Met Office

IMPROVER: A probabilistic, multi-model post-processing system for meteorological forecasts

EGU
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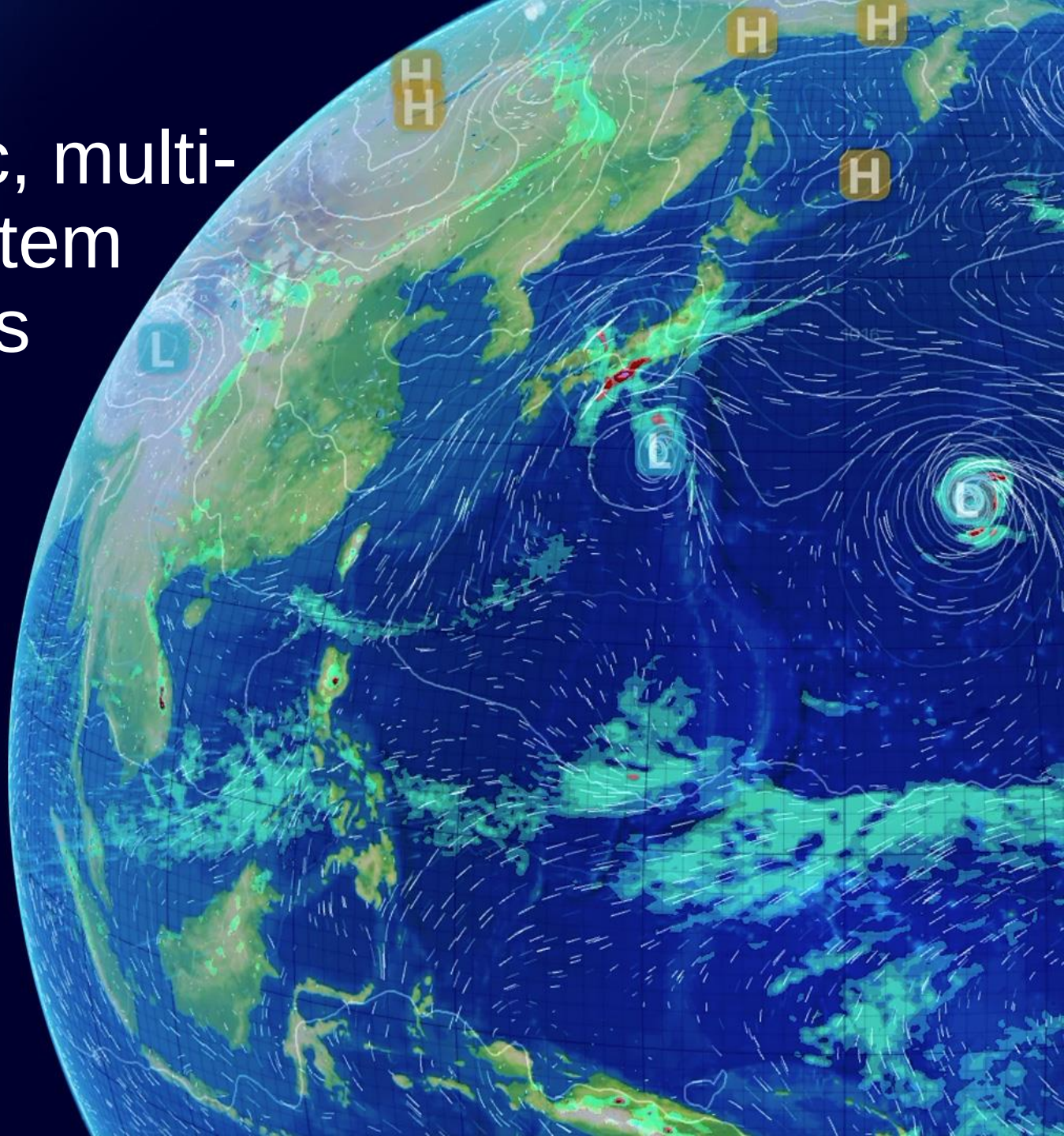


Met Office

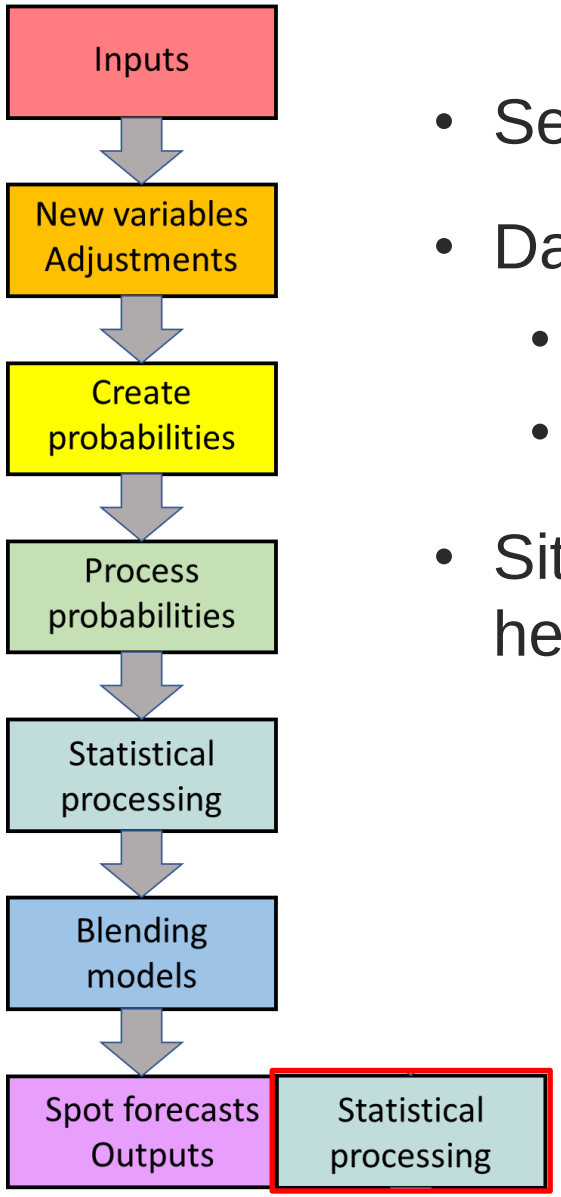
Contents

Integrated **M**odel Post **Pro**cessing & **Ver**ification

Vision

Provide the Met Office organisation with a single source of blended, probabilistic forecast information for the UK and globe out to 14 days ahead.

Post-processing chains



- Separate processing chains for each variable
- Data processed on standard grids:
  - UK = 2km
  - Global ~ 20 km
- Site-specific forecasts extracted as a final step helping to ensure consistency.

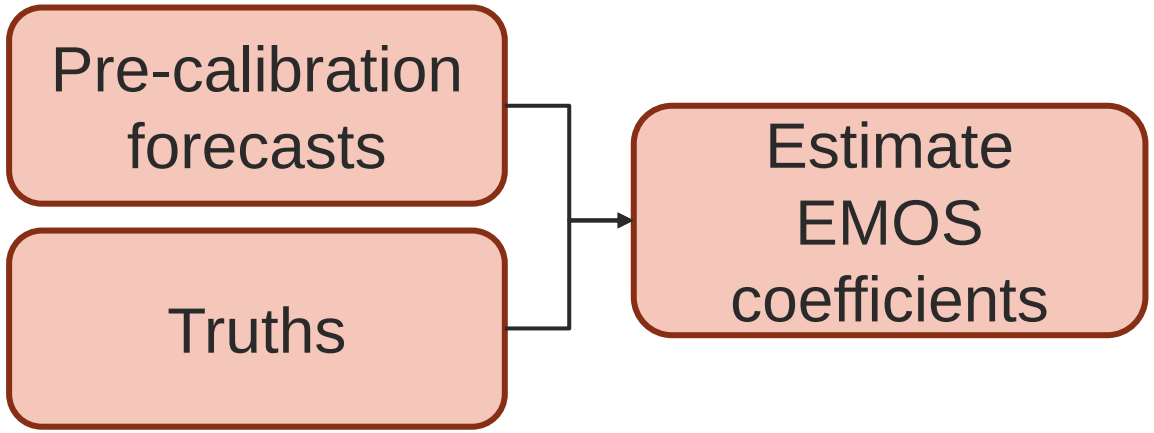
Site Calibration – Aim

Enhance the performance of IMPROVER site forecasts for comparison with BestData for

- screen temperature
- daytime max temperature
- night-time min temperature
- 10m wind speed

Constraints:

Prefer techniques that calibrate all sites, rather than as our current public forecast does: just sites with observations which can lead to large differences between neighbouring sites.



Effect of optimising the distribution

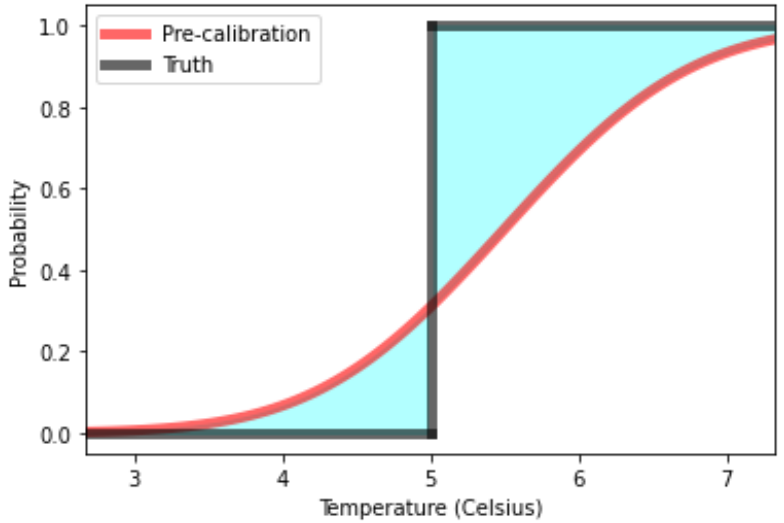
Using a chosen distribution (e.g. normal), EMOS aims to optimise the distribution to better match the truth.

$$N(a + b\bar{X}, c + dS^2)$$

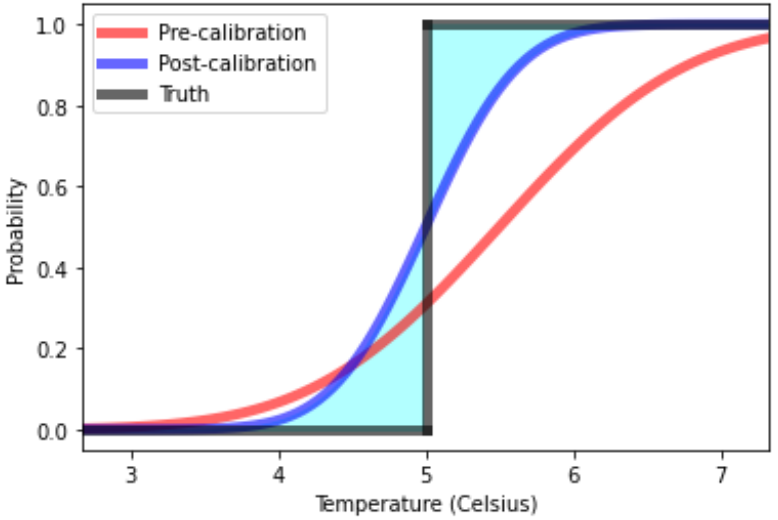
N – distribution
$\bar{X}$ – ensemble mean
S^2 - ensemble variance
a, b, c, d - coefficients

The a, b, c and d coefficients act to optimise the distribution using a scoring rule. In IMPROVER, the Continuous Ranked Probability Score (CRPS) is optimised. This reduces the area between the forecast CDF and the truth.

Pre-calibration



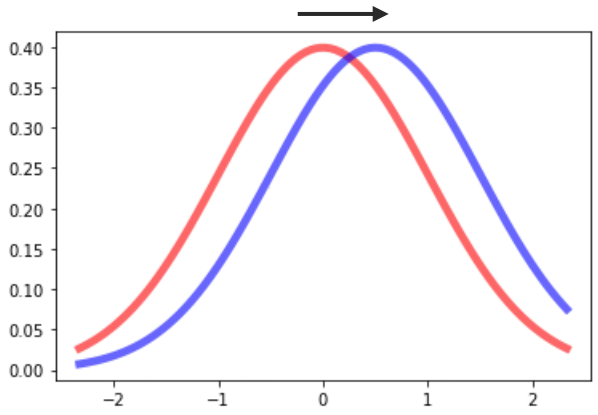
Post-calibration



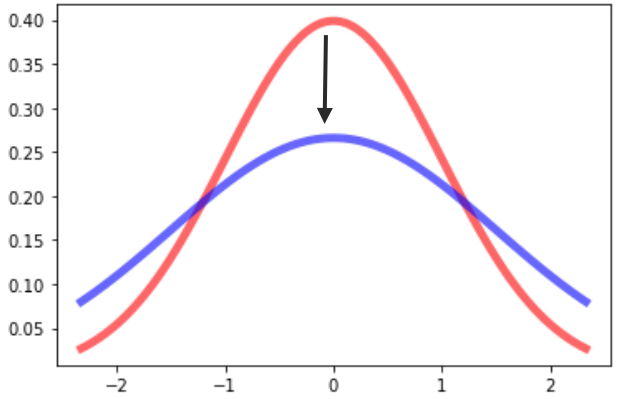
How to optimise the distribution?

A normal distribution is defined in terms of a location parameter, μ, and a scale parameter, σ^2.

Change location parameter



Change scale parameter



$$\mu = a + b\bar{X}$$

$$\sigma^2 = c + dS^2$$

$$N(a + b\bar{X}, c + dS^2)$$

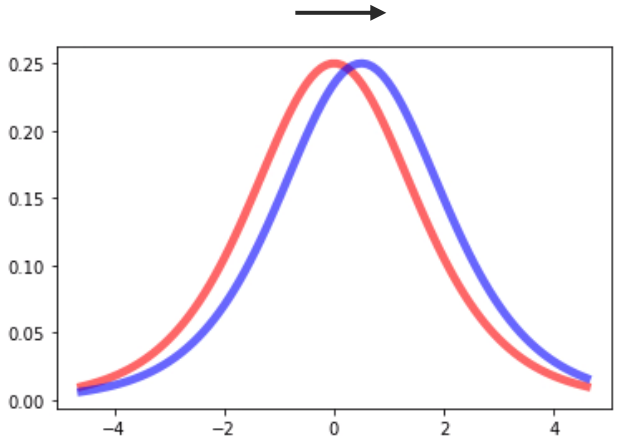
The EMOS coefficients therefore indicate how to modify the forecast in order to optimise the distribution.

Experiment details – Skew logistic distribution

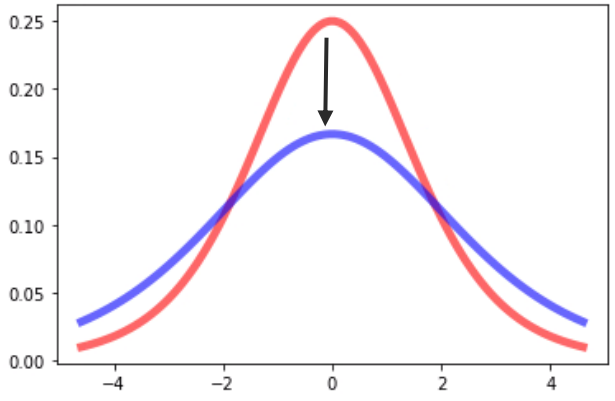
Some distributions can provide more flexibility than the normal distribution and provide a better “fit” to the forecasts. These are defined in terms of a location parameter, a scale parameter and a shape parameter (λ_s).

$$N(a + b\bar{X}, c + dS^2, \lambda_s)$$

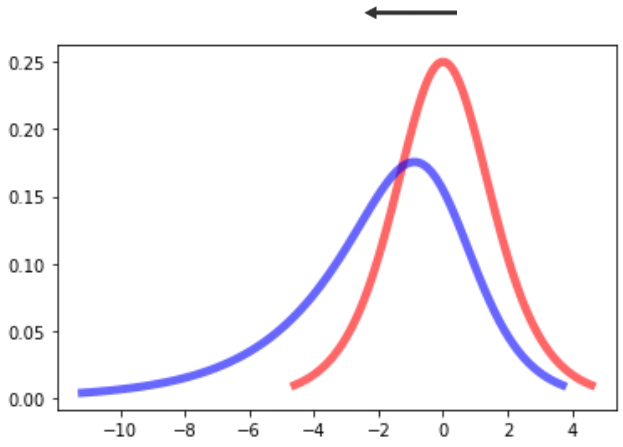
Change location parameter



Change scale parameter



Change shape parameter



Experiment details – additional predictors

EMOS can be extended to include additional predictors within the construction of a forecast distribution with the aim of minimising the CRPS.

$$N(a + b_1\overline{X_1} + \boldsymbol{b_2 X_2}, c + dS^2)$$

e.g. X_2 is an additional predictor.

Options investigated for additional predictors:

Temperature

Static predictors

- Altitude of the site
- Altitude difference between the site and the nearest model grid point
- Latitude
- Longitude

Dynamic predictors

- Wind speed

Wind speed

Static predictors

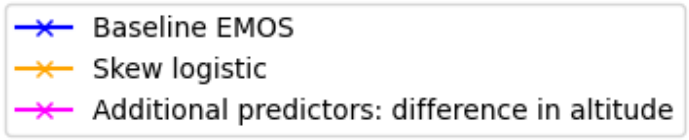
- Altitude difference between the site and the nearest model grid point
- Standard deviation of orography
- Vegetative roughness length

Dynamic predictors

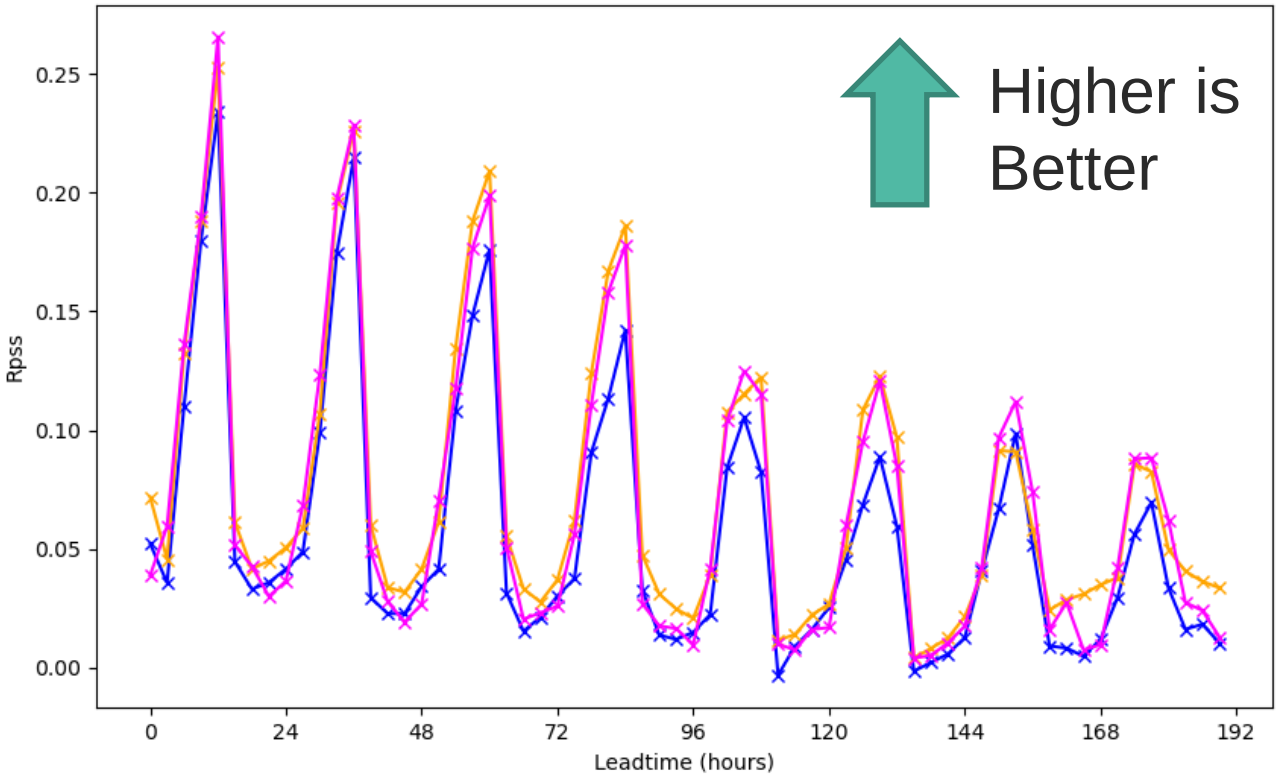
- Screen temperature

Results – EMOS – preferred non-local

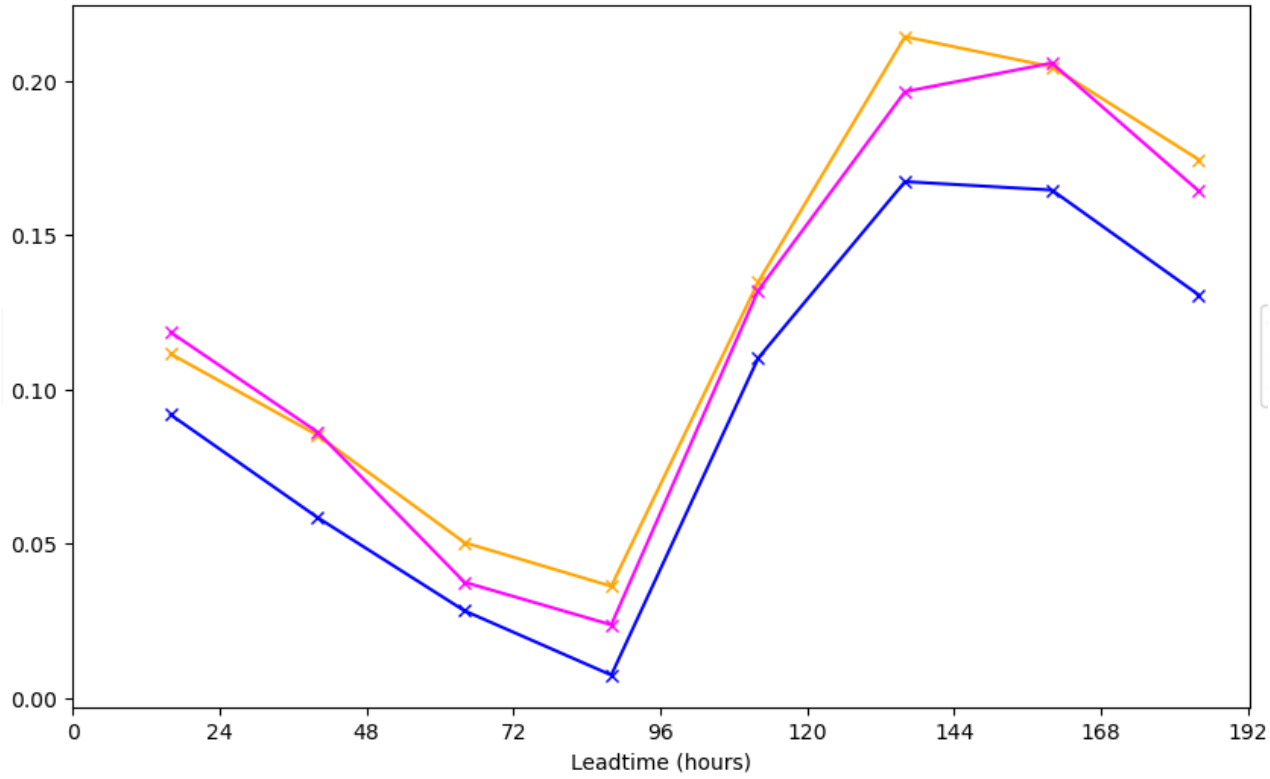
RPSS relative to pre-calibrated data



Screen temperature

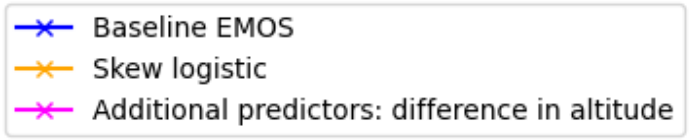


Daytime max temperature

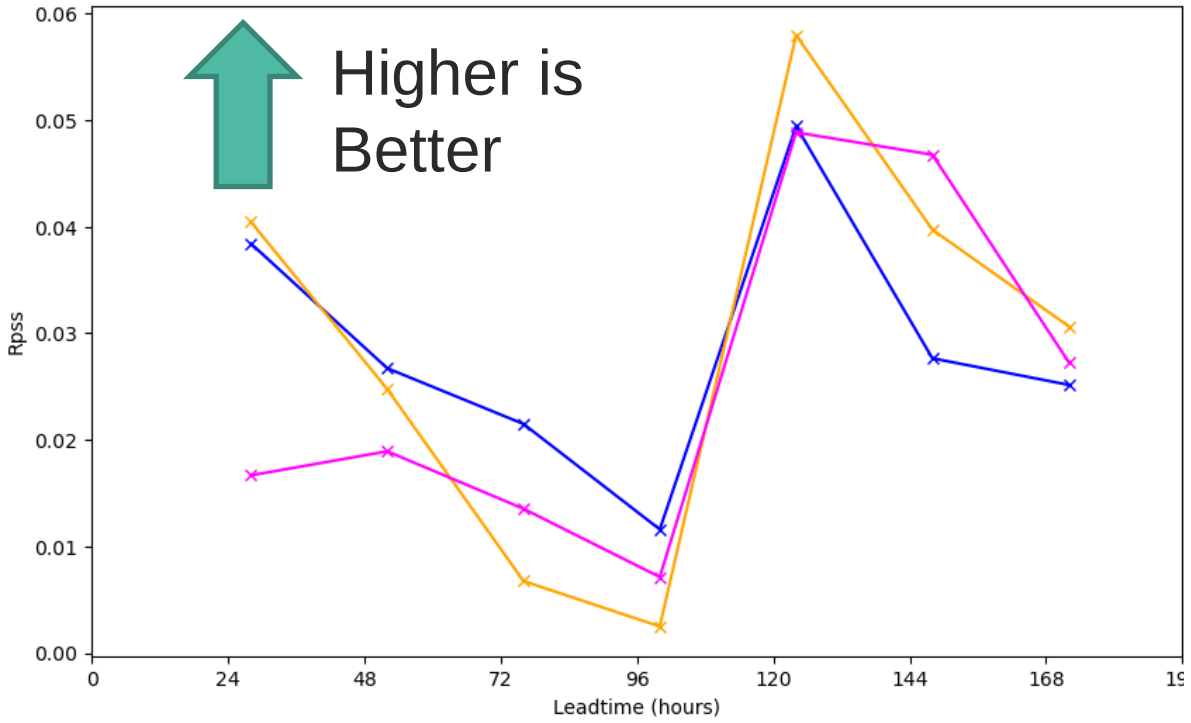


Results – EMOS – preferred non-local

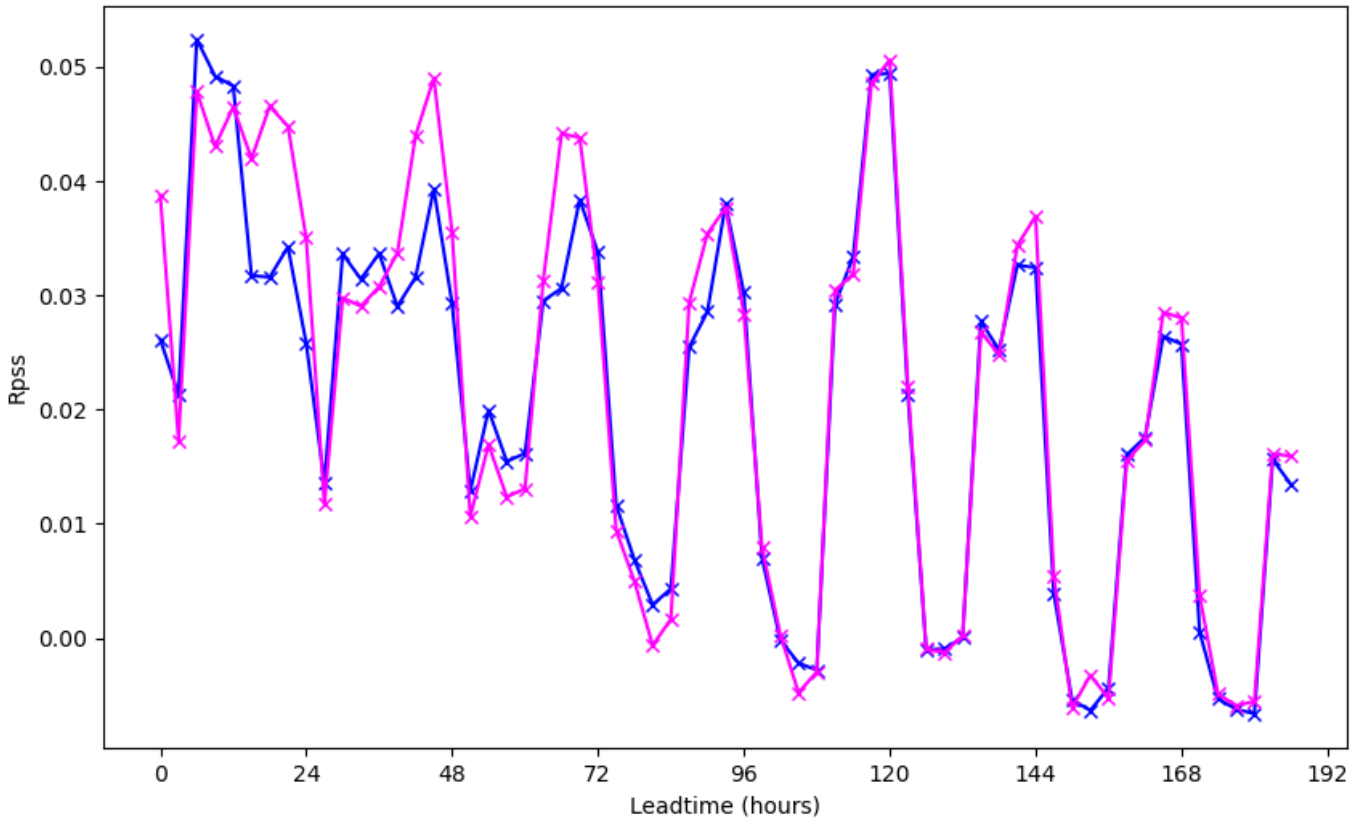
RPSS relative to pre-calibrated data



Night-time min temperature



10m wind speed



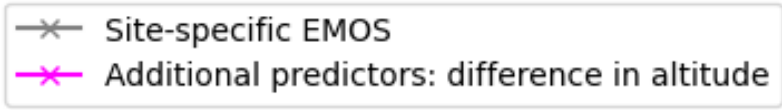
Summary

Configurations implemented:

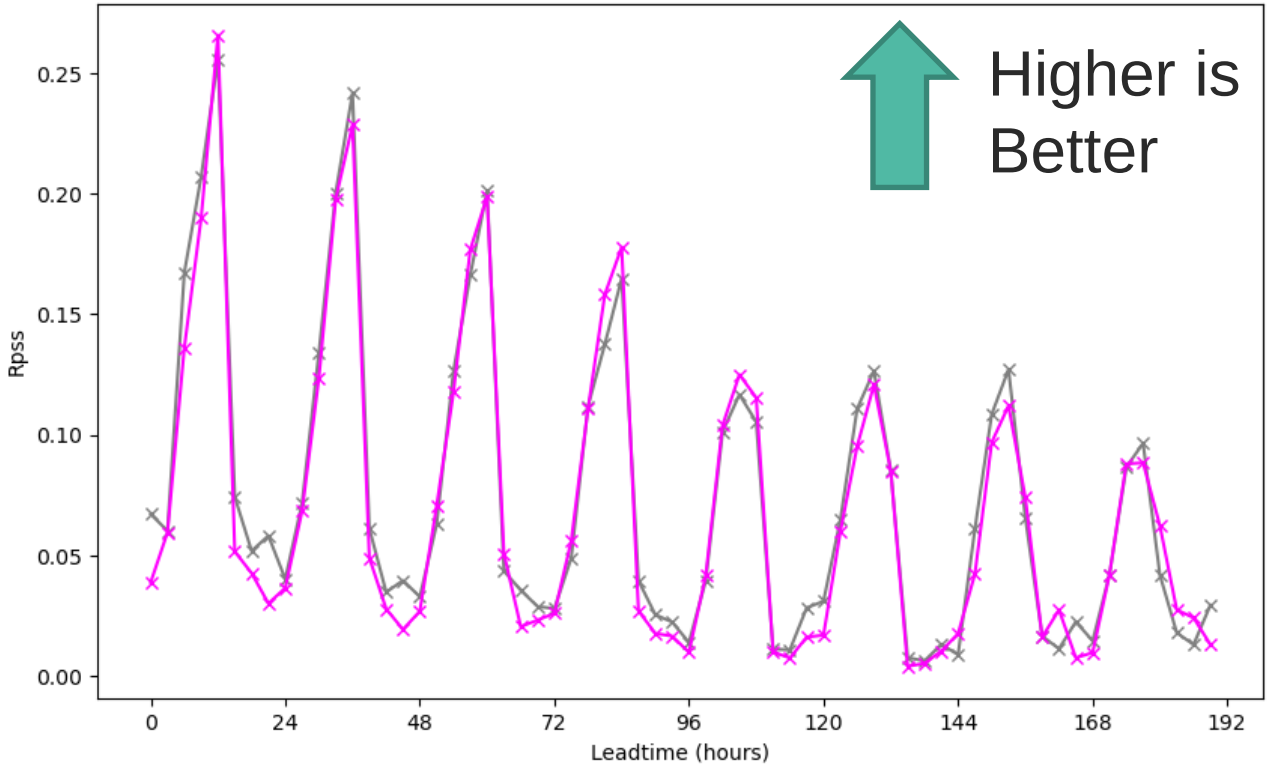
Diagnostic	Configuration
Screen temperature	EMOS with difference in altitude additional predictor
Daytime max temperature	EMOS with difference in altitude additional predictor
Night-time min temperature	EMOS with difference in altitude additional predictor
10m wind speed	EMOS

Results – EMOS – site-specific

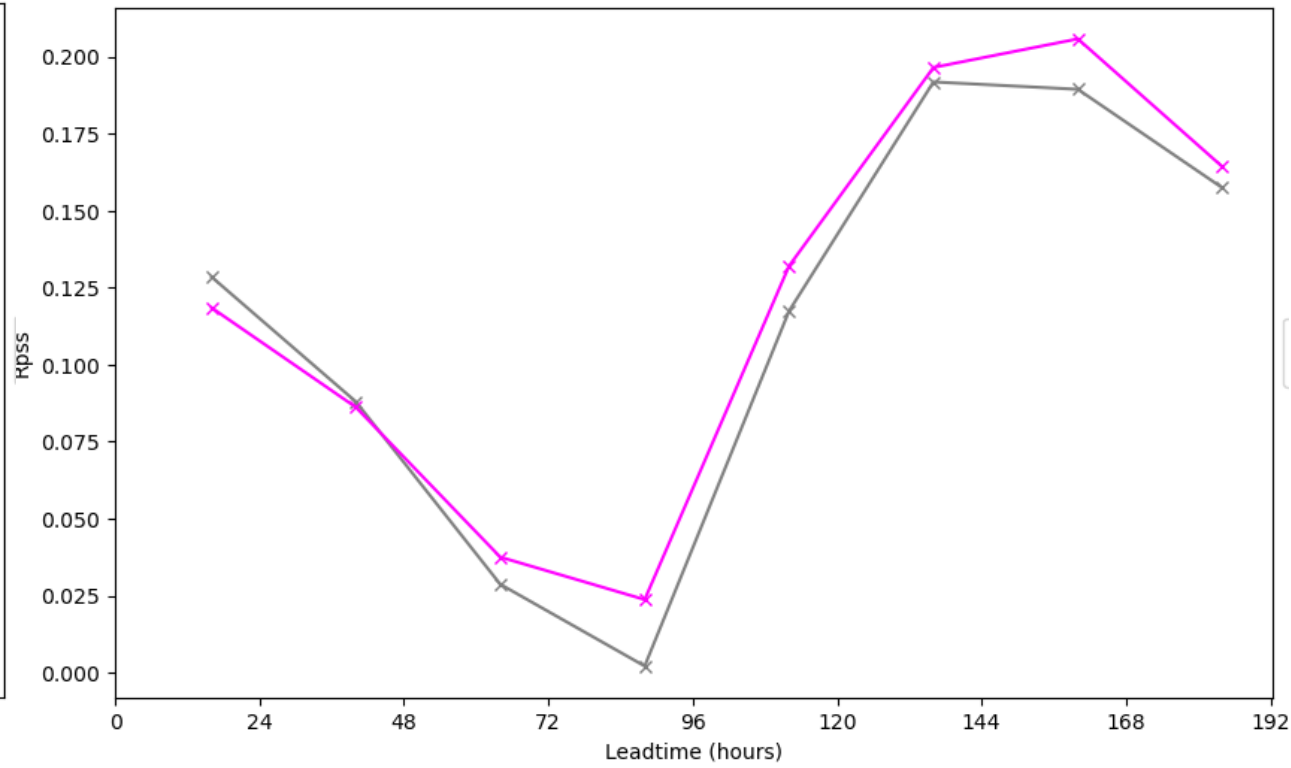
RPSS relative to pre-calibrated data



Screen temperature

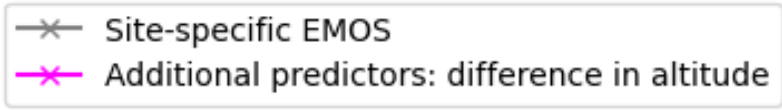


Daytime max temperature

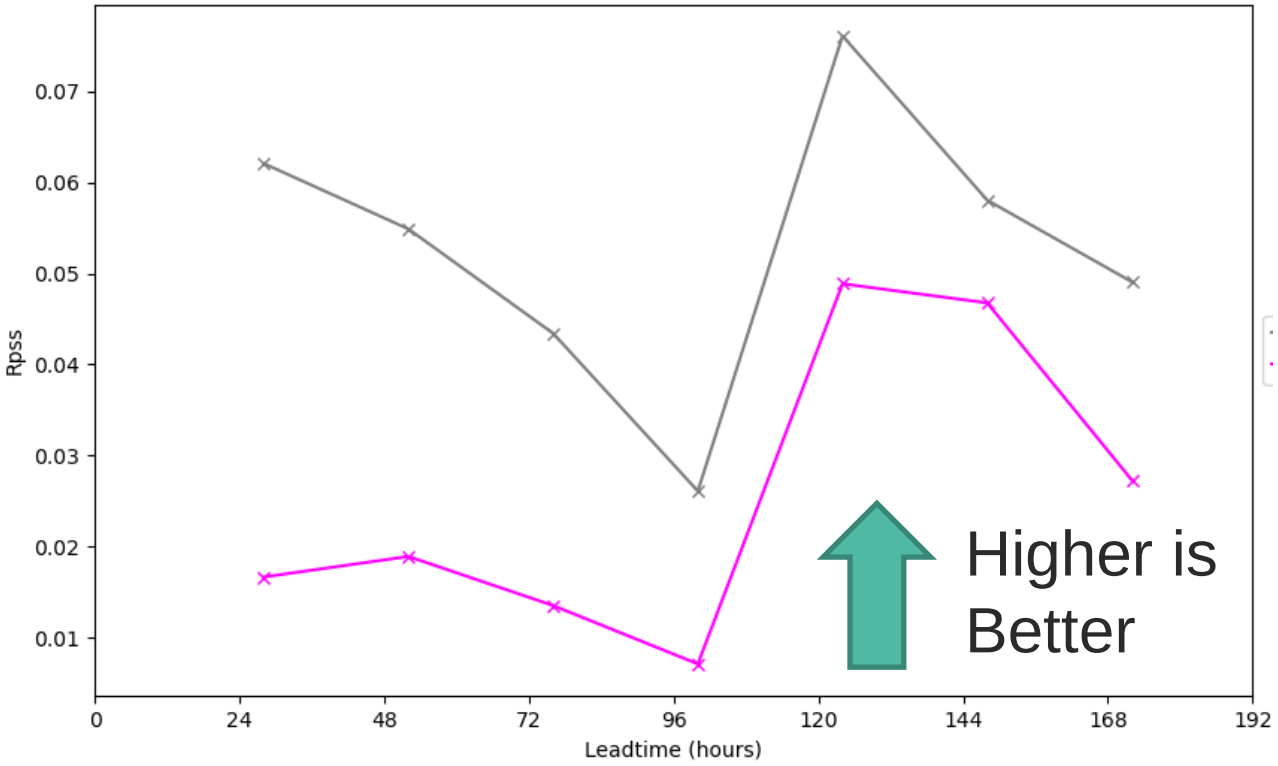


Results – EMOS – site-specific

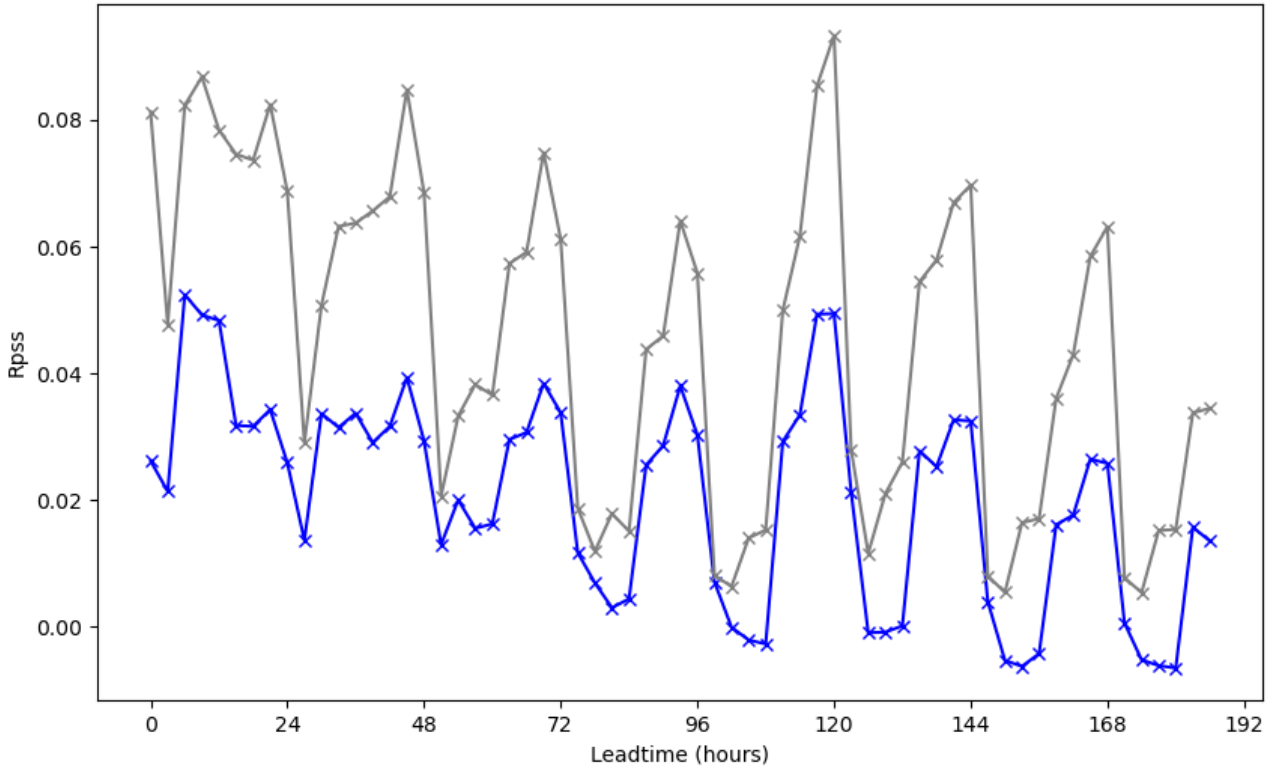
RPSS relative to pre-calibrated data



Night-time min temperature



10m wind speed



Summary

- IMPROVER needs a calibration method for spot forecasts of temperature and wind speed to get close to the skill of the UK public weather service forecasts.
- EMOS, to minimise CRPS, delivers significant benefit to spot forecasts of daytime temperatures, both those with observations, and those without.
- Local effects in nighttime temperatures and wind speeds require further work.

Future work

- Investigate use of SAMOS (Dabernig et al., 2017) to better calibrate sites without observations.
- Experiment with data denial experiments (i.e. excluding some sites with observations from the calibration).
- Experiment with other variables.
- Further experiments with Neural Networks – early experiments were not competitive with EMOS (see additional slides)

Additional information

There was no time to present the following two slides at the conference, but they are included here for those who wish to view them.

The Notes accompanying each slide explain how to interpret them.

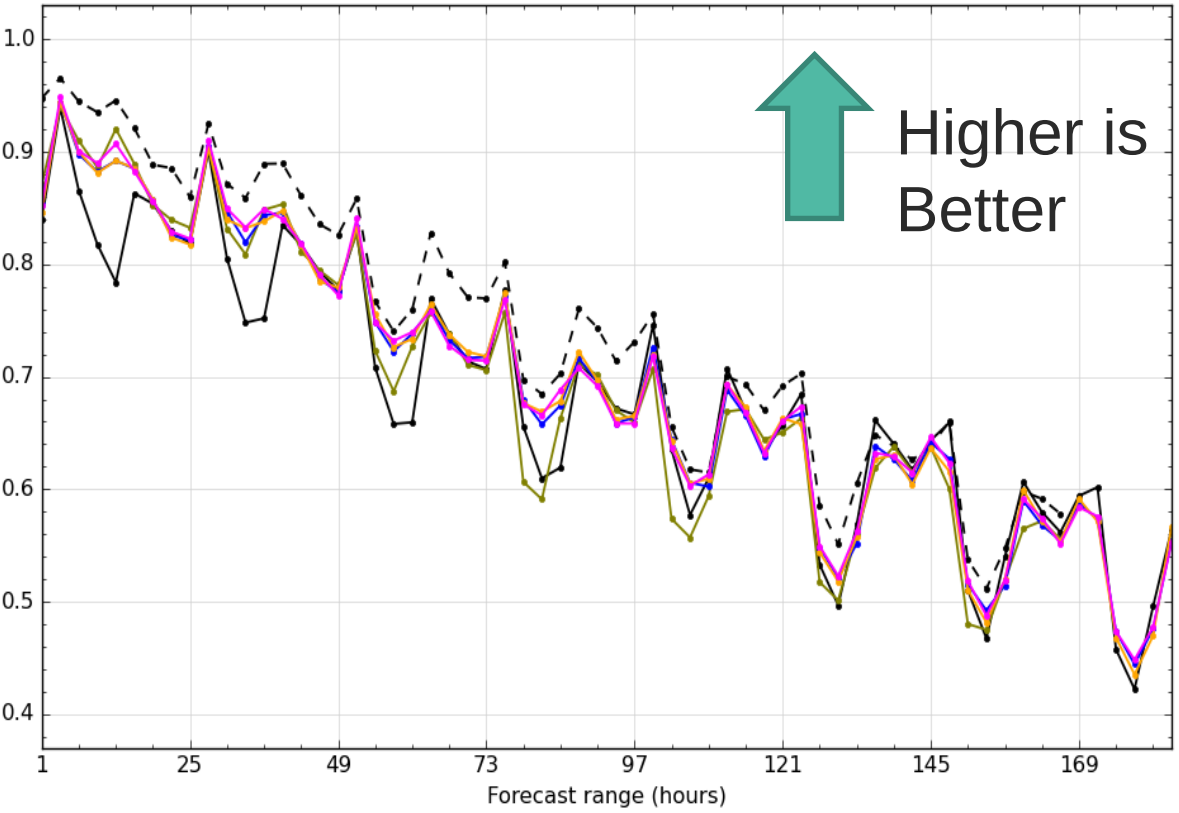
Results – EMOS and Neural Network comparison

Proportion of forecasts within 2K

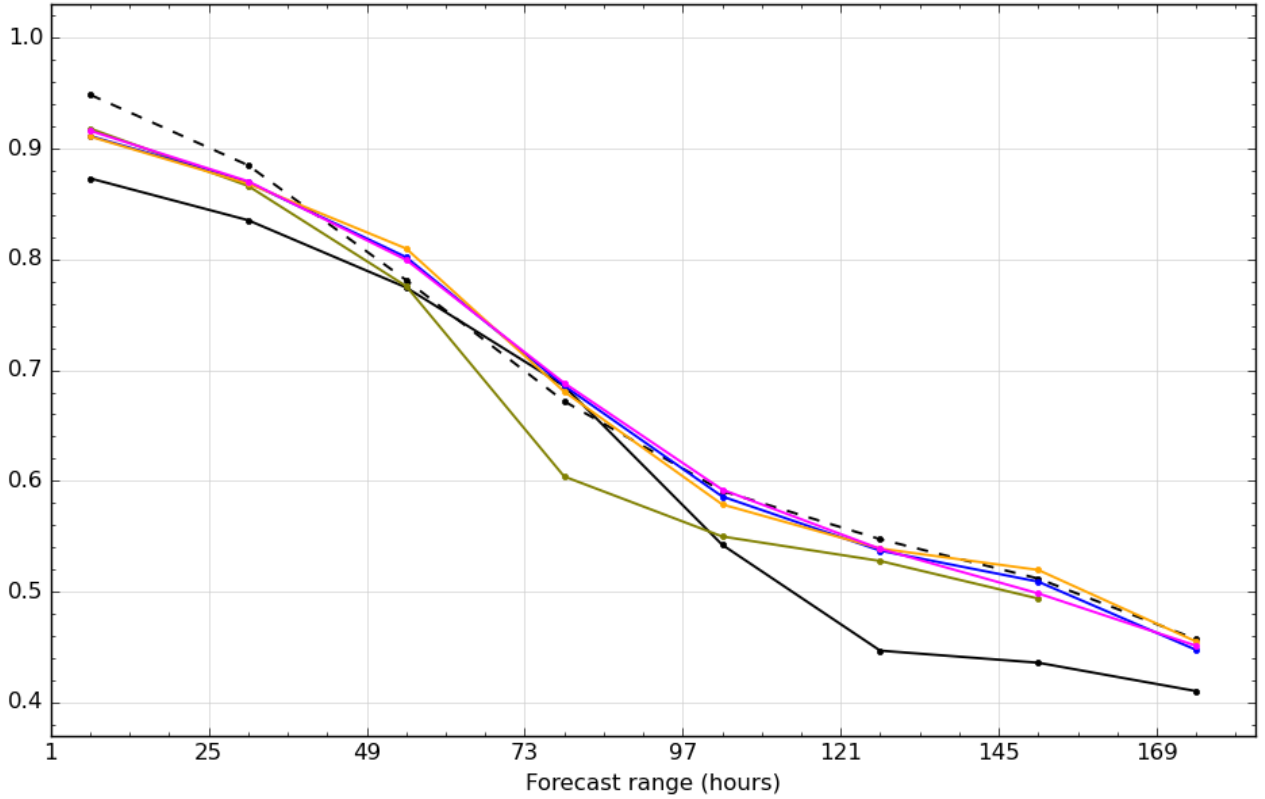
PWS (05Z DT offset by 0 hrs)
Pre-calibration (05Z DT offset by 0 hrs)
Neural Network (05Z DT offset by 0 hrs)
Baseline EMOS (05Z DT offset by 0 hrs)
Skew logistic (05Z DT offset by 0 hrs)
Additional predictors: difference in altitude (05Z DT offset by 0 hrs)

April

Screen temperature



Daytime max temperature



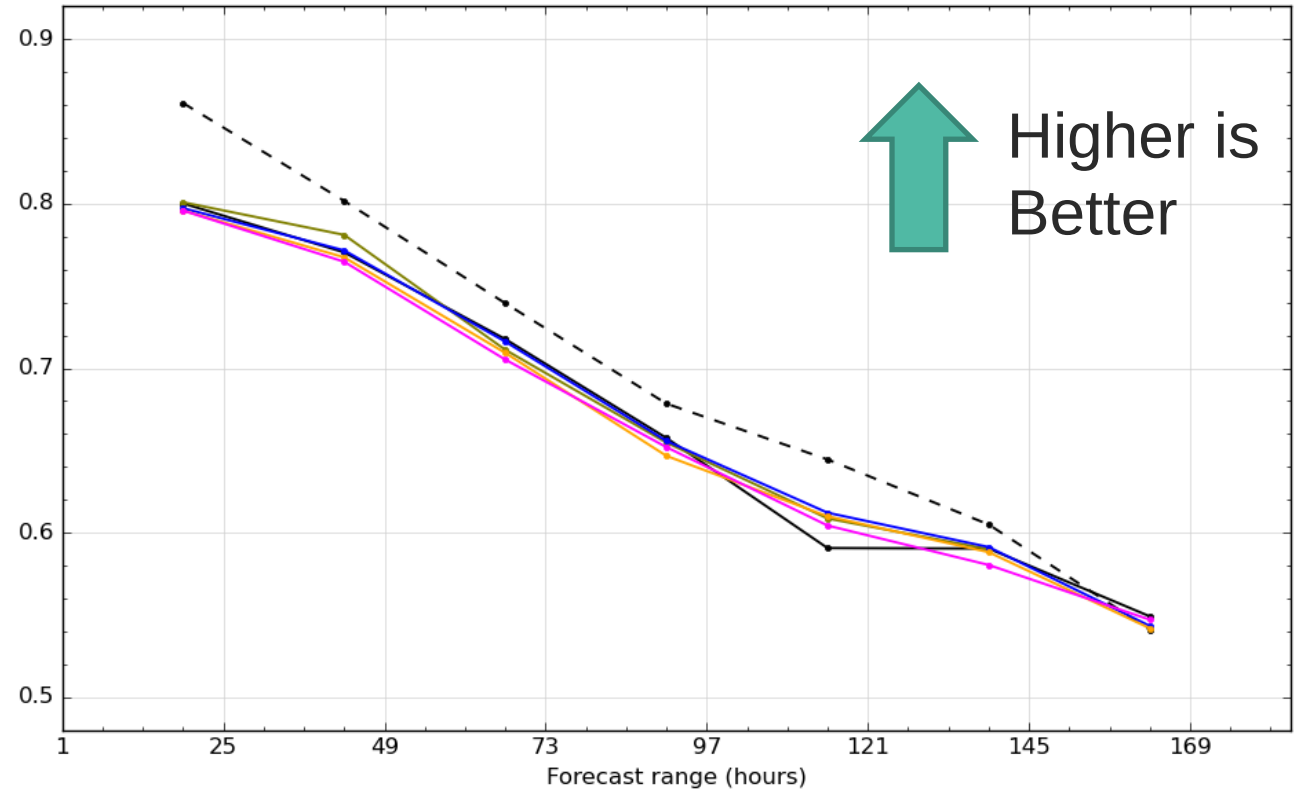
Results – EMOS and Neural Network comparison

Proportion of forecasts within 2K or 5kt

PWS (05Z DT offset by 0 hrs)
Pre-calibration (05Z DT offset by 0 hrs)
Neural Network (05Z DT offset by 0 hrs)
Baseline EMOS (05Z DT offset by 0 hrs)
Skew logistic (05Z DT offset by 0 hrs)
Additional predictors: difference in altitude (05Z DT offset by 0 hrs)

April

Night-time min temperature



10m wind speed