Tests of methods of estimating missing data from alternative station records

- Daily maximum and minimum temperatures

Report for: Fallback methodology study for ISDA

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Executive Summary

This study has assessed likely errors associated with estimating meteorological variables at an observing site when station data is unavailable. The study focuses on two variables - the maximum and minimum daily temperature. These two quantities are used widely within derivatives trading and it is therefore important to fully understand the magnitude of the various measurements of error associated with the variety of methodologies available to fill in these missing values.

There are many such methods available for filling in missing data. These include methods for spatially interpolating between a number of sites: time-wise interpolation for short spells of missing data and substituting climatological averages. This study has focussed on five methods, supplied to the Met Office, for the purpose of this study. All of these methods work on the principle of substituting data from a nearby reporting station to the site of interest - these are so-called *Designated* and *Fallback* Weather Stations (DWS and FWS).

The methods have been comprehensively tested using historical meteorological datasets from around the globe. The datasets chosen reflect the wide variety of differences which may be found between any two station pairs. These include differences in distance between sites, differences in how urbanised an area may be, differences in altitude of stations and variations associated with topography, such as mountainous areas or proximity to coasts, for example.

The results of the study are as were to be expected. Essentially, those methods which focus on utilising more recent data perform best. Those which utilise data from passed years suffer from the consequences of natural variations in annual climatic conditions, expected at most of the station pairs studied. Methods based on shorter adjustment periods are less vulnerable to errors generated by transient weather features.

The comparison completed here finds that 'Methodology B' is generally the better technique when replacing short periods of missing data. If a longer sequence of missing data forces uses of an alternative method then 'Methodology A*' performs best, as it incorporates a greater adjustment period and hence more data to provide the statistics. See Section 2 for a full description of the methodologies. Full results and conclusions are presented within the report together with a discussion of the method used to assess the ranking of the results.

1. Introduction

The purpose of this study is to test the accuracy of 3 methodologies for replacing missing daily maximum and minimum temperature data. These three methodologies, A, B and C are described in Section 2. Methodologies A and B have 2 modes of use depending on how many consecutive days of data are missing so that, in effect, there are really 5 methodologies. Each methodology utilises temperatures at an associated 'fallback' weather station.

Initially, in order to establish the testing procedure and quickly obtain provisional conclusions, data from only the 11 pairs of stations listed at Appendix A were analysed. Each pair of stations comprised a 'Designated Weather Station' (DWS) and a 'Fallback Weather Station' (FWS). Each methodology was applied in turn to estimate maximum and minimum temperatures at the DWS as if its data were missing, using the record from the FWS as a basis. The estimated DWS temperatures were then compared with the temperatures actually measured at the DWS. This initial study is termed 'Study A'.

The same testing procedures were applied to a further 39 pairs of stations, listed at Appendix B. These results were combined with those of Study A to form a more comprehensive 'Study B'. This study therefore includes 50 pairs of stations in total.

2. Methodologies

In each methodology the missing temperature at the DWS was estimated from the corresponding temperature at the FWS by applying a correction factor to it. This correction factor has been termed the 'Adjustment'. The Adjustment is the mean of the arithmetic differences (rounded to two decimal places) of the temperatures (maxima or minima) at the FWS subtracted from the corresponding temperatures at the DWS during the 'adjustment period'. The methodologies vary only in their definitions of the adjustment period and these are summarised below.

The Adjustment (whether positive or negative) is added to the relevant temperature (daily maximum or minimum) for the FWS. The result is an estimated daily maximum or minimum temperature for the missing data day at the DWS. This value is expressed to 2 decimal places and rounded up if the third number after the decimal place is 5 or greater and rounded down if the first number after the decimal place is less 5.

Methodology A

If maximum and/or minimum temperature data for the DWS are unavailable for a period of less than twelve consecutive days, then an 'Adjustment' is calculated for each missing data day using an adjustment period of the 15 days immediately prior to each missing data day and the 15 days immediately following each missing data day. The adjustment period therefore comprises 30 days.

Methodology A*

If temperature data are missing for twelve or more consecutive days, then an Adjustment for each missing data day will be calculated using an adjustment period of the 15 days immediately prior to the missing date to 15 days immediately after the missing date and including the date itself – for the three previous years and not the current year. In effect, the adjustment period therefore comprises 93 days.

Methodologies B and B*

These methodologies are identical to Methodologies A and A* respectively, but use an adjustment period extending to only 5 days either side of the missing date. The adjustment period for Methodology B therefore comprises 10 days in total while the adjustment period for Methodology B* comprises 33 days in total.

Methodology C

The adjustment to be applied to the FWS is calculated as the arithmetic mean of the daily differences between the relevant temperatures at the FWS and the DWS for the same day for each of the previous 10 years – that is, just 10 days in total.

Each methodology has finer detail not specifically tested in this trial. For instance, if there are further data missing from either the DWS or FWS during the adjustment period, then there is an instruction to search beyond the pre-defined adjustment period until sufficient data are found. However, for the purposes of this intercomparison, there were no additional missing data.

3. Testing Procedure

An EXCEL spreadsheet was developed and its reliability tested. This spreadsheet contained algorithms for estimating missing temperatures using each methodology. The spreadsheet also compared estimated temperatures against measured temperatures and summarised the results in terms of mean error (i.e. mean difference between estimated and measured temperatures), RMS error, standard deviation of the RMS error, maximum positive error and maximum negative error. Each pair of stations (a DWS and an FWS) was processed in turn by this spreadsheet.

Wherever possible a complete 41-year data period, 1961-2001 inclusive, was processed. For a few pairs of stations only shorter period of simultaneous data was available. Prior to processing, the data for both stations were scrutinised to ensure that there were no missing temperatures. For simplification of processing, all dates of Feb 29th (occurring only on leap years) were excluded from the analysis, so that each year contained exactly 365 days.

A minimum requirement for the project had been to select, randomly, at least 100 dates within the processing period on which estimated temperatures would be calculated by each method for the DWS and compared with the temperatures actually recorded at the DWS. In order to test the efficacy of using such a small random sample, a brief sensitivity test was carried out using the DWS/FWS pair for Paris. 100 days were randomly chosen and the RMS error calculated using methods A, B and C for the maximum temperature only. This was repeated 5 times, each time with a new set of 100 random dates, and the variability in the errors calculated were noted for each method. This was found to be as much as 6% for methods A and C, and 8% for method B.

Although only a rudimentary test, this suggested that the small sample size was likely to have a significant effect on the analysis. It was therefore decided to include every available data point (excluding Feb 29) with the expectation that the greatly increased processing overhead would be justified by much improved accuracy in the project results. For a 41-year record, the number of data points available for application of each method was 14965 for methodologies A and B, 13870 for methodologies A* and B* and 11315 for methodology C. RMS errors using such large samples are mostly accurate to within 1%.

Having processed all station pairs, the overall accuracy of the five methodologies were ranked in reverse order of mean error and RMS error.

4. Study A Results/Discussion

Unfortunately there proved to be a lack of data for the identified pairings of stations in Study A. The data for both the London and Stockholm pairs does not cover the entire time period 1961 to 2002, so the analysis was performed on the reduced number of years available. Additionally, data for the Japanese pair was found to cover too short a time period to apply Methodology C, however it was decided that the Japanese data should be included in Study A, but without the application of this final technique. Finally the requested data for Melbourne stations could not be acquired so two other Australian stations were selected and substituted. Appendix A give details of the all the stations selected and the relevant tables of Appendix B provides not only results from the application of each methodology but also information on the data period used when a dataset was found to be incomplete. Although these problems were identified it is believed that the remedial actions taken have had negligible impact on the results, given the separation between results from the methodologies, and the similarity of results between Studies A and B.

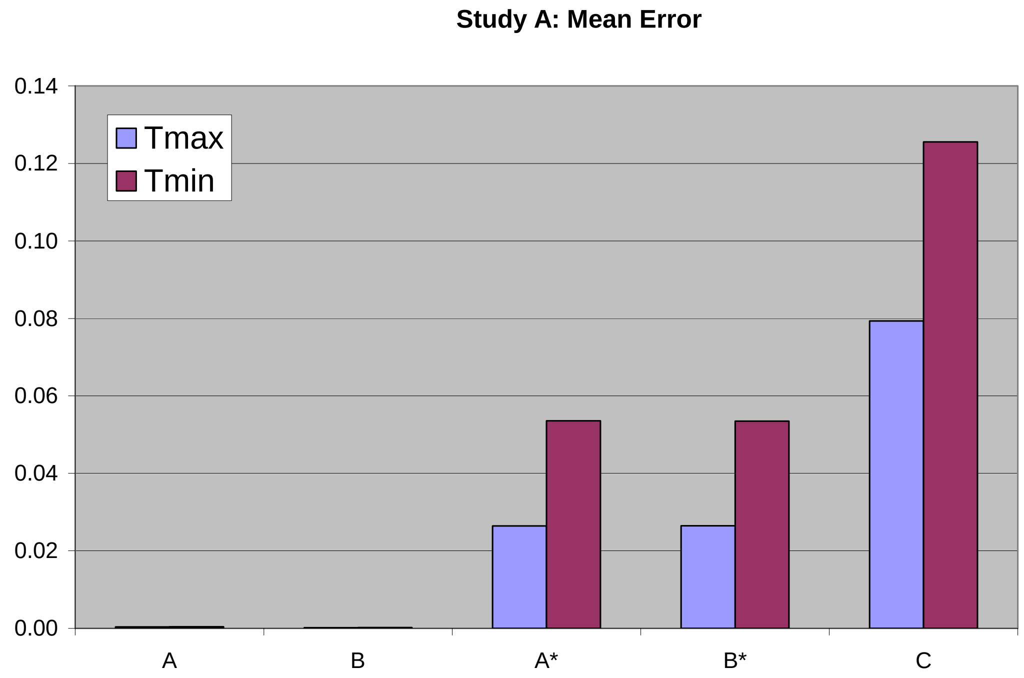

Figure 1: Absolute value of the averaged mean error (ºC) associated with the five methodologies applied to the eleven study A weather station pairings.

The mean errors (in degrees Celsius) associated with each of the methodologies is depicted in Figure1. Results from each method are shown for estimating daily maximum temperatures (on the left of each pair of columns) and daily minimum (the right-hand columns). Firstly it is apparent that estimating minimum temperatures presents more of a challenge than maximum daily temperatures. This is likely to be due to the nature of each of these quantities. Minimum temperatures can be very local in their nature, dependent on local topography and ground cover as well as prevailing weather conditions. The localised 'temperature inversions' often responsible for these spatial variations in daily minimum temperature are much less common in the daytime.

Each of the tested methods attempts to eliminate the mean error by calculating an adjustment intended to compensate for the difference between FWS temperature and DWS temperature. Given that this adjustment is based on actual records from either station then, for an infinite population of estimated missing temperatures, it might be expected that the mean error for each method would be zero. In reality, the mean errors are close to zero, but not quite, despite the large data population sizes in this study. The mean errors can only trend towards zero if the climate of either station is self-consistent throughout the period. It is pointed out that Method C has a weakness in this respect, because the data used to calculate the adjustment are drawn from a period of 10 years prior to the date of the temperature being estimated. For example, if Method C temperatures have been estimated for every date in the period 1971-2001, the climatology on which this is based is for 1961-91. The mean error for Method C may simply represent climate change in one site with respect to the other, 1961-91 versus 1971-2001.

The same weakness applies to a lesser extent to methods A* and B* which use data up to 3 years prior to the event. Figure 1 is consistent with these comments.

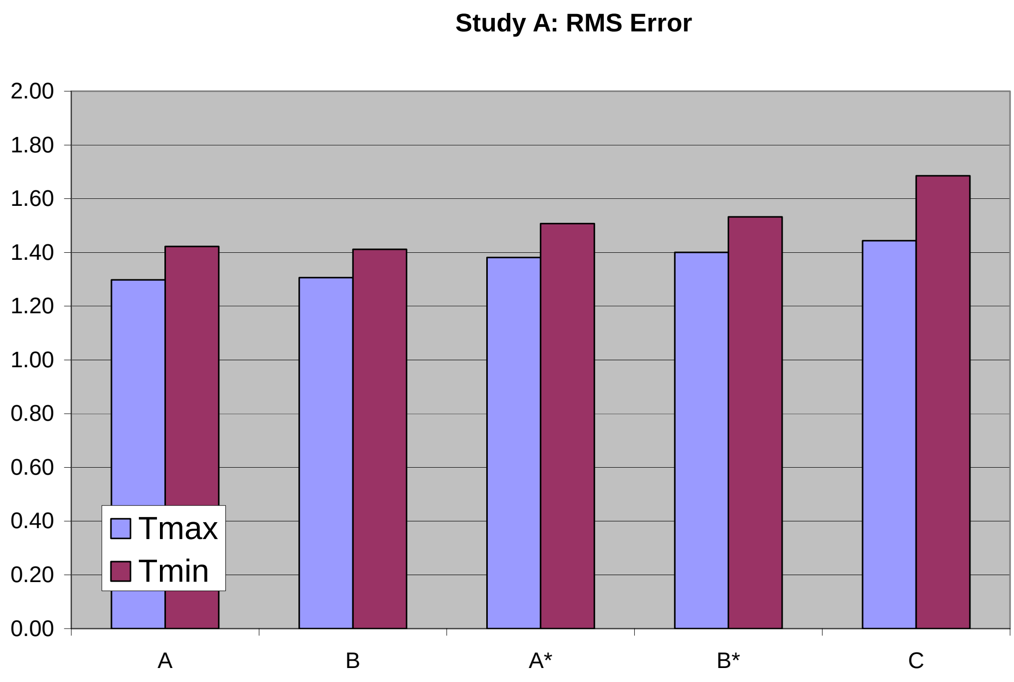

Figure 2: Average RMS error associated with the five methodologies applied to the eleven study A weather station pairings.

Figure 2 compares the RMS error for each of the methods, both for daily maximum and daily minimum temperature, averaged over all 11 stations. The RMS error represents the scatter of the individual estimated temperatures about the observed temperatures. Again, a similar ranking applies as to mean error, with smallest RMS errors for Methods A and B and largest RMS errors for Method C. However, for RMS errors the differences between methods are actually very small and minimum temperature fares almost as well as maximum temperature. The reason for the lack of significant difference between methods for RMS error is likely to be that the factors determining this error will be largely a function of how much the weather at one site varies with respect to the other on a day to day basis. This, in turn, can be expected to be strongly a function of the distance between the two sites. Other factors increasing the RMS are likely to be differences in climatological parameters such as urbanicity, altitude, distance from sea, surrounding topography, land usage and soil type.

The overall ranking of the methods based on the 11 Study A station pairs is given in Tables 1 and 2, respectively for maximum and minimum temperature, a ranking of '1' representing the most successful method. Differences in the effectiveness on Method A versus Method B have been illustrated by Figures 1 and 2 to be minimal, as also have differences between Methods A* and B*. Bearing this in mind, the rankings for maximum and minimum temperature are effectively identical, Methods A and B being the best, followed by Methods A* and B* and with Method C the least effective method.

Ranking	Mean error	RMS error
1	B	A
2	A	B
3	A*	A*
4	B*	B*
5	C	C

Table 1: Ranked methodologies for estimating daily maximum temperature based on the eleven Study A weather station pairs.

Ranking	Mean error	RMS error
1	B	B
2	A	A
3	B	B*
4	A*	A*
5	C	C

Table 2: Ranked methodologies for estimating daily minimum temperature based on the eleven Study A weather station pairs.

It is acknowledged that Method A* and B* are respectively used in conjunction with Methods A and B, the choice of method depending on how many consecutive days of data are missing. It would therefore be useful to rank the overall accuracy of Methods A/A* versus Methods B/B*. However, Study A reveals no significant difference between them.

For more detailed results see Appendix B which, for each pair of stations, tabulates the mean and RMS errors and also the standard deviation of the RMS errors, the maximum individual positive error and the maximum individual negative error. Note that, because such a large population of data has been processed, the standard deviations are typically only about 1% of the RMS value. This implies that the quoted RMS errors are accurate to within about 1% and that the much larger differences between the RMS errors for different methods are therefore significant.

Care needs to be taken when considering the maximum individual errors. Taken at face value their considerable magnitude would indicate that no method is absolutely foolproof and, on occasion, can produce a large error. Probably this is true, especially when the stations are well separated. For instance the stations could lie either side of a marked weather front on a particular day, or, even over short distances, one station could remain in fog while the other basks in sunshine. Also, on occasion, differences of several degrees Celsius in minimum temperature can occur between the centre and perimeter of a large city.

However, as described in the following section, some of the largest individual errors could be on account of a rogue value slipping through the QC procedure. Study of the raw temperature data (far too bulky to include in this report) actually reveals that the larger maximum errors are approached only by a very few outliers in the entire population of events. The RMS error is a far more reliable indicator of the typical range of error from day to day.

5. Study B Results/Discussion

This study adds a further 39 stations, details listed at Appendix C, to those used in Study A, making a total of 50 stations. The mean errors (in degrees Celsius) associated with each of the methodologies for Study B is depicted in Figure 3. Comparison of Figure 3 with Figure 1 (the corresponding chart for Study A) reveals the relative differences between the methods to be almost identical to those indicated in Study A, with Method C the least successful in terms of mean error and Method A and B the most successful. Averaging over the greater number of stations in Study B, the actual mean errors are proportionately smaller for each method.

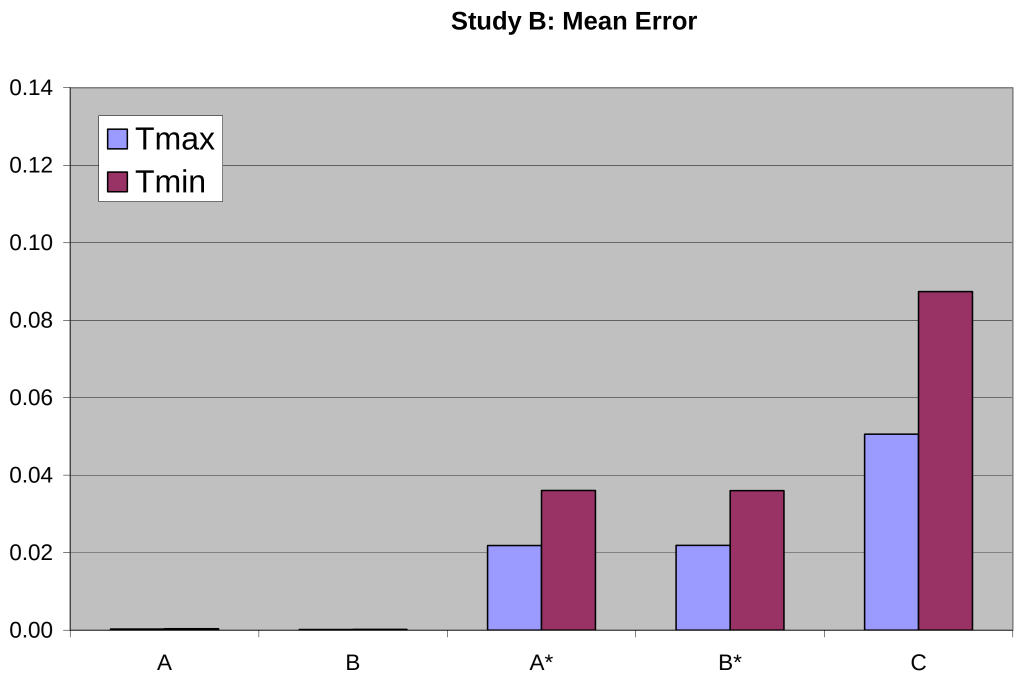

Figure 3: Average of the absolute mean error (ºC) associated with the five methodologies applied to fifty study B weather station pairings.

The greater difficulty of estimating minimum temperature (as opposed to maximum temperature) is again clearly illustrated.

Figure 4: RMS error associated with the five methodologies applied to fifty study B weather station pairings.

Figure 4 compares the RMS error for each of the methods, both for daily maximum and daily minimum temperature, averaged over all 50 stations. Again, comparison of Figure 4 with the corresponding Figure 2 of Study A shows the relative differences between methods to be almost identical to that indicated by Study A. The RMS error for each method is actually proportionately slightly greater in Study B, probably because of the inclusion of several station pairs with large spatial separations. As in Study A, a similar ranking applies as to mean error, with smallest RMS errors for Methods A and B and largest RMS errors for Method C and the same comments apply.

Ranking	Mean error	RMS error
1	B	B
2	A	A
3	A*	A*
4	B*	B*
5	C	C

Table 3: Ranked methodologies for estimating daily maximum temperature based on fifty Study B weather station pairs.

The overall ranking of the methods based on the 50 Study B station pairs is given in Tables 3 and 4, respectively for maximum and minimum temperature, a ranking of '1' representing the most successful method. Again, the rankings are very similar to those from Study A, with Methods A and B the best and Method C the worst. However, there are minor differences in the relative rankings of Method A versus Method B and Method A* versus Method B*. Given that Study B is the larger study, Tables 3 and 4 should be taken as the definitive results.

Ranking	Mean error	RMS error
1	B	B
2	A	A
3	B*	A*
4	A*	B*
5	C	C

Table 4: Ranked methodologies for estimating daily minimum temperature based on fifty B weather station pairs.

Detailed results for the additional 39 stations are given in Appendix D.

It should also be noted that a few of the station pairs have rather larger RMS errors than the more typical values of about 1.5 degrees Celsius. This is likely to be attributable to greater differences between the stations in these cases, as with Melbourne versus Adelaide (Study A) and Lisbon versus Funchal (Study B). Also, some of the maximum positive and negative errors can be quite large in some cases. Whether this is due to the method applied, the choice of FWS for any particular DWS or the quality of observed data cannot be commented on within the scope of this study, however it shooed be noted that meteorological data, from any source, is not without error. This is particularly true when considering very long term records of data from stations around the world. Sources of error in any dataset are numerous and include instrument error, manual measurement error and those associated with the data's quality control, storage and retrieval processes. These errors are present, to greater or lesser extents, in the datasets used for this study. However, the errors are minimised as much as is feasibly possible, by utilising the stations' quality controlled datasets.

Most of the errors mentioned have negligible impact on the results of this study. Most manual errors, which may be made in recording, have been cleaned by the originating country's quality control systems. Many other errors are minimal in magnitude. These errors are, in any case, smoothed out of the results due to the sheer volume of data which has been utilised in the study.

One key area where errors are manifest, however, is with the range statistics. These provide a measure of the maximum difference in temperatures at the DWS and FWS. As these ranges are, in effect, dependant on only a single variable within the time series, anomalies are expected. One example of how such anomalous values may occur is due to a recorded value of zero, rather than registering a missing data indicator for that time at one of the stations. If the other station is recording a significant temperature, a significant difference will be recorded.

It is therefore recommended that little attention be paid to the extreme range in maximum error for any of the *individual* sites. They have been included for reference only and as they were specified within the proposal. Great care has been taken to minimise any errors where possible, by excluding certain parts of the data for example.

6. Overall Conclusions

- Method C is clearly inferior to the other methods.
- Methods A and B fare better than Methods A* and B*.

- Differences between Methods A and B and between Method A* and B* are very small.

- Tables 3 and 4 indicate that Method B is marginally superior to Method A. A plausible reason for this is that Method B only considers data within 5 days of the missing date of 15 days for Method A. The shorter period is more likely to have the same weather type throughout as the day to be estimated and so is likely to give a better estimate.

- Conversely, Tables 3 and 4 also indicate that Method A* is marginally better than Method B*. In this case, the advantage of using data from within only 5 days of the date to be estimated disappears, since the data used to calculate the adjustment are not from the same year. In this circumstance the larger data sample used to calculate the adjustment in Method A* gives a slightly better estimate.

- Therefore, if temperatures are missing on only one day, then Method B is the best, but if temperatures are missing on 15 consecutive days, then Method A* is the best.

- Determination of the ideal cut-off number of consecutive days after which Method A* takes preference to Method B has not been within the scope of this study. It is noted that, following current procedure, the cut-off is hardwired to be after 11 consecutive days of missing data.

Appendix A

Location	Designated or Fallback	WMO number	Latitude (ºN)	Longitude (ºE)	Altitude (m)
1. Chicago O'Hare International Airport	Designated	72530	41.98	-87.92	200
Chicago Midway Airport	*Fallback*	*72534*	*41.78*	*-87.75*	*187*
2. New York La Guardia	Designated	72503	40.78	-73.88	3
New York Central Park	*Fallback*	*N/A*	*40.78*	*-73.97*	*40*
3. Philadelphia International Airport	Designated	72408	39.87	-75.23	2
Allentown Lehigh Valley	*Fallback*	*72517*	*40.65*	*-75.45*	*119*
4. Phoenix Sky Harbour International	Designated	72278	33.43	-112.00	337
Tucson International Airport	*Fallback*	*72274*	*32.13*	*-110.95*	*777*
5. Atlanta Hartsfield International Airport	Designated	72219	33.63	-84.43	308
Montgomery Dannelly Field	*Fallback*	*72226*	*32.30*	*-86.40*	*62*
6. London Heathrow International Airport	Designated	3772	51.48	-0.45	25
Northolt, Middlesex	*Fallback*	*3672*	*51.55*	*-0.43*	*40*
7. Paris Orly	Designated	7149	48.73	2.40	89
Paris Melun	*Fallback*	*7153*	*48.62*	*2.68*	*95*
8. Berlin Dahlem	Designated	10381	52.47	13.30	51
Berlin Tempelhof	*Fallback*	*10384*	*52.47*	*13.40*	*50*
9. Stockholm Observariat	Designated	2485	59.57	18.10	44
Stockholm Bromma	*Fallback*	*2464*	*59.35*	*17.95*	*18*
10. Melbourne	Designated	94864	-37.807	144.97	31
Adelaide	*Fallback*	*94672*	-34.958	138.534	6
11. Tokyo	Designated	47662	35.683	139.767	36
Yokohama	*Fallback*	*47670*	35.433	139.65	42

Unfortunately complete data for a number of these pairings of stations could not be acquired within the time constraints of this study. Data for the Tokyo pair is only available from January 1994, which means that method C cannot be applied. Data records for the Stockholm and London pairs are also incomplete although there is sufficient data to apply all methods of missing data replacement. Additionally, data for the two Melbourne stations could not be acquired so an alternative pairing have been substituted to complete the set of eleven station pairs for Study A.

Appendix B

1. Designated Weather Station: Chicago - O'Hare International Airport
   Fallback Weather Station: Chicago - Midway Airport

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.057	0.009	10.41	-12.96
	Tmin	0.000	1.387	0.011	10.34	-8.49
Method A (using previous 3 years)	Tmax	0.011	1.161	0.010	10.94	-12.08
	Tmin	-0.029	1.481	0.013	8.90	-8.49
Method B (using current year only)	Tmax	0.000	1.070	0.009	10.04	-13.03
	Tmin	0.000	1.355	0.011	9.98	-8.24
Method B (using previous 3 years)	Tmax	0.011	1.174	0.010	10.96	-11.68
	Tmin	-0.030	1.506	0.013	9.17	-8.64
Method C	Tmax	0.043	1.230	0.012	10.62	-12.92
	Tmin	0.028	1.547	0.015	10.15	-7.94

2. Designated Weather Station : New York – La Guardia
   Fallback Weather Station: New York – Central Park

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.921	0.008	6.17	-6.58
	Tmin	0.000	0.822	0.007	6.46	-3.99
Method A (using previous 3 years)	Tmax	-0.058	1.044	0.009	5.88	-6.80
	Tmin	-0.012	0.970	0.008	7.02	-3.89
Method B (using current year only)	Tmax	0.000	0.926	0.008	5.46	-6.55
	Tmin	0.000	0.808	0.007	5.98	-4.65
Method B (using previous 3 years)	Tmax	-0.058	1.059	0.009	5.88	-6.92
	Tmin	-0.012	0.982	0.008	7.24	-3.85
Method C	Tmax	-0.148	1.055	0.010	5.66	-6.97
	Tmin	-0.038	1.000	0.009	6.09	-3.67

3. Designated Weather Station: Philadelphia International Airport
Fallback Weather Station: Allentown Lehigh Valley

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.601	0.013	10.56	-12.74
	Tmin	-0.001	1.674	0.014	7.86	-9.85
Method A (using previous 3 years)	Tmax	-0.039	1.733	0.015	11.16	-12.26
	Tmin	-0.124	1.811	0.015	7.58	-9.38
Method B (using current year only)	Tmax	0.000	1.598	0.013	9.79	-12.47
	Tmin	0.000	1.659	0.014	7.33	-10.43
Method B (using previous 3 years)	Tmax	-0.039	1.757	0.015	11.30	-12.53
	Tmin	-0.124	1.844	0.016	7.64	-9.37
Method C	Tmax	-0.049	1.787	0.017	11.13	-12.99
	Tmin	-0.197	1.900	0.018	6.92	-9.44

4. Designated Weather Station: Phoenix Sky Harbour International Airport
Fallback Weather Station: Tucson International Airport

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	-0.001	1.681	0.014	9.25	-9.87
	Tmin	0.000	1.788	0.015	11.03	-7.80
Method A (using previous 3 years)	Tmax	0.018	1.885	0.016	9.14	-10.70
	Tmin	-0.196	1.954	0.017	10.13	-8.82
Method B (using current year only)	Tmax	0.000	1.649	0.013	10.00	-9.89
	Tmin	0.000	1.770	0.014	11.48	-7.64
Method B (using previous 3 years)	Tmax	0.018	1.918	0.016	9.13	-10.17
	Tmin	-0.196	1.983	0.017	10.79	-9.09
Method C	Tmax	0.111	1.954	0.018	9.60	-9.92
	Tmin	-0.525	2.098	0.020	9.74	-8.32

5. Designated Weather Station : Atlanta Hartsfield International Airport
Fallback Weather Station: Montgomery Dannelly Field

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	2.245	0.018	15.45	-14.71
	Tmin	0.000	2.017	0.017	10.24	-11.17
Method A (using previous 3 years)	Tmax	-0.040	2.415	0.021	15.87	-15.00
	Tmin	-0.093	2.204	0.019	11.34	-10.99
Method B (using current year only)	Tmax	0.000	2.257	0.018	15.23	-14.63
	Tmin	0.000	1.955	0.016	10.75	-11.28
Method B (using previous 3 years)	Tmax	-0.040	2.446	0.021	15.43	-15.08
	Tmin	-0.093	2.247	0.019	11.16	-11.01
Method C	Tmax	-0.043	2.501	0.024	16.95	-15.22
	Tmin	-0.256	2.353	0.022	12.04	-11.95

6. Designated Weather Station : London Heathrow International Airport
Fallback Weather Station: Northolt, Middlesex

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.459	0.006	3.67	-4.86
	Tmin	0.000	0.902	0.011	5.43	-5.75
Method A (using previous 3 years)	Tmax	0.006	0.522	0.007	3.57	-4.63
	Tmin	-0.046	0.929	0.013	5.28	-5.75
Method B (using current year only)	Tmax	0.000	0.464	0.006	3.61	-5.12
	Tmin	0.001	0.903	0.011	5.49	-5.62
Method B (using previous 3 years)	Tmax	0.006	0.526	0.007	3.53	-4.66
	Tmin	-0.046	0.942	0.013	4.89	-5.67
Method C	Tmax	-0.060	0.553	0.011	2.45	-1.98
	Tmin	-0.175	0.995	0.020	3.10	-4.37

Note: Data set is incomplete, the record begins in January 1985. Analysis has been based on the period available.

7. Designated Weather Station : Paris - Orly
Fallback Weather Station: Paris - Melun

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.726	0.006	7.79	-6.72
	Tmin	0.000	0.900	0.007	5.04	-4.55
Method A (using previous 3 years)	Tmax	-0.026	0.768	0.007	7.98	-6.94
	Tmin	-0.006	0.978	0.008	5.37	-5.55
Method B (using current year only)	Tmax	0.000	0.736	0.006	7.55	-6.67
	Tmin	0.000	0.890	0.007	5.02	-4.75
Method B (using previous 3 years)	Tmax	-0.026	0.779	0.007	7.99	-6.80
	Tmin	-0.006	0.993	0.008	5.45	-5.31
Method C	Tmax	-0.088	0.776	0.007	4.85	-7.10
	Tmin	-0.060	1.023	0.010	4.87	-5.86

8. Designated Weather Station: Berlin - Dahlem
Fallback Weather Station: Berlin - Tempelhof

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.471	0.004	4.73	-3.22
	Tmin	0.000	0.849	0.007	5.25	-4.06
Method A (using previous 3 years)	Tmax	0.013	0.502	0.004	4.64	-3.11
	Tmin	-0.004	0.877	0.007	3.77	-4.22
Method B (using current year only)	Tmax	0.000	0.475	0.004	4.71	-3.02
	Tmin	0.000	0.842	0.007	5.22	-4.35
Method B (using previous 3 years)	Tmax	0.013	0.508	0.004	4.55	-3.14
	Tmin	-0.004	0.892	0.008	4.13	-4.36
Method C	Tmax	-0.013	0.517	0.005	4.16	-3.21
	Tmin	-0.015	0.915	0.009	4.28	-4.16

9. Designated Weather Station: Stockholm - Observariat
Fallback Weather Station: Stockholm - Bromma

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.671	0.010	3.77	-6.16
	Tmin	0.001	1.562	0.023	5.88	-9.66
Method A (using previous 3 years)	Tmax	0.032	0.701	0.012	3.69	-6.05
	Tmin	0.005	1.588	0.026	6.19	-10.13
Method B (using current year only)	Tmax	0.000	0.666	0.010	3.86	-5.83
	Tmin	0.000	1.568	0.023	5.32	-8.29
Method B (using previous 3 years)	Tmax	0.032	0.713	0.012	3.76	-6.13
	Tmin	0.004	1.609	0.027	6.32	-9.99
Method C	Tmax	0.207	0.320	0.010	3.98	-5.73
	Tmin	-0.073	1.815	0.055	3.33	-10.82

Note: Data set is incomplete. Analysis has been based on the period January 1986 to December 1999.

10. Designated Weather Station: Melbourne
Fallback Weather Station: Adelaide

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.001	3.587	0.029	17.09	-22.06
	Tmin	0.001	3.089	0.025	15.81	-11.28
Method A (using previous 3 years)	Tmax	-0.012	3.603	0.031	17.23	-19.48
	Tmin	-0.022	3.124	0.027	15.96	-11.18
Method B (using current year only)	Tmax	0.000	3.650	0.030	17.83	-21.59
	Tmin	0.000	3.108	0.025	15.96	-12.05
Method B (using previous 3 years)	Tmax	-0.012	3.660	0.031	18.02	-18.22
	Tmin	-0.022	3.178	0.027	16.14	-11.36
Method C	Tmax	-0.109	3.750	0.035	16.60	-19.32
	Tmin	-0.013	3.208	0.030	14.25	-11.55

11. Designated Weather Station: Tokyo
    Fallback Weather Station: Yokohama

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.001	0.855	0.015	5.44	-8.92
	Tmin	0.000	0.661	0.012	6.62	-4.58
Method A (using previous 3 years)	Tmax	-0.037	0.856	0.018	4.86	-4.70
	Tmin	-0.052	0.667	0.014	5.60	-2.75
Method B (using current year only)	Tmax	0.000	0.876	0.015	5.30	-8.74
	Tmin	0.000	0.669	0.012	6.73	-4.37
Method B (using previous 3 years)	Tmax	-0.037	0.864	0.018	4.69	-4.58
	Tmin	-0.05	0.678	0.014	5.65	-2.68
Method C	Tmax					
	Tmin					

Note: Data set is incomplete. Analysis has been based on the period January 1994 to December 2002, which is an insufficient length of time for application of method C.

Appendix C

In addition to the above 11 stations, any additional 39 stations for which you have the weather data and which you consider to be representative for undertaking the study in question.

Location	Designated or Fallback	WMO number	Latitude (ºN)	Longitude (ºE)	Altitude (m)
1. Brussels - Uccle	Designated	6447	50.80	4.35	100
Brussels - National	*Fallback*	*6451*	*50.90*	*4.53*	*58*
2. Prague - Ruzyne	Designated	11518	50.10	14.25	365
Prague - Libus	*Fallback*	*11520*	*50.02*	*14.45*	*304*
3. Lyon - Bron	Designated	7480	45.72	4.95	200
Lyon - Satolas	*Fallback*	*7481*	*45.73*	*5.08*	*240*
4. Toulouse - Blagnac	Designated	7630	43.63	1.37	152
Toulouse - Francazal	*Fallback*	*7631*	*43.53*	*1.37*	*164*
5. Amsterdam - Schiphol Airport	Designated	6240	52.30	4.77	0
De Bilt	*Fallback*	*6260*	*52.10*	*5.18*	*2*
6. Alicante - El Altet	Designated	8360	38.28	-0.55	31
Alicante	*Fallback*	*8359*	*38.37*	*-0.50*	*81*
7. Paris Orly	Designated	7149	48.73	2.40	89
Paris - le Bourget	*Fallback*	*7150*	*48.97*	*2.45*	*66*
8. Leeds - Civil Centre	Designated	3347	53.80	-1.56	64
Leeds - Bramham	*Fallback*	*99077*	*53.87*	*-1.33*	*54*
9. Bordeaux- Merignac	Designated	7510	44.83	-0.70	49
Biarritz	*Fallback*	*7602*	*43.47*	*-1.53*	*71*
10. Bordeaux- Merignac	Designated	7510	44.83	-0.70	49
Cognac	*Fallback*	*7412*	*45.67*	*-0.32*	*30*
11. Marseilles - Marignane	Designated	7650	43.45	5.23	6
Nice	*Fallback*	*7690*	*43.65*	*7.20*	*4*
12. Strasbourg - Entzheim	Designated	7190	48.55	7.63	153
Bale – Mulhouse Airport	*Fallback*	*7299*	*47.60*	*7.52*	*271*
13. Bonn - Cologne	Designated	10513	50.87	7.17	100
Aachen	*Fallback*	*10501*	*50.78*	*6.10*	*202*
14. Hamburg – Fuhlabuettel	Designated	10147	53.63	10.00	16
Bremen	*Fallback*	*10224*	*53.05*	*8.80*	*5*
15. Essen	Designated	10410	51.40	6.97	153
Dusseldorf	*Fallback*	*10400*	*51.30*	*6.77*	*41*
16. Frankfurt – Flughafen	Designated	10637	50.05	8.60	113
Mannheim	*Fallback*	*10729*	*49.52*	*8.55*	*96*
17. Hanover	Designated	10338	52.47	9.70	55
Magdeburg	*Fallback*	*10361*	*52.12*	*11.58*	*85*
18. Dresden – Klotzsche	Designated	10488	51.13	13.78	222
Leipzig – Schkeuditz	*Fallback*	*10469*	*51.42*	*12.23*	*144*
19. Paris Orly	Designated	7149	48.73	2.40	89
Paris Melun	*Fallback*	*7153*	*48.62*	*2.68*	*95*
20. Rostock - Warnemuende	Designated	10170	54.18	12.08	4
Schwerin	*Fallback*	*10162*	*53.65*	*11.38*	*59*
21. Lisbon – Gago Coutinho	Designated	8579	38.77	-9.13	105
Funchal – Santa Catarina	*Fallback*	*8521*	*32.68*	*-16.77*	*49*
22. Malaga – Aeropuerto	Designated	8482	36.67	-4.48	7
Almeria – Aeropuerto	*Fallback*	*8487*	*36.85*	*-2.38*	*21*
23. Barcelona – Aeropuerto	Designated	8181	41.28	2.07	6
Zaragoza – Aeropuerto	*Fallback*	*8160*	*41.67*	*-1.02*	*258*
24. Limoges	Designated	7434	45.87	1.18	396
Cognac	*Fallback*	*7412*	*45.67*	*-0.32*	*30*

25. Marseilles - Marignane	Designated	7650	43.45	5.23	6
Toulouse - Francazal	*Fallback*	*7631*	*43.53*	*1.37*	*164*
26. Vienna – Schwechat Flughafen	Designated	11036	48.18	16.57	190
Linz – Hoersching Flughafen	*Fallback*	*11010*	*48.23*	*14.18*	*313*
27. Salzburg – Flughafen	Designated	11150	47.80	13.00	430
Innsbruck – Flughafen	*Fallback*	*11120*	*47.27*	*11.35*	*581*
28. Antwerp – Duerne	Designated	6450	51.20	4.47	12
Ostend - Airport	*Fallback*	*6407*	*51.20*	*2.87*	*4*
29. Stavanger – Sola	Designated	1415	58.88	5.63	9
Kristiansand – Kjevik	*Fallback*	*1452*	*58.20*	*8.08*	*17*
30. Bergen – Florida	Designated	1317	60.38	5.33	12
Trondheim – Vaernes	*Fallback*	*1271*	*63.47*	*10.93*	*17*
31. Berlin Dahlem	Designated	10381	52.47	13.30	51
Magdeburg	*Fallback*	*10361*	*52.12*	*11.58*	*85*
32. Manchester – Ringway	Designated	3334	53.36	-2.27	69
Church Fenton	*Fallback*	*3355*	*53.84*	*-1.20*	*8*
33. Brussels - National	Designated	6451	50.90	4.53	58
Antwerp – Duerne	*Fallback*	*6450*	*51.20*	*4.47*	*12*
34. Marham	Designated	3482	52.65	0.56	21
Wattisham	*Fallback*	*3590*	*52.12*	*0.96*	*89*
35. Nottingham - Watnall	Designated	3354	53.01	-1.25	117
Lincoln - Waddington	*Fallback*	*3377*	*53.18*	*-0.52*	*68*
36. Berlin - Tempelhof	Designated	10384	52.47	13.40	50
Berlin - Tegel	*Fallback*	*10382*	*52.57*	*13.32*	*37*
37. Nantes	Designated	7222	47.17	-1.60	27
Le Mans	*Fallback*	*7235*	*47.93*	*0.20*	*59*
38. Ostrava	Designated	11782	49.68	18.12	256
Prague - Ruzyne	*Fallback*	*11518*	*50.10*	*14.25*	*365*
39. Paris - Charles de Gaulle	Designated	7157	49.02	2.53	109
Paris - le Bourget	*Fallback*	*7150*	*48.97*	*2.45*	*66*

Appendix D

1. Designated Weather Station: Brussels - Uccle
   Fallback Weather Station: Brussels - National

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.329	0.011	12.42	-10.99
	Tmin	0.000	1.256	0.010	9.98	-9.80
Method A (using previous 3 years)	Tmax	-0.040	1.131	0.010	12.25	-9.14
	Tmin	0.011	1.288	0.011	10.10	-9.81
Method B (using current year only)	Tmax	0.000	1.401	0.011	12.97	-11.62
	Tmin	0.000	1.239	0.010	9.78	-10.41
Method B (using previous 3 years)	Tmax	-0.040	1.140	0.010	12.41	-8.88
	Tmin	0.011	1.312	0.011	9.97	-10.06
Method C	Tmax	-0.065	0.758	0.007	8.66	-4.32
	Tmin	-0.004	1.257	0.012	11.04	-7.62

2. Designated Weather Station: Prague -Ruzyne
   Fallback Weather Station: Prague - Libus

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.661	0.006	5.49	-4.32
	Tmin	0.000	0.930	0.009	4.42	-5.23
Method A (using previous 3 years)	Tmax	0.042	0.704	0.007	5.62	-4.14
	Tmin	0.027	0.960	0.009	4.70	-5.29
Method B (using current year only)	Tmax	0.000	0.671	0.006	5.41	-4.07
	Tmin	0.000	0.936	0.009	4.50	-5.56
Method B (using previous 3 years)	Tmax	0.041	0.712	0.007	5.77	-4.30
	Tmin	0.027	0.973	0.010	4.48	-5.31
Method C	Tmax	0.081	0.719	0.008	5.27	-4.03
	Tmin	0.016	1.004	0.011	4.57	-5.19

Note: Data set is incomplete, the record begins in January 1971. Analysis has been based on the period available.

3. Designated Weather Station: Lyon - Bron
Fallback Weather Station: Lyon - Satolas

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.599	0.006	10.87	-2.99
	Tmin	0.000	0.923	0.009	6.53	-5.98
Method A (using previous 3 years)	Tmax	-0.025	0.677	0.007	10.59	-3.05
	Tmin	0.005	0.973	0.011	6.56	-5.74
Method B (using current year only)	Tmax	0.000	0.606	0.006	11.04	-3.16
	Tmin	0.000	0.926	0.010	6.37	-6.34
Method B (using previous 3 years)	Tmax	-0.025	0.687	0.007	10.69	-3.05
	Tmin	0.004	0.989	0.011	6.38	-5.93
Method C	Tmax	0.025	0.685	0.009	5.47	-3.05
	Tmin	0.182	1.047	0.014	6.50	-5.46

Note: Data set is incomplete, the record begins in January 1975. Analysis has been based on the period available.

4. Designated Weather Station: Toulouse - Blagnac
Fallback Weather Station: Toulouse - Francazal

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.564	0.005	5.92	-5.05
	Tmin	0.000	0.811	0.007	6.02	-7.25
Method A (using previous 3 years)	Tmax	-0.010	0.601	0.005	5.46	-5.22
	Tmin	0.020	0.846	0.007	6.32	-7.19
Method B (using current year only)	Tmax	0.000	0.573	0.005	6.19	-4.87
	Tmin	0.000	0.828	0.007	6.07	-7.19
Method B (using previous 3 years)	Tmax	-0.009	0.608	0.005	5.50	-5.23
	Tmin	0.020	0.856	0.007	6.33	-7.14
Method C	Tmax	-0.013	0.639	0.006	5.34	-4.84
	Tmin	0.039	0.881	0.008	6.36	-7.71

5. Designated Weather Station: Amsterdam - Schiphol
Fallback Weather Station: De Bilt

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.787	0.006	5.47	-5.43
	Tmin	0.000	1.105	0.009	8.44	-7.08
Method A (using previous 3 years)	Tmax	-0.007	0.845	0.007	4.11	-5.38
	Tmin	0.010	1.137	0.010	7.95	-6.84
Method B (using current year only)	Tmax	0.000	0.791	0.006	4.73	-5.29
	Tmin	0.000	1.098	0.009	7.94	-6.40
Method B (using previous 3 years)	Tmax	-0.007	0.857	0.007	4.12	-5.25
	Tmin	0.010	1.158	0.010	8.21	-6.83
Method C	Tmax	-0.066	0.876	0.008	4.36	-5.18
	Tmin	0.050	1.175	0.011	8.11	-5.45

6. Designated Weather Station: Alicante – El Altet
Fallback Weather Station: Alicante

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.939	0.008	5.91	-4.95
	Tmin	0.000	1.043	0.009	9.57	-5.48
Method A (using previous 3 years)	Tmax	0.077	1.008	0.009	6.28	-5.03
	Tmin	0.042	1.072	0.010	9.43	-5.00
Method B (using current year only)	Tmax	0.000	0.947	0.008	6.39	-4.91
	Tmin	0.000	1.042	0.009	9.24	-5.32
Method B (using previous 3 years)	Tmax	0.077	1.022	0.009	6.27	-5.19
	Tmin	0.042	1.091	0.010	9.60	-4.95
Method C	Tmax	0.114	1.117	0.012	5.77	-4.70
	Tmin	0.047	1.077	0.011	6.06	-6.29

Note: Data set is incomplete, the record begins in January 1967. Analysis has been based on the period available.

7. Designated Weather Station: Paris - Orly
Fallback Weather Station: Paris – le Bourget

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.659	0.005	5.65	-5.60
	Tmin	0.000	0.973	0.008	4.27	-6.56
Method A (using previous 3 years)	Tmax	0.005	0.699	0.006	5.65	-5.59
	Tmin	0.011	1.055	0.009	4.27	-7.18
Method B (using current year only)	Tmax	0.000	0.665	0.005	5.26	-5.46
	Tmin	0.000	0.955	0.008	4.25	-6.60
Method B (using previous 3 years)	Tmax	0.004	0.707	0.006	5.58	-5.56
	Tmin	0.011	1.070	0.009	4.37	-7.21
Method C	Tmax	0.003	0.737	0.007	4.79	-5.75
	Tmin	0.033	1.111	0.010	4.25	-7.28

8. Designated Weather Station: Leeds – Civil Centre
Fallback Weather Station: Leeds - Bramham

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.876	0.012	7.42	-12.11
	Tmin	0.000	1.112	0.016	9.50	-9.04
Method A (using previous 3 years)	Tmax	0.006	0.900	0.014	7.36	-11.96
	Tmin	-0.038	1.163	0.018	9.62	-9.67
Method B (using current year only)	Tmax	0.000	0.890	0.012	7.52	-11.93
	Tmin	0.000	1.116	0.016	8.74	-9.06
Method B (using previous 3 years)	Tmax	0.007	0.911	0.014	7.20	-11.67
	Tmin	-0.038	1.182	0.019	9.43	-9.78
Method C	Tmax	0.007	0.886	0.023	4.59	-4.63
	Tmin	-0.151	1.157	0.030	3.83	-3.95

Note: Data set is incomplete, the record begins in January 1986. Analysis has been based on the period available.

9. Designated Weather Station: Bordeaux - Merignac
Fallback Weather Station: Biarritz

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.001	2.344	0.019	12.28	-11.73
	Tmin	0.000	2.061	0.017	9.83	-9.46
Method A (using previous 3 years)	Tmax	-0.021	2.446	0.021	14.14	-12.07
	Tmin	-0.068	2.095	0.018	9.30	-9.85
Method B (using current year only)	Tmax	0.000	2.284	0.019	12.03	-11.43
	Tmin	0.000	2.069	0.017	9.38	-9.09
Method B (using previous 3 years)	Tmax	-0.021	2.490	0.021	13.68	-13.38
	Tmin	-0.068	2.125	0.018	9.16	-10.19
Method C	Tmax	-0.063	2.547	0.024	14.68	-13.93
	Tmin	-0.181	2.179	0.021	9.44	-10.14

10. Designated Weather Station: Bordeaux - Merignac
Fallback Weather Station: Cognac

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.376	0.011	9.18	-12.74
	Tmin	0.000	1.464	0.012	8.29	-7.74
Method A (using previous 3 years)	Tmax	-0.005	1.403	0.012	8.60	-10.31
	Tmin	-0.043	1.492	0.013	7.74	-7.96
Method B (using current year only)	Tmax	0.000	1.388	0.011	10.18	-12.76
	Tmin	0.000	1.488	0.012	7.68	-7.61
Method B (using previous 3 years)	Tmax	-0.005	1.425	0.012	9.02	-10.47
	Tmin	-0.043	1.508	0.013	8.00	-8.20
Method C	Tmax	-0.038	1.464	0.014	8.58	-10.93
	Tmin	-0.133	1.552	0.015	8.07	-8.49

11. Designated Weather Station: Marseilles
    Fallback Weather Station: Nice

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	-0.001	2.494	0.020	11.73	-8.63
	Tmin	0.000	2.445	0.020	10.59	-9.38
Method A (using previous 3 years)	Tmax	-0.015	2.624	0.022	12.32	-9.70
	Tmin	0.000	2.512	0.021	11.40	-8.59
Method B (using current year only)	Tmax	0.000	2.413	0.020	11.76	-9.34
	Tmin	0.000	2.371	0.019	9.05	-10.54
Method B (using previous 3 years)	Tmax	-0.016	2.679	0.023	12.06	-9.85
	Tmin	0.000	2.556	0.022	11.42	-8.59
Method C	Tmax	-0.071	2.701	0.025	12.61	-10.50
	Tmin	0.046	2.637	0.025	12.31	-9.06

12. Designated Weather Station: Strasbourg
    Fallback Weather Station: Bale

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.001	1.730	0.014	9.97	-7.93
	Tmin	0.000	1.684	0.014	11.62	-10.23
Method A (using previous 3 years)	Tmax	-0.010	1.807	0.015	11.05	-7.52
	Tmin	-0.043	1.730	0.015	11.42	-11.27
Method B (using current year only)	Tmax	0.000	1.710	0.014	10.40	-9.13
	Tmin	0.000	1.682	0.014	10.90	-10.35
Method B (using previous 3 years)	Tmax	-0.010	1.838	0.016	11.50	-7.63
	Tmin	-0.043	1.759	0.015	11.72	-11.09
Method C	Tmax	-0.024	1.879	0.018	11.98	-7.30
	Tmin	-0.148	1.814	0.017	11.33	-11.47

13. Designated Weather Station: Bonn - Cologne
Fallback Weather Station: Aachen

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.390	0.011	9.36	-6.68
	Tmin	0.000	1.855	0.015	9.54	-7.92
Method A (using previous 3 years)	Tmax	0.004	1.441	0.012	10.49	-6.87
	Tmin	-0.002	1.907	0.016	9.75	-6.75
Method B (using current year only)	Tmax	0.000	1.348	0.011	8.68	-8.47
	Tmin	0.000	1.826	0.015	9.64	-8.01
Method B (using previous 3 years)	Tmax	0.004	1.469	0.012	10.82	-6.72
	Tmin	-0.002	1.940	0.016	9.68	-7.25
Method C	Tmax	0.005	1.488	0.014	11.07	-6.93
	Tmin	0.049	1.990	0.019	10.44	-6.33

14. Designated Weather Station: Hamburg
Fallback Weather Station: Bremen

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.236	0.010	8.25	-8.67
	Tmin	0.000	1.533	0.013	8.69	-7.53
Method A (using previous 3 years)	Tmax	-0.005	1.275	0.011	7.46	-8.13
	Tmin	-0.019	1.580	0.013	9.33	-8.20
Method B (using current year only)	Tmax	0.000	1.239	0.010	7.78	-8.69
	Tmin	0.000	1.543	0.013	9.16	-8.12
Method B (using previous 3 years)	Tmax	-0.005	1.292	0.011	7.58	-7.96
	Tmin	-0.019	1.601	0.014	9.41	-8.57
Method C	Tmax	-0.059	1.330	0.013	8.55	-7.87
	Tmin	-0.093	1.679	0.016	8.05	-8.45

15. Designated Weather Station: Essen
Fallback Weather Station: Dusseldorf

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.672	0.006	3.49	-4.33
	Tmin	0.000	1.283	0.012	3.73	-7.23
Method A (using previous 3 years)	Tmax	-0.008	0.701	0.007	3.46	-4.91
	Tmin	0.020	1.344	0.013	4.45	-7.65
Method B (using current year only)	Tmax	0.000	0.664	0.006	3.55	-4.37
	Tmin	0.000	1.229	0.011	4.38	-6.68
Method B (using previous 3 years)	Tmax	-0.008	0.713	0.007	3.56	-5.02
	Tmin	0.019	1.370	0.013	3.74	-7.36
Method C	Tmax	-0.061	0.736	0.008	3.57	-5.05
	Tmin	-0.010	1.388	0.015	3.47	-7.64

Note: Data set is incomplete, the record begins in January 1970. Analysis has been based on the period available.

16. Designated Weather Station: Frankfurt
Fallback Weather Station: Mannheim

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.102	0.009	6.11	-8.48
	Tmin	0.000	1.360	0.011	7.81	-9.28
Method A (using previous 3 years)	Tmax	-0.001	1.127	0.010	6.54	-9.45
	Tmin	-0.076	1.370	0.012	7.33	-10.39
Method B (using current year only)	Tmax	0.000	1.112	0.009	6.12	-8.87
	Tmin	0.000	1.375	0.011	8.16	-9.03
Method B (using previous 3 years)	Tmax	-0.001	1.143	0.010	6.57	-9.58
	Tmin	-0.076	1.389	0.012	7.15	-10.21
Method C	Tmax	-0.016	1.158	0.011	5.79	-8.31
	Tmin	-0.229	1.444	0.014	5.95	-10.88

17. Designated Weather Station: Hanover
Fallback Weather Station: Magdeburg

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.531	0.013	9.74	-10.30
	Tmin	0.000	1.730	0.014	9.04	-10.50
Method A (using previous 3 years)	Tmax	-0.034	1.569	0.013	10.10	-9.85
	Tmin	-0.027	1.741	0.015	7.36	-10.25
Method B (using current year only)	Tmax	0.000	1.549	0.013	9.48	-9.87
	Tmin	0.000	1.734	0.014	8.75	-10.86
Method B (using previous 3 years)	Tmax	-0.035	1.591	0.014	10.27	-10.02
	Tmin	-0.027	1.767	0.015	7.58	-10.25
Method C	Tmax	-0.029	1.640	0.015	10.44	-10.16
	Tmin	-0.086	1.813	0.017	7.54	-10.25

18. Designated Weather Station: Dresden
Fallback Weather Station: Leipzig

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.529	0.015	7.43	-12.01
	Tmin	0.001	1.409	0.014	6.05	-11.29
Method A (using previous 3 years)	Tmax	0.042	1.598	0.016	8.40	-12.36
	Tmin	0.031	1.473	0.015	6.57	-11.98
Method B (using current year only)	Tmax	0.000	1.506	0.015	6.90	-11.99
	Tmin	0.000	1.395	0.014	6.71	-9.52
Method B (using previous 3 years)	Tmax	0.042	1.624	0.017	8.48	-12.19
	Tmin	0.031	1.499	0.015	6.52	-12.25
Method C	Tmax	0.131	1.635	0.020	7.93	-10.93
	Tmin	0.062	1.518	0.018	6.83	-11.60

Note: Data set is incomplete, the record begins in January 1973. Analysis has been based on the period available.

19. Designated Weather Station: Paris - Orly
Fallback Weather Station: Paris - Melun

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.906	0.007	7.22	-8.73
	Tmin	0.000	1.067	0.009	6.24	-7.02
Method A (using previous 3 years)	Tmax	0.031	0.947	0.008	7.05	-8.28
	Tmin	0.017	1.091	0.009	5.94	-7.43
Method B (using current year only)	Tmax	0.000	0.916	0.007	7.47	-9.25
	Tmin	0.000	1.077	0.009	6.20	-7.20
Method B (using previous 3 years)	Tmax	0.031	0.959	0.008	7.05	-8.38
	Tmin	0.000	1.077	0.009	6.20	-7.20
Method C	Tmax	0.088	0.776	0.007	7.10	-4.85
	Tmin	0.060	1.023	0.010	5.86	-4.87

20. Designated Weather Station: Rostock
Fallback Weather Station: Schwerin

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.491	0.012	12.06	-7.22
	Tmin	0.000	1.371	0.011	8.08	-7.65
Method A (using previous 3 years)	Tmax	-0.025	1.568	0.013	13.68	-7.83
	Tmin	-0.016	1.431	0.012	7.78	-8.25
Method B (using current year only)	Tmax	0.000	1.446	0.012	10.68	-7.31
	Tmin	0.000	1.323	0.011	8.20	-6.82
Method B (using previous 3 years)	Tmax	-0.025	1.597	0.014	13.20	-8.04
	Tmin	-0.016	1.461	0.012	7.89	-8.18
Method C	Tmax	-0.026	1.593	0.015	12.97	-7.61
	Tmin	-0.063	1.475	0.014	5.96	-8.72

21. Designated Weather Station: Lisbon
    Fallback Weather Station: Funchal

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	-0.001	2.905	0.034	12.50	-12.00
	Tmin	0.000	2.229	0.026	8.44	-10.63
Method A (using previous 3 years)	Tmax	0.025	3.193	0.041	11.36	-12.40
	Tmin	-0.102	2.537	0.032	8.93	-9.85
Method B (using current year only)	Tmax	0.000	2.698	0.032	9.95	-13.42
	Tmin	0.000	2.106	0.025	8.92	-10.42
Method B (using previous 3 years)	Tmax	0.026	3.275	0.042	11.43	-13.30
	Tmin	-0.101	2.596	0.033	9.41	-9.96
Method C	Tmax	0.003	3.357	0.056	10.55	-12.77
	Tmin	-0.150	2.581	0.043	9.47	-10.00

Note: Data set is incomplete, the record begins in January 1982. Analysis has been based on the period available.

22. Designated Weather Station: Malaga
    Fallback Weather Station: Almeria

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.001	3.080	0.028	12.83	-15.60
	Tmin	0.001	2.141	0.019	8.34	-14.31
Method A (using previous 3 years)	Tmax	-0.018	3.140	0.030	12.16	-14.97
	Tmin	0.049	2.200	0.021	7.23	-9.71
Method B (using current year only)	Tmax	0.000	3.094	0.028	14.38	-16.78
	Tmin	0.000	2.128	0.019	8.54	-14.42
Method B (using previous 3 years)	Tmax	-0.018	3.189	0.030	11.66	-15.08
	Tmin	0.048	2.241	0.021	7.18	-9.83
Method C	Tmax	0.010	3.304	0.035	12.08	-15.10
	Tmin	0.014	2.289	0.024	7.96	-11.08

Note: Data set is incomplete, the record begins in January 1969. Analysis has been based on the period available.

23. Designated Weather Station: Barcelona
Fallback Weather Station: Zaragoza

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	3.024	0.025	12.24	-15.26
	Tmin	0.000	2.305	0.019	10.35	-13.27
Method A (using previous 3 years)	Tmax	0.073	3.234	0.027	14.10	-16.14
	Tmin	0.040	2.460	0.021	11.22	-12.20
Method B (using current year only)	Tmax	0.000	2.903	0.024	12.32	-14.63
	Tmin	0.000	2.236	0.018	11.66	-12.57
Method B (using previous 3 years)	Tmax	0.073	3.310	0.028	14.75	-16.07
	Tmin	0.040	2.503	0.021	11.33	-12.39
Method C	Tmax	0.071	3.329	0.031	14.52	-16.17
	Tmin	0.051	2.582	0.024	10.78	-11.03

24. Designated Weather Station: Limoges
Fallback Weather Station: Cognac

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.674	0.016	7.29	-10.85
	Tmin	0.000	1.823	0.018	7.00	-8.73
Method A (using previous 3 years)	Tmax	-0.004	1.768	0.018	7.14	-10.62
	Tmin	0.040	1.900	0.019	6.64	-9.92
Method B (using current year only)	Tmax	0.000	1.620	0.016	7.92	-10.06
	Tmin	0.000	1.796	0.017	8.24	-8.29
Method B (using previous 3 years)	Tmax	-0.004	1.803	0.019	8.09	-11.35
	Tmin	0.040	1.940	0.020	7.21	-9.69
Method C	Tmax	0.036	1.827	0.022	7.50	-10.87
	Tmin	0.105	1.957	0.023	7.00	-8.67

25. Designated Weather Station: Marseilles - Marignane
Fallback Weather Station: Toulouse - Francazal

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	-0.001	2.827	0.023	14.53	-12.10
	Tmin	0.000	2.741	0.022	11.52	-13.03
Method A (using previous 3 years)	Tmax	0.012	2.952	0.025	14.87	-13.17
	Tmin	-0.043	2.787	0.024	11.75	-12.25
Method B (using current year only)	Tmax	0.000	2.765	0.023	13.37	-10.77
	Tmin	0.000	2.710	0.022	12.09	-12.35
Method B (using previous 3 years)	Tmax	0.012	3.013	0.026	15.26	-12.55
	Tmin	-0.043	2.840	0.024	11.09	-12.35
Method C	Tmax	0.019	3.081	0.029	14.09	-13.96
	Tmin	-0.101	2.894	0.027	12.15	-12.15

26. Designated Weather Station: Vienna
Fallback Weather Station: Linz

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.001	2.192	0.018	14.63	-13.50
	Tmin	0.001	2.140	0.018	11.25	-16.11
Method A (using previous 3 years)	Tmax	-0.019	2.310	0.020	14.78	-13.17
	Tmin	0.011	2.214	0.019	11.88	-16.43
Method B (using current year only)	Tmax	0.000	2.135	0.017	15.02	-12.56
	Tmin	0.000	2.108	0.017	11.02	-13.93
Method B (using previous 3 years)	Tmax	-0.019	2.349	0.020	15.48	-13.05
	Tmin	0.010	2.250	0.019	11.97	-16.41
Method C	Tmax	0.040	2.392	0.023	14.80	-13.36
	Tmin	0.069	2.283	0.021	11.77	-18.30

27. Designated Weather Station: Salzburg
Fallback Weather Station: Innsbruck

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.001	2.401	0.020	13.25	-12.31
	Tmin	0.002	2.408	0.020	16.48	-11.31
Method A (using previous 3 years)	Tmax	-0.063	2.626	0.022	14.51	-11.40
	Tmin	-0.018	2.566	0.022	17.75	-13.06
Method B (using current year only)	Tmax	0.000	2.314	0.019	13.65	-12.08
	Tmin	0.001	2.301	0.019	14.82	-12.38
Method B (using previous 3 years)	Tmax	-0.063	2.678	0.023	14.79	-12.40
	Tmin	-0.018	2.612	0.022	18.54	-12.74
Method C	Tmax	-0.020	2.667	0.025	14.18	-12.44
	Tmin	0.005	2.614	0.025	17.76	-10.52

28. Designated Weather Station: Antwerp
Fallback Weather Station: Ostend

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.741	0.014	8.63	-14.30
	Tmin	0.001	1.791	0.015	14.94	-10.27
Method A (using previous 3 years)	Tmax	-0.003	1.832	0.016	9.36	-14.39
	Tmin	-0.051	1.844	0.016	15.57	-11.08
Method B (using current year only)	Tmax	0.000	1.679	0.014	9.00	-14.32
	Tmin	0.000	1.761	0.014	14.01	-9.25
Method B (using previous 3 years)	Tmax	-0.003	1.873	0.016	8.87	-14.85
	Tmin	-0.051	1.880	0.016	15.68	-11.25
Method C	Tmax	0.010	1.889	0.018	8.47	-14.13
	Tmin	-0.121	1.893	0.018	8.60	-11.18

29. Designated Weather Station: Stavanger
Fallback Weather Station: Kristiansand

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	2.404	0.020	12.57	-11.67
	Tmin	0.001	2.511	0.021	12.92	-13.75
Method A (using previous 3 years)	Tmax	0.018	2.645	0.022	12.09	-13.78
	Tmin	0.012	2.651	0.023	12.42	-14.94
Method B (using current year only)	Tmax	0.000	2.254	0.018	12.35	-13.41
	Tmin	0.000	2.447	0.020	14.36	-15.12
Method B (using previous 3 years)	Tmax	0.018	2.711	0.023	12.51	-13.72
	Tmin	0.013	2.705	0.023	12.25	-15.13
Method C	Tmax	0.078	2.751	0.026	13.38	-13.78
	Tmin	0.025	2.697	0.025	11.87	-14.89

30. Designated Weather Station: Bergen
Fallback Weather Station: Trondheim

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.001	3.166	0.026	13.75	-16.46
	Tmin	0.001	3.146	0.026	15.82	-17.63
Method A (using previous 3 years)	Tmax	-0.033	3.389	0.029	15.31	-17.47
	Tmin	0.036	3.360	0.029	13.35	-17.94
Method B (using current year only)	Tmax	0.000	2.953	0.024	14.93	-14.35
	Tmin	0.000	2.967	0.024	16.58	-16.14
Method B (using previous 3 years)	Tmax	-0.032	3.465	0.029	17.86	-17.25
	Tmin	0.037	3.434	0.029	15.19	-17.55
Method C	Tmax	-0.011	3.490	0.033	15.32	-16.97
	Tmin	0.181	3.425	0.032	14.49	-16.68

31. Designated Weather Station: Berlin - Dahlem
Fallback Weather Station: Magedeburg

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.442	0.012	8.01	-9.14
	Tmin	0.000	1.546	0.013	11.23	-6.97
Method A (using previous 3 years)	Tmax	0.001	1.478	0.013	8.52	-8.48
	Tmin	-0.024	1.585	0.013	10.62	-8.04
Method B (using current year only)	Tmax	0.000	1.440	0.012	8.00	-9.21
	Tmin	0.000	1.527	0.012	10.11	-6.99
Method B (using previous 3 years)	Tmax	0.001	1.502	0.013	8.64	-8.48
	Tmin	-0.023	1.610	0.014	10.68	-8.87
Method C	Tmax	-0.035	1.533	0.014	8.80	-8.59
	Tmin	-0.012	1.629	0.015	7.28	-10.10

32. Designated Weather Station: Manchester
Fallback Weather Station: Church Fenton

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.429	0.019	7.33	-8.64
	Tmin	0.000	1.767	0.024	7.46	-12.51
Method A (using previous 3 years)	Tmax	0.003	1.471	0.022	6.73	-8.31
	Tmin	-0.045	1.773	0.027	8.39	-12.67
Method B (using current year only)	Tmax	0.000	1.402	0.019	7.56	-8.35
	Tmin	0.000	1.760	0.024	8.16	-11.23
Method B (using previous 3 years)	Tmax	0.003	1.491	0.023	6.70	-8.46
	Tmin	-0.045	1.803	0.027	8.83	-12.37
Method C	Tmax	0.061	1.513	0.035	6.81	-7.98
	Tmin	-0.128	1.769	0.041	6.63	-7.78

Note: Data set is incomplete, the record begins in January 1984. Analysis has been based on the period available.

33. Designated Weather Station: Brussels - National
Fallback Weather Station: Antwerp

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.848	0.007	9.82	-9.80
	Tmin	0.001	1.209	0.010	7.51	-10.49
Method A (using previous 3 years)	Tmax	-0.025	0.911	0.008	8.95	-9.87
	Tmin	-0.033	1.256	0.011	6.90	-10.88
Method B (using current year only)	Tmax	0.000	0.854	0.007	9.20	-9.58
	Tmin	0.000	1.188	0.010	7.16	-10.55
Method B (using previous 3 years)	Tmax	-0.025	0.923	0.008	8.98	-9.86
	Tmin	-0.033	1.277	0.011	7.13	-10.93
Method C	Tmax	-0.051	0.903	0.008	9.87	-5.83
	Tmin	-0.114	1.277	0.012	11.24	-6.41

34. Designated Weather Station: Marham
Fallback Weather Station: Wattisham

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.974	0.011	7.50	-5.73
	Tmin	0.000	1.193	0.013	6.84	-5.61
Method A (using previous 3 years)	Tmax	-0.041	0.993	0.012	7.04	-5.48
	Tmin	0.040	1.222	0.015	7.10	-5.32
Method B (using current year only)	Tmax	0.000	0.985	0.011	7.22	-5.94
	Tmin	0.000	1.211	0.014	7.09	-5.26
Method B (using previous 3 years)	Tmax	-0.041	1.006	0.012	6.87	-5.52
	Tmin	0.040	1.239	0.015	7.28	-5.00
Method C	Tmax	-0.076	1.068	0.016	6.62	-5.19
	Tmin	0.051	1.278	0.019	6.46	-4.96

Note: Data set is incomplete, the record begins in January 1984. Analysis has been based on the period available.

35. Designated Weather Station: Nottingham - Watnall
Fallback Weather Station: Lincoln - Waddington

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.950	0.009	7.08	-8.52
	Tmin	0.000	0.990	0.009	9.97	-5.50
Method A (using previous 3 years)	Tmax	0.003	0.937	0.009	4.67	-5.82
	Tmin	0.001	0.977	0.010	5.08	-5.92
Method B (using current year only)	Tmax	0.000	0.950	0.009	7.31	-9.33
	Tmin	0.000	1.003	0.009	9.87	-5.92
Method B (using previous 3 years)	Tmax	0.003	0.954	0.009	4.87	-5.60
	Tmin	0.001	0.990	0.010	5.17	-5.73
Method C	Tmax	0.009	0.962	0.011	5.09	-5.32
	Tmin	0.012	1.011	0.012	4.92	-5.63

Note: Data set is incomplete, the record begins in January 1971. Analysis has been based on the period available.

36. Designated Weather Station: Berlin - Tempelhof
Fallback Weather Station: Berlin - Tegel

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.484	0.004	2.88	-9.04
	Tmin	0.000	0.892	0.007	4.73	-6.90
Method A (using previous 3 years)	Tmax	-0.004	0.483	0.004	3.01	-9.04
	Tmin	0.043	0.894	0.008	4.95	-5.57
Method B (using current year only)	Tmax	0.000	0.492	0.004	3.01	-9.01
	Tmin	0.000	0.896	0.007	5.13	-5.88
Method B (using previous 3 years)	Tmax	-0.004	0.490	0.004	2.94	-9.12
	Tmin	0.043	0.909	0.008	4.87	-5.56
Method C	Tmax	0.032	0.503	0.005	3.04	-8.77
	Tmin	0.081	0.910	0.009	4.76	-4.97

Note: Data set is incomplete, the record begins in January 1963. Analysis has been based on the period available.

37. Designated Weather Station: Nantes
Fallback Weather Station: Le Mans

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	1.551	0.013	10.37	-10.49
	Tmin	0.000	1.882	0.015	7.81	-12.05
Method A (using previous 3 years)	Tmax	0.024	1.585	0.013	9.76	-9.42
	Tmin	0.047	1.916	0.016	7.89	-12.40
Method B (using current year only)	Tmax	0.000	1.556	0.013	10.47	-10.79
	Tmin	0.000	1.899	0.016	7.89	-11.72
Method B (using previous 3 years)	Tmax	0.024	1.612	0.014	9.89	-9.23
	Tmin	0.047	1.940	0.016	7.85	-12.04
Method C	Tmax	0.081	1.652	0.016	10.27	-8.21
	Tmin	0.071	1.970	0.019	8.49	-9.70

38. Designated Weather Station: Ostrava
Fallback Weather Station: Prague - Ruzyne

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.001	2.661	0.022	12.54	-16.80
	Tmin	0.001	2.614	0.021	16.25	-13.51
Method A (using previous 3 years)	Tmax	-0.013	2.774	0.024	11.69	-15.88
	Tmin	-0.022	2.688	0.023	14.79	-14.43
Method B (using current year only)	Tmax	0.000	2.615	0.021	12.50	-16.94
	Tmin	0.000	2.561	0.021	14.37	-11.84
Method B (using previous 3 years)	Tmax	-0.014	2.817	0.024	12.32	-15.95
	Tmin	-0.023	2.747	0.023	14.65	-14.28
Method C	Tmax	-0.058	2.873	0.027	12.19	-16.94
	Tmin	0.005	2.840	0.027	21.30	-14.42

39. Designated Weather Station: Paris –Charles de Gaulle
Fallback Weather Station: Paris – le Bourget

METHOD		Mean error (ºC)	RMS error	STDEV of RMS error	Max +ve error (ºC)	Max -ve error (ºC)
Method A (using current year only)	Tmax	0.000	0.398	0.004	4.49	-3.38
	Tmin	0.000	0.968	0.010	5.04	-4.55
Method A (using previous 3 years)	Tmax	-0.018	0.438	0.005	4.86	-3.75
	Tmin	-0.009	1.017	0.011	3.38	-4.28
Method B (using current year only)	Tmax	0.000	0.399	0.004	4.61	-3.36
	Tmin	0.000	0.965	0.010	4.90	-4.53
Method B (using previous 3 years)	Tmax	-0.018	0.445	0.005	4.91	-3.92
	Tmin	-0.009	1.033	0.011	3.43	-4.48
Method C	Tmax	0.002	0.444	0.005	4.75	-3.81
	Tmin	0.009	1.093	0.013	3.18	-4.19

Note: Data set is incomplete, the record begins in January 1974. Analysis has been based on the period available.

Appendix E

A brief description of the sites in Study A.

Location	Comments
1. Chicago O'Hare International Airport *Chicago Midway Airport*	Both sites lay near an urbanised area close to Lake Michigan
2. New York La Guardia *New York Central Park*	Both sites are in an urbanised area very close to the Atlantic coast
3. Philadelphia International Airport *Allentown Lehigh Valley*	Whilst Philadelphia International Airport lies in near an urban environment, Allentown lays some tens of miles away in a much more rural setting and at a slightly higher elevation above sea level. Both sites are a similar distance from the coast
4. Phoenix Sky Harbour International *Tucson International Airport*	Though the two sites are quite some distance apart (approximately 100 miles), both lay near urban areas in arid conditions well away from the nearest coast. Tucson is almost 800 metres above sea level while Phoenix is at just over 300 metres.
5. Atlanta Hartsfield International Airport *Montgomery Dannelly Field*	Atlanta Hartsfield is as far from the Atlantic as Montgomery Dannelly Field is from the Gulf of Mexico. Hills rise between the two quite distant sites. Atlanta is a couple of hundred metres elevation above Montgomery.
6. London Heathrow International Airport *Northolt, Middlesex*	Both sites are tens of miles from the nearest coast though closer to the Thames. Both lay within urban areas.
7. Paris Orly *Paris Melun*	Both sites are significantly inland and near urban areas
8. Berlin Dahlem *Berlin Tempelhof*	Both sites are significantly inland and near urban areas
9. Stockholm Observariat *Stockholm Bromma*	Both largely urban sites are approximately ten miles from the coast and small lakes are nearby both.
10. Melbourne *Adelaide*	Although some distance apart both are urban sites on Australia's southern coast.
11. Tokyo *Yokohama*	These sites are relatively adjacent (less than 20 miles) in a relatively sheltered coastal position with mountains to the west.

Appendix F

Brief descriptions of the station pairings for Study B are given.

Location	Comments
1. Brussels - Uccle *Brussels - National*	Both sites are inland and near urban areas
2. Prague - Ruzyne *Prague - Libus*	Both sites well inland. Ruzyne about 8 miles west of city outskirts. Libus immediately south of city – more urban influence.
3. Lyon - Bron *Lyon - Satolas*	Approx. 8 miles apart, just east of Lyon in Rhone valley. Bron nearer to Lyon. Both sites well inland.
4. Toulouse - Blagnac *Toulouse - Francazal*	Both sites are well inland but lie just to the north of the Pyrennes mountain range.
5. Amsterdam - Schiphol Airport *De Bilt*	Both sites lie on very flat terrain. Amsterdam is less than 15 miles from the North Sea coast while De Bilt is further inland
6. Alicante - El Altet *Alicante*	Alicante is on the Mediterranean coast of Spain.
7. Paris Orly *Paris - le Bourget*	Both sites are significantly inland and near urban areas
8. Leeds - Civil Centre *Leeds - Bramham*	Significantly inland urban sites. Higher ground lies to the west.
9. Bordeaux- Merignac *Biarritz*	Biarritz is to the south of Bordeaux on the Atlantic Coast but very close to the Pyrennes Mountains, so local weather effects will be quite different.
10. Bordeaux- Merignac *Cognac*	Both sites lie a few miles inland from the French Atlantic Coast. Although Cognac is a distance to the north of Bordeaux both sites are on the very flat coastal plain characteristic of this region.
11. Marseilles - Marignane *Nice*	Both sites lay on the north Mediterranean coast separated by around 100 miles. Nice lays much closer to the foothills of the Alps.
12. Strasbourg - Entzheim *Bale – Mulhouse Airport*	Bale (or Basel) is approximately fifty miles south of Strasbourg. Both sites are inland. Strasbourg is in a valley while Bale is at higher elevation on the edge of the Alps.
13. Bonn - Cologne *Aachen*	Aachen lies approximately 40 miles east of Bonn. Both are significantly inland and near urban areas. There is high ground to the south of both sites.
14. Hamburg – Fuhlabuettel *Bremen*	Both sites are approximately forty miles inland from the coast and both are urban sites on rivers. While a distance apart the two sites are similar in that they are on the northern German plains.
15. Essen *Dusseldorf*	Both sites are significantly inland and near urban areas. Both sites lie on the edge of the low lands with higher ground rising to the east
16. Frankfurt – Flughafen *Mannheim*	Mannheim is less than fifty miles south of Frankfurt in the Rhine Valley. Both sites are significantly inland and near urban areas, and are fairly sheltered with higher ground on all sides.
17. Hannover *Magdeburg*	While separated by about fifty miles both are significantly inland and lie on the plains just to the north of higher ground
18. Leipzig – Schkeuditz *Dresden – Klotzsche*	While separated by about forty miles both are urban sites, significantly inland and lie on the plains just to the north of higher ground
19. Paris Orly *Paris Melun*	Both sites are significantly inland and near urban areas
20. Rostock - Warnemuende *Schwerin*	Rostock is on the German Baltic Coast while Schwerin is inland on the edge of a large lake. Both are on the north German plain.

21. Lisbon – Gago Coutinho *Funchal – Santa Catarina*	There is significant separation between these sites. Lisbon is on the Atlantic coast of Portugal which Funchal is on the eastern side of the island of Madeira
22. Malaga – Aeropuerto *Almeria – Aeropuerto*	Although separated by almost a hundred miles both of these sites have very similar characteristics, both on coastal Spain's southern Mediterranean coast.
23. Barcelona – Aeropuerto *Zaragoza – Aeropuerto*	Barcelona lies on the Mediterranean coast while Zaragoza is many miles inland. While there is significant separation between these sites they are both a similar distance to the south of the Pyrennes mountain range.
24. Limoges *Cognac*	Limoges is significantly further inland than Cognac and is at high elevation, being off the coastal plain.
25. Marseilles - Marignane *Toulouse - Francazal*	Marseilles lies on the Mediterranean coast, to the south of the Alps, while Toulouse is a significant distance to the west, inland and to the north of the Pyrennes.
26. Vienna – Schwechat Flughafen *Linz – Hoersching Flughafen*	Linz is a significant distance to the west of Vienna but both lie at similar elevations above sea level and at equivalent distances north of the Alps.
27. Salzburg – Flughafen *Innsbruck – Flughafen*	Both lie significantly inland in a mountainous region where local weather effects are likely to dominate.
28. Antwerp – Duerne *Ostend - Airport*	There is significant distance between these sites, and Ostend is located on the North Sea coast while Antwerp is further inland on a river, however both are in low-lying country
29. Stavanger – Sola *Kristiansand – Kjevik*	Both sites lie on Norway's Atlantic coast in fjord regions. There is significant separation between the sites as well as major topography
30. Bergen – Florida *Trondheim – Vaernes*	The two sites are significantly separated, though both lay on the west coast near the Norwegian Fjords. There is significant topography between the two sites.
31. Berlin Dahlem *Magdeburg*	Both sites are significantly inland and near urban areas
32. Manchester – Ringway *Church Fenton*	Both sites are inland and at similar elevation. Manchester is much more urban that Church Fenton and the Pennines lie between the two making an effective barrier to some weather effects.
33. Brussels - National *Antwerp – Duerne*	Both sites are inland and near urban areas. Antwerp is some distance to the north of Brussels and lies nearer to the Atlantic Coast
34. Marham *Wattisham*	Both sites lie on the East Anglian plain inland from the North Sea. Each site is fairly rural in nature.
35. Nottingham - Watnall *Lincoln - Waddington*	Both sites are fairly rural and inland. Lincoln is more exposed to weather coming in from the North Sea as it lies on the Lincolnshire plain.
36. Berlin - Tempelhof *Berlin - Tegel*	Both sites are significantly inland and near urban areas
37. Nantes *Le Mans*	Nantes is a few miles inland from the Atlantic coast while Le Man is significantly inland to the east. Both are on relatively flat terrain.
38. Ostrava *Prague - Ruzyne*	Both are significantly inland and separated by over a hundred miles, with a small mountain range between.
39. Paris - Charles de Gaulle *Paris - le Bourget*	Both sites are significantly inland and near urban areas