



**BALTIC SEA  
HYDROGRAPHIC  
COMMISSION**



**IHO**

# **Baltic Sea Chart Datum 2000 and dynamic S-100 products**

**BOOS Scientific Workshop**

**10 May 2023 Helsinki, Finland**

**Thomas Hammarklint**



# Baltic Sea Hydrographic Commission (BSHC)



## BALTIC SEA HYDROGRAPHIC COMMISSION



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### 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](#)

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# Chart Datum Working Group (CDWG)



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## Chart Datum Working Group (CDWG)

“To implement a common reference level in the Baltic Sea”



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

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

### Members of CDWG:

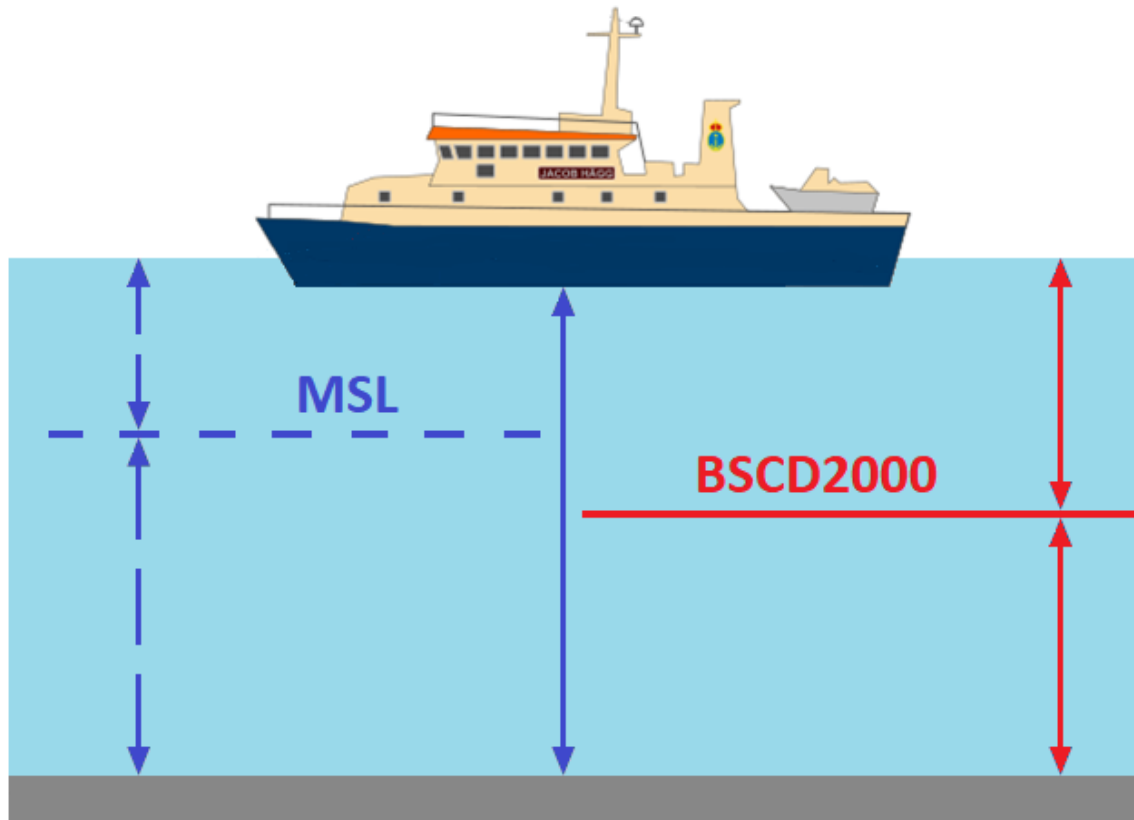
Denmark Mr Nikolaj Møller  
Estonia Mrs Gabriela Kotsulim  
Finland Mr Jarmo Mäkinen  
Germany Dr Patrick Westfeld  
Latvia Mr Bruno Špēls  
Lithuania Mr Mindaugas Zakarauskas  
Poland Mr Witold Stasiak  
Russia Mr Leonid Shalnov  
Russia Dr Sergey V. Reshetniak  
Sweden Mr Thomas Hammarklint (Chair)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

### Observers and Experts:

Estonia Prof. Artu Ellmann  
Estonia Mr 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  
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)

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



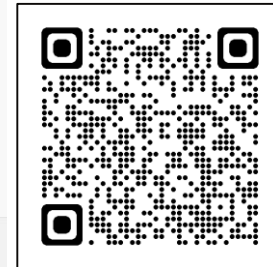
# Baltic Sea Chart Datum 2000 in IHO Registry

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

The screenshot displays the IHO Geospatial Information Registry Data Dictionary Register. The page title is "Data Dictionary Register". The navigation menu on the left includes: HOME, HELP&GUIDANCE, GI REGISTERS, PROPOSAL, TEST BED, Open Online Platform, and 2nd GI Registry(Old). The main content area shows a search filter with the following counts: Feature Type (366), Information Type (26), Attribute Type (667), Complex Type (92), Enumeration Value (2273), and Codelist Value (117). The search criteria are: Domain: ALL, Status: Valid, Type: ALL, Category: Name. The search results show a table with the following details:

[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	<table border="1"><thead><tr><th>Attribute type</th><th>Name</th></tr></thead><tbody><tr><td>Enumerated type</td><td><a href="#">Vertical Datum</a></td></tr></tbody></table>	Attribute type	Name	Enumerated type	<a href="#">Vertical Datum</a>
Attribute type	Name				
Enumerated type	<a href="#">Vertical Datum</a>				
Reference					
Reference Source	Baltic Sea Hydrographic Commission				

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KHOA Acknowledgements



# International Hydrographic Review Article

An article about the CDWG 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. Agren<sup>1</sup>, G. Liedsch<sup>1</sup>, P. Westhof<sup>1</sup>, T. Hammarik<sup>2</sup>, J. Mononen<sup>3</sup> and O. S. 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 Normal Amsterdam 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 Normal Amsterdam Peil (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.

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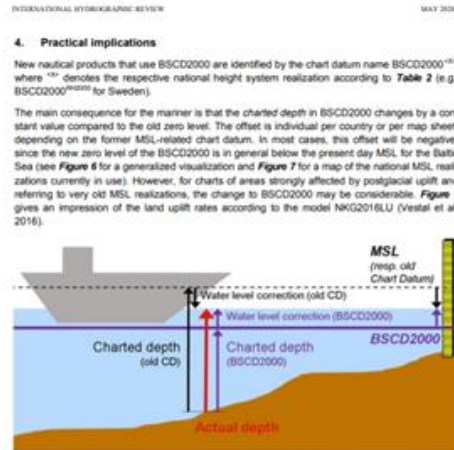


Figure 6: Schematic cartoon of the old MSL-based chart datum and the new BSCD2000

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 mareographs 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

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INTERNATIONAL HYDROGRAPHIC REVIEW MAY 2020

adopt BSCD2000 as the name of their chart datum without having to actually change their charted depths. Therefore, this section only gives an overview about the general situation in the respective countries. Table 2 summarizes the national geodetic reference frames, positioning services and HRS realizations that can be used with BSCD2000. Regularly updated details about the implementation status as well as instructions for users, e.g. leaflets, are provided via the CDWG website (<http://www.bahc.pro/working-groups/cdwg>).

In Sweden and Finland, a calculated MSL has been used as reference level (chart datum) for nautical charts and water level information. The reference level for regularly updated epochs (estimated present-day MSL) was estimated from long time series of annual mean values of mareograph observations. Depths from printed charts needed to be converted semi-automatically by means of a correction formula in order to correct for the time difference and to make the charted depth compatible with the provided water level information. As motivated in Section 2, this two-step approach implied a lot of work to keep the nautical products updated and consistent. At the same time, it was not straightforward and error-prone for the mariner.

Thus, decisions to make a transition to BSCD2000 in Sweden and Finland have come a long way. In Sweden, both water level information and 50% of all nautical charts are now using BSCD2000. In Finland, part of the bathymetric and chart data have already been transformed to BSCD2000. Water level information is ready to be provided in BSCD2000 when first charts will be published in the new datum. Figure 7 details the estimated height of the current calculated MSL relative to BSCD2000 for selected mareographs in Sweden and Finland.

Figure 7: Differences between the reference levels of the old national chart datums with respect to Baltic Sea Chart Datum (BSCD2000): in Sweden and Finland, the old reference levels are equal to the calculated MSL in the year 2020 (according to different national conventions). The values from Norway show the MSL over the period 1996-2014, relative BSCD2000<sup>100NOR</sup>. In Estonia, Latvia and Lithuania, the Kronstadt reference level is used as old chart datum. In Poland, the local Polish Height System Amsterdam Alpha is used as chart datum. Notice how postglacial rebound reduces the magnitude of the calculated MSL, relative BSCD2000 in the Bay of Botnie; it is now just a few cm above to the location of maximum uplift. The values are taken from BOOS (2020).

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# Swedish Chart Improvement project



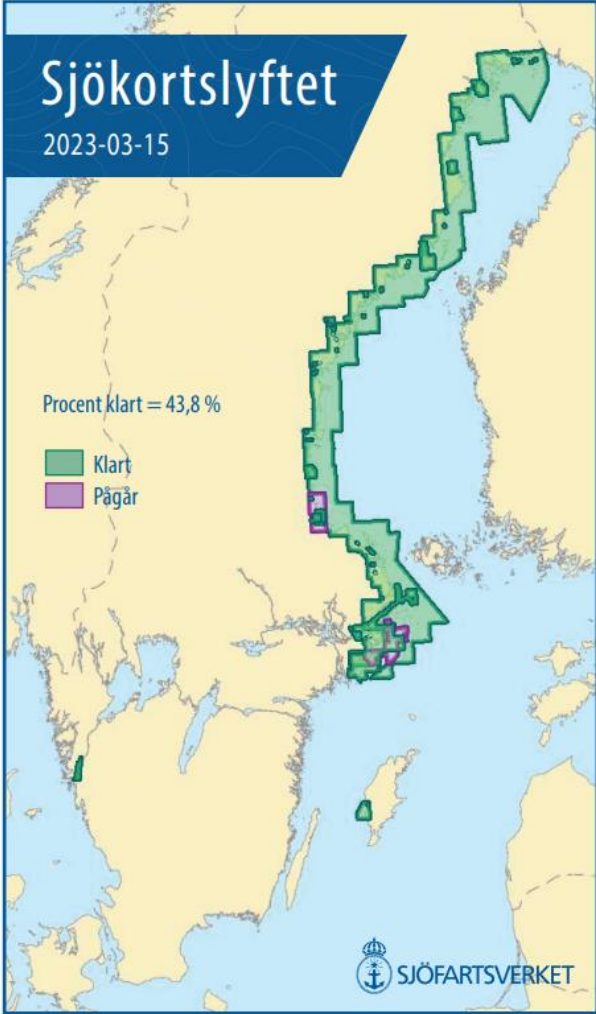
CHART DATUM: Mean Sea Level (Baltic Sea Chart Datum 2000<sup>RH2000</sup>)  
REFERENSNIVÅ: Medelvattenyta (Baltic Sea Chart Datum 2000<sup>RH2000</sup>)  
SYMBOLS and ABBREVIATIONS: see INT 1  
BETECKNINGAR och FÖRKORTNINGAR: se KORT 1

Referensnivå





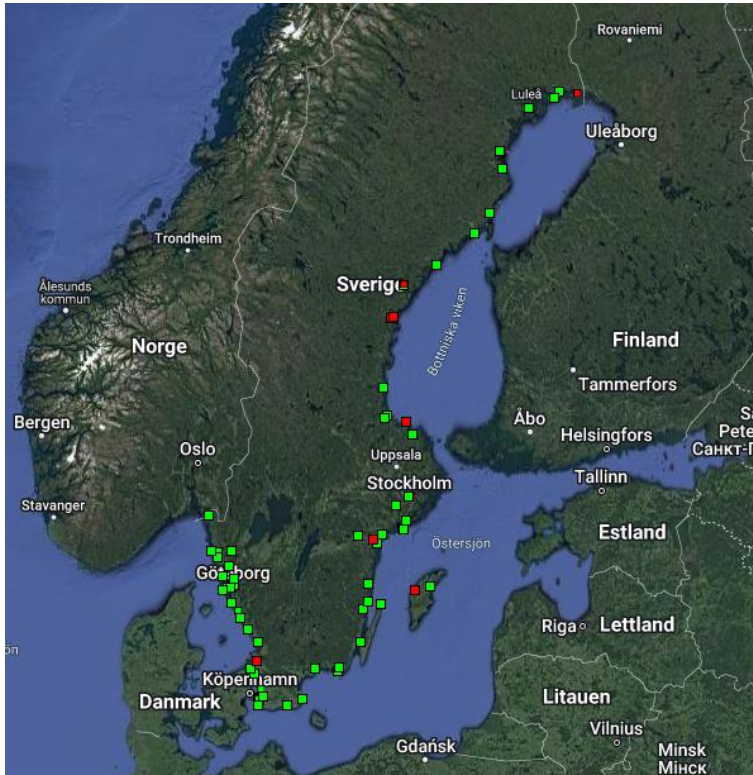
# Status transition from MSL to BSCD2000 in nautical charts



Updated 2023-03-15



# 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)

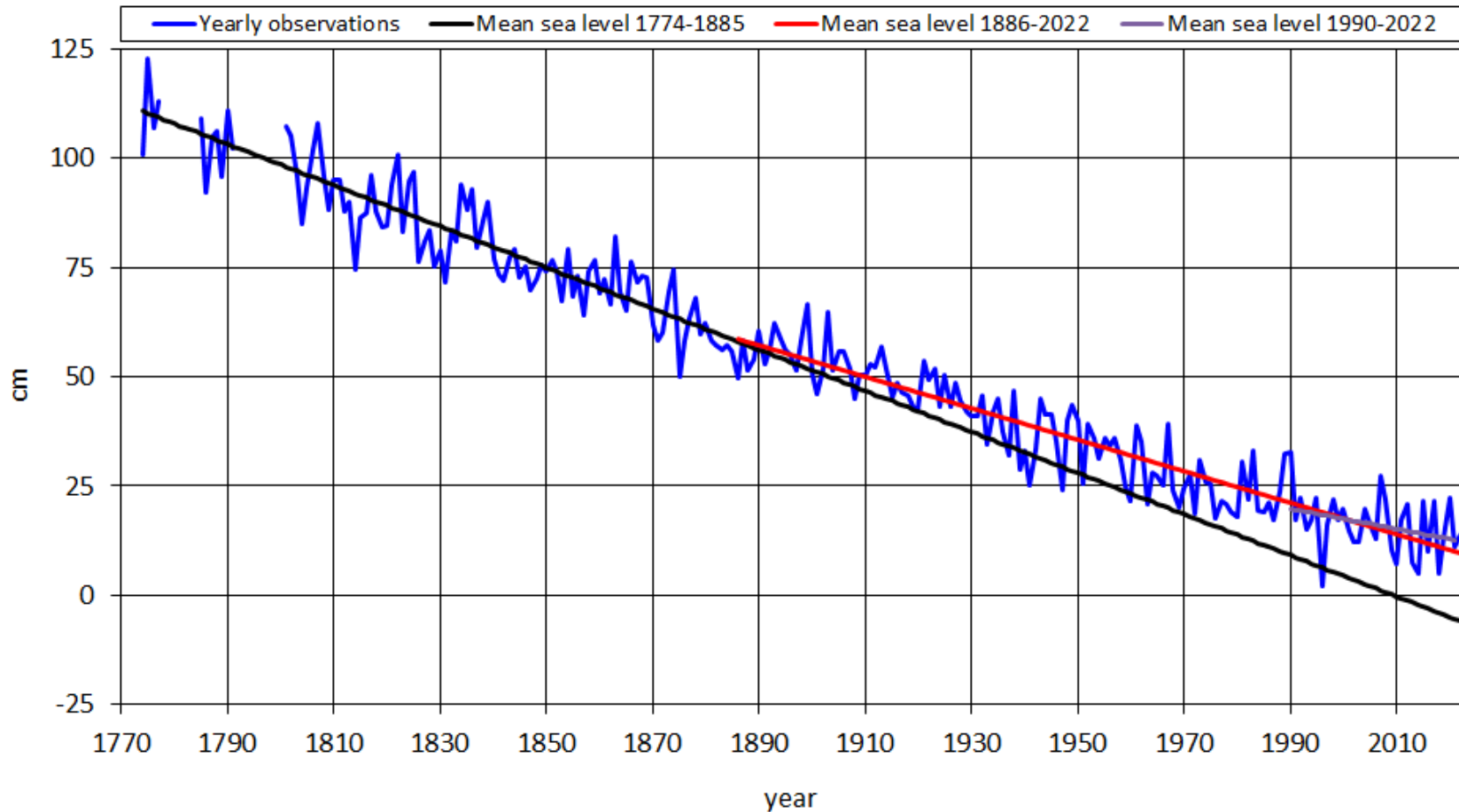
Present water level information are shown in Wind- and Water Information ([ViVa](#))

# Stockholm

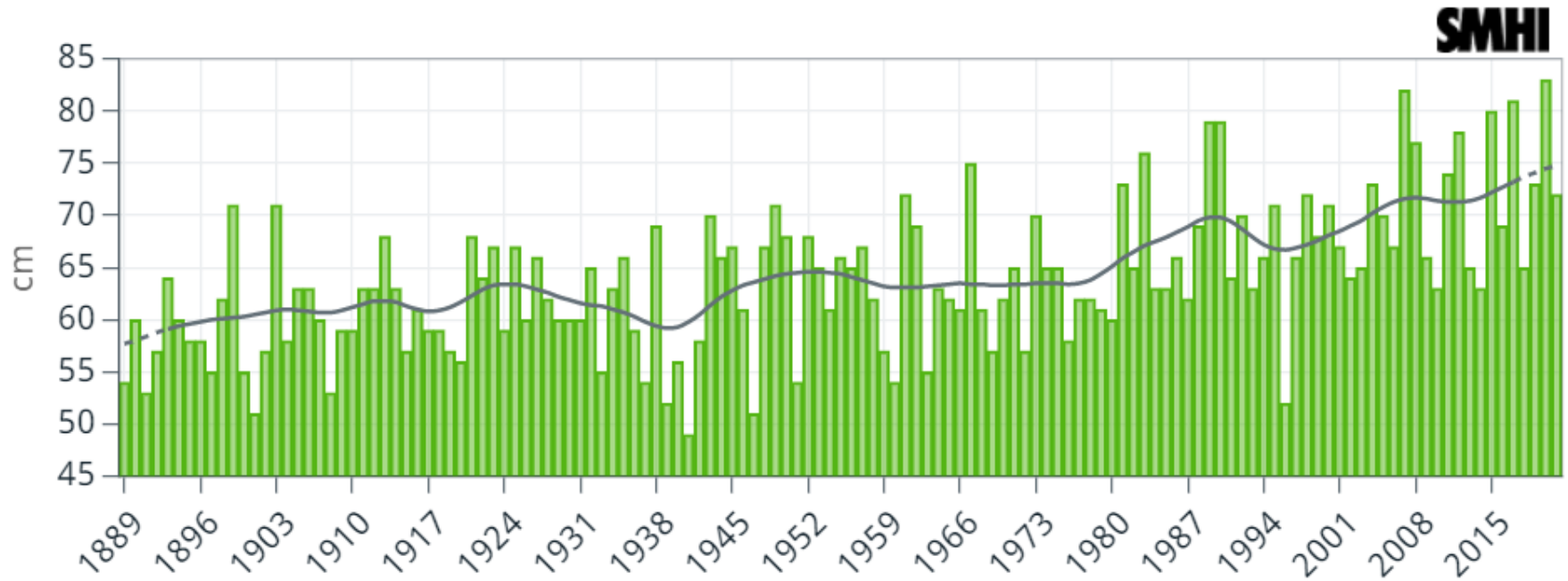
## “World’s longest sealevel record”

### Sealevel Stockholm 1774 - 2022

BSCD2000



# The sea level rise raises the mean sea level



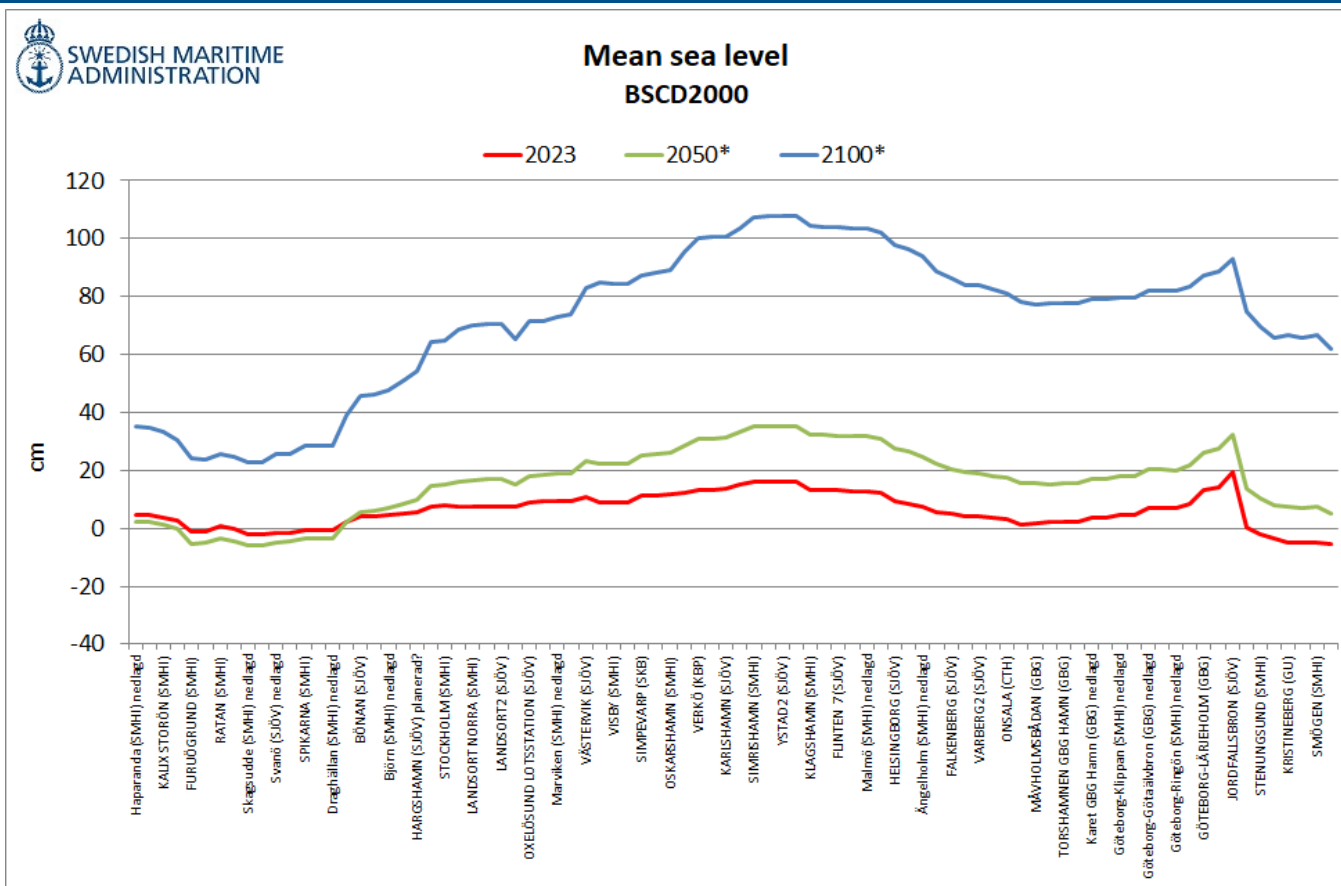
Observed sea level change in Stockholm since 1889

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

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



# Changing mean sea level



Calculated mean sea level for the years 2023, 2050 and 2100. \* incl. a predicted sea level rise, +1 m over the years 2020-2100 (IPCC 8,5) and correction for the leveled land-uplift.

[Mean sea level relative BSCD2000](#)



# Difference between old reference system and BSCD2000

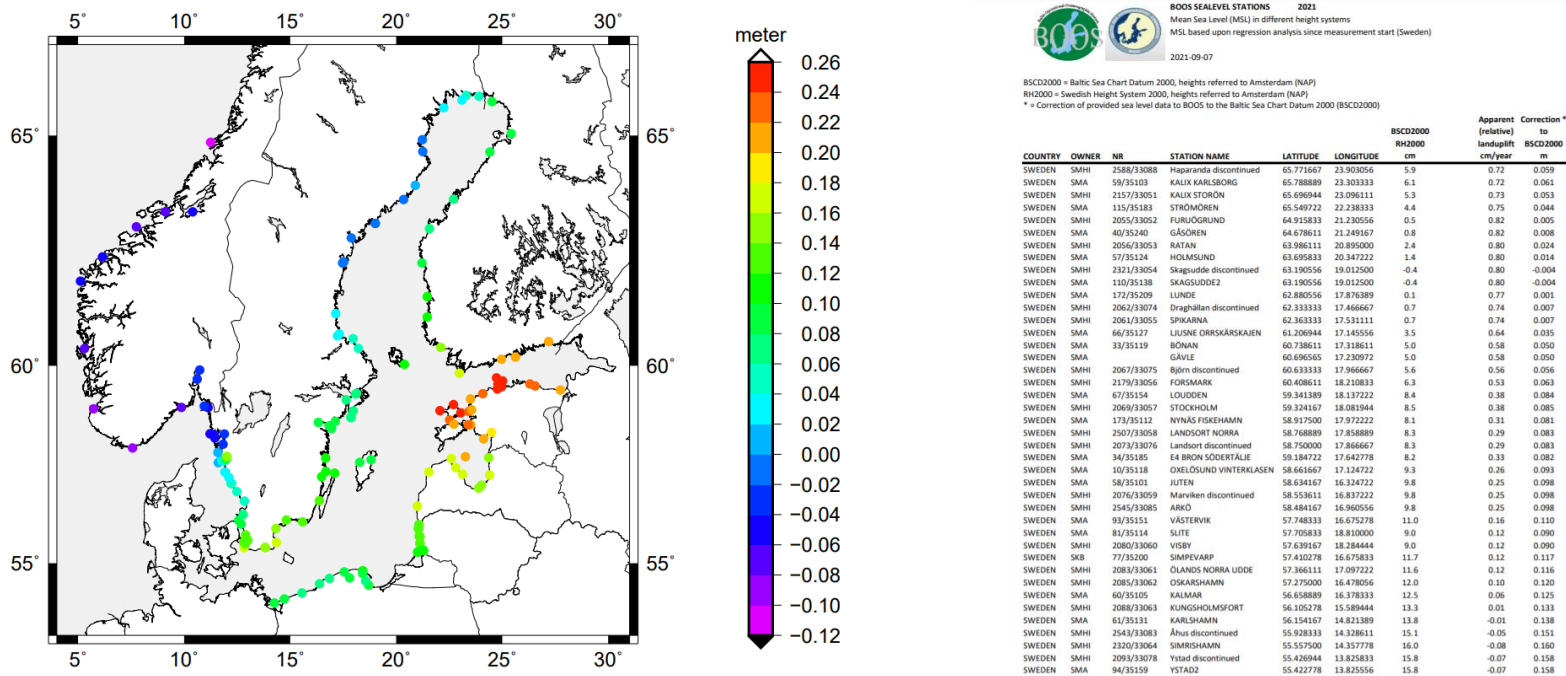
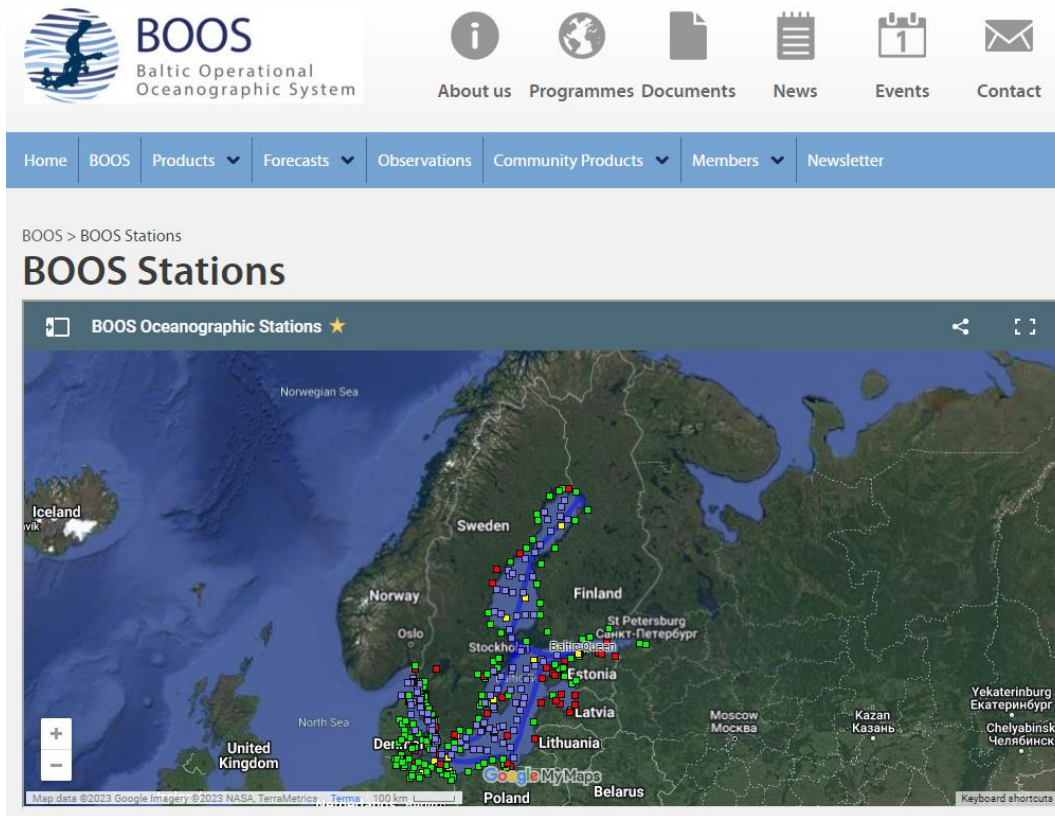


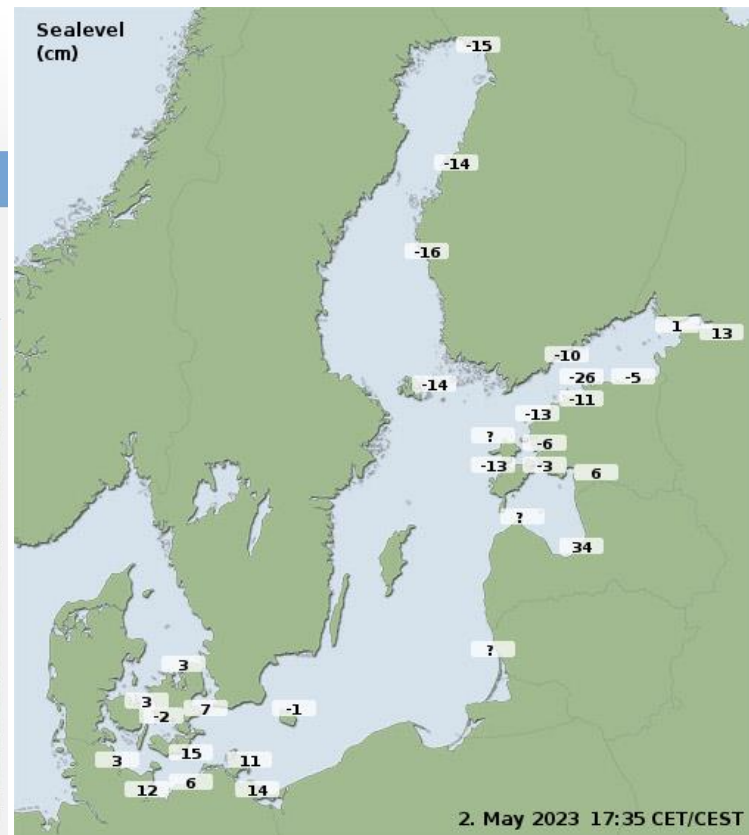
Fig. 4b: Differences between the reference levels of the old national chart datums with respect to Baltic Sea Chart Datum 2000 (BSCD2000). In Sweden and Finland, the old reference levels are equal to Mean Sea Level transferred to year 2023 (according to different national conventions). The values from 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](#).



# BOOS Stations and Sealevel



The screenshot shows the BOOS website interface. At the top left is the BOOS logo (Baltic Operational Oceanographic System). To its right are navigation icons for About us, Programmes Documents, News, Events, and Contact. Below this is a horizontal menu with links: Home, BOOS, Products, Forecasts, Observations, Community Products, Members, and Newsletter. The main content area is titled "BOOS > BOOS Stations" and "BOOS Stations". It features a map titled "BOOS Oceanographic Stations" showing a dense network of colored squares representing stations across the Baltic Sea region, including Norway, Sweden, Finland, Estonia, Latvia, Lithuania, Poland, and Belarus. Major cities like Oslo, Stockholm, St. Petersburg, and Moscow are labeled. The map includes a scale bar (100 km) and a keyboard shortcuts key.



# BOOS-BSHC Memorandum of Understanding (MoU)

## Memorandum of Understanding between BOOS and BSHC on transition to a harmonised vertical reference on the Baltic Sea

Noting that

- the IHO Baltic Sea Hydrographic Commission Conference (BSHCC19) has approved the goal to have a harmonised vertical reference on Baltic Sea for all water level and depth related information (e.g. tides, mareographs, interpolation and prediction of water levels, nautical charts). Chart datum Working Group was established to promote transition to the harmonised vertical reference which will be based on the European Vertical Reference System,
- the Baltic Oceanographic Observation System (BOOS) has a similar goal to have a harmonised vertical reference based on European Vertical Reference System on Baltic Sea,
- and both organisations expect that there will be many benefits with mutual co-operations and other relevant bodies

both organisations agree to co-operate on the transition to a common vertical reference for depth and water level information, with the aim to avoid duplication of work and to maximize mutual assistance.

Signatures

Tallinn, 30 June 2014

  
Urmas Lips  
BOOS Chair

Riga, 12 June 2014

  
Taivo Kivimäe  
BSHC Chair








# 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.

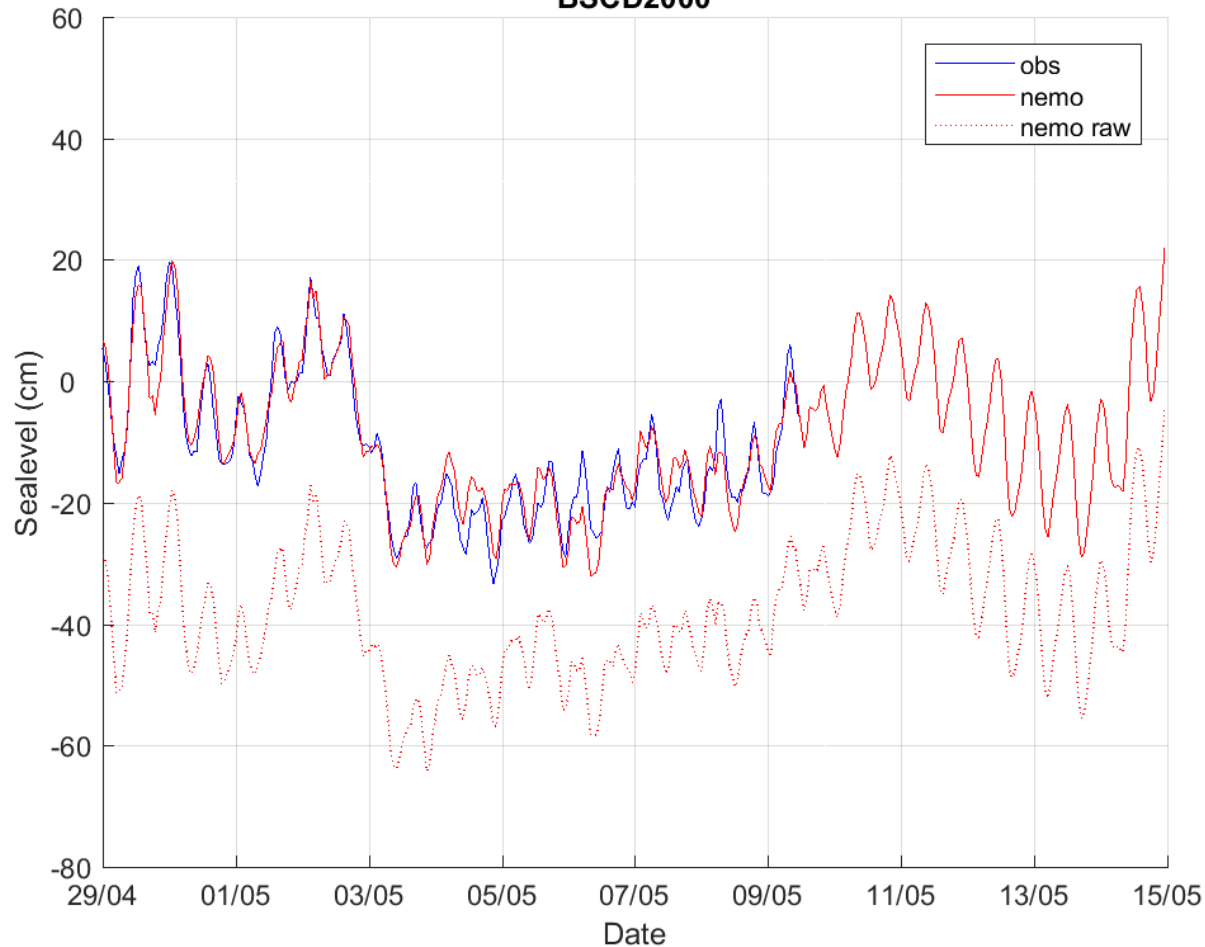
Högt vattenstånd   			
Varningsnivå	Gul	Orange	Röd
Område	cm i RH 2000		
<b>Grupp 1</b> (Västra Götalands län, Hallands län, Skåne län)	90	130	180
<b>Grupp 2</b> (Kalmar län, Östergötlands län, Gotlands län, Södermanlands län, Stockholms län)	80	110	-
<b>Grupp 3</b> (Blekinge län, Uppsala län, Gävleborgs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



# Sealevel forecast relative Baltic Sea Chart Datum (BSCD2000)

**Göteborg-Krossholmen (SMHI)**  
**2023-04-29 to 2023-05-14**  
**BSCD2000**



# A uniform reference system from land to sea

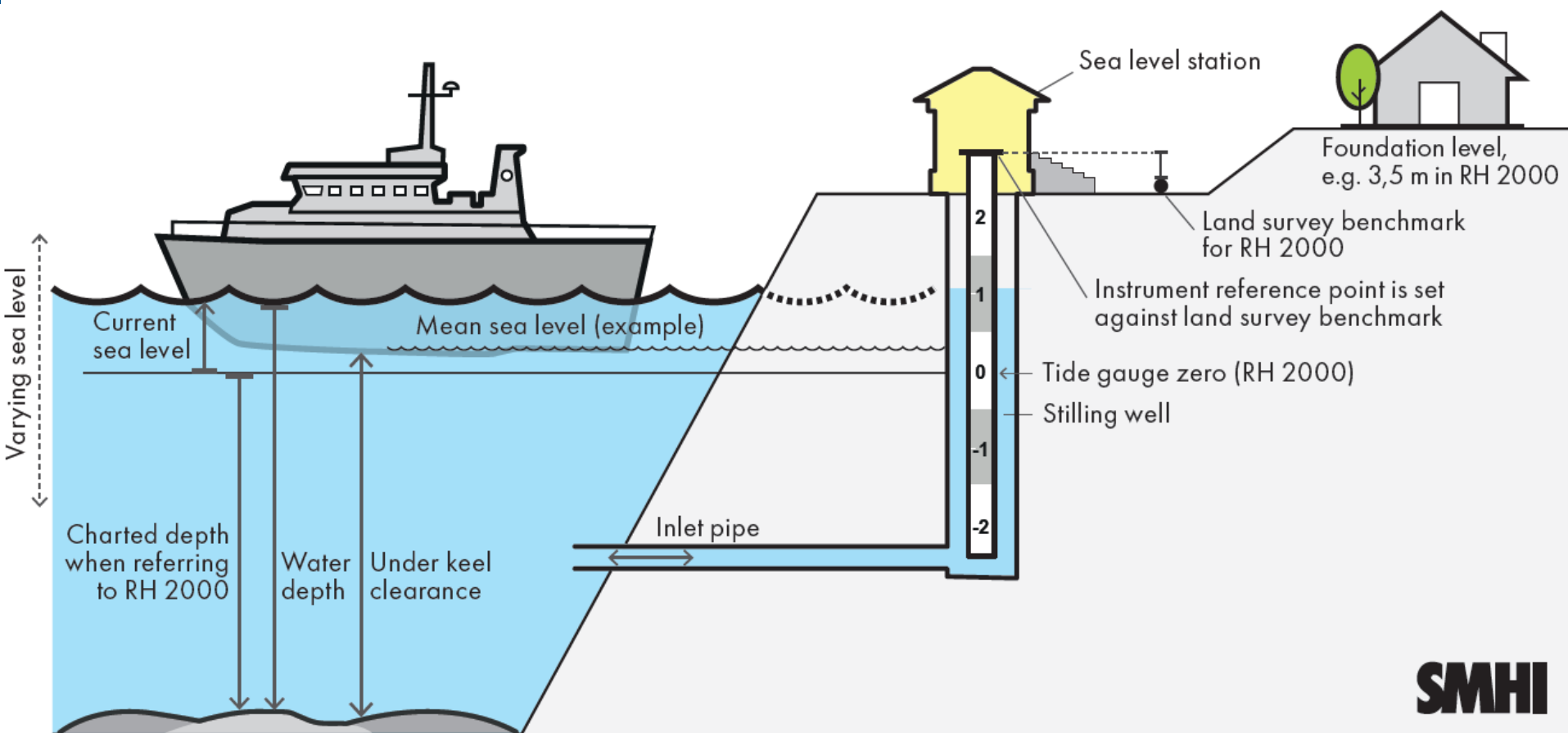


Illustration Veronica Wörn SMHI

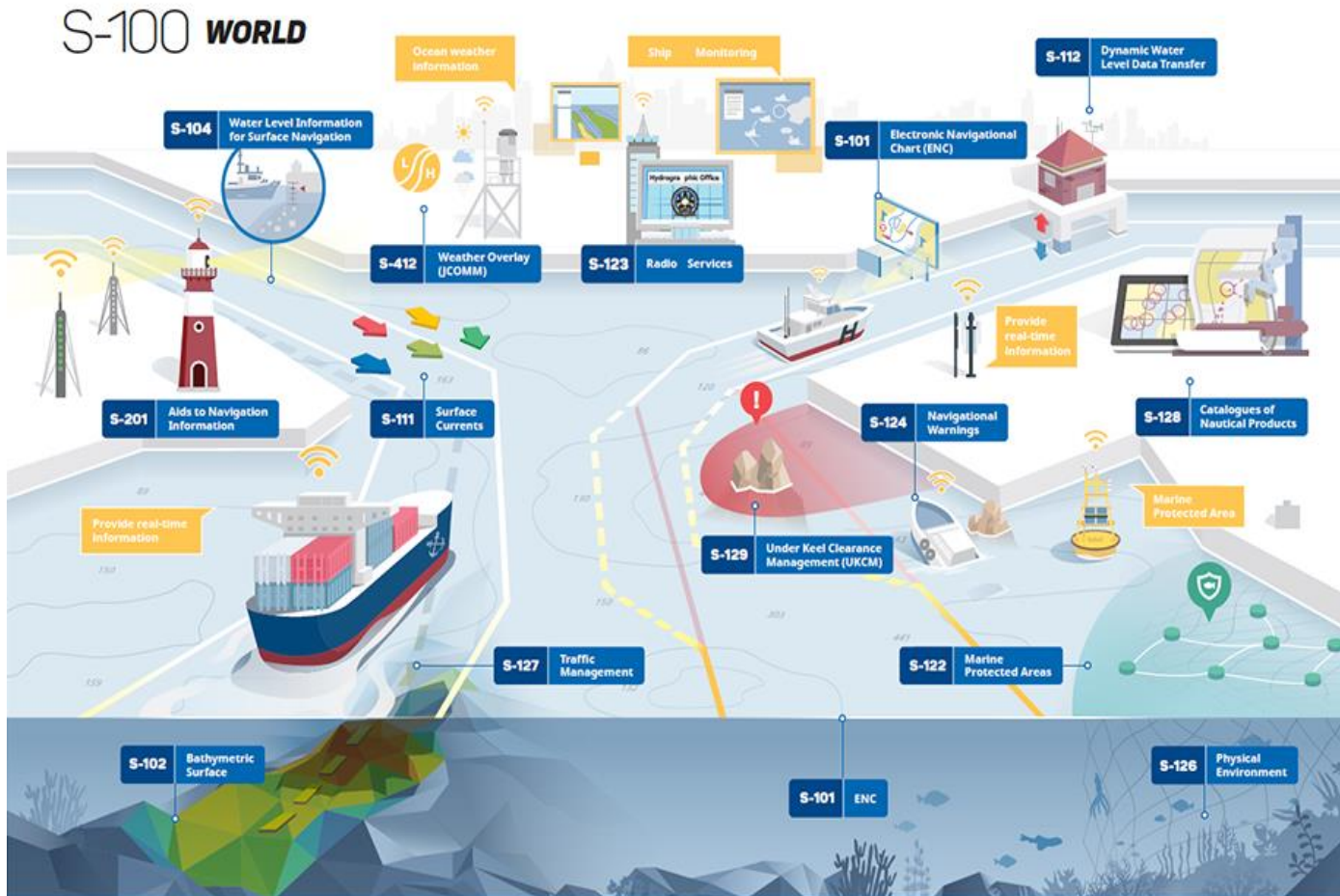
**SMHI**



# Future Maritime Services S-100



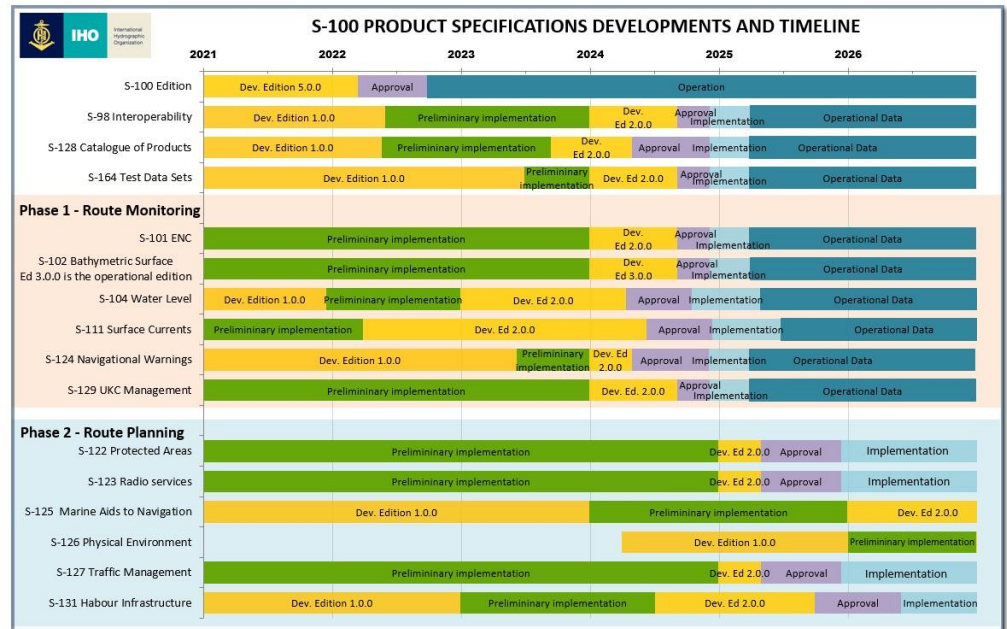
IHO



# IHO S-100 Implementation

## IHO S-100 Implementation Strategy

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

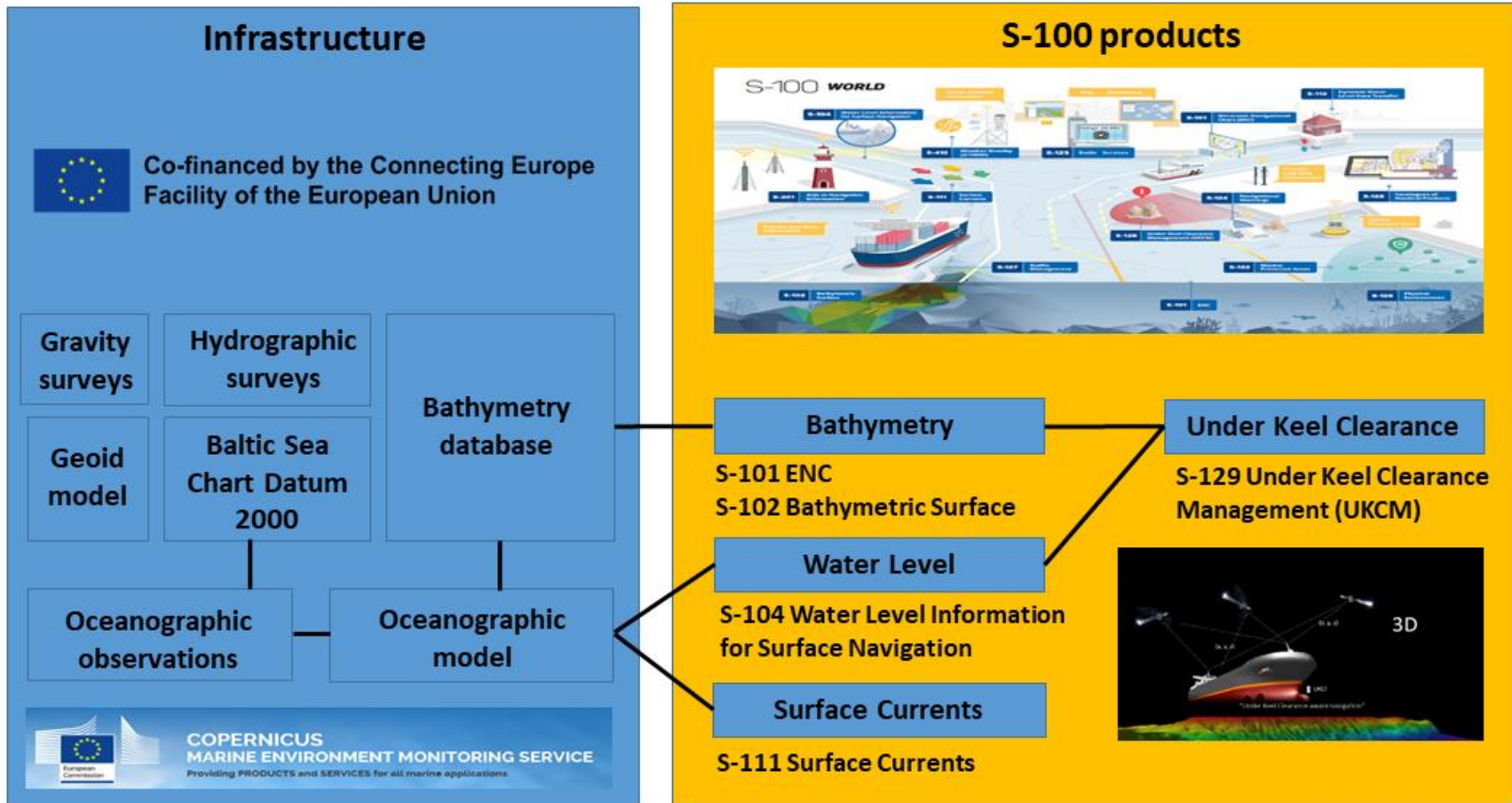


This S-100 timeline is updated: July 9th, 2023.



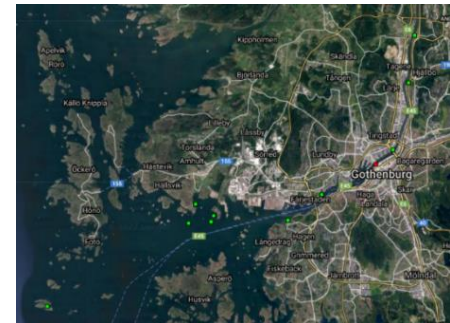
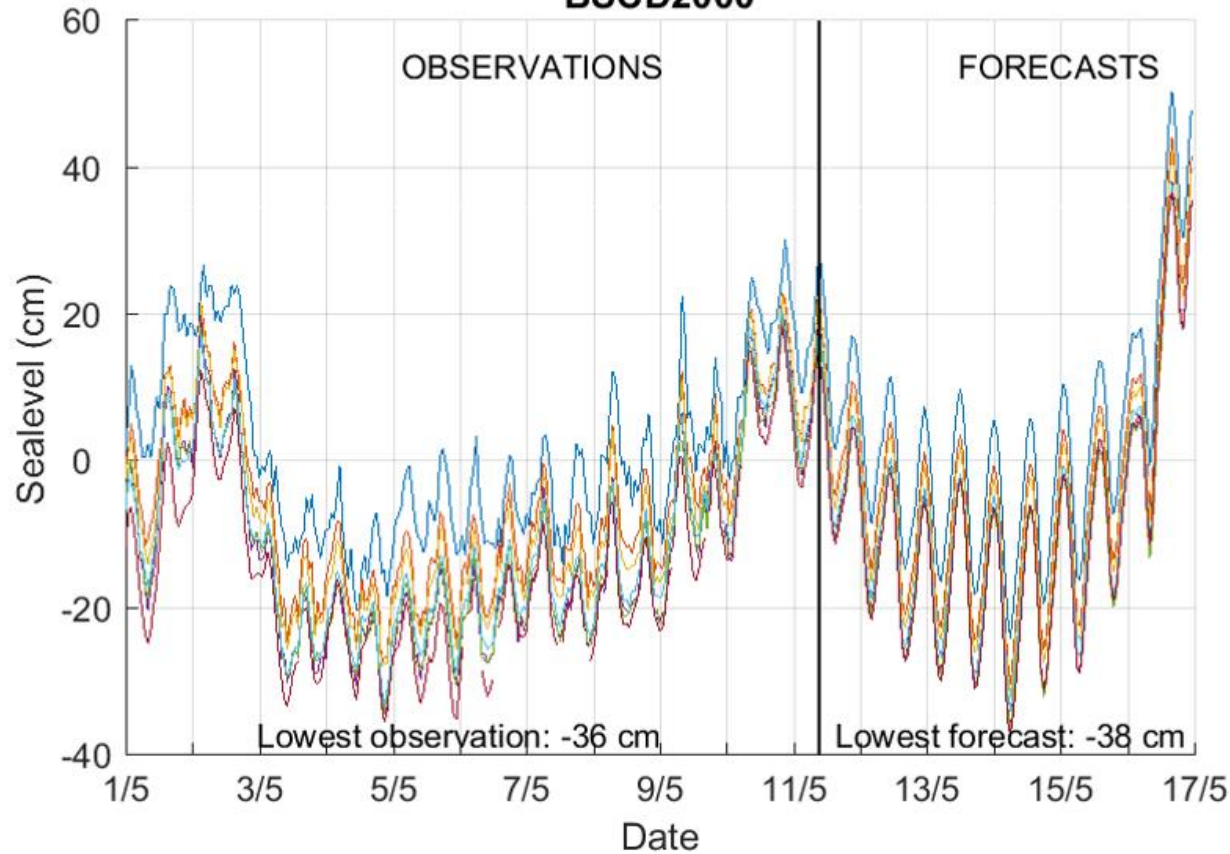
# Dynamic S-100 products

## Real Time Hydrographic and Environmental Information Service



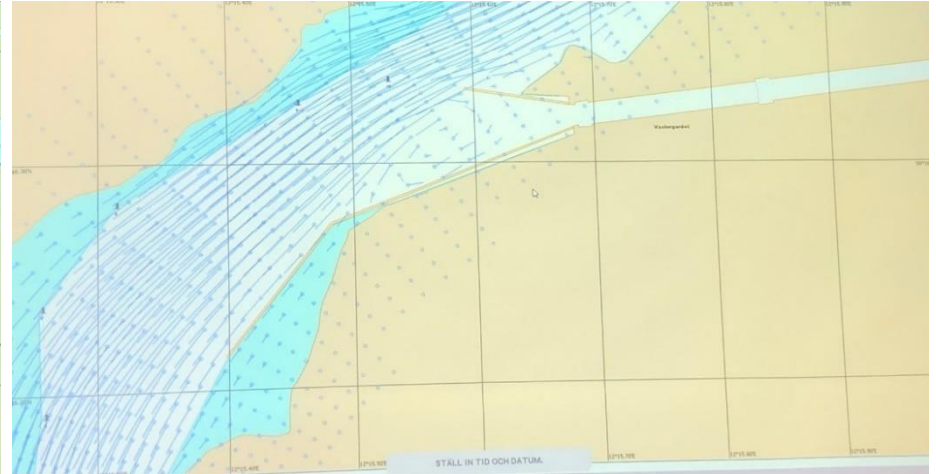
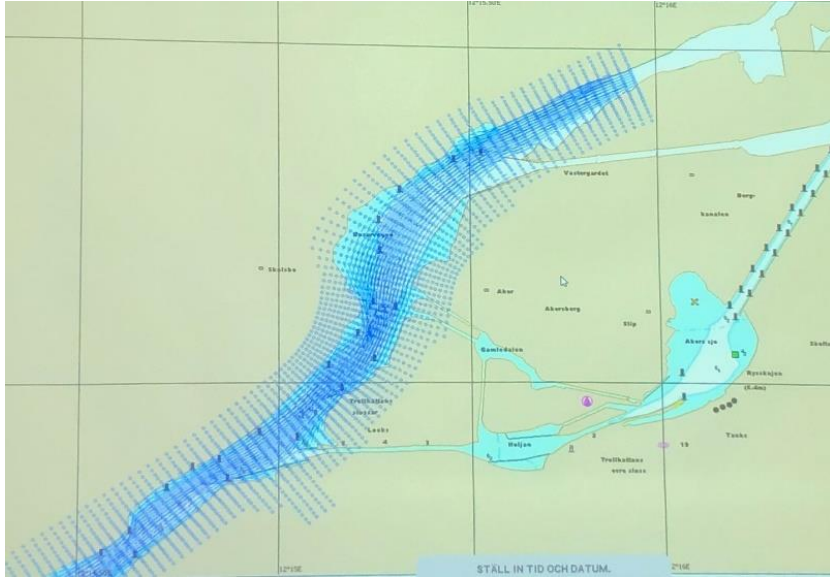
# Sealevels Göteborg (potential S-104 product)

**Sealevels Göteborg**  
**2023-05-01 to 2023-05-16**  
**Issued: 2023-05-11 09:00 UTC**  
**BSCD2000**





# Currents Göta River (potential S-111 product)



# Future Navigation



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



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## 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



# Thanks!



Thomas Hammarklint

Swedish Maritime Administration (SMA)

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

