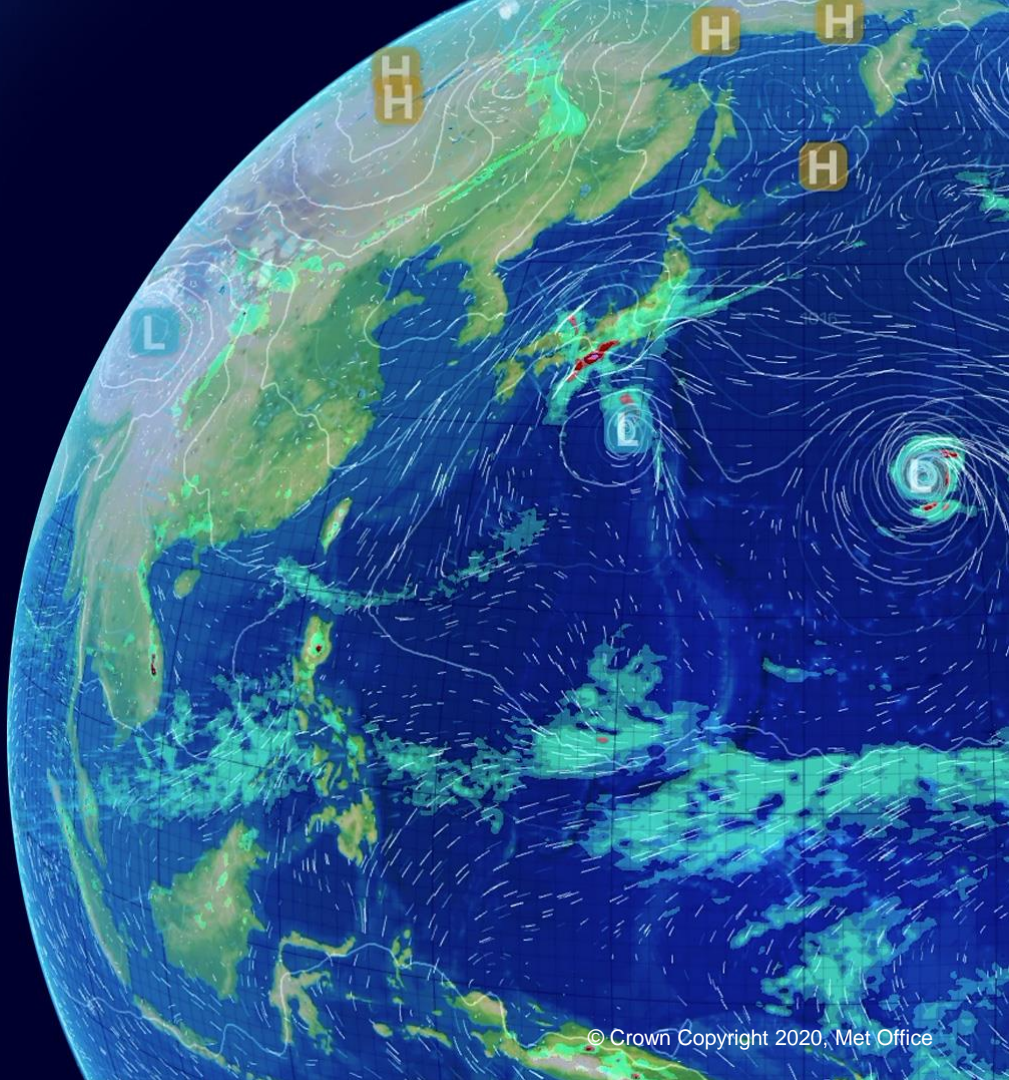# Recent progress in Met Office RAL physics

Anke Finnenkoetter, Mike Bush, Adrian Lock,
Stuart Webster, Mark Weeks, …

RAL - the "Regional Atmosphere and Land" configuration

- Large range of convection permitting models → risk of proliferation of model configurations

- Difficult to design a coherent programme of model development and ensure that research findings are relevant to the most up-to-date model configurations

- The aim: A single configuration for use in NWP operations, climate applications and research projects

- RAL2 used operationally since December 2019

- RAL3 aiming to unify remaining differences between mid-latitude and tropical configurations (RAL-M, RAL-T)

The RAL3 testing procedure

NWP operations   climate applications   research projects

UK case studies, climate runs, data assimilation trials, ensemble trials, sub-km tests, coupled runs, UM Partner case study tests, near real time forecasts, …

applications for RAL

Capacity

individual changes   mini-packages   one (two?) packages for proto-config

proposed science changes

limited capacity
→ not all changes can be tested in all configurations

The RAL3 testing procedure

Component testing of individual changes in mid-latitude and tropical case studies

Grouping components into mini-packages and finally a prototype configuration

Introducing more complex and expensive trialling as proposed
science changes are consolidated into a
decreasing number of packages

applications for RAL

climate runs,
ensemble trials,
UK case studies,
data assimilation trials,
UM Partner case studies,
sub-km tests, coupled runs,
near real time forecast evaluation

UK & Darwin
case studies

Capacity

individual changes

mini-
packages

one (two?) packages for
proto-config

proposed science changes

Science changes in RAL3

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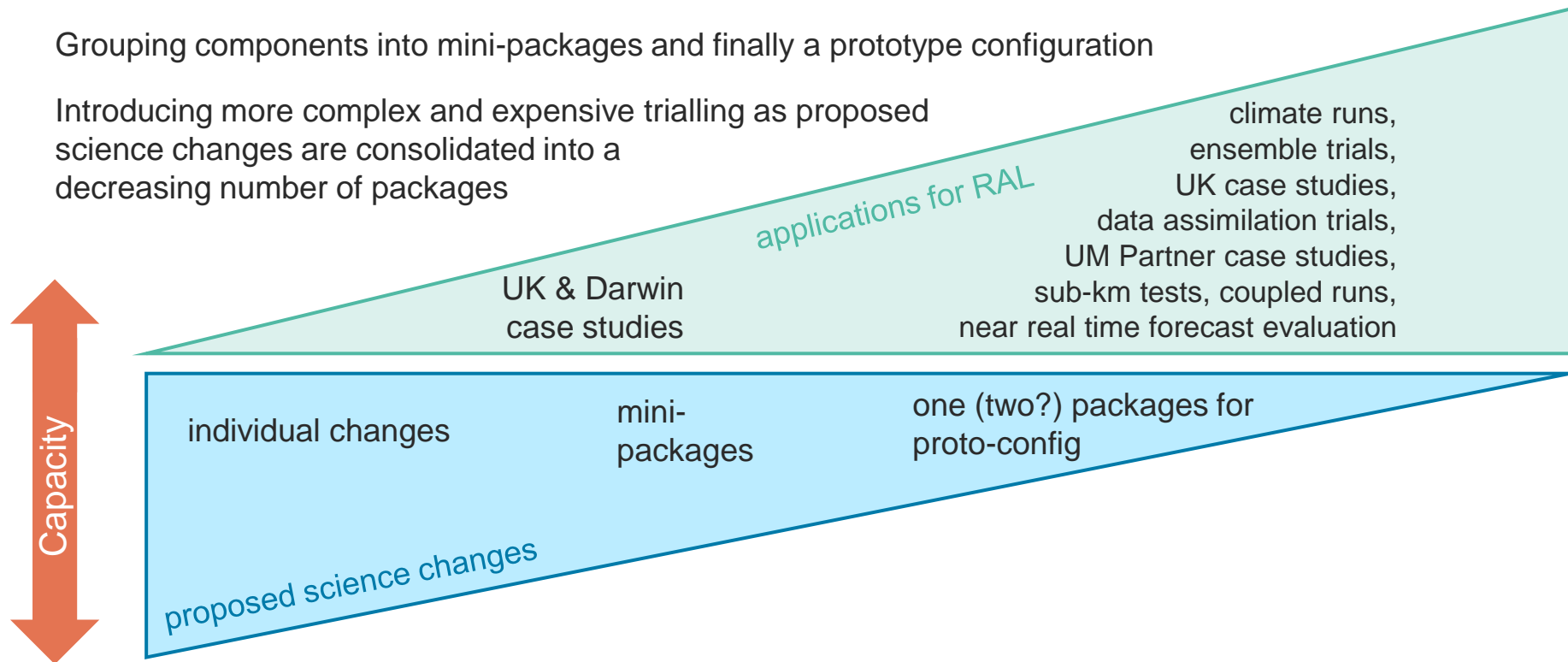
- Bi-modal cloud scheme *(Kwinten van Weverberg)*

  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 currently used in mid-latitude RAL

  - replacing Smith scheme in RAL2-M and prognostic PC2 scheme in the tropical version RAL2-T

  - important step towards unification of mid-latitude and tropical RAL configuration

- 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

- and many more…

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- Three packages in the final RAL3 testing

- Packages differ in use of cloud scheme and microphysics scheme

- All packages include the remaining RAL3 physics developments

Package 1	• Bi-modal cloud scheme • current Wilson-Ballard microphysics scheme	RAL-M
Package 2	• current PC2 cloud scheme • current Wilson-Ballard microphysics scheme	RAL-T
Package 3	• Bi-modal cloud scheme • CASIM microphysics scheme	RAL-M & RAL-T

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Package 3 no longer needs stochastic boundary layer perturbations in mid-latitudes

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![Met Office]

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RAL3 testing in the
1.5km UKV model

Cloud amount

- Increased cloud
  amounts in RAL3
  trials

Winter   **Summer**

- RAL2   **- RAL3 pack1**

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RAL3 testing in the
1.5km UKV model

1.5m temperature

- RAL3 warmer in Winter

- RAL3 cooler in during
  the daytime in summer

- changes largely driven
  by increased cloud
  cover
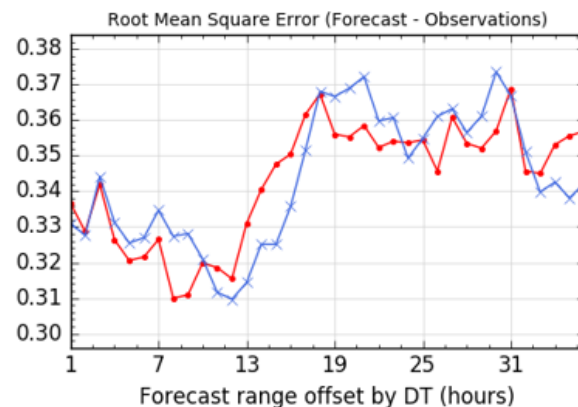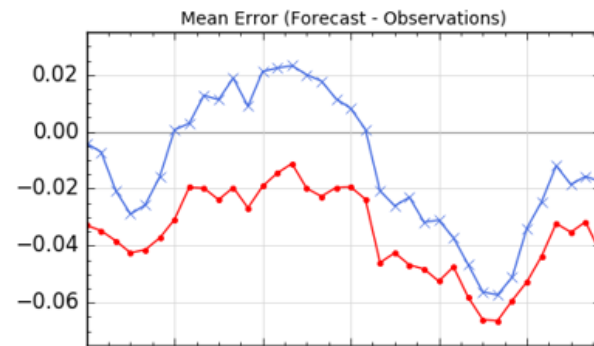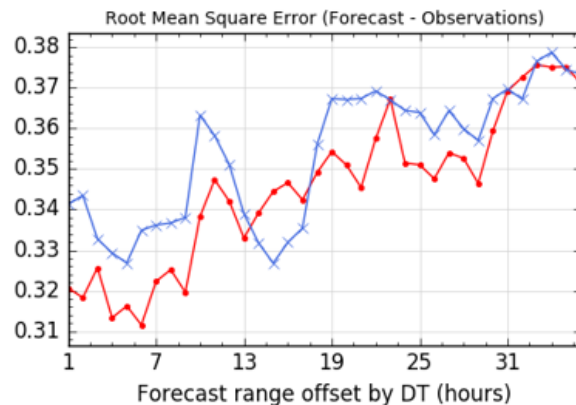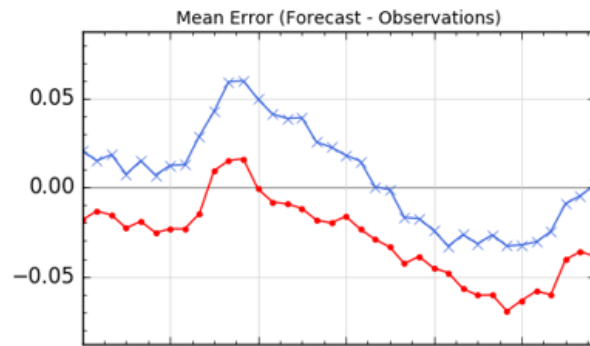
Winter   **Summer**

- RAL2   - RAL3 pack1
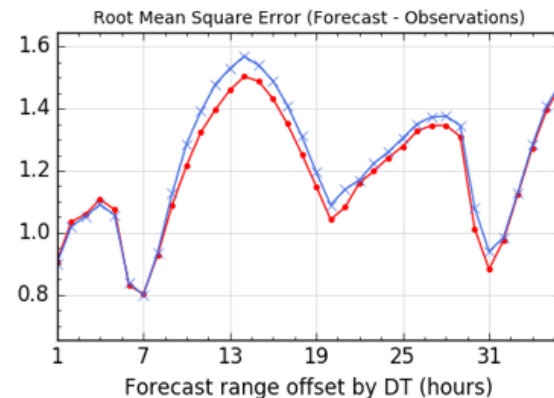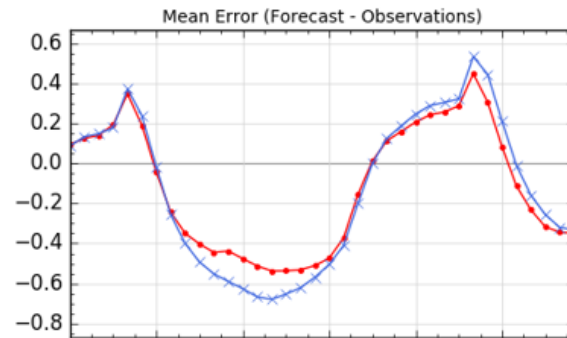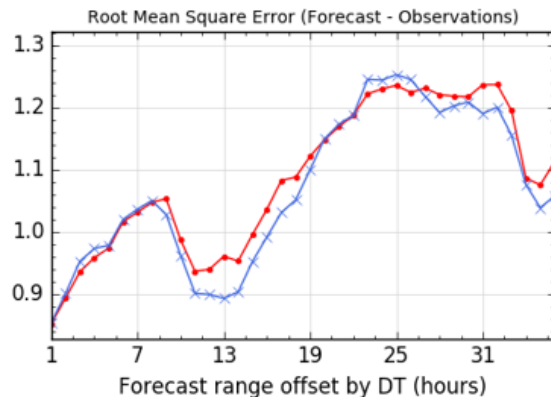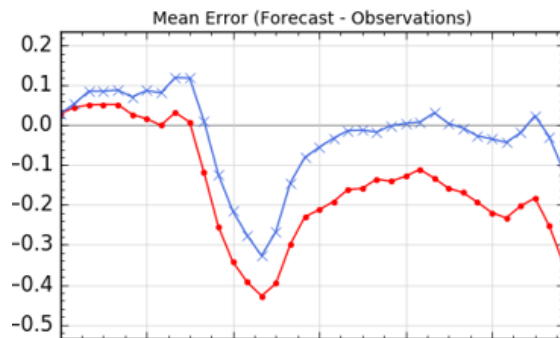
RAL3 testing in the 1.5km UKV model

RAL3 better
RAL3 worse

RAL2 vs RAL3 pack1

- Three packages in the final RAL3 testing

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Package 3	• Bi-modal cloud scheme • CASIM microphysics scheme • Stochastic BL perturbations switched off	**Unified configuration for mid-latitudes and tropics**

Package 3 testing has just started...

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Both RAL3 packages overall performing better than RAL2

RAL2 vs RAL3 pack1

RAL2 vs RAL3 pack3
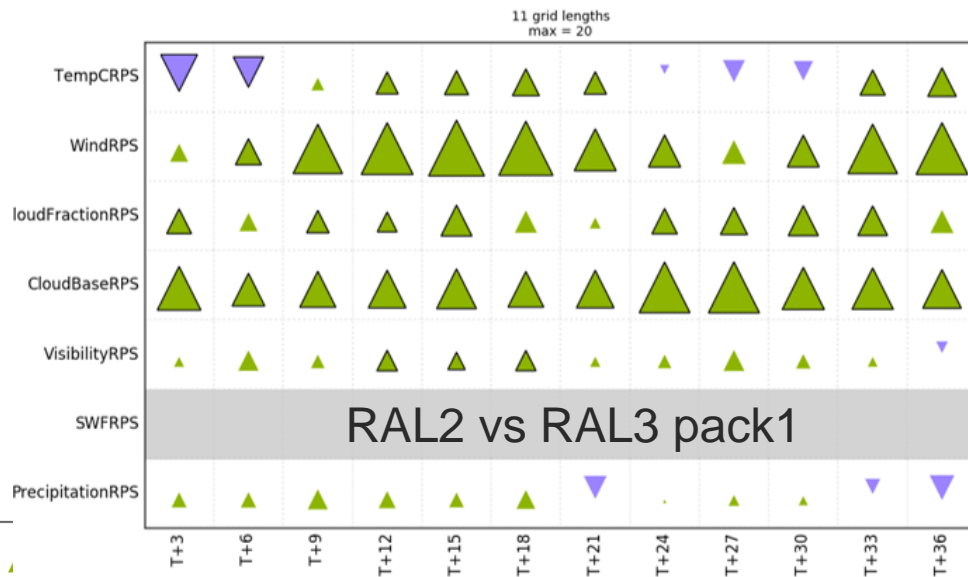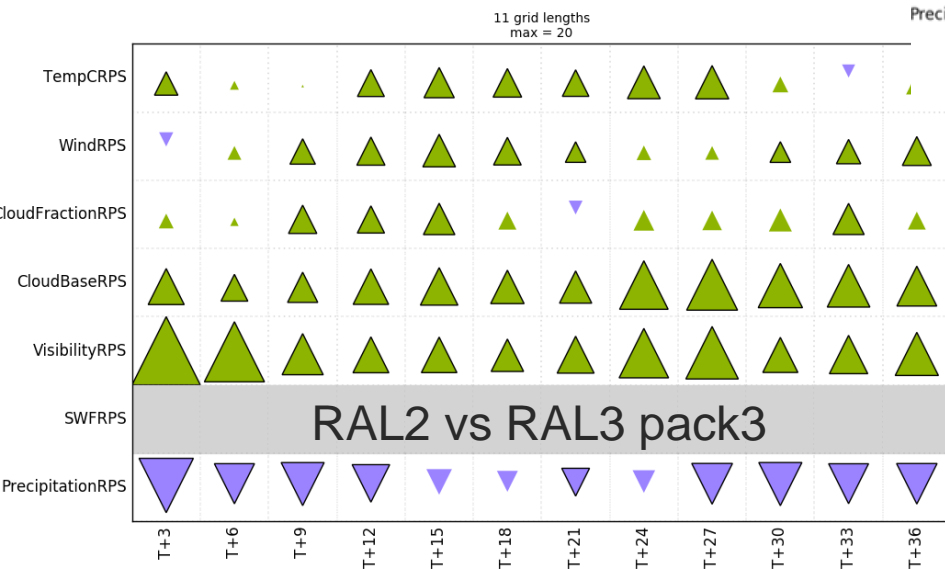
RAL3 better
RAL3worse

Fraction skill score shows improvement for pack3 precipitation

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Large contrast in precipitation structure between RAL2 and RAL3 with CASIM microphysics scheme (package 3)

Instantaneous Precipitation Rate
Met Office UKV RA2M from 2021/09/27 12Z
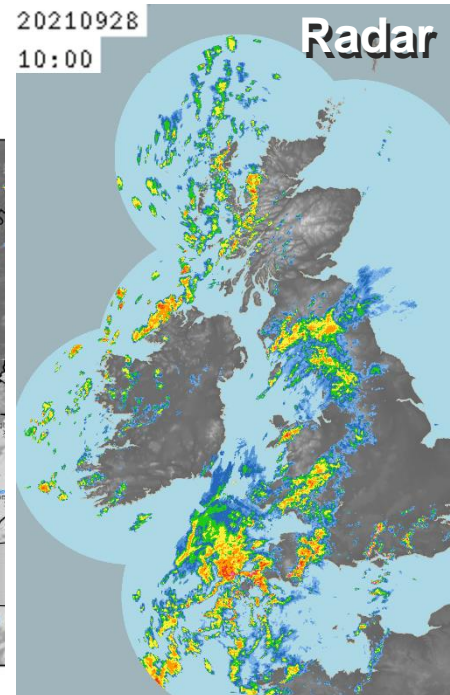Tue 2021/09/28 10Z T+22

RAL2

MIN=0.000, MAX=76.849, MEAN=0.311, SD=1.686, RMS=1.71
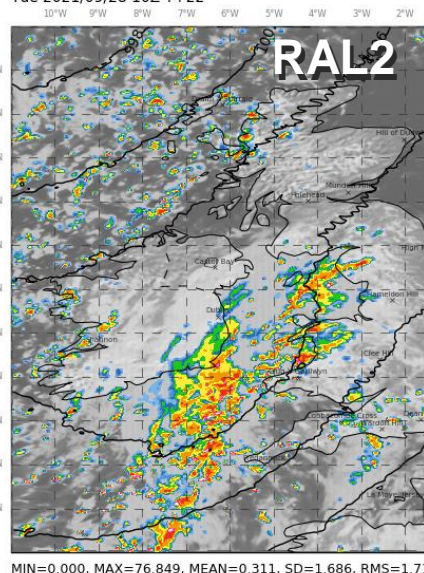
Instantaneous Precipitation Rate
Met Office UKV RA3M Pack 1 from 2021/09/27 12Z
Tue 2021/09/28 10Z T+22

RAL3 pack1

MIN=0.000, MAX=107.735, MEAN=0.319, SD=2.239, RMS=2.262
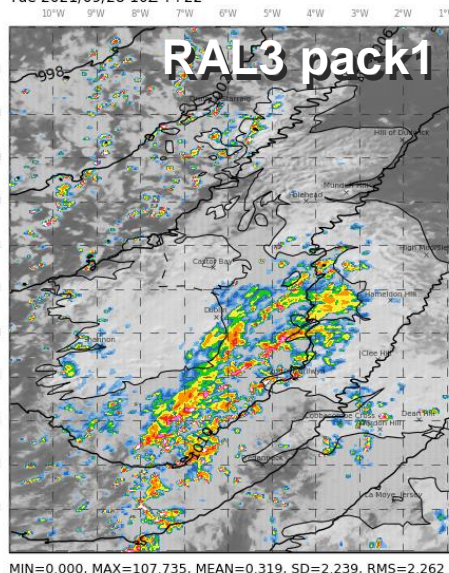
Instantaneous Precipitation Rate
Met Office UKV RA3 Pack 3 from 2021/09/27 12Z
Tue 2021/09/28 10Z T+22

RAL3 pack3

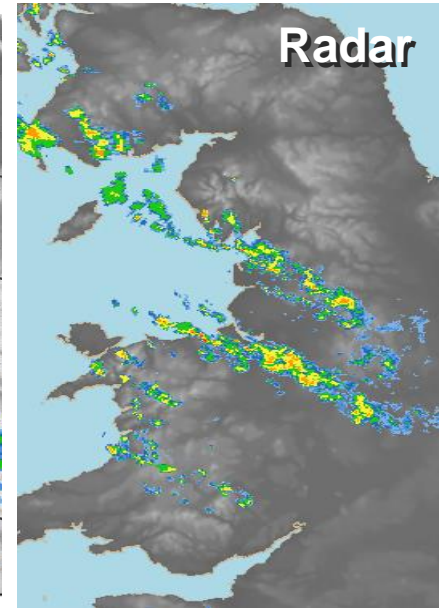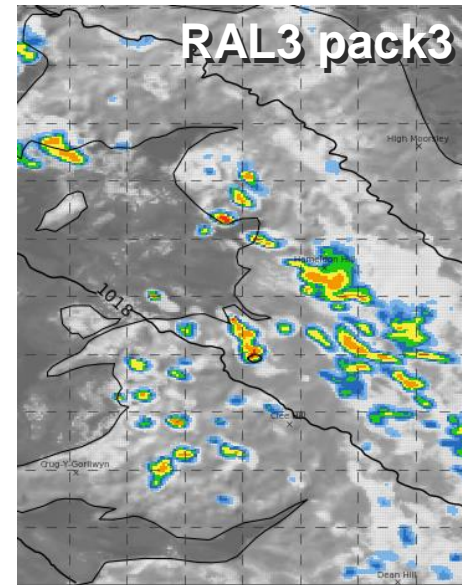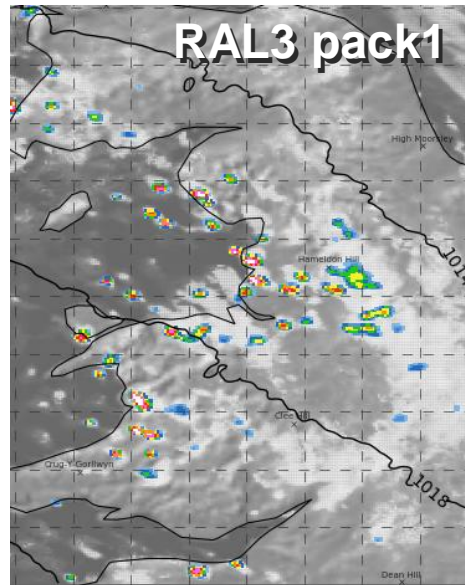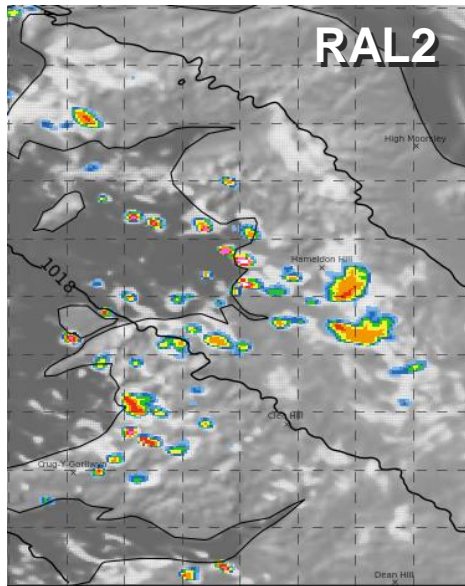MIN=0.000, MAX=117.142, MEAN=0.330, SD=1.750, RMS=1.781

20210928 10:00

Radar
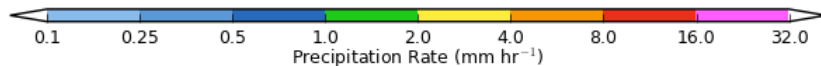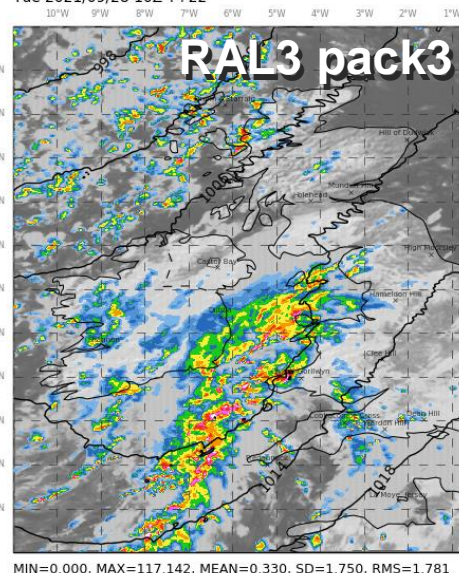
Precipitation Rate (mm hr⁻¹)
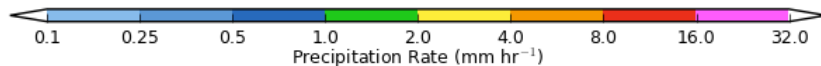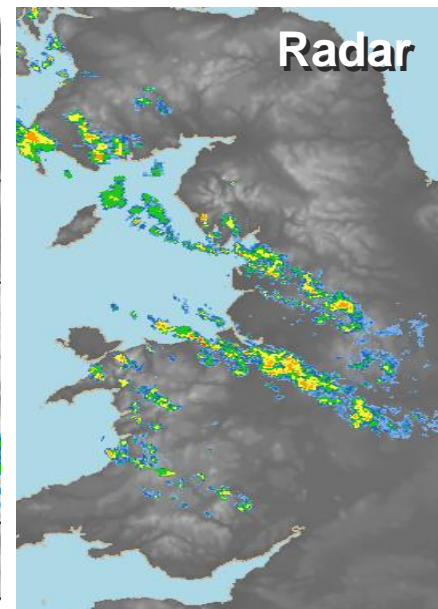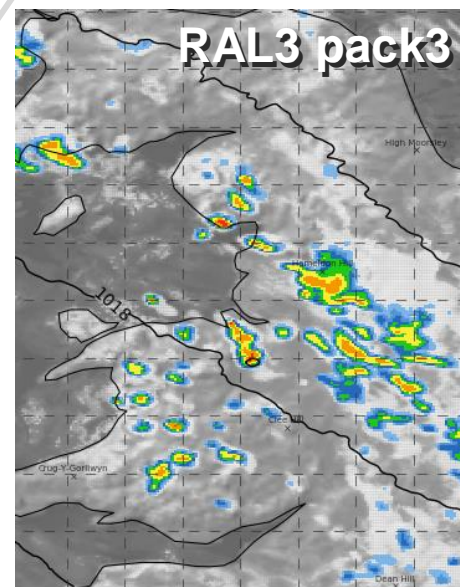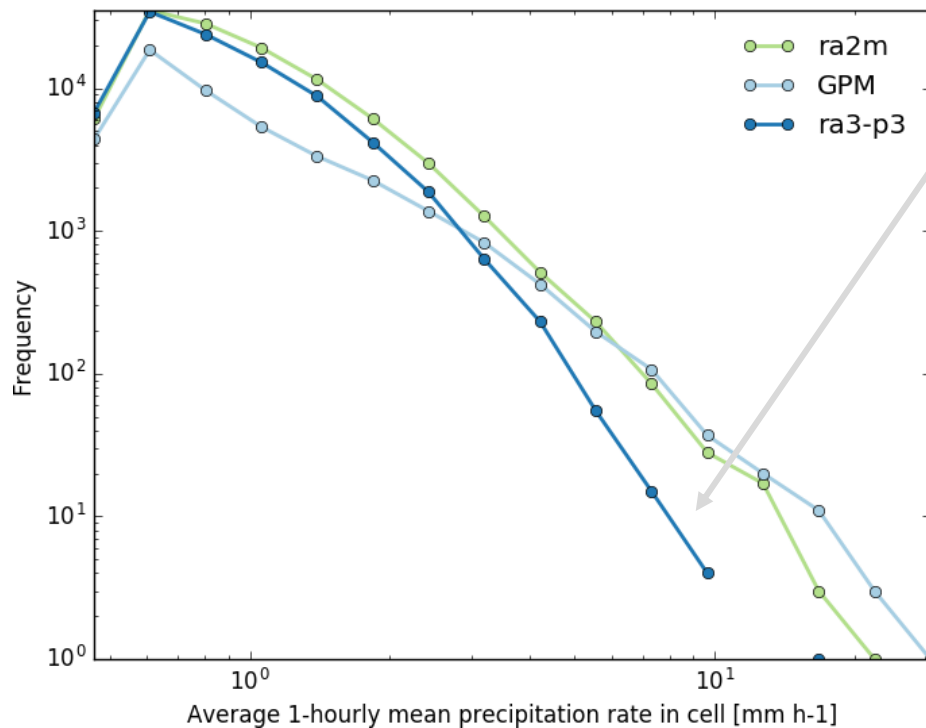0.1 0.25 0.5 1.0 2.0 4.0 8.0 16.0 32.0

CASIM introduces light rain "halo" around precipitation cells and reduces maximum precipitation rates in cell centres
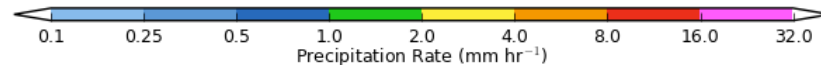
CASIM introduces light rain "halo" around precipitation cells and reduces maximum precipitation rates in cell centres

... potentially too much

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Summary

- A broad range of changes is trialled for the third Regional Atmosphere/Land configuration (cloud scheme, surface evaporation and albedo, boundary layer turbulence, microphysics, visibility, …)

- Introduction of bi-modal scheme offers opportunity to unify tropical and mid-latitude treatment of cloud

- RAL3 package 3 including CASIM microphysics scheme allows switching off stochastic boundary layer perturbations in mid-latitude RAL

  → potential for unified mid-latitude and tropical RAL configurations with release of RAL3

- RAL3 results show positive impact with reduction in negative cloud bias and better performance due to warmer temperatures in winter

- RAL3 also performing well in tropics

- Work in progress to determine which RAL3 package we will take forward