Using crowd-sourced observations to verify post-processed forecasts

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Met Office, UK

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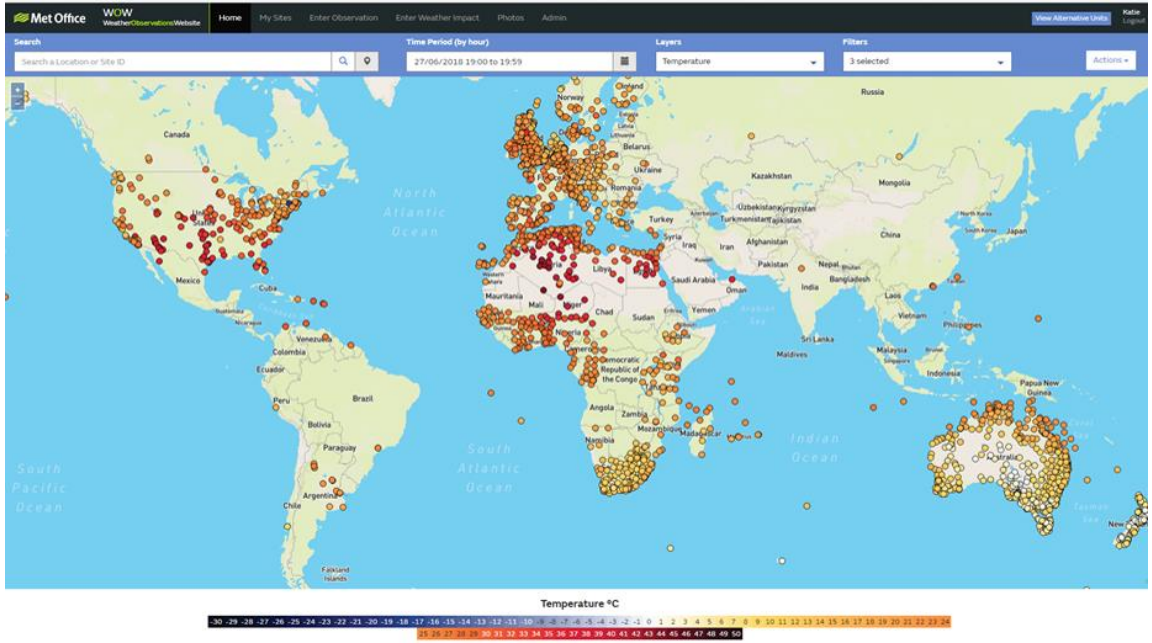
Why use crowd-sourced data?



- Potentially 1000's observations
- Data have been collected over a long period of time
  - WOW: June 2011
  - WUnderground : 1993
  - Weathercloud: 2012
- Data coverage where people live!
- Public engagement

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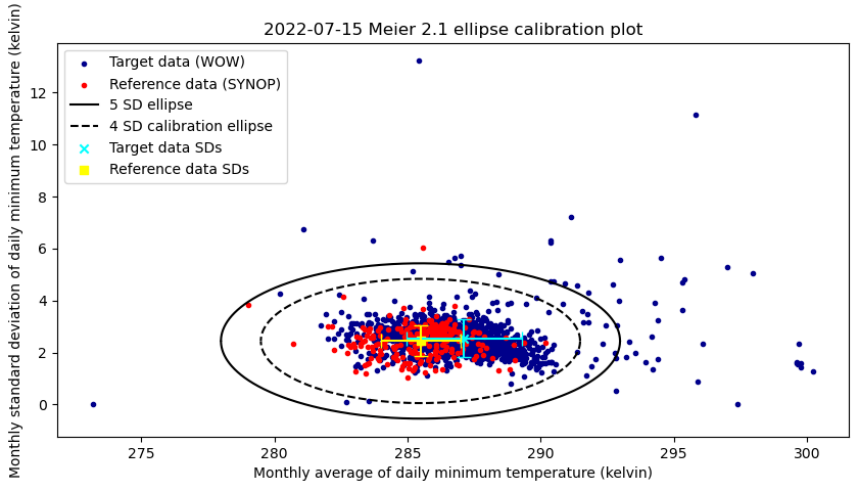
But is it good quality?

But is it good quality?

- It is true that the instrumentation may not be the same quality as those used in the official meteorological network
  - It varies throughout the network!
- The stations may also not be sited in the best locations
  - If you go to the trouble of purchasing a weather station and uploading the data to a crowd-source data centre, then it’s likely not been sited without some thought.
  - Again, this is the weather where people live and are actively experiencing

WOW industrial placement

- Assessed WOW temperature observations for possible use in operational verification.
- Applied simple Quality Control (QC) measures and assessed the impact at different stages
  - Majority of sites passed QC
  - Some outliers remained
  - Short time period studied



An opportunity…

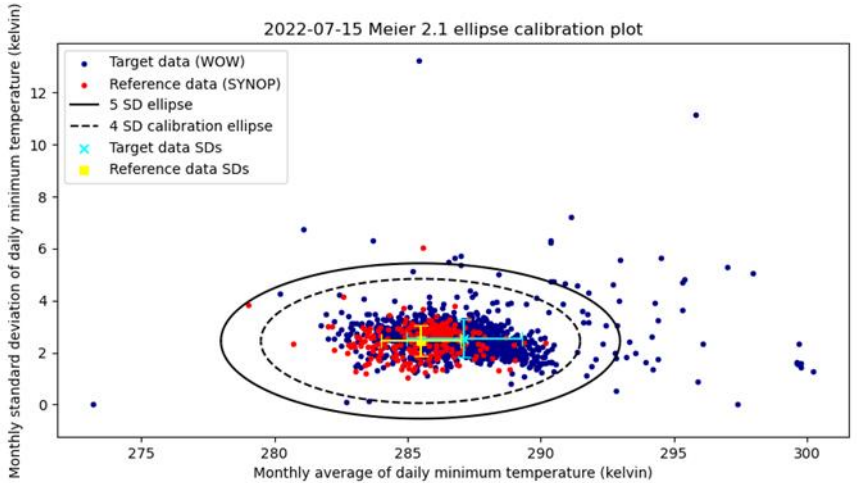
- The Met Office is in the process of replacing our old post-processing system with IMPROVER
- Usually, we would evaluate using a set of PWS sites, but the old system is tuned to these locations.
- We need to find an alternative source of observations…so why not WOW data?

Methodology

1. Extend the QC and run over a 12-month period to produce a static site list
2. Match to the nearest spot forecast location
   - Mimics what you would see on web/app
3. Evaluate forecasts
   - Between January – March 2024
   - Proportion of errors <=2K (POE2), RMSE, MAE, ME
   - T+1 – T+120
   - 1.5m temperature

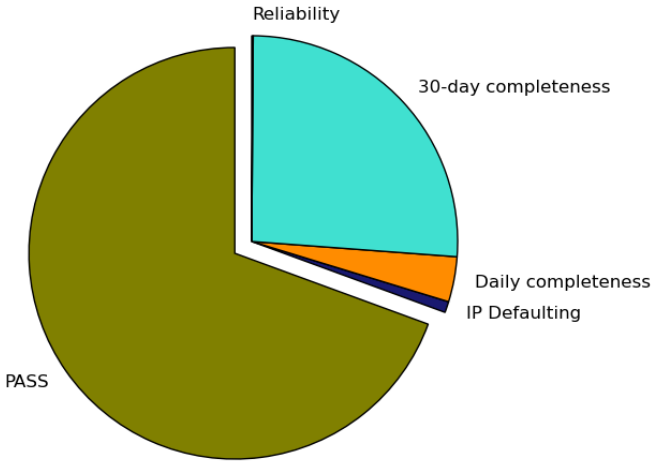
Quality Control

1. **IP defaulting** – Identical locations
2. **Data completeness**
   a) 80% reporting in 24hrs
   b) 80% reporting over rolling 30 days
3. **Data reliability**
   - Fails if the station 30-day mean minimum temperature is larger than 5σ of the average WOW temperature or has σ > 5 times a reference data set.



Meier, F., Fenner, D., Grassmann, T., Otto, M. & Scherer, D. (2017) Crowdsourcing air temperature from citizen weather stations for urban climate research. Urban Climate, 19, 170–191.

Quality control



- 69% of observations passed QC
- Most common cause for rejection is data completeness.
- A site list of 975 stations that consistently passed QC was created.

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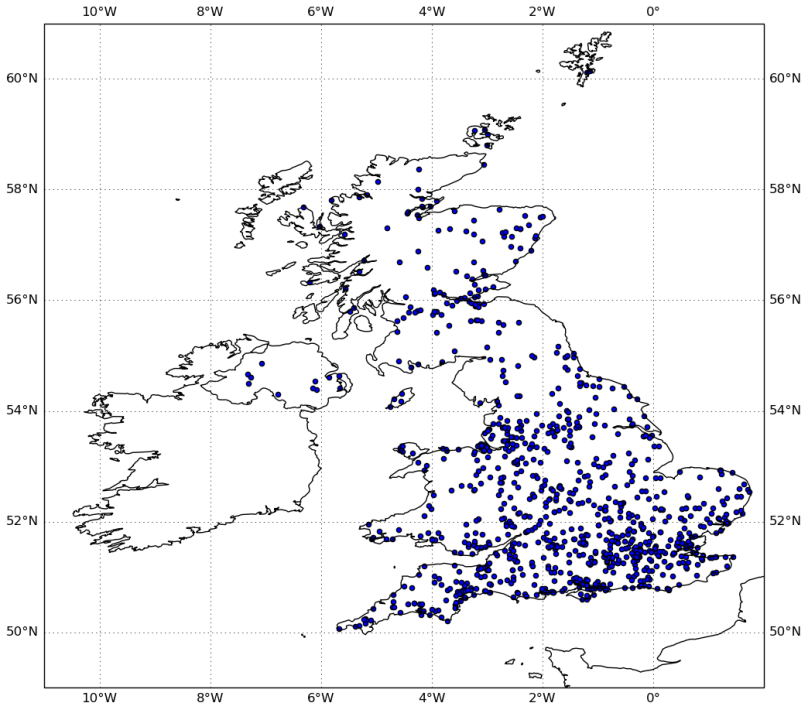
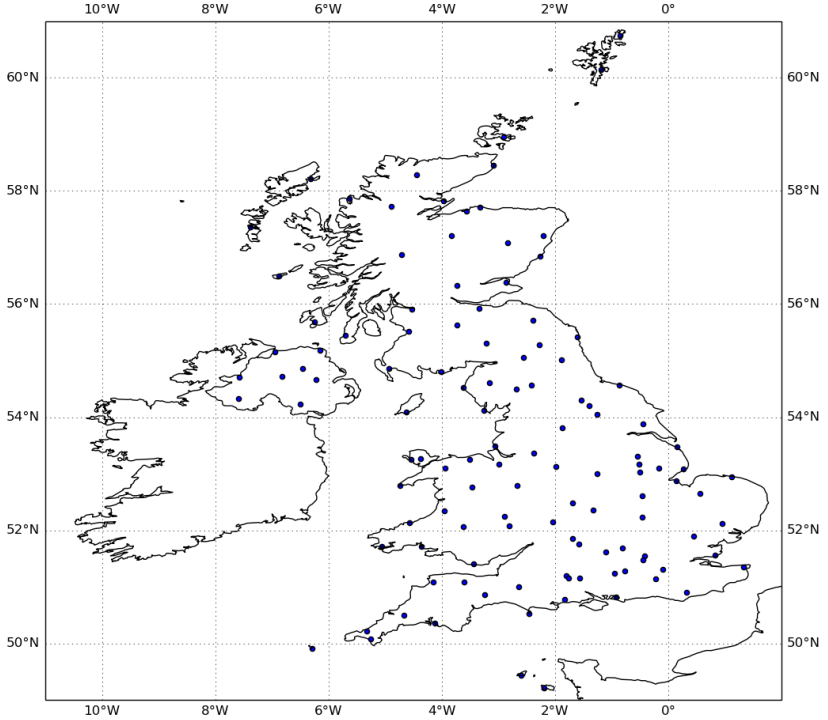
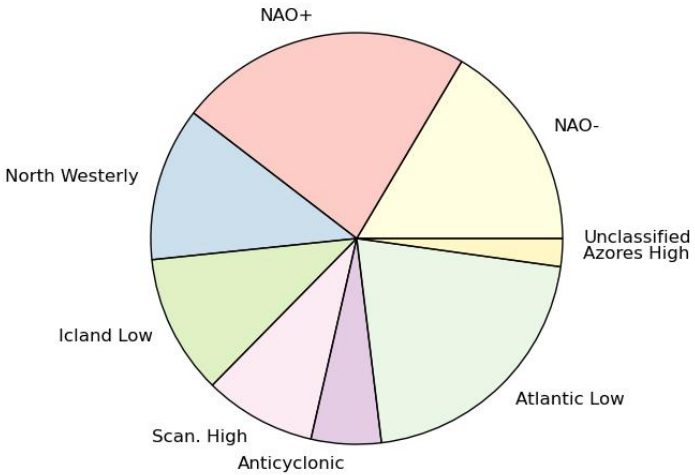
WOW



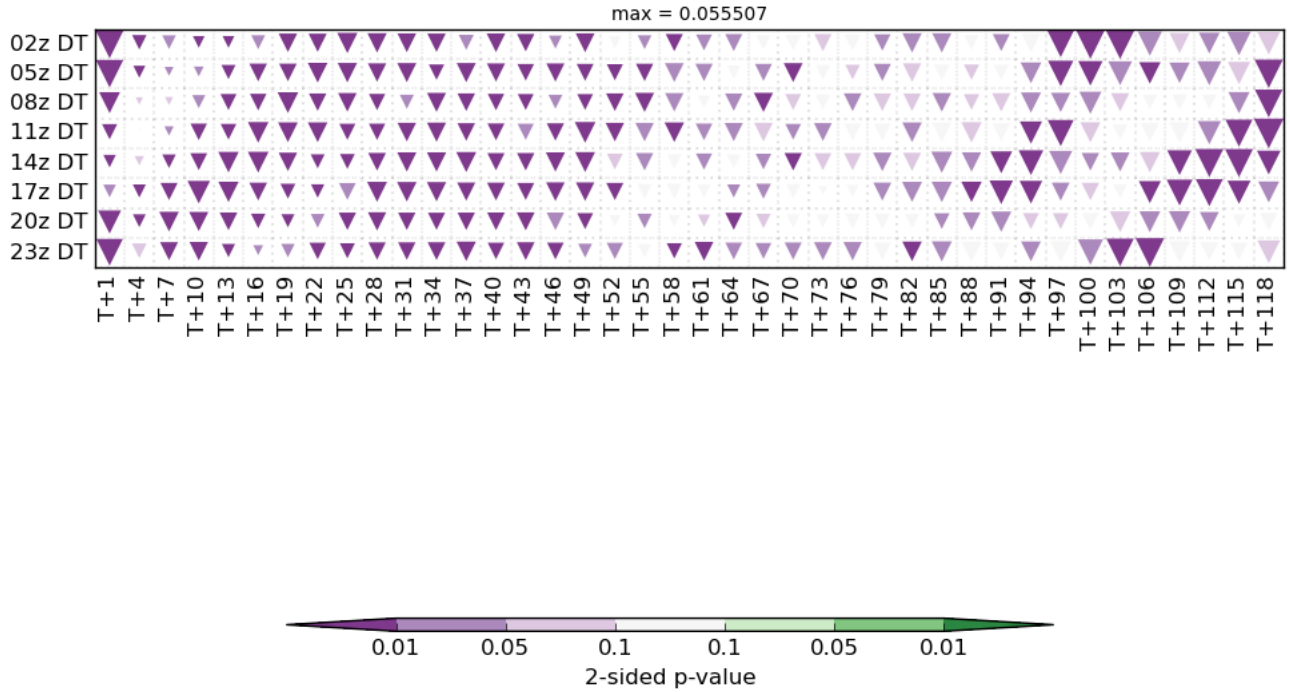
PWS



Weather regimes



- Early January dominated by NAO^{-} , transitioning to NAO+, NW's and Icelandic Low
- February dominated by NAO+ and Icelandic Low (72%)
- March more changeable. Early dominance of Scandinavian High moving to wetter regimes later in the month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2-sided p-value

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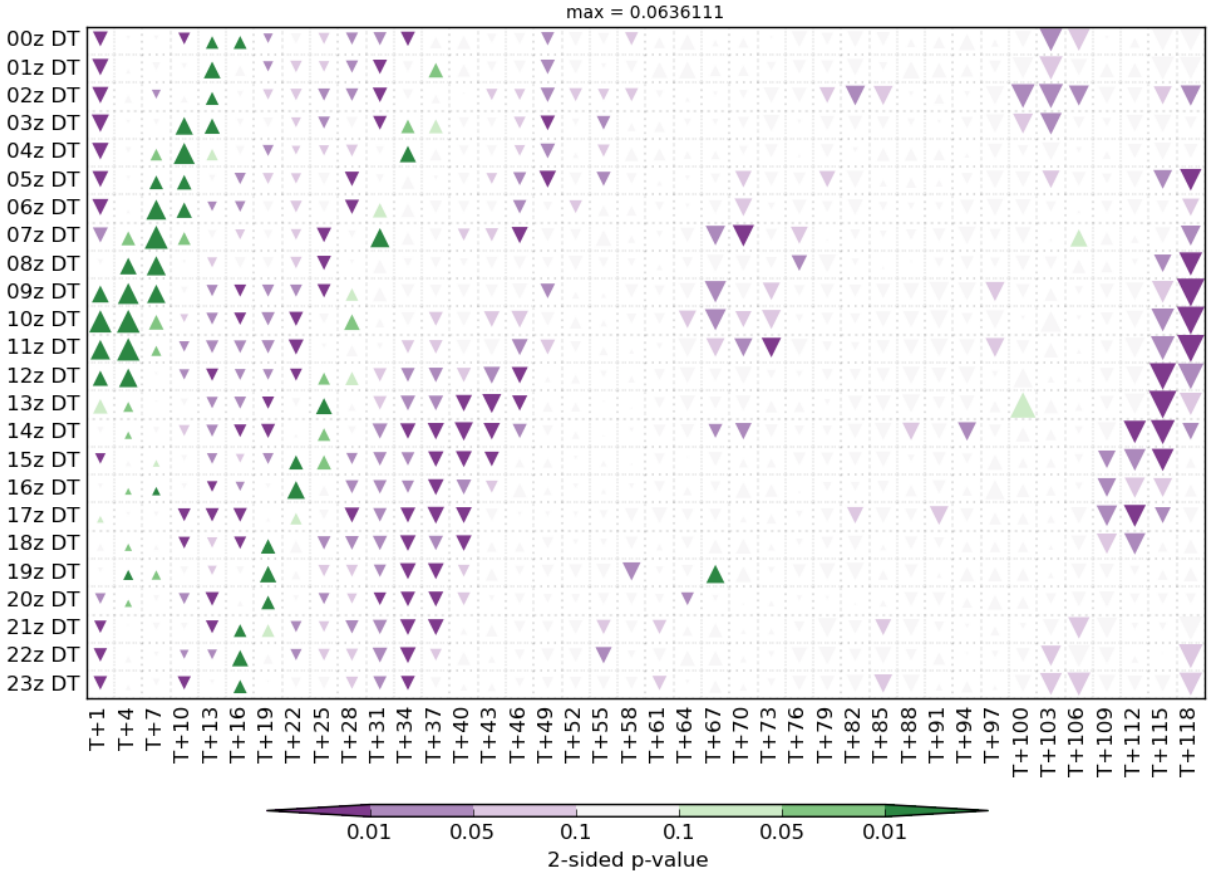
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2-sided p-value

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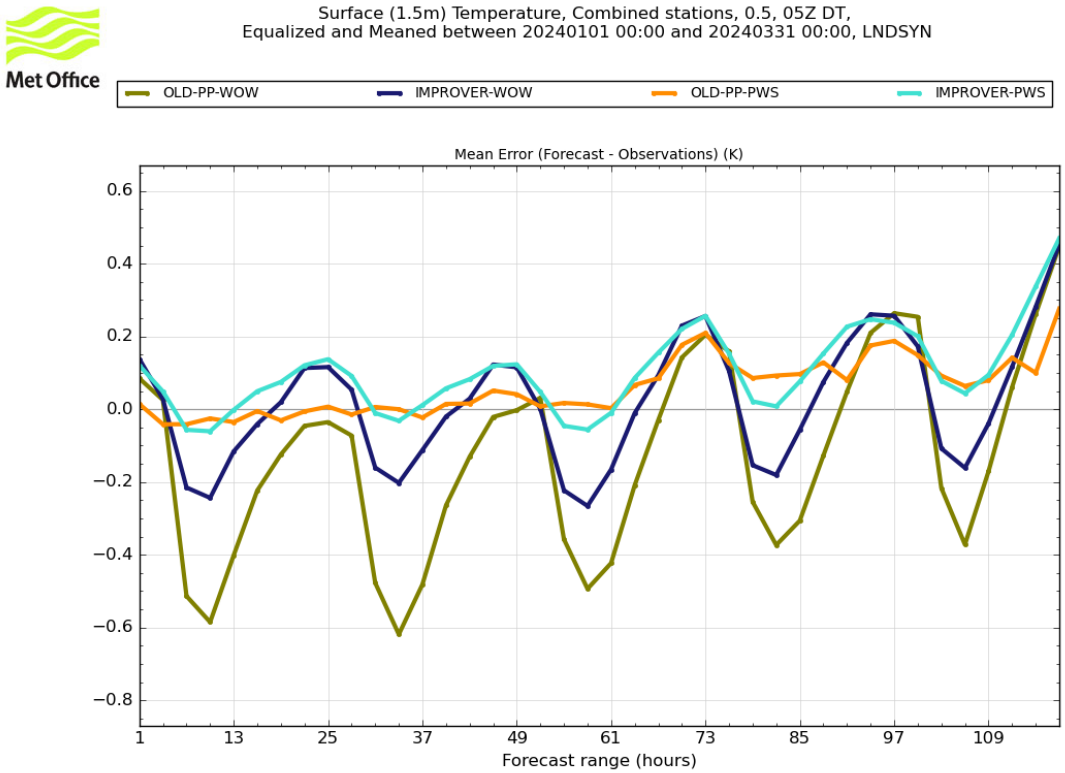

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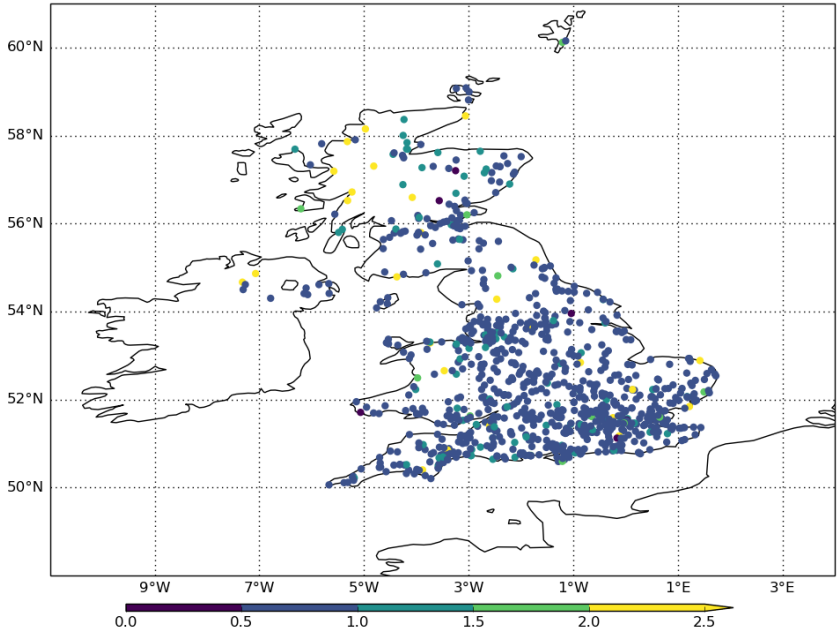
WOW

Surface (1.5m) Temperature (K), Mean Absolute Error (Forecast - Observations), 05Z DT,
20240101 00:00 to 20240331 23:00, LNDSYN, IMPROVER



PWS

Surface (1.5m) Temperature (K), Mean Absolute Error (Forecast - Observations), 0.5, 05Z DT,
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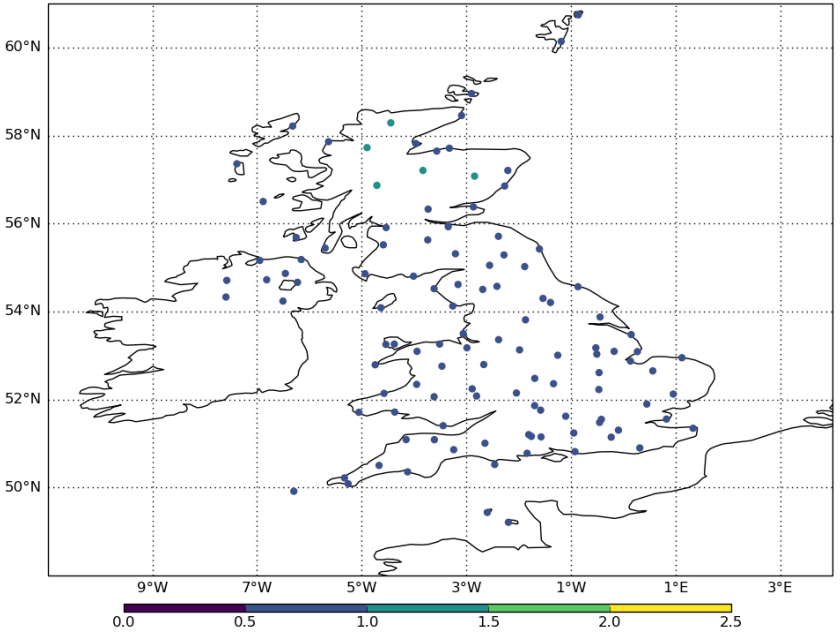

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Initial comments…

- Using only PWS sites, the old system is consistently better than IMPROVER at all lead times
- Using WOW, the difference depends on time of day with daytime temperature better predicted by IMPROVER
- IMPROVER ME more neutral than the old system
- Most WOW sites have a comparable forecast error when compared to PWS
  - Though there are a few outliers, mostly in more remote locations

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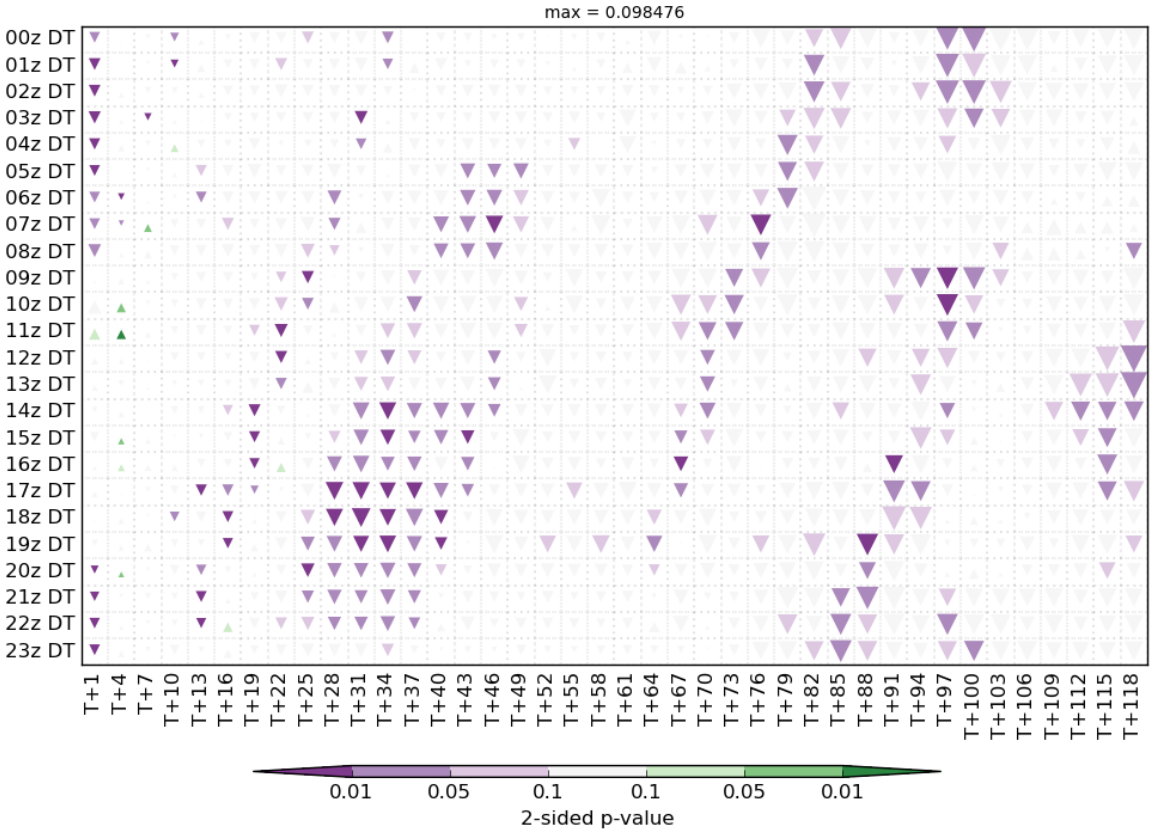
Surface (1.5m) Temperature (K), Proportion of Errors <=2K (Forecast - Observations),
Combined stations, Equalized, 20240101 00:00 to 20240131 00:00, LNDSYN,
Difference (IMPROVER - Old System)



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Surface (1.5m) Temperature (K), Proportion of Errors <=2K (Forecast - Observations),
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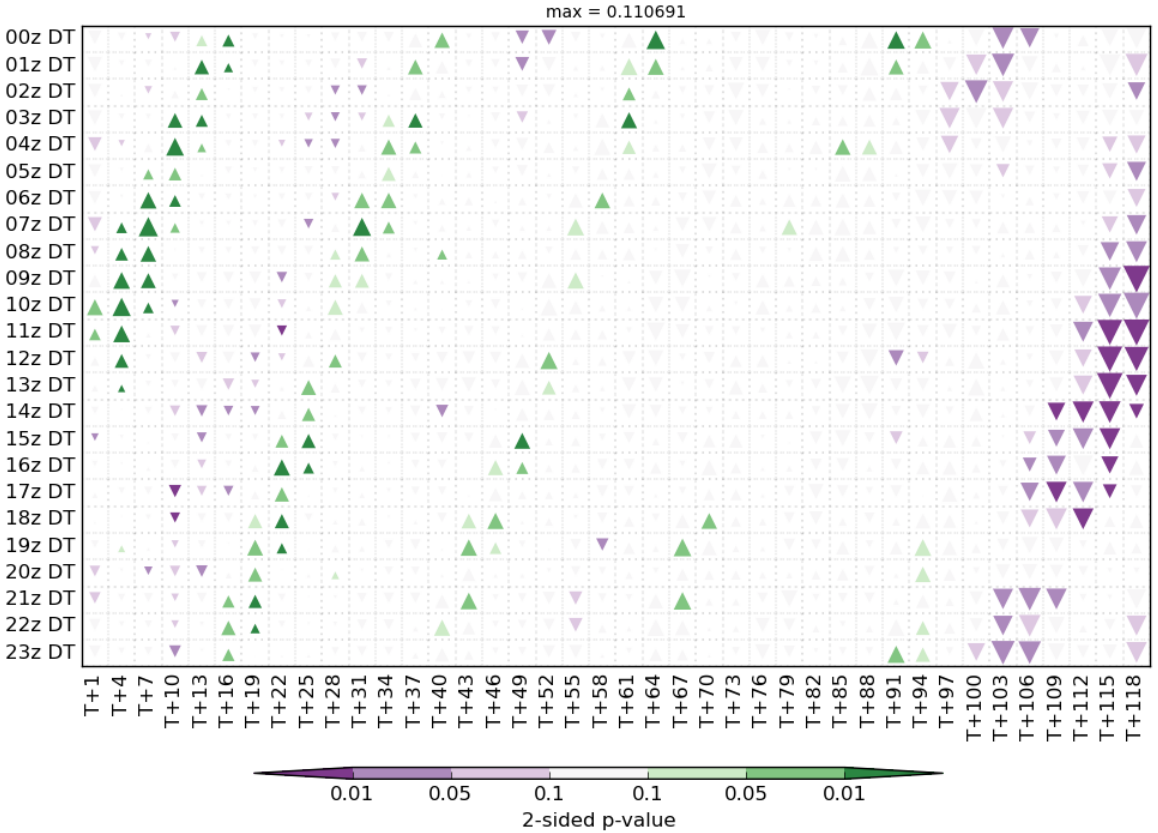
Difference (IMPROVER - Old System)



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Surface (1.5m) Temperature (K), Proportion of Errors <=2K (Forecast - Observations),
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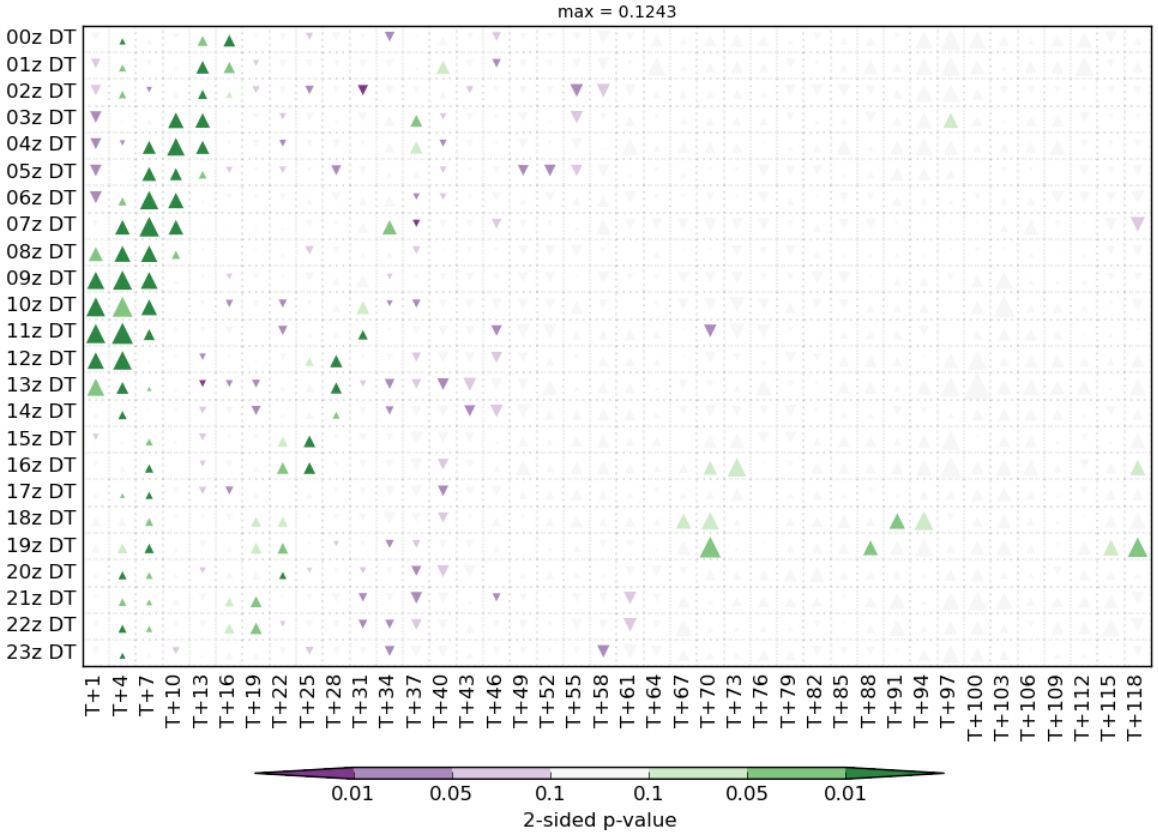

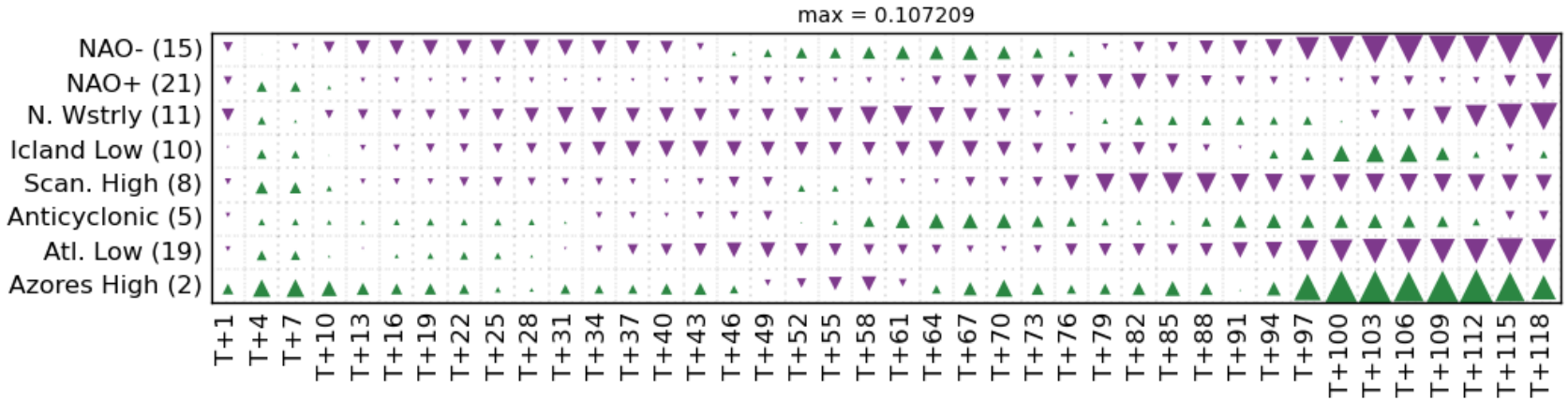
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NAO+ (21)
N. Wstrly (11)
Icland Low (10)
Scan. High (8)
Anticyclonic (5)
Atl. Low (19)
Azores High (2)
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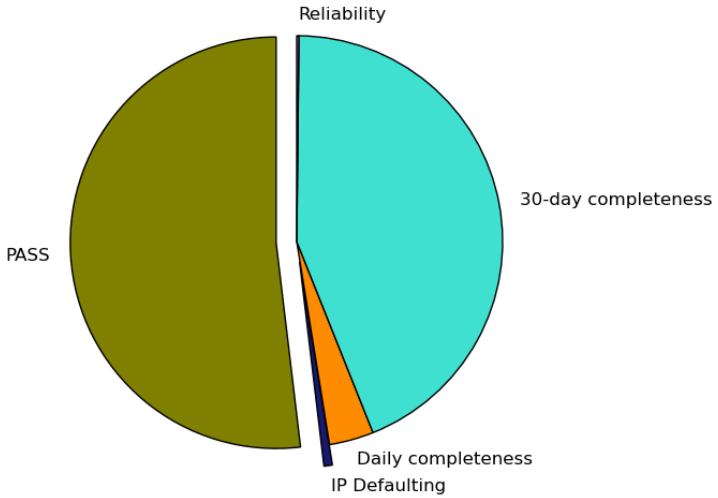
Monthly performance…

- January worse for IMPROVER than the other months
  - Weak/no signal of better daytime IMPROVER temperatures
- February/March were known for being particularly wet
  - Some regime differences but too few data to be certain about any regime-based differences in performance

Quality control of study period

- Significant rejection based on 30-day completeness
- Just over half of data passed (51.9%)



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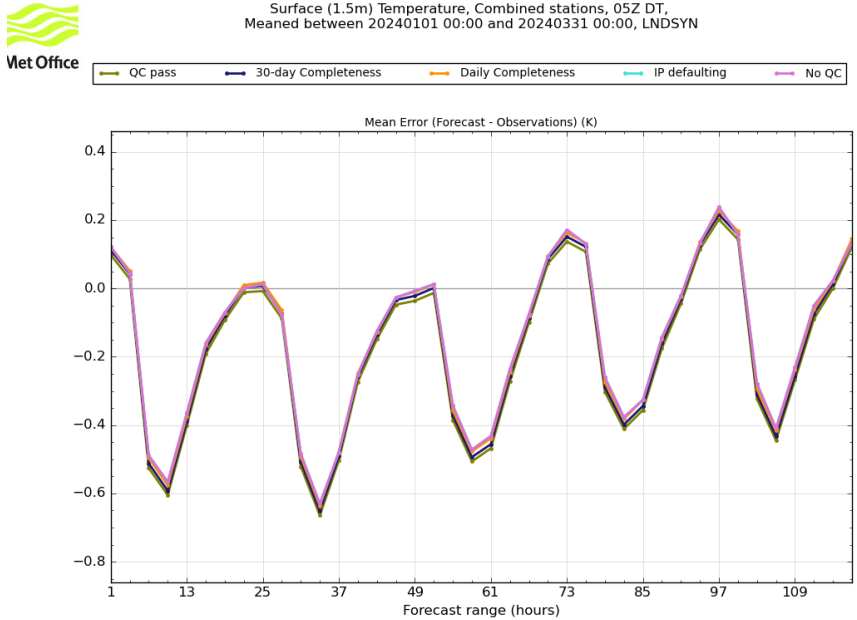

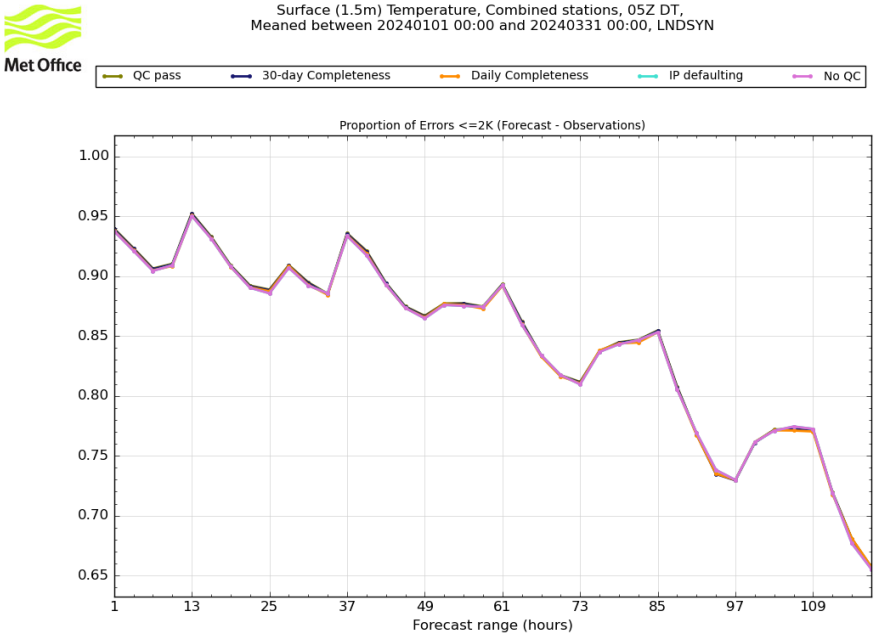

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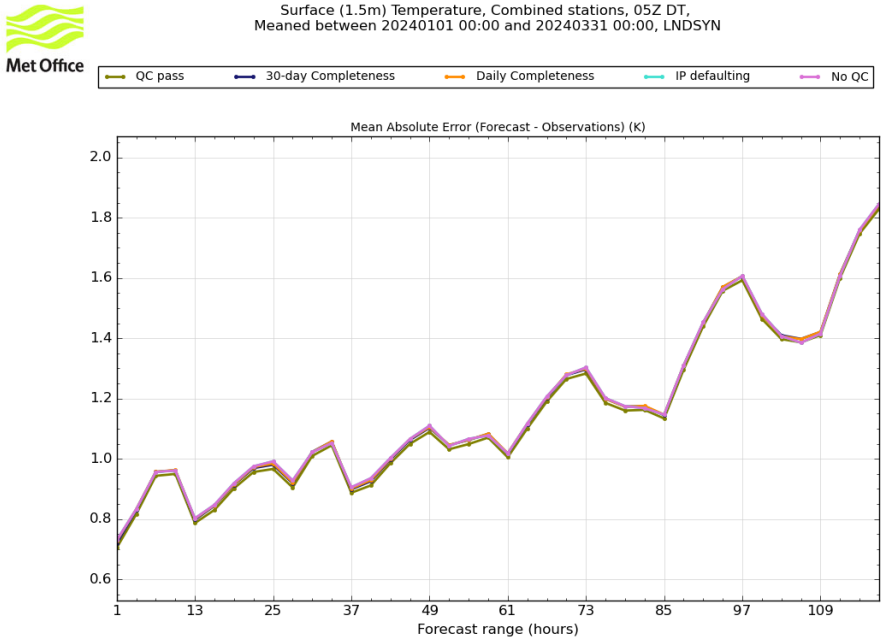

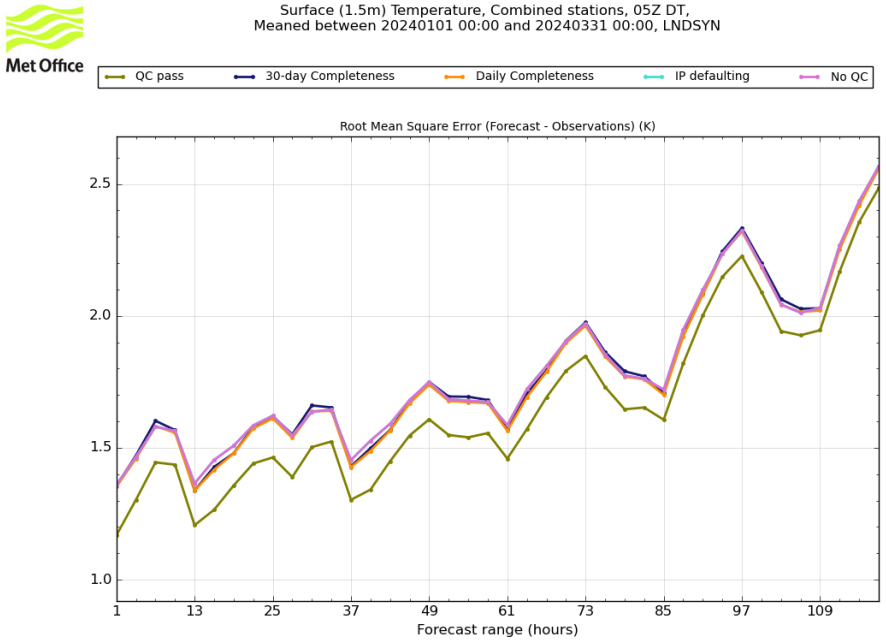

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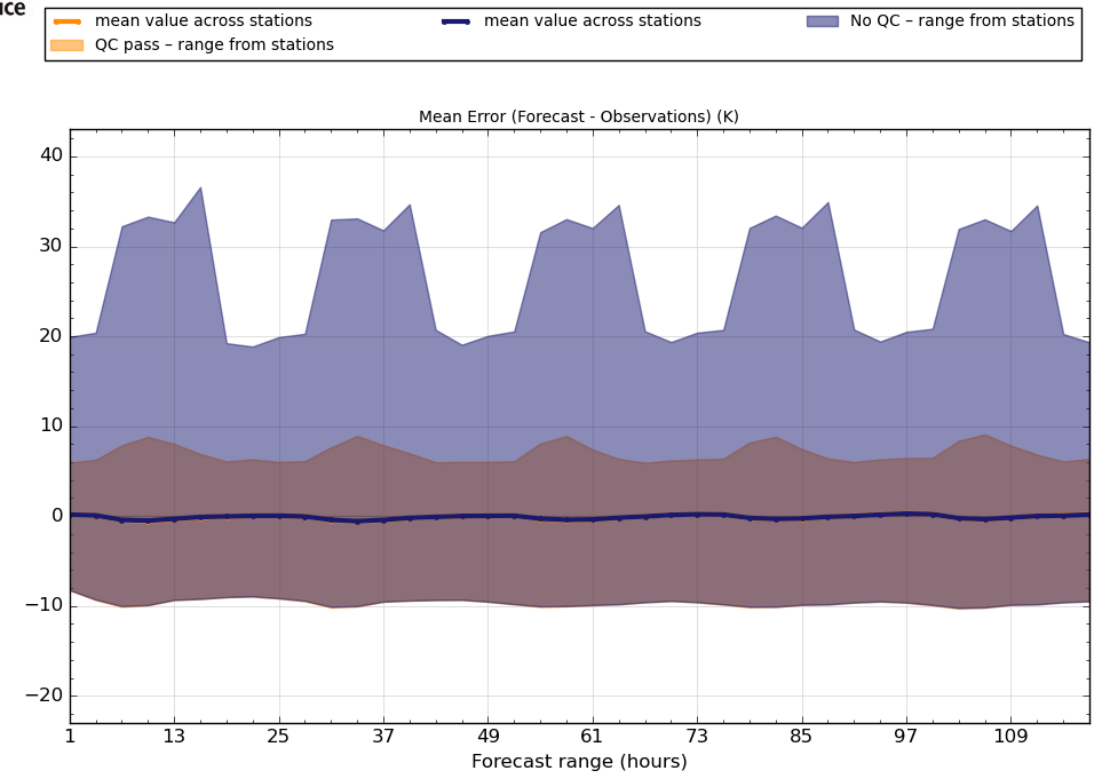
Surface (1.5m) Temperature, 05Z DT, Meaned between 20240101 00:00 and 20240331 00:00, LNDSYN



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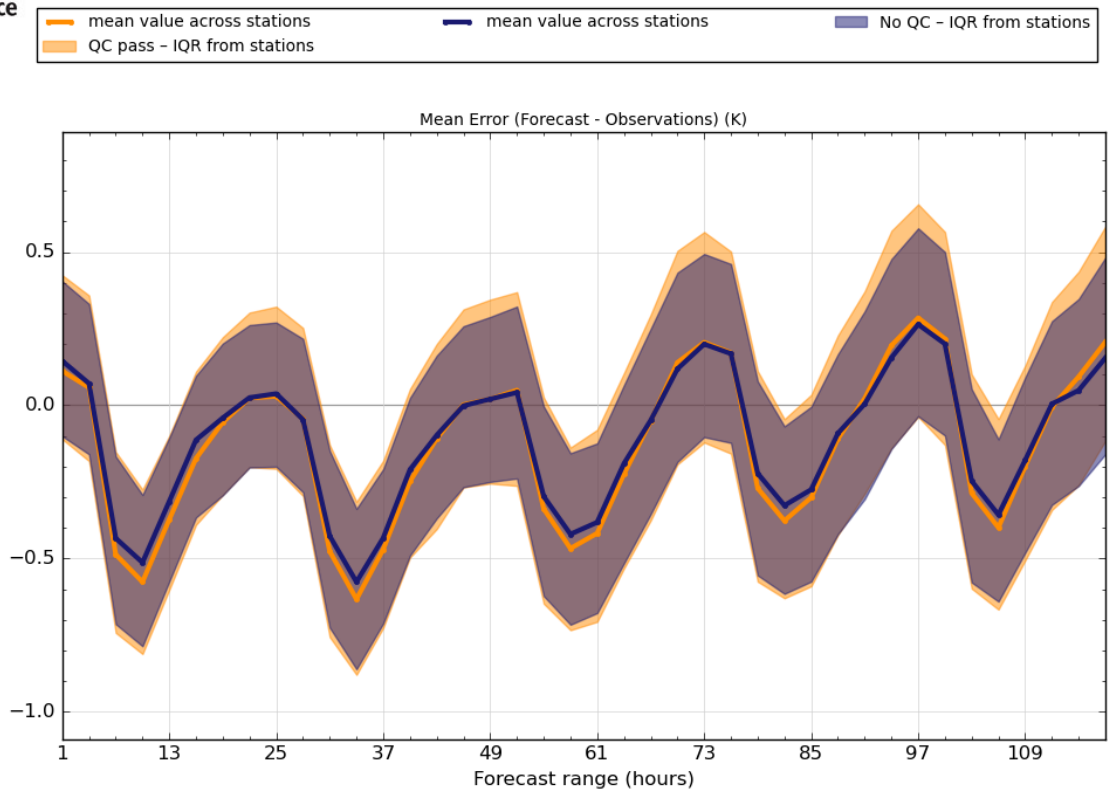
Surface (1.5m) Temperature, 05Z DT, Meaned between 20240101 00:00 and 20240331 00:00, LNDSYN



Summary of QC

- Quality control has a little influence on the overall score
  - There are a large number of good sites!
  - Unless using a metric that depends on the squared error (RMSE)
- Most influential stage is the data reliability check
- Still the occasional large error, most often associated with more remote sites.

Overall…

- Crowd-sourced data are a useful resource for operational verification!
- Most WOW sites after QC had a comparable forecast error when compared to PWS sites
- Very little change in score was observed with and without QC (except RMSE)
  - Large number of good sites compared to a few outliers

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What next?

- Generate larger volumes of data
- Add additional parameters?
- Explore different Quality Control Schemes?


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