Estimating daily mean temperature from synoptic climate observations

Short title: Daily mean temperature

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Abstract

We compare some different approaches to estimating daily mean temperature. In many countries the routine approach is to calculate the average of the directly measured minimum and maximum daily temperature. In some, the maximum and minimum are obtained from hourly measurements. In other countries, temperature readings at specific times throughout the day are taken into account. For example, the Swedish approach uses a linear combination of five temperature readings, including the minimum and the maximum, with coefficients that depend on longitude and month. We first look at data with very high temporal resolution, and compare some different approaches to estimating daily mean temperature. Then we compare the Swedish formula to various averages of the daily minimum and maximum, finding the latter method being substantially less precise. We finally compare the Swedish formula to hourly averages, and find that a recalibrated linear combination improves estimation accuracy.

Key words: Ekholm-Modén formula, linear combination, variability, bias.

1. *Introduction*

There are different ways to calculate daily mean temperature at a station from data collected at different times of the day. In many countries the approach is to average the minimum and maximum temperature observed, although this may be the minimum and maximum hourly readings or the actual minimum and maximum obtained from minimum and maximum thermometers or other devices (see WMO, 2008, for details about temperature measurements). In other countries a linear combination of measurements taken at different times of the day is used, sometimes including the minimum and maximum as well. For example, the Scandinavian countries each have a different linear combination of data, depending on the frequency of recorded observations (Nordli et al., 1996, Appendix II). There has not been much work on comparing the different approaches to estimating daily mean temperature. Weiss and Hays (2005) compare hourly average (taken as ground truth), 3-hourly average, average of min and max, a weighted average, and a method used in the CERES crop simulation program that uses a cubic interpolation between min and max. The goal of their paper was to see what the effect was of different daily mean temperature computations when used as input to a highly nonlinear algorithm. The 3-hour average performed best in their context. However, few synoptic networks report that frequently.

Reicosky et al. (1989) looked at five different ways of computing the diurnal hourly temperature curve based on observing only the minimum and the maximum. They found that such methods worked better on clear than on cloudy days.

In this paper we will look at different ways of combining synoptic temperature measurements to estimate the daily mean temperature. We will mainly focus on Swedish measurements at a few stations in the SMHI synoptic network (http://www.smhi.se/klimatdata/meteorologi/dataserier-for-observationsstationer-1961-2008-1.7375).

The standard Swedish approach dates back at least to 1916 (Ekholm 1916), and in its current form has been in use since 1947 (Nordli et al. 1996). It is called the Ekholm-Modén formula, and is a linear combination of the daily minimum, the daily maximum, and measurements at 6, 12 and 18 hours UTC. The maximum and minimum both correspond to the time period 18 hours UTC the previous day until 18 hours UTC the current day. Swedish time is UTC+1 in the winter, UTC+2 in the summer (last Sunday of March through last Sunday of October). We then can write the formula, using observations at Swedish standard time, as $T_{\text{mean}} = aT_{07} + bT_{13} + cT_{19} + dT_{\max} + eT_{\min}$. The coefficients of the linear combination depend on month and longitude, although the longitude dependence is relatively small, and are given in Appendix 1. They were essentially derived by least squares fitting to stations with hourly data available (Ekholm 1916, Modén 1939). It is interesting that the coefficients are restricted to sum to one. Apparently this originates in numerical work in the early part of the 20$^{\text{th}}$ century, where this constraint stabilized the least squares calculations (Ekholm 1916). Also, the coefficient *d* for the maximum daily temperature is always set to 0.1, regardless of month and longitude. We have not found any reason for this constraint in the literature. In Ekholm's and Modén's original papers the maximum temperature was not included (i.e., *d*=0).

We begin in section 2 by looking at the accuracy and precision of various estimates of daily mean temperature compared to an estimate from a high resolution (one minute) data set. In section 3 we compare the Ekholm-Modén formula (Alexanderson, 2002) to various linear combinations of the minimum and maximum, and note that the latter generally is substantially more variable. Section 4 is devoted to comparing the Ekholm-Modén formula to hourly averages for two stations. We discuss our findings in the final section 5.

2. ***Hourly measurements compared to high frequency measurements***

The highest temporal resolution measurements we have access to have one-minute resolution. These stations are all in the United States. The question of interest in this section is how accurate the average of hourly measurements is compared to the average of the one-minute data. We look at three stations: airport stations at Buffalo (station A), South Dakota (45.67N, 96.99W), and Andover (station B), New Jersey (41.01N, 74.74W), and Lehigh Valley (station C), Pennsylvania (40.65N, 74.45W) from National Climatic Data Center (NCDC). Figure 1 shows the average daily temperature curve (minute by minute) for stations A and B, averaged over the available days in the months of January and June, 2010.

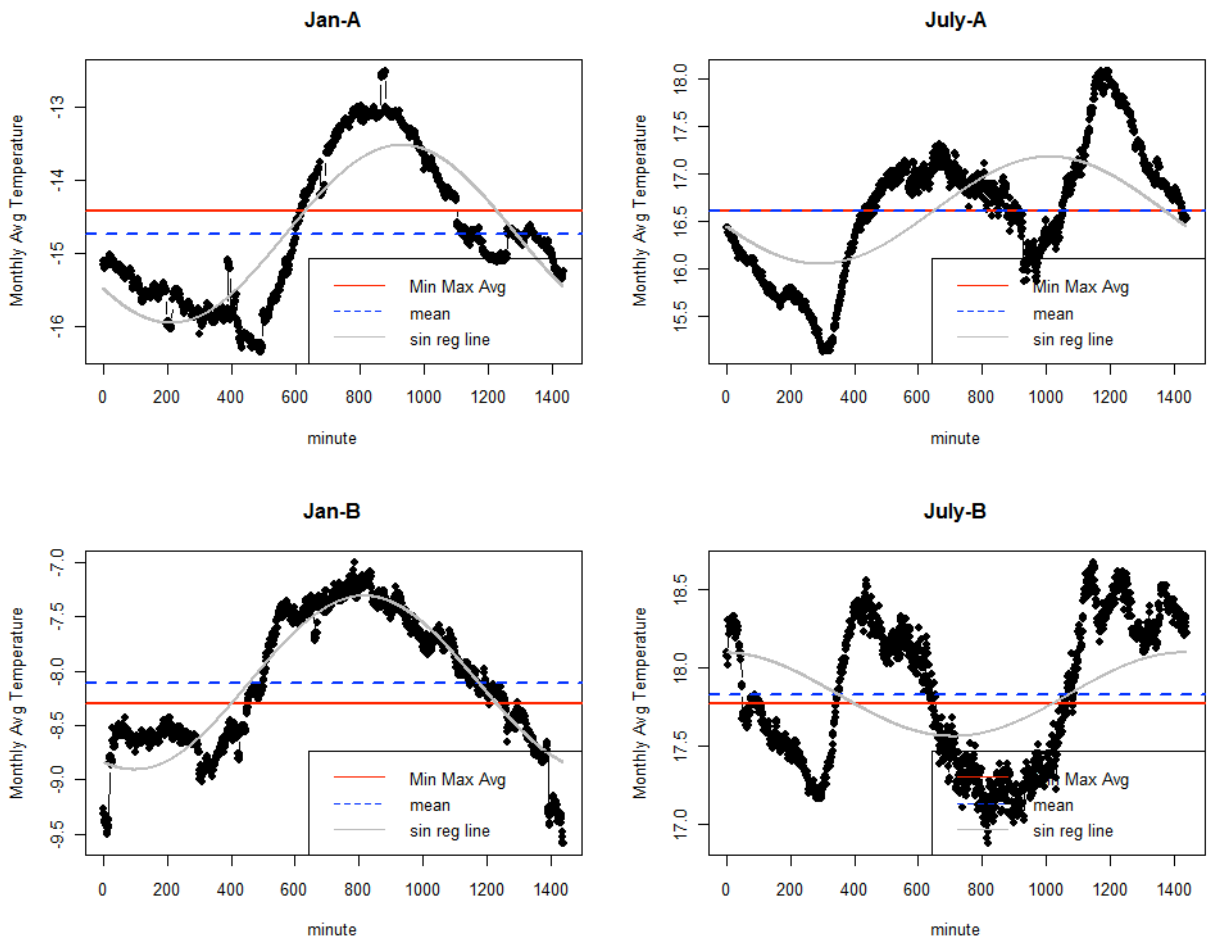

Figure 1. Average daily temperature curves for sites A (Buffalo, SD; top row) and B (Andover, NJ; bottom row) for January (left column) and July (right column) using available minute-data from 2010. Also shown are fitted sine curves, the average daily temperature (dashed horizontal line) and the average of daily minimum and maximum average temperature (solid horizontal line)

The temperatures provided are the dry bulb temperatures in Fahrenheit, which we converted to Celsius to make this study consistent. We use local time for extracting hourly temperatures. Also, as documented by NCDC (ftp://ftp.ncdc.noaa.gov/pub/data/asosonemin/missing_period_report.txt), the one-minute data sets were missing some air temperature observations; the missing data could range from an hour to several days. No attempt was made to estimate these missing data and a daily mean air temperature was not calculated for any days that had missing data. Therefore, when comparing estimated DMT calculated by different methods, we omitted days with any missing hours. These stations were selected because they had a long period of record with fewer missing observations than the others. It is clear from Figure 1 that the daily temperature curves are not symmetric about the average daily temperature, and that a sine curve is not a particularly good fit, at least in July.

First of all, different approaches to calculation of daily mean temperatures (DMT) are applied to study their bias and variability. We consider the daily average of one-minute temperatures as the true value of DMT, and compare the method of taking the average of minima and maxima and the method averaging hourly temperatures (every 60^{th} observation) to them. From the comparison results (see Table 1), it is found that the method using hourly average is better than that of averaging daily minima and maxima for estimating DMT, with smaller bias from the one-minute average for both winter and summer. Also, the variability of the hourly averages is about a quarter of that for the average of minimum and maximum daily temperature, implying greater instability of estimation for the method of estimating DMT by taking the average of daily minima and maxima. The p-values are calculated without taking into account the serial dependence of the estimated daily temperatures, and so are likely somewhat lower than if a correction for this had been made.

Table 1: Estimator comparison results (bias and standard deviation) for station A (Buffalo) and B (Andover) by using one-minute data during January and July 2010. We also show p-values for the hypothesis of equal means.

		Buffalo(A)		Andover(B)	
		Jan	Jul	Jan	Jul
Hourly Average	Bias	0.05	-0.15	-0.03	-0.04
	SD	0.30	0.15	0.20	0.20
	p-value	0.39	0.00	0.34	0.30
Min & Max Average	Bias	0.14	0.17	-0.05	-0.29
	SD	1.23	0.98	0.82	0.82
	p-value	0.52	0.35	0.73	0.02

We also apply a linear combination of Ekholm-Modén type to one-minute data in US. We get the following coefficients for January at station C (Lehigh Valley) by using a least squares fit (function *nls* in R; R Development Team 2011) to data from January during 2002 – 2010 (omitting 2005, which has too many missing observations): a = 0.21, b = 0.18, c = 0.14, d = 0.26, e = 0.21.

Using the resulting coefficients on the one-minute data from January, 2011 for the same station, we compare the estimated DMT based on them to the average of daily minima and maxima, setting the daily averages of one-minute observations as the truth. We also compare the average hourly temperatures to the minute average. Note that we trim the data by eliminating the days with missing observations, and conduct comparisons only for days with complete observations. The total number of valid days during the January of years 2002-2010 (except 2005) is 200, and the number of valid days during January, 2011 at station C is 23. The results are given in Table 2.

Table 2: Estimator comparison (bias, 95% confidence interval and standard deviation) results for station Lehigh Valley(C)

Estimators	Bias	95% CI		SD
LS Coefficients Formula	-0.02	-0.37	0.32	0.80
Average of Daily Minima and Maxima	-0.65	-1.44	0.15	1.83
Hourly Average	0.01	-0.10	0.11	0.24

Using the Ekholm-Modén formula, the estimated DMT have much smaller bias relative to the minute average, compared to the currently using method of averaging daily minima and maxima, which are more than 0.6°C lower than the minute averages. The estimated values from LS coefficients are quite close to the hourly averages. Moreover, the Ekholm-Modén method also substantially reduces the variability of the estimated values, increasing the stability of estimation.

3. ***Comparison of Ekholm-Modén to linear combinations of maximum and minimum***

In this section we will take T_{mean} as the true value, and look at what linear combinations of T_{min} and T_{max} provide the best approximation to T_{mean} in the least squares sense based on 49 years of observations on Stockholm-Bromma (59.35N,17.95E) and Sundsvall (62.52N, 17.44E) airports. We consider four different models. The first compares T_{mean} to T_{ave}, the average of T_{min} and T_{max}. In the second, we find the coefficient f that minimizes the sum of squared differences between T_{mean} and $T_{\text{ave}}^{(1)} = fT_{\text{min}} + (1-f)T_{\text{max}}$. In the third, we find the coefficients g and h that minimizes the sum of squared differences between T_{mean} and $T_{\text{ave}}^{(2)} = gT_{\text{min}} + hT_{\text{max}}$. Finally, the fourth estimator is the same as the third, but allowing the coefficients to change with the month. To examine the resulting linear combinations of T_{min} and T_{max}, we apply them to the data of 2009 (which were not used in the fitting) and compare the PRMSE from the T_{mean} given by SMHI. Table 3 contains the results.

Method	Stockholm				Sundsvall			
	Estimates		Bias	PRMSE	Estimates		Bias	PRMSE
$T_{ave}=(T_{min}+T_{max})/2$	NA		0.05	0.810	NA		0.035	1.056
$T_{ave}^{(1)} = fT_{min} + (1-f)T_{max}$	$f = 0.503$		0.028	0.804	$f = 0.495$		0.077	1.064
$T_{ave}^{(2)} = gT_{min} + hT_{max}$	$g = 0.505$		0.025	0.798	$g = 0.494$		0.082	1.066
	$h = 0.492$				$h = 0.491$			
Monthly Coefficients of	0.439	0.567	0.019	0.742	0.436	0.581	0.022	1.022
$T_{ave}^{(2)} = gT_{min} + hT_{max}$	0.475	0.523			0.436	0.585		
	0.472	0.487			0.454	0.563		
	0.406	0.508			0.418	0.525		
	0.331	0.563			0.348	0.548		
	0.322	0.595			0.297	0.595		
	0.322	0.599			0.297	0.604		
	0.358	0.577			0.360	0.566		
	0.418	0.538			0.443	0.505		
	0.449	0.522			0.462	0.509		
	0.434	0.536			0.436	0.594		
	0.443	0.548			0.443	0.589		

Table 3: Comparison of different linear combinations of T_{min} and T_{max} to approximate T_{mean}.

From the table, we see no salient differences among the predictions of T_{ave} in 2009 of the first three linear combinations of T_{min} and T_{max}. Notice that, although T_{ave} is a special case of $T_{\text{ave}}^{(1)}$ which in turn is a special case of $T_{\text{ave}}^{(2)}$, the PRMSE for 2009 are not necessarily monotone, since the coefficients are based on earlier data. The PRMSEs from T_{mean} are all large (of the order of a degree C) and different annual linear combination do not show substantial improvement over the average of T_{min} and T_{max}. Using monthly coefficients rendered, for both Stockholm and Sundsvall, somewhat larger decreases of PRMSE, of course at the cost of estimating more parameters. A comparison between the annual and monthly coefficients for the two stations is shown in Figure 2. The monthly coefficient g for T_{max} reaches its highest value and the coefficient h for T_{min} reaches its nadir around July (summer time), and the reverse occurs around February (winter time).

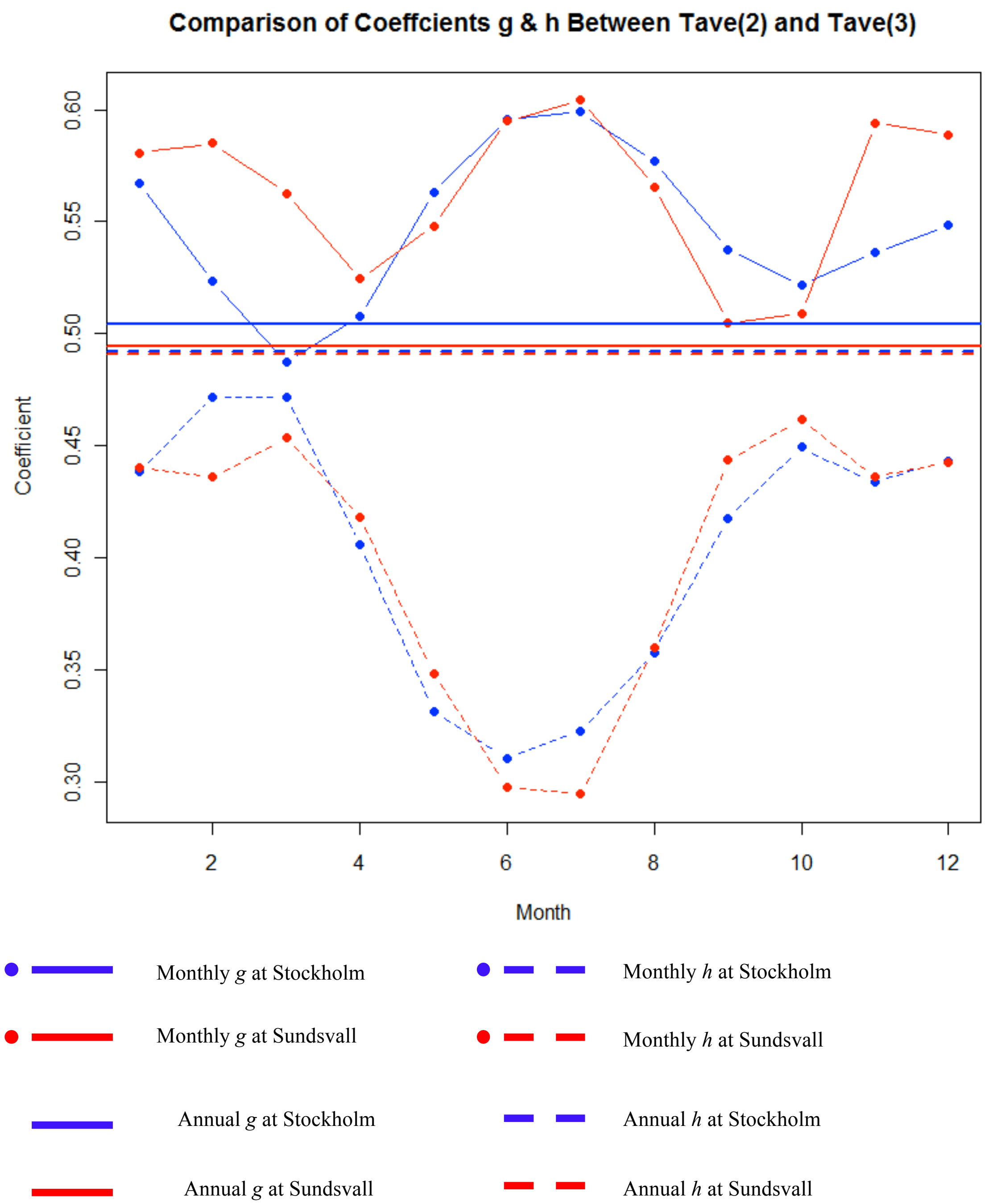

Figure 2. Comparison of coefficients *g* and *h* between monthly and annual fits for Stockholm-Bromma and Sundsvall.

4. The Ekholm-Modén formula compared to average of hourly measurements

The Ekholm-Modén formula was developed using a few stations with hourly measurements with mean of the hourly observations as ground truth (Ekholm, 1914; Modén, 1944). Hence it appears sensible to compare the formula to the daily average for some current hourly stations, not used in the original determinations. We do this for Malmö (55.57N, 13.07E) and Stockholm Observatory (59.34N, 18.06E). In addition, we do a recalibration of the formula for these stations.

Using the Ekholm-Modén formula described in Section 1, we use least-square optimization (function *nls* in R; R Development Team 2011) to derive the best linear combination of T_{07}, T_{13}, T_{19}, T_{min}, and T_{max} by taking T_{mean} as the true value. To simplify the calculations we divide the data into three-month seasons (rather than months) with winter being December-January-February, etc. The seasonal least-square (LS) coefficients for Stockholm and Malmö are listed in Table 4.

Station	Season	*a*	*b*	*c*	*d*	*e*
Stockholm	Spring	0.22	0.16	0.24	0.16	0.22
	Summer	0.20	0.20	0.23	0.10	0.27
	Autumn	0.29	0.21	0.30	0.09	0.12
	Winter	0.32	0.17	0.31	0.10	0.10
Malmö	Spring	0.19	0.22	0.21	0.14	0.24
	Summer	0.18	0.20	0.27	0.09	0.26
	Autumn	0.30	0.20	0.28	0.11	0.13
	Winter	0.32	0.17	0.32	0.09	0.10

Table 4: Seasonal LS coefficients for Stockholm and Malmö (unitless).

To examine the existing Ekholm-Modén formula, we first compare the given T_{mean} from the SMHI synoptic network and the observed daily hourly-average temperature, which we set as the truth for daily mean temperature for both Malmö and Stockholm. We find (Table 5) that T_{mean} of Malmö is quite close to the truth, and the residuals from hourly average temperatures are evenly distributed. But T_{mean} of Stockholm has a relatively large bias, and is usually smaller than the hourly average temperature.

We would also like to compare the average of T_{min} and T_{max} to hourly average temperatures. In some data sets, such as WMO's Global Surface Summary Of Day (GSOD; http://gosic.org/ios/MATRICES/ECV/ATMOSPHERIC /SURFACE/ECV-GCOS-ATM-SURFACE-airpressure-GSOD-data-context.htm), the maximum and minimum temperatures are calculated from hourly data. Our results (Table 5) show that, as expected, the hourly min and max temperatures are less extreme than the continuously measured $\mathrm{T_{min}}$ and $\mathrm{T_{max}}$ from SMHI. The absolute differences between the hourly and the continuous values for $\mathrm{T_{min}}$ and $\mathrm{T_{max}}$ for Malmö are approximately the same, around 0.2°C; however, for Stockholm there are greater differences between hourly max and $\mathrm{T_{max}}$,

Finally, we investigate the differences between different methods of estimating daily mean temperatures, by using the original Ekholm-Modén formula, and by using the seasonal least-square (LS) coefficients we derived above, setting the daily hourly-average temperatures as the true values. We also look at the consequences of using the minimum and maximum hourly temperatures instead of the actual minima and maxima. We see that the Ekholm-Modén coefficients incur a bias of up to 0.1 °C, and that by using LS coefficients, the bias is halved. The standard errors are substantially decreased, implying better stability of estimation by using the LS coefficients. Therefore, we conclude that our seasonal LS coefficients may provide more accurate estimates of daily mean temperatures than the currently used coefficients. The confidence intervals given are computed without taking into account the serial dependence of the data, and are likely somewhat too short.

Station	Comparison	Bias	CI(3)		SD(4)
Stockholm	T_{mean} vs. hourly average	0.148	0.11	0.18	0.34
	T_{min} vs. hourly min	-0.055	-0.08	-0.02	0.30
	T_{max} vs. hourly max	0.171	0.09	0.25	0.79
	DMT(1) with hourly min & max vs. with real min & max	-0.032	-0.06	0.00	
	DMT by original coefficients vs. hourly average(2)	0.1	0.07	0.14	
	Estimated DMT by LS coefficients vs. hourly average	0.042	0.00	0.08	
Malmö	T_{mean} vs. hourly average	-0.020	-0.04	0.01	
	T_{min} vs. hourly min	-0.269	-0.30	-0.24	0.26
	T_{max} vs. hourly max	0.259	0.20	0.32	0.58
	DMT with hourly min & max vs. with real min & max	0.103	0.08	0.13	
	Estimated DMT by original coefficients vs. hourly average	0.06	0.02	0.10	
	Estimated DMT by LS coefficients vs. hourly average	0.004	-0.03	0.03	

(1) DMT stands for Daily Mean Temperature
(2) Original monthly coefficients from Ekholm-Modén formula are converted to seasonal coefficients by taking the averages of monthly coefficients.
(3) CI stands for the 95% confidence interval of the difference between two values in question
(4) SD stands for the standard deviation of the differences between two values in question.\

Table 5: Estimator comparisons for Stockholm and Malmö (units are degrees C).

5. ***Discussion***

The practice of averaging minimum and maximum temperature to estimate a daily mean temperature assumes that the diurnal cycle is symmetric throughout the year. We have seen that the variability of this estimator is substantially larger than one that in addition uses temperature readings from throughout the day. WMO (2010) recommends use of this estimator in spite of these drawbacks, saying "Even though this method is not the best statistical approximation, its consistent use satisfies the comparative purpose of normals." It is a difficulty that in many databases different calculations are used for different countries, and furthermore that the calculations often change over time.

The standard Swedish formula for estimating daily mean temperature could probably be improved by fitting the model to the much larger set of hourly measurements available today. In particular, it would be interesting to see whether anything is gained from the longitude dependence of the coefficients.

The practice of using the minimum and maximum hourly temperatures is defensible when estimating daily mean temperature using a formula of the Ekholm-Modén type, but can add substantially to the bias incurred when just averaging minimum and maximum temperature. A further problem with the latter method is that different countries have different conventions in what hours the extreme values are computed for. Thus, direct comparisons of these estimates between countries are not so easy. A change in the definition of the climate day can make differences of up to 20° C (Hopkinson et al., 2011) at a single station.

Generally temperature series tend to exhibit so-called long term memory (Beran, 1994). This implies that standard error that assume independent observations (or even autoregressive dependence structure) underestimate the true variability. This dependence structure is partly due to decadal modes of variability, and partly to the oceans' heat storing capacity. A rough estimate of the difference in standard errors is a factor of 3, based on the approach by Craigmile et al. (2004).

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Appendix 1: Ekholm-Modén coefficients as used by SMHI

ı						Feb						Mar					
ıg	**a**	**b**	**c**	**d**	**e**	**long**	**a**	**b**	**c**	**d**	**e**	**long**	**a**	**b**	**c**	**d**	**e**
	0.33	0.15	0.32	0.1	0.1	**11**	0.31	0.18	0.31	0.1	0.1	**11**	0.32	0.22	0.26	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**12**	0.31	0.18	0.31	0.1	0.1	**12**	0.32	0.22	0.26	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**13**	0.31	0.18	0.31	0.1	0.1	**13**	0.32	0.22	0.26	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**14**	0.31	0.18	0.31	0.1	0.1	**14**	0.32	0.22	0.26	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**15**	0.31	0.18	0.31	0.1	0.1	**15**	0.31	0.22	0.27	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**16**	0.31	0.18	0.31	0.1	0.1	**16**	0.31	0.22	0.27	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**17**	0.31	0.18	0.31	0.1	0.1	**17**	0.31	0.21	0.28	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**18**	0.31	0.18	0.31	0.1	0.1	**18**	0.31	0.21	0.28	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**19**	0.31	0.18	0.31	0.1	0.1	**19**	0.31	0.2	0.29	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**20**	0.31	0.18	0.31	0.1	0.1	**20**	0.31	0.2	0.29	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**21**	0.31	0.18	0.31	0.1	0.1	**21**	0.31	0.19	0.3	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**22**	0.31	0.18	0.31	0.1	0.1	**22**	0.3	0.19	0.31	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**23**	0.31	0.18	0.31	0.1	0.1	**23**	0.3	0.19	0.31	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**24**	0.31	0.18	0.31	0.1	0.1	**24**	0.3	0.18	0.32	0.1	0.1
	0.33	0.15	0.32	0.1	0.1	**25**	0.31	0.18	0.31	0.1	0.1	**25**	0.3	0.18	0.32	0.1	0.1

r						May						June					
ıg	**a**	**b**	**c**	**d**	**e**	**long**	**a**	**b**	**c**	**d**	**e**	**long**	**a**	**b**	**c**	**d**	**e**
	0.25	0.19	0.27	0.1	0.19	**11**	0.21	0.2	0.24	0.1	0.25	**11**	0.21	0.18	0.25	0.1	0.26
	0.24	0.19	0.28	0.1	0.19	**12**	0.21	0.2	0.24	0.1	0.25	**12**	0.21	0.18	0.25	0.1	0.26
	0.24	0.19	0.28	0.1	0.19	**13**	0.21	0.2	0.24	0.1	0.25	**13**	0.21	0.19	0.24	0.1	0.26
	0.24	0.19	0.28	0.1	0.19	**14**	0.21	0.2	0.24	0.1	0.25	**14**	0.21	0.19	0.24	0.1	0.26
	0.24	0.19	0.28	0.1	0.19	**15**	0.21	0.2	0.24	0.1	0.25	**15**	0.21	0.19	0.24	0.1	0.26
	0.24	0.18	0.29	0.1	0.19	**16**	0.22	0.2	0.24	0.1	0.24	**16**	0.21	0.19	0.24	0.1	0.26
	0.24	0.18	0.29	0.1	0.19	**17**	0.22	0.2	0.24	0.1	0.24	**17**	0.21	0.19	0.24	0.1	0.26
	0.23	0.18	0.3	0.1	0.19	**18**	0.22	0.2	0.23	0.1	0.25	**18**	0.21	0.19	0.24	0.1	0.26
	0.23	0.18	0.3	0.1	0.19	**19**	0.22	0.2	0.23	0.1	0.25	**19**	0.21	0.19	0.24	0.1	0.26
	0.23	0.18	0.3	0.1	0.19	**20**	0.22	0.2	0.23	0.1	0.25	**20**	0.21	0.19	0.24	0.1	0.26
	0.23	0.18	0.3	0.1	0.19	**21**	0.22	0.19	0.24	0.1	0.25	**21**	0.21	0.19	0.24	0.1	0.26
	0.24	0.17	0.3	0.1	0.19	**22**	0.22	0.19	0.24	0.1	0.25	**22**	0.21	0.19	0.24	0.1	0.26
	0.24	0.17	0.3	0.1	0.19	**23**	0.22	0.19	0.24	0.1	0.25	**23**	0.21	0.19	0.24	0.1	0.26
	0.24	0.16	0.31	0.1	0.19	**24**	0.23	0.18	0.24	0.1	0.25	**24**	0.21	0.18	0.25	0.1	0.26
	0.24	0.16	0.32	0.1	0.18	**25**	0.23	0.18	0.24	0.1	0.25	**25**	0.21	0.18	0.25	0.1	0.26

						Aug						Sep					
ıg	**a**	**b**	**c**	**d**	**e**	**long**	**a**	**b**	**c**	**d**	**e**	**long**	**a**	**b**	**c**	**d**	**e**
	0.19	0.18	0.27	0.1	0.26	**11**	0.18	0.23	0.22	0.1	0.27	**11**	0.26	0.24	0.23	0.1	0.17
	0.19	0.18	0.27	0.1	0.26	**12**	0.18	0.23	0.22	0.1	0.27	**12**	0.26	0.24	0.23	0.1	0.17
	0.19	0.18	0.27	0.1	0.26	**13**	0.18	0.23	0.22	0.1	0.27	**13**	0.26	0.24	0.23	0.1	0.17

0.19	0.18	0.27	0.1	0.26	**14**	0.18	0.23	0.22	0.1	0.27	**14**	0.26	0.24	0.23	0.1	0.17
0.19	0.18	0.26	0.1	0.27	**15**	0.18	0.23	0.22	0.1	0.27	**15**	0.25	0.23	0.24	0.1	0.18
0.19	0.18	0.26	0.1	0.27	**16**	0.18	0.23	0.22	0.1	0.27	**16**	0.25	0.23	0.24	0.1	0.18
0.19	0.18	0.26	0.1	0.27	**17**	0.18	0.23	0.22	0.1	0.27	**17**	0.25	0.23	0.24	0.1	0.18
0.19	0.18	0.26	0.1	0.27	**18**	0.18	0.23	0.22	0.1	0.27	**18**	0.25	0.23	0.24	0.1	0.18
0.19	0.18	0.26	0.1	0.27	**19**	0.18	0.23	0.22	0.1	0.27	**19**	0.24	0.23	0.24	0.1	0.19
0.19	0.18	0.26	0.1	0.27	**20**	0.18	0.23	0.22	0.1	0.27	**20**	0.24	0.22	0.25	0.1	0.19
0.19	0.18	0.26	0.1	0.27	**21**	0.18	0.23	0.22	0.1	0.27	**21**	0.24	0.22	0.25	0.1	0.19
0.19	0.18	0.26	0.1	0.27	**22**	0.18	0.22	0.24	0.1	0.26	**22**	0.24	0.22	0.25	0.1	0.19
0.19	0.18	0.26	0.1	0.27	**23**	0.19	0.21	0.24	0.1	0.26	**23**	0.23	0.22	0.25	0.1	0.2
0.19	0.18	0.26	0.1	0.27	**24**	0.19	0.21	0.24	0.1	0.26	**24**	0.23	0.22	0.25	0.1	0.2
0.19	0.18	0.26	0.1	0.27	**25**	0.19	0.21	0.25	0.1	0.25	**25**	0.23	0.22	0.25	0.1	0.2

t						**Nov**						**Dec**					
ıg	**a**	**b**	**c**	**d**	**e**	**long**	**a**	**b**	**c**	**d**	**e**	**long**	**a**	**b**	**c**	**d**	**e**
	0.31	0.19	0.3	0.1	0.1	**11**	0.3	0.16	0.34	0.1	0.1	**11**	0.34	0.15	0.31	0.1	0.1
	0.31	0.19	0.3	0.1	0.1	**12**	0.3	0.16	0.34	0.1	0.1	**12**	0.34	0.15	0.31	0.1	0.1
	0.31	0.19	0.3	0.1	0.1	**13**	0.3	0.16	0.34	0.1	0.1	**13**	0.34	0.15	0.31	0.1	0.1
	0.3	0.19	0.31	0.1	0.1	**14**	0.3	0.16	0.34	0.1	0.1	**14**	0.34	0.15	0.31	0.1	0.1
	0.3	0.19	0.31	0.1	0.1	**15**	0.3	0.16	0.34	0.1	0.1	**15**	0.34	0.15	0.31	0.1	0.1
	0.3	0.19	0.31	0.1	0.1	**16**	0.3	0.16	0.34	0.1	0.1	**16**	0.34	0.15	0.31	0.1	0.1
	0.3	0.19	0.31	0.1	0.1	**17**	0.3	0.16	0.34	0.1	0.1	**17**	0.34	0.15	0.31	0.1	0.1
	0.29	0.19	0.32	0.1	0.1	**18**	0.3	0.16	0.34	0.1	0.1	**18**	0.34	0.15	0.31	0.1	0.1
	0.29	0.19	0.32	0.1	0.1	**19**	0.3	0.17	0.33	0.1	0.1	**19**	0.34	0.15	0.31	0.1	0.1
	0.29	0.19	0.32	0.1	0.1	**20**	0.3	0.17	0.33	0.1	0.1	**20**	0.34	0.15	0.31	0.1	0.1
	0.29	0.19	0.32	0.1	0.1	**21**	0.3	0.17	0.33	0.1	0.1	**21**	0.34	0.15	0.31	0.1	0.1
	0.29	0.18	0.33	0.1	0.1	**22**	0.3	0.17	0.33	0.1	0.1	**22**	0.34	0.15	0.31	0.1	0.1
	0.29	0.18	0.33	0.1	0.1	**23**	0.3	0.17	0.33	0.1	0.1	**23**	0.34	0.15	0.31	0.1	0.1
	0.29	0.18	0.33	0.1	0.1	**24**	0.3	0.17	0.33	0.1	0.1	**24**	0.34	0.15	0.31	0.1	0.1
	0.28	0.18	0.34	0.1	0.1	**25**	0.3	0.17	0.33	0.1	0.1	**25**	0.34	0.15	0.31	0.1	0.1