

# Nationellt informationssystem för vattenstånd



Kartdagarna  
Linköping 2018-03-21

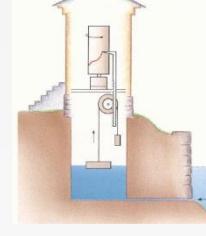
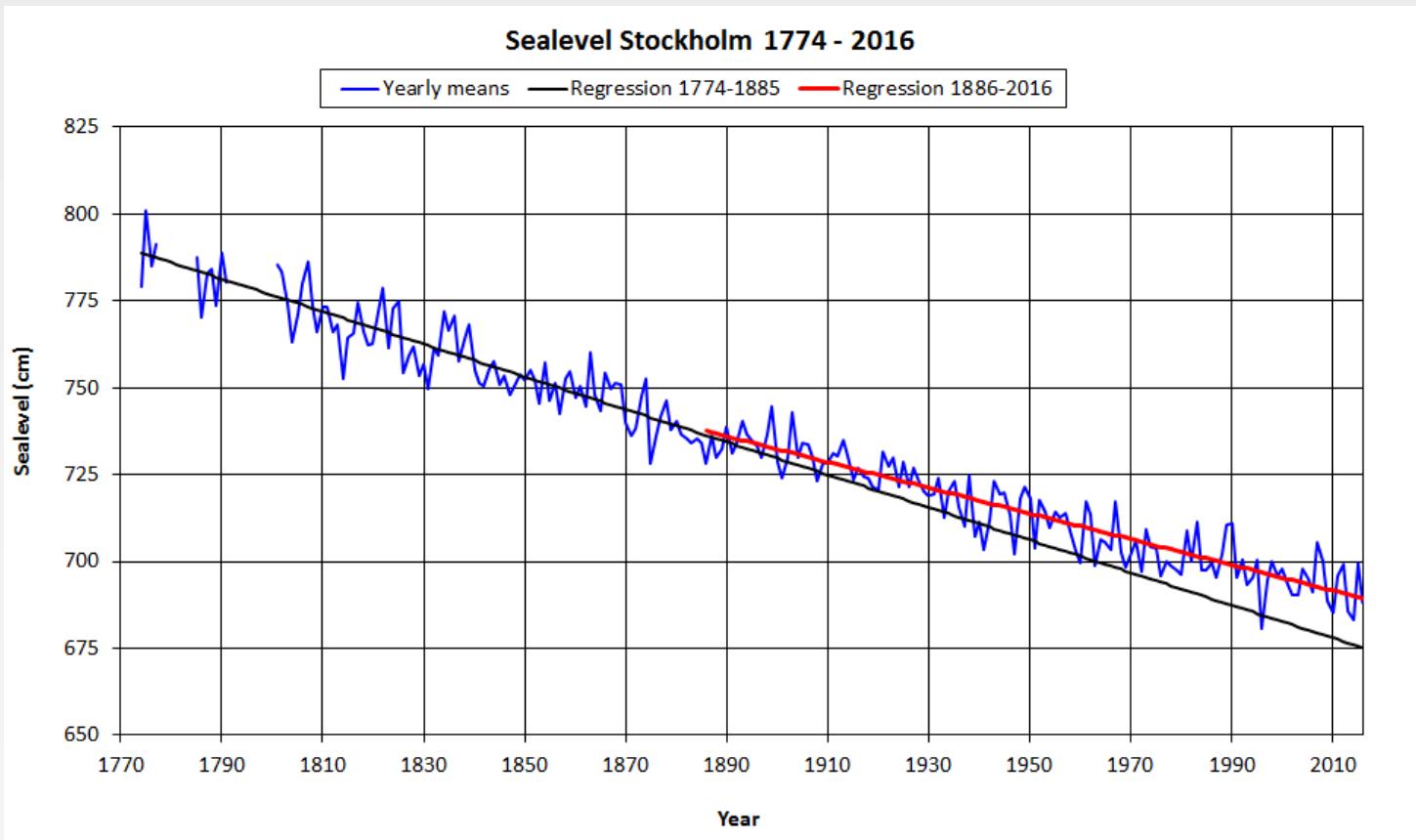
Thomas Hammarklint, Sjöfartsverket

**SMHI**

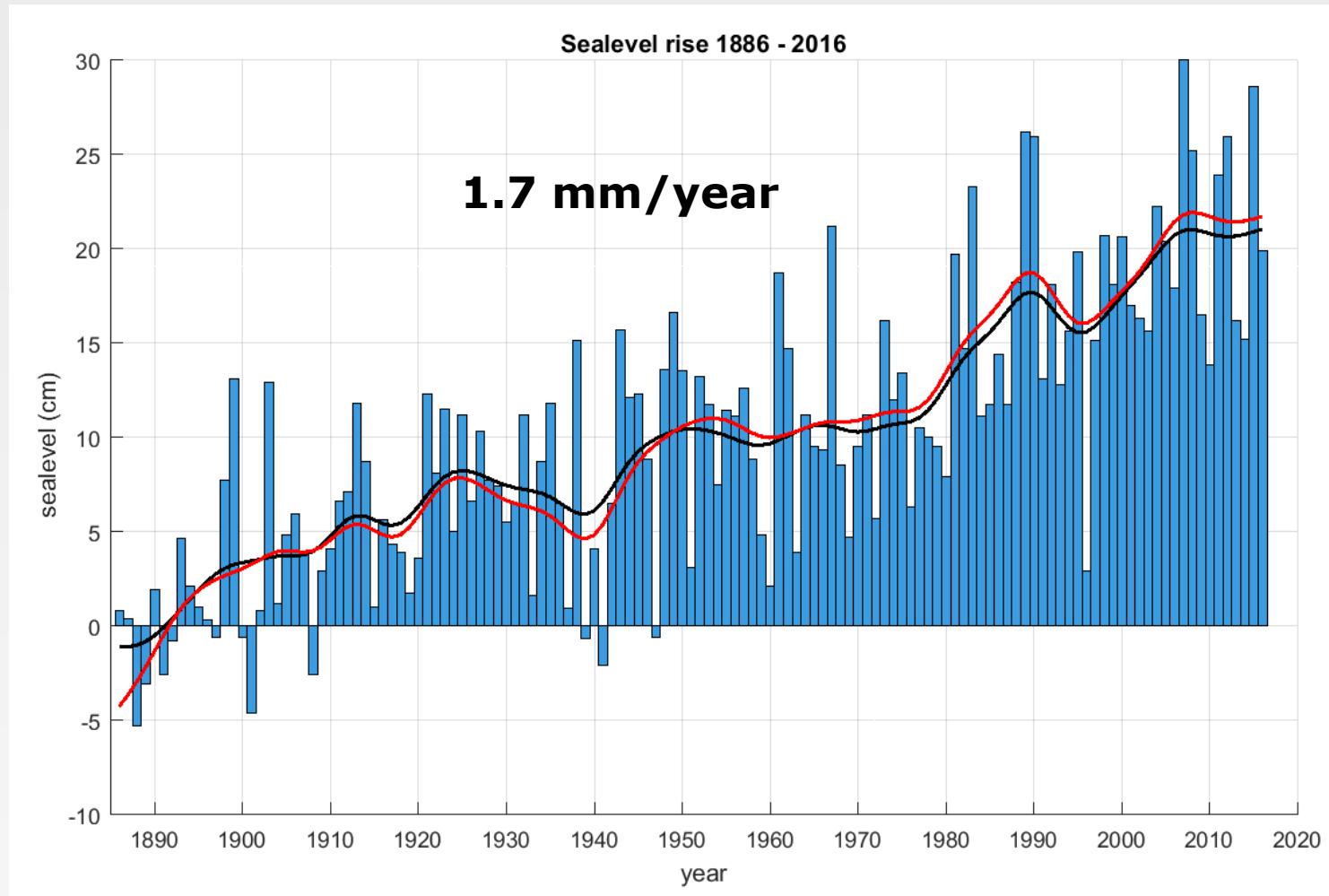
 SJÖFARTSVERKET

# Stockholm

## “World’s longest sea level record”



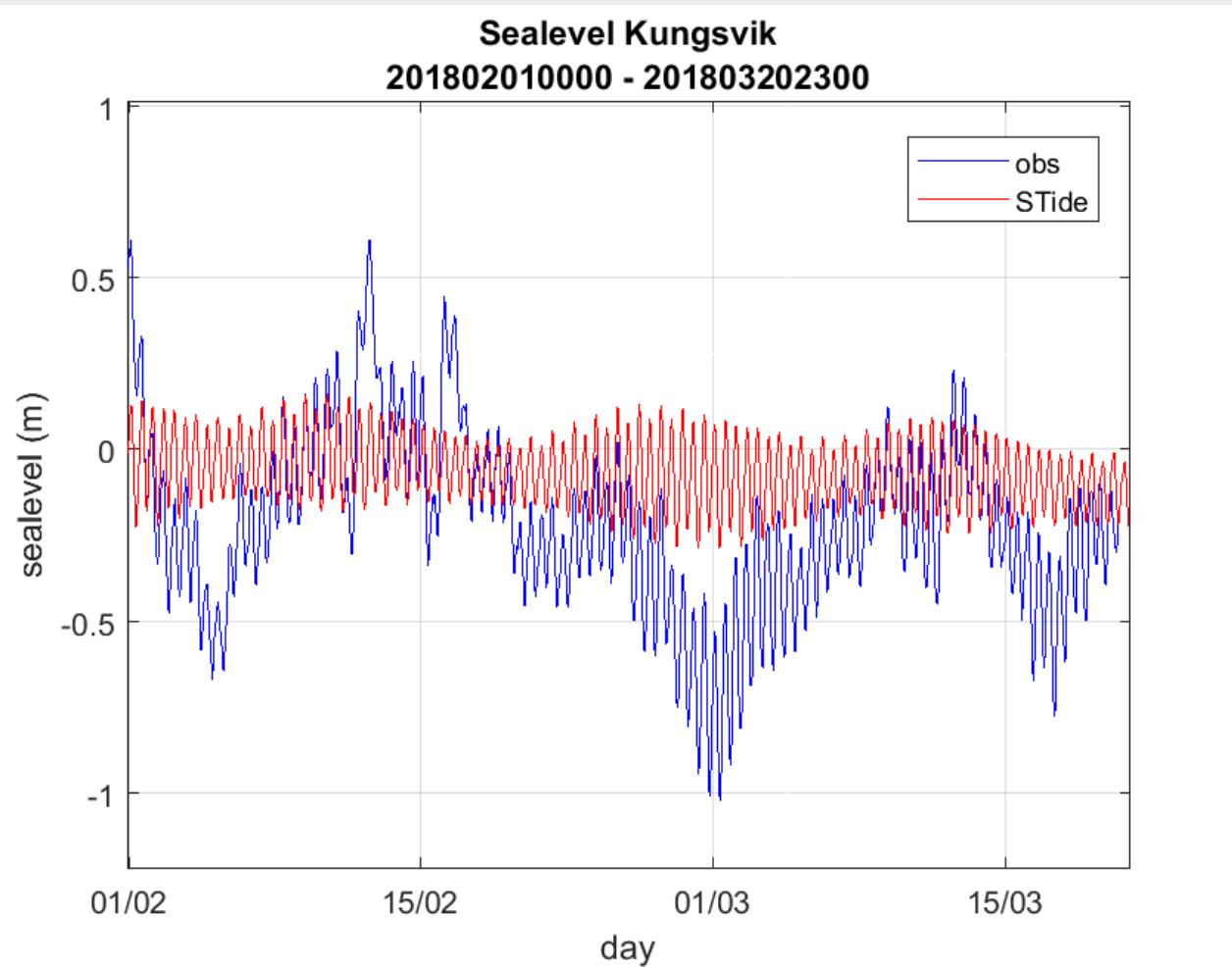
# Climate changes in Swedish sea level data



Analysis of 14 Swedish sea level records since 1886

Sealevel corrected for the levelled land-uplift (glacial isostatic adjustment)

# Sea level variations Swedish west coast



## Tidal analysis Kungsvik 1996-2014

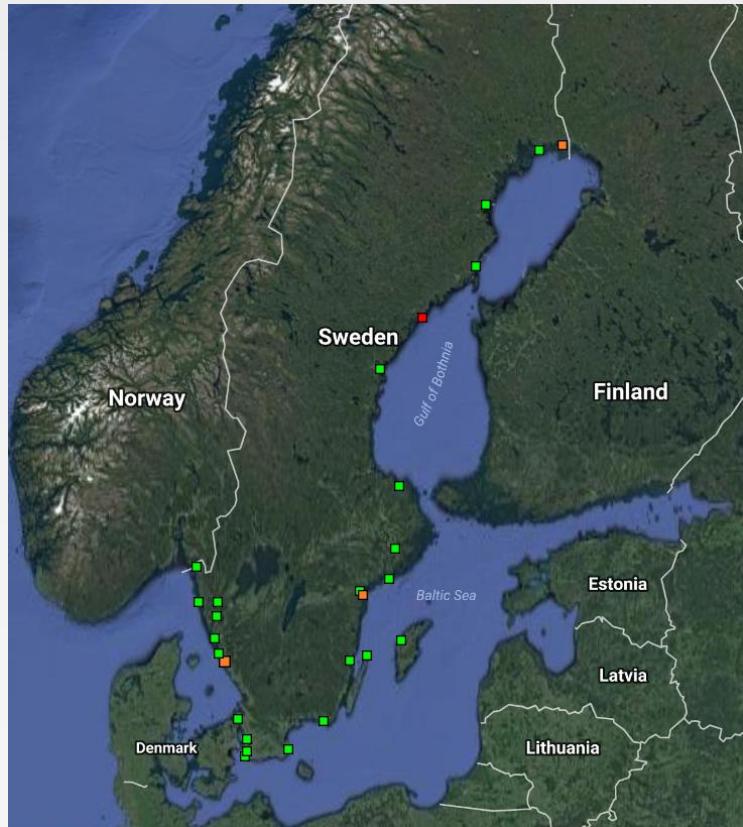
Highest Astronomical Tide (HAT): 0.27 m

Lowest Astronomical Tide (LAT): -0.35 m

Maximum tidal range: 0.62 m

# Present Swedish Sea Level Networks (January 2017)

**SMHI**

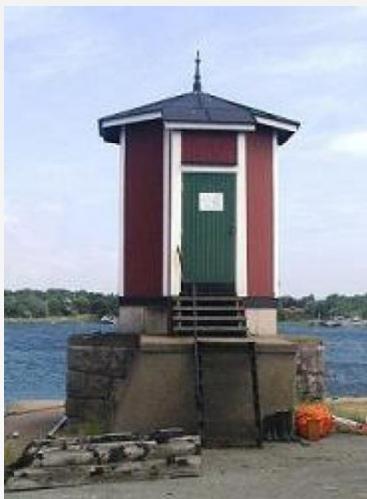


24 sealevel stations in the official  
network + 2 temporary gauges



37 sealevel stations in the network

# Present techniques



## Stations operated by SMHI:

- Stilling well technique, steel wires and floats, real time data via shaft encoders
- Paper charts is used as a backup
- Radar/bubble sensors (temporary) at two locations
- Validation of real-time data weekly at site by an observer
- Data acquired every hour (10 minute averages, min&max every hour)

## Stations operated by SMA:

- Pressure sensors (3 sensors)
- Data acquired every 30s

# **Famos ODIN, EU-financed project 2016-2018**

## **Activity 2: Vessel navigation for the future**

Harmonizing the chart datum in the Baltic Sea, preparing better satellite navigation for vessels at sea.

### **Subactivity 2.3**

- Harmonise and upgrade the Swedish Sea Level Network (2016-2018), including 2-3 new sensors for 50 stations
- Level the Swedish Sea Level stations that have not yet been connected to the national precision levelling network RH2000, and check already levelled Sea Level stations for stability (2016-2018)

# Upgrade of the Swedish Sea Level Network 2017-2018

- One common and harmonised Swedish Sea Level Network
- 50+7 stations in the new network, two or three new sensors at all locations
- Sea level data of better accuracy, continuous time series, presented in RH2000
- Data acquired every minute
- Open and faster access to quality controlled real-time and archive data
- Real-time quality control (RTQC)
- Human quality control of data is performed continuously (MQC)
- Levelling is done every two years
- Partly financed (50%) by the EU-project FAMOS Odin



# **Classification of sea level stations**

## **Partly based upon a customer survey**

### **Future Swedish Sea Level Network**

	<b>Number of stations</b>	<b>Double sensors</b>	<b>Battery backup (UPS)</b>	<b>New sensors</b>	<b>Data Logger (logging on site)</b>	<b>Observers on site</b>
<b>Class 1</b>	26	Yes	Yes	Yes	Yes	Yes
<b>Class 2</b>	24	Yes	No	Yes	Yes	No
<b>Class 3</b>	7	No	No	No	No	No
<b>Class 4</b>	6 will be phased out	No	No	No	No	No

# Upgrade status End of February 2018

SMHI Stations 2017	Status
Arkö	Installed
Klagshamn	Installed
Ölands Norra	Installed
Uddevalla	Installed
Stenungsund	Installed
Skanör	Moved to 2018
Barsebäck	Moved to 2018
Viken	Moved to 2018
Furuögrund	Moved to 2018
Spikarna	Moved to 2018

SMA Stations 2017	Status
Juten	Installed
Vinterklasen (Oxelösund)	Installed
Falkenberg	Installed
Malmö Hamn	Installed
Västervik	Installed
Simpevarp	Installed
Kalmar	Installed
Holmsund	Installed (test site)
SkagsUdde	Planned for March 2018
Marstrand	Installed

# Upgrade plan 2018

<b>SMHI Stations 2018</b>	<b>Planned</b>
Spikarna	Mar
Forsmark	Mar
Smögen	Apr
Kungsvik	Apr
Göteborg-Torshamnen	TBD
Ratan	May
Furuögrund	May
Kalix-Storön	Aug
Viken	May
Barsebäck	May
Skanör	May
Stockholm-Skeppsholmen	Jun
Landsort Norra	Aug
Visby	Jun
Oskarshamn	Sep
Kungsholmsfort	Sep
Simrishamn	Sep

<b>SMA Stations 2018</b>	<b>Planned</b>
Skags Udde	Mar
Ljusne	May
Svanö	May
Kalix-Karlsborg	Sep
Strömören	Sep
Loudden	May
E4-Bron	May
Nynäshamn	Sep
Gävle	Sep
Ystad	Apr
Karlshamn	Apr
Helsingborg	Sep
Vinga	May
Brofjorden	May
Halmstad	May
Göta älv	Sep
Tångudden	May
Varberg	TBD

# Test site at Holmsund

- One radar sensor and two pressure sensors at the test site Holmsund
- Weather-shifts during the winter 2016-2017 resulted in condensation on the radar antenna
- Condensation froze into ice and the measurements failed



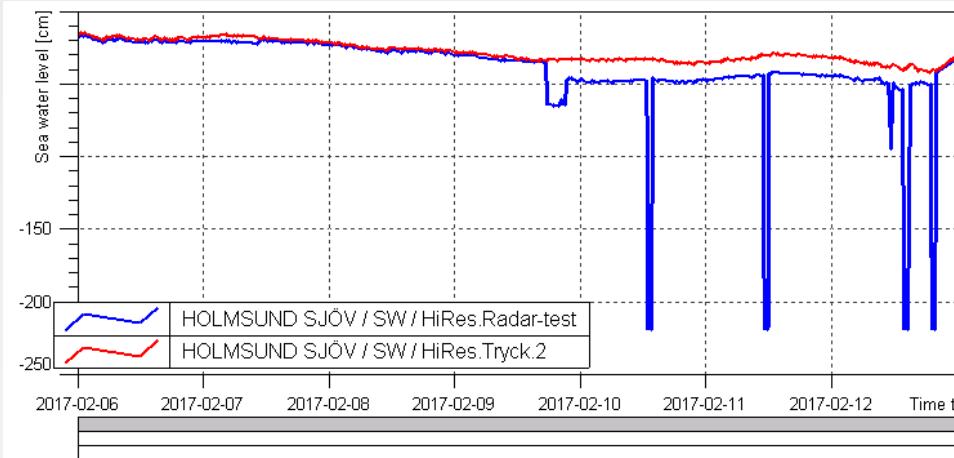
# Test site at Holmsund

## Actions

- More powerful heating cable 150W
- Heating cable around the antenna
- Temperature monitoring in the tube and outside
- Test will continue winter 2017-2018 with a new contracted radar sensor



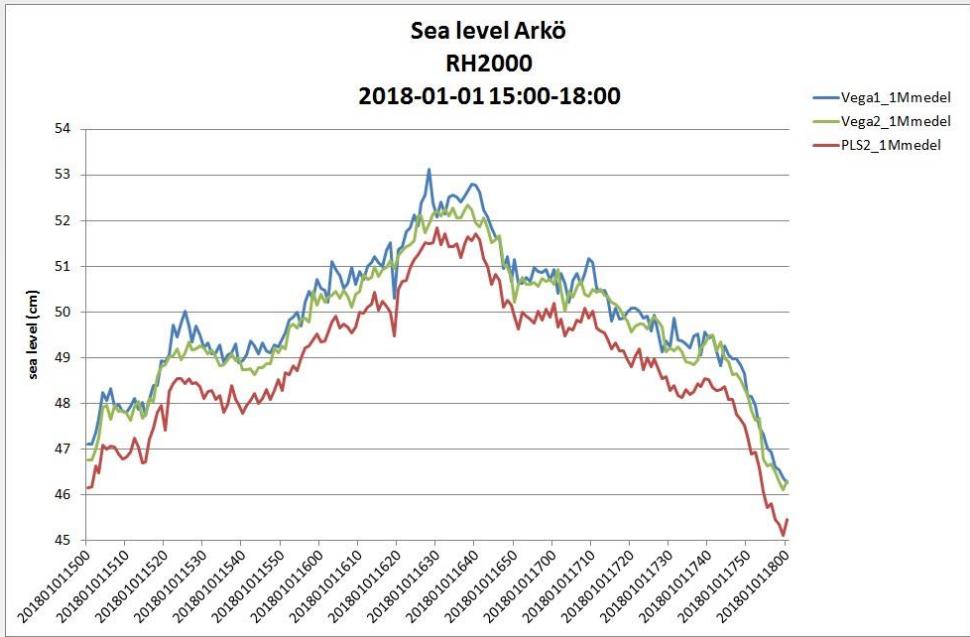
## Holmsund Feb 2017



## Holmsund Jan-Feb 2018



# Testsite Arkö – mechanical damping



- Mechanical damping installed on a radar to evaluate if waves can be filtered out
- No heating and insulation
- Evaluation is ongoing

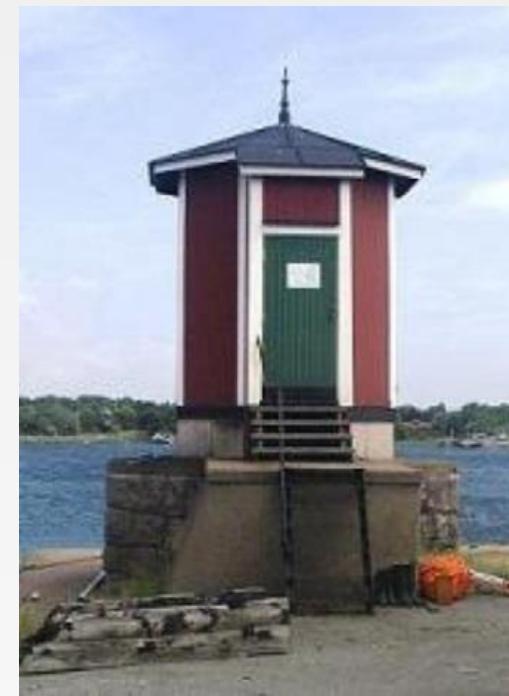
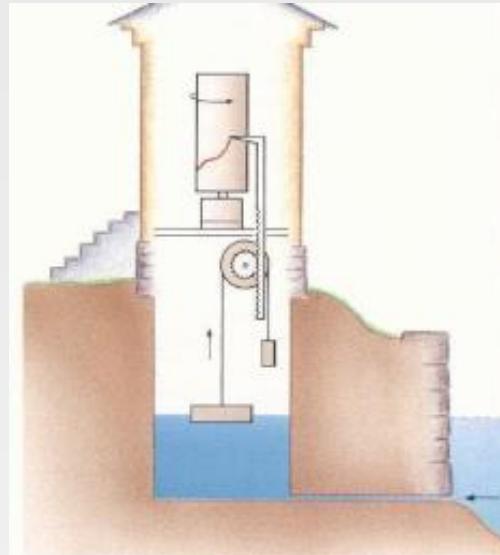


# Testsite Arkö – software damping

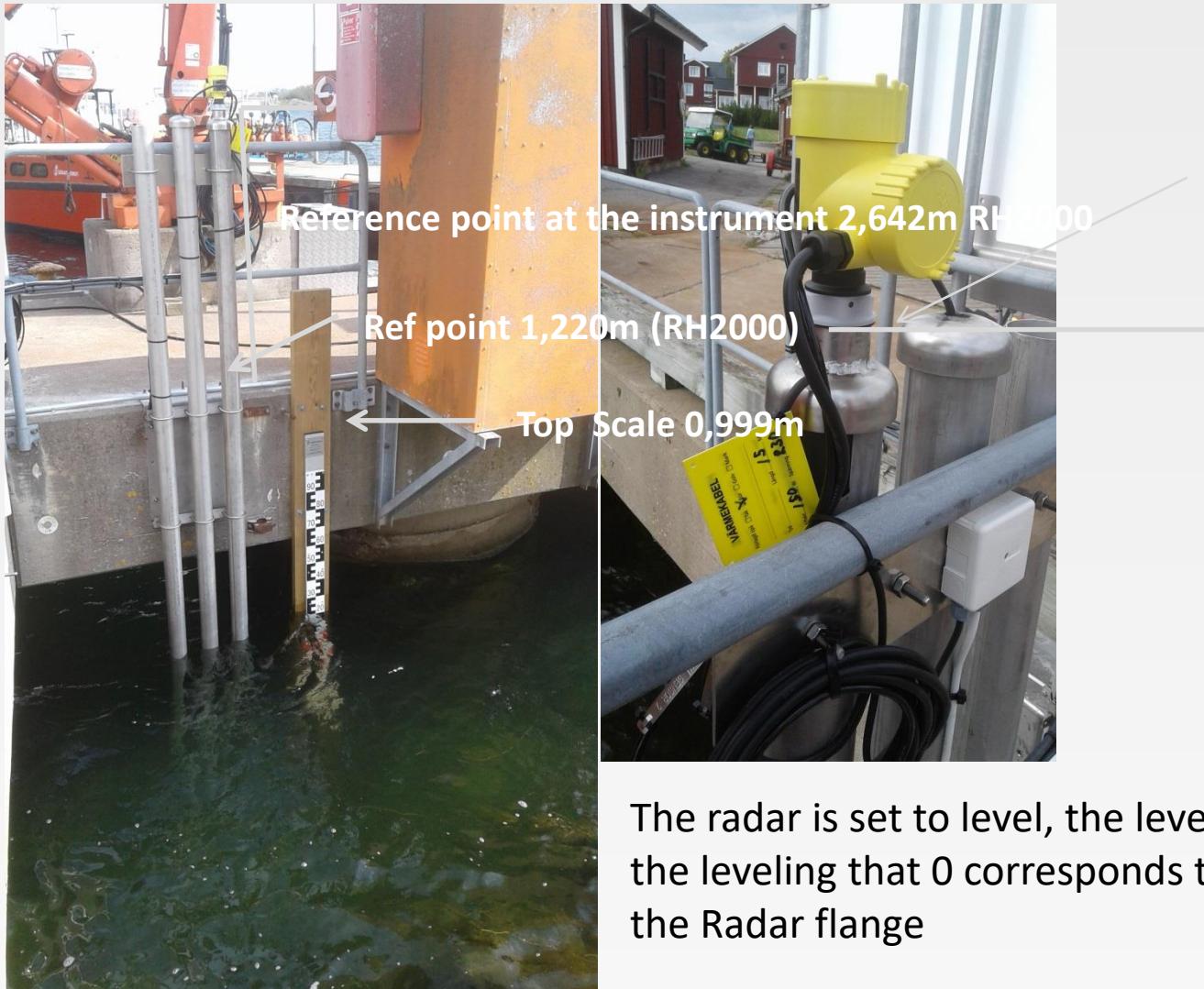


# Mounting the radar sensor in a well

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



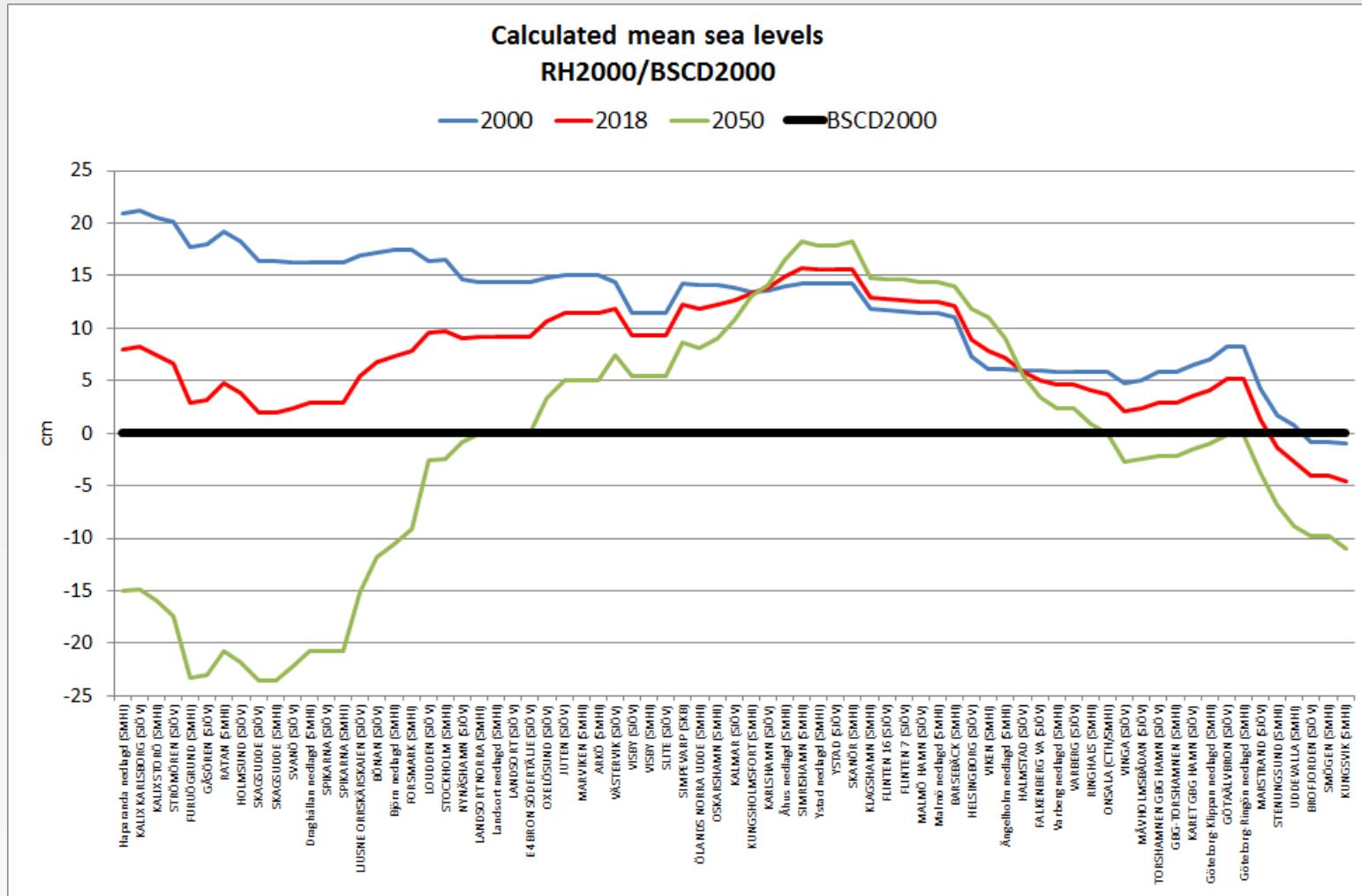
# Levelling of the sea level sensors



The radar is set to level, the level is set from the the leveling that 0 corresponds to the distance to the Radar flange

# New reference datum: Baltic Sea Chart Datum 2000 (BCSD2000)

## Swedish implementation of BSCD2000: nollan i RH2000

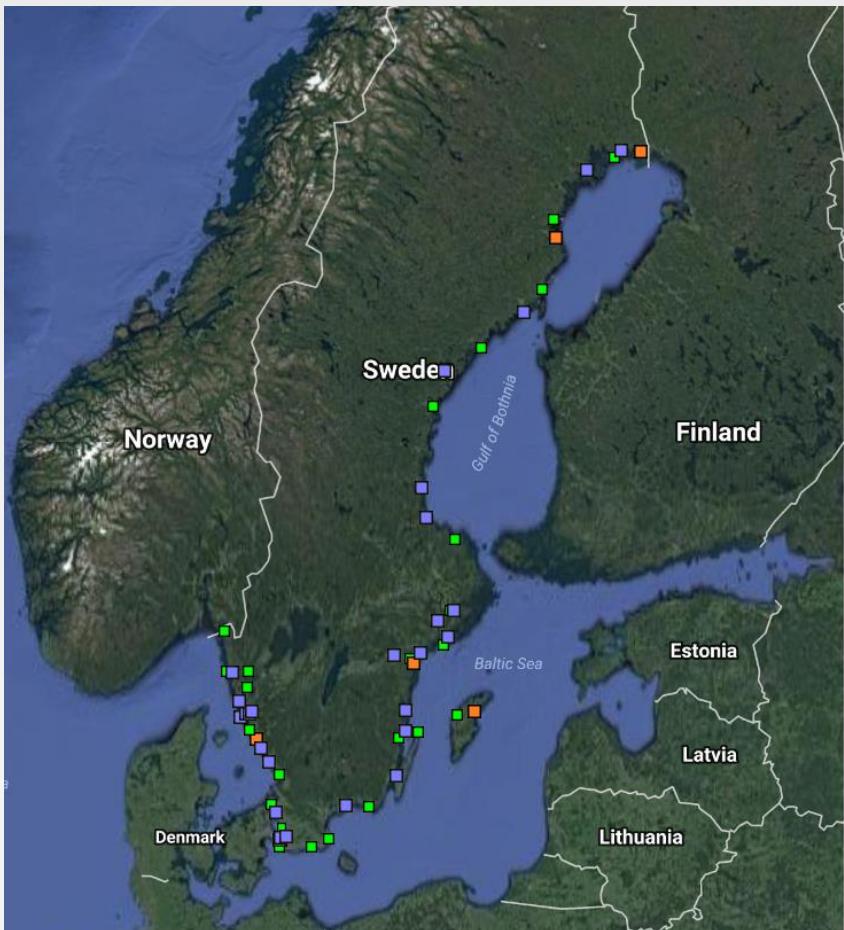


# Present work

- All stations will be connected to the national reference datum RH2000 (BSCD2000)
- Joint service organisation SMA-SMHI: levelling, maintenance, service personnel etc.
- Test of equipment and evaluation will continue
- Implementation of RTQC and MQC routines to all data
- Upgrade with new sensors and datalogger 2017-2018
- Planning for the next FAMOS project 2019-2020



# Future Swedish Sea Level Network (December 2018)

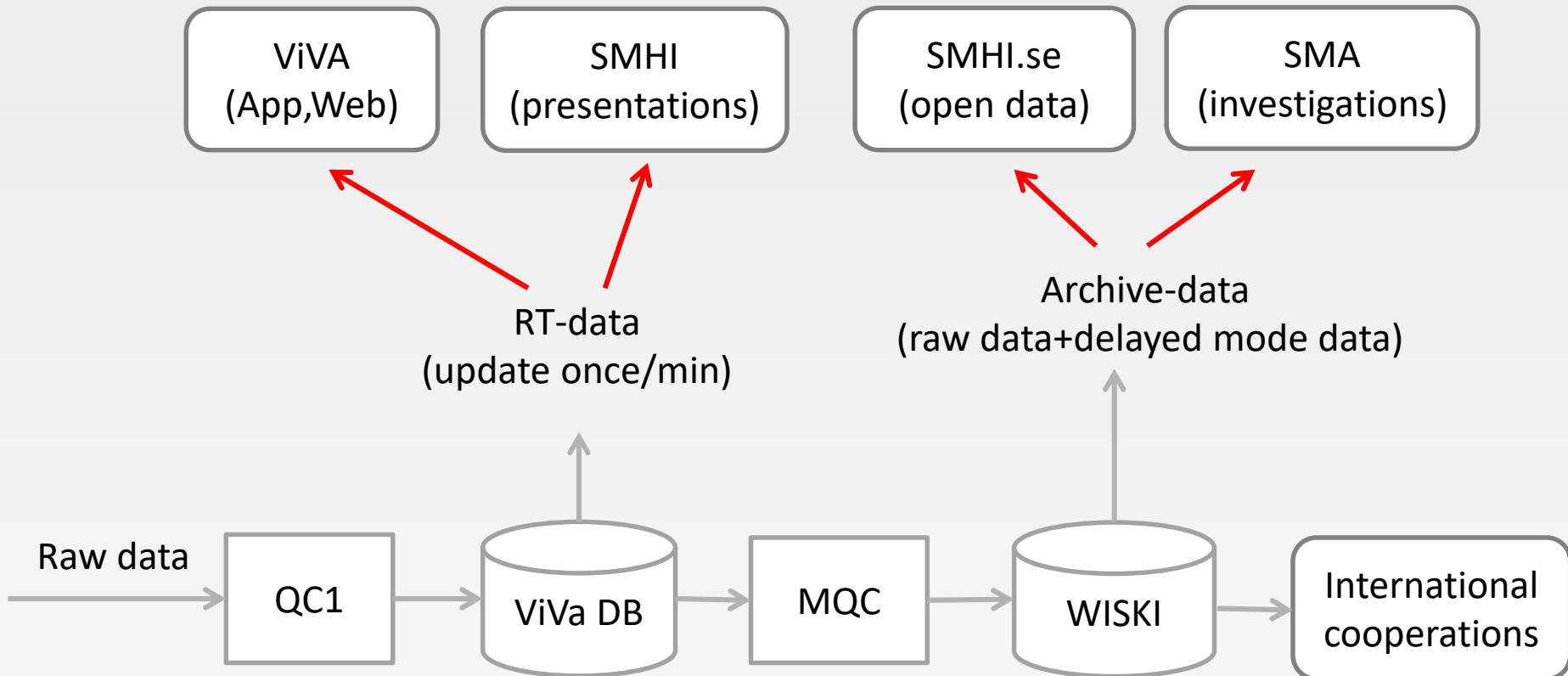


Real-time data in RH2000 from 57 stations  
1-min values with 1 cm accuracy  
Real-time QC + Archive MQC



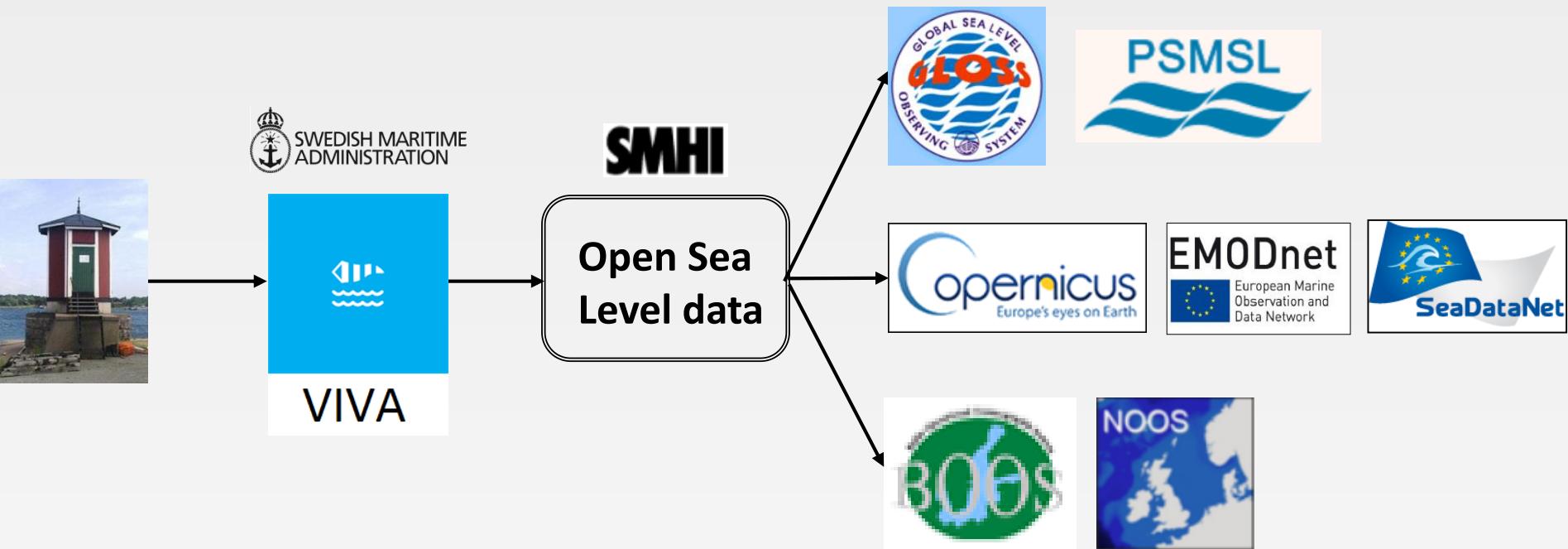
- Class I Upgrade with battery backup 26 stations (23 SMHI + 3 SMA)
- Class II Upgrade without battery backup 24 stations (24 SMA)
- Class III Unchanged, temporary 7 stations (3 SMHI + 4 SMA)

# Schematic data flow



# International programs

Users  

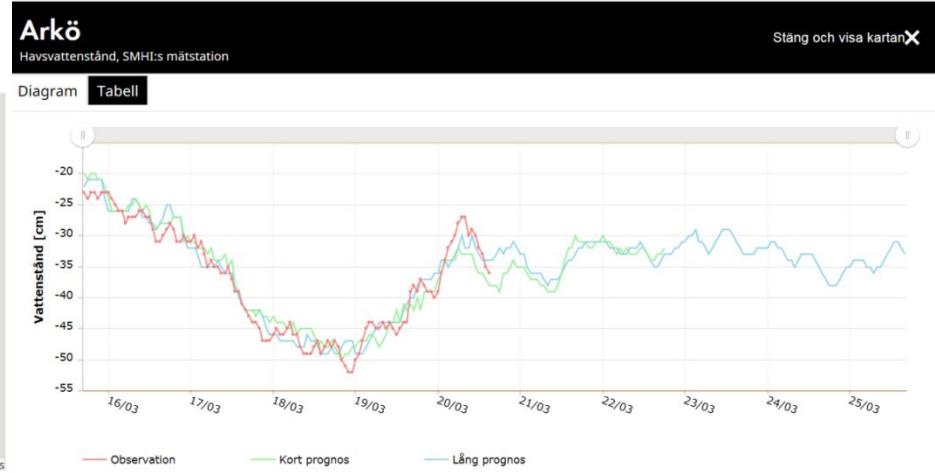
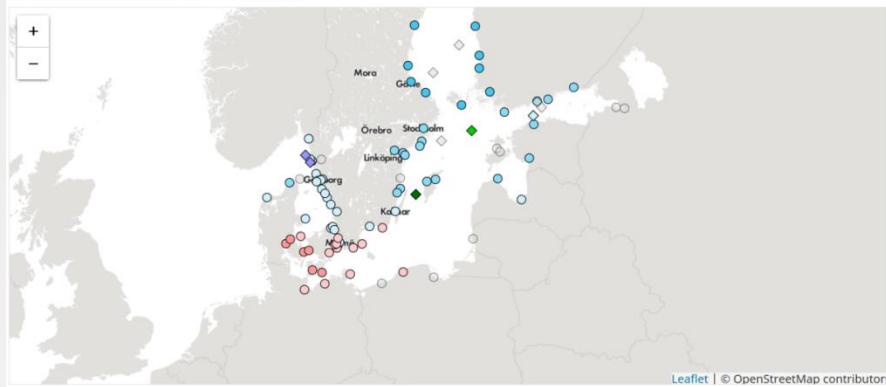



# Visualization of sea level data

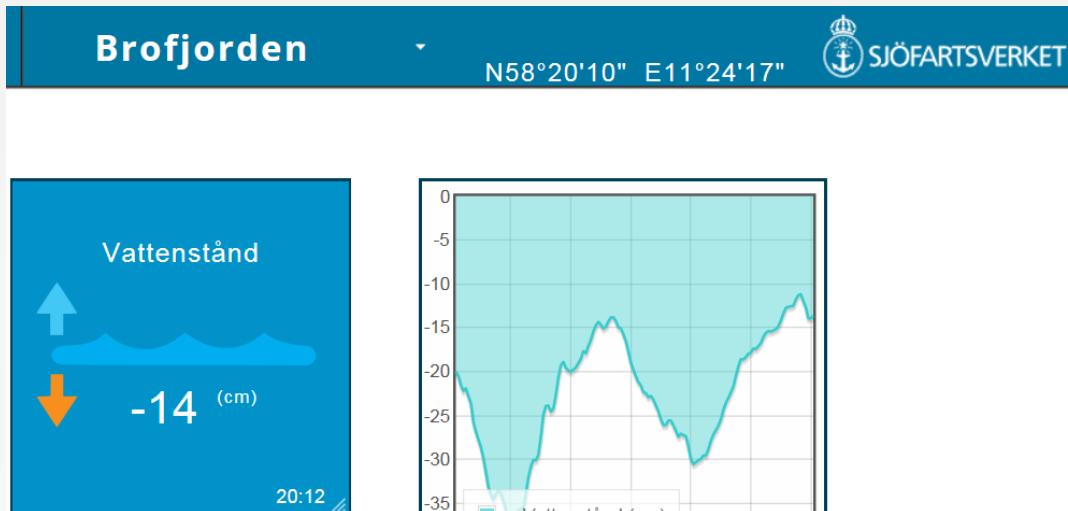
<https://www.smhi.se/vadret/hav-och-kust/vattenstand-och-vagor>

## Vattenstånd och vågor

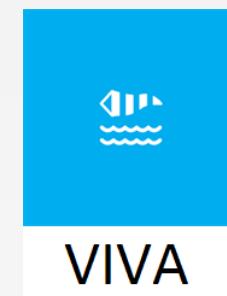
Kartan visar positioner där det mäts havsvattenstånd eller vågor. Klicka på en punkt i kartan eller använd drop down-listan för att se observationer och prognoser i ett diagram eller tabell. Vattenståndet är angivet relativt medelvattenståndet.



<http://vivadisplay.sjofartsverket.se>



App for Android and iPhone





# Baltic Operational Oceanographic System (BOOS)

## Provides oceanographic information from the Baltic Sea

<http://www.boos.org/boos-stations>



- 20 Fixed platforms (FP)



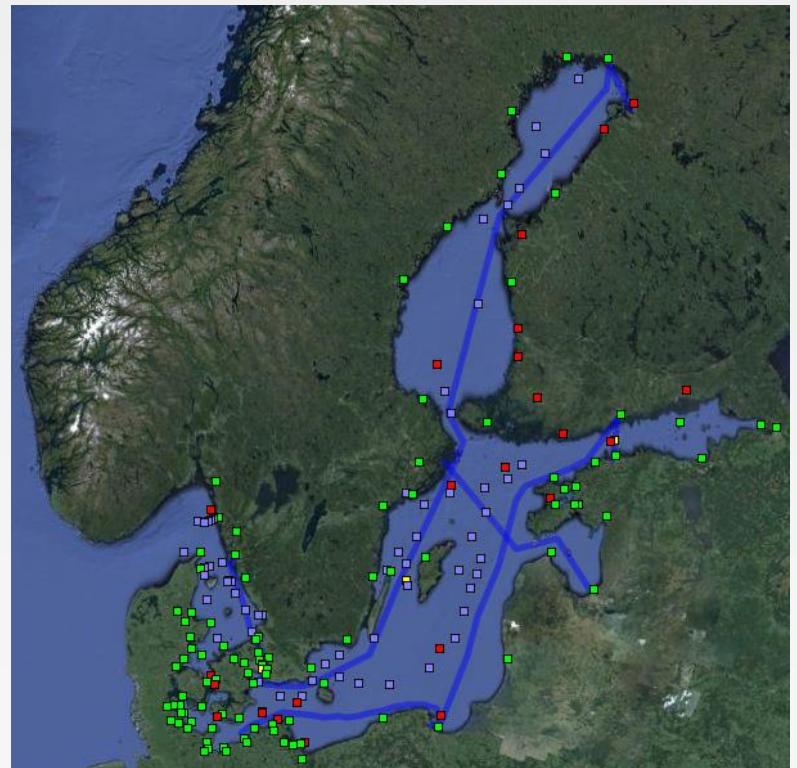
- 200 Tide gauges (TG)



- 20 Moored buoys (MB)



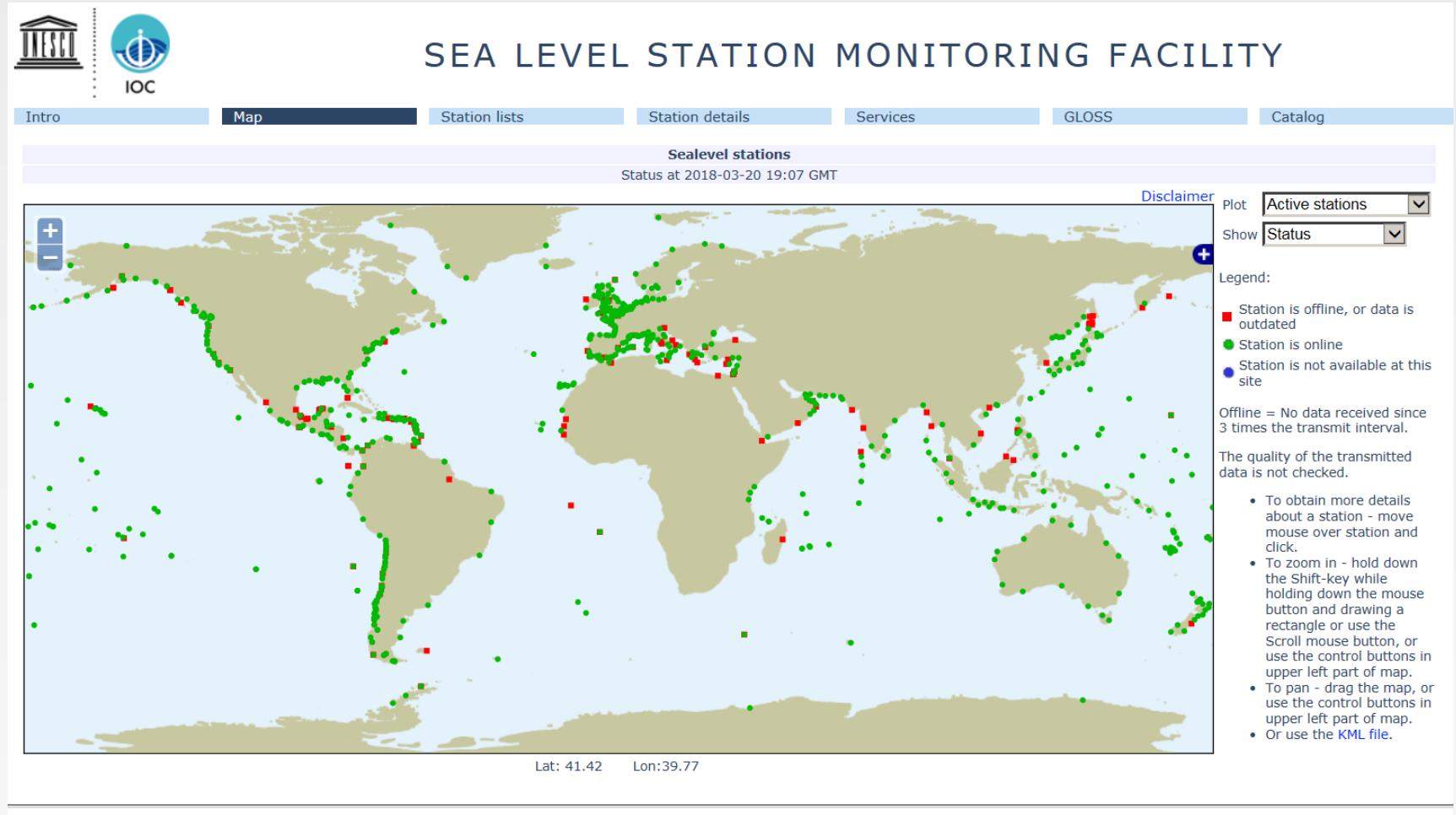
- 30 Ferrybox-lines (FB)
- 5 Ice-breakers (FB)
- □ >1000 Monitoring stations (CT)





# Global Sea Level Observing System (GLOSS)

<http://www.ioc-sealevelmonitoring.org>



# Thanks for your attention!

## Questions?

