

FAMOS Odin Activity 2.3

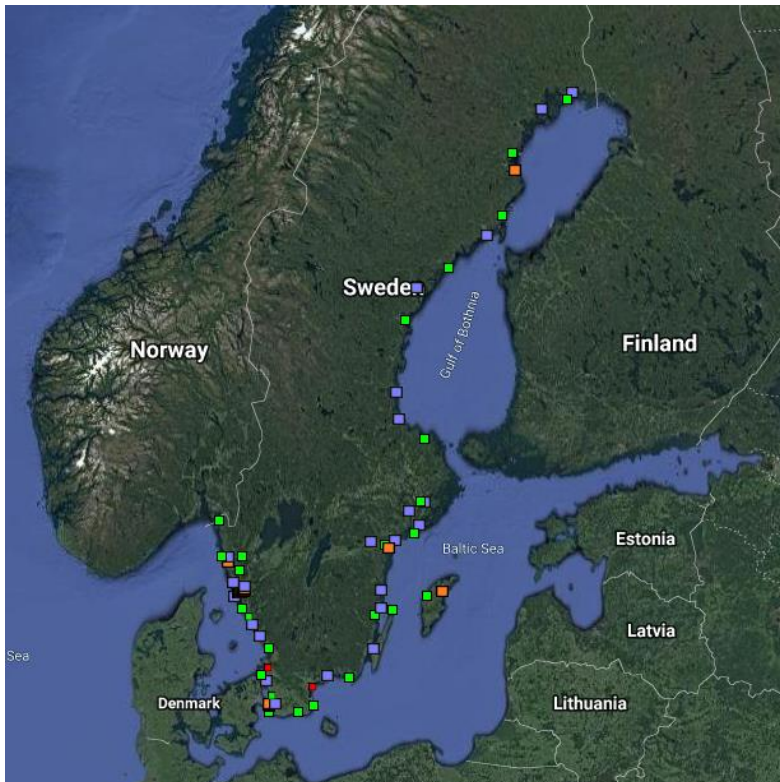
Upgrade and harmonization of the Swedish Sea level stations into one common network (SHIP), final report

CDWG12 Gdynia 2020-03-03

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The Swedish Sea Level Network



- Real-time data relative BSCD2000 from 60 stations
- 1-minute values with 1 cm accuracy
- Real-time and delayed mode quality control



Class I Upgrade with battery backup
Class II Upgrade without battery backup
Class III Unchanged, temporary

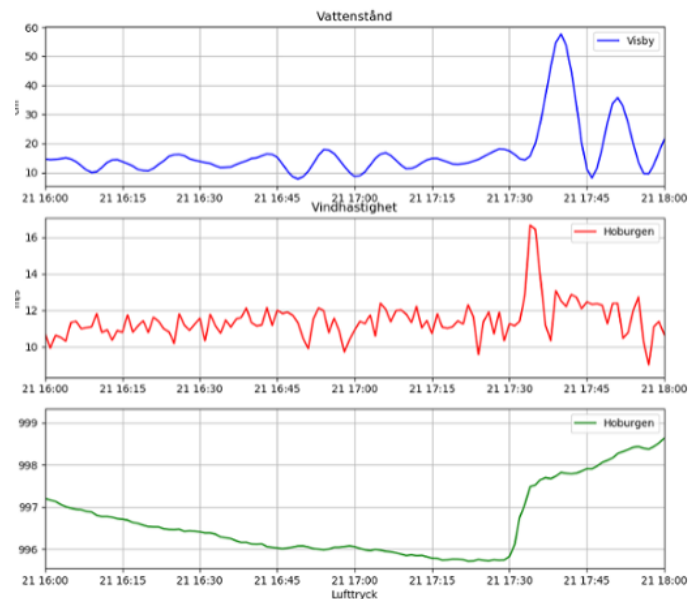
27 stations (23 SMHI + 3 SMA + 1 CTH)
25 stations (21 SMA + 3 GBG + 1 SKB)
7 stations (6 SMA + 1 SMHI)

Achievements:

- **A national Sea level network has been established**
 - A joint Swedish Sea level network between SMHI-SMA
 - Unified measurement technique (radar and pressure level sensors)
 - Unified quality control both in real-time and delayed mode
 - Unified data flow from sensor to archive data base
 - More accurate measurement, better quality
 - 1 min update of data 24/7
 - All stations are connected to the national precision levelling network i.e. Baltic Sea Chart Datum 2000 (BSCD2000)
 - New chart datum from 2019-06-03

Benefits with an upgraded sea level network

- Possible to detect fast sea level variations
- A common observation network provide better input for forecasting and warning service
- Temperature measurements from the stations provide a better basis in connection with icing for shipping and forecasting service
- The data loggers make it possible to supplement with other measurements in connection with the tide gauges
- Possible to do remote troubleshooting



Measurement principle Swedish Sea Level network

- Heated and insulated pipes to avoid ice and condensation
- Instruments leveled and connected to BSCD2000
- The radar is set to level 0, corresponds to the distance to BSCD2000
- To avoid wave measurements we use software damping in the radar sensors 60's
 - A microwave pulse is emitted every 0.5 nanoseconds and reflected back to the sensor. This produces 3.6 million pulses per second.
- OTT PLS secondary sensors

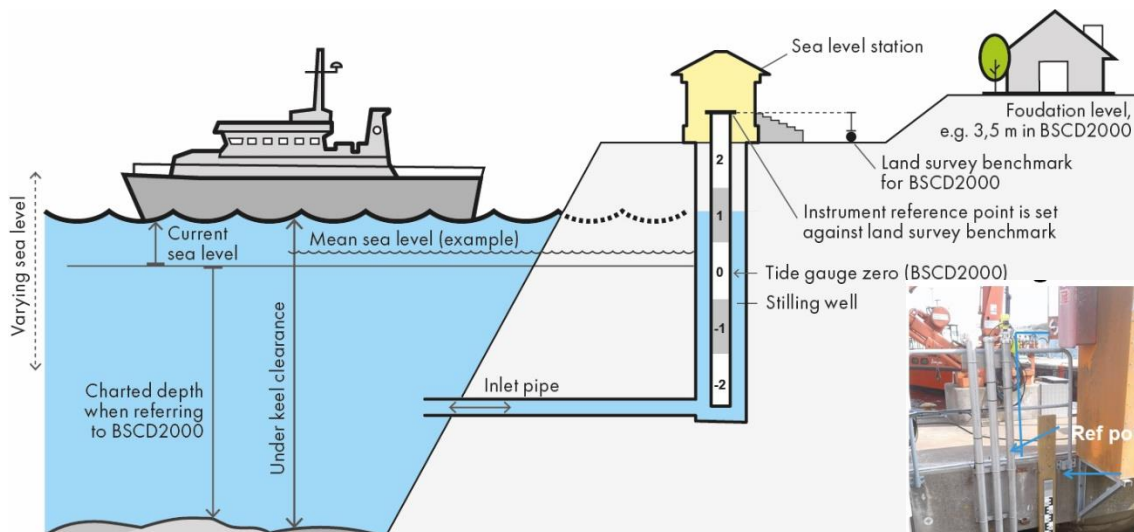
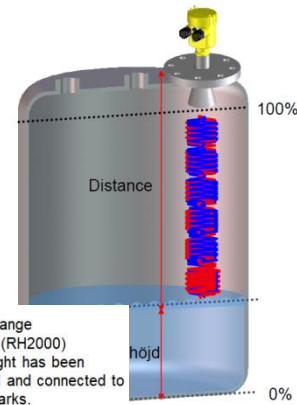


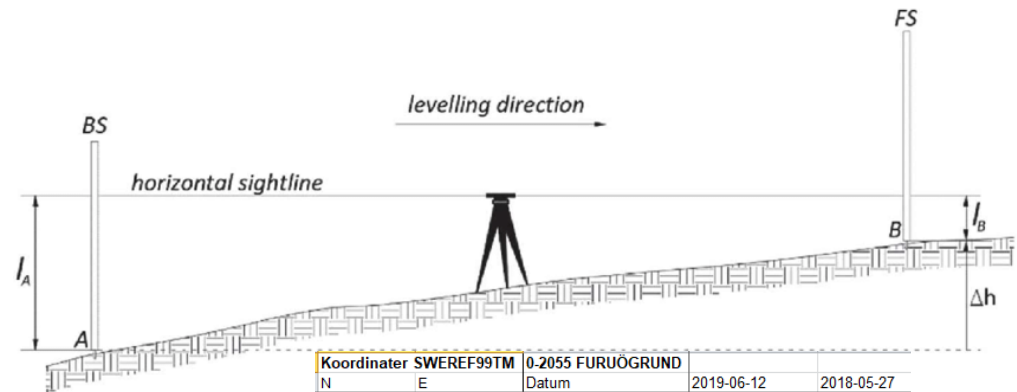
Illustration Veronica Wärm SMHI

Mätprincip Pulsradar



Service and inspections every two years

- Levelling of
 - Sea surface
 - Benchmarks
 - Measuring instruments
- Control
 - Data
 - Pumping of wells
 - Control of echo curves
 - Calibration of OTT PLS

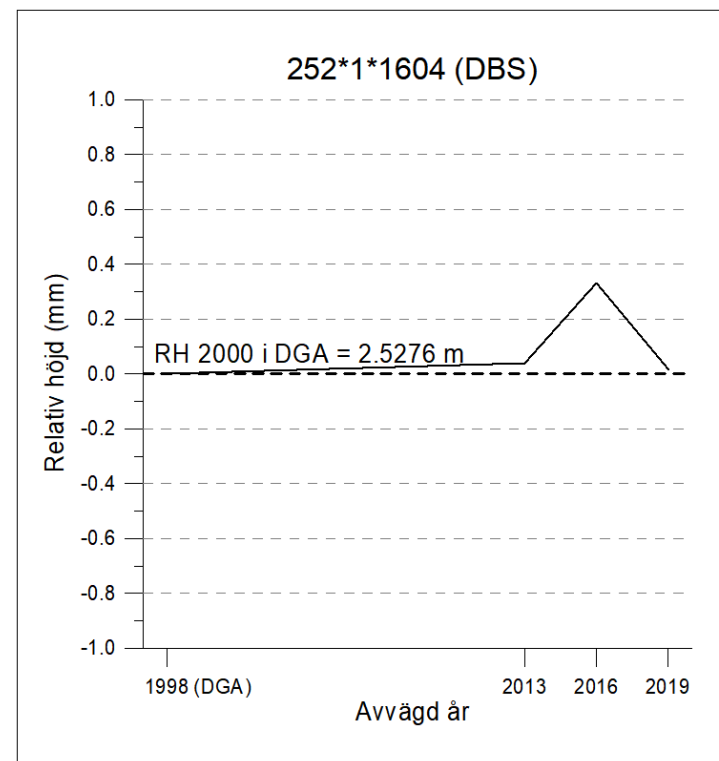


| Koordinater SWEREF99TM | | 0-2055 FURUÖGRUND | | |
|------------------------|------------|--|--------------------|-------------|
| N | E | Datum | 2019-06-12 | 2018-05-27 |
| | | Bok | | 1782 |
| | | Utgångsfix | | a |
| | | Anmärkning | Lantmäterikontroll | Se stn-info |
| 7213579,456 | 794360,086 | a (231°2'2101) | 2,444 | 2,444 |
| 7213519,002 | 794319,924 | b (231°2'2102) | 4,65 | 4,648 |
| 7213528,572 | 794308,244 | c (231°1'2105) | 5,416 | 5,413 |
| | | golv | | 3,101 |
| | | 0-pkt mb | -2,130 | -2,131 |
| | | Wut | | -0,282 |
| | | Win | -0,244 | -0,282 |
| | | Vst mb | 1,886 | 1,849 |
| | | W Vega 1 | -0,2402 | |
| | | W Vega 2 | -0,2380 | |
| | | Vst reg pegel | | |
| | | Vst telepegel | | |
| | | vst Thalimedes | | |
| | | vst Maws | | |
| | | 0-pkt MAWS | | |
| | | OK glaslock Vega 1 | 4,157 | 4,156 |
| | | Fläns/refnivå Vega 1 | 3,998 | 3,997 |
| | | OK glaslock Vega 2 | 4,162 | 4,160 |
| | | Fläns/refnivå Vega 2 | 4,003 | 4,001 |
| | | Fläns/refnivå för radarema beräknas genom OK lock-159 mm och är lika med distance B-värdet i radarinställningarna. | | |

Lantmäteriet controls every three years

Class 1 stations

- Control of stability of benchmarks
- Levelling of benchmarks
- Levelling of measuring instruments
- Levelling of sea surface (2-3 h logging using a laser)





| | | |
|----------|--|----------|
| 3 | BESKRIVNING AV KONTROLLERNA..... | 4 |
| 3.1 | Kontroll av tiden (Timing/Gap test)..... | 4 |
| 3.2 | Format test (Syntax test)..... | 4 |
| 3.3 | Positions test (Location test)..... | 4 |
| 3.4 | Gränsvärdestest (Gross range test)..... | 5 |
| 3.5 | Klimatologisk test (climatology test)..... | 5 |
| 3.6 | Spiktest (Spike test)..... | 5 |
| 3.7 | Stagnationstest (Rate of change test)..... | 5 |
| 3.8 | Flat line test..... | 5 |

<https://ioos.noaa.gov/ioos-in-action/currents/>

1.1 QC-flaggor.

Följande värden används i kontrollen.

| | | |
|---|--|---|
| 0 | No QC was performed | Ingen kvalitetskontroll utförd på data |
| 1 | Good data | Data godkänt av kvalitetskontroll |
| 2 | Probably good data | Data godkänt av kvalitetskontroll med anmärkning |
| 3 | Bad data that is potentially correctable | Data ej godkänt av kvalitetskontroll men kan korrigeras |
| 4 | Bad data | Data ej godkänt av kvalitetskontroll |
| 5 | Value changed (almost never used) | Datavärde förändrat |
| 6 | Not used | (ej använt) |
| 7 | Nominal value | Nominellt värde (ej uppmätt) |
| 8 | Interpolated value | Interpolerat värde |
| 9 | Missing value | Datavärde saknas |

Class 1 stations

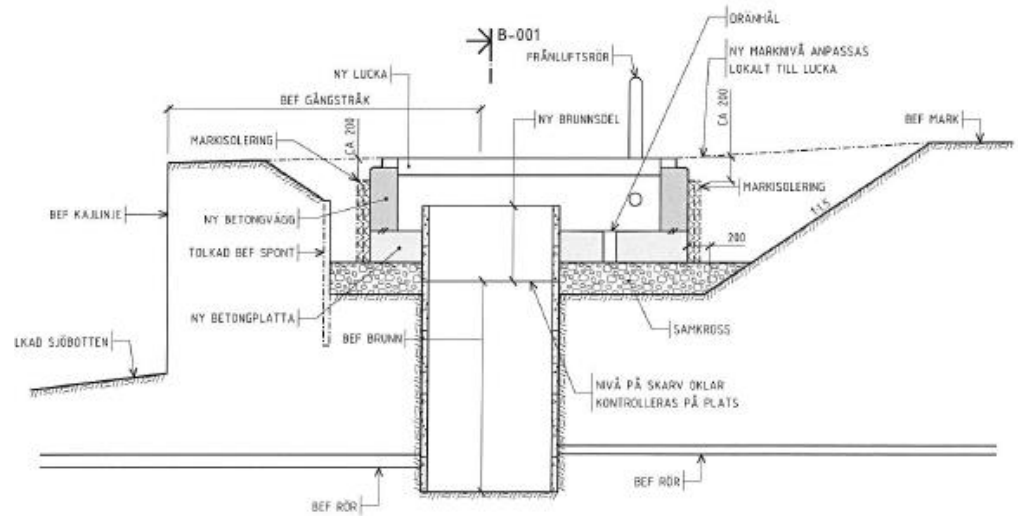
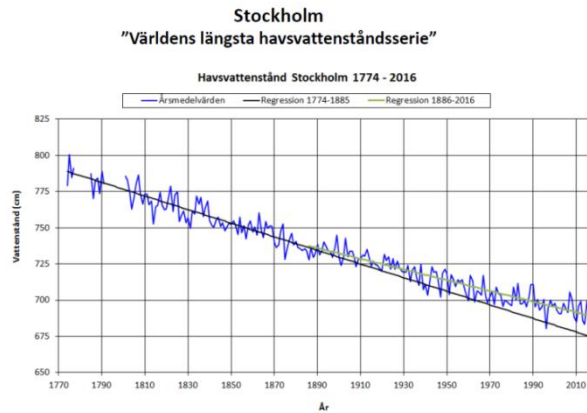
- Comparison between reference tape and radar sensors twice a month (Observer on site)
- Conversion table to BSCD2000 in the mareographs



| Måttband (cm) | Vattenst. (cm) RH2000 | Måttband (cm) | Vattenst. (cm) RH2000 | Måttband (cm) | Vattenst. (cm) RH2000 | Måttband (cm) | Vattenst. (cm) RH2000 |
|---------------|-----------------------|---------------|-----------------------|---------------|-----------------------|---------------|-----------------------|
| 650,0 | -19,2 | 700,0 | 30,8 | 750,0 | 80,8 | 800,0 | 130,8 |
| 651,0 | -18,2 | 701,0 | 31,8 | 751,0 | 81,8 | 801,0 | 131,8 |
| 652,0 | -17,2 | 702,0 | 32,8 | 752,0 | 82,8 | 802,0 | 132,8 |
| 653,0 | -16,2 | 703,0 | 33,8 | 753,0 | 83,8 | 803,0 | 133,8 |
| 654,0 | -15,2 | 704,0 | 34,8 | 754,0 | 84,8 | 804,0 | 134,8 |
| 655,0 | -14,2 | 705,0 | 35,8 | 755,0 | 85,8 | 805,0 | 135,8 |
| 656,0 | -13,2 | 706,0 | 36,8 | 756,0 | 86,8 | 806,0 | 136,8 |
| 657,0 | -12,2 | 707,0 | 37,8 | 757,0 | 87,8 | 807,0 | 137,8 |
| 658,0 | -11,2 | 708,0 | 38,8 | 758,0 | 88,8 | 808,0 | 138,8 |
| 659,0 | -10,2 | 709,0 | 39,8 | 759,0 | 89,8 | 809,0 | 139,8 |
| 660,0 | -9,2 | 710,0 | 40,8 | 760,0 | 90,8 | 810,0 | 140,8 |
| 661,0 | -8,2 | 711,0 | 41,8 | 761,0 | 91,8 | 811,0 | 141,8 |
| 662,0 | -7,2 | 712,0 | 42,8 | 762,0 | 92,8 | 812,0 | 142,8 |
| 663,0 | -6,2 | 713,0 | 43,8 | 763,0 | 93,8 | 813,0 | 143,8 |
| 664,0 | -5,2 | 714,0 | 44,8 | 764,0 | 94,8 | 814,0 | 144,8 |
| 665,0 | -4,2 | 715,0 | 45,8 | 765,0 | 95,8 | 815,0 | 145,8 |
| 666,0 | -3,2 | 716,0 | 46,8 | 766,0 | 96,8 | 816,0 | 146,8 |
| 667,0 | -2,2 | 717,0 | 47,8 | 767,0 | 97,8 | 817,0 | 147,8 |
| 668,0 | -1,2 | 718,0 | 48,8 | 768,0 | 98,8 | 818,0 | 148,8 |
| 669,0 | -0,2 | 719,0 | 49,8 | 769,0 | 99,8 | 819,0 | 149,8 |
| 670,0 | 0,8 | 720,0 | 50,8 | 770,0 | 100,8 | 820,0 | 150,8 |
| 671,0 | 1,8 | 721,0 | 51,8 | 771,0 | 101,8 | 821,0 | 151,8 |
| 672,0 | 2,8 | 722,0 | 52,8 | 772,0 | 102,8 | 822,0 | 152,8 |
| 673,0 | 3,8 | 723,0 | 53,8 | 773,0 | 103,8 | 823,0 | 153,8 |
| 674,0 | 4,8 | 724,0 | 54,8 | 774,0 | 104,8 | 824,0 | 154,8 |
| 675,0 | 5,8 | 725,0 | 55,8 | 775,0 | 105,8 | 825,0 | 155,8 |
| 676,0 | 6,8 | 726,0 | 56,8 | 776,0 | 106,8 | 826,0 | 156,8 |
| 677,0 | 7,8 | 727,0 | 57,8 | 777,0 | 107,8 | 827,0 | 157,8 |
| 678,0 | 8,8 | 728,0 | 58,8 | 778,0 | 108,8 | 828,0 | 158,8 |
| 679,0 | 9,8 | 729,0 | 59,8 | 779,0 | 109,8 | 829,0 | 159,8 |
| 680,0 | 10,8 | 730,0 | 60,8 | 780,0 | 110,8 | 830,0 | 160,8 |

Stockholm World's longest Sea level serie.

New measuring chamber 2019



Station Kalix-Karlsborg (SMA) (Pos: N65,8 E23,3)

Before, May 2018



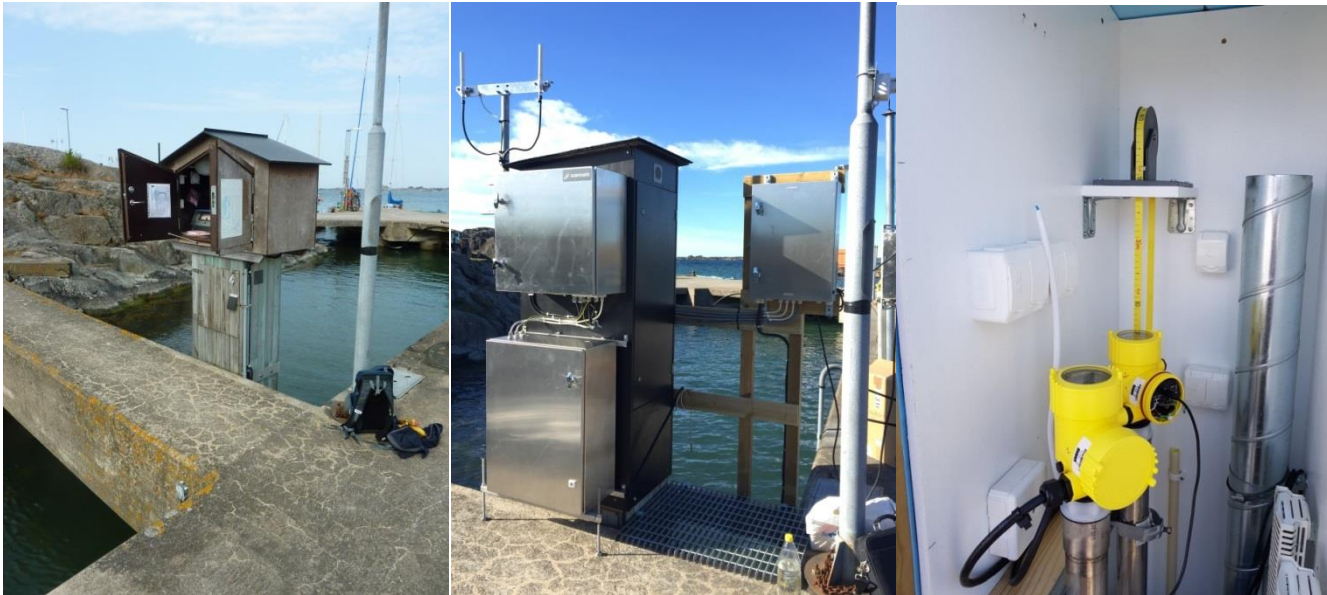
After, November 2018



- Quay side installation
- New data logger
- Radar and pressure level sensor
- Heating cable and insulation to avoid ice

Station Landsort Norra (SMHI), Pos: N58,8 E17,9

Before and after reconstruction



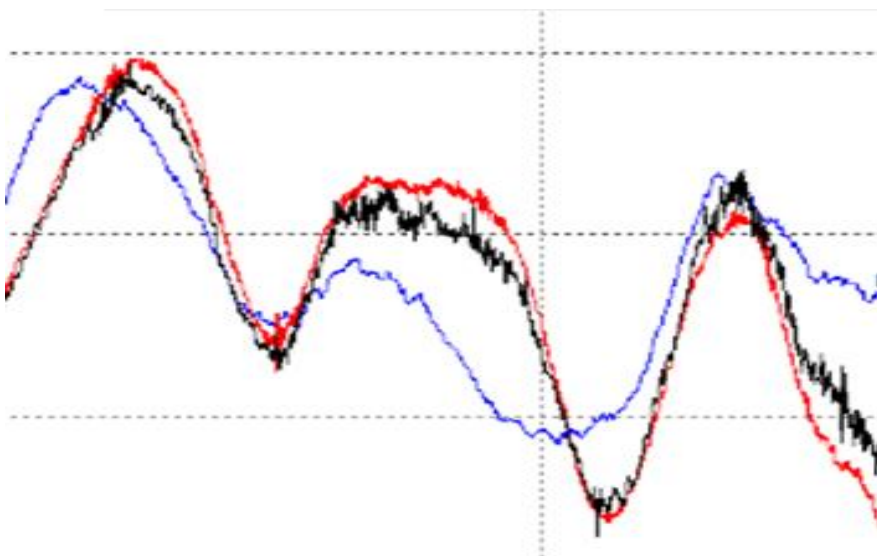
- To avoid false echoes, the sensor is mounted in a 50 mm tube
- 2 radar sensors at each station
- Heated house and well
- No heating cable

Station Visby (SMHI), Pos: N58,8 E17,9

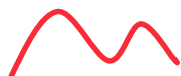
Before and after reconstruction



Comparisons between station types



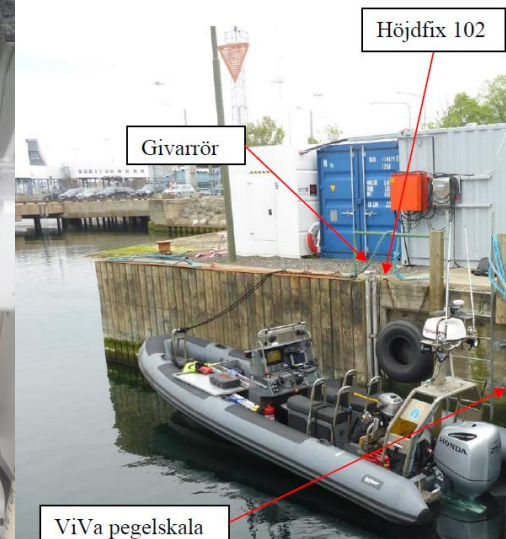
Klagshamn, stilling well (with inlet pipe)



Barsebäck, Wodden drum

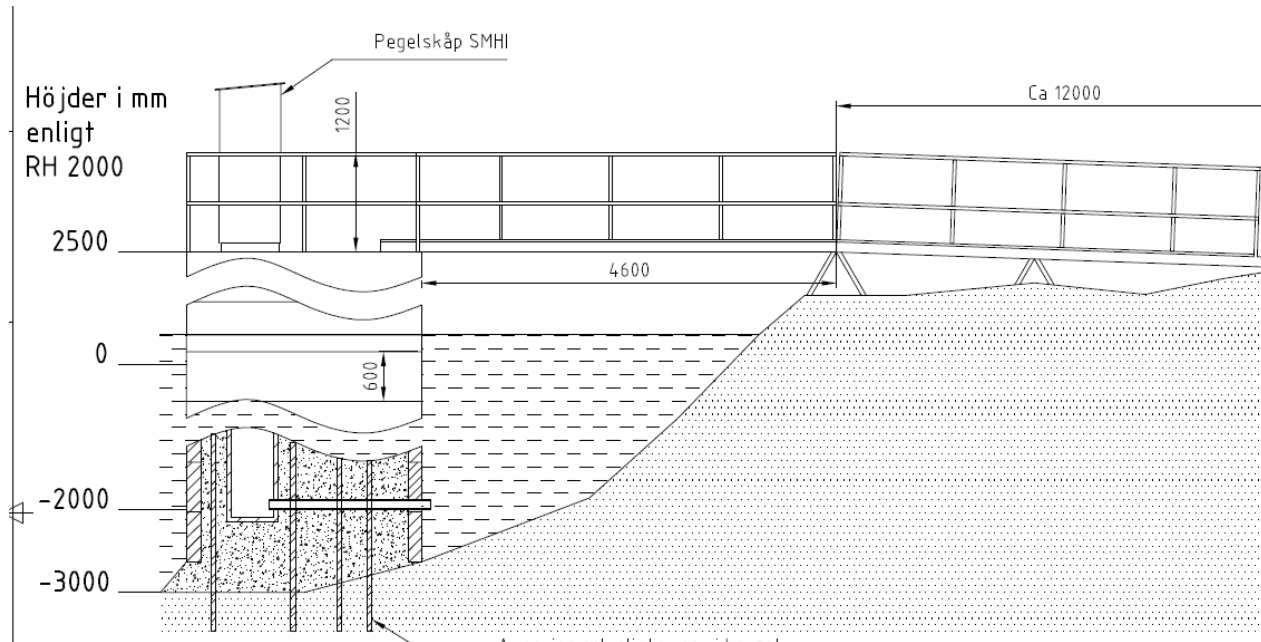


Malmö hamn, quay side installation (open pipes)



New Sea level station in Gothenburg

- A new Sea level station in Gothenburg is planned
- Will replace the one we have in Torshamnen (GLOSS-station)
- Contract procurement will be completed in the spring of 2020
- Construction start in autumn 2020



Observations on webpages

- <https://www.smhi.se/vadret/vadret-i-sverige/observationer#ws=wpt-a,proxy=wpt-a,tab=vatten,param=sealevel>
- <https://www.smhi.se/vadret/hav-och-kust/vattenstand-och-vagor#ws=wpt-a,proxy=wpt-a,lang=sv,station=none>
- <https://www.smhi.se/klimatdata/oceanografi/havsvattenstand>
- <http://www.sjofartsverket.se/karta>
- <http://vivadisplay.sjofartsverket.se/#station>