Crowdsourced meteorological observations from Netatmo home weather stations

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Quick Summary

- This work was done as part of my MRes in Climate and Atmospheric Science. A paper is under review in *Meteorological Applications* examining utility of Netatmo temperature measurements. Email me for a preprint (`mm16jdc@leeds.ac.uk`).
- >5000 Netatmo home weather stations making observations in the UK at any one time
- Archive of Netatmo data (temperature/pressure/humidity/rainfall/wind) stretching back to March 2020
- Unusual design resulting in lagged temperature measurements
- Mean warm bias compared to Met Office temperatures of 1.23 °C (Coney et al., 2021).
- Data set used by SOEE3790/5090M students in investigation to crowdsourced observations

Netatmo Home Weather Stations

Figure 1: Netatmo Home Weather Station (from L-R): Indoor 'Base Station' with barometer; outdoor temperature and humidity sensor; rain gauge (optional extra); anemometer (optional extra).

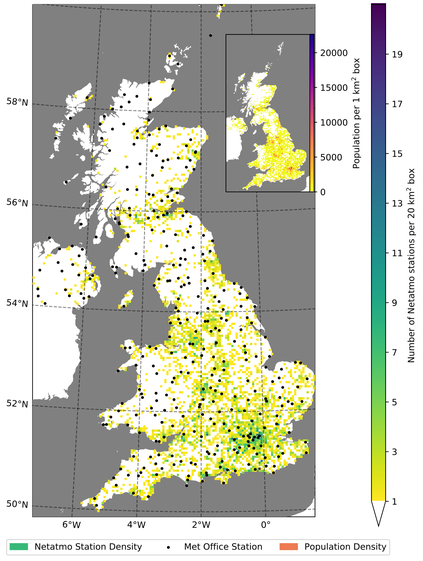

Figure 2: Location and density of Netatmo stations (yellow to purple) and Met Office surface stations (black) in the UK. Population density map (inset) made with data supplied by NERC.

Netatmo sell various smart home products, including the 'Smart Home Weather Station'. The full weather station is shown in Figure 1.

There are over 5000 Netatmo stations making measurements in the UK, compared to ∼ 250 Met Office surface stations. While Netatmo station observations are likely to be of poorer quality than Met Office observations, the move to forecasting at meso and microscales warrants the need for additional surface observations. Figure 2 shows that the distribution of Netatmo stations across the UK are correlated to population centres.

The mean distance between Netatmo stations across the UK is 2.14 km, compared to 17.6 km for the mean distance between Met Office surface stations (Coney et al., 2021).

The data was used as part of my MRes in Climate and Atmospheric Science, and is now utilised by students on SOEE 3790 and SOEE 5090M on investigations into citizen science. The archive dates back to March 2020.

Accessing Netatmo data: Netatmo API

Owners of Netatmo devices (including weather stations) can allow access to their data. Netatmo maintain an API to allow retrieval of the data. There are limits imposed on the API by Netatmo of no more than 50 requests every 10 seconds, and no more than 500 requests per hour per API key (Netatmo, 2012). The API documentation on the Netatmo website is somewhat limited but enough to get going. It is geared towards app developers rather than meteorologists interested in the data.

A series of Python scripts were written to collect data operationally using LOTUS and stored in a Group Workspace on JASMIN. The scripts are designed to collect as much data as possible within the limits of the API. There is a lag of one day to allow slow to upload stations catch up. Data from each station for each calendar day are stored separately as netCDF files, following Climate and Forecast (CF) guidelines. Each netCDF file takes up between 49 and 74 KB of disk space, depending on whether a station has the rain gauge and/or anemometer as shown in Figure 1.

I will happily make my code or data available. Please let me know.

Netatmo Observations

The Netatmo temperature sensor is inside an aluminium case rather than a conventional Stevenson Screen. This may result in solar heating if incorrectly placed by the owner, and a lagged response to changes in temperature.

Comparison of Netatmo measurements and those made by a high accuracy dewpointmeter in a climate chamber showed that while Netatmo observations were within 0.3 °C of the reference temperatures, the mean lag time τ to respond to a temperature decrease of 2.5 °C was 12.7 minutes. 7 Netatmo stations were tested at a range of temperatures from -10 °C to 40 °C. Figure 3 shows a section of a temperature test.

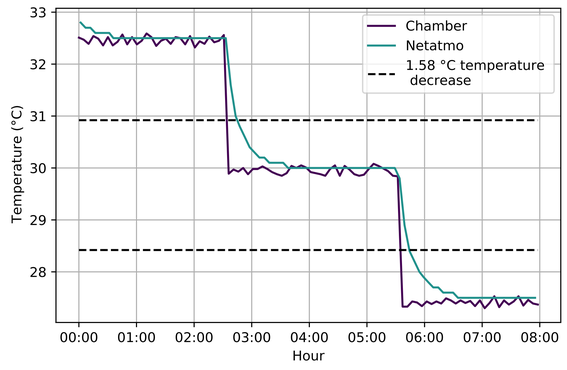

Figure 3: Section of a temperature chamber test, showing the lagged response time in the Netatmo temperature sensor compared to the response by the thermocouple in the chamber. A 1.58 °C decrease represents τ.

When interpolated over England and compared to Met Office reference observations, the Netatmo observations showed a mean warm bias of 1.23 °C (Coney et al., 2021). Various quality control (QC) schemes have been proposed for in Netatmo temperature observations: Meier et al. (2017), Nipen et al. (2020), and Clark et al. (2018). The effects of each QC scheme on some raw data are shown in Figure 4. Finding an appropriate QC scheme for Netatmo (or any other crowdsourced meteorological observations) will ensure the observations are reliable and fit to be assimilated into an NWP model.

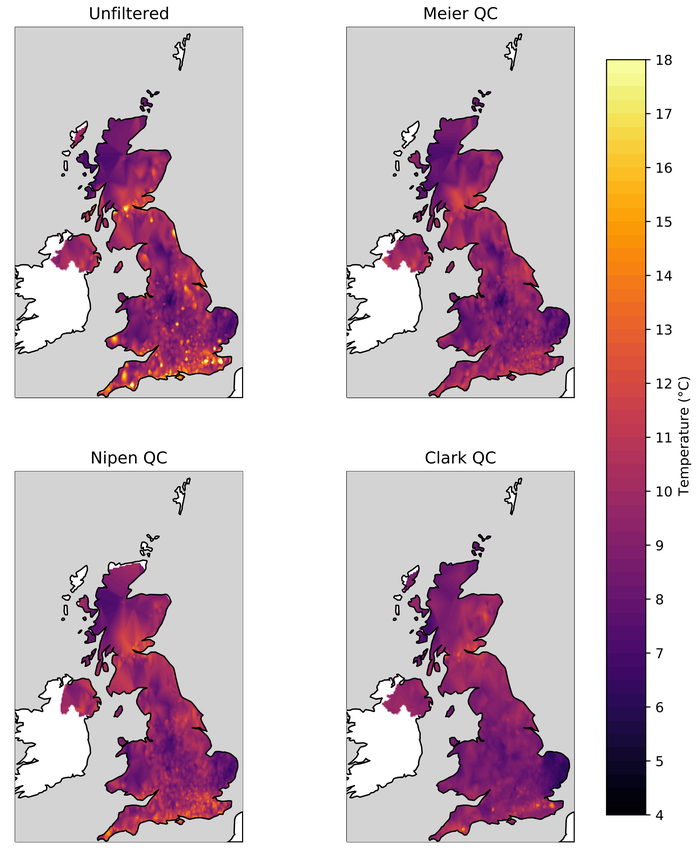

Figure 4: Comparison of the Netatmo observations for 1200 UTC on 1 April 2020. The effects of each QC scheme on the unfiltered data can be seen.

References

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