



**BALTIC SEA  
HYDROGRAPHIC  
COMMISSION**



# Baltic Sea Chart Datum 2000

**26<sup>th</sup> NSHC Tidal Working Group meeting**  
6 February 2024 Göteborg, Sweden

Thomas Hammarklint



# Baltic Sea Hydrographic Commission (BSHC)



## The Baltic Sea Hydrographic Commission,

which is an integrant part of the International Hydrographic Organisation (IHO), promotes the technical co-operation in the domain of hydrographic surveying, marine cartography and nautical information among the neighboring countries of the Baltic Sea region.

The main objectives of the Commission are the coordination of the production of the Baltic Sea INT Charts, the coordination of hydrographic re-surveys, harmonization of chart datums, harmonization of Baltic Sea ENCs, and the exchange of information and the harmonization of practices with regard to various issues related to hydrography.

The most recent development is the [Baltic Sea Bathymetric Database](#) – accessible via this portal.

### International Hydrographic Organization

The International Hydrographic Organization is an intergovernmental consultative and technical organization that was established in 1921 to support safety of navigation and the protection of the marine environment. The object of the Organization is to bring about:

- The coordination of the activities of national hydrographic offices
- The greatest possible uniformity in nautical charts and documents
- The adoption of reliable and efficient methods of carrying out and exploiting hydrographic surveys
- The development of the sciences in the field of hydrography and the techniques employed in descriptive oceanography

You are here: Home

Copyright 2013–2019 Baltic Sea Hydrographic Commission

# Chart Datum, Water level and Currents Working Group (CDWCWG)

## Chart Datum, Water level and Currents Working Group (CDWCWG)

“To implement a common reference system, S-104 and S-111 in the Baltic Sea”



Photo: Chart Datum Working Group 14th meeting, 28-29 March 2023, Göteborg, Sweden

<https://www.bshc.pro/working-groups/cdwcwg>

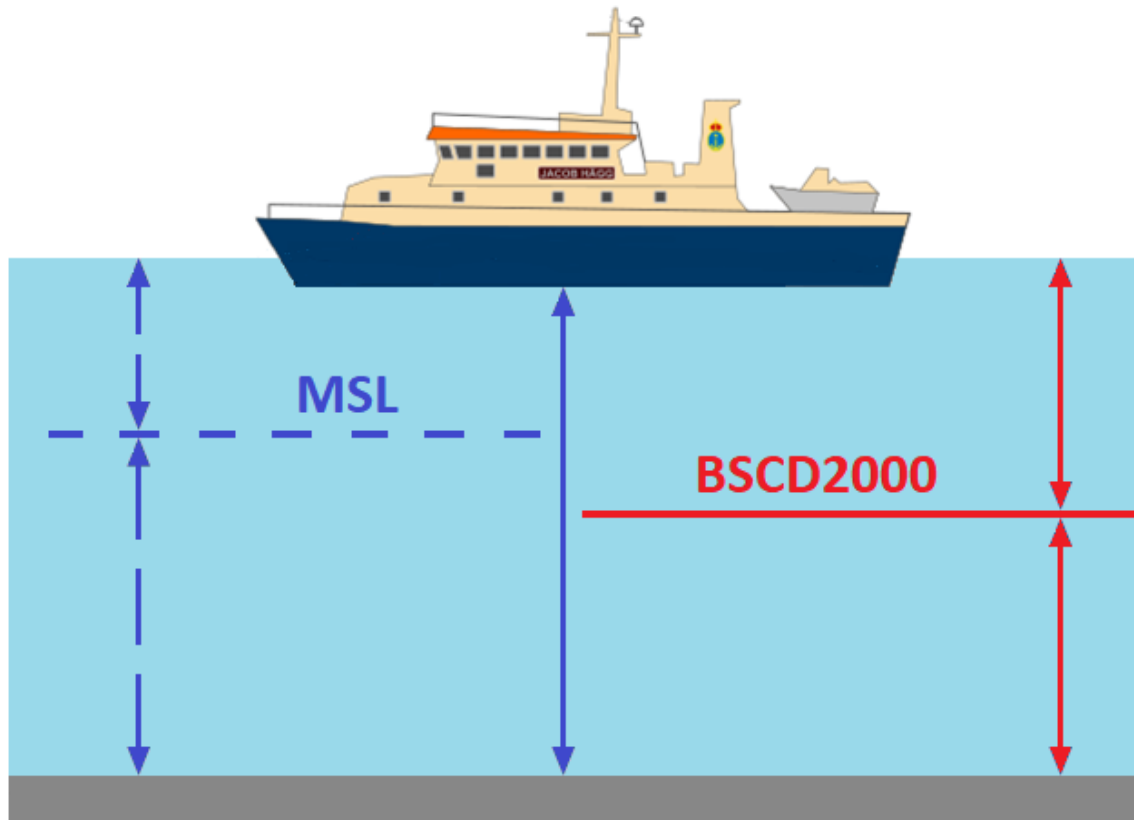
### Members of CDWCWG:

Denmark	Mr Nikolaj Møller
Denmark	Mr Kristian Villadsen Kristmar
Estonia	Mrs Gabriela Kotsulim
Finland	Mr Jarmo Mäkinen
Finland	Mr Jyrki Mononen
Germany	Dr Patrick Westfeld
Latvia	Mr Bruno Špēls
Lithuania	Mr Mindaugas Zakarauskas
Poland	Mr Witold Stasiak
Poland	Mrs Alicja Olszewska
Russia	Mr Leonid Shalnov
Russia	Dr Sergey V. Reshetniak
Sweden	Mr Thomas Hammarklint (Chair)
Sweden	Mr Lars Jakobsson
Sweden	Mr Henrik Tengbert

### Observers and Experts:

Estonia	Prof. Artu Ellmann
Estonia	Dr Sander Varbla
Finland	Dr Mirjam Bilker-Koivula
Finland	Mrs Anni Jokiniemi
Germany	Dr Gunter Liebsch
Germany	Dr Joachim Schwabe
Latvia	Mr Armands Murans
Latvia	Mr Kristis Dzenis
Latvia	Mr Mārtiņš Rēvalds
Lithuania	Mr Emilis Tertelis
Lithuania	Mr Romuald Obuchovski
Norway	Mr Aksel Voldsund
Poland	Mr Krzysztof Pyrchla
Poland	Mrs Małgorzata Pająk
Poland	Dr Monika Wilde-Piórko
Poland	Dr Małgorzata Szelachowska
Sweden	Prof. Anna Jensen
Sweden	Dr Jonas Ågren
Sweden	Dr Per-Anders Olsson
Sweden	Mrs Johanna Linders

# New reference level



**The water level remains!**

# Baltic Sea Chart Datum 2000 (BSCD2000)

## ➤ Definition:

The datum refers to each Baltic country's realization of the European Vertical Reference System (EVRS) with land-uplift epoch 2000, which is connected to the Normaal Amsterdams Peil (NAP).

## ➤ Justification:

The Baltic Sea is an international shallow, non-tidal area in the northern part of Europe with dense traffic. IHO BSHC has approved the name and the adoption of the Baltic Sea Chart Datum 2000 ([specification](#)).

## ➤ Height systems used as national realization of BSCD2000 (EVRS-based):

Sweden RH2000	Denmark DVR90	Germany DHHN2016
Poland PL-EVRF2007-NH	Lithuania LAS07	Latvia LAS2000,5
Estonia EH2000	Finland N2000	Norway NN2000

## ➤ Chart datum name to be shown in paper charts:

Mean Sea Level (Baltic Sea Chart Datum 2000<sup>national realization name</sup>)

or

Mean Sea Level (Baltic Sea Chart Datum 2000)



# Baltic Sea Chart Datum 2000 in IHO Registry

**BSCD2000 is now included in IHO Geospatial Information (GI) Registry, as chart datum number 44:**

**IHO Geospatial Information Registry**

**Data Dictionary Register**

Home / GI REGISTERS / Data Dictionary Register

Feature Type: 366 Information Type: 26 Attribute Type: 667 Complex Type: 92 Enumeration Value: 2273 Codelist Value: 117

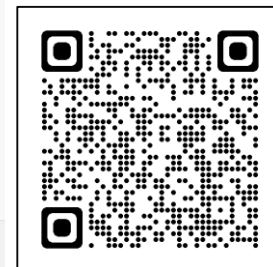
Domain: ALL Status: Valid Type: ALL Category: Name

**[Listed Value] Dictionary Details**

Domain	IHO Hydro	
Name	Baltic Sea Chart Datum 2000	
CamelCase	balticSeaChartDatum2000	
Item Identifier	1213 ?	
Definition	The datum refers to each Baltic country's realization of the European Vertical Reference System (EVRS) with land-uplift epoch 2000, which is connected to the Normaal Amsterdams Peil (NAP).	
Data type	Enumerated value	
Associated Attribute	Attribute type	Name
	Enumerated type	<a href="#">Vertical Datum</a>
Reference		
Reference Source	Baltic Sea Hydrographic Commission	

COPYRIGHT © IHO Geospatial Information Registry. ALL RIGHTS RESERVED.

KHOA Acknowledgements





# International Hydrographic Review Article

An article about the CDWCWG work and the implementation of the Baltic Sea Chart Datum 2000 has been published in the International Hydrographic Review (IHR) in May 2020: [THE BALTIC SEA CHART DATUM 2000 \(BSCD2000\) - Implementation of a common reference level in the Baltic Sea](#)

INTERNATIONAL HYDROGRAPHIC REVIEW MAY 2020

## Articles

### THE BALTIC SEA CHART DATUM 2000 (BSCD2000) Implementation of a common reference level in the Baltic Sea

By J. Schwabe<sup>1</sup>, J. Ägren<sup>2</sup>, G. Lebech<sup>3</sup>, P. Westfeld<sup>4</sup>, T. Hamminkens<sup>5</sup>, J. Mononen<sup>6</sup> and O. B. Andersen<sup>4</sup>

1. Federal Agency for Cartography and Geodesy (Germany)
2. University of Gävle (Sweden) and Lantmäteriet, the Swedish mapping, cadastral and land registration authority (Sweden)
3. Federal Maritime and Hydrographic Agency (Germany)
4. Swedish Maritime Administration (Sweden)
5. Finnish Transport Agency (Finland)
6. DTU Space (Denmark)

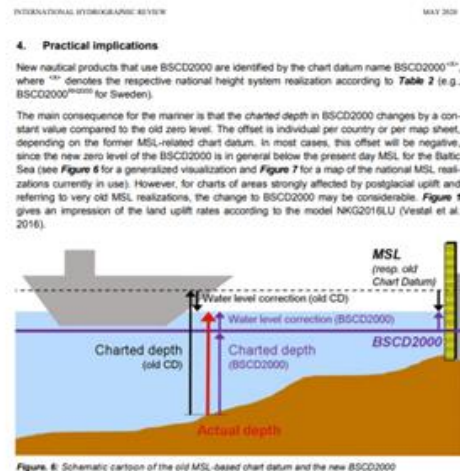
#### Abstract

The Baltic Sea Chart Datum 2000 (BSCD2000) is a geodetic reference system adopted for Baltic Sea hydrographic surveying, hydrographic engineering, nautical charts, navigational publications and water level information. It is based on the common geodetic standards for the height system (EVRS) and the spatial reference system (ETRS89) in Europe. In particular, the zero level of BSCD2000 is in accordance with the Normaal Amsterdams Peil (NAP). BSCD2000 is about to be adopted as unified chart datum by all the countries around the Baltic Sea. It agrees with most national height realizations used on land. BSCD2000 will facilitate effective use of GNSS methods like GPS, GLONASS and Galileo for accurate navigation and hydrographic surveying in the future.

#### Résumé

Le Baltic Sea Chart Datum 2000 (BSCD2000) est un système de référence géodésique adopté pour les levés hydrographiques, l'ingénierie hydrographique, les cartes marines, les publications nautiques et les informations sur le niveau de l'eau de la mer Baltique. Il est basé sur les normes géodésiques communes au Système de Référence Vertical Européen (EVRS) et au Système de Référence Terrestre Européen (ETRS89). En particulier, le zéro hydrographique du BSCD2000 est conforme au Normaal-Amsterdams-Peël (NAP). Le BSCD2000 est sur le point d'être adopté en tant que niveau de référence des cartes commun par l'ensemble des pays bordant la mer Baltique. Il correspond à la plupart des mesures de hauteur nationales utilisées à terre. Le BSCD2000 facilitera l'utilisation efficace des méthodes du GNSS comme le GPS, GLONASS et Galileo pour une navigation et des levés hydrographiques précis à l'avenir.

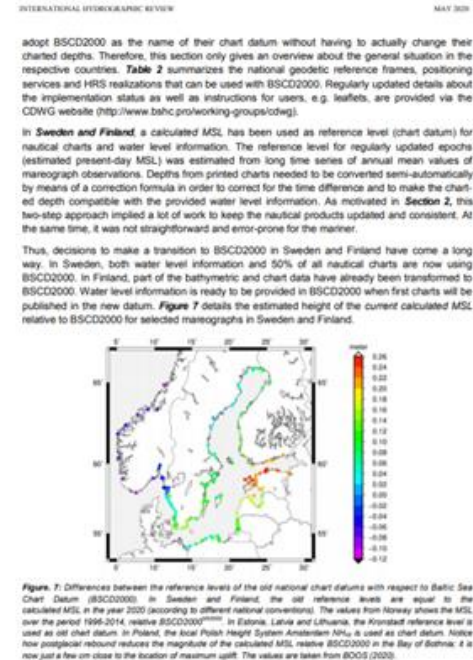
63



At the same time, real-time water level information (water level observations, corrections to the charted depths, forecasts, etc.) will also be changed accordingly to comply with the new chart datum. This also allows for a better and easier monitoring and prediction of the current and future sea states out at sea, since real-time oceanographic models can be simply interpolated (**Figure 8**), whereas switching between the sometimes far-distant manographs and their local references may introduce a large error margin (**Figure 9**).

The transition from the numerous MSL-based chart datums of each country to BSCD2000 is a complex and stretched process from the first decisions to the final implementation in the chart products. In particular, paper charts need longest to be switched due to the long production cycles. Some countries, like Estonia, have already informed mariners about the changes to BSCD2000 and have published the first products. Others, like Denmark, are about to formally

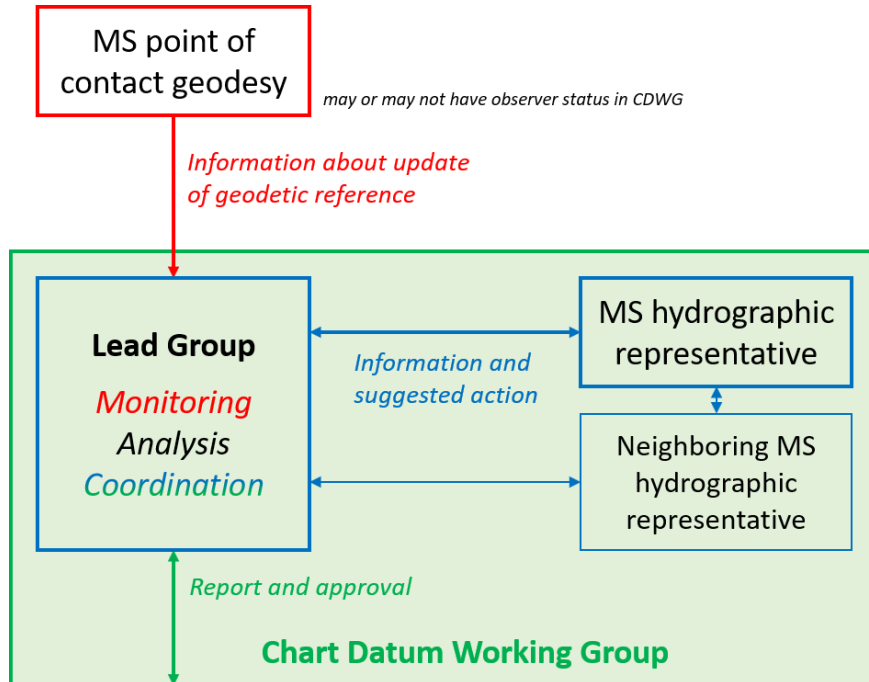
76



77

# Continuity Management of BSCD2000

## Organizational scheme and workflow



## BSCD2000 height transformation grid (geoid model)

### Release note:

<https://doi.org/10.58440/ihr-29-2-n11>

### Landing page:

<https://www.bshc.pro/iho-bscd2000>

## Digital Object Identifier (DOI) with download

DOI: 10.58440/iho-bscd2000

URL: <https://doi.org/10.58440/iho-bscd2000>

The DOI has been configured as type 'database'. In perspective, we can assign any number of "datasets" to a "database". This means that each new BSCD2000 release can have its own entry.

We can also assign literature references (definition, specification, publications etc.) in the future.



# Swedish height systems



## ➤ RH00 National height system 1900

Official national height system until 1970

Zero-level defined by:

Normal height point in Stockholm from 1886

Placed +11,800 m above mean sea level in Stockholm 1900

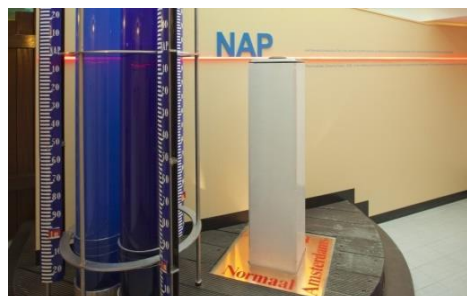


## ➤ RH70 National height system 1970

Official national height system 1970-2005

Zero-level defined by:

Normaal Amsterdams Peil (NAP), a reference point in Varberg placed +4,234 m above NAP



## ➤ RH 2000 National height system 2000

"Baltic Sea Chart Datum 2000 (BSCD2000)"

Official national height system since 2005

Zero-level defined by:

NAP is the reference point in the European Vertical Reference System (EVRS)

Epoch year 2000

# Swedish Chart Improvement project



CHART DATUM: Mean Sea Level (Baltic Sea Chart Datum 2000<sup>RH2000</sup>)

REFERENSNIVÅ: Medelvattenyta (Baltic Sea Chart Datum 2000<sup>RH2000</sup>)

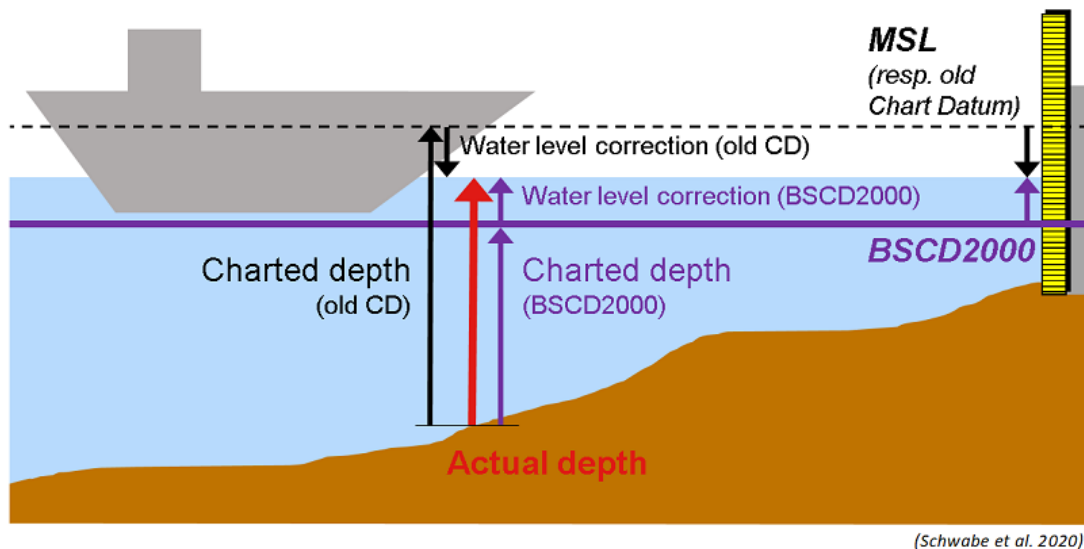
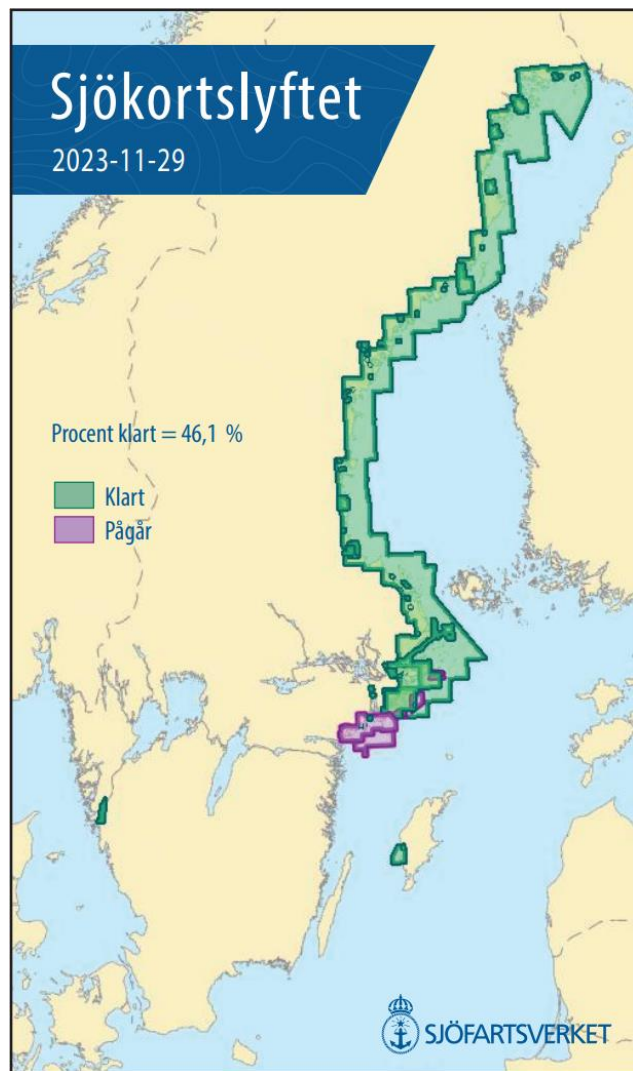
SYMBOLS and ABBREVIATIONS: see INT 1

BETECKNINGAR och FÖRKORTNINGAR: se KORT 1

Referensnivå



# Status transition from MSL to BSCD2000 in nautical charts



Updated 2023-11-29

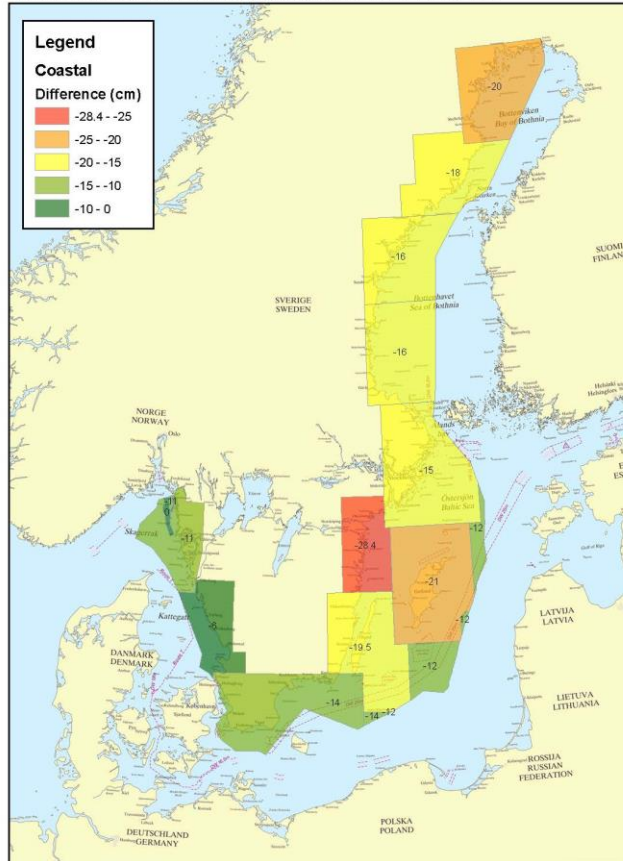
# Difference between old chart datum and BSCD2000

Annex 1 To Questionare, BSHC CDWG

Page 2 (4)

## Difference between existing chart datum and RH 2000 - Coastal

Swedish Maritime Administration, Hydrographic Office, May 16, 2013



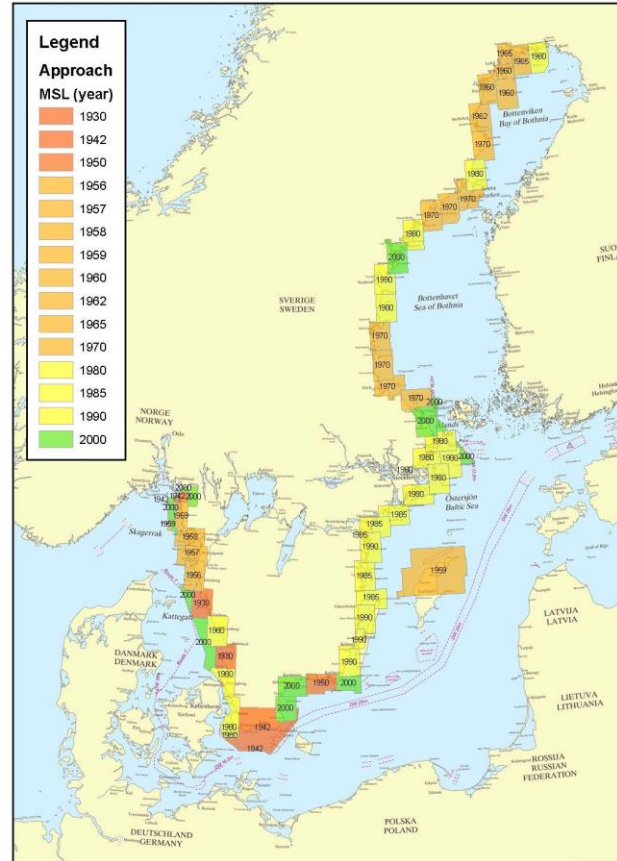
1 centimeters = 60 kilometers

Annex 1 To Questionare, BSHC CDWG

Page 3 (4)

## Year of MSL in Swedish chart database - Approach (Swedish water)

Swedish Maritime Administration, Hydrographic Office, May 16, 2013

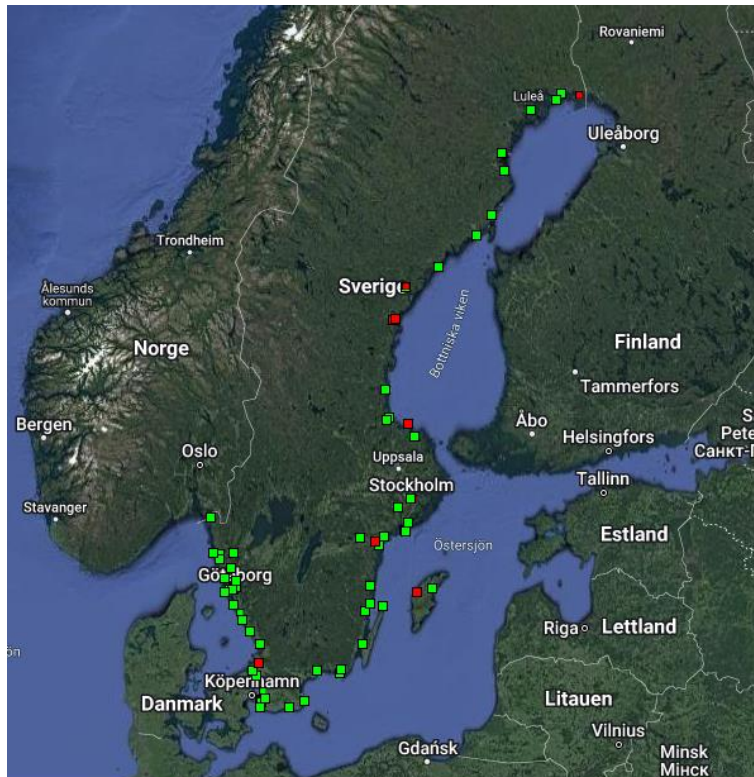


1 centimeters = 60 kilometers





# 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



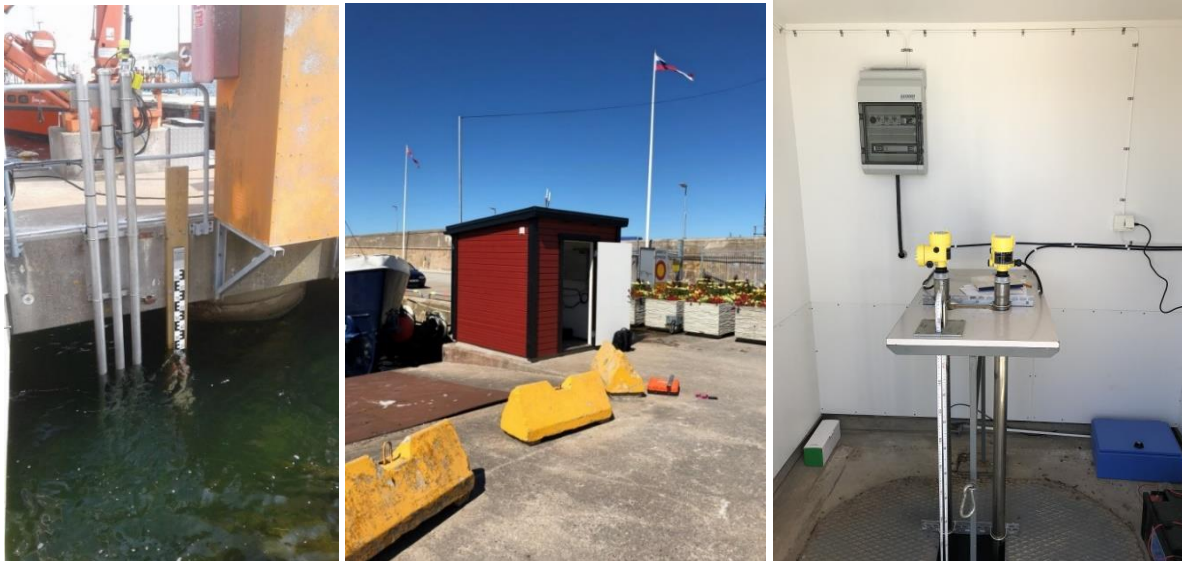
Class I	Upgrade with battery backup
Class II	Upgrade without battery backup
Class III	Unchanged, temporary

27 stations (23 SMHI, 3 SMA, 1 CTH)
27 stations (23 SMA, 3 GBG, 1 SKB)
6 stations (6 SMA)

Present water level information are shown in Wind- and Water Information ([ViVa](#))

# Upgrade of the Swedish Sea Level network 2017-2019

- One common and harmonised Swedish Sea Level network
- Upgrade and modernize 53 stations in the new network, two new sensors at all stations
- Sea level data of better accuracy, continuous time series
- Open and faster access to quality controlled real-time and archive data
- All stations connected to the land survey datum (RH 2000/BSCD2000)
- Partly financed by the EU-project FAMOS Odin. Leads to that the objectives of the FAMOS Odin is achieved: safer and more cost effective shipping routes





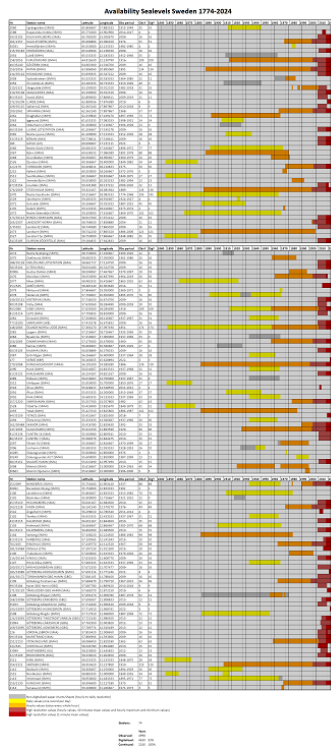
# Swedish Sea Level observations 1774-2024

- First observations started in Stockholm 1774
- 140 sea level stations/records, 60 stations are active (2024)
- 4998 years of observations, 4630 years of data are digitalized (93%)
- 2240 years from continued stations, 100% digitalized

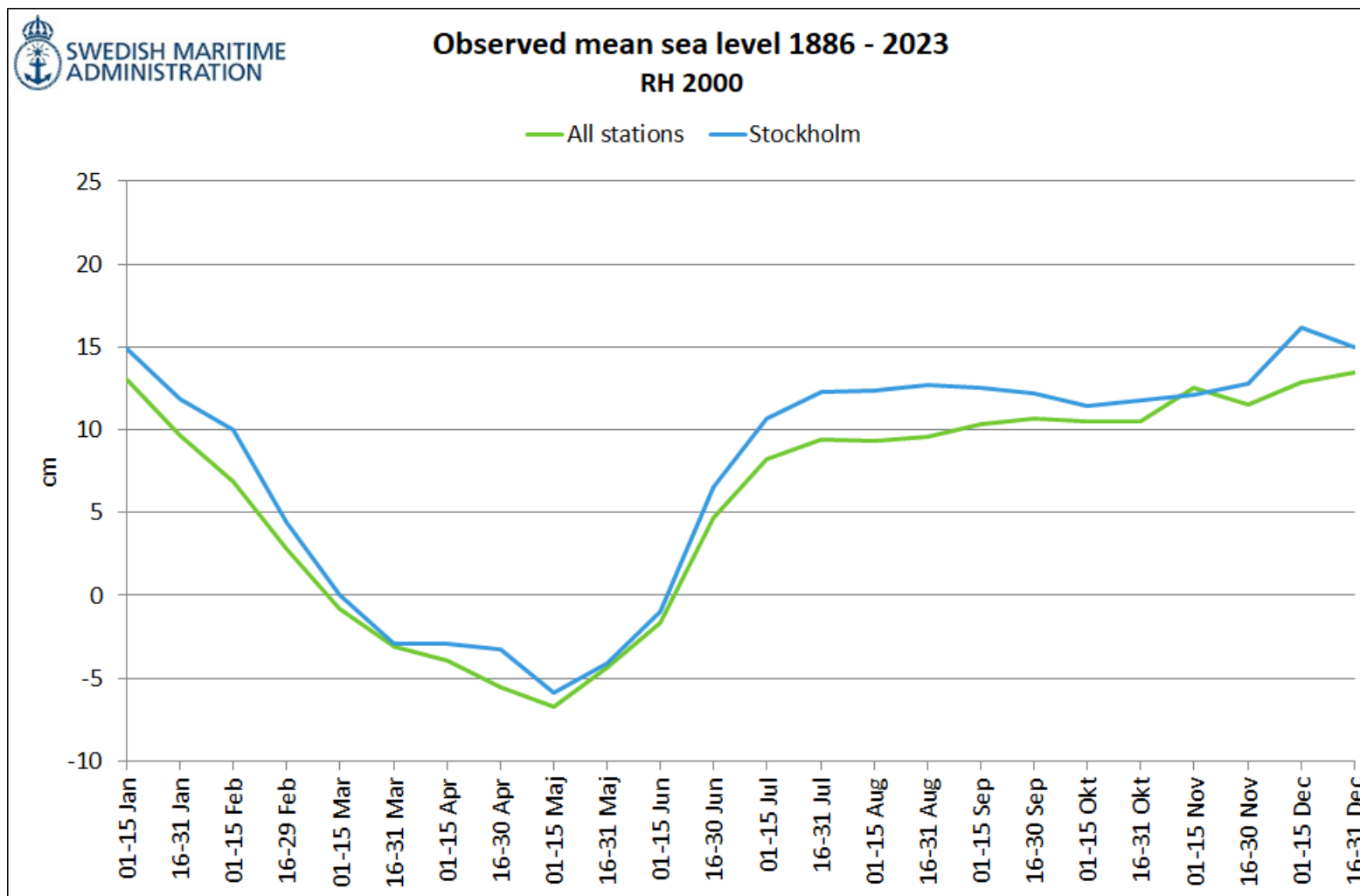
High-Resolution data (1-15 minutes)

Hourly values

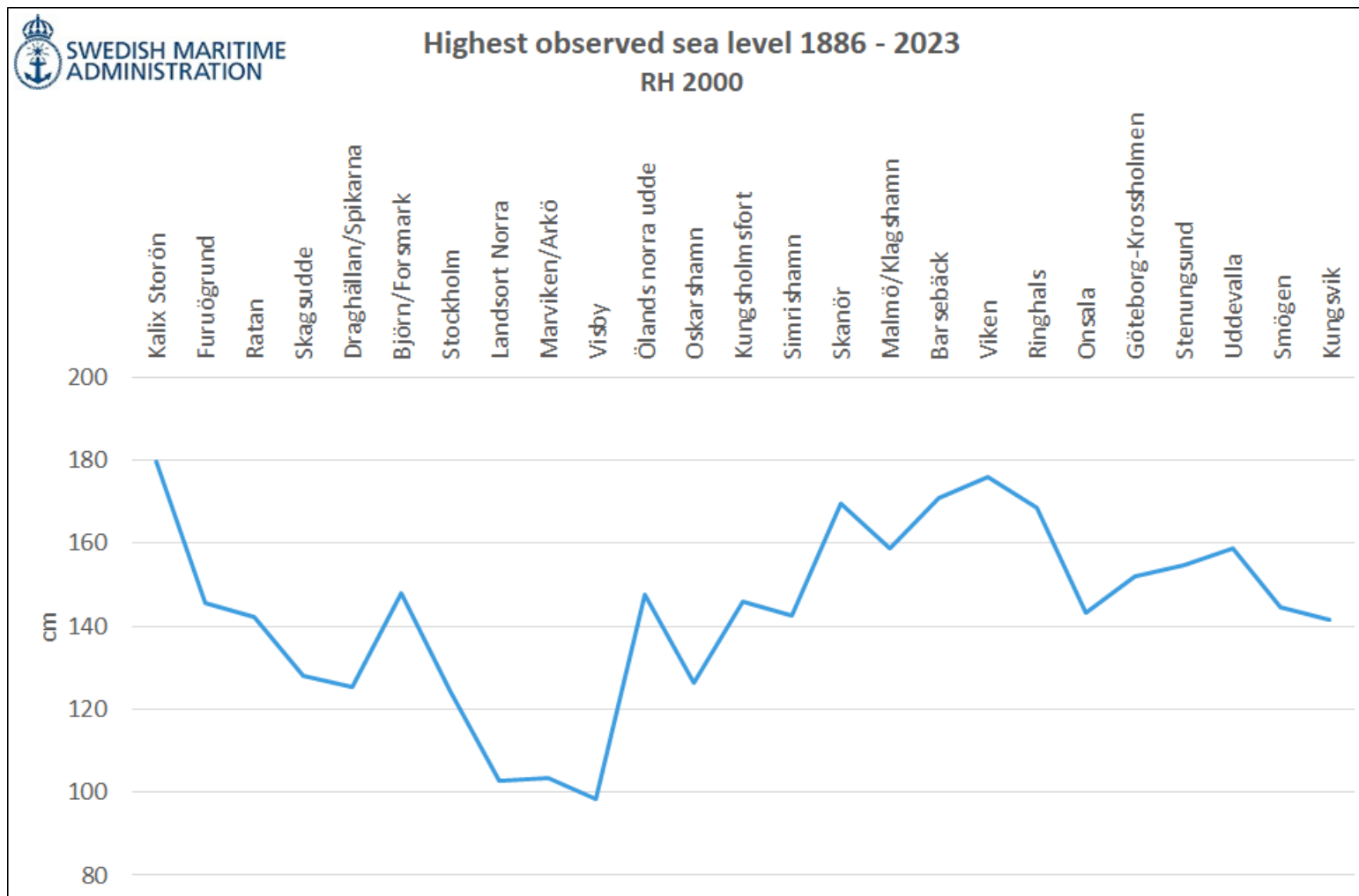
Daily values



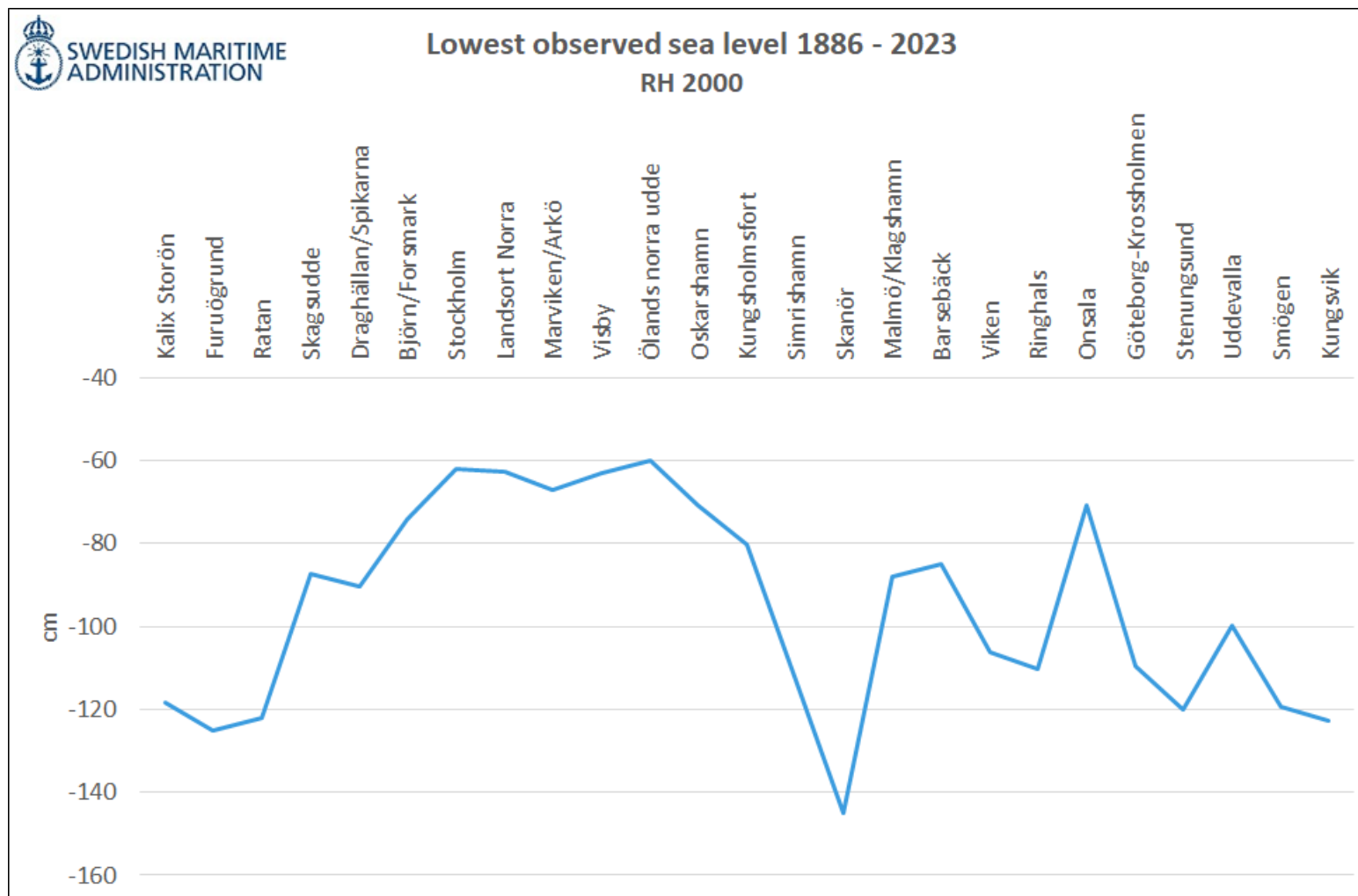
# Observed mean sea level



# Highest observed sea level

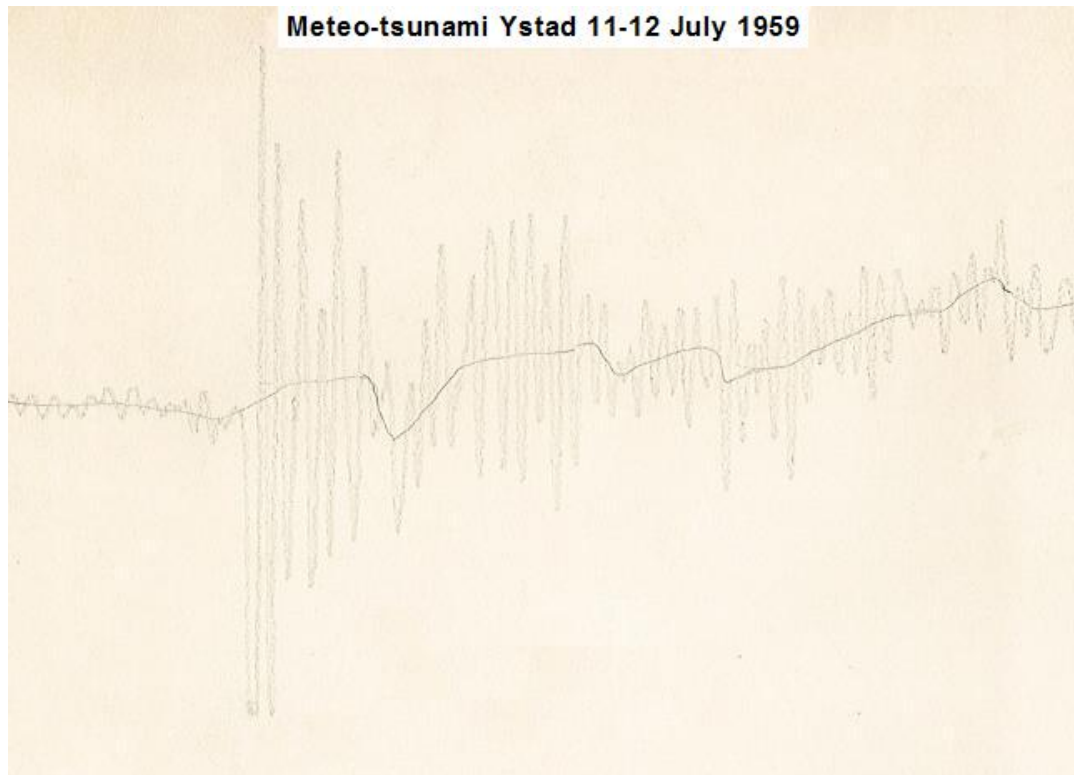


# Lowest observed sea level



# Phenomena in Swedish Sea Level data

## Meteo-tsunami Ystad 11-12 July 1959

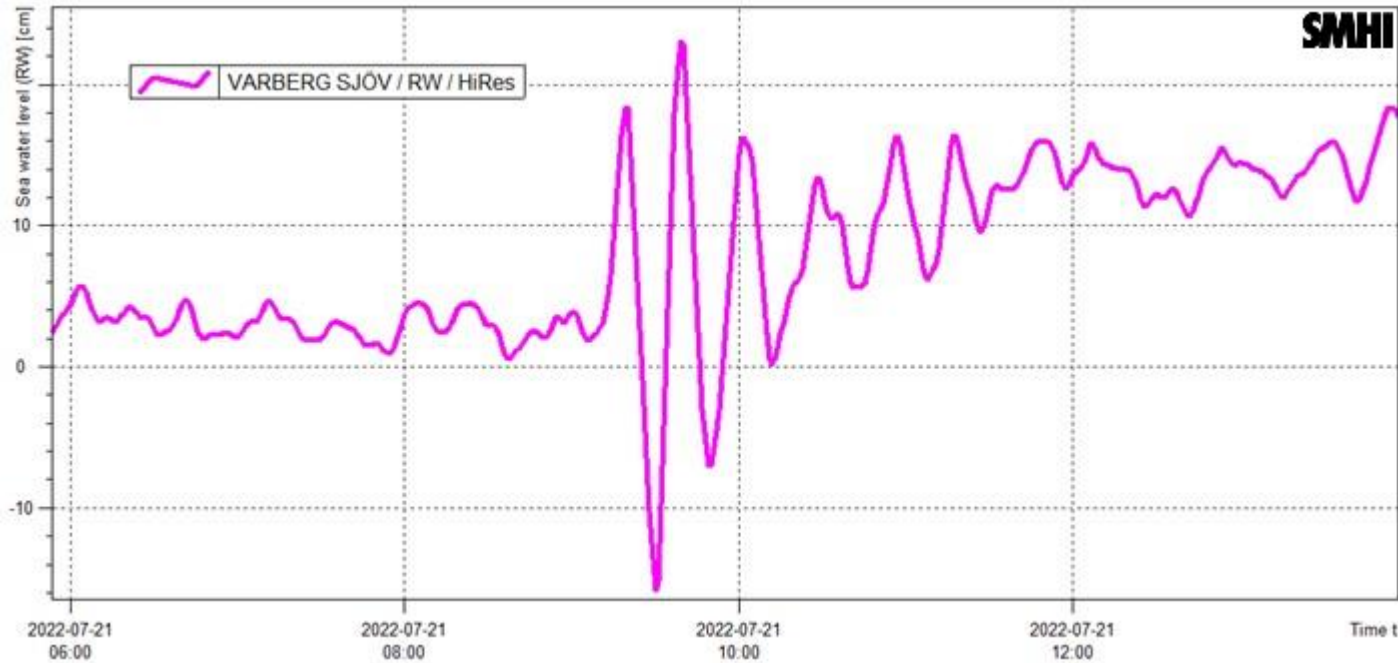


**Disturbance lasted about:** 6 hours

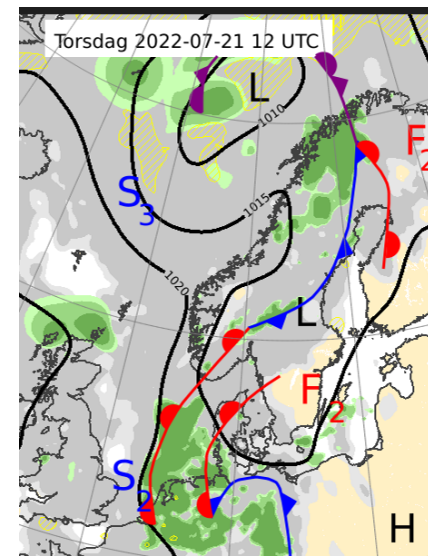
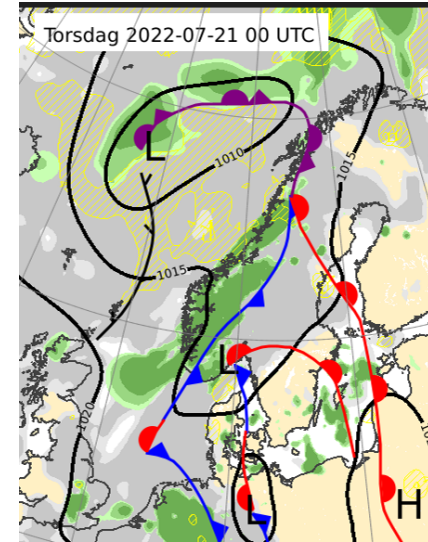
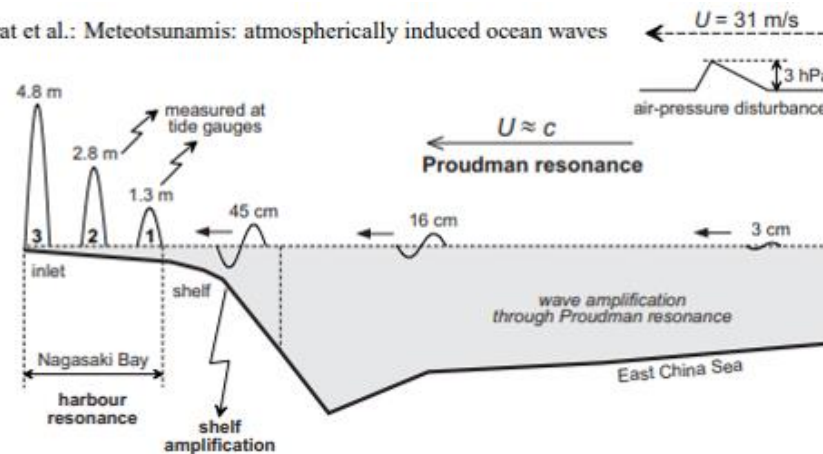
**Largest difference between high and low:** 132 cm

**Time between two highs or lows (period):** 10 minutes

# Meteo-tsunami Varberg 21<sup>st</sup> July 2022

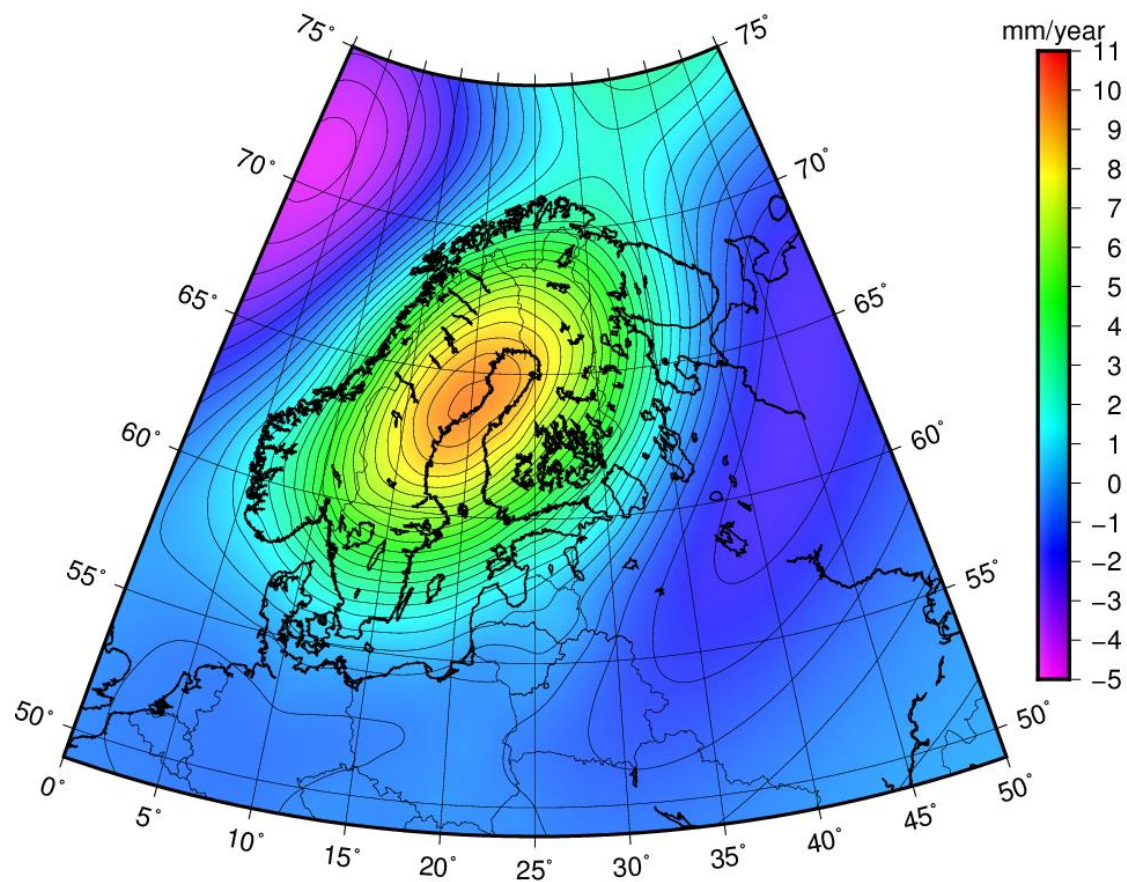


S. Monserrat et al.: Meteotsunamis: atmospherically induced ocean waves





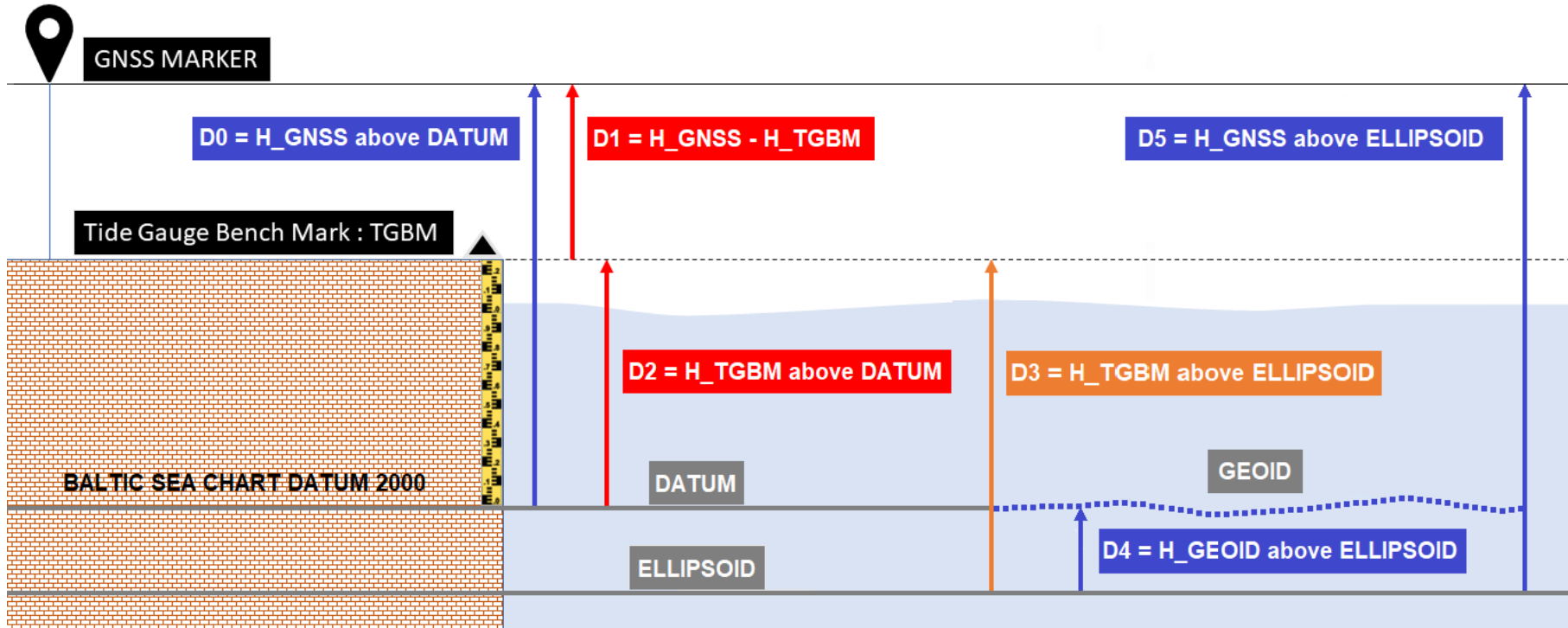
# Land-uplift



Levelled land-uplift (relative the geoid, NKG2016LU\_lev) from the Nordic Geodetic Commission's (NKG) land-uplift model NKG2016LU

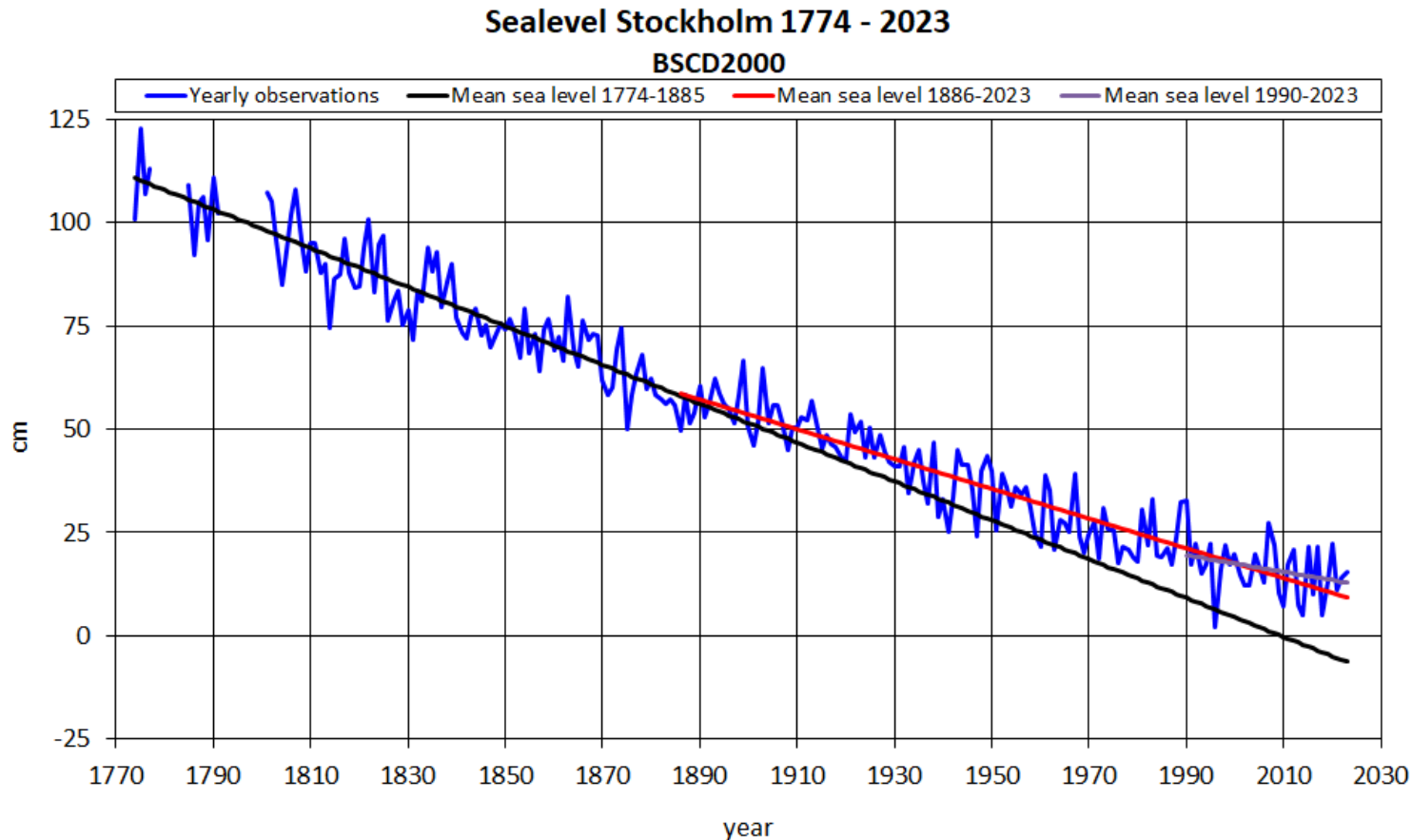


# Co-location of sea level stations and GNSS

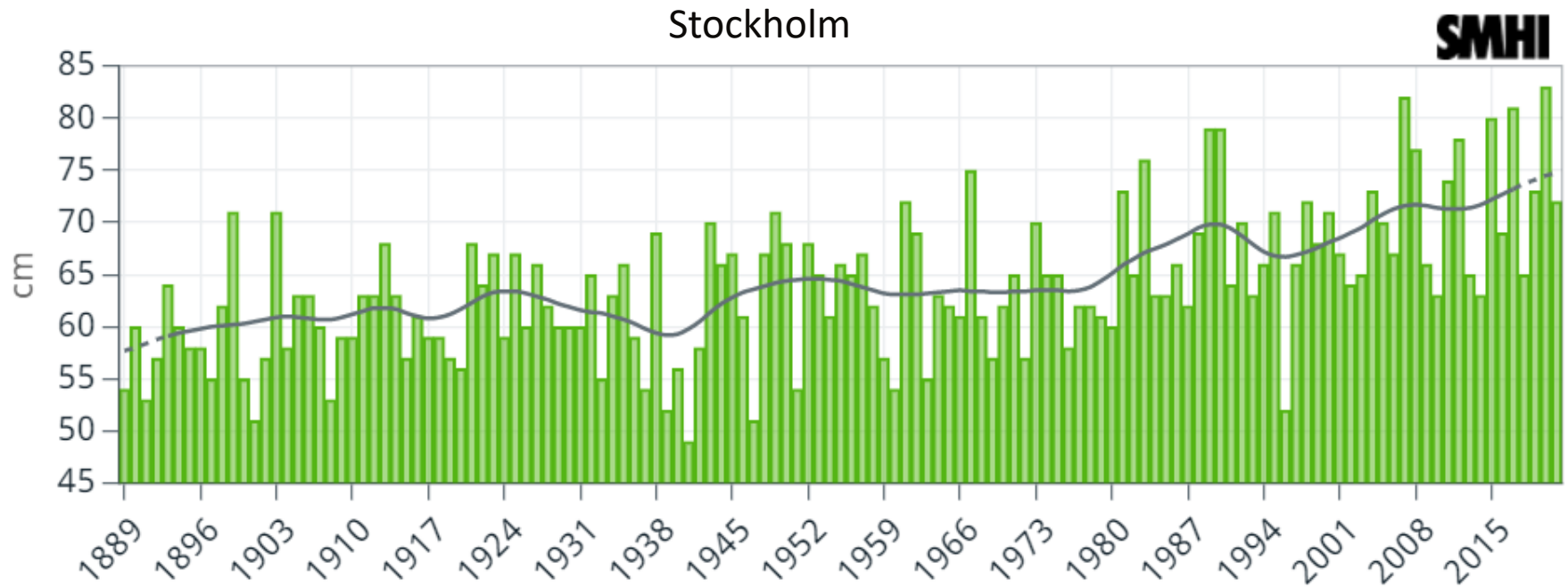


# Stockholm

## "World's longest sealevel record"



# Sea level rise



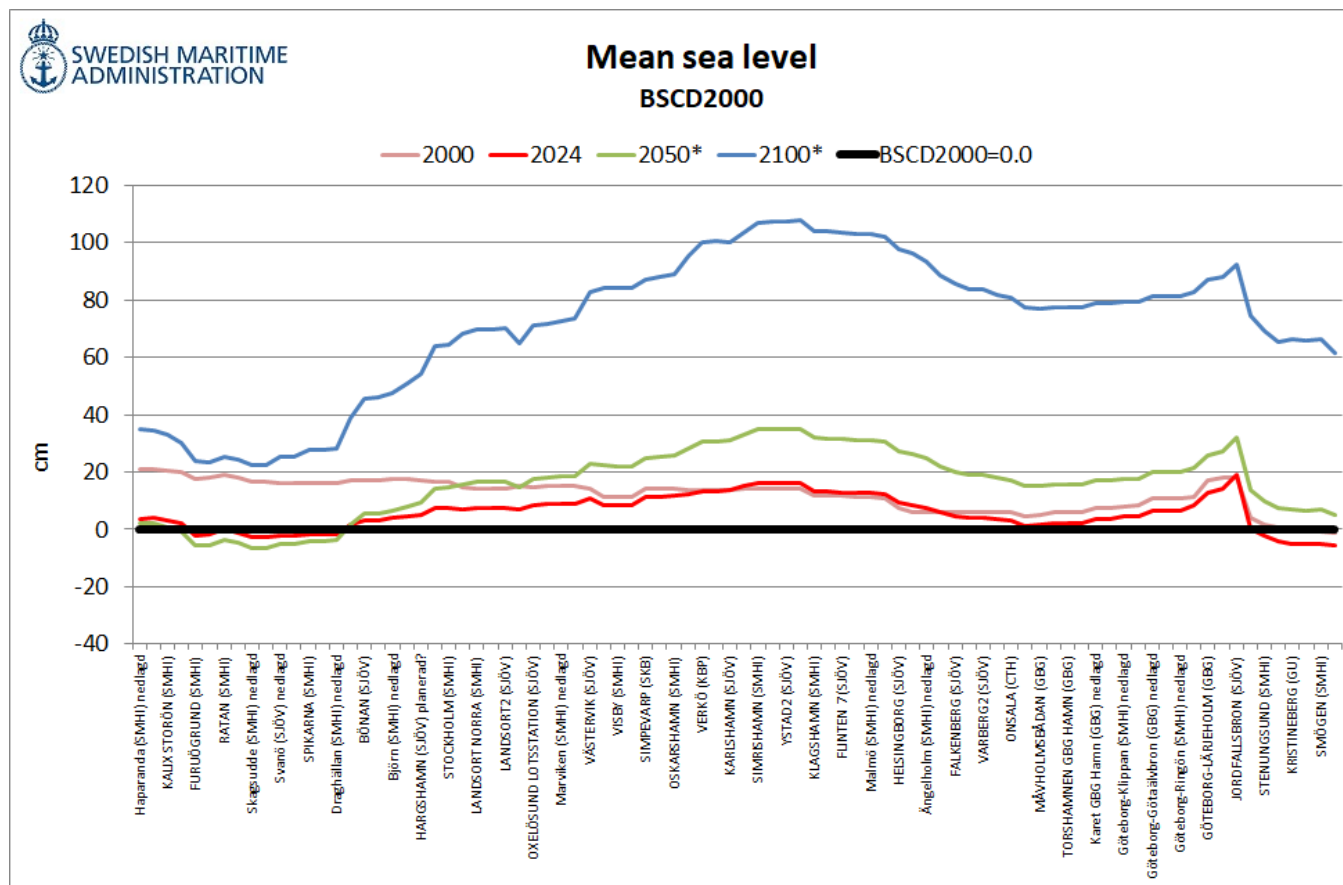
Observed sea level change in Stockholm since 1889

Sea level corrected for the levelled land-uplift (NKG2016LU\_lev)

The black line shows the gauss-filtered (smoothed) average



# Mean sea level



Calculated mean sea level relative BSCD2000 for the years 2000, 2024, 2050 and 2100.

\* including a predicted sea level rise +1 m over the period 2020-2100 ([SROCC](#)) and correction for the levelled land-uplift (NKG2016LU\_lev).

[Mean sea level relative BSCD2000](#)



# Future sea levels

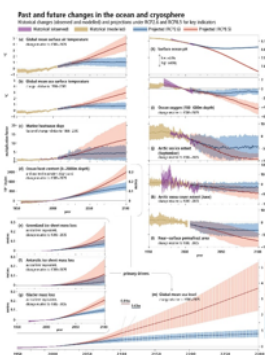
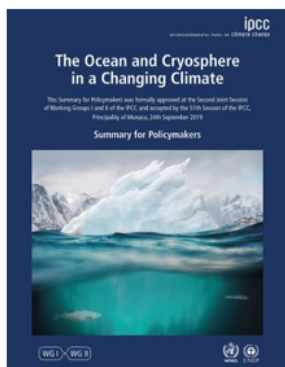


Thomas Hammarikint  
Hydrographic Office

PM

Published 2019-11-30  
Updated 2022-04-05

## Future sea levels in Sweden

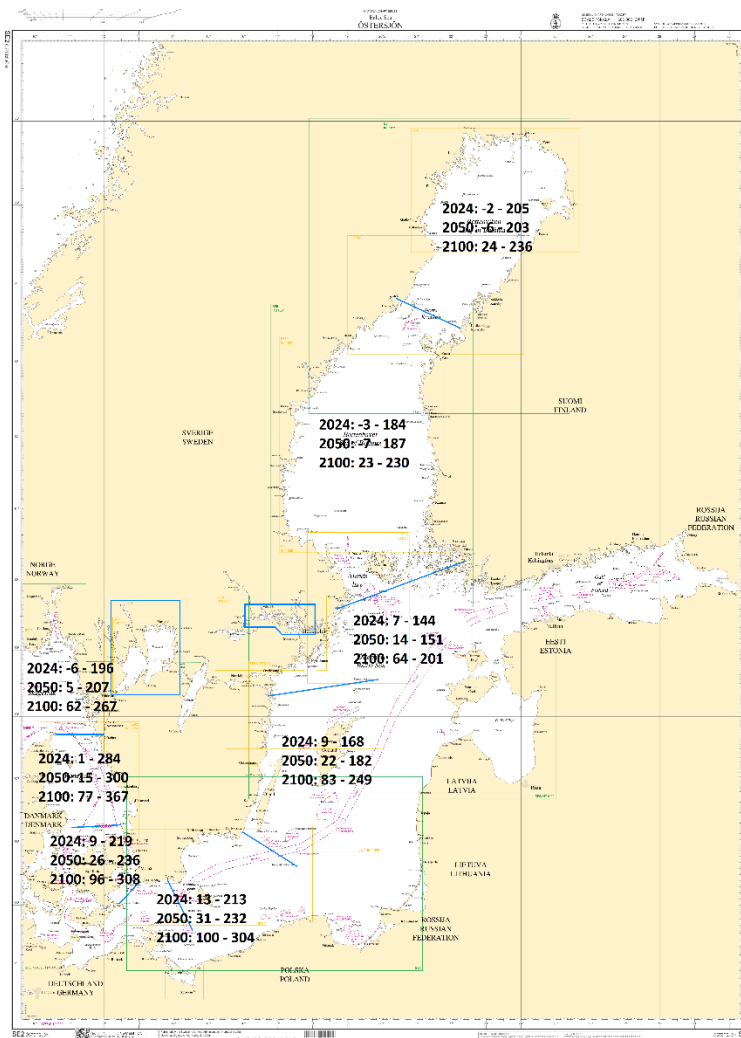


In September 2019, the Intergovernmental Panel on Climate Change (IPCC), published a new special report; Assessment Report 6 (AR6) - Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC), the recent predictions of the future sea level were presented. The Headline statements states: "Global Mean Sea Level (GMSL) is rising, with acceleration in recent decades due to increasing rates of ice loss from the Greenland and Antarctic ice sheets (*very high confidence*), as well as continued glacier mass loss and ocean thermal expansion".

## Summary

Calculations of [mean sea level](#), highest observed and estimated sea level for the years 2022, 2050 and 2100 have been conducted for 76 Swedish Sea Level stations (Figure 5, 6, 7 and Appendix Table 1). The results are based on analysis of historical observations of the sea level ([SMHI Open Data Service](#)) from 1886 to 2021, highest estimated sea level ([SMHI Climatology No 45](#)), data on the global sea level rise from the climate scenario RCP8.5 (likely scenario) in IPCC's special report (SROCC) and information about the leveled land-uplift from the Nordic Geodetic Commission (NKG) and the land-uplift model ([NKG2016LU](#)). All results are presented in Sweden's official land survey datum for depth, heights and sea level; Land Survey Datum 2000 (RH 2000). Estimated mean sea levels for the year 2100 are about 5-10 centimeters higher than the figures that Swedish Meteorological and Hydrological Institute (SMHI) previously presented per coastal municipality ([pdf](#)), which were based on data from the previous Assessment Report (AR5), published in 2014.

1 (10)





# Difference between old reference system and BSCD2000

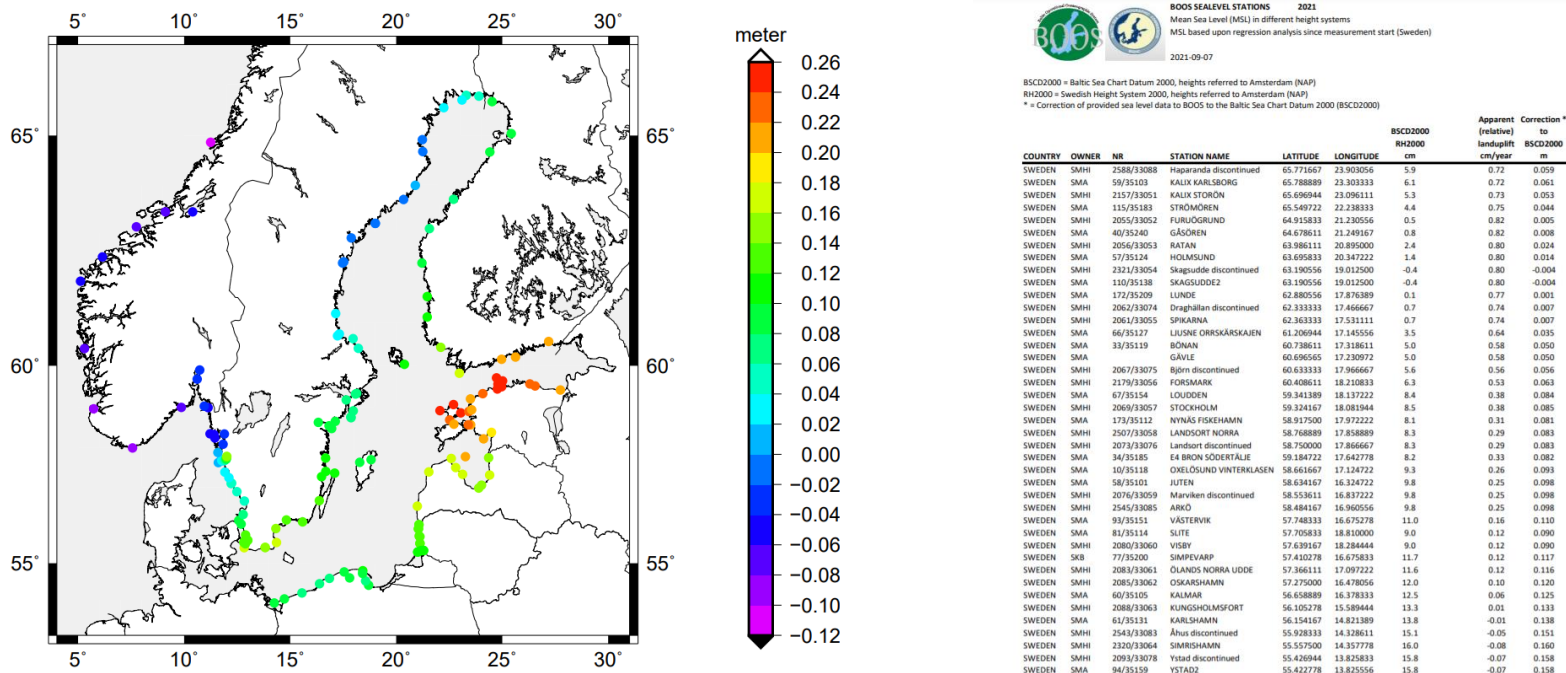
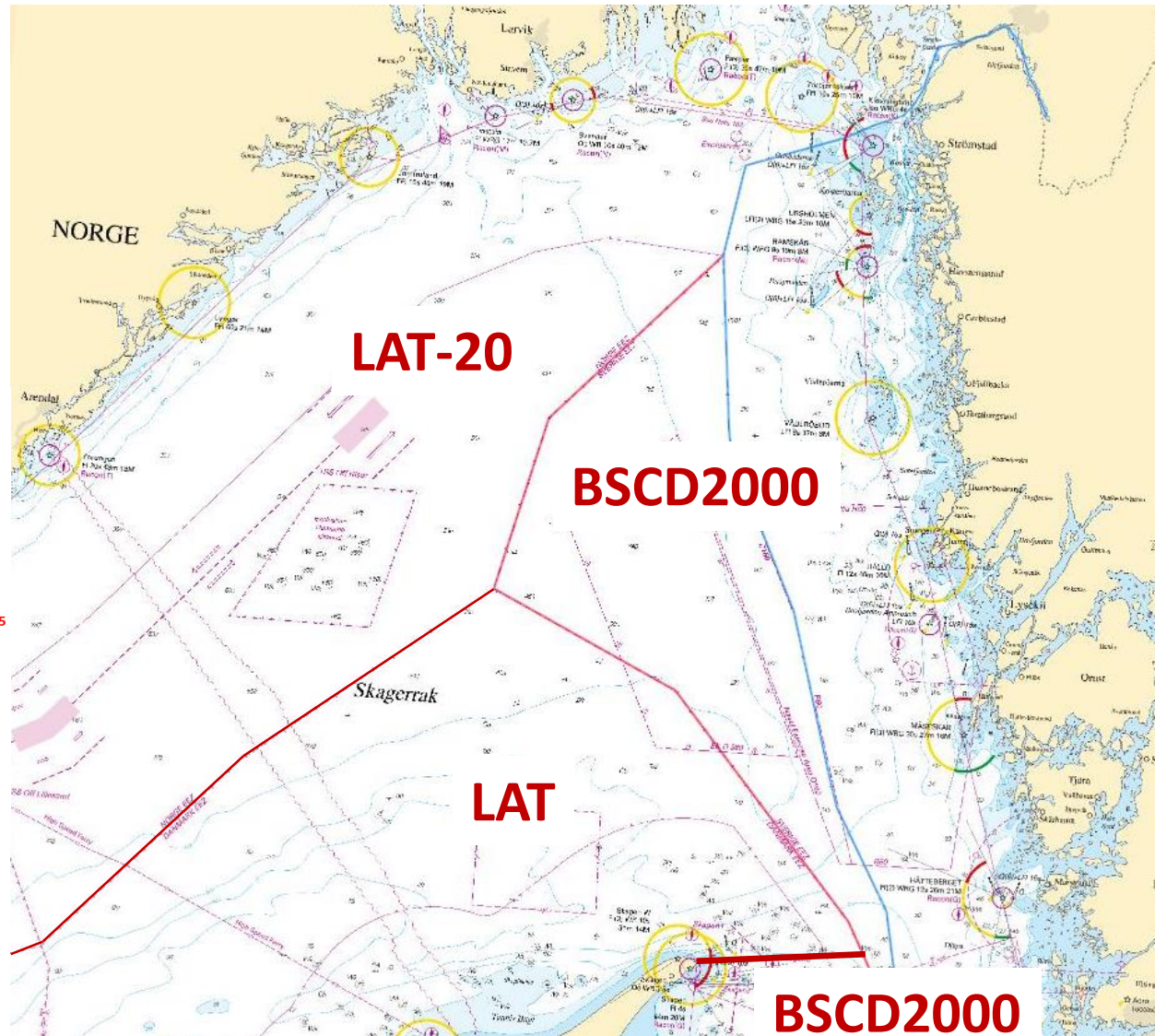
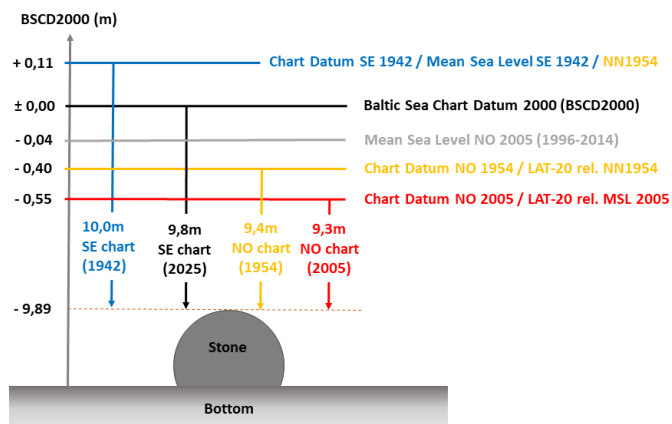


Fig. 4b: Differences between the reference levels of the old national chart datums with respect to Baltic Sea Chart Datum 2000 (BSCD2000). In Sweden and Finland, the old reference levels are equal to Mean Sea Level transferred to year 2023 (according to different national conventions). The values from Norway shows the Mean Sea Level over the period 1996-2014, relative BSCD2000. In Estonia, Latvia and Lithuania, the Kronstadt reference level is used as old chart datum. In Poland, the local Polish Height System Amsterdam NN<sub>55</sub> is used as chart datum. Notice how postglacial rebound reduces the magnitude of the mean sea level in the Bay of Bothnia. The values are shown in this [Table](#).

# Reference levels in Skagerack

- Norwegian reference datum (LAT-20) ca 50-60 cm below BSCD2000
- Danish LAT ca 30 cm below BSCD2000

Chart datum Skagerrak (Swedish-Norwegian border)






# New reference level in Sweden

SMA and SMHI presents sea level data relative BSCD2000 since 3rd June 2019



# SMHI oceanographic warning and forecasting service

- A transition to BSCD2000 (RH 2000) has been implemented at SMHI, where forecasts, warnings and current sea level are issued relative BSCD2000.
- A new impact-based and regional adapted warning system has also been introduced, which includes yellow, orange and red warning, where red is the most serious.

Högt vattenstånd   			
Varningsnivå	Gul	Orange	Röd
Område	cm i RH 2000		
<b>Grupp 1</b> (Västra Götalands län, Hallands län, Skåne län)	90	130	180
<b>Grupp 2</b> (Kalmar län, Östergötlands län, Gotlands län, Södermanlands län, Stockholms län)	80	110	-
<b>Grupp 3</b> (Blekinge län, Uppsala län, Gävleborgs län, Västernorrlands län)	90	130	-
<b>Grupp 4</b> (Västerbottens län, Norrbottens län)	100	150	-

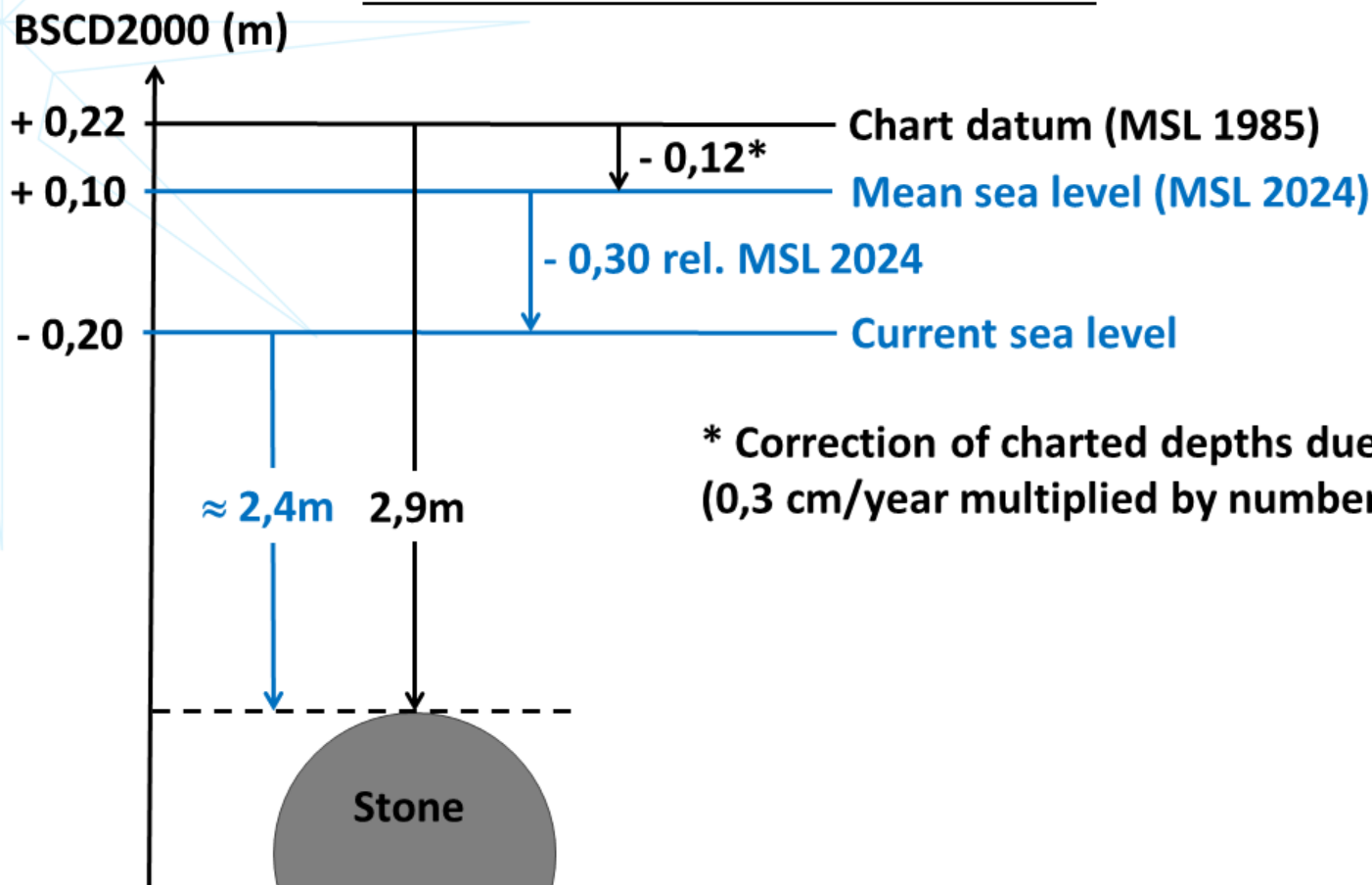
Lågt vattenstånd 	
Varningsnivå	Gul
Område	cm i RH 2000
Skagerrak, Kattegatt, Södra Östersjön, Mellersta Östersjön, Norra Östersjön, Ålands hav	-80
Sydvästra Östersjön, Öresund, Bälten	-50
Södra Bottenhavet, Norra Bottenhavet, Norra Kvarken, Bottenviken	-90



# Nautical charts with chart datum MSL

CHART DATUM: Mean Sea Level (MSL) 1985  
REFERENSNIVÅ: Medelvattenyta (MVY) 1985  
LAND UPLIFT/LANDHÖJNING 0.3 cm annually / per år  
SYMBOLS and ABBREVIATIONS: see INT 1  
BETECKNINGAR och FÖRKORTNINGAR: se KORT 1

## Nautical charts with chart datum MSL

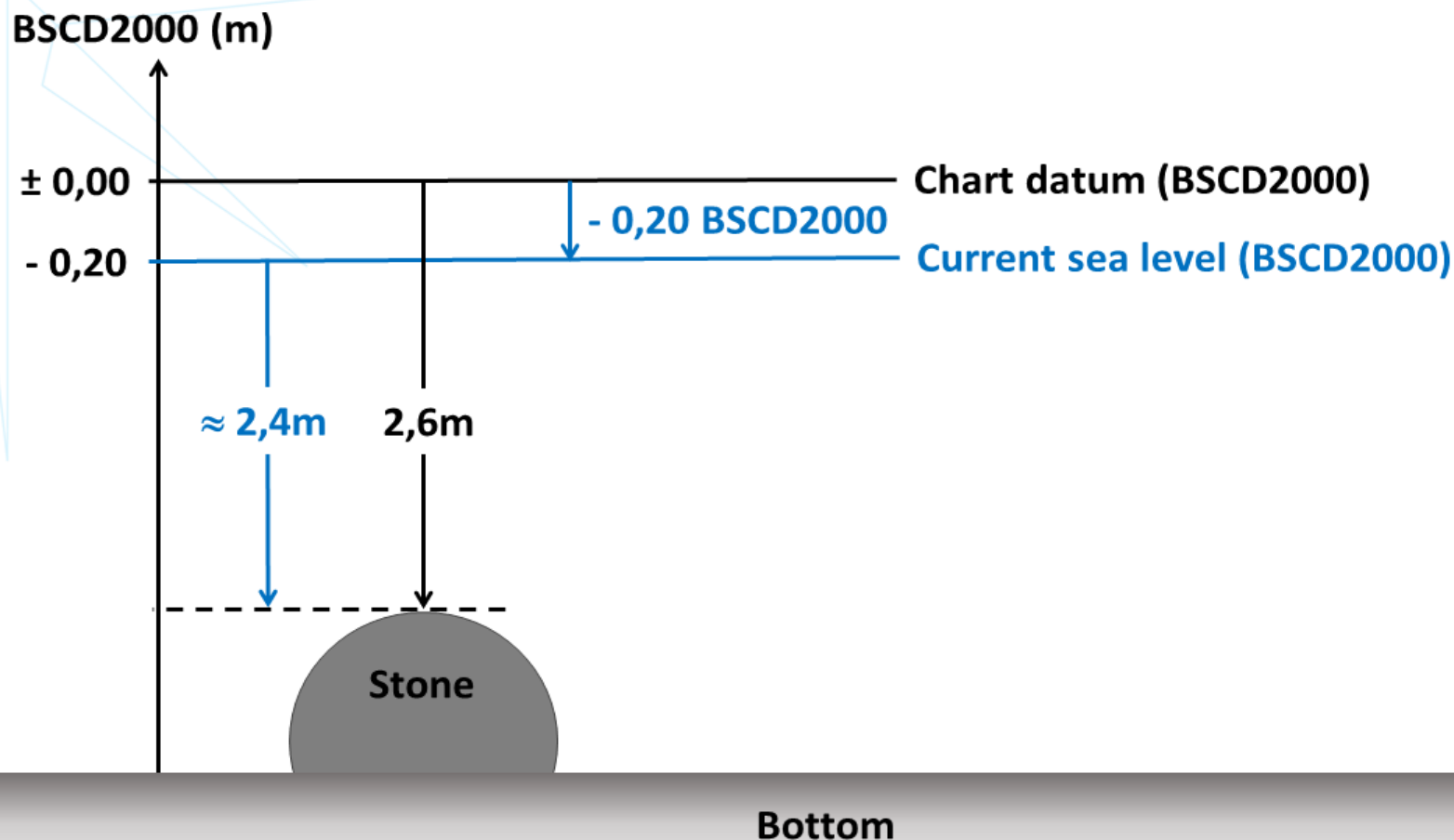


# Nautical charts with chart datum BSCD2000

CHART DATUM: Mean Sea Level (Baltic Sea Chart Datum 2000<sup>MSL2000</sup>)  
REFERENSNIVÅ: Medelvattenyta (Baltic Sea Chart Datum 2000<sup>MSL2000</sup>)  
SYMBOLS and ABBREVIATIONS: see INT 1  
BETECKNINGAR och FÖRKORTNINGAR: se KORT 1

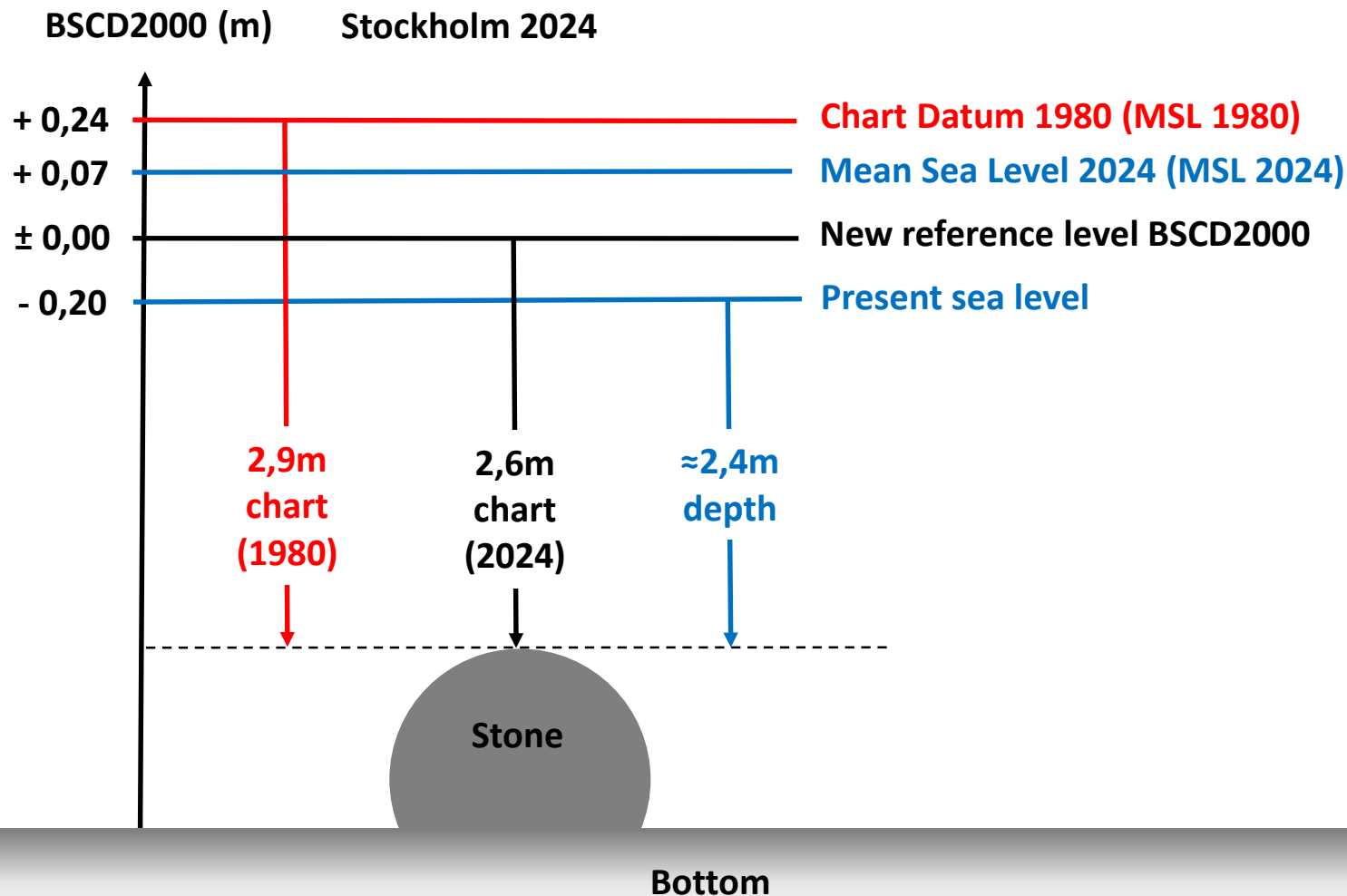


## Nautical charts with chart datum BSCD2000

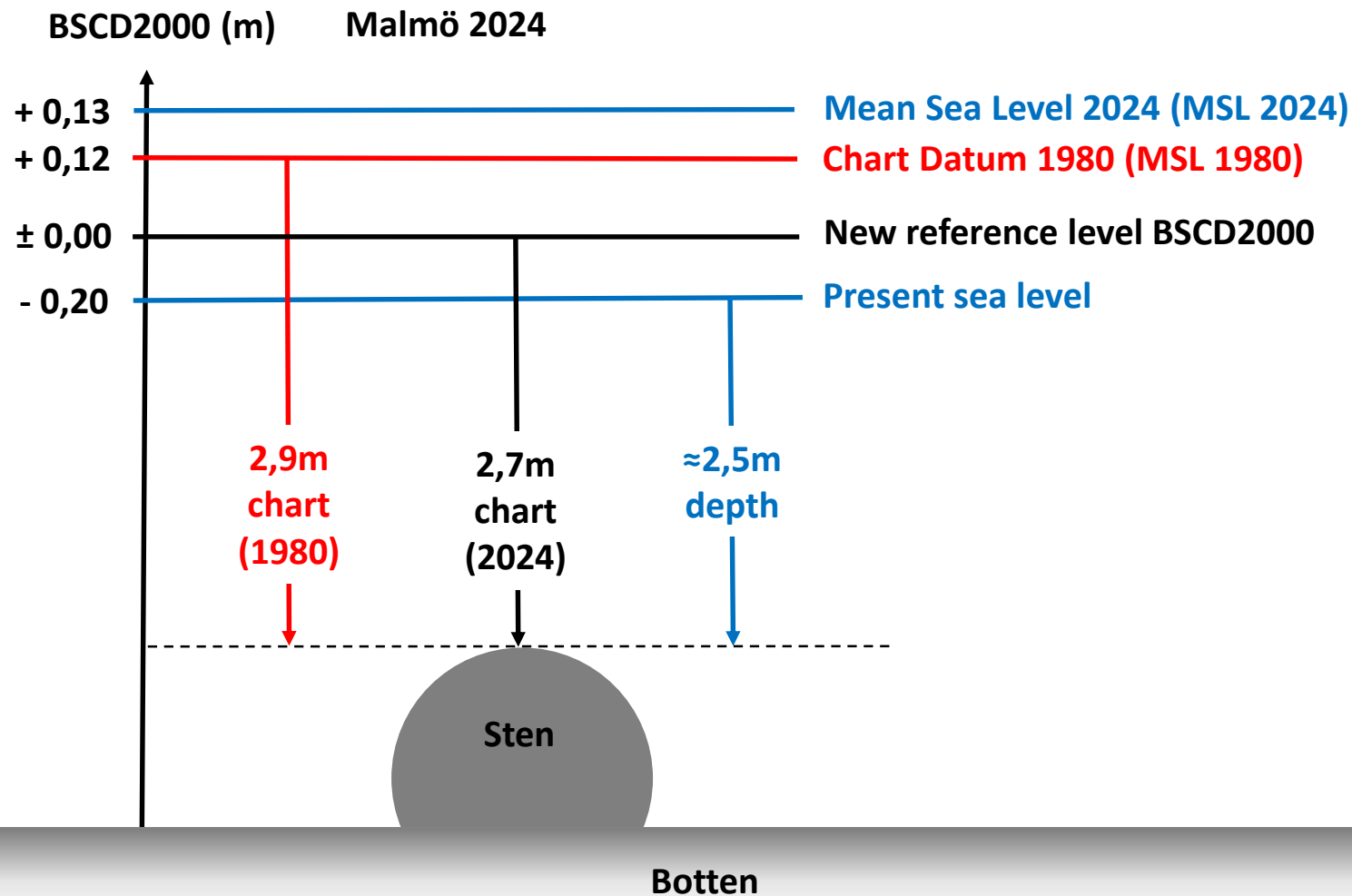




# Transition to RH 2000/BSCD2000 in charts and sea level



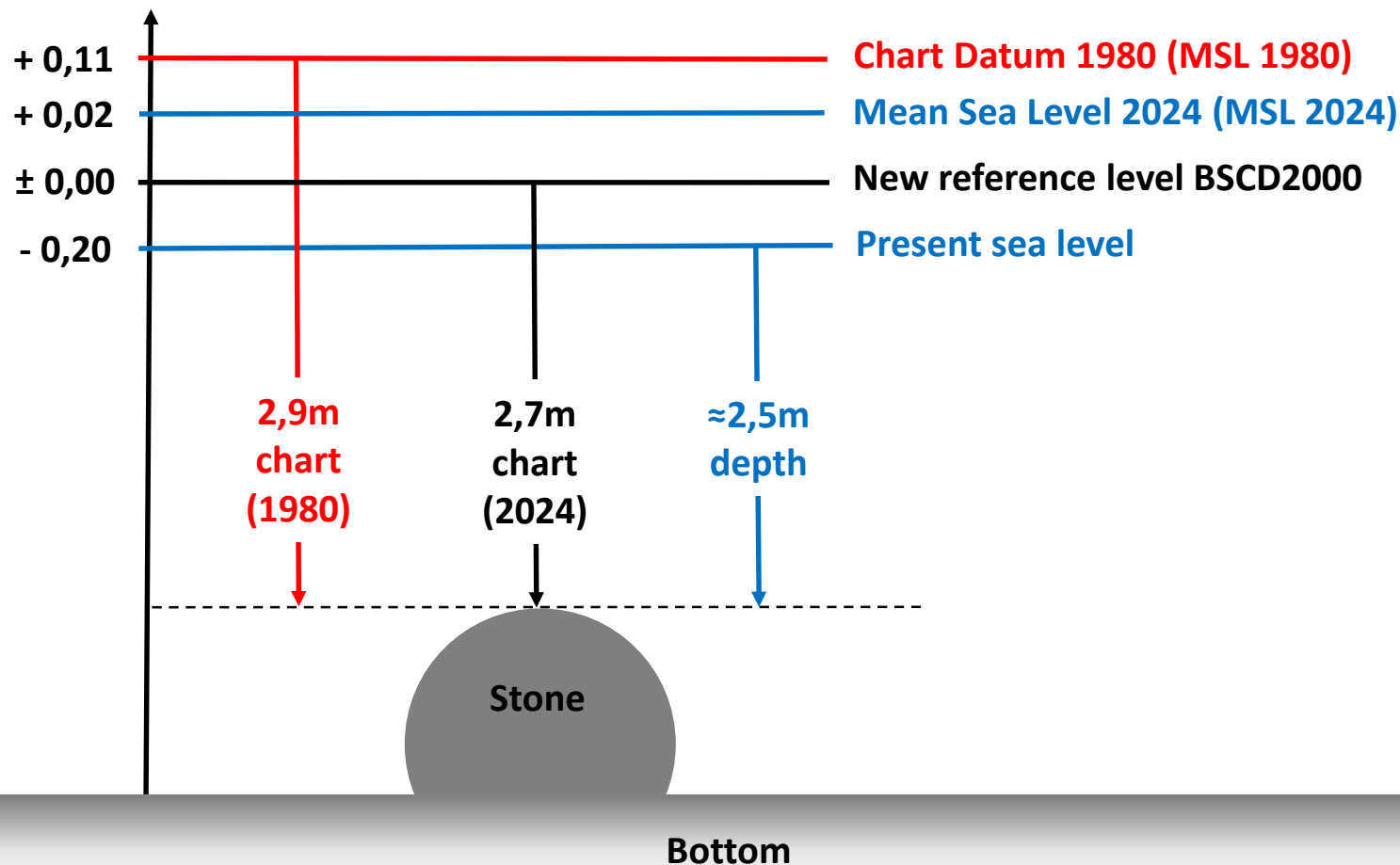
# Transition to RH 2000/BSCD2000 in charts and sea level



# Transition to RH 2000/BSCD2000 in charts and sea level

BSCD2000 (m)

Göteborg 2024



# Notices to Mariners (NtM)

\* 14040

**Sweden. not area bound. New reference system for sea level, nautical charts and warnings.  
BSCD2000 / RH 2000.**

Expired notices: 2019:754/13917

See: 2018:716/13140

As of June 3, 2019, the Swedish national height system 'Rikets Höjdsystem 2000', or RH 2000 (international name 'Baltic Sea Chart Datum 2000', BSCD2000) will constitute the reference level for observations and forecasts of the water level in Swedish waters.

The zero level in RH 2000 is fixedly linked to land, and is not affected by land uplift, changes in sea level or geographical variations.

The change means that observations, forecasts, and warnings in the Swedish Maritime Administration's and Swedish Meteorological and Hydrological Institute's (SMHI) viewing services from 3 June 2019, or soon thereafter, refer to the new reference level and no longer to the 'mean sea level'.

The Swedish Maritime Administration is gradually adapting the charts to the new reference system. This is a time consuming process which will take several years to complete. During the transition period, it is important to know which reference level is used in the different charts. If the text 'Baltic Sea Chart Datum 2000', or 'BSCD2000' is printed in the chart, the update has been performed.

More information: [www.sjofartsverket.se/RH2000](http://www.sjofartsverket.se/RH2000) and [www.smhi.se](http://www.smhi.se)

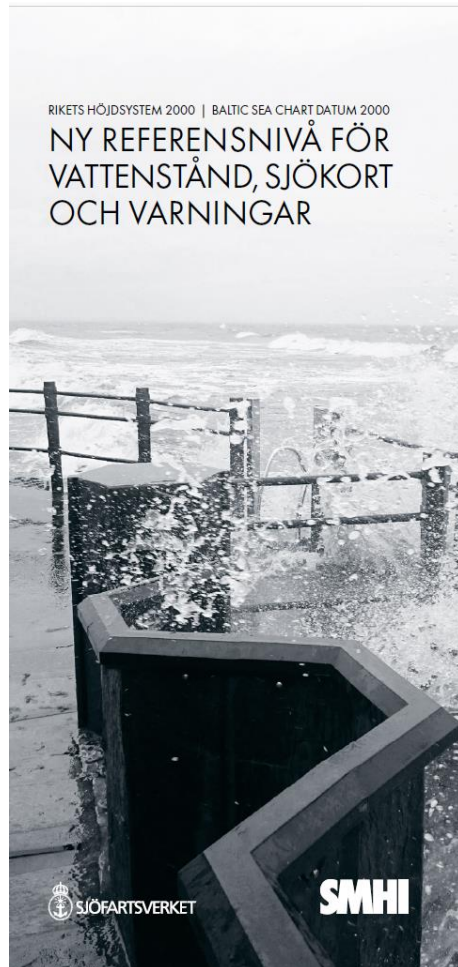
[www.sjofartsverket.se/RH2000](http://www.sjofartsverket.se/RH2000) [www.smhi.se](http://www.smhi.se)

*SMHI och Sjöfartsverket. Publ. 15 May 2019*



# New info sheets about the transition to BSCD2000 as the new reference level for sea level, nautical charts and warnings

## Svensk



## English





# A uniform reference system from land to sea

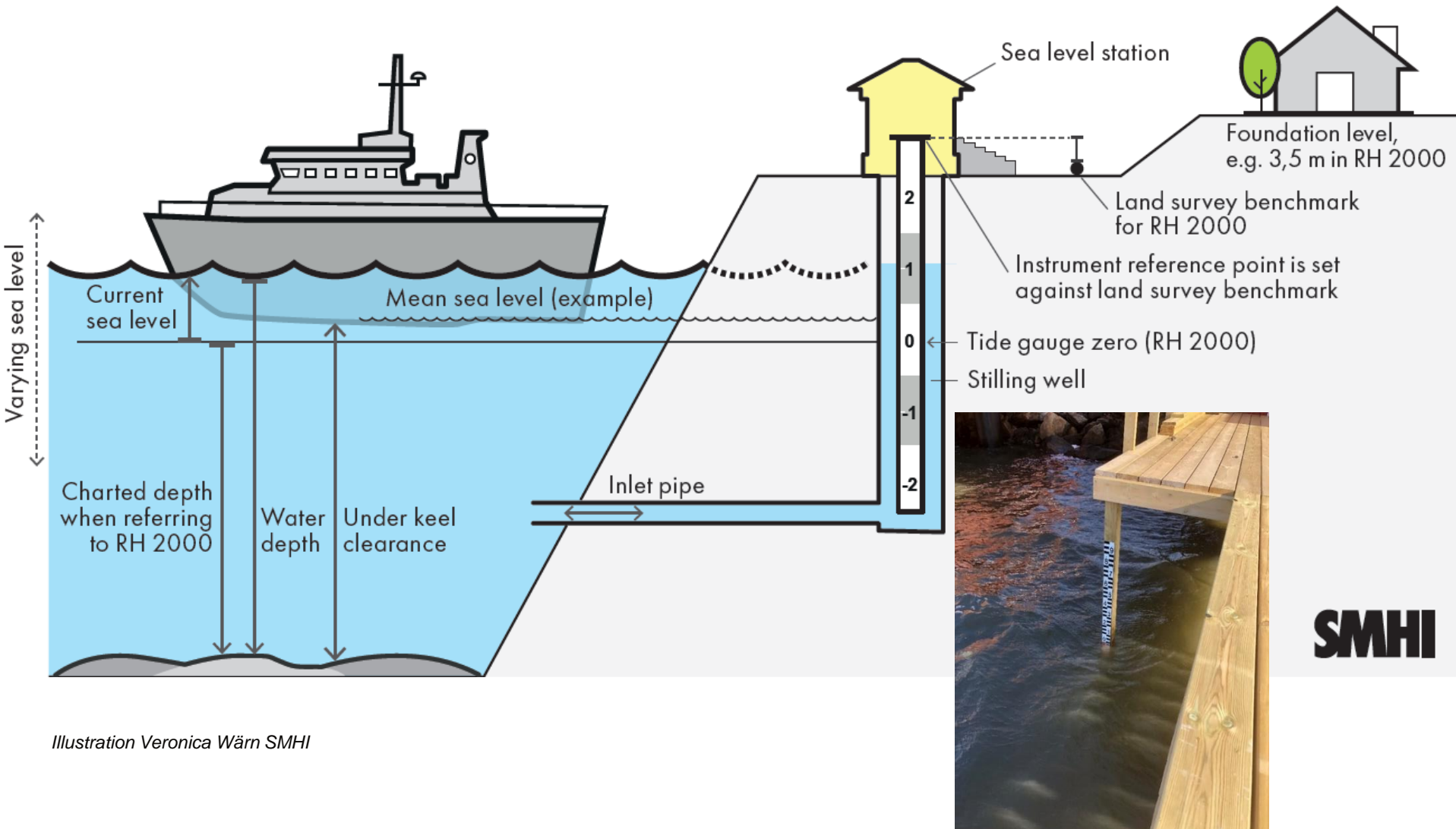
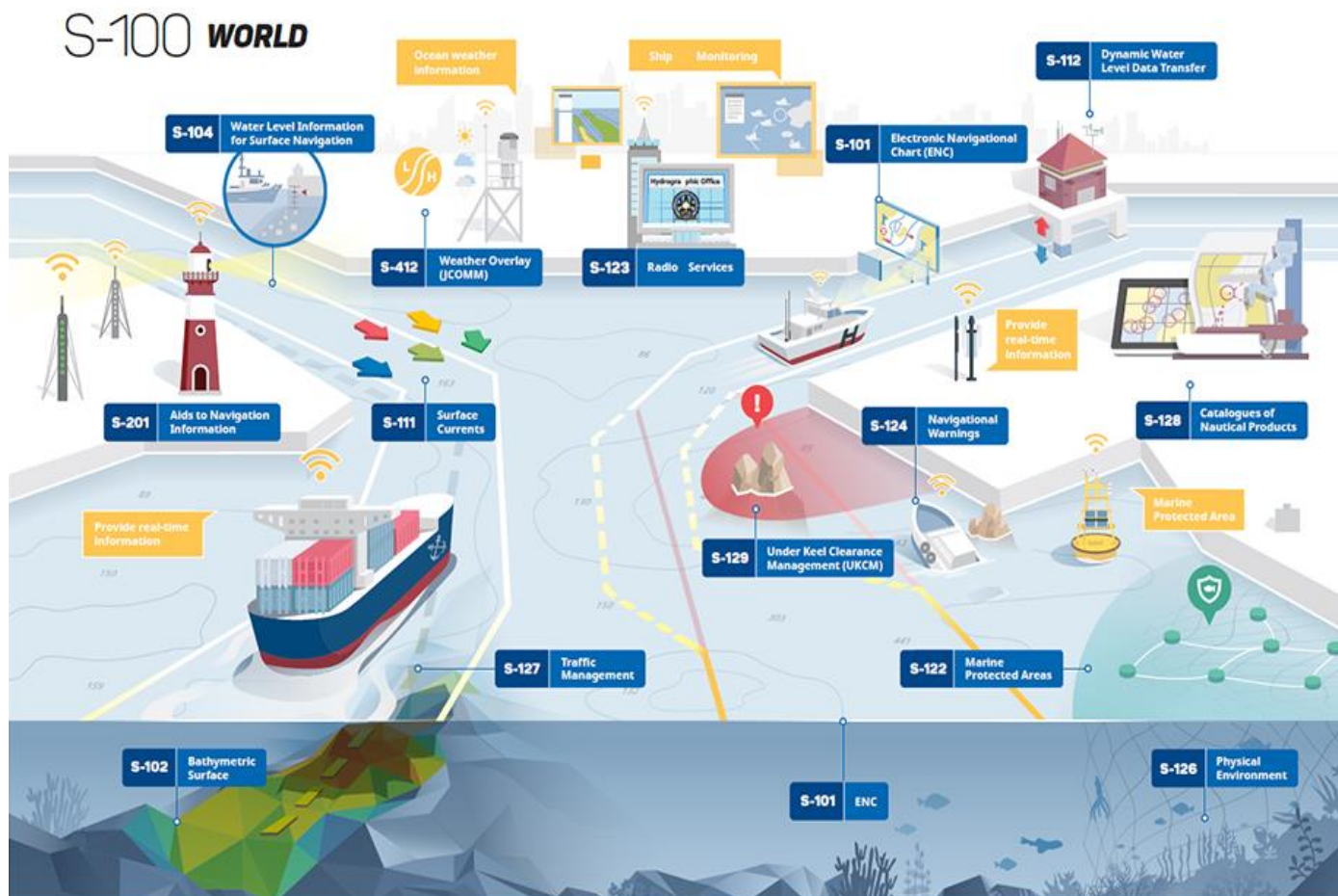


Illustration Veronica Wärm SMHI

# Future Maritime Services S-100



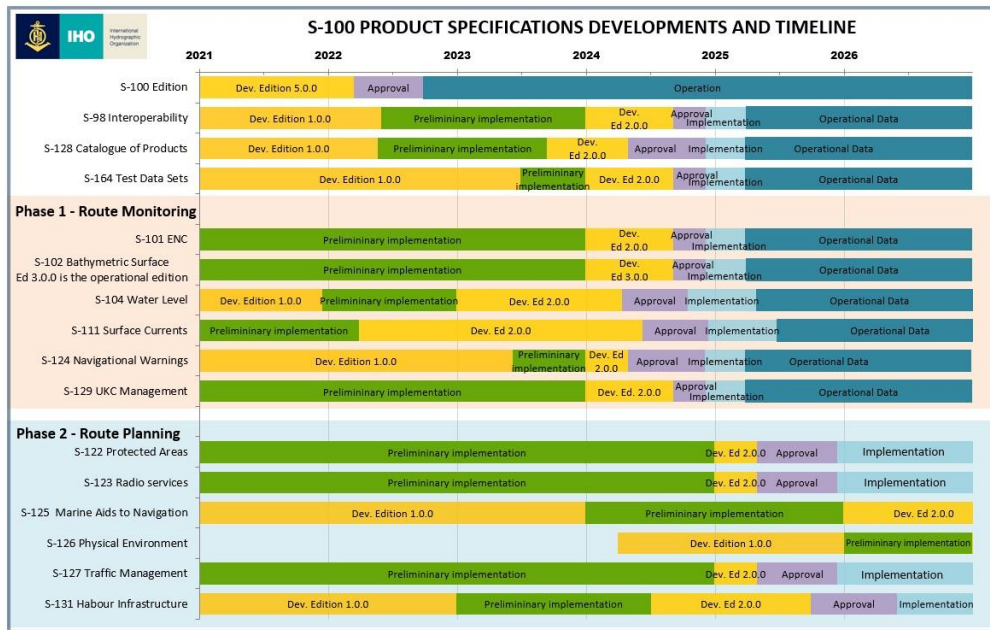
IHO



# IHO S-100 Implementation

## IHO S-100 Implementation Strategy

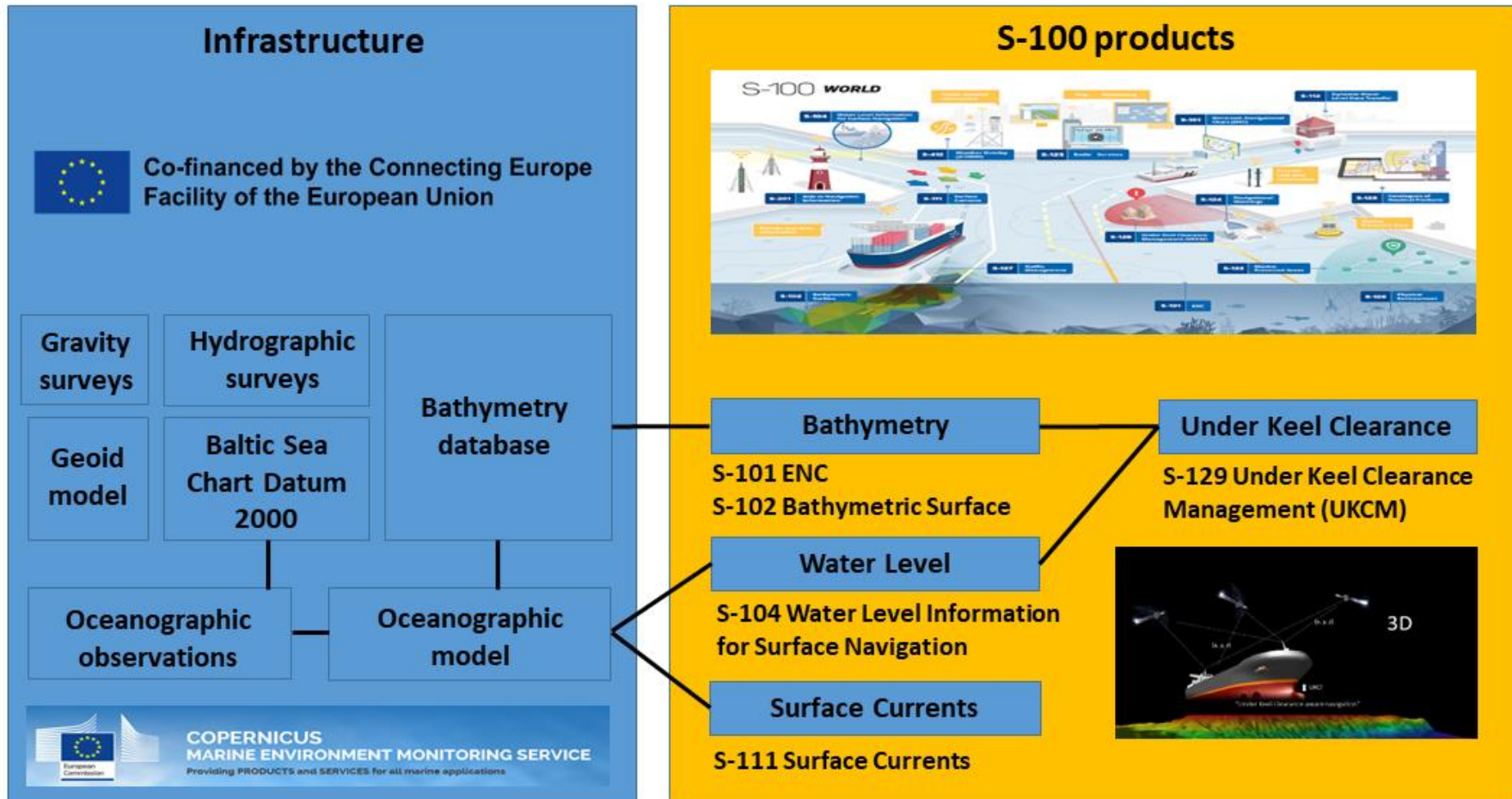
Table A – IHO list of S-100 products with special focus	
First step – Route monitoring mode	
<b>S-101</b>	Electronic Navigational Chart (ENC)
<b>S-102</b>	Bathymetric Surface
<b>S-104</b>	Water Level Information for Surface Navigation
<b>S-111</b>	Surface Currents
<b>S-124</b>	Navigational Warnings
<b>S-129</b>	Under Keel Clearance Management
Critical Framework	
	IHO Geospatial Information Registry
<b>S-98</b>	Interoperability Specification
<b>S-100</b>	Universal Hydrographic Data Model
<b>S-128</b>	Catalogue of Nautical Products
<b>S-164</b>	Test Data Set for S-100 and ECDIS Type Approval
Second step – Route planning mode	
<b>S-122</b>	Marine Protected Areas
<b>S-123</b>	Marine Radio Services
<b>S-125</b>	Marine Aids to Navigational (AtoN)
<b>S-126</b>	Marine Physical Environment
<b>S-127</b>	Marine Traffic Management
<b>S-131</b>	Marine Harbour Infrastructure



This S-100 timeline is updated: July 9th, 2023.

# Dynamic S-100 products (S-104, S-111 and S-129)

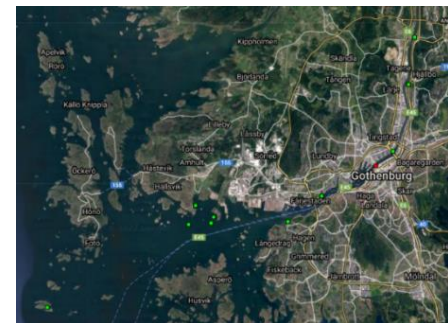
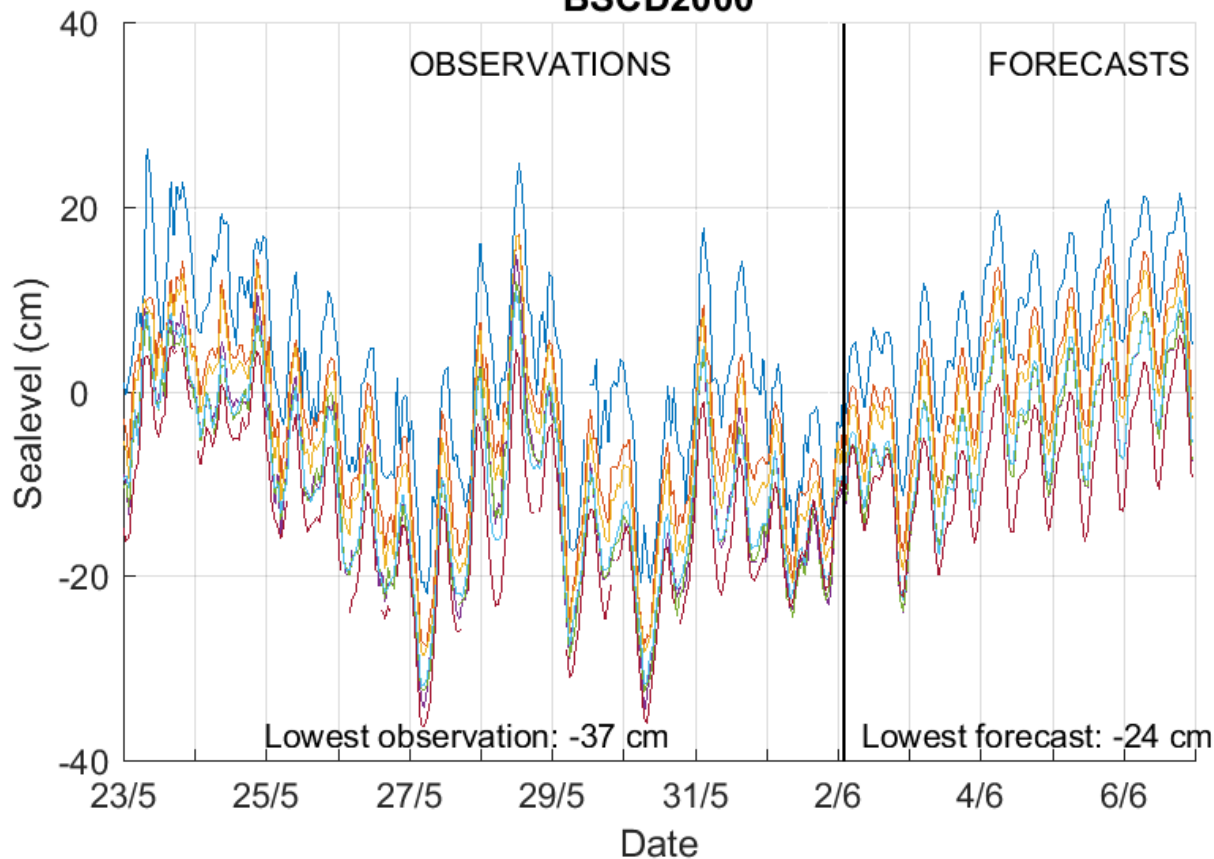
## Real Time Hydrographic and Environmental Information Service





# Sealevels Göteborg (potential S-104 product)

**Sealevels Göteborg**  
**2023-05-23 to 2023-06-06**  
**Issued: 2023-06-02 02:00 UTC**  
**BSCD2000**





The map displays the Åkersberg area, including the proposed railway line (Stall i tid och datum) in blue. Key locations marked include Åkersberg, Åkersbergsjön, Åkersjön, and Åkersberg. The map also shows existing infrastructure like roads and railways. The map is overlaid with a grid of latitude and longitude coordinates.





# Future Navigation



# Thanks!



Thomas Hammarklint

Swedish Maritime Administration (SMA)

[Thomas.Hammarklint@sjofartsverket.se](mailto:Thomas.Hammarklint@sjofartsverket.se)