



UM Consortium

Regional atmospheric model/system
development and implementation

Mike Bush

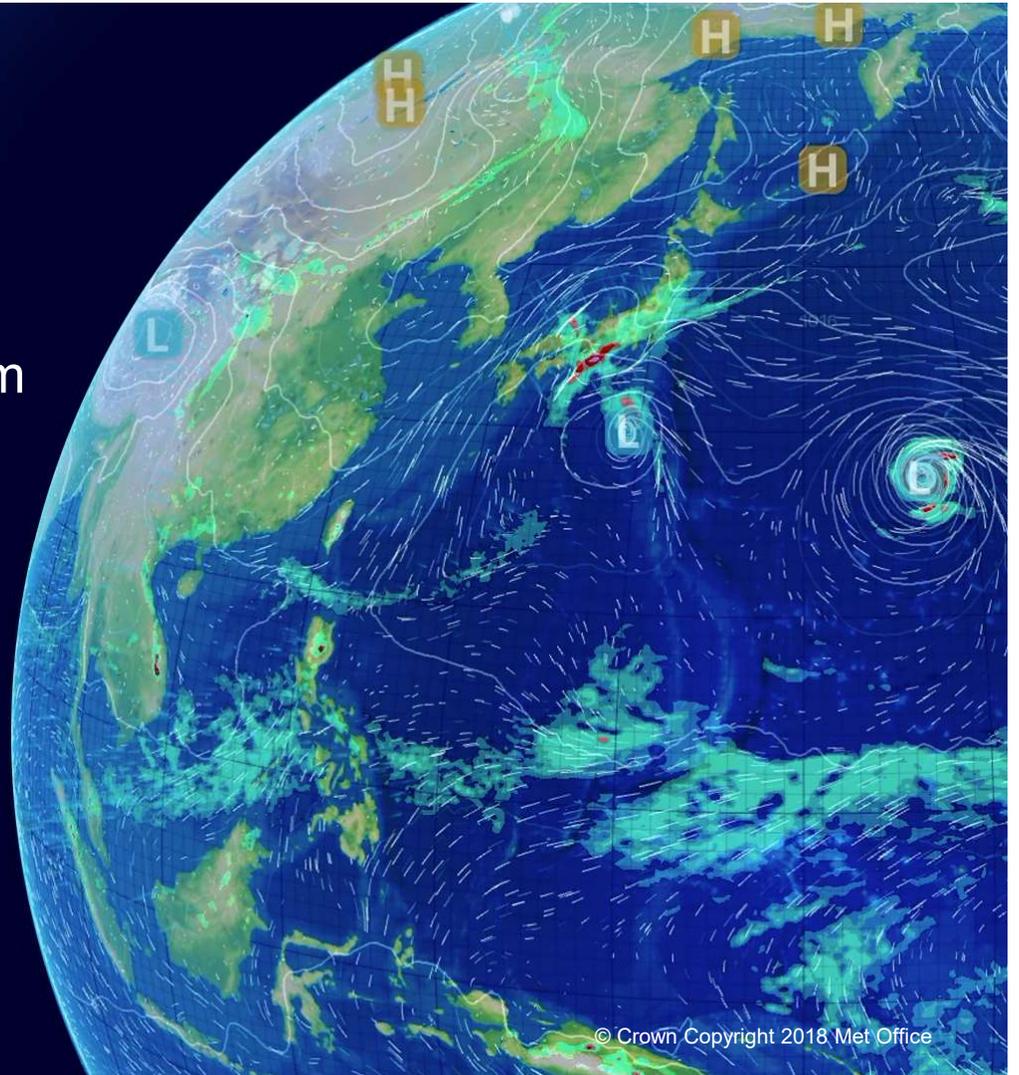
Content by many colleagues and collaborators

41st EWGLAM- 26th SRNWP Workshop

Sofia, Bulgaria, 30th September - 3rd October 2019.

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Outline

- UM partnership
- Latest operational upgrades
- Next Generation Modelling Systems

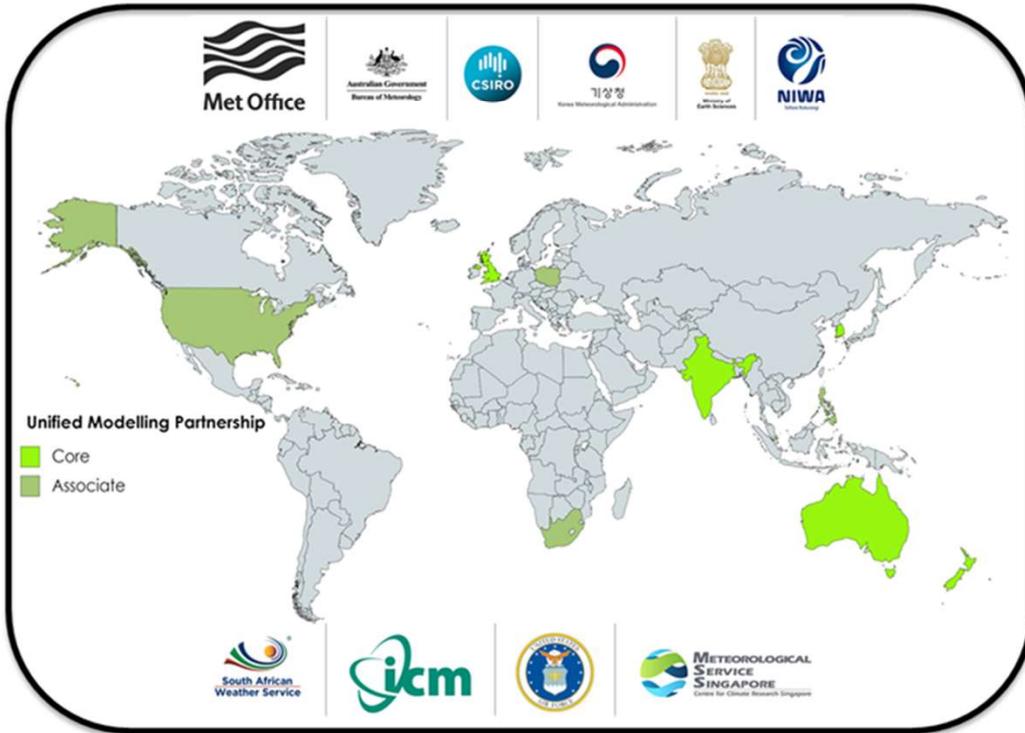


UM partnership





UM partners 2019





UM partnership 2018-19

- US Air Force / Oak Ridge National Lab Exeter (Oct 2018)
- 3rd Convective Scale modelling workshop Darwin (Nov 2018)
- 1st Convective Scale DA workshop Wellington (Mar 2019)
- In-person board & NZ stakeholder meeting Wellington (Mar 2019)
- Core partner agreement signed 2019-2024 (Mar 2019)
- UM user workshop Exeter (Jun 2019)



Photo: Courtesy Dave Allen (NIWA)



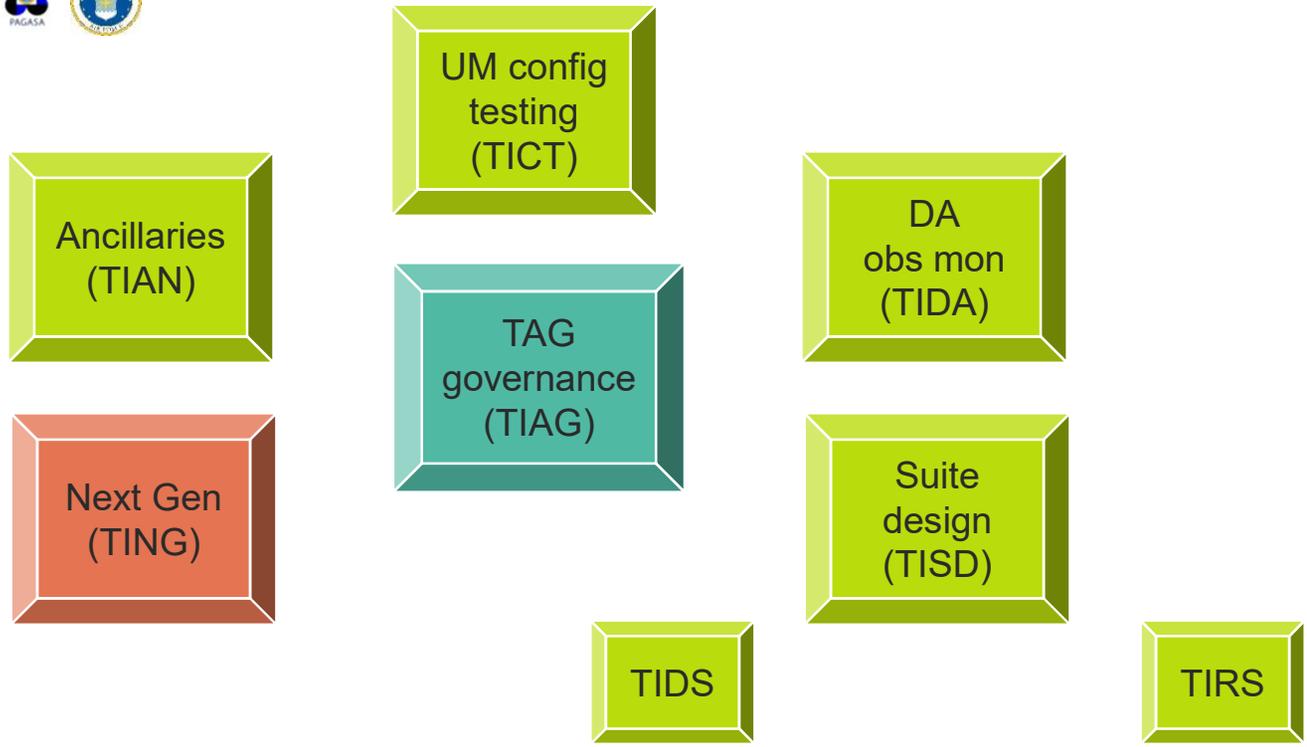
13th UM User Workshop Exeter, 17-21 June 2019

- Over 150 UM users, researchers and developers from 20 organisations.
- An emphasis this year was on Next Generation Modelling Systems (NGMS) and UM partner effort on the Technical Infrastructure Next Generation (TING) work package.

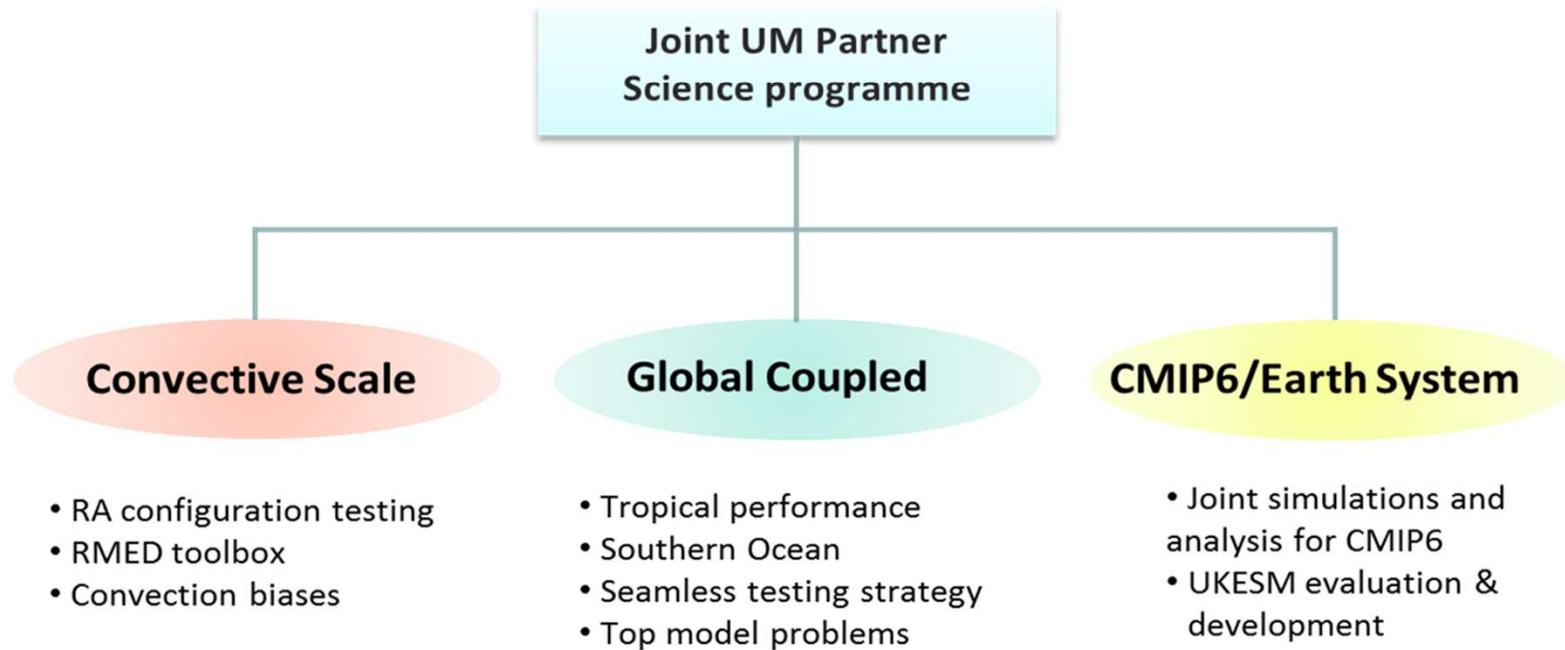




Technical programme



Science programme



Model development priorities

Climate NWP

Rank	Performance and process Improvements needed
1.	Issue of heavy rainfall being too intense in CPMs
2.	Land surface - atmosphere coupling (more intense/intermittent nature of rainfall in CPMs means that not enough rainfall is infiltrating soils)
3.	Too much small graupel leading to too much snow fall.
4.	Converge climate and NWP suites (TOPMODEL v PDM, Brooks Corey v Van Genuchten hydraulics, treatment of saturation layers).

- Model development priorities are guided by:
- priorities for applications such as UK NWP and climate.
- UM Partner priorities
- physical process understanding
- objective verification measures
- subjective assessment by forecasters
- *“Understanding ensemble spread in MOGREPS-UK” Anne McCabe, Wednesday morning*

Rank	Performance and process Improvements needed
1.	Lack of spread in MOGREPS-UK
2.	Low vis/fog errors
3.	Triggering and/or upscale growth of elevated convection
4.	Stratus - too extensive and bases too low
5.	Diurnal cycle of screen temperatures
6.	Snow accumulations overdone
7.	Under representation of light rain/drizzle
8.	Excessive showers in capped situations
9.	Unrealistic frontal/organized features
10.	Excessive sea fog



Latest operational upgrades





- *“Met Office Operational Status and Plans”* UK national poster

Parallel Suite 42

Went live 12th March 2019

- Parallel Suite 42 (PS42) saw a major upgrade to the UK ensemble prediction system (MOGREPS-UK).
- The short-range ensemble (which previously produced 2-day ensemble forecasts with 12 members once every 6 hours) was replaced by an 18 member time-lagged hourly-cycling ensemble, producing forecasts out to 5 days ahead.
- UKV assimilation of MODE-S aircraft winds.



Parallel Suite 43: Global models upgrade

Due to go live November 2019

- The global ensemble system (MOGREPS-G) is being upgraded to replace the current ETKF scheme with the En-4DEnVar scheme.
- This is a major overhaul to the way the perturbations at the start of the forecast are generated.
- We introduce GA7.2 which is the NWP version of GA7. This physics package includes changes to improve deep convection by making its representation more realistic, to improve long-standing cloud-biases and numerous other improvements to the physical realism of the model.

PS43 Improvements to model initialisation

- The PS43 UKV package contains numerous satellite data assimilation updates and introduction of an independent soil moisture assimilation.
- Instead of the current daily interpolation of global soil moisture analyses, we are introducing the UKV's own hourly soil moisture assimilation via the same Extended Kalman Filter (EKF) technique as used for the global model.
- The EKF uses the JULES land surface model to help derive increments to soil moisture from ASCAT satellite observations and screen-level errors in temperature and humidity.
- The EKF brings a substantial improvement in simulation of sub-surface runoff, with a knock-on benefit in simulated river flow.

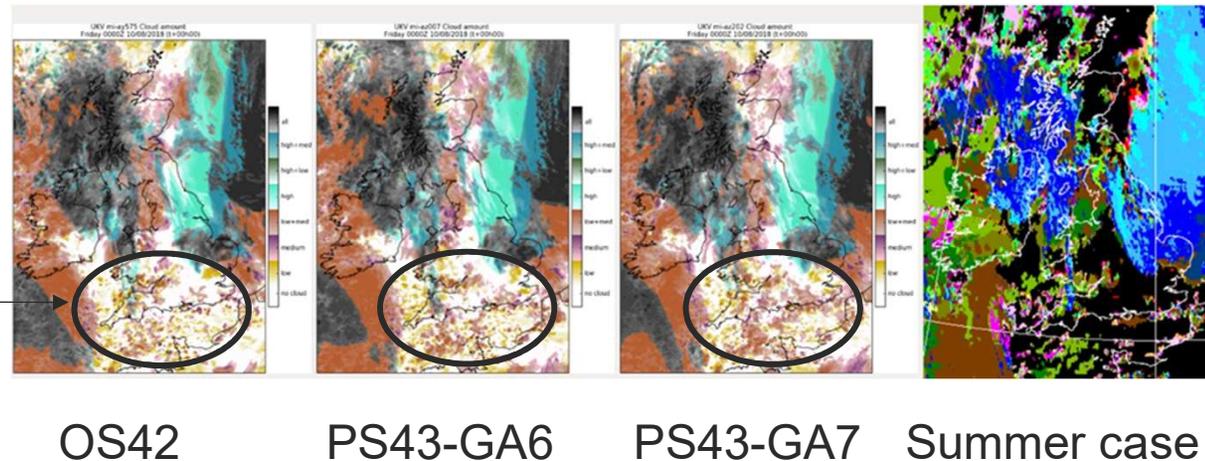
PS43 Improvements to model physics

- The Regional Atmosphere Land 2 (RAL2) physics package includes improvements to:
 - i.) treatment of lying snow (allowing the melting of thin layers from below)
 - ii.) sub-grid turbulence
 - iii.) ice cloud fraction in mixed-phase clouds.
- The latter change reduces the ice cloud fraction in mixed-phase regions, to protect a region of supercooled liquid and prevent excessive depletion of this by riming (modification of the Smith scheme following Abel et al. (2017, JAS)).
- This should delay the transition of cold-air outbreaks into snow showers and improve the reflected short-wave radiation by **increasing stratiform regions**.

Met Office **Increased Cu development in RAL2 models**

- Subjective assessment of the model by forecasters.
Main diagnosed change in model characteristics is that PS43 is a slightly more convective model than OS42 in favourable situations
- This manifests itself with a small but notable increase of shallow low Cu cloud under suitable conditions which may lead to more extensive Sc sheets

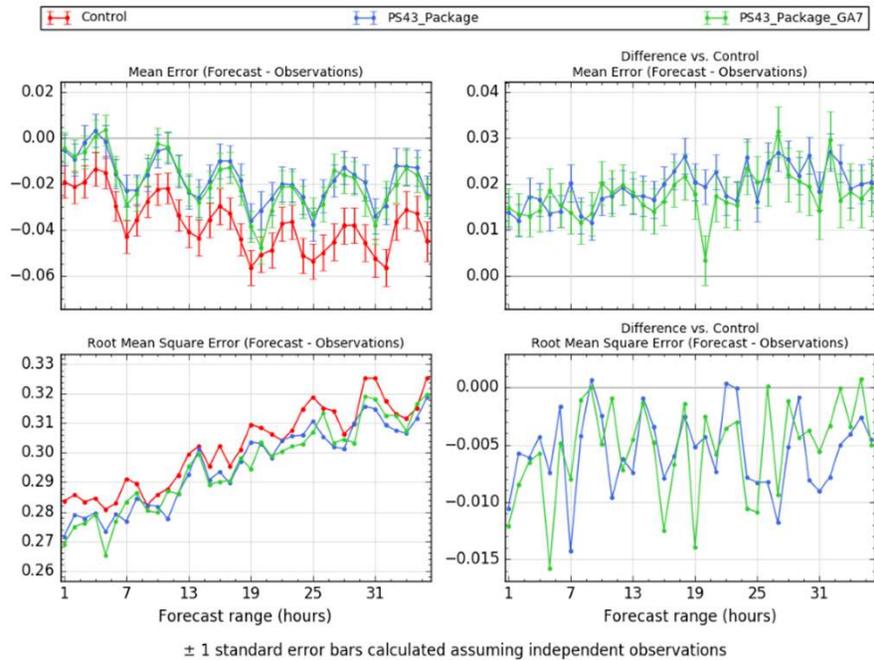
Increased
low/shallow
Cu in RA2
models



General trend is that Cu in OS42 < PS43-GA6 < PS43-GA7

PS43 Total Cloud cover in Summer

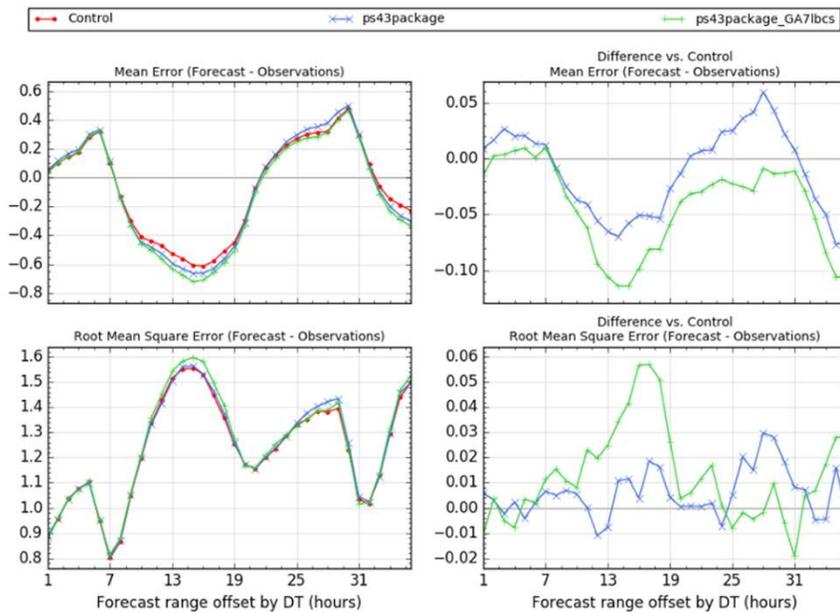
Total Cloud Cover, WMO Block 03 station list,
Equalized and Meaned between 20180716 00:00 and 20180902 23:00, Surface Obs



- PS43 has increased cloud compared to OS42.
- The left pair of panels show mean error (top) and root mean square error (bottom).

PS43 Screen temperature in Summer

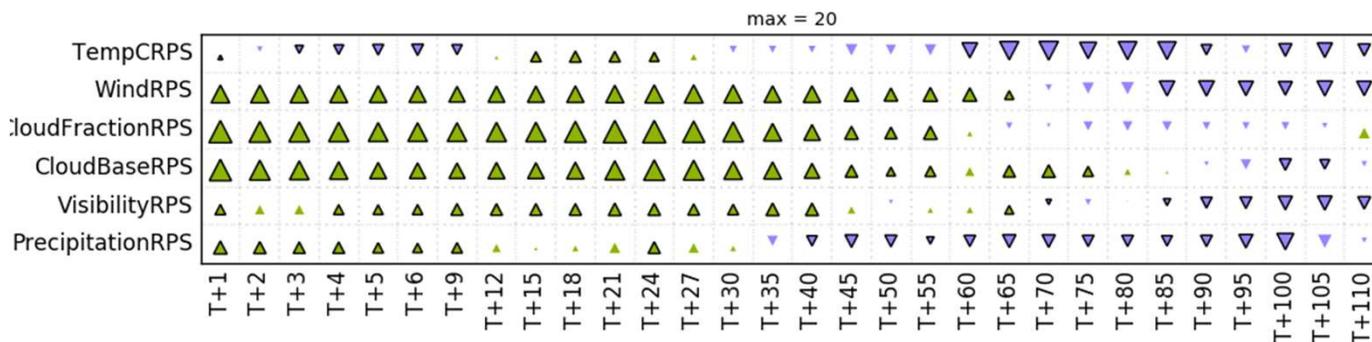
Surface (1.5m) Temperature (K), Current UK Index station list, 00Z DT,
Equalized and Meaned between 20180715 00:00 and 20180905 00:00, Surface Obs



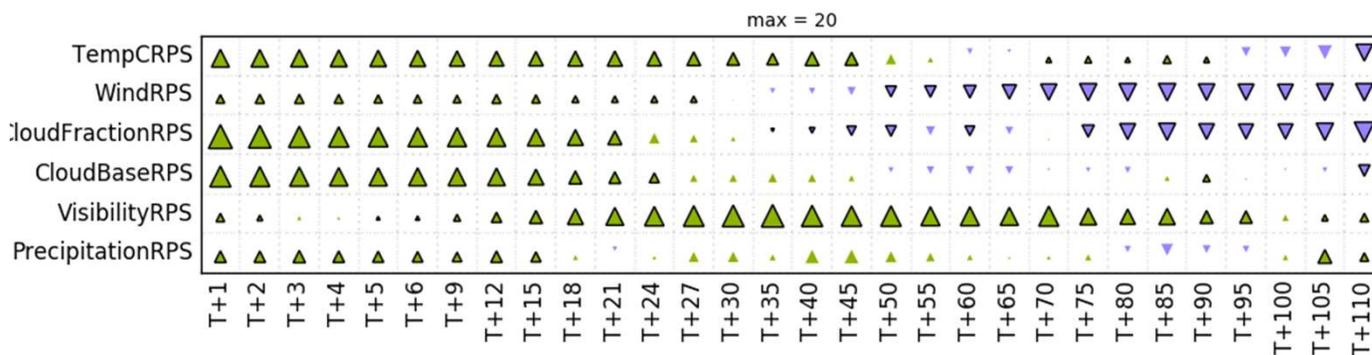
- PS43 has slightly degraded diurnal cycle of temperature with colder daytime max temperatures
- The left pair of panels show mean error (top) and root mean square error (bottom).

PS43 MOGREPS-UK package (PS43-GA7 M-G forcing) v Control

Summer
16/7/18-
16/8/18



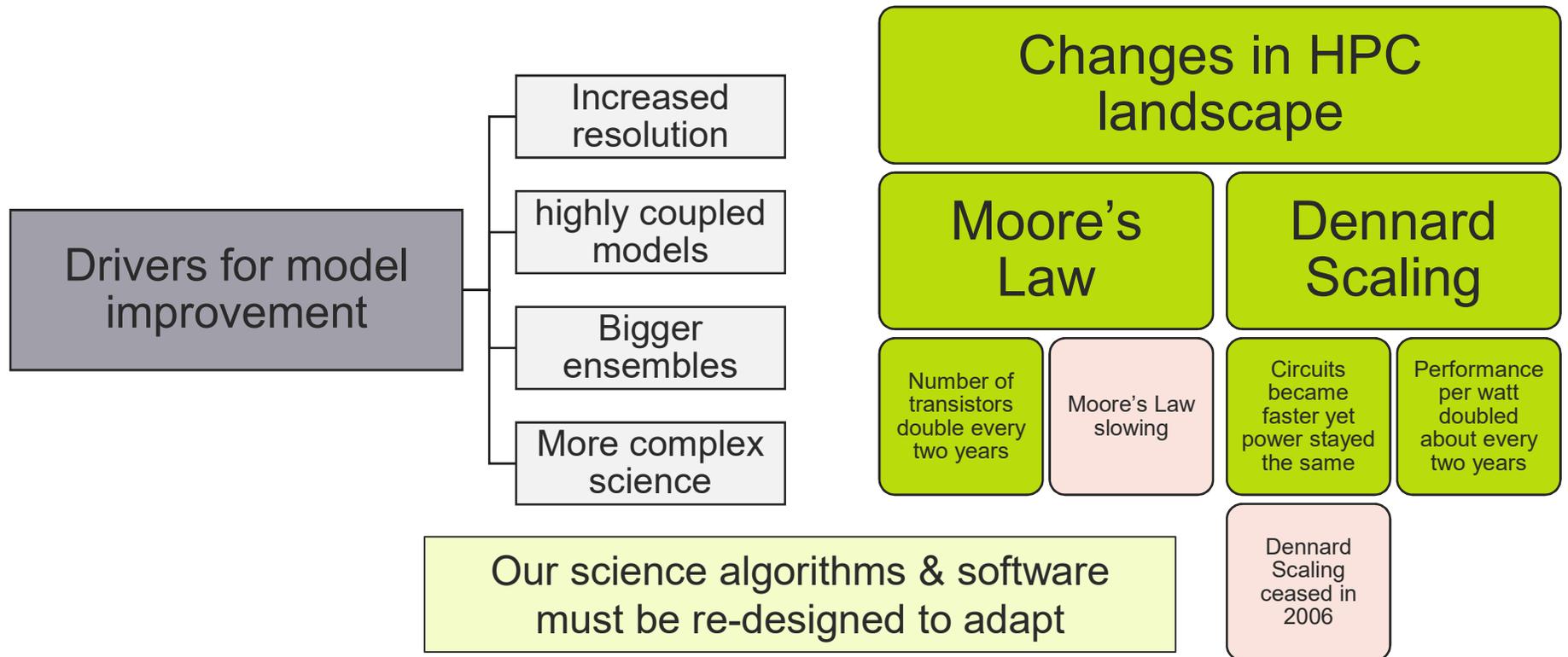
Winter
2/12/18-
18/01/19



Next Generation Modelling Systems (NGMS)



 Met Office **NGMS Programme Motivation**





Met Office

Programme vision

To reformulate and redesign our complete weather and climate research and operational/production systems, including oceans and the environment, to allow the Met Office and its partners to fully exploit future generations of supercomputer for the benefits of society.

Met Office Active NGMS projects as of September 2019

GungHo Atmosphere Science Project (GHASP) Ben Shipway

- Develop atmospheric science aspects & deliver model scientifically as good as UM
- Make UKCA and LFRic talk to each other
- Support model assessment

LFRic development Steve Mullerworth

- Deliver infrastructure to replace the UM scalable for future platforms
- Interface with PScyclone development

Marine systems Mike Bell

- Deliver scalable marine systems including ocean, sea-ice & wave models
- Community collaboration supported by code optimisation experts

Coupling project J C Rioual

- OASIS3-MCT coupled components

NG-DA Marek Wlasak

- Exascale-ready coupled atmos/ocean DA
- JEDI as a DA framework

LFRic Inputs project Rich Gilham

- Tools to ingest fixed & time-varying fields.
- Include initial conditions, ancillary fields and LBCs

FAB build system Rich Gilham

- Replacement for FCM to work on NGMS components



GA/GL=Global Atmosphere/Land
(formerly known as AMIP)
RA/RL=Regional Atmosphere/Land
(formerly known as LAM)
GC=Global Coupled

HPC 1!!

Trialling period

Parallel suite

HPC 2

Complete Next Gen System

2018/19

2019/20

2020/21

2021/22

2022/23

2023/24

2024/25

2025/26

Aqua-planet

Develop GA/GL & RA/RL

Basic GA/GL & RA/RL

Proto-GA/GL & RA/RL

UM DA
LFRic DA

Proto-GC

Timeline

Working backwards

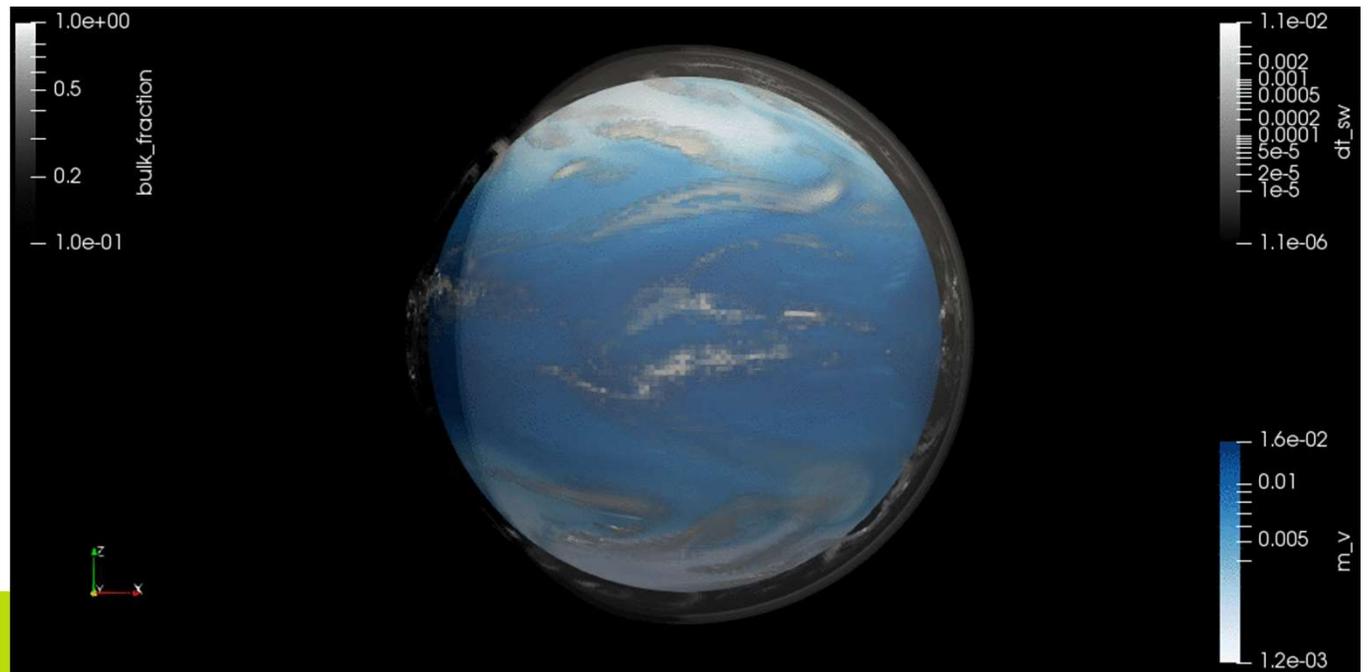
Working forwards

ENDGame vs GungHo



NGMS milestone: 1000 day 'Aquaplanet'

- First 1000 day Aquaplanet simulations have been run. This is a significant achievement on our path to develop our new next generation atmospheric model.
- Combines LFRic infrastructure, GungHo dynamical core, coupling to UM subgrid physics parametrizations and initialization from a UM start dump.





Thank you for listening. Questions?

