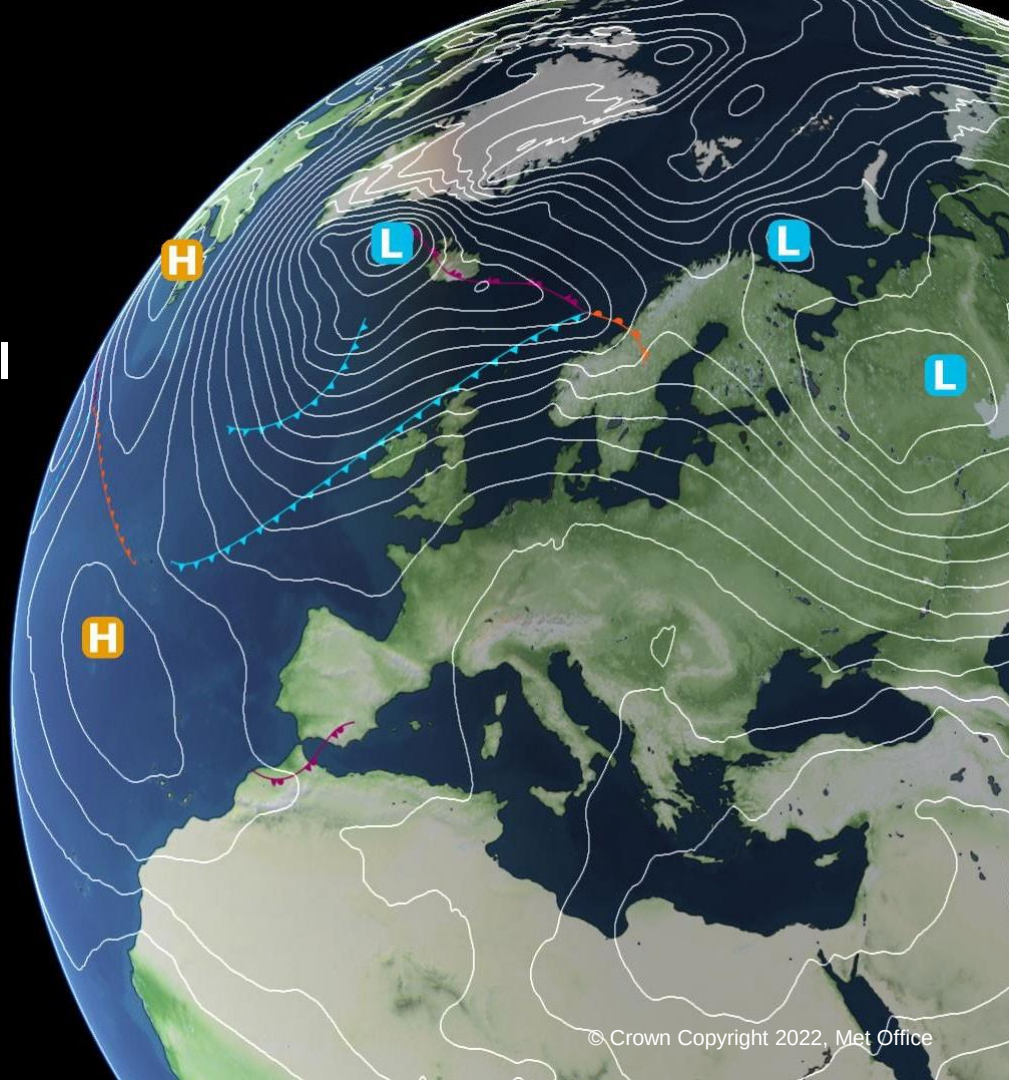
RAL3

Update on the Met Office Regional Atmosphere Land Configuration

Anke Finnenkoetter, Christine Johnson,

Mike Bush, David Flack, and many others …



RAL - the “Regional Atmosphere and Land” configuration

- Large range of convection permitting models → risk of proliferation of model configurations
- RAL provides a single configuration for use in NWP operations, climate applications and research projects and ensures a coherent programme of model development
- RAL2 used operationally since December 2019
- RAL3 released in August 2022, operational implementation planned for autumn 2023

RAL3 science changes

- 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…

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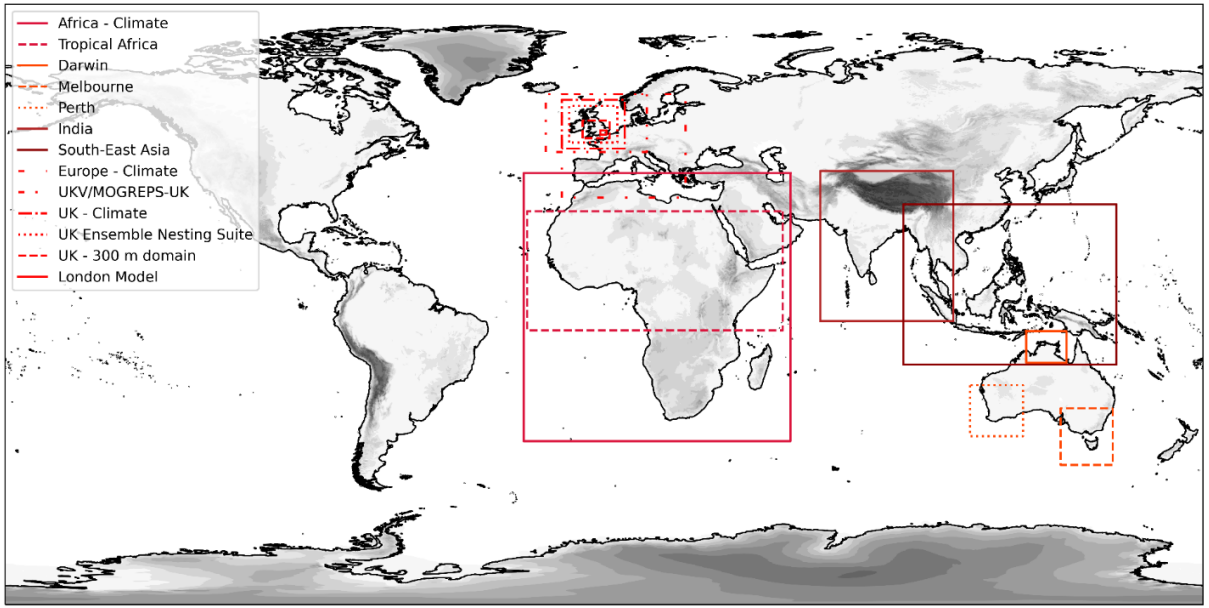
  - consolidation of global and regional model land surface settings

Remaining differences between mid-latitude and tropical RAL configuration removed!

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

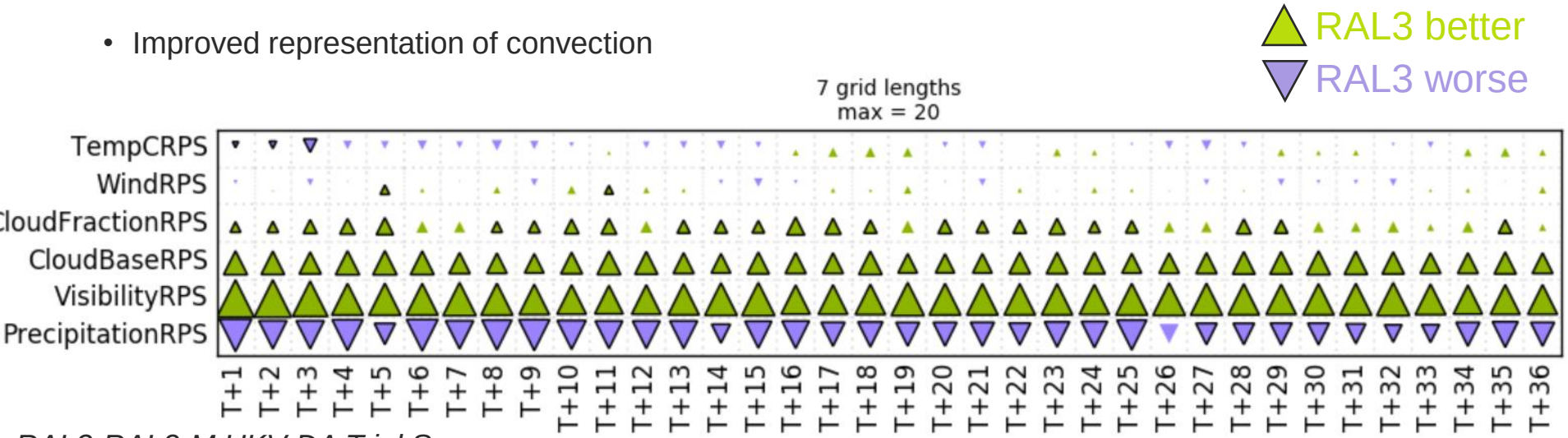
Testing & Evaluating RAL3



- NWP case studies
- sub-km tests
- climate runs
- ensemble trials
- UK data assimilation trials
- near real time forecast evaluation

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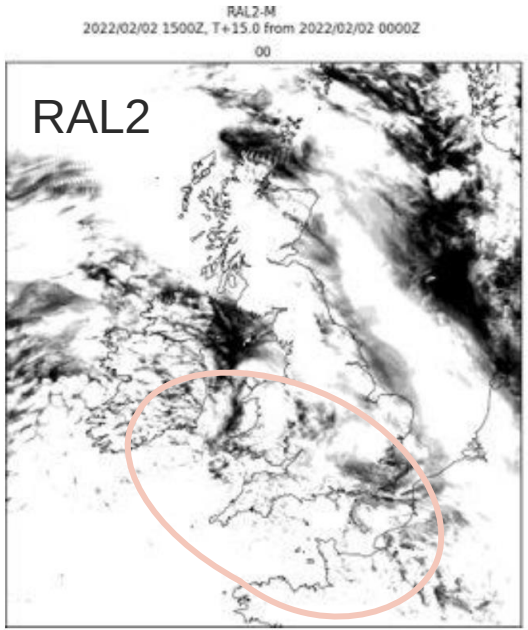
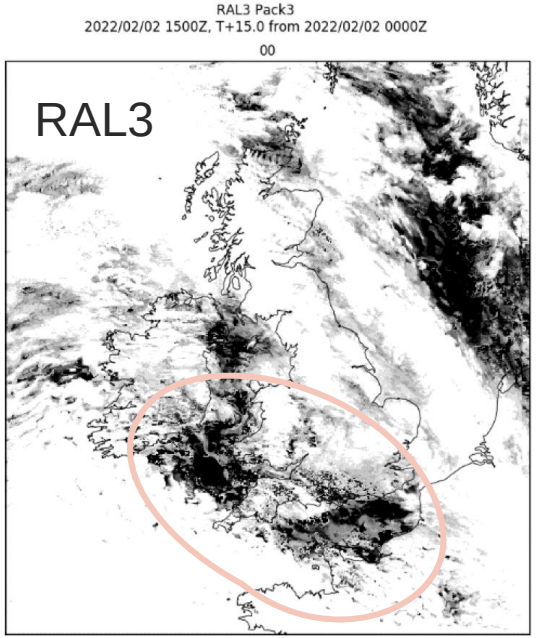
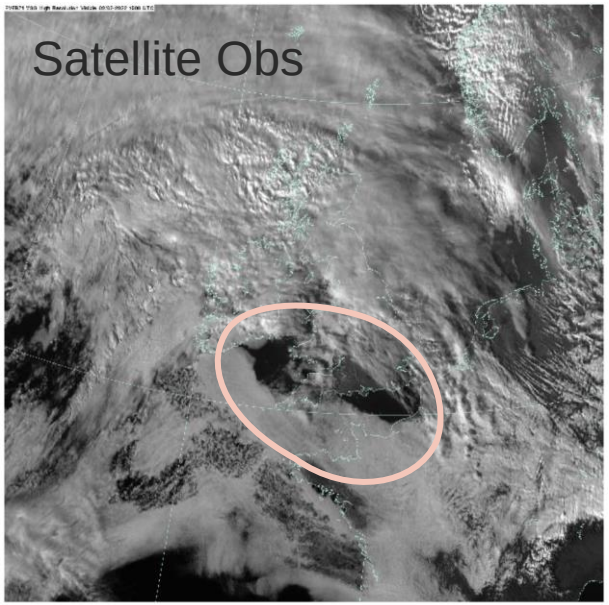
Bi-modal cloud scheme helps with better representation of cloud in RAL3







Steven Keates, William Rosling, Aurore Porson

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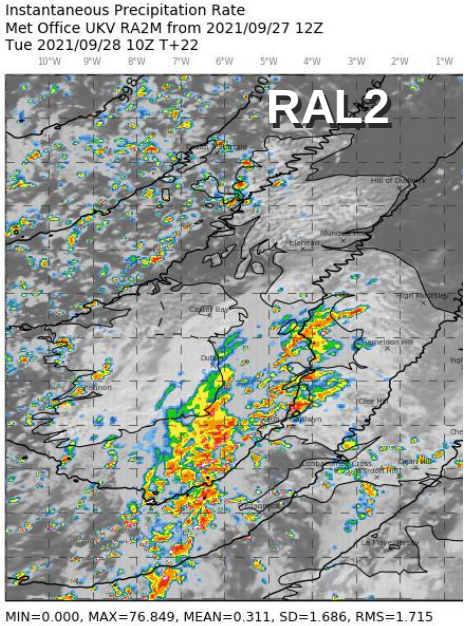
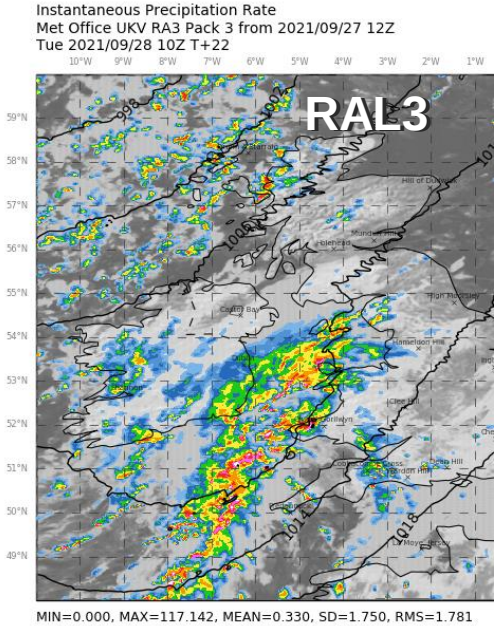
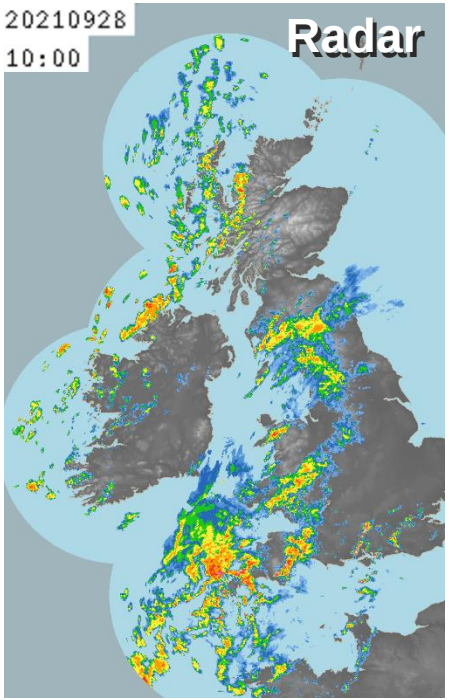
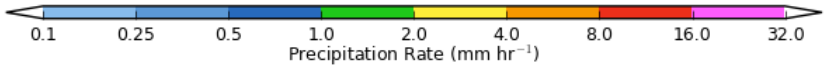
CASIM microphysics scheme introduces light rain “halo” around precipitation cells and reduces maximum precipitation rates in cell centres



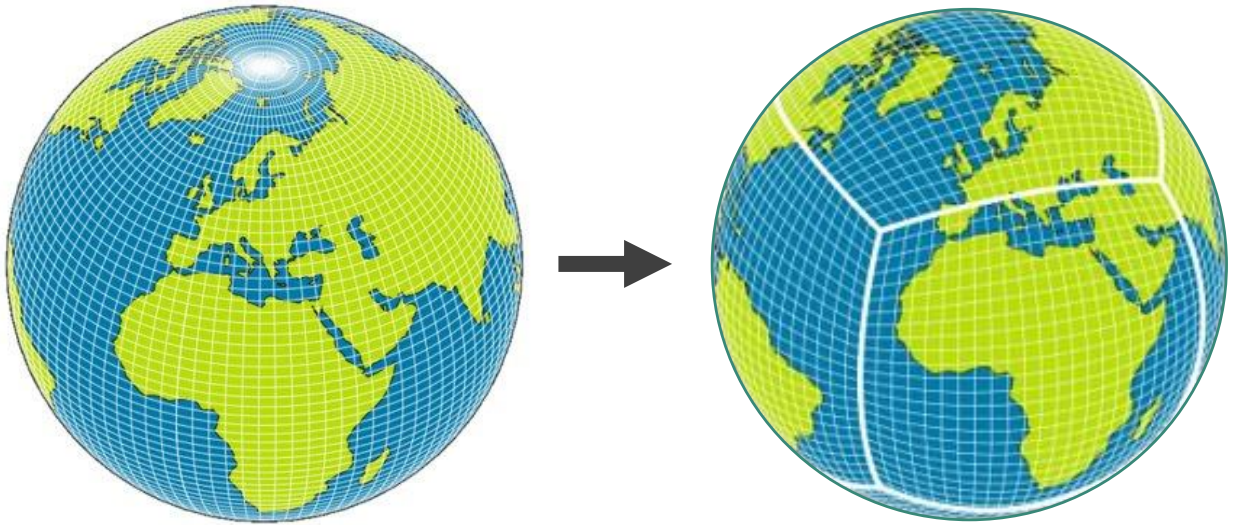






Transition to LFRic

- Better scalability
- Cubed sphere mesh avoids problems at the poles



Unified Model (UM)

LFRic (after Lewis Fry Richardson)

Regional UM Grid vs Regional LFRic Grid

UM LAM grids and LFRic LAM grids look the same on the surface

- rotated pole
- no poles or irregular cubed sphere features in regional modelling
- grid boxes arranged to form rows and columns

Underlying data structure is very different!

UM	**LFRic**
structured	unstructured (UGRID)
actual rows and columns matrix	one big long array with all the data dumped in
a few bits of meta data defining the grid	large amount of mesh data detailing location and neighbourhood info for each “grid box”

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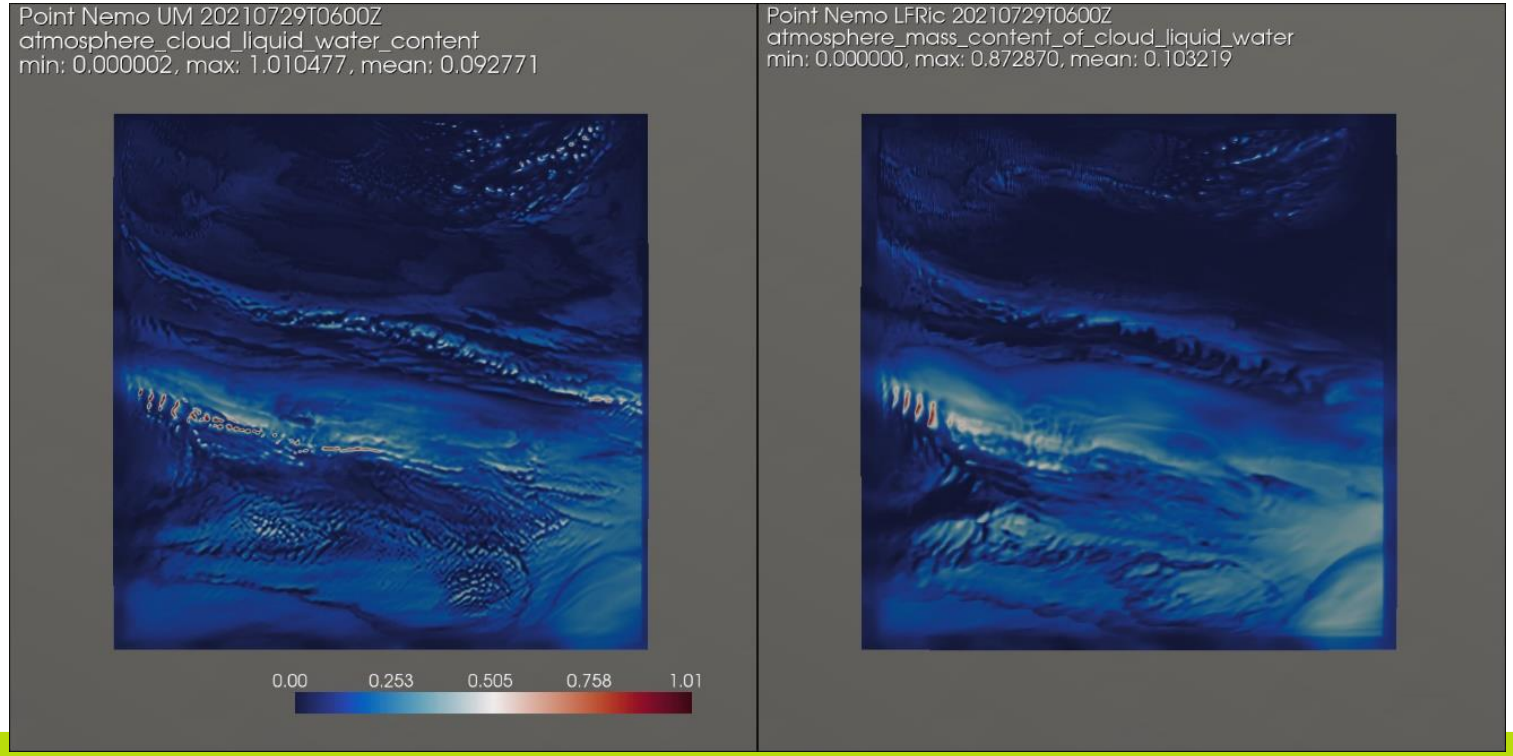
Successfully ran “Basic-RAL” LFRic simulations over aqua domain (nested inside UM global)



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From RAL3-UM to RAL3-LFRic

2-year “RAL3-LFRic” project started in September

- Incorporating new model into suites and standard tools for running NWP experiments
- Adaptation of evaluation & verification tools to unstructured grid
- Evaluation of “Proto-RAL”
- Strong interdependencies between different aspects of RAL3-LFRic project
- Heavily relying on input and ongoing development from numerous other LFRic projects

Summary

- The third Regional Atmosphere/Land configuration RAL3 features a broad range of science changes (cloud scheme, surface evaporation and albedo, boundary layer turbulence, microphysics, …)
- Unification of tropical and mid-latitude RAL configuration through removing differences in cloud scheme and stochastic boundary layer perturbations
- RAL3 improvements include representation of clouds, convection, distribution of precipitation, …
- Focus on transition to RAL3-LFRic prior to work starting on RAL4