Operations-to-Research (O2R) at the Met Office

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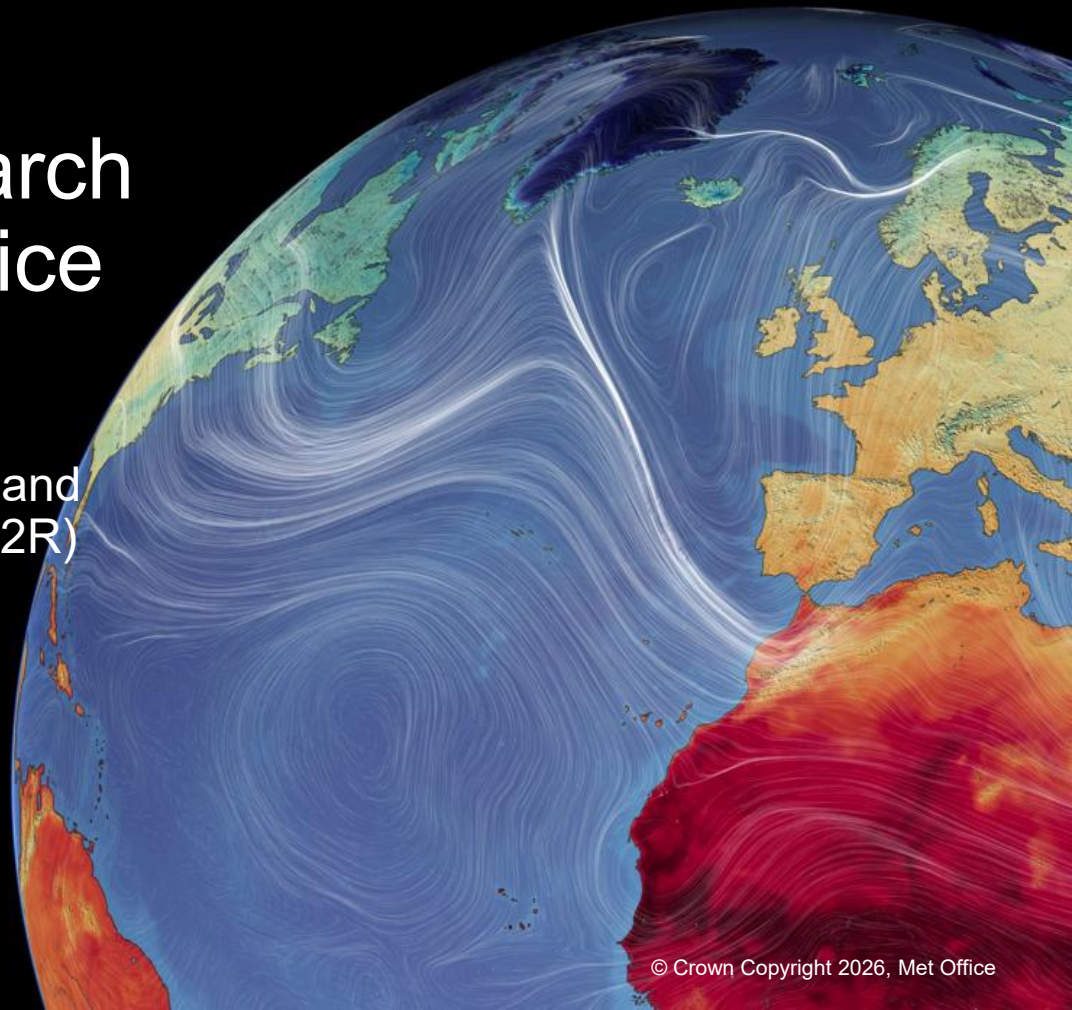

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Introduction

- Operations-to-Research (O2R) at the Met Office – A Gateway for Operational Meteorologists to Inform Met Office Science and Help Improve Forecasting of Extreme and Impactful Weather.
- Growth and advances in NWP, post-processed output and new forecasting tools over the last 20 or 30 years has led to a greater need for dialogue between operations and research, i.e. O2R and R2O.
- The Met Office has had a formal role leading O2R since around 2018/19. O2R has expanded into a small, highly-motivated team of OpMets.
- The aim of this presentation is to say a bit about what O2R at the Met Office does and why and, hopefully, promote discussion and collaboration!

What, How and Why?

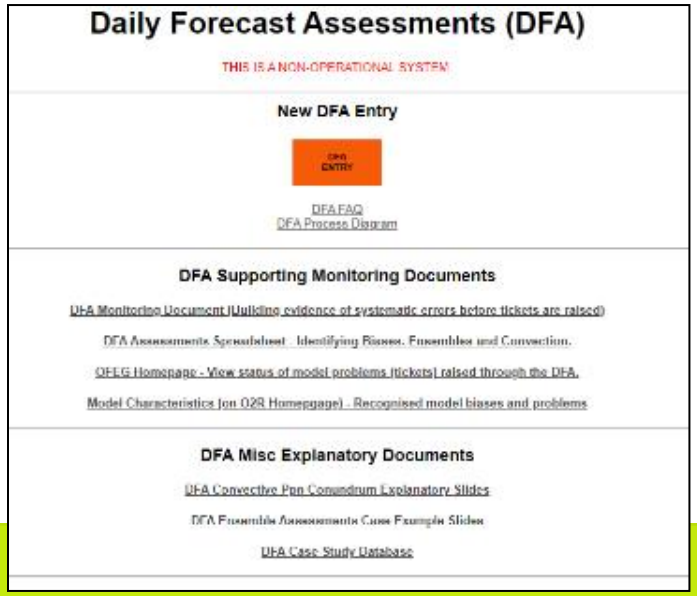
- O2R provides perspective, representation and leadership on behalf of the OpMet community both internally and external (e.g. Met Office research, ECMWF).
- Focus is mainly NWP and post-processing, but other areas of Met Office research tap into O2R expertise.
- O2R is all about providing operationally-focused feedback to better understand our NWP etc and shape/direct new science to help bring it to fruition to benefit our operational community and customers.
- Most feedback is from OpMets. They experience model weaknesses and strengths first-hand on shift and mitigate their impacts in their delivery of forecasts so are well-placed to offer insights.
- The purpose of this feedback is to provide operational perspectives, use cases and customer benefits, on current, new and experimental outputs to help their development.
- O2R also keeps the OpMet community in the loop about NWP matters and model upgrades.
- Next, we'll look at some of the ways we do this and see some examples.

Daily Forecast Assessment

- For current operational models, Daily Forecast Assessment (DFA) log is of key importance.
- This log is the formal process for our OpMets to feed back on model performance to research areas.
- What happens is that OpMets complete to comment on model performance during their shifts.
- Submissions to this log are then further investigated by the O2R team and then reviewed at a monthly meeting between O2R and areas of Met Office science.
- The aim of this feedback is to:
  - Help identify characteristics and systematic biases in our models.
  - Provide input and impetus to deeper research into aspects of our models.
  - Inform discussion around prioritising model improvements.
- Recent input into the DFA has led to improvements into our visibility diagnostics, informed more detailed investigation of biases in lightning diagnostics, added to our understanding of biases in model maximum temperature forecasts and informed best practice in forecasting some elements.

Daily Forecast Assessment

- The beauty of the log is that it is very quick and easy for OpMets to complete.



Daily Forecast Assessments (DFA)

THIS IS A NON-OPERATIONAL SYSTEM

New DFA Entry

DFA FAQ
DFA Process Diagram

DFA Supporting Monitoring Documents

DFA Monitoring Document (Building evidence of systematic errors before tickets are raised)

DFA Assessments Spreadsheet - Identifying Biases, Ensembles and Convection.

OFLG Homepage - View status of model problems (tickets) raised through the DFA.

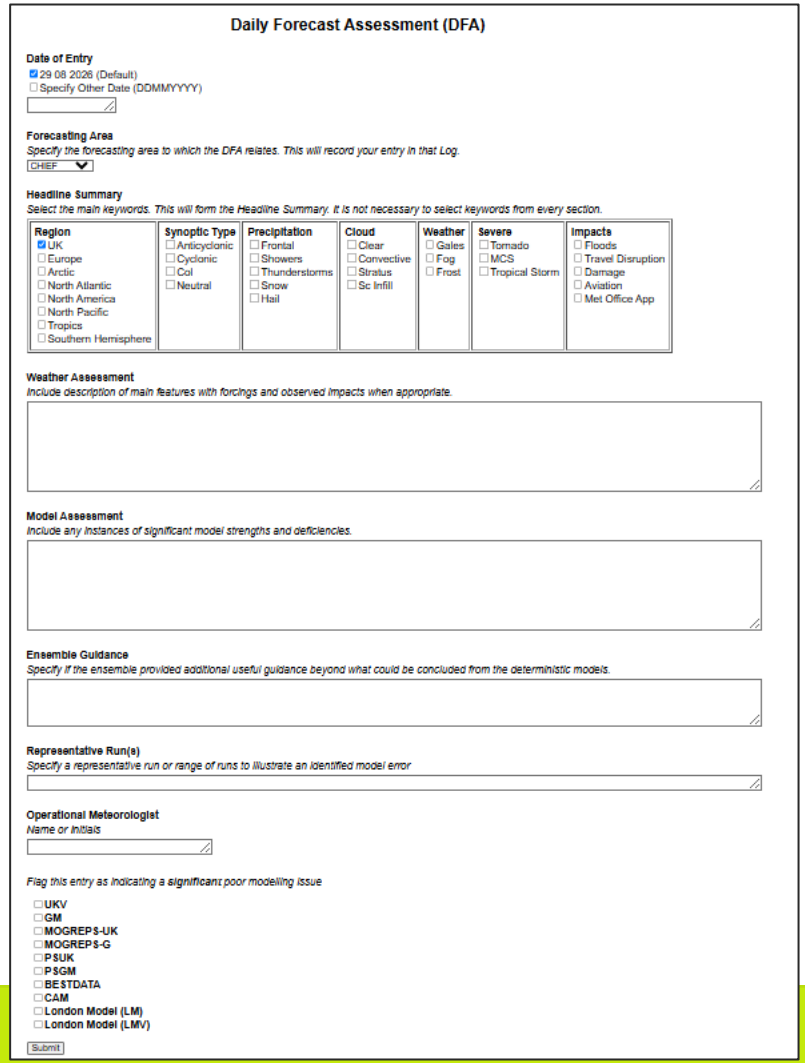
Model Characteristics (on O2R Homepage) - Recognised model biases and problems

DFA Misc Explanatory Documents

DFA Convective Psn Conundrum Explanatory Slides

DFA Ensemble Assessments Case Example Slides

DFA Case Study Database



Daily Forecast Assessment (DFA)

Date of Entry
29 08 2026 (Default)
Specify Other Date (DDMMYYYY)

Forecasting Area
Specify the forecasting area to which the DFA relates. This will record your entry in that Log.
CHIEF

Headline Summary
Select the main keywords. This will form the Headline Summary. It is not necessary to select keywords from every section.

Region	Synoptic Type	Precipitation	Cloud	Weather	Severe	Impacts
UK	Anticyclonic	Frontal	Clear	Gales	Tornado	Floods
Europe	Cyclonic	Showers	Convective	Fog	MCS	Travel Disruption
Arctic	Col	Thunderstorms	Stratus	Frost	Tropical Storm	Damage
North Atlantic	Neutral	Snow	Sc Infill			Aviation
North America		Hail				Met Office App
North Pacific						
Tropics						
Southern Hemisphere						

Weather Assessment
Include description of main features with forcings and observed impacts when appropriate.

Model Assessment
Include any instances of significant model strengths and deficiencies.

Ensemble Guidance
Specify if the ensemble provided additional useful guidance beyond what could be concluded from the deterministic models.

Representative Run(s)
Specify a representative run or range of runs to illustrate an identified model error

Operational Meteorologist
Name or Initials

Flag this entry as indicating a significant poor modelling issue

UKV
GM
MOGREPS-UK
MOGREPS-G
PSUK
PSGM
BESTDATA
CAM
London Model (LM)
London Model (LMV)

Submit

Met Office

Subjective Assessments

Urban-scale models, including over London and Paris.

Convection-permitting model run over the Alps as part of the TEAMx project.

Forecasting tools to help diagnose sting jets and embedded convection.

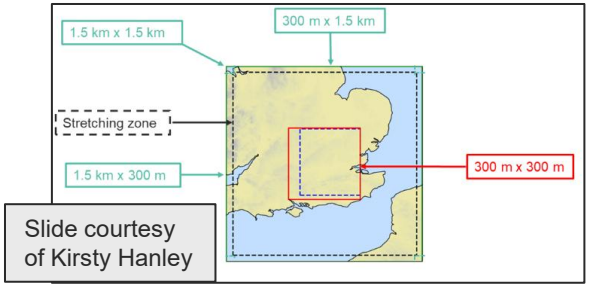
Performance of 4 km horizontal resolution model over Scandinavia.

Improvements to UKV and MOGREPS-UK lightning diagnostics.

Trial and new model formulations to inform characteristics and help explain objective verification statistics.

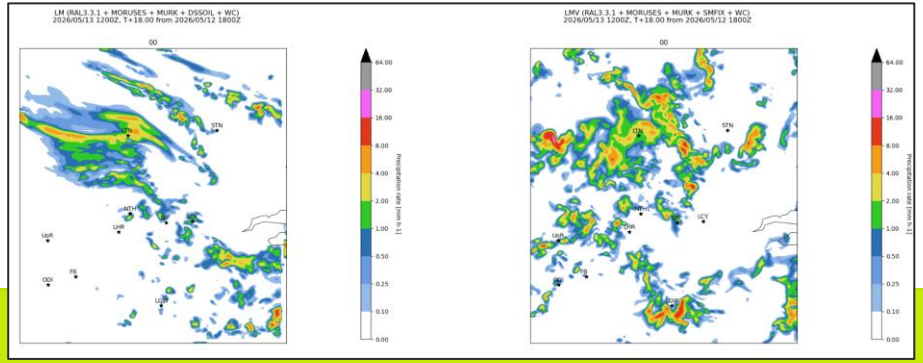
Reviews of severe weather events over the UK to consider performance of current and trial models.

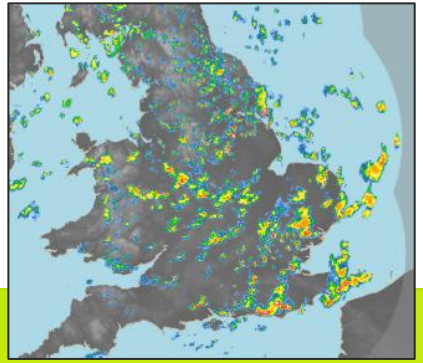
Urban-Scale Modelling

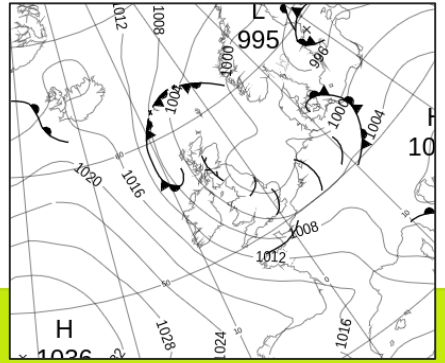


Slide courtesy of Kirsty Hanley

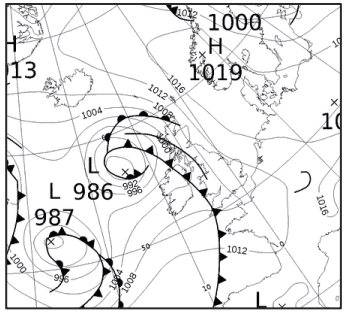
- Routinely assessment of two versions of a 300m horizontal resolution model focused on the London area.
- Aims include considering:
  - Benefits of 300m resolution over 1.5 km (UKV) or 2.2 km (MOGREPS-UK).
  - Differences and benefits of the different domains.
  - Value of running an ensemble and what best practice consideration there are for OpMets
- Helps inform future strategy of our urban-scale modelling. Builds on ongoing work, e.g. an urban-scale ensemble over SW UK in the 2023 Summer Testbed and contribution to the Paris 2024 Olympics RDP.



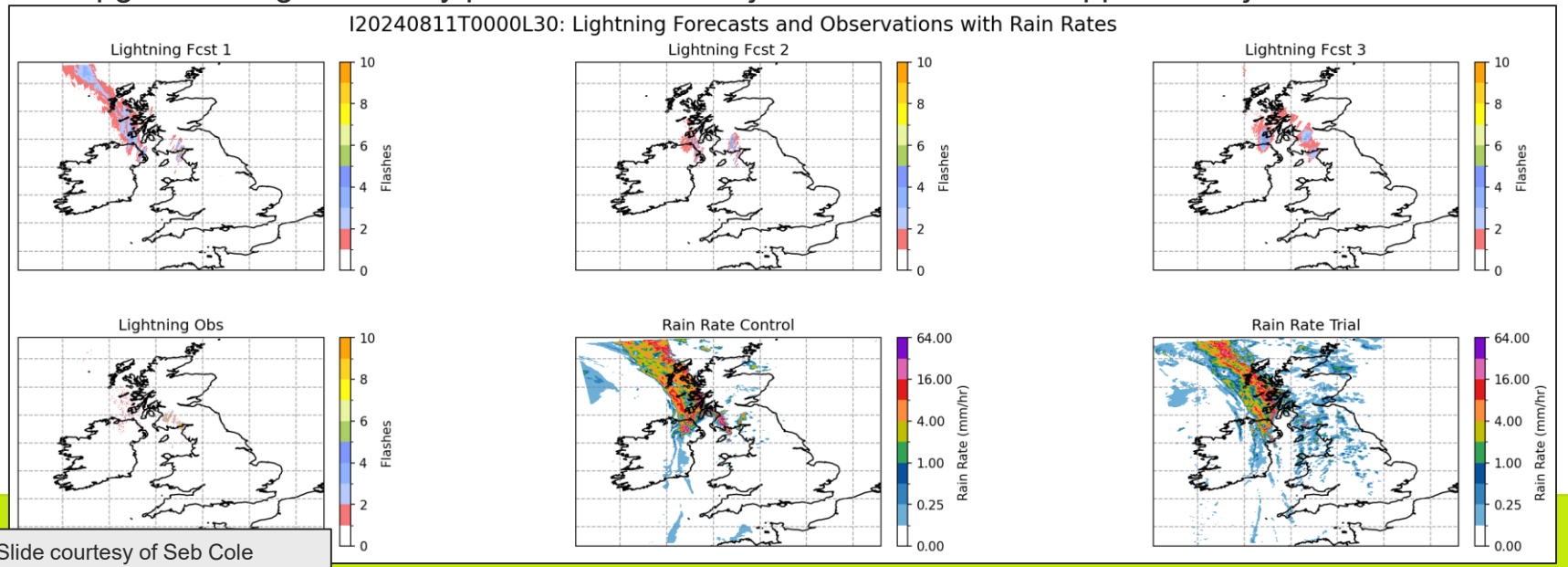




Lightning



- Met Office regional models use a version of [McCaul et al 2009] for lightning. This was fine-tuned for our last model upgrade, PS47. OpMets undertook blind testing stating a preference as to which version of the upgraded diagnostic they preferred. This subjective assessment supported objective verification.



Slide courtesy of Seb Cole

Testbeds and Intensive Evaluations

Proven concept for bringing research and operations together to collaborate in forecasting and subjective verification exercises in simulated operational environments unencumbered by day-to-day deadlines. Accelerates development of new tools and forecasting techniques and a core evaluation platform prior to final operationally-focused testing.

The first Met Office-run testbeds were fortnight-long internal testbeds in autumn 2013 and summer 2015, inspired by attending NOAA's Hazardous Weather Testbed Spring Forecasting Experiment.

From 2020-2024 testbeds ran annually, mainly as R2O/O2O collaboration and in 2024 as an O2R and Weather Science Space Applications and Nowcasting (SAN) collaboration.

Since 2020 testbeds have evolved into muti-week, hybrid events with internal and external participants (e.g. modelling and academic partners and NMSs who we work closely with) and supporting OpMet resource. ~100 participants in 2023 and 2024 Summer Testbeds.

Focus of recent testbeds has included new model configurations/diagnostics (2022), convection/ensembles (2023) and nowcasting tools (2024).

Since 2025, focus shifted to implementation of new model upgrades and are internal-only so have a new name: Intensive Evaluations!

Testbeds and Intensive Evaluations

- 2023: Convection and Ensembles:
  - Informed further development of IMPROVER, including improved visualizations and OpMet training.
  - Subjective verification exercise of ensembles helped establish characteristics/contributed to major strategic goals.
  - Characteristics of hectometric models documented.
  - Testing of surface water hazard impact models informed decisions as to which ones further develop.
- 2024: Nowcasting:
  - Informed further development and operationalisation of nowcasting products.
  - Helped inform further refinements to surface water hazard impact models.
  - Provide insight as to how short-notice emergency warnings for high rainfall totals can be made.
  - Informed ongoing socio-meteorological work and stress-testing of Vortex, the next generation of OpMet visualization.
- 2025: Model Upgrade (PS47) Testing:
  - Supported Met Office corporate targets and Testing and Issue investigation and resolution processes, helping ensure corporate targets around model upgrade go-live were met on time and in full.
  - Further informed model characteristics and OpMet best practice and helped understand user and customer benefits.
  - Assessed untested aspects of the model upgrade and downstream diagnostics in systems used by OpMets.

Looking Ahead

- Key areas of work for O2R during the next 2-3 years include:
    - Assessment of major Met Office NWP upgrades as we move to our Momentum modelling framework.
    - Includes multi-week Intensive Evaluations by default to provide final OpMet-focused testing of upgrades.
    - Perspectives on AI/ML models and new forecasting tools.
    - Hopefully also increasing engagement with climate modelling and ECMWF.
- Resource and visualization of data are our biggest challenges…
- …we need increased collaboration with our modelling and academic partners as well as other meteorological services and institutions.

Find Out More/Exchange Experience...

We'll leave you with a list of papers O2R have written/contributed to!

- Gonzalez et al. 2026 Named Storms: https://essd.copernicus.org/preprints/essd-2026-181/
- Flynn and Suri 2026 Aircraft Icing: https://doi.org/10.1002/wea.7714
- Sladić et al. 2026 UK Heatwaves: https://doi.org/10.1002/wea.70075
- Masson et al. 2026 Paris Olympics Urban Scale Modelling: https://doi.org/10.1175/BAMS-D-25-0008.1
- Neal et al. 2026 Storms Eunice and Ciarán: https://doi.org/10.1175/WAF-D-25-0083.1
- Mylne et al. 2025 Use of Ensembles: https://doi.org/10.1175/BAMS-D-24-0183.1
- Suri, Keates and Sidaway 2025 Storm Éowyn: https://doi.org/10.1002/wea.7725
- Keates and Suri 2024 Storm Ciarán: https://doi.org/10.1002/wea.7634
- Harrison et al. 2022 Volcanic Ash and British Airspace: https://doi.org/10.1175/WAF-D-22-0023.1
- Manning et al. 2022 Sting Jets: https://doi.org/10.1007/s00382-021-06011-4
- Gray et al. 2021 Sting Jets: https://doi.org/10.1002/wea.3889

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