

Upgraded Swedish Sea Level Network

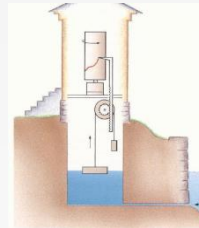
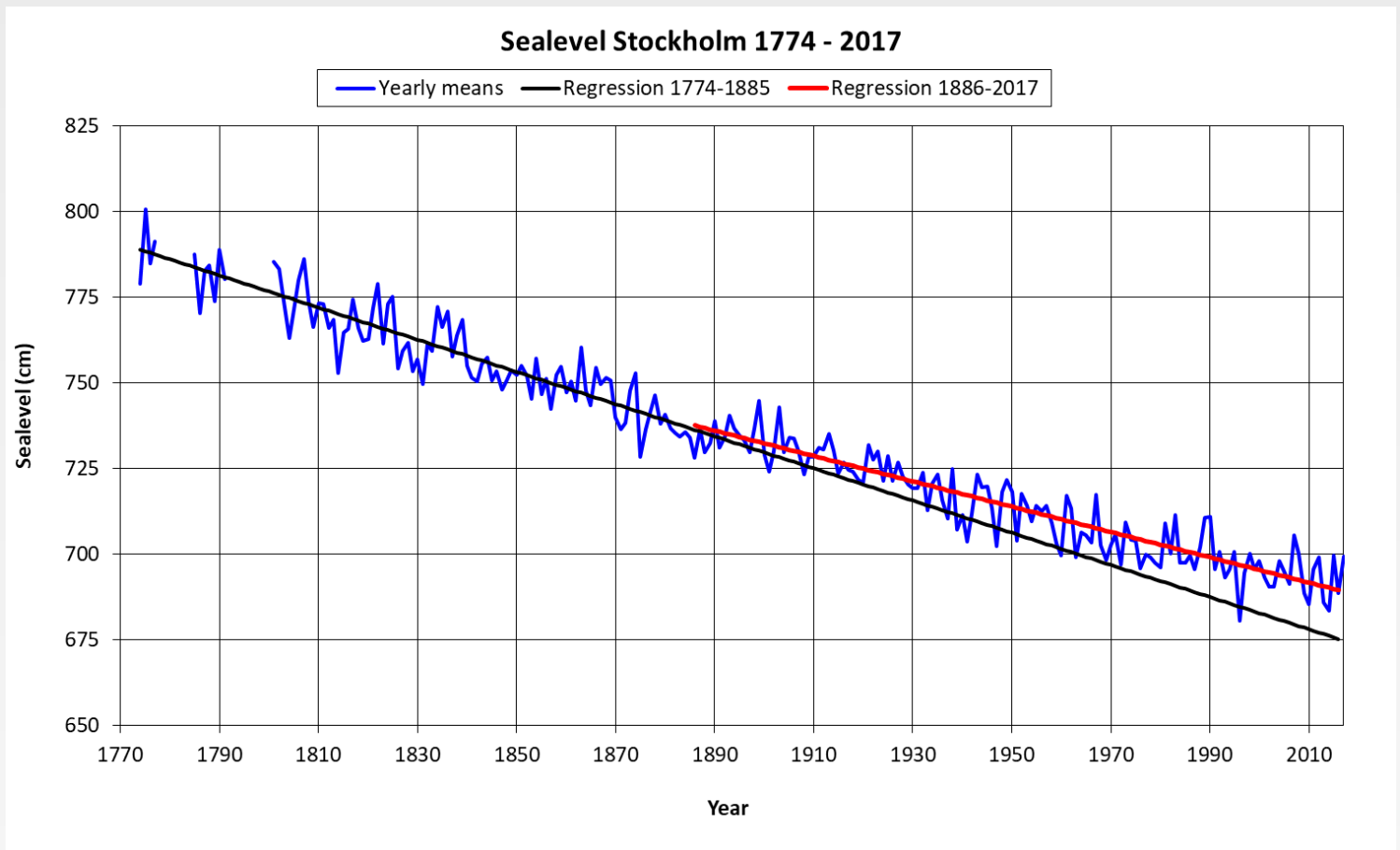


BOOS Workshop on Coastal Operational Oceanography
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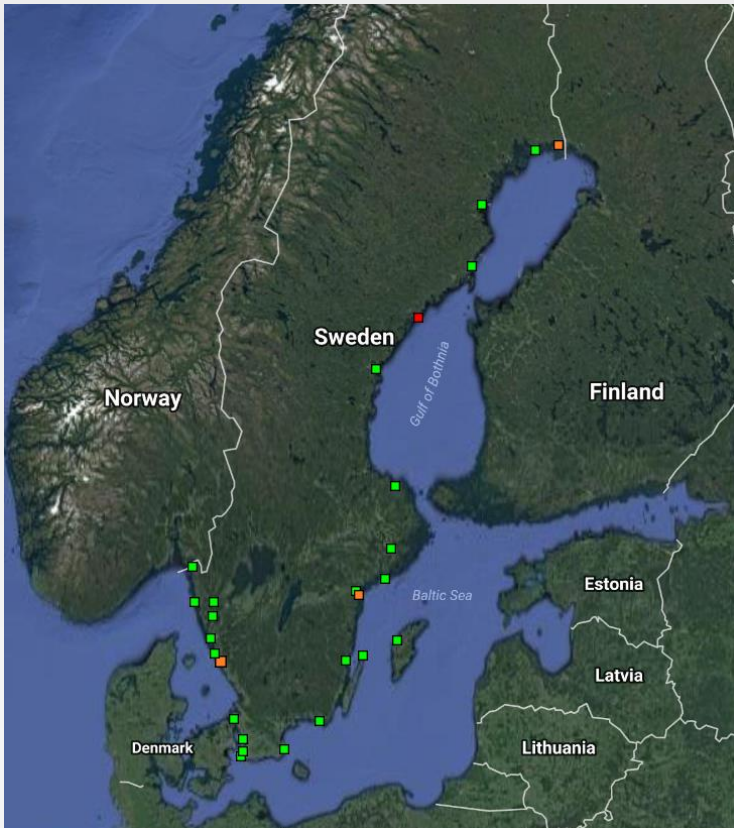
Stockholm

"World's longest sea level record"

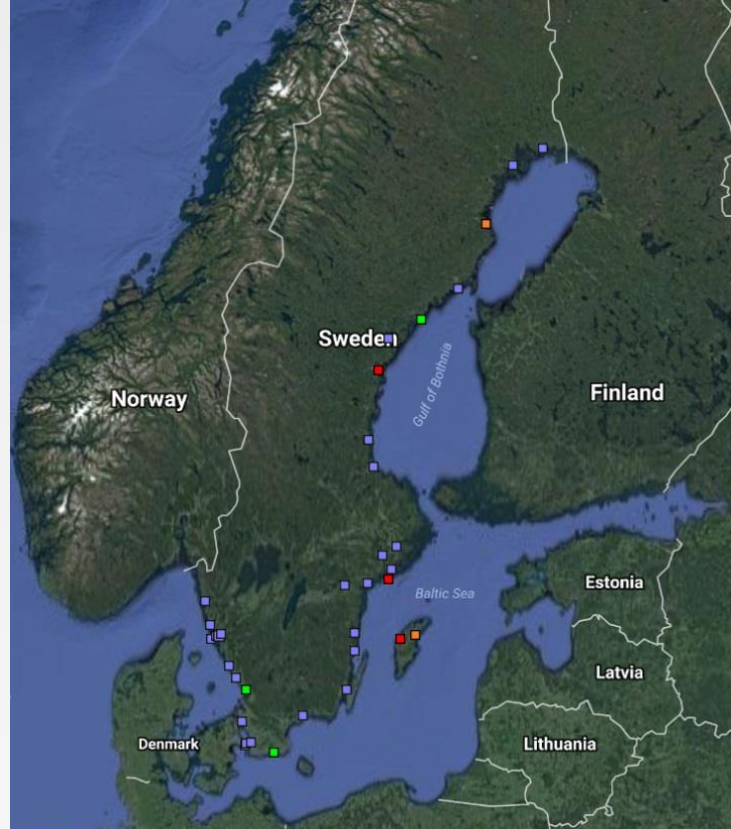


Present Swedish Sea Level Networks (January 2017)

SMHI



24 Sea level stations in the official network + 2 temporary gauges



37 Sea level stations in the network

Techniques before the upgrade

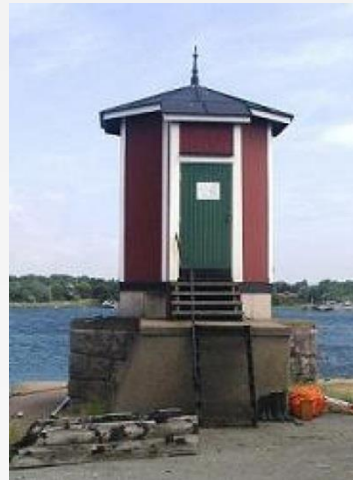


Stations operated by SMA:

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

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)



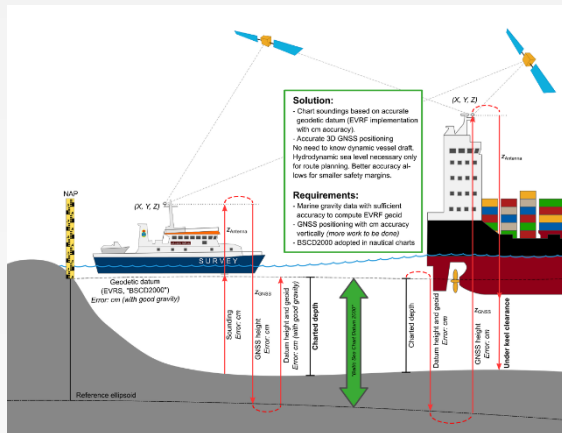
FAMOS Odin, EU-financed project 2016-2018

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 tide gauge network (2016-2018), including new sensors for 50 stations
- Level the Swedish tide gauges that have not yet been connected to the national precision levelling network, and check already levelled tide gauges 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
- 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

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

Upgrade status End of February 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

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

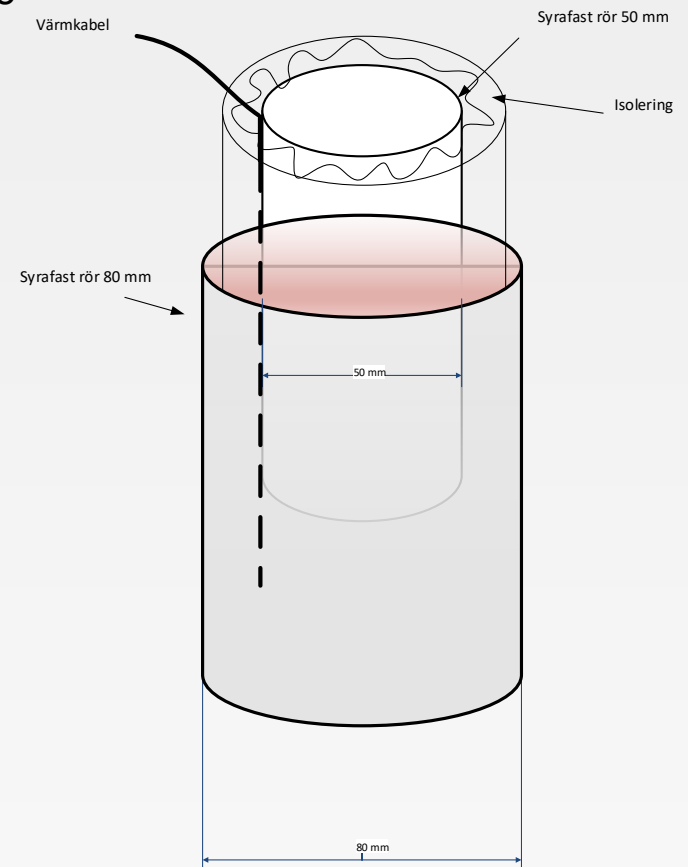
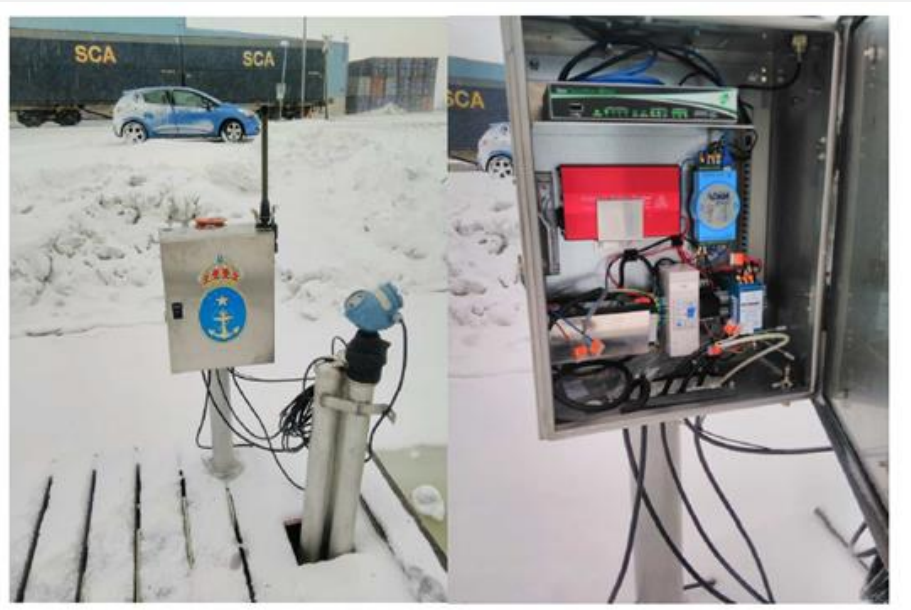
Upgrade plan 2018

SMA Stations 2018	Status / planned
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

SMHI Stations 2018	Status / planned
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

Measurements with Radar sensors in a cold climate test-site established in a pilot project 2016

- Ice-free surface is needed to measure with radar sensors
- High accuracy and no long-term sensor drift is an advantage with the sensor type
- No parts into the water (avoid bio-fouling on the sensor)
- The SHIP project has developed a measurement concept to avoid ice and condensation
- Measurement in a 50 mm tube
- Insulated and a heating cable around the 50 mm tube and a 80 mm tube outside



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 went wrong



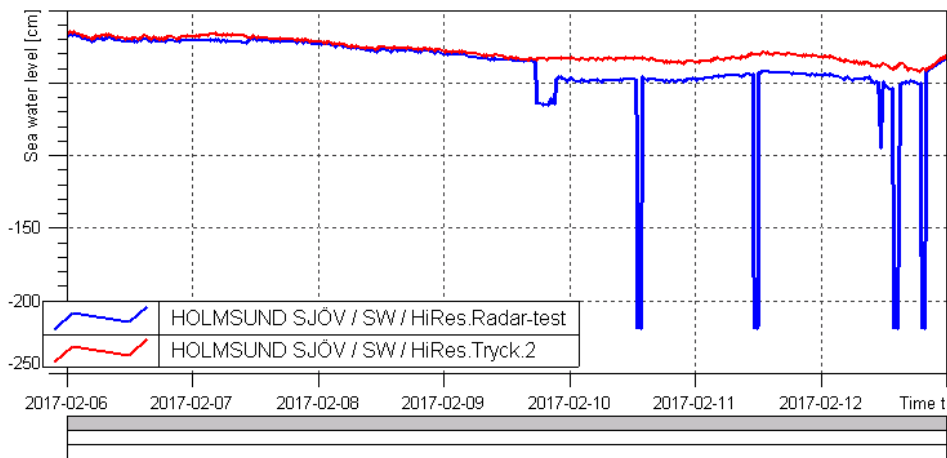
Test site at Holmsund

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



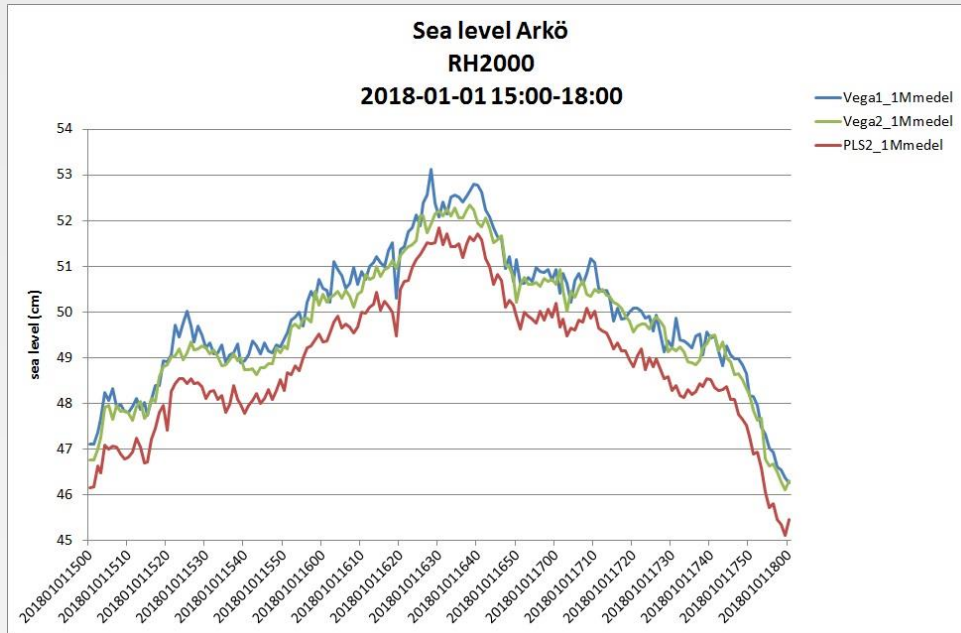
Arkö - Mounting of sensors at the quayside

Radar sensor mounted in a stilling tube
Insulated and heating cable. To avoid ice and condensation.

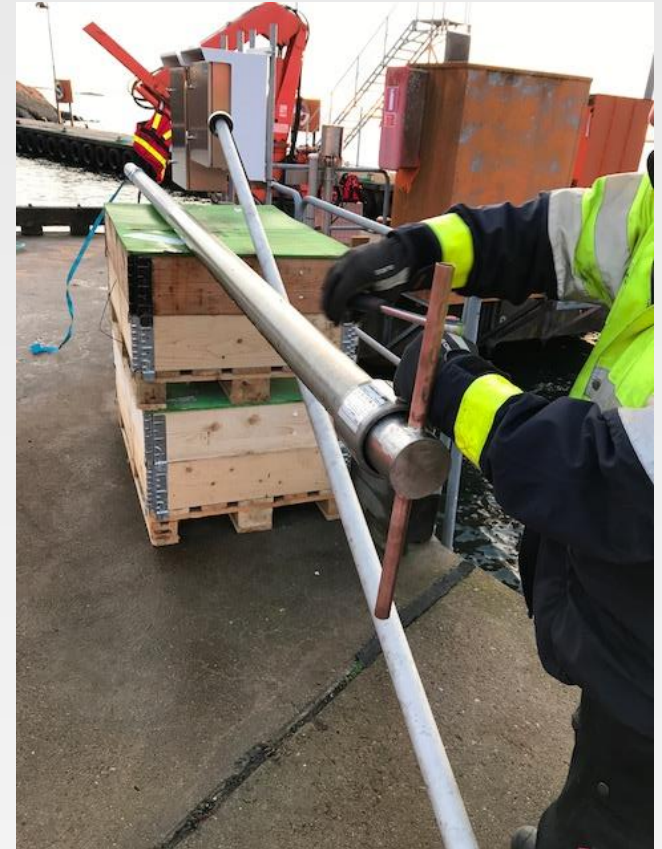
Pressure sensor mounted in
a tube



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

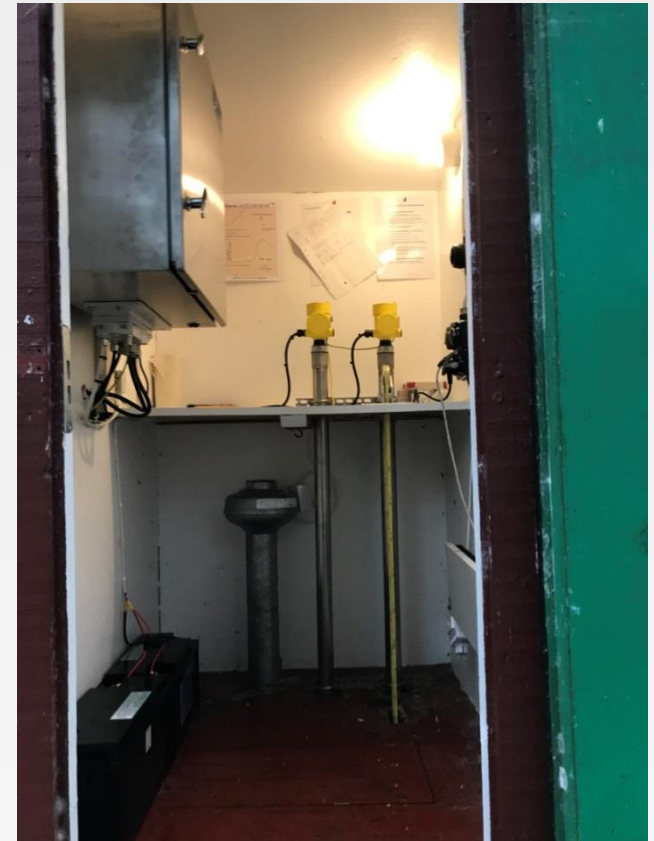
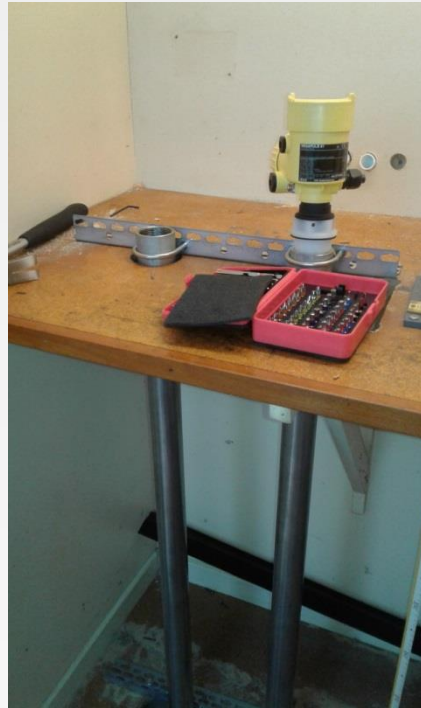


Testsite Arkö – software damping

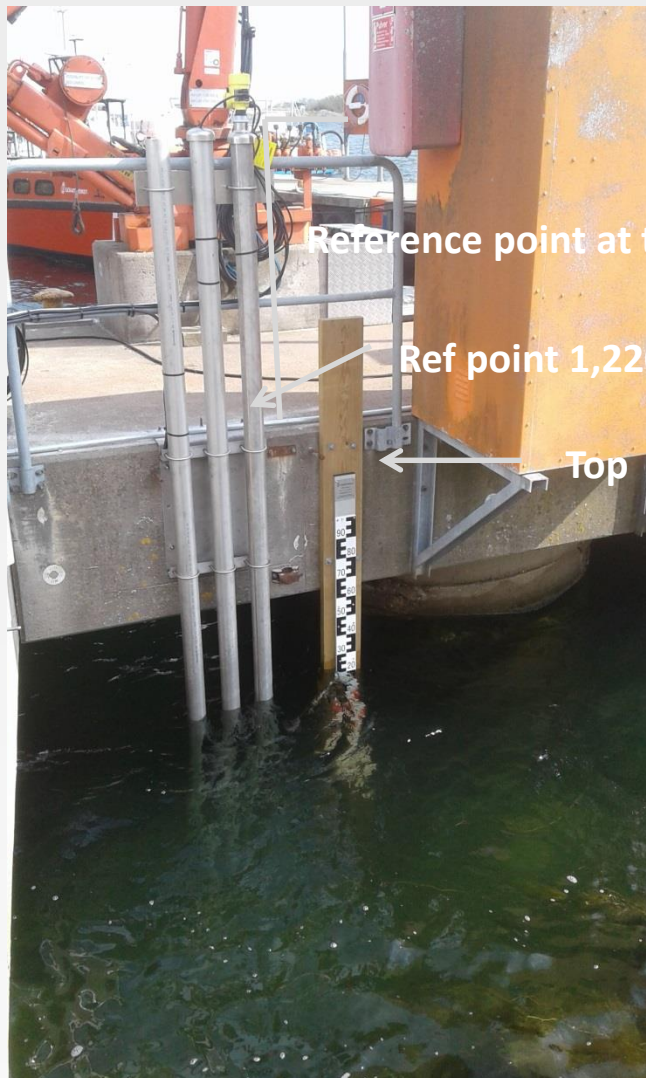


Mounting the radar sensor in a well

- 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



Radar flange
2,642m (RH2000)
The height has been
levelled

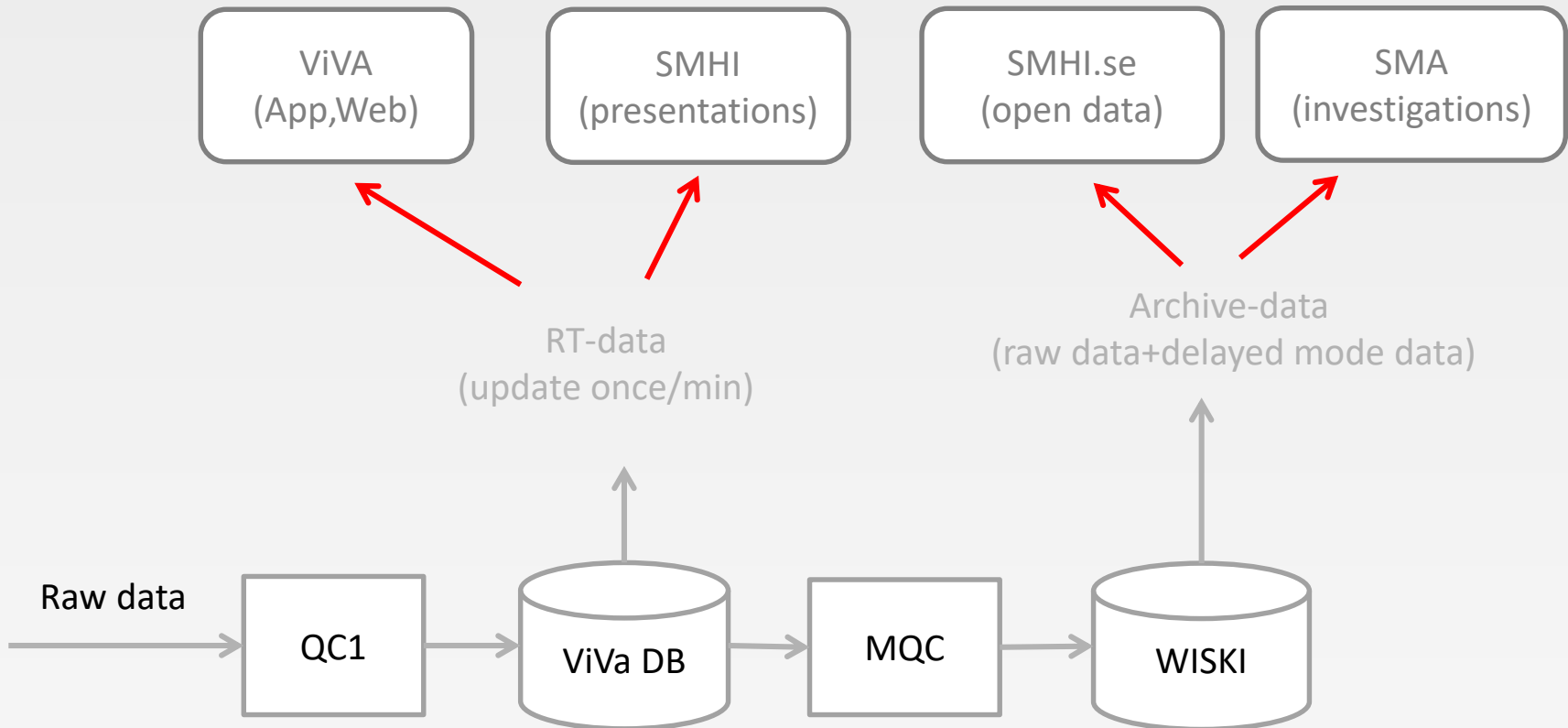
The radar is set to level, the level is set from the the leveling that 0 corresponds to the distance to the Radar flange

Present work

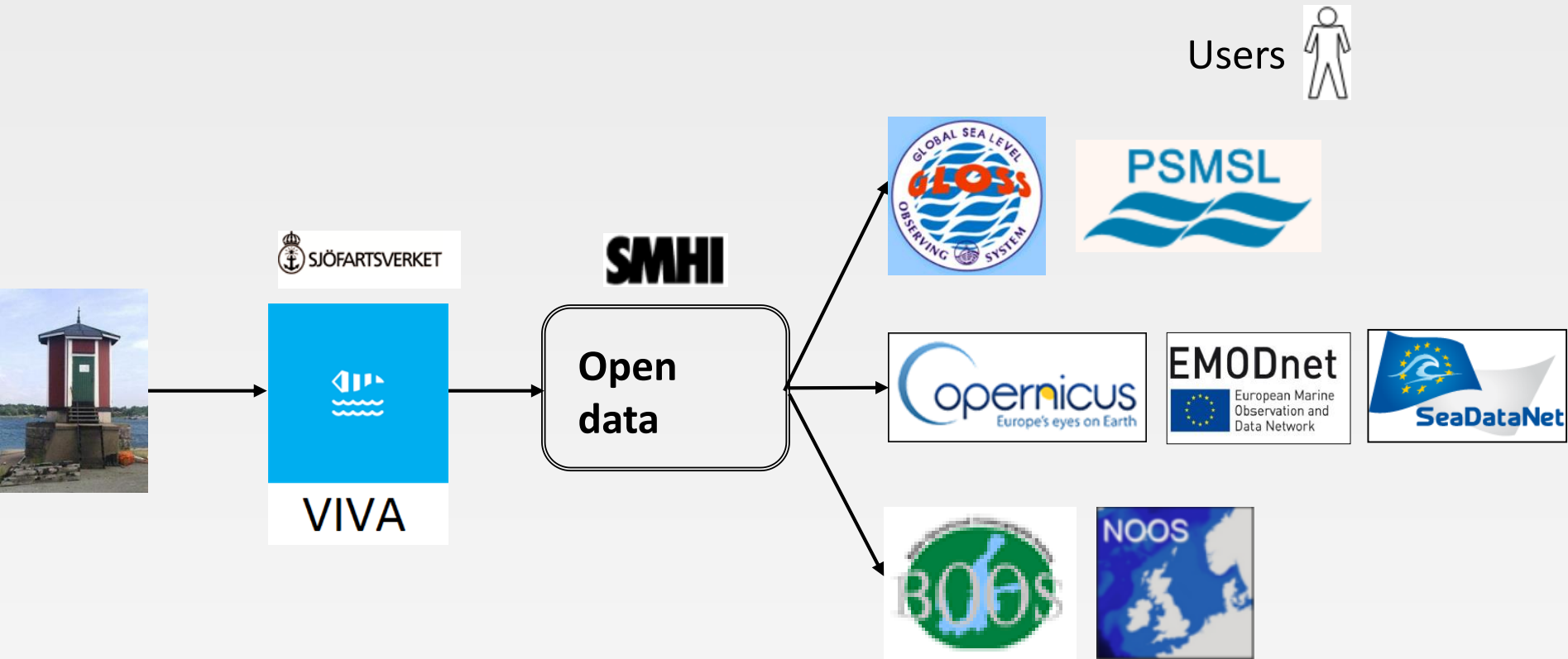
- All stations will be connected to the national reference datum RH2000 (BSCD2000)
- Joint service organisation SMA-SMHI: levelling, maintenance, service personel etc.
- Test of equipment and evaluation will continue
- Implementation of RTQC and MQC routines to all data
- Upgrade with new sensors and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



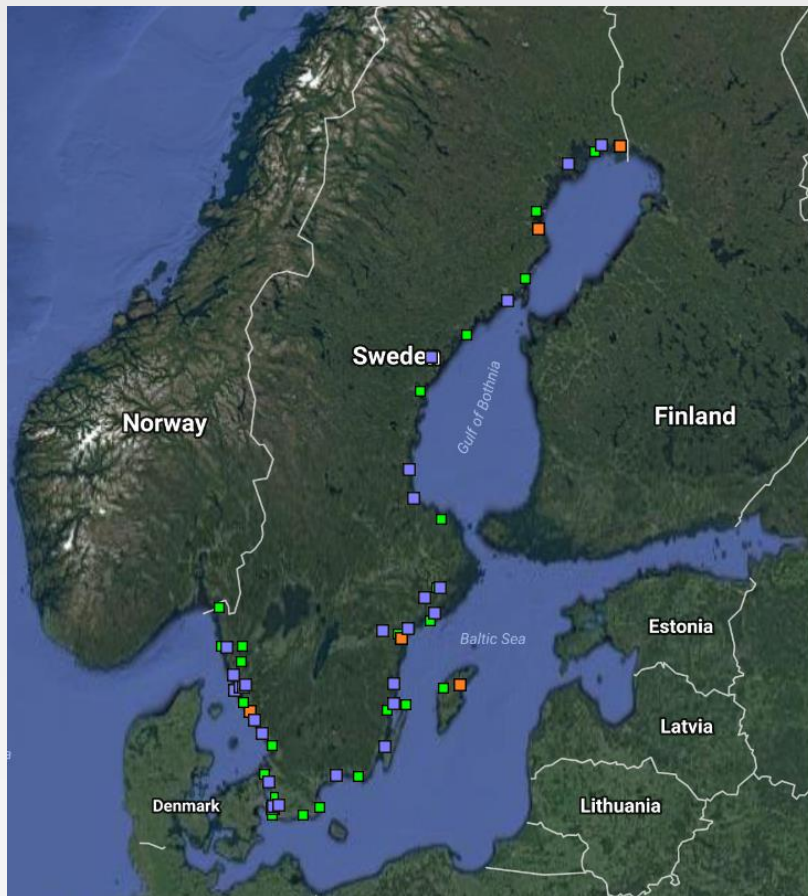
Schematic data flow



International programs and projects



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
- Class II Upgrade without battery backup
- Class III Unchanged, temporary

26 stations (23 SMHI + 3 SMA)

24 stations (24 SMA)

7 stations (3 SMHI + 4 SMA)

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

Thanks for your attention!



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