BALTIC SEA HYDROGRAPHIC COMMISSION

IHO

Baltic Sea Chart Datum 2000 – implementation of one common reference level in the Baltic Sea

BOOS Annual Meeting

25 November 2021

VTC

Thomas Hammarklint

Baltic Sea Hydrographic Commission (BSHC)

BALTIC SEA HYDROGRAPHIC COMMISSION

IHO

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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

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SWEDISH MARITIME ADMINISTRATION

Chart Datum Working Group (CDWG)

Photo: Chart Datum Working Group 13th meeting, 7 September 2021, VTC

http://www.bshc.pro/working-groups/cdwg

Members of CDWG:
Denmark Mrs Gitte Hauerberg Iversen
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 Montonen
Germany Dr Gunter Liebsch
Germany Dr Joachim Schwabe
Norway Mr Aksel Voldsund
Poland Mr Krzysztof Pyrchla
Poland Mrs Małgorzata Pająk
Poland Dr Monika Wilde-Piórko
Poland Dr Malgorzata Szelachowska
Sweden Dr Jonas Ågren
Sweden Dr Per-Anders Olsson
Sweden Mr Mikael Stenström

Representative of BOOS:
Sweden Mr Thomas Hammarklint

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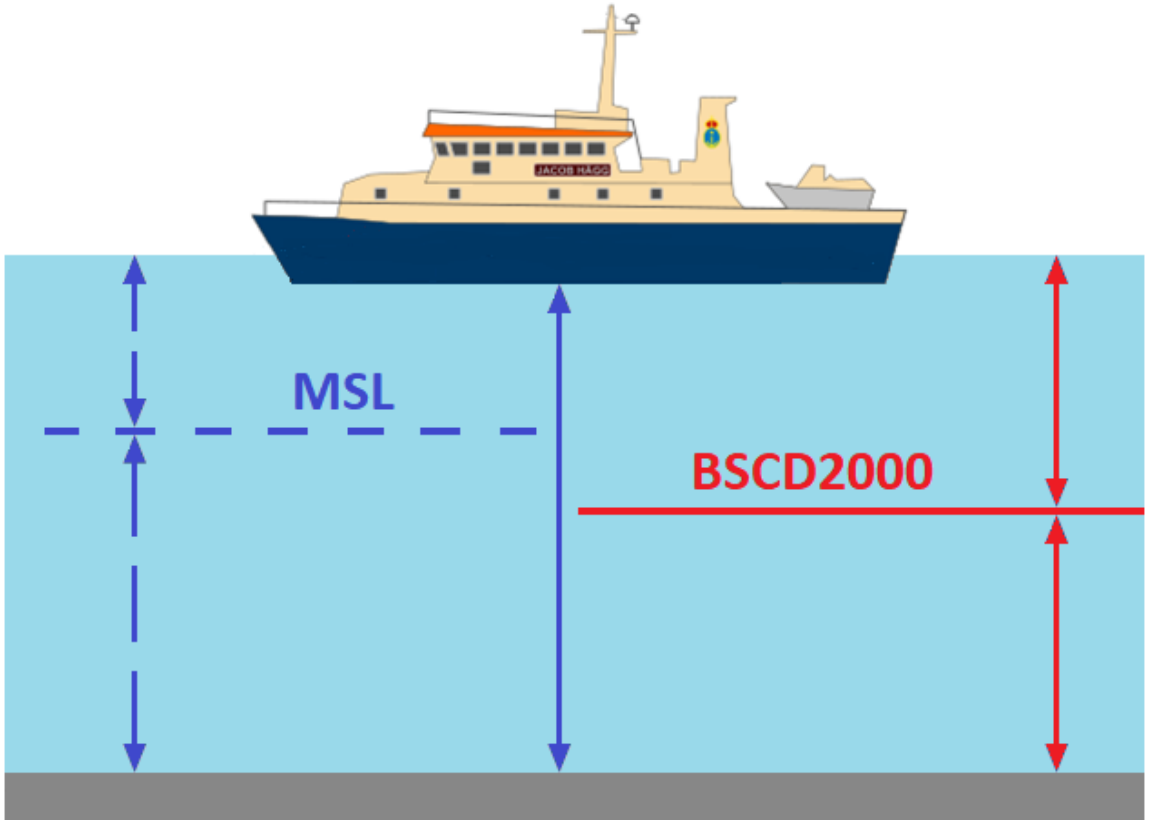
New reference level



The water level remains!

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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$^{\text{national realization name}}$)
or
Mean Sea Level (Baltic Sea Chart Datum 2000)

CHART DATUM: Mean Sea Level (Baltic Sea Chart Datum 2000$^{\text{RH2000}}$)
REFERENSNIVÅ: Medelvattenyta (Baltic Sea Chart Datum 2000$^{\text{RH2000}}$)
SYMBOLS and ABBREVIATIONS: see INT 1
BETECKNINGAR och FÖRKORTNINGAR: se KORT 1

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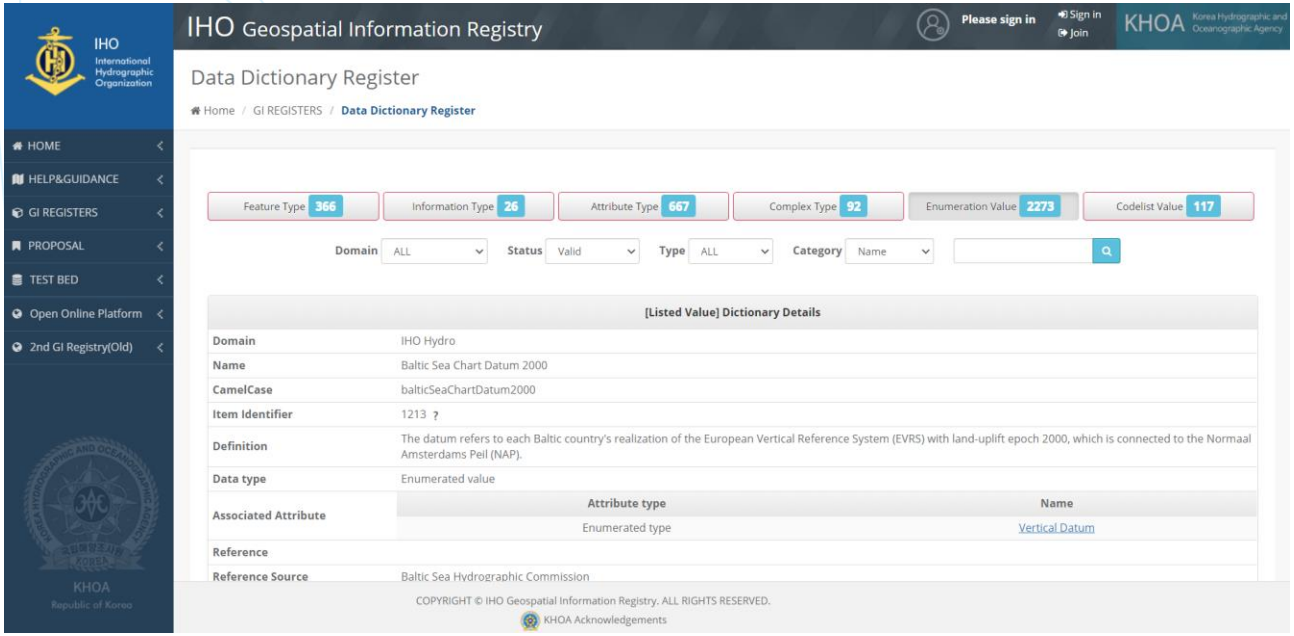
Baltic Sea Chart Datum 2000 in IHO Registry

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



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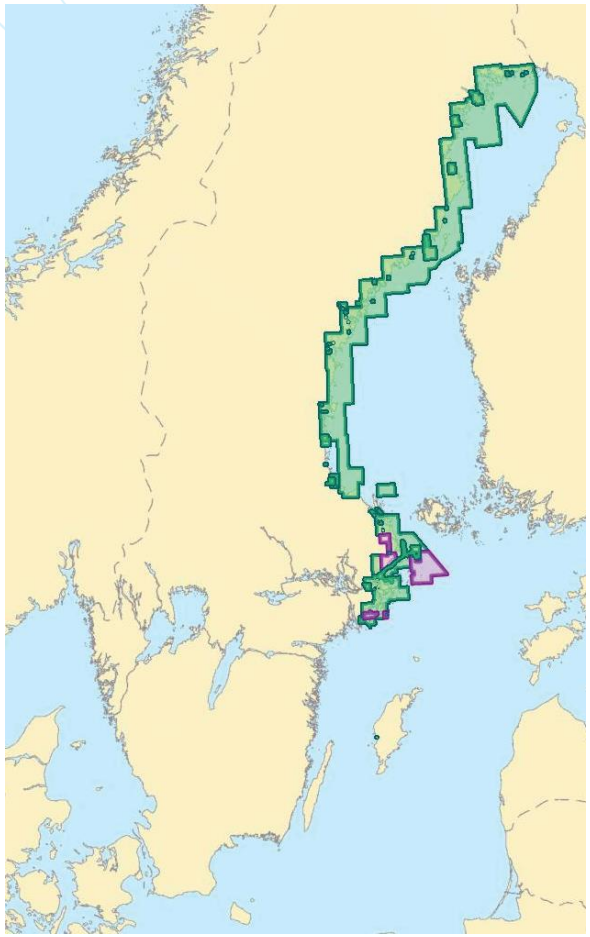
Status transition to BSCD2000 in nautical charts



Updated 2021-11-19

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Swedish Chart Improvement project

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

Referensnivå

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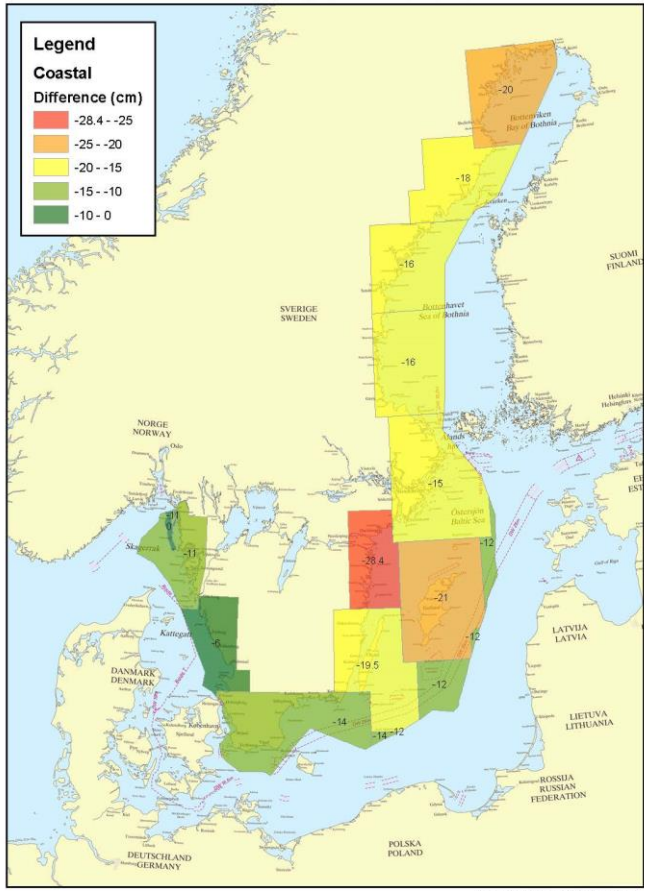
Difference between present chart datum and BSCD2000

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

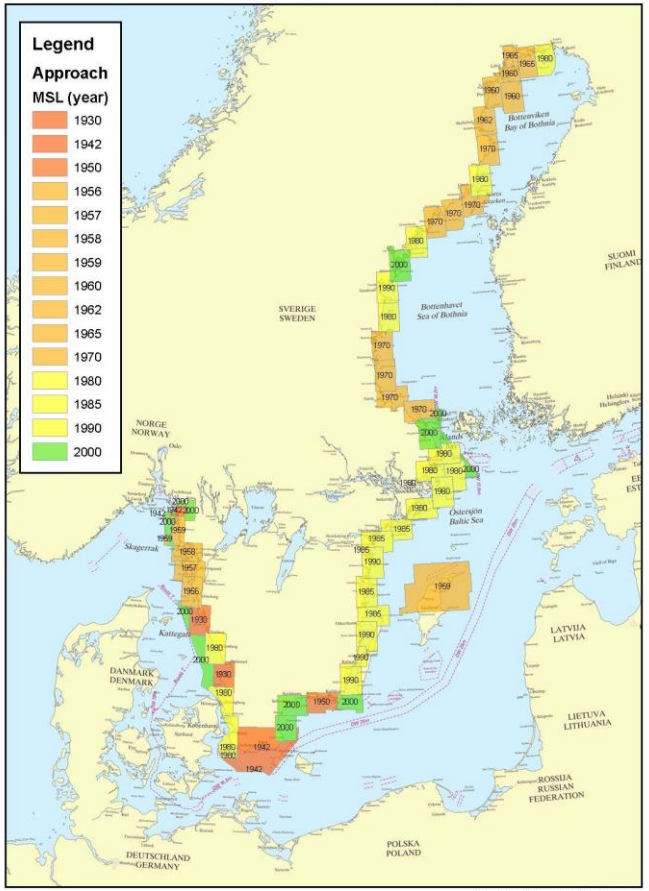


1 centimeters = 60 kilometers

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

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Swedish Sea Level Network

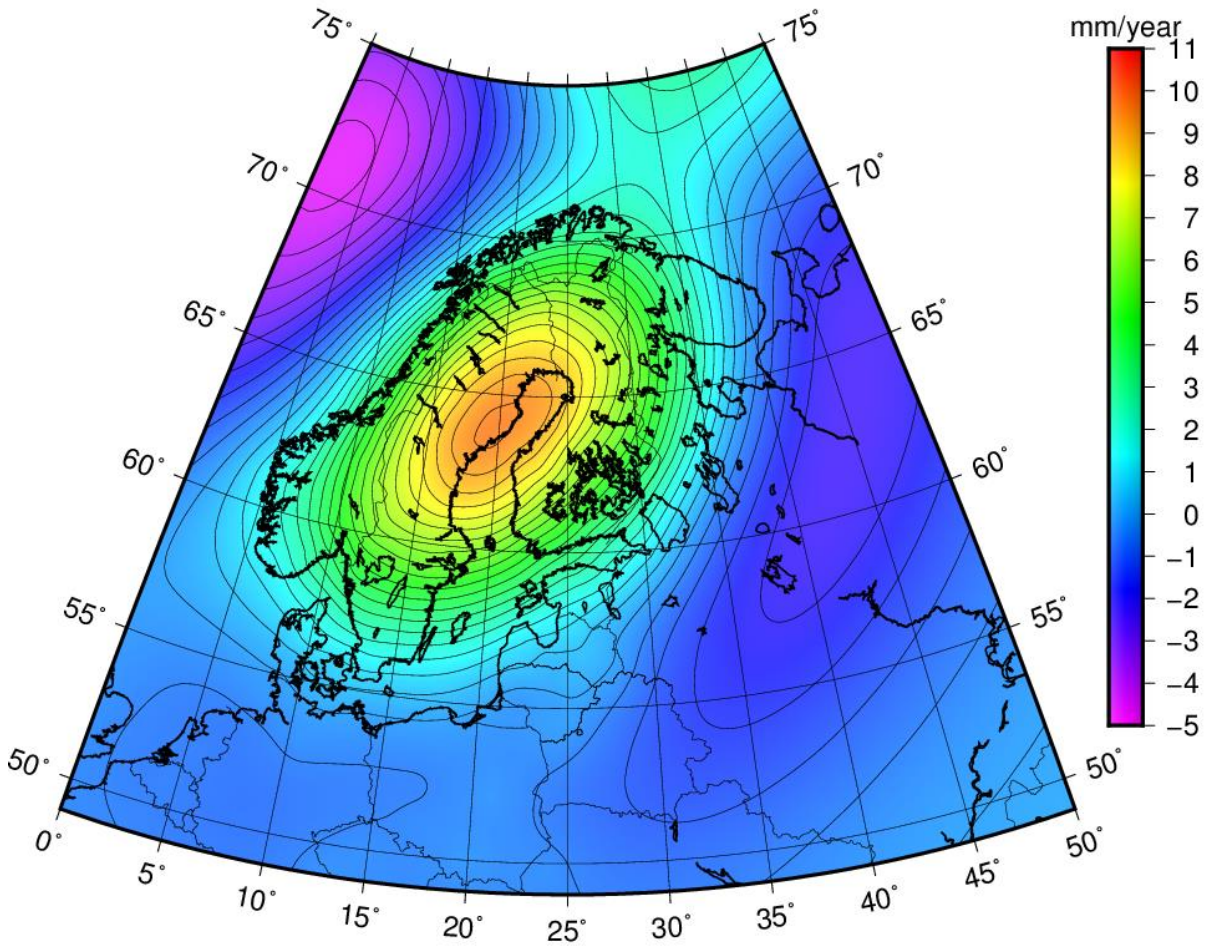
Co-financed by the European Union
Connecting Europe Facility

- 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	27 stations (23 SMHI, 3 SMA, 1 CTH)
Class II	Upgrade without battery backup	25 stations (21 SMA, 3 GBG, 1 SKB)
Class III	Unchanged, temporary	7 stations (6 SMA, 1 SMHI)

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

The land-uplift lowers the mean sea level



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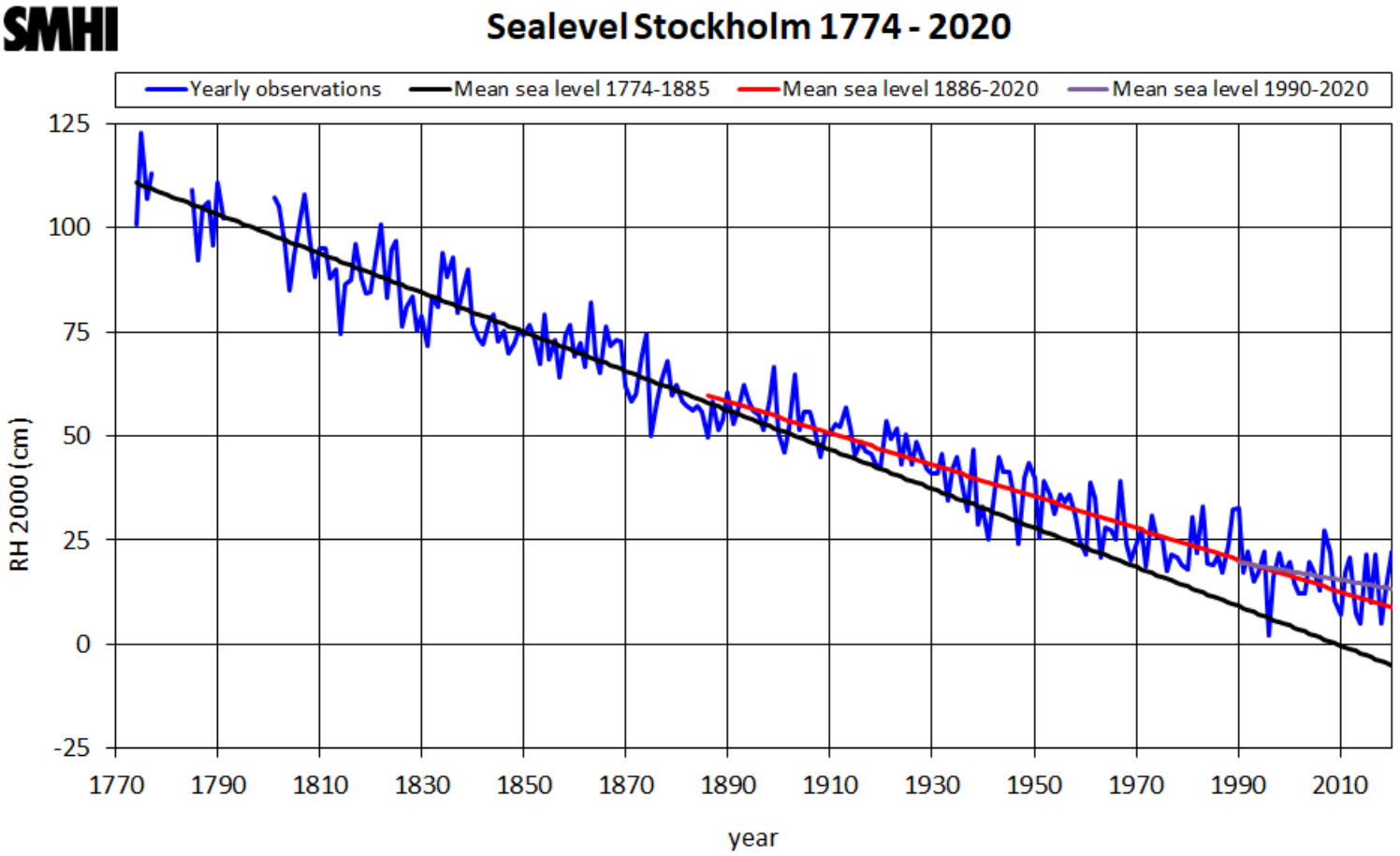
Stockholm
”World’s longest sealevel record”



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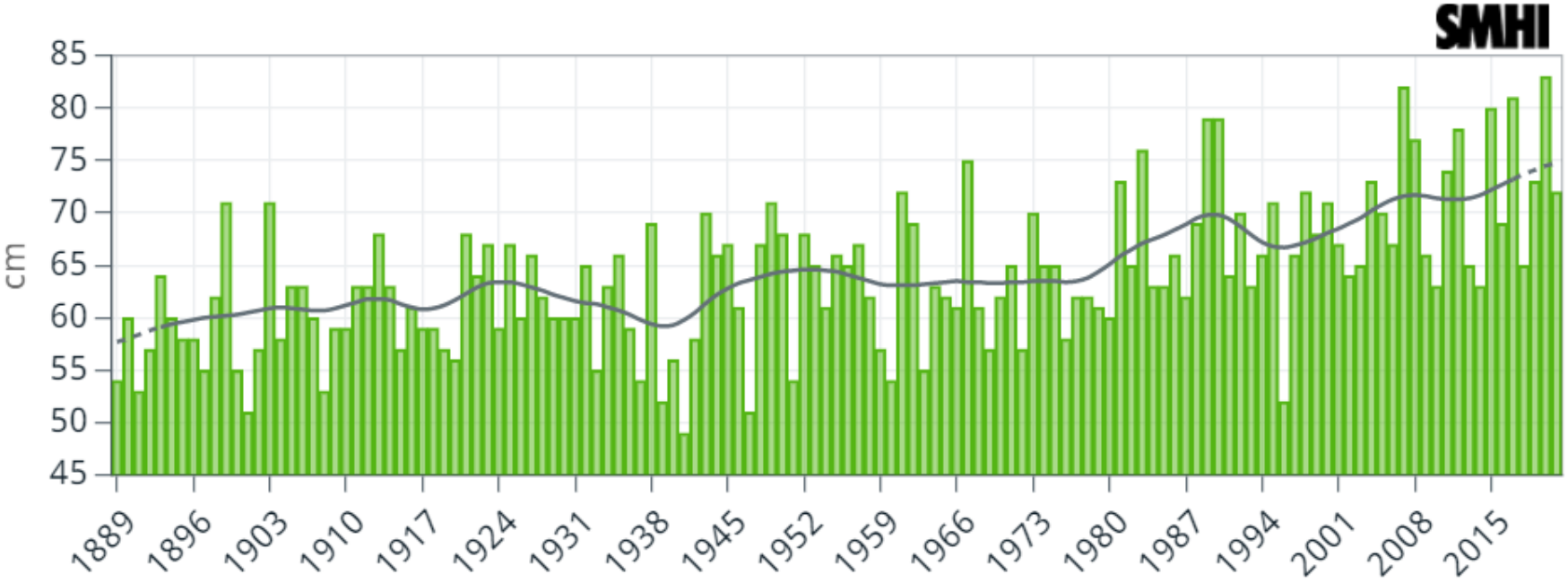
The sea level rise raises the mean sea level



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

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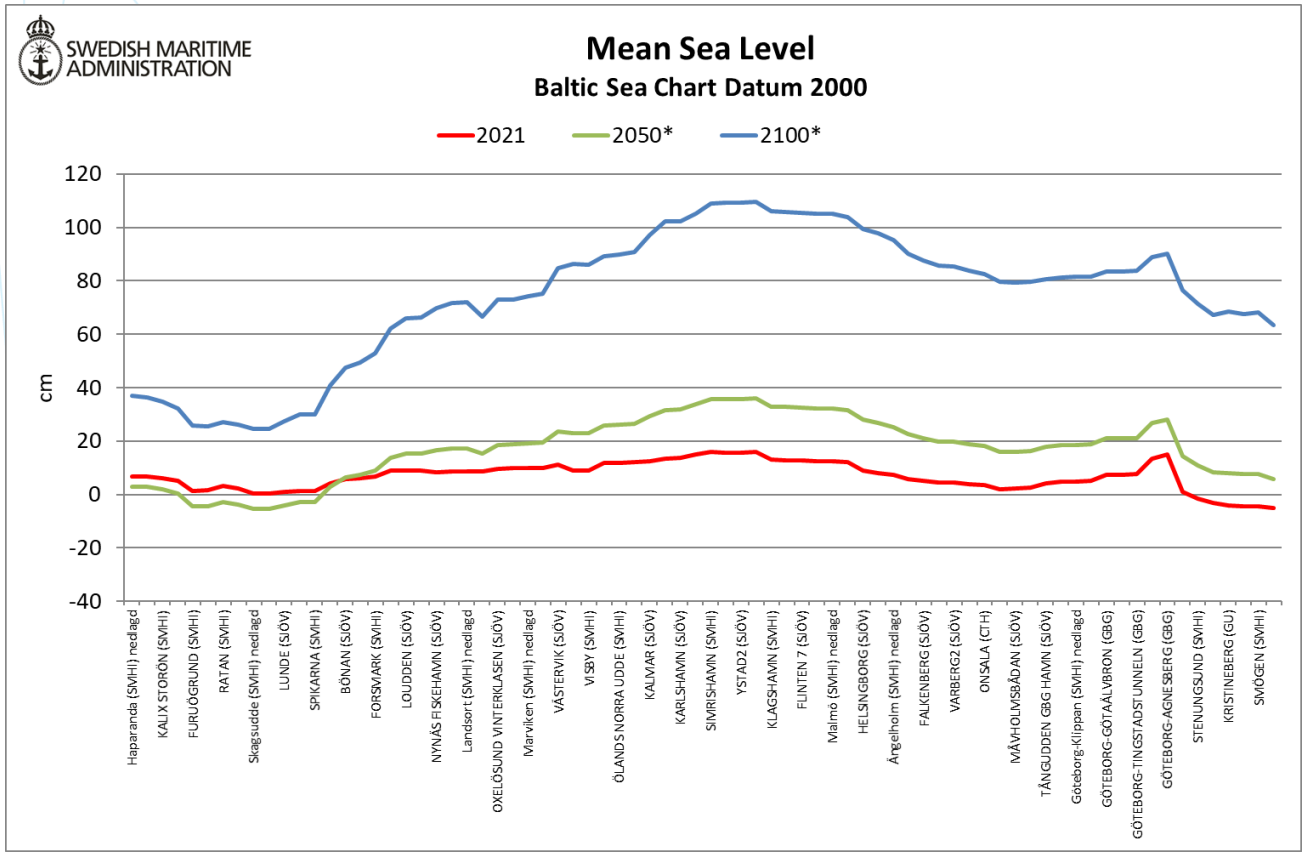
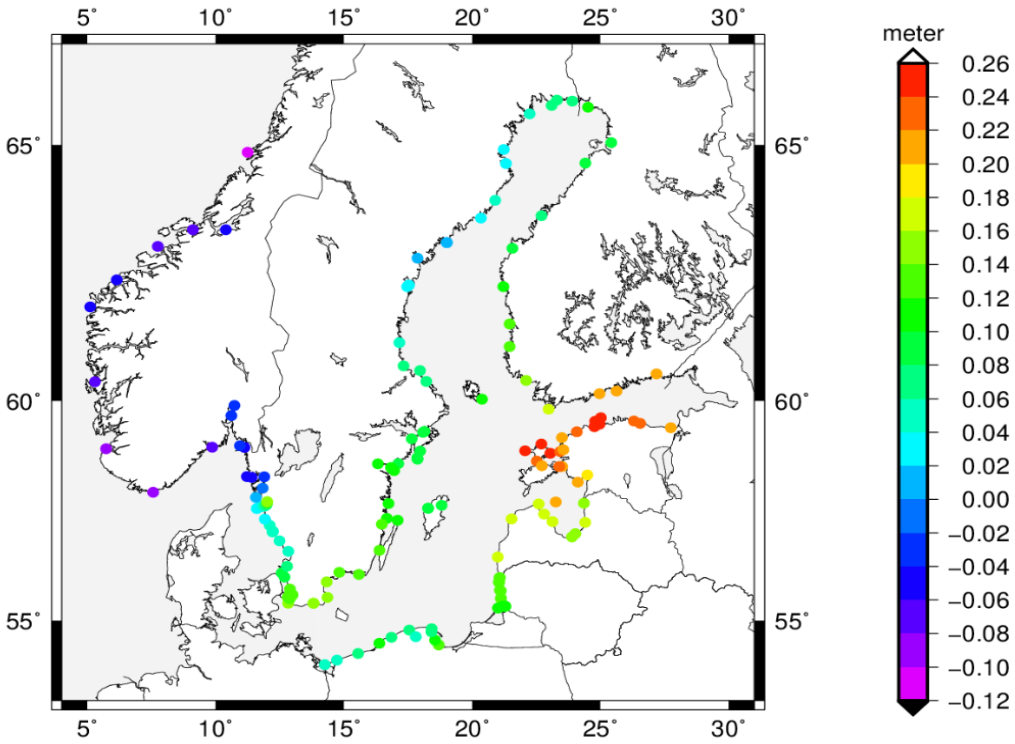
Changing mean sea level



Calculated mean sea level for the years 2021, 2050 and 2100. * including a predicted sea level rise, +1 m over the years 2020-2100 and correction for the leveled land-uplift.

Mean sea level relative BSCD2000

Difference between old reference system and BSCD2000



BOOS SEALEVEL STATIONS 2021

Mean Sea Level (MSL) in different height systems

MSL based upon regression analysis since measurement start (Sweden)

2021-09-07

BSCD2000 = Baltic Sea Chart Datum 2000, heights referred to Amsterdam (NAP)

RH2000 = Swedish Height System 2000, heights referred to Amsterdam (NAP)

* = Correction of provided sea level data to BOOS to the Baltic Sea Chart Datum 2000 (BSCD2000)

COUNTRY	OWNER	NR	STATION NAME	LATITUDE	LONGITUDE	BSCD2000 RH2000 cm	Apparent (relative) landuplift cm/year	Correction * to BSCD2000 m
SWEDEN	SMHI	2588/33088	Haparanda discontinued	65.771667	23.903056	5.9	0.72	0.059
SWEDEN	SMA	59/35103	KALIX KARLSBORG	65.788889	23.303333	6.1	0.72	0.061
SWEDEN	SMHI	2157/33051	KALIX STORÖN	65.696944	23.096111	5.3	0.73	0.053
SWEDEN	SMA	115/35183	STRÖMÖREN	65.549722	22.238333	4.4	0.75	0.044
SWEDEN	SMHI	2055/33052	FURUÖGRUND	64.915833	21.230556	0.5	0.82	0.005
SWEDEN	SMA	40/35240	GÄSÖREN	64.678611	21.249167	0.8	0.82	0.008
SWEDEN	SMHI	2056/33053	RATAN	63.986111	20.895000	2.4	0.80	0.024
SWEDEN	SMA	57/35124	HOLMSUND	63.695833	20.347222	1.4	0.80	0.014
SWEDEN	SMHI	2321/33054	Skagsudde discontinued	63.190556	19.012500	-0.4	0.80	-0.004
SWEDEN	SMA	110/35138	SKAGSUDDE2	63.190556	19.012500	-0.4	0.80	-0.004
SWEDEN	SMA	172/35209	LUNDE	62.880556	17.876389	0.1	0.77	0.001
SWEDEN	SMHI	2062/33074	Draghällan discontinued	62.333333	17.466667	0.7	0.74	0.007
SWEDEN	SMHI	2061/33055	SPIKARNA	62.363333	17.531111	0.7	0.74	0.007
SWEDEN	SMA	66/35127	LJUSNE ORRSKÄRSKAJEN	61.206944	17.145556	3.5	0.64	0.035
SWEDEN	SMA	33/35119	BÖNAN	60.738611	17.318611	5.0	0.58	0.050
SWEDEN	SMA		GÄVLE	60.696565	17.230972	5.0	0.58	0.050
SWEDEN	SMHI	2067/33075	Björn discontinued	60.633333	17.966667	5.6	0.56	0.056
SWEDEN	SMHI	2179/33056	FORSMARK	60.408611	18.210833	6.3	0.53	0.063
SWEDEN	SMA	67/35154	LOUDDEN	59.341389	18.137222	8.4	0.38	0.084
SWEDEN	SMHI	2069/33057	STOCKHOLM	59.324167	18.081944	8.5	0.38	0.085
SWEDEN	SMA	173/35112	NYNÄS FISKEHAMN	58.917500	17.972222	8.1	0.31	0.081
SWEDEN	SMHI	2507/33058	LANDSORT NORRA	58.768889	17.858889	8.3	0.29	0.083
SWEDEN	SMHI	2073/33076	Landsort discontinued	58.750000	17.866667	8.3	0.29	0.083
SWEDEN	SMA	34/35185	E4 BRON SÖDERTÄLJE	59.184722	17.642778	8.2	0.33	0.082
SWEDEN	SMA	10/35118	OXELÖSUND VINTERKLASEN	58.661667	17.124722	9.3	0.26	0.093
SWEDEN	SMA	58/35101	JUTEN	58.634167	16.324722	9.8	0.25	0.098
SWEDEN	SMHI	2076/33059	Marviken discontinued	58.553611	16.837222	9.8	0.25	0.098
SWEDEN	SMHI	2545/33085	ARKÖ	58.484167	16.960556	9.8	0.25	0.098
SWEDEN	SMA	93/35151	VÄSTERVIK	57.748333	16.675278	11.0	0.16	0.110
SWEDEN	SMA	81/35114	SLITE	57.705833	18.810000	9.0	0.12	0.090
SWEDEN	SMHI	2080/33060	VISBY	57.639167	18.284444	9.0	0.12	0.090
SWEDEN	SKB	77/35200	SIMPEVARP	57.410278	16.675833	11.7	0.12	0.117
SWEDEN	SMHI	2083/33061	ÖLANDS NORRA UDDE	57.366111	17.097222	11.6	0.12	0.116
SWEDEN	SMHI	2085/33062	OSKARSHAMN	57.275000	16.478056	12.0	0.10	0.120
SWEDEN	SMA	60/35105	KALMAR	56.658889	16.378333	12.5	0.06	0.125
SWEDEN	SMHI	2088/33063	KUNGSHOLMSFORT	56.105278	15.589444	13.3	0.01	0.133
SWEDEN	SMA	61/35131	KARLSHAMN	56.154167	14.821389	13.8	-0.01	0.138
SWEDEN	SMHI	2543/33083	Åhus discontinued	55.928333	14.328611	15.1	-0.05	0.151
SWEDEN	SMHI	2320/33064	SIMRISHAMN	55.557500	14.357778	16.0	-0.08	0.160
SWEDEN	SMHI	2093/33078	Ystad discontinued	55.426944	13.825833	15.8	-0.07	0.158
SWEDEN	SMA	94/35159	YSTAD2	55.422778	13.825556	15.8	-0.07	0.158

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 2021 (according to different national conventions). The values from Norway shows the Mean Sea Level over the period 1996-2014, relative NN2000/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_{55} is used as chart datum. Notice how postglacial rebound reduces the magnitude of the mean sea level in the Bay of Bothnia; it is now just a few cm near the land uplift maximum. The values are shown in this Table.

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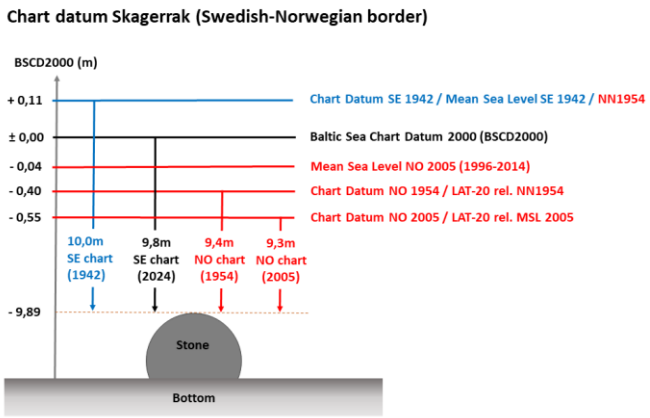
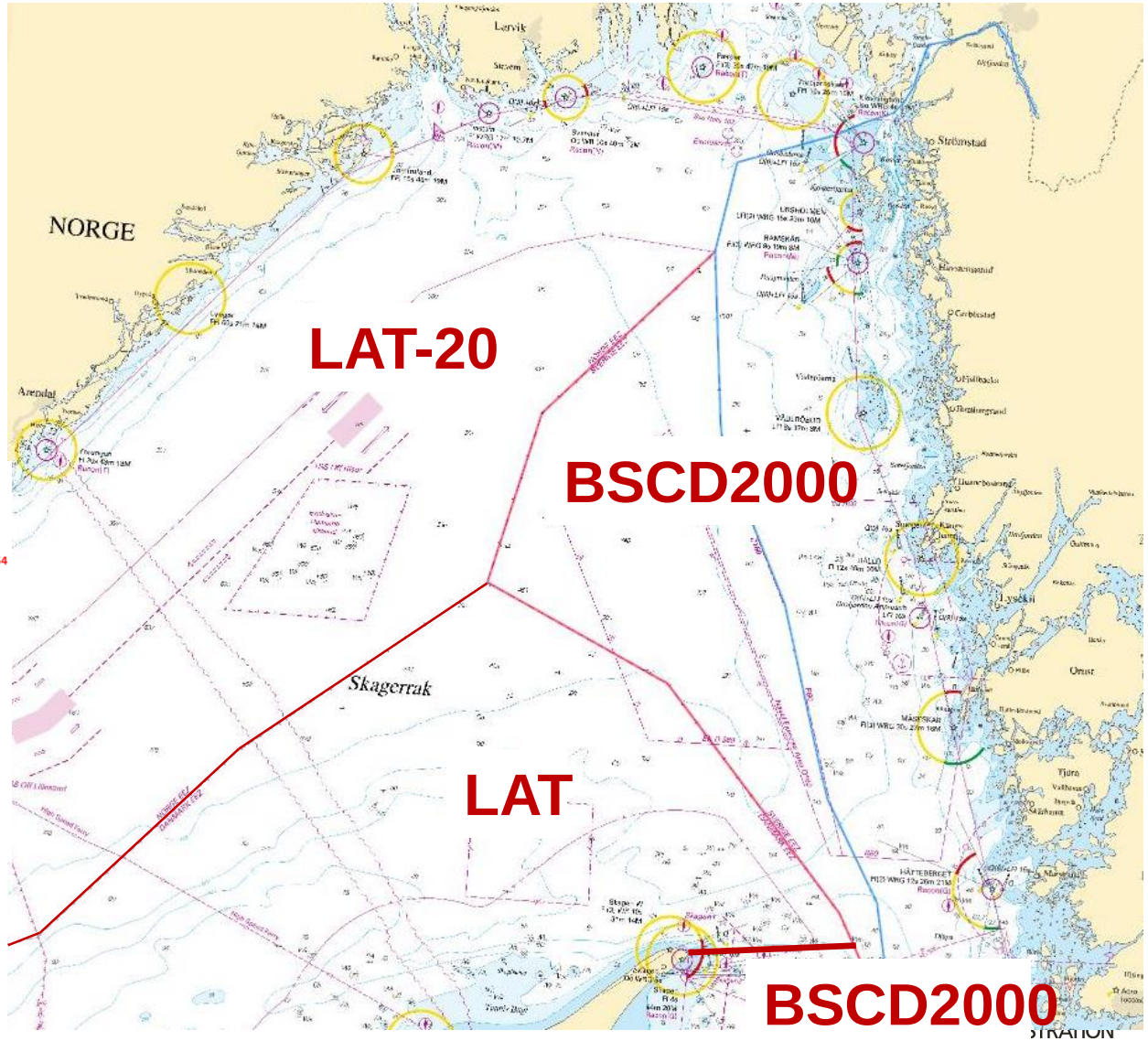
Reference levels in Skagerack

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





New reference level in Sweden

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

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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*		
Grupp 1 (Västra Götalands län, Hallands län, Skåne län)	90	130	180
Grupp 2 (Kalmar län, Östergötlands län, Gotlands län, Södermanlands län, Stockholms län)	80	110	-
Grupp 3 (Blekinge län, Uppsala län, Gävleborgs län, Västernorrlands län)	90	130	-
Grupp 4 (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

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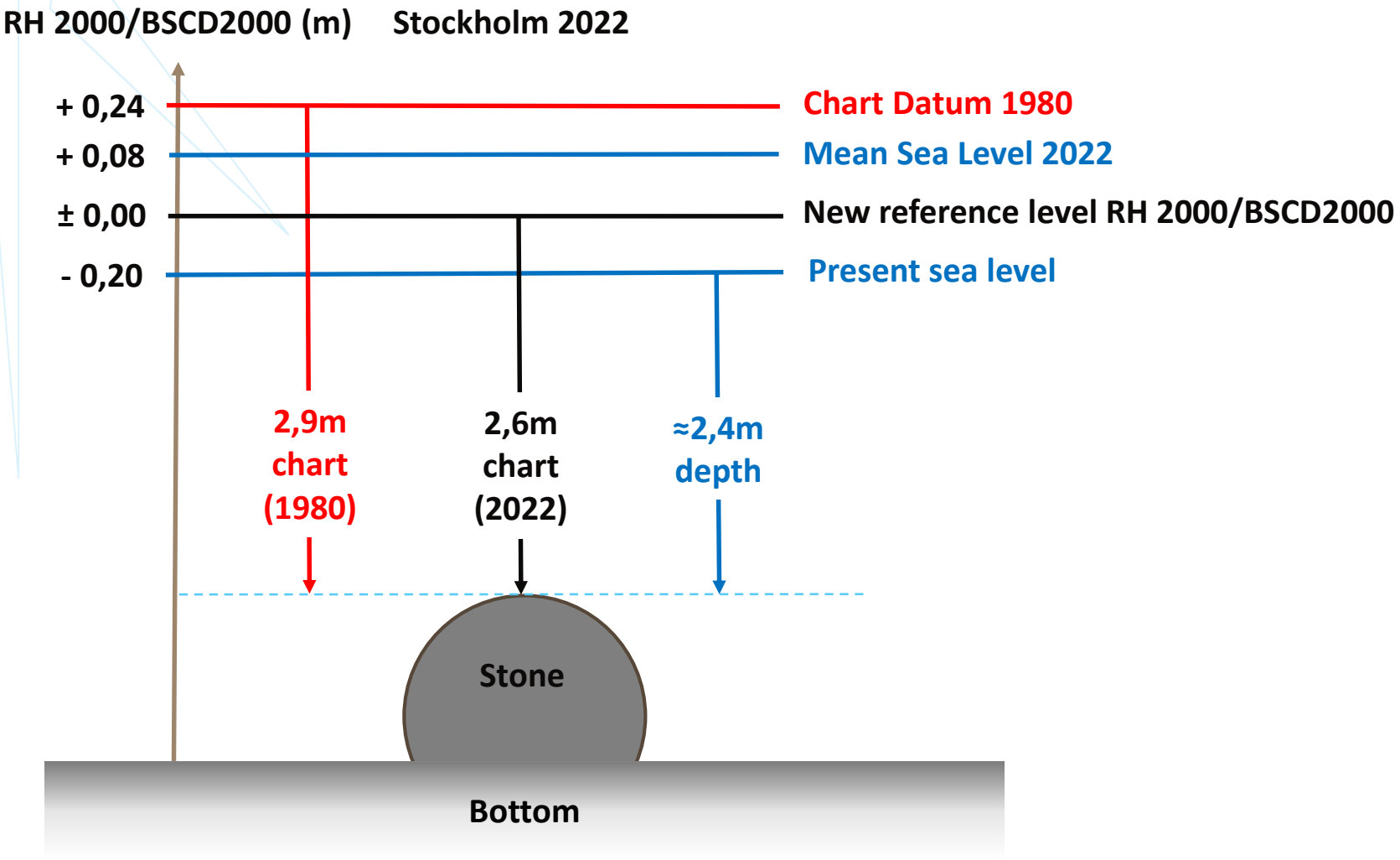
Transition to RH 2000/BSCD2000 in charts and sea level



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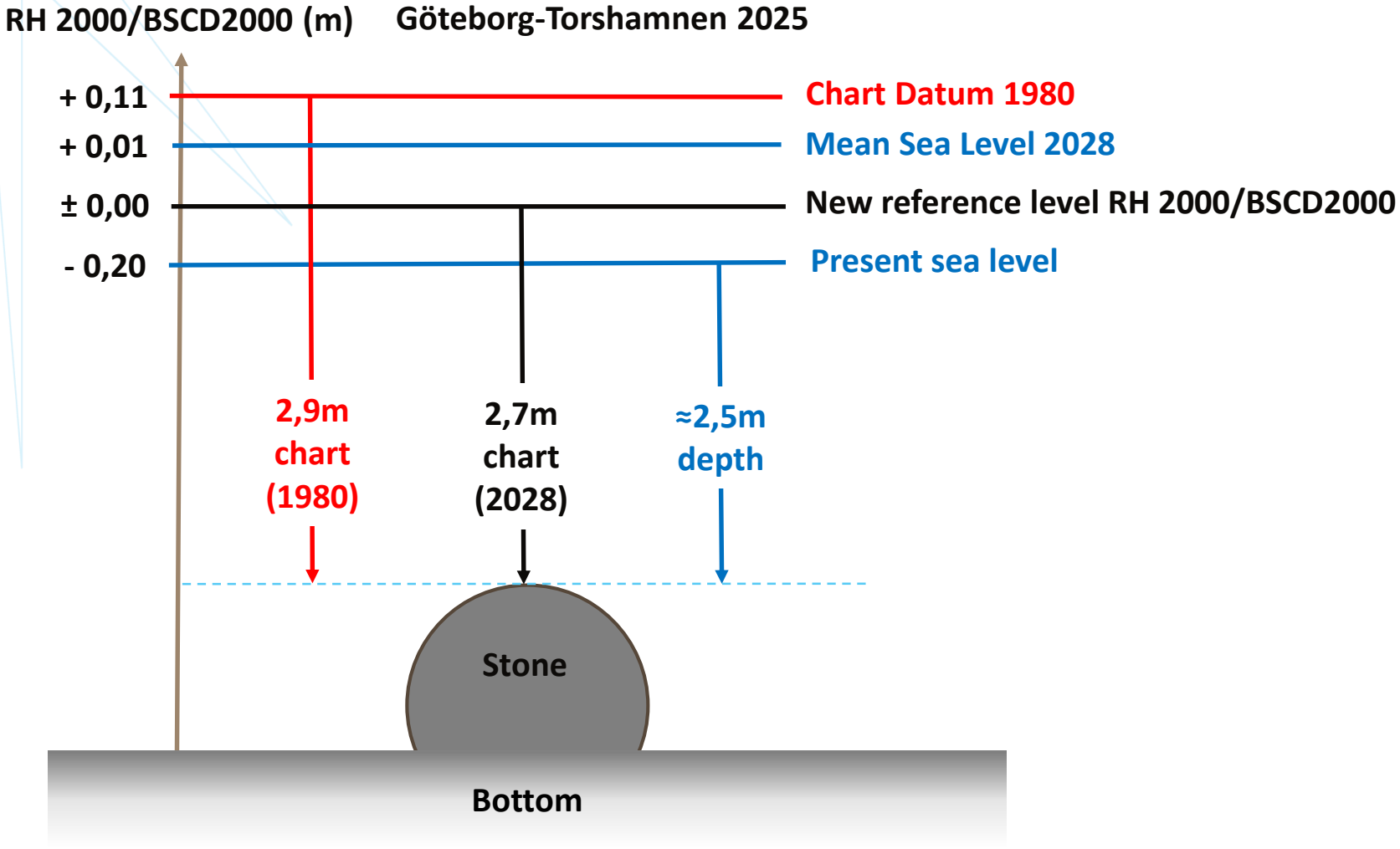
Transition to RH 2000/BSCD2000 in charts and sea level



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Notices to mariners

Example from Sweden, 2019-05-15

*** 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 and www.smhi.se

www.sjofartsverket.se/RH2000 www.smhi.se

SMHI och Sjöfartsverket. Publ. 15 May 2019

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

Svensk

English

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A uniform reference system from land to sea

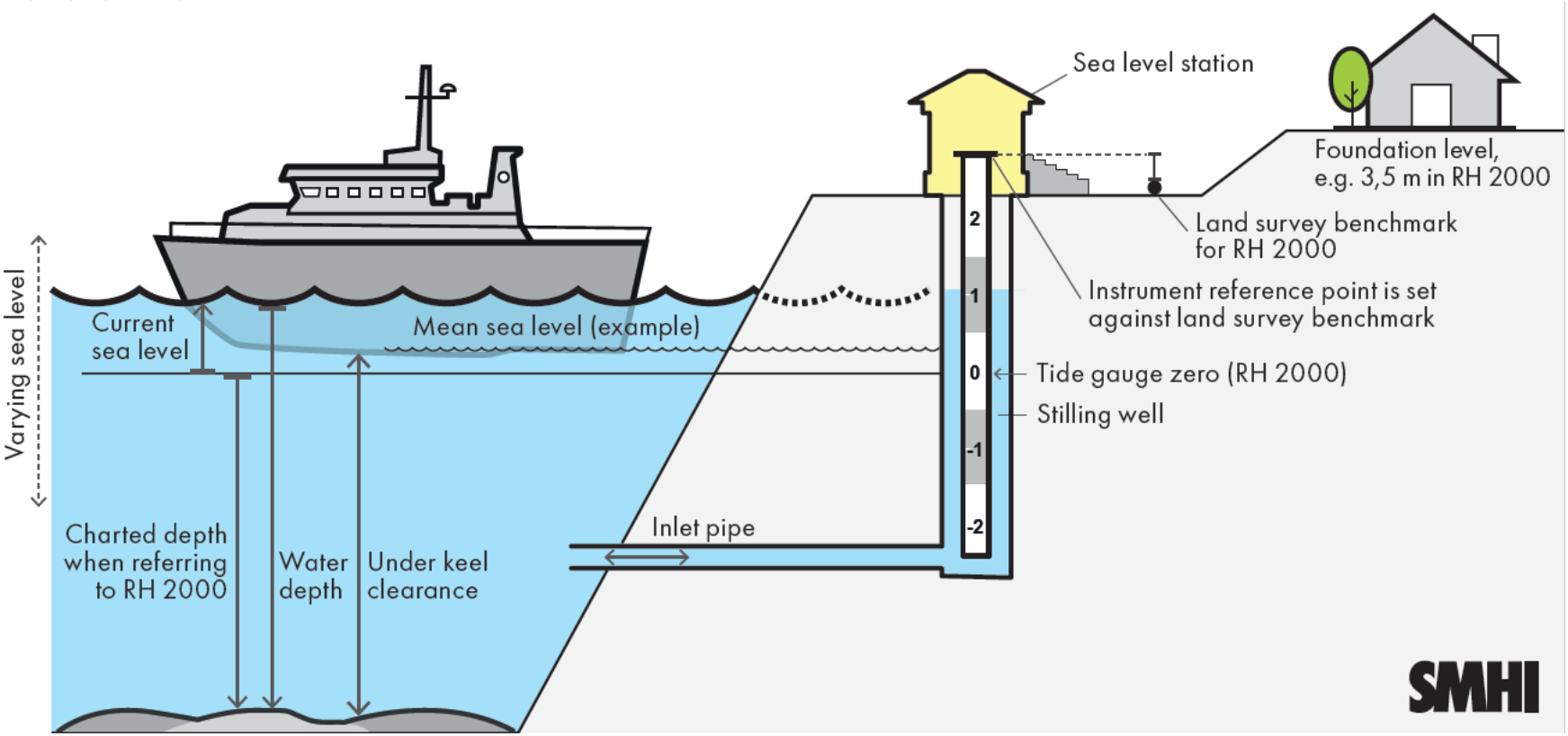

Illustration Veronica Wärn SMHI

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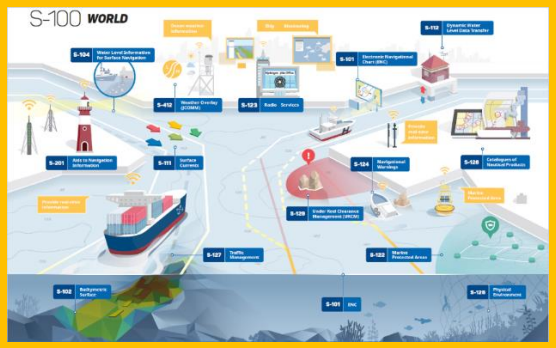
FAMOS Continuation

FAMOS Freja+Odin Infrastructure

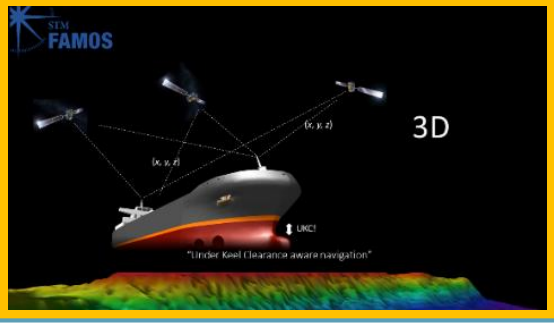
- FAMOS Gravity surveys
- FAMOS Geoid computations
- Baltic Sea Chart Datum 2000
- FAMOS Hydrographic surveys
- Oceanographic observations
- Oceanographic model

FAMOS Continuation

- FAMOS Geoid model BSCD2000 Height Correction model
- Bathymetry
  - S-101 ENC
  - S-102 Bathymetric Surface
- Water level
  - S-104 Waterlevel Information for Surface Navigation
- Surface Currents
  - S-111 Surface Currents
- Navigational Warnings
  - S-124 Navigational Warnings



- Under Keel Clearance
  - S-129 Under Keel Clearance Management (UKCM)



SWEDISH MARITIME ADMINISTRATION

Thanks!

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Thomas.Hammarklint@sjofartsverket.se

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