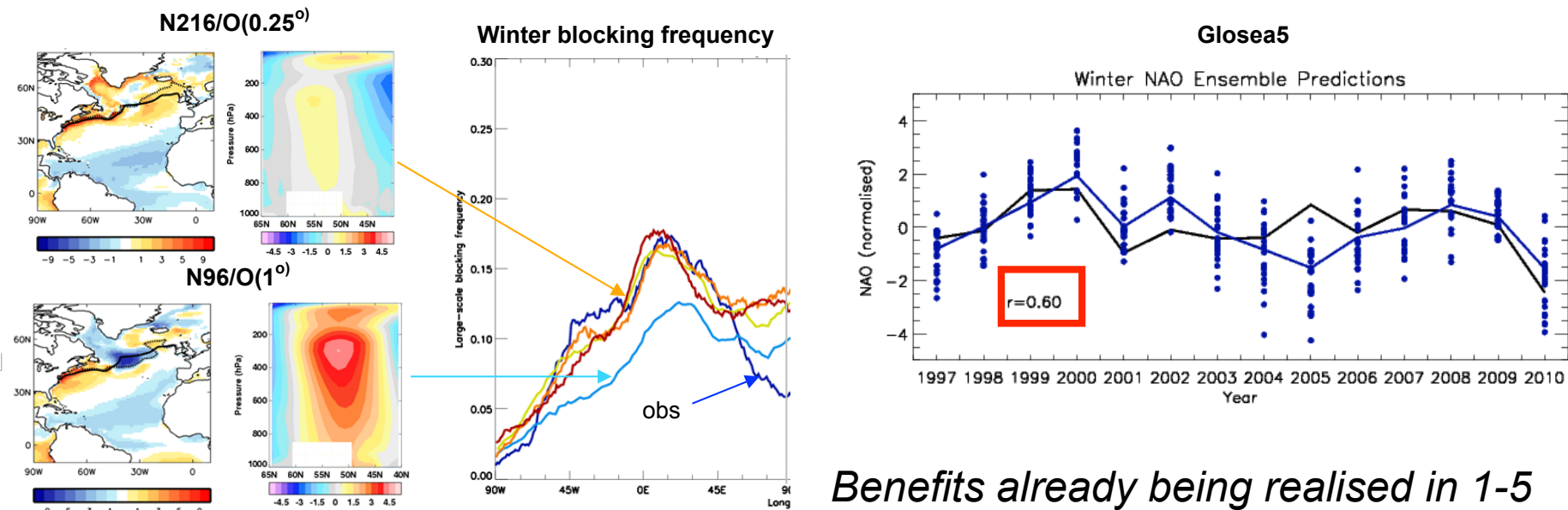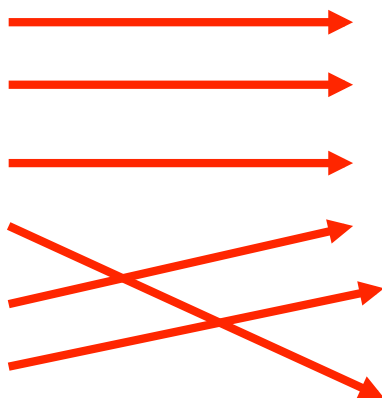

Benefits already being realised in 1-5 days and seasonal prediction systems

HadGEM3-GC2 experiments

Plan to perform a small sub-set of runs at N216 (60km) and N96 (135km) from CMIP5:

- AMIP (3.3)
- Pre-industrial control (3.1)
- Historical (1850-2005) (3.2)
- RCP 8.5 (2005-2100) (4.1)
- 1% year^{-1} to 4xCO2 (6.1)
- Step change to 4xCO2 (6.3)

Proposed CMIP6 'Diagnosis and Evaluation' experiments

- AMIP (~1979-2010)
- Pre-industrial control
- Historical simulation
- 1%/yr CO2 to quadrupling
- Instantaneous 4 times CO2
- Radiative forcing simulation
- A high and low 21stcentury simulation

Emphasis initially on idealised scenarios rather than realistic RCPs. Understand impact of resolution (TCR, ECS, mechanisms of regional climate change) rather than focus on new projections.
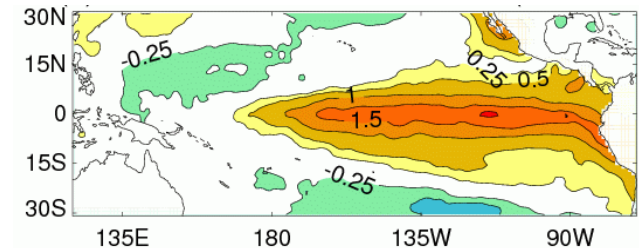
ENSO (N216, O(1/4)); GA5.0

Met Office Hadley Centre

Composite El Niño

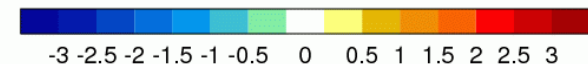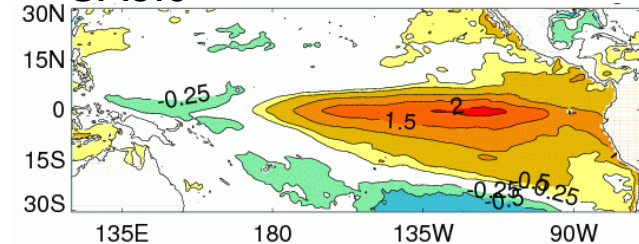Nino3 timeseries σ=0.80 (HadISST 0.79)

HadISST

GA5.0
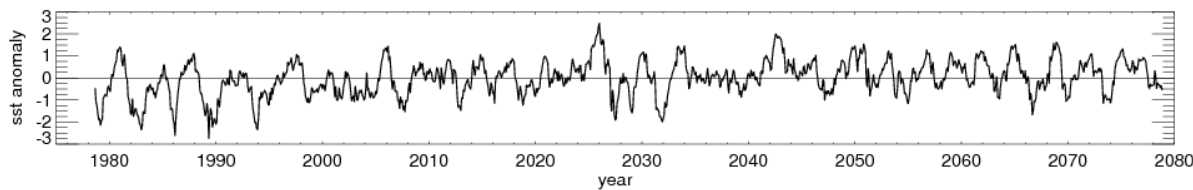
• realistic ENSO amplitude, dominant frequency is in the observed 3-7 year range
• spatial ENSO pattern is well represented, no westward extension error
• events peak in boreal winter
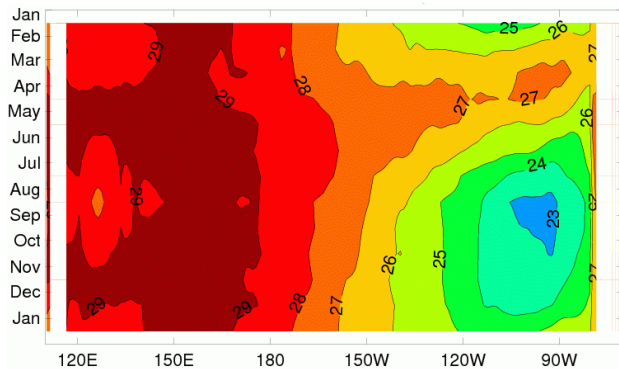• mean state has improved, annual cycle in east

HadISST

GA5.0

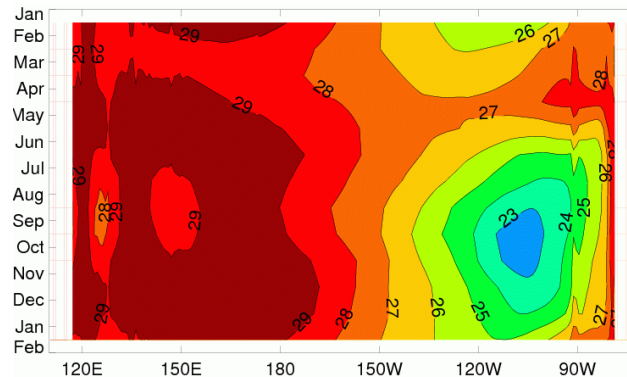Seasonal cycle of equatorial SST

Sarah Ineson

SST Teleconnections to African rainfall

Better → Worse

Model Skill: Very Poor — Poor — Neutral — Good

GA5 · GA4 · GA3

Dave Rowell

UK Model Development for CMIP6

2015/16

HadGEM3-GC3: Physical model upgraded from GC2

@N216L85/ORCA025L75 - CMIP6 'core' simulations+ decadal
[likely higher resolution coupled/atmosphere only timeslice]

2016/17

UKESM1: HadGEM3-GC3+ *Medusa OBGC, JULES (C+N cycles, possibly Fire)*
+ UKCA (trop+strat chem.) + GLOMMAP Mode + Land Ice

@N216L85/ORCA025L75 – CMIP6 'core' simulations

@'Low resolution' – all/part of the RCP/SSP matrix in ESM form: ~2017 (*runs*
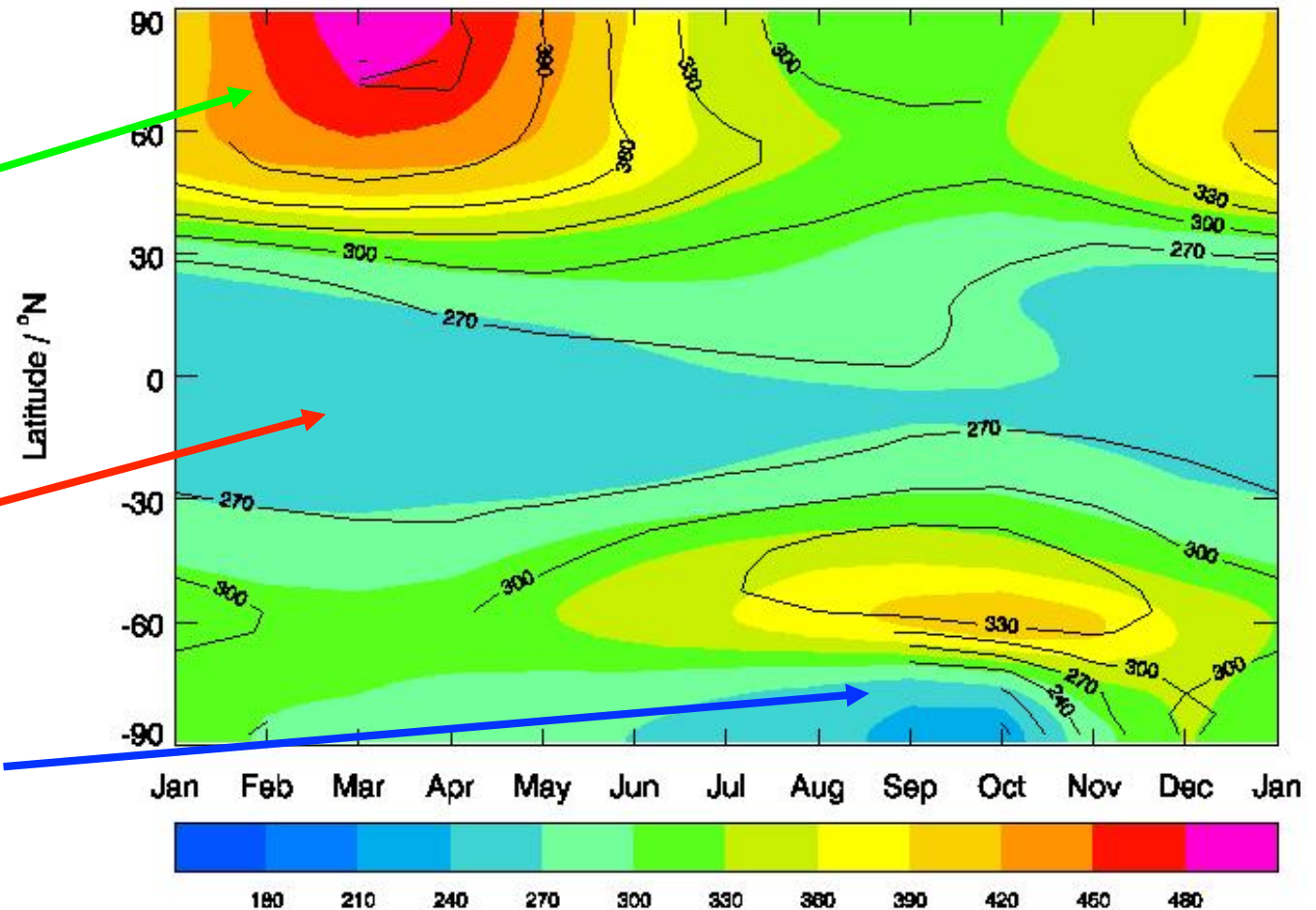*performed jointly by MO/NERC across UK machines*)

2017/18

@N216L85/ORCA025L75 reduced number of RCP/SSP matrix

UKCA combined trop-strat chemistry: Total Ozone

Modelled O$_3$ too high and early
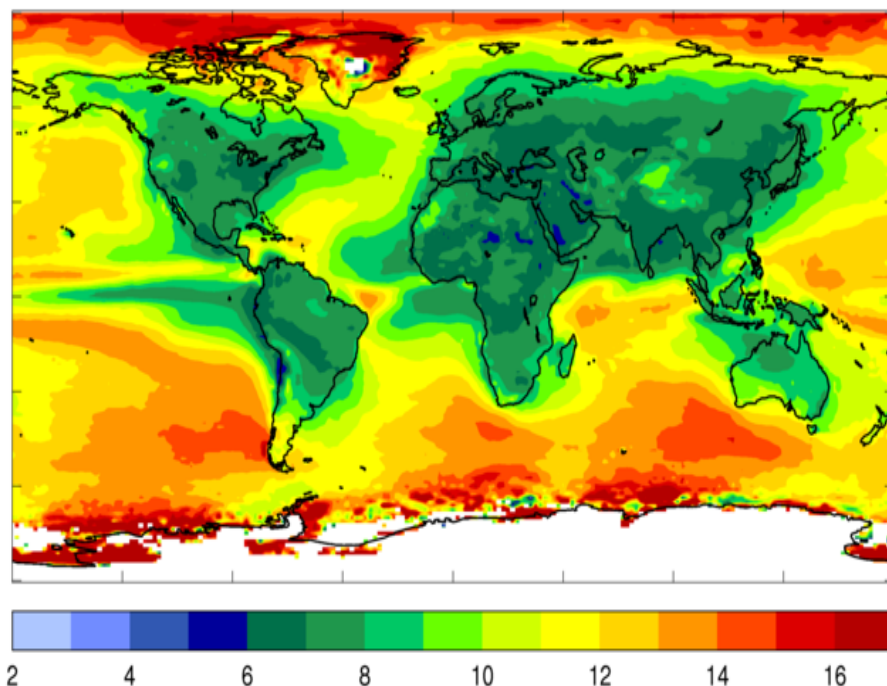
Excellent agreement in the tropics

Modelled O$_3$ hole too shallow

Colours: HadGEM3-GA4 with UKCA (20-year monthly means)
Lines: TOMS (Satellite obs from 1978 to 2005)

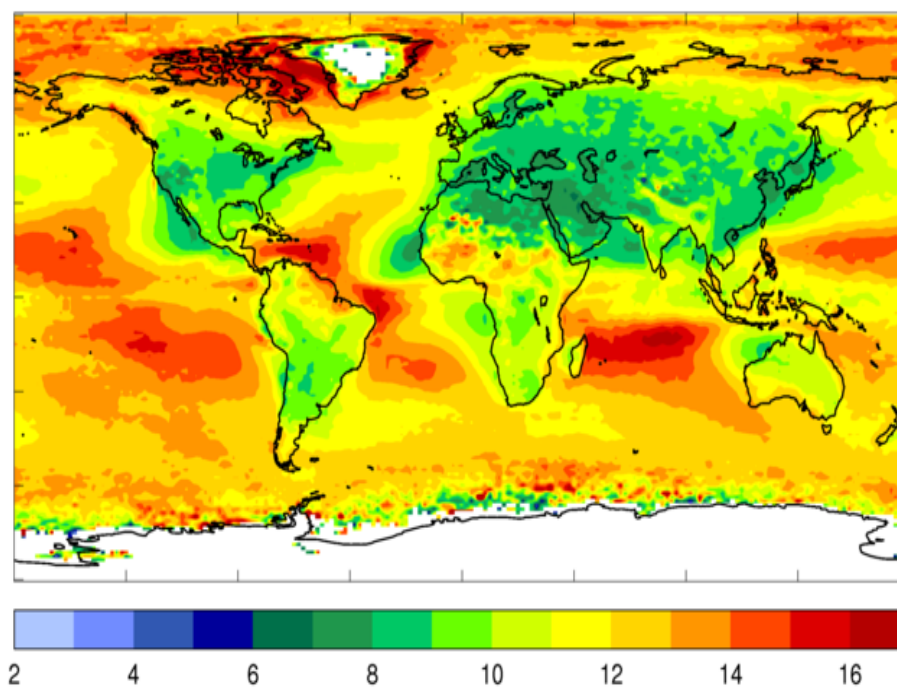# Improved aerosol: effective radius at cloud top & forcing
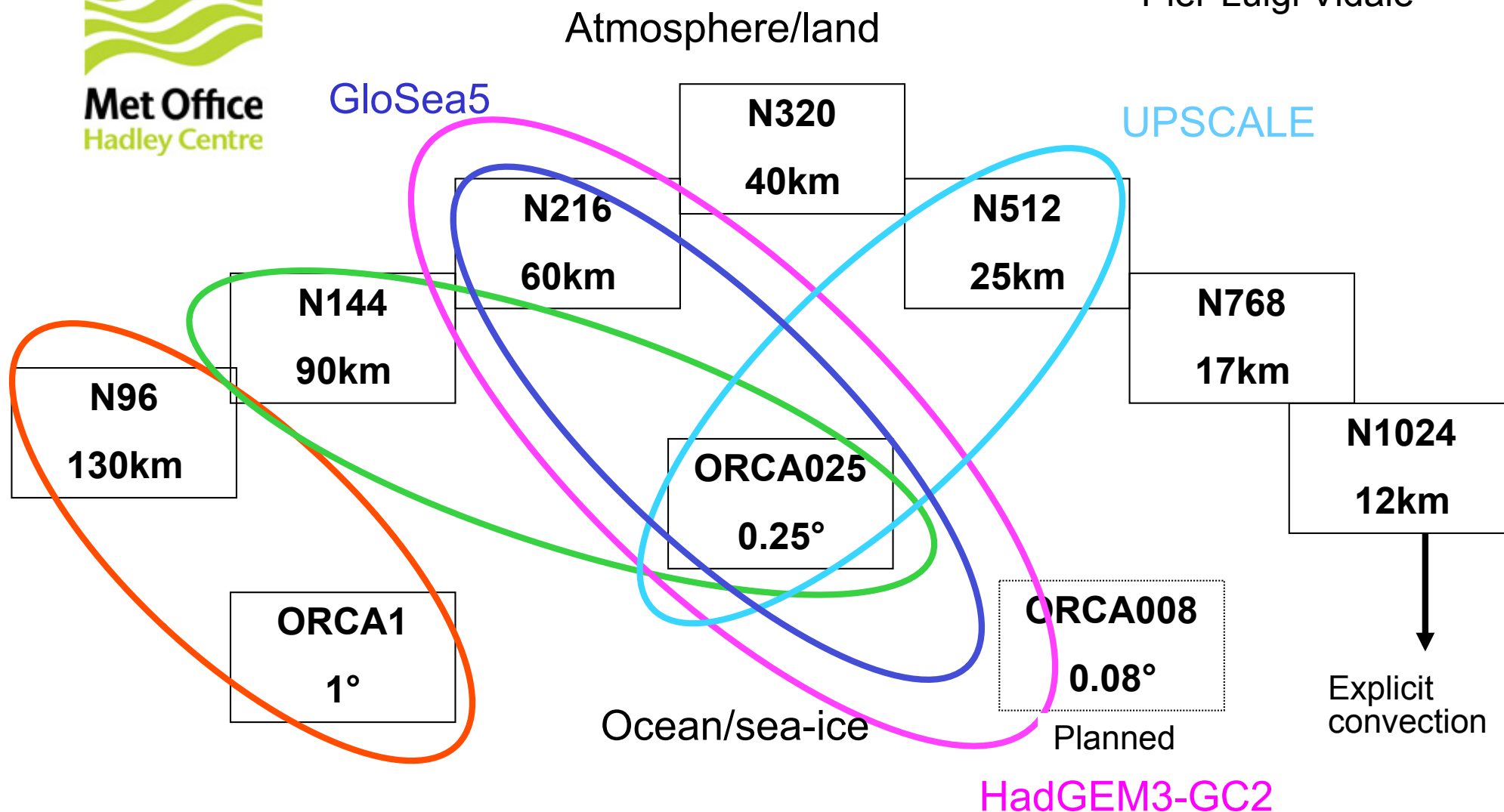
HadGEM2-ES (CLASSIC)

HadGEM3-ES (MODE)

**-1.44±0.18 Wm⁻²
(1860-2000 forcing)**

**-1.47±0.45 Wm⁻²
(1860-2000 forcing)**

Andy Jones

Global atmosphere/coupled model climate configurations

Priorities for CMIP6

Strong science link to Grand Challenges
   Need progress on clouds, water cycle, cryosphere, sea-level, regional and extremes,

High resolution AO models: Near term climate change (~to 2040)
   In 5-7 years will not see a step change in resolution (e.g. at ~10-25km)
   Maybe need to get Global Convection resolving. CMIP7?

Decadal climate prediction (~1-5 (10) years).
   Crucial to support developing climate services & GFCS
   Important to build on what is in place and learnt
   Key science questions: initialisation, role of aerosols, strength of coupling

Second generation ESMs – 'global to regional'
   Nitrogen cycle, Ice-sheets, Full troposphere-stratosphere chemistry
   Improved treatment of aerosol-cloud interaction, On-line impacts.
   Assessment of dangerous climate change (Tipping Points)

Importance of Idealized experiments, process diagnostics and sensitivity tests
   Crucial for model improvement and understanding

Feedback on CMIP6 design

Structure

Support the separation of CMIP core and satellite MIPs

Scenarios

Potential for proliferation of scenarios modelling groups 'encouraged' to run, e.g. by Governments.

Design needs knowledge of climate sensitivity prior to decisions on which models/scenarios to pair

Model Evaluation

Strongly support development of metrics, diagnostics and software for the evaluation tools

MIPS

Risk of too much diversity and not enough models participating in some MIPS

Need to ensure 'core' experiments include process level diagnostics for use in MIPS
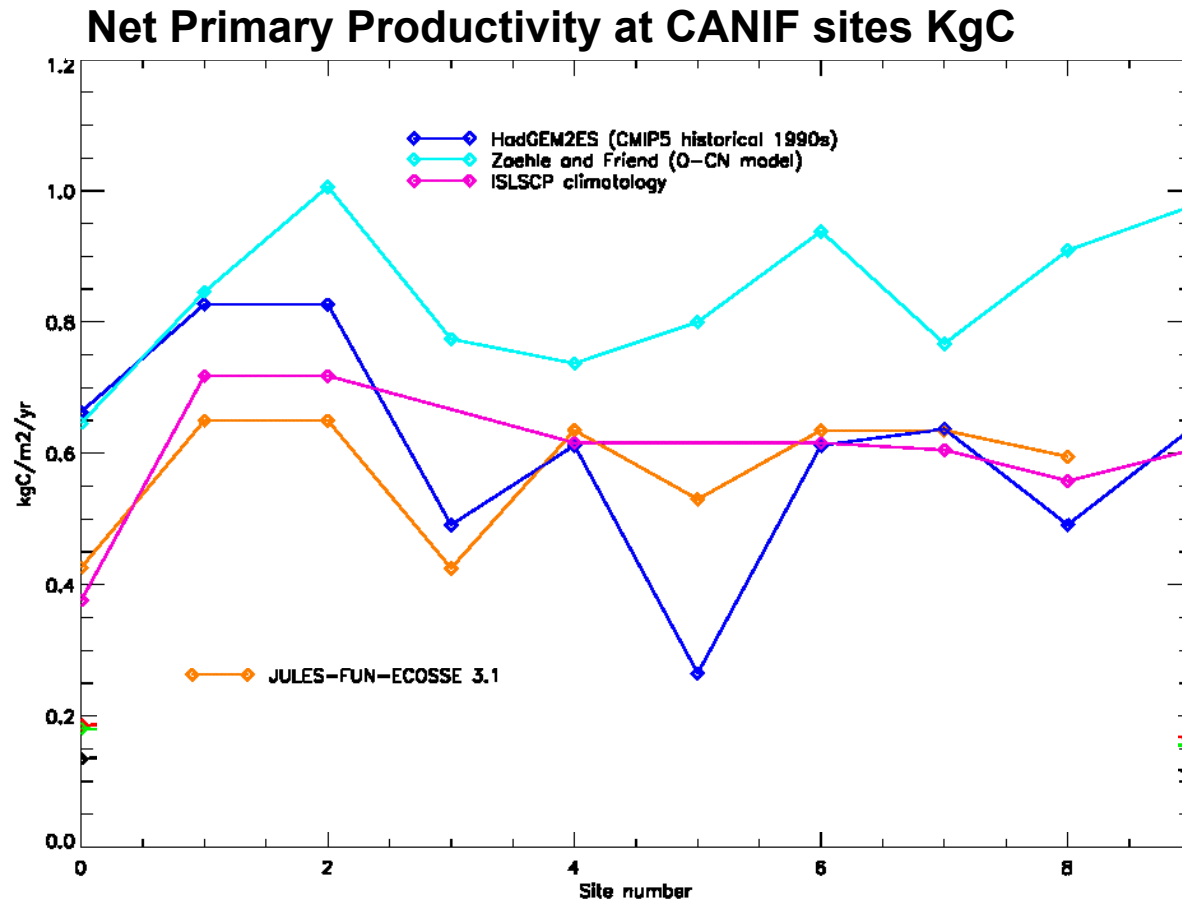
WIP

Welcome thinking at this early stage

Needs representation from users/data providers (modelling groups) to address requirements for standard tools

Funding for 'back-room' work will be difficult

Nitrogen modelling

Net Primary Productivity at CANIF sites KgC

- ECOSSE (soil) and FUN (plant) N models coupled to JULES.
- Global simulations/evaluation still to be carried out