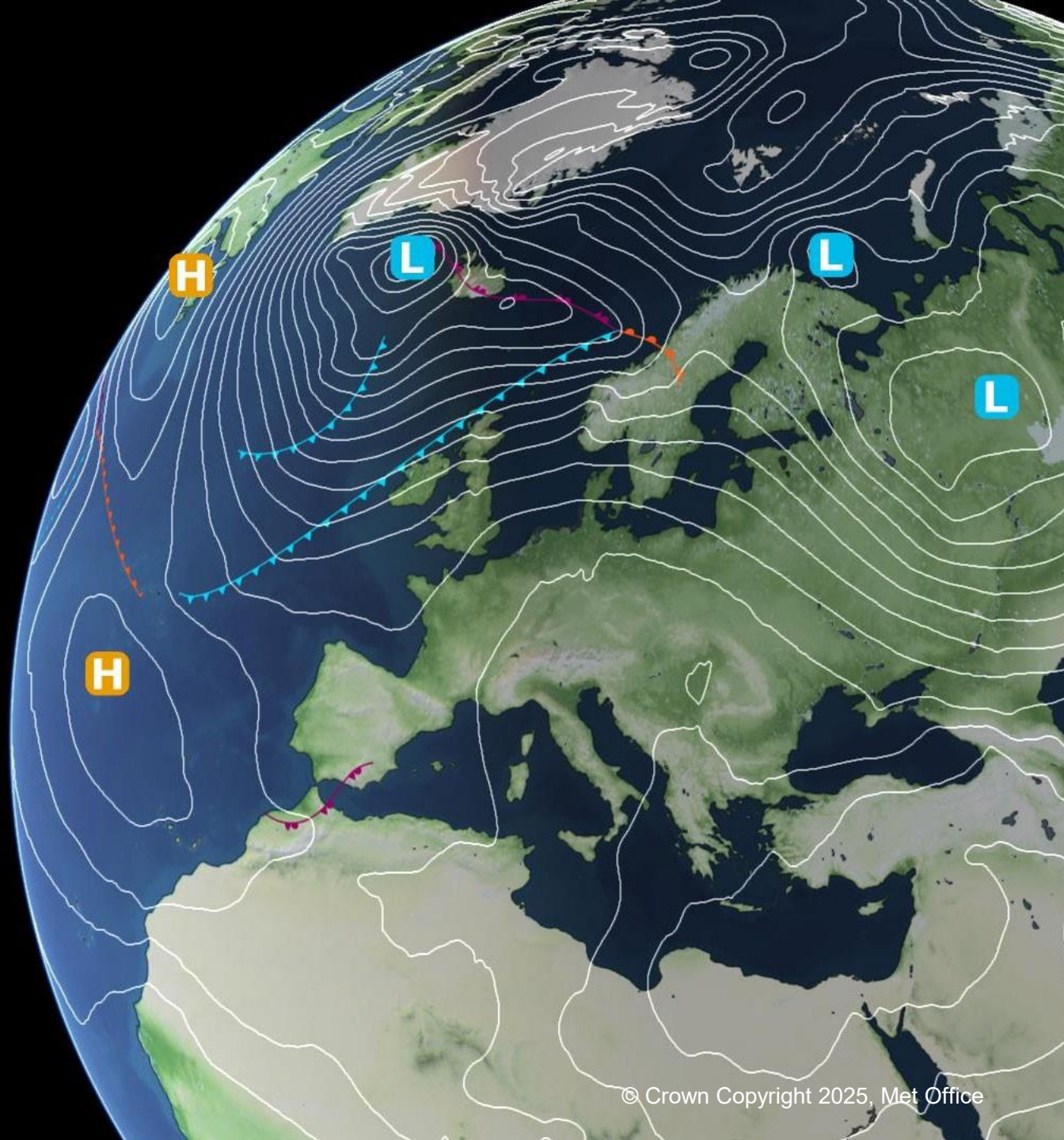
Quality Assurance of Extreme Observational Data

Gill Taylor-Walker
Paul Gibb



Met Office

Introduction – Quality Assurance of Extreme Observational Data at the Met Office

- What do we do?
- Why is this important?
- The Process
- Worked example
- Questions

Met Office

What do we do?

SWAT Analysis Site Weather Assessment Team

- SWAT - is a team made up of cross discipline operational subject matter experts.
- They are responsible for carrying out Quality Assurance on any potential new record or extreme observation that is of regional or national significance and assessing any issues that may be raised.

Purpose: To validate or dismiss any potential new record/extreme observation recorded within the Met Office Network in a timely manner.

Why is this important?

We need to ensure all our observations are reliable, plausible and accurate. Media, and other stakeholder interest, has grown significantly over the last 5 years. This requires our quality assurance process to be enacted as soon as these instances are alerted.

There are approximately 300 Land Synoptic sites and 150 Voluntary Climate sites reporting hourly and daily values into the Met Office databases.

- Key observations are used in real time and delayed mode by:
  - Forecasting models
  - Press Office
  - Social Media (internal & external)
  - Media Services
  - Business Services
  - Media Channel Presenters
  - Met Office products (either sold to customers or viewed on a national media platforms).
  - Acedemia

Met Office

The Process

Before the Weather event

Quality Control Team receives guidance ~ 3-4 days in advance of any extreme weather event where potential records could be reached.

QC team On Alert.

When there is an impending high-profile weather event that is likely to cause higher-than-normal national media interest, SWAT Chair meets with Chief Forecaster & Head of Media Services to discuss approach.

Parameters covered by SWAT

- National and Regional records
- Temperature (max / min)
- Rainfall
- Wind max gust
- Snow depth, MSL Pressure & Sunshine (to a lesser extent)

The Process

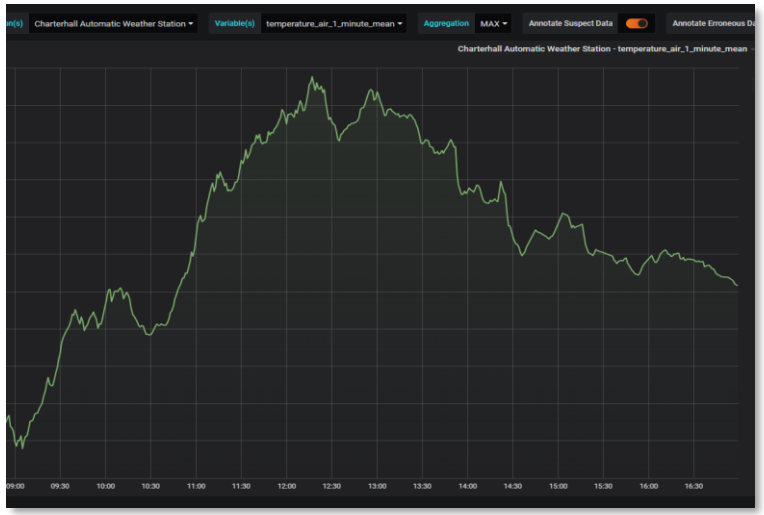
During the Weather event

Real Time Monitoring (RTM) Quality Control team monitor hourly +/or minute data (depending on the element) during the weather event.

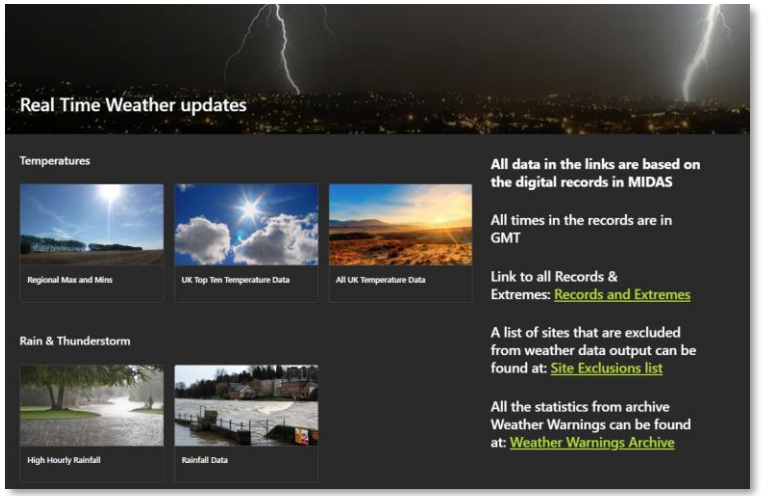
SurfaceNet data trend view using Grafana/STORM (applications for viewing live minute data) to check if the value is plausible.

Yellow Warning = 2 hourly
Amber Warning = 1 hourly
Red Warning = 1 hourly

} Updates issued to internal & external customers / users via SharePoint.



Minute data trace (Grafana) for Air Temperature at Charterhall Weather Station



Met Office

The Process

Step 1

SWAT Meeting

- called ASAP after an extreme has been identified
- All standard checks carried out and discussed
- Observation verified as possible or
- Observation dismissed as erroneous:
  - SWAT document completed and all evidence filed
  - Statement issued to data users
  - Faults rectified.

Step 2

Site Visit required

- Regional Network Officer (RNO) carries out site visit ASAP.
- Instrument field verification carried out.
- Exposure assessed following WMO Guidelines (CIMO)
- RNO completes SWAT document.
- Sensor recovered and sent to QA Lab for Calibration.

SWAT Members
Senior Operational Meteorologist, Chair
Climate & Pollen Observations Manager
Land Observations Manager
Operational Meteorologist, Secretary
Regional Network Officer representative
Local Regional Network Officer
OBQM Data Analyst

Step 3

SWAT Meeting

- RNO & QA Lab report findings back to SWAT.
- SWAT examine findings and discuss validity of observation.
- Observation either verified or dismissed.
- Statement issued to data users:
  - Press Office & Media Services
  - National Climate Information Centre (NCIC)
  - Weather Impacts and Advice Guidance unit (WIA)
- SWAT Chair completes SWAT document containing all relevant verification details and evidence for archive.

Standard Checks carried out

- Near real time and standard quality monitoring of initial data.
- Closer inspection of 1-minute data, checking for error flags or any other irregularities with the data.
- Asset check in ServiceNow.
- Check calibration dates of the sensor.
- Check for any relevant current INCs
- Check Site Condition Reports and latest inspections.
- Check the minute data for the period is complete in the MIDAS Minute Data database.
- Check latest Site photographs relating to the exposure, condition of the instrument and installation.

Met Office

Worked example

Summer 2022 UK Heatwave

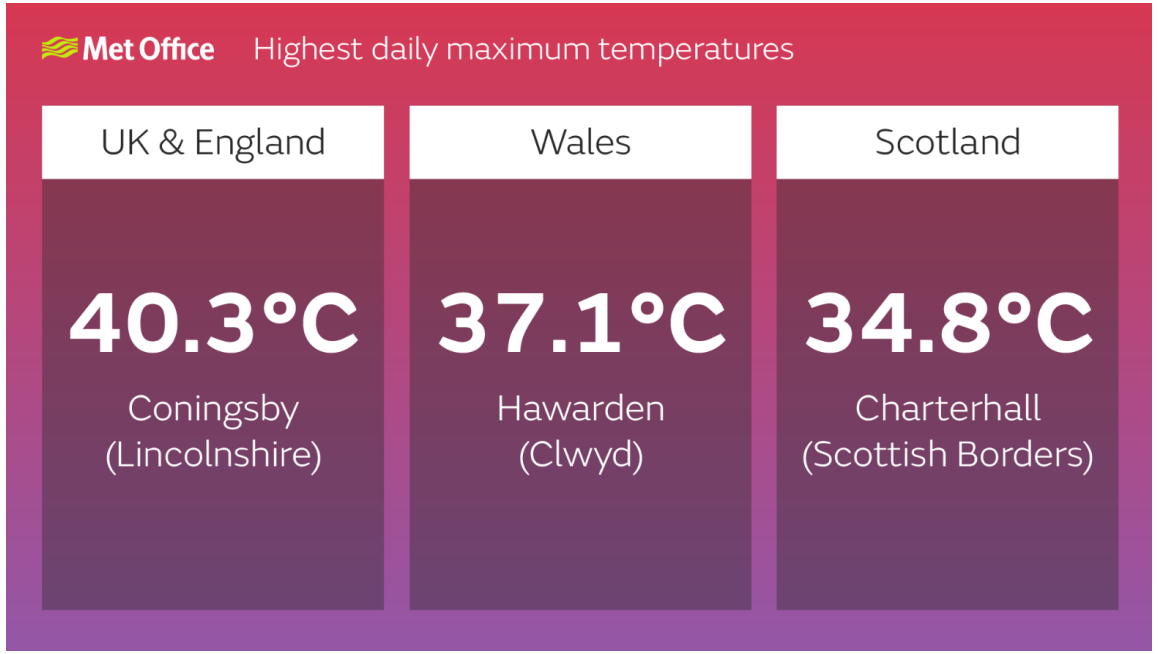
- Extreme Weather Warning issued affecting large area of central England from 00:00 Mon 18th July – 23:59 Tues 19th July.
- Real Time Monitoring QC Team alerted that extreme temperatures were expected and records may be broken.
- Constant monitoring of data using Grafana/Storm.
- High media interest.

Met Office

New Provisional UK & England high temperature record

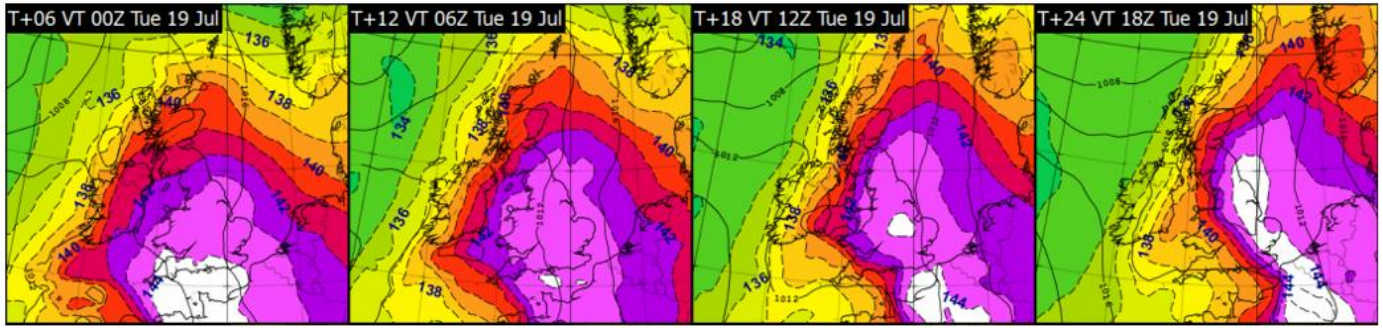
On 19th July 2022, 40.3°C was recorded at Coningsby (Lincolnshire), setting a new UK and England temperature record by a margin of 1.6°C, and multiple stations across England also exceeding 40°C.

This heatwave marked a milestone in UK climate history, with temperatures over 40°C being recorded for the first time in the UK.

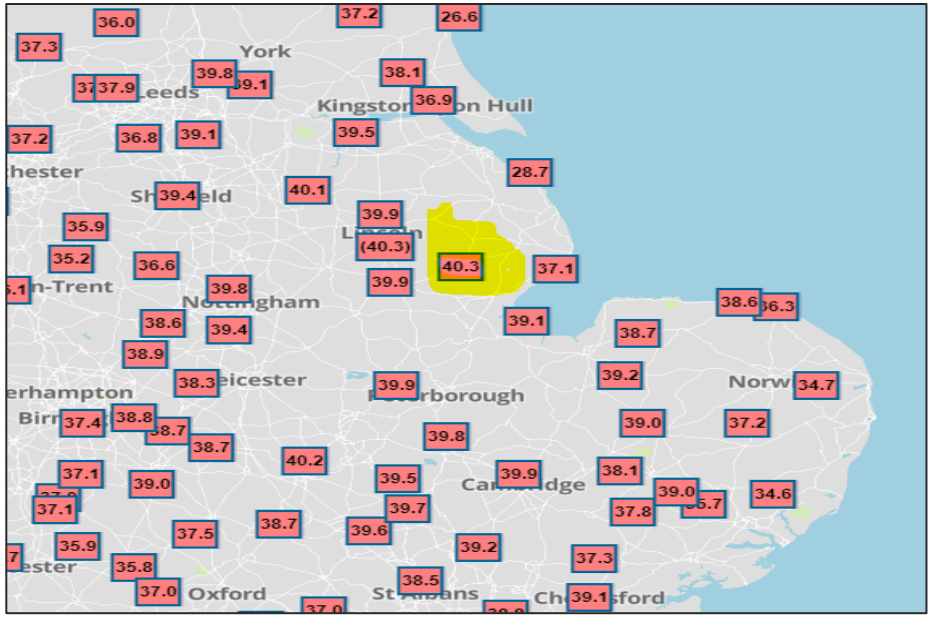


Standard Checks carried out

Forecast data provides the context and locations of expected extremes accompanied by the UK's first red extreme Heat Warning stretching from London up to Central England. Coningsby being located within the extreme warning area and the forecast higher thickness values for the period.



The value of 40.3°C recorded at Coningsby has significant support among not only near neighbours but generally within the airmass.



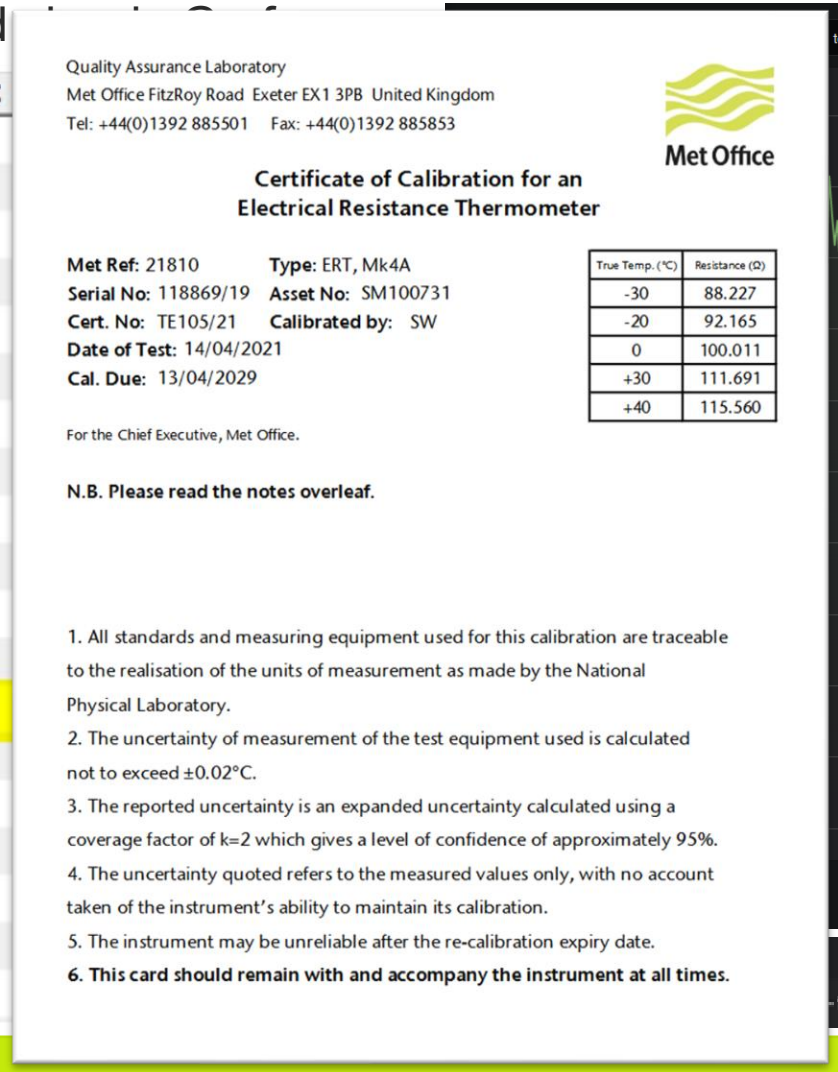
No recent /historical issues have been identified with the data prior to the event, with the site maintaining a high QC record.

Value passed automated Quality Control checks, along with manual verification from both the Real Time Monitoring and Climate QC teams.

Standard Checks carried out

Inspection of 1-minute data and trend

STATION	DATE_TIME	ELEM_NAME
CONINGSBY	19/07/2022 15:00:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:01:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:02:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:03:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:04:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:05:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:06:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:07:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:08:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:09:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:10:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:11:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:12:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:13:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:14:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:15:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:16:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:17:00.000000	TEMP_AIR
CONINGSBY	19/07/2022 15:18:00.000000	TEMP_AIR



Quality Assurance Laboratory
Met Office FitzRoy Road Exeter EX1 3PB United Kingdom
Tel: +44(0)1392 885501 Fax: +44(0)1392 885853

Met Office

Certificate of Calibration for an Electrical Resistance Thermometer

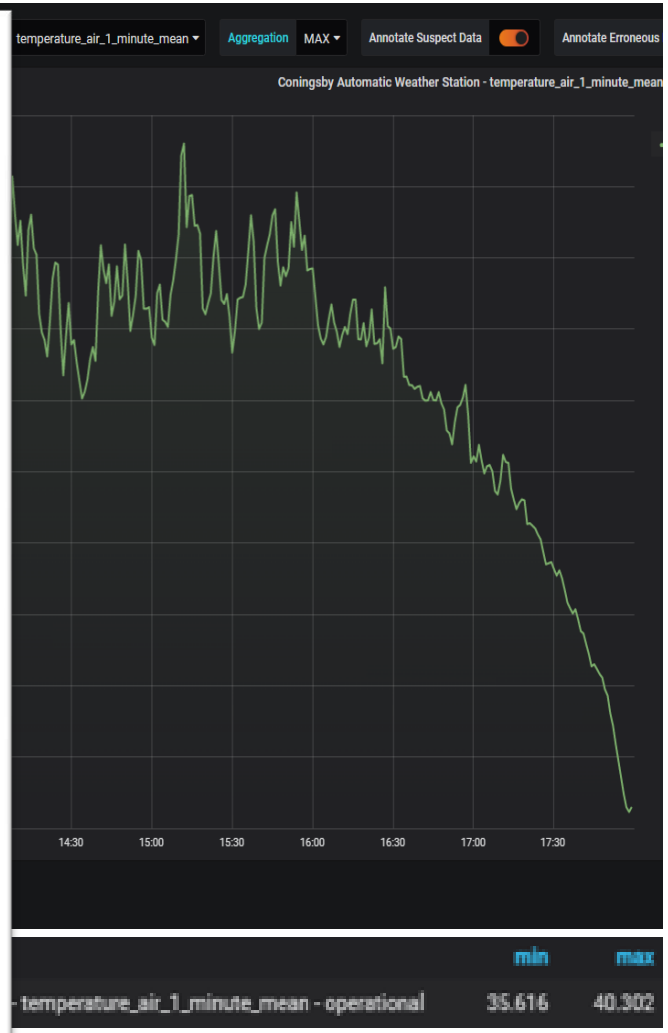
Met Ref: 21810 **Type:** ERT, Mk4A
Serial No: 118869/19 **Asset No:** SM100731
Cert. No: TE105/21 **Calibrated by:** SW
Date of Test: 14/04/2021
Cal. Due: 13/04/2029

True Temp. (°C)	Resistance (Ω)
-30	88.227
-20	92.165
0	100.011
+30	111.691
+40	115.560

For the Chief Executive, Met Office.

N.B. Please read the notes overleaf.

1. All standards and measuring equipment used for this calibration are traceable to the realisation of the units of measurement as made by the National Physical Laboratory.
2. The uncertainty of measurement of the test equipment used is calculated not to exceed ±0.02°C.
3. The reported uncertainty is an expanded uncertainty calculated using a coverage factor of k=2 which gives a level of confidence of approximately 95%.
4. The uncertainty quoted refers to the measured values only, with no account taken of the instrument's ability to maintain its calibration.
5. The instrument may be unreliable after the re-calibration expiry date.
6. **This card should remain with and accompany the instrument at all times.**

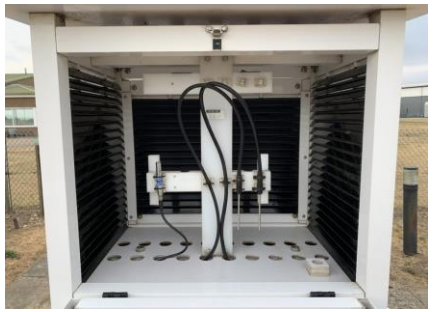


Met Office

Site Visit by RNO on 20th July (next day)

- Field verification carried out using an ice bath. Both the duty air temperature sensor (SM100731) and standby sensor (SM100736) passed site verification.
- Instruments were found to be clean, free from damage and installed correctly.
- CIMO Assessment for Temperature and Humidity calculated as Class 3 – due to proximity of potential heat sources (Concrete pathways)
    - CIMO 'Commission for Instruments and Methods of Observation' is the sitting classification as described in WMO No8

Exposure Comments:
The grass had previously been weed killed under the screen but is showing signs of recovery – tufts of grass are present. The grass in the rest of the enclosure was very dry due to a prolonged period of hot dry weather. This is representative of the surrounding area.



Met Office

QA Lab report

Physical Condition

The ERT (SM100731) was returned to the QA Lab on Monday 26th, on arrival it was visually inspected for any defects and the electrical insulation between the individual wires and the probe case was tested. The probe was found to be in excellent (nearly new) condition and the electrical insulation test results were >9.0GΩ (an ERT passes inspection if the insulation value is above 100MΩ).

Calibration

The ERT was immersed in a stirred calibration bath and tested against one of our SPRT probes at the standard 5 calibration points (-30º, -20ºC, 0ºC, +30ºC and +40ºC). The results were compared to the results found before the unit was deployed in 2021 and are shown in the table

Temperature standard

An Isotech 670SQ SPRT, sn:368 was used to carry out the recalibration. It was checked against our ITS-90 fixed point Gallium Standard prior to the calibration and an offset of +0.002ºC was found, this is well within our calibration uncertainties which are +/-0.02ºC at 95% confidence levels.

Bath Temperature (+/- 0.001ºC)	ERT Resistance ohms (14/04/2021)	ERT Resistance ohms (26/07/2022)	Difference ohms
-30.000	88.227	88.228	+0.001
-20.000	92.165	92.167	+0.002
0.000	100.011	100.011	0.000
30.000	111.691	111.690	-0.001
40.000	115.560	115.558	-0.002

*Note a change of 0.001Ω is approximately equivalent to a change of 0.004ºC

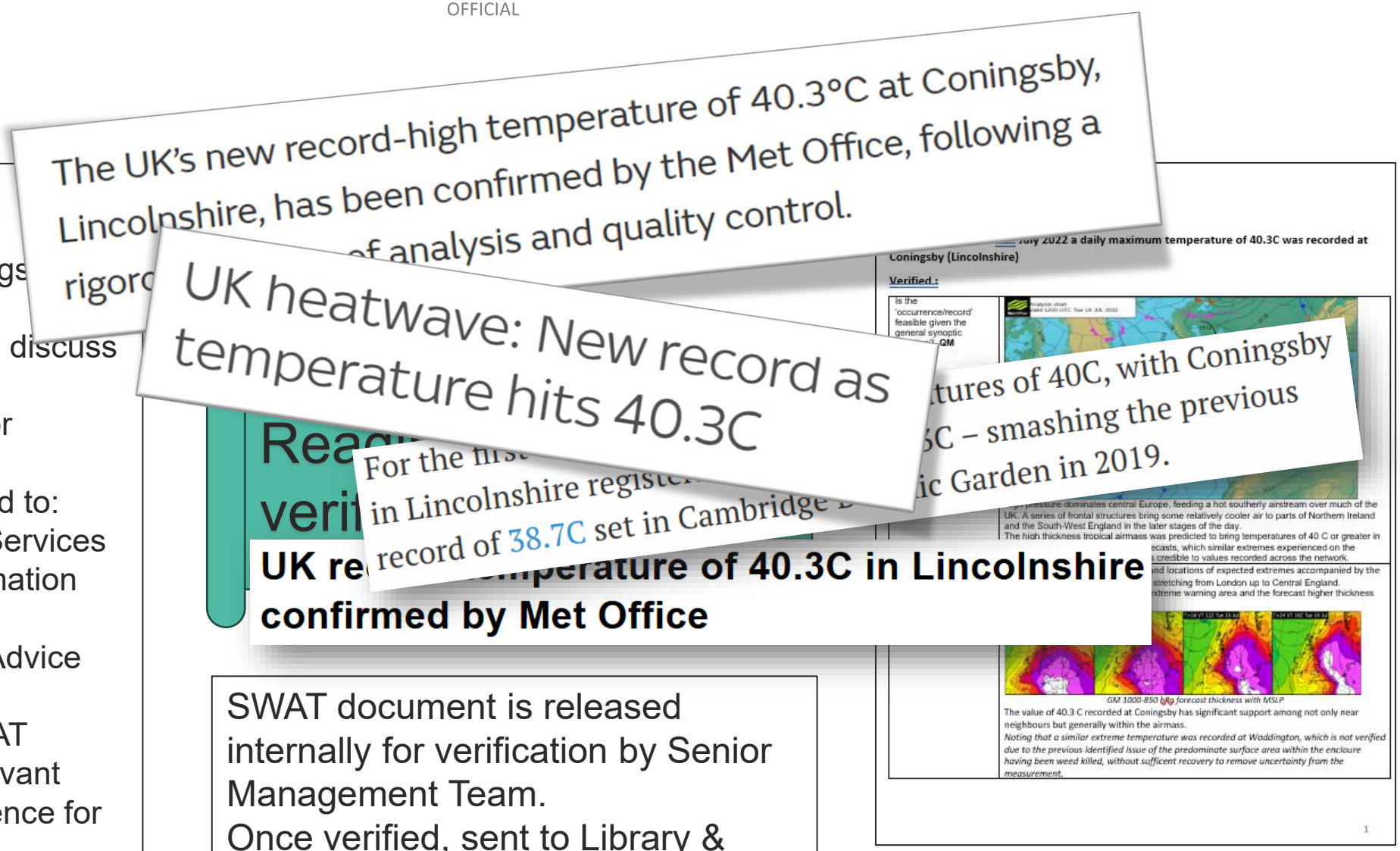
Conclusion

The probe was found to be in excellent condition and is showing a negligible change in calibration since April 2021.

Met Office

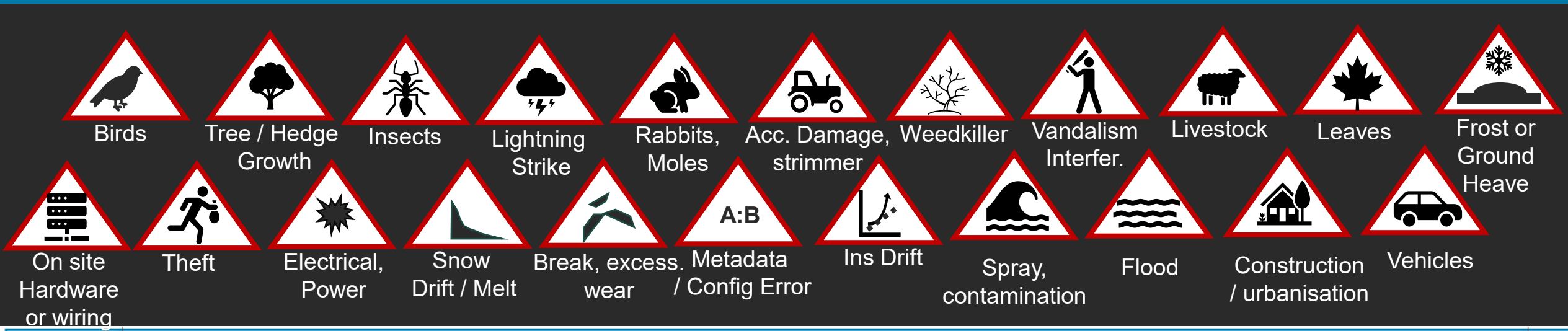
Step 3
SWAT Meeting

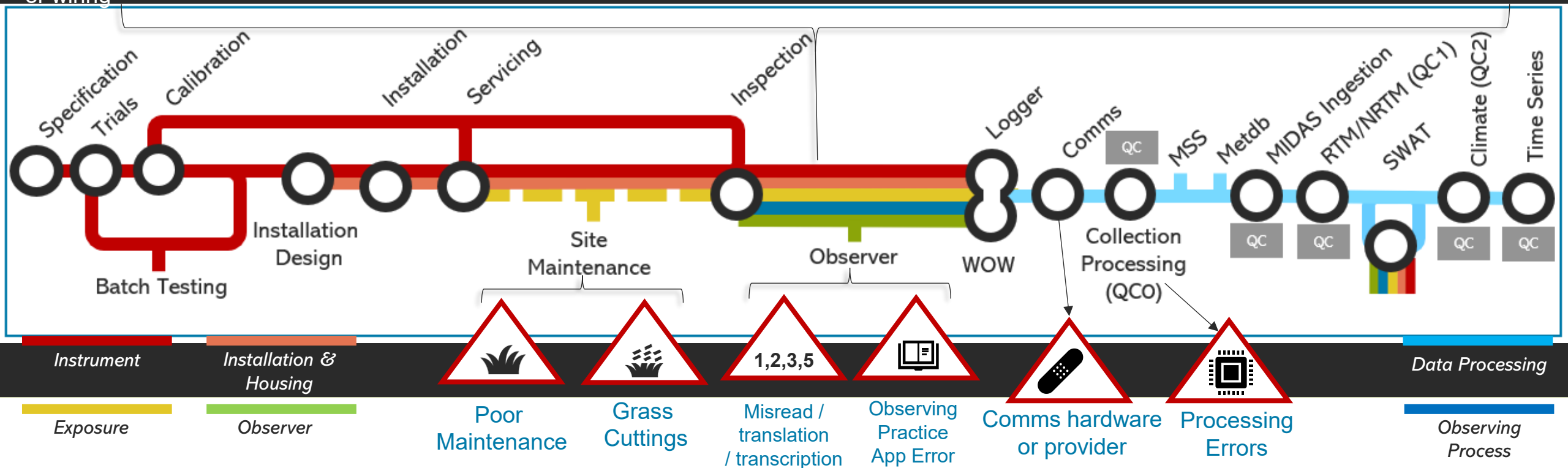
- RNO & QA Lab report findings to SWAT.
- SWAT examine findings and discuss validity of observation.
- Observation either verified or dismissed.
- If verified – Statement issued to:
  - Press Office & Media Services
  - National Climate Information Centre (NCIC)
  - Weather Impacts and Advice Guidance unit (WIA)
- SWAT Chair completes SWAT document containing all relevant verification details and evidence for archive.



SWAT document is released internally for verification by Senior Management Team.
Once verified, sent to Library & Archive Team to be published on External Website for public access.

Issues SWAT can uncover





Met Office

Questions?