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Improving the blend of multiple weather forecast sources by Reliability Calibration

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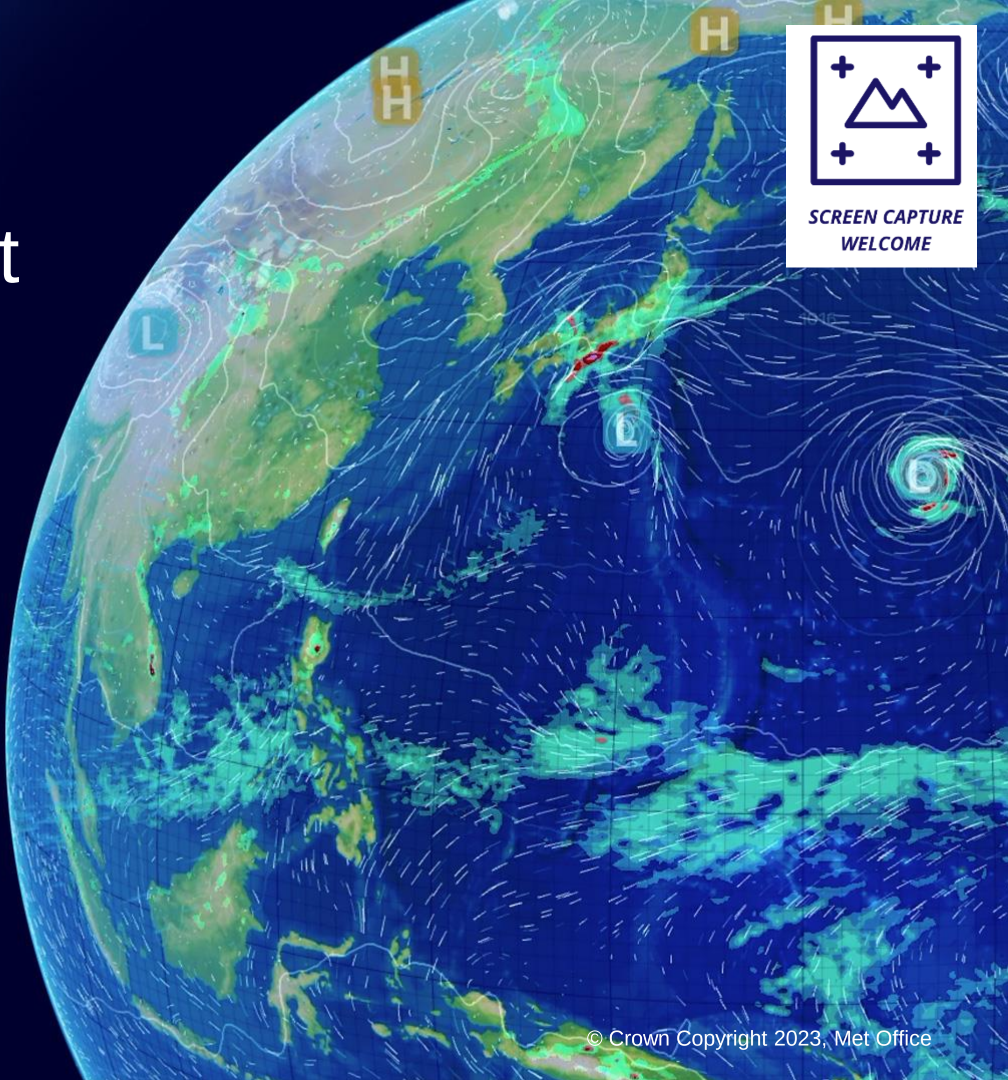
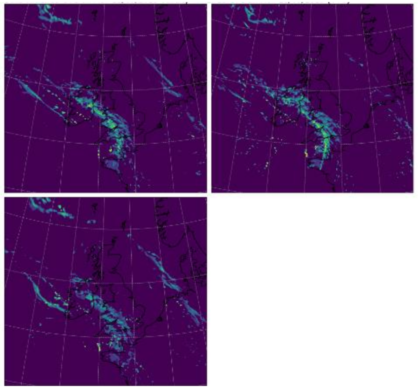
Tuesday 5th September

European Meteorological Society Conference 2023, Bratislava

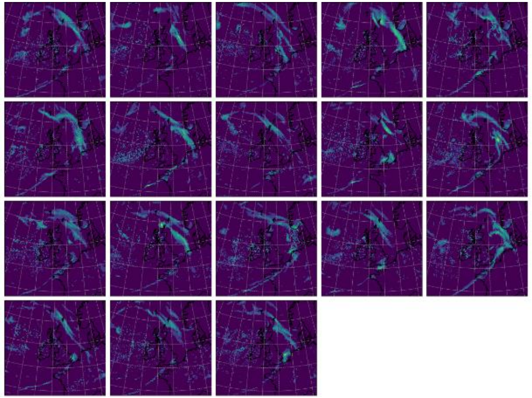


SCREEN CAPTURE WELCOME

Met Office ensemble models



MOGREPS-UK
Out to 5 days
Available every hour
3 members



MOGREPS-G
Out to 8 days
Available every 6 hours
18 members

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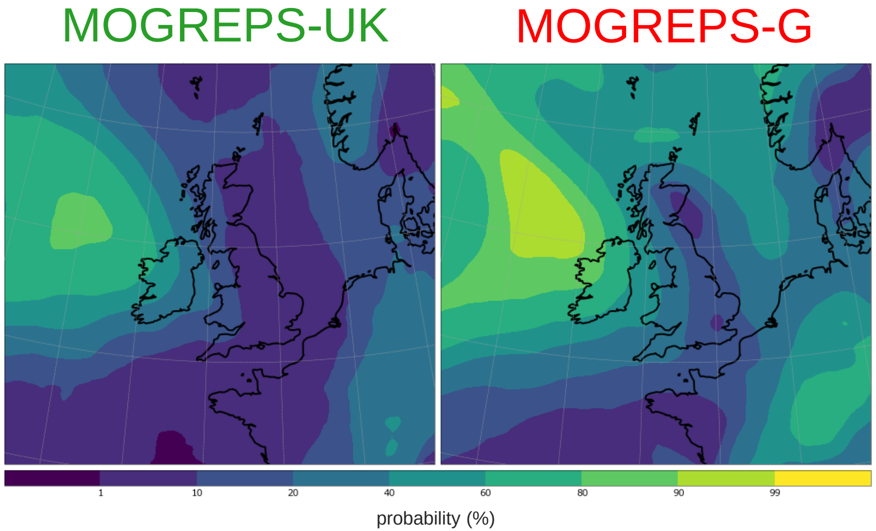
Create a seamless probabilistic forecast

High resolution, convective-scale models (MOGREPS-UK) resolve meteorological processes that are parametrized in lower resolution models (MOGREPS-G).

Transitions between models can introduce jumps and inconsistencies.



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How to improve the blend?

Calibrate MOGREPS-UK and MOGREPS-G using a common truth (high resolution deterministic model analysis - UKV).

Constraints:

- Use a rolling training period to fit within existing IMPROVER infrastructure. A large archive of the inputs to calibration is not available.
- We perform probabilistic blending and therefore it is more difficult to implement a method acting on ensemble members e.g. quantile mapping.
- Want to apply to a range of diagnostics.

Strategy

- Implement reliability calibration (Flowerdew 2014).

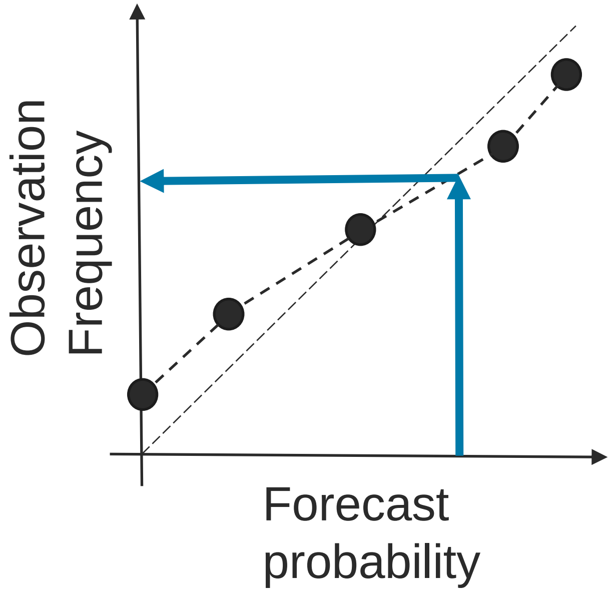
Flowerdew, J. (2014). Calibrating ensemble reliability whilst preserving spatial structure. *Tellus, Series A: Dynamic Meteorology and Oceanography*, *66*(1). https://doi.org/10.3402/tellusa.v66.22662

What is Reliability Calibration?

Build a reliability diagram for each threshold based on training data.

Calibrate today's probabilistic forecast using the reliability diagram.

Corrects each threshold separately.



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This study

- 30-day training period for total cloud cover and precipitation rate.
- Reliability tables aggregated over all grid points. Separate calibration for each cycletime and leadtime.
- Extend handling of edge cases relative to Flowerdew (2014) following assessing reliability diagrams from training period.

Rust, F. M., Evans, G. R., & Ayliffe, B. A. (2023). Improving the blend of multiple weather forecast sources by Reliability Calibration. Meteorological Applications, 30(4), e2142. https://doi.org/10.1002/met.2142

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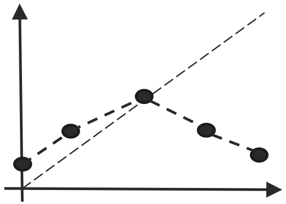
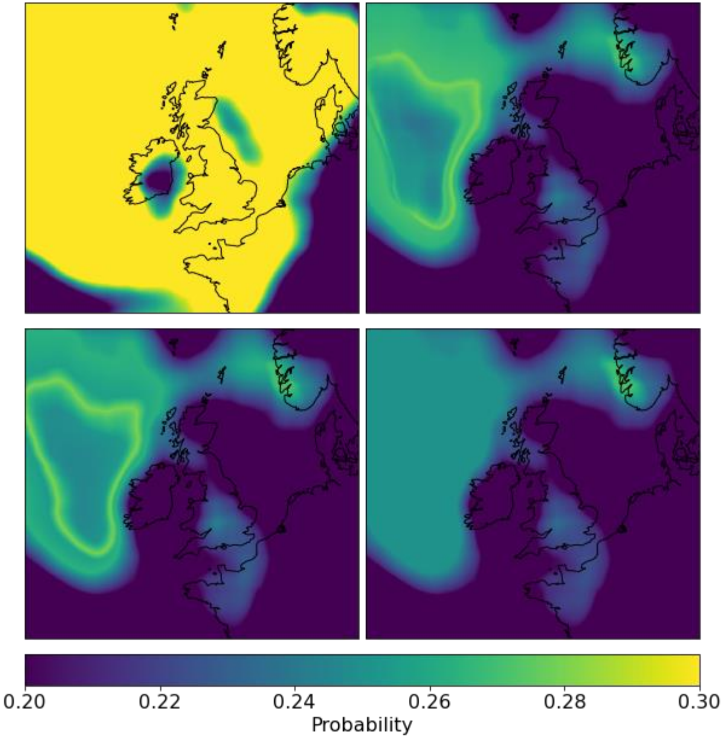
Adaptions to Reliability Calibration



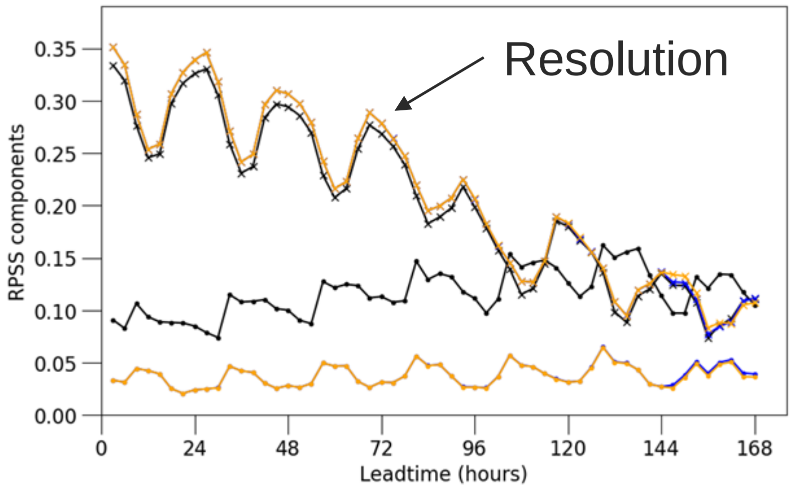


- Original reliability diagram could result in unrealistic lower probabilities in central region.
- Instead we combine bins with:
  - very low sample counts
  - that have non-monotonic observation frequency.
- Enforce monotonicity to avoid edge cases where combining bins is not sufficient.

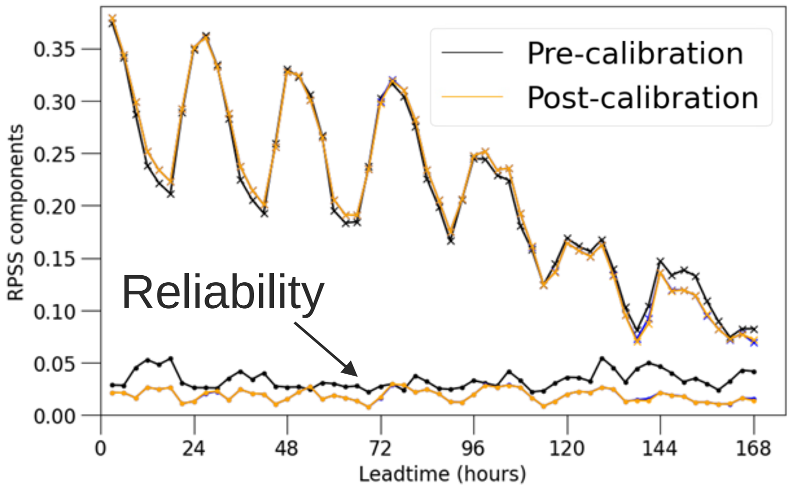
Precipitation rate > 0.03 mm/hr

Ranked Probability Skill Score components – total cloud cover

February, March



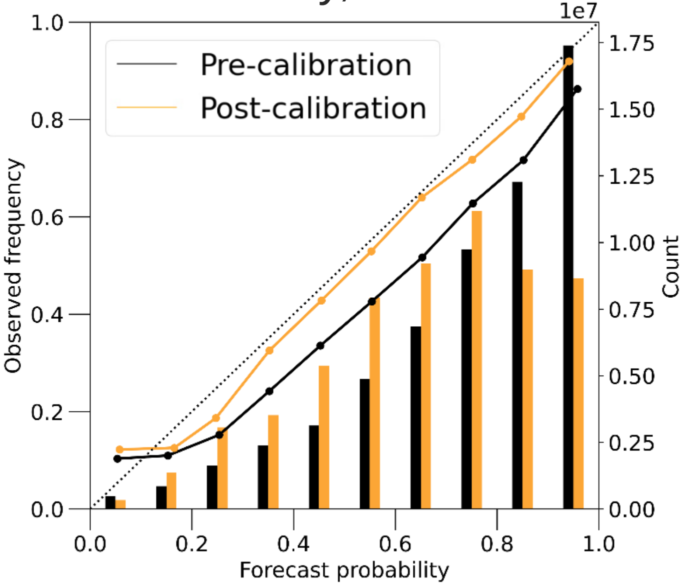
June, July



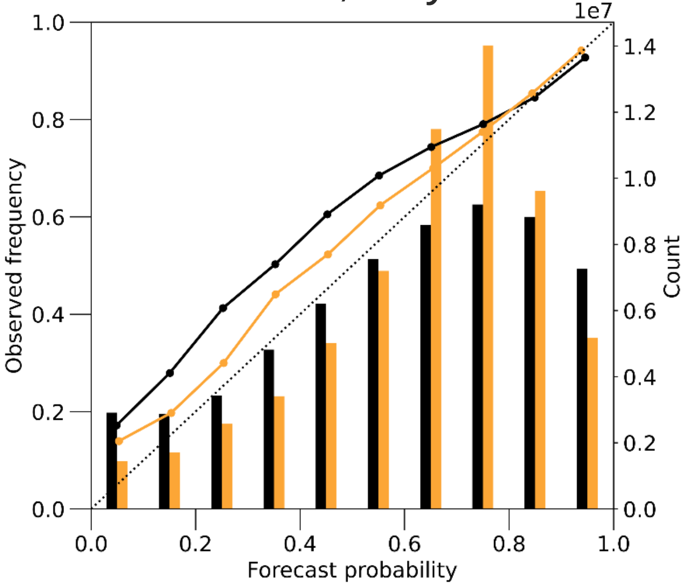
The large reliability penalty term is reduced in February, March.
There is a smaller reduction in June, July.

Verification reliability diagram – total cloud cover

February, March



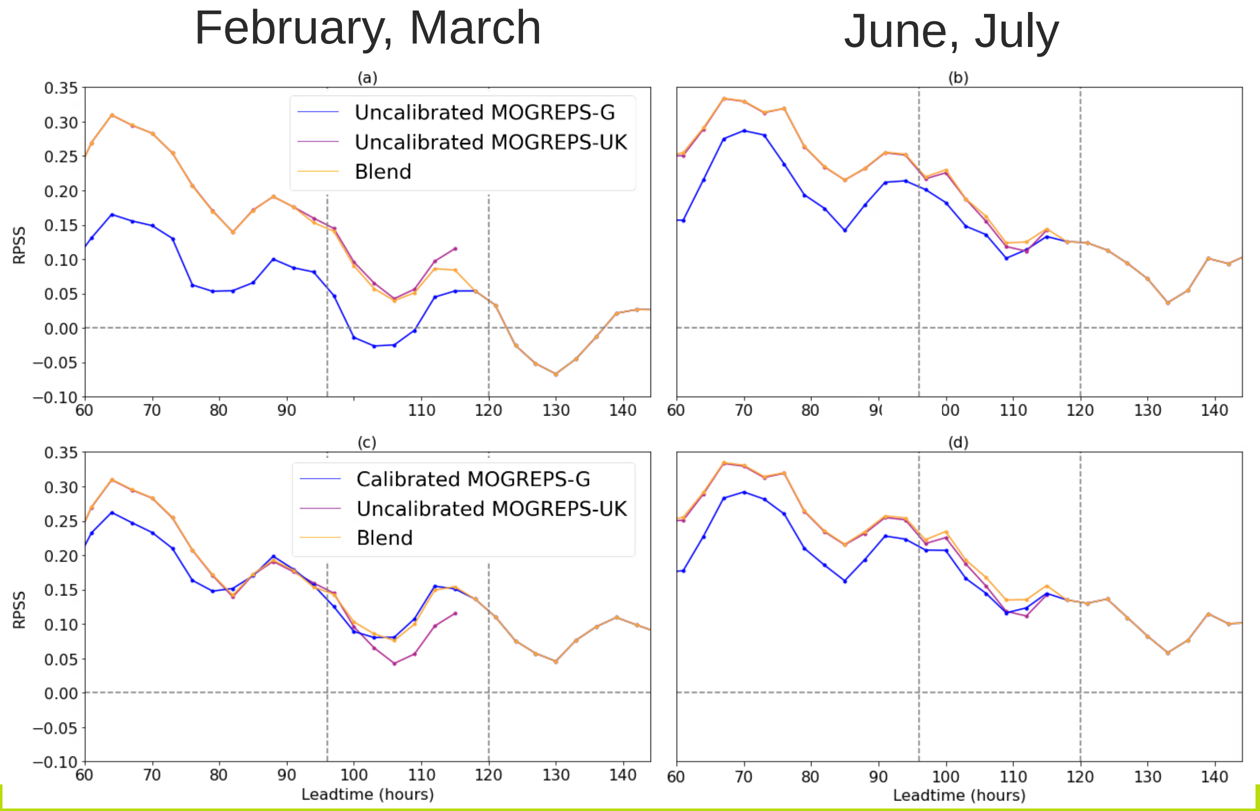
June, July



Reliability improved following calibration

Ranked Probability Skill Score of blended forecasts – total cloud cover

- Improvement in RPSS for MOGREPS-G
- Improvement in RPSS across blending window



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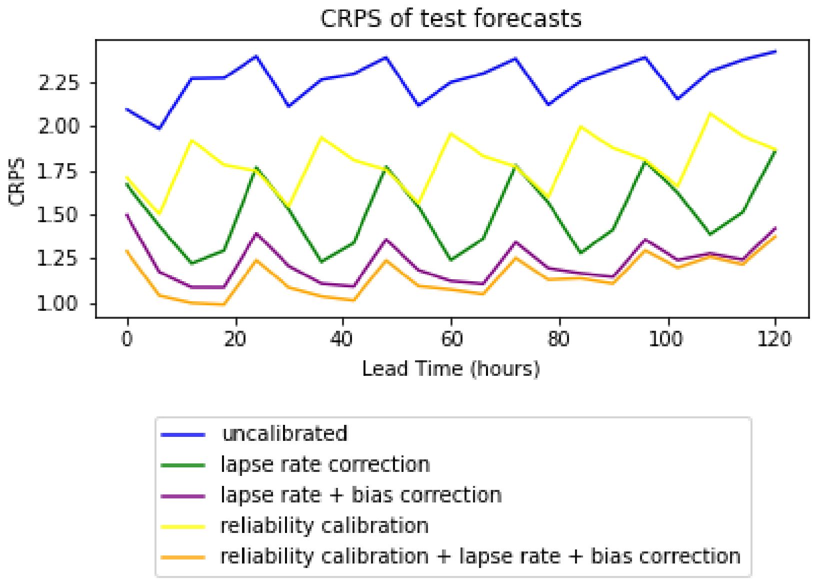
Applying reliability calibration to temperature

- Part of [Demaeyer et al., 2023]
- Reliability Calibration particularly suited to diagnostics with more complex distributions, so not typically used for temperature.
- Reliability Calibration used in conjunction with other complementary steps.
  - Lapse rate correction
  - Deterministic bias correction
  - Reliability Calibration
- Competitive with other approaches



Summary

- Reliability calibration has been applied to total cloud cover, precipitation rate and temperature forecasts.
- The configuration from Flowerdew, 2014 has been amended to operational implementation and to avoid artefacts. Details in Rust et al., 2023.
- The reliability calibration is producing more reliable forecast for thresholds that were previously over-forecast.
- The impact of reliability calibration is clear on a case study of the blended forecast.
- Code available in https://github.com/metoppv/improver.

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Future work

Improvements to usage:

- Training dataset length.
- Choice of truth – currently using UKV analysis.
- Apply to other variables.
- Calibrate convective and dynamic precipitation rate separately.
- Compare with other techniques.

Improvements to algorithm:

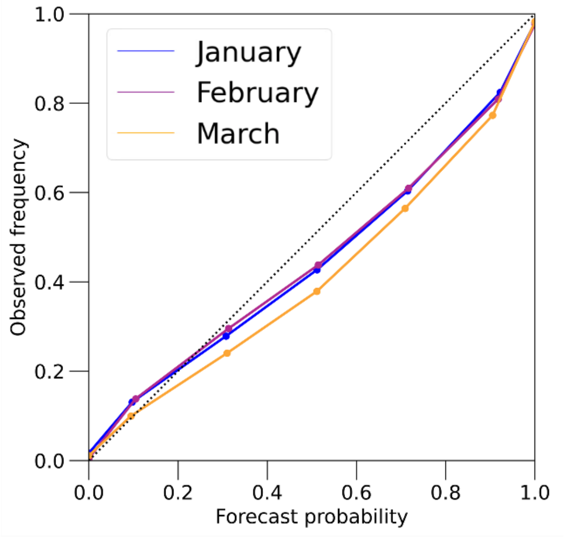
- Local correction i.e. use a reliability diagram per grid point.
- Impact on extremes – do we need explicit extreme handling?
- Transitions from dry training dataset to wet forecast. How will this be handled?

Thank you

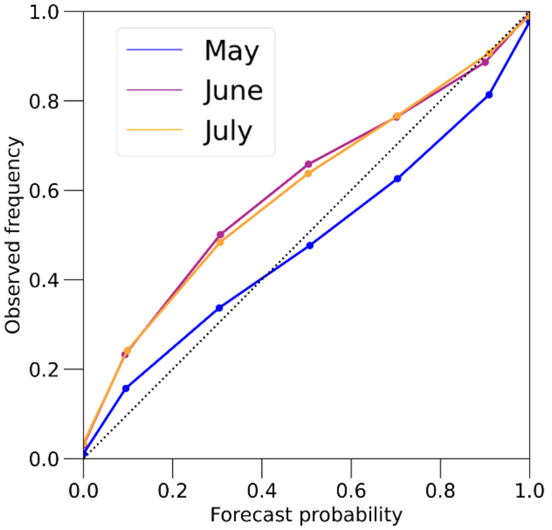
Email: gavin.evans@metoffice.gov.uk

Reliability diagram from training dataset – total cloud cover

January, February, March



May, June, July



Clear over-forecasting signal in Jan/Feb/Mar.

Over-forecasting in May transitions to under-forecasting in June and July.