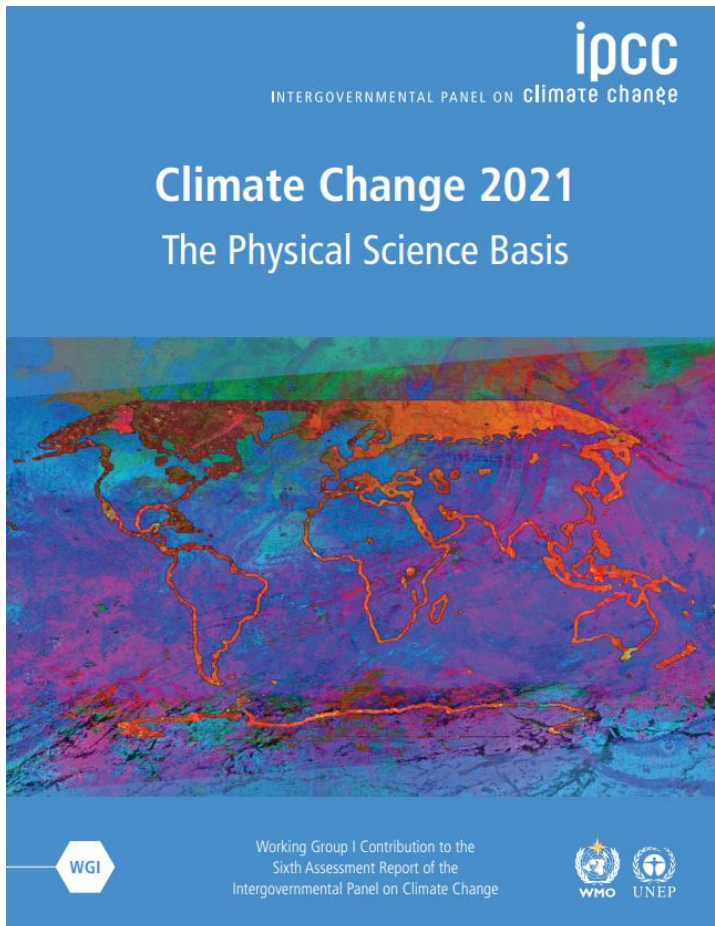




Future sea levels in Sweden



In 2021, the Intergovernmental Panel on Climate Change ([IPCC](#)) released the Sixth Assessment Report; AR6 Interim Report 1 - The Physical Science Basis [IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change] ([AR6 WG1](#)), where they present the latest calculations, including on future sea levels. SMHI has compiled data for probable projections for the years 2050, 2100 and 2150 municipality by municipality on its website ([SMHI Future mean sea levels](#)), which has been used in the calculations in this memorandum.

Summary

Calculations of [mean sea levels](#) and highest sea levels for the years 2025, 2050, 2100 and 2150 have been conducted for 86 Swedish stations (Figures 5, 6, 7 and Appendix Table 1). The results are based on analysis of historical observational data from 1886 through 2024 ([SMHI Open Data Service, Availability Swedish sea levels](#)) and extreme levels calculated at SMHI ([SMHI Extreme levels](#)) regional data on global sea level rise from the SSP5-8.5 projection (Figure 4, median values, upper likely scenario) in the Intergovernmental Panel on Climate Change ([IPCC](#)) projections presented in AR6 Interim Report 1 - The Scientific Basis (([AR6 WG1](#)) and total (aggregated) land uplift data compiled by SMHI ([SMHI Future mean sea levels](#)), which is based on the Nordic Commission for Geodesy ([NKG](#)) land uplift model ([NKG2016LU](#)). All results are reported in Sweden's national reference system for depths, heights and water levels; Land Survey Datum 2000 ([RH 2000](#)) or Baltic Sea Chart Datum 2000 ([BSCD2000](#)).

Sea level observations

The [Swedish sea level network](#), operated by the Swedish Maritime Administration ([SMA](#)), Swedish Meteorological and Hydrological Institute ([SMHI](#)), Swedish Nuclear Fuel and Waste Management Company ([SKB](#)), Chalmers ([CTH](#)) and Göteborg harbour ([GBG](#)) records sea level at 60 locations (Figure 1 and Appendix 1). The Swedish sea level records constitute some of the longest and most robust sea level records in the world ([Sweden's national report to GLOSS](#)). The first systematic Swedish observations of the sea level started 1774 (Figure 2) at the sluice in the harbour of Stockholm and later on several more stations have been established and several of these mareographs are still in operation or have been substituted by other stations. During the years 2017-2019 the stations were upgraded within the [FAMOS](#)-project with new sensors (two sensors, radar- or pressure gauges). The stations were also connected to the land survey datum 2000 ([RH 2000](#)) and delivers a sea level value every minute. On the website [ViVa](#) real-time data are shown from all stations. Historical observations from all stations are provided by SMHI ([SMHI Open Data Service, Availability Swedish sea levels](#)).

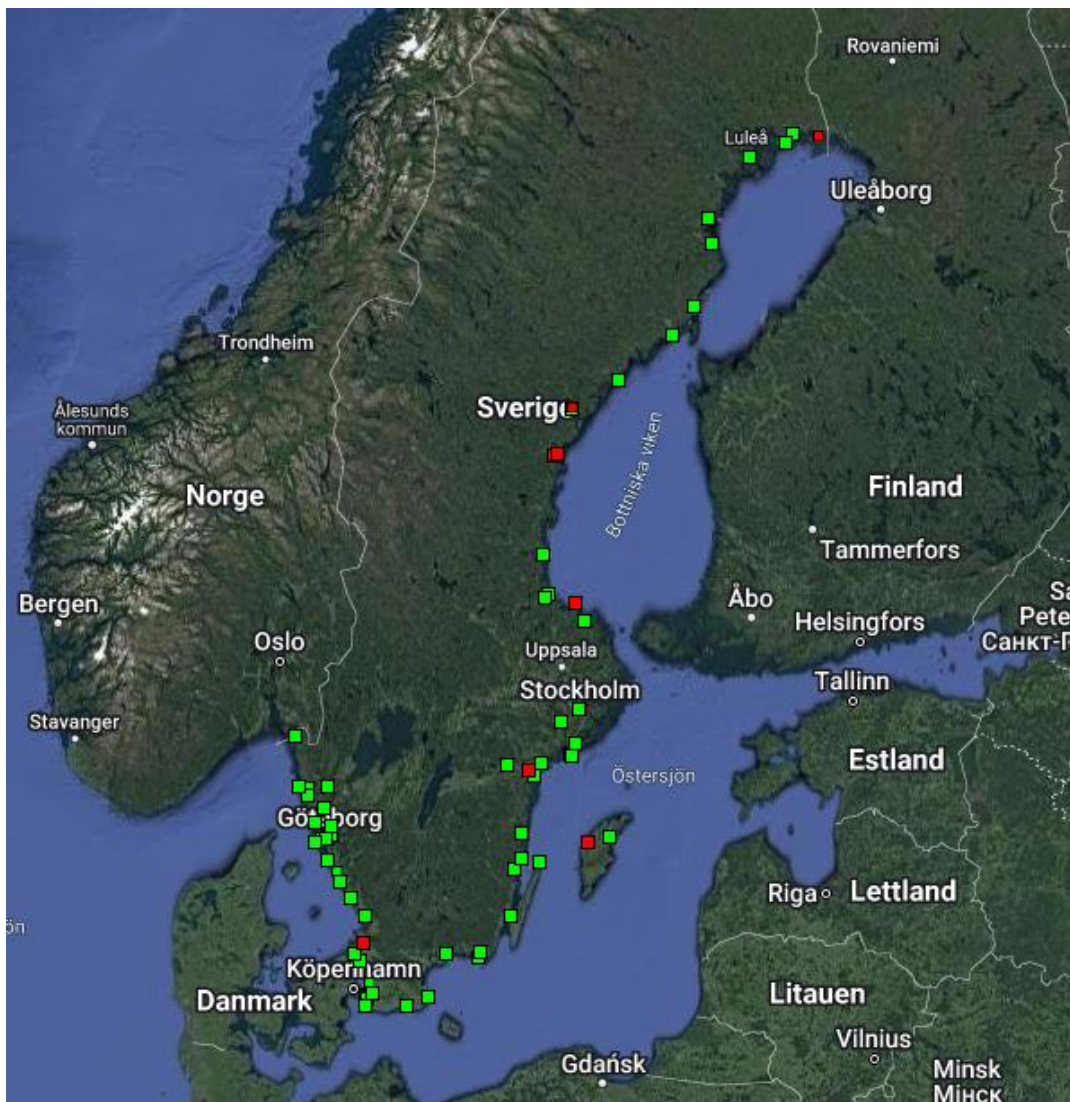


Figure 1. The [Swedish Sea Level network](#) in January 2025.

Rising sea levels

From the long Swedish time series of sea level, we can detect the global sea level rise. In the [Stockholms series](#), the 'world's longest sea level series' (Figure 2), a clear sea level rise is noticeable at the end of the 19th century. Towards the end of the 20th century, the increase becomes more visible and the rate of increase since 1980 is about 0,3 cm per year (Figure 3).

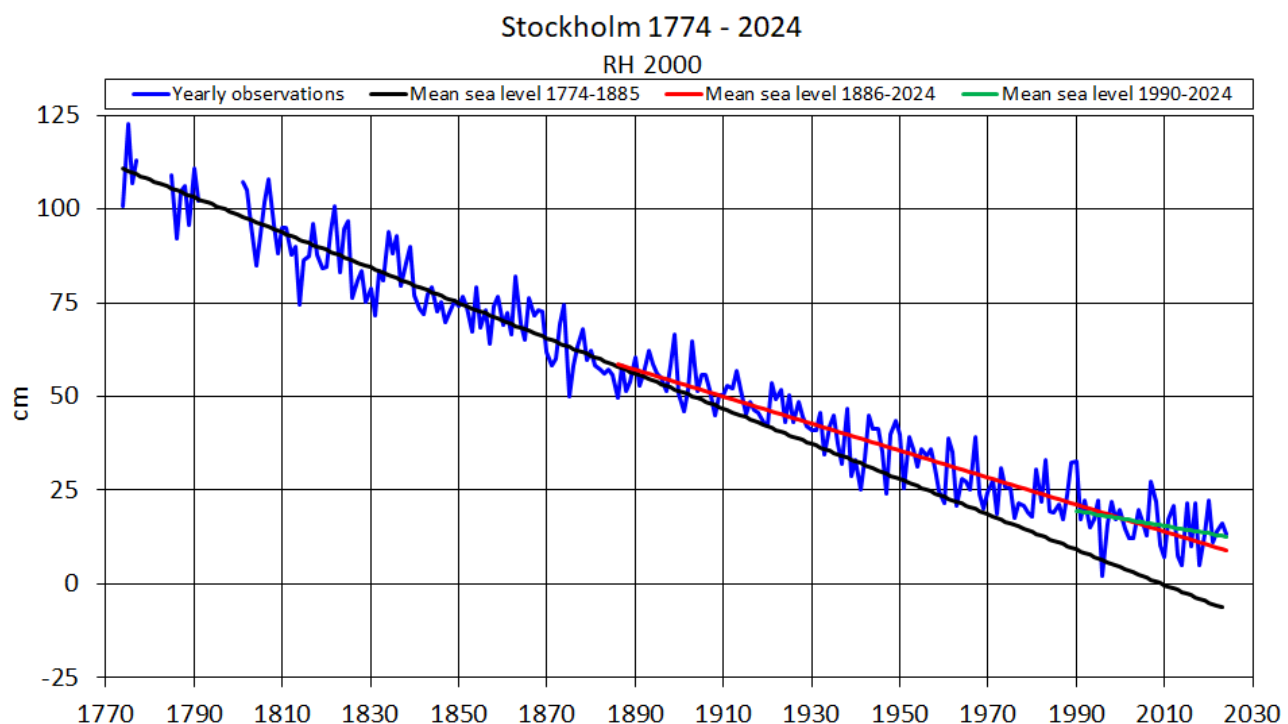


Figure 2. Annual mean sea levels in Stockholm since 1774. The sea level rise since the end of the 19th century appears as the deviation from the black line that represents the land uplift. The red and green lines show the estimated mean sea levels 1886-2024 and 1990-2024, respectively.

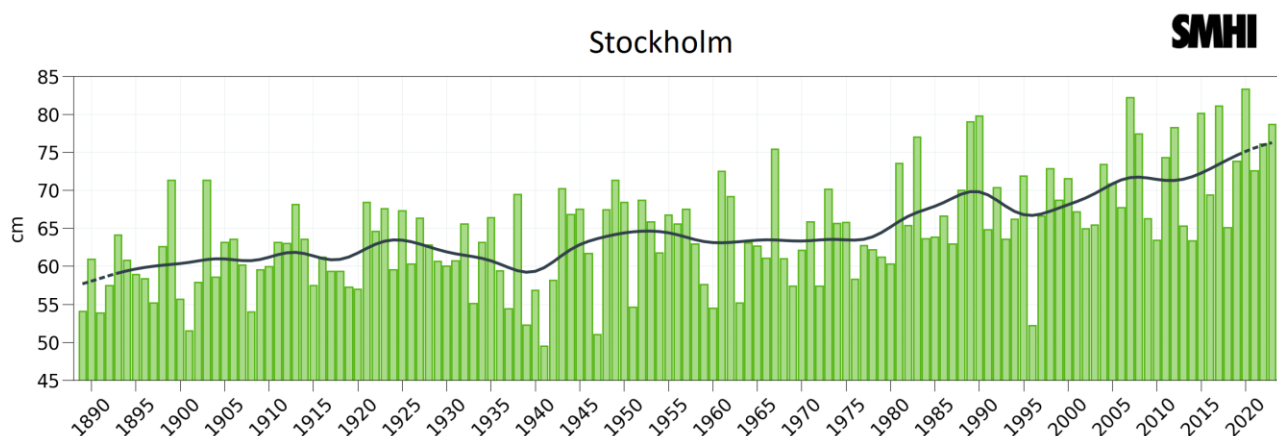


Figure 3. Observed sea level change in Stockholm since 1889. Sea level corrected for the total land-uplift (glacial isostatic adjustment). The black line shows the gauss-filtered (smoothed) average. The sea level has been risen by approximately 20 centimeters since 1886 ([SMHI Climate Indicator for sea level](#)).

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Future sea levels according to IPCC

Calculations of future sea levels are based on projections that the Intergovernmental Panel on Climate Change ([IPCC](#)) considers likely (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5). All projections take into account large-scale regional variations in sea level rise that cause the sea to rise at different rates across the globe. The Swedish Maritime Administration has chosen to follow the median value of the upper projection SSP5-8.5, within the likely range 17th to 83rd percentile (Figure 4).

Projected global mean sea level rise under different SSP scenarios

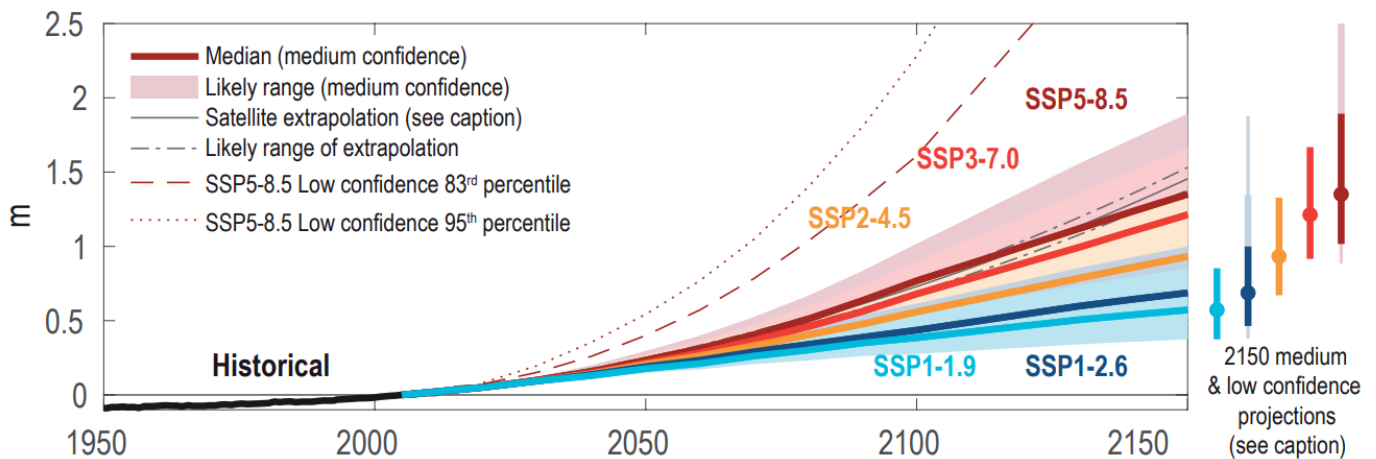


Figure 4. Projected global mean sea level rise under different Shared Socio-economic Pathway (SSP) scenarios. Likely global mean sea level (GMSL) change for SSP scenarios resulting from processes in whose projection there is medium confidence. Projections and likely ranges at 2150 are shown on right. Lightly shaded ranges and thinner lightly shaded ranges on the right show the 17th–83rd and 5th–95th percentile ranges for projections including low confidence processes for SSP1-2.6 and SSP5-8.5 only, derived from a p-box including structured expert judgement and marine ice-cliff instability projections. Black lines show historical GMSL change, and thick solid and dash-dotted black lines show the mean and likely range extrapolating the 1993–2018 satellite altimeter trend and acceleration.

Source: AR6 Interim Report 1 - The scientific basis - IPCC, 2021: Climate change 2021: The scientific basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change ([AR6 WG1](#), Figure 9.27).

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Mean sea levels

[Calculated mean sea levels](#) for the year 2025 (Figure 5) have been derived using regression analysis of observed annual mean values (Figure 2) from the start of measurements up to and including the year 2023 ([SMHI Open Data Service, Availability Swedish sea levels](#)). The regression analysis provides the best possible linear fit to a series of annual mean values and reproduces the calculated mean sea level (MSL) or mean water surface (MVY) for a desired year forward or backward in time. For stations with a short measurement period, we have estimated values based on data from the nearest station(s).

To calculate mean sea level for the years 2050, 2100 and 2150 (Figure 5), we use data from AR6 Interim Report 1 - The Physical Science Basis - IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change ([AR6 WG1](#)) and data on total (aggregated) land uplift ([SMHI Future mean sea levels](#)), which is based on the NKG land uplift model ([NKG2016LU](#)).

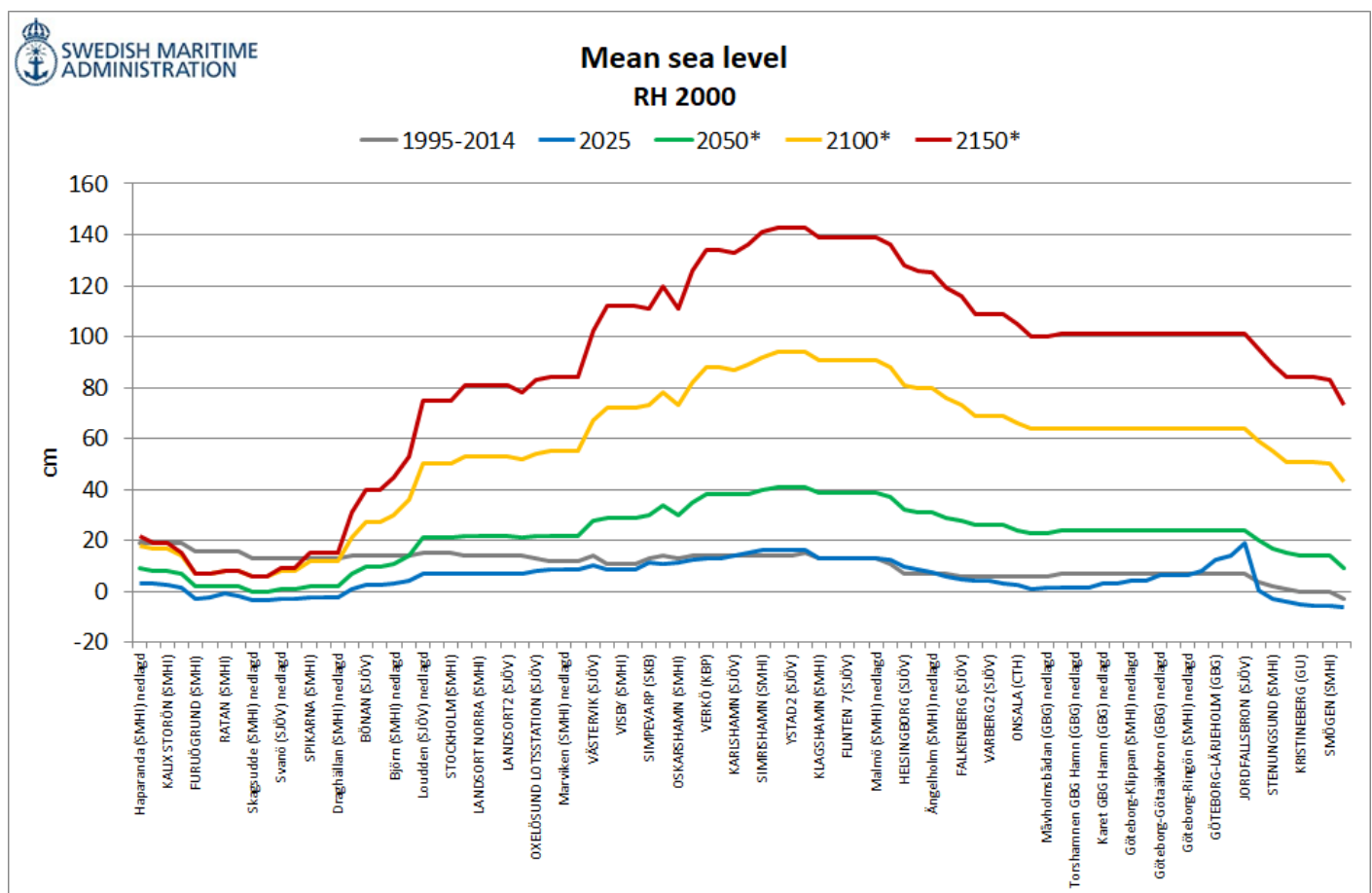


Figure 5. Diagram showing the [calculated mean sea level](#) in RH 2000 (cm) for the period 1995-2014, year 2025, 2050*, 2100* and 2150* at 86 Swedish stations (same values as shown in Appendix Table 1). The values are calculated from historical observation data from 1886 through 2024 ([SMHI Open Data Service, Availability Swedish sea levels](#)), * including sea level rise according to IPCC's projection SSP5-8.5 median values ([IPCC, AR6 WG1](#)) and total land uplift ([SMHI Future mean sea levels](#)).

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Highest observed sea levels

High or extreme sea levels usually occur in connection with strong winds, known as storm surges. The highest levels are observed along the Norrland coast, the Skåne coast and the west coast. Continuous measurements (every hour) have been carried out at a number of stations since 1886, but even earlier extreme levels have occurred, but these are not included in the analysis. For example, there are eyewitness accounts of over three meters of water level above mean sea level in the southwestern Baltic Sea in connection with the “Backafloden” on the 13th November 1872. Large parts of the coastal areas of Skåne were flooded and hundreds of people died in Denmark and Germany. The highest measured sea level in Sweden was observed in Halmstad on November 29, 2015 (2.31 m above mean sea level, Figure 6).

By analyzing long series of sea level measurements, the highest observed sea level at each station can be determined. From the analysis of historical observation data from 1886 through 2024 ([SMHI Open Data Service, Availability Swedish sea levels](#)) and extreme levels calculated at SMHI ([SMHI Extreme levels](#)), we have compiled the highest observed sea level and highest 100-year return level per station (Figure 6). For stations with a short measurement period, we have estimated values based on data from the nearest station(s).

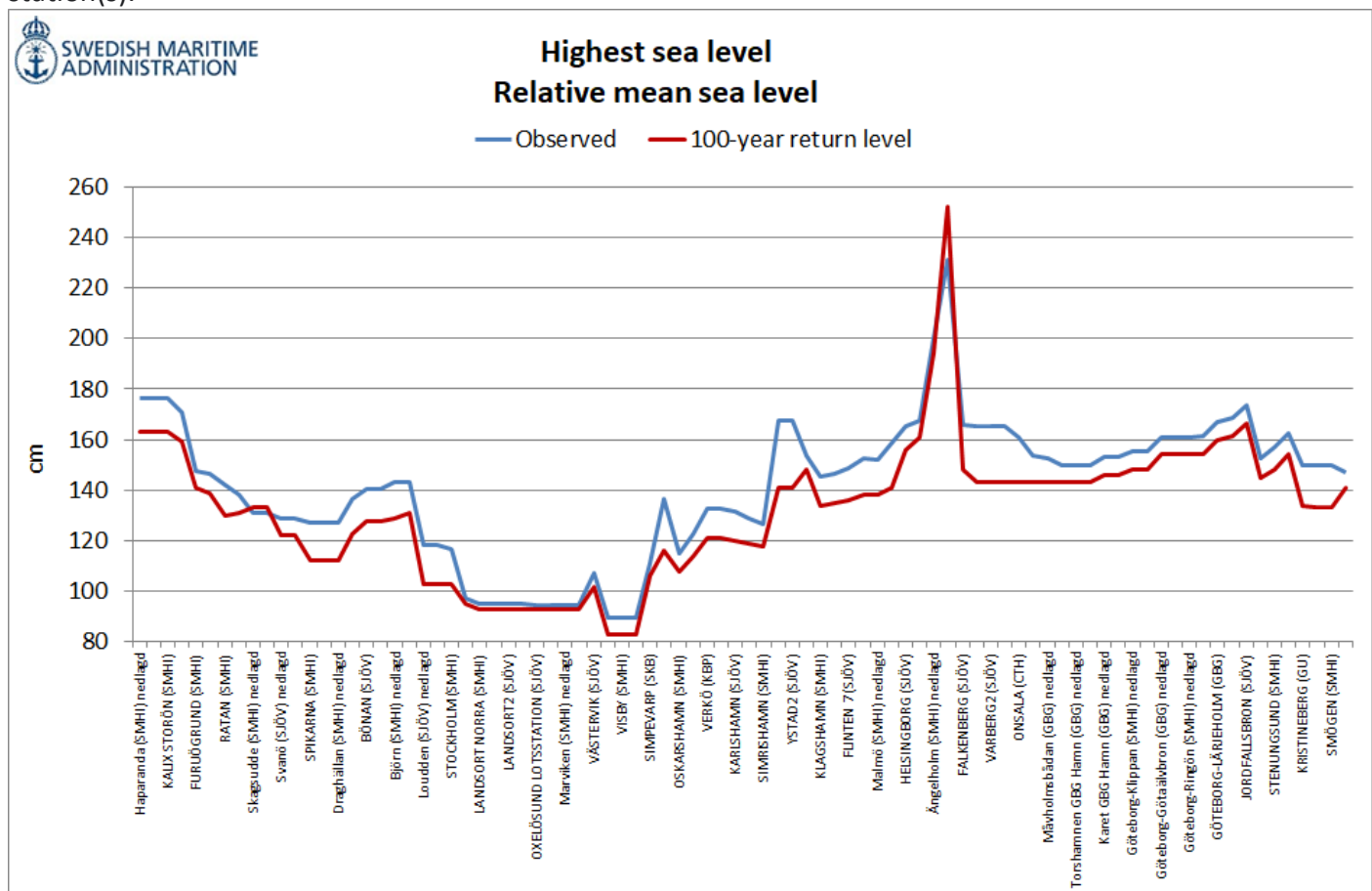


Figure 6. Graph showing highest observed sea levels and 100-year return values relative to mean sea level (cm) at 86 Swedish stations. The values are calculated from historical observation data from 1886 through 2024 ([SMHI Open Data Service, Availability Swedish sea levels](#)) and extreme levels calculated at SMHI ([SMHI Extreme levels](#)).

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Highest calculated sea levels

From the highest observed sea levels relative to mean sea level (Figure 6) and mean sea level rise according to the Intergovernmental Panel on Climate Change ([IPCC](#)) projection SSP5-8.5 median value (Figure 4) and the total land uplift ([SMHI Future mean sea levels](#)), we have calculated the highest sea level per station (Figure 7). The value is not to be regarded as an absolute upper limit for how high the sea level can be at different locations. For stations with a short measurement period, we have estimated values based on data from the nearest station(s).

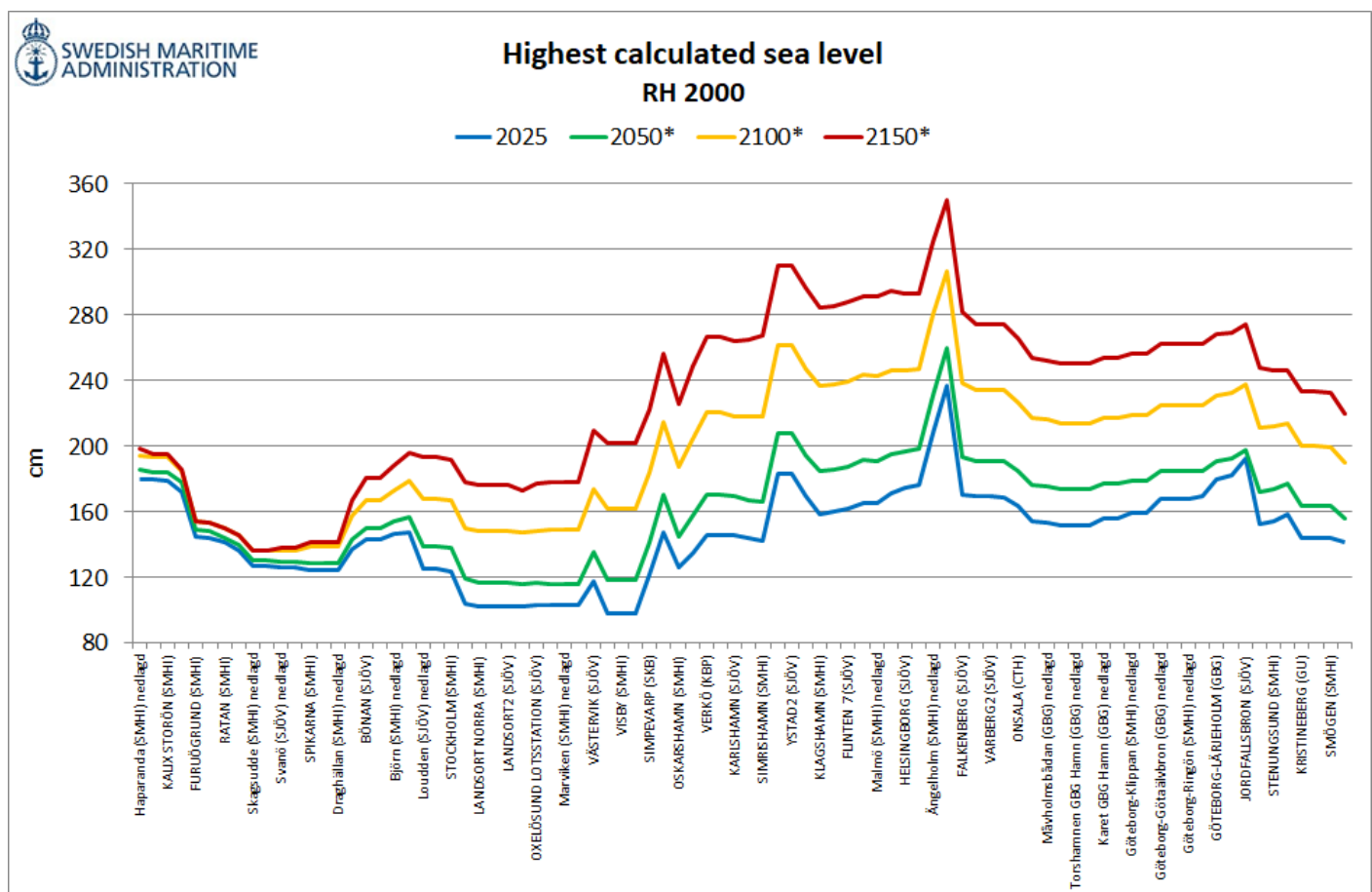


Figure 7. Diagram showing the highest calculated sea levels in RH 2000 (cm) for the years 2025, 2050*, 2100* and 2150* at 86 Swedish stations (same values as shown in Appendix Table 1). The values are calculated from historical observation data from 1886 through 2024 ([SMHI Open Data Service](#), [Availability Swedish sea levels](#)), * including sea level rise according to IPCC's projection SSP5-8.5 median values ([IPCC](#), [AR6 WG1](#)) and total land uplift ([SMHI Future mean sea levels](#)).

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Generalized future sea levels

From calculations of mean sea levels and highest calculated sea levels per station, generalized future sea levels per sea area can be produced (Figure 8), based on the stations included in each sea area (Appendix Table 1).

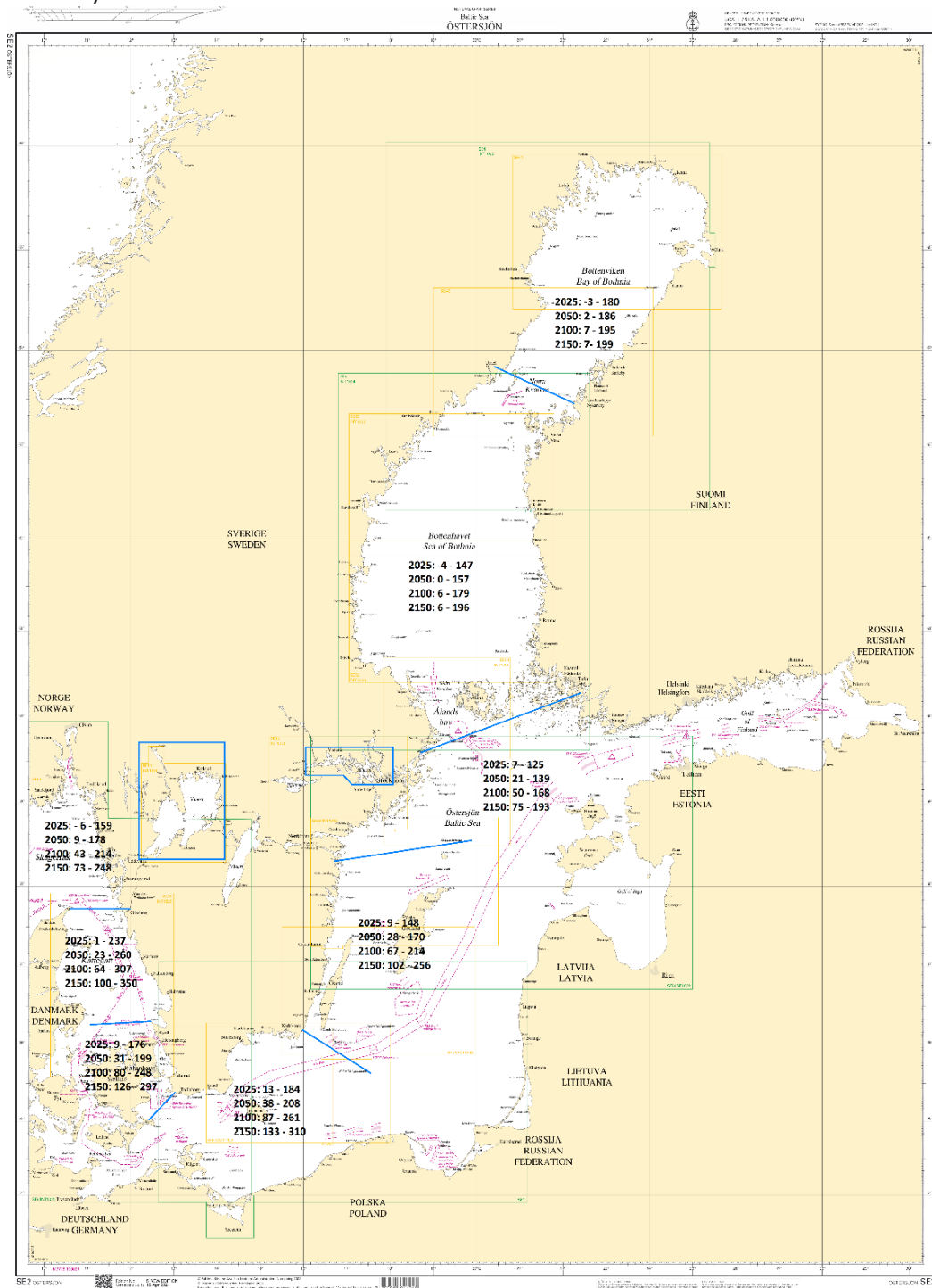


Figure 8. Generalized projected mean sea levels and highest calculated sea levels in RH 2000 (cm) for the years 2025, 2050*, 2100* and 2150* per sea area, * including sea level rise according to IPCC's projection SSP5-8.5 median values ([IPCC, AR6 WG1](#)) and total land uplift ([SMHI Future mean sea levels](#)).

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**Appendix. Results**

Table 1. Calculated mean sea levels, highest calculated sea levels and highest 100-year return levels in RH 2000 (cm) for the year 2025, 2050*, 2100* and 2150* for 86 Swedish stations. The values are obtained by analyzing historical observation data 1886-2024 ([SMHI Open Data Service, Availability Swedish sea levels](#)) and extreme levels calculated at SMHI ([SMHI Extreme levels](#)), * including sea level rise according to IPCC's SSP5-8.5 median values ([IPCC, AR6 WG1](#)) and total land uplift ([SMHI Future mean sea levels](#)). Values marked in **red** are estimates from the nearest station(s).

Station	Latitude	Longitude	Calculated mean sea level				Highest calculated sea level				Highest 100-year return level			
	degrees	degrees	2025	2050	2100	2150	2025	2050	2100	2150	2025	2050	2100	2150
Haparanda (SMHI) discontinued	65.771661	23.902961	3.0	9	18	22	180	186	195	199	166	172	181	185
KALIX KARLSBORG (SMA)	65.789299	23.300648	3.2	8	17	19	180	185	194	196	166	171	180	182
KALIX STORÖN (SMHI)	65.697056	23.096014	2.4	8	17	19	179	185	194	196	165	171	180	182
STRÖMÖREN (SMA)	65.548442	22.237961	1.4	7	14	15	173	178	185	186	160	166	173	174
FURUÖGRUND (SMHI)	64.915639	21.230675	-2.8	2	7	7	145	150	155	155	138	143	148	148
GÅSÖREN (SMA)	64.675760	21.286607	-2.5	2	7	7	144	148	153	153	137	141	146	146
RATAN (SMHI)	63.986042	20.894989	-0.8	2	8	8	141	144	150	150	129	132	138	138
HOLMSUND (SMA)	63.702800	20.347010	-1.8	2	8	8	136	140	146	146	129	133	139	139
Skagsudde (SMHI) discontinued	63.190519	19.012345	-3.6	0	6	6	127	131	137	137	129	133	139	139
SKAGSUDDE2 (SMA)	63.190519	19.012345	-3.6	0	6	6	127	131	137	137	129	133	139	139
Svanö (SMA) discontinued	62.889972	17.869111	-3.0	1	8	9	126	130	137	138	119	123	130	131
LUNDE (SMA)	62.880674	17.876406	-3.0	1	8	9	126	130	137	138	119	123	130	131
SPIKARNA (SMHI)	62.363333	17.531111	-2.3	2	12	15	125	129	139	142	110	114	124	127
Spikarna2 (SMA) discontinued	62.363333	17.530833	-2.3	2	12	15	125	129	139	142	110	114	124	127
Draghällan (SMHI) discontinued	62.339840	17.439470	-2.3	2	12	15	125	129	139	142	110	114	124	127
LJUSNE LOTSSTATION (SMA)	61.206945	17.145578	0.9	7	21	31	137	144	158	168	124	130	144	154
BÖNAN (SMA)	60.738800	17.317720	2.7	10	27	40	143	150	167	180	131	138	155	168
GÄVLE (GH)	60.696700	17.231400	2.7	10	27	40	143	150	167	180	131	138	155	168
Björn (SMHI) discontinued	60.638375	17.986394	3.4	11	30	45	147	154	173	188	132	140	159	174
FORSMARK (SMHI)	60.408500	18.210850	4.2	14	36	53	147	157	179	196	135	145	167	184
Loudden (SMA) discontinued	59.340850	18.137950	6.9	21	50	75	125	139	168	193	110	124	153	178
Frihamnen (SH)	59.346298	18.127075	6.9	21	50	75	125	139	168	193	110	124	153	178
STOCKHOLM (SMHI)	59.324200	18.081700	7.0	21	50	75	124	138	167	192	110	124	153	178
NYNÄS FISKEHAMN (SMA)	58.900638	17.953586	6.9	22	53	81	104	120	151	179	102	117	148	176
LANDSORT NORRA (SMHI)	58.768653	17.858872	7.2	22	53	81	102	117	148	176	100	115	146	174
Landsort (SMHI) discontinued	58.742231	17.865322	7.2	22	53	81	102	117	148	176	100	115	146	174
LANDSORT2 (SMA)	58.744581	17.865014	7.2	22	53	81	102	117	148	176	100	115	146	174
E4 BRON SÖDERTÄLJE (SMA)	59.184710	17.642930	6.9	21	52	78	102	116	147	173	100	114	145	171
OXELÖSUND LOTSSTATION (SMA)	58.661670	17.124750	8.3	22	54	83	103	117	149	178	101	115	147	176
JUTEN (SMA)	58.632009	16.332540	8.8	22	55	84	103	117	150	179	102	115	148	177
Marviken (SMHI) discontinued	58.553689	16.837389	8.8	22	55	84	103	117	150	179	102	115	148	177
ARKÖ (SMHI)	58.483147	16.963647	8.8	22	55	84	103	117	150	179	102	115	148	177
VÄSTERVIK (SMA)	57.748331	16.675316	10.4	28	67	102	118	135	174	209	112	130	169	204
SLITE (SMA)	57.705950	18.810610	8.5	29	72	112	98	119	162	202	92	112	155	195
VISBY (SMHI)	57.639242	18.284503	8.5	29	72	112	98	119	162	202	92	112	155	195
Visby2 (SMA) discontinued	57.639242	18.284503	8.5	29	72	112	98	119	162	202	92	112	155	195
SIMPEVARP (SKB)	57.409257	16.675627	11.2	30	73	111	122	141	184	222	118	136	179	217
ÖLANDS NORRA UDDE (SMHI)	57.366278	17.097228	11.1	34	78	120	148	170	214	256	127	150	194	236
OSKARSHAMN (SMHI)	57.271569	16.479922	11.6	30	73	111	126	145	188	226	120	138	181	219
KALMAR (SMA)	56.658950	16.378223	12.3	35	82	126	135	158	205	249	126	149	196	240

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Station	Latitude	Longitude	Calculated mean sea level				Highest calculated sea level				Highest 100-year return level			
	degrees	degrees	2025	2050	2100	2150	2025	2050	2100	2150	2025	2050	2100	2150
VERKÖ (KBP)	56.166655	15.628894	13.3	38	88	134	146	171	221	267	134	159	209	255
KUNGSHOLMSFORT (SMHI)	56.105194	15.589278	13.3	38	88	134	146	171	221	267	134	159	209	255
KARLSHAMN (SMA)	56.154577	14.821403	13.9	38	87	133	146	170	219	265	134	158	207	253
Åhus (SMHI) discontinued	55.928020	14.328350	15.3	38	89	136	144	167	218	265	134	157	208	255
SIMRISHAMN (SMHI)	55.557611	14.357722	16.3	40	92	141	143	166	218	267	134	158	210	259
Ystad (SMHI) discontinued	55.427022	13.825800	16.1	41	94	143	184	208	261	310	157	182	235	284
YSTAD2 (SMA)	55.422743	13.825619	16.1	41	94	143	184	208	261	310	157	182	235	284
SKANÖR (SMHI)	55.416789	12.829633	16.2	41	94	143	170	195	248	297	164	189	242	291
KLAGSHAMN (SMHI)	55.522300	12.893628	13.3	39	91	139	159	185	237	285	147	173	225	273
FLINTEN 16 (SMA)	55.560981	12.809542	13.2	39	91	139	160	186	238	286	148	174	226	274
FLINTEN 7 (SMA)	55.589378	12.844475	13.1	39	91	139	162	188	240	288	149	175	227	275
MALMÖ HAMN (SMA)	55.613560	12.997670	12.9	39	91	139	165	192	244	292	151	177	229	277
Malmö (SMHI) discontinued	55.616667	13.000000	12.9	39	91	139	165	191	243	291	151	177	229	277
BARSEBÄCK (SMHI)	55.756400	12.903410	12.5	37	88	136	171	196	247	295	154	178	229	277
HELSINGBORG (SMA)	56.044649	12.687319	9.6	32	81	128	175	197	246	293	166	188	237	284
VIKEN (SMHI)	56.142142	12.579267	8.6	31	80	126	176	199	248	294	170	192	241	287
Ängelholm (SMHI) discontinued	56.298011	12.786511	7.6	31	80	125	208	231	280	325	202	225	274	319
HALMSTAD (SMA)	56.651249	12.844667	5.8	29	76	119	237	260	307	350	258	281	328	371
FALKENBERG (SMA)	56.892023	12.489460	4.8	28	73	116	171	194	239	282	153	176	221	264
Varberg (SMHI) discontinued	57.108225	12.224925	4.2	26	69	109	169	191	234	274	147	169	212	252
VARBERG2 (SMA)	57.109513	12.241566	4.2	26	69	109	169	191	234	274	147	169	212	252
RINGHALS (SMHI)	57.249756	12.112531	3.4	26	69	109	169	191	234	274	146	169	212	252
ONSALA (CTH)	57.391944	11.918889	2.9	24	66	105	164	185	227	266	146	167	209	248
VINGA2 (SMA)	57.631650	11.608772	1.1	23	64	100	155	177	218	254	144	166	207	243
Måvholmsbådan (GBG) discontinued	57.672294	11.707439	1.4	23	64	100	154	175	216	252	144	166	207	243
GÖTEBORG-KROSSHOLMEN (SMHI)	57.691283	11.771256	1.8	24	64	101	152	174	214	251	145	167	207	244
Torshamnen GBG Hamn (GBG) discontinued	57.681111	11.788100	1.8	24	64	101	152	174	214	251	145	167	207	244
Göteborg-Torshamnen (SMHI) discontinued	57.684667	11.790722	1.8	24	64	101	152	174	214	251	145	167	207	244
Karet GBG Hamn (GBG) discontinued	57.687786	11.869625	3.3	24	64	101	157	177	217	254	149	170	210	247
TÅNGUDDEN GBG HAMN (SMA)	57.682064	11.872143	3.3	24	64	101	157	177	217	254	149	170	210	247
Göteborg-Klippan (SMHI) discontinued	57.691475	11.908781	4.2	24	64	101	160	179	219	256	152	172	212	249
GÖTEBORG-ERIKSBERG (GBG)	57.696567	11.908833	4.2	24	64	101	160	179	219	256	152	172	212	249
Göteborg-Götaälvbron (GBG) discontinued	57.714442	11.966611	6.6	24	64	101	168	185	225	262	161	178	218	255
GÖTEBORG-HISINGSBRON (SMA)	57.715220	11.968204	6.6	24	64	101	168	185	225	262	161	178	218	255
Göteborg-Ringön (SMHI) discontinued	57.717917	11.968056	6.6	24	64	101	168	185	225	262	161	178	218	255
GÖTEBORG-TINGSTADSTUNNELN (GBG)	57.723144	11.986922	8.2	24	64	101	170	185	225	262	162	178	218	255
GÖTEBORG-LÄRJEHOLM (GBG)	57.761944	12.003819	12.7	24	64	101	180	191	231	268	173	184	224	261
GÖTEBORG-AGNESBERG (GBG)	57.789775	12.010203	14.1	24	64	101	183	193	233	270	176	186	226	263
JORDFALLSBRON (SMA)	57.855419	12.008650	19.1	24	64	101	193	198	238	275	186	191	231	268
MARSTRAND (SMA)	57.887036	11.593596	0.2	20	59	95	153	173	212	248	145	165	204	240
STENUNGSUND (SMHI)	58.088461	11.820221	-2.6	17	55	89	154	174	212	246	145	165	203	237
UDDEVALLA (SMHI)	58.346778	11.894472	-4.1	15	51	84	159	178	214	247	150	169	205	238
KRISTINEBERG (GU)	58.250000	11.445833	-5.2	14	51	84	144	164	201	234	129	148	185	218
BROFJORDEN (SMA)	58.336008	11.404658	-5.3	14	51	84	144	164	201	234	128	147	184	217
SMÖGEN (SMHI)	58.353619	11.217850	-5.3	14	50	83	144	164	200	233	128	147	183	216
KUNGSVIK (SMHI)	58.996583	11.127250	-6.0	9	43	73	141	156	190	220	135	150	184	214