Met Office Consortium talk

47th EWGLAM and 32nd SRNWP workshop

22-25 September,

Norrkoping, Sweden

Met Office

Content

- Momentum Partnership (adoption of RAL3 operationally)
- Future operational upgrades
  - PS47
  - RAL3 – LFRic
  - Momentum timeline (PS48, PS49)
- Machine Learning Weather Prediction
- Hectometric plans
- Other Met Office talks

Met Office Partners & Collaborators

The Momentum® Partnership

Bringing together international partners to use and effectively contribute to the development of a world leading seamless **Unified Earth Environmental Prediction Framework, Momentum®**, which provides foundations for weather and climate science and services

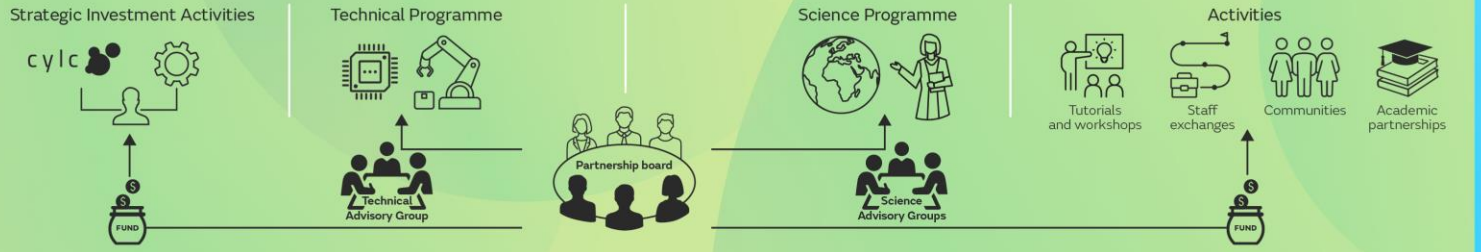
Momentum
The Unified Earth Environment Prediction Framework

Benefits:

By leveraging the diverse strengths and specialisations of all partners we enable a faster rate of improvement of Earth System prediction services than any single organisation can make

Priority areas:

- Global, regional and local prediction and projections
- Applications of Artificial Intelligence and Machine Learning
- Technical Infrastructure development that supports Momentum



Through funding of Strategic Investment and Leadership Activities, we build a robust Partnership with both scientific and technical infrastructure programmes

Key
- Core partner
- Associate partner

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Future Operational Upgrades

Met Office

PS47 – Big science upgrade – operational in January 26

Global

- Model physics upgrade (GC5; set of modest changes including convection & GWD)
- Global Mode-S observations
- GC5-consistent additive inflation sampling
- JOPA - Next generation observations processing (first element of the NGMS programme)
- Extension of the global ensemble to 10 days (user request to support NSWWS warnings to 7 days)

UK

- Model physics upgrade (RAL3) (*see Gareth Dow's talk, Thursday*)
- Quality control of visibility observations re-activated
- Small Data Assimilation changes in preparation for UK JOPA at PS48
- Improvements and coverage extension for radar reflectivity assimilation (*see Lee Hawkness-Smith's talk, Wednesday*)

Keith Williams, Warren Tennant, Aurore Porson, Chris Harris, Adam Maycock, David Simonin, Adrian Lock

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UKV

RAL3.3.1:

- Unification mid-latitude and tropical configurations
- CASIM
- new bi-modal cloud scheme
- boundary-layer mixing changes
- land-surface changes (consistency with global)
- new ancillaries (including LAI revision)
- bug fixes

RAL3 paper

DA Bias package:

- Visibility QC
- Removal of AVG
- Removal of latent heat nudging
- RRTOV (technical move)
- Cloud bug fixes

Improvements to the radar reflectivity package:

- Increase in coverage (French and German radars)
- Better QC over the UK

Coupling CASIM to the DA

Driving from GC5

MOGREPS-UK

RAL3.3.1:

- Unification mid-latitude and tropical configurations
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- new ancillaries (including LAI revision)
- bug fixes
- **New RP stochastic physics**
- **UKV RAL3.3.1**

RAL3 paper

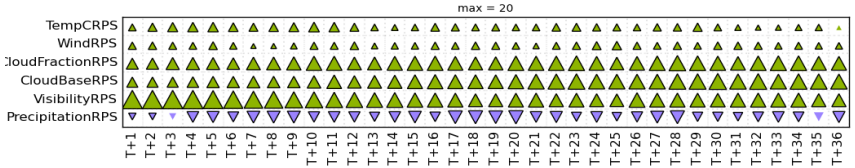
Driving from GC5

Changes to the UKV analysis

Met Office

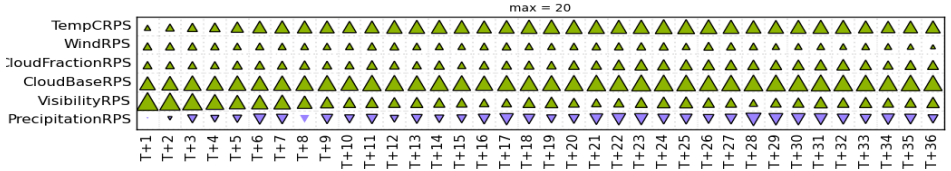
% Difference (o-aa234 vs. o-aa198), Surface Obs, 11 grid lengths

UKV (9th June-10th August 2024)



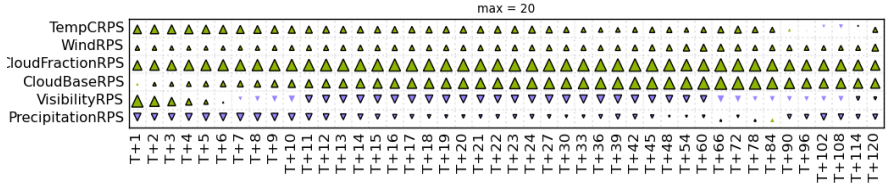
% Difference (o-aa233 vs. o-aa197), Surface Obs, 11 grid lengths

UKV (2nd December 2023-4th February 2024)



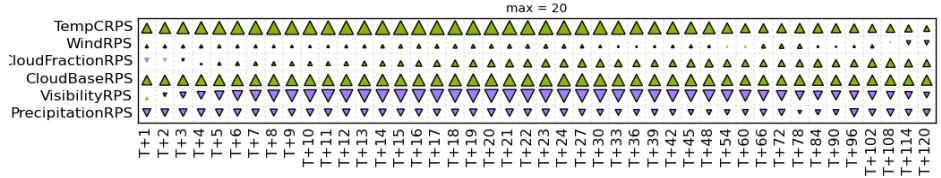
% Difference (PS47 vs. CTRL), Surface Obs, 3 grid lengths

MOGREPS-UK (9th June-12th August 2024)



% Difference (PS47 vs. CTRL), Surface Obs, 3 grid lengths

MOGREPS-UK (5th December 2023-2nd February 2024)



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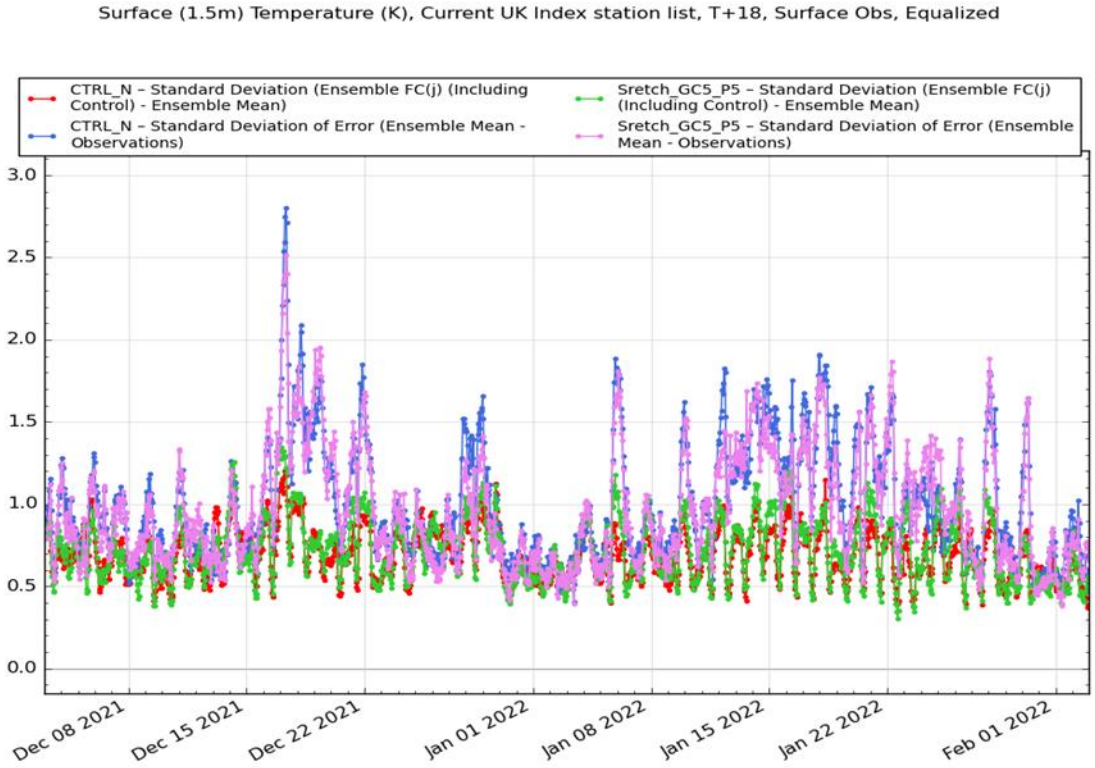


Time-aggregated scores shows a small increase in the overall spread-to-skill ratio for the new operational system. Further work and research on the aggregation of these scores needed to capture events where spread and skill evolve differently.

Beyond PS47 and 2026

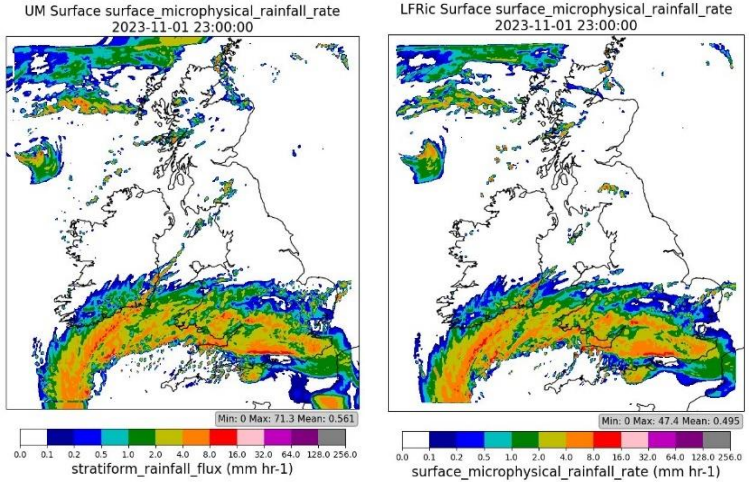
RAL3-LFRic project

The RAL3-LFRic project is an initiative within the Met Office's Next Generation Modelling System (NGMS) programme

Aim: transitioning the Regional Atmosphere and Land 3 (RAL3) configuration from the Unified Model (UM) to LFRic.

Focus: enhancing the scalability, flexibility, portability, and usability of regional atmospheric models, ensuring they are well-suited for future supercomputer architectures.

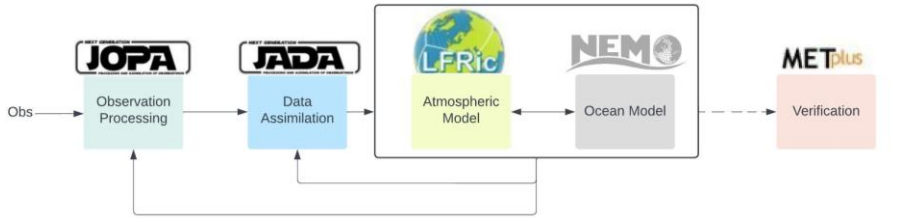
Case study 1st November 2023: warm frontal rainfall



Similar structure between LFRic and UM

Presentation: Sylvia Bohnenstengel, Thursday 0930am

Met Office Momentum Science Timeline



Momentum cycling global deterministic NWP **workflow**.

	PS47 2025	PS48 2026	PS49 2027-2029	PS50 2029/30
MET	**Global**	Additional metrics, methods and visualisations to better understand performance and improve model development		
	UK			
JOPA	**Global**		More rapid/flexible assimilation of new obs types (MTG, METOP-SG, Global Mode-S, etc.) and more suitable for re-analysis	
		UK		
LFRic			**Global**	Ready for new science
			UK	Ready for new science
JADA			**Global**	Collaborate and improve EDA through more flexible approach
				UK

For further information about JOPA and JADA, please contact David Simonin

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Machine Learning Weather Prediction

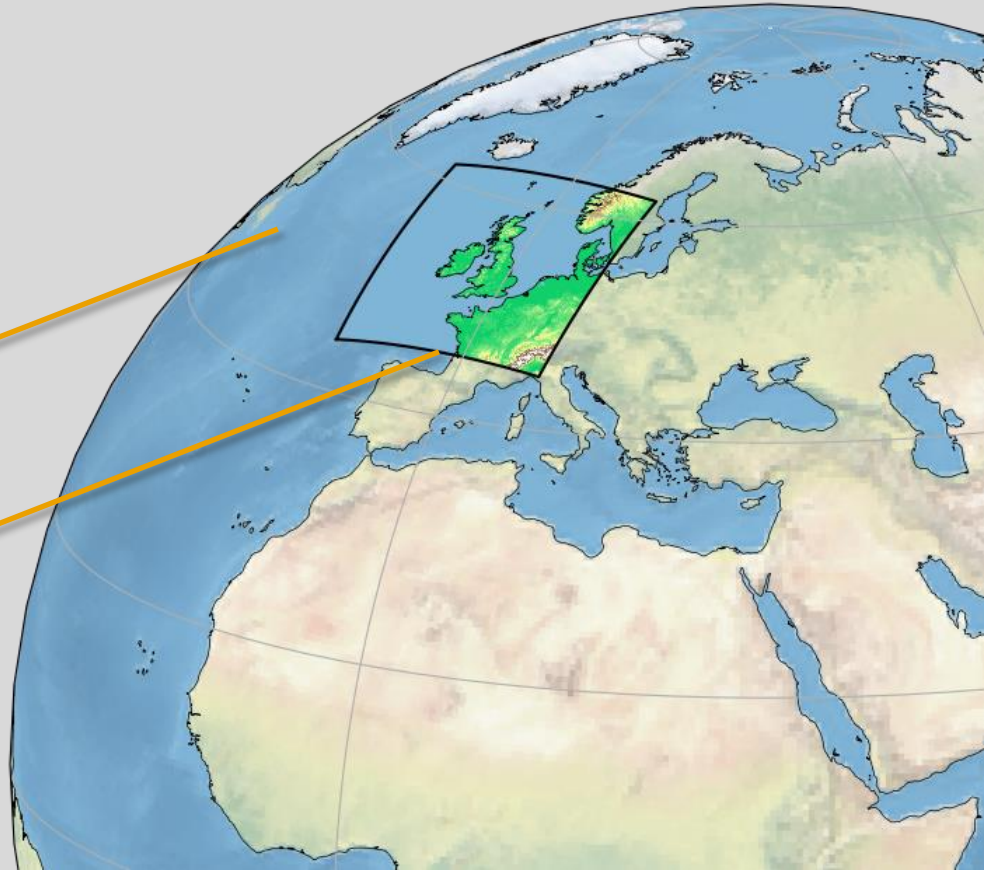
(David Walters)

Met Office goals/ambitions for AI/ML modelling

In the development of ML Weather Prediction (MLWP):

Fast follower in development of ML models for global weather prediction.

Leader in application of ML for UK regional weather prediction.



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Adopter of frameworks for training and running ML models.

anemoi

ECMWF

Adoption of the Anemoi framework

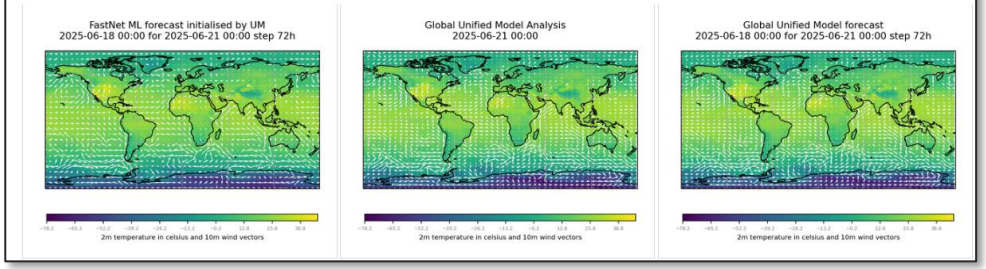
We have decided to:

- Adopt Anemoi as the primary tool for training, fine-tuning and deploying machine learning prediction and projection models.
- Attempt to adopt Anemoi for both weather and climate applications.
- Maximise reuse of existing tooling in workflow orchestration, verification and model evaluation.

FastNet:
AI-based weather prediction model

The name FastNet will be familiar to many as one of the 31 sea areas covered by the Shipping Forecast: a nod to the Met Office's founder, Vice-Admiral Robert FitzRoy, the first professional weather forecaster, who established the Shipping Forecast.

Researchers are exploring how to incorporate their new AI model into the Met Office's workflows and routinely compare its accuracy compared to existing physics-based forecasting methods.



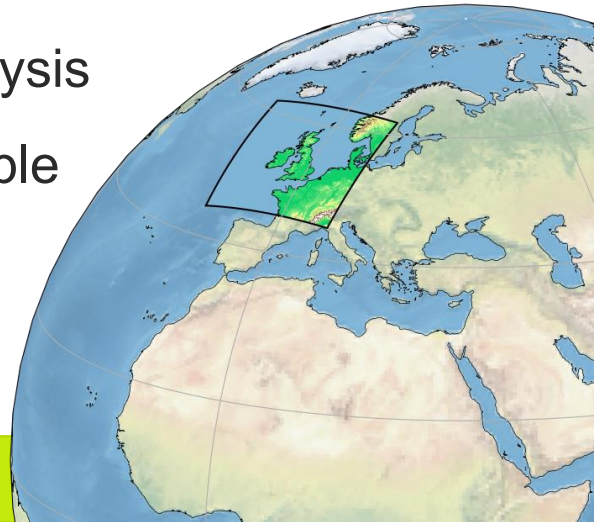
- Aiming for global and regional ensemble prediction system.
- Developing in collaboration with The Alan Turing Institute.
- GNN architecture like GraphCast, AIFS and Bris.

Met Office

The Alan Turing Institute

FastNet:
Next steps

- Port into Anemoi (mostly done) and finalise as Global FastNet v2.0
- Train on archived UK NWP data to predict km-scale UK weather
- Train on UK observations in addition to global analysis
- Further development to produce global/UK ensemble data to supplement physics-based ensembles

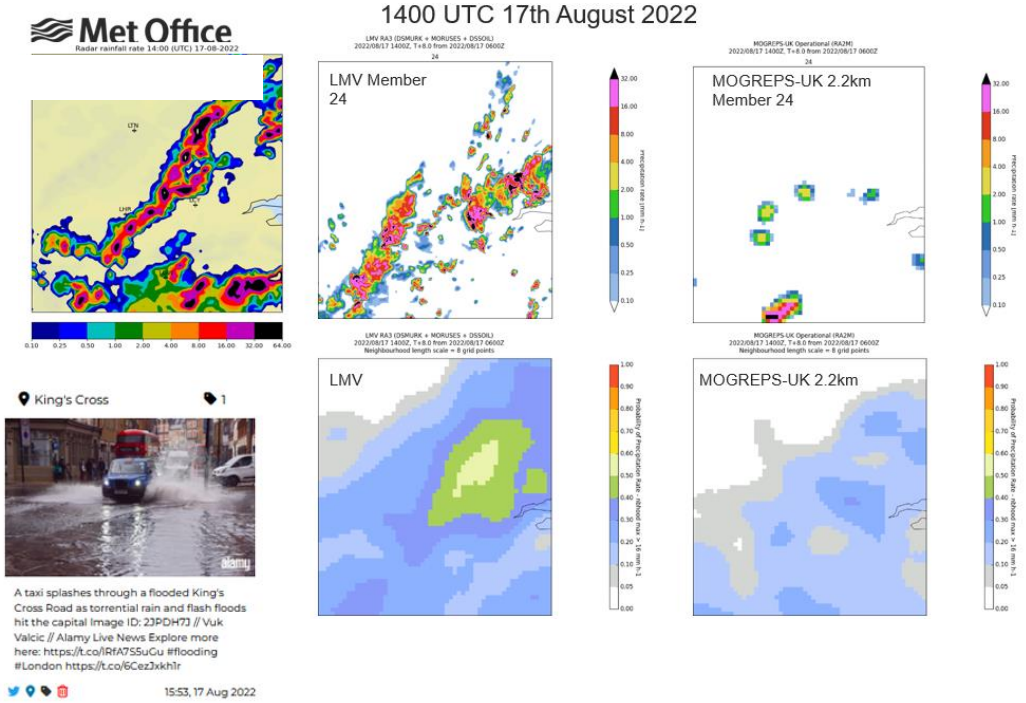


Moving towards hectometric models

(Humphrey Lean)

Met Office Variable Resolution 300m ensemble

Mainly developed for convection: will be used for other elements



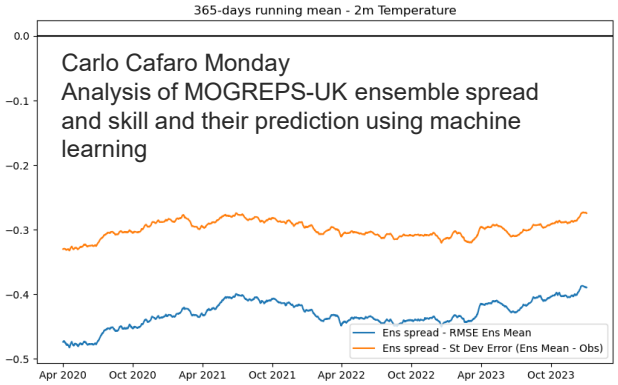
Better indication of chance of heavy rain
This case resulted in flood impacts in London and the SE.

Hanley and Lean (2024) https://doi.org/10.1002/qj.4794.

- 300 m model gives better representation of convection particularly organisation.
- Gives much better indication of storm structures (storm mode) which is important for forecasting.
- Needs to be ensemble due to predictability scales being large compared to scales being forecast.

- Has been run in trial mode for 3 summers for London (2022), Wessex (2023) and Paris (2024).
- Now running daily for London as single deterministic forecast. Planning ensemble in early 2026 on next stage of HPC (gen 1b).

Met Office talks



Future science configuration updates:

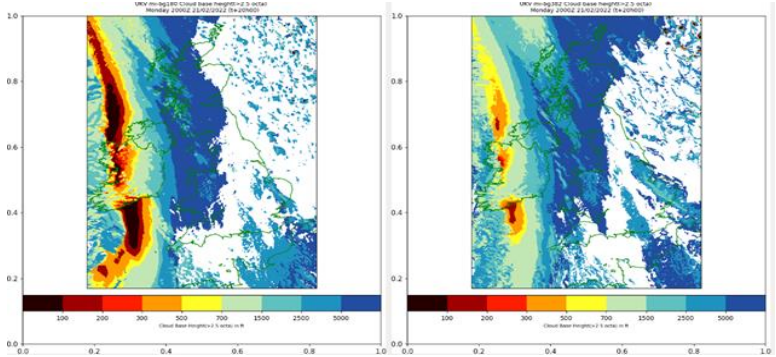
- Sylvia Bohnenstengel on Thursday about RAL3 and LFRic.
- Marion Mittermaier, Wednesday about verification of model improvements during the development cycle

Data assimilation:

- Marco Miland on Tuesday about LAM-DA impact during the forecast time

Next operational updates:

- Lee Hawkness-Smith on Wednesday about radar reflectivity
- Gareth Dow on Thursday about RAL3 developments



Future applications:

- Humphrey Lean on Monday about hectometric models
- Brent Walker on Tuesday about new tools and visualisation for operational meteorologists