Reference levels, charts and water level

Swedish Maritime Administration 2024-03-21 Thomas Hammarklint

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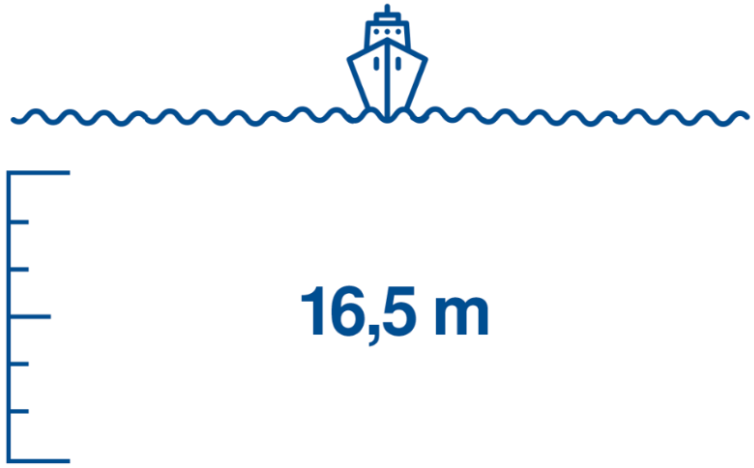
What is a reference level?

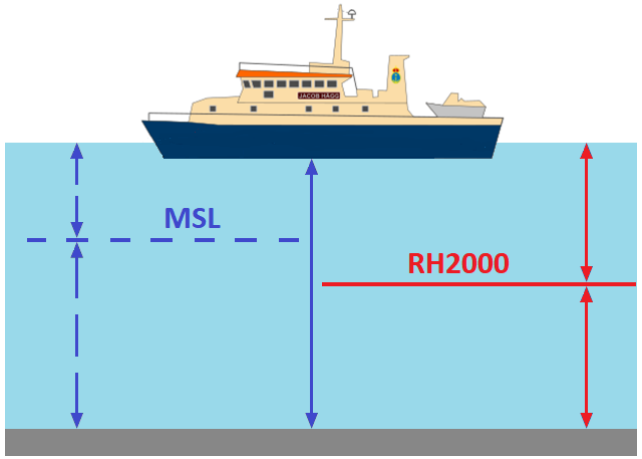
The depth information on a chart should be interpreted as the depth measured from the surface of the water to the bottom. The challenge is that the level of the water surface is constantly changing – winds, currents, air pressure, salinity and tides affect what level the water surface is at. Variations of 3-4 decimeters during a day are normal. In order to be able to calculate the current depth at a given position, a fast and well-defined reference level for the water surface is therefore needed. This is especially important if you are moving in shallow waters with small margins in relation to the ship's draft.

In addition to the fact that the level of the water surface varies, the depth is also affected by the elevation of the land. It is greatest along parts of the Norrland coast, about 1 cm per year. For charts of the Norrland coast produced in the 1960's, the depths have decreased by around half a metre.

Which reference level?



The current depth is unchanged when you change the reference level!



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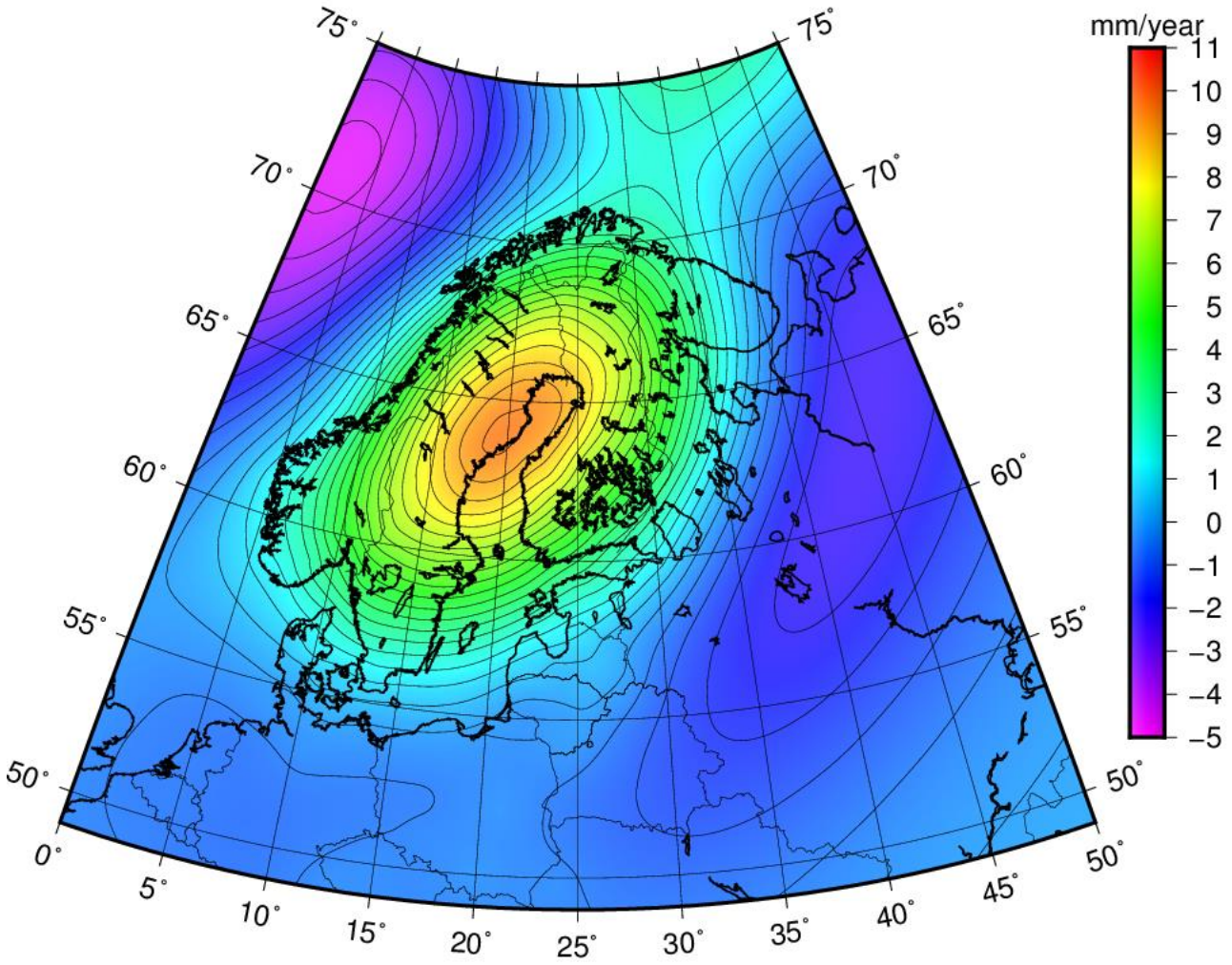
Land uplift



Levelled land uplift (land uplift relative the geoid, NKG2016_lev), from the Nordic Geodetic Commission (NKG) land uplift model NKG2016LU.

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What different reference levels are used today?

Mean sea level (MSL) or mean surface (MVY)
An estimated reference level used in older Swedish charts, based on observed mean sea level and a certain reference year (epoch) or year of publication. The level changes over time depends on the land and sea level rise, i.e. the "apparent" or relative land uplift, which is observed using tide gauges (water level stations). A table showing the mean sea level for the present year in different height systems and land uplift rates at all measurement locations around the coast can be found here.

Baltic Sea Chart Datum 2000 (BSCD2000) or the zero-level in Swedish national height system 2000 (RH 2000)
The realization in each country of the European Vertical Reference System (EVRS). The height reference surface of BSCD2000 is the equipotential surface of the Earth's gravity field. The reference level thus refers to a surface that is only affected by the Earth's gravitational field and does not change significantly over time. The zero level of BSCD2000 is in accordance with the Normaal Amsterdams Peil (NAP). The level is used also for heights on land. The member states around the Baltic have an agreement to switch to BSCD2000 in charts and water level information. The work is coordinated by the BSHC Chart Datum, Water level and Currents Working Group (CDWCWG). In Sweden the transition was completed for water levels in June 2019. The transition in all Swedish charts (Swedish Chart Improvement Project) is expected to be completed by 2030 at the latest.

Lowest Astronomical Tide (LAT) – not used in Swedish charts
The lowest calculated tide, based on at least 18.6 years of water level observations, to account for all tidal components. Used as a chart datum in sea areas with significant tidal variations, e.g. in the North Sea. The variations depend on the gravitational pull of the moon and sun, depth and topography. On the Swedish west coast, the largest difference between the highest (flood) and lowest (ebb) water levels amounts to approx. 0.8 m (tidal height), in conjunction with full or new moon.

Information about which reference level is used in a specific chart can be found on the right in the upper margin of the printed charts. Example of how it looks in a newer Swedish chart, where BSCD2000 is used:

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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 and www.smhi.se

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

SMHI och Sjöfartsverket. Publ. 15 May 2019

A uniform reference system from land to sea

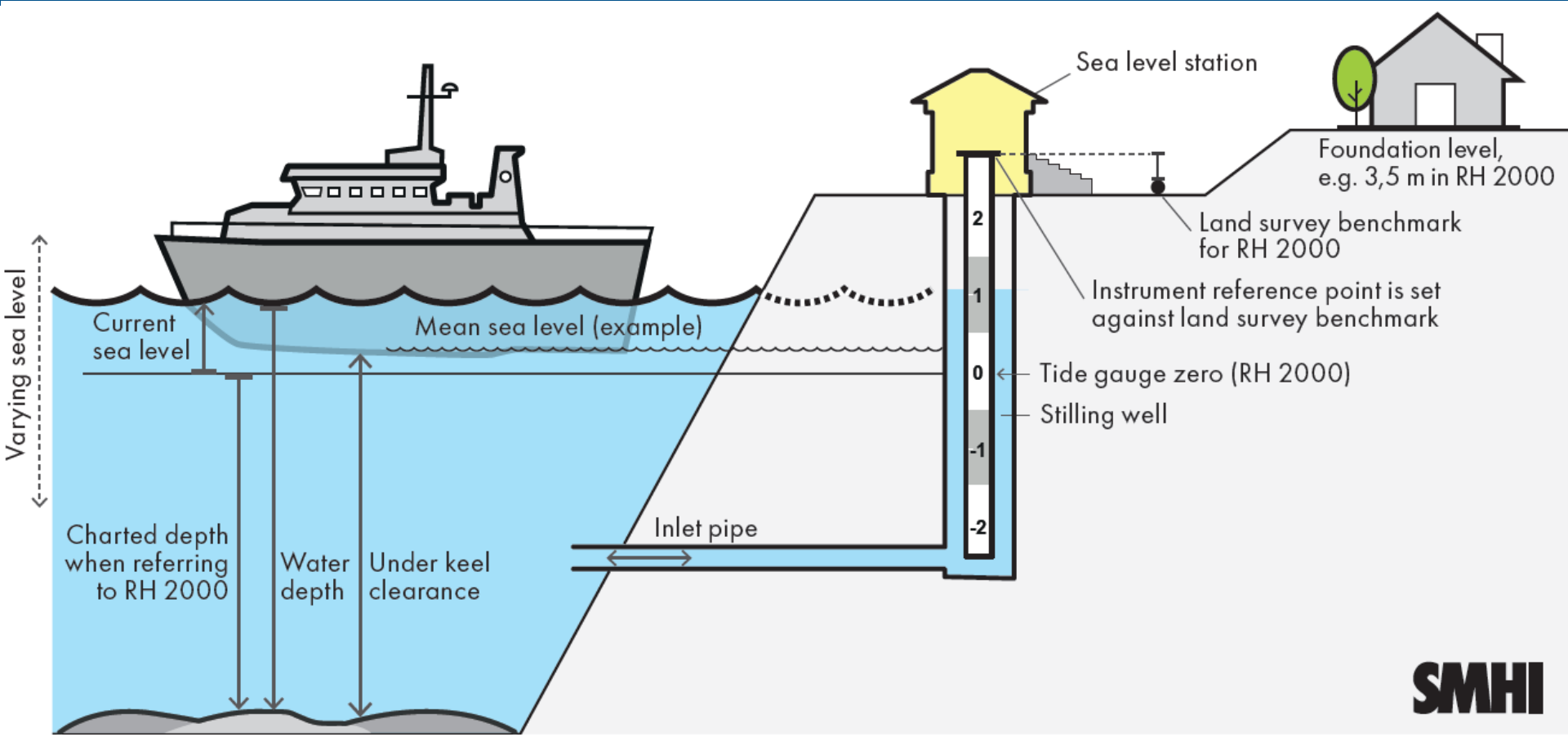

Illustration Veronica Wärn SMHI

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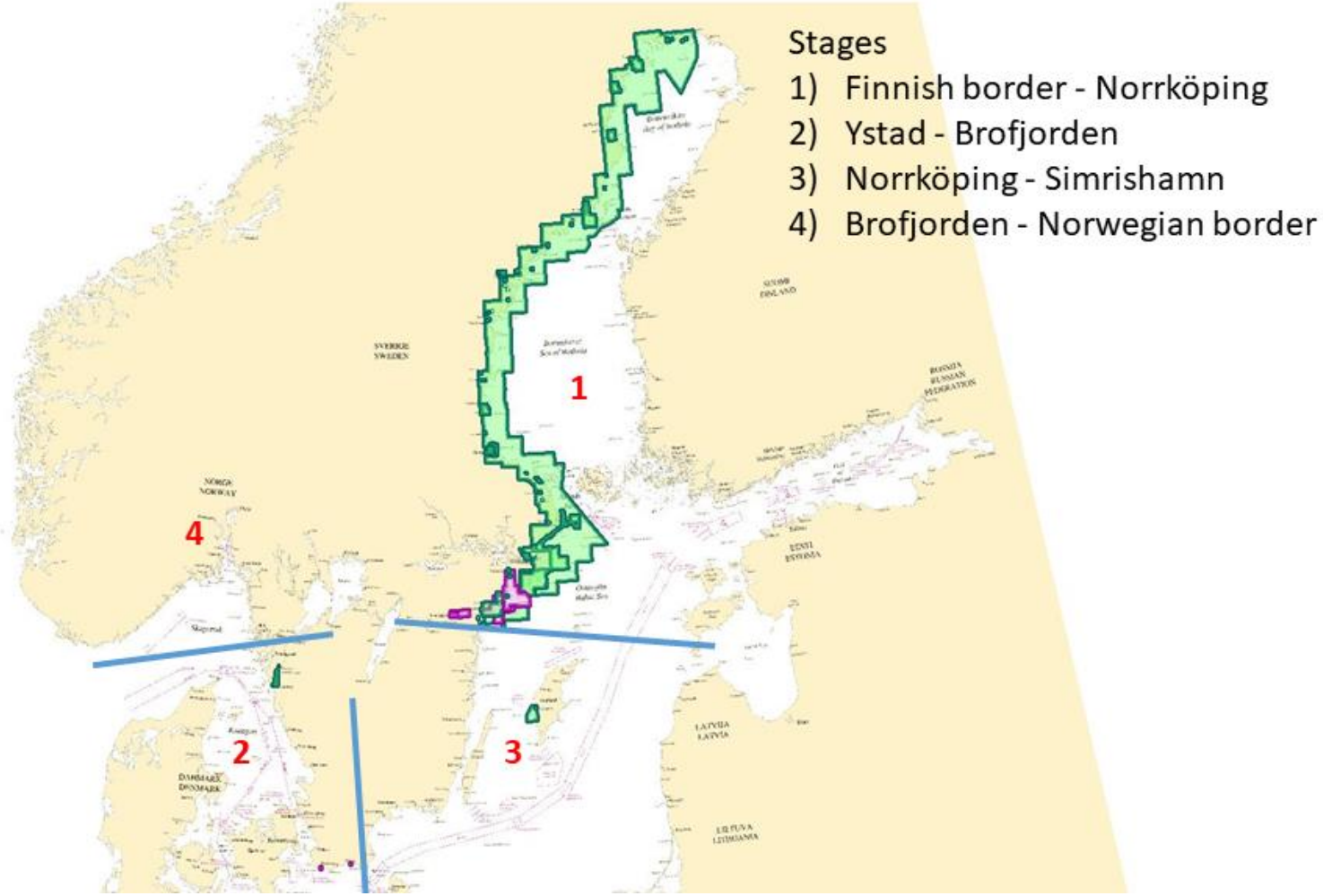
Status transition from MSL to BSCD2000 in nautical charts

Chart Improvement Project (status 2024-03-19)



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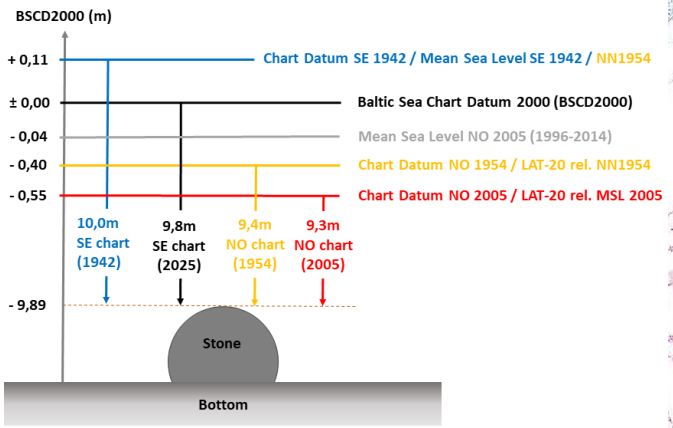
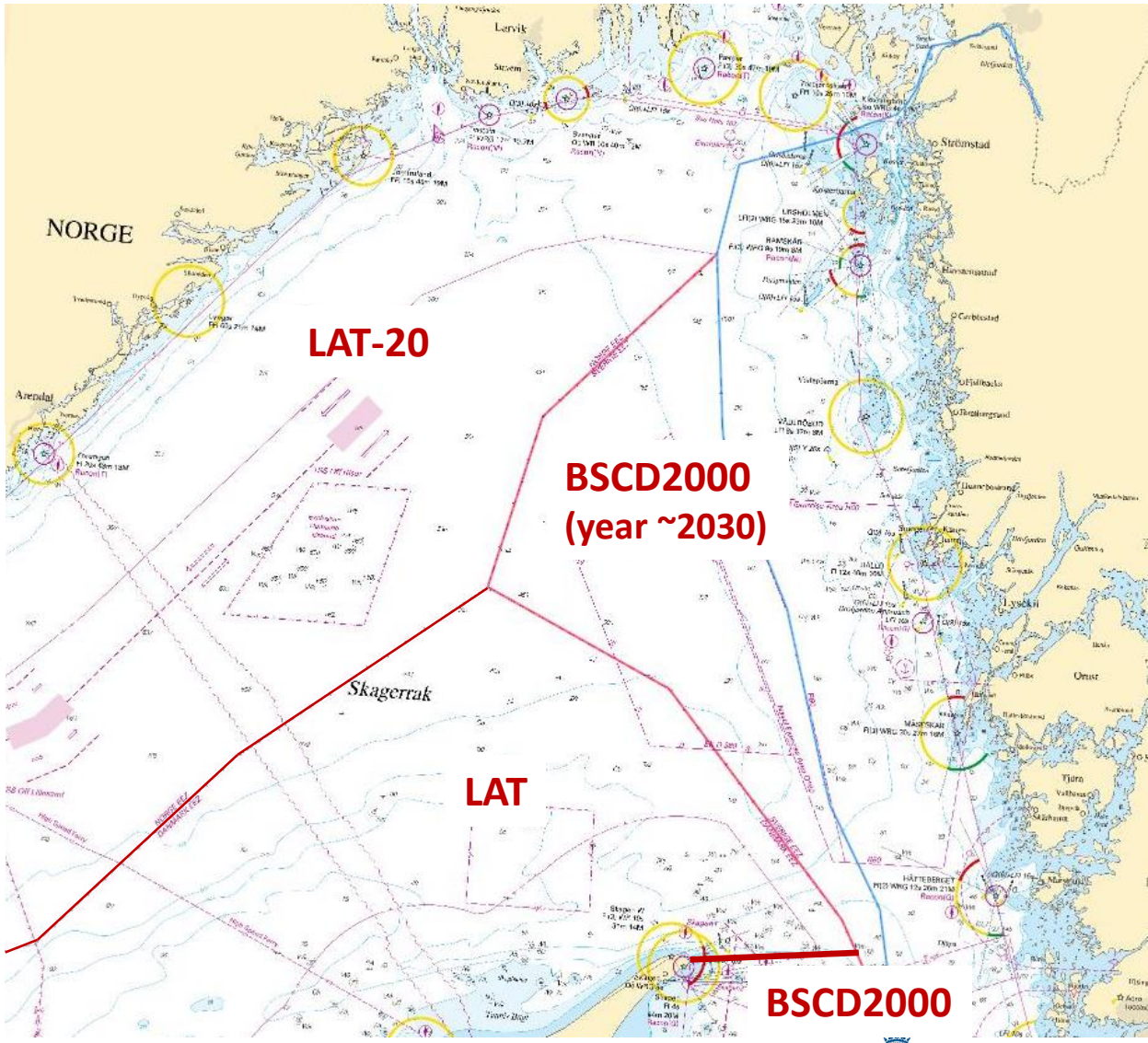
Reference levels in Skagerrak

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

Chart datum Skagerrak (Swedish-Norwegian border)





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Co-financed by the European Union
Connecting Europe Facility

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

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

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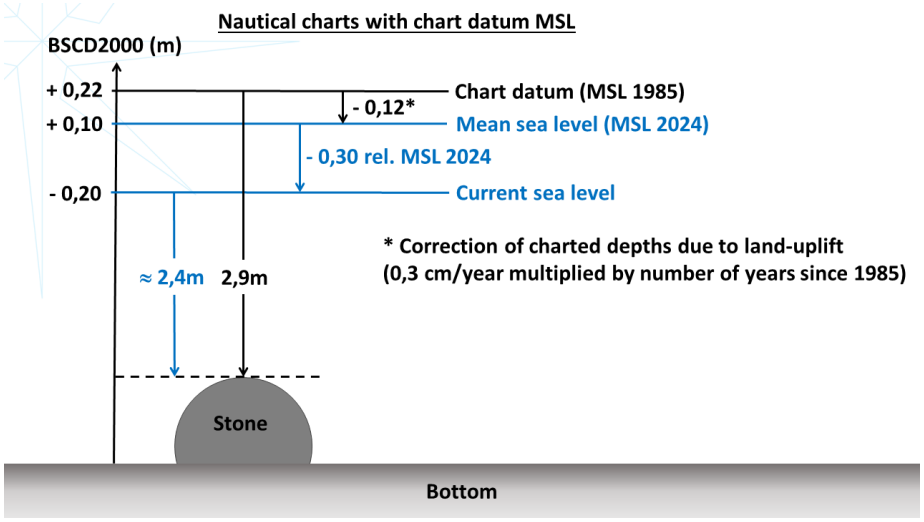
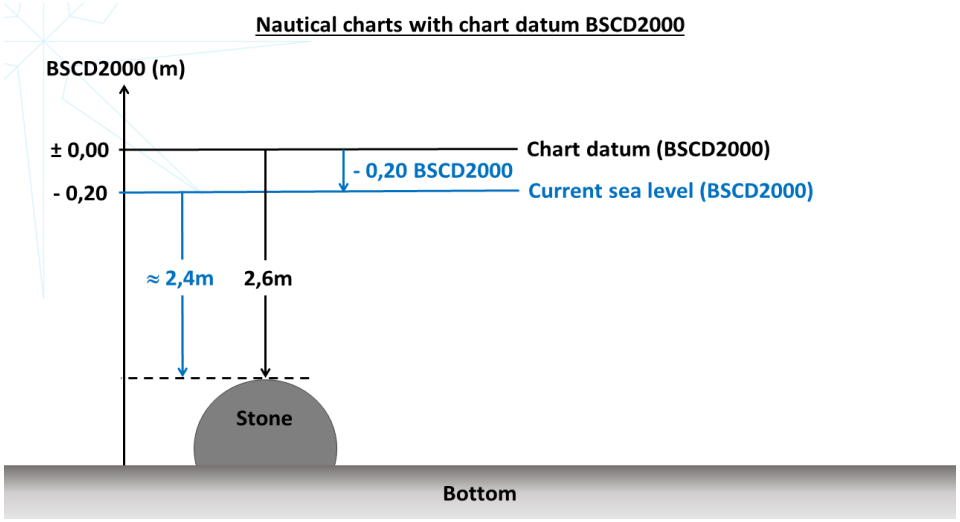
Nautical charts with chart datum MSL or BSCD2000

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

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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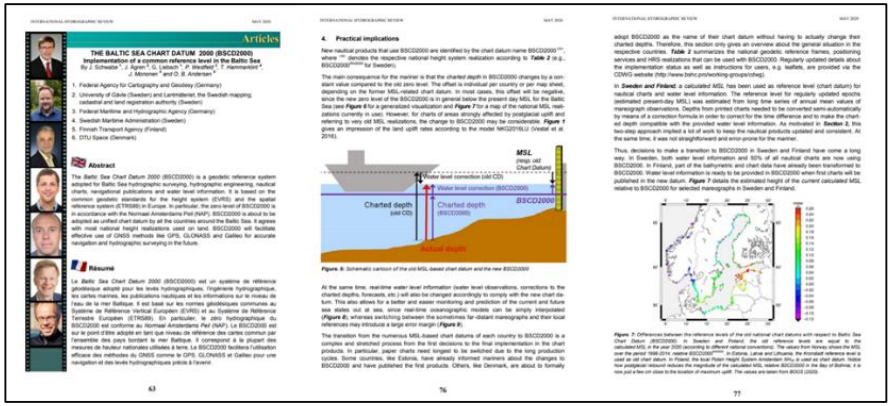
More information

Articles, fact-sheets and web pages about Baltic Sea Chart Datum 2000:



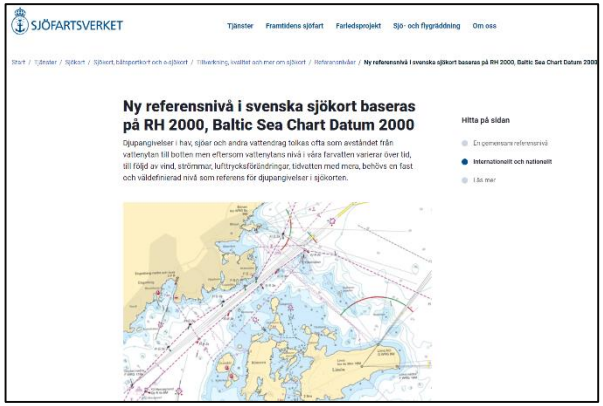


Chart Datum, Water level and Currents Working Group (CDWCWG)

"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

Referensnivå

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Thanks!

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