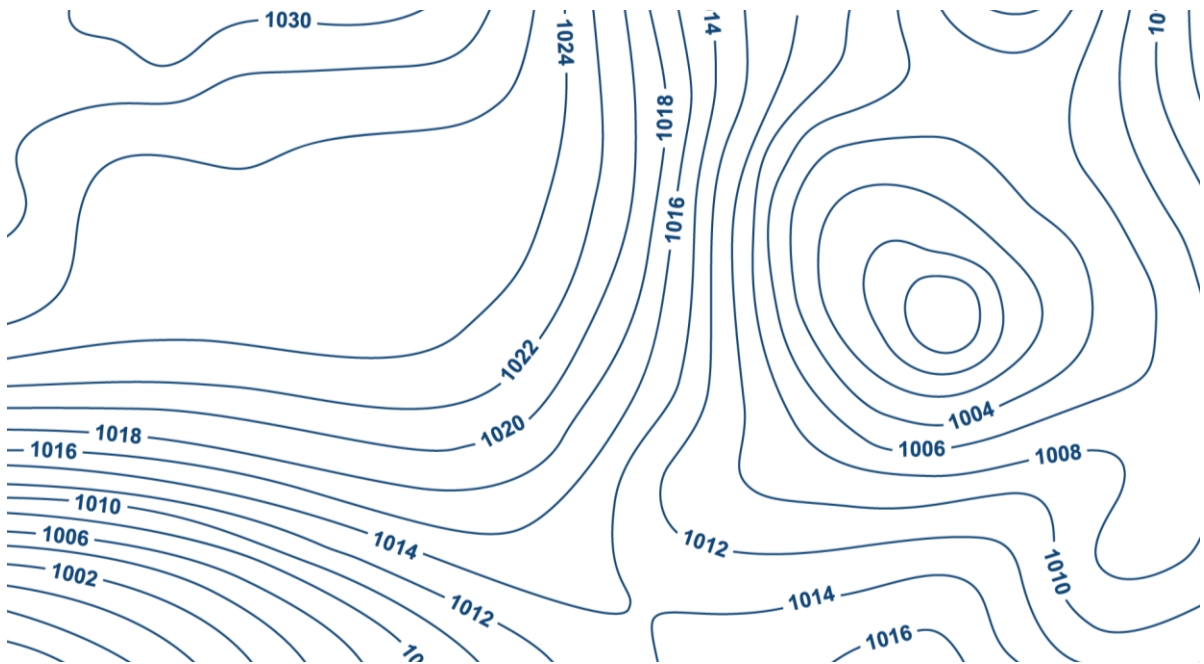


Assessment of the Copernicus Arctic Regional Reanalysis (CARRA) dataset for Iceland

Tarek Zaqout
Andréa-Giorgio R. Massad
Halldór Björnsson



Skýrsla

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Höfundar	Tarek Zaqout, Andréa-Giorgio R. Massad, Halldór Björnsson
Verkefnisstjóri	Tinna Þórarinsdóttir
Yfirfarið af	Guðrúnu Nínu Petersen
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Ágrip

Endurgreiningar veita nauðsynlega sýn á stöðu og þróun veðurs og loftslags með netsettum gögnum í hárri upplausn. Þetta er sérstaklega mikilvægt fyrir svæði þar sem þéttleiki veðurstöðva er lítil. Á Veðurstofu Íslands hefur lengi verið þörf á endurgreiningargögnum sem ná lengra fram í tímann en íslenska endurgreiningin (ICRA; 1979–2017) nær yfir og í þessari rannsókn eru skoðuð gæði CARRA-endurgreiningarinnar (Copernicus Arctic Regional Reanalysis) sem nær frá 1990 til 2026. Þótt meira en 20 breytur hafi verið sóttar gegnum Climate Data Store (CDS) viðmót Kópernikusar-áætlunarinnar, einblínir þessi rannsókn á þrjár þeirra: hita í 2 metra hæð, vindhraða í 10 metra hæð og úrkomu. Skýrslan lýsir hvernig gögnin voru sótt í CDS og unnið úr þeim, ásamt þeim aðferðum sem notaðar voru til að búa til tímaraðir fyrir 49 sjálfvirkar veðurstöðvar víða um landið. Á heildina litið sýna niðurstöðurnar gott samræmi á milli mælinga og hermdra gagna fyrir allar þrjár breytur. Reikniupplausn CARRA er 2.5 km sem kann að vera of lítið til að leysa upp landslag á svæðum þar sem það er flókið, svo sem í þröngum fjörðum og dölum. Þar nær CARRA endurgreiningin ekki að fullu að herma gögnin. Fervik (RMSE) fyrir meðal-, hámarks- og lágmarkshita í 2 metra hæð er undir 2 °C á flestum stöðvum, og hlýnunun kemur vel fram í endurgreiningunni. Daglegur vindhraði í 10 metra hæð er vel hermdur á sléttlendum svæðum og á stöðvum inn til landsins, en hermd gildi eru ofmetin á stöðvum þar sem landslag er flókið. Fyrir daglega úrkomu er fervik undir 3 mm á níu stöðvum, yfir 5 mm á 11 stöðvum, en aðrar stöðvar eru þar á milli. Niðurstöðurnar batna til muna þegar aðeins er miðað við sumargildi. Árleg hámarksmörk árstíða (AMS) byggð á daglegri úrkomu eru einnig metin, og er meðaltal hermds AMS á flestum stöðvum innan við 5% breytileika miðað við mælingar.

Lykilorð: CARRA, endurgreining, 2-m hiti, 10-m vindhraði, úrkoma.

Abstract

Reanalyses are essential to provide scientists with high-resolution, continuous gridded datasets that help improve the understanding of weather and climatology. This is particularly important in regions with sparse weather station coverage. At the Icelandic Meteorological Office (IMO), a reanalysis dataset extending further than the timespan covered by the Icelandic Reanalysis (ICRA; 1979–2017) has long been needed. This study provides a first assessment of the Copernicus Arctic Regional Reanalysis (CARRA) dataset that extends from 1990 until 2026. While more than 20 variables were downloaded and processed through the Copernicus Climate Data Store (CDS), this study focuses on three of them: the 2-m temperature, 10-m wind speed and precipitation. In this report, details on how this dataset was retrieved from CDS are provided, as well as the methods used to create time series at the locations of 49 automatic weather stations distributed all around Iceland. Overall, the results show a good agreement between observations and simulated data for all three variables. The largest discrepancies arise in areas of complex orography, such as narrow fjords and valleys, where orography is not fully resolved by the CARRA grid, which has a 2.5-km resolution. The RMSE for the mean, maximum, and minimum 2-m temperature is below 2°C for most stations, with warming trends well reproduced by the reanalysis. Daily 10-m wind speed is well simulated in flat areas and inland stations, while simulated values are overestimated for stations located in complex terrain. For daily precipitation, RMSE is below 3 mm for nine stations, above 5 mm for 11 stations, with all other stations having an RMSE in between, with results improving significantly when only summer values are considered. Annual Maximum Series (AMS) based on daily precipitation are also evaluated, with most stations having mean AMS within a 5% difference when based on observations and simulations.

Key words: CARRA, reanalysis, 2-m temperature, 10-m wind speed, precipitation.

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1 Introduction

In the effort to provide the European community with climate monitoring products and climate services for various applications, the Copernicus Climate Change Service (C3S) produced a new reanalysis adapted for the Arctic regions. This reanalysis is of particular importance for understanding the weather and climatology of high latitudes as they have been experiencing a more rapid warming compared to lower latitudes due to Arctic amplification (Yang et al., 2020; Rantanen et al., 2022).

This Copernicus Arctic Regional Reanalysis dataset, hereafter referred to as CARRA, is based on the non-hydrostatic HARMONIE-AROME mesoscale Numerical Weather Prediction (NWP) system (Bengtsson et al., 2017). The CARRA dataset has a temporal resolution of 3 hours for analyses and hourly forecasts and is available from September 1990 to the present (2026), which includes the WMO's 30-year climate normal period (1991–2020). CARRA has a 2.5-km horizontal resolution, and the reanalysis was performed on two model domains: one covering Greenland and Iceland (CARRA-West), and the other covering Svalbard and Northern Scandinavia (CARRA-East). In this report, only the western domain (CARRA-West) was used. For the CARRA reanalysis, ERA5 data were used as the lateral boundary conditions. Improved physiographic features and reprocessed or local observations were also incorporated. The variables evaluated in this work are obtained from the analysis stream except for precipitation, which is an accumulated variable. It should be noted that a second generation of the Copernicus Arctic Regional Reanalysis dataset (CARRA2), with a domain that covers the full Arctic (pan-Arctic) region, has been released. CARRA2 has the same horizontal resolution, extends back to 1986 and will be continued in the coming years. However, the evaluation of the CARRA2 dataset is not included in this report.

The high-resolution, gridded climate dataset from the CARRA reanalysis system can provide valuable information for socio-economic, environmental, and engineering applications, as well as climate change impact studies, especially in areas where observations are not available. Therefore, the aim of this report, is to evaluate the quality of the CARRA reanalysis in relation to weather observations in order to provide a more comprehensive understanding of the data. This report focuses on evaluating three climate variables from the CARRA dataset including near-surface air temperature at 2-m elevation, wind speed at 10-m height, and precipitation. The assessment was carried out by comparing the CARRA reanalysis data with observations from a set of 49 reliable automatic weather stations around Iceland (previously used in Massad et al., 2020).

2 Methodology

The gridded CARRA data were obtained using the Python API provided by the Copernicus Climate Data Store. Details regarding data retrieval procedures and the calculation of daily and monthly statistics are provided in Appendix I.

The dataset was then compared to observations from 49 selected automatic weather stations whose locations are shown in Figure 1. More information about the station coordinates can be found in Table 1. To carry out the comparison, the CARRA dataset was interpolated to the grid-point locations of the automatic weather stations using inverse distance weighted average interpolation of the four nearest grid points (see Eq. 1 and Figure 2):

$$\text{Weighted average at point } x = \frac{\sum_{i=1}^{n=4} \left(\frac{x_i}{d_i} \right)}{\sum_{i=1}^{n=4} \left(\frac{1}{d_i} \right)} \quad (1)$$

where x is the estimated value at a given station for which the interpolation is carried out, x_i is the known values at the nearest four grid points, and d_i is the distance between the known-value grid points to the interpolated value. The extracted 3-hour CARRA data at each of the 49 stations (Table 1) were used to calculate the daily average, maximum, and minimum near-surface air temperature and the daily average wind speed. The 3-hour precipitation was used to calculate the daily accumulated precipitation from midnight to midnight. The daily precipitation was then used to calculate the Annual Maximum Series (AMS) of daily precipitation and the accumulated annual precipitation at all stations. Prior to carrying out the comparison, the missing values from the observed variables were identified and removed from the corresponding simulated dataset.

The probability density function (PDF) and the cumulative distribution function (CDF) of the daily observed and modelled 2-m temperature (mean, maximum, and minimum) and mean 10-m wind speed were compared to identify systematic biases in the CARRA data at each station. For daily precipitation, quantile–quantile (Q–Q) plots were created at each location showing each quantile of the observed time series against the corresponding quantile from the simulated CARRA time series. Scatter plots were also created for all assessed variables, i.e., mean, maximum, and minimum air temperature, average wind speed, and daily precipitation. Additionally, the Annual Maximum Series (AMS) of daily precipitation that gives for every year the maximum daily precipitation and the accumulated annual precipitation were compared to observations. To quantify the agreement between modelled and observed values, the root mean square error (RMSE) and the mean absolute error (MAE) were used. For the annual precipitation, the normalised root mean square error (NRMSE) was used, which was determined by normalising the RMSE using the range of the observed annual precipitation at each station.

Table 1. List of automatic weather stations used for the comparison with the CARRA data with the name of the station, abbreviation, and coordinates.

Station	Abbreviation	Latitude	Longitude
Eskifjörður	ESK	65.08	-14.04
Flateyri	FLA	66.05	-23.51
Höfn í Hornafirði	HOFN	64.27	-15.21
Ísafjörður	ISA	66.06	-23.17
Kvísker	KVI	63.98	-16.44
Laufbali	LAUF	64.03	-18.12
Neskaupstaður	NESK	65.15	-13.67
Ólafsfjörður	OLAFS	66.07	-18.67
Reykjavík	RVK	64.13	-21.90
Seyðisfjörður	SEYÐ	65.28	-14.00
Siglufjörður	SIGL	66.13	-18.92
Súðavík	SVK	66.04	-22.99
Grindavík	GVK	63.84	-22.42
Korpa	KOR	64.15	-21.75
Hellisskarð	HELL	64.03	-21.37
Ölkelduháls	OLK	64.06	-21.25
Pingvellir	PVL	64.28	-21.09
Hvanneyri	HVA	64.56	-21.76
Fíflholt	FIF	64.69	-22.15
Gufuskálar	GUF	64.90	-23.93
Ólafsvík	OVK	64.89	-23.71
Grundarfjörður	GRU	64.92	-23.25
Stykkishólmur	STYK	65.07	-22.73
Patreksfjörður	PATR	65.60	-23.97
Tálknafjörður	TALK	65.63	-23.83
Bíldudalur	BILD	65.68	-23.61
Bolungarvík	BOL	66.16	-23.25
Nautabú	NAU	65.46	-19.37
Blönduós	BLO	65.66	-20.29
Möðruvellir	MOD	65.77	-18.25
Akureyri	AKU	65.70	-18.11
Hallormsstaður	HALL	65.09	-14.74
Dalatangi	DALA	65.27	-13.58
Egilsstaðaflugvöllur	EGIL	65.28	-14.40
Raufarhöfn	RAUF	66.46	-15.95
Brúaröræfi	BRUA	64.83	-16.09
Karahnjúkar	KARA	64.93	-15.78
Brú á Jökuldal	BRU	65.11	-15.53
Eyjabakkar	EYJA	64.82	-15.42
Þykkvibær	ÞYKK	63.75	-20.62
Sámsstaðir	SAMS	63.74	-20.11
Kirkjubæjarklaustur	KLAU	63.79	-18.01
Kálfhóll	KALF	63.96	-20.57
Búrfell	BURF	64.12	-19.74
Vatnsfell	VATN	64.20	-19.05
Veiðivatnahraun	VEID	64.40	-18.50
Hágöngur	HAG	64.57	-18.11
Hveravellir	HVE	64.87	-19.56
Sandbúðir	SBD	64.93	-17.98



Figure 1 – Location of the 49 selected IMO automatic weather stations used in this report.

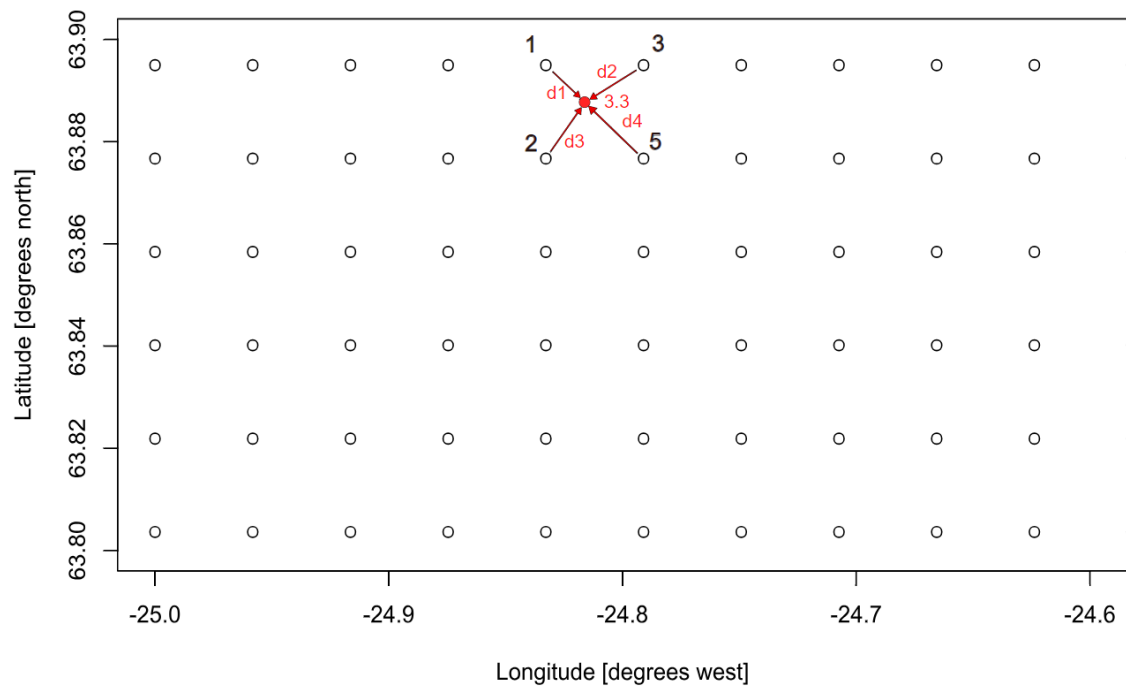


Figure 2 — Schematic of the weighted average of the nearest four grid points interpolation of the CARRA gridded data to the stations' coordinates listed in Table 1. The numbers shown in the figure are hypothetical.

3 Results

3.1 2-meter air temperature

In general, the simulated air temperature (daily mean, maximum, and minimum) agreed well with the observations. Biases can still be found to different extents in the simulated data in comparison to the observations. In Akureyri, for example, the daily mean temperature agrees quite well with the observations with an RMSE of 0.5 °C and an MAE of 0.38 °C (Figure 3 and 4; left). The daily maximum temperature, however, is slightly underestimated in the CARRA data, while the minimum temperature is slightly overestimated (Figure 3 and 4; center and right). In comparison, in Reykjavík, both the daily mean and maximum temperature agree well with the observations with RMSE and MAE of less than 1 °C (Figure 5 and 6; left and center). The daily minimum temperature, on the other hand, is slightly overestimated (Figure 5 and 6; right).

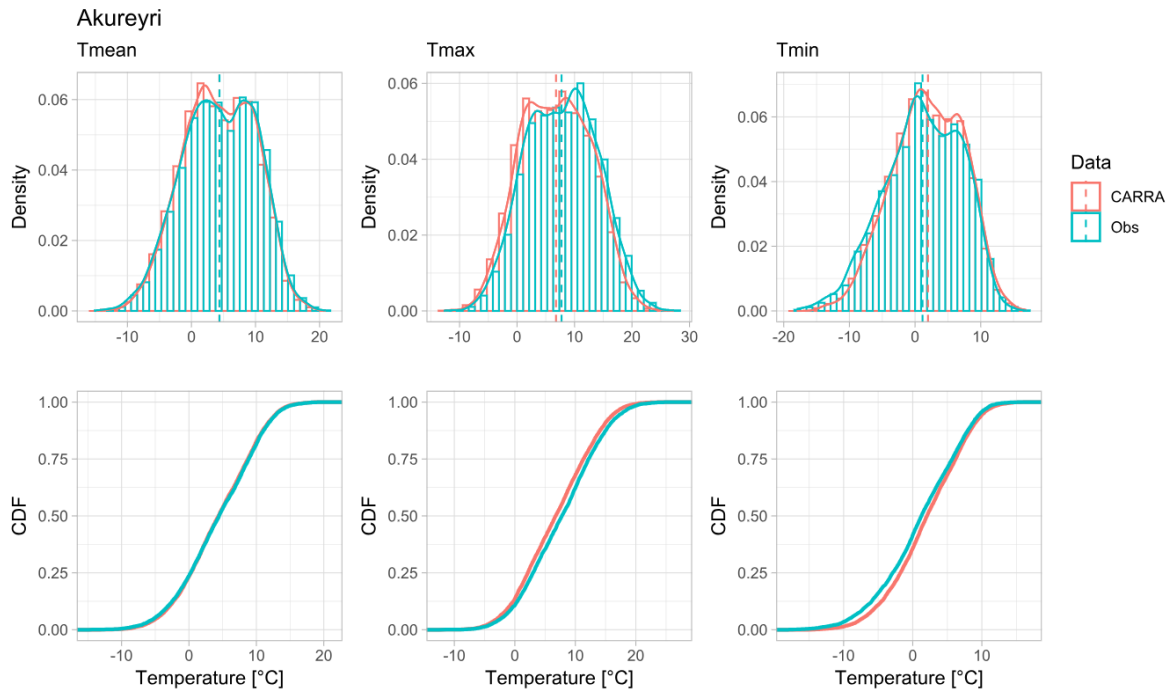


Figure 3 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Akureyri automatic station.

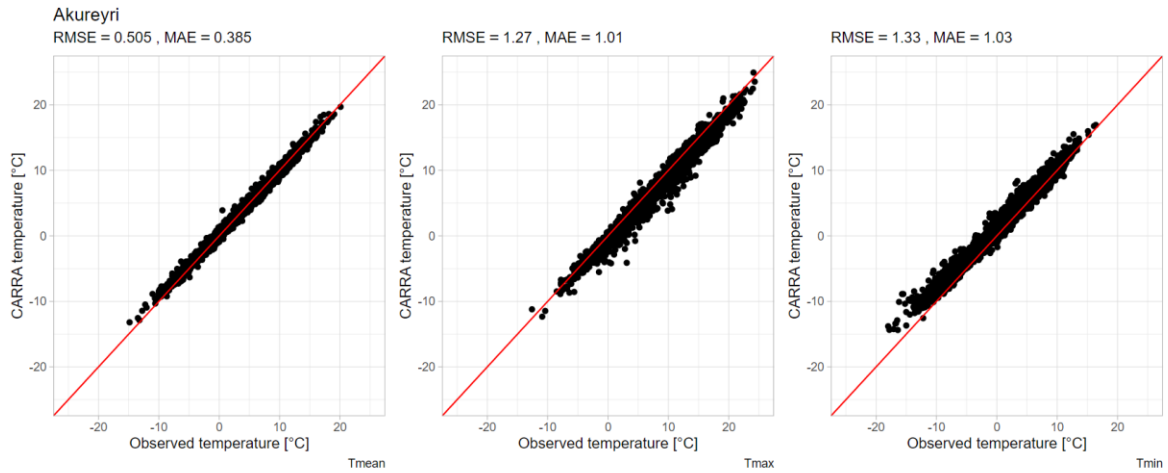


Figure 4 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Akureyri automatic station. The RMSE and MAE (in °C) are shown above each panel.

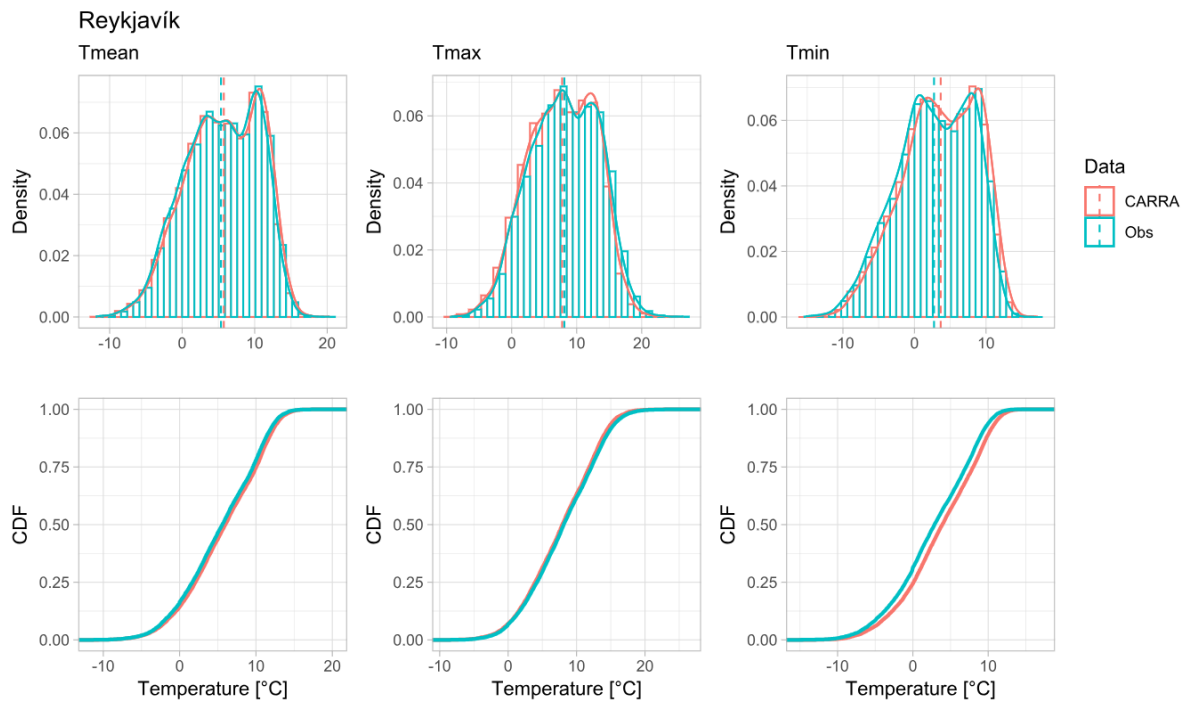


Figure 5 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Reykjavik automatic station.

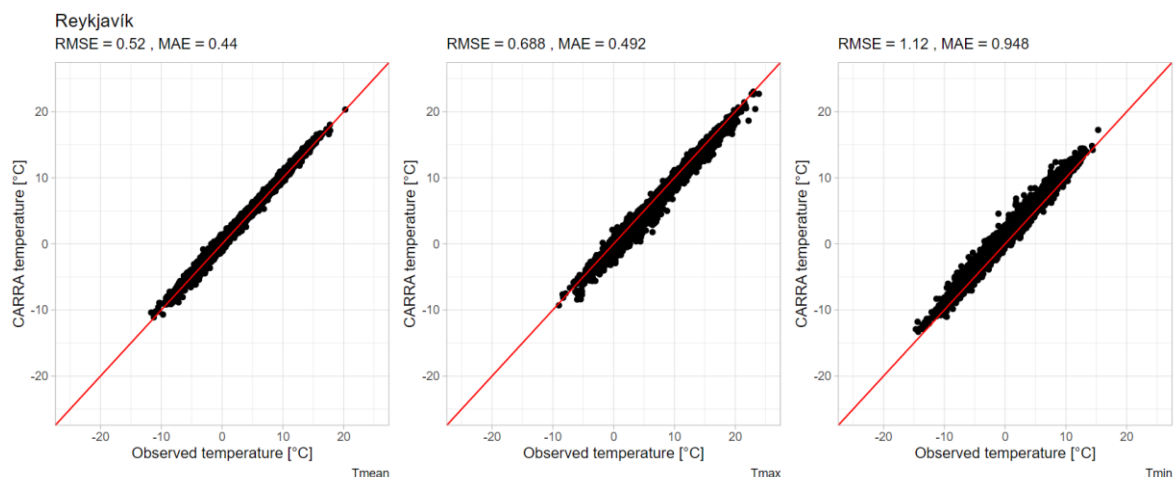


Figure 6 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Reykjavík automatic station. The RMSE and MAE (in °C) are shown above each panel.

Despite the high horizontal resolution of the CARRA data (2.5×2.5 km), areas with complex orography, such as narrow fjords and valleys, are still not fully resolved. This can result in larger biases in these locations, which can be clearly seen in the Westfjords and Eastfjords. For example, Figures 7 and 8 show that at the Ísafjörður station, a large systematic bias can be found, especially for the daily maximum temperature (RMSE, MAE > 2 °C), while a bias can also be seen for the daily mean temperature (RMSE, MAE > 1 °C). In contrast, the daily minimum temperature agrees well with the observed temperature. Similarly, the daily mean and maximum temperature in Eskifjörður show a substantial systematic bias compared to observations, while the daily minimum temperature is comparatively less biased (Figure 9 and 10). The temperature distribution and scatter plots for all the stations can be found in Appendix II.

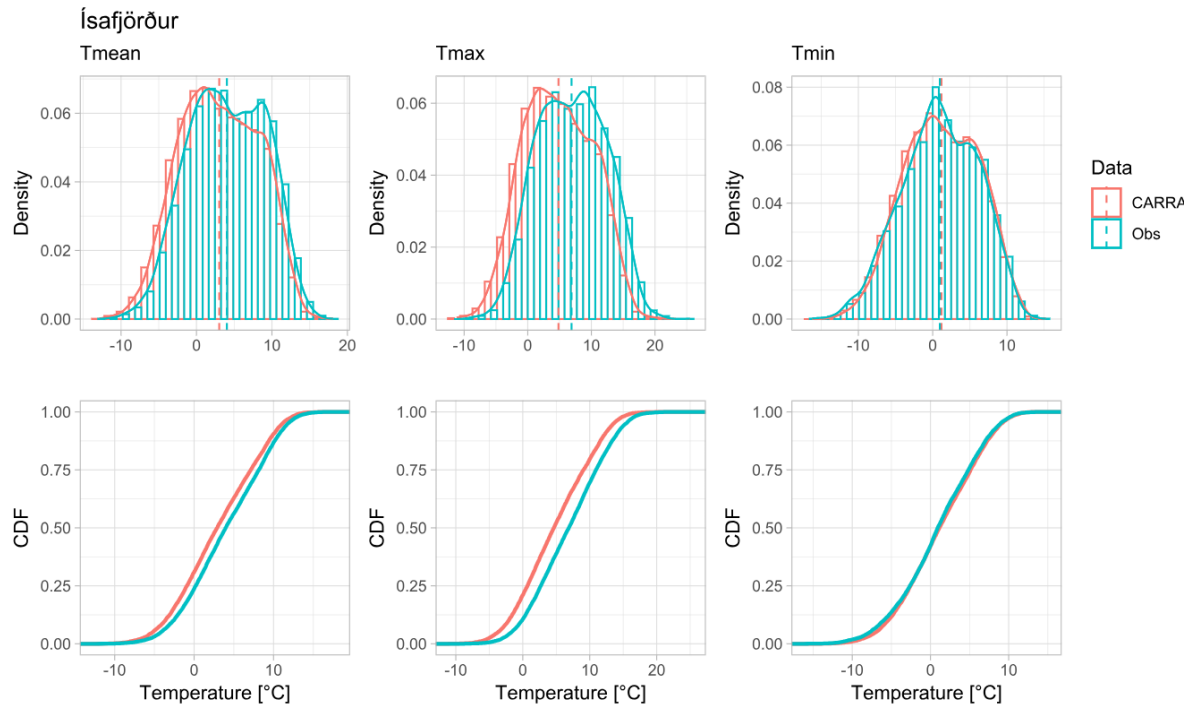


Figure 7 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Ísafjörður automatic station.

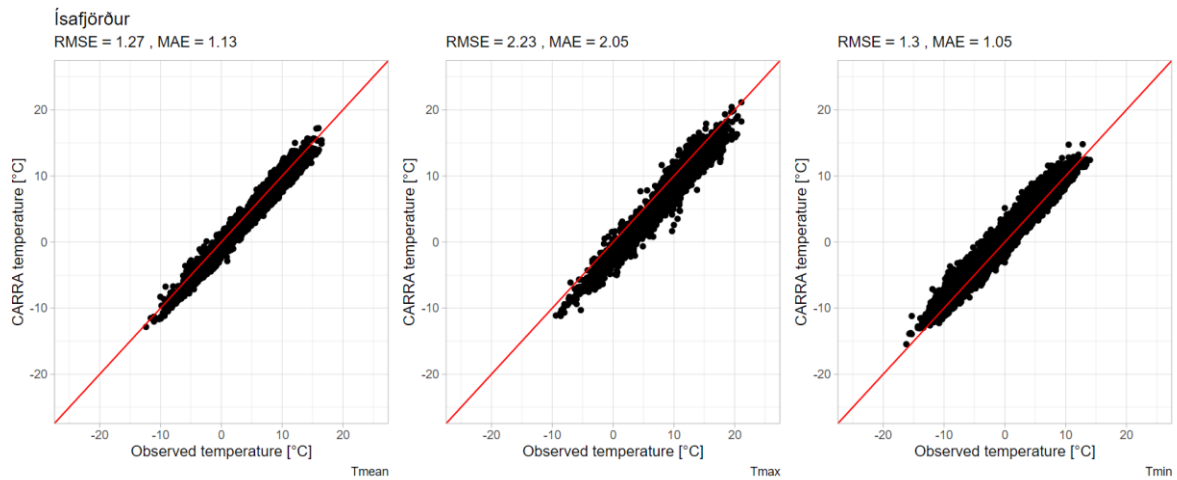


Figure 8 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Ísafjörður automatic station. The RMSE and MAE (in °C) are shown above each panel.

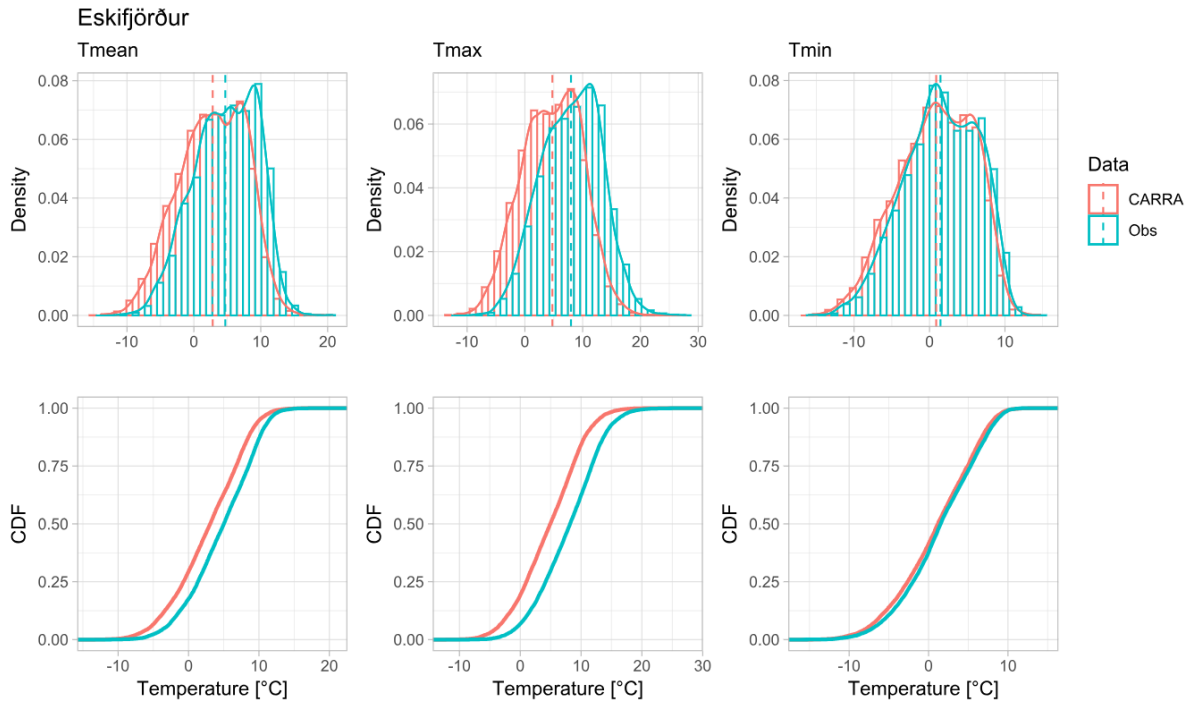


Figure 9 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Eskifjörður automatic station.

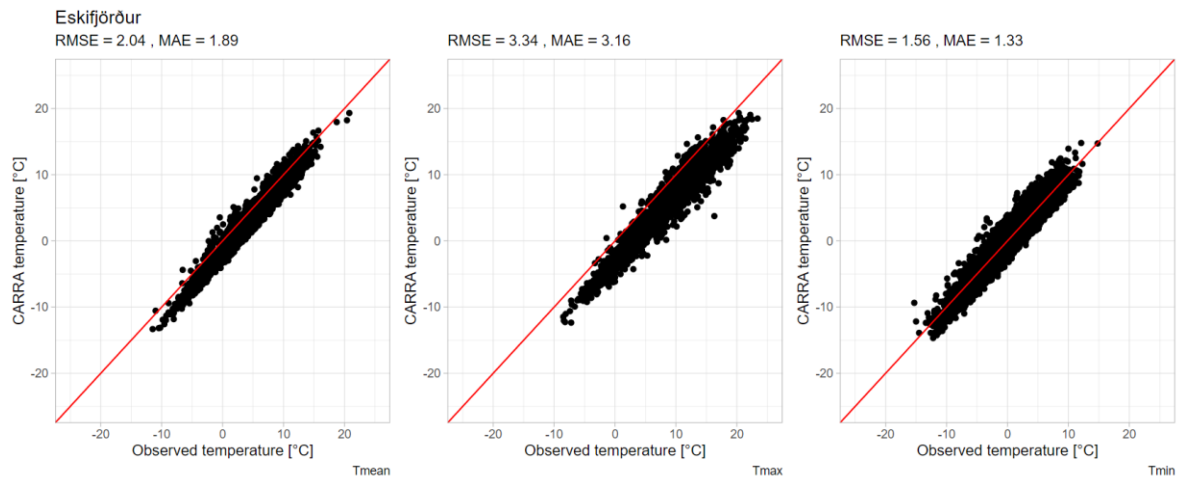


Figure 10 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Eskifjörður automatic station. The RMSE and MAE (in °C) are shown above each panel.

In order to evaluate the agreement between the warming in the CARRA reanalysis and observations, the difference in average temperature between two periods (1991–2005 and 2006–2024) has been calculated for selected locations in Iceland (Figure 11). The chosen observed mean annual temperature data was not limited to only the automatic stations in Table 1 due to the fact that the observations from the automatic weather

stations often do not extend back to 1991. The temperature anomaly derived from the CARRA dataset and shown in Figure 11 for the period 2006–2024 relative to the chosen reference period agreed well with the observations, especially in Akureyri, Reykjavík, and Stykkishólmur. Results differ more for the stations Dalatangi and Vatnsskarðshólar. Warming intensifies particularly at the turn of the 21st century at all locations analysed. The warming is also larger in the northwestern part of the country and to a lesser extent in the central and central eastern parts. In a report by Björnsson *et al.* (2018) using the Icelandic reanalysis of atmospheric conditions (ICRA) data, the warming was higher in the western and northwestern parts of Iceland for 2000–2014 relative to the reference period of 1985–1999.

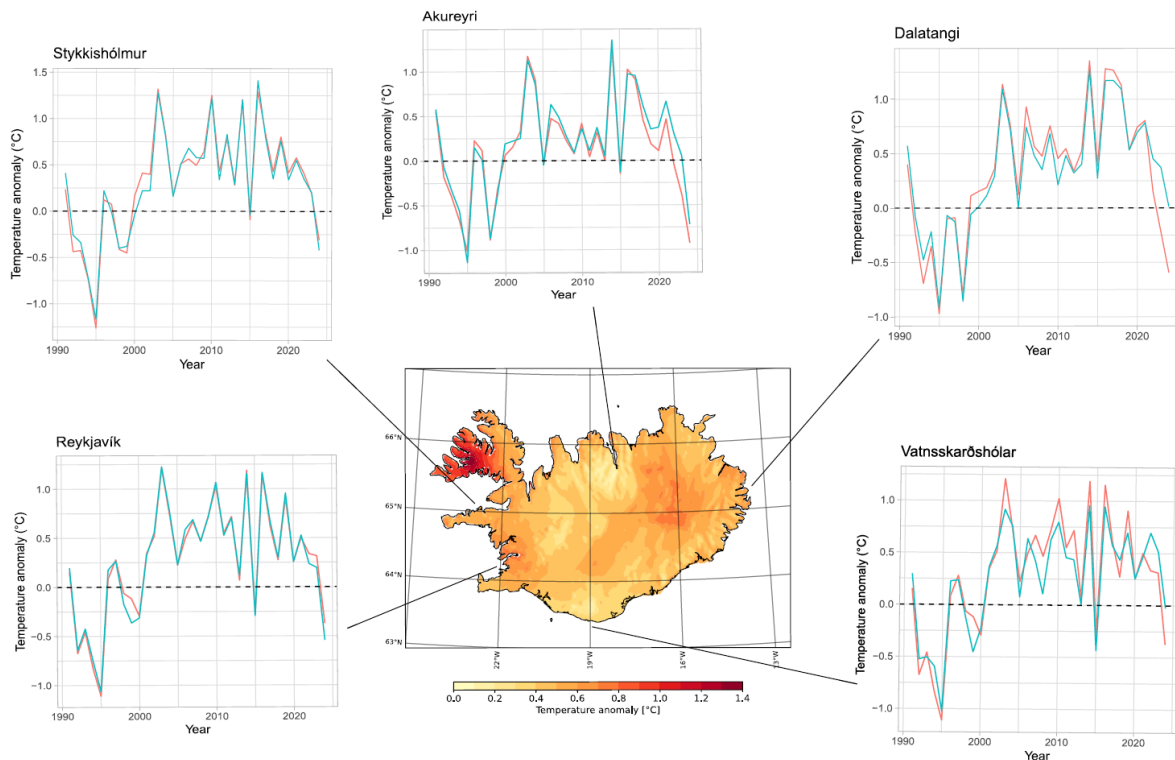


Figure 11 – Temperature anomaly for the period of 2006–2024 relative to the reference period of 1991–2005 using the CARRA data (map). The graphs show a comparison between the observed warming at selected stations (blue line) and simulated temperature from CARRA (red lines).

3.2 10-meter wind speed

The agreement between the simulated average daily wind speed from CARRA and the observations also varied depending on the location of the measurement. In Akureyri and Reykjavík, the simulated wind speed matches well with the observations despite the slight bias in both locations (Figures 12 and 13). In Akureyri, wind speed agreed well with the observations for low wind speeds (~0–5 m/s), but the bias increased for wind speeds higher than 5 m/s (Figure 12). In Reykjavík, the bias was more uniformly distributed, i.e.

the simulated values were slightly overestimated throughout the period under consideration (Figure 13). That said, the RMSE and MAE at the Reykjavík station were lower than those at the Akureyri station (see Figures 12 and 13; left).

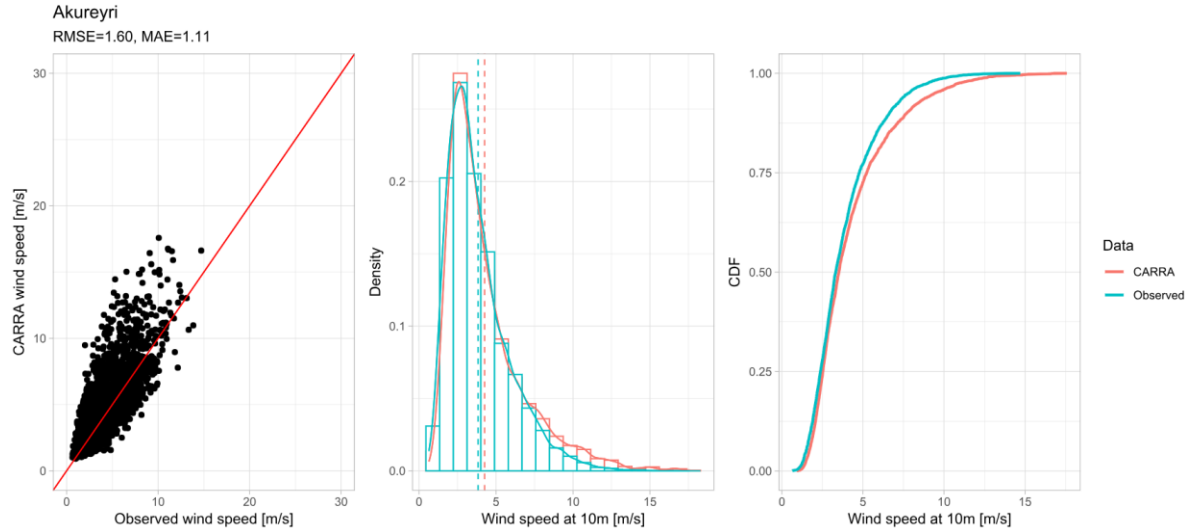


Figure 12 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Akureyri automatic station.

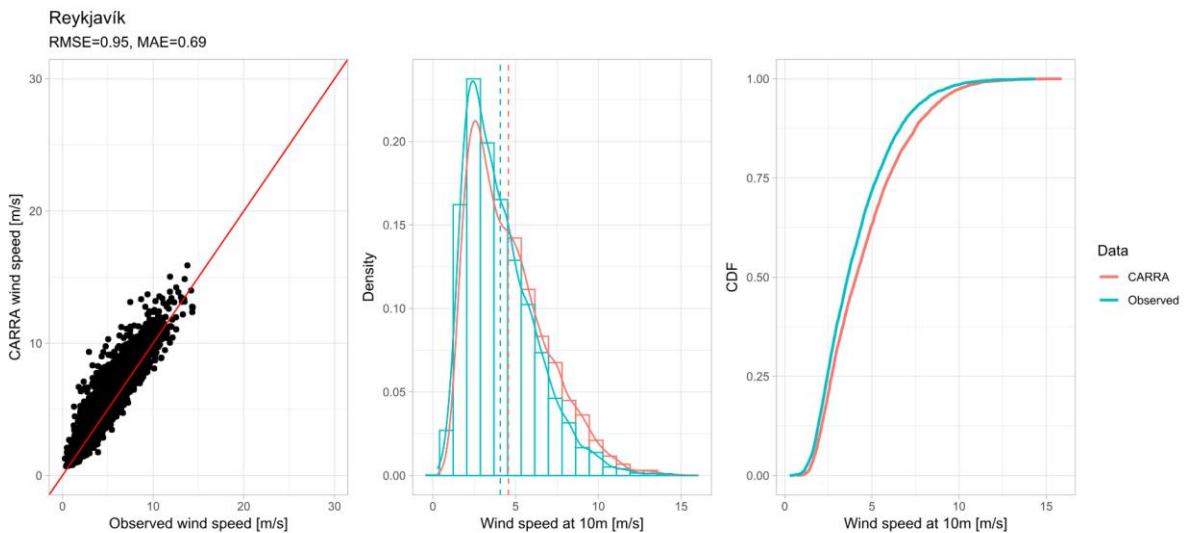


Figure 13 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Reykjavík automatic station.

In areas of complex terrain, more biases can be found. In Ísafjörður and Eskifjörður, the CARRA values substantially deviate from the observations, even at low wind speeds (Figure 14 and 15). This can be explained by the inability of the model to resolve narrow fjords and

valleys, which can often result in overestimation of the wind speed in such areas. In contrast, in regions that are more inland or relatively flat, the model seems to capture wind speed quite well. This can be seen for the stations Kirkjubæjarklaustur and Nautabú, as shown in Figure 16 and 17. The wind speed distribution and scatter plots for all the stations can be found in Appendix III.

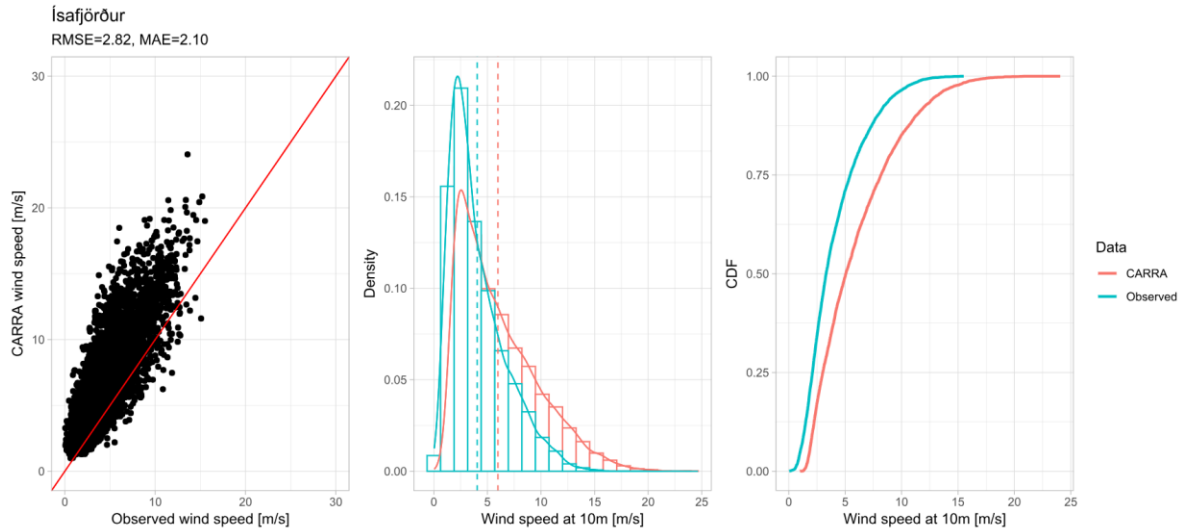


Figure 14 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Ísafjörður automatic station.

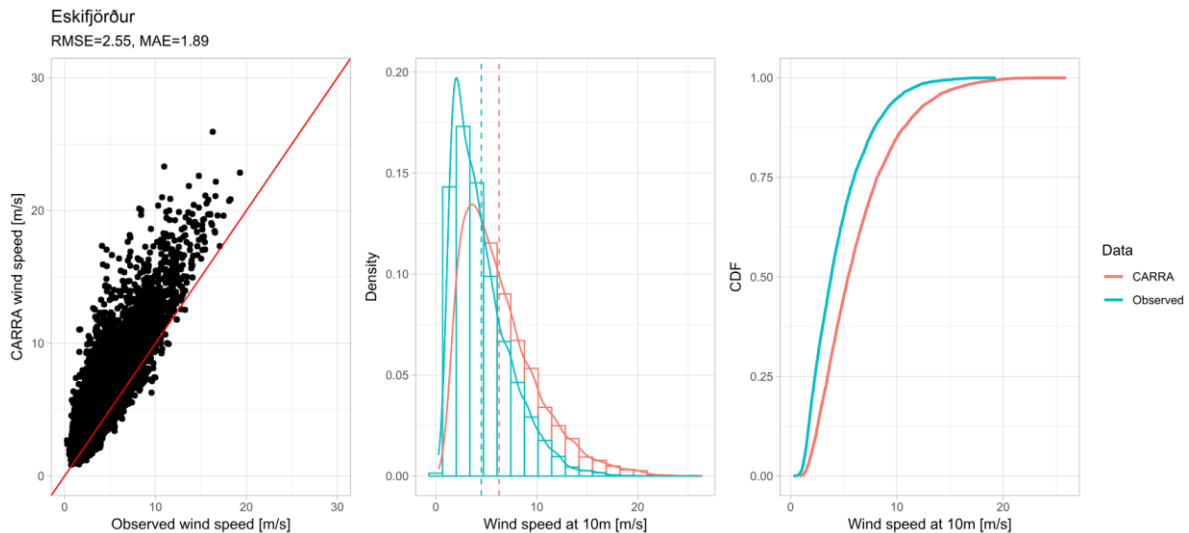


Figure 15 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Eskifjörður automatic station.

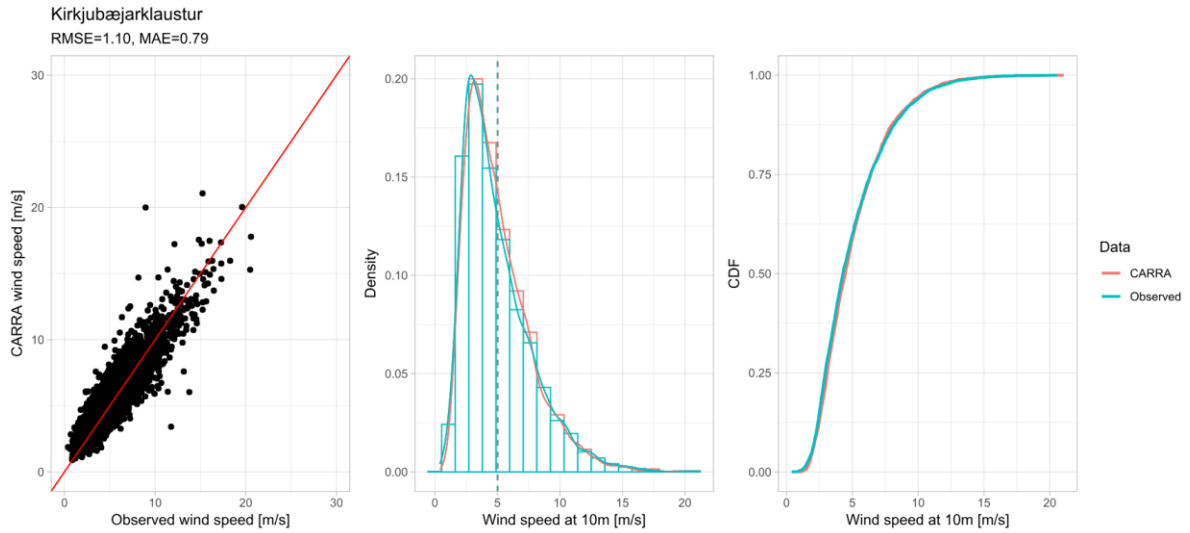


Figure 16 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Kirkjubæjarklaustur automatic station.

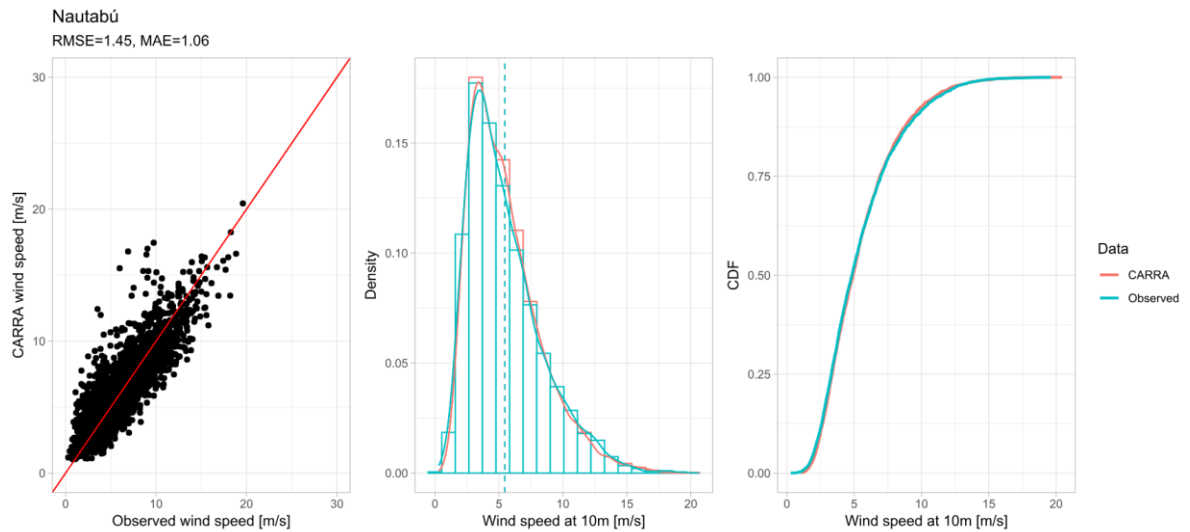


Figure 17 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Nautabú automatic station.

3.3 Precipitation

3.3.1 Daily precipitation

In order to assess the quality of the simulated daily precipitation against measurements, scatter plots and Q-Q plots were created for all stations. Dates with no measurements were also discarded from the CARRA time series for time series to be comparable. Examples for the stations Reykjavík and Kvísker are shown in Figure 18, along with the

RMSE and MAE values. Plots for other stations are shown in Appendix IV. For Reykjavík, simulated precipitation from the CARRA dataset agreed generally well with the measurements, as indicated by the RMSE and MAE values (2.6 and 1.4 mm, respectively). However, in both locations, daily precipitation was slightly overestimated by the CARRA dataset. The Q–Q plots show that higher values are found in the CARRA dataset than in the measurements. Likewise for smaller values, there is a slight systematic overestimation in the simulated data, with values skewed above the 1:1 line, indicating slightly higher values in the simulations. The same trend can be seen for low precipitation values in Kvísker. This station is the wettest in Iceland, which explains the values up to 150 mm, and the larger RMSE and MAE values (11.1 and 5.3 mm, respectively). However, in this case, the largest values were underestimated by the CARRA dataset. Overall, for most stations (31 out of 49), low daily precipitation values were overestimated by the model. Extreme values were often underestimated in the simulated data. This will be discussed further in the next paragraphs.

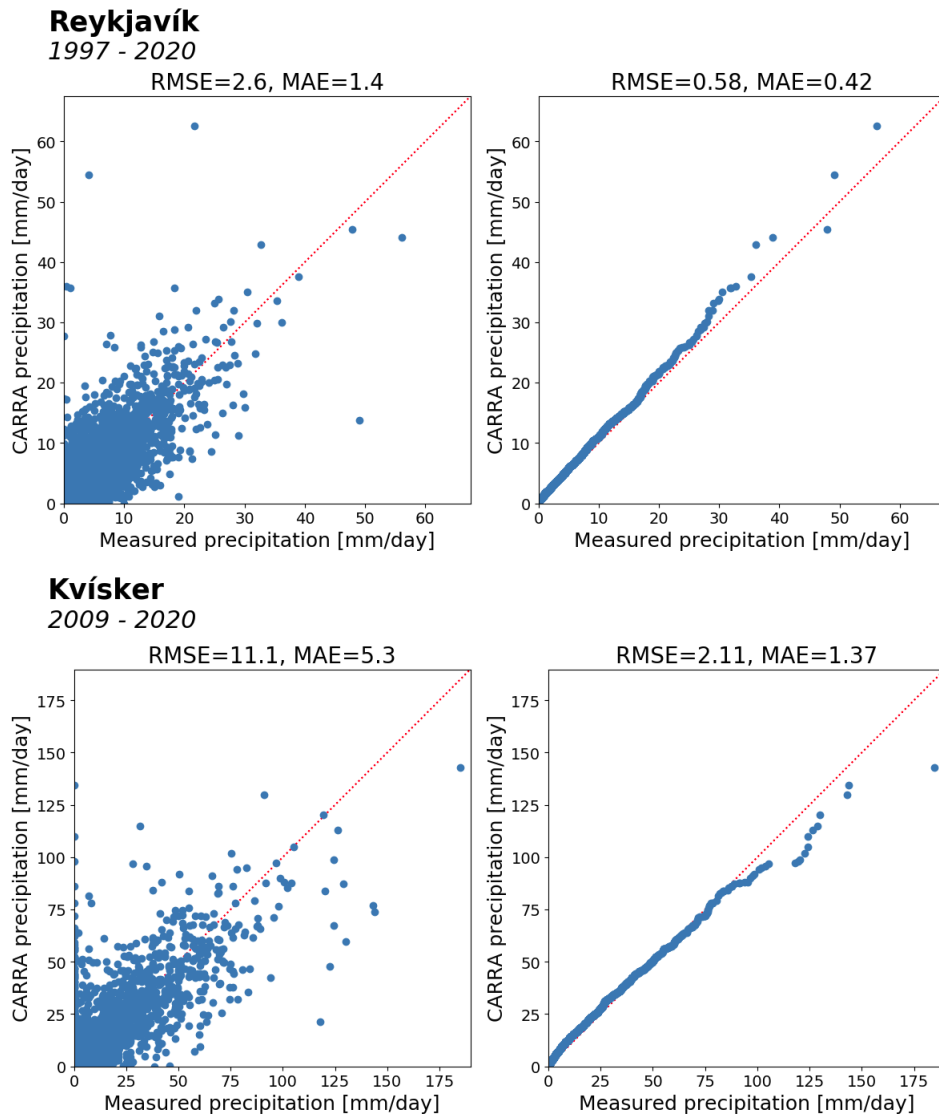


Figure 18 — Scatter plots (left panels) and Q–Q plots (right panels) comparing daily precipitation (mm/day) from the CARRA dataset and observations for stations Reykjavík and Kvísker. RMSE and ME are given in mm/day.

Table 2 compiles the RMSE and MAE for all stations, based on the complete dataset (first two rows), and summer months only (last two rows). RMSE values based on the complete dataset range from 2.3 mm (Akureyri, Nautabú and Stykkishólmur) to 11.1 mm (Kvísker), while MAE values range from 1.2 mm (Akureyri, Blönduós, Nautabú, Raufarhöfn and Stykkishólmur) to 5.3 mm (Kvísker). Overall, nine stations have an RMSE of less than 3 mm, and 11 stations have an RMSE of more than 5 mm. Those stations are all located in complex terrain (Eastfjords, Tröllaskagi, Bláfjöll or Snæfellsness) or in the wettest parts of the country (Laufbali and Kvísker). The results improved when only summer months were used. This can be explained by the fact that solid precipitation is under-caught by gauges during the winter months (Goodison *et al.*, 1998) severely in windy conditions. In most cases, RMSE and MAE values were lower when only summer months were included, and when this is not the case (five stations), values only increased by a small amount. Based on the summer months, 19 stations have an RMSE of less than 3 mm, and eight stations have an RMSE of more than 5 mm.

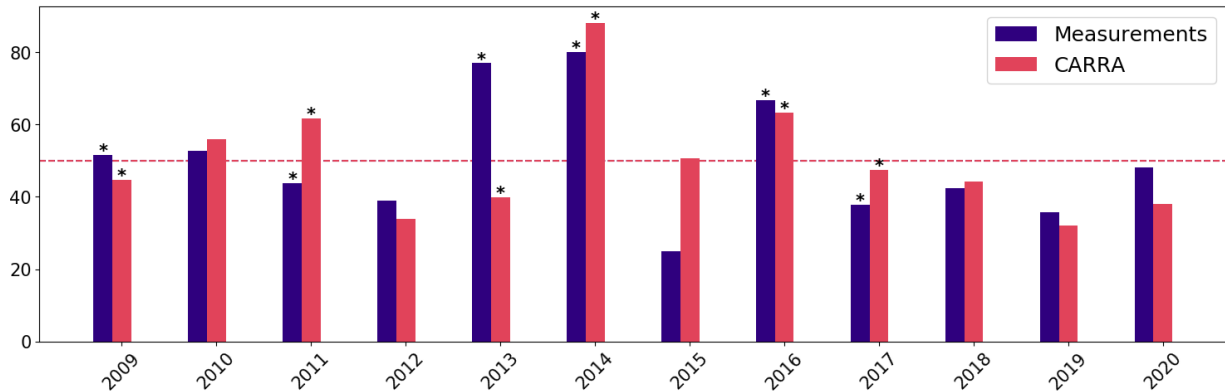
Annual Maximum Series (AMS) was also calculated based on the daily datasets and are presented as histograms. An example is given in Figure 19 for the stations Höfn í Hornafirði, Kvísker, and Neskaupstaður, other results are shown in Appendix IV. In the figure, blue bars show the AMS calculated from the measurements, and pink bars show the results from the CARRA dataset. Dashed vertical lines indicate the mean values for each AMS, and asterisks above the bars indicate that those values were found in each dataset within a 5-day interval. For Höfn í Hornafirði, the AMS are quite close overall, except for the years 2013 and 2015. Over 12 years of data, the annual maximum corresponded to the same event six times, and the mean values shown by the dashed lines are identical (50 mm). For Kvísker, there is a good agreement between observations and simulations except for 2012. Four out of nine times, the same event led to the annual maximum in both datasets. The difference between the average AMS values is 18 mm, which is not that large considering the amount of precipitation recorded at this station. It should be noted that in all cases, measurements are higher than the CARRA values, which was already noticed based on scatter plots and Q-Q plots. Finally, results for Neskaupstaður show a systematic underestimation of the annual maximum by the CARRA dataset leading to a large difference between the mean AMS based on observations (113 mm) compared to simulations (65 mm). This is in line with the results shown in the scatter and Q-Q plots (see Appendix IV). However, it should be noted that in 13 cases out of 23, the same event led to the annual maximum in both datasets. Overall, the mean AMS value is underestimated by the CARRA dataset in 16 cases and overestimated in 13 cases. For the remaining 20 stations, those mean differ by less than 5%.

Table 2 – RMSE and MAE comparing daily precipitation measurements to the CARRA simulations for all stations based on the complete dataset and only the summer months (May – September).

Station	Complete year		Summer months	
	RMSE (mm)	MAE (mm)	RMSE (mm)	MAE (mm)
Eskifjörður	4.7	2.3	4.3	1.8
Flateyri	4.2	2.1	3.3	1.5
Höfn í Hornafirði	3.9	1.9	3.4	1.5
Ísafjörður	3.8	2.0	3.6	1.6
Kvísker	11.1	5.3	9.5	4.3
Laufbali	9.6	4.4	7.6	3.4
Neskaupstaður	7.6	3.0	6.4	2.2
Ólafsfjörður	5.2	2.4	4.4	1.8
Reykjavík	2.6	1.4	2.3	1.2
Seyðisfjörður	6.2	2.8	4.5	1.9
Síglufjörður	6.3	2.8	5.6	2.2
Súðavík	2.9	1.5	3.1	1.3
Grindavík	3.0	1.6	2.6	1.3
Korpa	3.3	1.7	3.0	1.4
Hellisskarð	7.5	3.8	5.8	2.9
Ölkelduháls	8.3	3.9	8.5	3.6
Pingvellir	4.0	2.1	3.4	1.7
Hvanneyri	3.5	1.7	2.7	1.3
Fíflholt	3.1	1.6	2.9	1.4
Gufuskálar	3.4	1.7	2.6	1.2
Ólafsvík	6.2	2.8	4.7	1.9
Grundarfjörður	7.5	3.3	7.2	2.8
Stykkishólmur	2.3	1.2	2.1	1.0
Patreksfjörður	3.5	1.7	3.1	1.3
Tálknafjörður	3.6	1.8	2.9	1.3
Bíldudalur	3.0	1.5	2.4	1.1
Bolungarvík	3.7	1.8	3.2	1.4
Nautabú	2.3	1.2	2.1	1.1
Blönduós	2.4	1.2	2.1	1.0
Möðruvellir	2.9	1.5	2.3	1.1
Akureyri	2.3	1.2	2.0	1.0
Hallormsstaður	4.4	1.9	2.8	1.3
Dalatangi	5.1	2.3	5.2	2.2
Egilsstaðaflogvöllur	3.1	1.5	2.4	1.1
Raufarhöfn	2.5	1.2	1.8	0.9
Brúaröræfi	3.5	1.8	2.9	1.4
Karahnjúkar	3.1	1.6	2.6	1.3
Brú á Jökuldal	2.7	1.4	2.4	1.2
Eyjabakkar	4.8	2.4	3.4	1.7
Pykkvibær	3.9	2.0	3.1	1.5
Sámsstaðir	4.0	2.0	4.2	1.8
Kirkjubæjarklaustur	4.4	2.3	3.7	1.9
Kálfhóll	3.4	1.8	3.2	1.6
Búrfell	3.6	1.8	3.5	1.6
Vatnsfell	3.9	2.2	3.0	1.7
Veiðivatnahraun	4.0	2.2	3.0	1.7
Hágöngur	4.5	2.4	3.0	1.6
Hveravellir	4.0	2.1	3.3	1.6
Sandbúðir	3.8	2.2	2.9	1.5

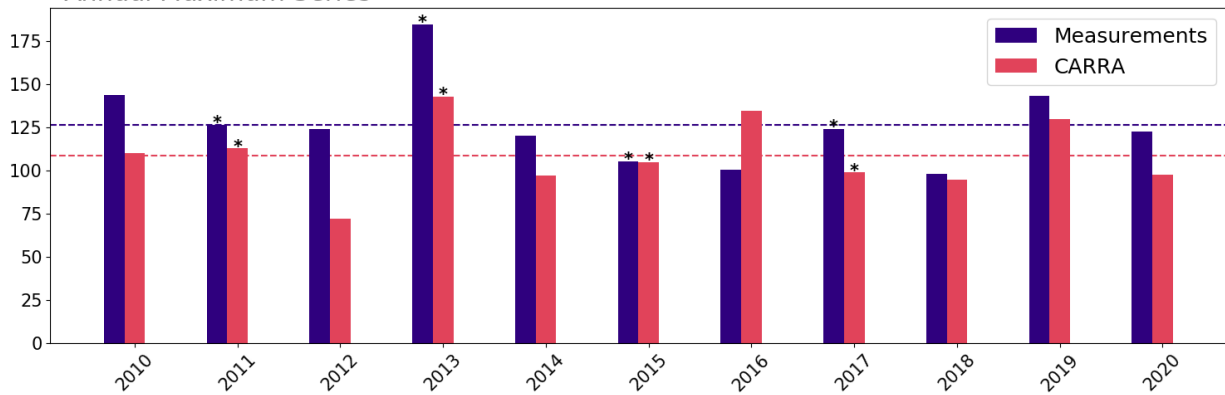
Höfn í Hornafirði

Annual Maximum Series



Kvísker

Annual Maximum Series



Neskaupstaður

Annual Maximum Series

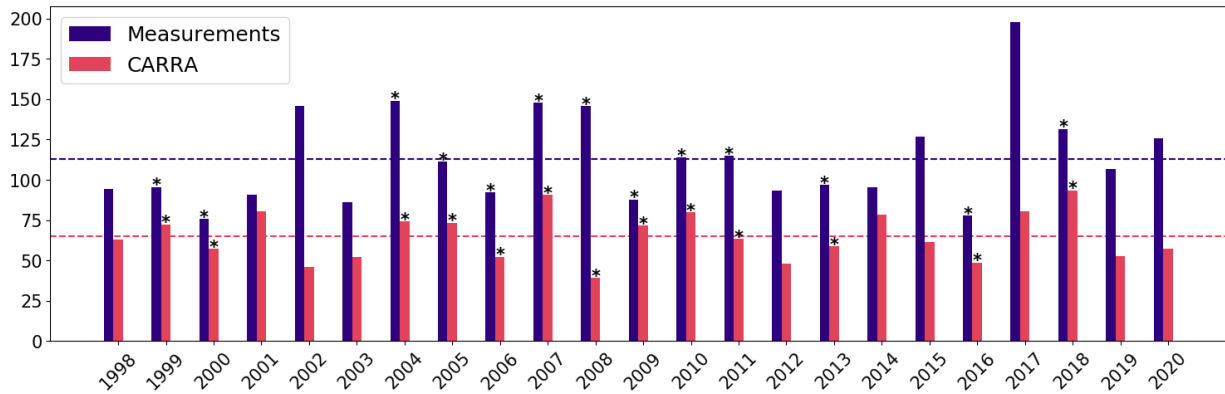


Figure 19 – Annual Maximum Series (AMS) for Reykjavík, Kvísker and Neskaupstaður based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

3.3.2 Annual precipitation

Figure 20 shows annual precipitation over Iceland calculated from the CARRA dataset and averaged over the period 1991–2022. A similar map was previously presented in Egilson et al. (2019) based on the ICRA dataset averaged over the period 1981–2010. Although values differed slightly because of the differences in the models and time periods

considered, general patterns of precipitation in Iceland were well preserved. Maximum values were found in the southeastern part of the country, while the northern half appeared drier. On the new map, annual precipitation range between 584 mm (in Eyjafjörður) and 11,458 mm (close to Hvannadalshnúkur). Overall, regions of complex orography, such as the Tröllaskagi and Snæfellsness peninsulas, as well as the East- and Westfjords have higher annual precipitation, with values above 1,000 mm as indicated by the blue-shaded areas. In areas adjacent to the largest glaciers (Vatnajökull, Eyjafjalljökull, Mýrdalsjökull, Hofsjökull, Langjökull, and Drangajökull) values exceed 3,000 mm, as indicated by the dark-blue shaded areas.

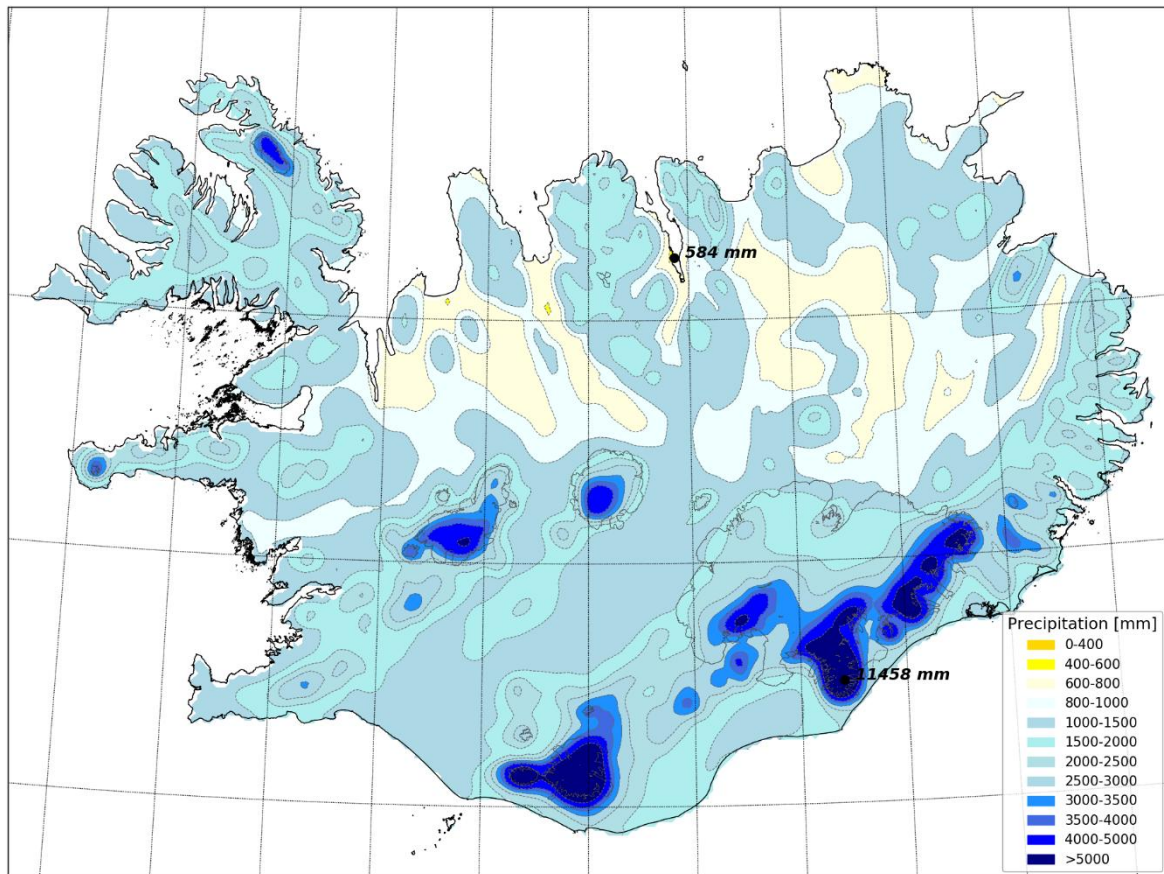


Figure 20 – Annual precipitation based on the CARRA dataset averaged over the period 1991–2022.

The annual precipitation was also calculated for the 49 stations and shown as histograms. An example is given in Figure 21 for Ísafjörður and Neskaupstaður, while results for the other stations are shown in Appendix IV. Overall, the annual precipitation was overestimated by the CARRA dataset at 45 stations, as indicated by the mean annual values (shown by the horizontal dashed line). This result can also be noticed from the shape of the Q–Q plots, with the CARRA precipitation generally higher than the observations for lower values. This is the case for Ísafjörður, with annual precipitation higher in the CARRA dataset than in the measurements for every single year. It should be noted, however, that the general patterns were respected for both time series, with wetter years such as 2015 and 2020 leading to higher values in both datasets, and drier years such as 2010 and 2019 leading to lower values. Results for Neskaupstaður are also shown in Figure 21. As

previously discussed, this station is an outlier in how the CARRA values were underestimated compared to the measurements. This can be attributed to the complex location of the station, and possibly a consequence of using a weighted average that include grid points located over the sea (see Massad *et al.*, 2020).

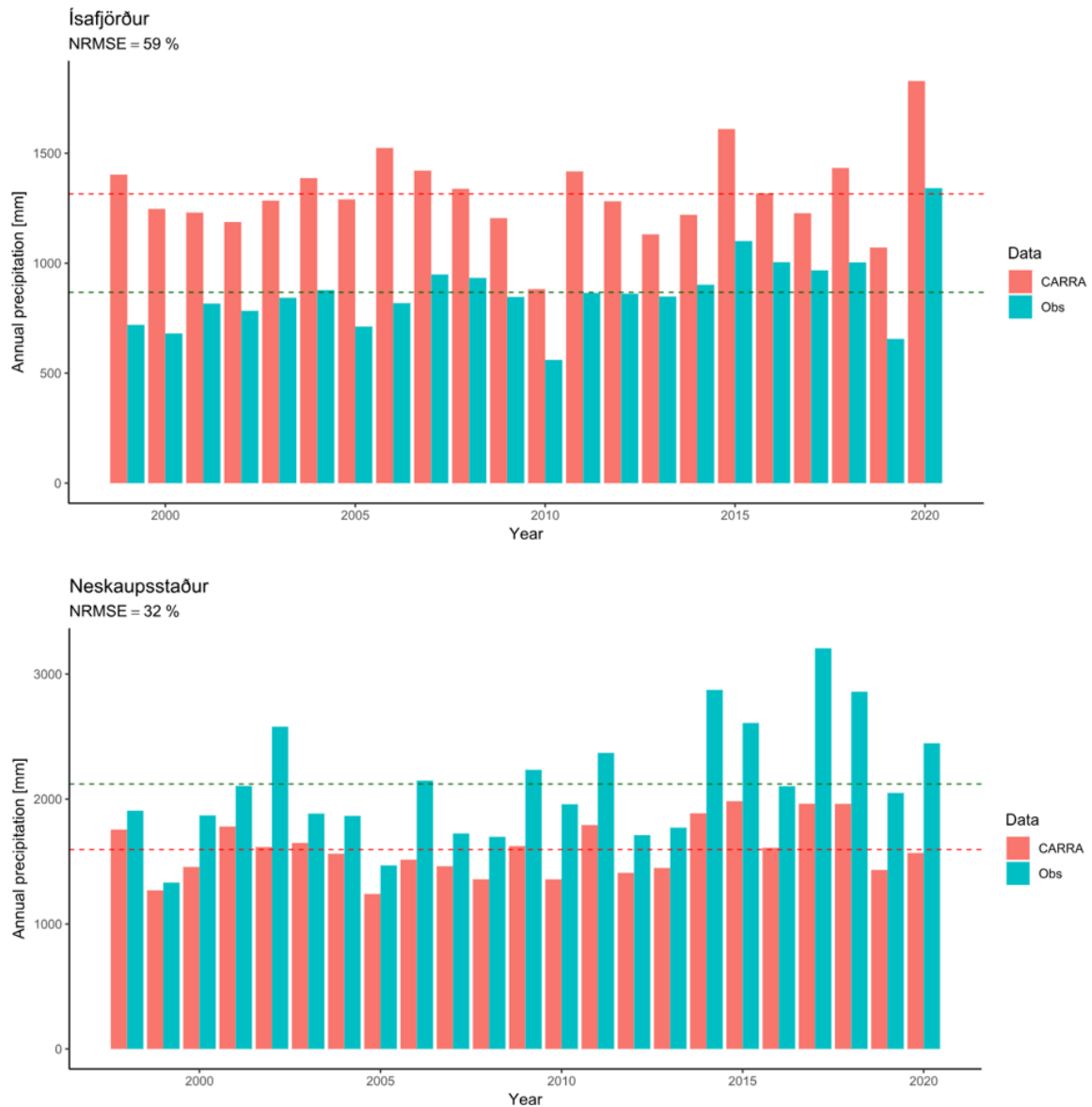


Figure 21 – Annual precipitation based on the CARRA dataset (red) and observations (blue) for stations Ísafjörður and Neskaupsstaður.

Figure 22 shows the changes in annual precipitation in Iceland over the same periods used in Figure 11 for temperature. Interestingly, in Figure 22, a clear divide can be seen regarding the change in annual precipitation over Iceland with the eastern parts showing an increase and the western parts mostly showing a decrease. Annual precipitation also increases in the south and north of Iceland. To assess how well the CARRA data agrees with observations, the evolution of changes in annual precipitation at selected locations

was compared to observed values (similar to the earlier analysis carried out for temperature). The chosen observed annual precipitation data was not limited to the automatic stations in Table 1 due to the differences in length of the observed data series. The CARRA dataset agrees well with the observations despite the apparent higher discrepancy compared to temperature, which can be expected especially in complex terrain. That said, both CARRA and observed values show a similar temporal evolution and no clear trends can be seen.

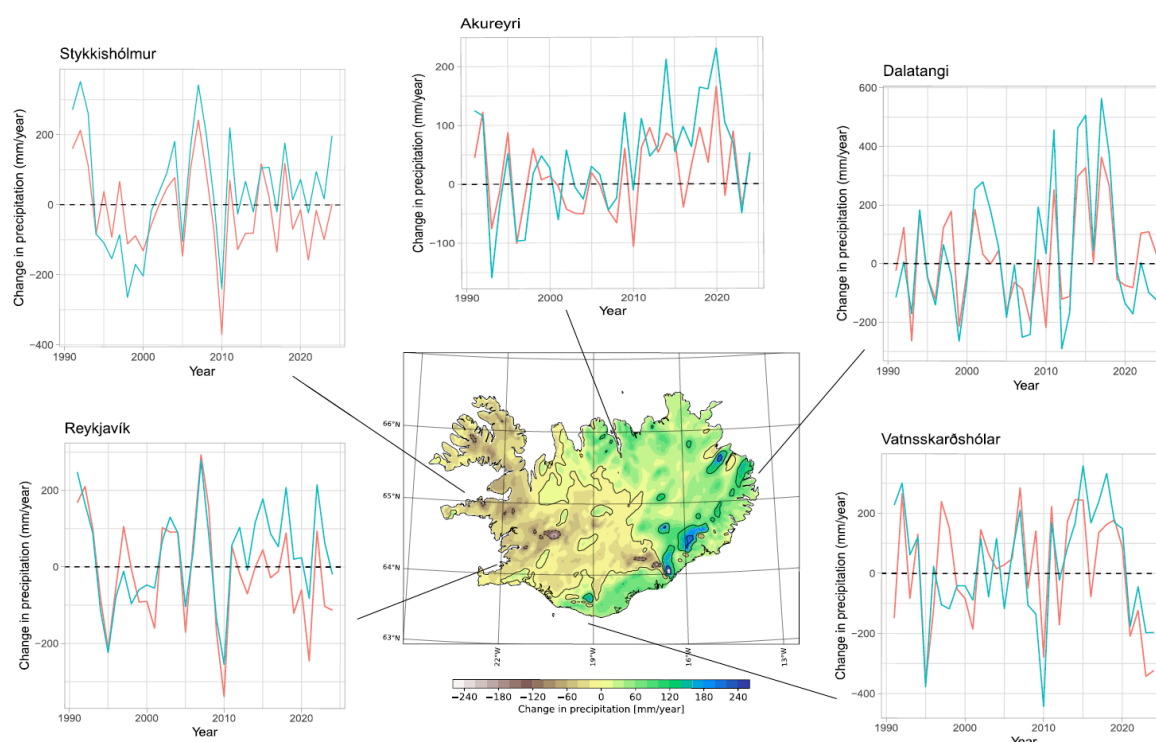


Figure 22 – Change in annual precipitation (mm) for the period of 2006–2024 relative to the reference period of 1991–2005 using the CARRA data (map). The graphs show a comparison between the observed change at selected stations (blue line) and calculated change from CARRA (red lines).

4 Summary

In this report, three variables from the gridded CARRA dataset were compared to measurements from 49 automatic weather stations located all around Iceland. Time series at the exact location of the stations were calculated using the inverse distance weighted average among the four nearest grid points around the station coordinates.

Overall, simulated 2-m temperature time series agreed well with observations when comparing daily mean, maximum and minimum values. While this is true for most of the stations (with RMSE under 2 °C), some areas with complex orography, such as narrow fjords and valleys, were not fully resolved by the CARRA dataset, despite its 2.5-km horizontal resolution. A map to assess recent warming was created for the temperature anomaly between the period 2006–2024 and the reference period. Warming trends agree with measurements for all stations, with an intensification at the turn of the 21st century at all locations.

Daily wind speed also showed good agreement between simulation from CARRA and observations, with larger biases found in regions of complex terrain. This can be attributed to the difficulty for the model to resolve properly narrow fjords and valleys, resulting in an overestimation of the wind speed in those regions. Wind speed is better captured in regions more inland or with less relief.

Finally, daily precipitation was also compared with measurements. Out of the 49 stations, nine had an RMSE of less than 3 mm, and 11 had an RMSE larger than 5 mm. Those latter stations are all located in complex terrain, such as the Eastfjords, Tröllaskagi, Bláfjöll and the Snæfellsness peninsula, or in the wettest parts of the country (Laufbali and Kvísker). It should also be noted that when only analysing summer months, results are better since there is an undercatch of solid precipitation by the instruments during the winter months. Annual Maximum Series of daily precipitation were also calculated from the CARRA dataset, overestimating them in 13 cases, and underestimating the maximum precipitation in 16 cases. For the remaining cases, the values were very comparable, within a 5% difference. Mean annual precipitation over Iceland for the gridded dataset was also calculated and averaged over the period 1991–2022. General patterns were consistent when compared to previous works based on the ICRA dataset, with maximum values found in the southeast and drier results in the northern half.

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Appendix I. Obtaining the CARRA data from CDS

This appendix discusses the procedures used to obtain the CARRA data from the Copernicus Climate Data Store (CDS), and details what data was obtained and how.

The CARRA dataset and the data from the follow-on project CARRA-TU (timely update) provide data from 1990 to 2025, with additions until March 2027 planned. At IMO, considerable work was put into acquiring data for a region around Iceland for the entire time period covered by the reanalysis.

AI.1 Download of the CARRA data to IMO and data streams.

Information about the CARRA data can be examined on the CDS webpage¹. Based on a user survey at IMO a subset of this data was downloaded for a region around Iceland and stored in the IMO file system. The data can be obtained from CDS through a web interface² or through an API accessed by a Python script. Due to the volume of the data, and number of files, here the API route was used. These two methods work together, since it is possible to specify data to be requested on the web interface and then select “show API request” on the web interface. This will display Python code that can be used to access the data. The Python code can then be modified as needed.

The data downloaded is listed in Table AI.1. In the table, the short name refers to the variable name as is provided by CDS, the long name is the readable name needed for the data request to CDS and the type is the class of data and which method was used for obtaining it as explained below.

As usual for reanalysis data, it comes in two different streams. The *analysis stream* contains analysed variables that are valid at the initialisation time (IT). For instance, if temperature (*T2M*) for the IT-time 2000-01-01 00:00:00 is required, then the analysed variable can simply be requested at this IT. All variables are, however, also available in the *forecast stream*, which contains the *forecasted* variables during the next hours. Working with this stream is slightly more complicated than the analysis stream. In the analysis stream, the IT time-axis has eight possible hours (00, 03, 06, 09, 12, 15, 18, 21 UTC) but for forecasted variables, there is also another time axis: the *lead time*. This axis has the following increments: 1, 2, 3, 4, 5, 6, 9, 12, 15, 18, 21, 24, 27, 30 and reflects the lead time in hours.

¹ See <https://cds.climate.copernicus.eu/datasets/reanalysis-carra-single-levels>

² See any Carra download page on cds

Table AI.1. CARRA data downloaded from CDS. See text below for a discussion about the method used to obtain the variable.

Short name	Long name	Type/Method
D10	10-m wind direction	analysed
F10	10-m wind speed	analysed
R2	2-m relative humidity	analysed
SH2	2-m specific humidity	analysed
T2M	2-m temperature	analysed
FSCOV	Fraction of snow cover	analysed
slp	Mean sea level pressure	analysed
sst	Sea surface temperature	analysed
rsn	Snow density	analysed
SD	Snow depth water equivalent	analysed
sro	Surface runoff	analysed
PR/TP	Precipitation during the 3-hour time step	IT-diff
tirf	Time integral of rain flux	IT-diff
titspf	Time integral of total solid precipitation flux	IT-diff
ssr	Direct solar radiation	step = 3
eva	Evaporation	step = 3
ptype	Precipitation type	step = 3
slh	Surface latent heat flux	step = 3
ssrd	Surface net solar radiation	step = 3
str	Surface net thermal radiation	step = 3
strd	Surface net thermal radiation downwards	step = 3
ssh	Surface sensible heat flux	step = 3
tidirswrf	Time-integrated surface direct shortwave radiation flux	step = 3

This is where the complications start. If we refer to the traditional time axis as IT-time (initialisation time) and the lead time as the step, there are differences in how many steps are available for the different IT-times. For all IT-times, the steps 1, 2, and 3 are available, but for IT-times of 00 UTC and 12 UTC all steps up to 30 are available. Note that the step-axis has an increment of 1 hour for the first 6 hours and 3 hours after that, for a total of 14 increments.

If requesting data for IT-times 00 or 12 UTC, there will be considerable overlap in the timestamp of results if all steps are chosen. However, this also means that if all IT-times are chosen with only steps 1, 2, and 3, the results will be a continuous hourly time axis with a forecast of 1, 2, or 3 hours.

Finally, it should be noted that forecast variables tend to be accumulated over the forecast, indicating that step 1 is the accumulation during the first hour of the forecast, step 2 is the accumulation during the first two hours, etc. This means that if one wants to know the change between forecast steps, the results must be differenced, and it then depends on the variable being considered if the differences further need to be divided by a time constant (for instance the number of seconds in 3 hours).

The third column in Table A1.1 lists whether the variable in question was obtained from the analysis stream (analysed variables) or the forecast stream. For the latter, two different methods were used to obtain the data, with step = 3, the data was obtained for all IT-times but only step = 3. This was acceptable for most forecast variables and produced a continuous 3-hourly time series similar to the analysed stream variables. For a few forecast stream variables (precipitation and related variables) there were significant transients in the first few hours after initialisation so more complicated differencing methods were employed.

The details of the three methods are described in the next sections.

A1.1.1 Obtaining data from the analysis stream

As stated before, downloading data from the analysis stream is more straightforward to deal with, as only one timestamp needs to be specified: the hour of day (00, 03,...18, 21), the day (1–31), the month (1–12), and year (1990–onwards). The CDS server is lax in several ways that make it easier to formulate request. For instance in a given year it is possible to ask for all times, months: 1–2 and days: 1–31, and CDS will ignore the fact that February 30th and 31st do not exist - but simply delivers a 3-hourly time series from January 1st to February 28th (29th on leap years). This means that it is easy to make programs that loop through the data, picking up various years, months, etc. As an example, the following Python request will deliver one year's worth of *snow density* data:

```
import cdsapi

ar = 2000

outfile = "Snow2000.grib"

client = cdsapi.Client()

dataset = "reanalysis-carra-single-levels"

request = {
    'domain': 'west_domain',
    'level_type': 'surface_or_atmosphere',
    'variable': 'snow_density',
    'product_type': 'analysis',
    'time': [
        '00:00', '03:00', '06:00',
        '09:00', '12:00', '15:00',
        '18:00', '21:00',
    ],
    'year': ar,
    'month': [
        '01', '02', '03',
        '04', '05', '06',
    ],
}
```

```

        '07', '08', '09',
        '10', '11', '12',
    ],
    'day': ['01', '02', '03', '04', '05', '06', '07', '08', '09', '10',
            '11', '12', '13', '14', '15', '16', '17', '18', '19', '20', '21', '22',
            '23', '24', '25', '26', '27', '28', '29', '30', '31'],
    'grid': [0.04180602, 0.01826484],
    'area': [67, -25, 63, -12.5],
    'data_format': 'grib'

}

target=outfile;

client.retrieve(dataset, request, target)

```

If the program is called `getSnow.py` then it can be run with:

```
$ python3 getSnow
```

Here the `cdsapi` must be imported for the Python program to work. It can be installed with `anaconda` or `pip3`. It is easy to modify this script to pass variables names, years, and outfiles at runtime (see next code example). The grid and area specification are used to obtain data for an area around Iceland (see the discussion in a separate section).

AI.1.2 Obtaining data from the forecast stream: the step = 3 method

If one only wants a 3-hourly time series as is readily obtained from the analysis stream, the easiest thing to do is to ask for all IT-times and step 3. This will give a 3-hourly forecast with a 3-hour increment. This is appropriate for forecast variables where there is little worry of initialisation transients affecting the results during the first hours after IT-time. The code below shows how this is obtained using the `cdsapi` with small modifications to yield one year of 3-hourly forecast data.

```

import sys
import cdsapi

ar=sys.argv[1]
outfile=sys.argv[2]
varuse=sys.argv[3]

c = cdsapi.Client()

c.retrieve(
    'reanalysis-carra-single-levels',
    {
        'domain': 'west_domain',

```

³ See <https://cds.climate.copernicus.eu/how-to-api> for details

```

'level_type': 'surface_or_atmosphere',
'variable': varuse,
'product_type': 'forecast',

'time': ['00:00', '03:00', '06:00', '09:00', '12:00',
        '15:00', '18:00', '21:00'],

'leadtime_hour': ['3', ],
'year': ar,
'month': ['01', '02', '03', '04', '05', '06', '07', '08', '09',
          '10', '11', '12'],

'day': ['01', '02', '03', '04', '05', '06', '07', '08', '09',
        '10', '11', '12', '13', '14', '15', '16', '17', '18',
        '19', '20', '21', '22', '23', '24', '25', '26', '27',
        '28', '29', '30', '31', ],
'format': 'grib',

'grid': [0.04180602, 0.01826484],
'area': [67, -25, 63, -12.5],

},

outfile)

```

Notice that here the `product_type` is different from the analysis stream code example, and a `leadtime_hour` is specified. Also, variable passing is enabled, so if this code is called `getCarraStep3Forecast.py` it can be run with:

```
$ python3 getCarraStep3Forecast.py 2022 'ssr2022.grib' "surface_net_solar_radiation"
```

and will retrieve `ssr` for all IT-times and all days in 2022 and pick up the 3-hourly forecast. Since the IT-times have a spacing of 3 hours, this will give a 3-hourly time series for the whole year.

There is one thing to note, however, and that is that the data timestamp for the forecast mode is the IT-time + the 3-hourly step. So if the data timestamp says (*dd-mm-yyyy*) 12 UTC we get the data initialized at 09 UTC and accumulated until 12 UTC. This is not a problem, except when calculating daily statistics (or monthly, annual, etc), then care must be taken that the data with the timestamp 00 UTC on day *dd* is actually accumulated from 21 to midnight, and therefore belongs to day *dd-1*. This issue is discussed in the section on post-processing.

AI.1.3 Obtaining data from the forecast stream: the IT-diff method for IT-times 00 and 12 UTC and for steps 6, 9, 12, 15, and 18

The third method used related to forecast stream variables where initial transients needed to be avoided. In this case, it was decided to use IT-times 00 and 12 UTC and request steps 6, 9, 12, 15, and 18. Then the differences from 6–9, 9–12, etc were calculated resulting in four 3-hourly values starting at 09 and ending at 18 UTC for IT-time 00 UTC and starting at 21 and ending at 06 UTC for IT-time 12 UTC. When this is combined, a 3-hourly time series from 09 UTC on day *dd* and ending at 09 UTC on day *dd+1* is obtained.

This method is more complicated because it picks up five steps and two IT-times, and the time axis has to be built from these. The following code picks up the data for a particular month:

```
import cdsapi
import sys

varuse=sys.argv[1]
ar=sys.argv[2]
man=sys.argv[3]
target=sys.argv[4]

dataset = "reanalysis-carra-single-levels"
request = {
    "domain": "west_domain",
    "level_type": "surface_or_atmosphere",
    "variable": varuse,
    "product_type": "forecast",
    "time": ["00:00", "12:00"],
    "leadtime_hour": [ "6",  "9",  "12",  "15",  "18" ],
    "year": ar,
    "month": man,
    "day": ["01", "02", "03", "04", "05", "06", "07", "08", "09", "10", "11",
            "12", "13", "14", "15", "16", "17", "18", "19", "20", "21",
            "22", "23", "24", "25", "26", "27", "28", "29", "30", "31" ],

    "grid": [0.04180602,0.01826484],
    "area": [67, -25,63, -12.5 ],
    "data_format": "grib"
}

client = cdsapi.Client()
client.retrieve(dataset, request, target)
```

If the file is called `getCarraIT0012Forecast.py`, it can be run by:

\$ python3 getCarraIT0012Forecast.py "time_integral_of_rain_flux" 1999 12 "fileout.grib"

This will yield a grib file that is 4-dimensional, because the time axis contains both the IT-times and the step. Furthermore, we want the 3-hourly accumulated values so we must difference the step variable. Once that has been done, we need to merge the two time axes. The following Python code accomplishes this and writes out a NetCDF file.

```
# -*- coding: utf-8 -*-
# use: python reikna_step_mun.py innskra utskra
```

```

import xarray as xr
import sys

# note that this is tested for cases where innskra is grib but
# utskra is netcdf. In principle the input file could be netcdf,
# so long as the structure is 4D, sth like (time, step, lat, lon)

innskra=sys.argv[1]
utskra=sys.argv[2]

mydata=xr.open_dataset(innskra)

# This should be 3 hourly differences, but method will work if
# step is hourly or unevenly spaced in time.
ds = mydata.diff("step")

# Flatten the file to a 3D shape: (times,lat,lon)

def flatten_time_step(ds):
    ds_flat = ds.stack(time_step=("time", "step"))
    ds_flat =ds_flat.transpose("time_step", "latitude", "longitude")
    return ds_flat

ds_flat=flatten_time_step(ds)

# clean up
dsout=ds_flat.drop_vars(["time","step","time_step","surface"])
dsout = dsout.rename_dims({"time_step": "time"})
dsout['time']=dsout['valid_time']
dsout=dsout.drop_vars(["valid_time"])

dsout.to_netcdf(utskra)

```

If this code is called `difference_and_reorder.py`, the call is simply;

`$ python3 difference_and_reorder.py innskra.grib utskra.nc`

AI.2 The grid and area trick

The three examples for Python requests sent to CDS all have the parameters

```
"grid": [0.04180602, 0.01826484],  
"area": [67, -25, 63, -12.5],
```

which is not found in the code generated by CDS. This is based on a note at the ECMWF website⁴, that explains ways of interpolating on the fly with a specified grid and area.

Using GRIB, all that is needed is to specify the resolution as 90/N where N is an integer, but if NetCDF is used, then there are limits to which values are supported.

The point of this is to subset CARRA, which is not an explicit option on CDS. This means that a much smaller region can be downloaded, which saves on pickup times, and indeed without this trick, retrieving data is very time consuming.

The spatial size of the domain is given by the area specification, it will be returned on a lon-lat grid and the grid specification is the increments in longitude and latitude (*dlon*, *dlat*). The size of the spatial domain is 300 x 220 points which means that a time series of data is a 3D array size of (Ntimes, 300, 2020), where Ntimes is the number of timesteps.

AI.2.1 NetCDF and GRIB

The original plan was to use only CF compatible netcdf files for the data. However, the NetCDF files were quite large, and it turned out that GRIB files were 50% of the size of the NetCDF files. Thus, the decision was made to pick the data up as GRIB, but as soon as they are used for calculations (for instance daily averages, or daily sums, see section on post-processing), they were saved as NetCDF. Many users are not at ease with the GRIB format, but have softwares that can handle NetCDF easily. With `python xarray`, this is not as much an issue as before, but still there are many users that prefer NetCDF, so post-processed files were saved as netcdf.

AI.3 Post-processing the downloaded data

Once the 3-hourly data time series were obtained, daily, monthly, and other statistics were calculated from them. As with reading variables there were also differences in the best way to handle data from the different streams and methods.

AI.3.1 Post-processing data from the analysis stream

For the analysis stream, the timestamps correspond to the analysis time, and the daily statistics were calculated in the same way as would be done for observations. As an example, the sea level pressure *SLP* is an analysed variable and daily time series can be calculated using the Climate Data Operators (CDO), viz.

⁴ See <https://confluence.ecmwf.int/pages/viewpage.action?pageId=123799065>


```
cdo -f nc dayavg $loc3hr/CF_SLP1991.grib $locDaily/SLP1991_daily.nc
```

The above CDO command reads in the 3-hourly time series for the year 1991 from the correct location (\$loc3hr), calculates the daily averages and returns to a location for the daily data. The first time stamp in the *CF_SLP1991.grib* file is 1991-01-01 00:00:00 and the last one is 1991-12-31 21:00:00. The daily average is therefore a 365-day time series, where each day is the average of the eight 3-hourly values (00, 03,..., 21 UTC), starting at 00 UTC on January 1st and ending at 21 UTC on 31st December.

Similar CDO operators (daymax, daymin etc) can be used for other daily statistics, or monthly statistics if needed. Finally, note that the “-f nc” option is applied, meaning that the daily files will be written as NetCDF.

AI.3.2 Post-processing data from the forecast stream

As described earlier, the forecast data are stored as accumulated values over the preceding three hours. This means that data with the timestamp 00 UTC on a particular day is actually accumulated from 21 UTC to midnight on the preceding day. This means that the CDO command given above will count the accumulation in the three hours preceding midnight as part of the next day. Therefore, a timeshift operation must be done in parallel to the calculation of daily statistics. There is a difference whether the data is picked up with the step = 3 method or with the more involved IT-diff method used for the precipitation variables. These differences will now be examined.

AI.3.2.1 Post-processing data when downloading all times with step = 3

As an example, we consider a file containing surface latent heat flux *slh* for the year 2012. The first timestamp of the file is 2012-01-01T03:00:00 and the last one is 2013-01-01T00:00:00. For a 3-hourly time series, we would expect eight values per day, but on the first day of the year we get the seven values from 2012-01-01T03:00:00 to 2012-01-01T21:00:00 and the eighth value (2012-01-02T00:00:00) belongs to the next day. For the last day of the year the last value will then be at the beginning of next year. This means that daily statistics calculated by CDO will be for seven values on the first day of the year, and then for eight values reflecting the 21:00:00 to 21:00:00 average for other days of the year, with the very last value becoming its own daily average for the first day of the next year.

To fix this and obtain statistics based on the eight values per day, it is necessary to shift the timestamps back by 1 second, calculate the average, and then shift the timestamps forward again.

For *slh* we would do:

```
cdo -f nc -shifttime,1sec -dayavg -shifttime,-1sec CF_slh2012.grib  
slh_dayavg2012.nc
```

The -1 second shift before the calculation of the daily average means that the value at 2012-01-02T00:00:00 will have the timestamp at 2012-01-01T23:59:59, and the first day will have eight values to calculate the average with. The final value is therefore shifted from 2013 to the timestamp 2012-12-31T23:59:59. Again, note the “-f nc” option, indicating that the daily files will be written as NetCDF.

Similar considerations apply to all other daily statistics (especially sums) for other variables that were retrieved with a lead time of 3 hours.

AI.3.2.2 Post-processing data downloaded using the IT-diff method

As described above, the precipitation forecast data is stored as accumulated values from 06–09, 09–12, 12–15 and 15–18 for the IT-time 00 UTC, and 18–21, 21–00 (day+1), 00–03 and 03–06 for IT-time 12 UTC. The timestamp for each 3-hourly accumulated value is the end of the 3-hourly period. This means that for a given month, the file will start at 09 UTC on the first day of the month and end at 06 UTC on the first day of the next month. As an example, for October 2023 the first and last timestamps are:

```
2023-10-01T09:00:00, 2023-10-01T12:00:00, ..., 2023-11-01T03:00:00, 2023-11-01T06:00:00
```

This means that to get all values for a month, data from the previous month must be included. This is easily done with `cdo mergetime`.

Daily statistics can then be calculated, but care must be taken that as in the case for the `step = 3` data, the accumulation from 21 to 00 UTC will get a timestamp for the next day. Again, this issue can be sidestepped using the `shifttime` operator and then it is easy to select the month of interest. For the October example, we would issue the command:

```
cdo -selmon,10 -shifttime,-1sec -mergetime CF_PR_2023-09.nc CF_PR_2023-10.nc  
OCT2023.nc  
  
cdo showtimestamp OCT2023.nc
```

which yields the timestamps:

```
2023-10-01T02:59:59, 2023-10-01T05:59:59, ..., 2023-10-31T20:59:59, 2023-10-31T23:59:59
```

This way, each day of the month will have eight 3-hourly values and we can calculate the daily sum (or other daily statistics) with the CDO `daysum` operator. Again, for the October example, we have:

```
cdo -shifttime,1sec -selmon,10 -daysum -shifttime,-1sec -mergetime CF_PR_2023-09.nc  
CF_PR_2023-10.nc OCTDAYSUM_2023.nc
```

Shifting the time axis back by 1 second after calculating the daily sum and selecting the month is only for aesthetics. This will move the timestamps in the daily file to 13:30 UTC each day. It could be argued that a better choice is noon (12:00 UTC) since this is the exact middle of the day. This choice is arbitrary; we could use `shifttime` only once and shift everything back by 90 minutes (5400 seconds). This would use the same eight values per day for calculating daily statistics but would result in a time axis in the daily file where the timestamp always 12 UTC:

```
cdo -selmon,10 -daysum -shifttime,-5400sec -mergetime CF_PR_2023-09.nc  
CF_PR_2023-10.nc OCTDAYSUM_2023.nc
```

Appendix II. Temperature

In this appendix, figures similar to Figures 3–10 presenting a comparison between the observed and simulated (CARRA) daily mean, maximum, and minimum near-surface air temperature at 2 m are shown for the 49 automatic stations (Table 1).

The plots include a comparison between the probability density function and the cumulative distribution function of observed and simulated temperatures, as well as scatter plots for observed versus simulated temperatures.

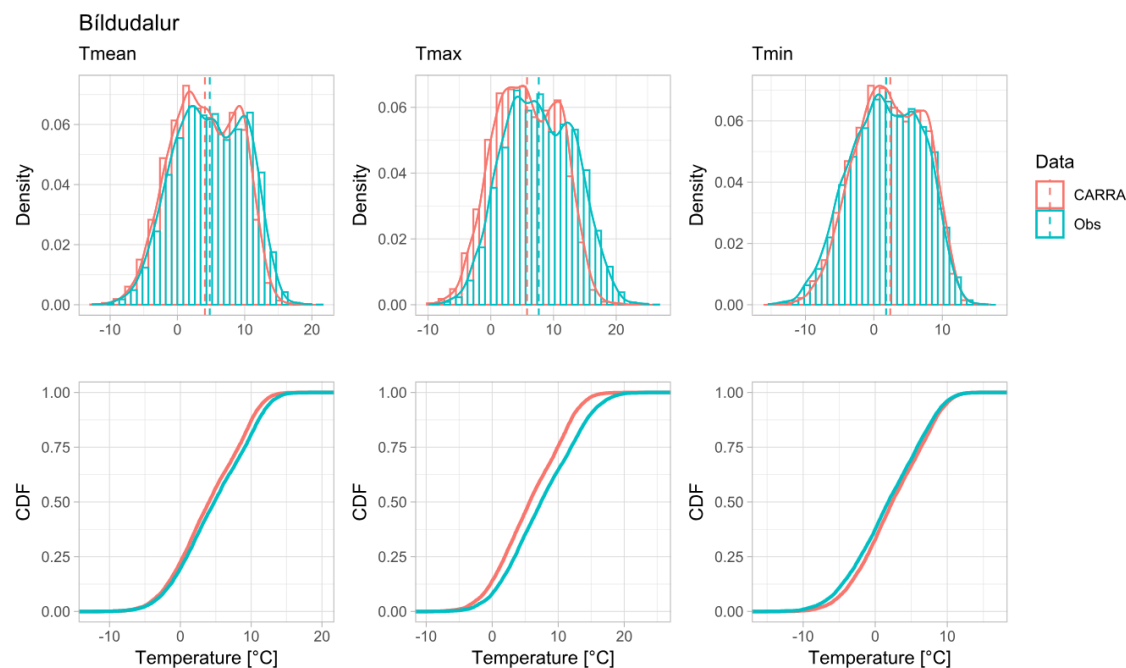


Figure II.1 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Bíldudalur automatic station.

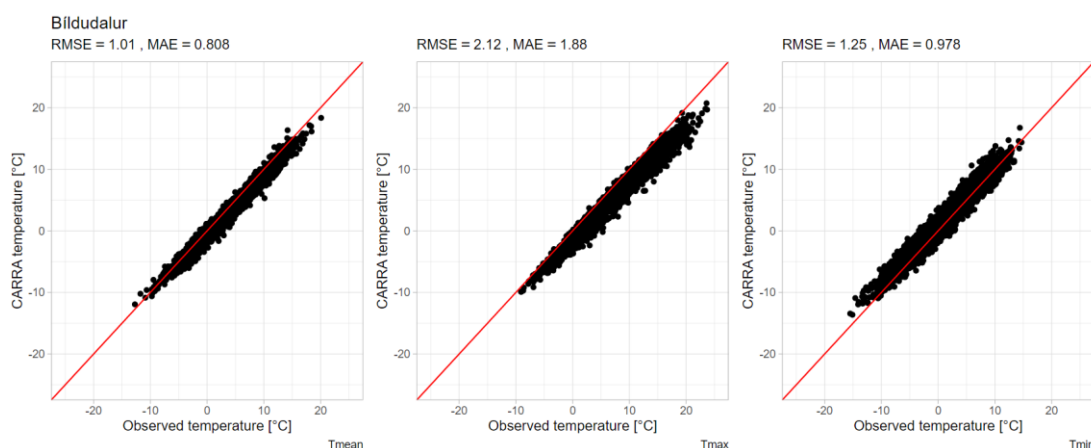


Figure II.2 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Bíldudalur automatic station. The RMSE and MAE (in °C) are shown above each panel.

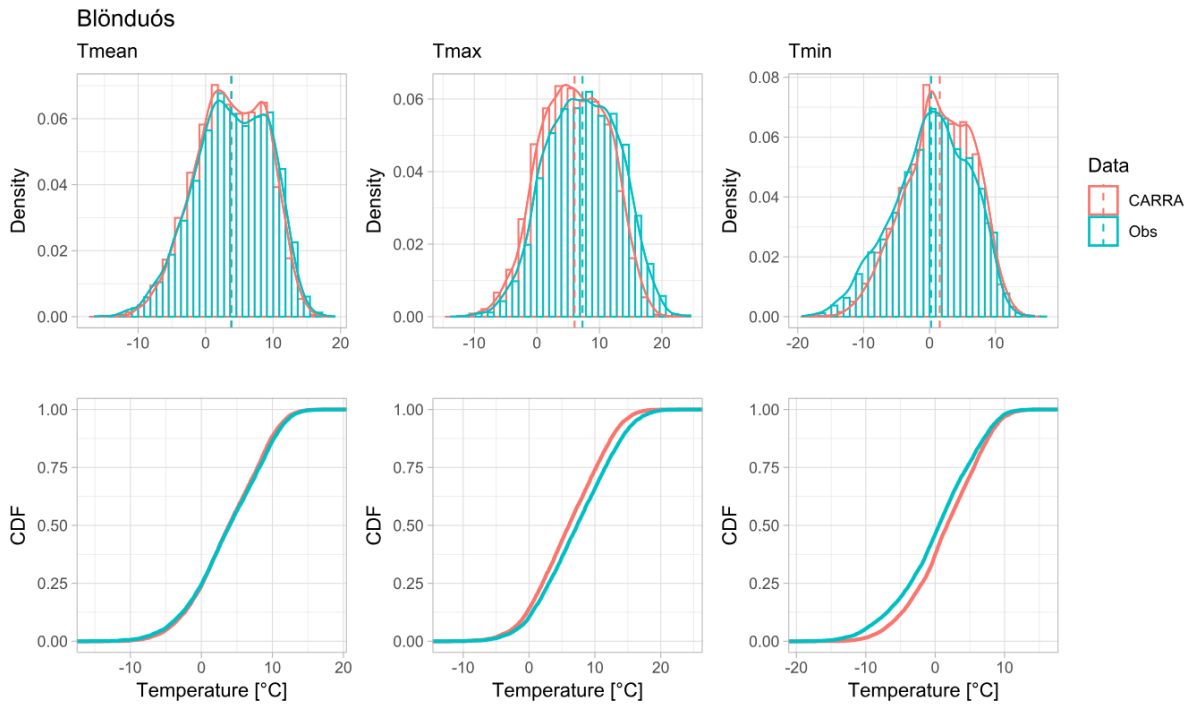


Figure II.3 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Blönduós automatic station.

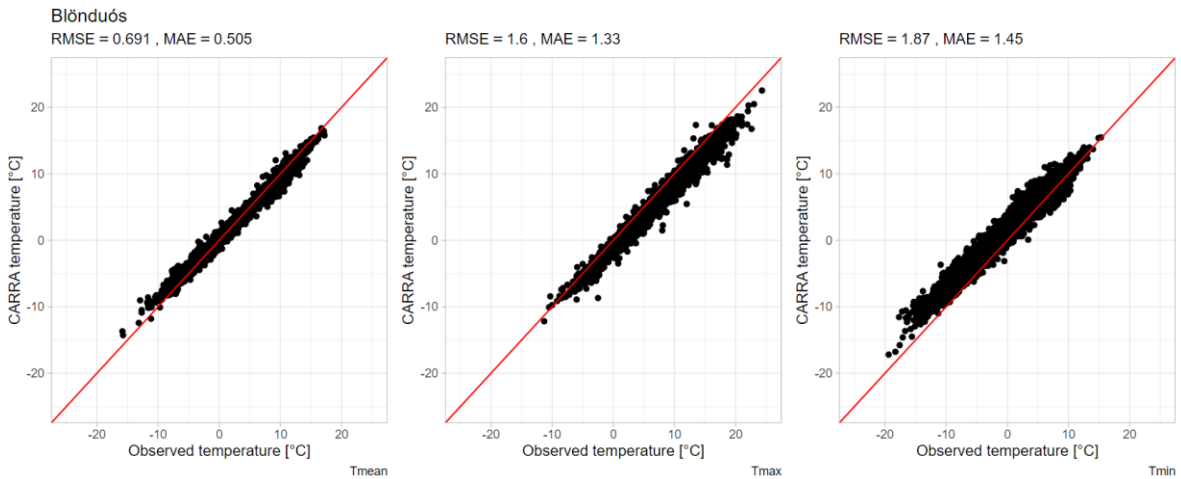


Figure II.4 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Blönduós automatic station. The RMSE and MAE (in °C) are shown above each panel.

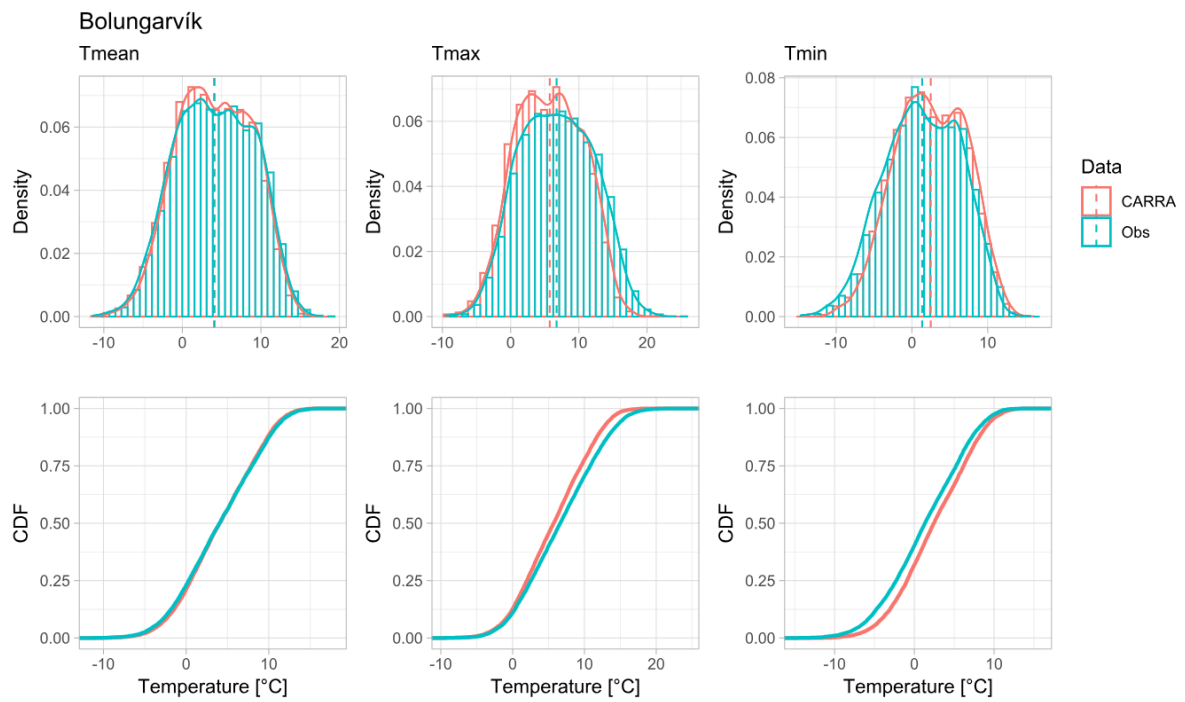


Figure II.5 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Bolungarvík automatic station.

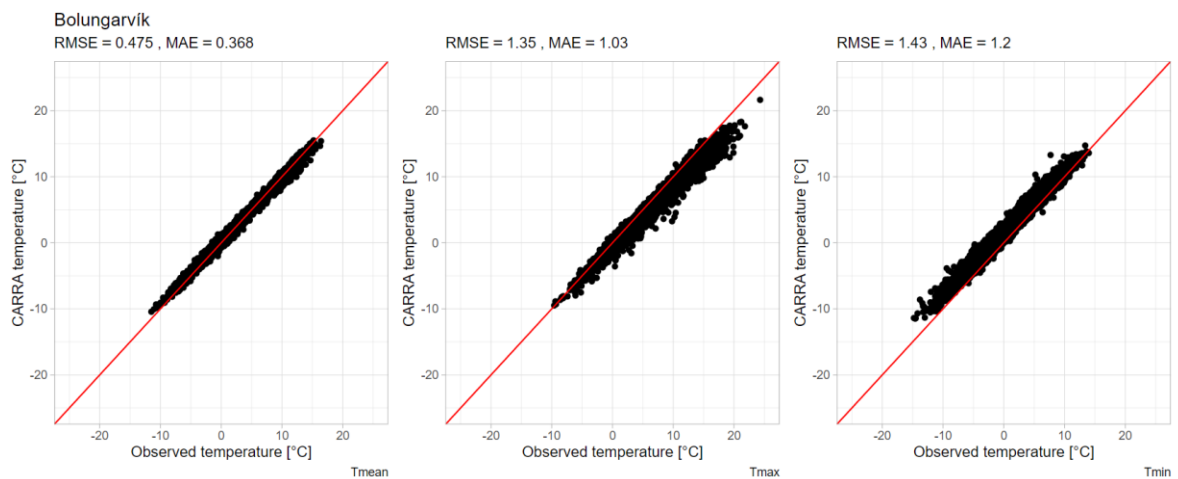


Figure II.6 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Bolungarvík automatic station. The RMSE and MAE (in °C) are shown above each panel.

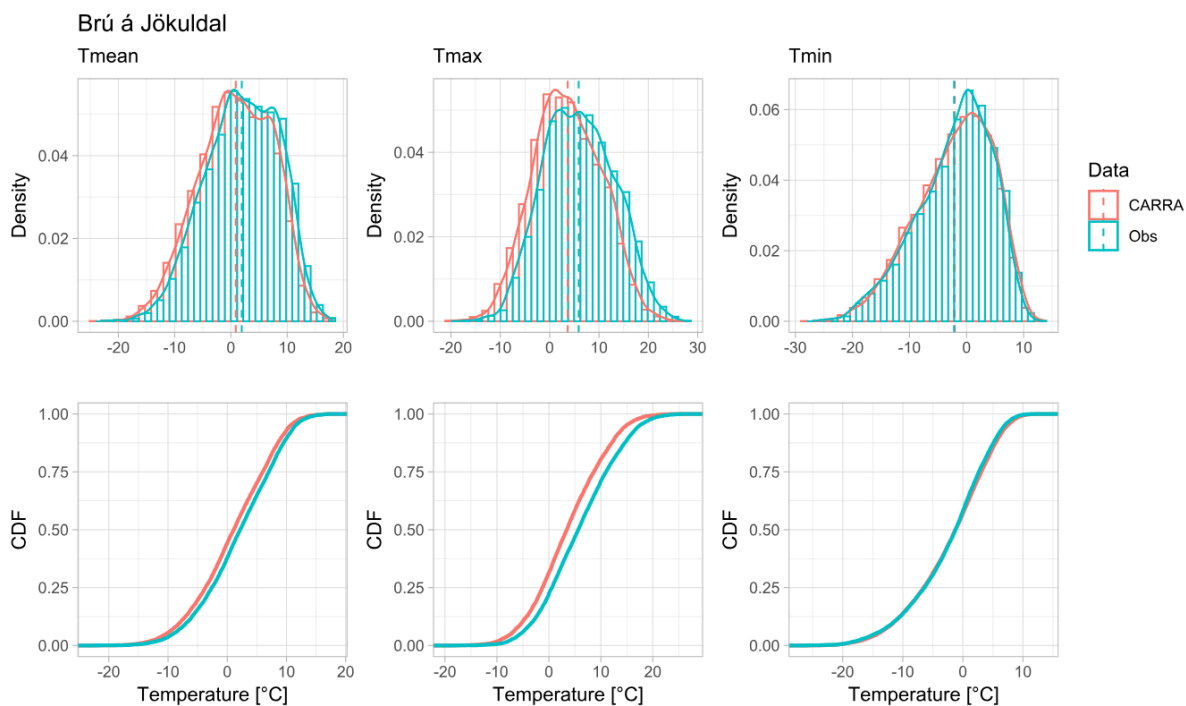


Figure II.7 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Brú á Jökuldal automatic station.

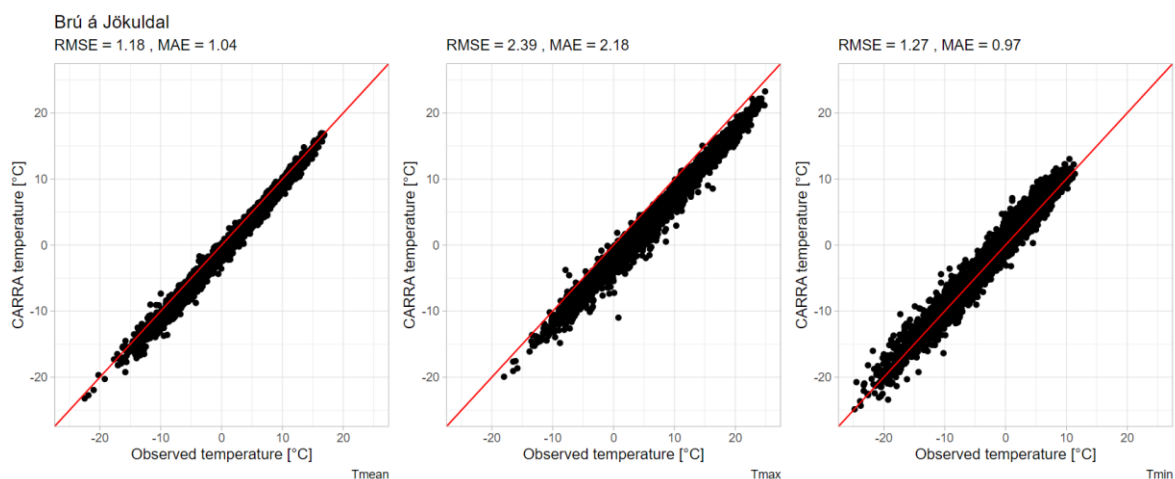


Figure II.8 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Brú á Jökuldal automatic station. The RMSE and MAE (in °C) are shown above each panel.

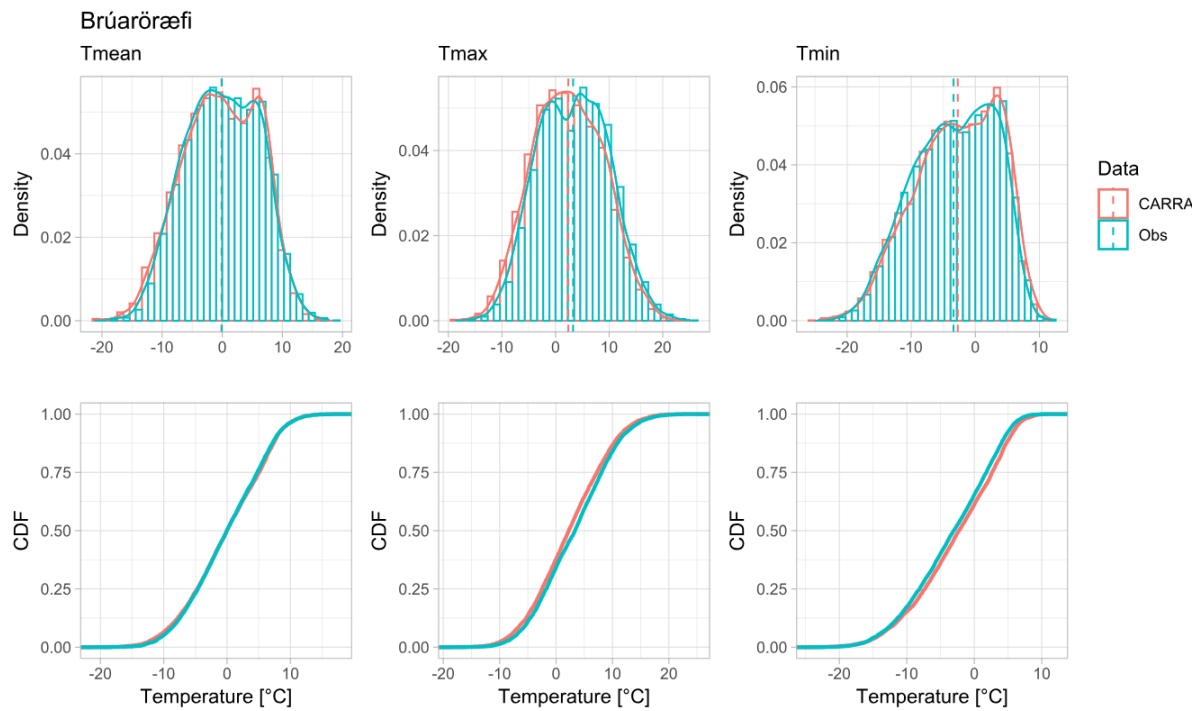


Figure II.9 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Brúaröræfi automatic station.

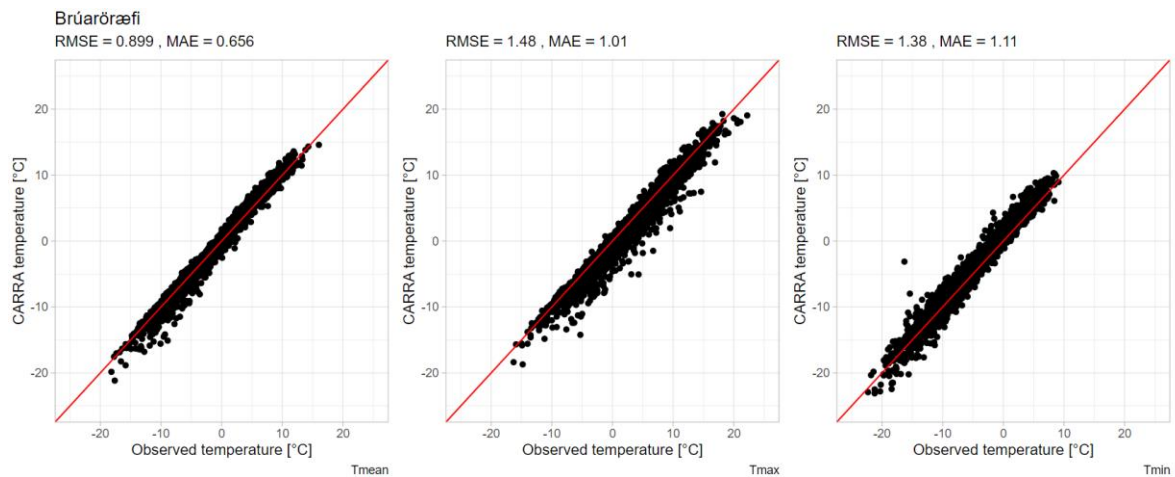


Figure II.10 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Brúaröræfi automatic station. The RMSE and MAE (in °C) are shown above each panel.

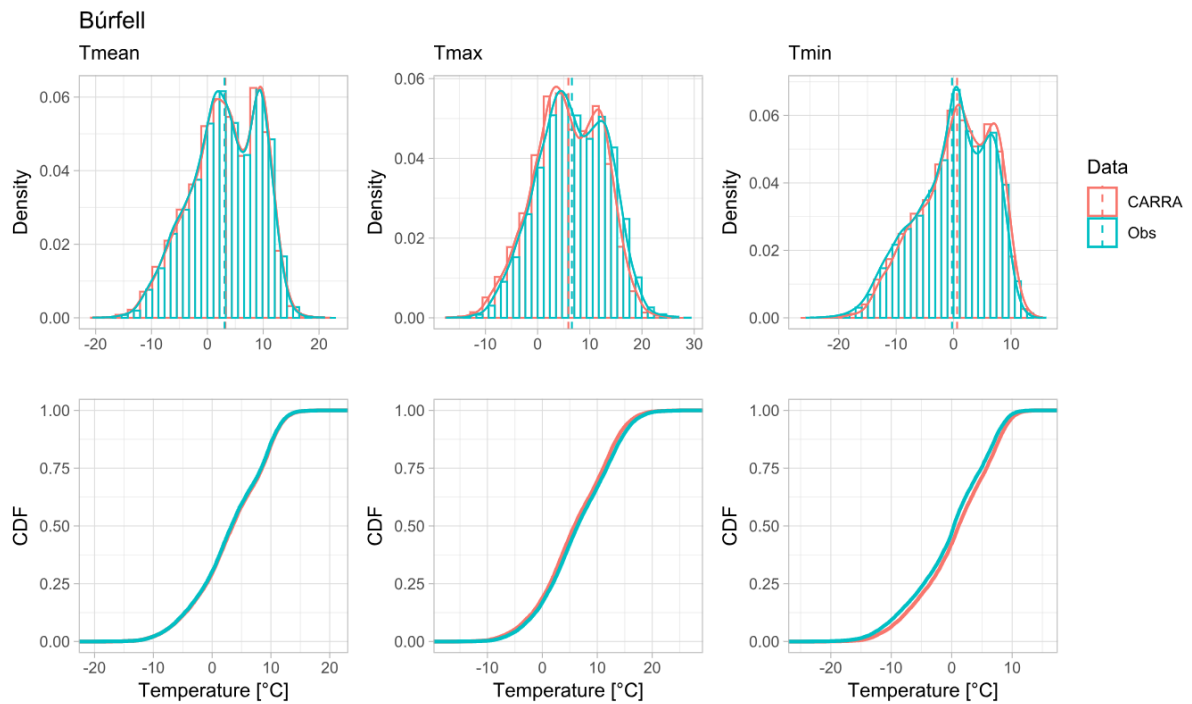


Figure II.11 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Búrfell automatic station.

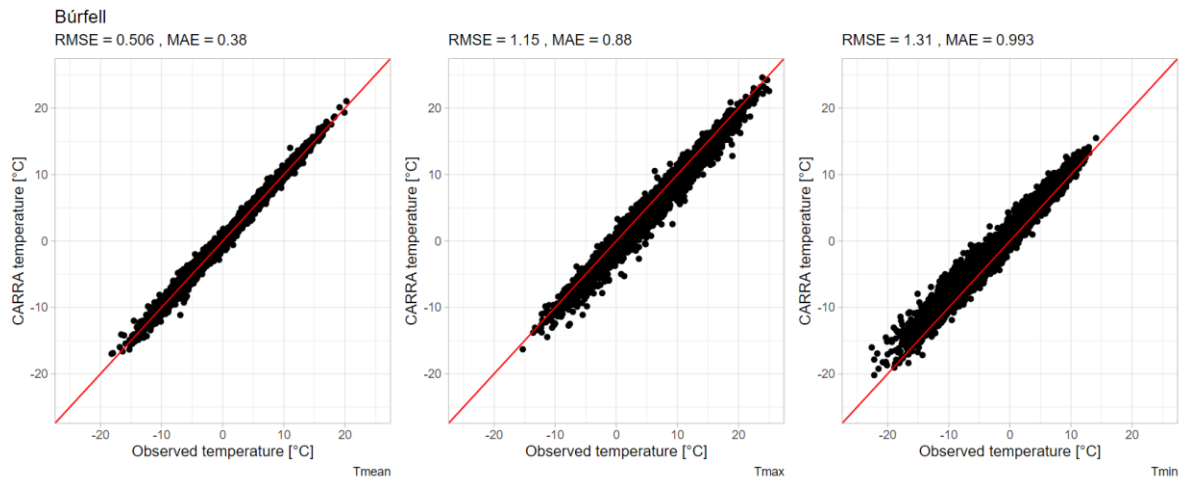


Figure II.12 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Búrfell automatic station. The RMSE and MAE (in °C) are shown above each panel.

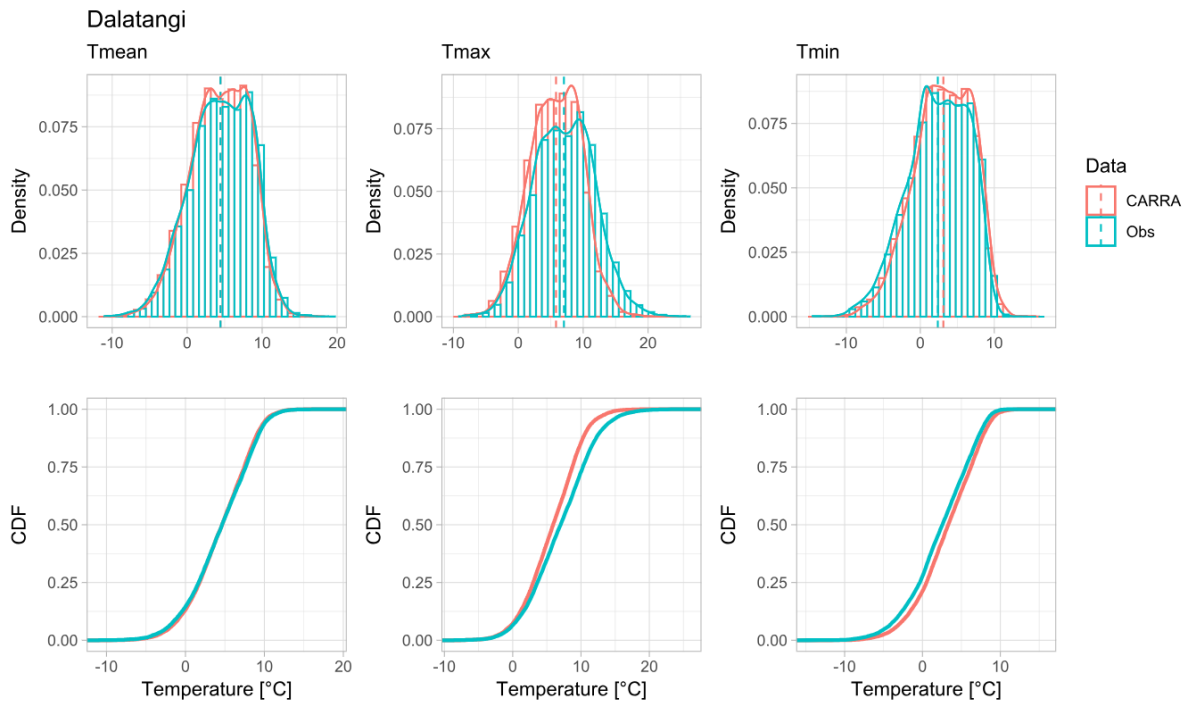


Figure II.13 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Dalatangi automatic station.

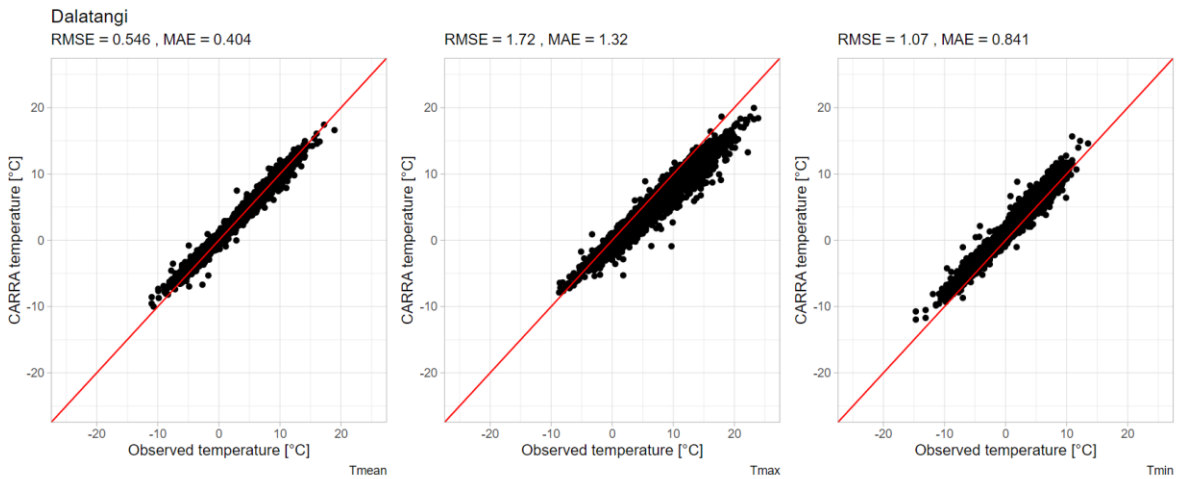


Figure II.14 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Dalatangi automatic station. The RMSE and MAE (in °C) are shown above each panel.

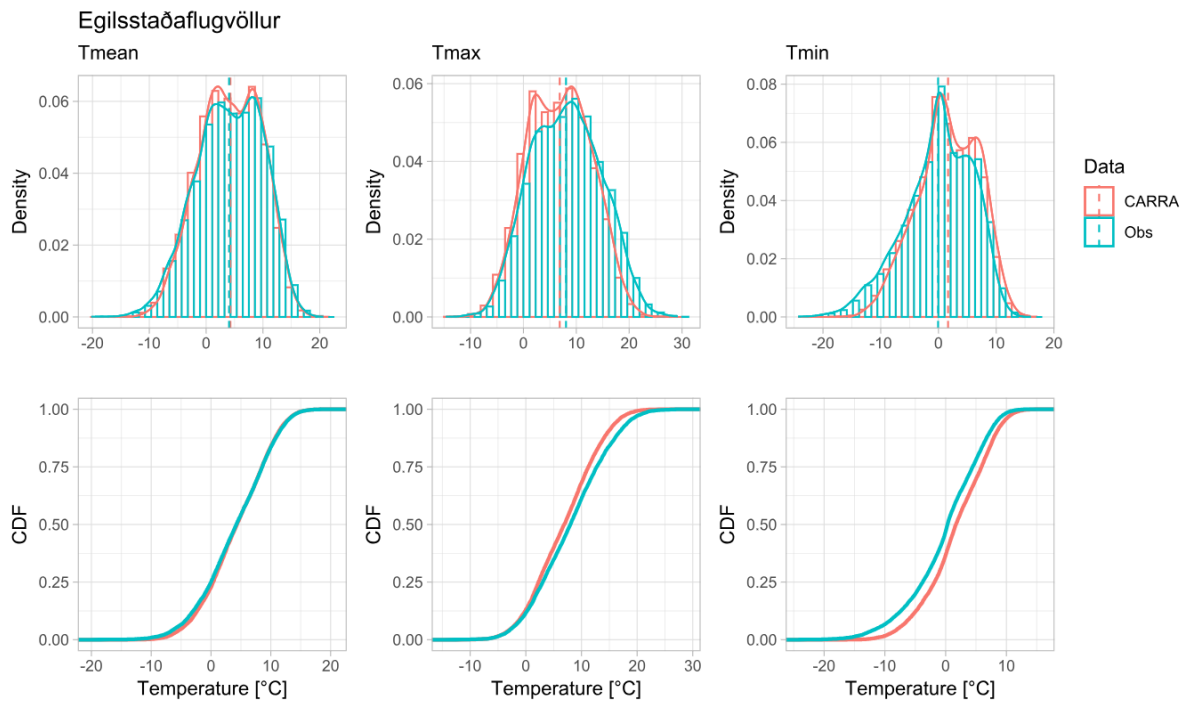


Figure II.15 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Egilsstaðflugvöllur automatic station.

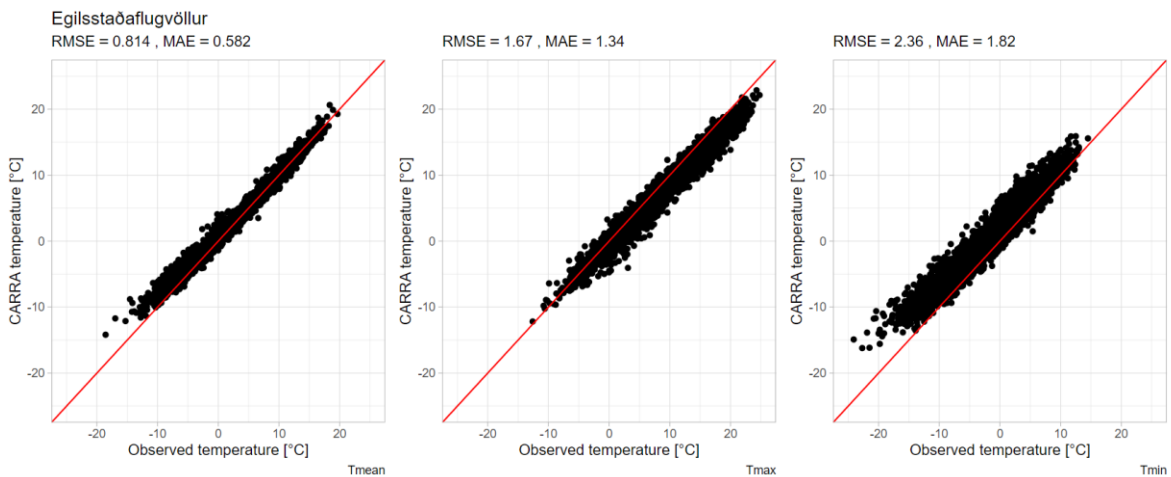


Figure II.16 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Egilsstaðflugvöllur automatic station. The RMSE and MAE (in °C) are shown above each panel.

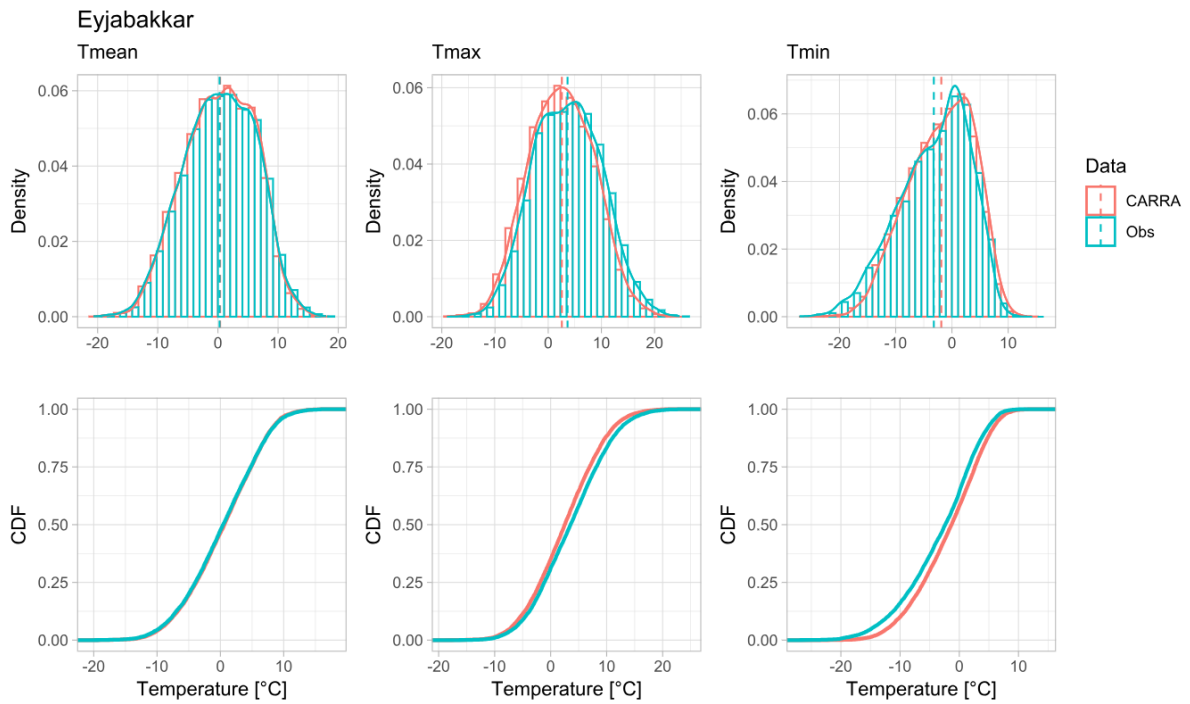


Figure II.17 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Eyjabakkar automatic station.

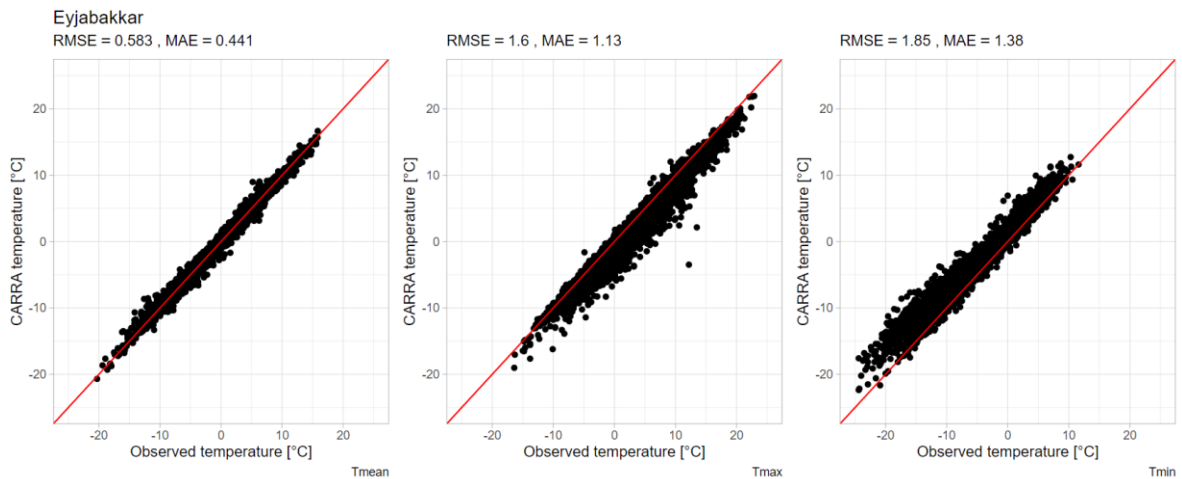


Figure II.18 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Eyjabakkar automatic station. The RMSE and MAE (in °C) are shown above each panel.

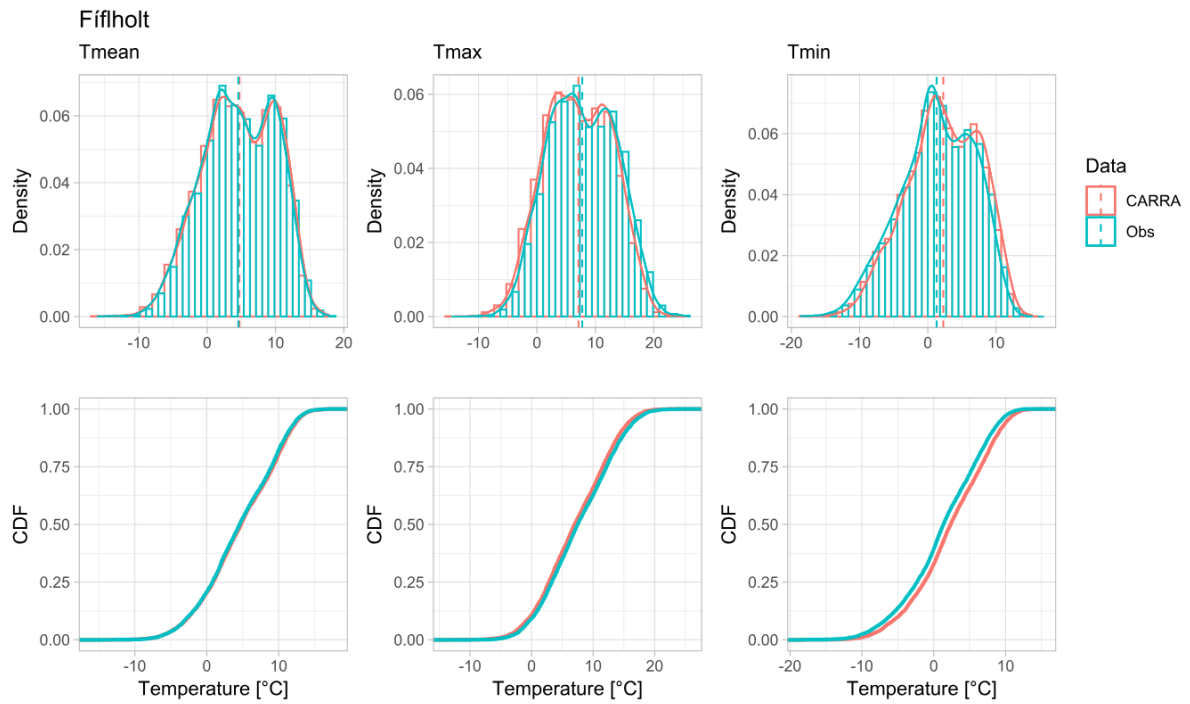


Figure II.19 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Fíflholt automatic station.

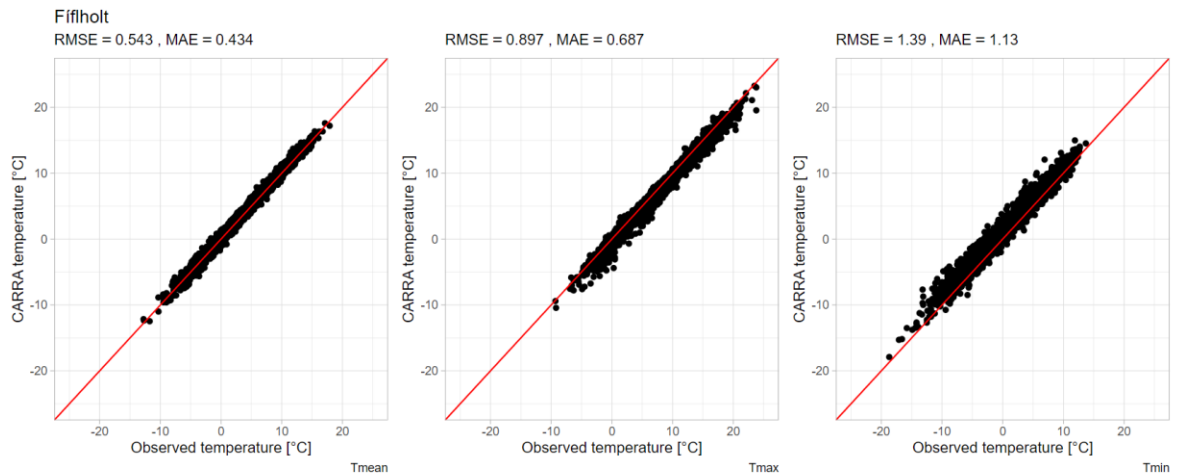


Figure II.20 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Fíflholt automatic station. The RMSE and MAE (in °C) are shown above each panel.

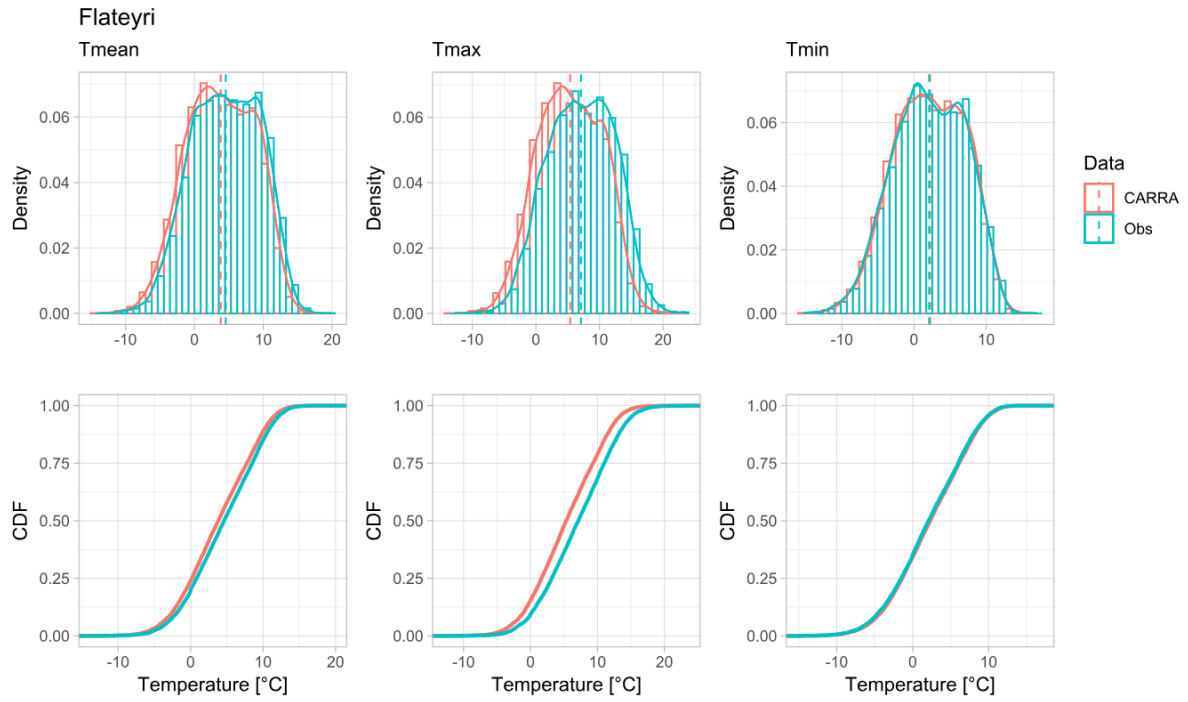


Figure II.21 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Flateyri automatic station.

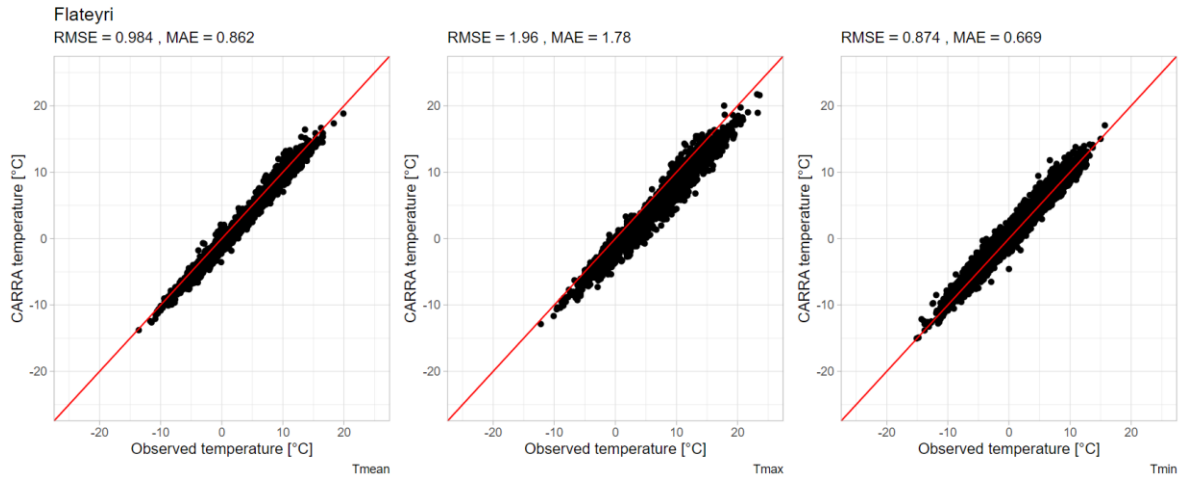


Figure II.22 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Flateyri automatic station. The RMSE and MAE (in °C) are shown above each panel.

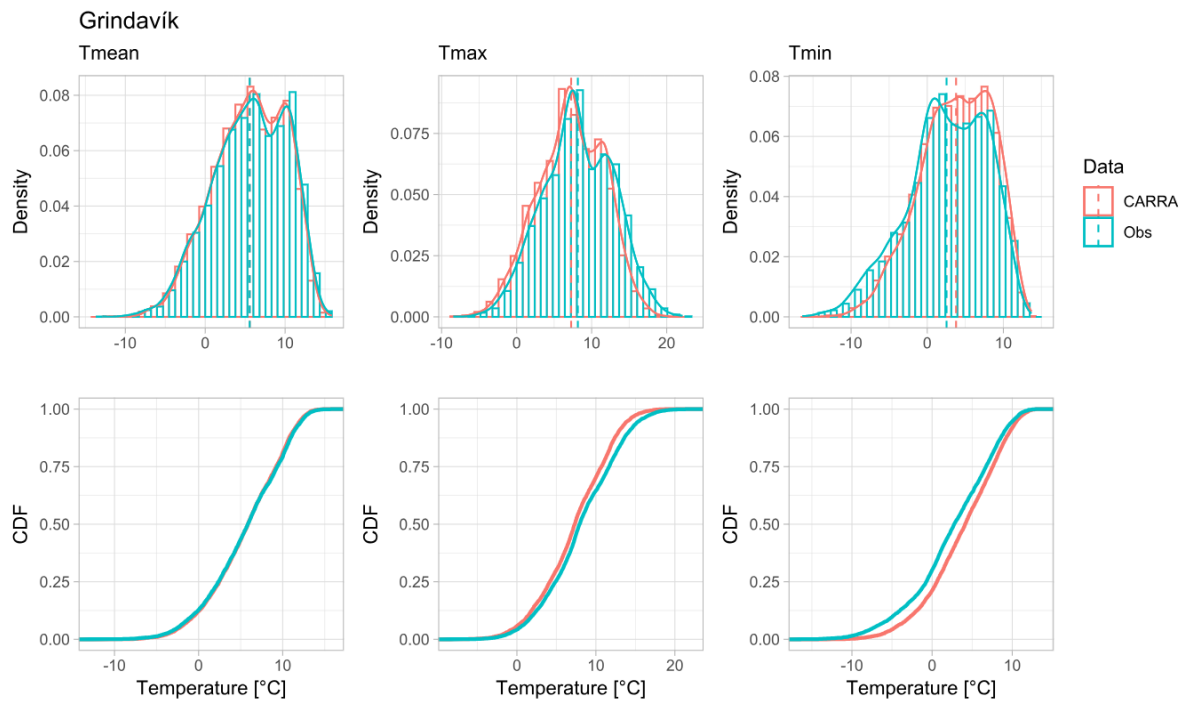


Figure II.23 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Grindavík automatic station.

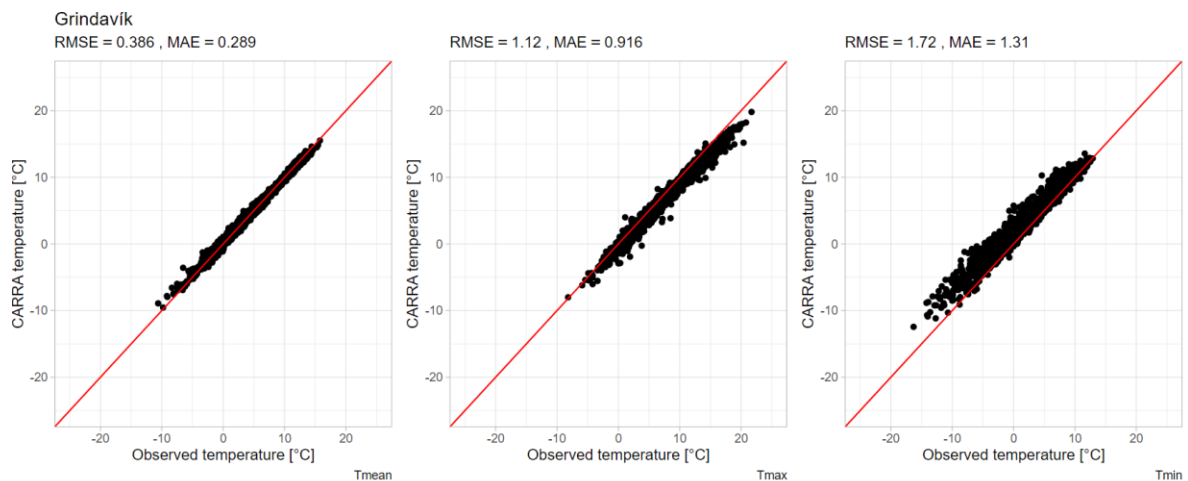


Figure II.24 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Grindavík automatic station. The RMSE and MAE (in °C) are shown above each panel.

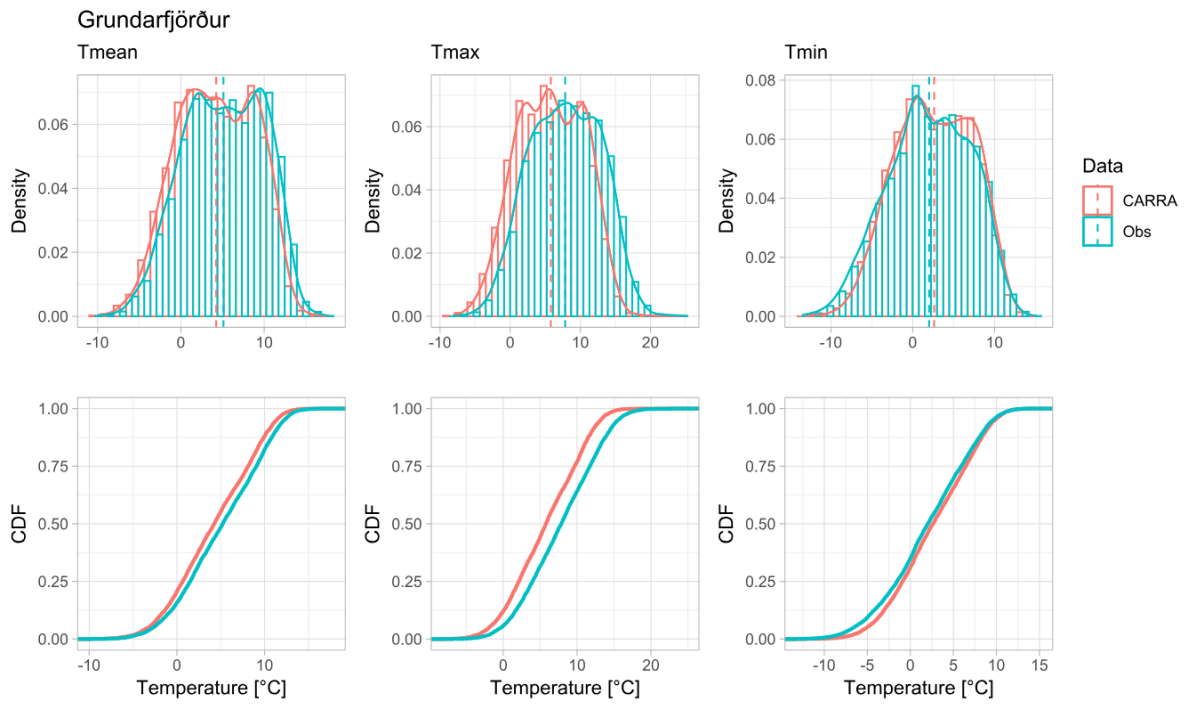


Figure II.25 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Grundarfjörður automatic station.

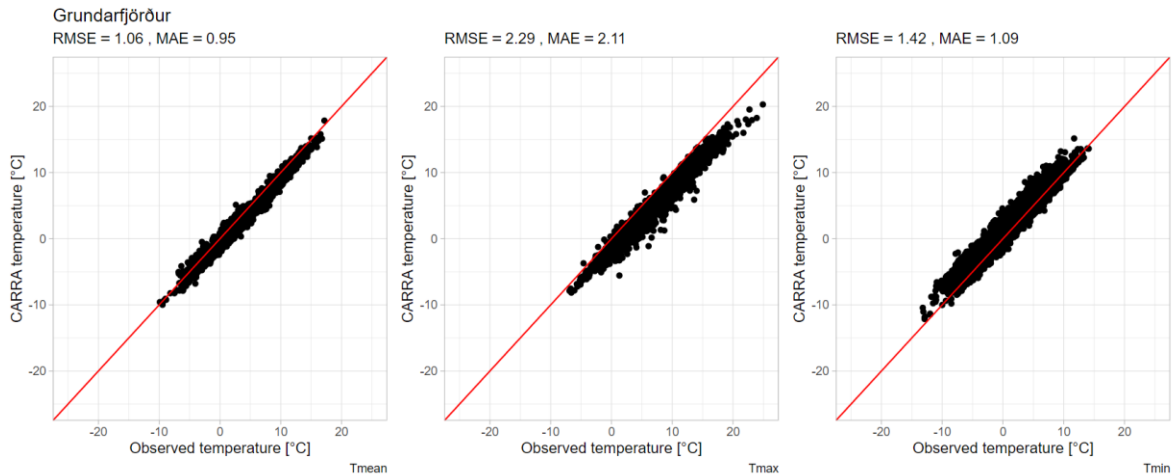


Figure II.26 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Grundarfjörður automatic station. The RMSE and MAE (in °C) are shown above each panel.

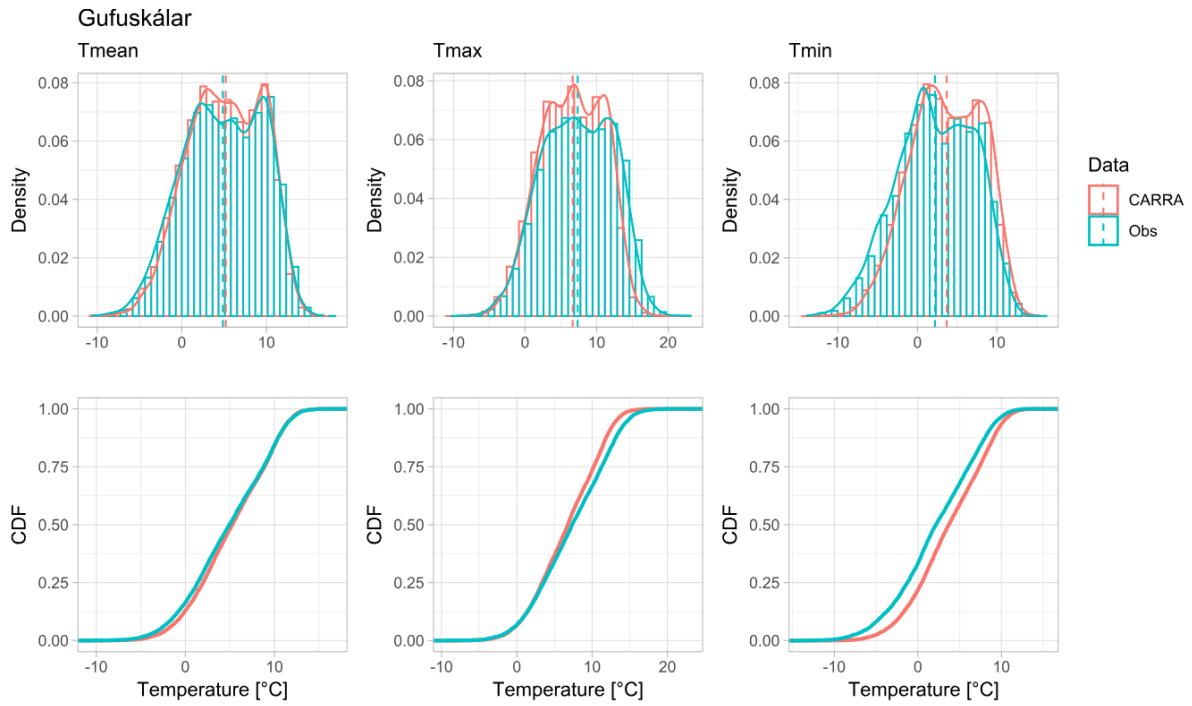


Figure II.27 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Gufuskálar automatic station.

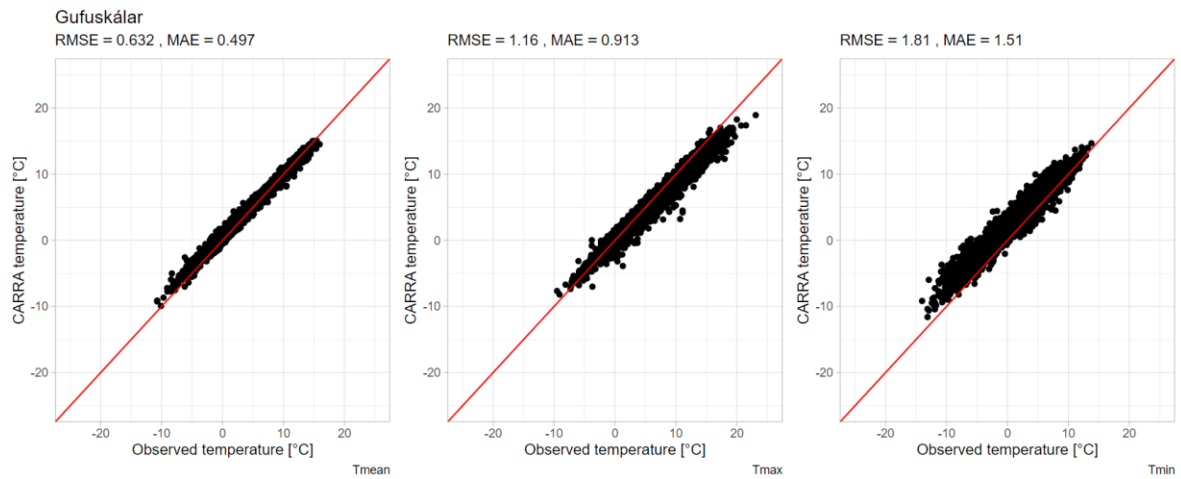


Figure II.28 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Gufuskálar automatic station. The RMSE and MAE (in °C) are shown above each panel.

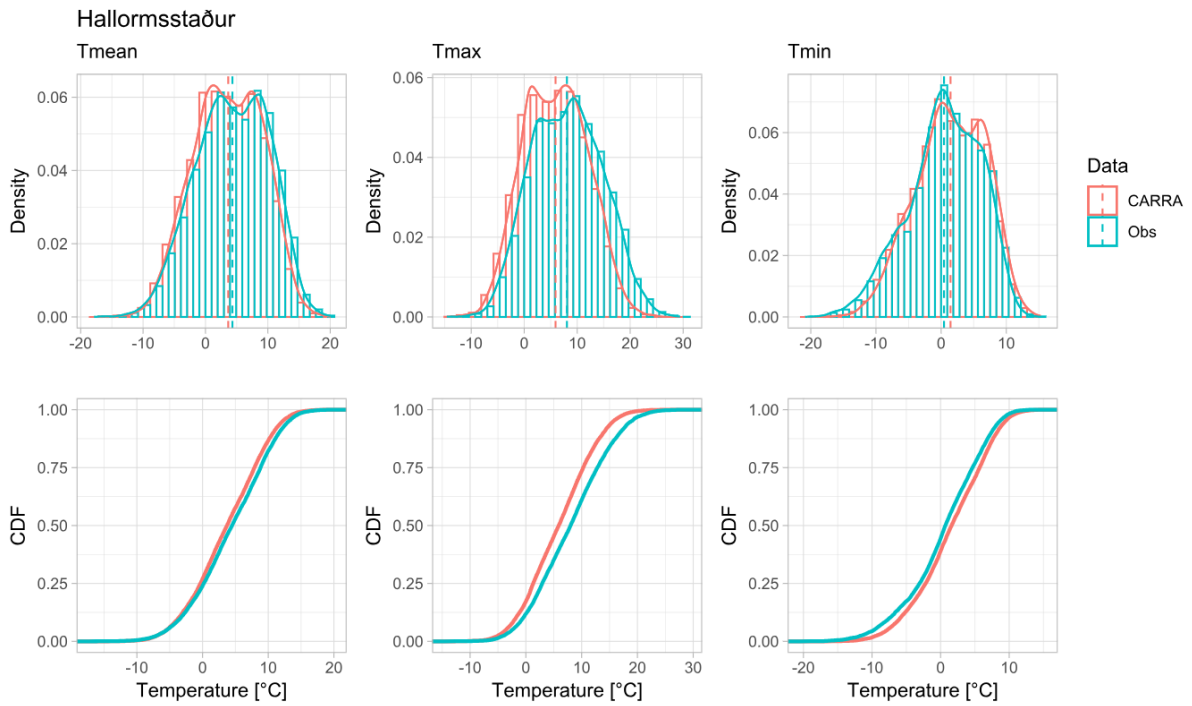


Figure II.29 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Hallormsstaður automatic station.

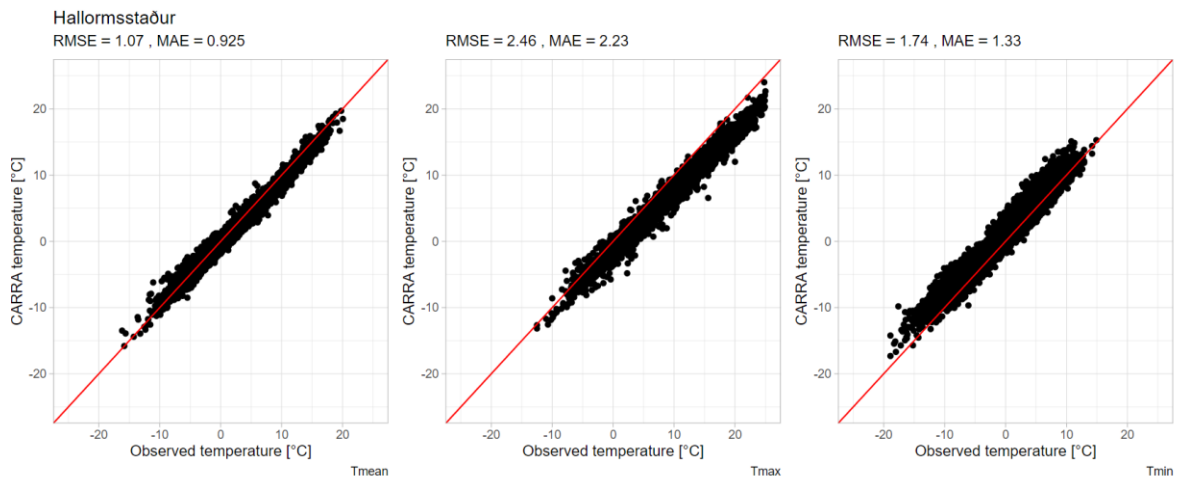


Figure II.30 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Hallormsstaður automatic station. The RMSE and MAE (in °C) are shown above each panel.

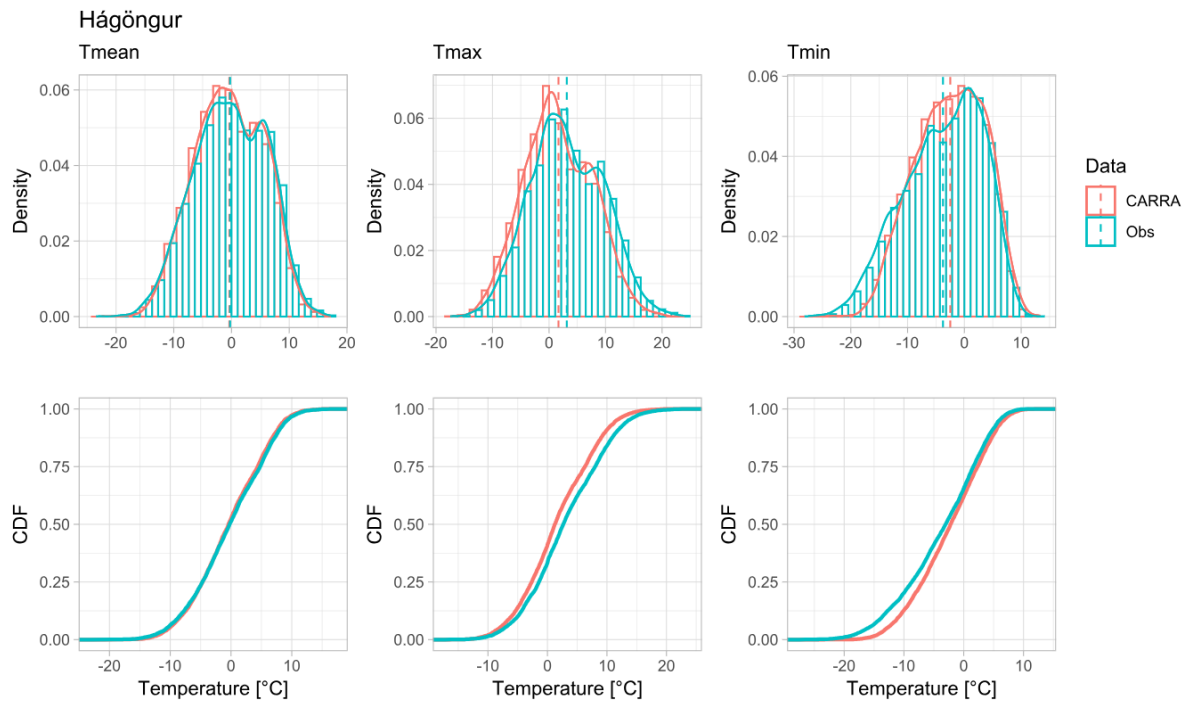


Figure II.31 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Hágöngur automatic station.

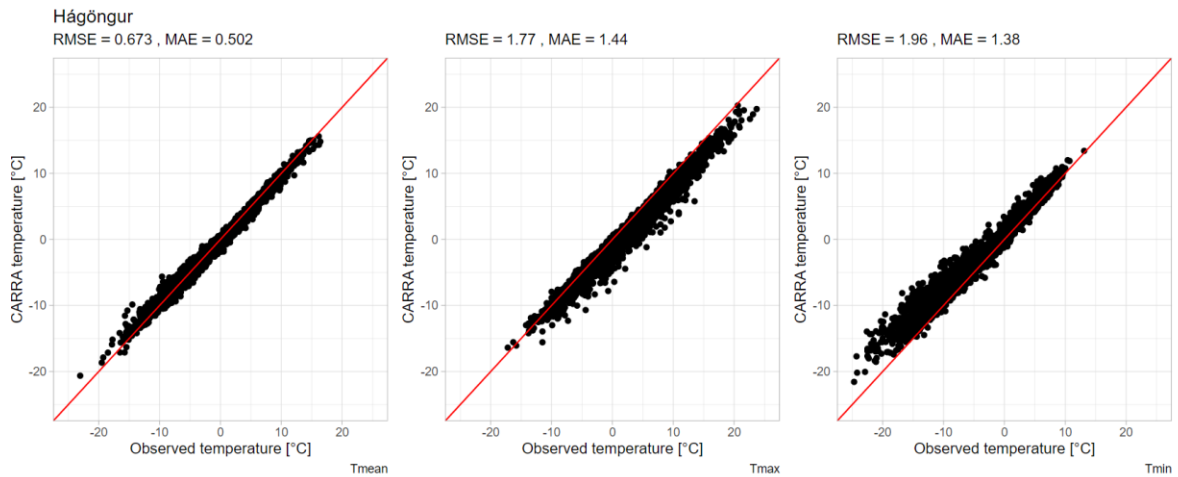


Figure II.32 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Hágöngur automatic station. The RMSE and MAE (in °C) are shown above each panel.

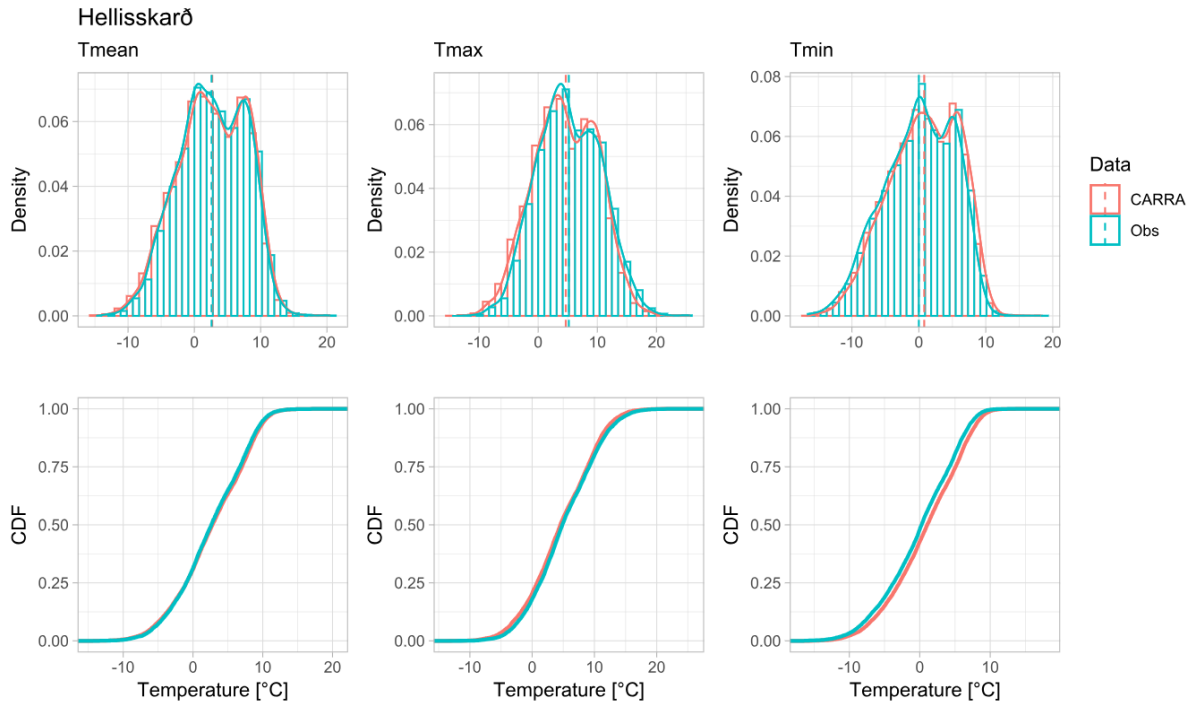


Figure II.33 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Hellisskarð automatic station.

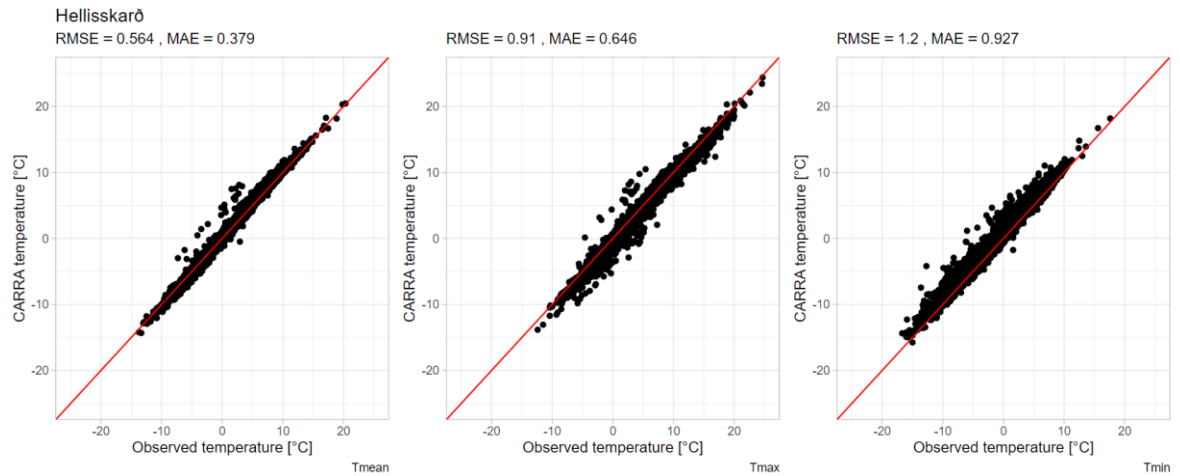


Figure II.34 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Hellisskarð automatic station. The RMSE and MAE (in °C) are shown above each panel.

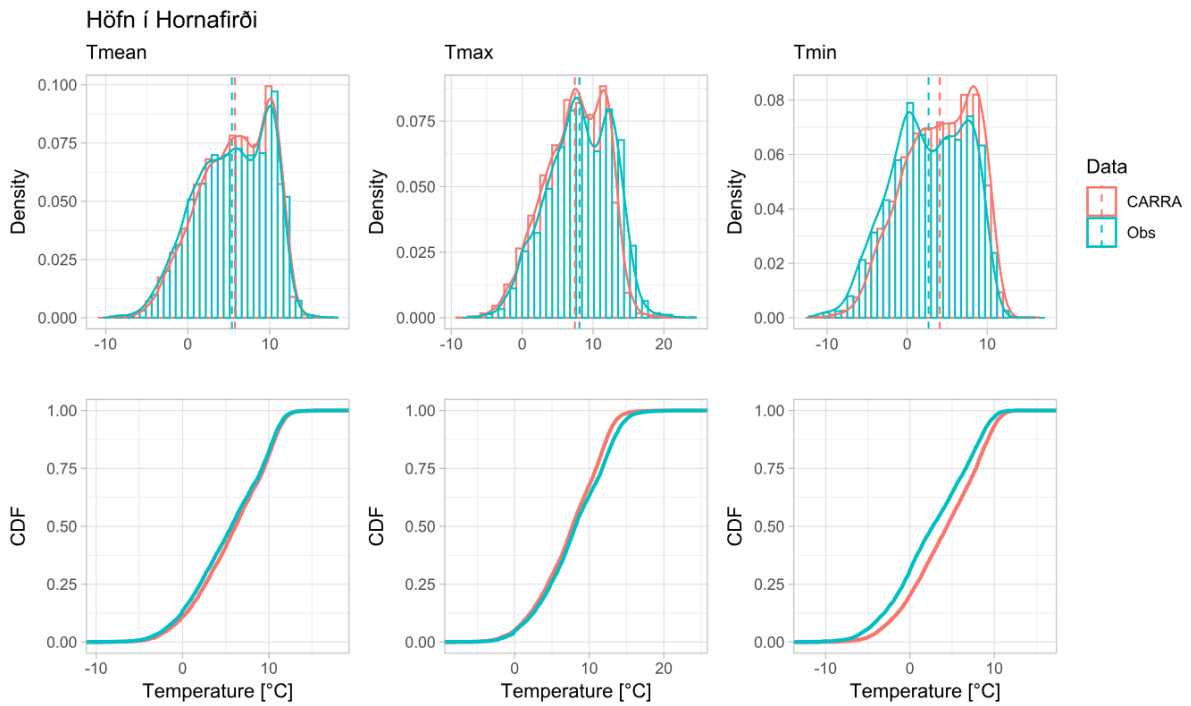


Figure II.35 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Höfn í Hornafirði automatic station.

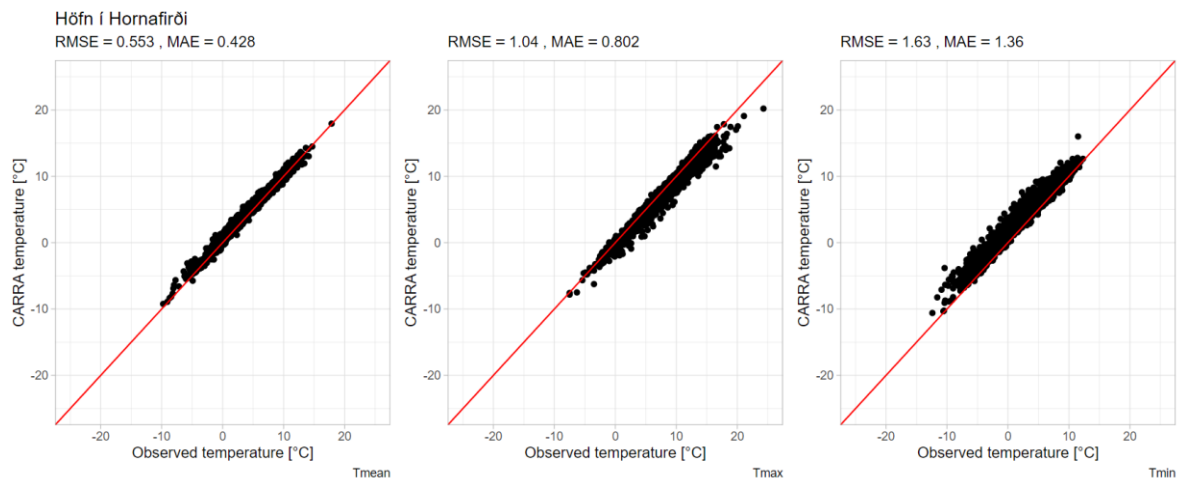


Figure II.36 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Höfn í Hornafirði automatic station. The RMSE and MAE (in °C) are shown above each panel.

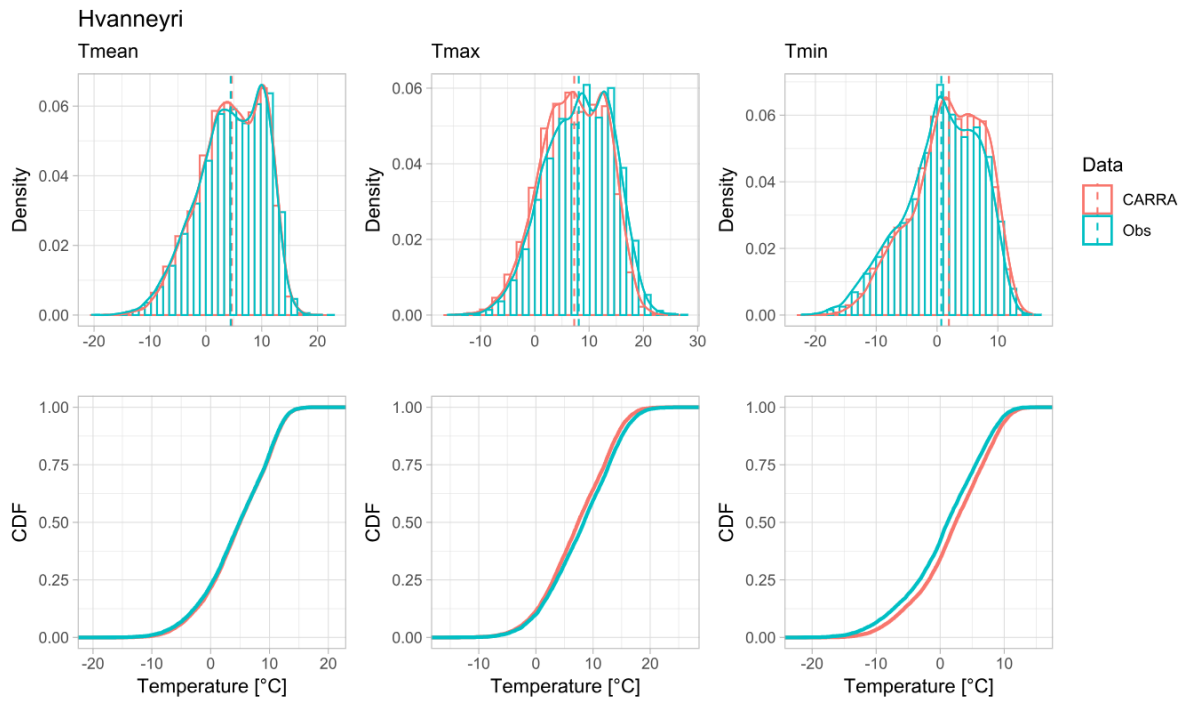


Figure II.37 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Hvanneyri automatic station.

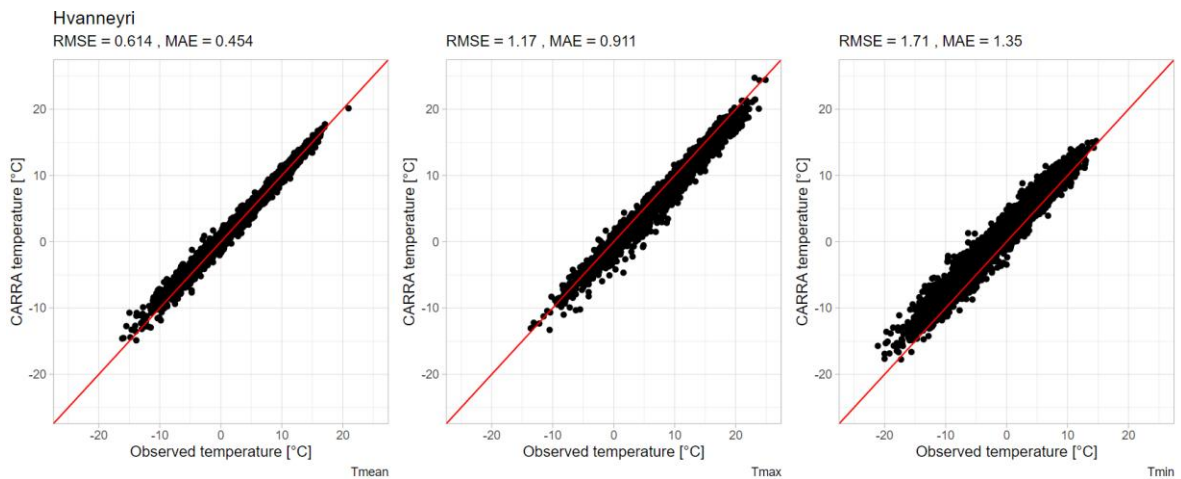


Figure II.38 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Hvanneyri automatic station. The RMSE and MAE (in °C) are shown above each panel.

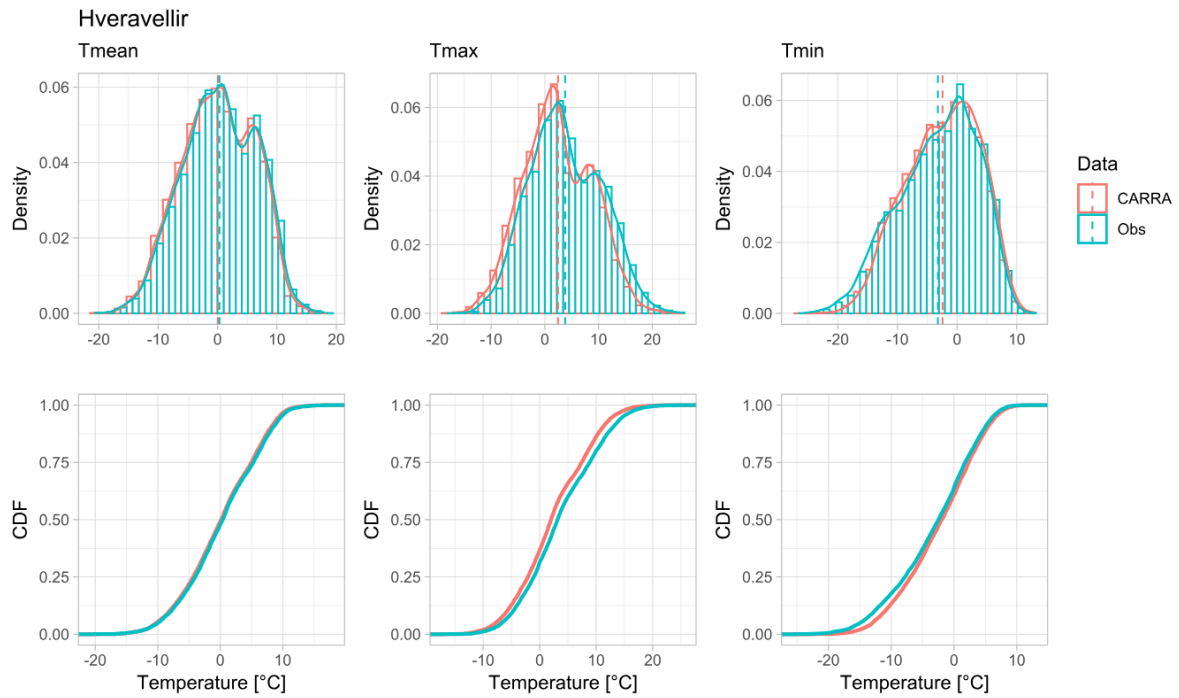


Figure II.39 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Hveravellir automatic station.

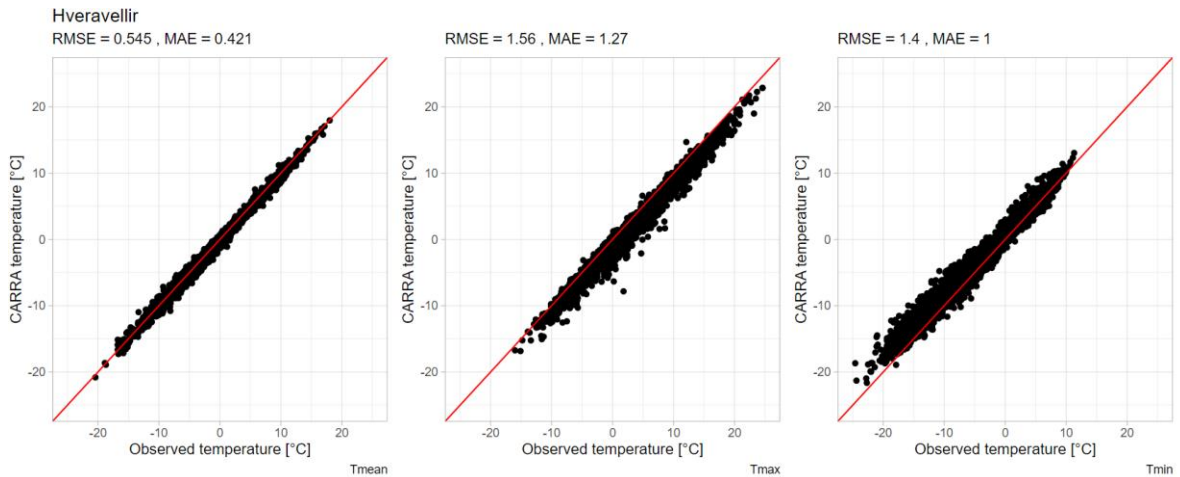


Figure II.40 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Hveravellir automatic station. The RMSE and MAE (in °C) are shown above each panel.

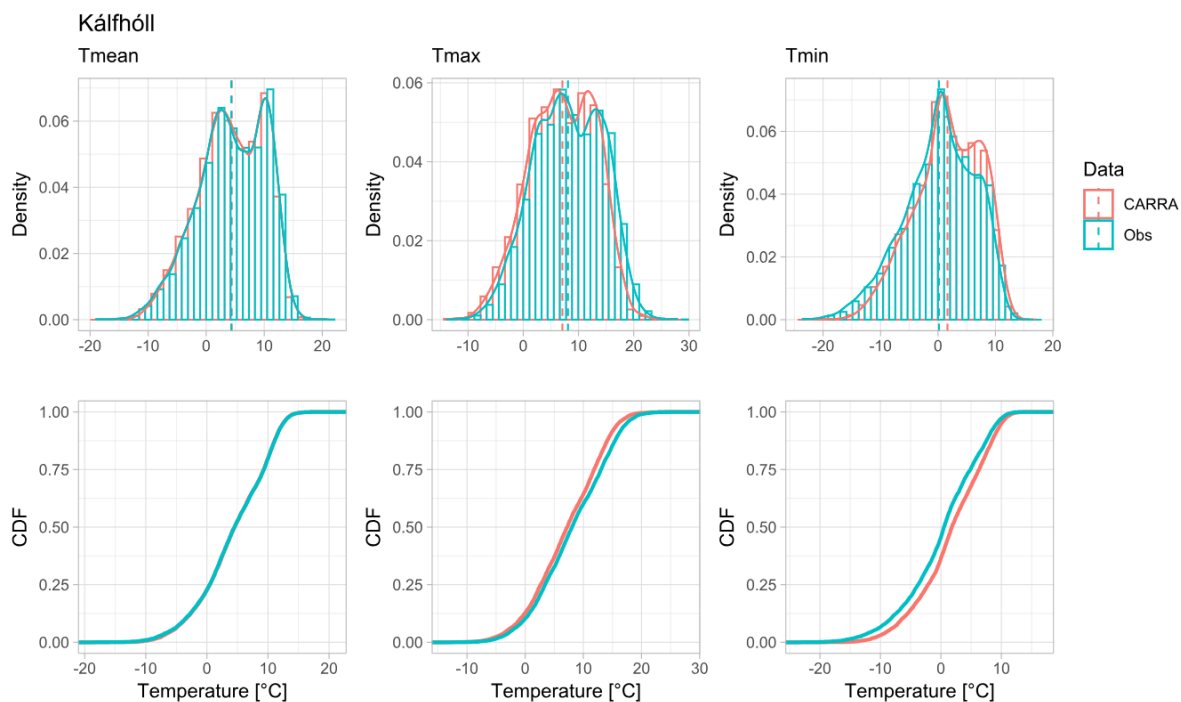


Figure II.41 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Kálfhóll automatic station.

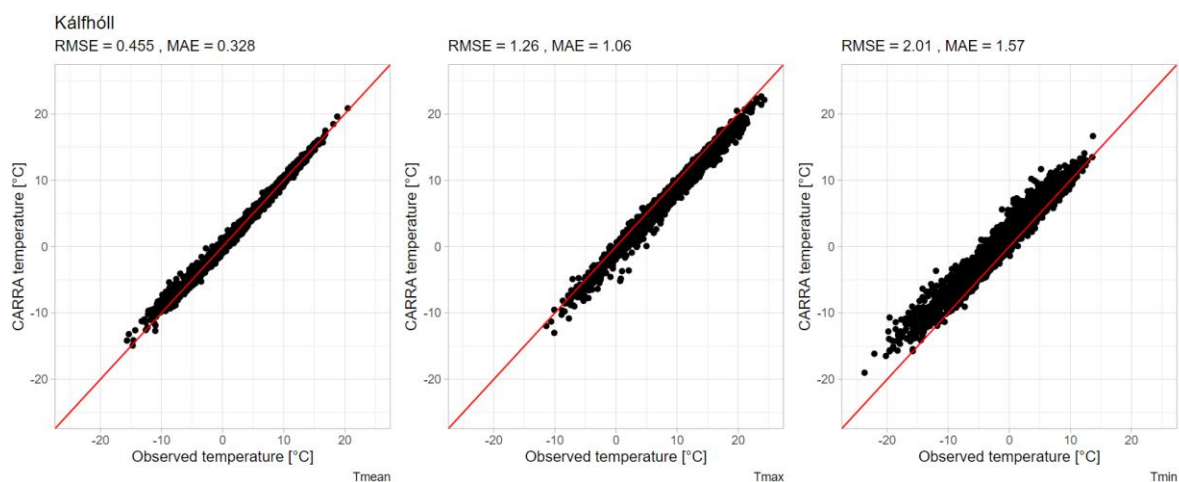


Figure II.42 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Kálfhóll automatic station. The RMSE and MAE (in °C) are shown above each panel.

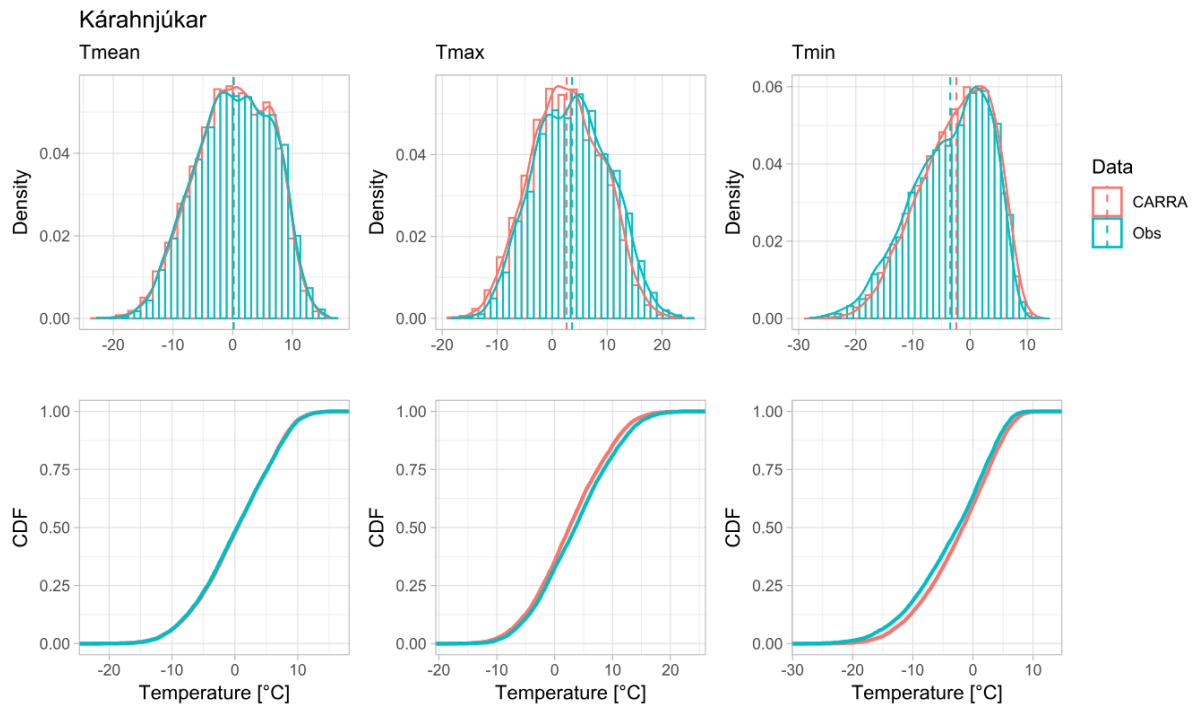


Figure II.43 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Kárahnjúkar automatic station.

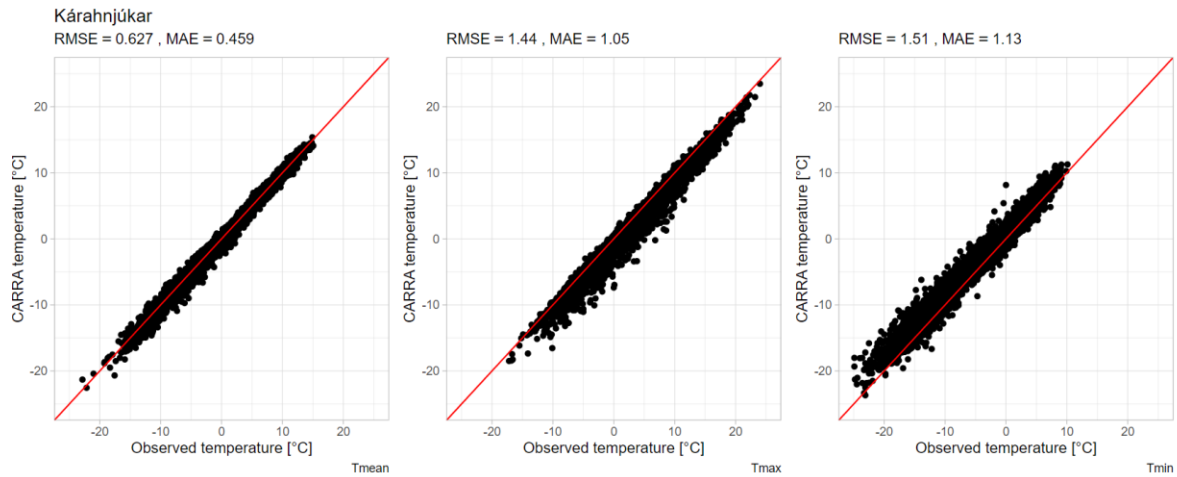


Figure II.44 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Kárahnjúkar automatic station. The RMSE and MAE (in °C) are shown above each panel.

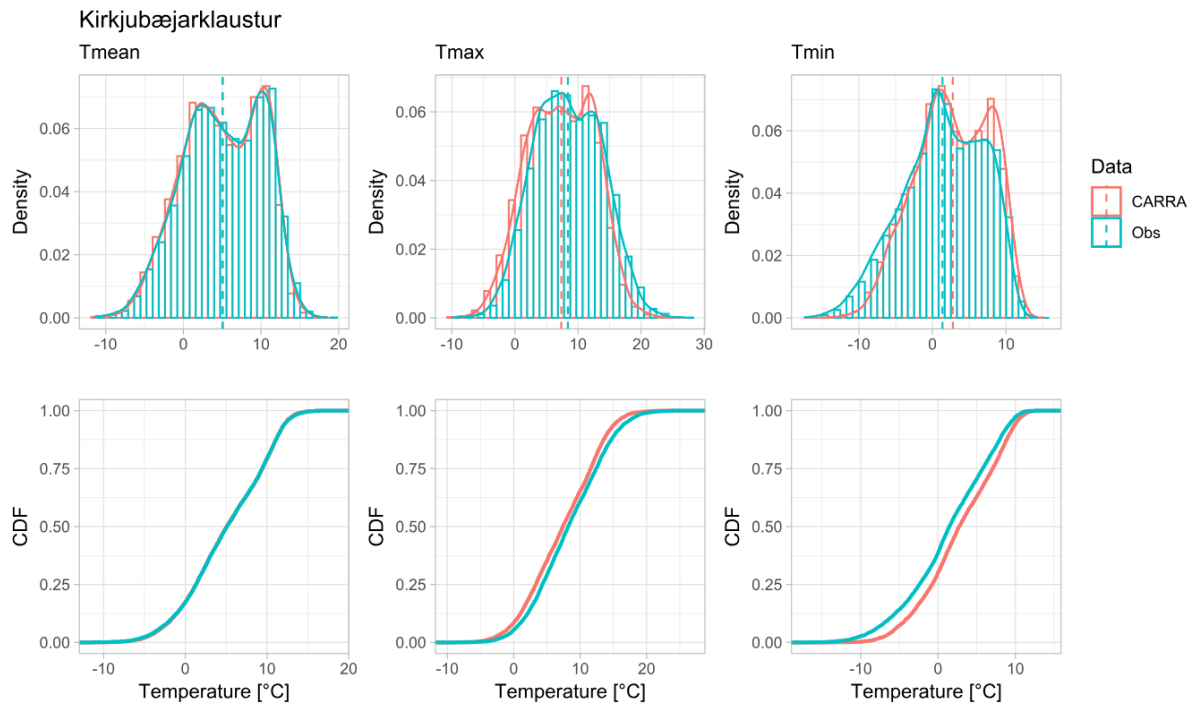


Figure II.45 —1 Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Kirkjubæjarklaustur automatic station.

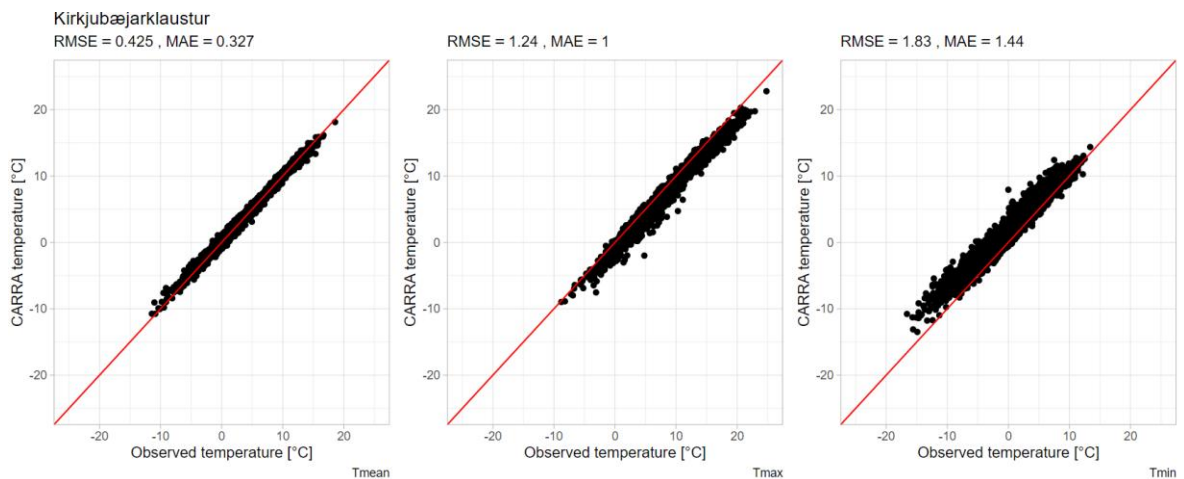


Figure II.46 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Kirkjubæjarklaustur automatic station. The RMSE and MAE (in °C) are shown above each panel.

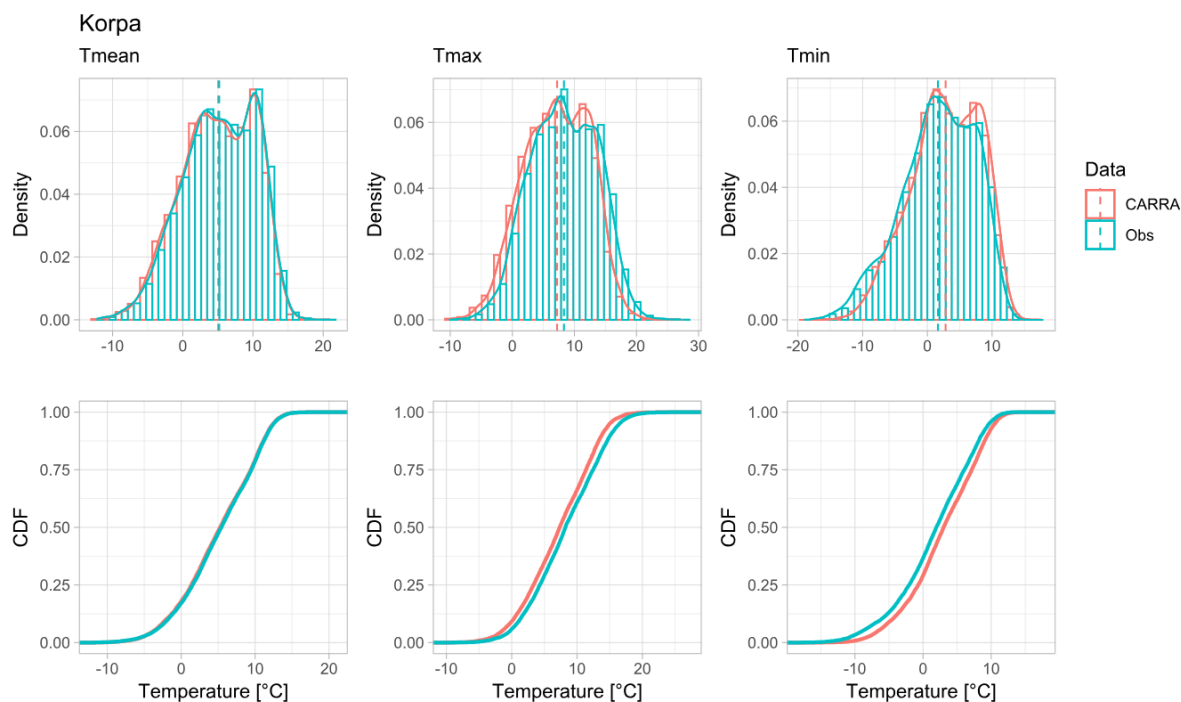


Figure II.47 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Korpa automatic station.

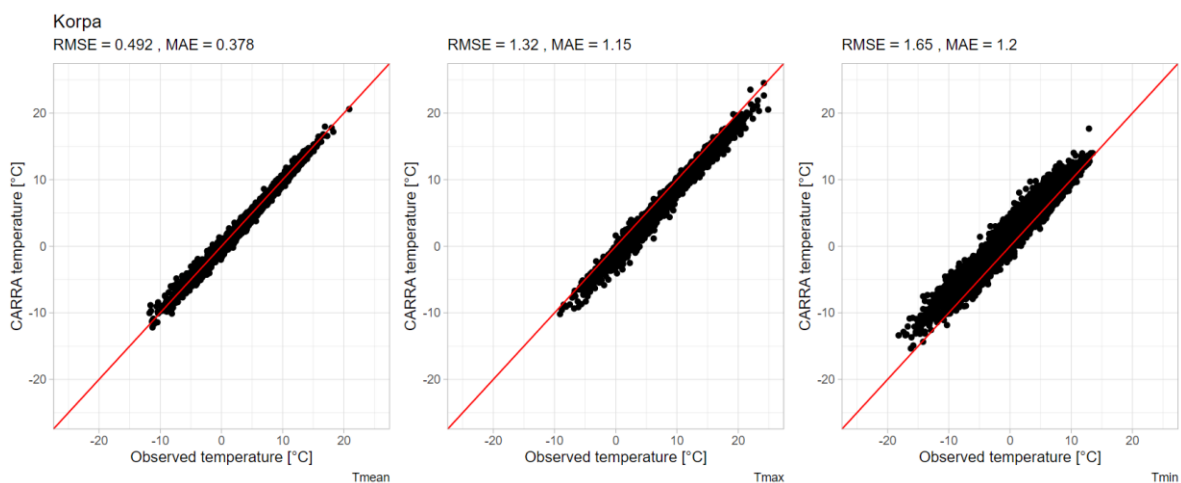


Figure II.48 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Korpa automatic station. The RMSE and MAE (in °C) are shown above each panel.

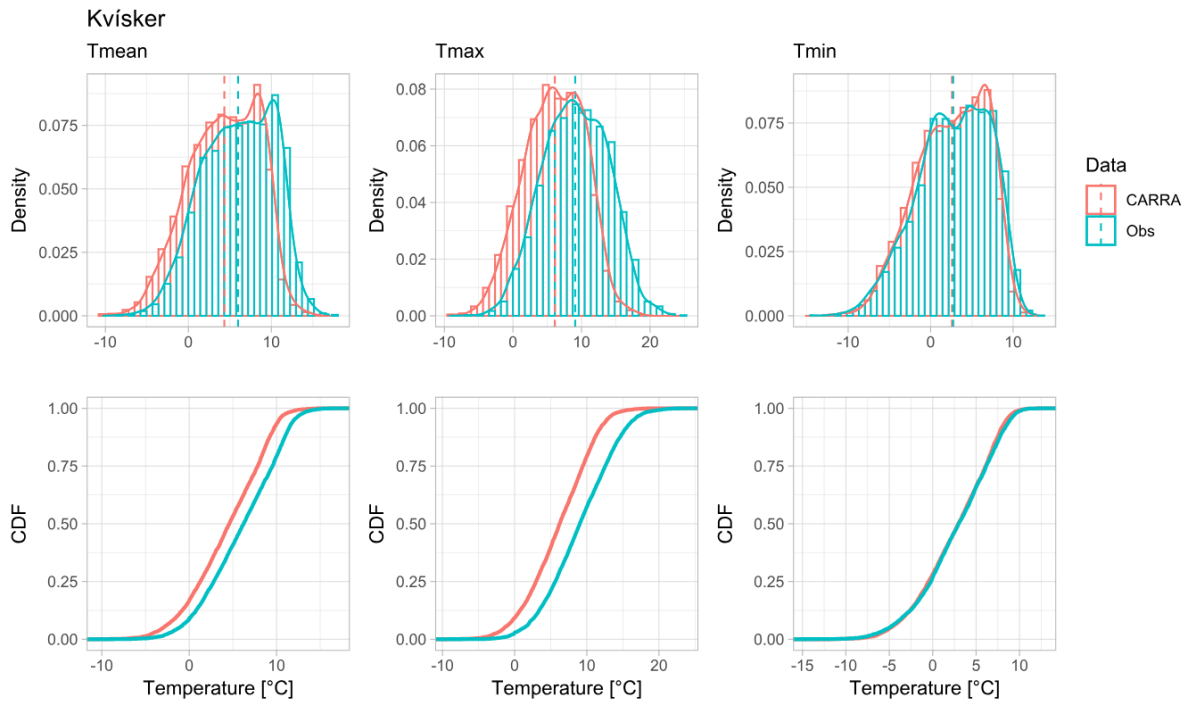


Figure II.49 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Kvisker automatic station.

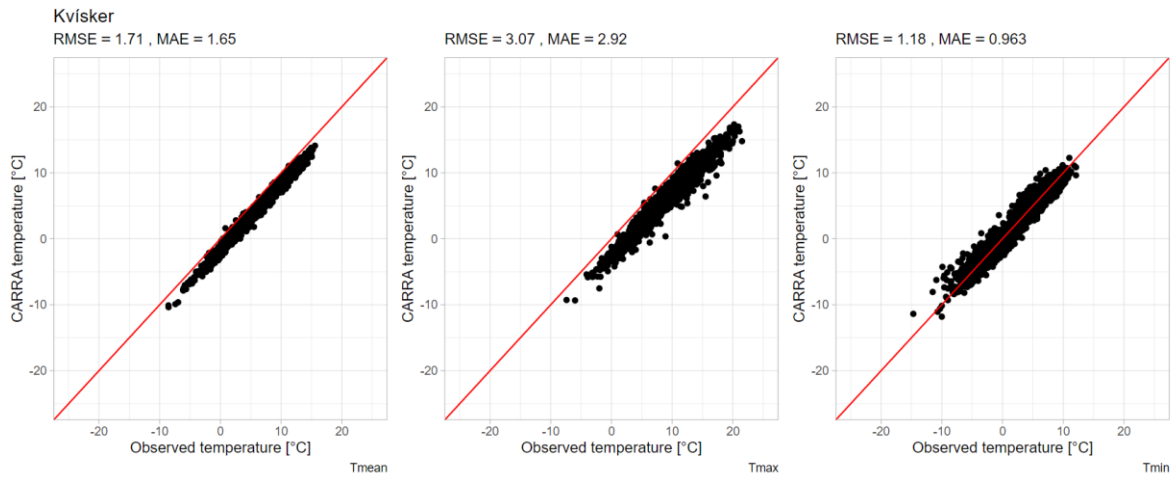


Figure II.50 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Kvisker automatic station. The RMSE and MAE (in °C) are shown above each panel.

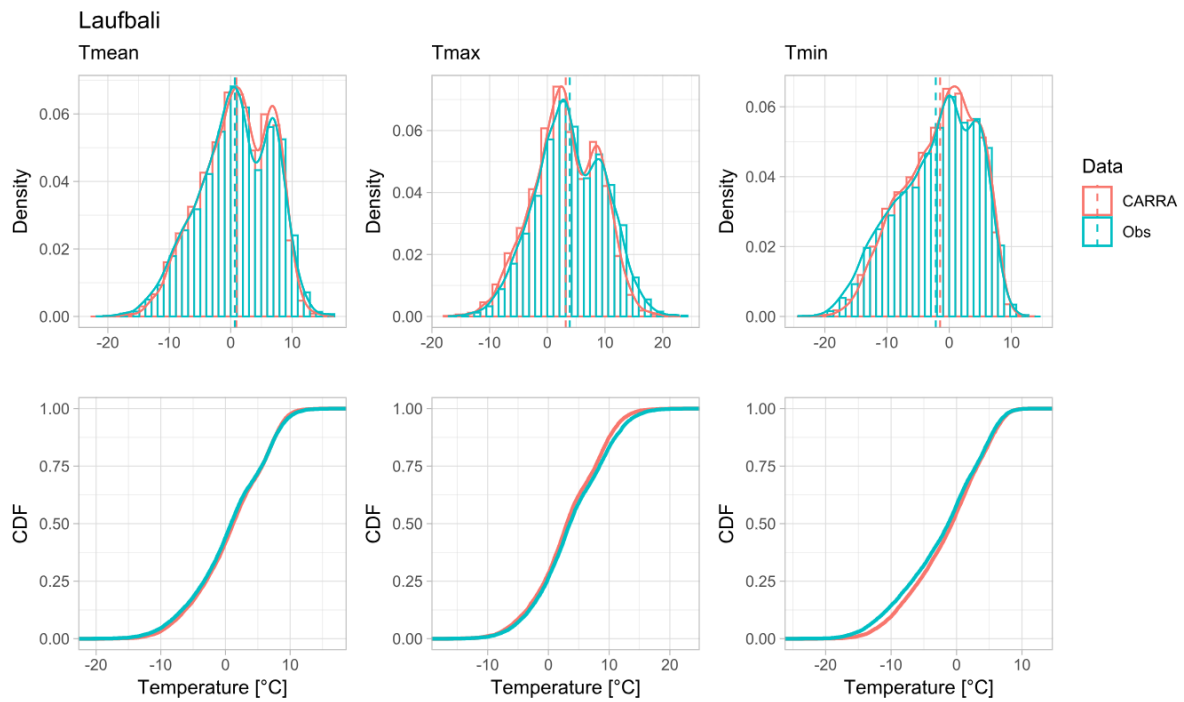


Figure II.51 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Laufbali automatic station.

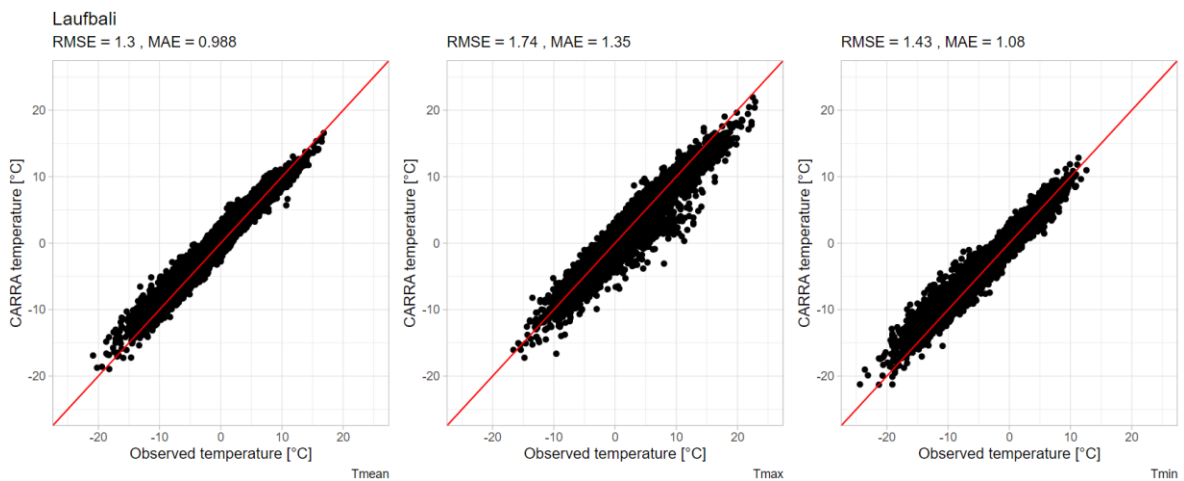


Figure II.52 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Laufbali automatic station. The RMSE and MAE (in °C) are shown above each panel.

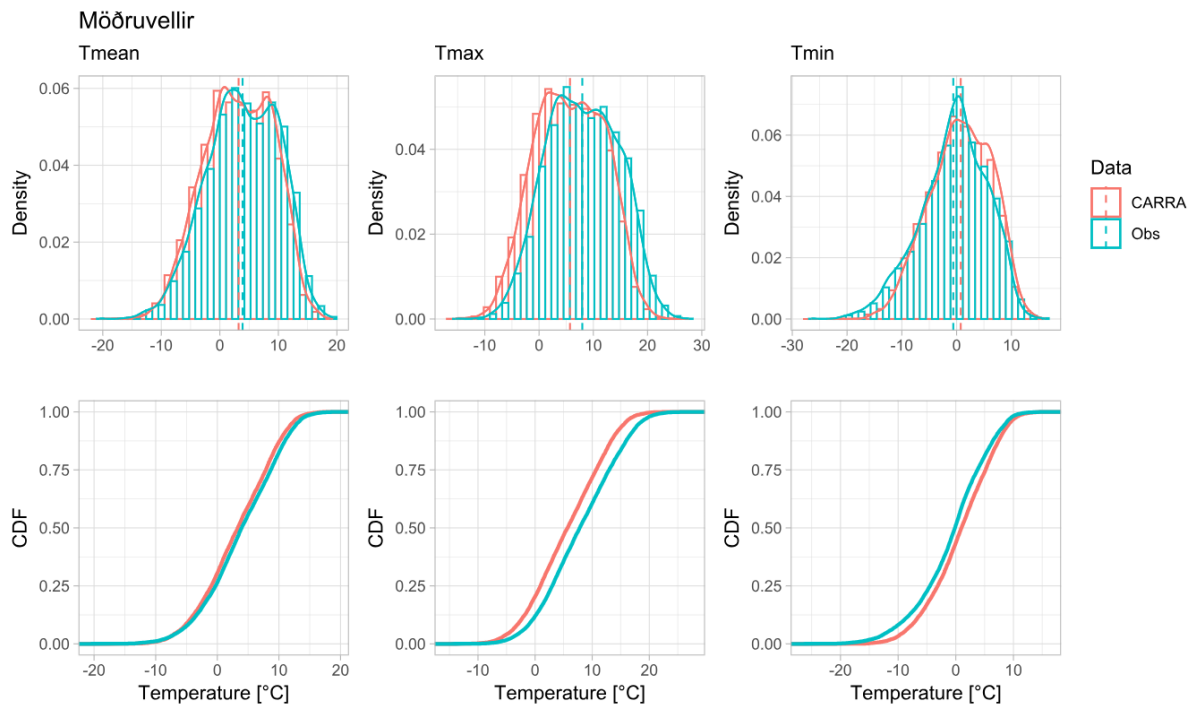


Figure II.53 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Möðruvellir automatic station.

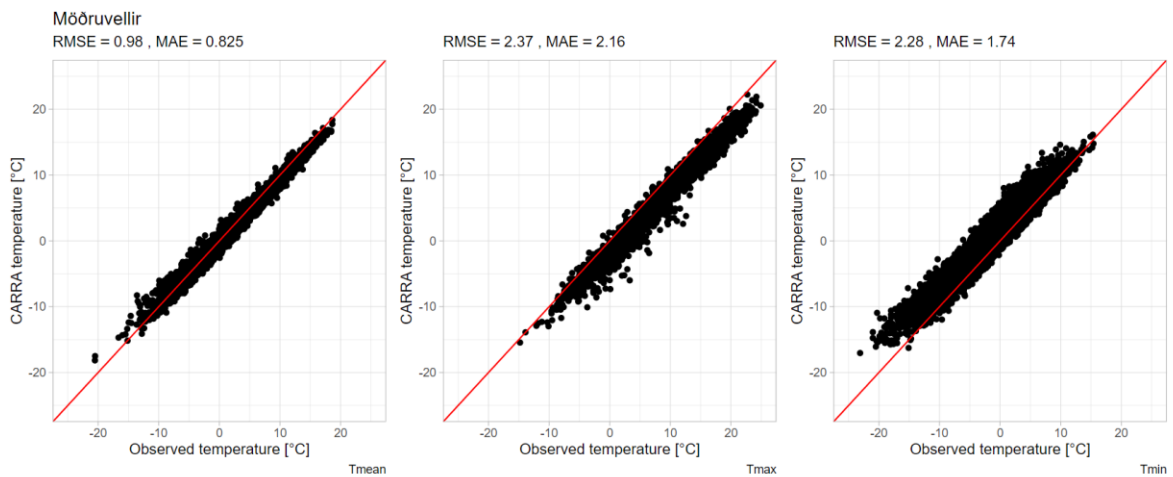


Figure II.54 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Möðruvellir automatic station. The RMSE and MAE (in °C) are shown above each panel.

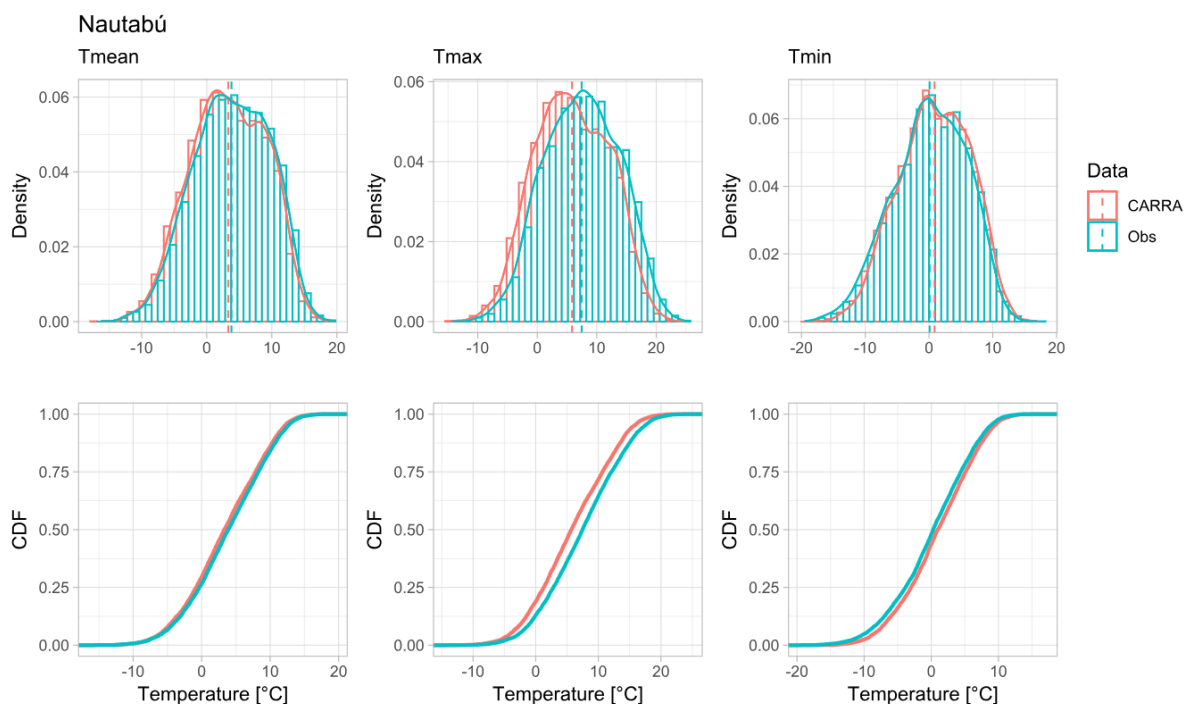


Figure II.55 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Nautabú automatic station.

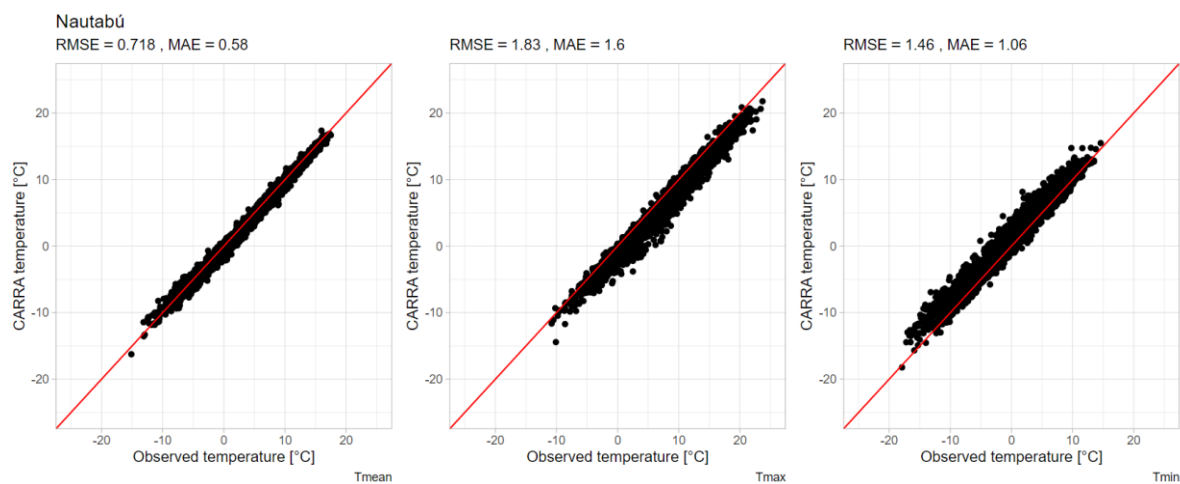


Figure II.56 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Nautabú automatic station. The RMSE and MAE (in °C) are shown above each panel.

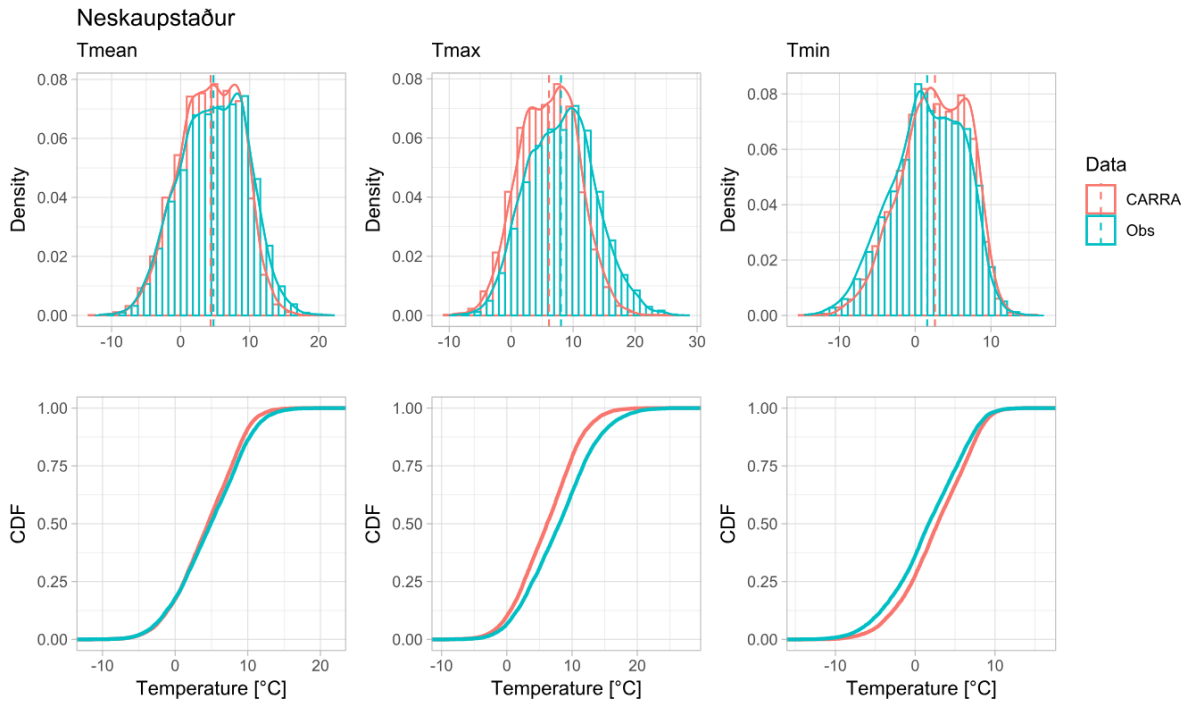


Figure II.57 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Neskaupsstaður automatic station.

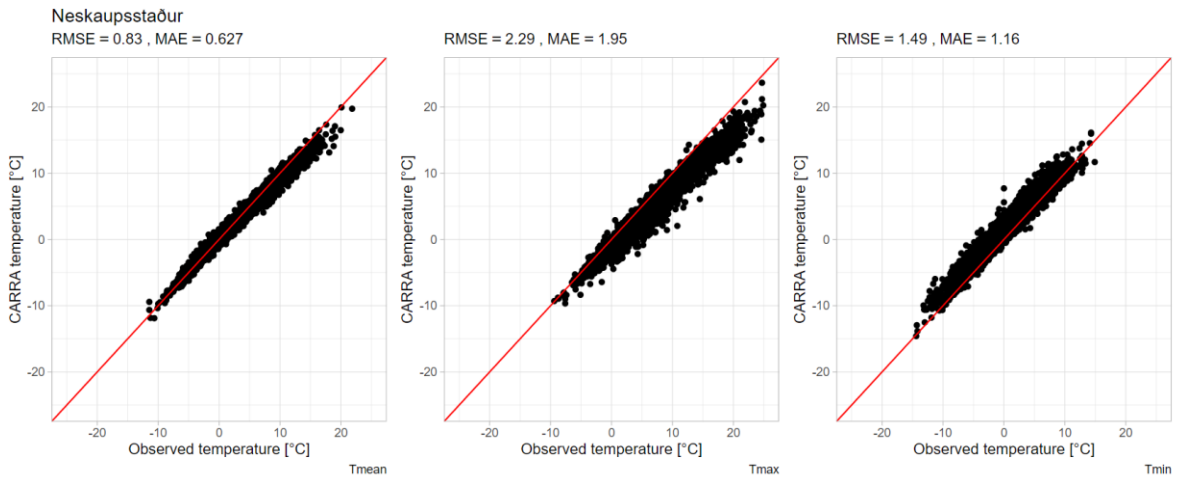


Figure II.58 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Neskaupsstaður automatic station. The RMSE and MAE (in °C) are shown above each panel.

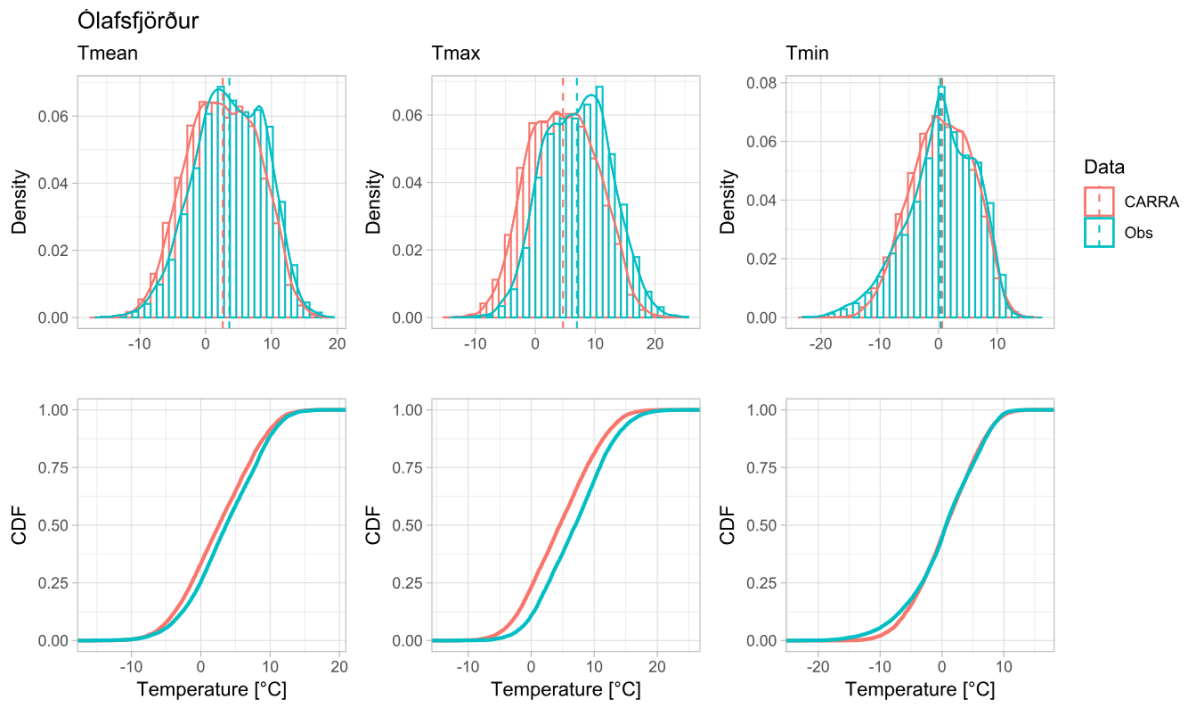


Figure II.59 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Ólafsfjörður automatic station.

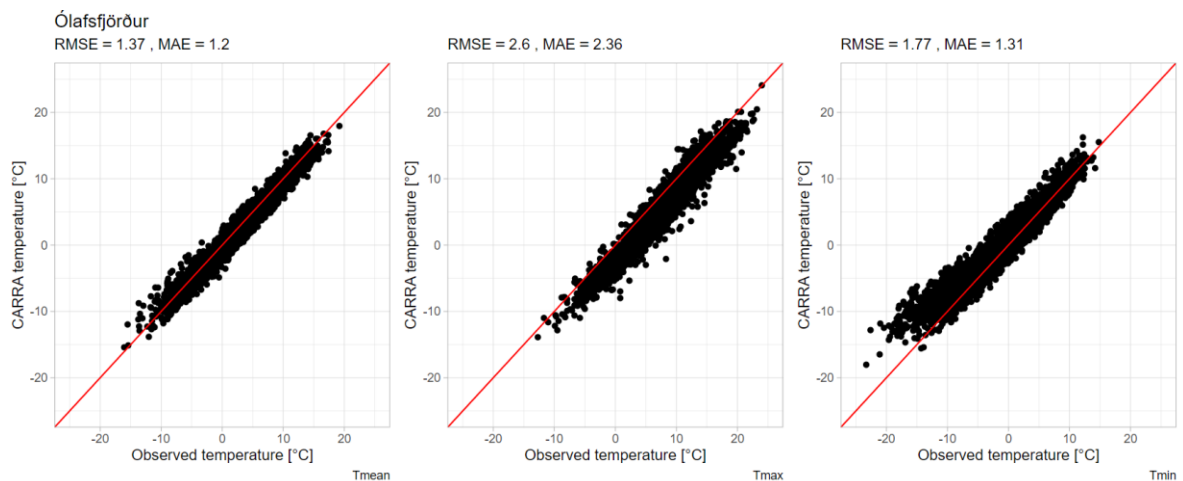


Figure II.60 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Ólafsfjörður automatic station. The RMSE and MAE (in °C) are shown above each panel.

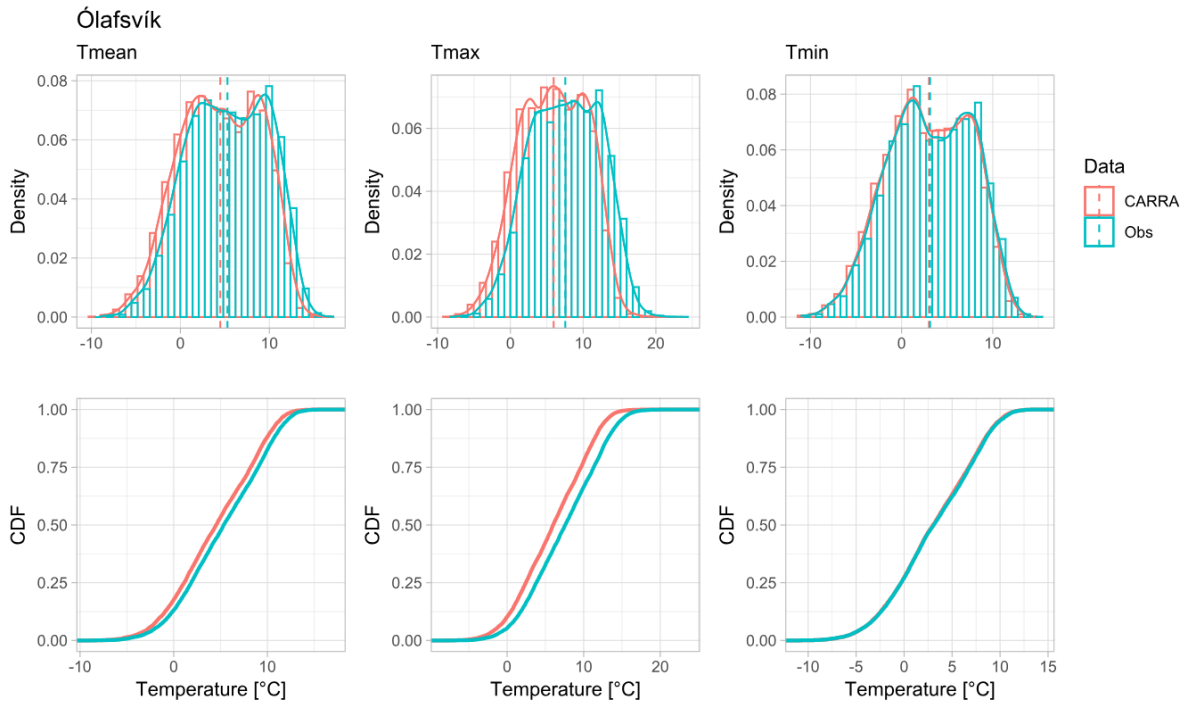


Figure II.61 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Ólafsvík automatic station.

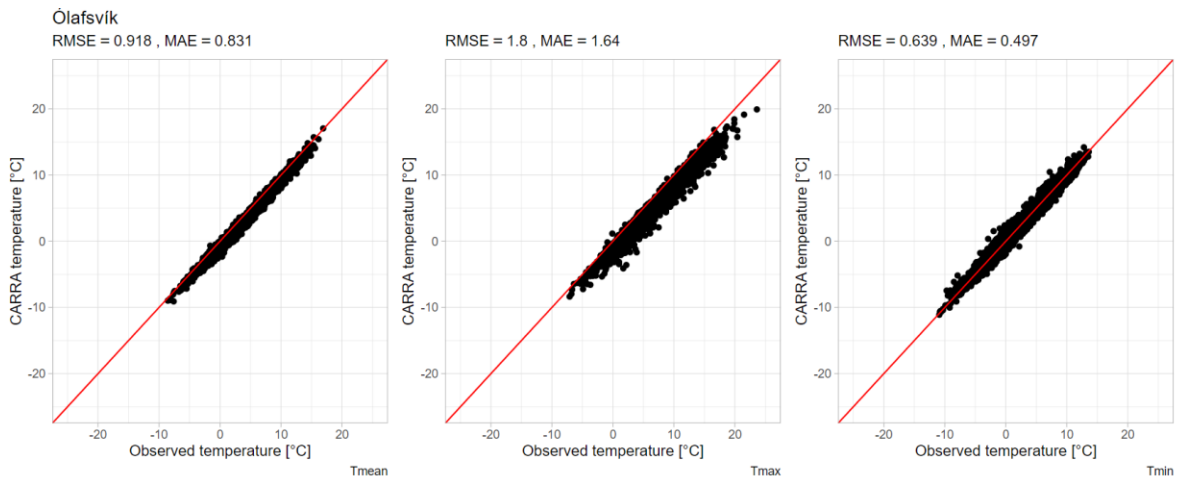


Figure II.62 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Ólafsvík automatic station. The RMSE and MAE (in °C) are shown above each panel.

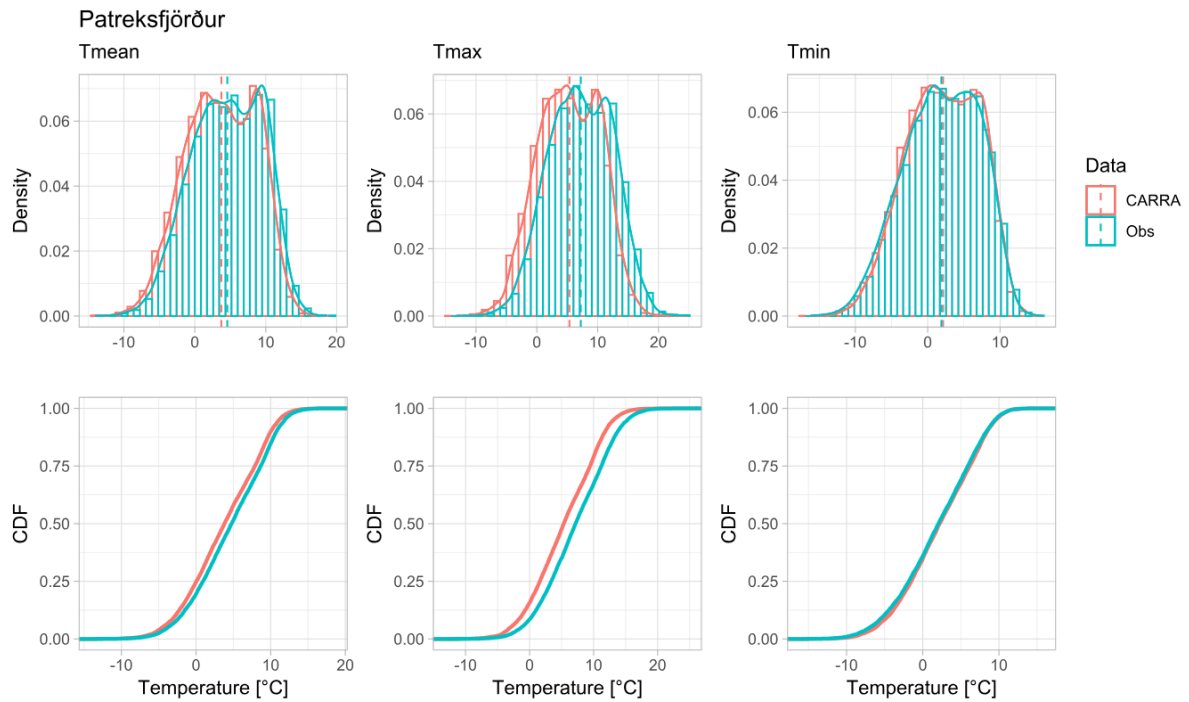


Figure II.63 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Patreksfjörður automatic station.

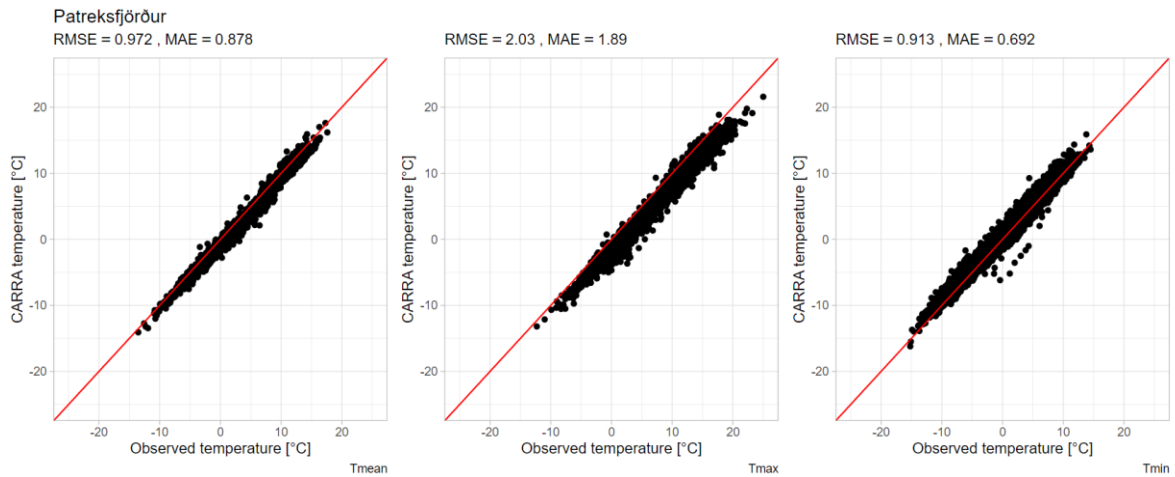


Figure II.64 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Patreksfjörður automatic station. The RMSE and MAE (in °C) are shown above each panel.

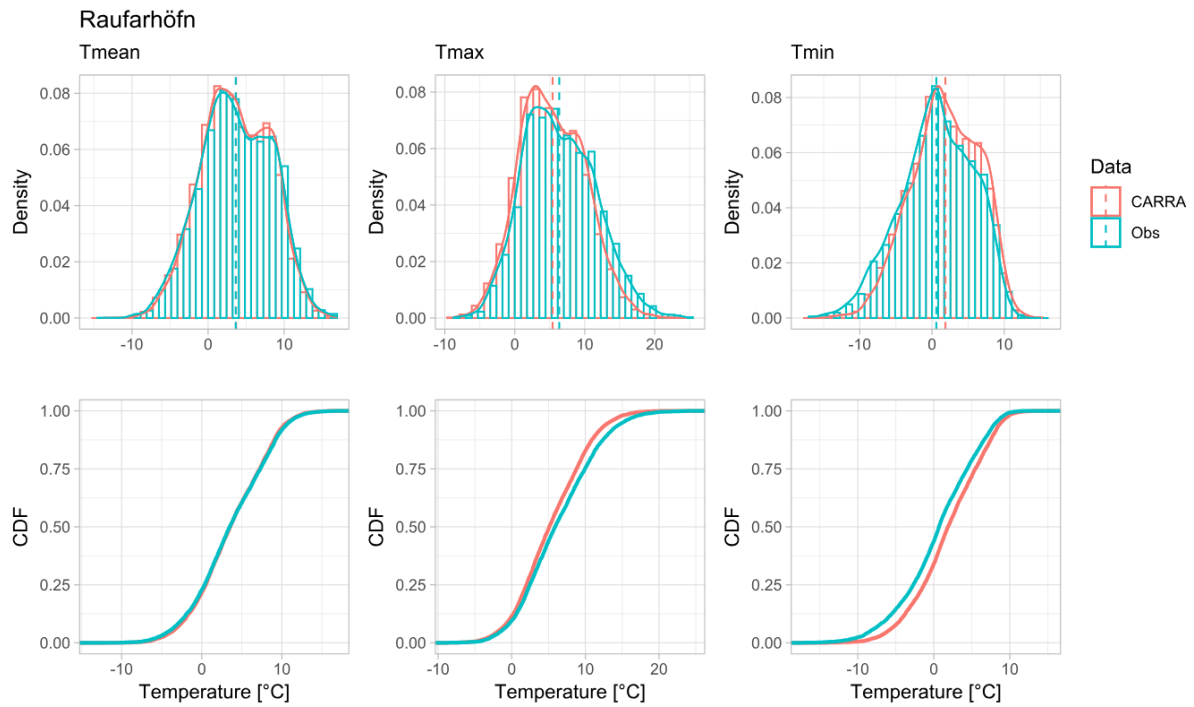


Figure II.65 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Raufarhöfn automatic station.

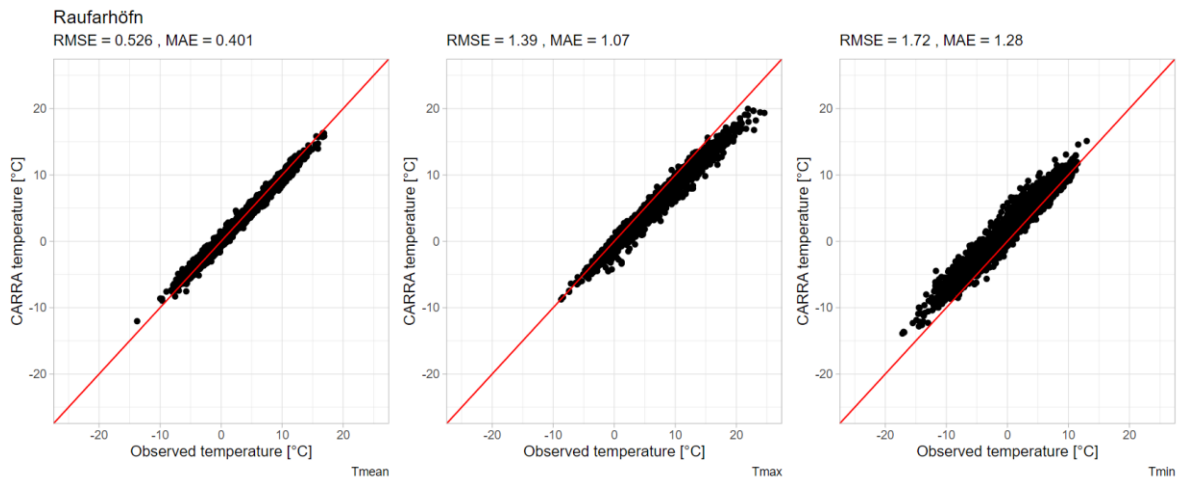


Figure II.66 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Raufarhöfn automatic station. The RMSE and MAE (in °C) are shown above each panel.

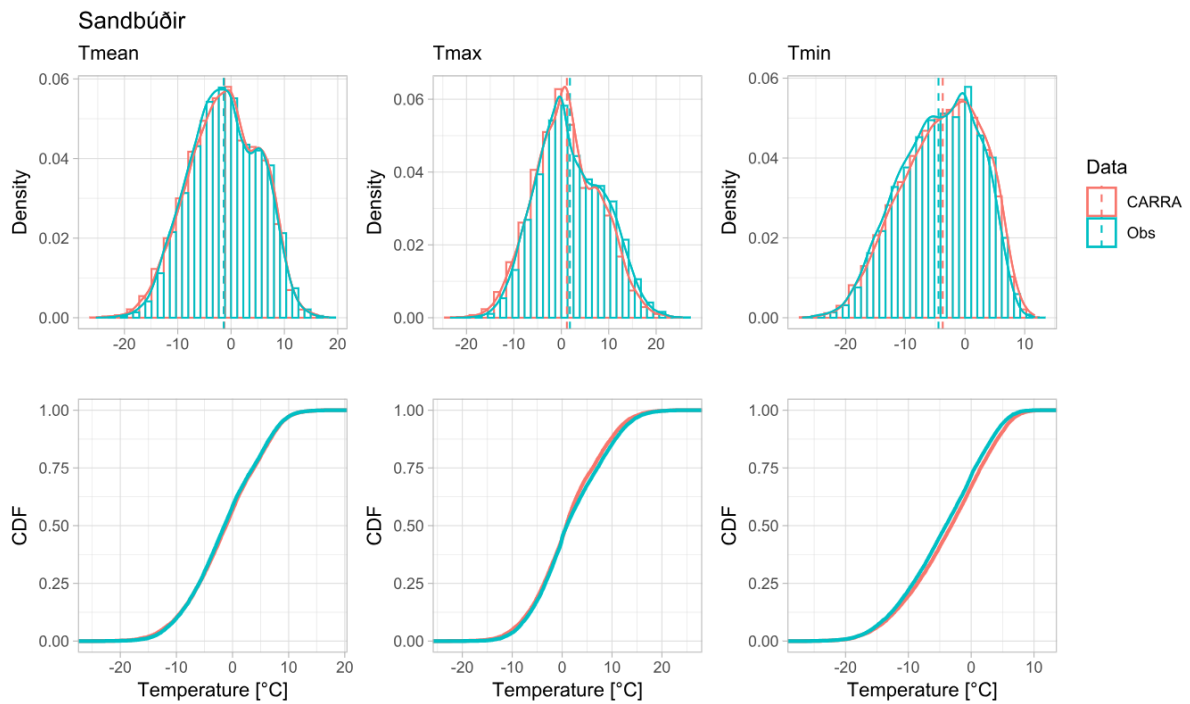


Figure II.67 —2 Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Sandbúðir automatic station.

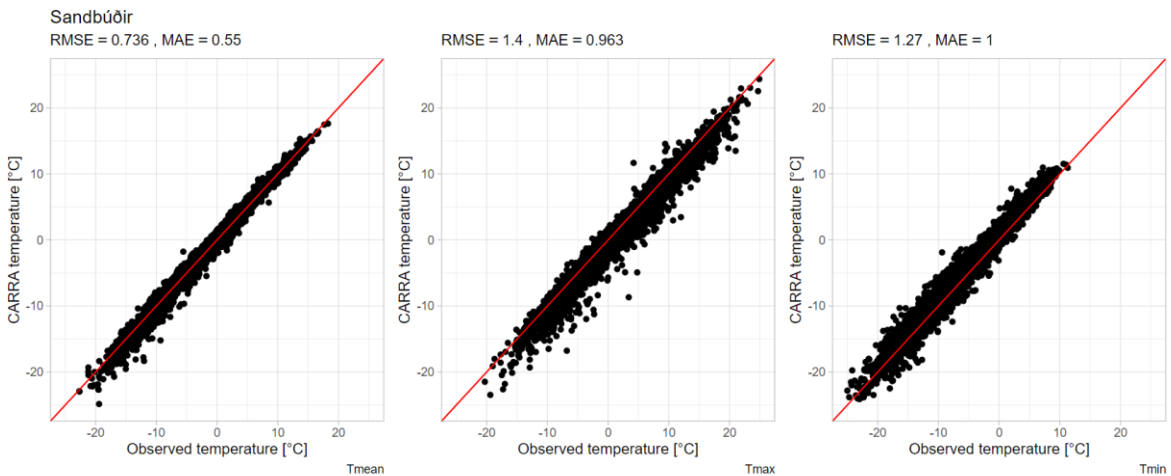


Figure II.68 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Sandbúðir automatic station. The RMSE and MAE (in °C) are shown above each panel.

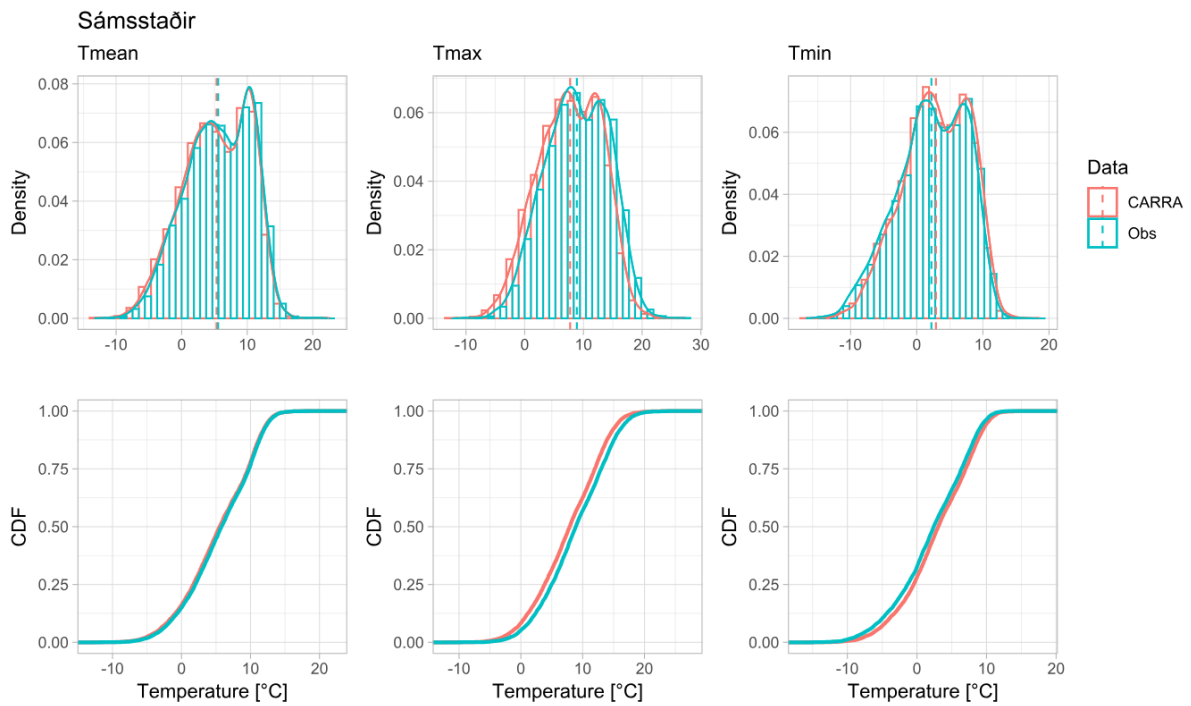


Figure II.69 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Samsstaðir automatic station.

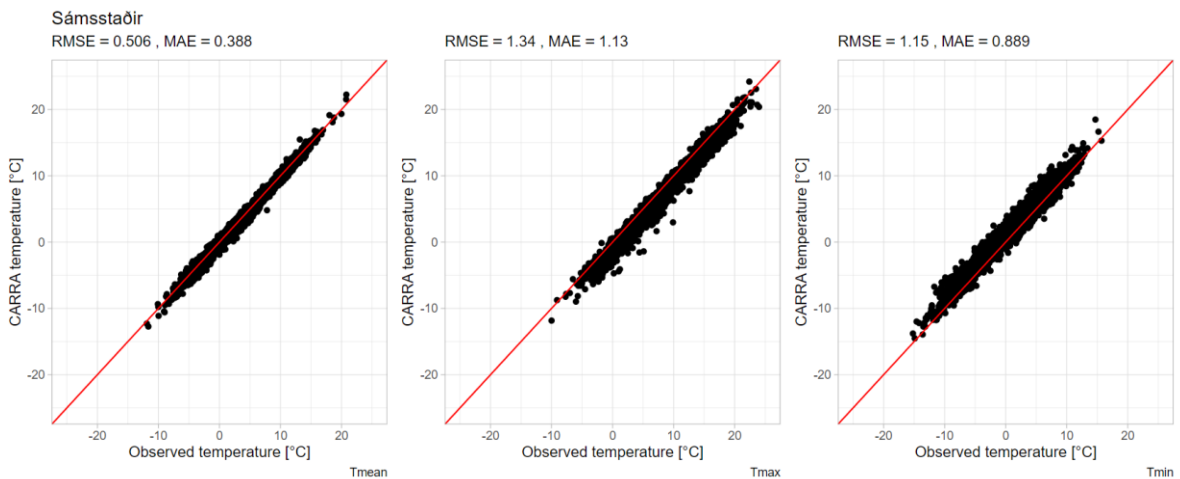


Figure II.70 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Samsstaðir automatic station. The RMSE and MAE (in °C) are shown above each panel.

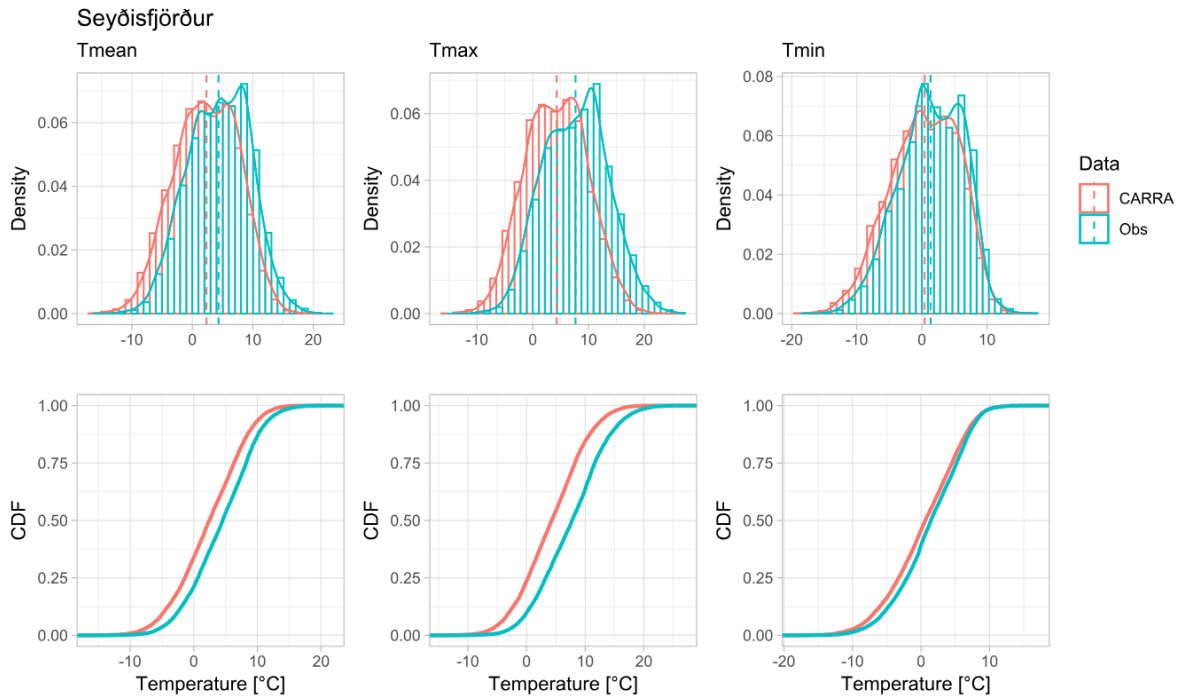


Figure II.71 —3 Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Seyðisfjörður automatic station.

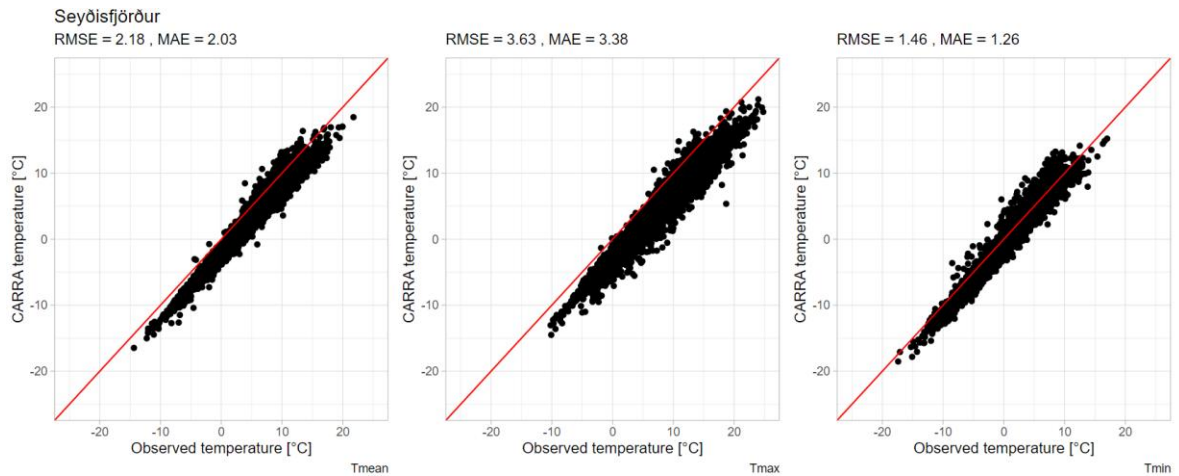


Figure II.72 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Seyðisfjörður automatic station. The RMSE and MAE (in °C) are shown above each panel.

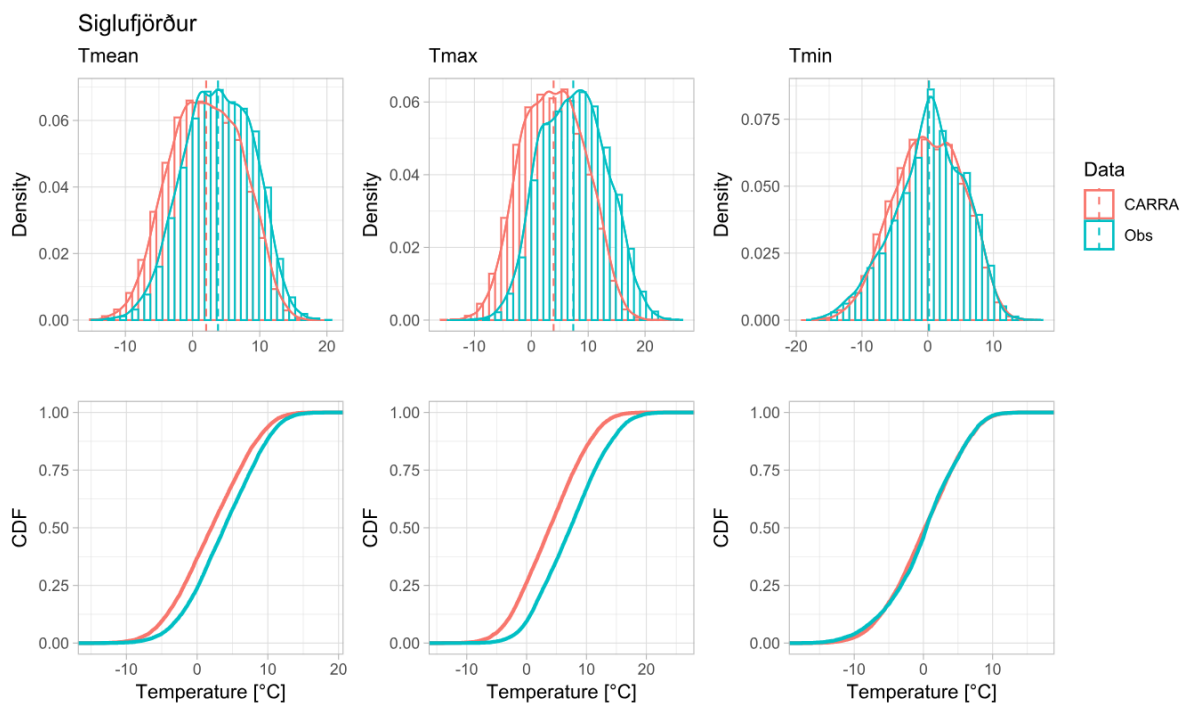


Figure II.73 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Siglufjörður automatic station.

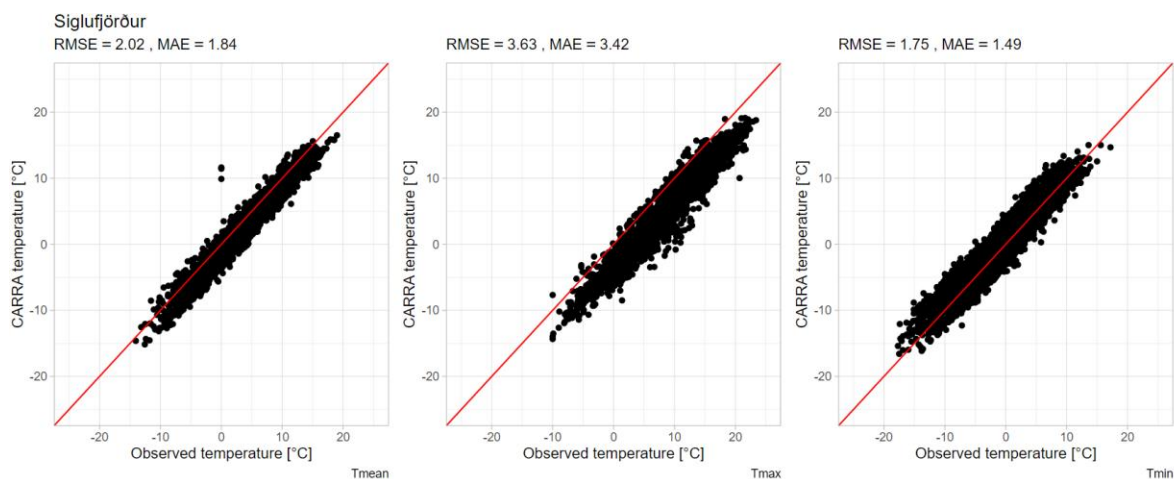


Figure II.74 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Siglufjörður automatic station. The RMSE and MAE (in °C) are shown above each panel.

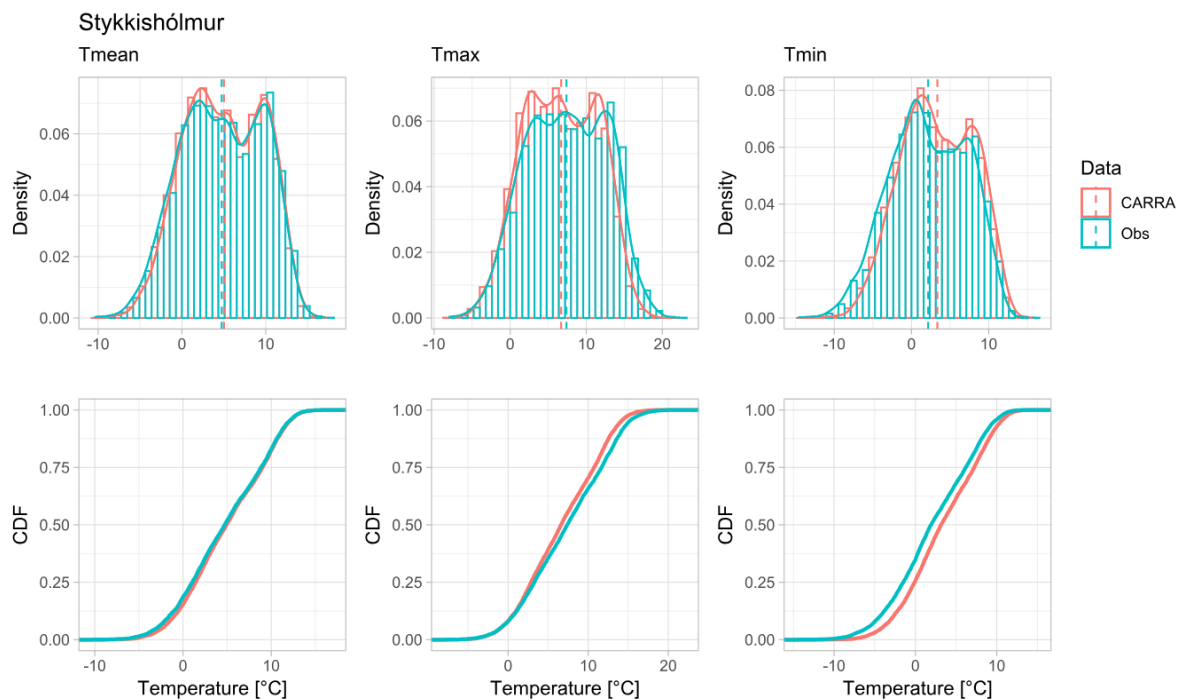


Figure II.75 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Stykkishólmur automatic station.

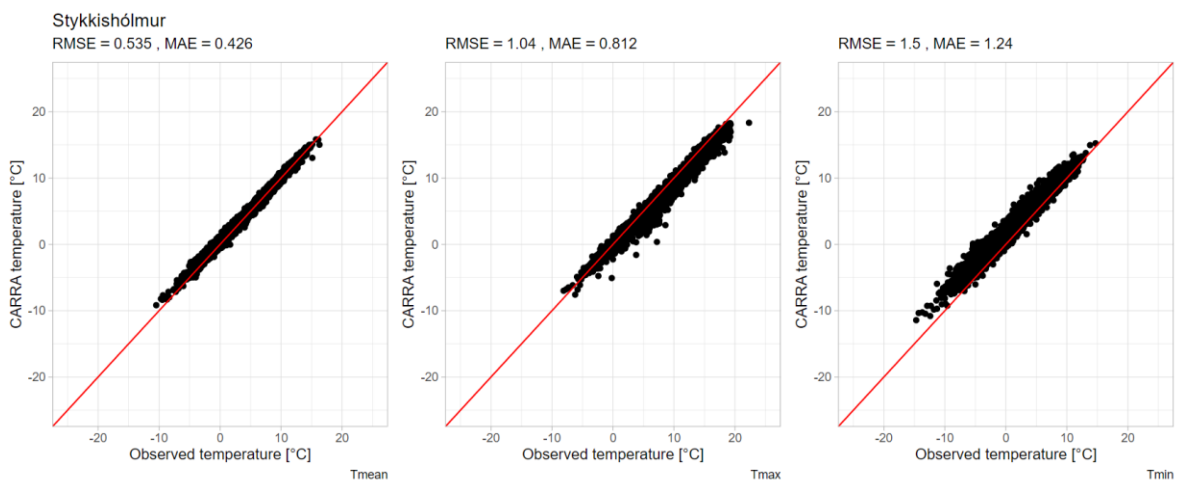


Figure II.76 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Stykkishólmur automatic station. The RMSE and MAE (in °C) are shown above each panel.

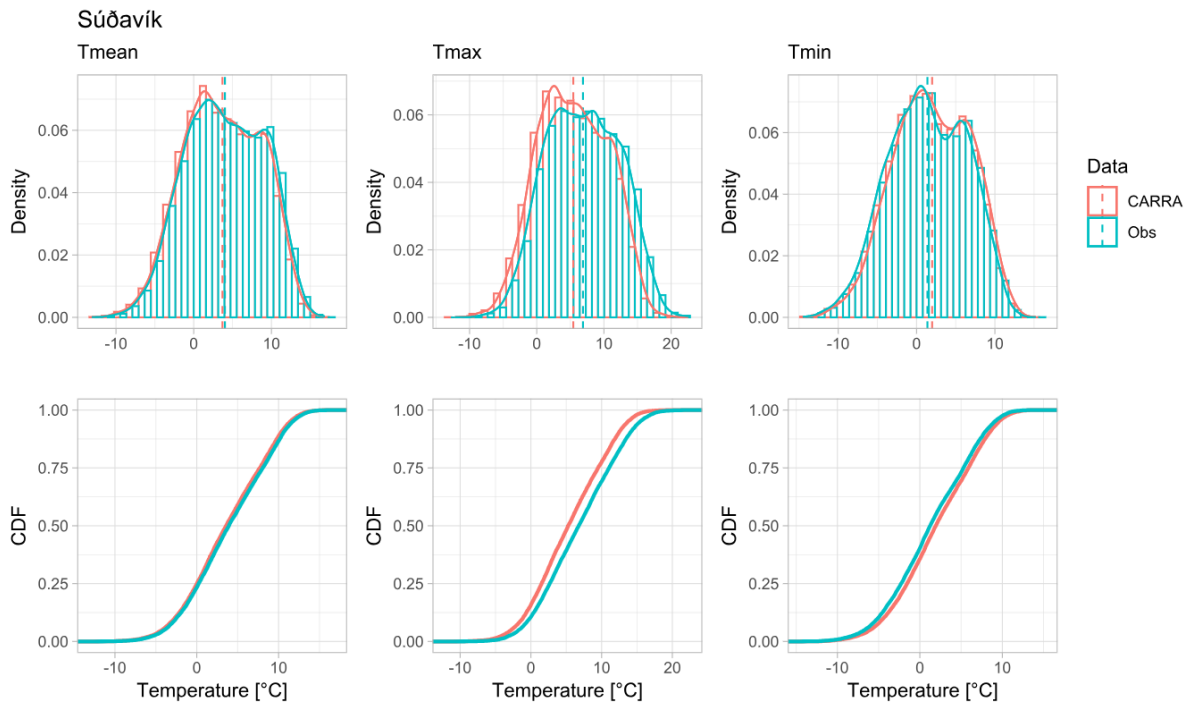


Figure II.77 —4 Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Súðavík automatic station.

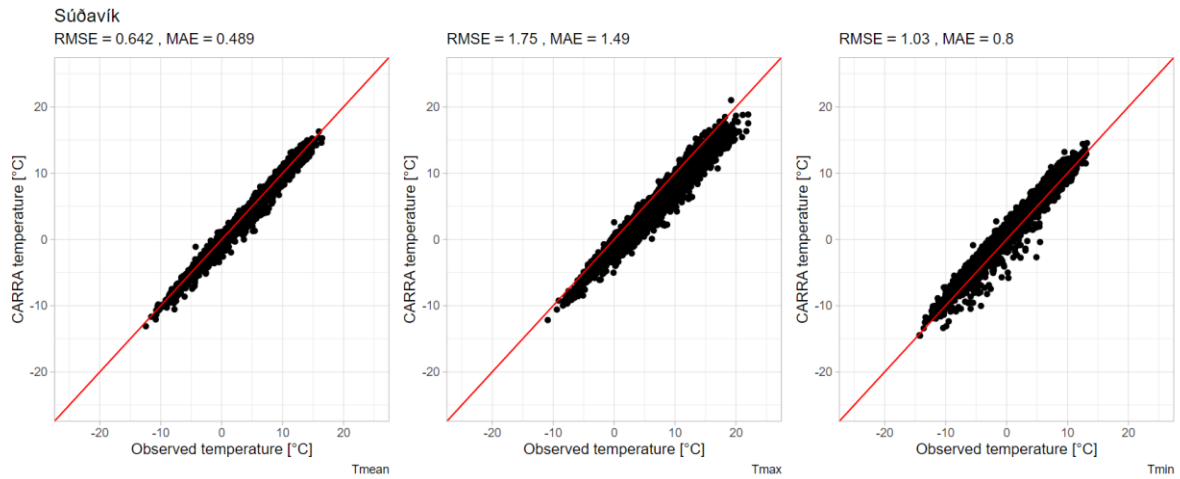


Figure II.78 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Súðavík automatic station. The RMSE and MAE (in °C) are shown above each panel.

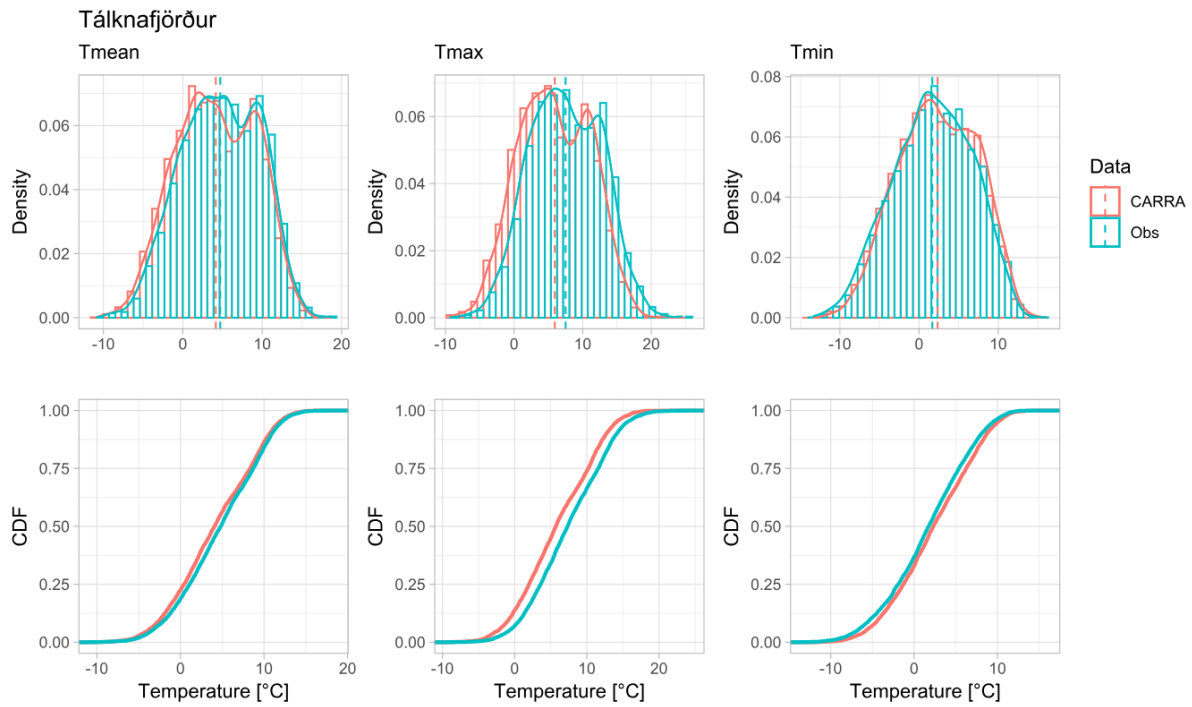


Figure II.79 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Tálknafjörður automatic station.

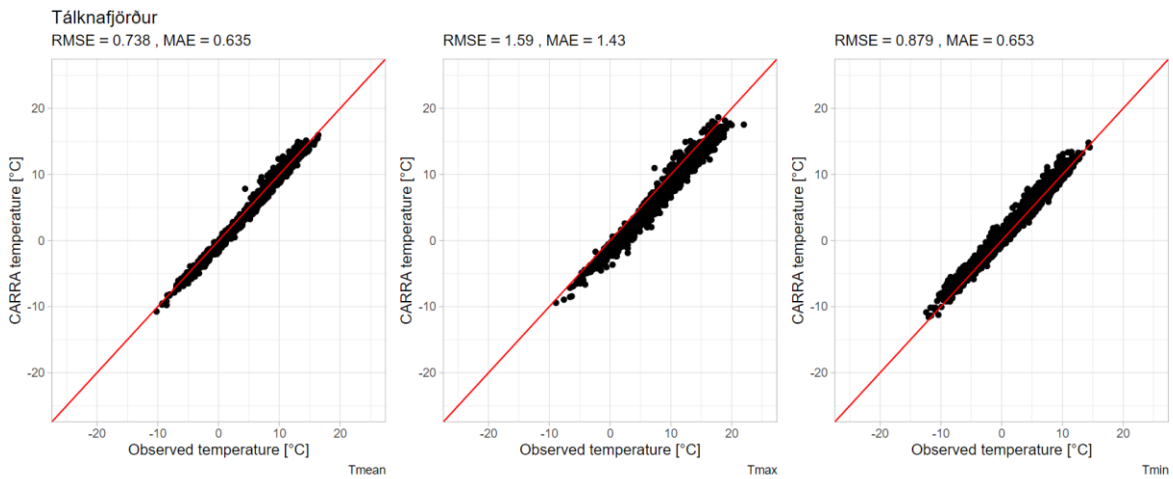


Figure II.80 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Tálknafjörður automatic station. The RMSE and MAE (in °C) are shown above each panel.

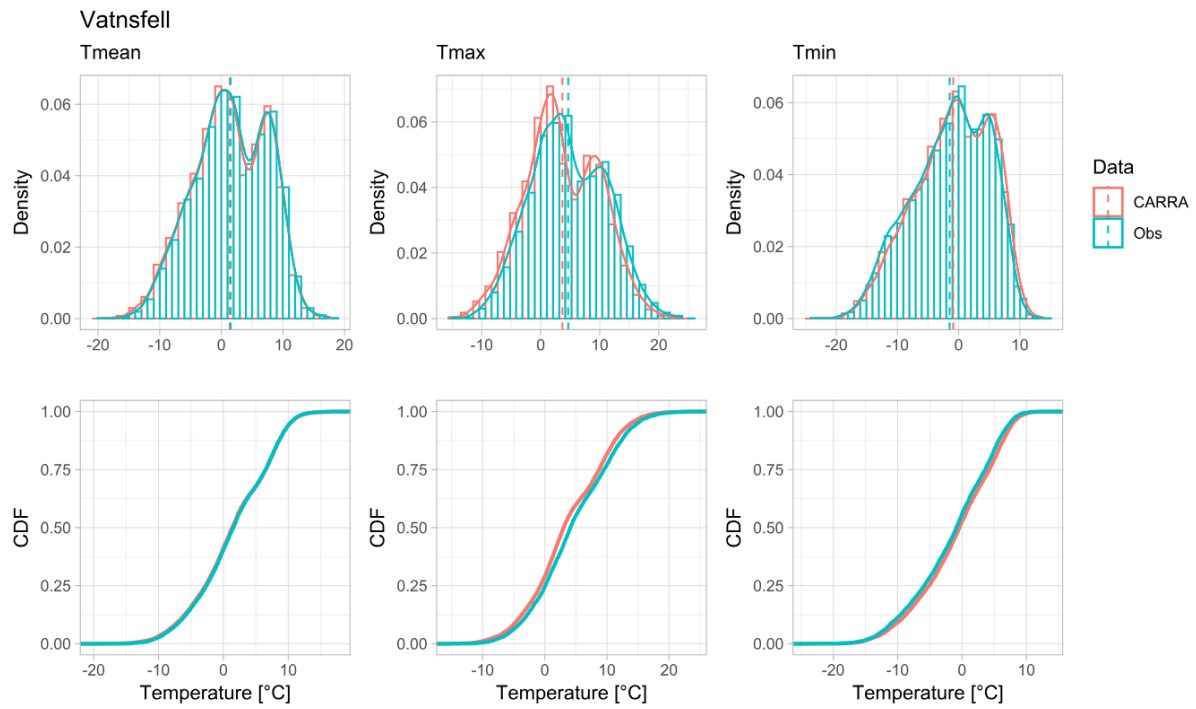


Figure II.81 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Vatnsfell automatic station.

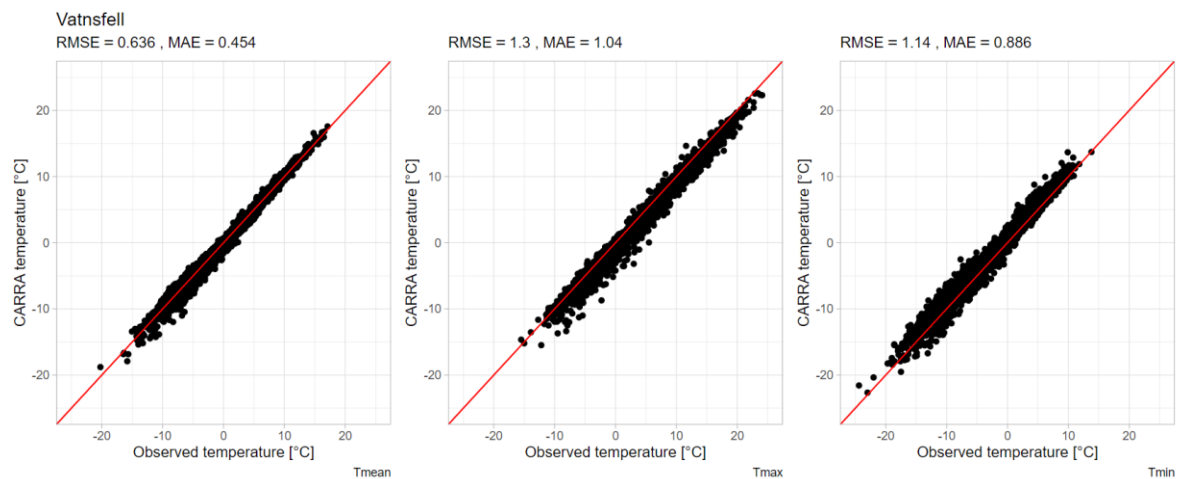


Figure II.82 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Vatnsfell automatic station. The RMSE and MAE (in °C) are shown above each panel.

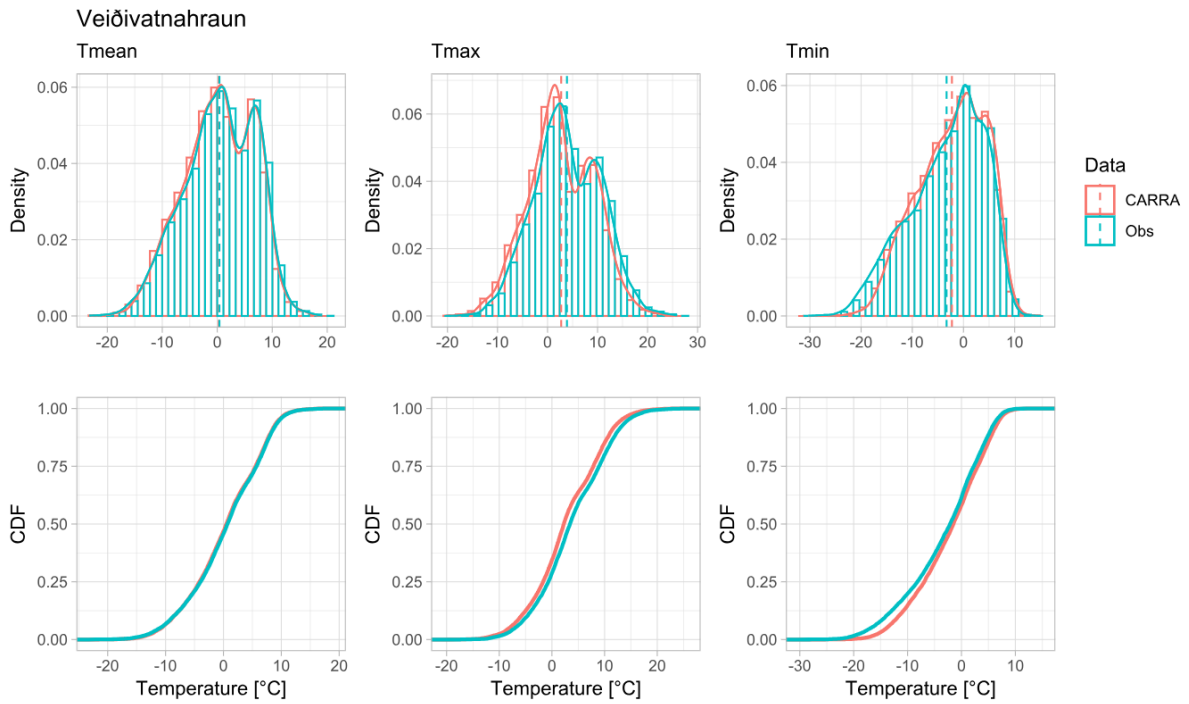


Figure II.83 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Veiðivatnahraun automatic station.

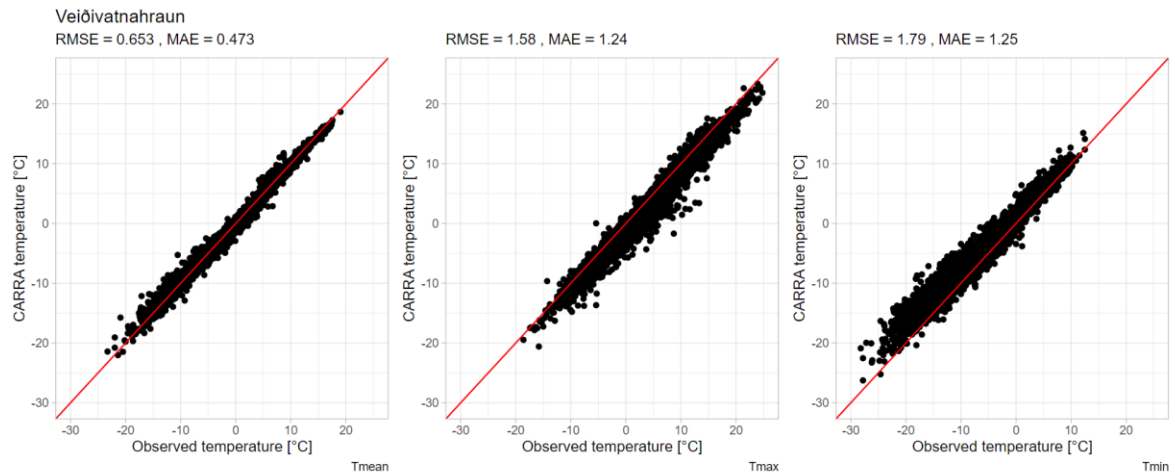


Figure II.84 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Veiðivatnahraun automatic station. The RMSE and MAE (in °C) are shown above each panel.

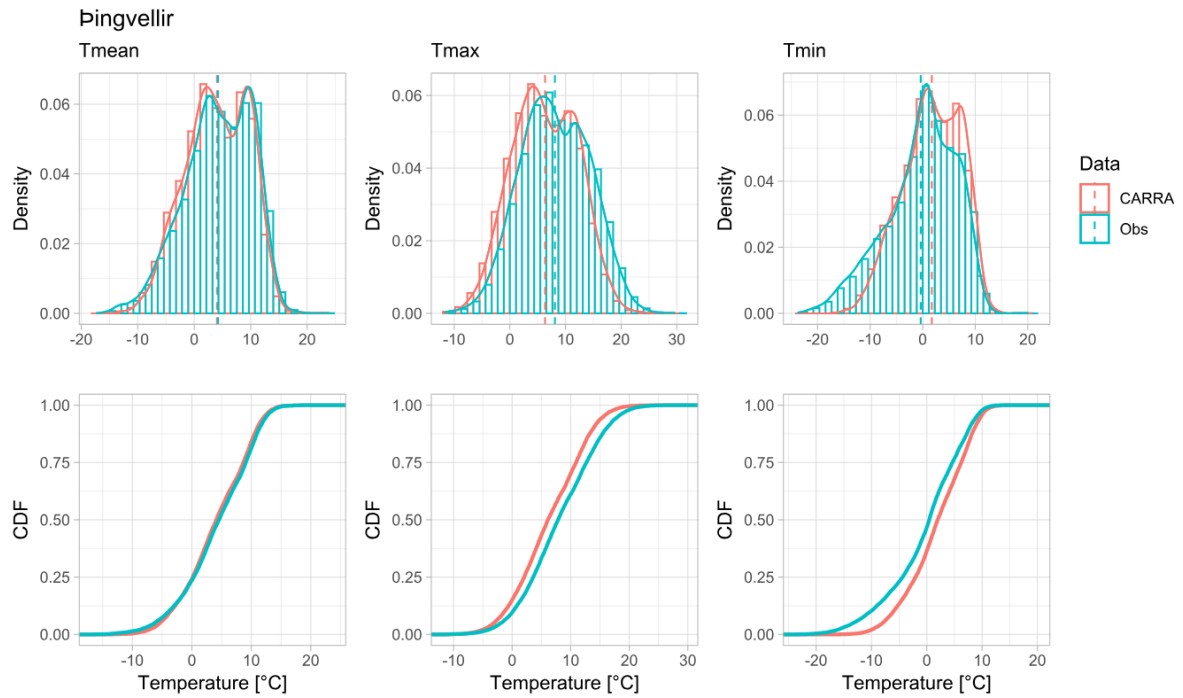


Figure II.85 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Pingvellir automatic station.

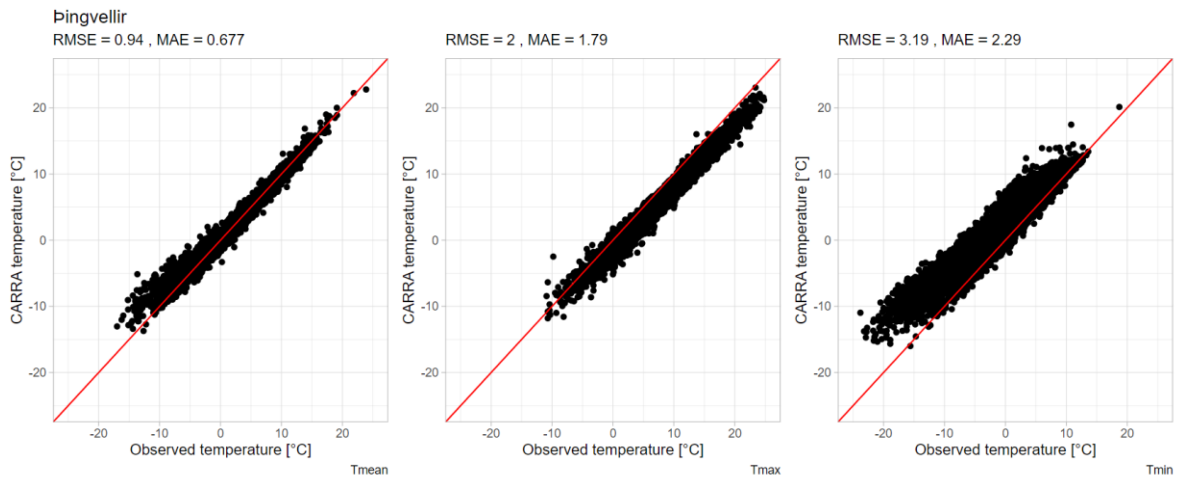


Figure II.86 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Pingvellir automatic station. The RMSE and MAE (in °C) are shown above each panel.

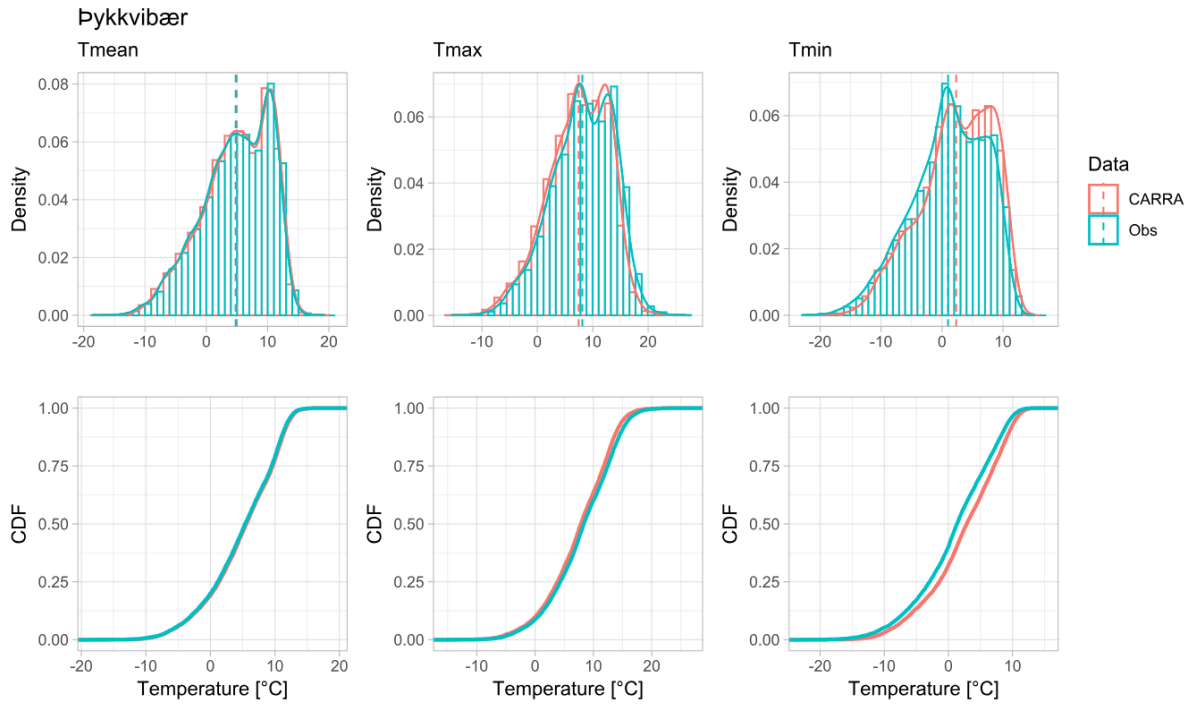


Figure II.87 — Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Pykkvibær automatic station.

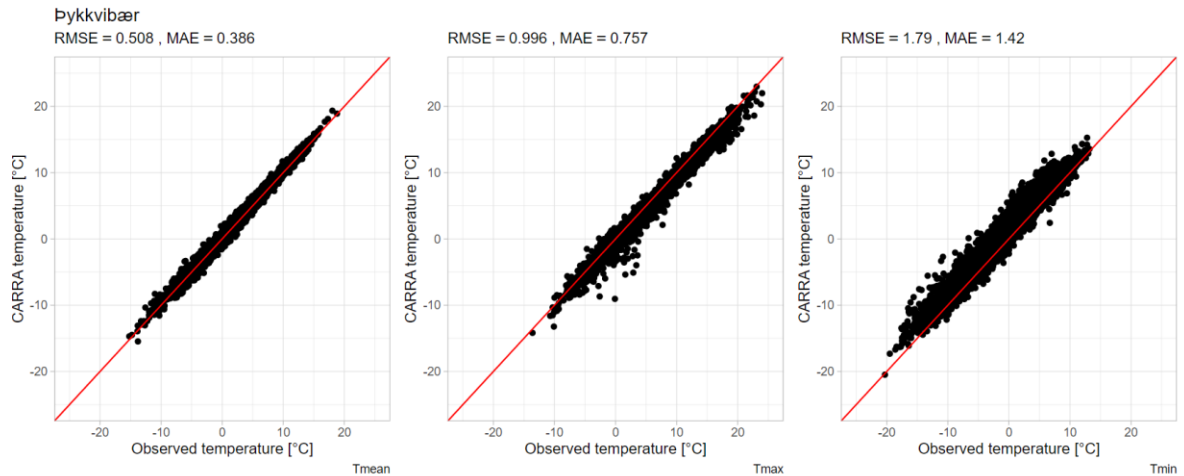


Figure II.88 — Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Pykkvibær automatic station. The RMSE and MAE (in °C) are shown above each panel.

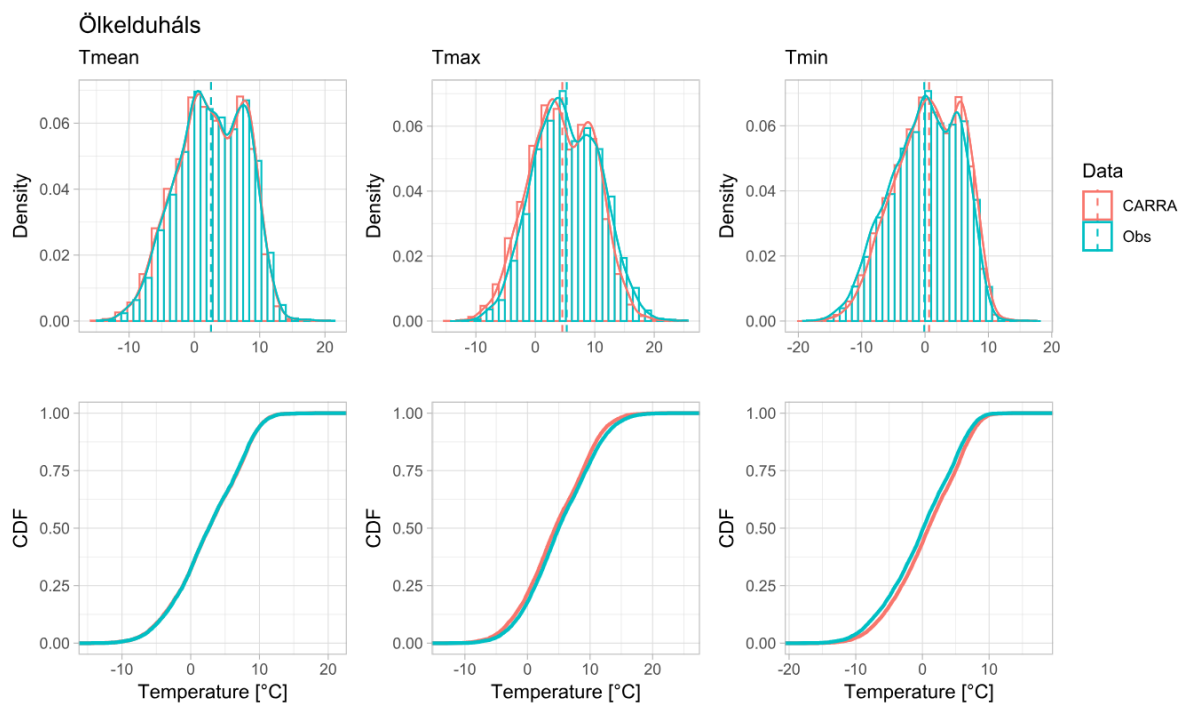


Figure II.89 – Comparison between the distributions of observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Ölkelduháls automatic station.

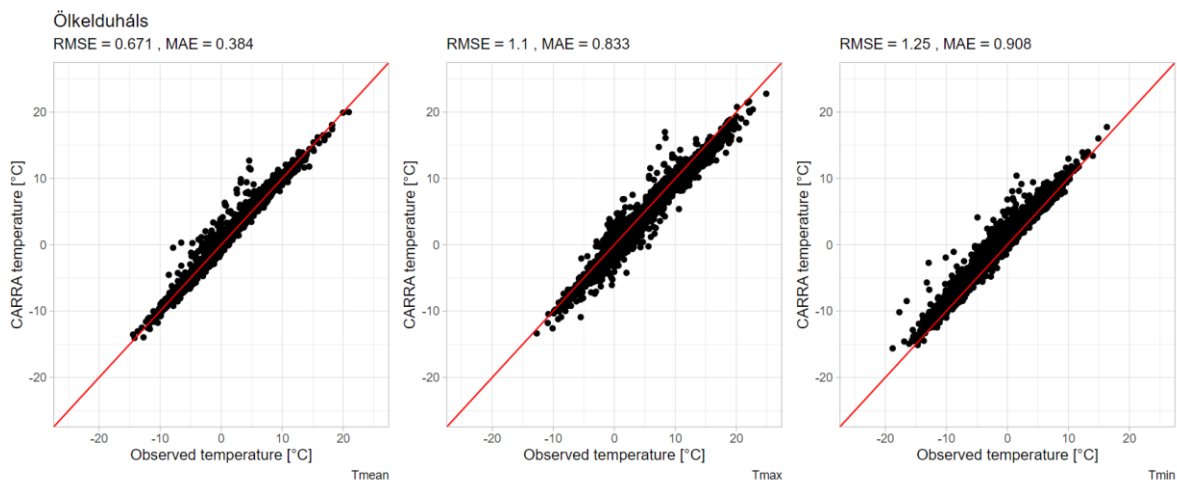


Figure II.90 – Scatter plot of the comparison between the observed and simulated (CARRA) daily mean (left), maximum (center), and minimum (right) air temperature at 2-m height at the Ölkelduháls automatic station. The RMSE and MAE (in °C) are shown above each panel.

Appendix III. Wind speed

In this appendix, figures similar to Figures 12–17 presenting a comparison between the observed and simulated daily mean near-surface wind speed at 10 m are shown for the selected automatic stations (Table 1).

The plots include a scatter plot for observed versus simulated daily wind speed, as well as a comparison between the probability density function and the cumulative distribution function of observed and simulated wind speeds.

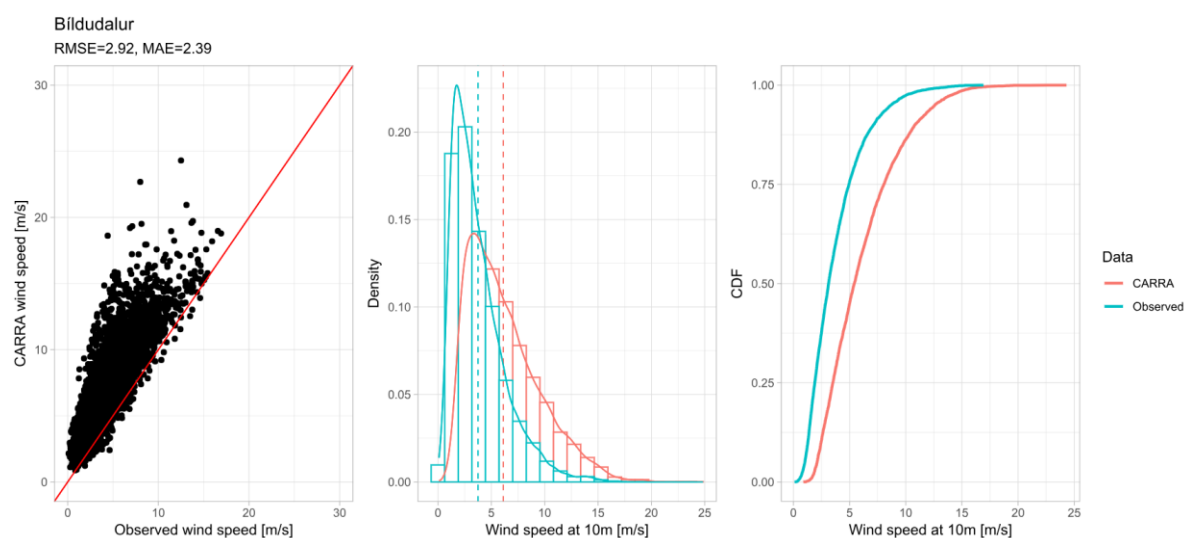


Figure III.1 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Bíldudalur automatic station.

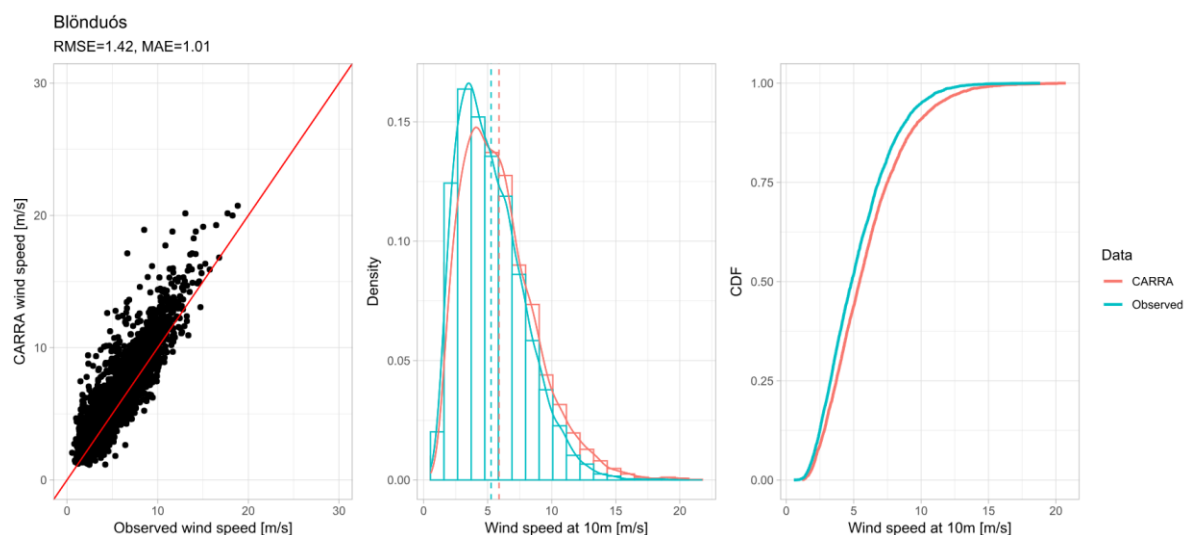


Figure III.2 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Blönduós automatic station.

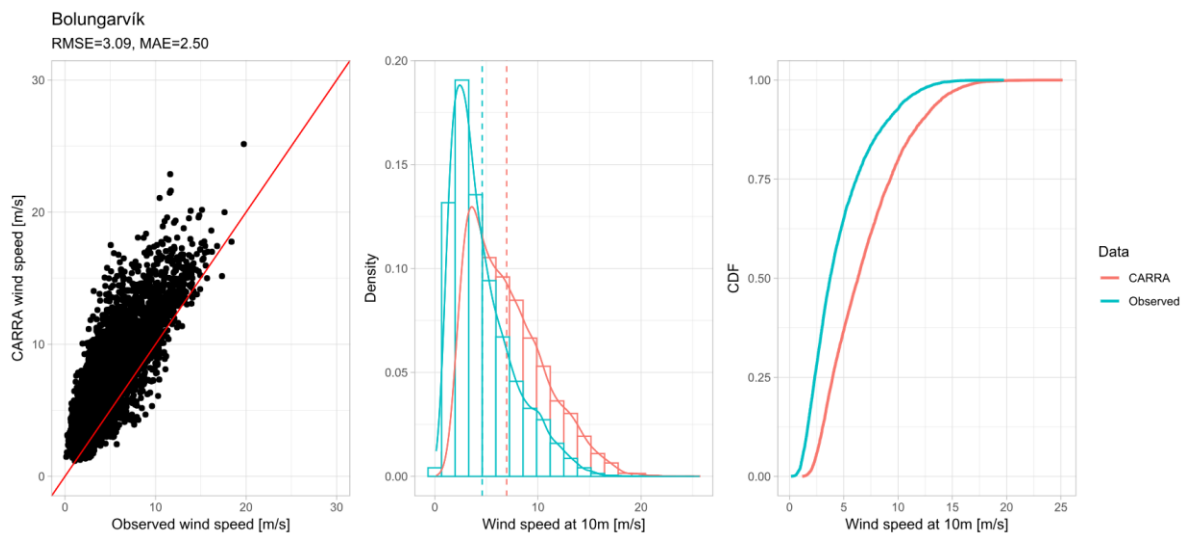


Figure III.3 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Bolungarvík automatic station.

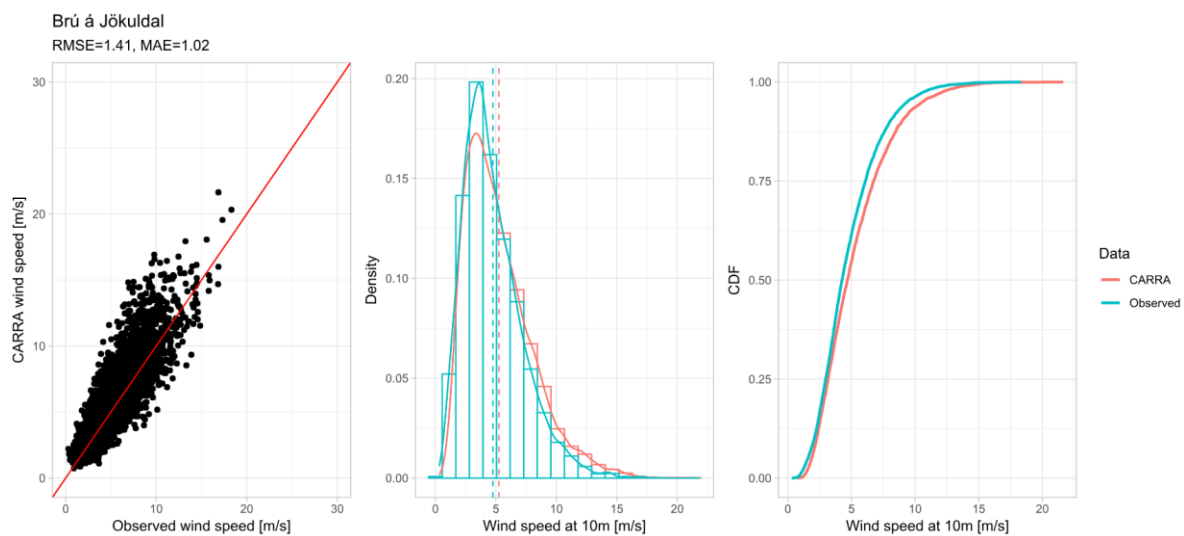


Figure III.4 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Brú á Jökuldal automatic station.

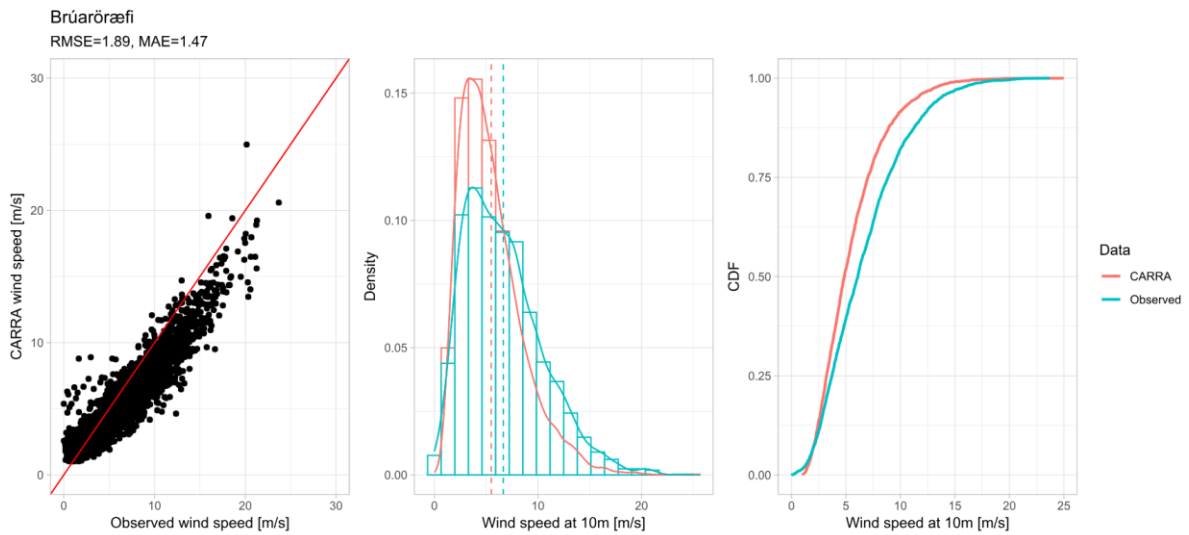


Figure III.5 — Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Brúaröræfi automatic station.

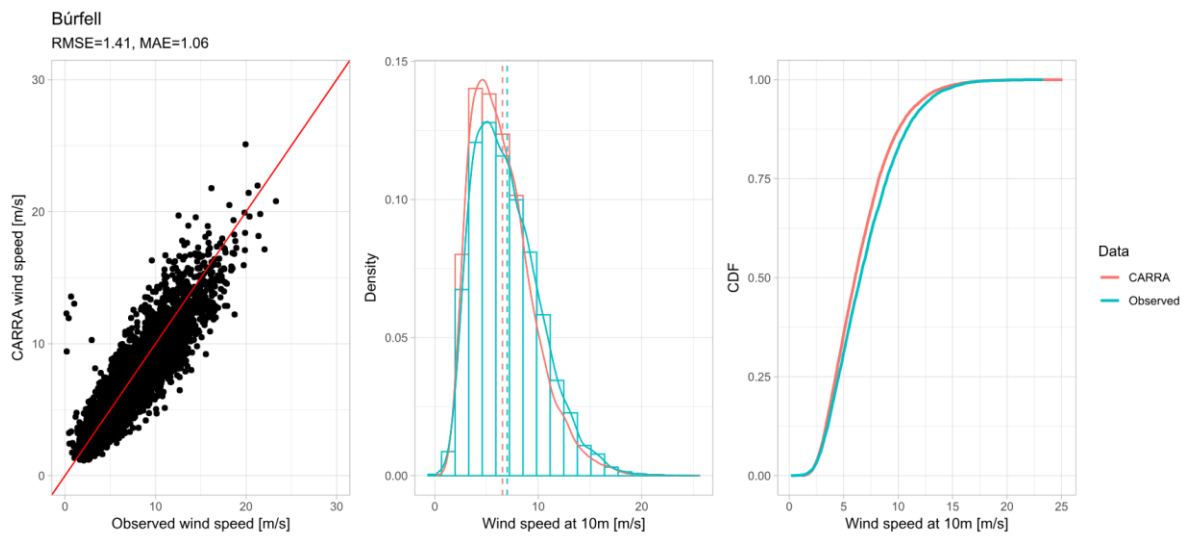


Figure III.6 — Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Búrfell automatic station.

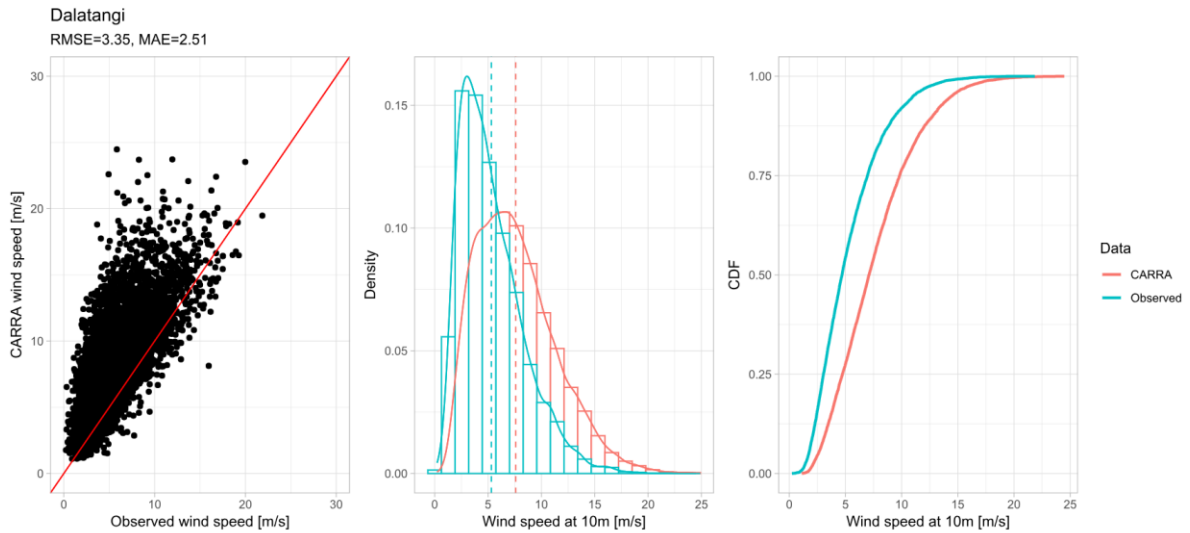


Figure III.7 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Dalatangi automatic station.

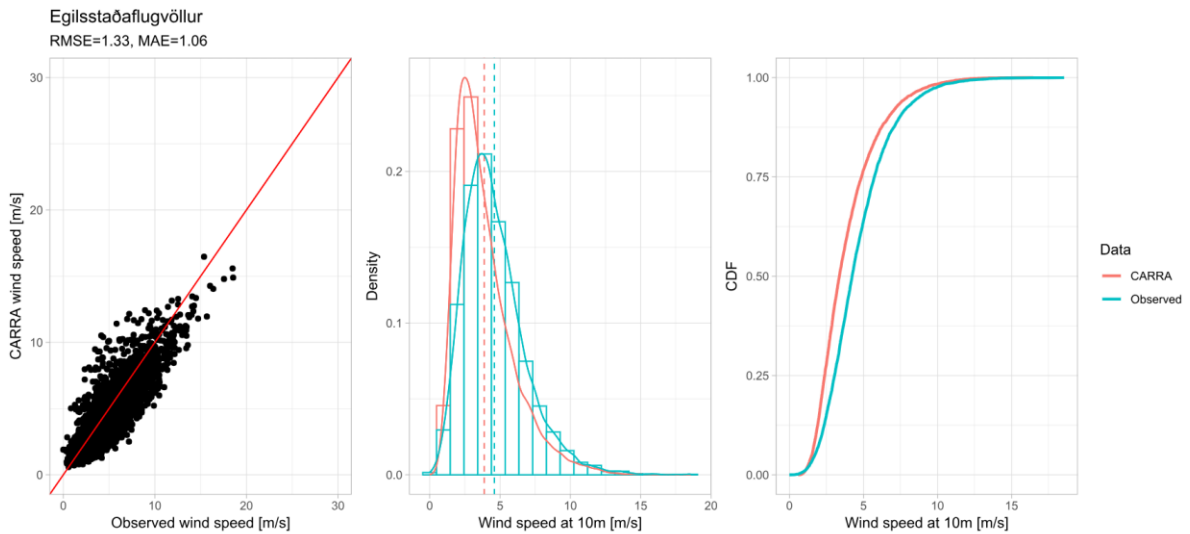


Figure III.8 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Egilsstaðflugvöllur automatic station.

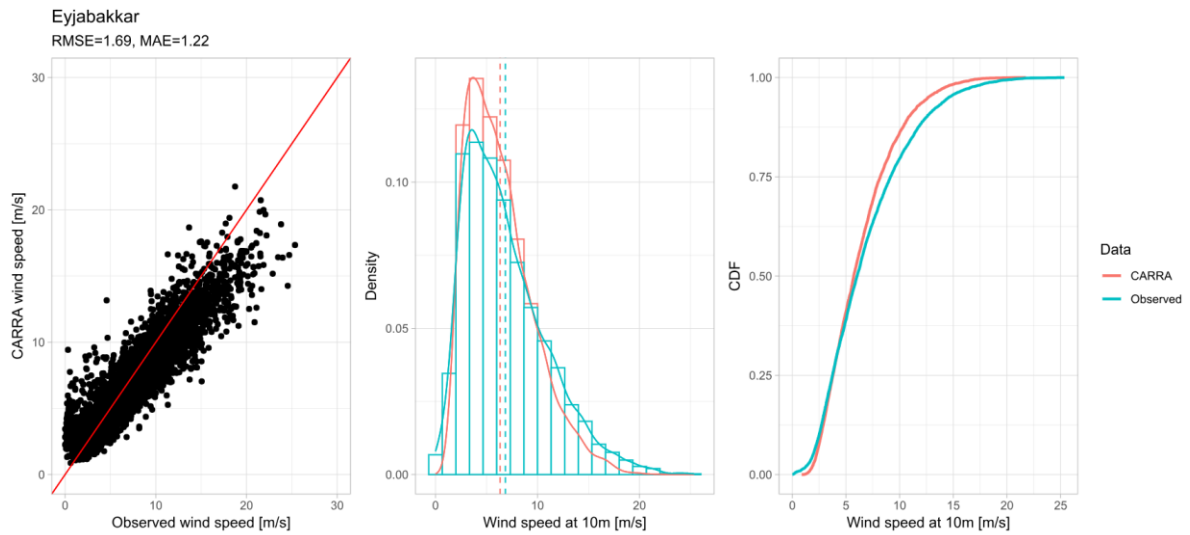


Figure III.9 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Eyjabakkar automatic station.

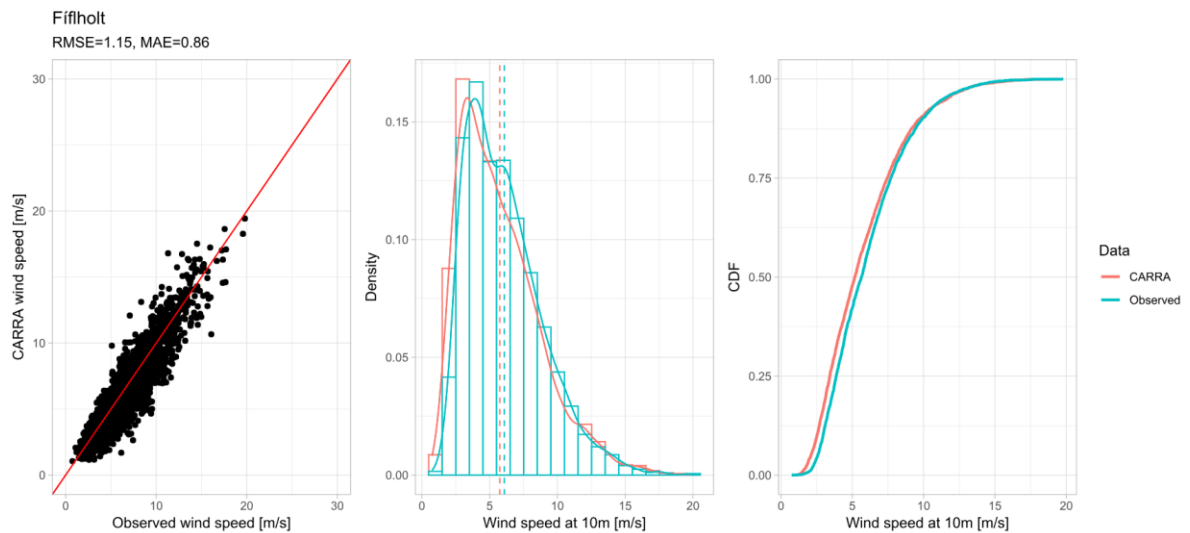


Figure III.10 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Fiflholt automatic station.

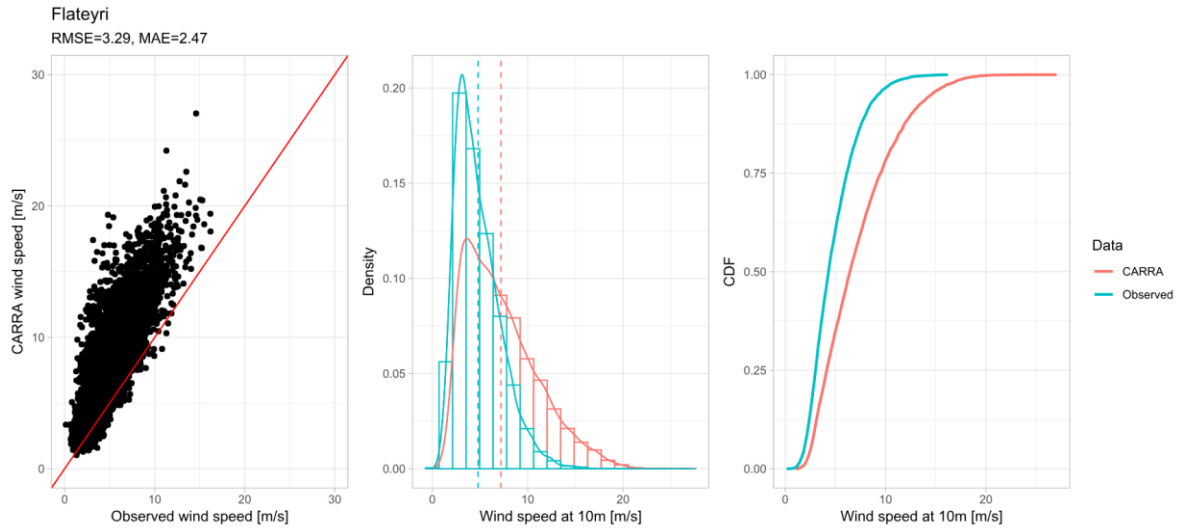


Figure III.11 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Flateyri automatic station.

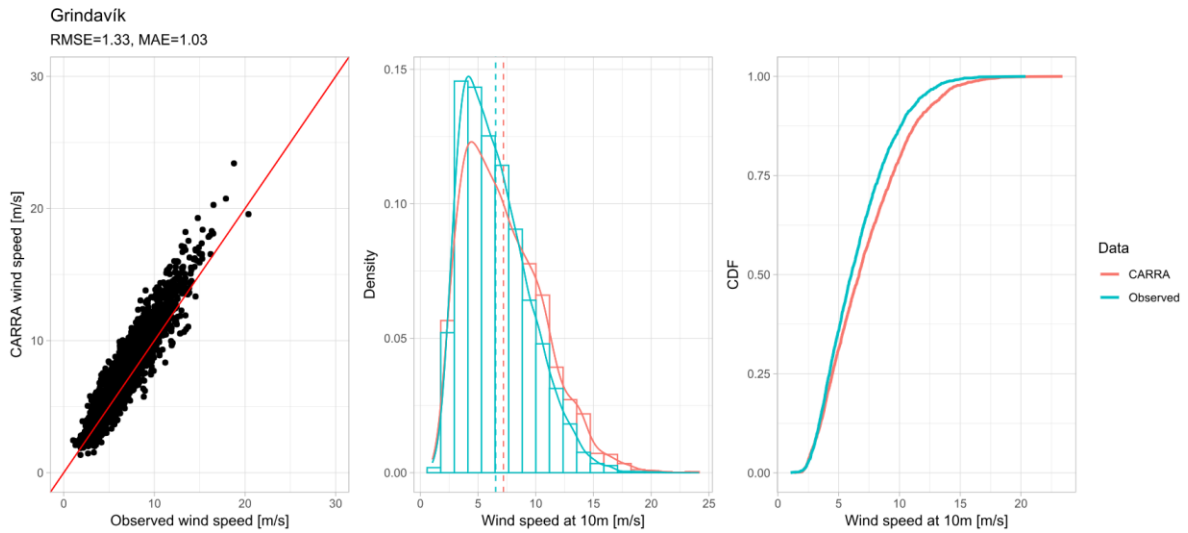


Figure III.12 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Grindavík automatic station.

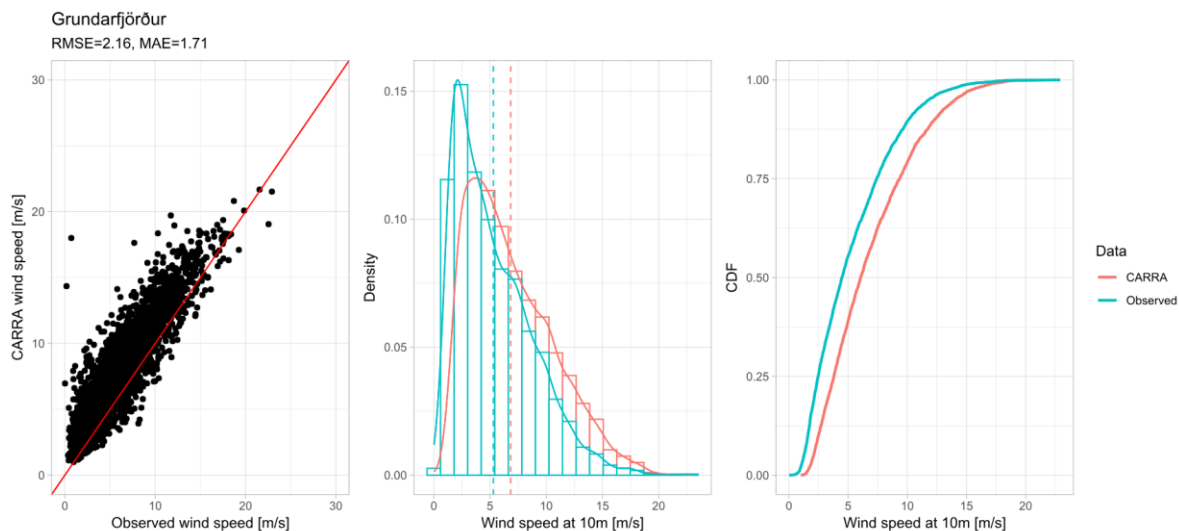


Figure III.13 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Grundarfjörður automatic station.

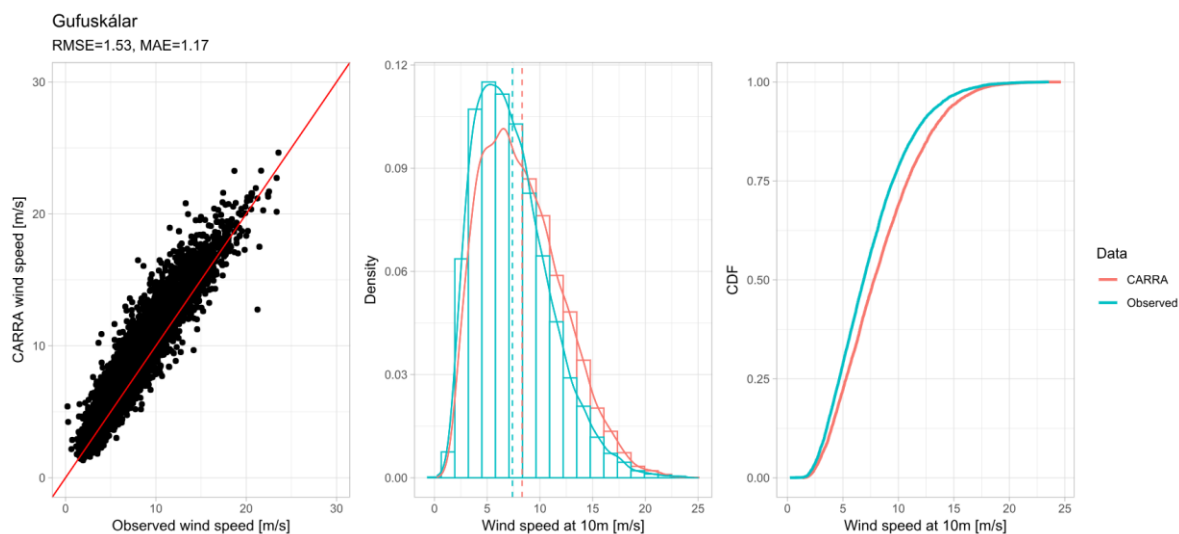


Figure III.14 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Gufuskálar automatic station.

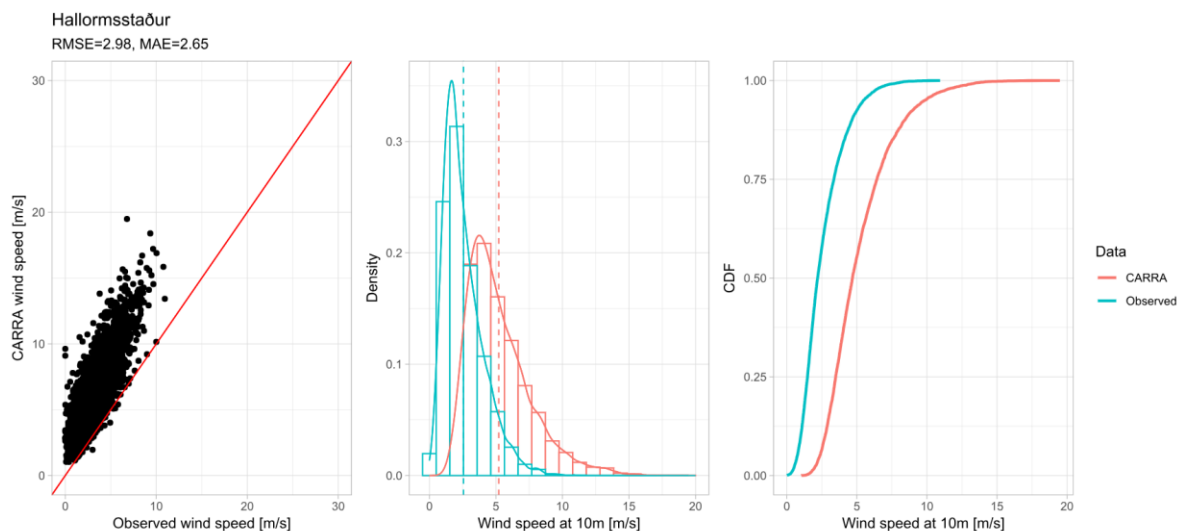


Figure III.15 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Hallormsstaður automatic station.

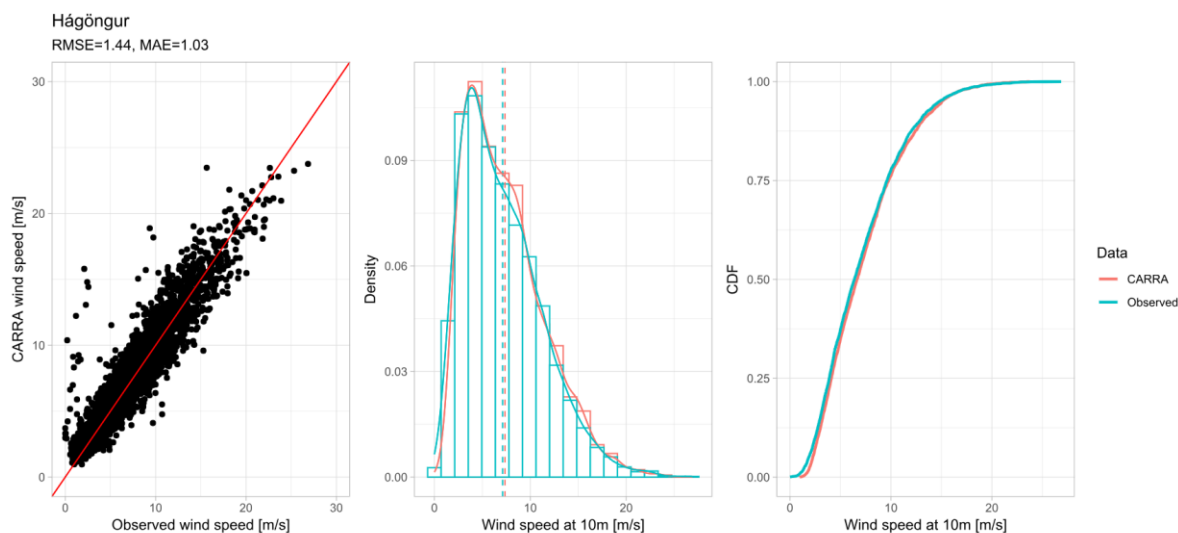


Figure III.16 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Hágöngur automatic station.

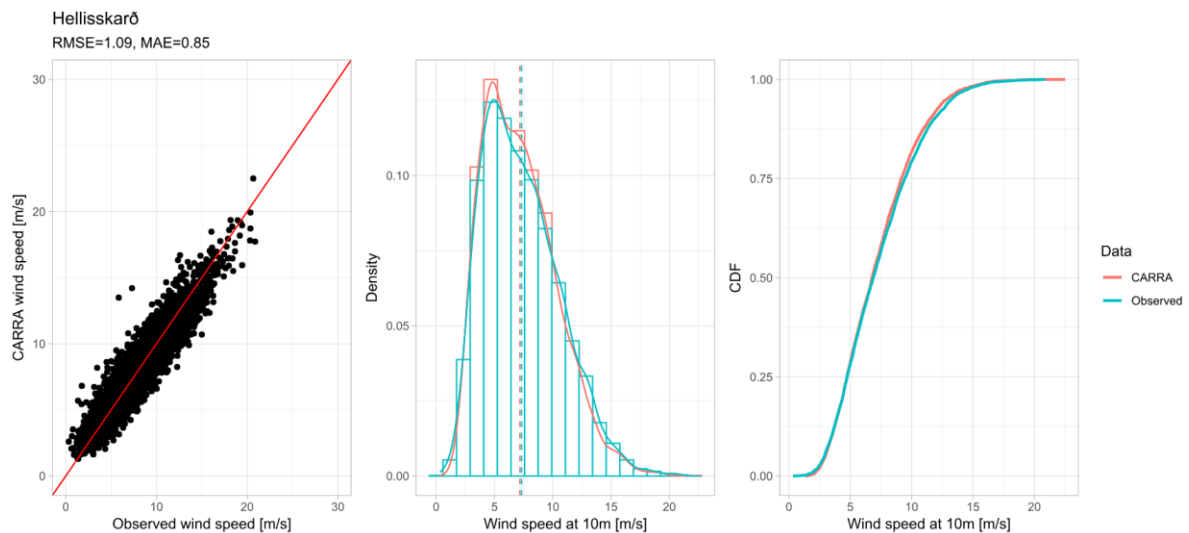


Figure III.17 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Hellisskarð automatic station.

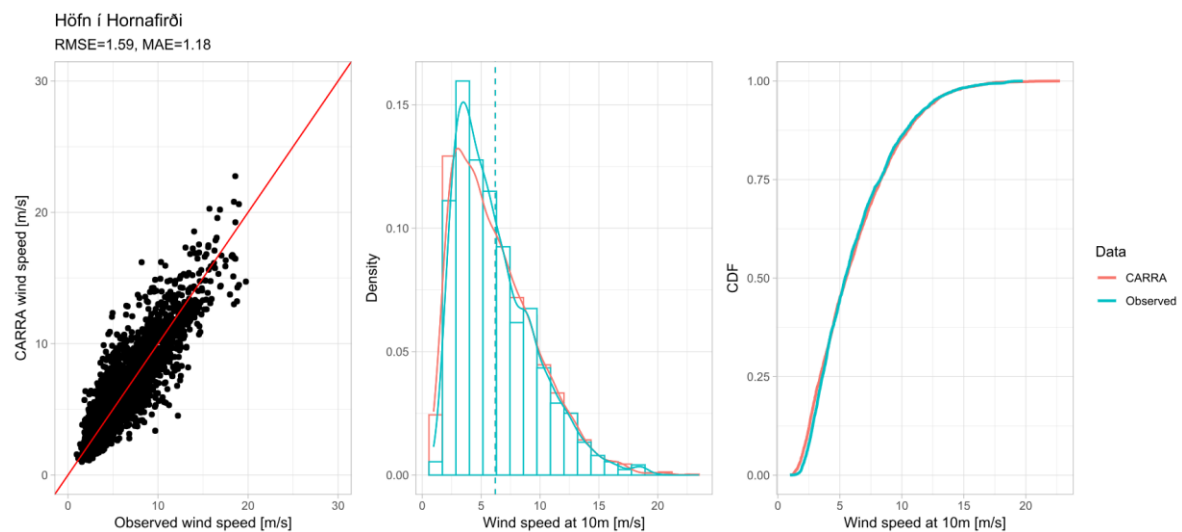


Figure III.18 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Höfn í Hornafirði automatic station.

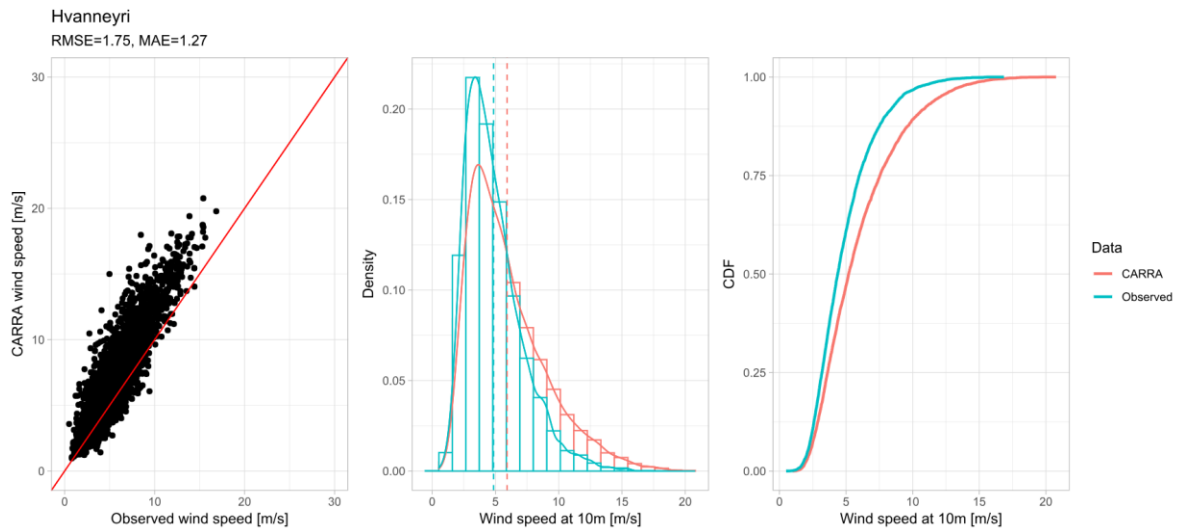


Figure III.19 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Hvanneyri automatic station.

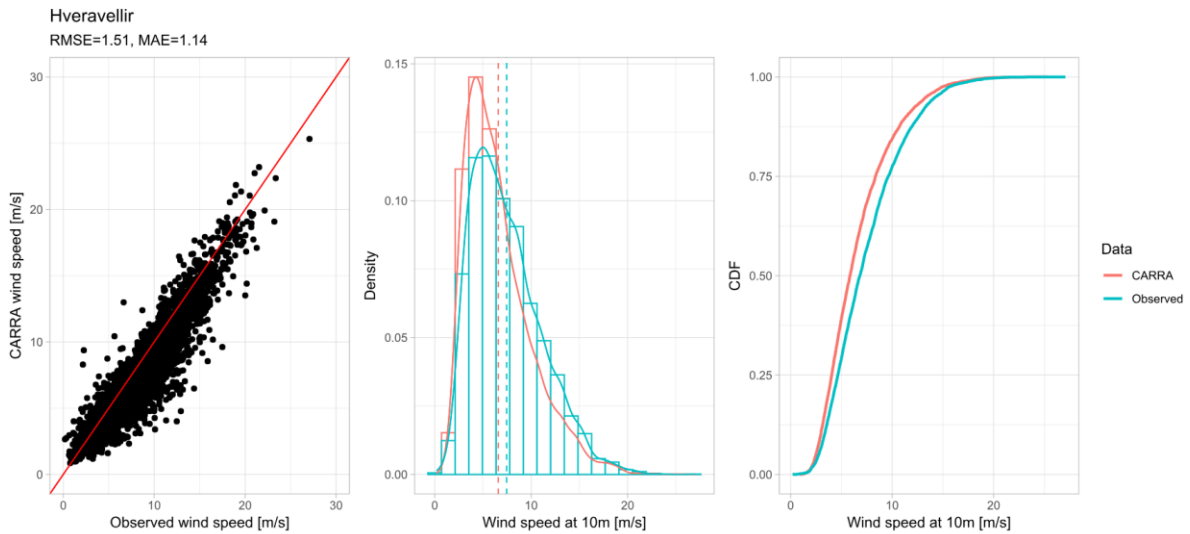


Figure III.20 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Hveravellir automatic station.

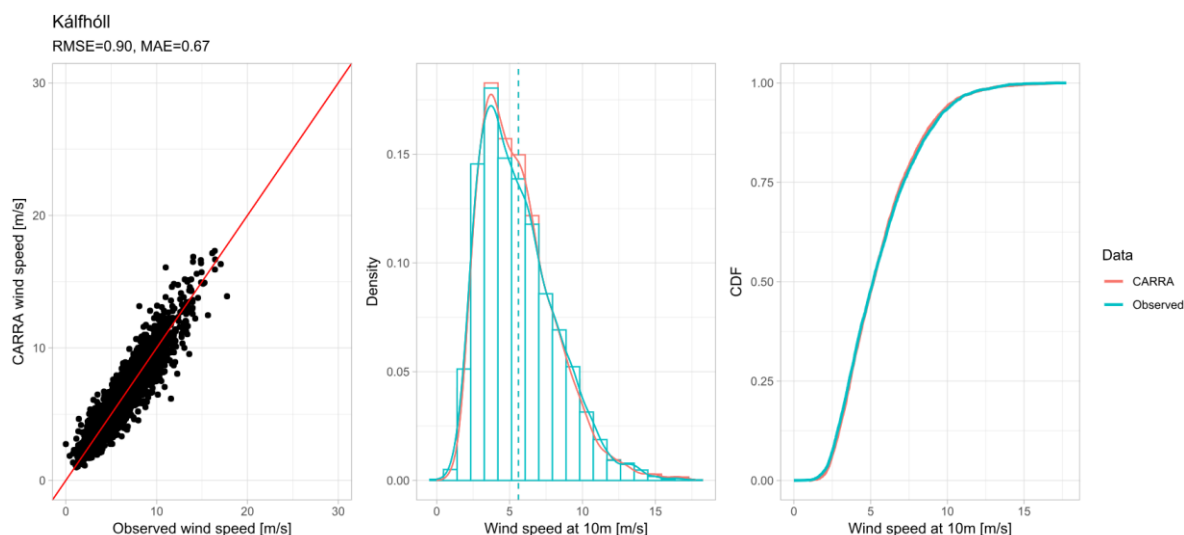


Figure III.21 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Kálfhóll automatic station.

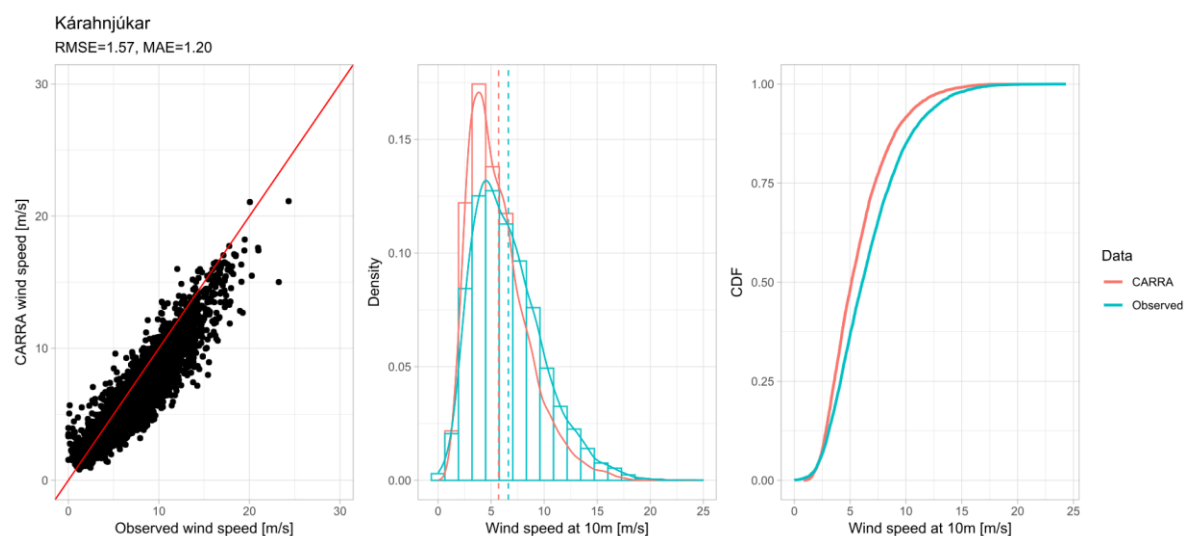


Figure III.22 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Kárahnjúkar automatic station.

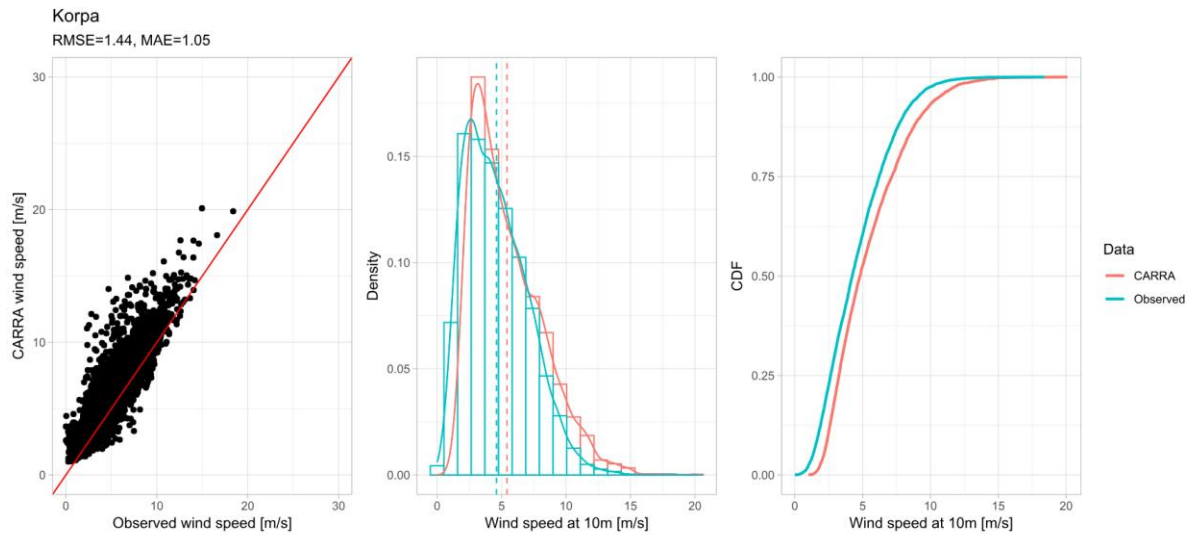


Figure III.23 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Korpa automatic station.

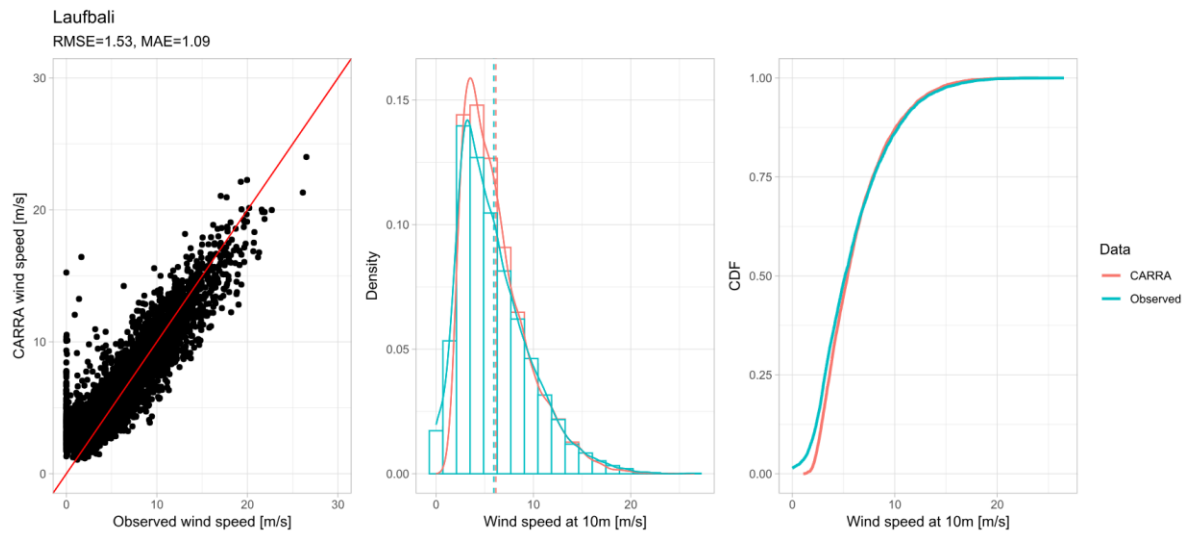


Figure III.24 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Laufbali automatic station.

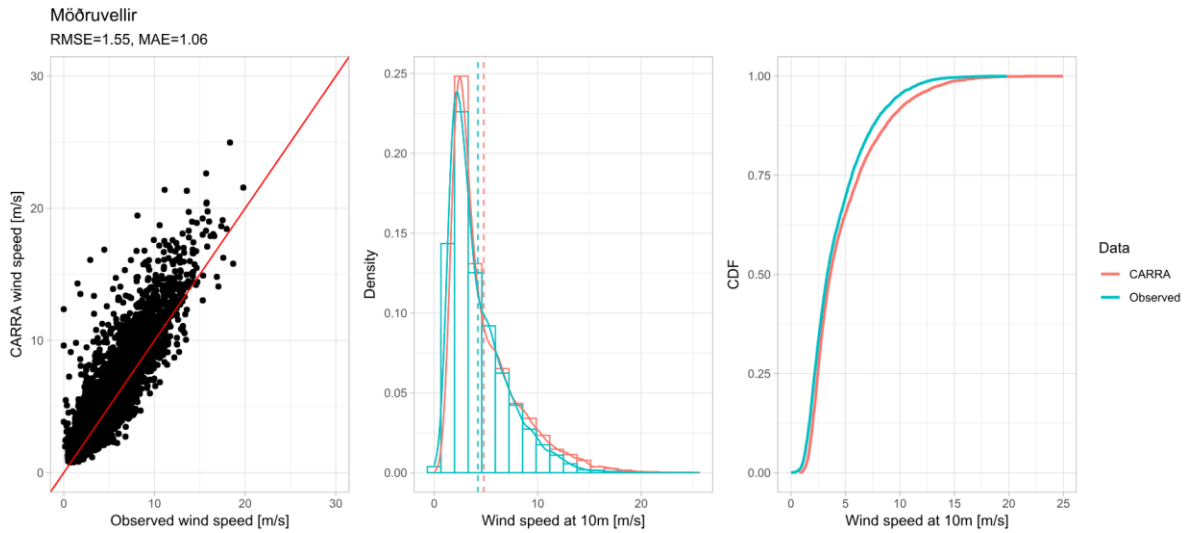


Figure III.25 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Möðruvellir automatic station.

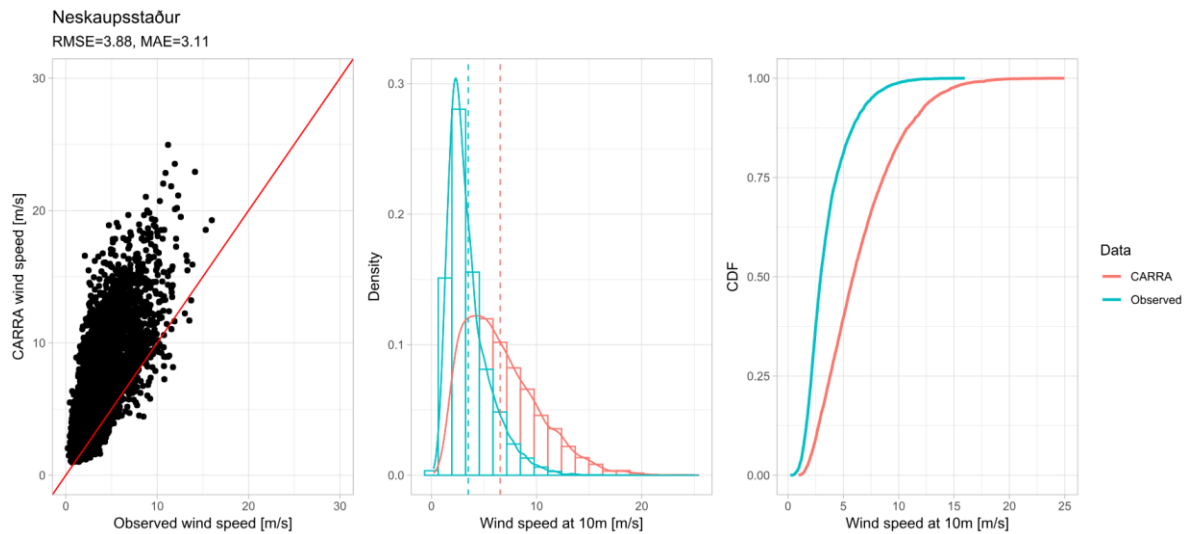


Figure III.26 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Neskaupsstaður automatic station.

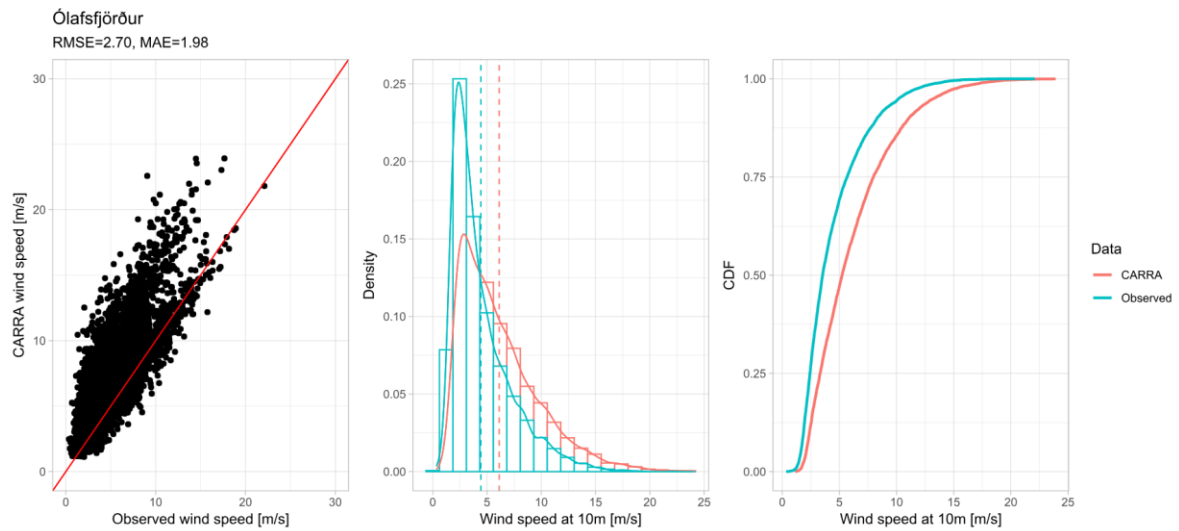


Figure III.27 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Ólafsfjörður automatic station.

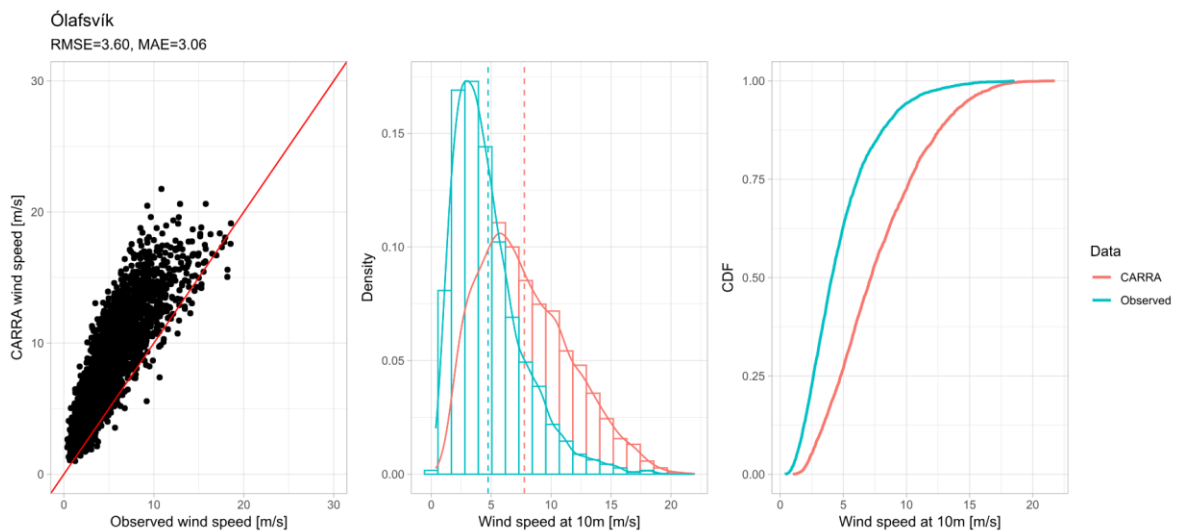


Figure III.28 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Ólafsvík automatic station.

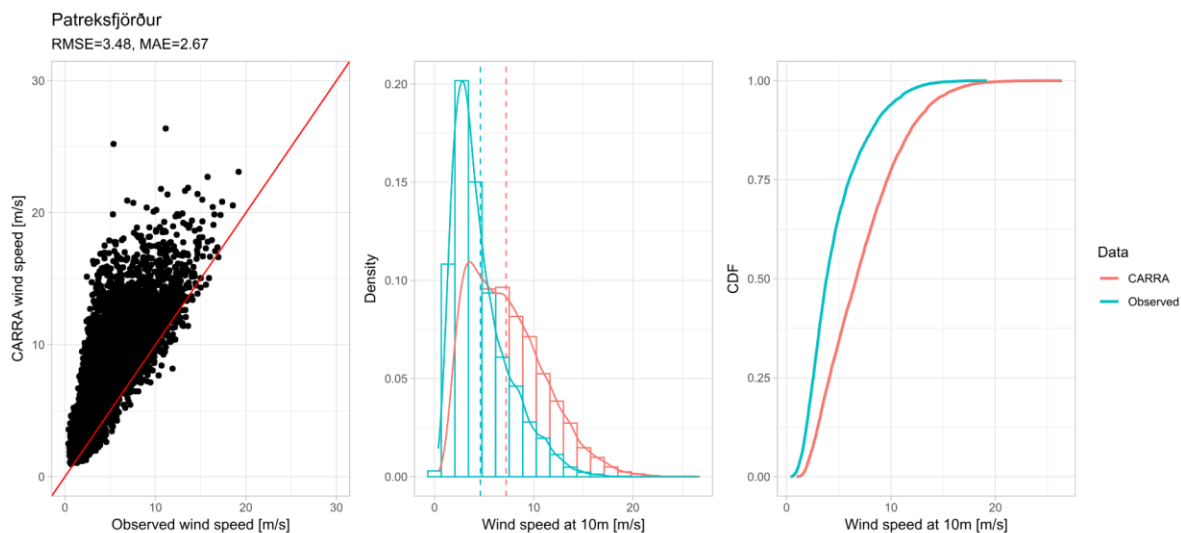


Figure III.29 — Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Patreksfjörður automatic station.

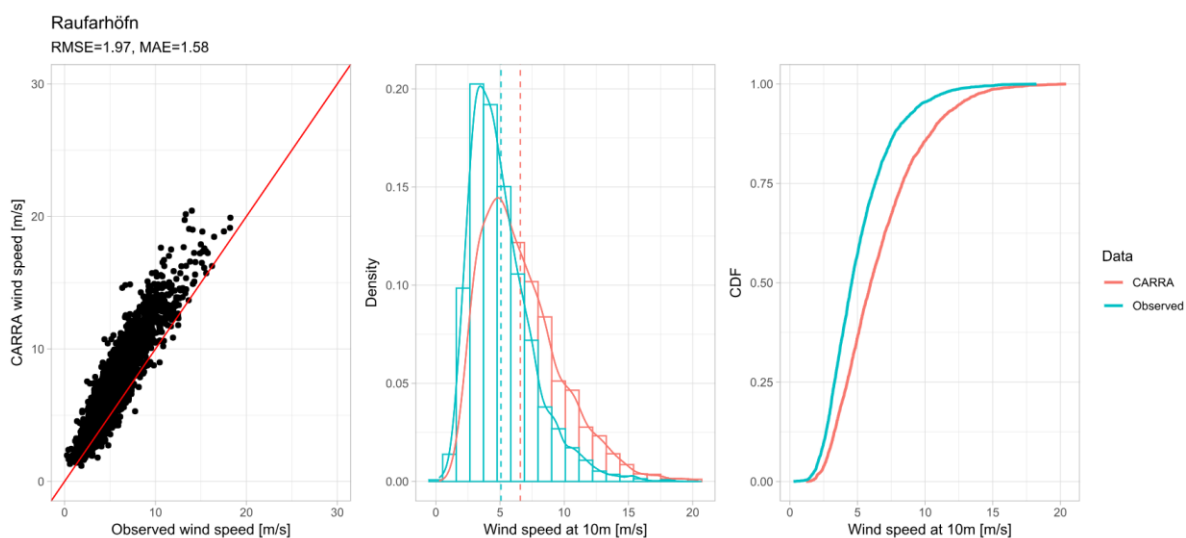


Figure III.30 — Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Raufarhöfn automatic station.

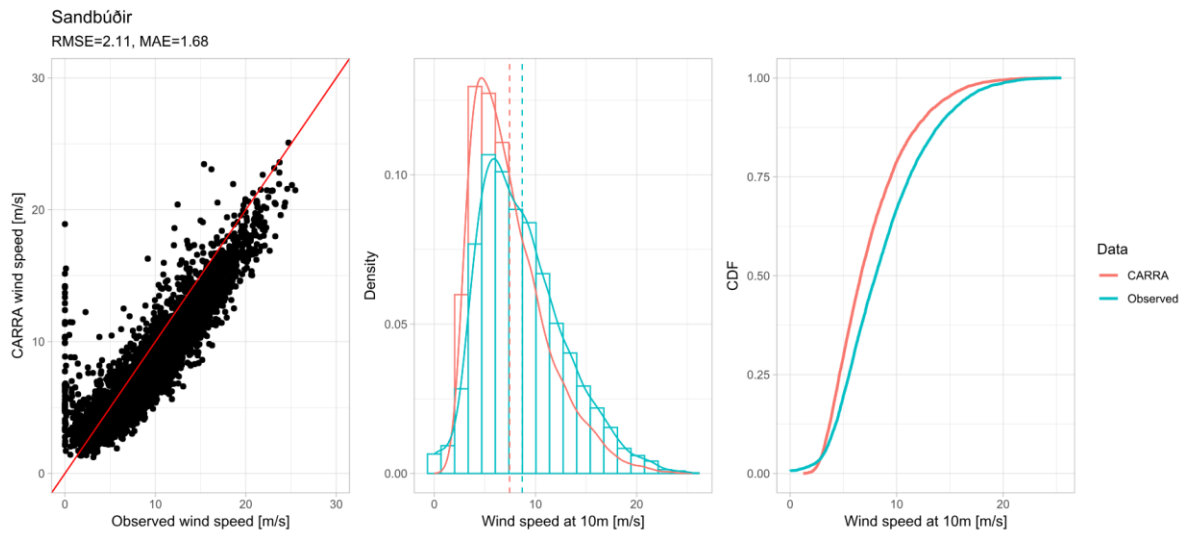


Figure III.31 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Sandbúðir automatic station.

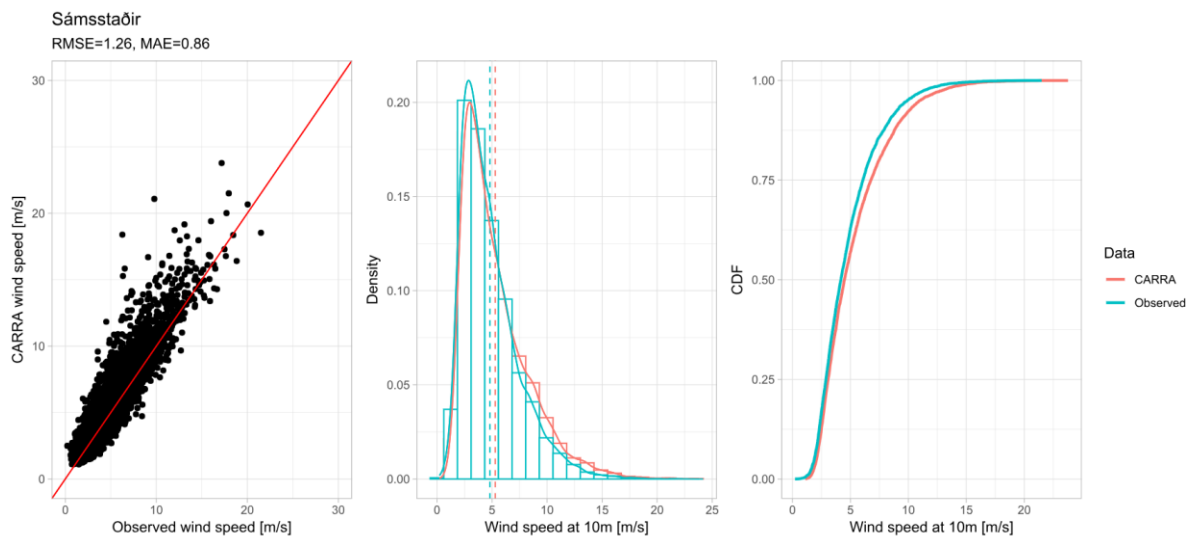


Figure III.32 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Sámsstaðir automatic station.

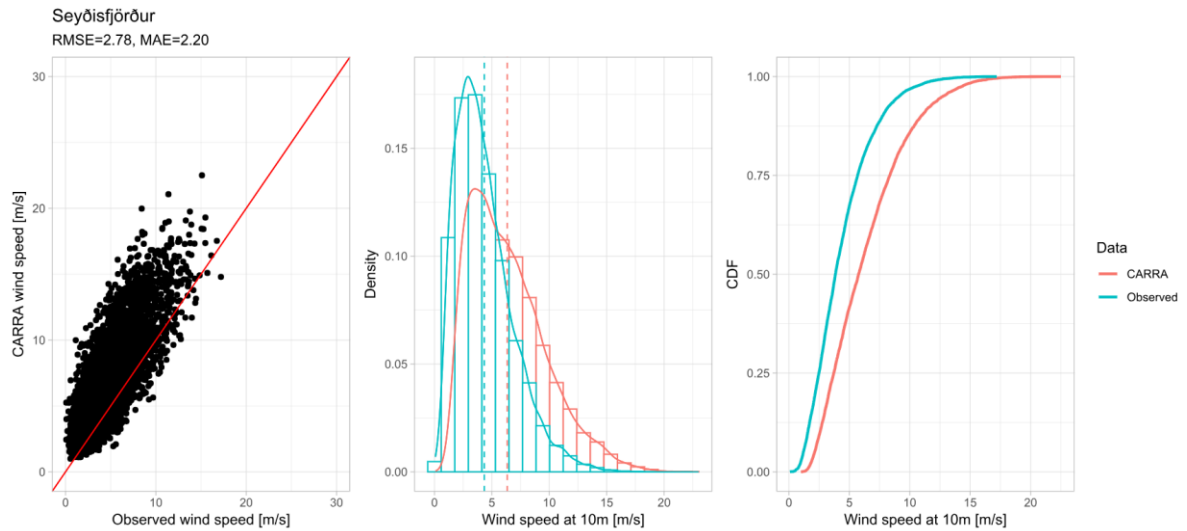


Figure III.33 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Seyðisfjörður automatic station.

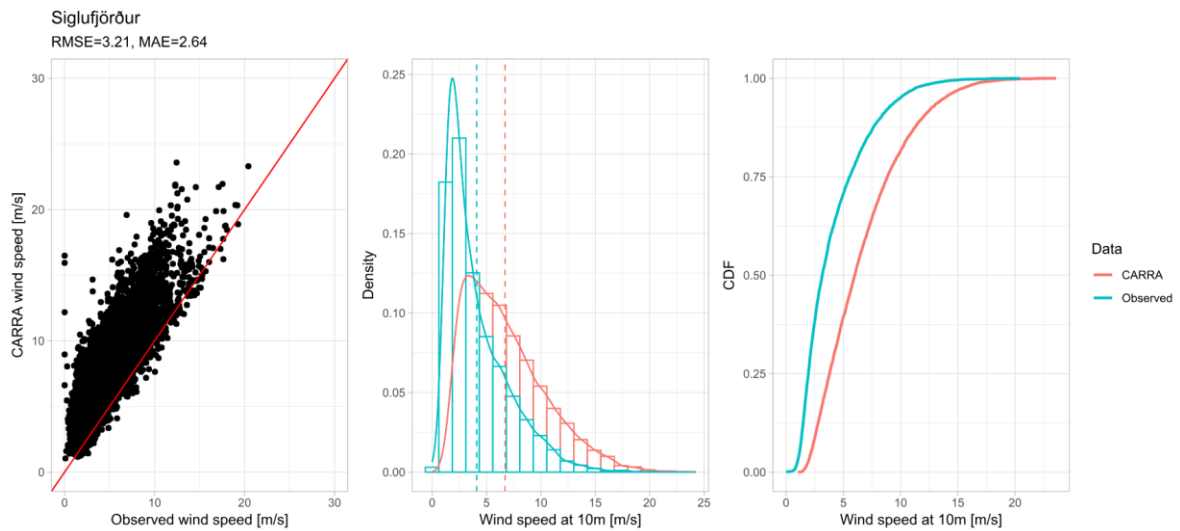


Figure III.34 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Siglufjörður automatic station.

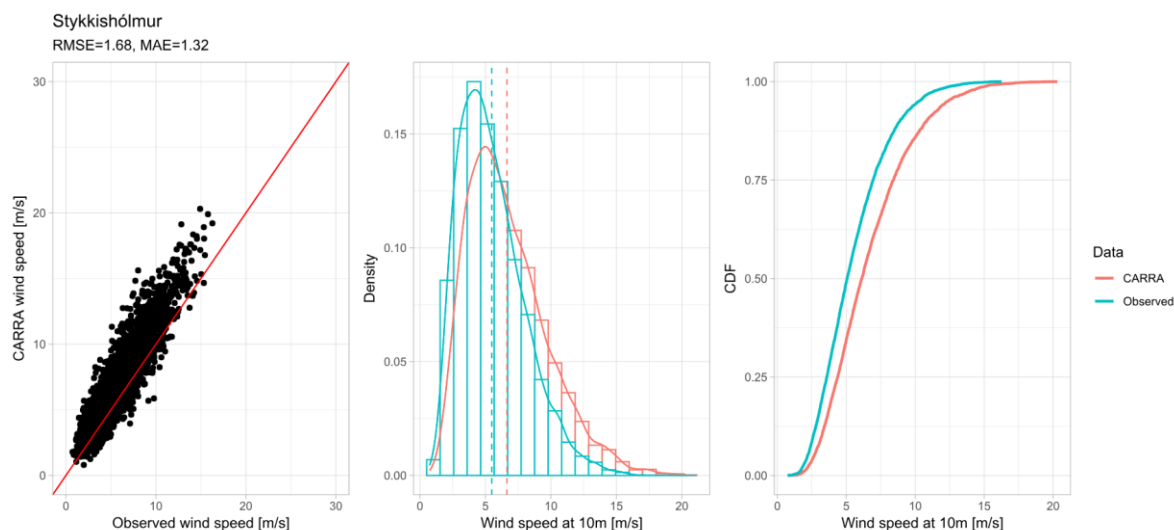


Figure III.35 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Stykkishólmur automatic station.

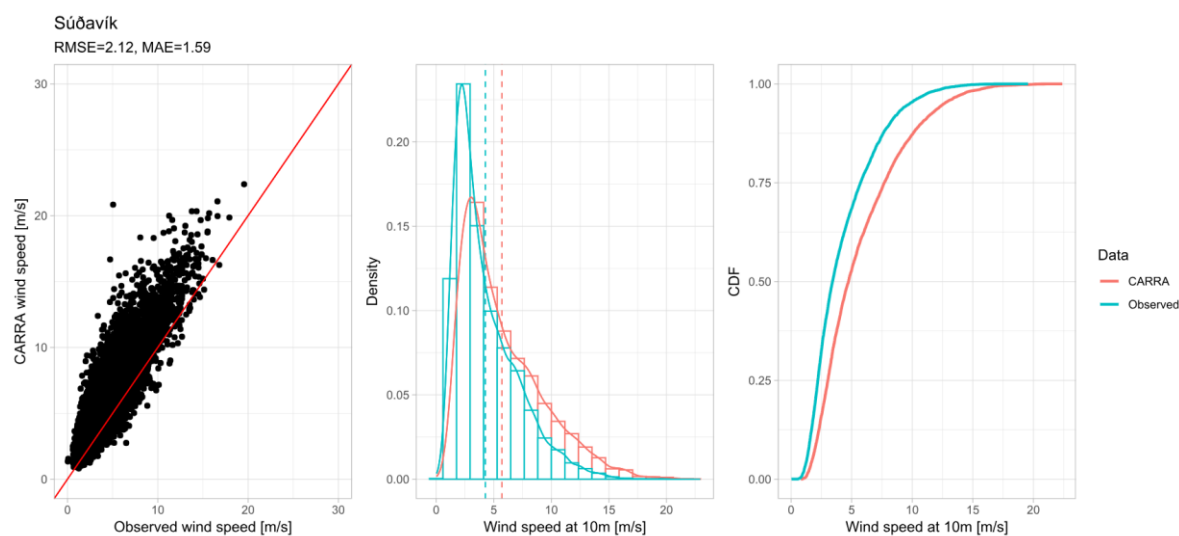


Figure III.36 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Súðavík automatic station.

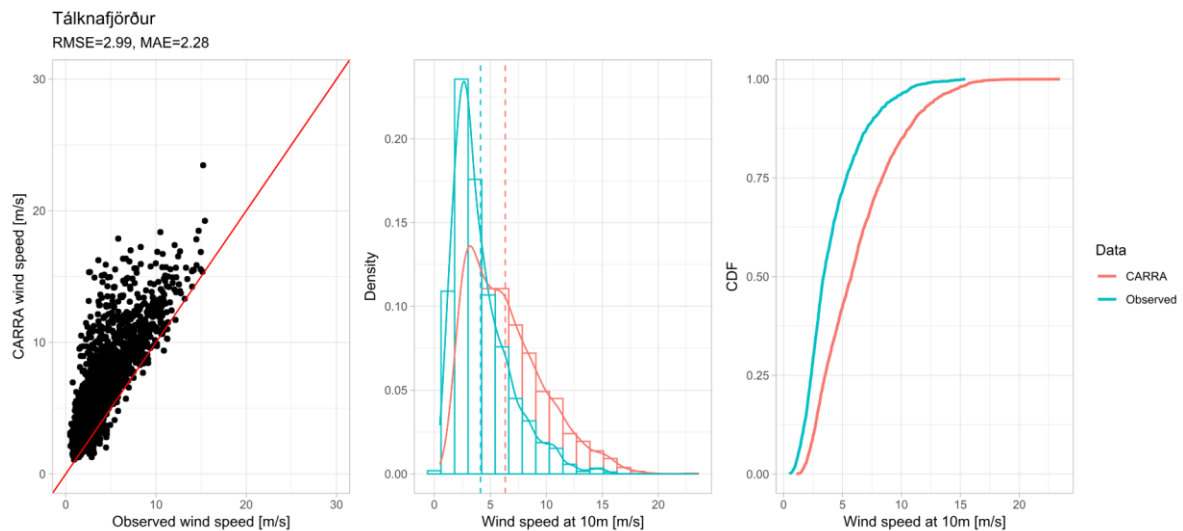


Figure III.37 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Tálknafjörður automatic station.

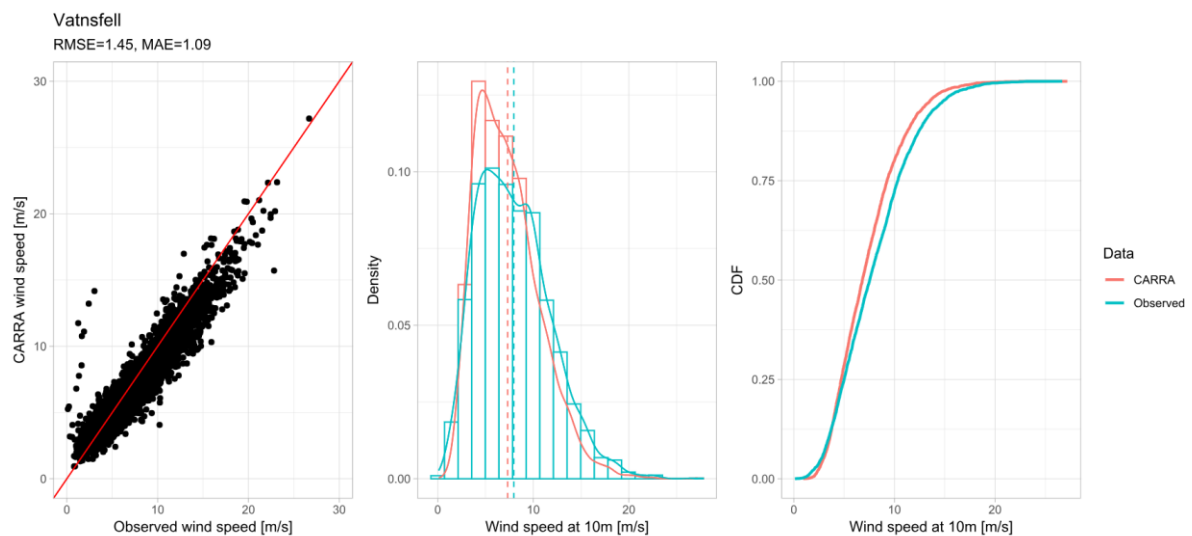


Figure III.38 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Vatnsfell automatic station.

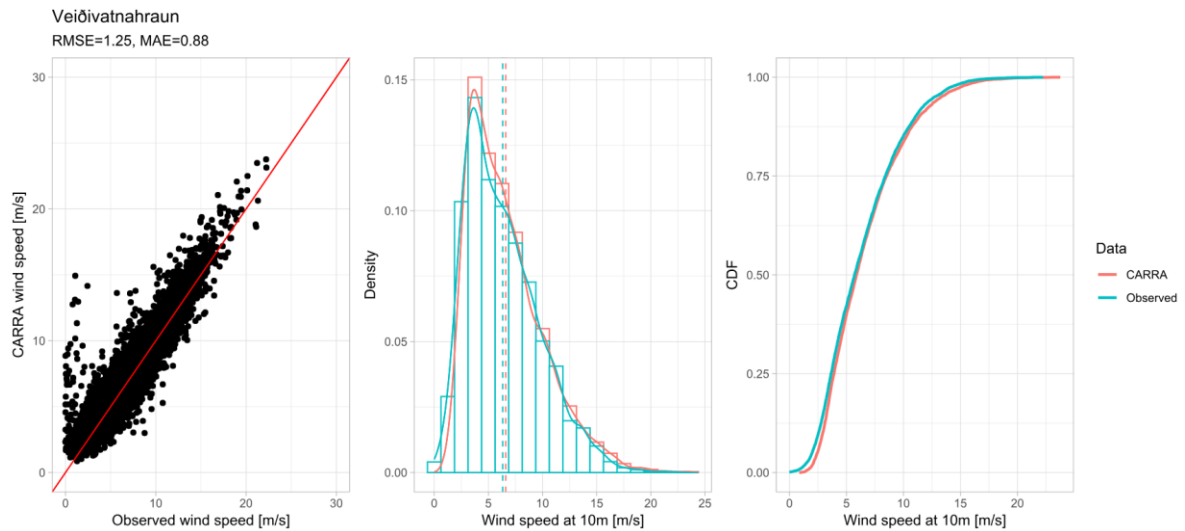


Figure III.39 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Veiðivatnahraun automatic station.

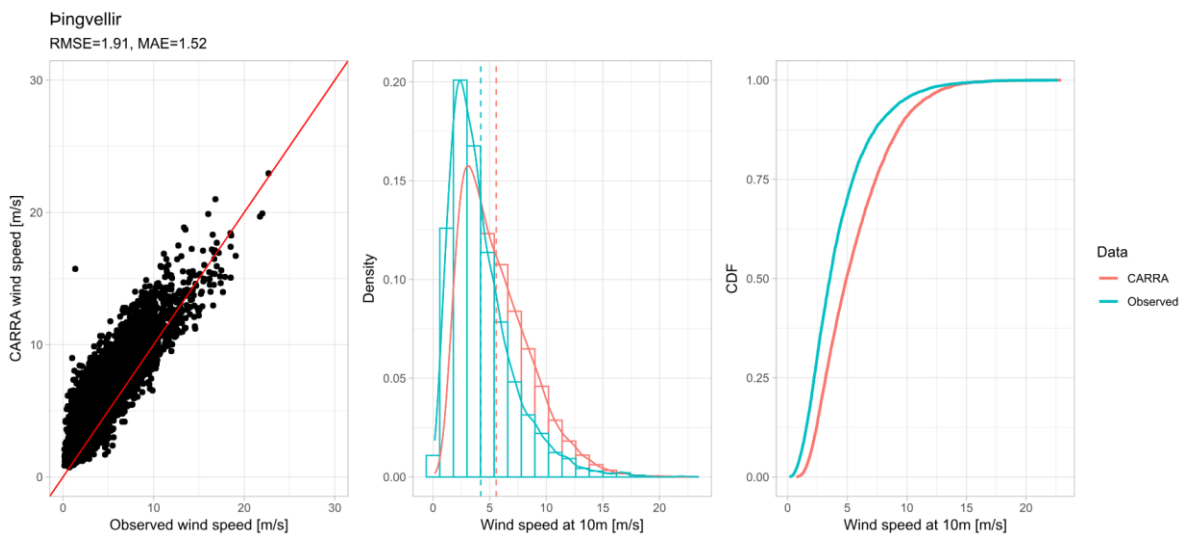


Figure III.40 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Pingvellir automatic station.

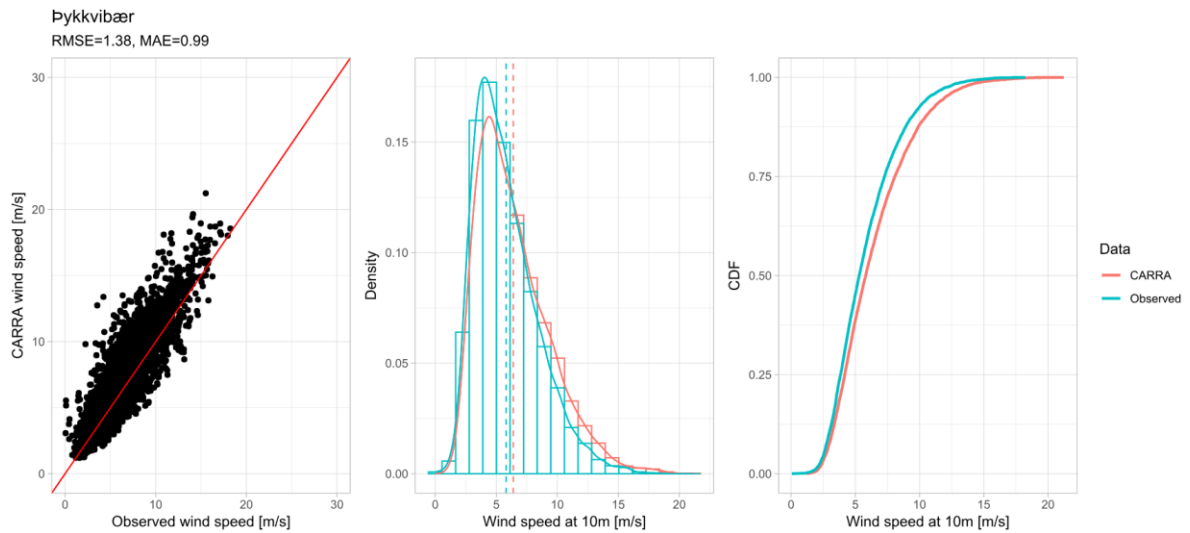


Figure III.41 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Þykkvibær automatic station.

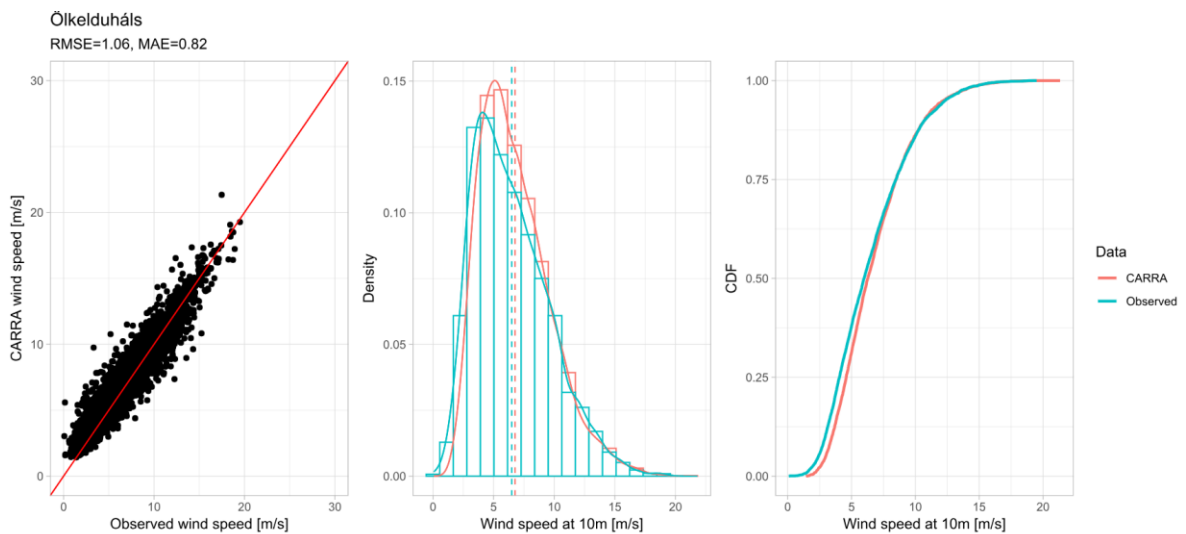


Figure III.42 – Comparison between the observed and simulated (CARRA) daily mean wind speed at 10-m height; scatter plot (left), probability density function (center), and cumulative distribution function (right) at the Ölkelduháls automatic station.

Appendix IV. Precipitation

In this appendix, figures similar to Figures 18, 19 and 21 are shown for the 49 automatic stations selected for this study (see Table 1).

Figures IV.1–49 present scatter plots and Q–Q plots comparing daily precipitation measurements to simulations from the CARRA dataset. Figures IV.50–98 show annual maximum series based on measured and simulated daily precipitation from the CARRA dataset. Finally, Figures 99–147 show annual precipitation from both datasets as histograms.

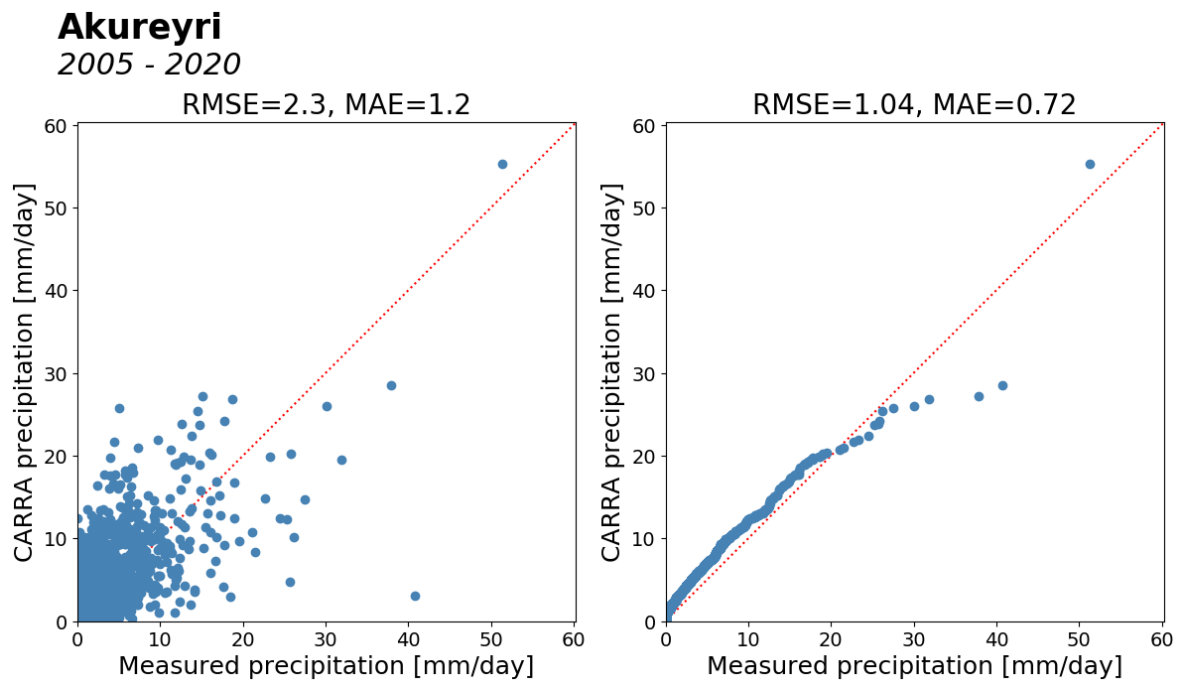


Figure IV.1 – Scatter plot (left) and Q–Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Akureyri.

Bíldudalur

1998 - 2020

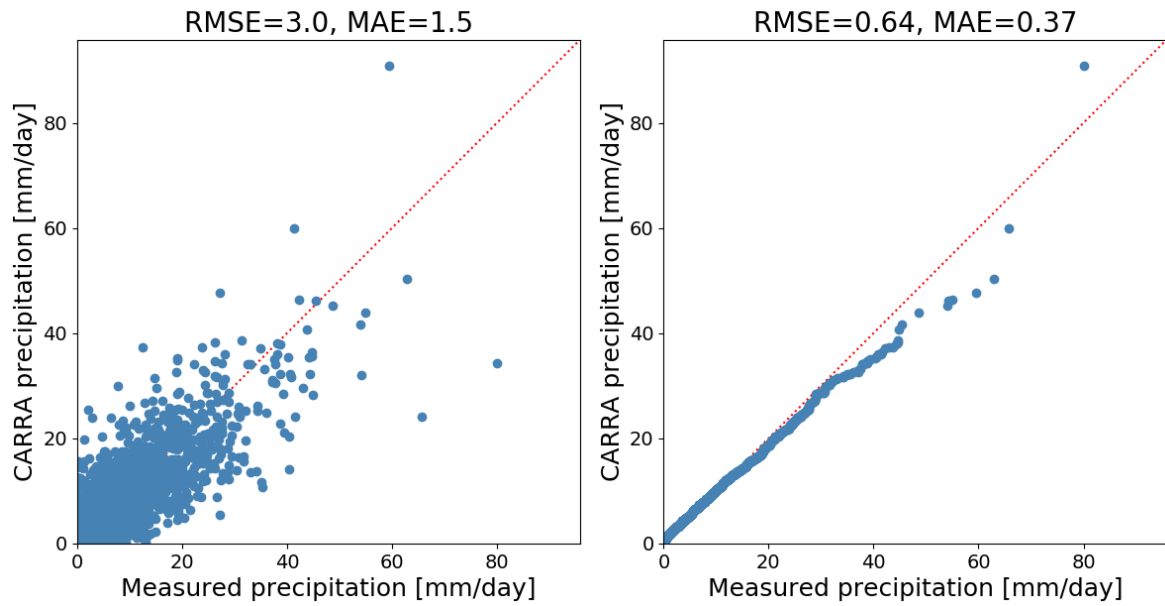


Figure IV.2 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Bíldudalur.

Blönduós

2005 - 2020

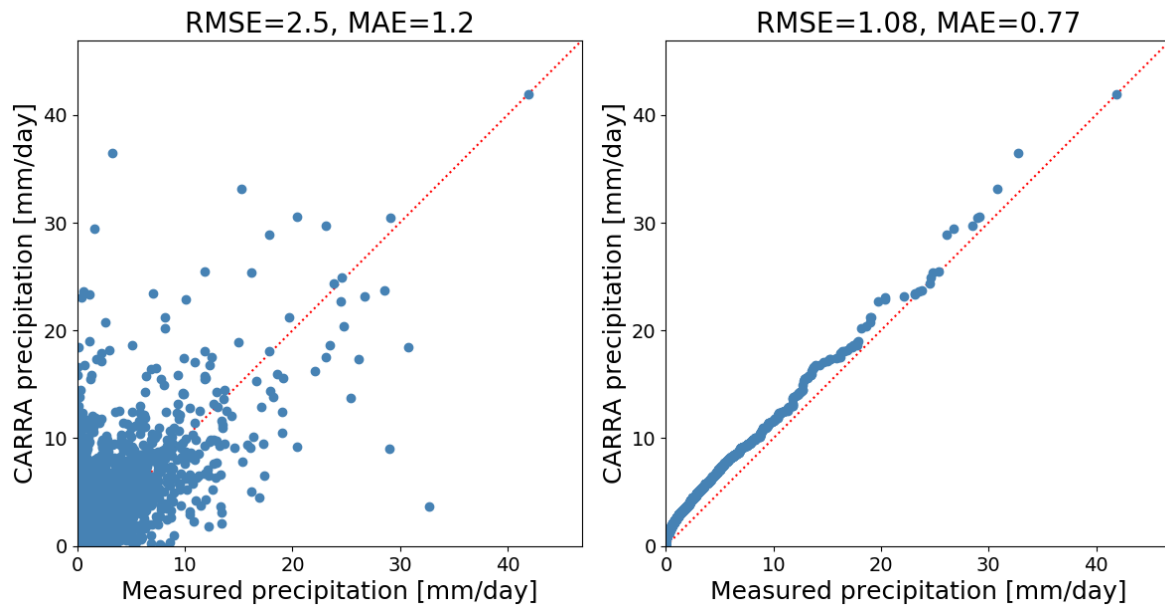


Figure IV.3 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Blönduós.

Bolungarvík

2005 - 2020

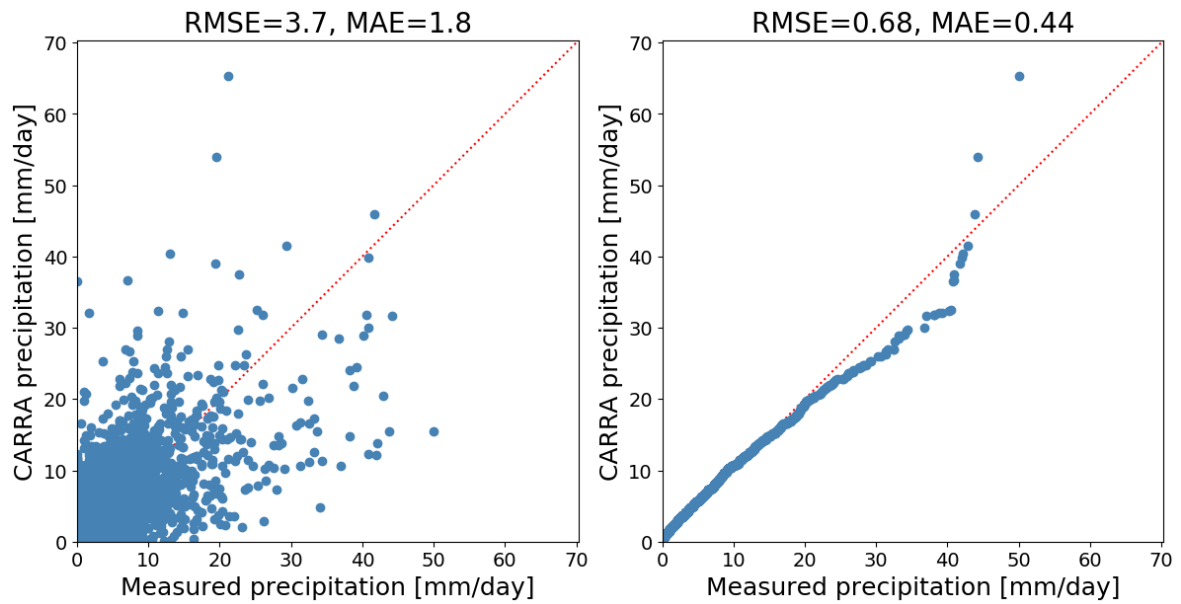


Figure IV.4 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Bolungarvík.

Brú á Jökuldal

1998 - 2020

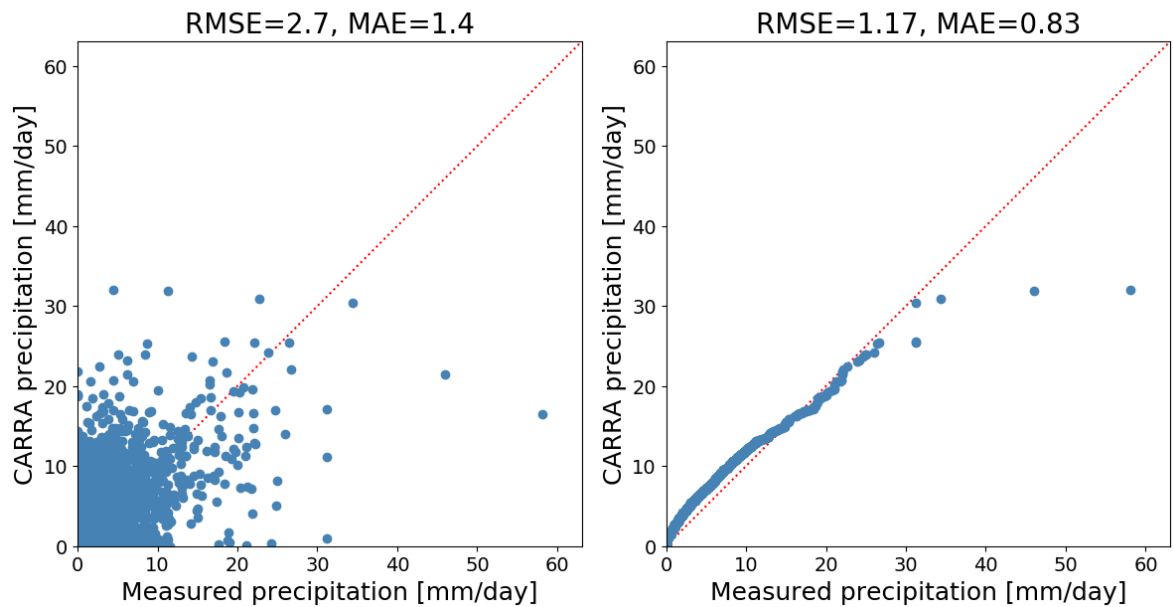


Figure IV.5 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Brú á Jökuldal.

Brúaröræfi

2007 - 2020

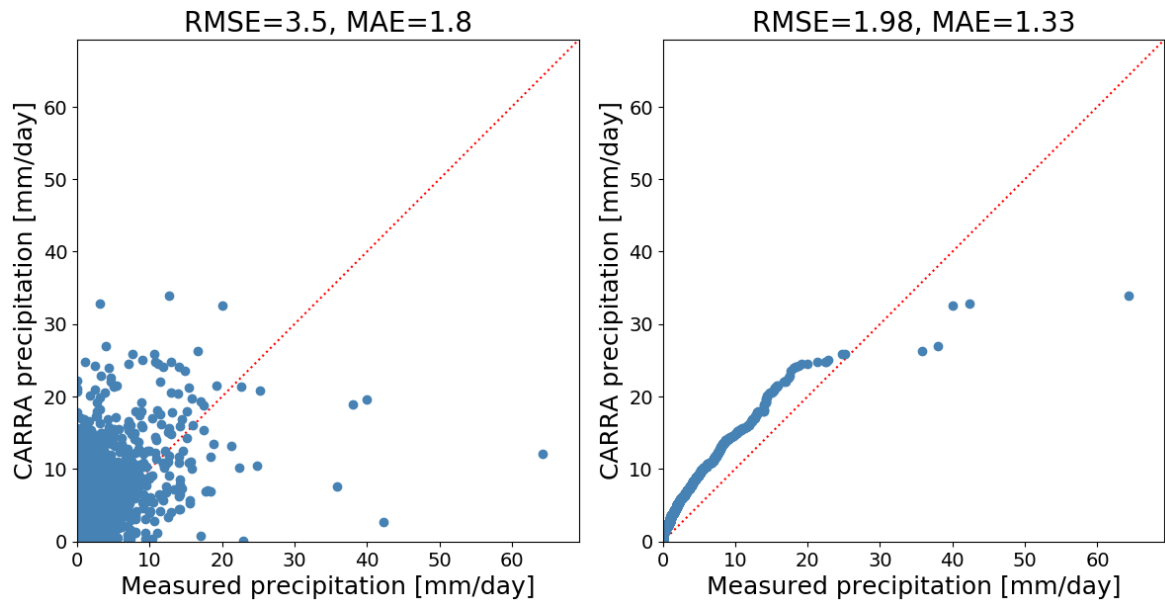


Figure IV.6 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Brúaröræfi.

Búrfell

2003 - 2020

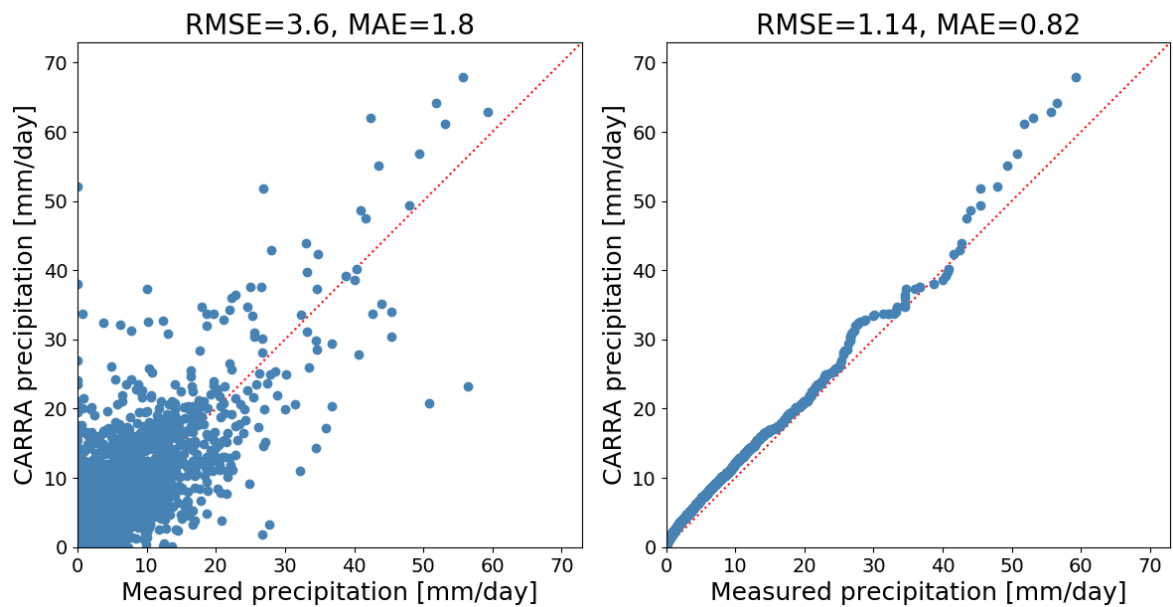


Figure IV.7 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Búrfell.

Dalatangi

2006 - 2020

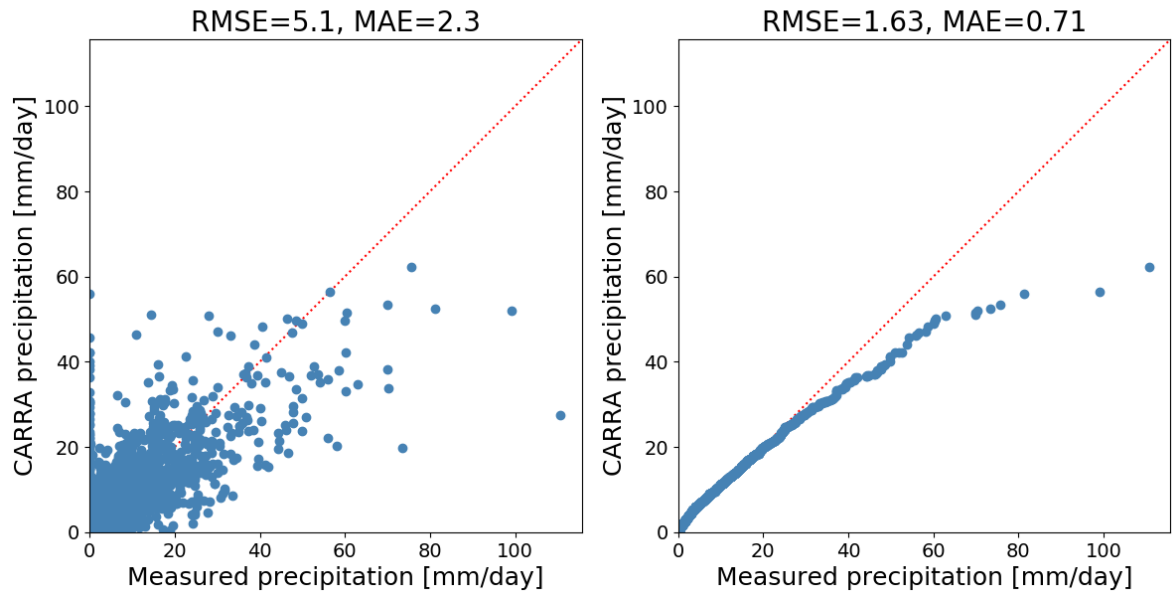


Figure IV.8 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Dalatangi.

Egilsstaðaflogvöllur

1998 - 2020

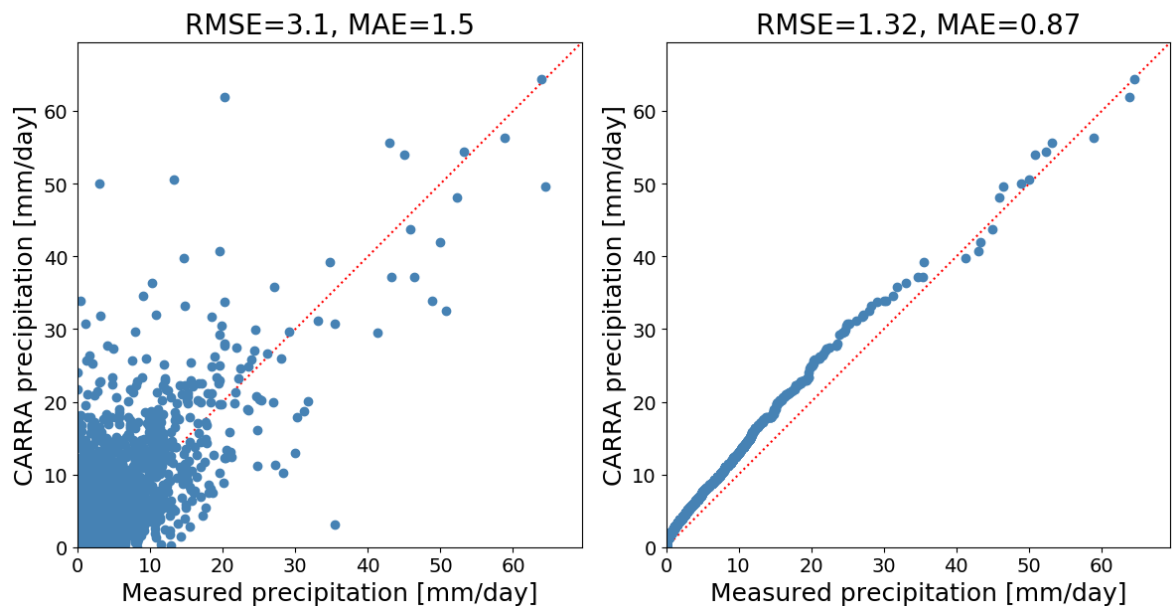


Figure IV.9 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Egilsstaðaflogvöllur.

Eskifjörður

1998 - 2020

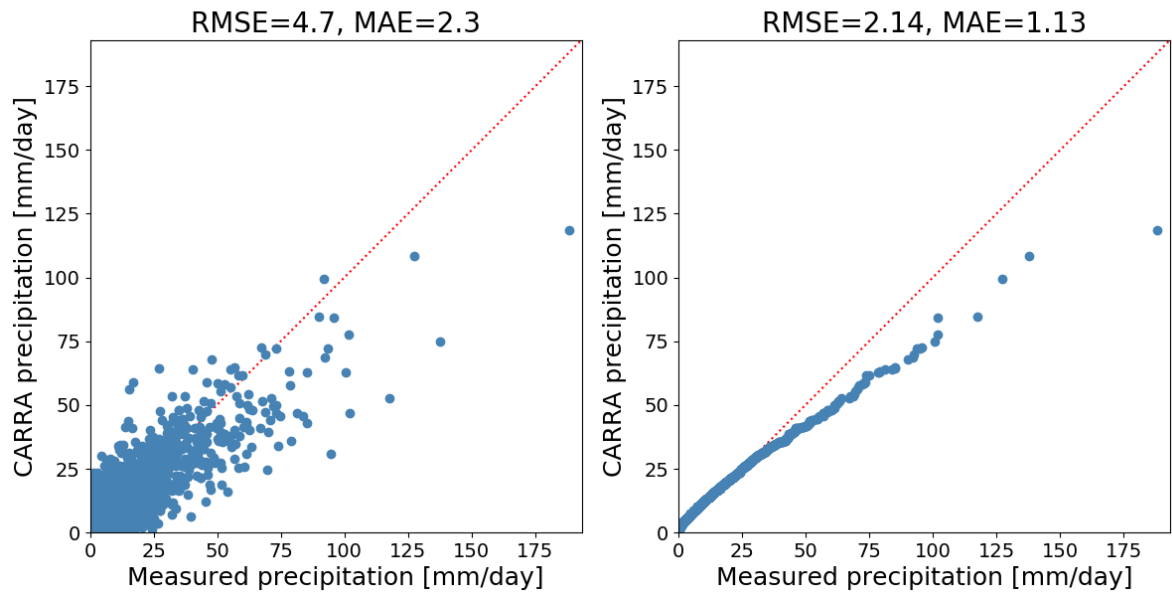


Figure IV.10 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Eskifjörður.

Eyjabakkar

2003 - 2020

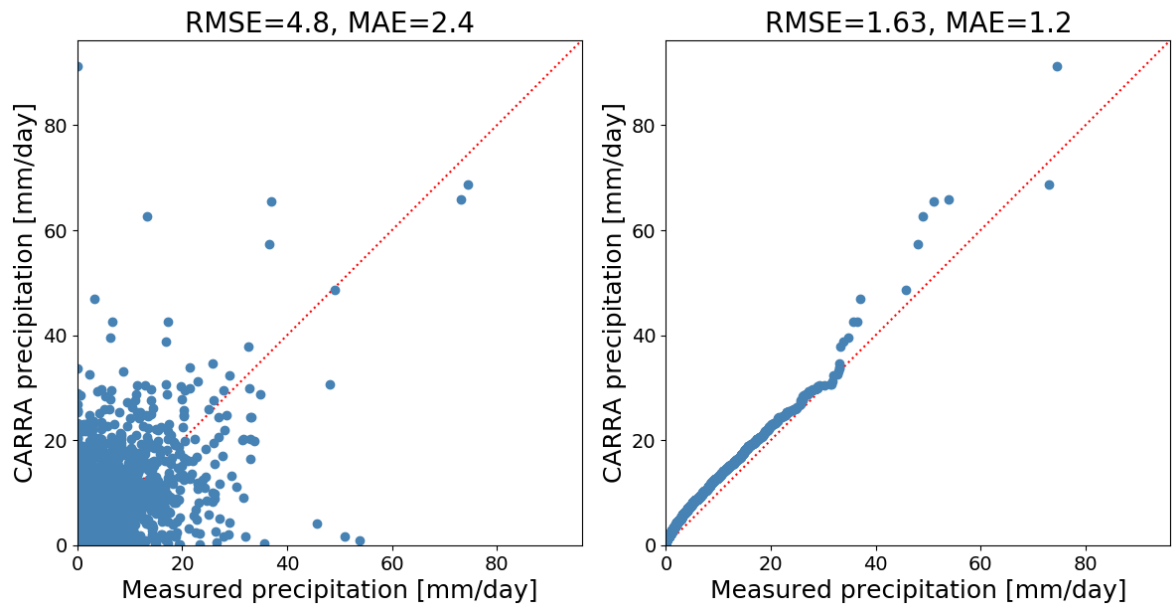


Figure IV.11 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Eyjabakkar.

Fíflholt á Mýrum

2006 - 2020

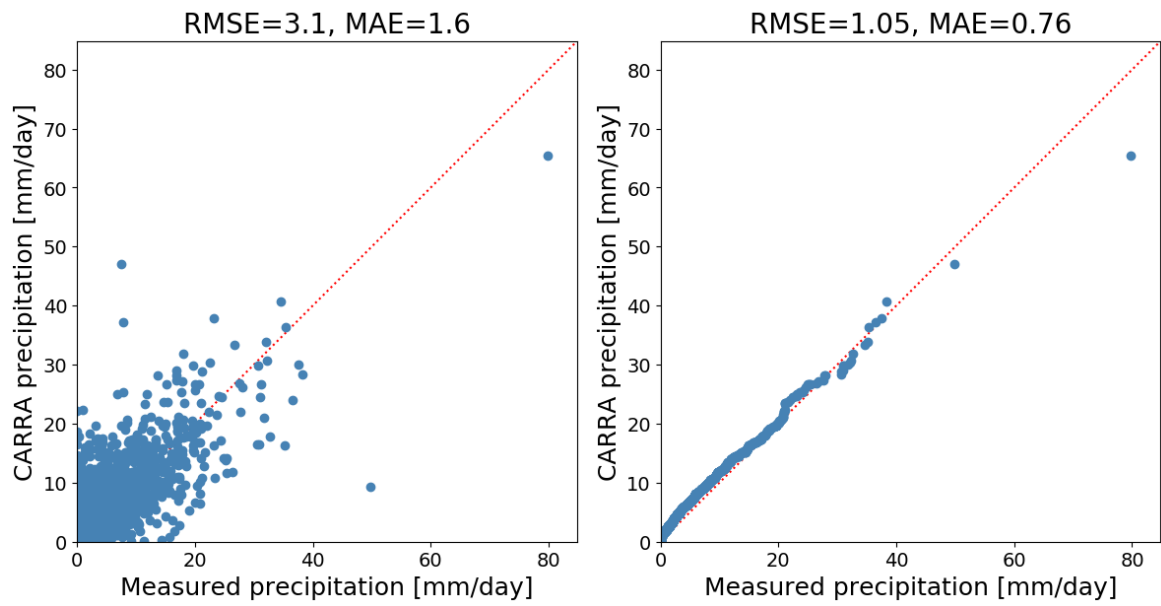


Figure IV.12 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Fíflholt.

Flateyri

1997 - 2020

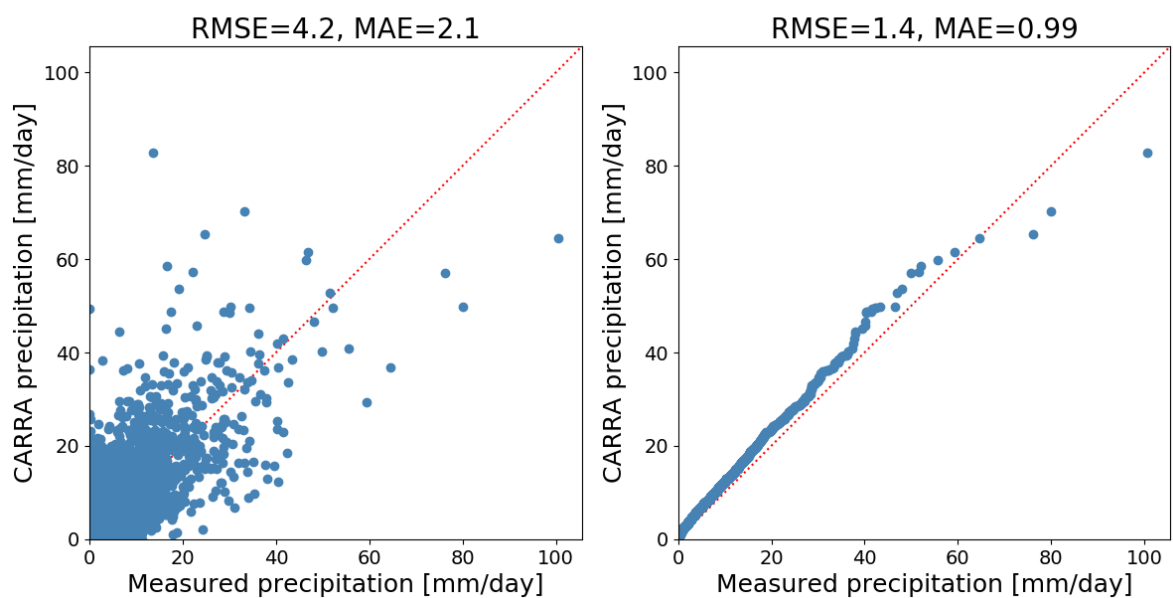


Figure IV.13 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Flateyri.

Grindavík

2009 - 2020

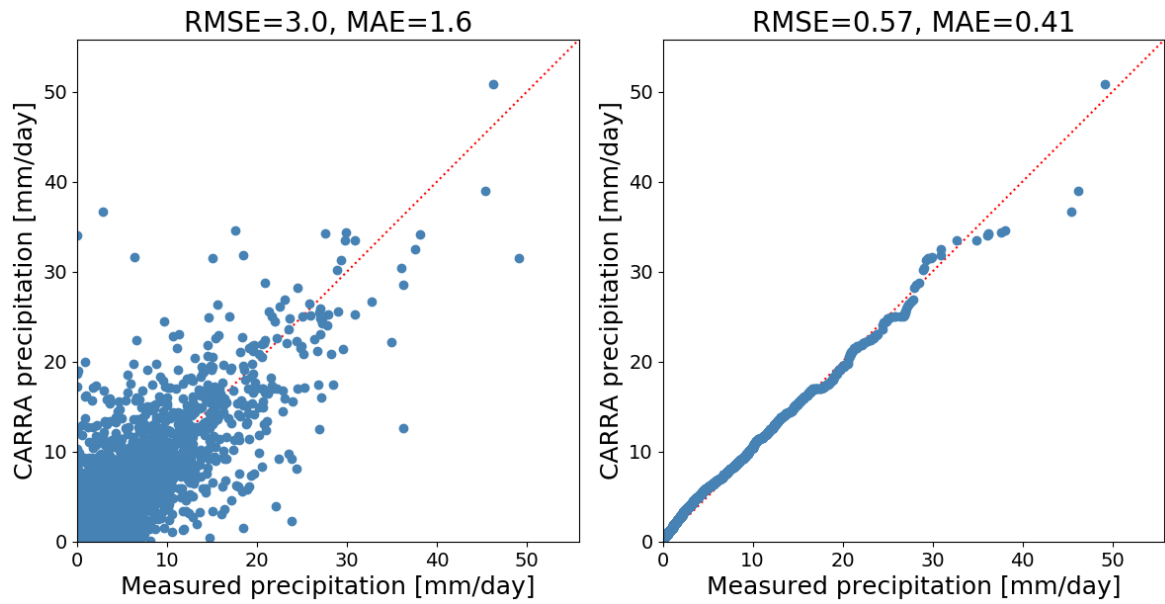


Figure IV.14 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Grindavík.

Grundarfjörður

2005 - 2020

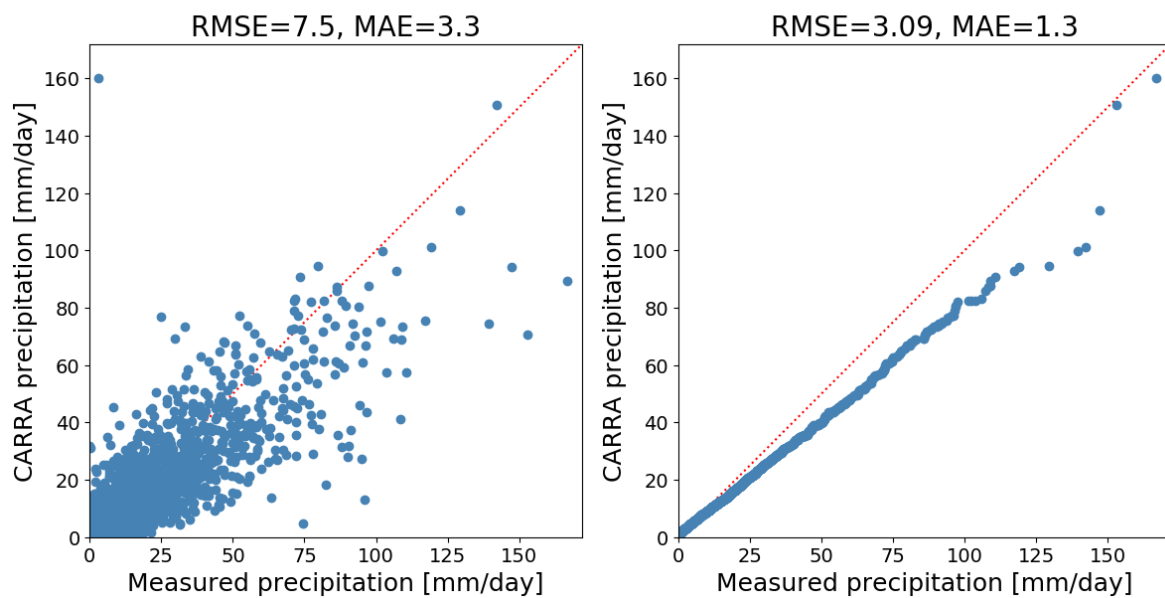


Figure IV.15 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Grundarfjörður.

Gufuskálar

2005 - 2020

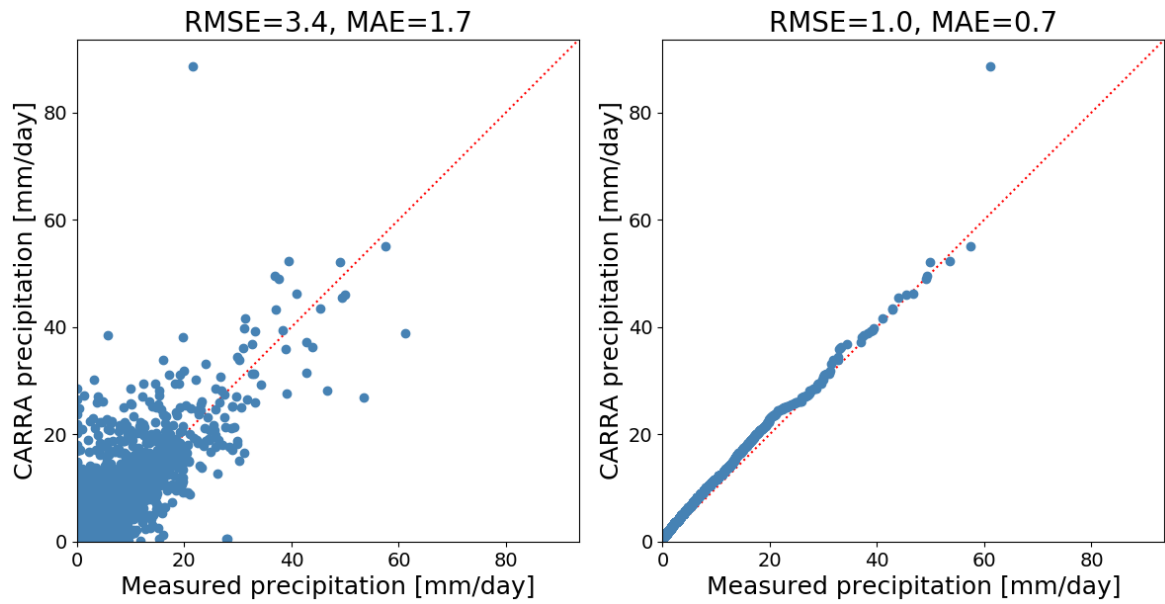


Figure IV.16 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Gufuskálar.

Hágöngur

2004 - 2020

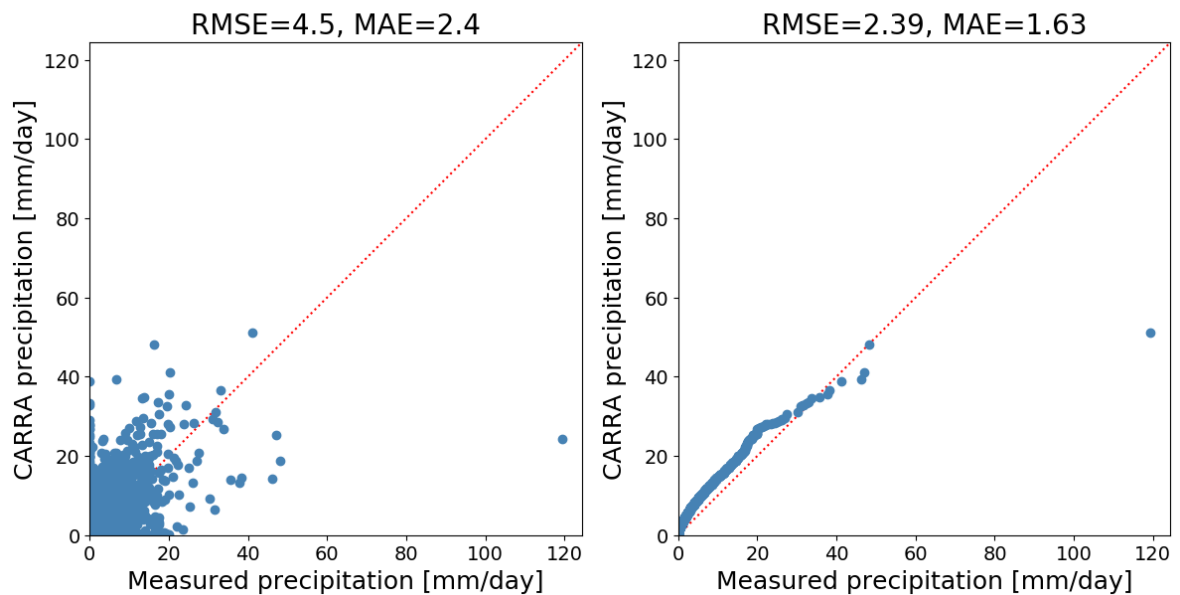


Figure IV.17 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Hágöngur.

Hallormsstaður

1999 - 2020

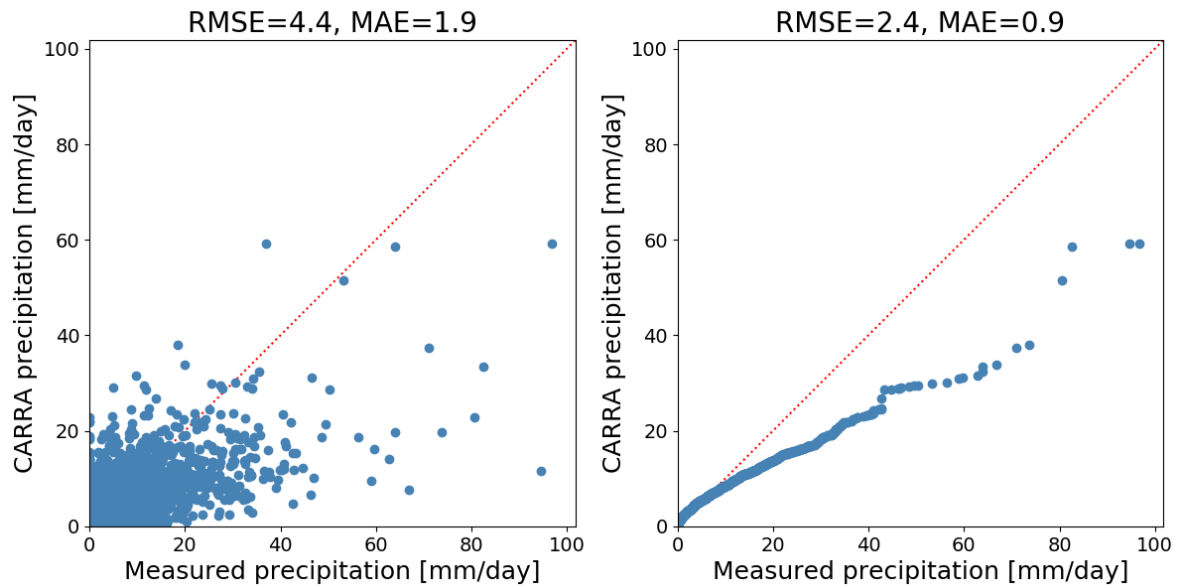


Figure IV.18 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Hallormsstaður.

Hellisskarð

2001 - 2020

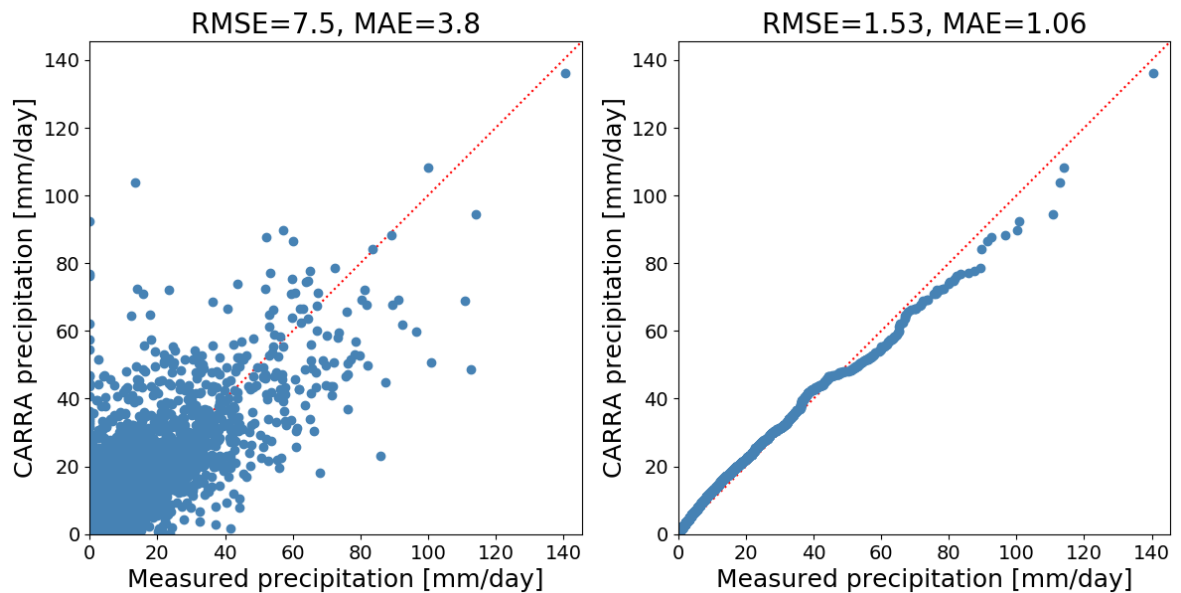


Figure IV.19 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Hellisskarð.

Höfn í Hornafirði

2008 - 2020

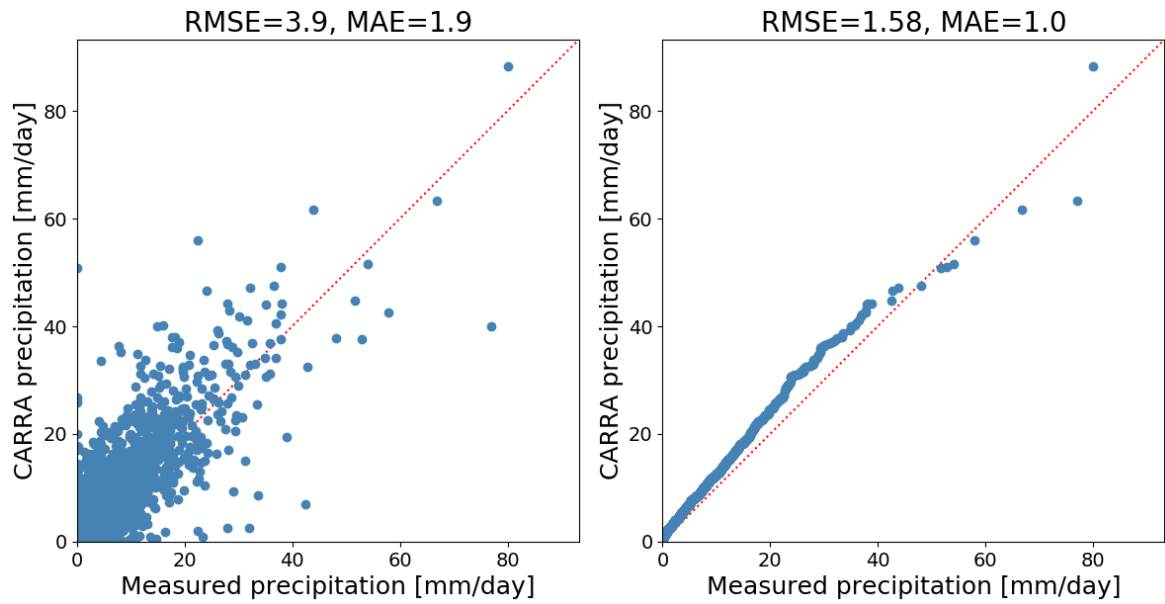


Figure IV.20 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Höfn í Hornafirði.

Hvanneyri

1999 - 2020

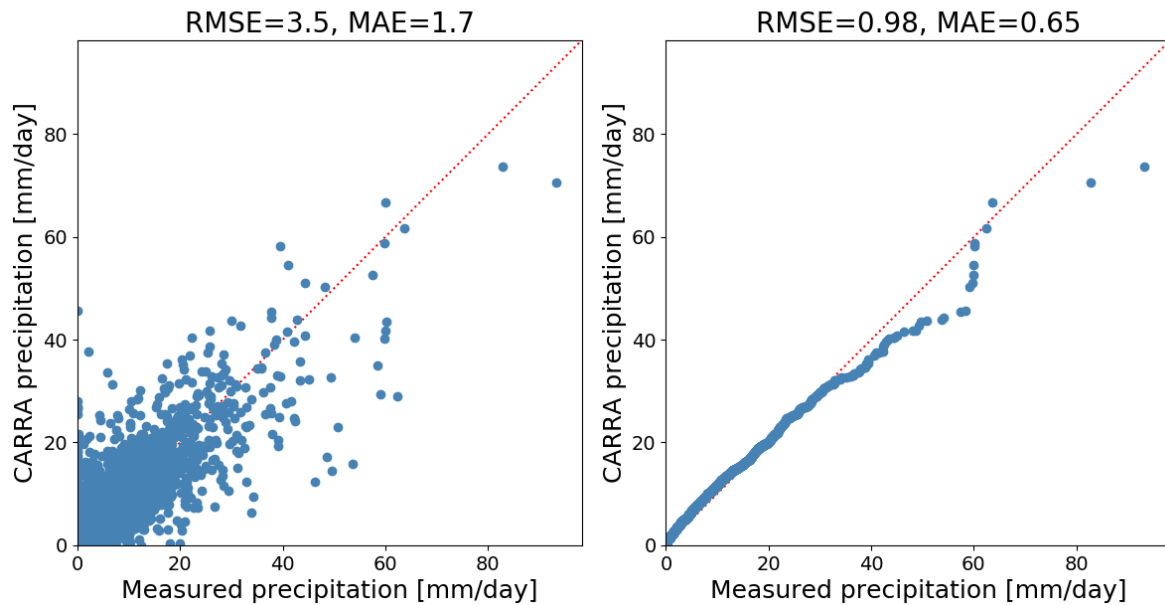


Figure IV.21 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Hvanneyri.

Hveravellir

2002 - 2020

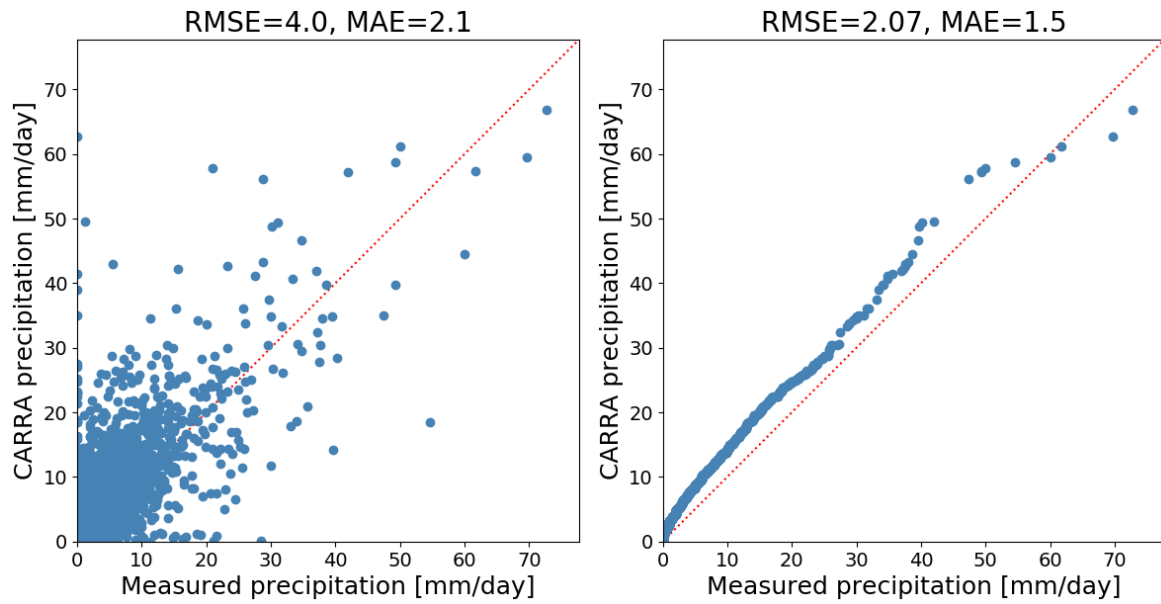


Figure IV.22 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Hveravellir.

Ísafjörður

1998 - 2020

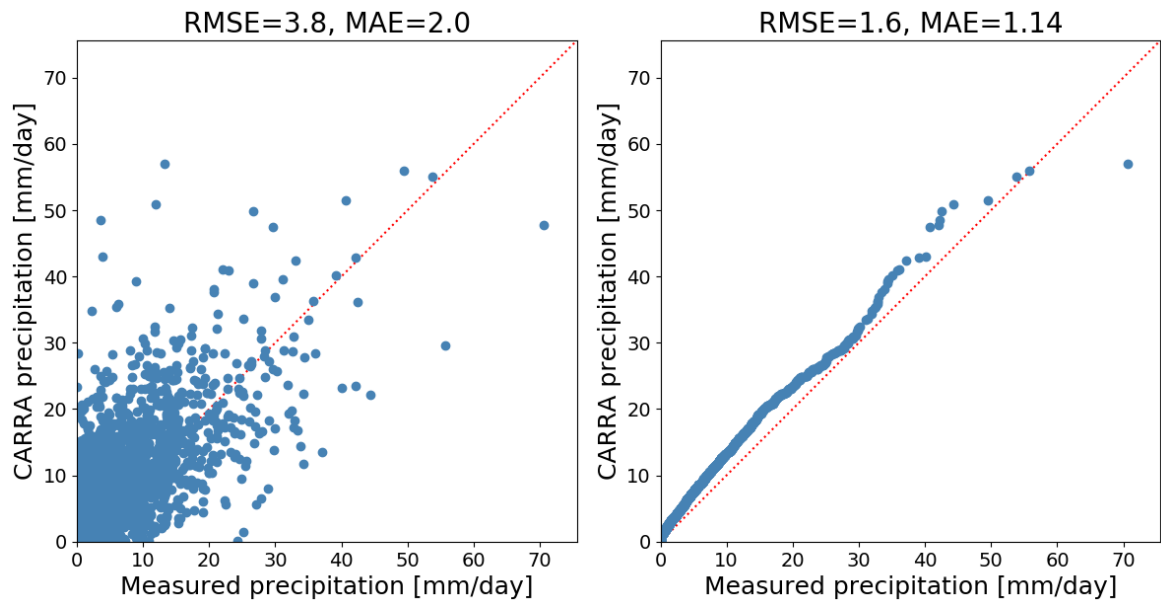


Figure IV.23 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Ísafjörður.

Kálfhóll

2005 - 2020

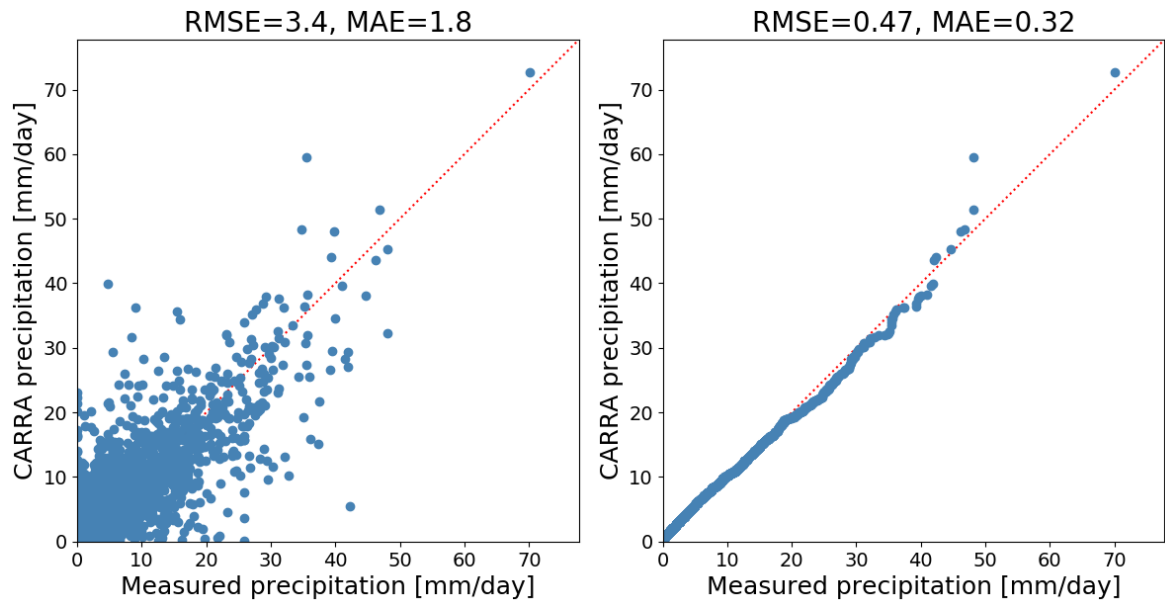


Figure IV.24 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Kálfhóll.

Kárahnjúkar

2003 - 2020

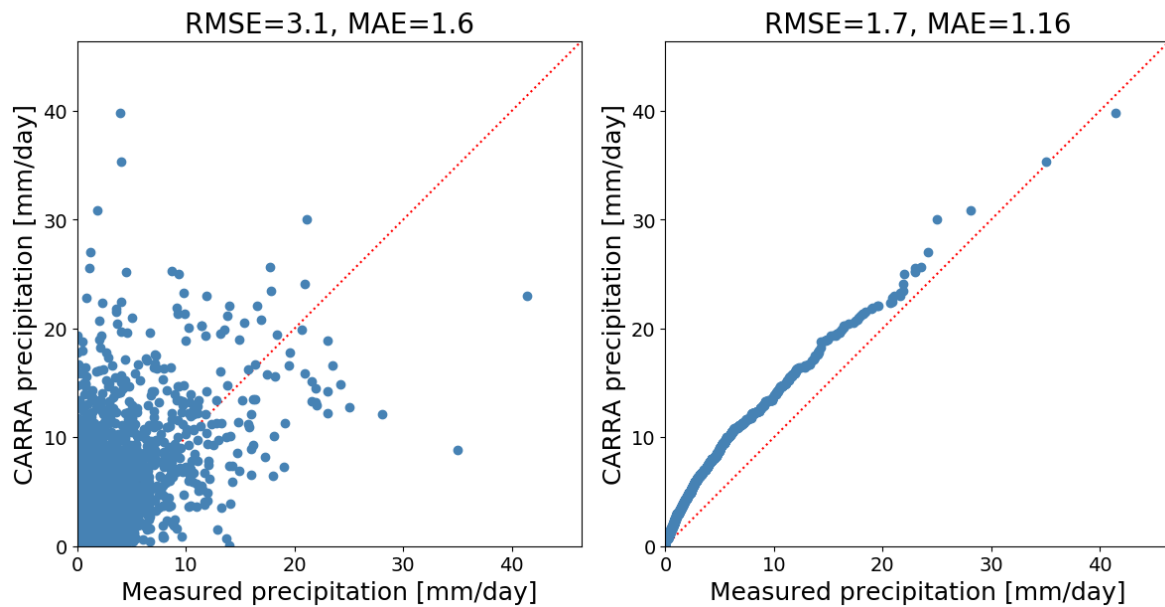


Figure IV.25 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Kárahnjúkar.

Kirkjubæjarklaustur

2006 - 2020

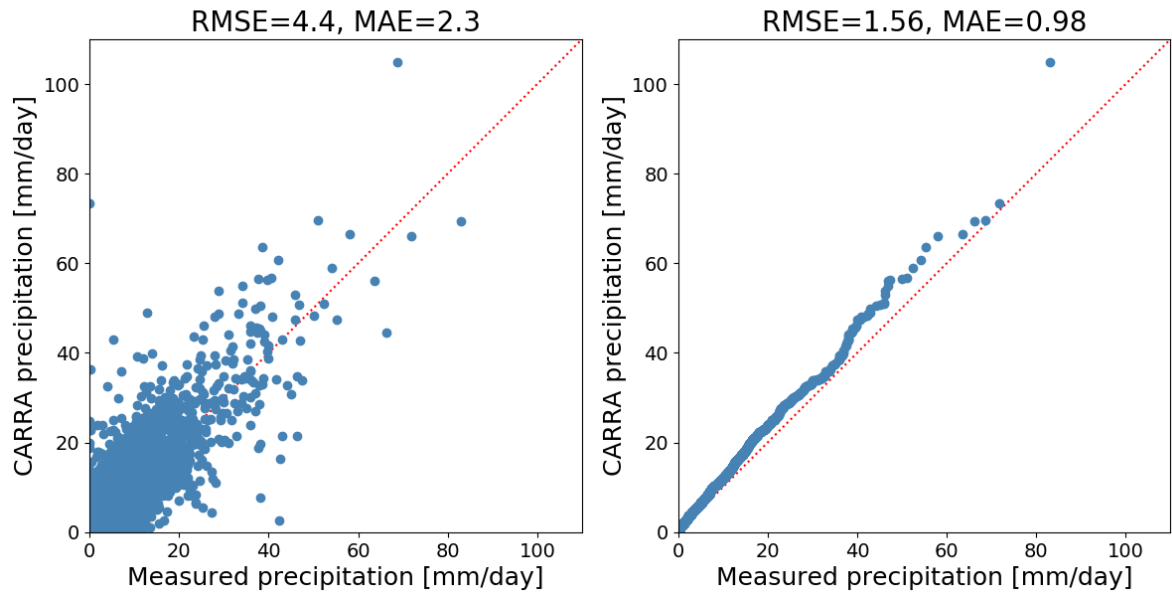


Figure IV.26 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Kirkjubæjarklaustur.

Korpa

2000 - 2020

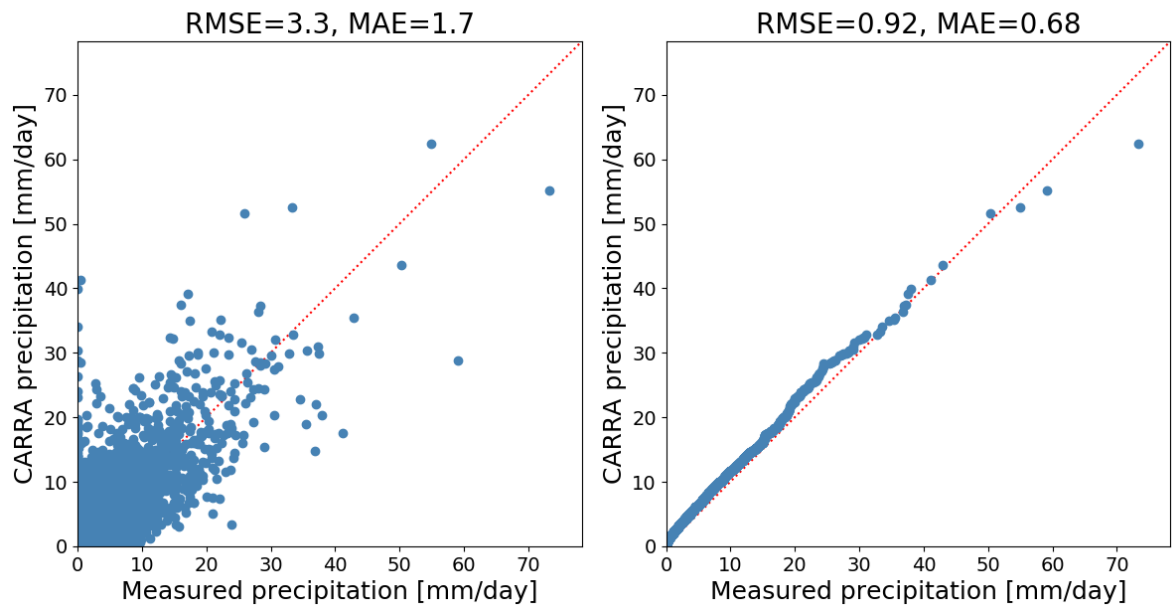


Figure IV.27 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Korpa.

Kvísker

2009 - 2020

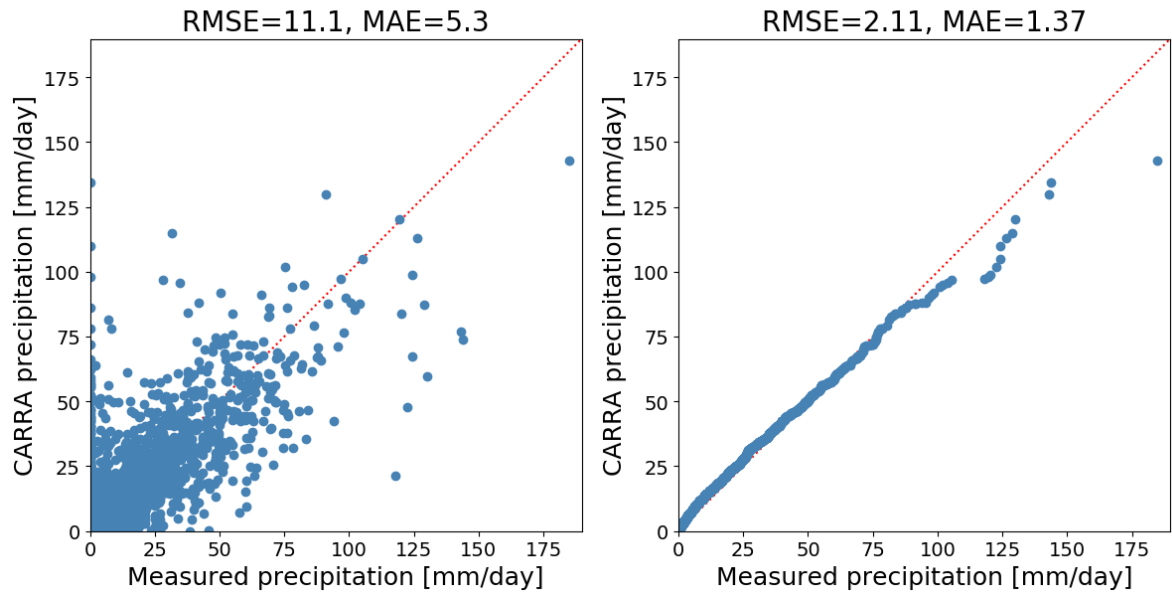


Figure IV.28 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Kvísker.

Laufbali

2004 - 2020

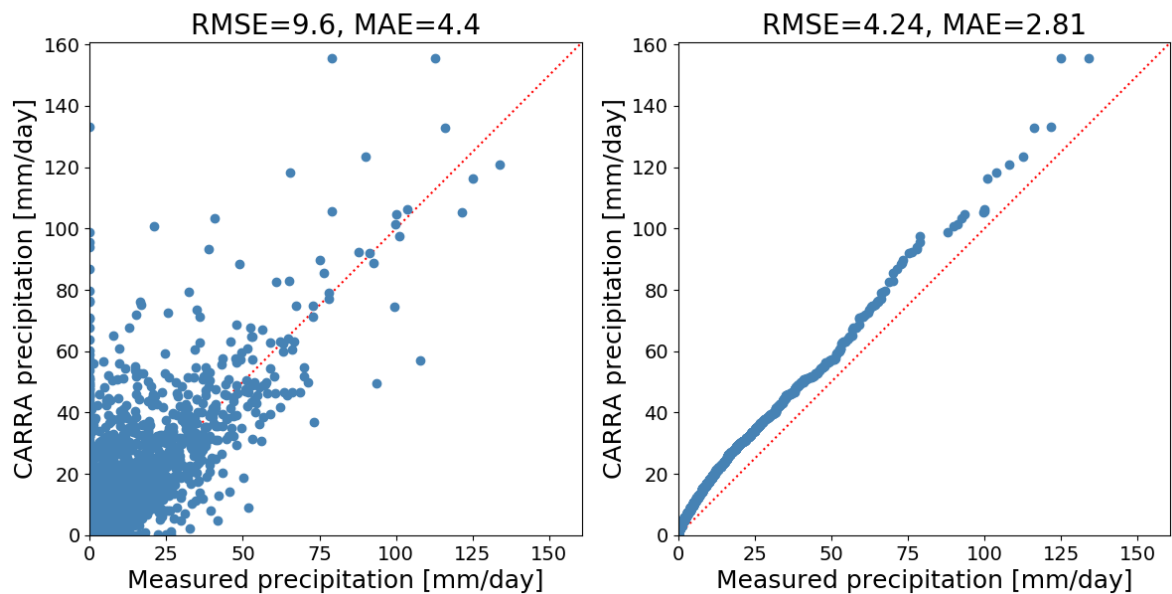


Figure IV.29 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Laufbali.

Möðruvellir

2005 - 2020

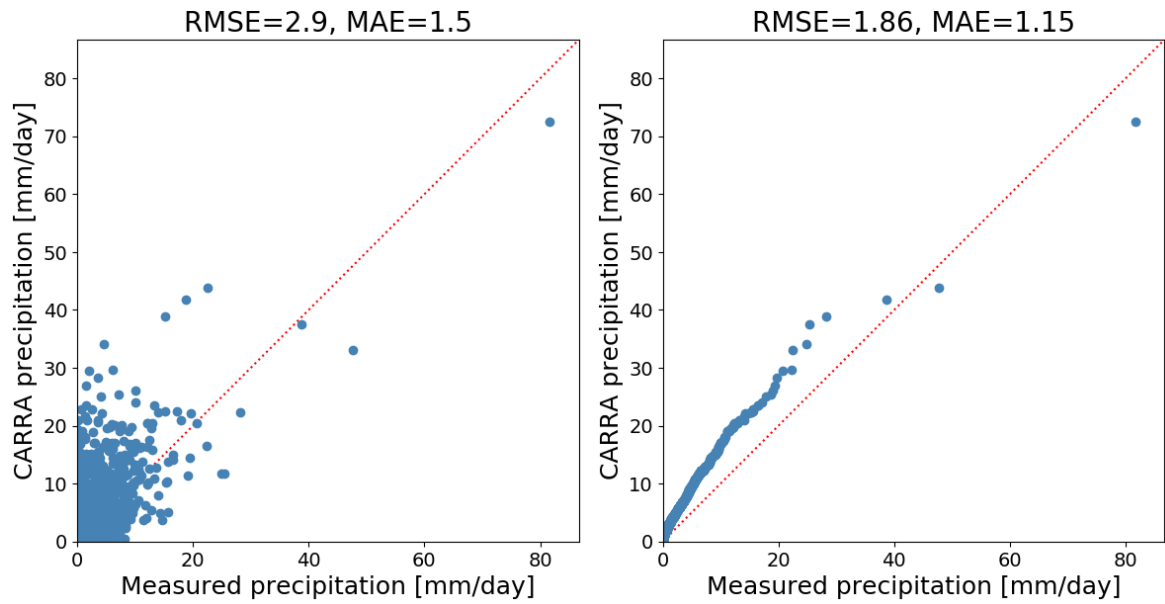


Figure IV.30 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Möðruvellir.

Nautabú

2005 - 2020

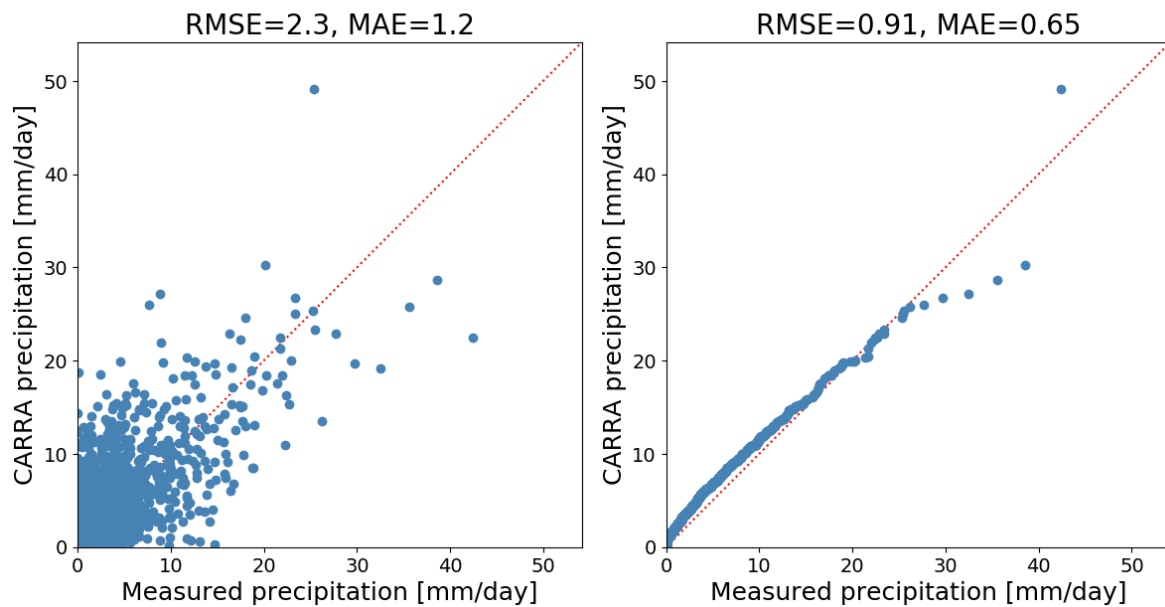


Figure IV.31 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Nautabú.

Neskaupstaður

1997 - 2020

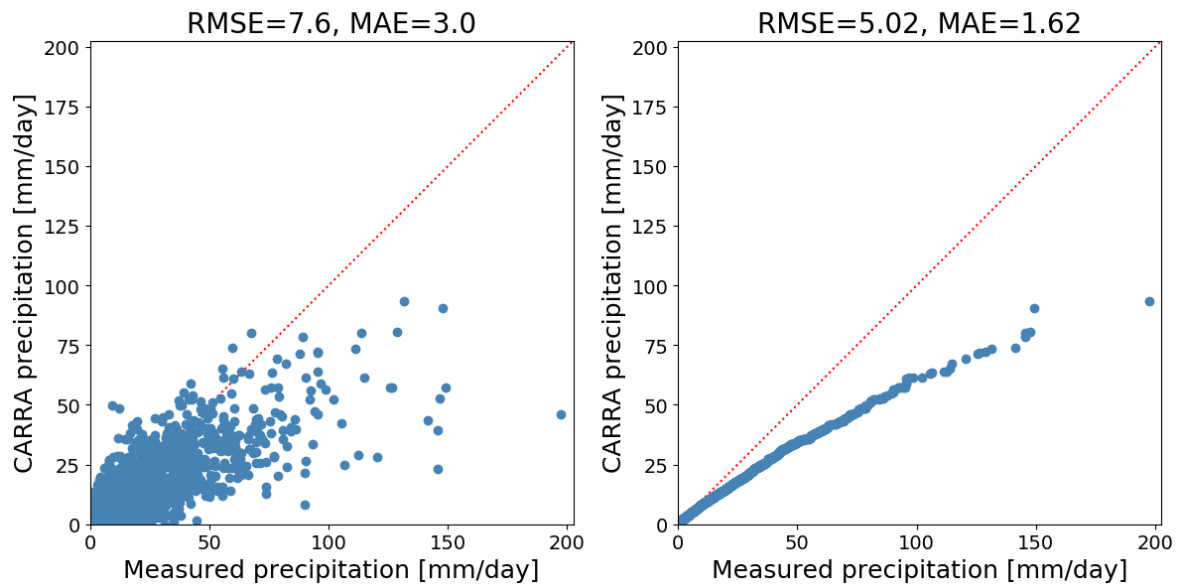


Figure IV.32 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Neskaupstaður.

Ólafsfjörður

1997 - 2020

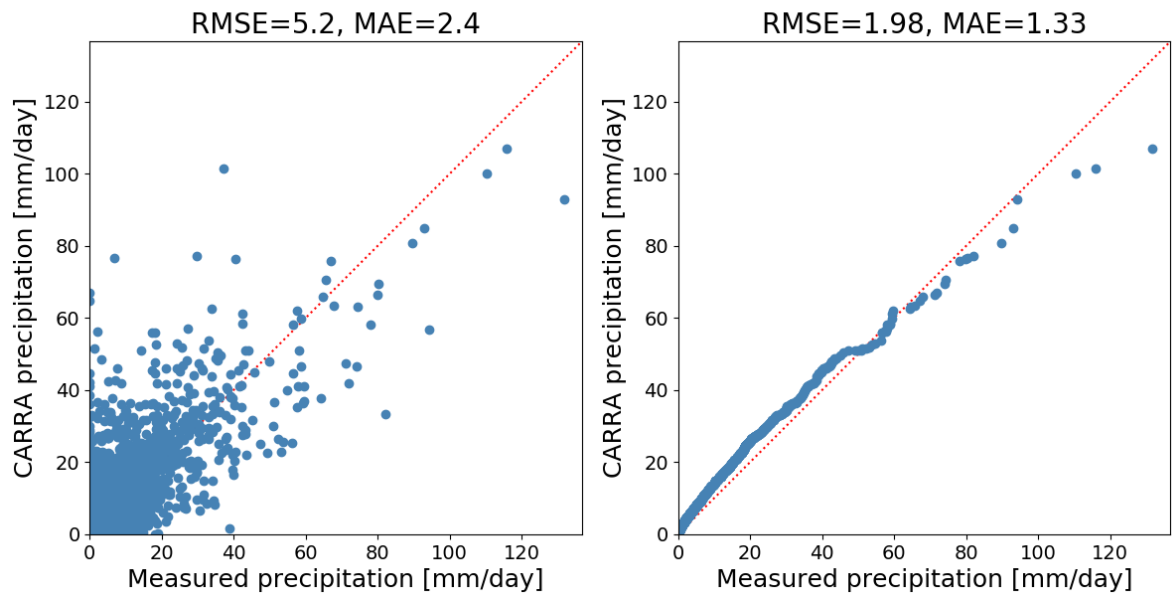


Figure IV.33 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Ólafsfjörður.

Ólafsvík 2000 - 2020

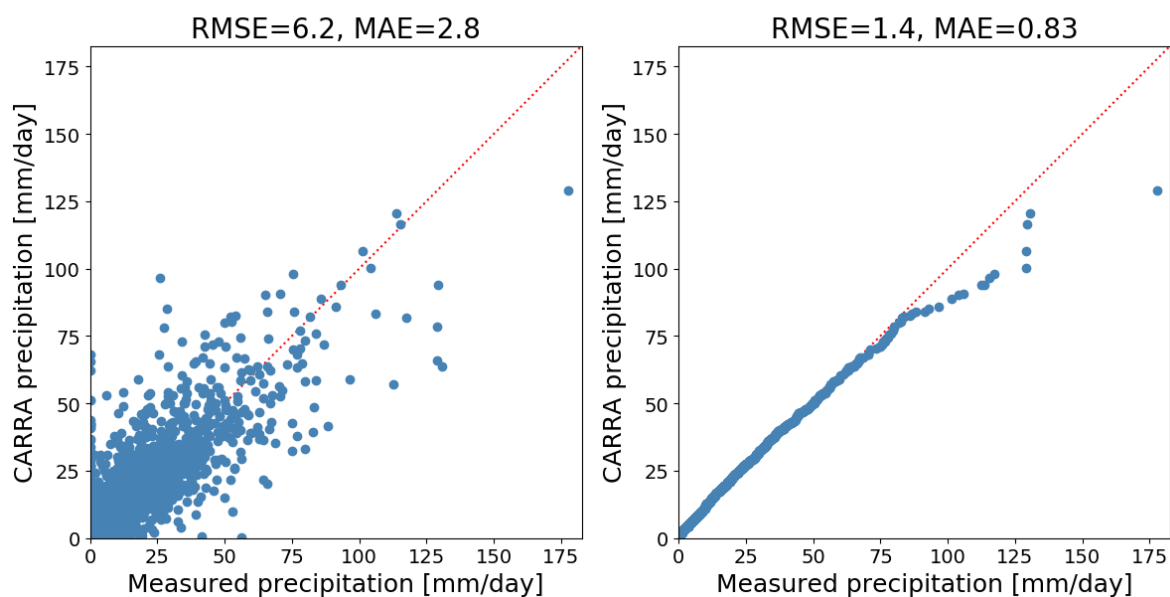


Figure IV.34 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Ólafsvík.

Ölkelduháls 2001 - 2020

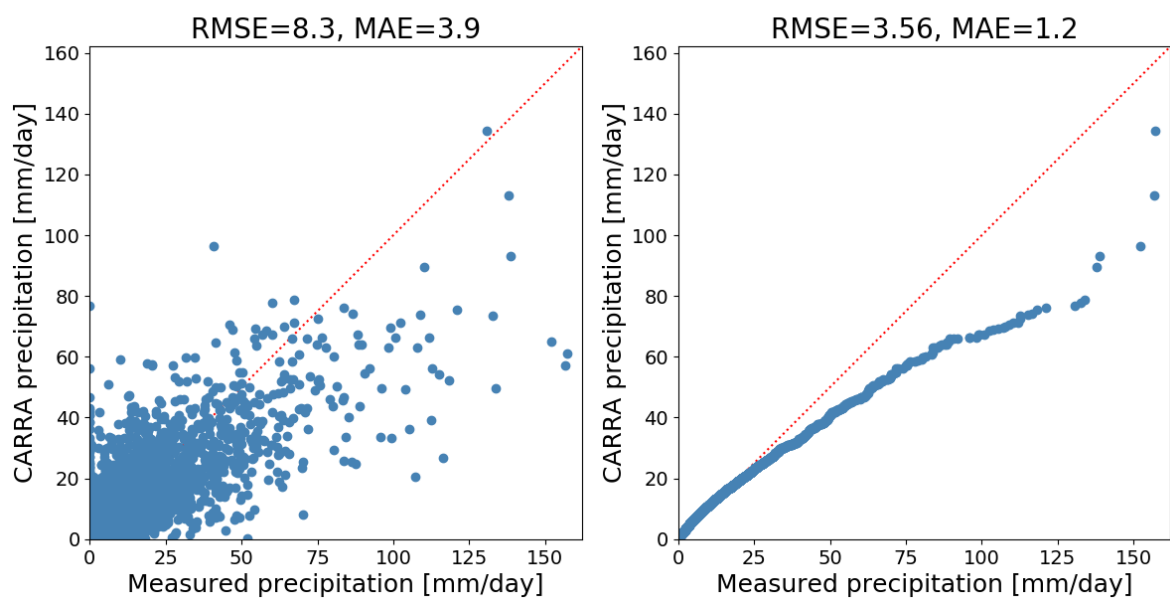


Figure IV.35 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Ölkelduháls.

Patreksfjörður

1996 - 2020

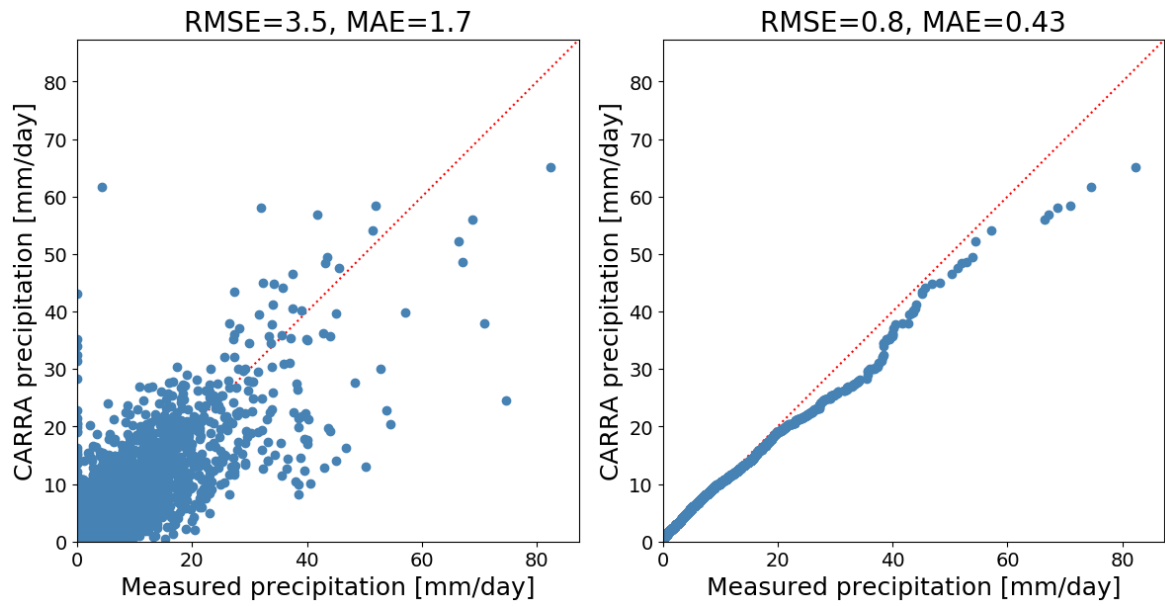


Figure IV.36 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Patreksfjörður.

Raufarhöfn

2005 - 2020

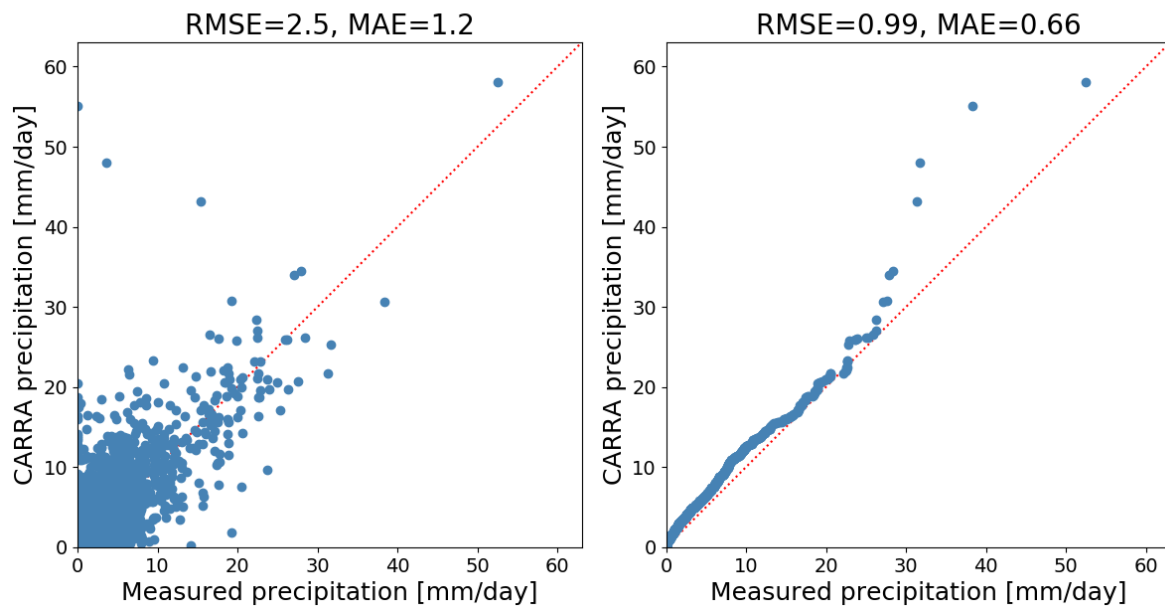


Figure IV.37 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Raufarhöfn.

Reykjavík

1997 - 2020

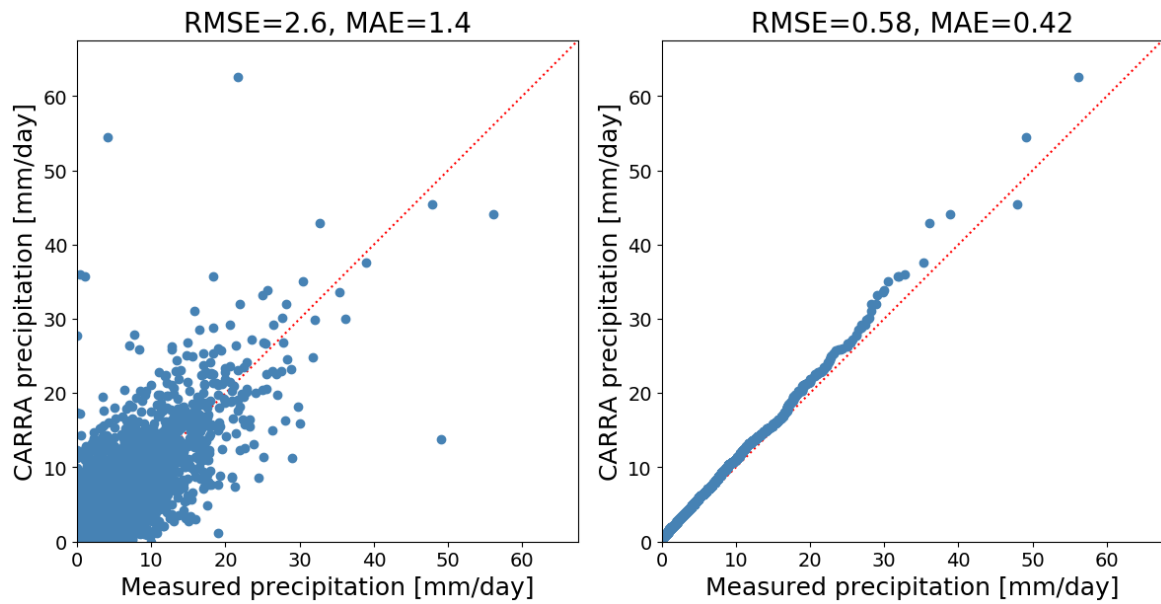


Figure IV.38 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Reykjavík.

Sámsstaðir

2000 - 2020

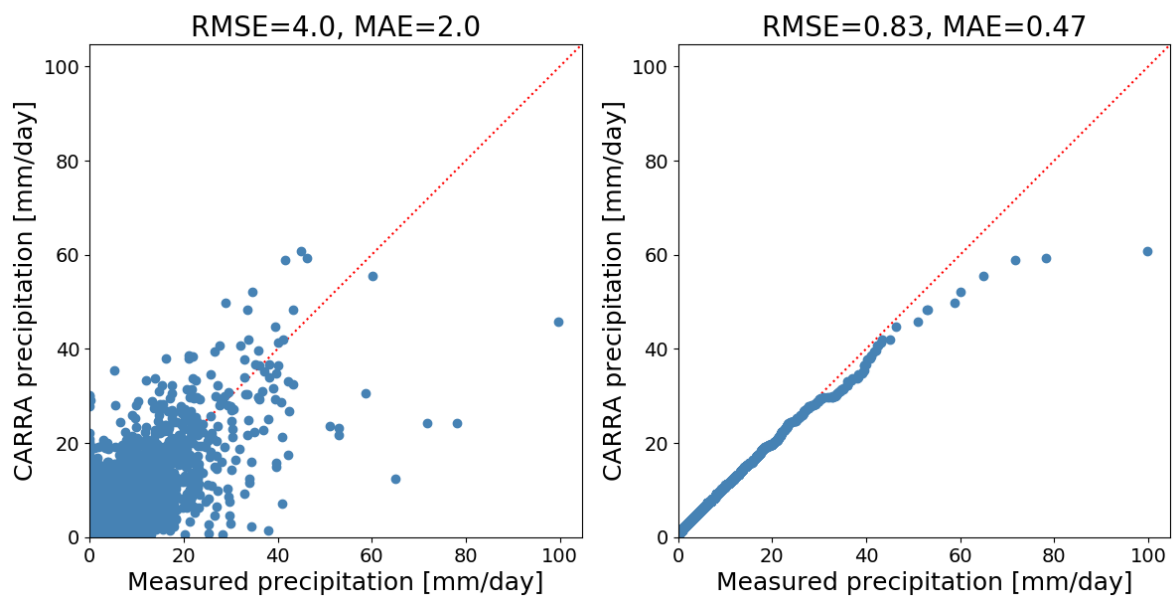


Figure IV.39 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Sámsstaðir.

Sandbúðir

2003 - 2020

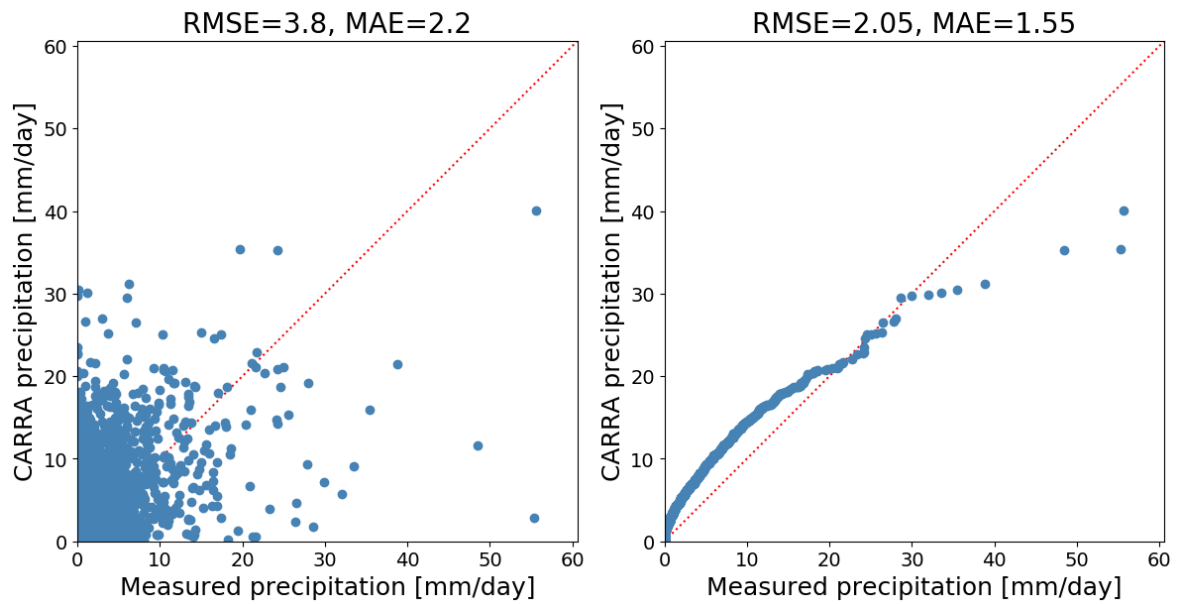


Figure IV.40 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Sandbúðir.

Seyðisfjörður

1995 - 2020

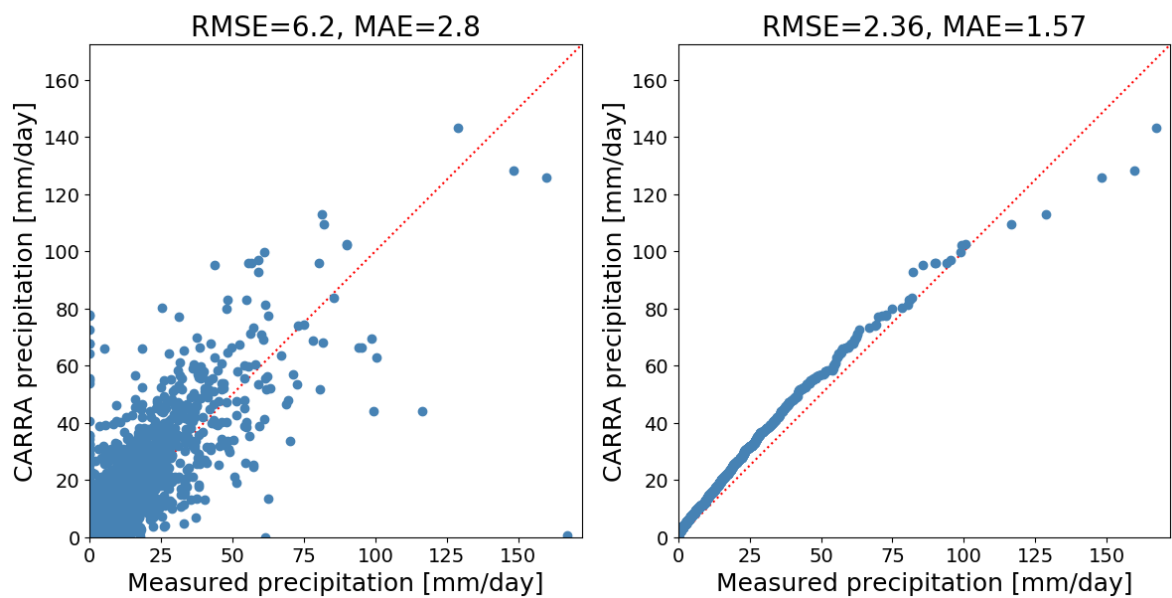


Figure IV.41 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Seyðisfjörður.

Siglufjörður

1995 - 2020

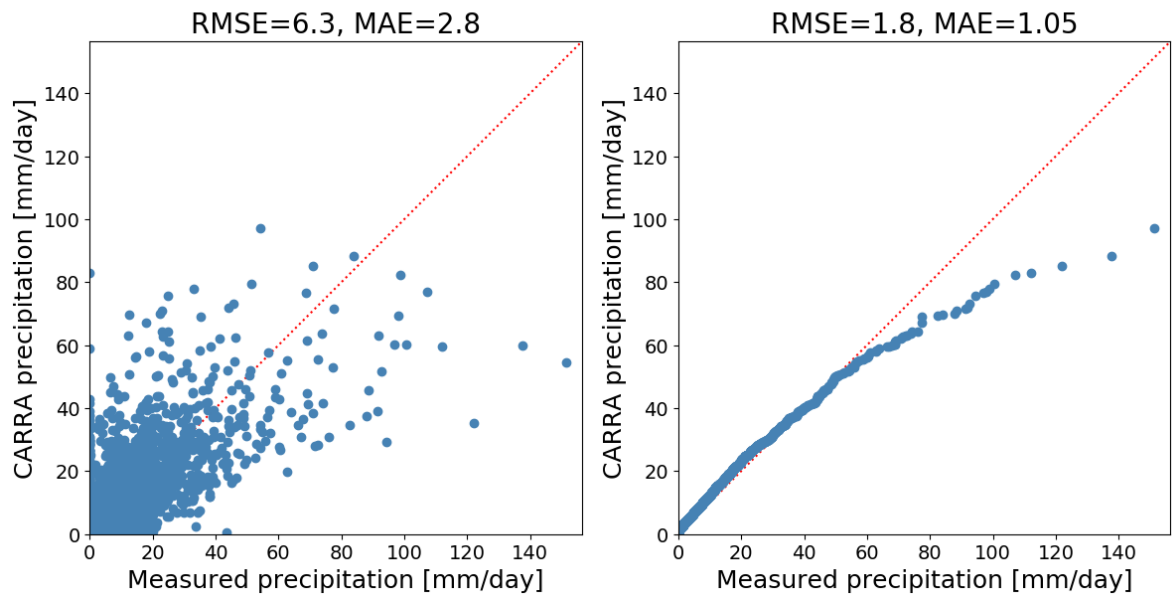


Figure IV.42 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Siglufjörður.

Stykkishólmur

2005 - 2020

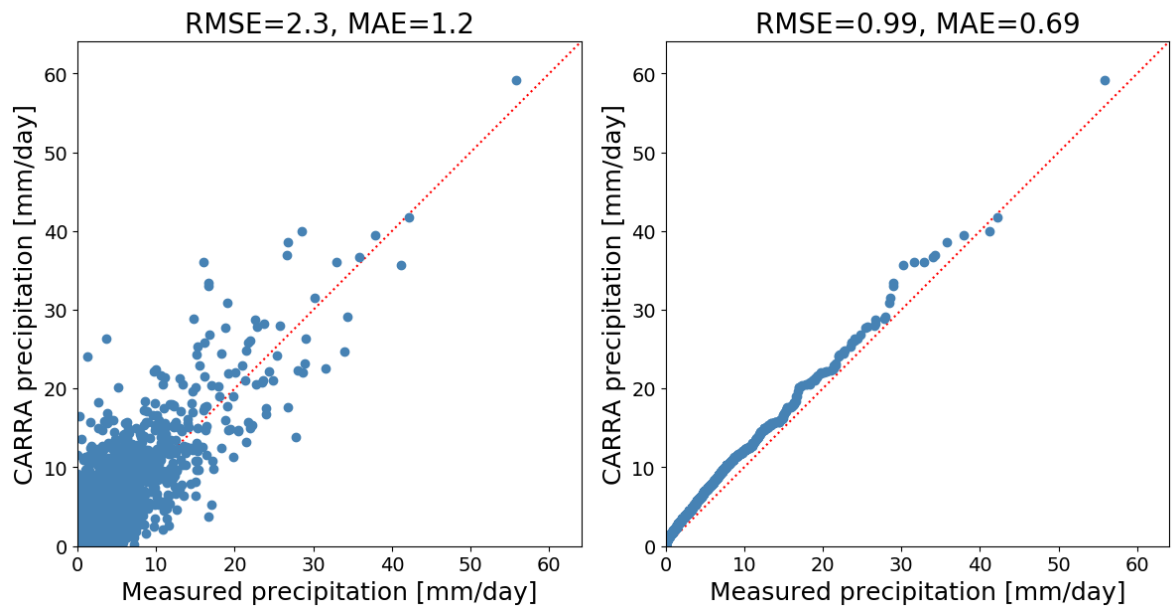


Figure IV.43 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Stykkishólmur.

Súðavík

1999 - 2020

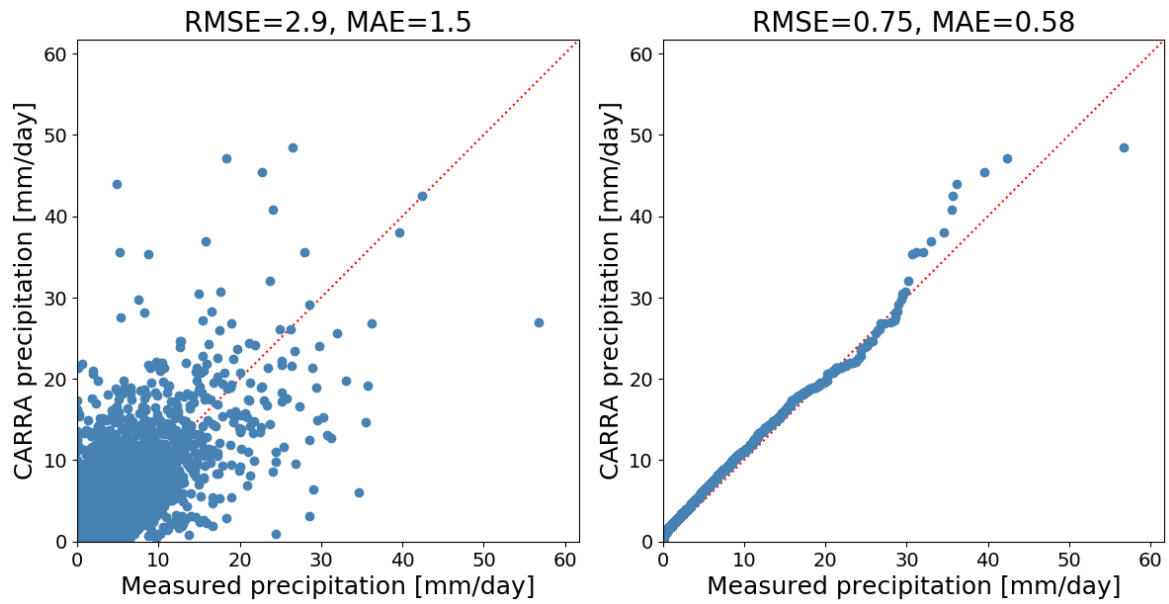


Figure IV.44 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Súðavík.

Tálknafjörður

2009 - 2020

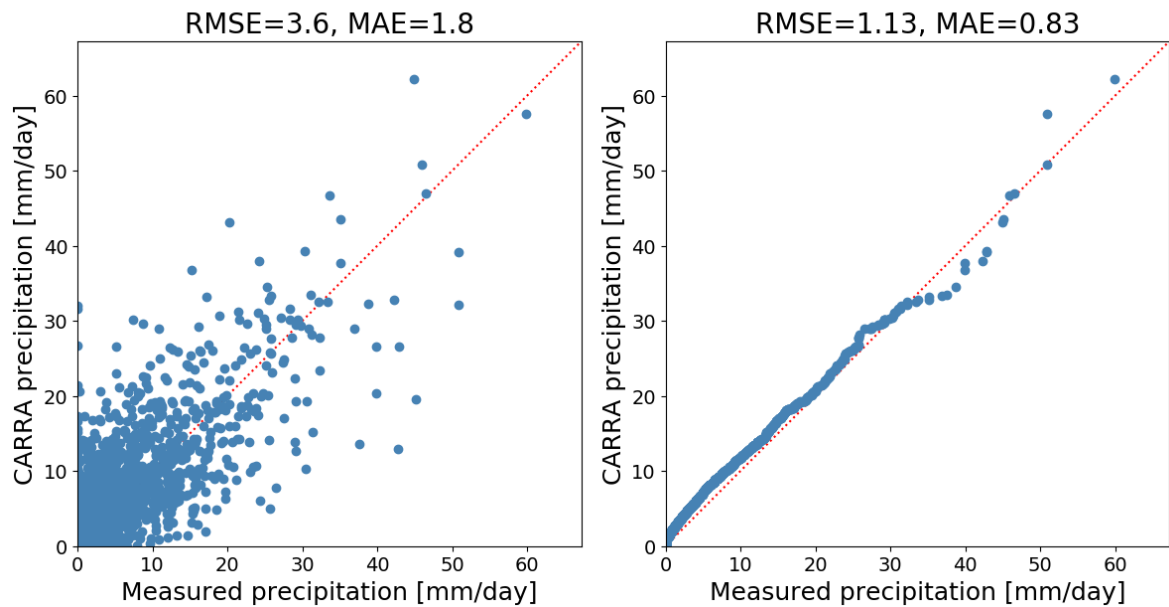


Figure IV.45 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Tálknafjörður.

Þingvellir

1998 - 2020

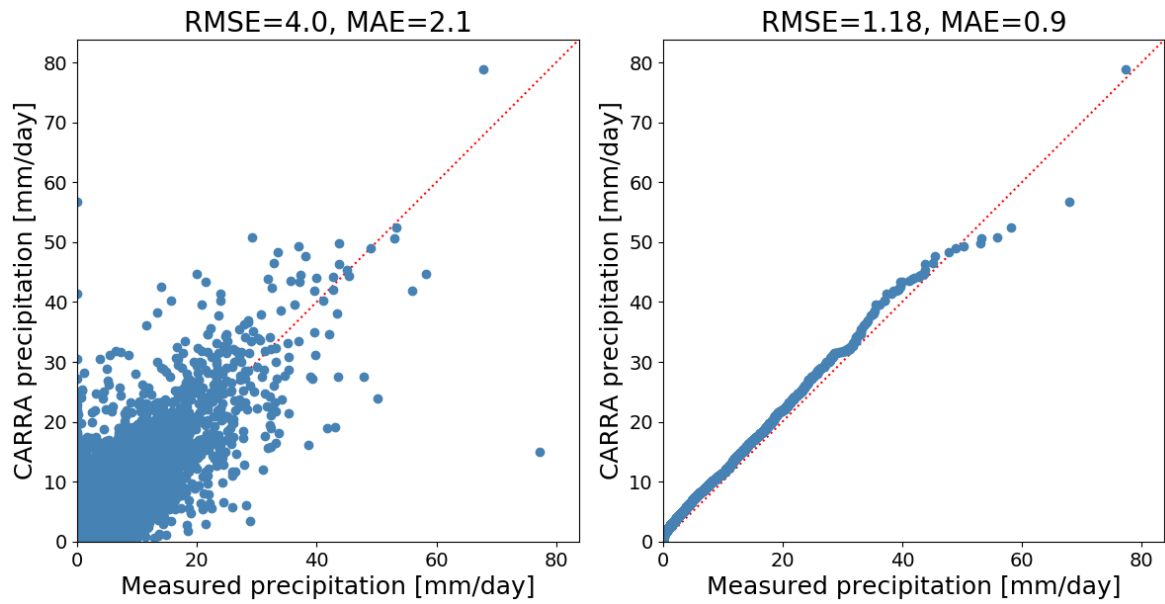


Figure IV.46 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Þingvellir.

Þykkvibær

1996 - 2020

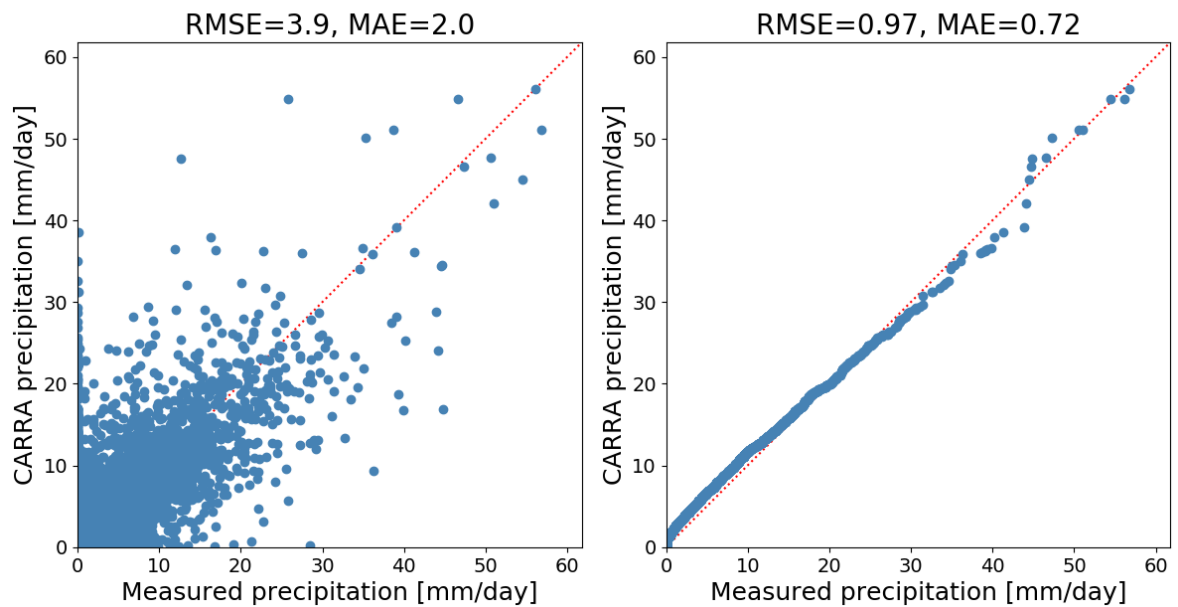


Figure IV.47 — Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Þykkvibær.

Vatnsfell

2004 - 2020

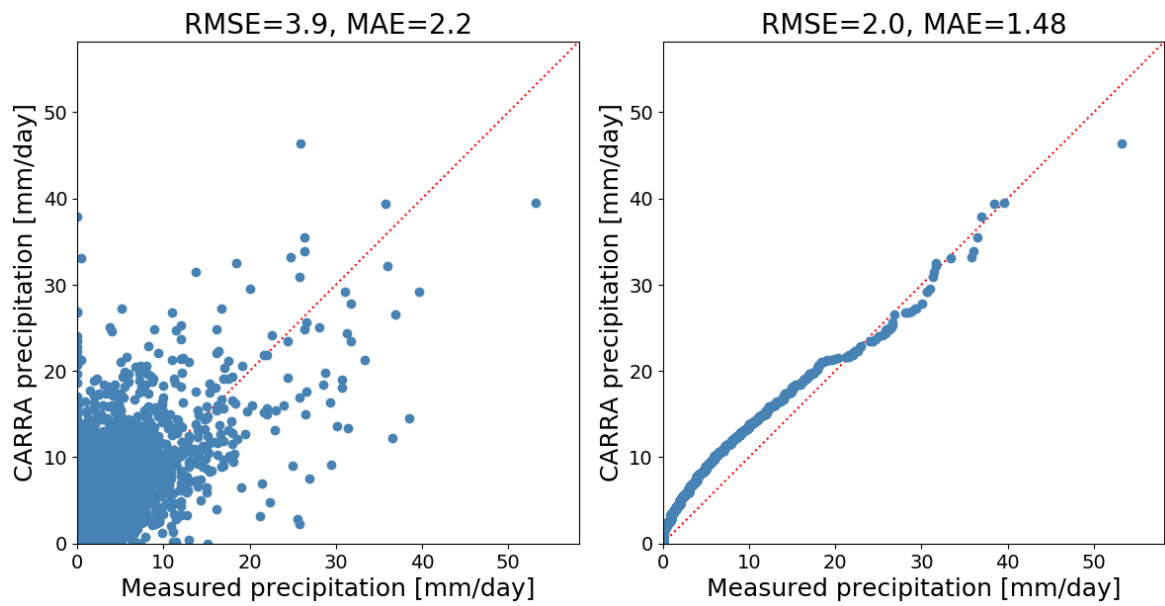


Figure IV.48 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Vatnsfell.

Veiðivatnahraun

2003 - 2020

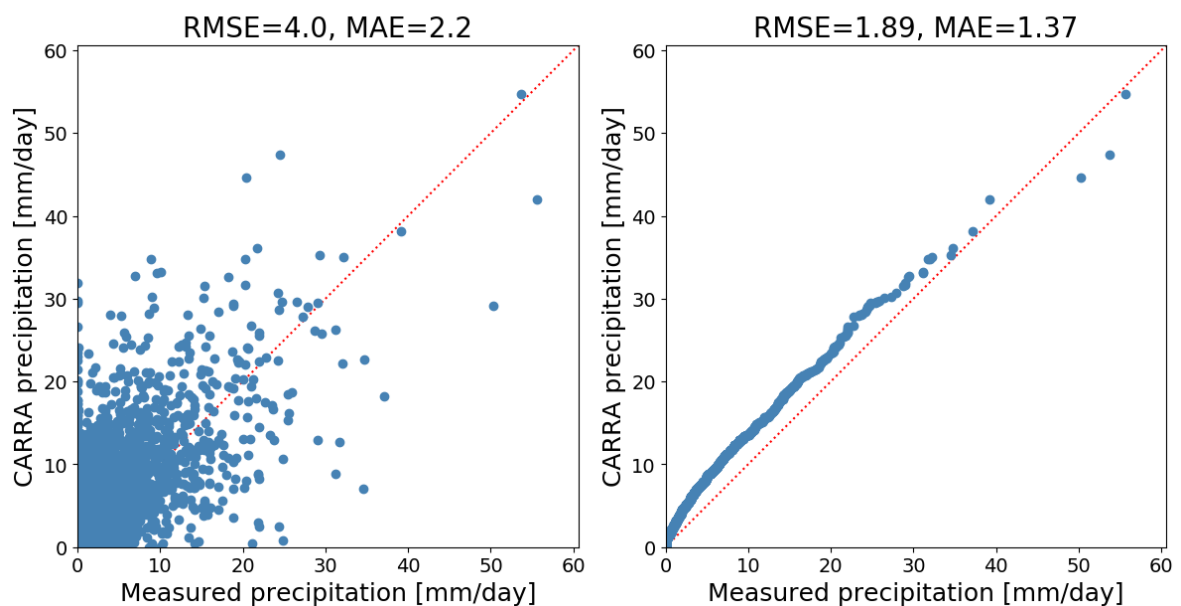


Figure IV.49 – Scatter plot (left) and Q-Q plot (right) comparing daily precipitation (mm/day) between the CARRA dataset and observations for station Veiðivatnahraun.

Akureyri

Annual Maximum Series

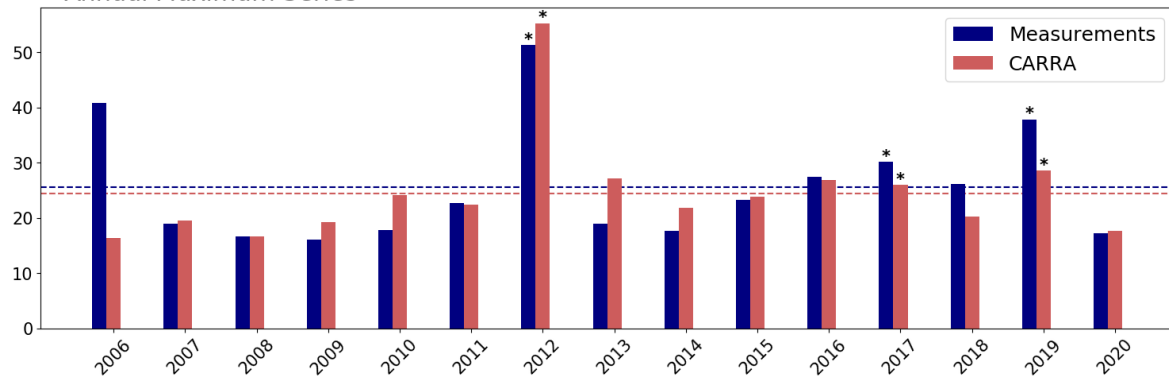


Figure IV.50 — Annual Maximum Series (AMS) for Akureyri based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

Bíldudalur

Annual Maximum Series

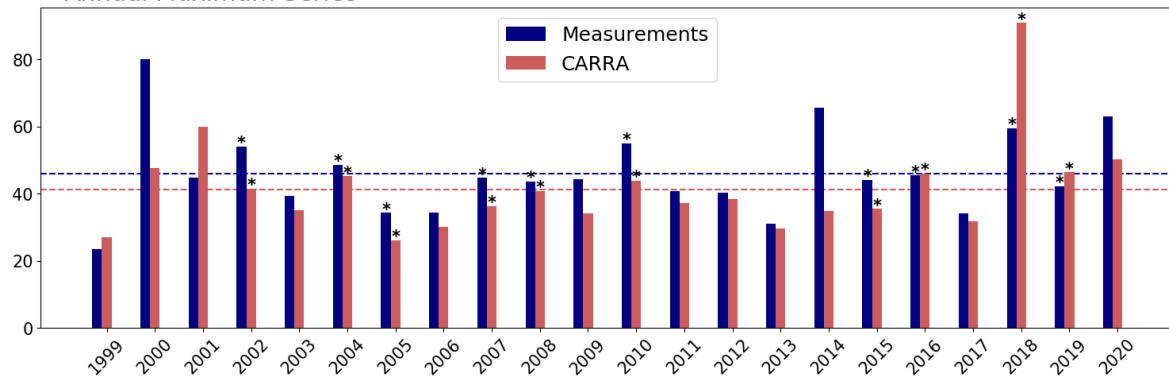


Figure IV.51 — Annual Maximum Series (AMS) for Bíldudalur based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

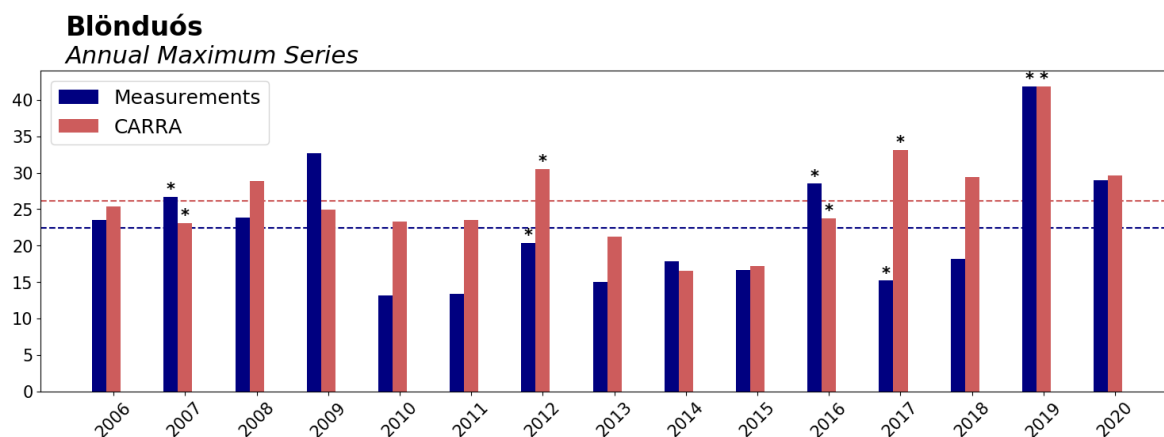


Figure IV.52 — Annual Maximum Series (AMS) for Blönduós based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

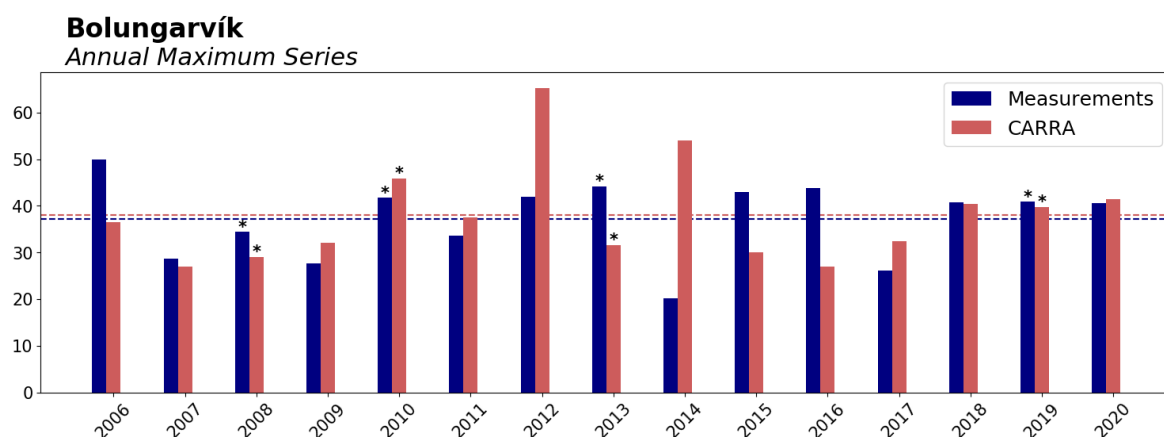


Figure IV.53 — Annual Maximum Series (AMS) for Bolungarvík based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

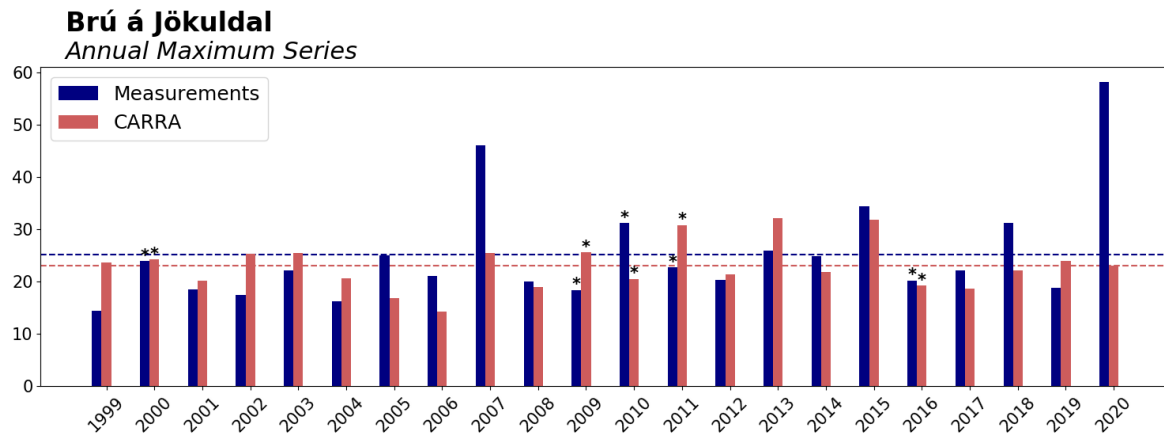


Figure IV.54 — Annual Maximum Series (AMS) for Brú á Jökuldal based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

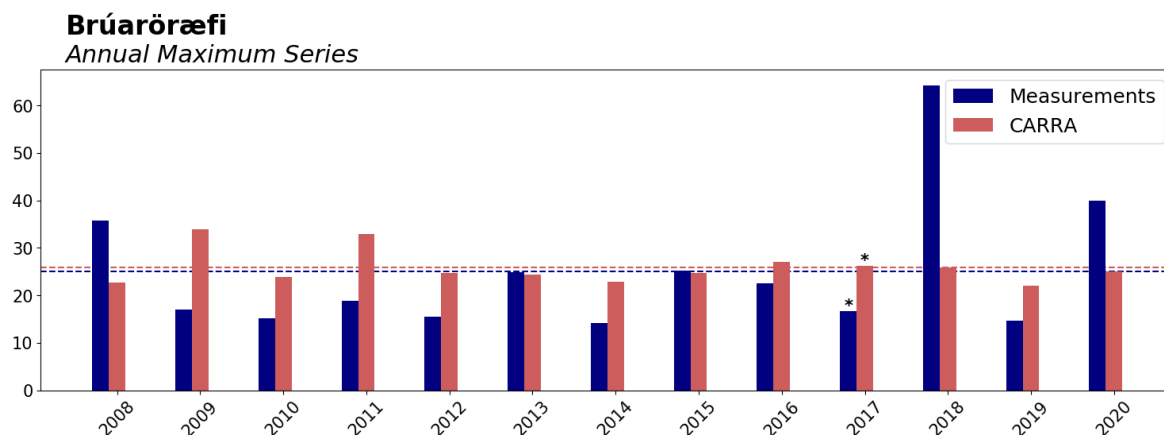


Figure IV.55 — Annual Maximum Series (AMS) for Brúaröræfi based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

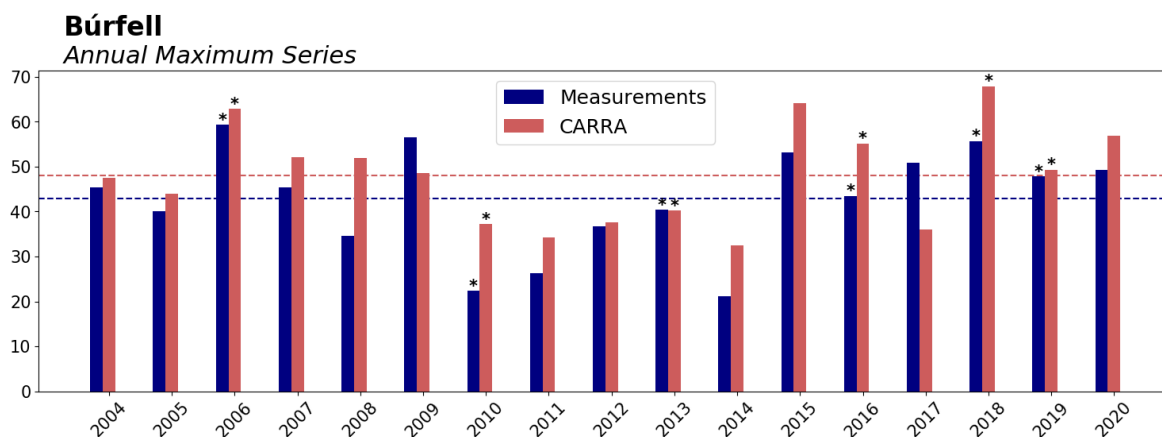


Figure IV.56 – Annual Maximum Series (AMS) for Búrfell based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

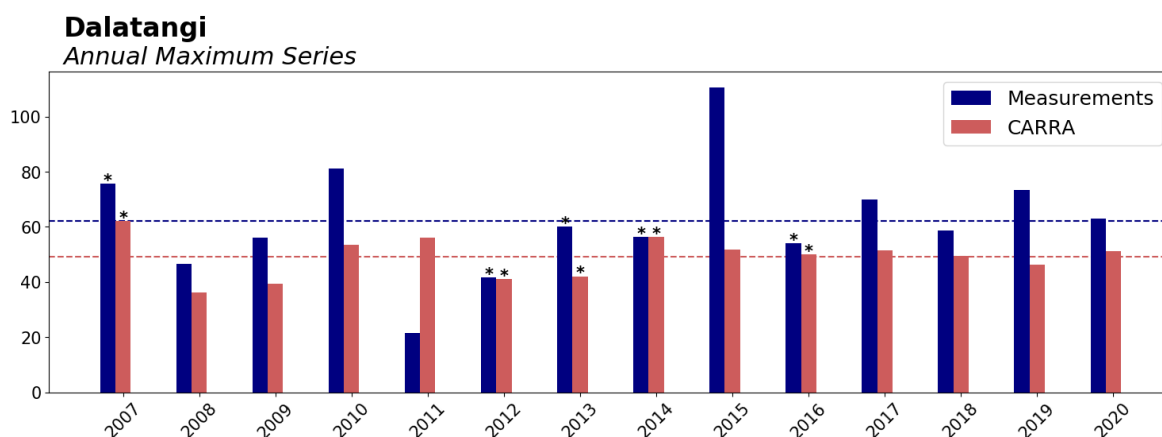


Figure IV.57 – Annual Maximum Series (AMS) for Dalatangi based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

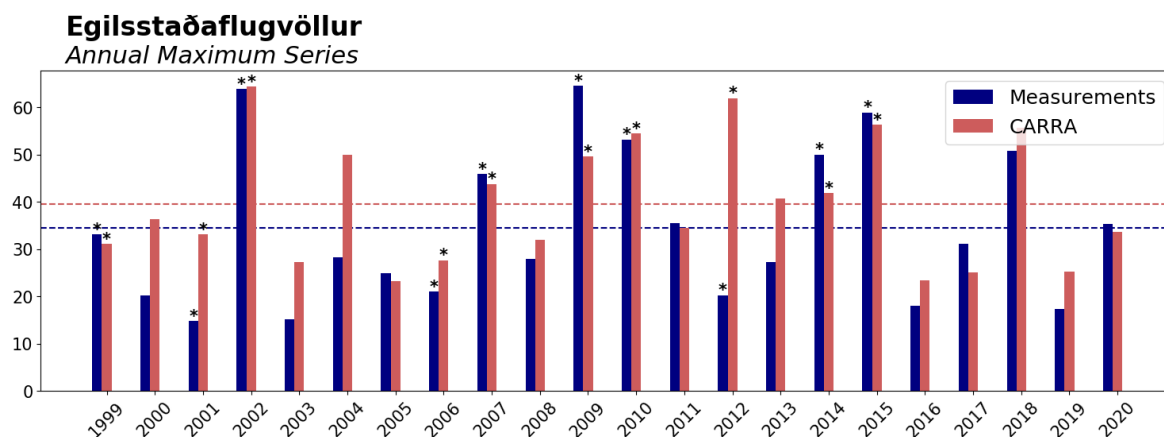


Figure IV.58 — Annual Maximum Series (AMS) for Egilsstaðaflugvöllur based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

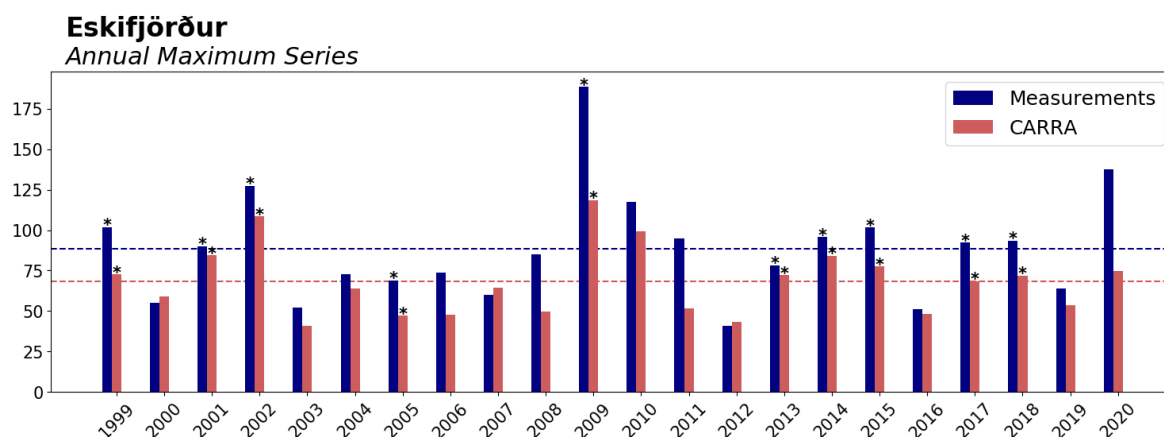


Figure IV.59 — Annual Maximum Series (AMS) for Eskifjörður based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

Eyjabakkar

Annual Maximum Series

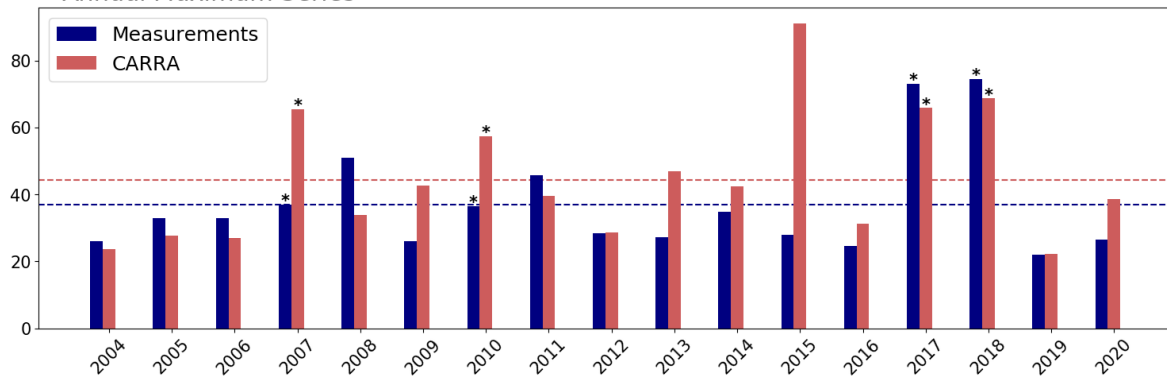


Figure IV.60 — Annual Maximum Series (AMS) for Eyjabakkar based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

Fíflholt á Mýrum

Annual Maximum Series

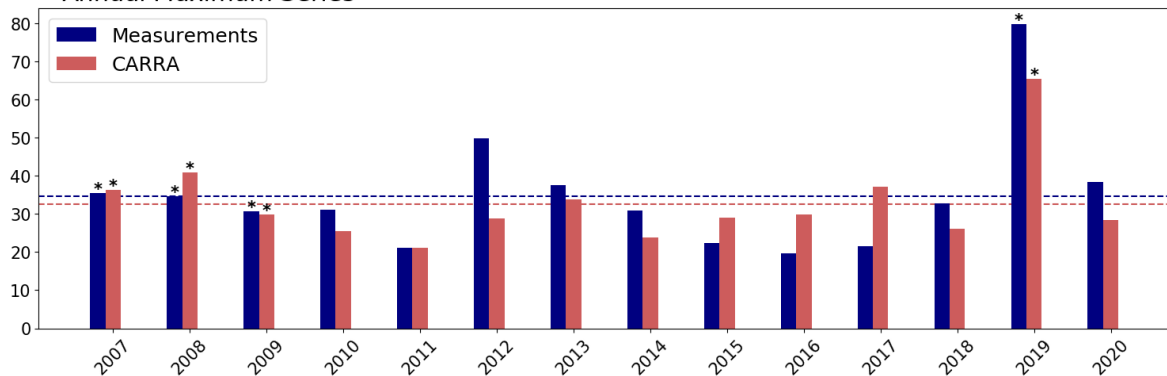


Figure IV.61 — Annual Maximum Series (AMS) for Fíflholt á Mýrum based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

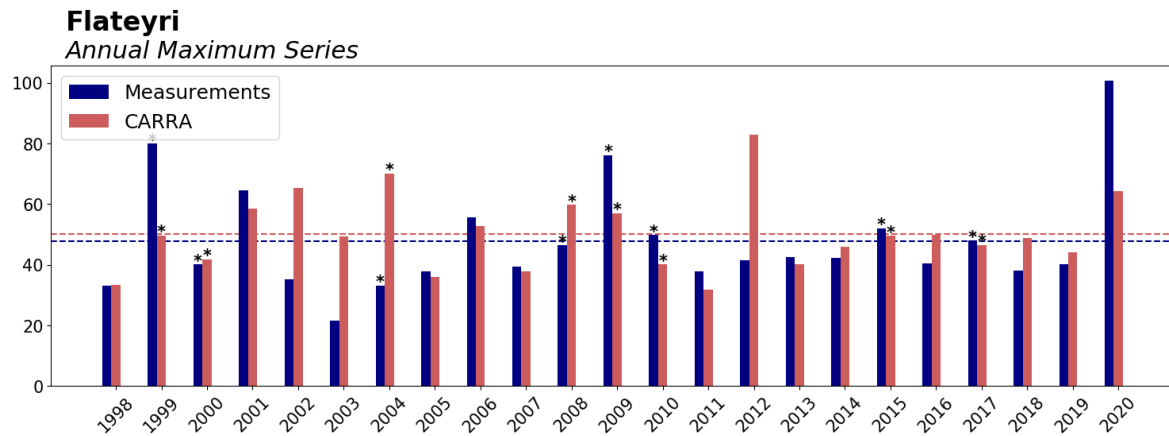


Figure IV.62 — Annual Maximum Series (AMS) for Flateyri based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

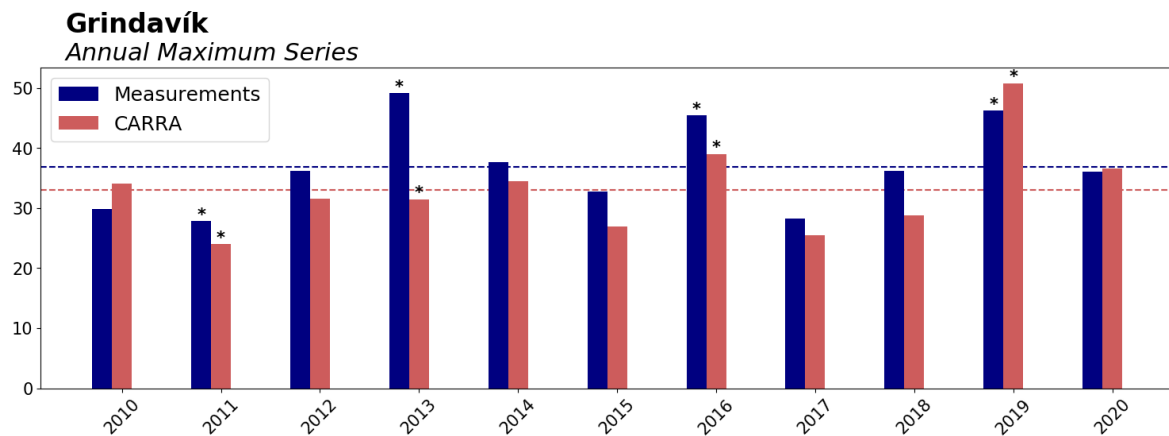


Figure IV.63 — Annual Maximum Series (AMS) for Grindavík based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

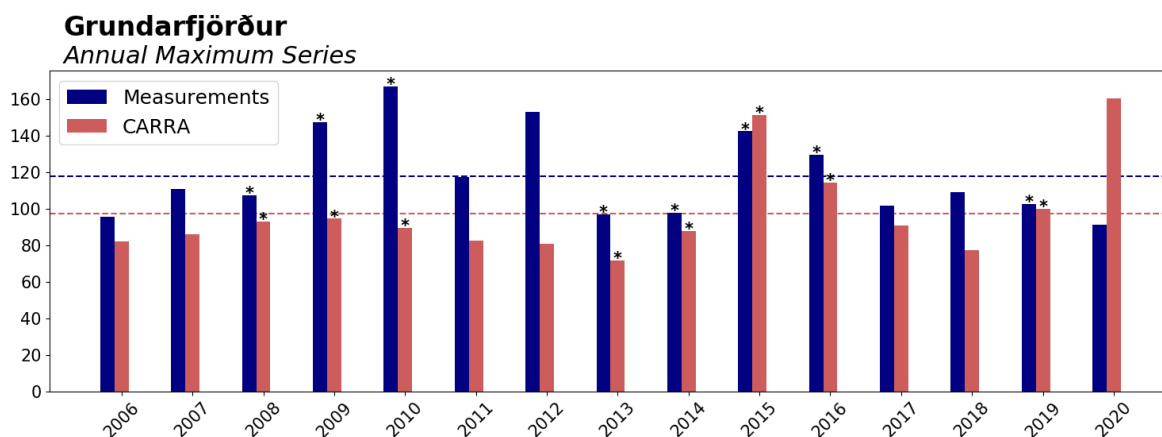


Figure IV.64 — Annual Maximum Series (AMS) for Grundarfjörður based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

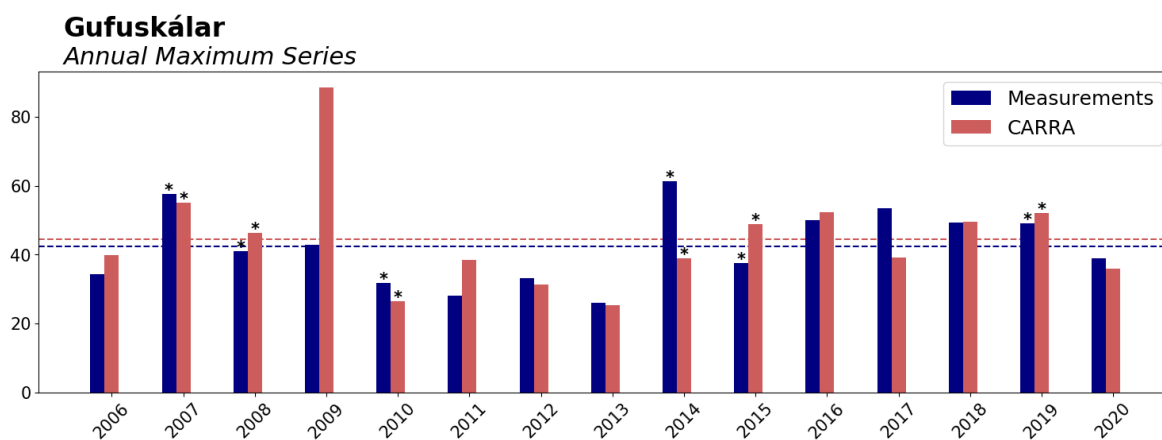


Figure IV.65 — Annual Maximum Series (AMS) for Gufuskálar based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

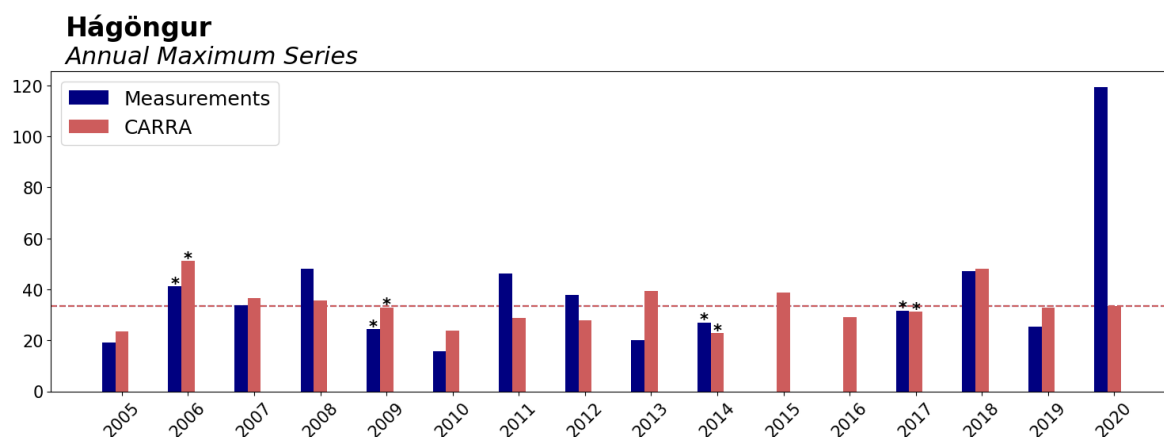


Figure IV.66 — Annual Maximum Series (AMS) for Hágöngur based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

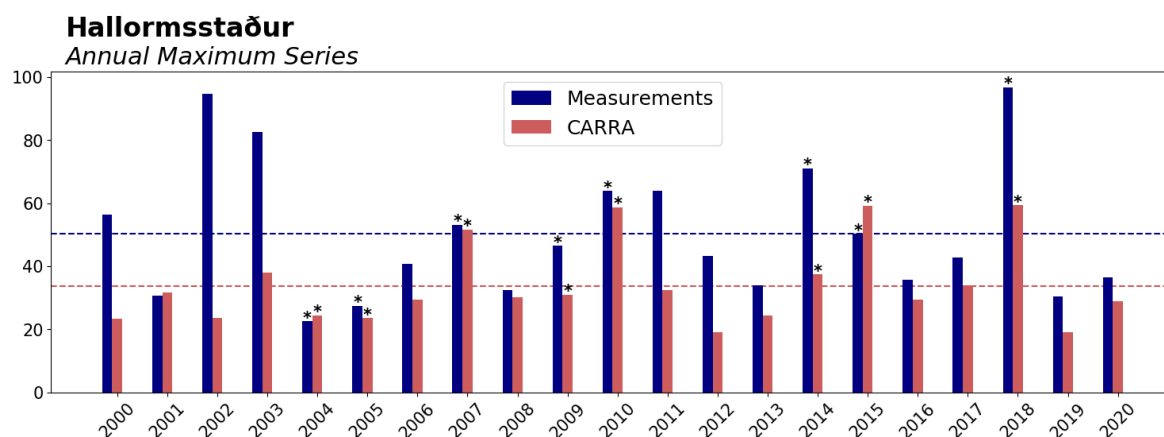


Figure IV.67 — Annual Maximum Series (AMS) for Hallormsstaður based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

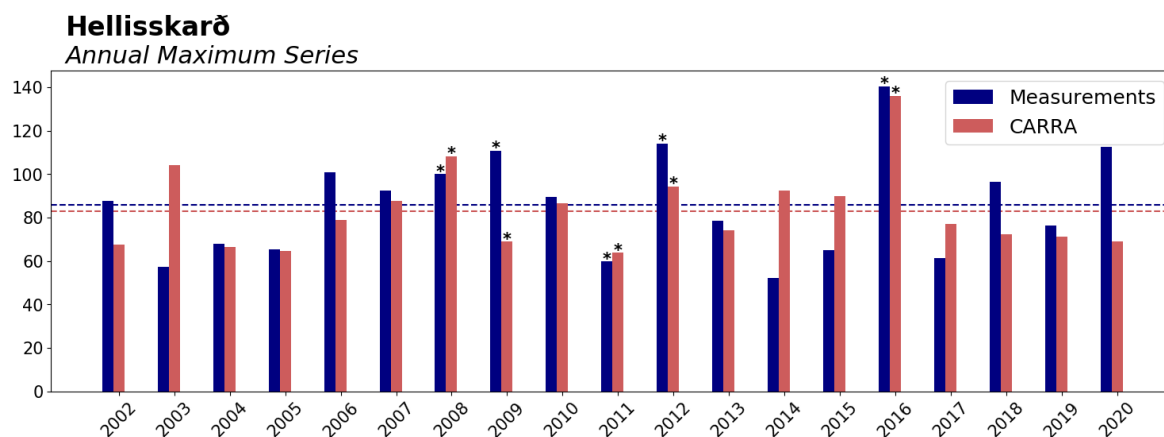


Figure IV.68 — Annual Maximum Series (AMS) for Hellisskarð based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

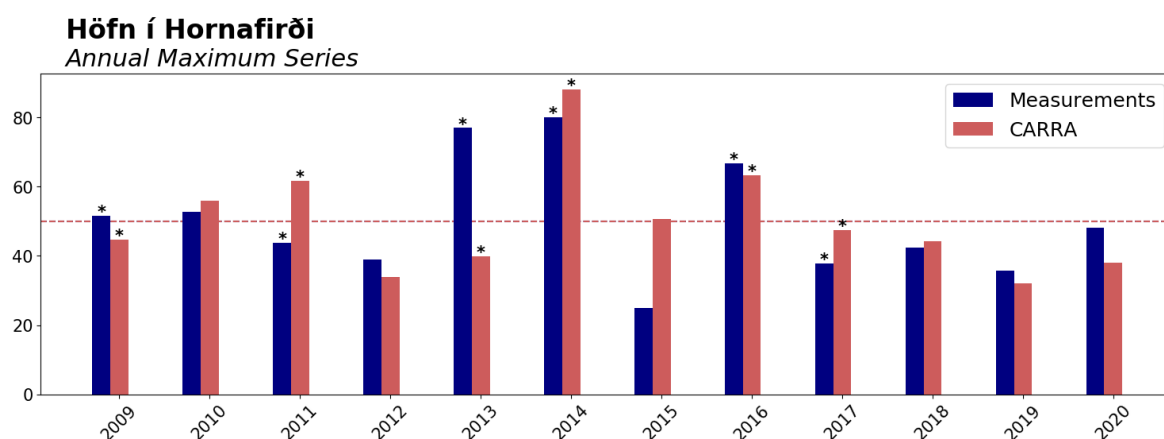


Figure IV.69 — Annual Maximum Series (AMS) for Höfn í Hornafirði based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

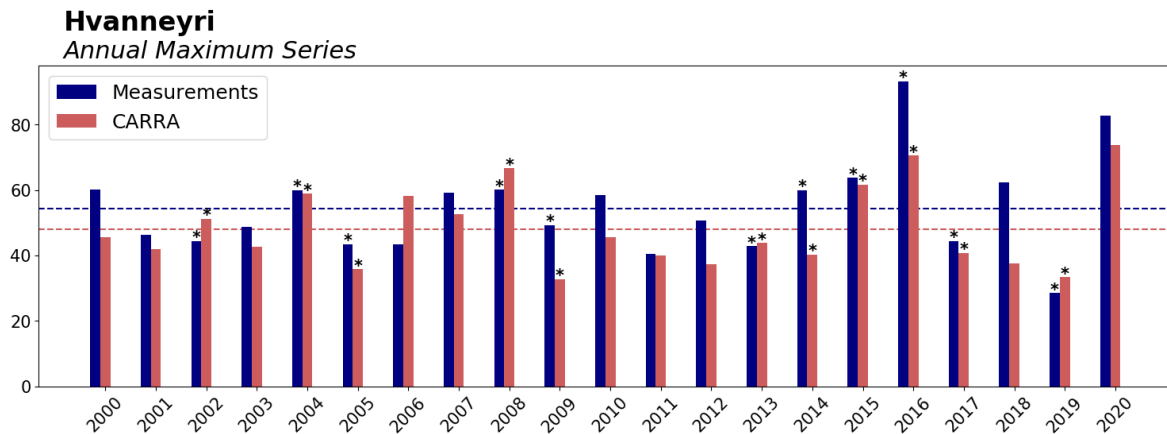


Figure IV.70 — Annual Maximum Series (AMS) for Hvanneyri based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

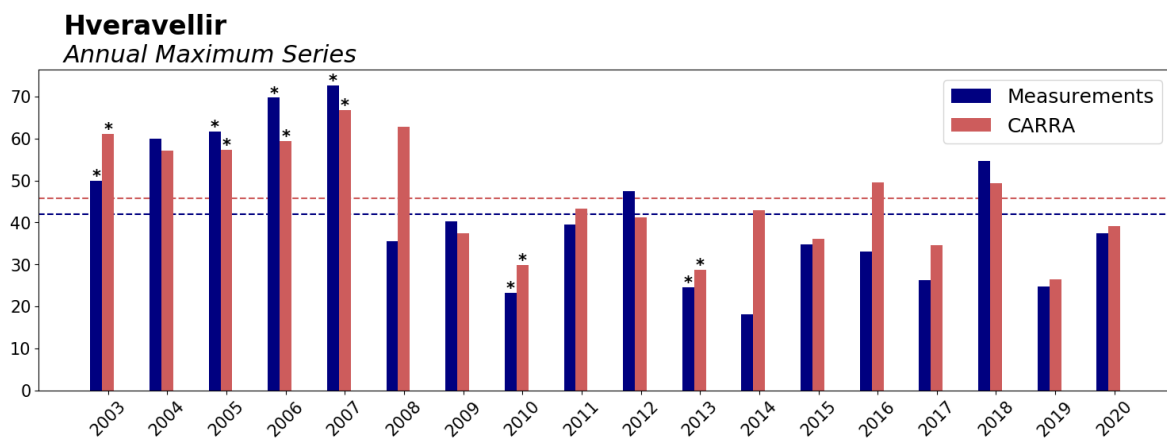


Figure IV.71 — Annual Maximum Series (AMS) for Hveravellir based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

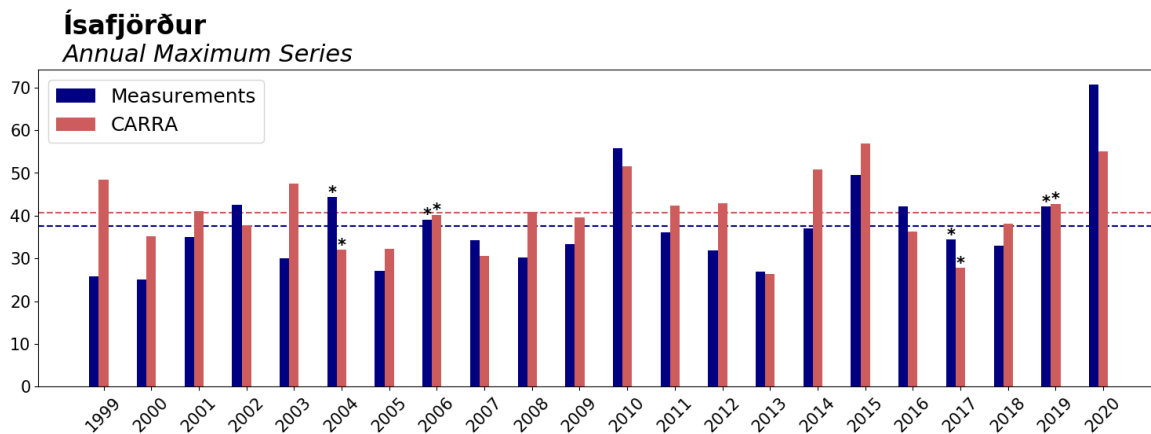


Figure IV.72 — Annual Maximum Series (AMS) for Ísafjörður based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

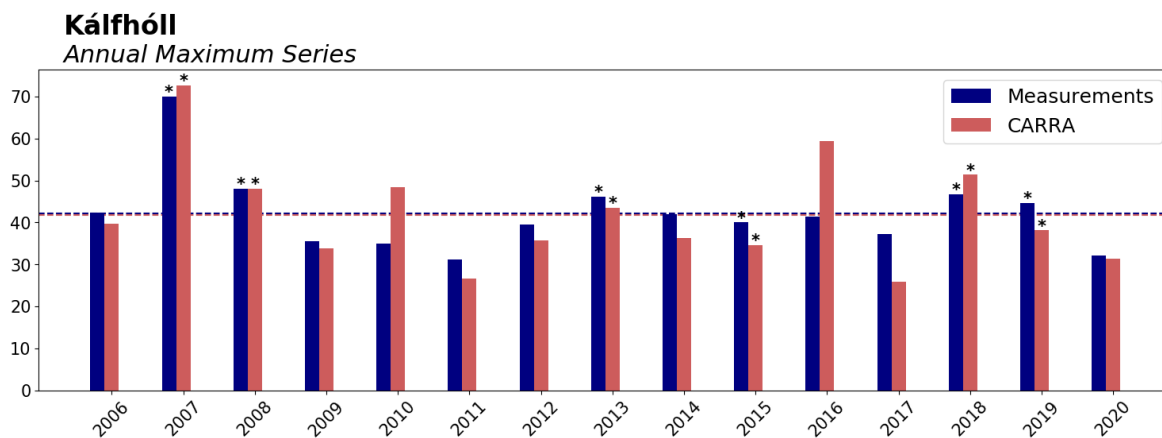


Figure IV.73 — Annual Maximum Series (AMS) for Kálfhóll based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

Kárahnjúkar Annual Maximum Series

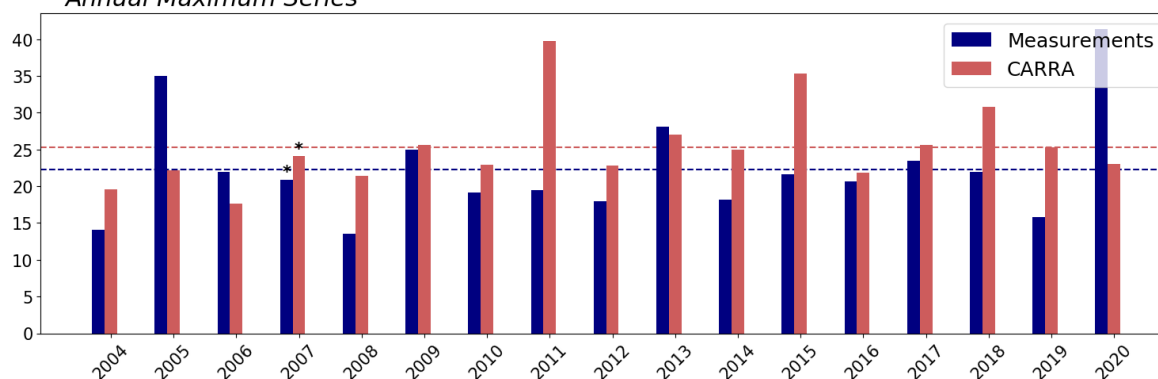


Figure IV.74 — Annual Maximum Series (AMS) for Kárahnjúkar based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

Kirkjubæjarklaustur Annual Maximum Series

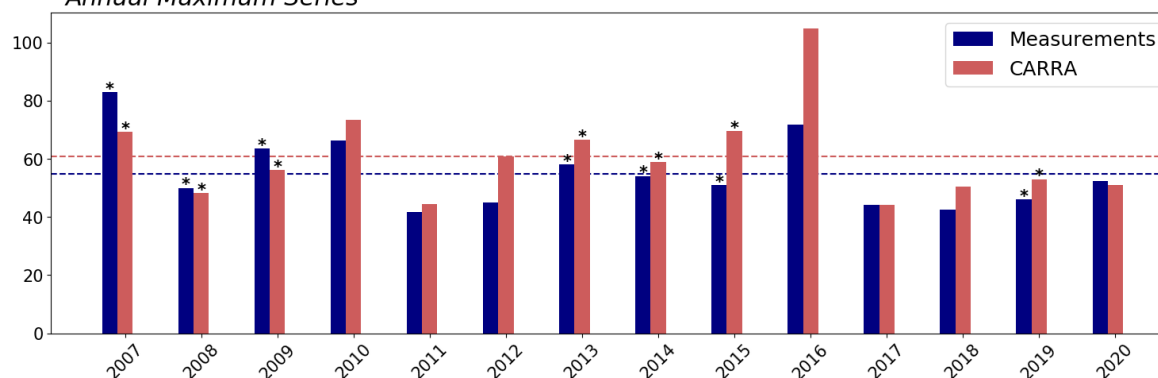


Figure IV.75 — Annual Maximum Series (AMS) for Kirkjubæjarklaustur based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

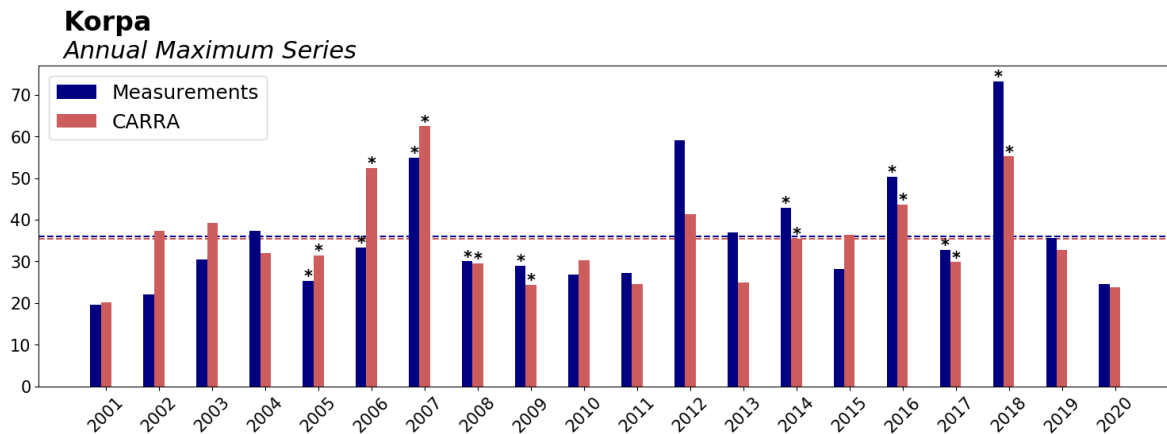


Figure IV.76 — Annual Maximum Series (AMS) for Korpa based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

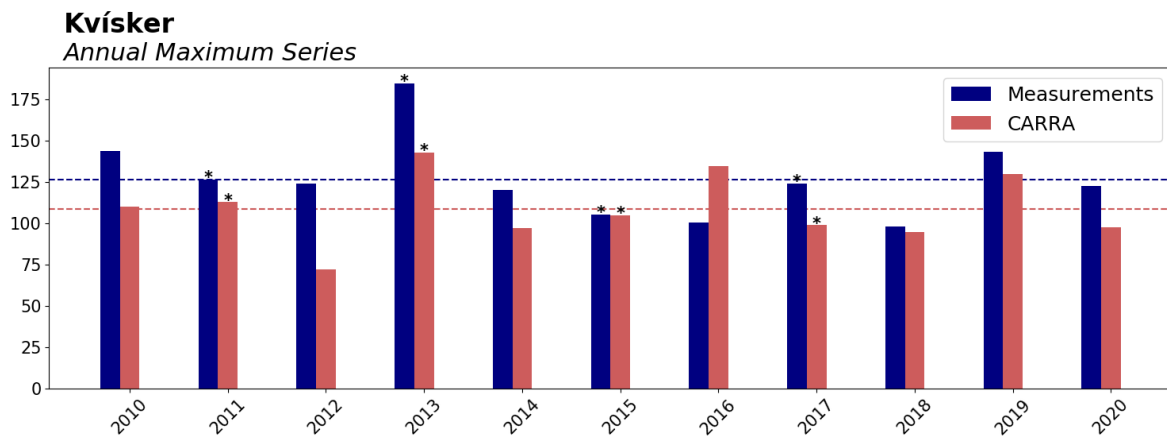


Figure IV.77 — Annual Maximum Series (AMS) for Kvísker based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

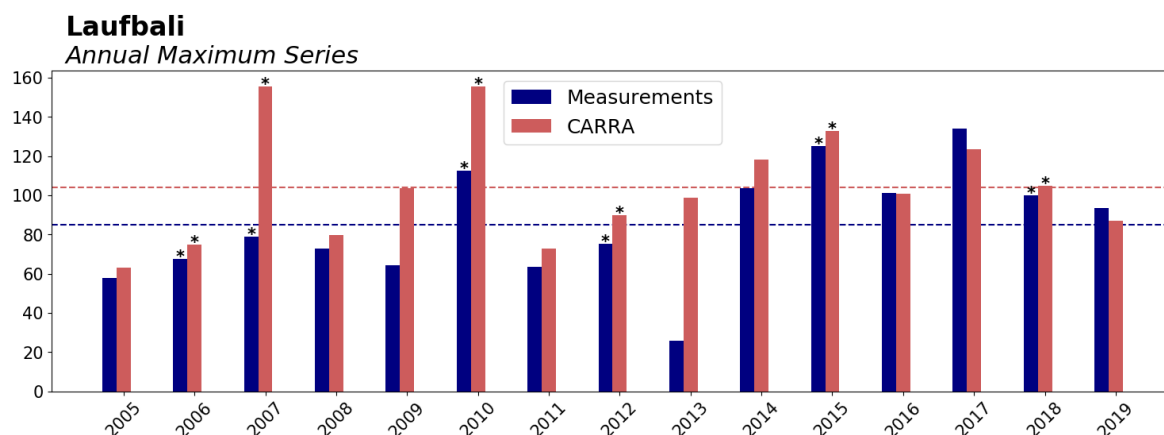


Figure IV.78 — Annual Maximum Series (AMS) for Laufbali based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

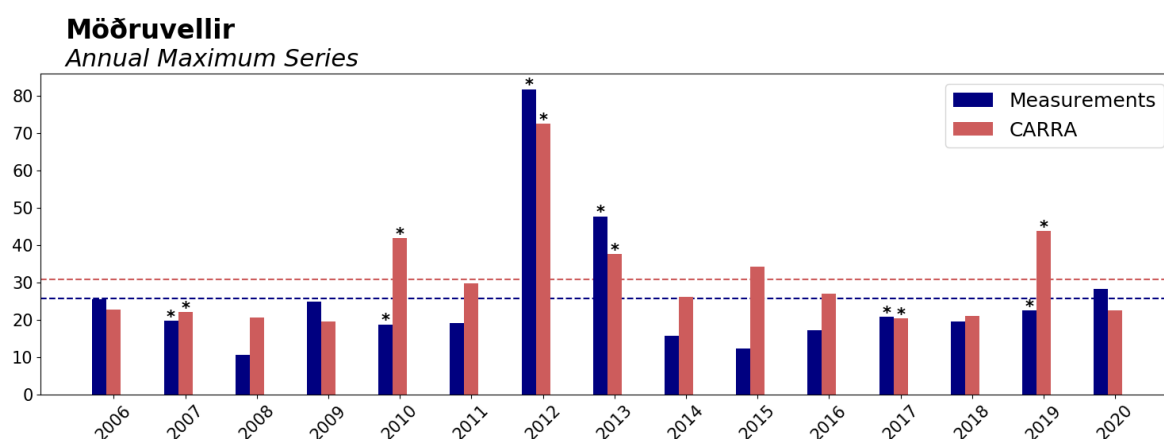


Figure IV.79 — Annual Maximum Series (AMS) for Möðruvellir based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

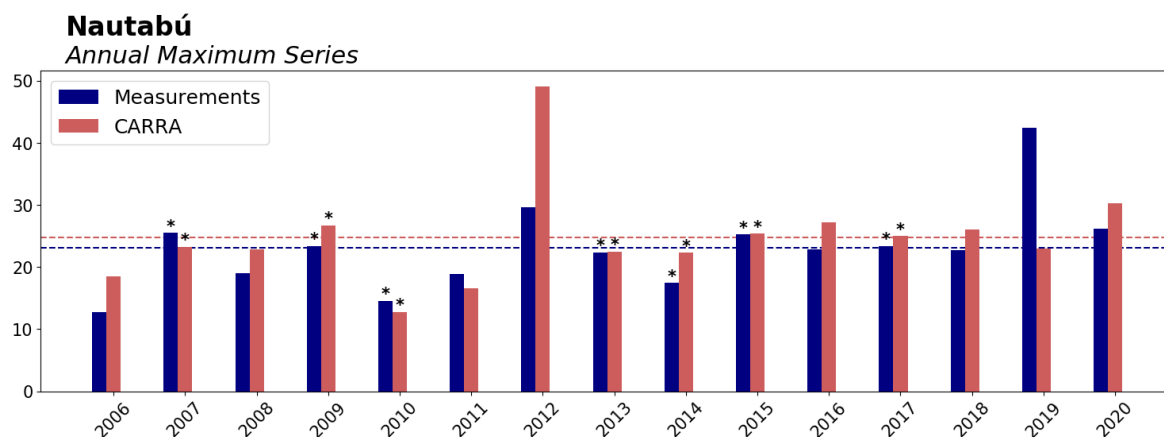


Figure IV.80 — Annual Maximum Series (AMS) for Nautabú based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

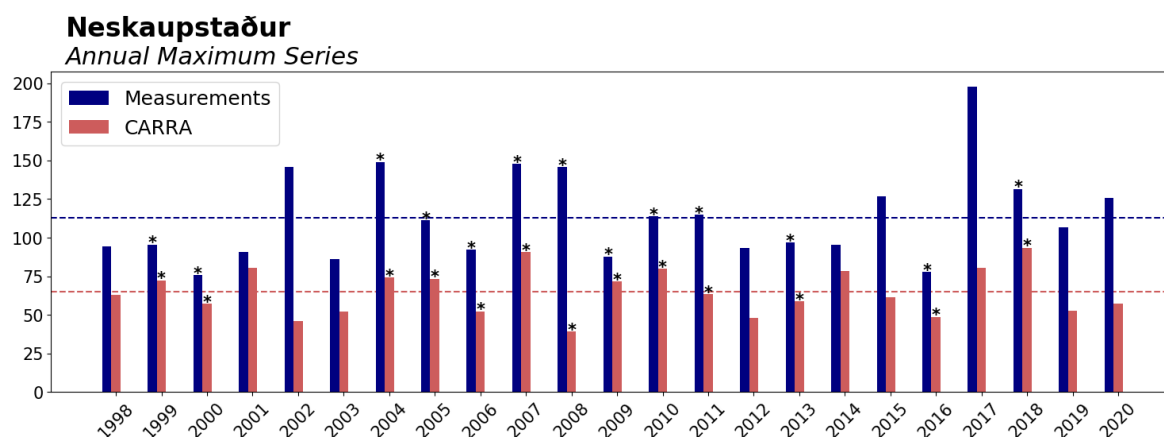


Figure IV.81 — Annual Maximum Series (AMS) for Neskaupstaður based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

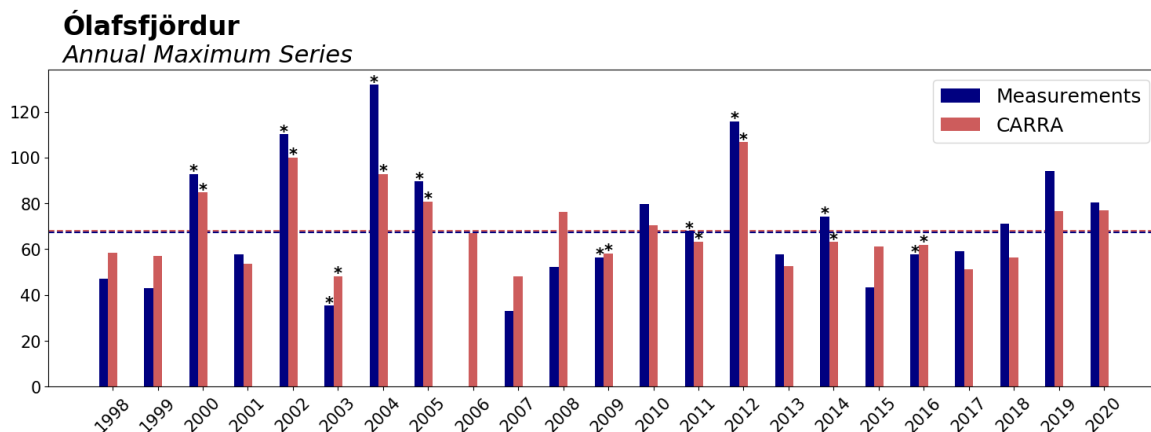


Figure IV.82 — Annual Maximum Series (AMS) for Ólafsfjörður based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

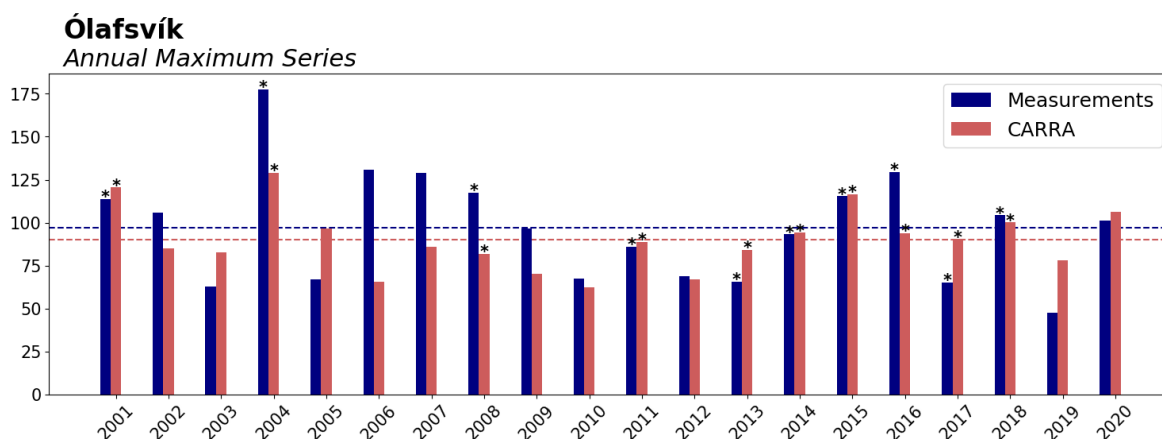


Figure IV.83 — Annual Maximum Series (AMS) for Ólafsvík based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

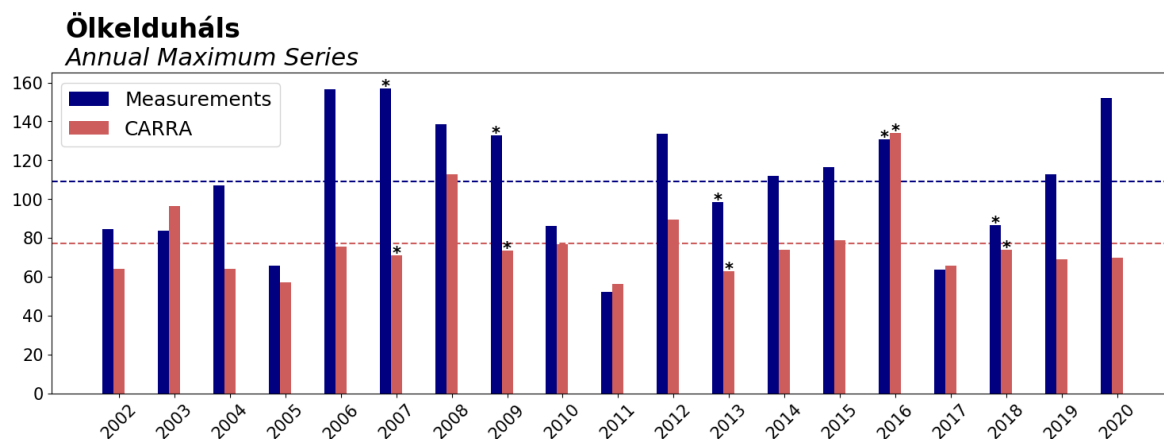


Figure IV.84 — Annual Maximum Series (AMS) for Ölkelduháls based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

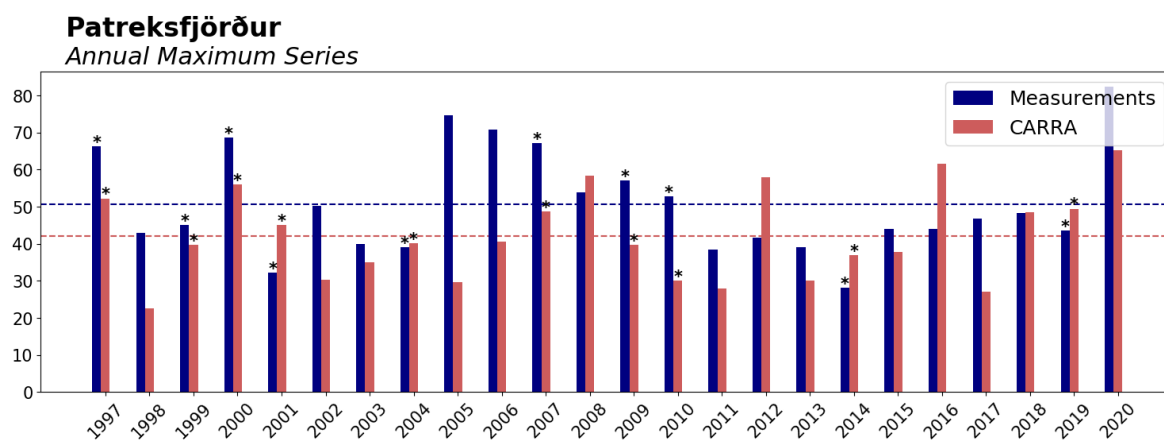


Figure IV.85 — Annual Maximum Series (AMS) for Patreksfjörður based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

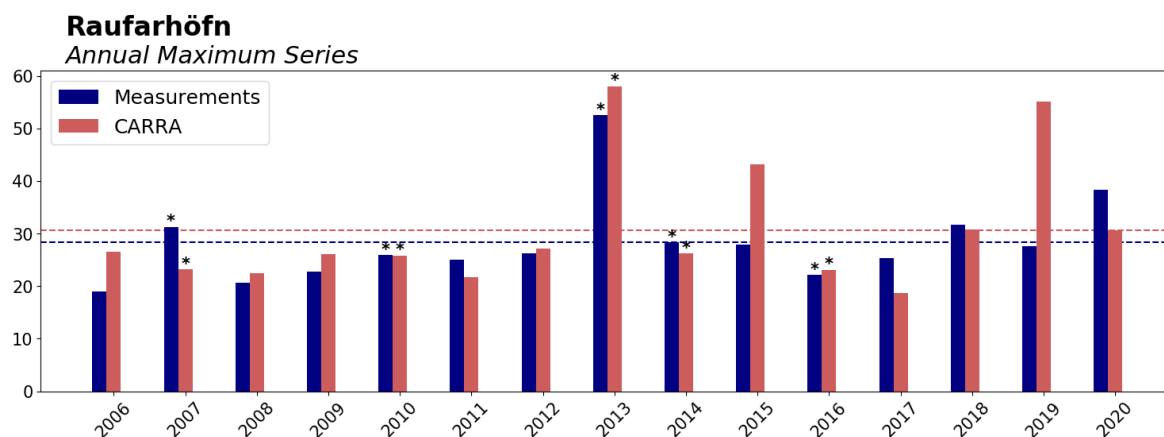


Figure IV.86 — Annual Maximum Series (AMS) for Raufarhöfn based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

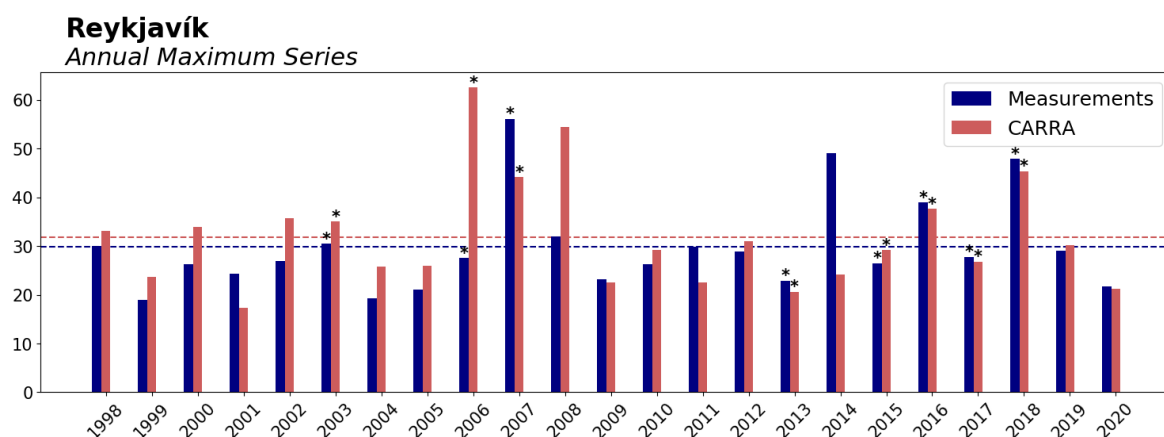


Figure IV.87 — Annual Maximum Series (AMS) for Reykjavík based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

Sámsstaðir

Annual Maximum Series

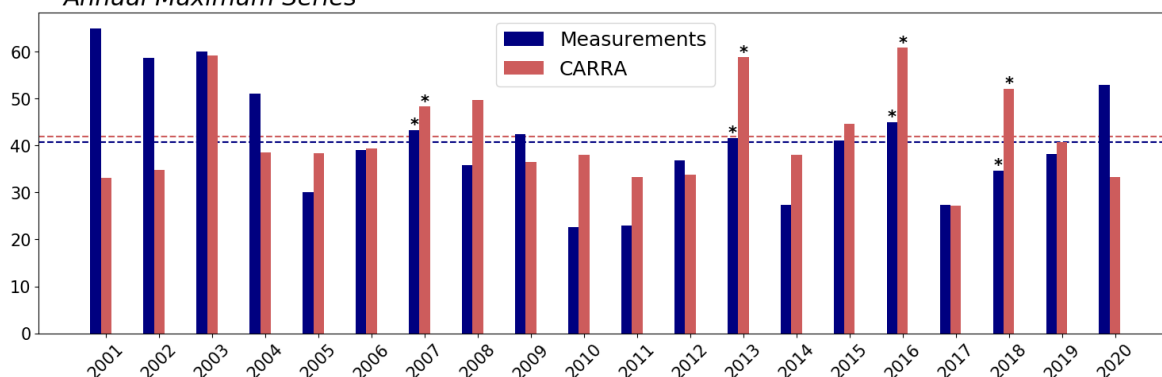


Figure IV.88 — Annual Maximum Series (AMS) for Sámsstaðir based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

Sandbúðir

Annual Maximum Series

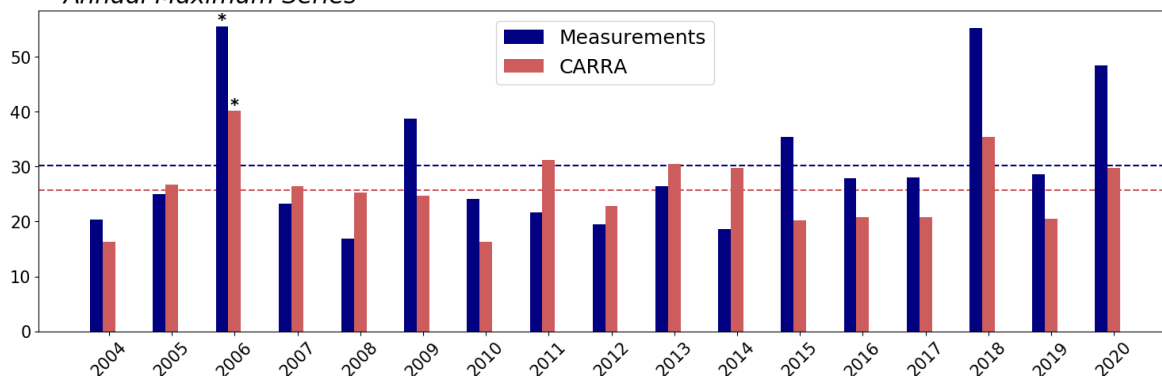


Figure IV.89 — Annual Maximum Series (AMS) for Sandbúðir based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

Seyðisfjörður

Annual Maximum Series

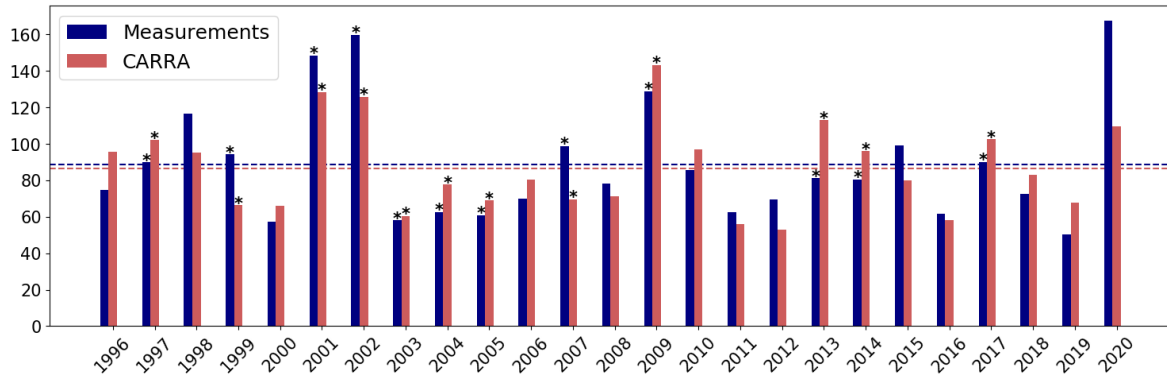


Figure IV.90 — Annual Maximum Series (AMS) for Seyðisfjörður based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

Siglufjörður

Annual Maximum Series

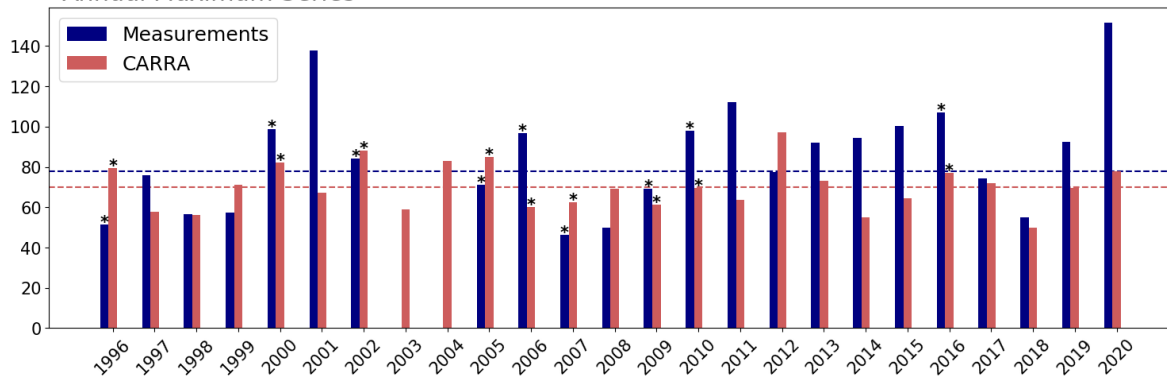


Figure IV.91 — Annual Maximum Series (AMS) for Siglufjörður based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

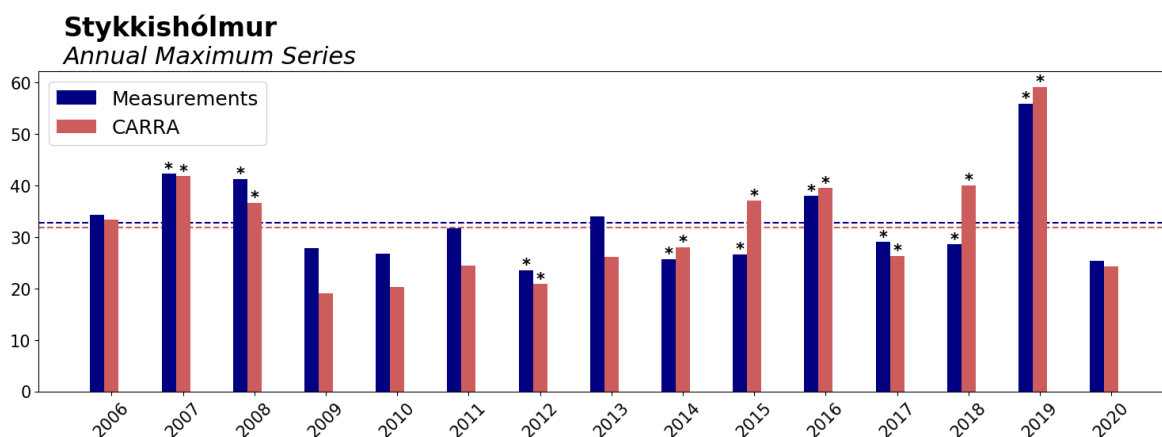


Figure IV.92 — Annual Maximum Series (AMS) for Stykkishólmur based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

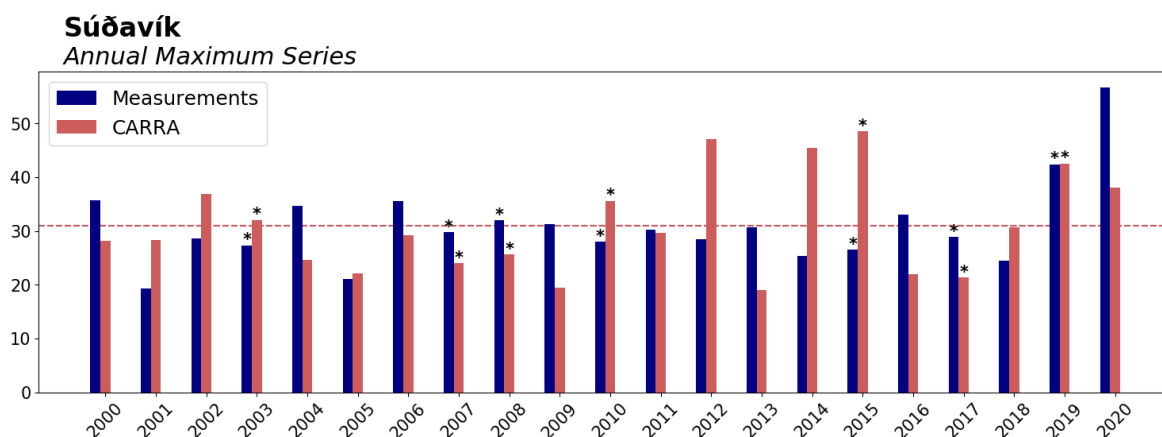


Figure IV.93 — Annual Maximum Series (AMS) for Súðavík based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

Tálknafjörður Annual Maximum Series

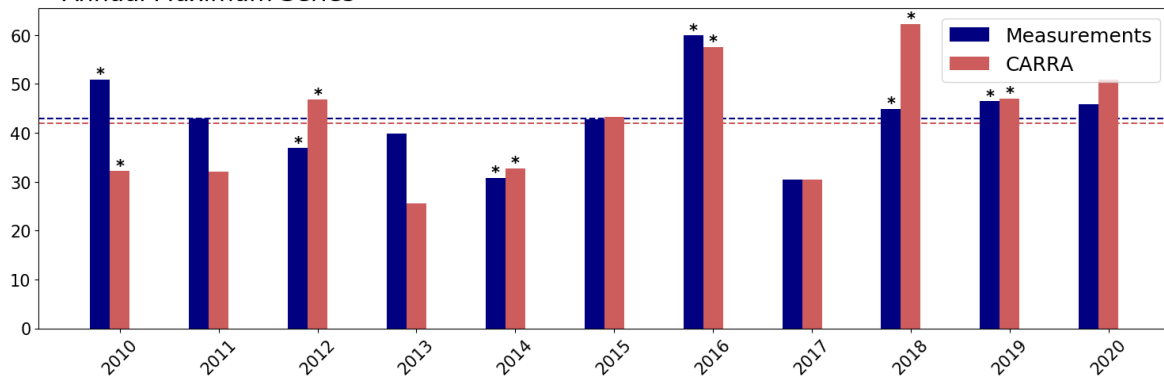


Figure IV.94 — Annual Maximum Series (AMS) for Tálknafjörður based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

Þingvellir Annual Maximum Series

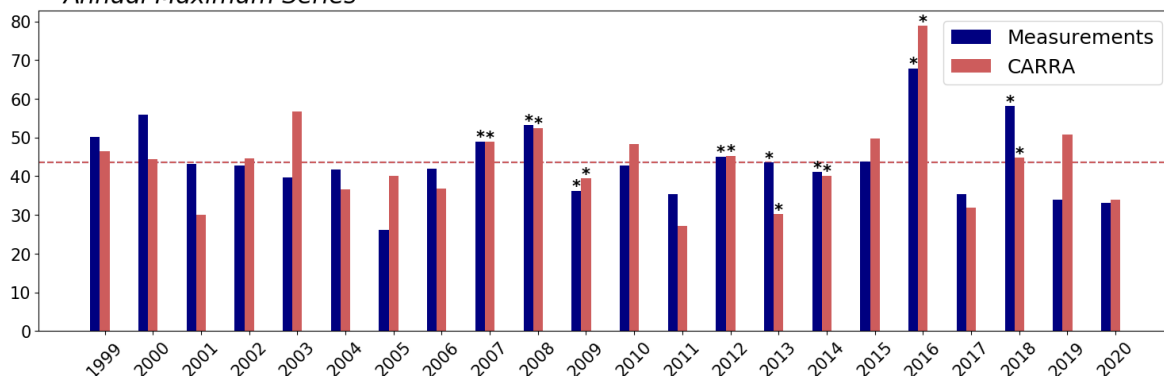


Figure IV.95 — Annual Maximum Series (AMS) for Þingvellir based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

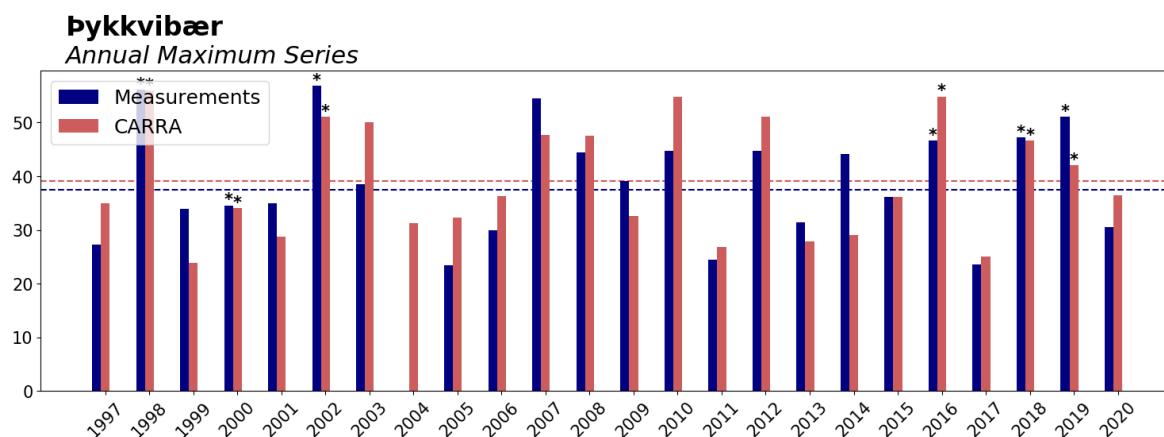


Figure IV.96 — Annual Maximum Series (AMS) for Þykkvibær based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

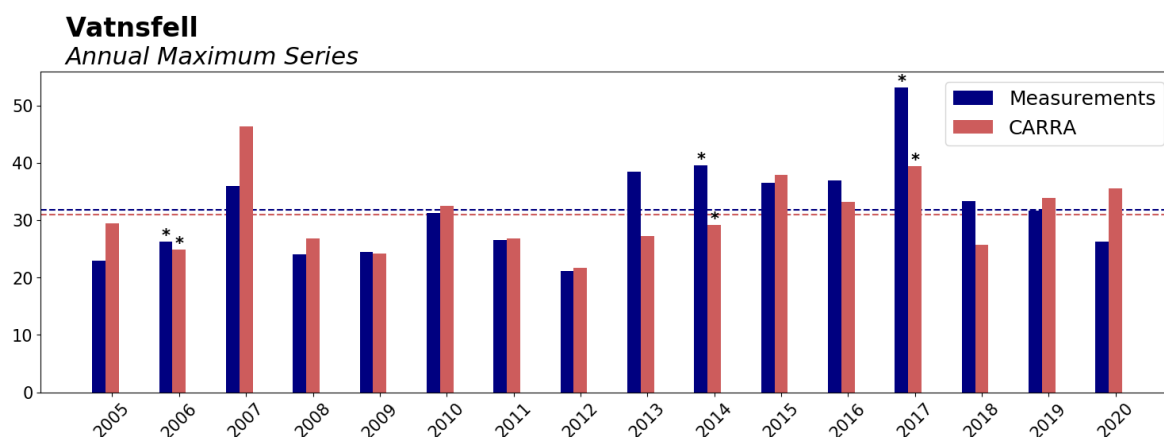


Figure IV.97 — Annual Maximum Series (AMS) for Vatnsfell based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.

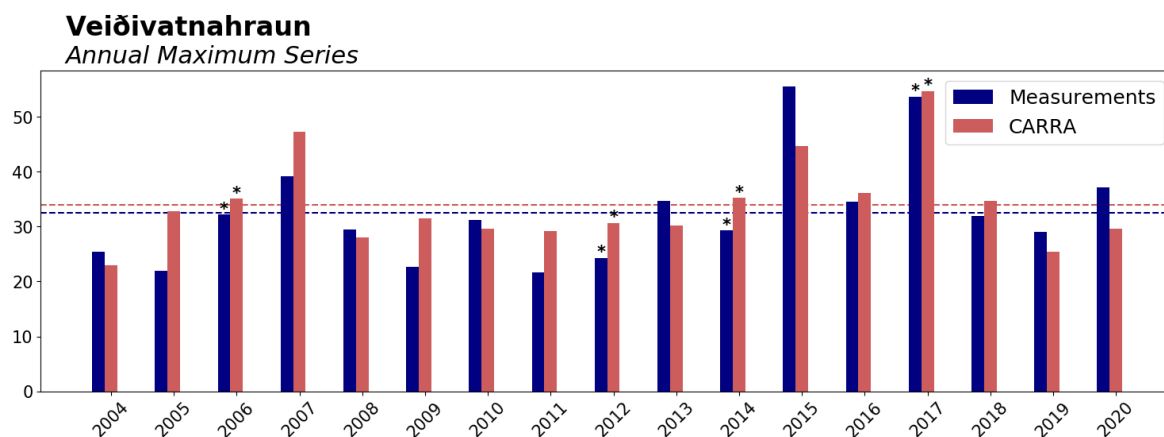


Figure IV.98 — Annual Maximum Series (AMS) for Veiðivatnahraun based on measurements (blue bars) and the CARRA dataset (red bars). Dashed vertical lines indicate the mean values for each series, and asterisks above the bars indicate that maximum values were reached in each dataset within a 5-day interval.



Figure IV. 99 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Akureyri automatic station.



Figure IV. 100 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Bíldudalur automatic station.



Figure IV.101 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Blönduós automatic station.

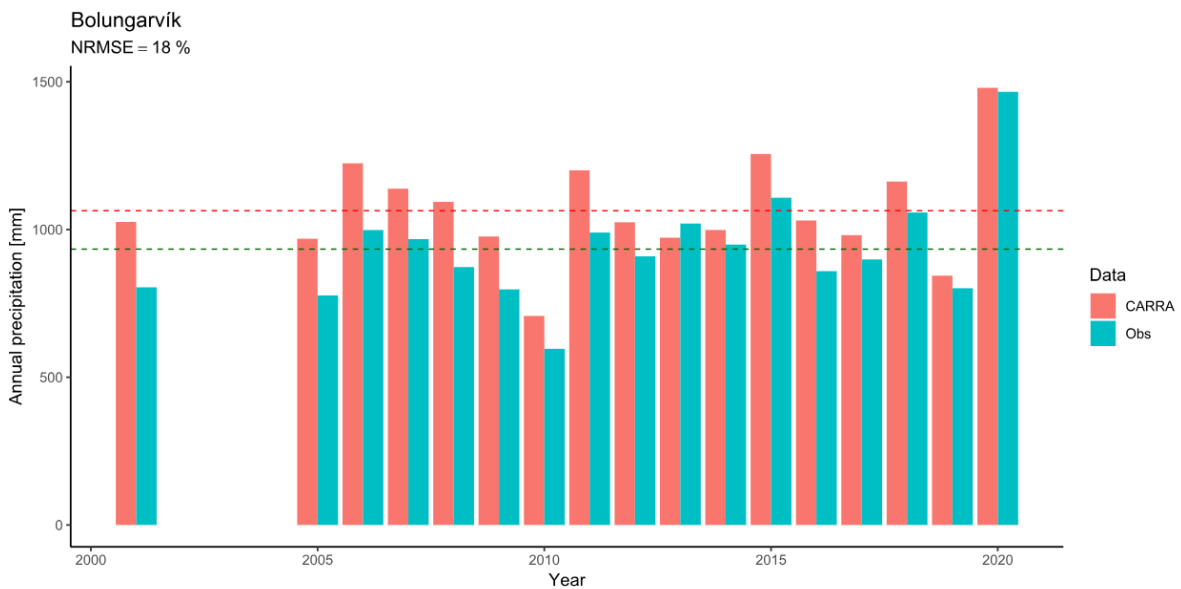


Figure IV.102 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Bolungarvík automatic station.

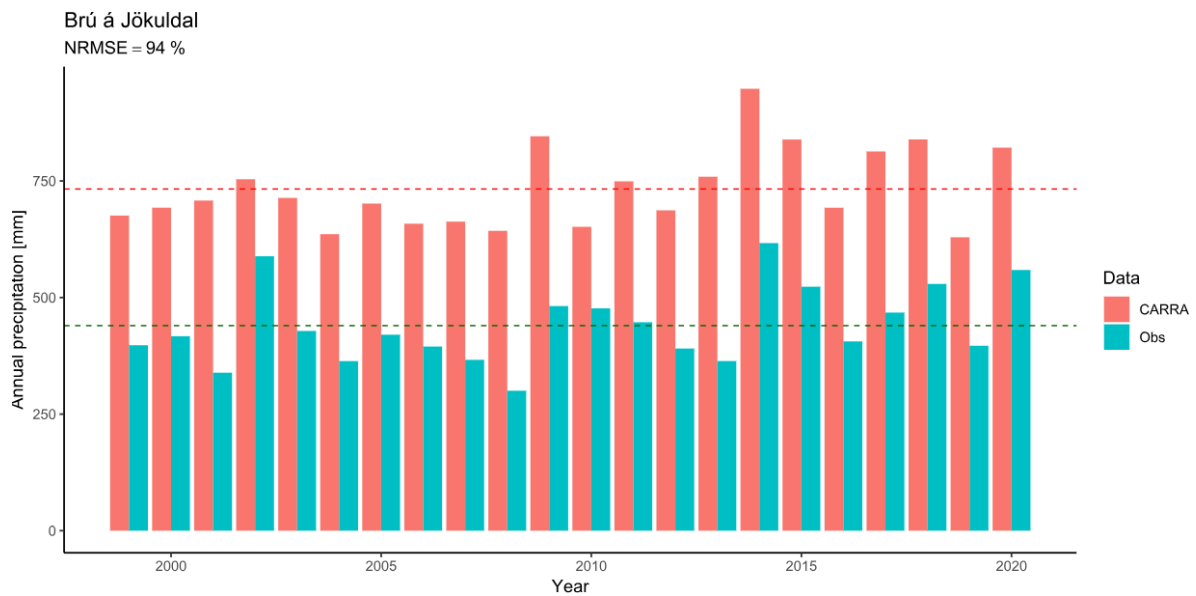


Figure IV.103 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Brú á Jökuldal automatic station.

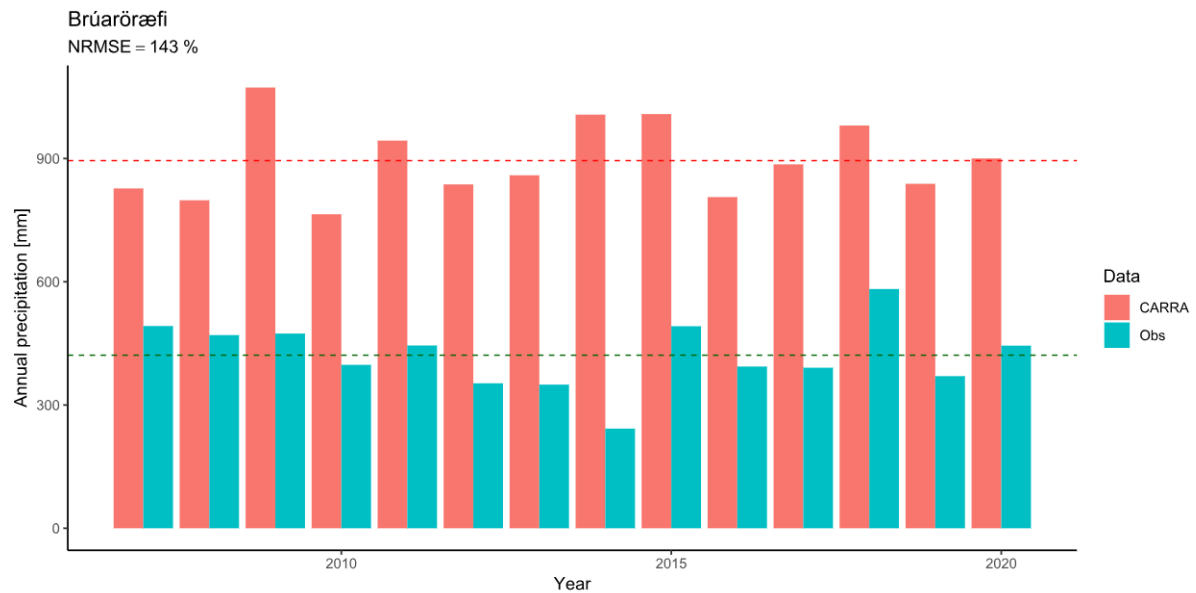


Figure IV.104 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Brúaröræfi automatic station.

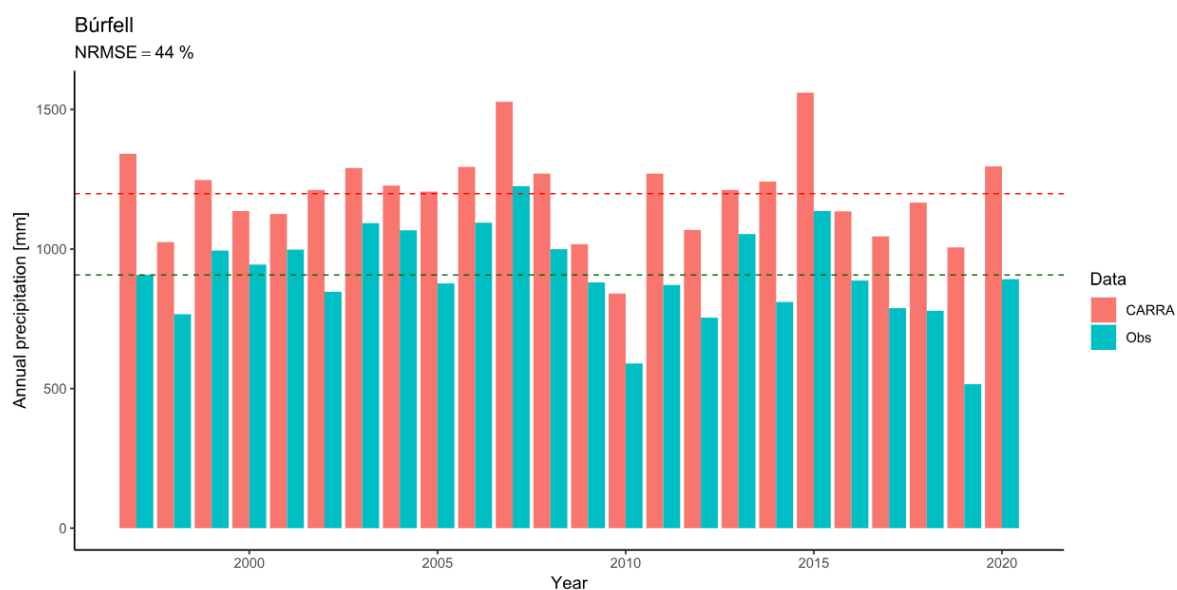


Figure IV.105 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Búrfell automatic station.



Figure III.106 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Dalatangi automatic station.

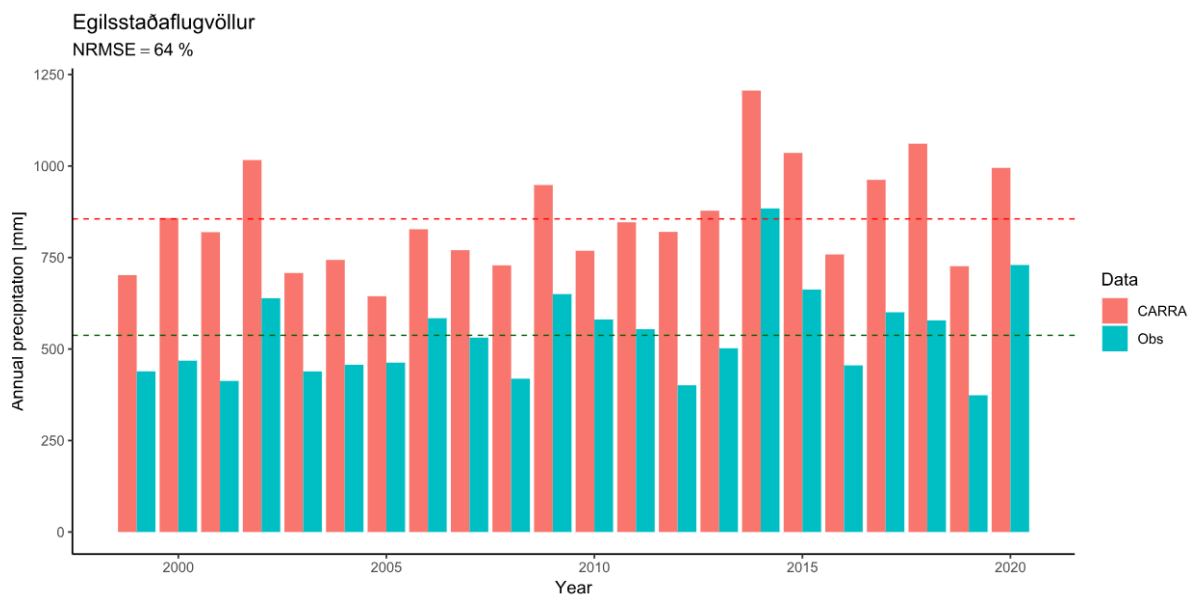


Figure IV.107 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Egilsstaðaflogvöllur automatic station.

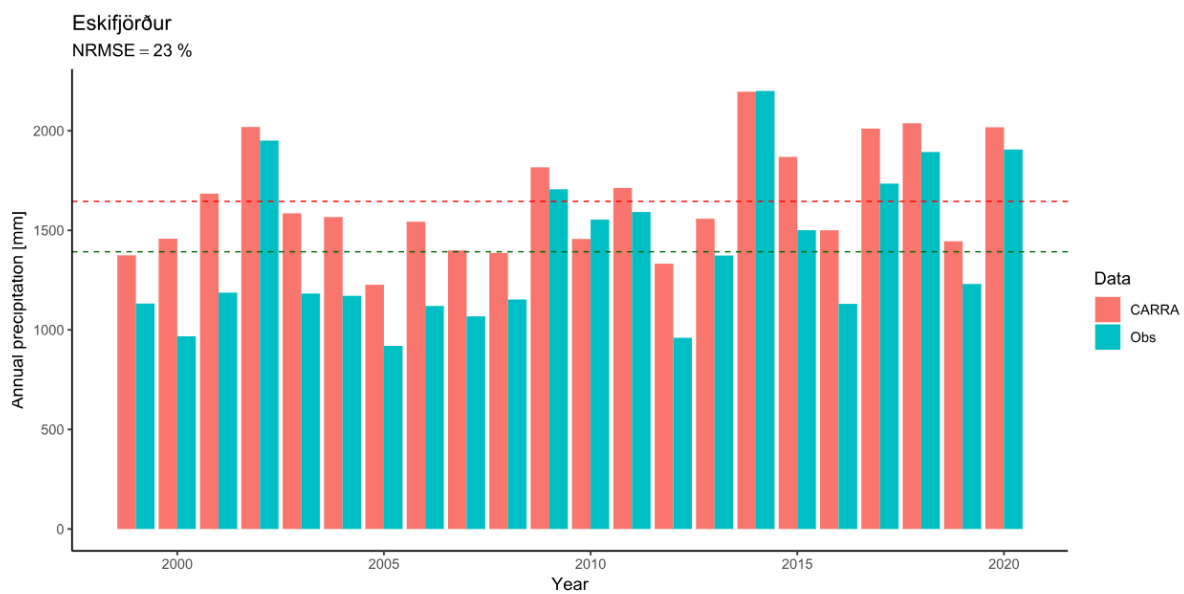


Figure IV.108 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Eskifjörður automatic station.

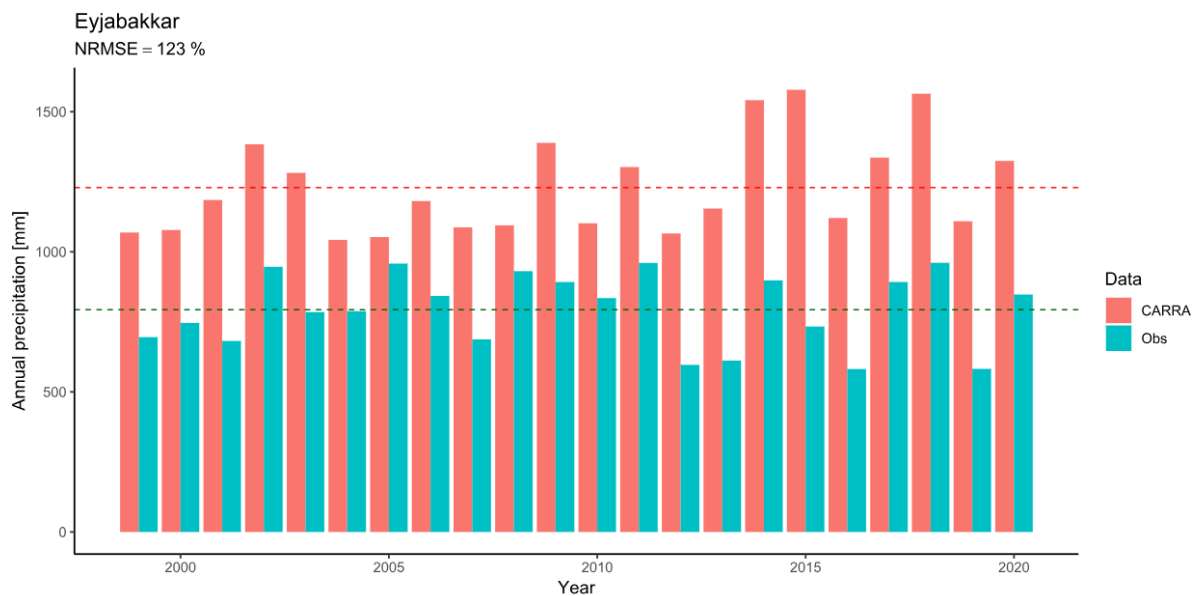


Figure IV.109 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Eyjabakkar automatic station.

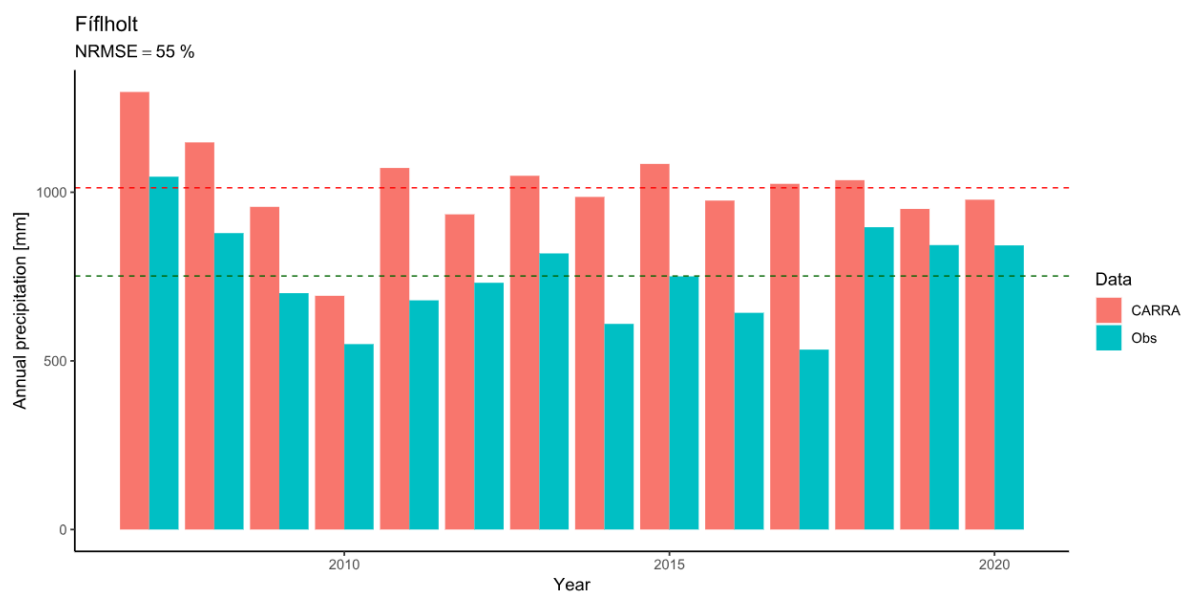


Figure IV.110 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Fíflholt automatic station.

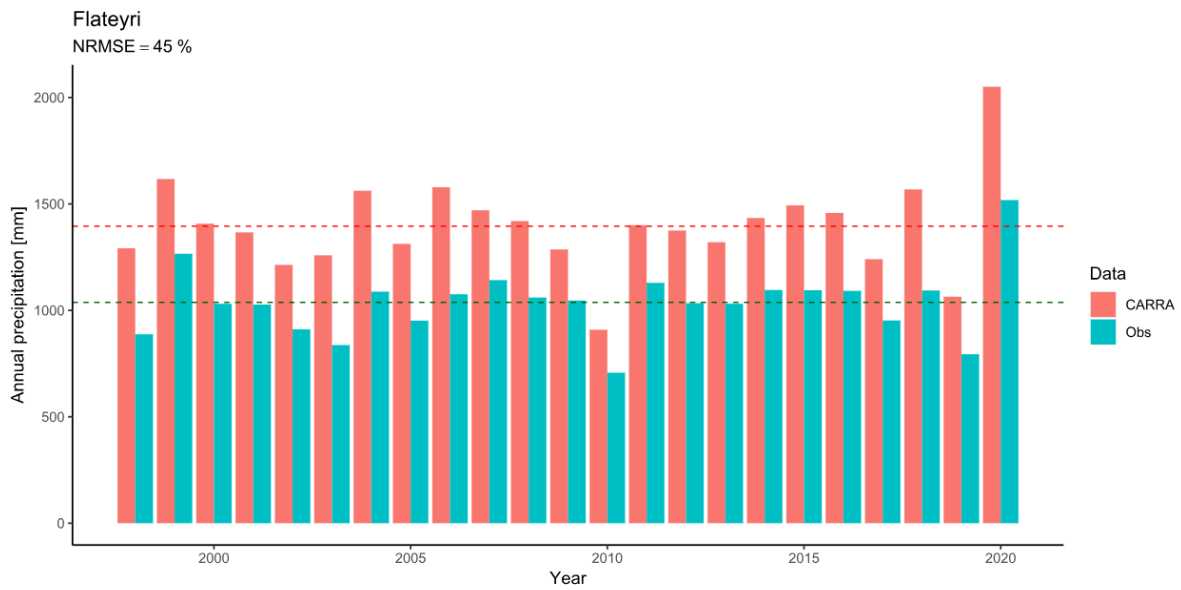


Figure IV.111 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Flateyri automatic station.



Figure IV.112 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Grindavík automatic station.



Figure IV.113 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Grundarfjörður automatic station.



Figure IV.114 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Gufuskálar automatic station.



Figure IV.115 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Hallormsstaður automatic station.

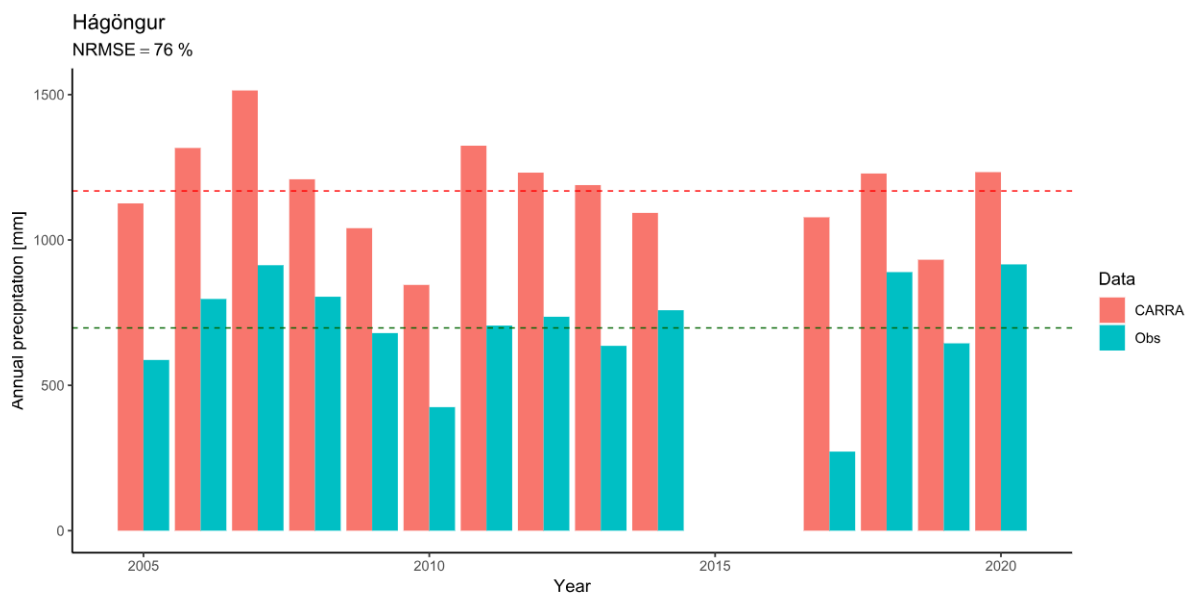


Figure IV.116 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Hágöngur automatic station.



Figure IV.117 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Hellisskarð automatic station.

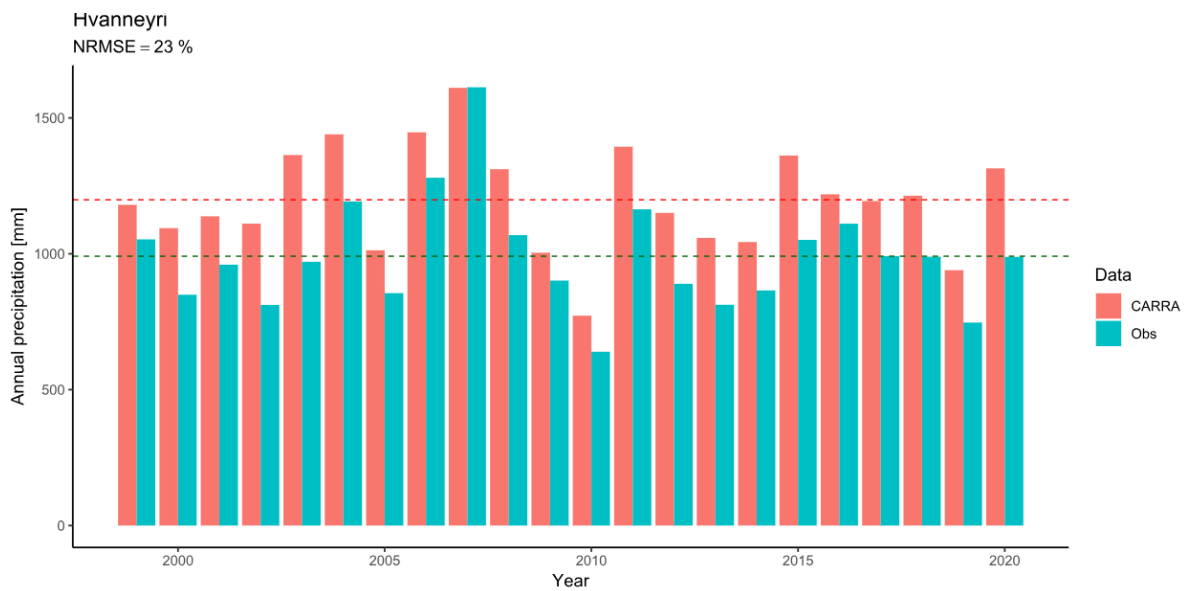


Figure IV.118 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Hvanneyri automatic station.

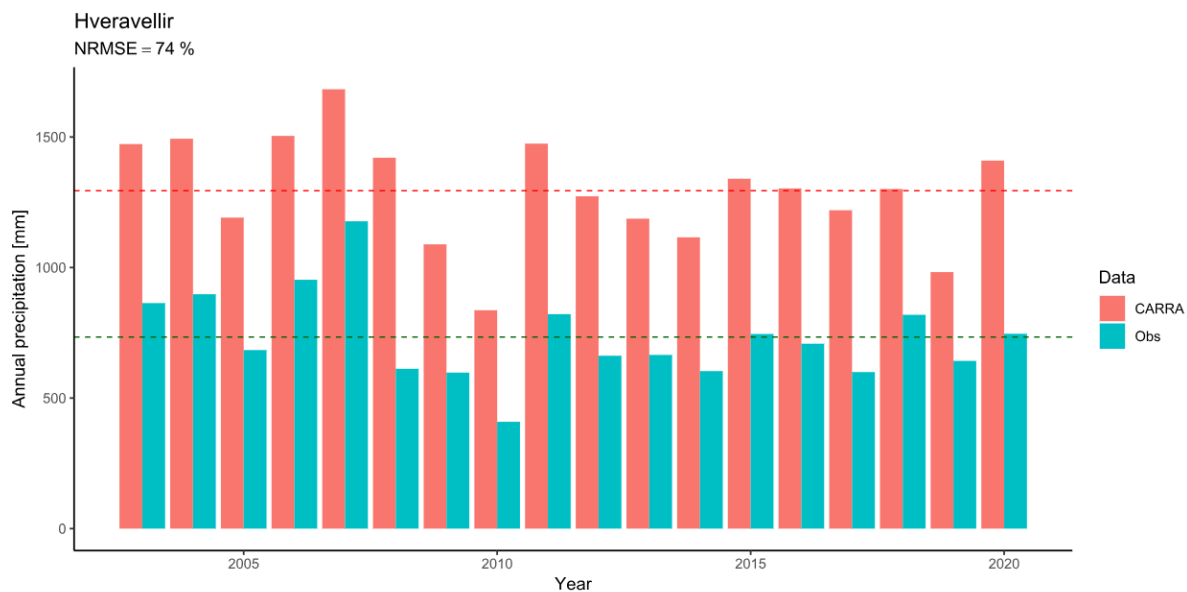


Figure IV.119 –1 Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Hveravellir automatic station.

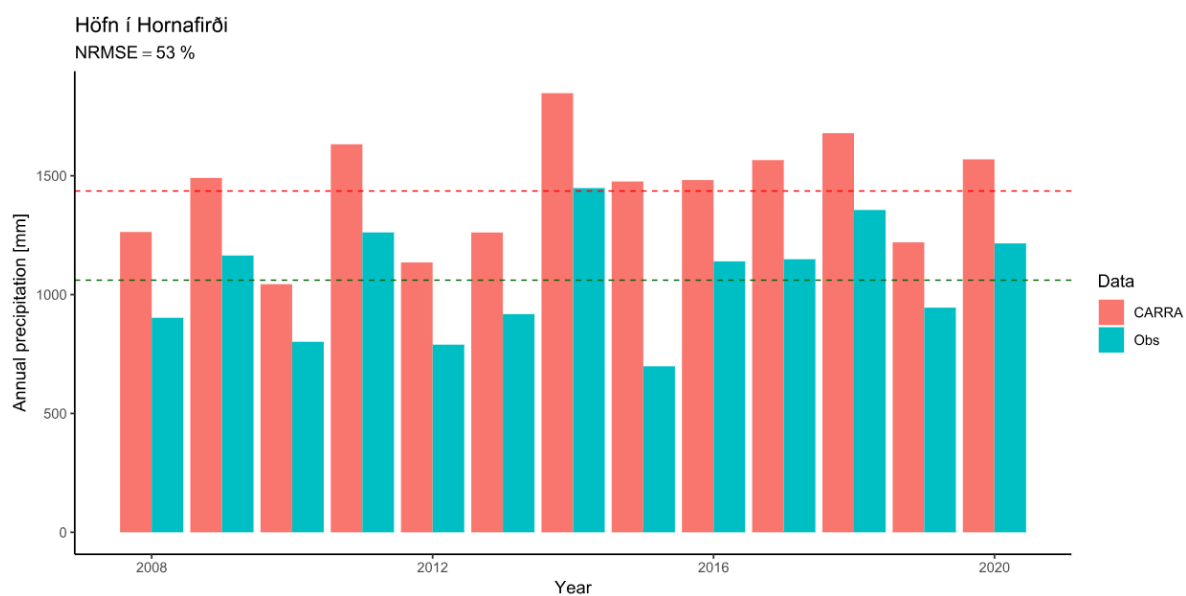


Figure IV.120 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Höfn í Hornafirði automatic station.

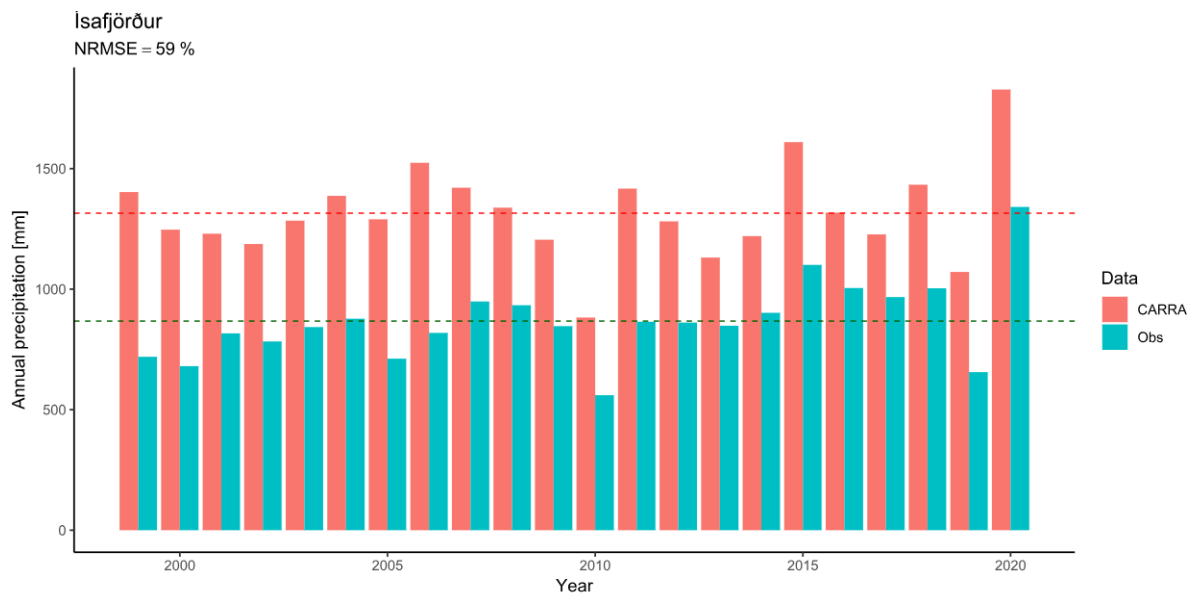


Figure IV.121 –2 Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Ísafjörður automatic station.



Figure IV.122 – Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Kálfhóll automatic station.

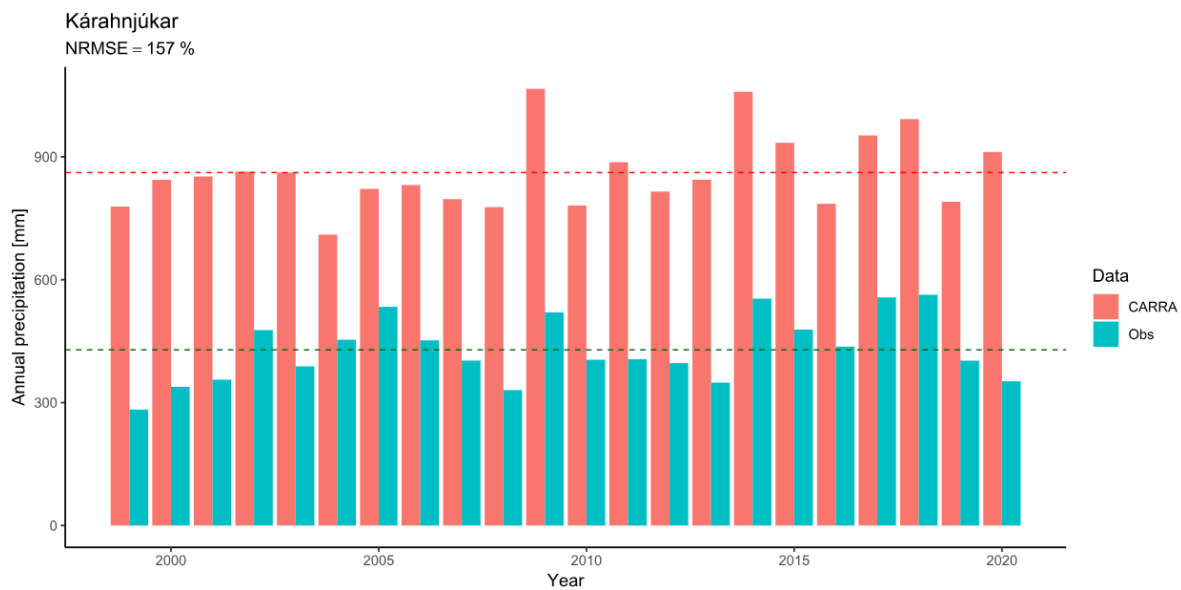


Figure IV.123 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Kárahnjúkar automatic station.

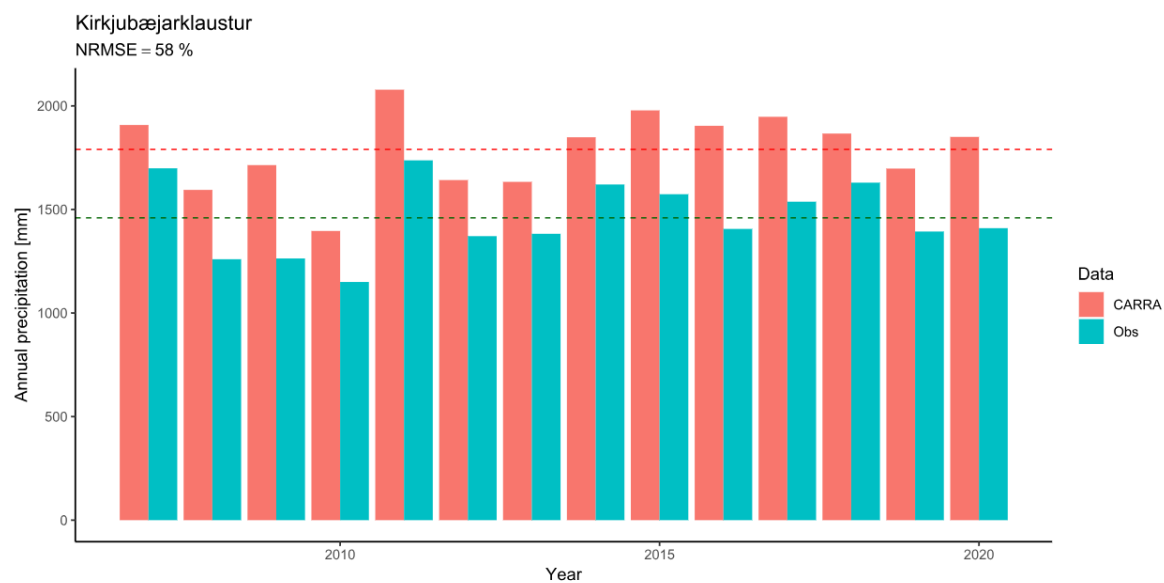


Figure IV.124 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Kirkjubæjarklaustur automatic station.

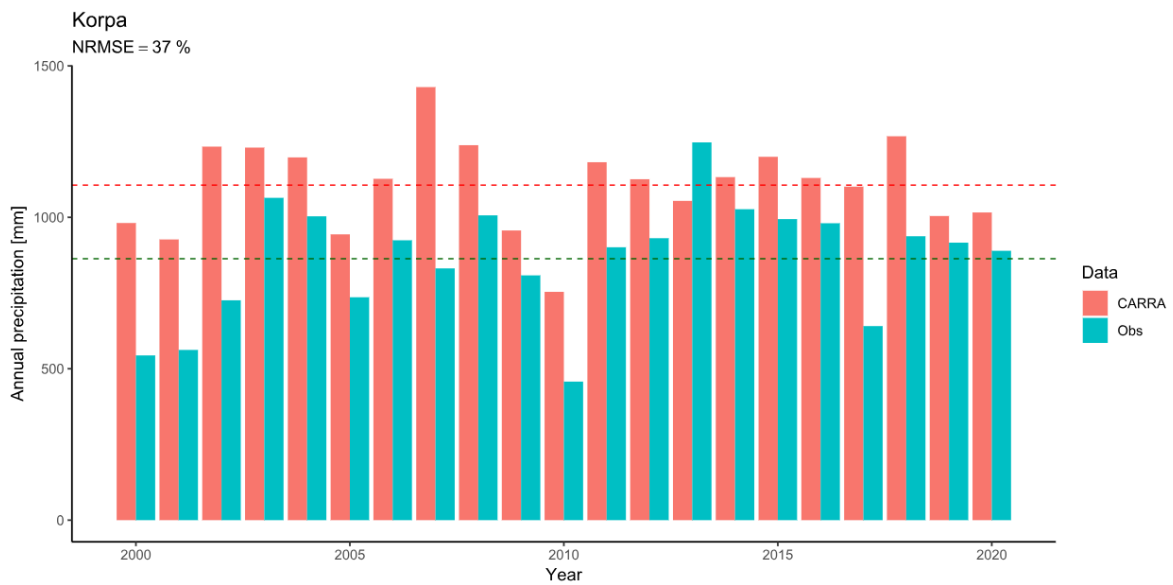


Figure III.125 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Korpa automatic station.



Figure IV.126 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Kvisker automatic station.

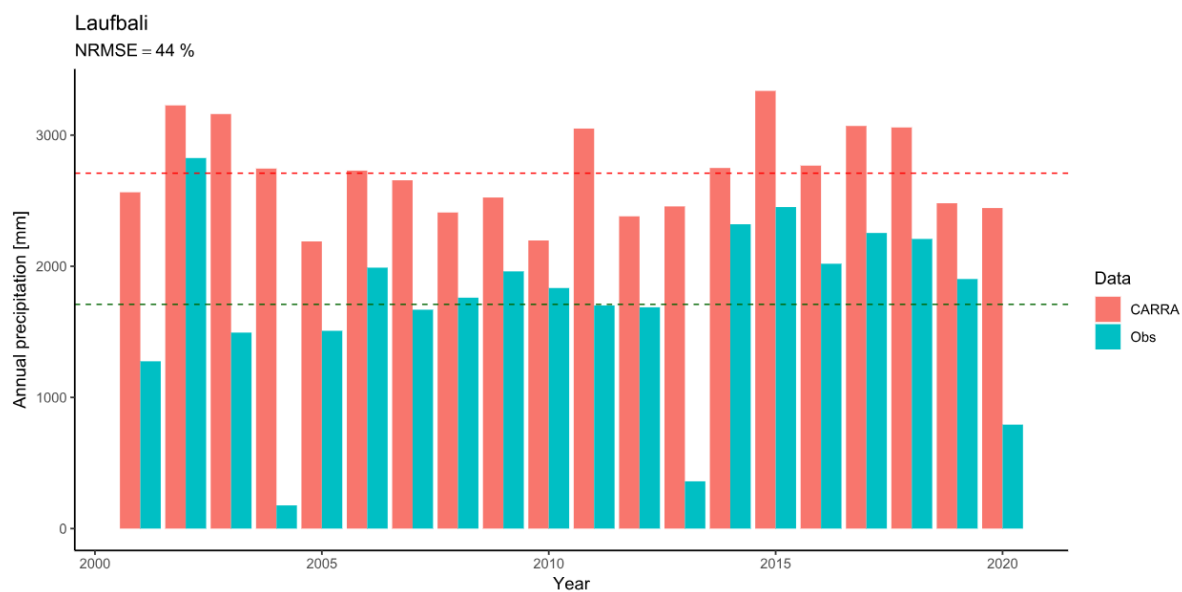


Figure IV.127 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Laufbali automatic station.

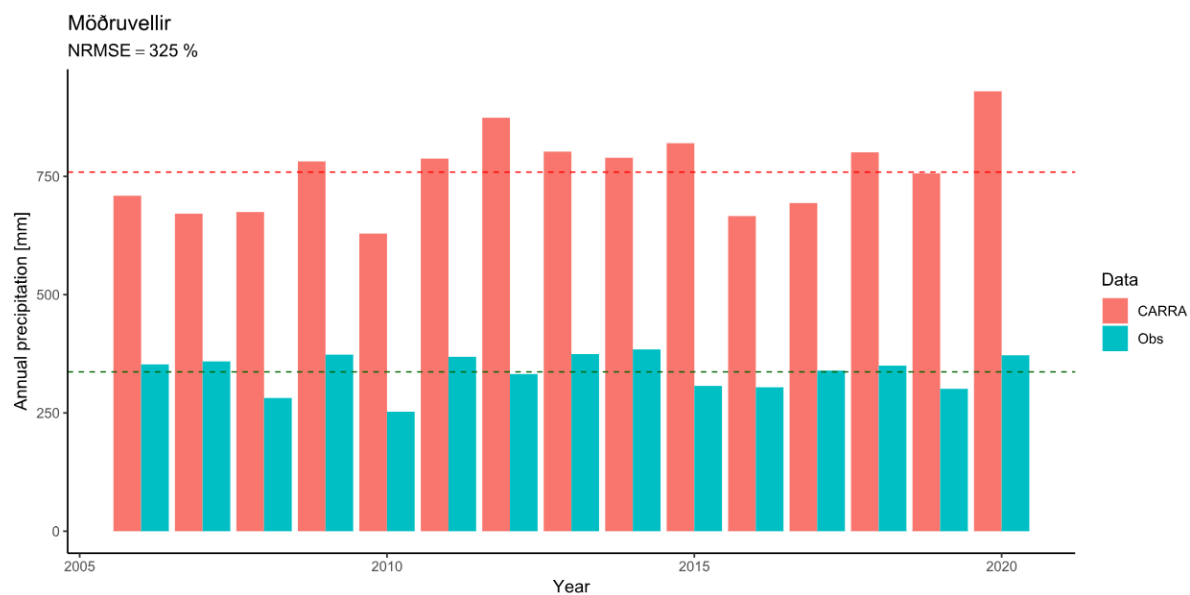


Figure IV.128 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Möðruvellir automatic station.



Figure IV.129 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Nautabú automatic station.

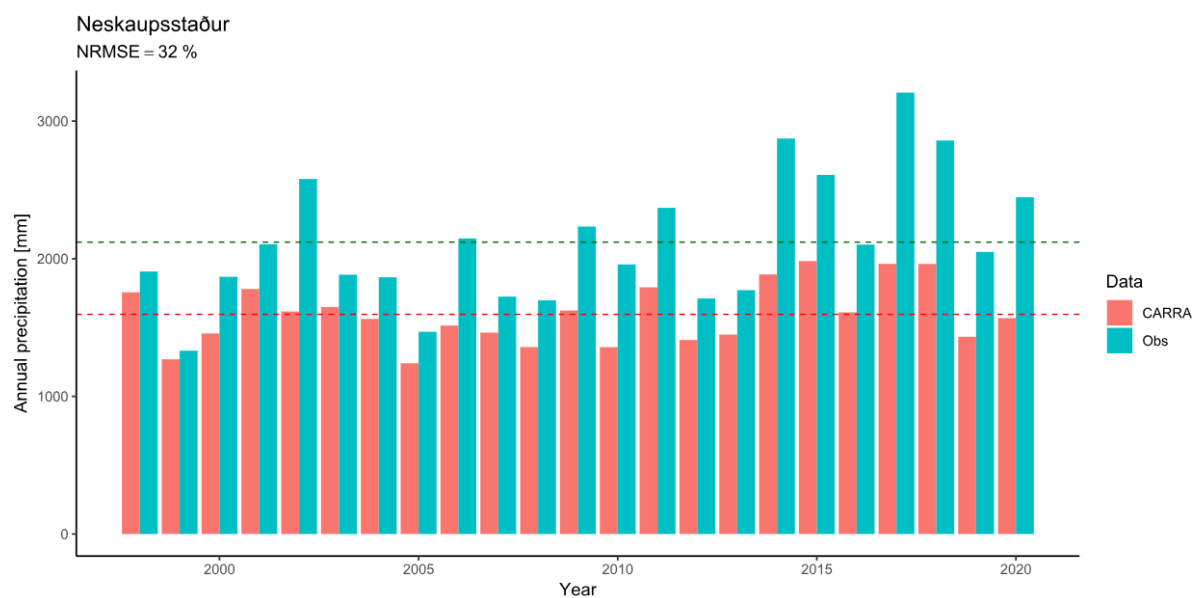


Figure IV.130 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Neskaupsstaður automatic station.

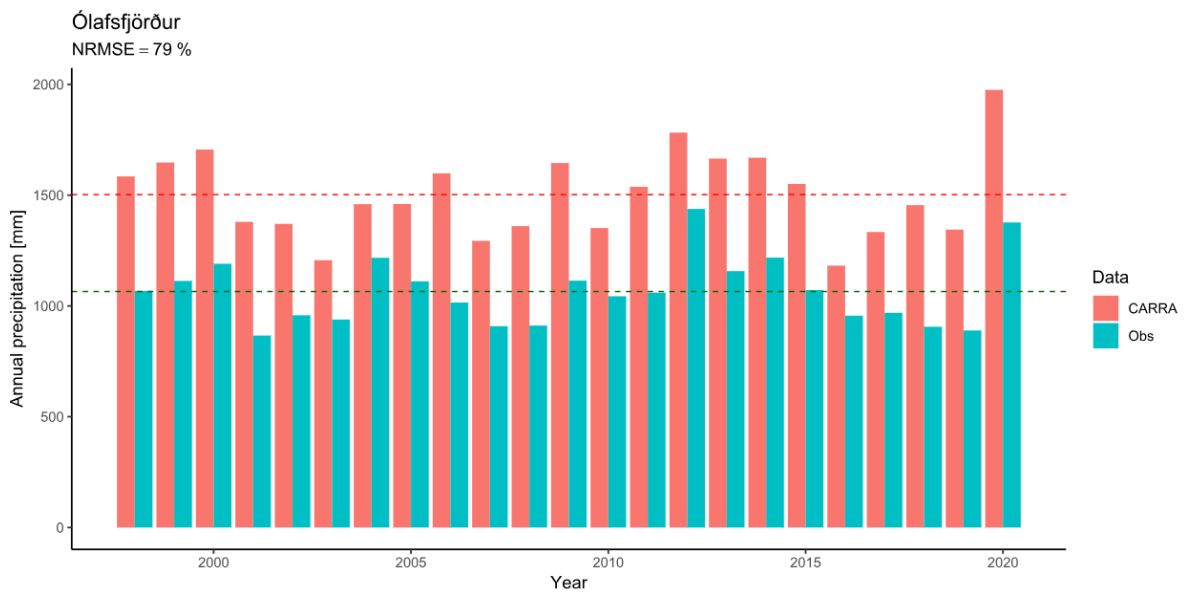


Figure IV.131 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Ólafsfjörður automatic station.

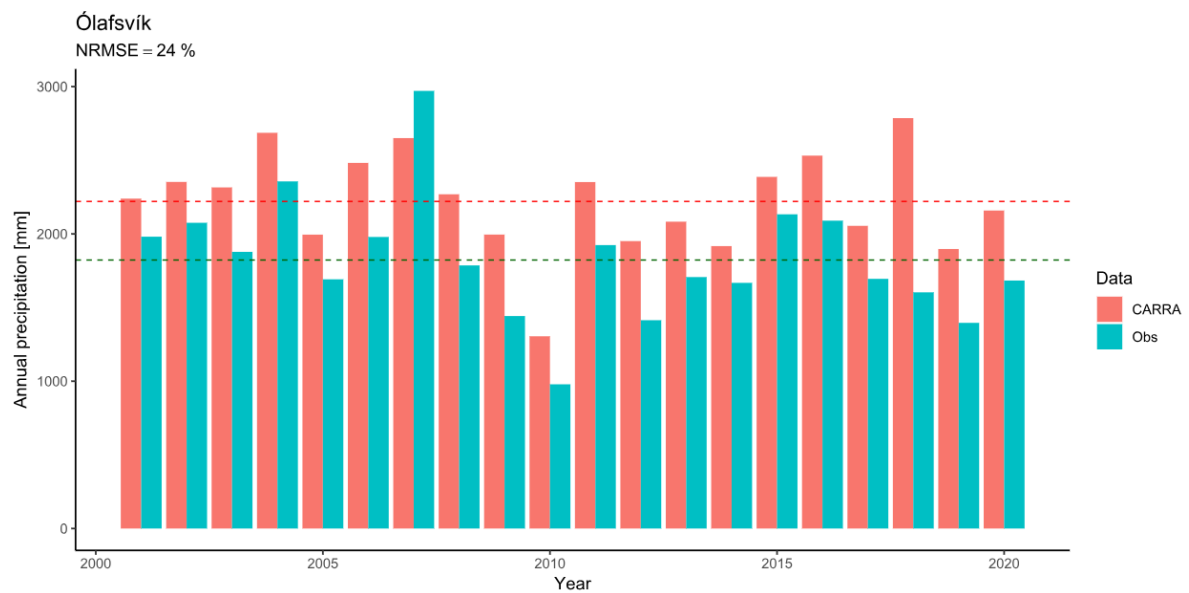


Figure IV.132 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Ólafsvík automatic station.



Figure IV.133 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Patreksfjörður automatic station.



Figure IV.134 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Raufarhöfn automatic station.

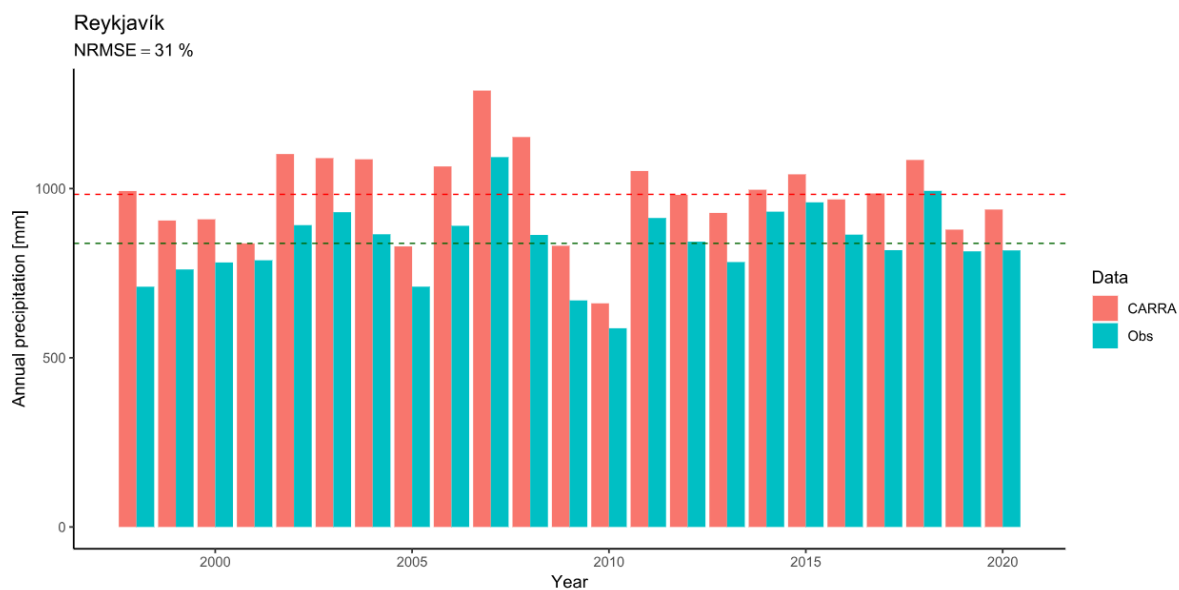


Figure IV.135 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Reykjavík automatic station.

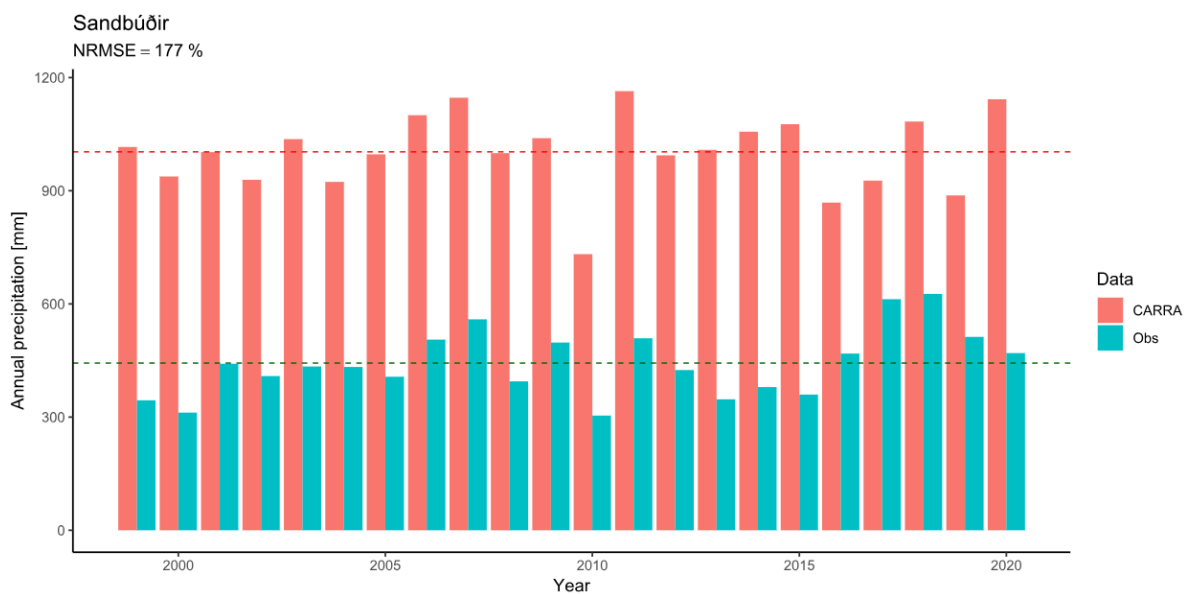


Figure IV.136 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Sandbúðir automatic station.



Figure IV.137 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Sámsstaðir automatic station.

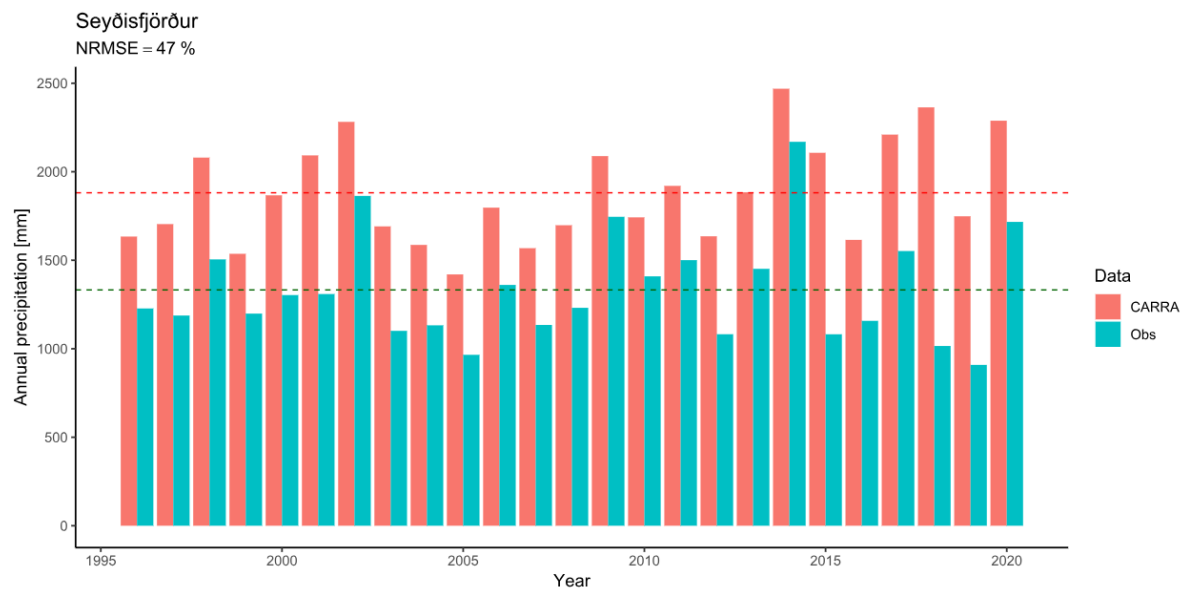


Figure IV.138 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Seyðisfjörður automatic station.

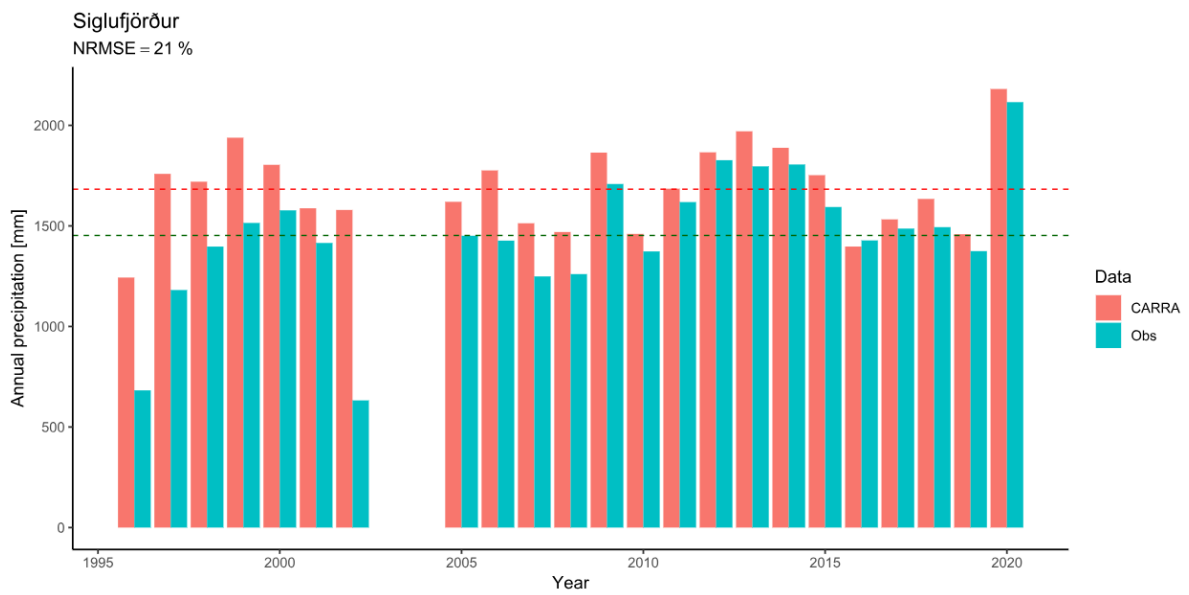


Figure IV.139 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Sigluðfjörður automatic station.

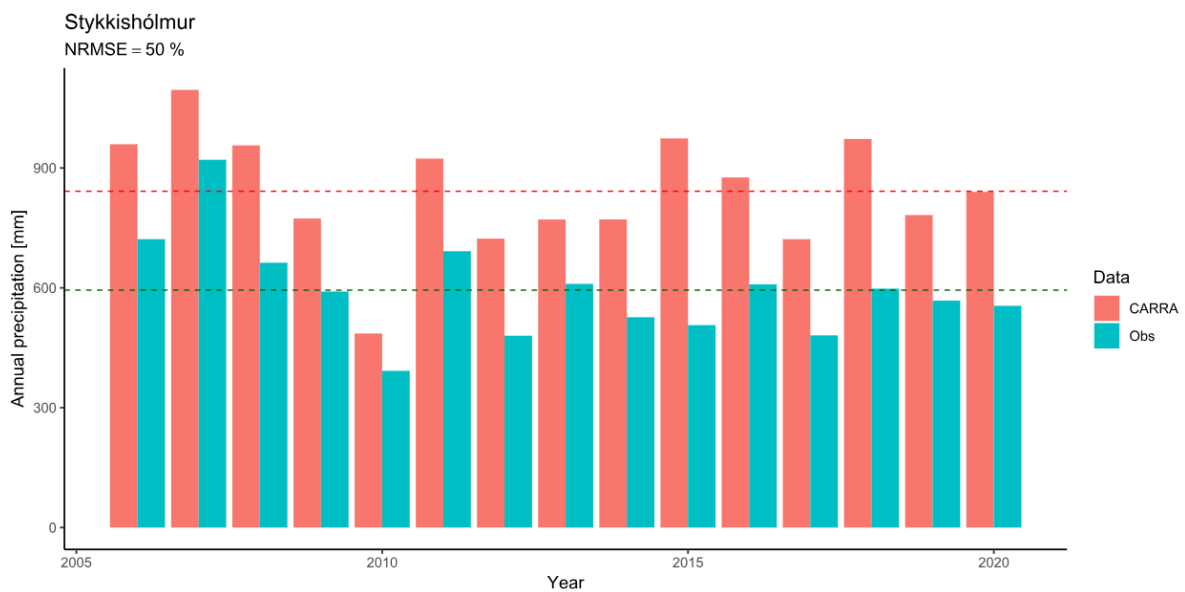


Figure IV.140 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Stykkishólmur automatic station.



Figure IV.141 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Súðavík automatic station.

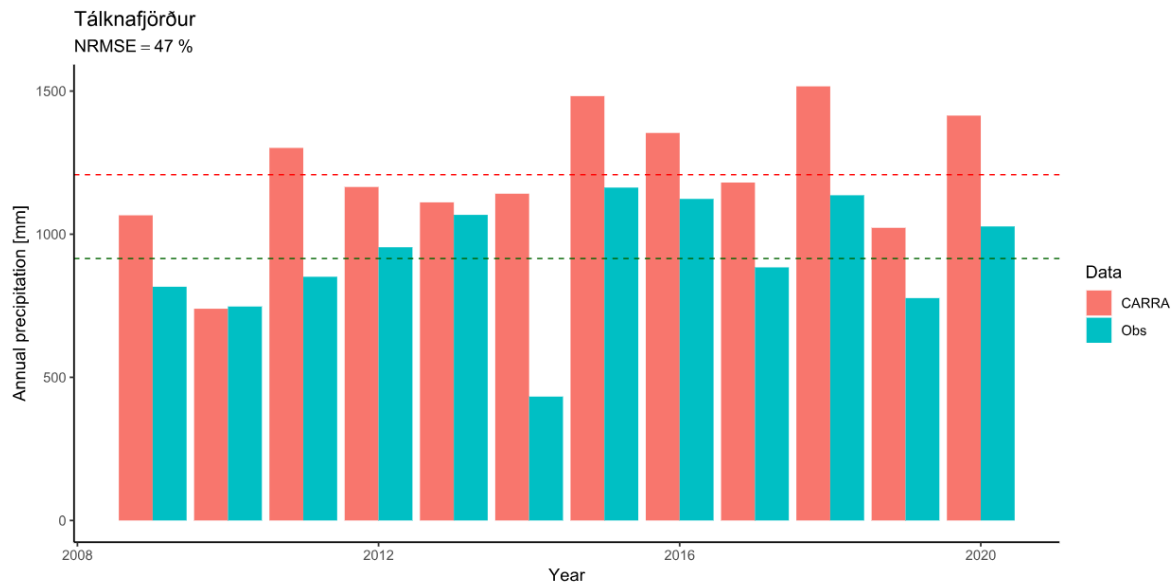


Figure IV.142 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Tálknafjörður automatic station.

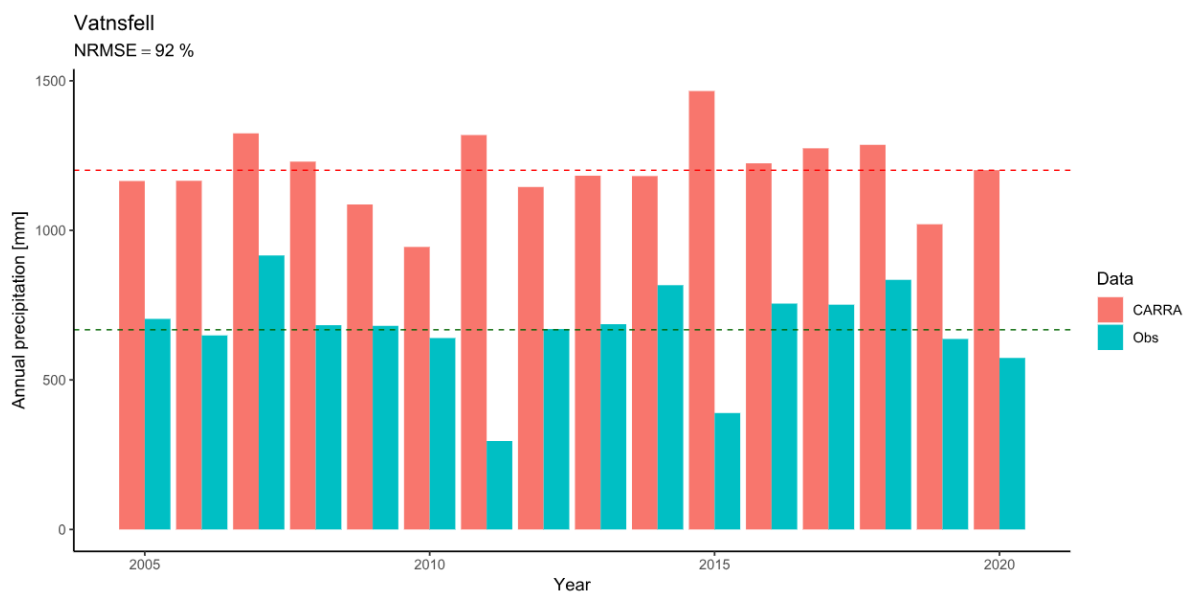


Figure IV.143 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Vatnsfell automatic station.

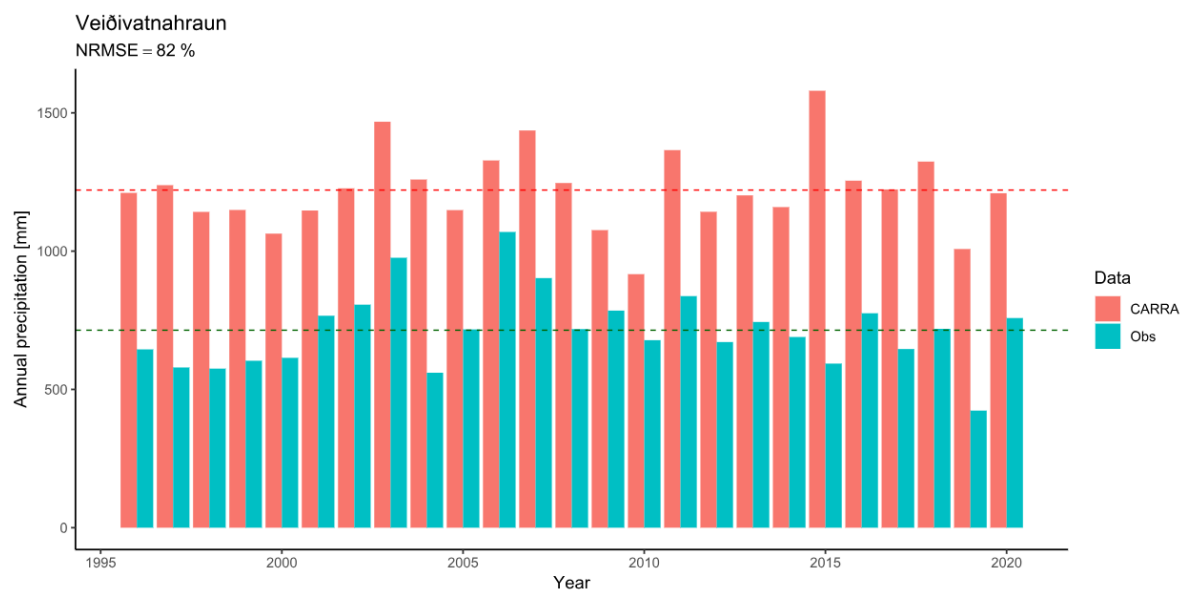


Figure IV.144 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Veiðivatnahraun automatic station.

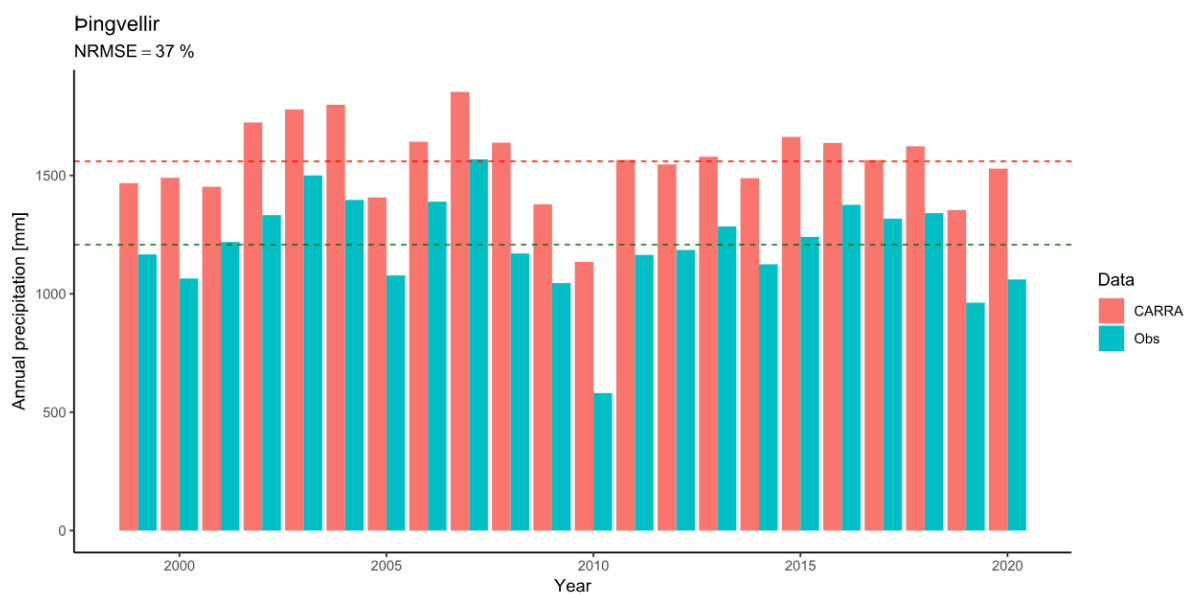


Figure IV.145 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Pingvellir automatic station.



Figure IV.146 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Þykkvibær automatic station.



Figure IV.147 — Comparison between the observed and simulated (CARRA) accumulated annual precipitation at the Ölkelduháls automatic station.