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Calculation of design temperatures

Proposed use of Bayesian GEV to calculate design summer and design winter temperatures

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Abstract

This report presents methods to calculate design temperature for summer and winter. It is a new probabilistic approach to design temperatures based on Bayesian statistics and GEV. Previous methods extracted data from meteorological observation sites and interpolated these to municipality centres. MET Norway calculates operationally gridded climatology of 1*1 km for daily mean temperatures. The new method uses daily mean temperatures extracted at municipality centres from this gridded dataset. Unlike previous calculations, consisting of one value, these new calculations give a distribution based on return periods from 2 to 200 years and 1 to 5 days mean. This provides the possibility to consider the needs and the risk of the building in the future calculation, but also a need for guidance in applying the right temperatures.

In addition to the design temperatures for summer and winter,a simple method to calculate diurnal variation in temperature and humidity is presented, and the idea that the warmest and coldest days coincide with clear weather conditions.

Keywords

Design temperatures, Standardisation

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MET report

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1 Background

Design winter/summer temperatures are extensively used in the design and construction of the built environment. The calculation of these values are standardised in ISO 15927-5:2004(E) and 15927-2:2009(E). Some troubling parts with these standards will be highlighted in chapter 1.1 and 1.2. The following chapters will present an alternate method to calculate robust values and provide a broader set of information.

1.1 Design winter temperature

1.1.1 The challenge of an unclear definition

The current definition of Design winter temperature in ISO 15927-5:2004(E) is:
"The n-day mean design temperature, θ^{*}_{nd} , is calculated as the n-day mean air temperature, where n is one, two, three or four, having an average return period of 1 year (e.g. occurring on average 20 times in 20 years). The n-day mean air temperature on which it is based may be calculated, for every combination of n successive days, in one of several ways, depending on the data available."

For the record, there is a different nuance in the definitions «return period of 1 year» and «occurring on average 20 times in 20 years», but this is outside the scope of this report. We will further point out that in standard tools to calculate return periods there exists no definition of "average return period of 1 year", and that most systems to calculate this fail when using 1 year return period.

1.1.2 The challenge of spatial resolution and short periods of measurements

The current calculations are based on in situ measurements at the site of observations. At sites with good continuous observations for the period used to calculate design values, this is a good approach. The challenge with this approach for a major part of Norwegian municipalities is the lack of a stable reference near the centre of the municipality. Their challenge is composed of two not exclusive problems: No relevant station and stations with short or broken timeseries. In figure 1, the daily mean temperatures of Trondheim-Voll (purple) and Værnes (blue) are shown. There are two points worth attention: The records at Trondheim – Voll start in 1996, and Værnes, which is geographically the closest observation site, is slightly colder in winter.

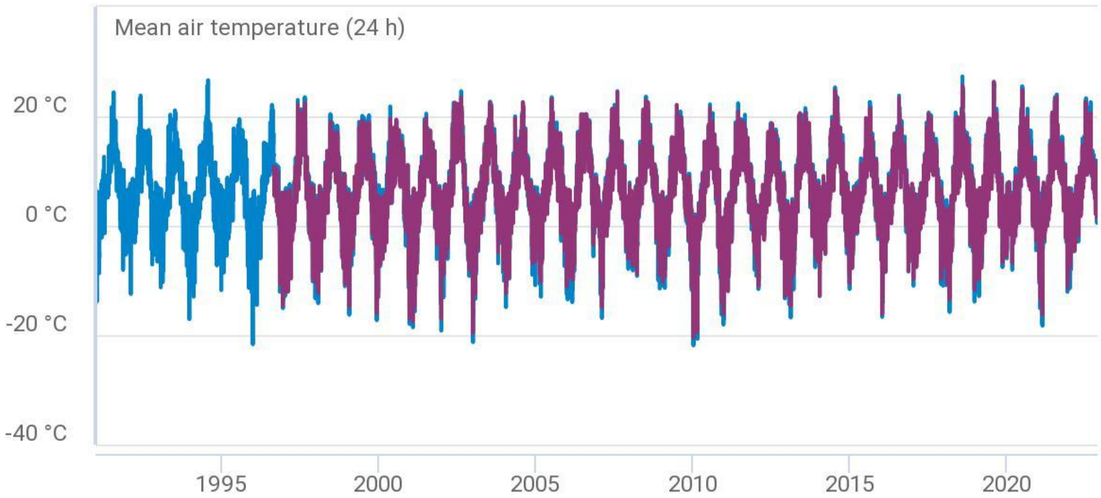


Figure 1: Daily mean temperature at Trondheim - Voll (purple) and Værnes (blue) for the periode 1991-2022 show that the records in Trondheim are incomplete, and that Værnes tends to be colder winters than Trondheim - Voll.

The example above from Trondheim illustrates both the challenge of short and broken records and spatial resolution. If the intention is to create design values based on the current normal period, 1991-2020, one needs to either merge the Trondheim series with the Værnes series or adjust the Værnes series to fit the statistics of the Trondheim series. In this case with almost 25 years overlap, the task of merging and/or adjusting is manageable, at other sites it can be less fortunate.

1.2 Design summer temperature

1.2.1 The challenge of spatial resolution and choice of reference period

As pointed out for design winter temperature there is a challenge in the temporal resolution. The definition states that a station must have “at least 10 years of hourly data”, however, there are several stations that don't have a complete record of 10 years of hourly data. Good climatological practice would be, if possible, to use 30 years of data to avoid annual and decadal variations.

1.2.2 The challenge of the definition

In ISO 15927-2:2009(E) chapter 4 and 5 contains definitions on the construction. The design reference temperature in question is defined in 5:
“For all the hourly data in the data set, calculate the dry-bulb temperature exceeded on 1 %, 2 % and 5 % of occasions. These are $\theta_{99\%}$, $\theta_{98\%}$ and $\theta_{95\%}$”.

Numbers of hours in a year is 365*24=8760. One percent of this is 88, two percent is 175 and 5 percent is 438. It is a tradition in Norway to use temperatures that exceed maximum 50 hours a year, which finds no reference in the standard. Figure 2 shows these temperatures calculated at Oslo - Blindern. The average for the normal period, 1991-2020, is $\theta_{99\%}$ = 25,0 °C, $\theta_{98\%}$ = 23,2 °C, $\theta_{95\%}$ = 20,3 °C, 50H = 26,3 °C.

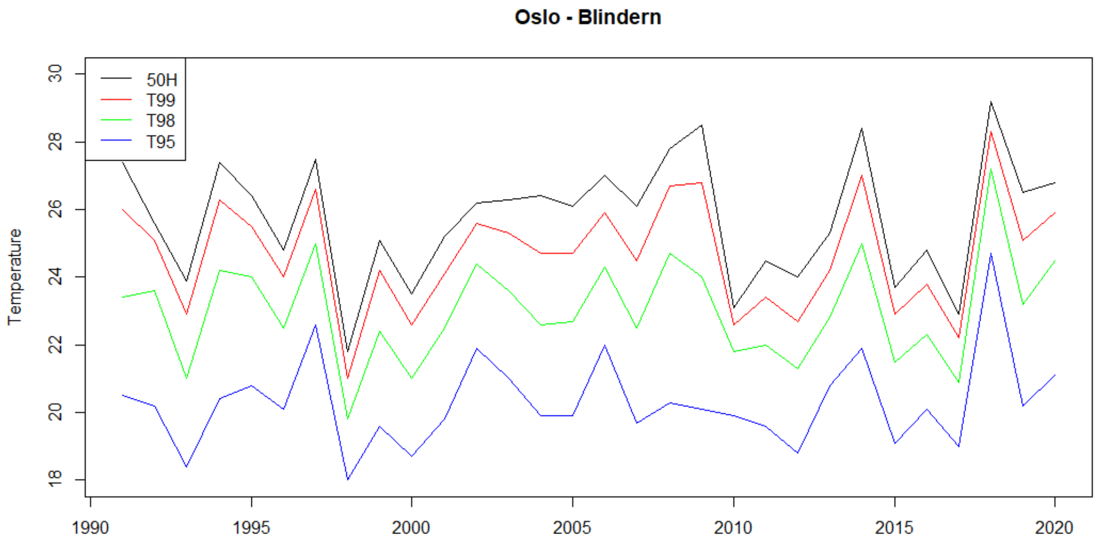


Figure 2: Annual variations in dry-bulb temperature $\theta_{99\%}$, $\theta_{98\%}$ and $\theta_{95\%}$ and 50 hours.

The use of hourly data for the current normal period is a challenge since most stations, as mentioned above, do not have 30 years of hourly data. This challenge may be overcome by different approaches.

- One may interpolate less frequent data to hourly data by introducing certain assumptions, e.g., minimum temperature reflects early morning temperature, and maximum temperature is recorded in the afternoon. This kind of interpolation may amend the problem if there are observations at a relevant site.
- As stated above many municipalities do not have a homogeneous relevant series of observations. For the municipalities without relevant observations, one would need to adjust nearby observations to fit the site, thus requiring methods for spatial interpolation in addition to temporal interpolation.

As mentioned above, the definition does contain “at least 10 years of hourly data”. Figure 3 shows the $\theta_{99\%}$ based on various 10-year periods (solid red lines) and 30 years (dotted line). $\theta_{99\%}$ based on the 10-year reference period show a variation from 24,3 °C (2008 -2017) to 25,3 °C (2011 – 2020), while $\theta_{99\%}$ based on the normal period (1991 – 2020) is 25,0 °C and stable. The variability in shorter reference periods leads to a recommendation of a reference period of

30 years, e.g. standard normal periods by WMO.

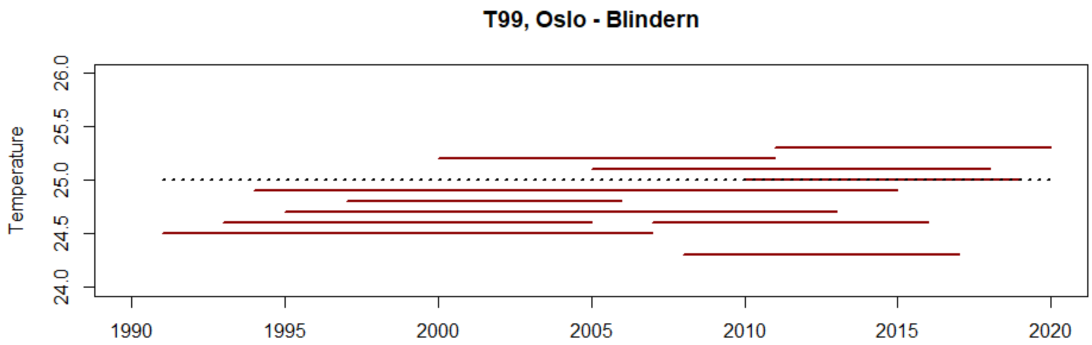


Figure 3: 10 year (red lines) and 30-year (dotted) values for $\theta_{99\%}$.

2 Suggested method

2.1 Availability of data

Norway has an extensive net of observations, but as mentioned before, there is not a complete coverage for every municipality. However there exists another dataset: Daily gridded values for mean daily temperature (Lussana et.al. (2019)). You may see these on the website senorge.no. Figure 4 is an example of daily temperature from senorge.no.

Using these grids as a foundation of design temperatures will eliminate the challenge of finding, and adjusting, data from observation sites. These maps will provide a fairly homogeneous dataset in space and time. These maps lack the temporal resolution beyond daily values, which implicates that definitions and tools must be based on daily values.

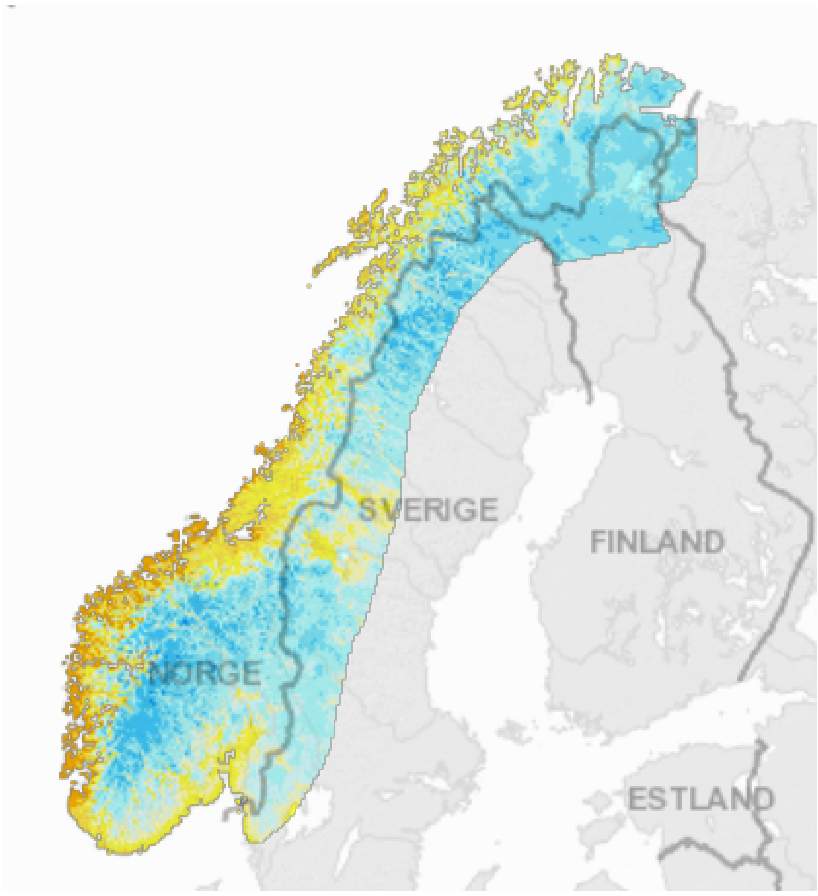


Figure 4: Example of temperature map from senorge.no

Using daily values from grids, for both summer and winter design temperatures, allows a homogenisation in methodology for calculating both summer and winter values.

2.2 Description of calculations

A complete description of the grid and grid methodology is available in Lussana et al. (2019). Based on these national grids, annual maximum and minimum for 1 to 5 days of mean temperature are calculated at selected sites. These sites represent municipality centres. The time period is chosen to match the latest normal period 1991-2020. This generates a matrix of 5*30*2 data points which are estimated using a Generalized Extreme Value, GEV, method with a Bayesian approach.

2.2.1 GEV, Bayesian approach

Prior to March 2022, MET used a Gumbel method to evaluate extremes and their return values. The theory was developed by Emil J. Gumbel and presented in a series of lectures at the National Bureau of Standards (USA) in 1954. (Gumbel, 1954). The Gumbel method in use at MET was developed in partnership with The Norwegian Water Resources and Energy Directorate, NVE, during the mid 1970's. It was primarily used for calculating return values of extreme rainfall for defined durations in Intensity-Duration-Frequency, IDF, analysis. The Gumbel method has also been applied to analyse snow-water equivalents and temperatures.

The Gumbel method is old. It is also now known to have a tendency to underestimate longer durations and return periods (e.g. Papalexiou & Koutsoyiannis, 2013 og Kouitsoyannis, 2004)(ref). MET has therefore developed a new method utilising Generalized Extreme Value, GEV, estimation with a Bayesian approach, hereafter referred to as GEV-Bay. The distribution of observations are described by 3 parameters, location μ, scale σ and shape ξ. The three-parameter GEV distribution is on the form

$$G(x) = exp\left\{-\left(1 + \xi\frac{x-\mu}{\sigma}\right)^{\frac{-1}{\xi}}\right\} \text{ for } 1 + \xi(\frac{x-\mu}{\sigma}) > 0, \qquad (1)$$

where $\mu \in R$ is the location parameter, $\sigma > 0$ is the scale parameter, and $\xi \in R$ is the shape parameter.

GEV-Bay uses the Bayesian inference to estimate an entire probability distribution of the parameter set θ that contains the three GEV parameters, that is: θ = (μ, σ, ξ).
The Bayesian inference is based on the Bayes' Theorem (Bayes, 1763) which states that the probability of an event is dependent on prior knowledge of conditions that are related to the event. Mathematically, the probability is

$$P(\theta|x) = \frac{L(x|\theta)P(\theta)}{P(x)}, \qquad (2)$$

where $P(\theta|x)$, called the posterior probability, is the probability density function of θ, given the observations x. $L(x|\theta)$ is the likelihood function, the probability that all observations x_i occur together, given the GEV parameters (μ, σ, ξ)

$$L(x|\mu, \sigma, \xi) = \prod_{i=1}^{n} f(x_i|\mu, \sigma, \xi), \qquad (3)$$

and $P(\theta)$ is the prior probability of θ, that is, the GEV parameters. Since $P(x)$ is a constant, $P(\theta|x)$ is ultimately sampled as the product of likelihood and prior probability

$$P(\theta|x) \propto L(x|\theta)P(\theta), \qquad (4)$$

using the Markov Chain Monte Carlo (MCMC) method (Richey, 2010).

The prior probability of the shape parameter ξ, is restricted by a beta distribution $B(p = 6, q = 9)$ defined on the interval $[-0.5, 0.5]$ (Martins, E.S.; Stedinger, J.R., 2000). This is to ensure convergence and to avoid unnaturally high return values.

For each return period, 50.000 iterations are carried out. To ensure stability in the simulated parameters θ, only the last 3000 are kept and forms the basis for calculating return values. Mathematically, the return values are calculated by

$$x_T = \mu - \frac{\sigma}{\xi}\left[1 - \{-\,log(1 - 1/T)\}^{-\xi}\right] \text{ for } \xi \neq 0, \qquad (5)$$

where x_T is the return value and T is the return period.

As there are 3000 sets of parameters, this enables the determination of uncertainties. The median is considered best fit and is extracted and presented as the return value. The interval between the 2.5 quantile and the 97.5 quantile represents the 95 % confidence interval. An example of uncertainty is shown in Figure 8.

All calculations of return values are calculated in R (R Core Team (2020)) using the R package $extRemes.R$, *Weather and Climate Applications of Extreme Value Analysis (EVA), Eric Gilleland, Richard W. Katz (2016).* Special R functions for restricted shape values and median extraction by Julia Lutz, MET, 2022.

2.2.2 Correction of inconsistencies

Due to the fact that values for each return period are calculated separately, we sometimes encounter inconsistencies. In the case of winter design temperatures for Røros shown in Figure 6, the calculated minimum mean temperature for a 1 day duration is warmer than both the 2 day and 3 day calculated minimum mean temperatures for some return periods. This can not be correct.

In this case, we carefully move the curves to consistency to see if the fit is better by trying to use i.e. the 51 quantile for the 1 day/30 years return period calculated minimum mean temperature instead of the median. The process is repeated for all crossing curves until consistency is gained with a minimum of changes to the median for all durations and return period values. Example from Røros in Figure 7 after adjustment.

The software, fixIDF.R, used for adjusting curves to consistency is run with R. It was developed in the project ClimDesign by Thea Roksvåg at the Norwegian Computing Center. The package is available on GitHub, https://github.com/ClimDesign/fixIDF.

The quantiles chosen by fixIDF.R on design temperatures at Røros are shown in Figure 5.

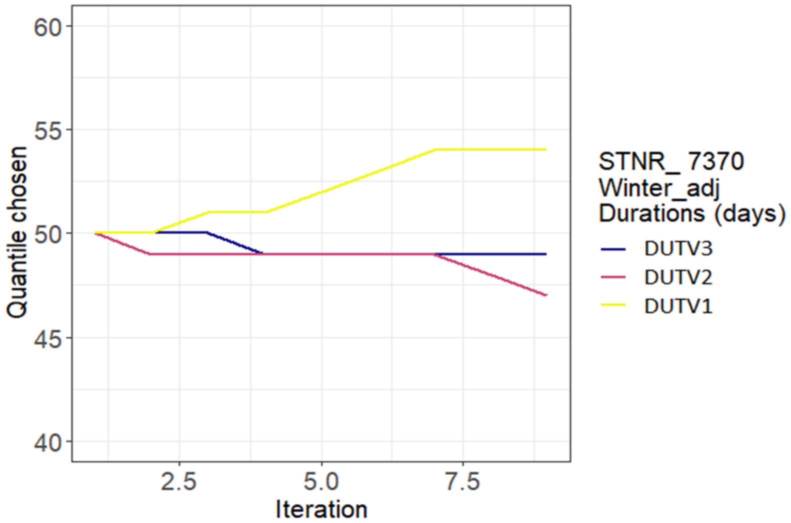


Figure 5: Quantiles chosen by fixIDF.R to correct inconsistencies in design temperatures at Røros.

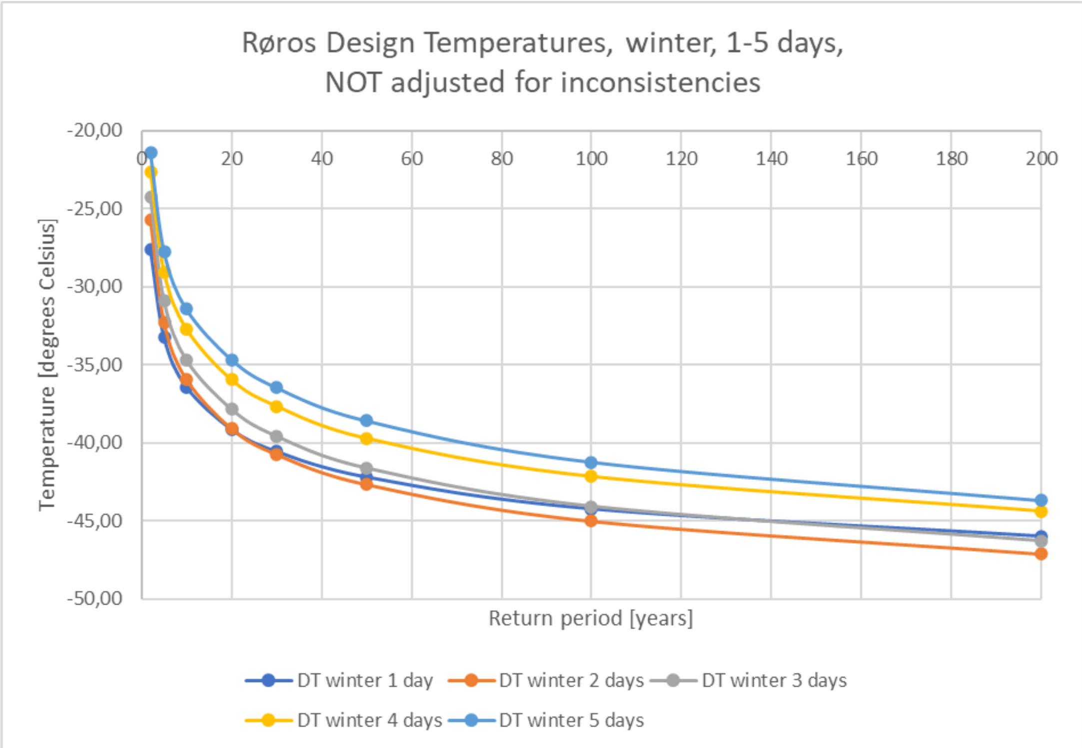


Figure 6: Design temperatures calculated at Røros without considering consistency between the values.

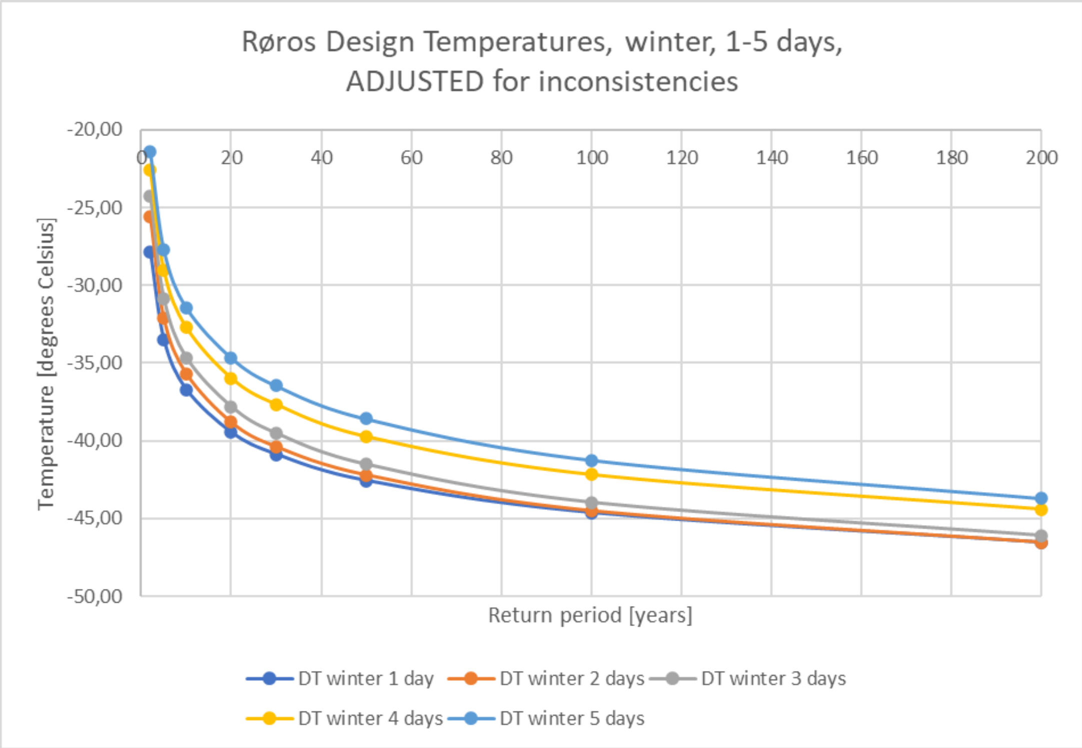


Figure 7: Design temperatures at Røros adjusted to accommodate for consistency.

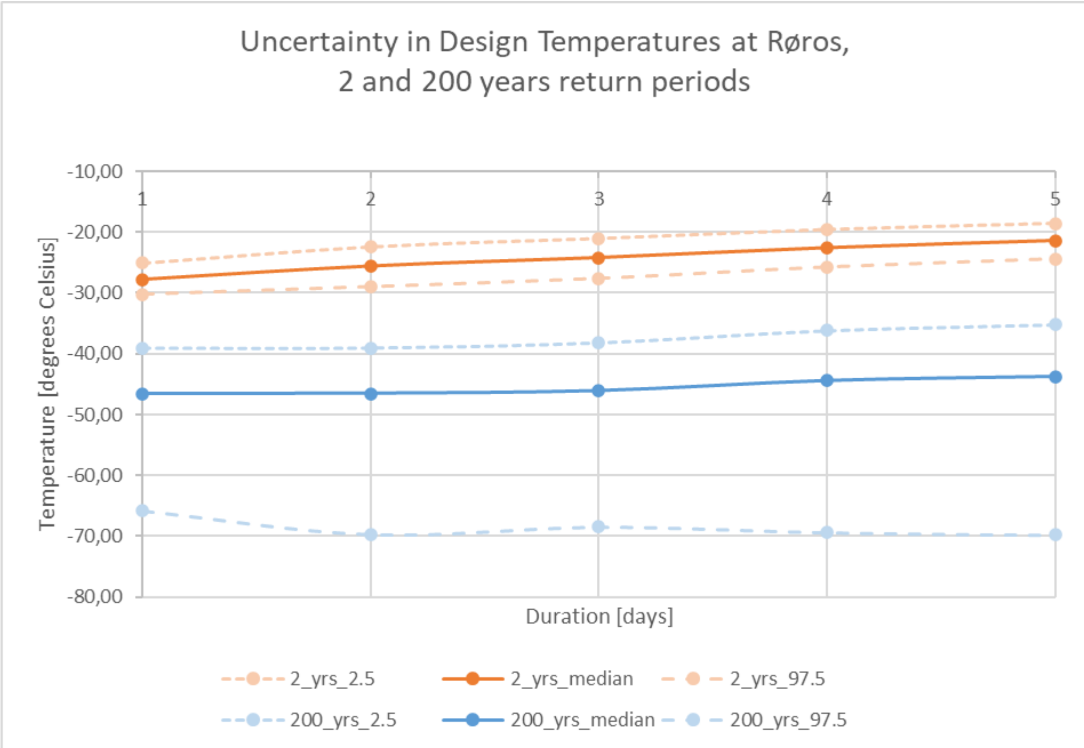


Figure 8: Uncertainty estimates for 2 and 200 years return period at Røros.

3 Example of calculated return values for winter and summer design values for Oslo

In the following chapter design temperatures for winter and summer are presented for Oslo municipality centre as an example. In the summer chapter a comparison of design temperatures according to current standard, the Norwegian practice and the proposed method will be presented.

3.1 Design temperatures winter

The following table shows the winter design temperatures, for 1-5 days and return period of 2-200 years, calculated at Oslo municipality centre with gridded data from seNorge 2018.

Table 1: Design temperatures winter for Oslo.

DUT, WINTER, Oslo municipality center, gridded data from seNorge 2018									
	Return period [years]								
Duration	2	5	10	20	25	30	50	100	200
1 day	-13,2	-16,9	-19,2	-21,1	-21,7	-22,2	-23,5	-25,0	-26,4
2 days	-12,2	-16,0	-18,3	-20,3	-20,9	-21,4	-22,7	-24,3	-25,9
3 days	-11,3	-15,2	-17,6	-19,7	-20,4	-20,9	-22,3	-24,1	-25,7
4 days	-10,5	-14,5	-16,9	-19,1	-19,7	-20,3	-21,7	-23,5	-25,4
5 days	-10,0	-14,0	-16,4	-18,6	-19,3	-19,8	-21,2	-23,0	-24,8

3.2 Design temperatures summer

The following table shows the summer design temperatures, for 1-5 days and return period of 2-200 years, calculated for Oslo municipality centre.

Table 2: Design temperatures summer for Oslo.

DUT, SUMMER, Oslo municipality center, gridded data from seNorge 2018									
	Return period [years]								
Duration	2	5	10	20	25	30	50	100	200
1 day	22,3	24,3	25,6	26,8	27,2	27,5	28,3	29,5	30,5
2 days	21,9	23,8	25,0	26,2	26,5	26,8	27,5	28,5	29,4
3 days	21,6	23,5	24,7	25,8	26,1	26,4	27,1	28,0	28,8
4 days	21,3	23,3	24,5	25,5	25,8	26,1	26,8	27,7	28,5
5 days	21,1	23,0	24,2	25,3	25,6	25,8	26,5	27,4	28,2

3.2.1 Comparison of GEV calculated summer design values and other values

Figure 9 compares the design values for Oslo from the Bayesian GEV and the current standard calculations. The standard used value of temperatures exceeding max 50 hours in a normal year is 26.3 °C, which is comparative to e.g. a 20 year return period of 3 days of 26.5 °C.

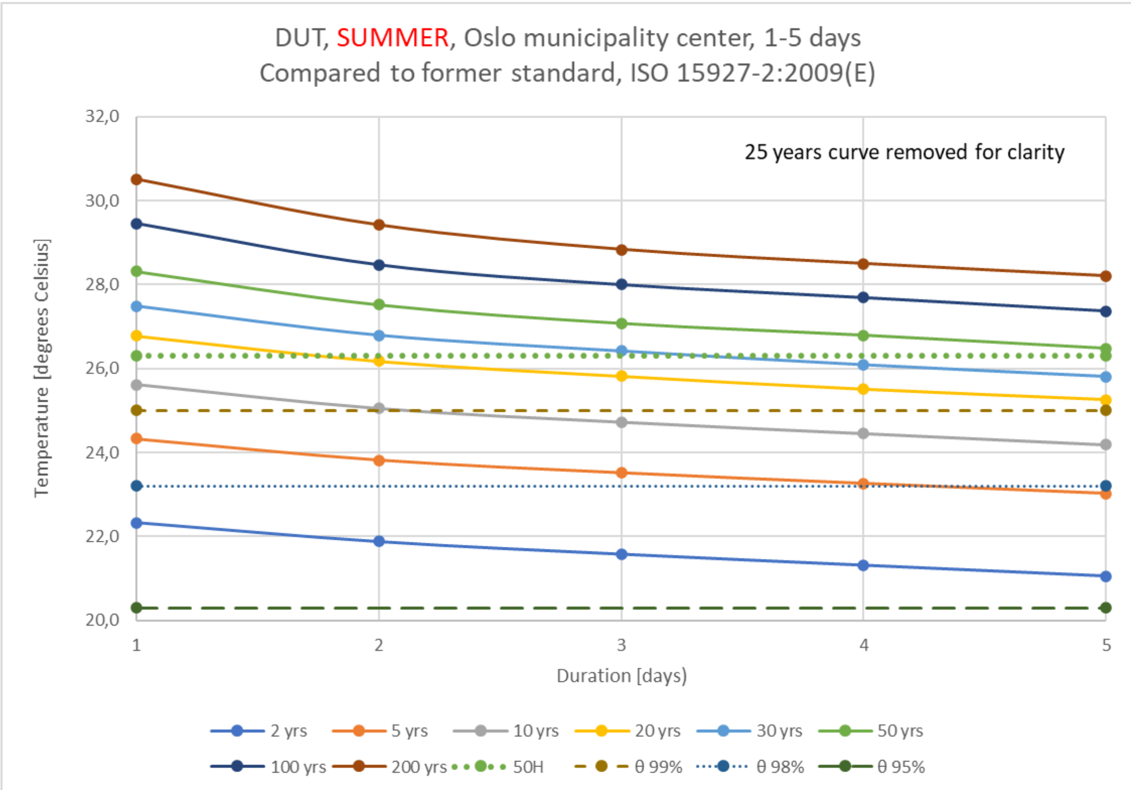


Figure 9: Comparison of design values from the GEV based method, the standard and the Norwegian practice of temperatures exceeding max 50 hours per year.

4 Populating a more complete reference dataset

Dimensioning of cooling and heating of houses are dependent on more data than just one value for winter and summer. Ideally one should have a reference year, or similar. To create a reference year is a huge task. As a substitute for a reference year, three supporting datasets/thesis are explored:

- A description of local standardised temperature variations on extreme days (Daily temperature range, DTR/ΔT)
- A matching set of humidity values
- A test if one can assume that the coldest and warmest days coincide with clear weather

For DTR and humidity there are chosen to calculate this on representative stations and associate municipalities with these (Figure 10).

4.1 Daily temperature range (DTR / ΔT)

The amplitude of diurnal temperature variations is considered a valid and relevant substitute for a full detailed hourly temperature profile. The most important description of this amplitude is connected to the most extreme days. Instead of generating this via extreme value distributions, we may use the assumption that the warmest and coldest days may also represent the seasonal greater variations. Figure 11 illustrates this, and verifies that the greater temperature ranges for summer, and in lesser degree for winter, is associated with the warmer and colder days. Based on this is an assumption that a warm and cold period are periods with greater DTR verified. This verification leads to the possibility that extracting DTR from warm and cold periods is a valid DTR to describe the temperature variations associated with the Design temperatures. The proposed method is to extract the DTR/ΔT from identified warm days at selected locations where also absolute humidity is calculated. The selection of locations are based on MET Norway's climatological regions and administrative regions (municipalities and counties. The result is presented in the appendix sorted by county.

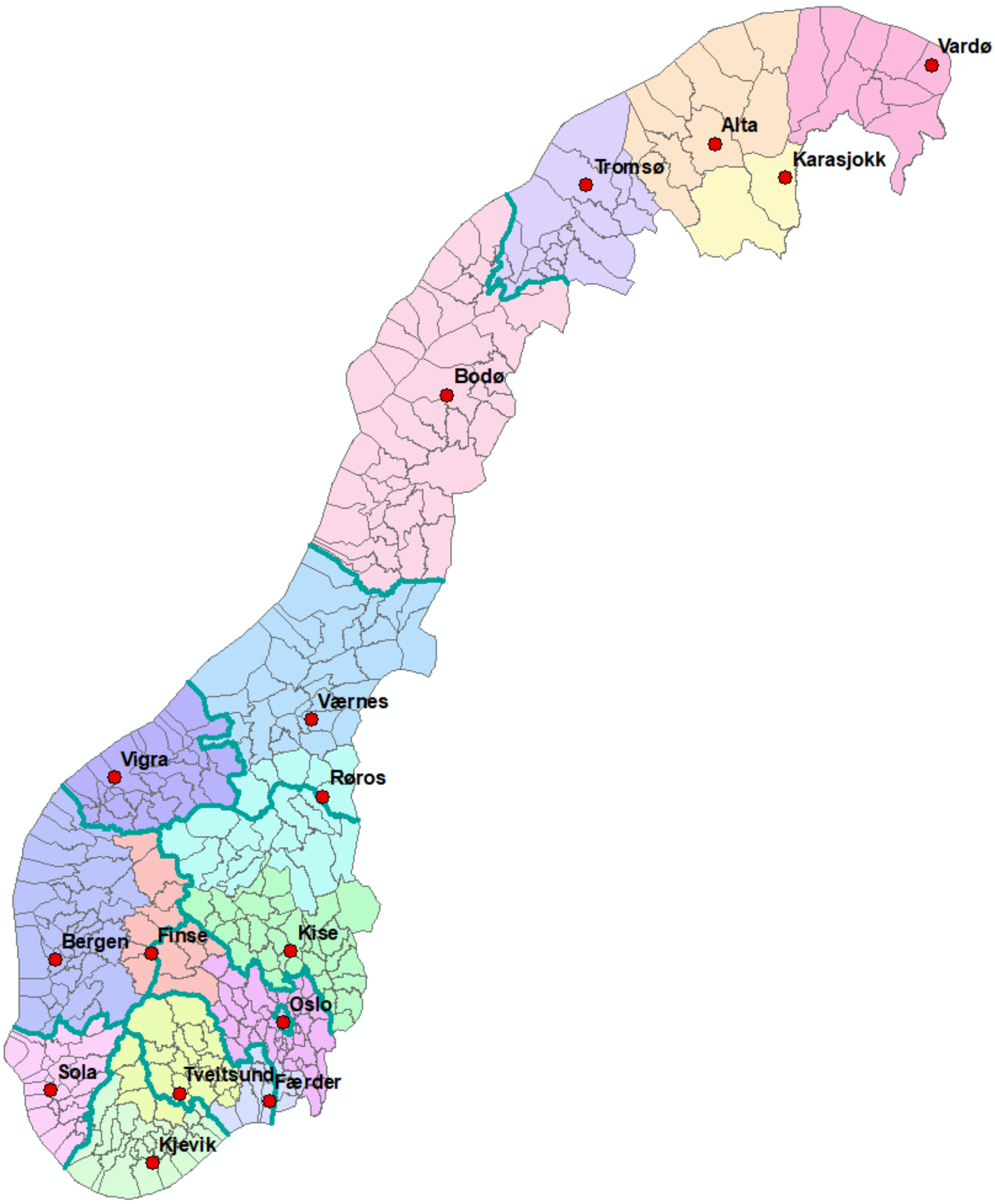


Figure 10: Map of Norway with municipalities coloured according to the observational site recommended for the municipality and observational stations presented.

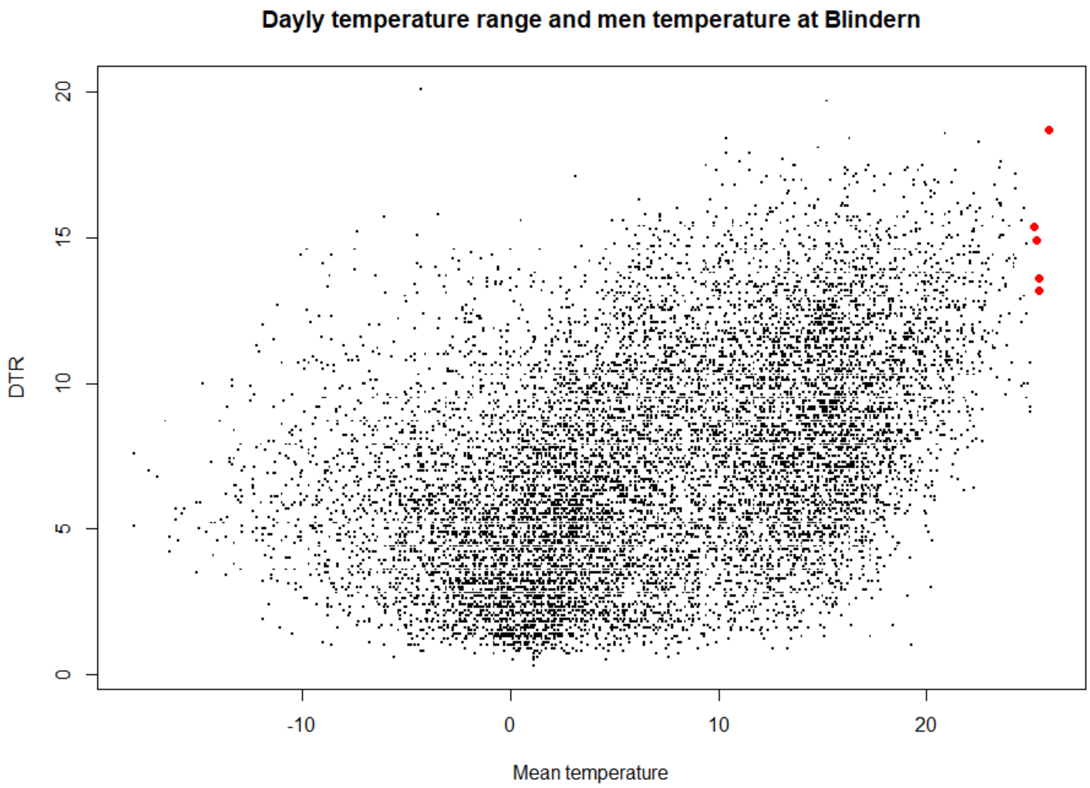


Figure 11: Daily temperature range at Blindern compared to mean temperatures. The five warmest days are shown in red.

4.2 Clear day hypothesis and radiation

The thermal response and properties of the buildings are affected by solar radiation, thus the knowledge of cloudiness and solar radiation is very relevant. Unfortunately the measurements of radiation are severely limited in Norway. One assumption to be explored is whether the coldest and warmest days coincide with clear days. Figure 12 explores the connection on a monthly basis. This plot is rather complex and has three lines for each month. The upper line, marked with triangles, indicates days which were classified as "Fair-Weather-days", while the lower, marked with squares, is for overcast days. The middle line, with circles, is neither. The classification is based on cloud observations in octa three times a day. Fair weather requires a sum of 9 or less and no observation above 4, while overcast is a sum of 20 and more.
For the three winter months (December, top blue, January bottom blue and February in purple) the extreme cold days coincide with Fair weather. For the summer (orange, yellow and green) it's clear that the extreme warm days do not coincide with overcast. Some of them might be on neither, this is usually due observations with octa higher than 4 in either morning or afternoon.
Testing on other stations reveals the same pattern, here represented with Bergen-Florida and Værnes, Figure 13 and 14.

The conclusion: The assumption that the warmest and coldest days are associated with clear, or almost clear skies, is valid.

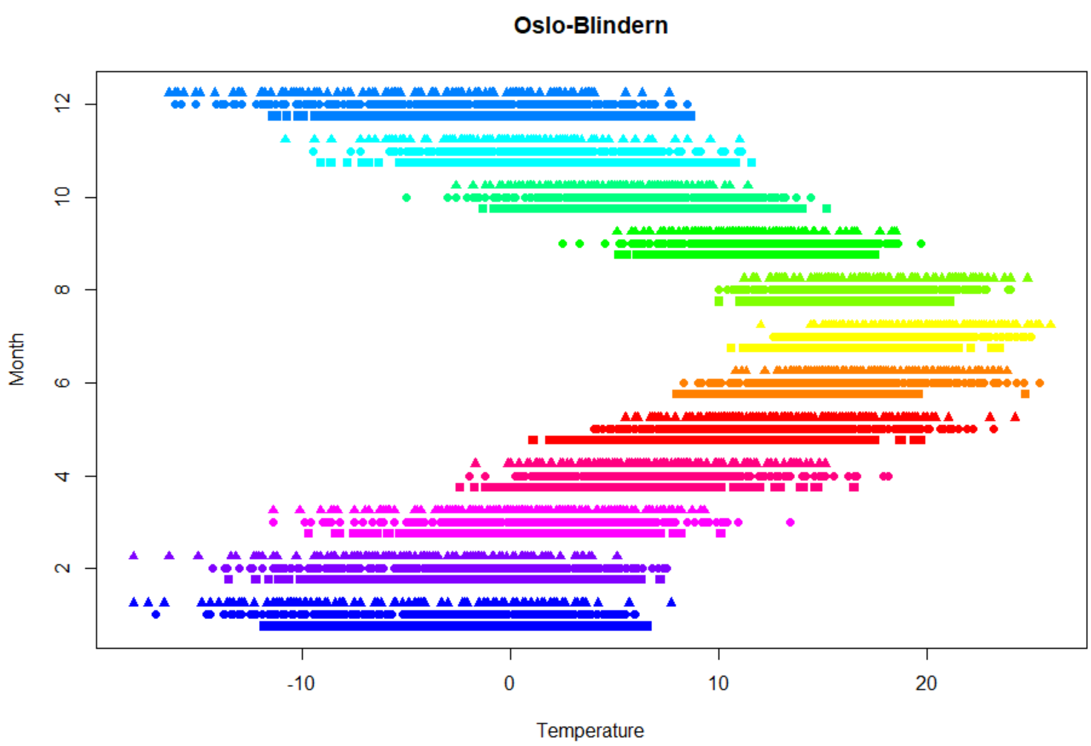


Figure 12: Monthly distribution of temperature sorted by cloudiness for Oslo-Blindern. Upper line in each month has clear days, lower lines are cloudy days, and the middle line is partly cloudy.

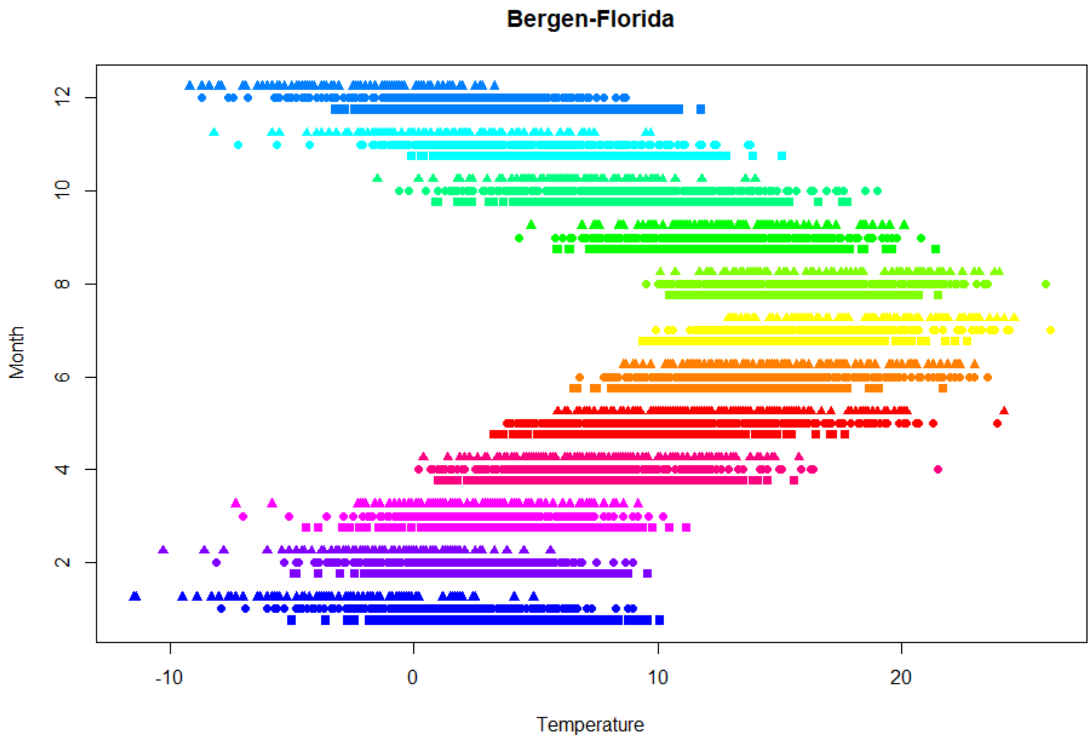


Figure 13: Monthly distribution of temperature sorted by cloudiness for Bergen-Florida. Upper line in each month has clear days, lower lines are cloudy days, and the middle line is partly cloudy.

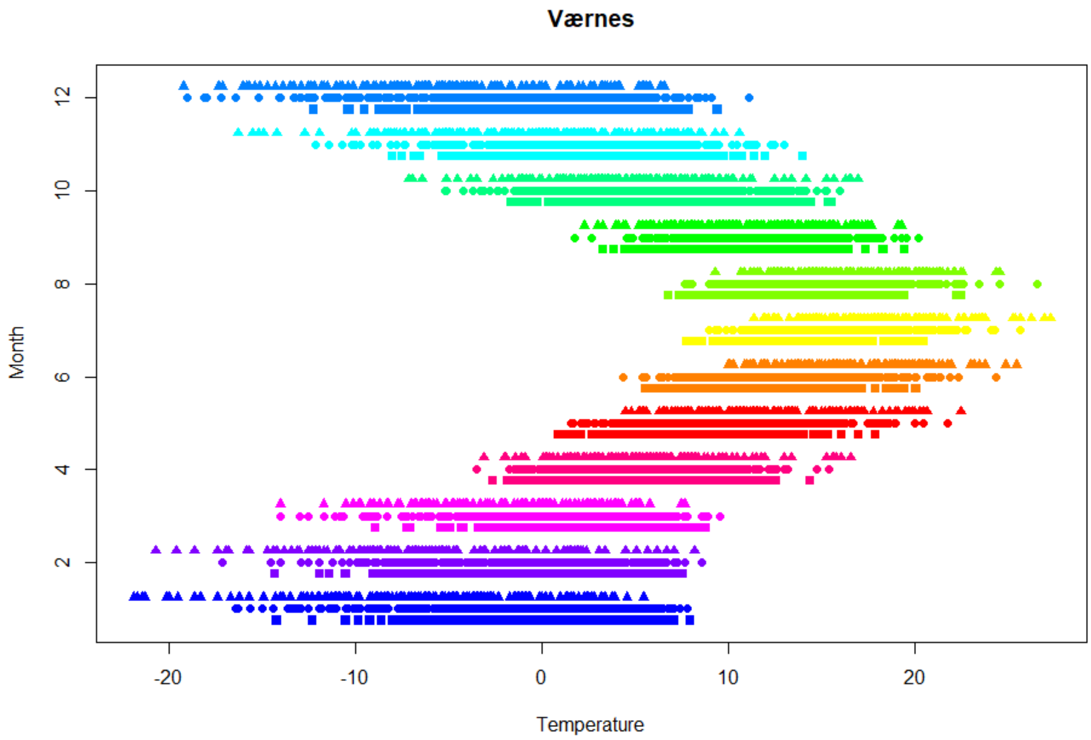


Figure 14: Monthly distribution of temperature sorted by cloudiness for Værnes. Upper line in each month has clear days, lower lines are cloudy days, and the middle line is partly cloudy.

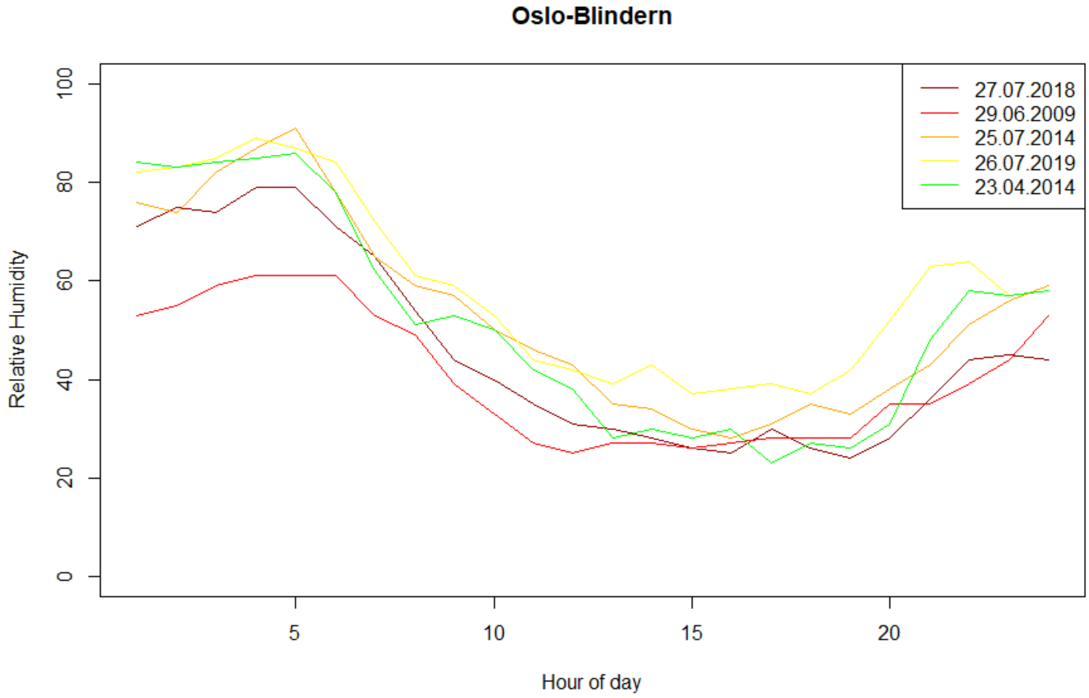
4.3 Humidity

What is the typical humidity of the days matching the dimensioning temperatures? The following simple exploration is based on Oslo-Blindern for the period of 2016 to 2020. Conversion between relative humidity and temperature to absolute humidity is performed with:

$$AbsHum. = \frac{6.112 * e^{((16,67*T)/(T+243,5))} * RH * 18,2}{(273,15+T)*100*0,08314} \qquad (6)$$

- AbsHum is the absolute humidity in g/m^3
- T is temperature in ℃
- RH is relative temperature in %

Figures 15 and 16 explore the five warmest and coldest days at Oslo-Blindern, and show how the absolute humidity reveals minor variations throughout the day even though the relative humidity has large variations. For warm days, relative humidity in the morning is typically 70-75 %, and decreases to about 30 % in the afternoon as temperature increases. Absolute humidity on the other hand is fairly stable throughout the day at 10 to 15 g/m^3. In the colder days the relative humidity for all but one of the days is about 80% throughout the day. The absolute humidity these 5 cold days is about 1 g/m^3 throughout the day.



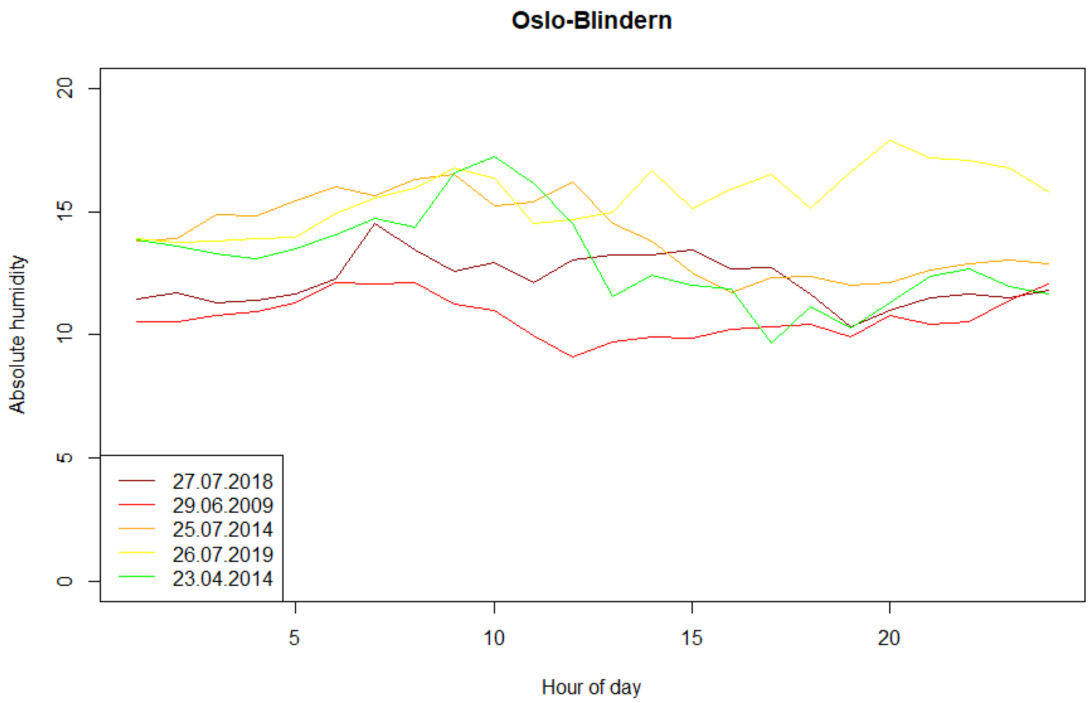


Figure 15: Relative and absolute humidity of the five warmest days at Oslo-Blindern.

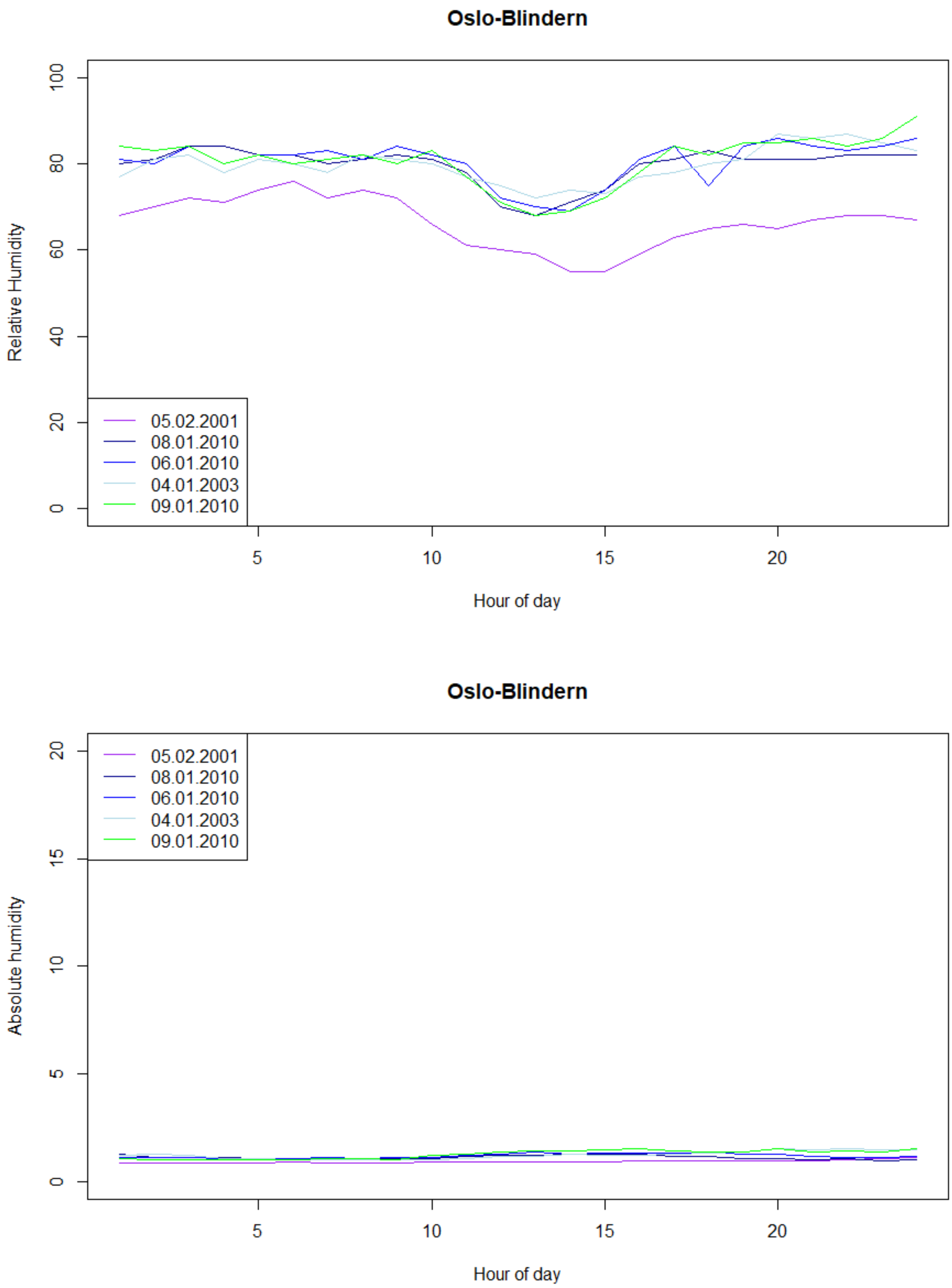


Figure 16: Relative and absolute humidity of the five coldest days at Oslo-Blindern.

The design humidities are gathered by calculating the mean humidity for the five warmest days, according to daily average temperature. Standard deviations for these observations are also presented both in Figure 17 and Table 3.

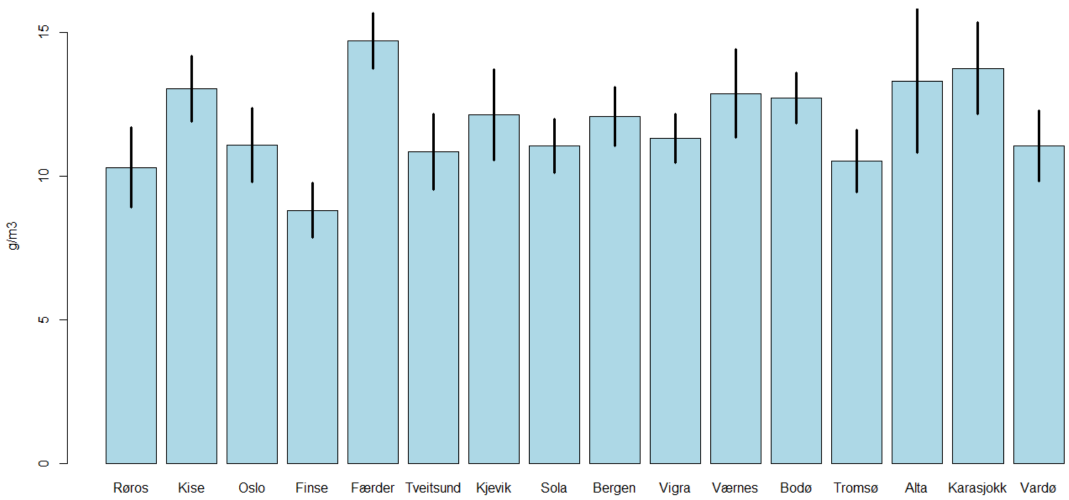


Figure 17: Average and standard deviation for absolute humidity at selected stations.

*Table 3: Average daily temperature range, and average and standard deviation of absolute humidity at selected stations for the five warmest days according to daily mean temperature of the observations. Stations with * consists of two stations at the location due to change of location. Homogeneity is considered good enough for this application.*

Station	Mean absolute humidity	Standard deviation of absolute humidity	Mean daily temperature range
Røros *	10,3	1,4	17,0
Kise	13,0	1,1	14,6
Oslo	11,1	1,3	15,2
Finse *	8,8	0,9	11,7
Færder	14,7	1,0	5,2
Tveitsund	10,8	1,3	16,6
Kjevik	12,1	1,6	12,3
Sola	11,0	0,9	12,1
Bergen	12,1	1,0	12,7
Vigra	11,3	0,8	11,6

Værnes	12,9	1,5	12,9
Bodø	12,7	0,9	9,7
Tromsø	10,5	1,1	10,8
Alta	13,3	2,5	11,3
Karasjok *	13,7	1,6	11,7
Vardø	11,0	1,2	10,4

5 Recommendation

Based on the above work is the following approach recommended:

1. The base of calculating the design values should be the gridded climatology that is calculated at MET Norway. These grids are of 1 km resolution, and it is recommended to extract a subset of these matching the Norwegian municipalities, and maybe other sites of special interest.
2. It is recommended to approach the calculation of summer and winter values with the same methodology. The best grids have a temporal resolution of one day, thus diurnal values are recommended as a base.
3. It is recommended to do the calculations with a Bayesian-GEV method.
4. It is recommended to consider the need of safety and certainty when applying the data to calculations of loads. From the GEV calculations, various return values from 2 years and upward can be extracted. The extra information found in multiple values versus one deterministic value should be considered in this framework and possibly lead to different types of buildings using different return values.
5. DTR/ΔT is to be extracted at the warmer and colder 5 day period at each station.
6. It is valid to assume that the warmer and colder days are associated with clear, or almost clear skies.
7. The assumption that absolute humidity only has minor variations in hot and cold days is verified, and may be used as a basis for calculations. It is recommended to calculate the absolute humidity of warm and cold days on 10 - 20 representative stations throughout Norway and associate each municipality with one station.

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A1 Appendix: County-wise table with associated observational station

Troms og Finnmark

Kommunenummer	Kommune	Stasjonsnummer	Sted
5401	Tromsø	90450	Tromsø
5402	Harstad	90450	Tromsø
5403	Alta	93140	Alta
5404	Vardø	98550	Vardø
5405	Vadsø	98550	Vardø
5406	Hammerfest	93140	Alta
5411	Kvæfjord	90450	Tromsø
5412	Tjeldsund	90450	Tromsø
5413	Ibestad	90450	Tromsø
5414	Gratangen	90450	Tromsø
5415	Lavangen	90450	Tromsø
5416	Bardu	90450	Tromsø
5417	Salangen	90450	Tromsø
5418	Målselv	90450	Tromsø
5419	Sørreisa	90450	Tromsø
5420	Dyrøy	90450	Tromsø
5421	Senja	90450	Tromsø
5422	Balsfjord	90450	Tromsø
5423	Karlsøy	90450	Tromsø
5424	Lyngen	90450	Tromsø
5425	Storfjord	90450	Tromsø
5426	Kåfjord	90450	Tromsø
5427	Skjervøy	93140	Alta

5428	Nordreisa	93140	Alta
5429	Kvænangen	93140	Alta
5430	Kautokeino	97250	Karasjok
5432	Loppa	93140	Alta
5433	Hasvik	93140	Alta
5434	Måsøy	93140	Alta
5435	Nordkapp	93140	Alta
5436	Porsanger	93140	Alta
5437	Karasjok	97250	Karasjok
5438	Lebesby	98550	Vardø
5439	Gamvik	98550	Vardø
5440	Berlevåg	98550	Vardø
5441	Tana	98550	Vardø
5442	Nesseby	98550	Vardø
5443	Båtsfjord	98550	Vardø
5444	Sør-Varanger	98550	Vardø

Nordland

Kommunenummer	Kommune	Stasjonsnummer	Sted
1804	Bodø	82290	Bodø
1806	Narvik	82290	Bodø
1811	Bindal	82290	Bodø
1812	Sømna	82290	Bodø
1813	Brønnøy	82290	Bodø
1815	Vega	82290	Bodø
1816	Vevelstad	82290	Bodø
1818	Herøy	82290	Bodø
1820	Alstahaug	82290	Bodø
1822	Leirfjord	82290	Bodø
1824	Vefsn	82290	Bodø
1825	Grane	82290	Bodø
1826	Hattfjelldal	82290	Bodø
1827	Dønna	82290	Bodø
1828	Nesna	82290	Bodø
1832	Hemnes	82290	Bodø
1833	Rana	82290	Bodø
1834	Lurøy	82290	Bodø
1835	Træna	82290	Bodø
1836	Rødøy	82290	Bodø
1837	Meløy	82290	Bodø
1838	Gildeskål	82290	Bodø
1839	Beiarn	82290	Bodø
1840	Saltdal	82290	Bodø
1841	Fauske	82290	Bodø
1845	Sørfold	82290	Bodø
1848	Steigen	82290	Bodø
1851	Lødingen	82290	Bodø
1853	Evenes	82290	Bodø

1856	Røst	82290	Bodø
1857	Værøy	82290	Bodø
1859	Flakstad	82290	Bodø
1860	Vestvågøy	82290	Bodø
1865	Vågan	82290	Bodø
1866	Hadsel	82290	Bodø
1867	Bø	82290	Bodø
1868	Øksnes	82290	Bodø
1870	Sortland	82290	Bodø
1871	Andøy	82290	Bodø
1874	Moskenes	82290	Bodø
1875	Hamarøy	82290	Bodø

Trøndelag

Kommunenummer	Kommune	Stasjonsnummerr	Sted
5001	Trondheim	69100	Værnes
5006	Steinkjer	69100	Værnes
5007	Namsos	69100	Værnes
5014	Frøya	69100	Værnes
5020	Osen	69100	Værnes
5021	Oppdal	10400	Røros
5022	Rennebu	10400	Røros
5025	Røros	10400	Røros
5026	Holtålen	10400	Røros
5027	Midtre Gauldal	10400	Røros
5028	Melhus	69100	Værnes
5029	Skaun	69100	Værnes
5031	Malvik	69100	Værnes
5032	Selbu	69100	Værnes
5033	Tydal	10400	Røros
5034	Meråker	69100	Værnes
5035	Stjørdal	69100	Værnes
5036	Frosta	69100	Værnes
5037	Levanger	69100	Værnes
5038	Verdal	69100	Værnes
5041	Snåsa	69100	Værnes
5042	Lierne	69100	Værnes
5043	Røyrvik	69100	Værnes
5044	Namsskogan	69100	Værnes
5045	Grong	69100	Værnes
5046	Høylandet	69100	Værnes
5047	Overhalla	69100	Værnes
5049	Flatanger	69100	Værnes

5052	Leka	69100	Værnes
5053	Inderøy	69100	Værnes
5054	Indre Fosen	69100	Værnes
5055	Heim	69100	Værnes
5056	Hitra	69100	Værnes
5057	Ørland	69100	Værnes
5058	Åfjord	69100	Værnes
5059	Orkland	69100	Værnes
5060	Nærøysund	69100	Værnes
5061	Rindal	69100	Værnes

Møre og Romsdal

Kommunenummer	Kommune	Stasjonsnummer	Sted
1507	Ålesund	60990	Vigra
1506	Molde	60990	Vigra
1505	Kristiansund	60990	Vigra
1511	Vanylven	60990	Vigra
1514	Sande	60990	Vigra
1515	Herøy	60990	Vigra
1516	Ulstein	60990	Vigra
1517	Hareid	60990	Vigra
1520	Ørsta	60990	Vigra
1525	Stranda	60990	Vigra
1528	Sykkylven	60990	Vigra
1531	Sula	60990	Vigra
1532	Giske	60990	Vigra
1535	Vestnes	60990	Vigra
1539	Rauma	60990	Vigra
1547	Aukra	60990	Vigra
1554	Averøy	60990	Vigra
1557	Gjemnes	60990	Vigra
1560	Tingvoll	60990	Vigra
1563	Sunndal	60990	Vigra
1566	Surnadal	60990	Vigra
1573	Smøla	60990	Vigra
1576	Aure	60990	Vigra
1577	Volda	60990	Vigra
1578	Fjord	60990	Vigra
1579	Hustadvika	60990	Vigra

Vestland

Kommunenummer	Kommune	Stasjonsnummer	Sted
4601	Bergen	50540	Bergen
4602	Kinn	50540	Bergen
4611	Etne	50540	Bergen
4612	Sveio	50540	Bergen
4613	Bømlo	50540	Bergen
4614	Stord	50540	Bergen
4615	Fitjar	50540	Bergen
4616	Tysnes	50540	Bergen
4617	Kvinnherad	50540	Bergen
4618	Ullensvang	50540	Bergen
4619	Eidfjord	25840	Finse
4620	Ulvik	25840	Finse
4621	Voss	50540	Bergen
4622	Kvam	50540	Bergen
4623	Samnanger	50540	Bergen
4624	Bjørnafjorden	50540	Bergen
4625	Austevoll	50540	Bergen
4626	Øygarden	50540	Bergen
4627	Askøy	50540	Bergen
4628	Vaksdal	50540	Bergen
4629	Modalen	50540	Bergen
4630	Osterøy	50540	Bergen
4631	Alver	50540	Bergen
4632	Austrheim	50540	Bergen
4633	Fedje	50540	Bergen
4634	Masfjorden	50540	Bergen
4635	Gulen	50540	Bergen

4636	Solund	50540	Bergen
4637	Hyllestad	50540	Bergen
4638	Høyanger	50540	Bergen
4639	Vik	50540	Bergen
4640	Sogndal	50540	Bergen
4641	Aurland	25840	Finse
4642	Lærdal	25840	Finse
4643	Årdal	25840	Finse
4644	Luster	25840	Finse
4645	Askvoll	50540	Bergen
4646	Fjaler	50540	Bergen
4647	Sunnfjord	50540	Bergen
4648	Bremanger	50540	Bergen
4649	Stad	50540	Bergen
4650	Gloppen	50540	Bergen
4651	Stryn	25840	Finse

Rogaland

Kommunenummer	Kommune	Stasjonsnummer	Sted
1101	Eigersund	44560	Sola
1103	Stavanger	44560	Sola
1106	Haugesund	44560	Sola
1108	Sandnes	44560	Sola
1111	Sokndal	44560	Sola
1112	Lund	44560	Sola
1114	Bjerkreim	44560	Sola
1119	Hå	44560	Sola
1120	Klepp	44560	Sola
1121	Time	44560	Sola
1122	Gjesdal	44560	Sola
1124	Sola	44560	Sola
1127	Randaberg	44560	Sola
1130	Strand	44560	Sola
1133	Hjelmeland	44560	Sola
1134	Suldal	44560	Sola
1135	Sauda	44560	Sola
1144	Kvitsøy	44560	Sola
1145	Bokn	44560	Sola
1146	Tysvær	44560	Sola
1149	Karmøy	44560	Sola
1151	Utsira	44560	Sola
1160	Vindafjord	44560	Sola

Agder

Kommunenummer	Kommune	Stasjonsnummer	Sted
4201	Risør	39040	Kjevik
4202	Grimstad	39040	Kjevik
4203	Arendal	39040	Kjevik
4204	Kristiansand	39040	Kjevik
4205	Lindesnes	39040	Kjevik
4206	Farsund	39040	Kjevik
4207	Flekkefjord	39040	Kjevik
4211	Gjerstad	39040	Kjevik
4212	Vegårshei	39040	Kjevik
4213	Tvedestrand	39040	Kjevik
4214	Froland	39040	Kjevik
4215	Lillesand	39040	Kjevik
4216	Birkenes	39040	Kjevik
4217	Åmli	37230	Tveitsund
4218	Iveland	39040	Kjevik
4219	Evje og Hornnes	39040	Kjevik
4220	Bygland	37230	Tveitsund
4221	Valle	37230	Tveitsund
4222	Bykle	37230	Tveitsund
4223	Vennesla	39040	Kjevik
4224	Åseral	39040	Kjevik
4225	Lyngdal	39040	Kjevik
4226	Hægebostad	39040	Kjevik
4227	Kvinesdal	39040	Kjevik
4228	Sirdal	39040	Kjevik

Vestfold og Telemark

Kommunenummer	Kommune	Stasjonsnummer	Sted
3801	Horten	27500	Færder
3802	Holmestrand	27500	Færder
3803	Tønsberg	27500	Færder
3804	Sandefjord	27500	Færder
3805	Larvik	27500	Færder
3806	Porsgrunn	37230	Tveitsund
3807	Skien	37230	Tveitsund
3808	Notodden	37230	Tveitsund
3811	Færder	27500	Færder
3812	Siljan	37230	Tveitsund
3813	Bamble	37230	Tveitsund
3814	Kragerø	27500	Færder
3815	Drangedal	37230	Tveitsund
3816	Nome	37230	Tveitsund
3817	Midt-Telemark	37230	Tveitsund
3818	Tinn	37230	Tveitsund
3819	Hjartdal	37230	Tveitsund
3820	Seljord	37230	Tveitsund
3821	Kviteseid	37230	Tveitsund
3822	Nissedal	37230	Tveitsund
3823	Fyresdal	37230	Tveitsund
3824	Tokke	37230	Tveitsund
3825	Vinje	37230	Tveitsund

Oslo og Viken

Kommunenummer	Kommune	Stasjonsnummer	Sted
301	Oslo	18700	Oslo-Blindern
3001	Halden	18700	Oslo-Blindern
3002	Moss	27500	Færder
3003	Sarpsborg	27500	Færder
3004	Fredrikstad	27500	Færder
3005	Drammen	18700	Oslo-Blindern
3006	Kongsberg	18700	Oslo-Blindern
3007	Ringerike	18700	Oslo-Blindern
3011	Hvaler	27500	Færder
3012	Aremark	18700	Oslo-Blindern
3013	Marker	18700	Oslo-Blindern
3014	Indre Østfold	18700	Oslo-Blindern
3015	Skiptvet	18700	Oslo-Blindern
3016	Rakkestad	18700	Oslo-Blindern
3017	Råde	27500	Færder
3018	Våler	18700	Oslo-Blindern
3019	Vestby	18700	Oslo-Blindern
3020	Nordre Follo	18700	Oslo-Blindern
3021	Ås	18700	Oslo-Blindern
3022	Frogn	18700	Oslo-Blindern
3023	Nesodden	18700	Oslo-Blindern
3024	Bærum	18700	Oslo-Blindern
3025	Asker	18700	Oslo-Blindern
3026	Aurskog-Høland	18700	Oslo-Blindern
3027	Rælingen	18700	Oslo-Blindern

3028	Enebakk	18700	Oslo-Blindern
3029	Lørenskog	18700	Oslo-Blindern
3030	Lillestrøm	18700	Oslo-Blindern
3031	Nittedal	18700	Oslo-Blindern
3032	Gjerdrum	18700	Oslo-Blindern
3033	Ullensaker	18700	Oslo-Blindern
3034	Nes	18700	Oslo-Blindern
3035	Eidsvoll	18700	Oslo-Blindern
3036	Nannestad	18700	Oslo-Blindern
3037	Hurdal	18700	Oslo-Blindern
3038	Hole	18700	Oslo-Blindern
3039	Flå	18700	Oslo-Blindern
3040	Nesbyen	18700	Oslo-Blindern
3041	Gol	25840	Finse
3042	Hemsedal	25840	Finse
3043	Ål	25840	Finse
3044	Hol	25840	Finse
3045	Sigdal	18700	Oslo-Blindern
3046	Krødsherad	18700	Oslo-Blindern
3047	Modum	18700	Oslo-Blindern
3048	Øvre Eiker	18700	Oslo-Blindern
3049	Lier	18700	Oslo-Blindern
3050	Flesberg	18700	Oslo-Blindern
3051	Rollag	18700	Oslo-Blindern
3052	Nore og Uvdal	25840	Finse
3053	Jevnaker	18700	Oslo-Blindern
3054	Lunner	18700	Oslo-Blindern

Innlandet

Kommunenummer	Kommune	Stasjonsnummer	Sted
3401	Kongsvinger	12550	Kise
3403	Hamar	12550	Kise
3405	Lillehammer	12550	Kise
3407	Gjøvik	12550	Kise
3411	Ringsaker	12550	Kise
3412	Løten	12550	Kise
3413	Stange	12550	Kise
3414	Nord-Odal	12550	Kise
3415	Sør-Odal	12550	Kise
3416	Eidskog	12550	Kise
3417	Grue	12550	Kise
3418	Åsnes	12550	Kise
3419	Våler	12550	Kise
3420	Elverum	12550	Kise
3421	Trysil	12550	Kise
3422	Åmot	12550	Kise
3423	Stor-Elvdal	10400	Røros
3424	Rendalen	10400	Røros
3425	Engerdal	10400	Røros
3426	Tolga	10400	Røros
3427	Tynset	10400	Røros
3428	Alvdal	10400	Røros
3429	Folldal	10400	Røros
3430	Os	10400	Røros
3431	Dovre	10400	Røros
3432	Lesja	10400	Røros

3433	Skjåk	10400	Røros
3434	Lom	10400	Røros
3435	Vågå	10400	Røros
3436	Nord-Fron	10400	Røros
3437	Sel	10400	Røros
3438	Sør-Fron	12550	Kise
3439	Ringebu	12550	Kise
3440	Øyer	12550	Kise
3441	Gausdal	12550	Kise
3442	Østre Toten	12550	Kise
3443	Vestre Toten	12550	Kise
3446	Gran	12550	Kise
3447	Søndre Land	12550	Kise
3448	Nordre Land	12550	Kise
3449	Sør-Aurdal	12550	Kise
3450	Etnedal	12550	Kise
3451	Nord-Aurdal	12550	Kise
3452	Vestre Slidre	12550	Kise
3453	Øystre Slidre	12550	Kise
3454	Vang	12550	Kise