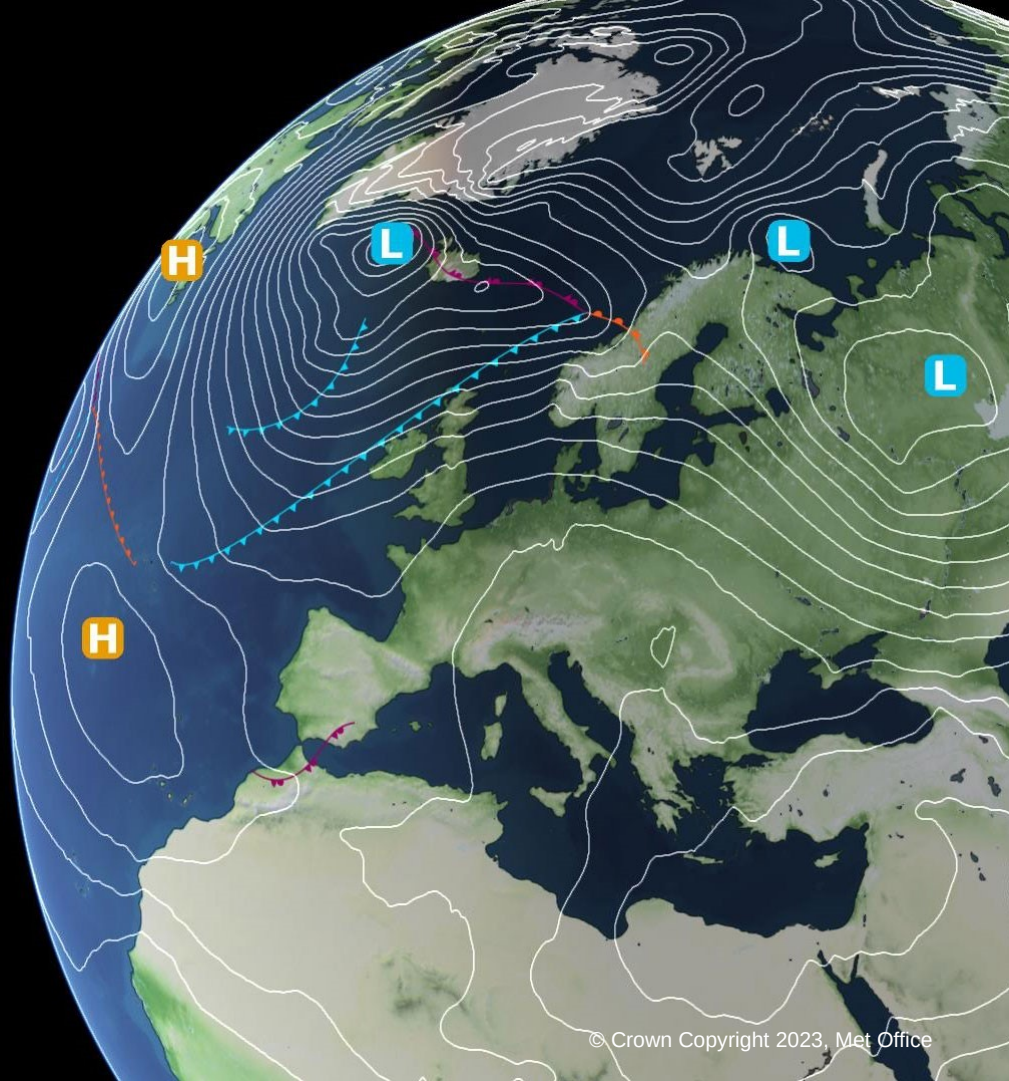
Met Office Update

Tim Graham

Thanks to Anke Finnenkoeter & Keith Williams



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3 related topics

1) CASIM Microphysics Scheme

2) New regional model configuration (RAL3)

3) Unified Physics programme (UP) – aiming to provide parameterisations that are suitable for across scales.

CASIM in RAL3

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CASIM multi-moment microphysics scheme

5

hydrometeor species

Cloud droplets
Rain
Cloud ice
Snow
Graupel

2

prognostic moments

Number
Mass

[Optional 3rd prognostic]

Can be coupled to aerosol to represent CCN and INP.

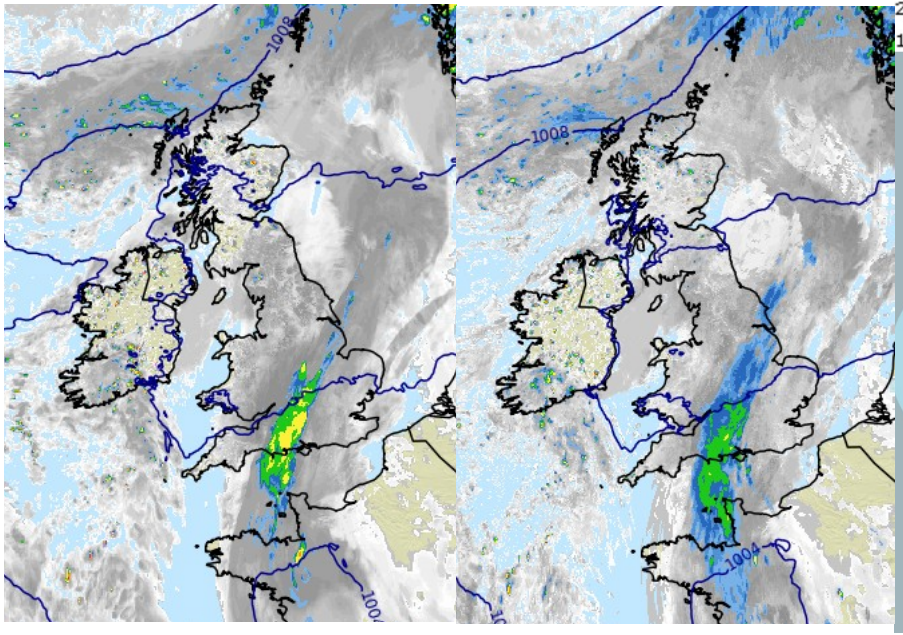
[UKCA, MURK, ARCL]

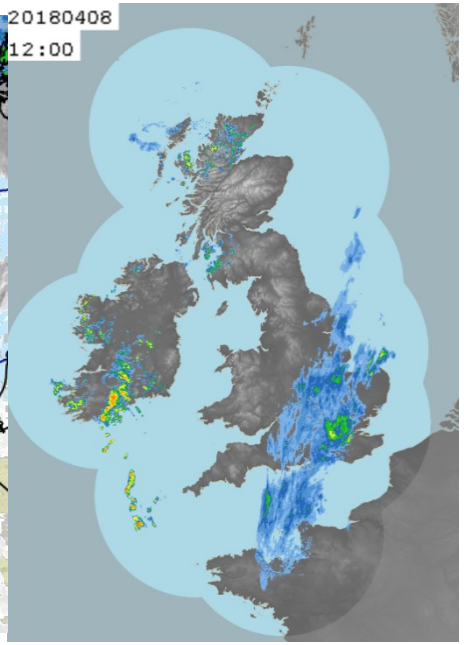
[RA3-pack3 uses a prescribed in-cloud number concentration]

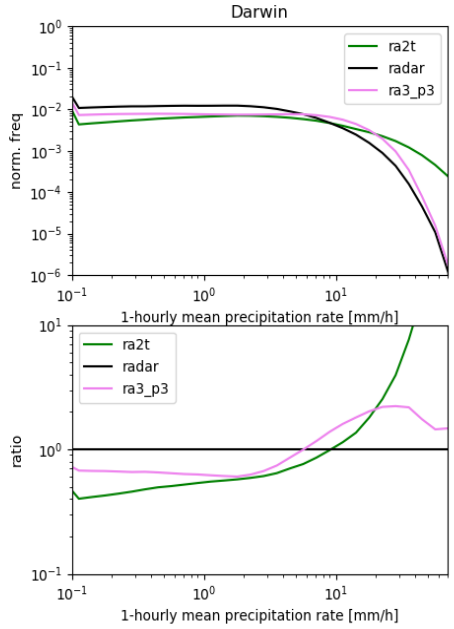
RA3 pack3 = CASIM + bimodal cloud

Unrealistic Fragmentation of Precipitation Bands #526
lack of light rain – too much heavy rain #525

Ctrl CASIM RADAR precip.

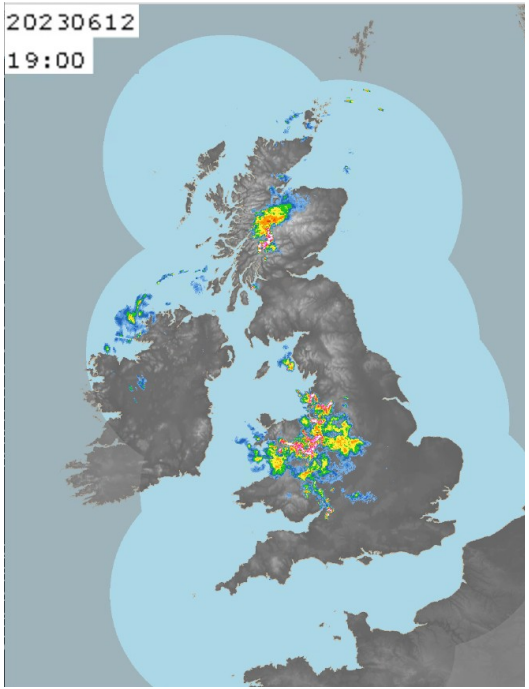


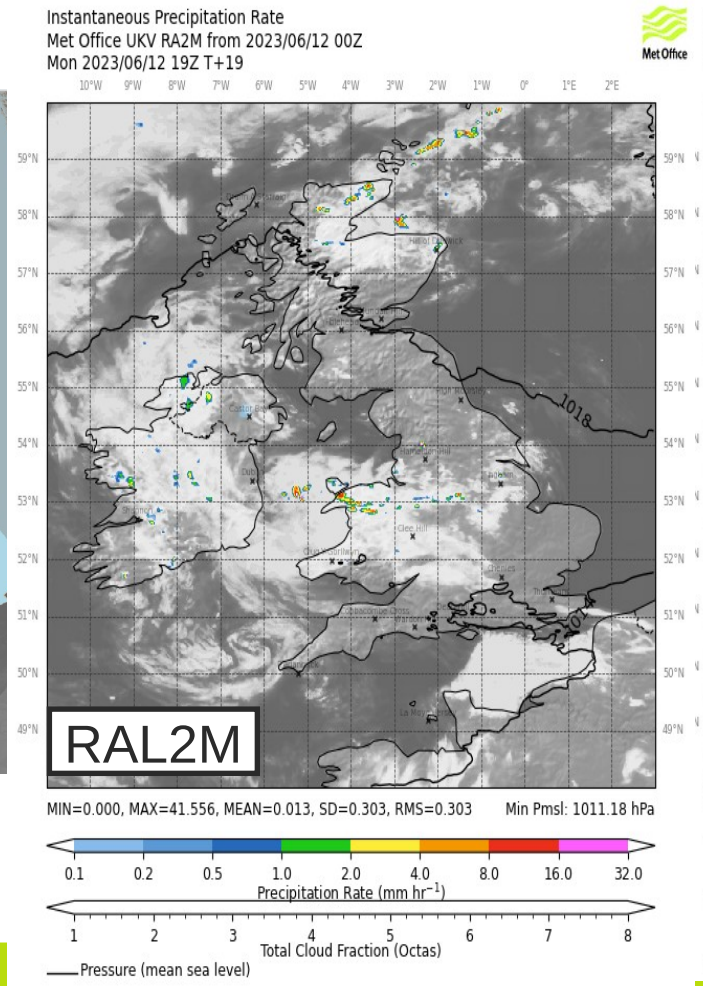


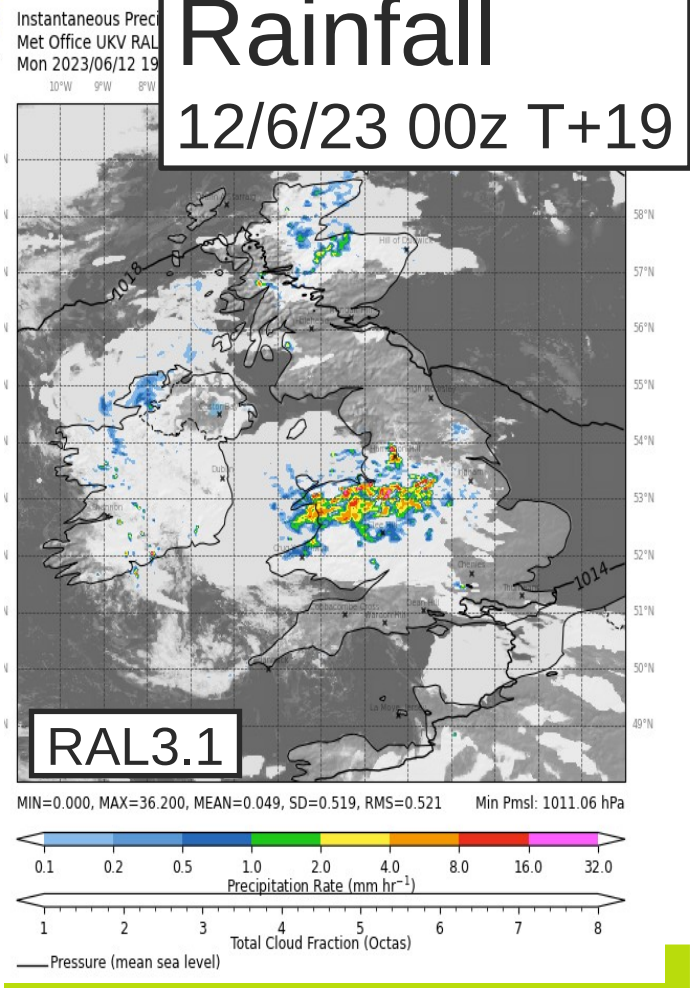


Rainfall

12/6/23 00z T+19







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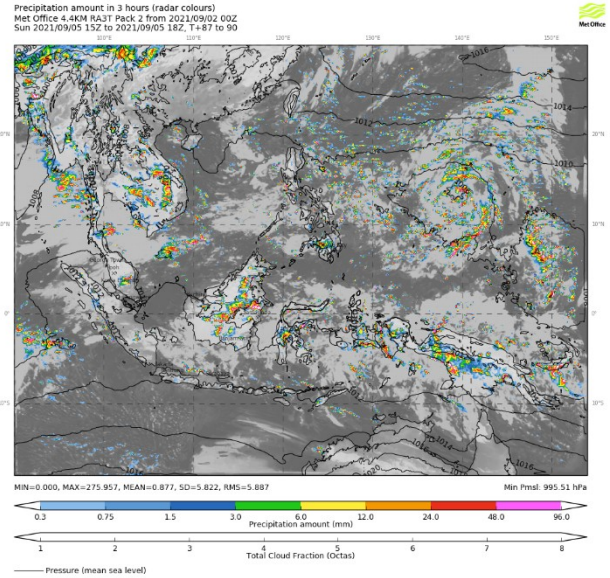
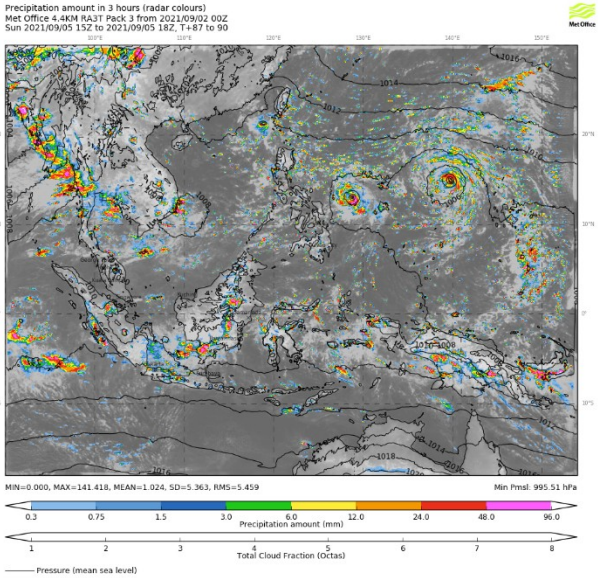
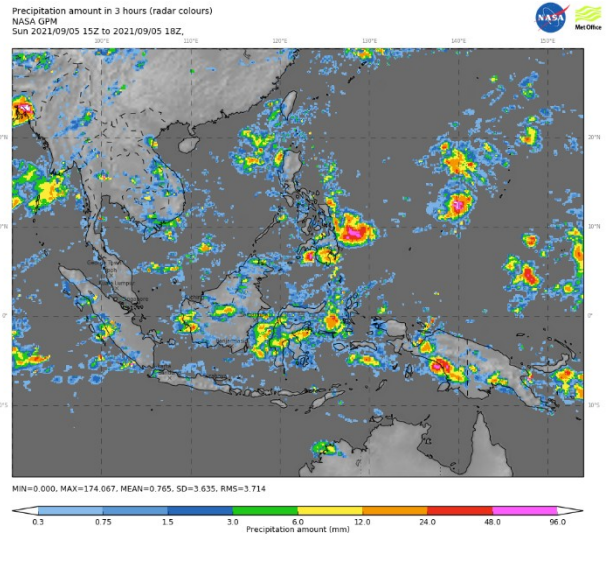
South East Asia 4.4km realtime monitoring (S. Webster)



RA3T pack2
Old microphys+PC2



CASIM
RA3 pack3



GPM

T+90 forecast accurately captures formation of 2 TCs when CASIM is added that are missing without

RAL3

Thanks to Anke Finnenkoeter

Uses of the regional atmosphere land configuration

- Regional model used for convection permitting to convection resolving simulations
- UKV model for Met Office forecasts (forced with time varying SST from AMM15 model).
- London 300m model (research configuration)
- Used by several UM partners (e.g. NIWA, Bureau of Meteorology, MSS)
- Can be used as a relocatable model for crisis areas
- RAL2 had two version RAL-M (for mid-latitudes) and RAL-T for tropics.
- There is also a coupled configuration – not yet operational

Main Science Changes in RAL3

- Bi-modal cloud scheme *(Kwinten van Weverberg)*

  Van Weverberg et al., 2021: https://doi.org/10.1175/MWR-D-20-0224.1 and https://doi.org/10.1175/MWR-D-20-0230.1

  - based on Smith cloud scheme previously used in mid-latitude RAL
  - replaces Smith scheme in RAL2-M and prognostic PC2 scheme in the tropical version RAL2-T
- CASIM multi-moment cloud microphysics scheme *(Adrian Hill, Paul Field, Kalli Furtado)*

  Shipway and Hill, 2012 - https://doi.org/10.5194/acp-18-14253-2018 , Miltenberger et all, 2018 - https://doi.org/10.5194/acp-18-3119-2018

  - **C**loud **A**ero**S**ol **I**nteracting **M**icrophysics
  - permits the UM to have single or double moments microphysical capability
- changes to the land surface configuration *(Martin Best)*
  - consolidation of global and regional model land surface settings
- stochastic boundary layer perturbations in mid-latitude configuration no longer needed *(Adrian Lock)*
- and many more…

RAL3 science changes

- Bi-modal cloud scheme *(Kwinten van Weverberg)*

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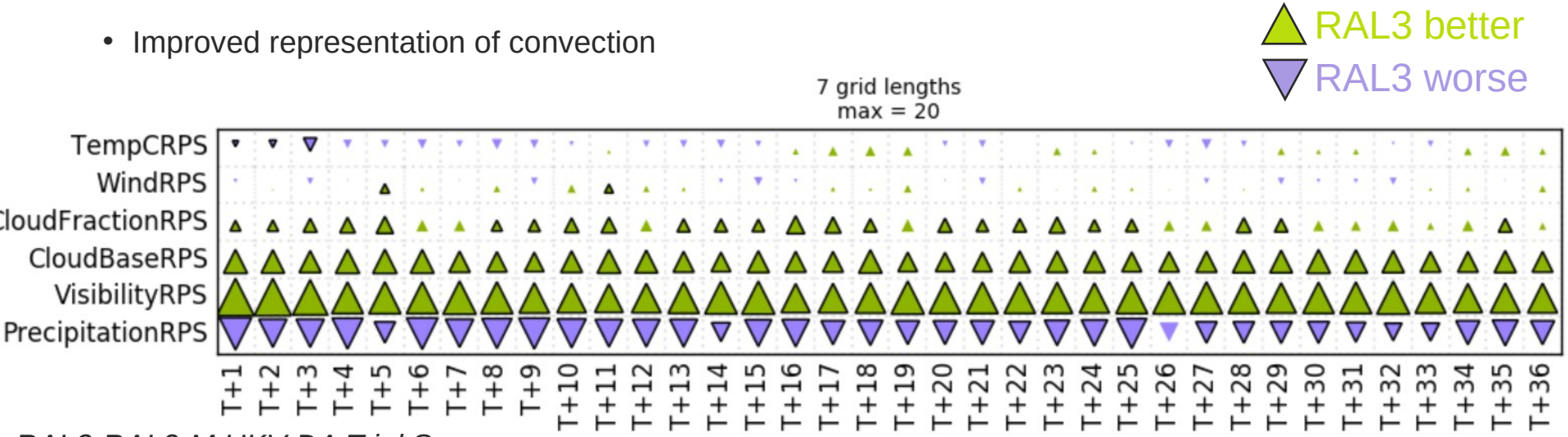
No longer need separate tropical and mid-latitude configurations.

- stochastic boundary layer perturbations in mid-latitude configuration no longer needed
- and many more…

Impact of RAL3:

- Exacerbation of existing cold temperature bias
- Improved representation of clouds
- Improved visibility
- Precipitation worse against gauges, improved against radar. Distributions improved.
- Improved representation of convection



RAL3-RAL2-M UKV DA Trial Summer

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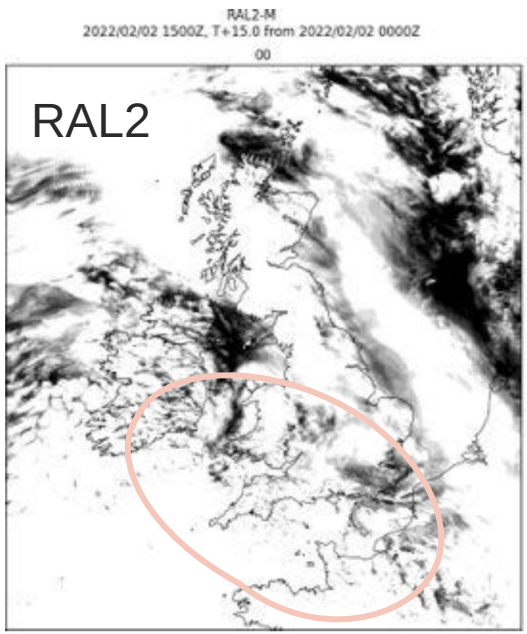
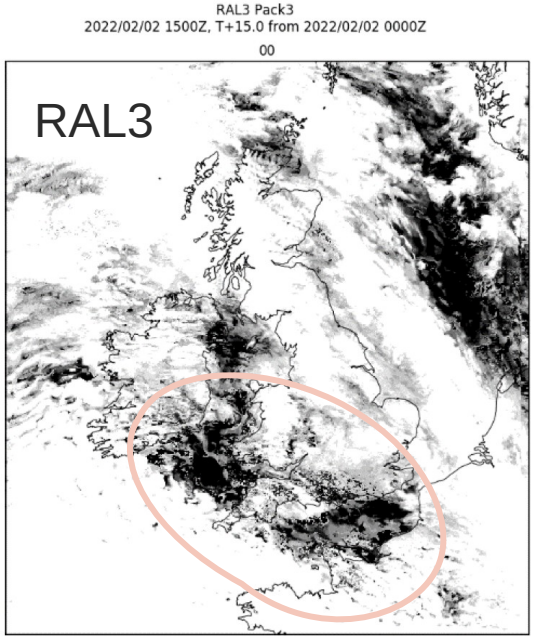
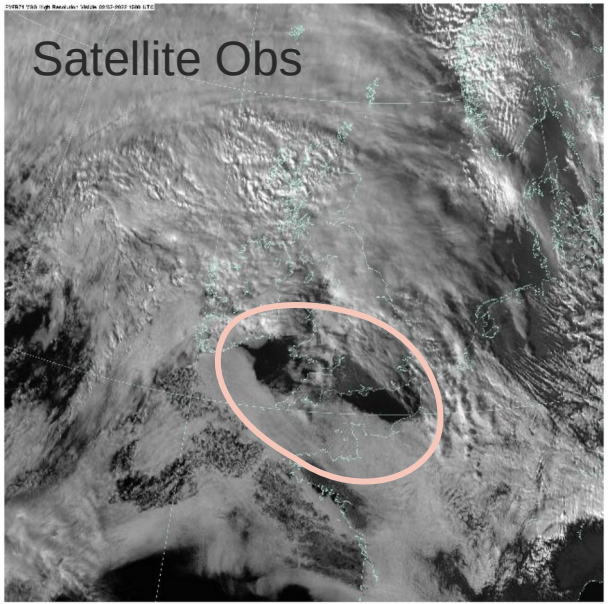
Bi-modal cloud scheme helps with better representation of cloud in RAL3







Steven Keates, William Rosling, Aurore Porson

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UP ↑

Unified Physics

Develop a Unified Physics configuration for GAL and RAL which includes CoMorph, CASIM and a single cloud scheme. This will be a physical improvement on what's used currently and aims to reduce systematic errors.

Background

UP ↑

- Global & convective-scale model science is unified across timescales in Met Office models.
- However there are a number of differences between global (GAL) and regional (RAL) configurations, most notably:
  - Convection parametrization on vs off
  - Prognostic vs diagnostic cloud scheme
  - McICA in GAL and not RAL and associated radiation differences
  - Land surface and orographic drag differences

Removing outstanding seams to create a seamless system

UP ↑

- A scale-aware convection scheme (CoMorph) provides the opportunity to unify GAL and RAL science
- This is desirable because:
  - Plans to run the global model in the convective ‘grey zone’ mean a configuration distinction between parametrized and explicit convection is no longer appropriate.
  - It is increasingly problematic to develop new science (e.g. CoMorph & CASIM) within two significantly different model configurations (end up with different versions of new schemes).
  - The overheads associated with maintaining and testing new science in different configurations in terms of staff and computer time are significant.
  - There are potentially significant benefits for parametrization development (traditional and ML approaches) from having a more unified configuration

CoMorph convection scheme development

UP ↑

- **CoMorph A**: First formulation for new global convection scheme, developed in 2021; recent revisions to operate with GAL9 physics.
- **CoMorph B**: *In progress*. Also aimed at global (10-100km) resolutions. Targets improving diurnal cycle; aiming for release early 2023.
- **CoMorph C**: Plan is for this to be a scale-adaptive, stochastic version of scheme that can operate down to km scales for inclusion with UP.

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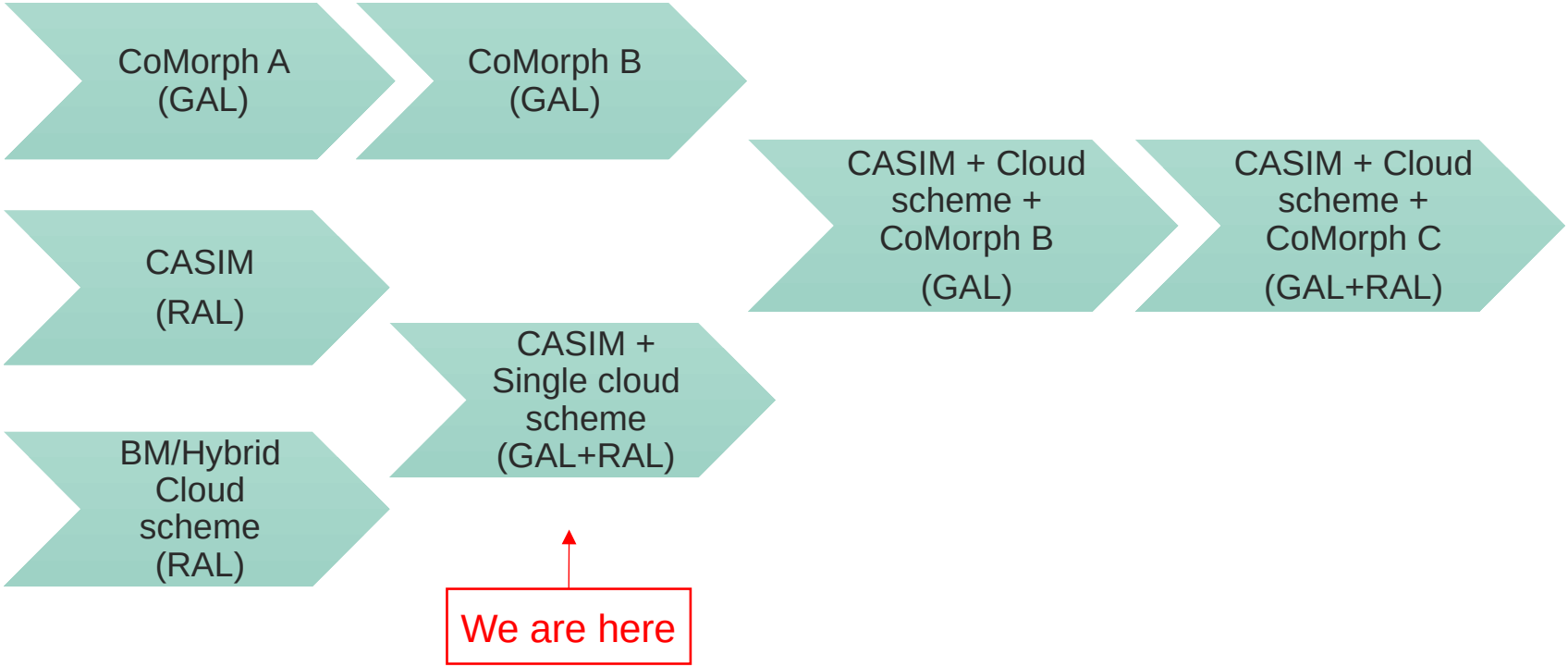
UP ↑

Order of work



Summary

- A new regional model configuration (RAL3) with many improvements. First regional model to have same physics in mid-latitudes and tropics
- RAL3 expected to go operational in 2024 on new HPC along with latest global coupled model GC5 (NWP & seasonal).
- Unified physics project aims to implement the same physics in global and regional models:
  - CASIM microphysics
  - Bi-modal cloud
  - COMORPH convection
- A key step towards development of kilometre scale global models.