



BUNDESAMT FÜR
SEESCHIFFFAHRT
UND
HYDROGRAPHIE

Draft for a new German chart-datum-surface

Andreas Boesch, BSH



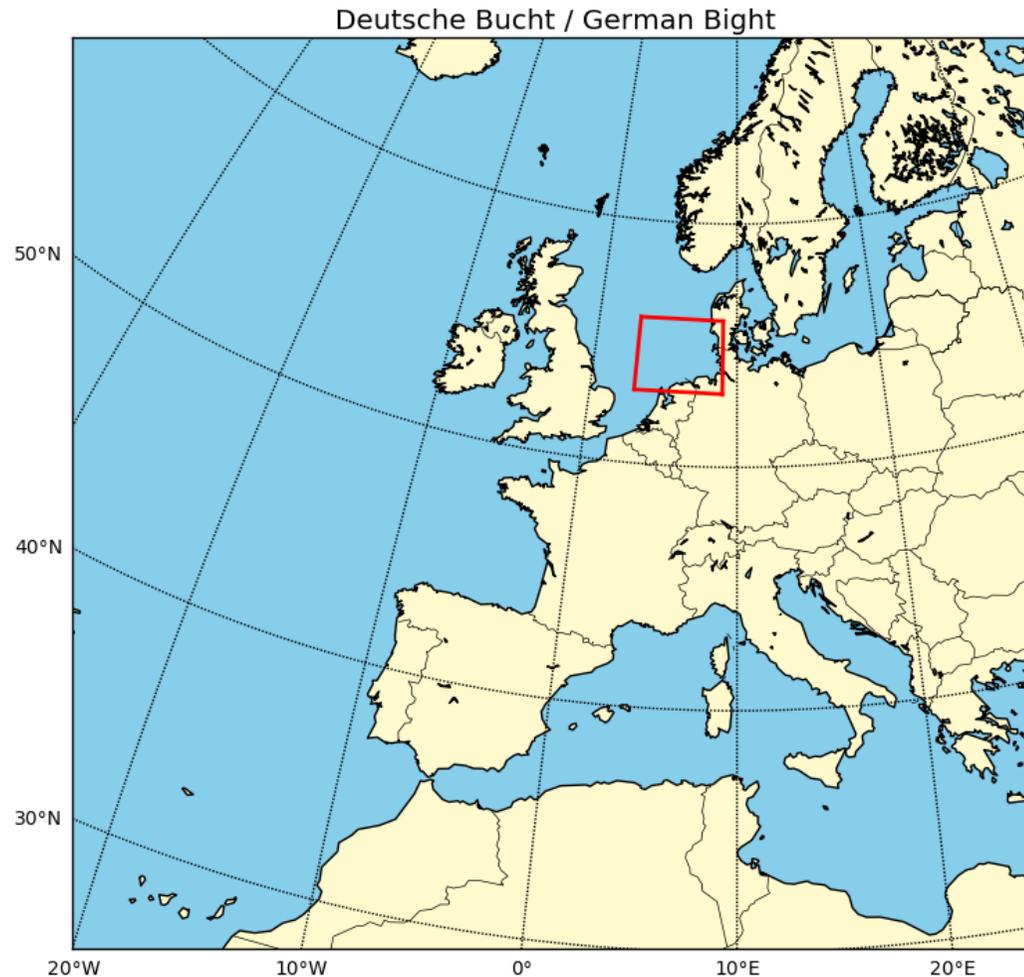
23rd meeting of the NSHC-TWG – Reykjavík – February 5-6, 2020

Area of interest

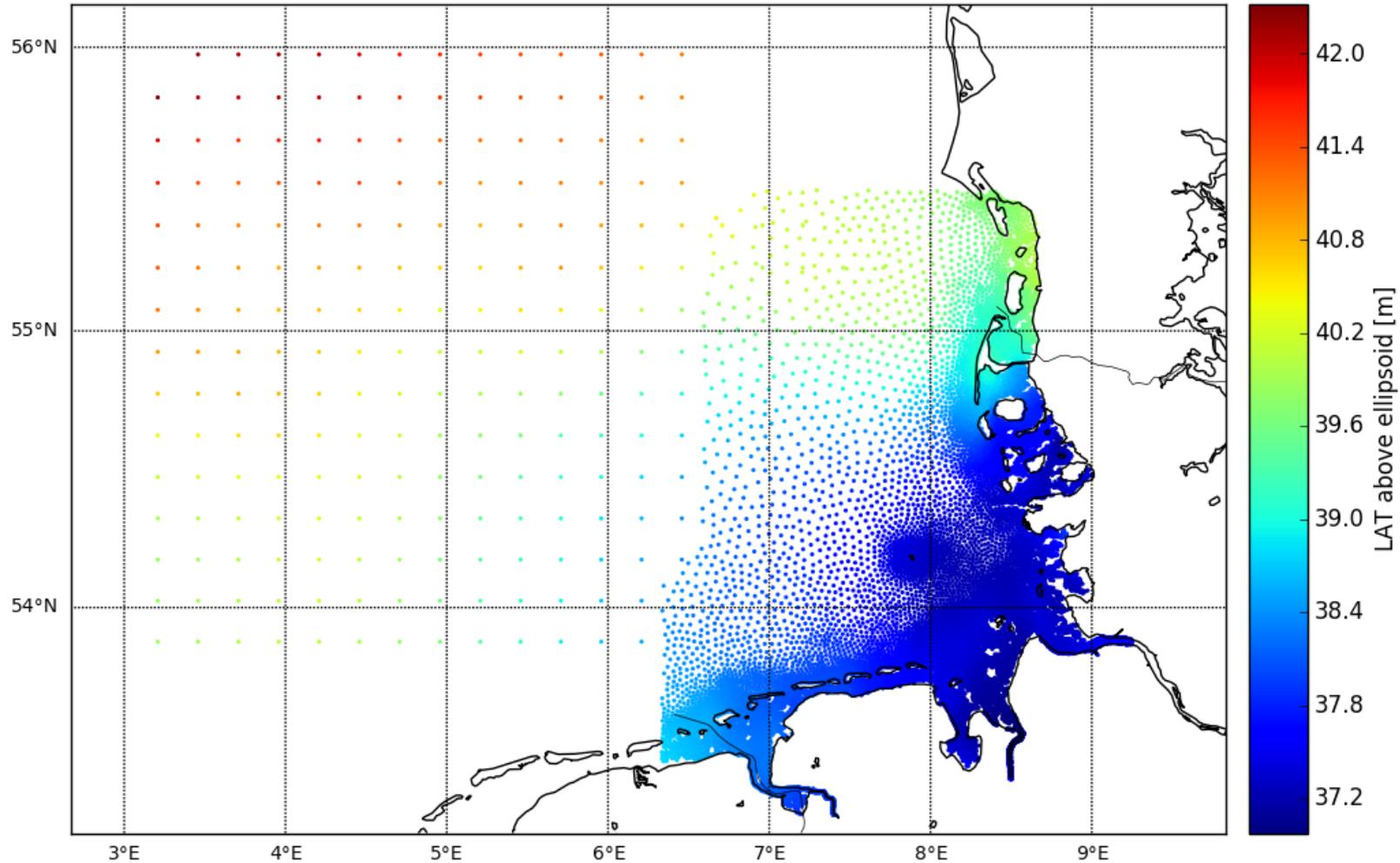
German Bight

53°N - 56°N
8°E - 9.5°E

Tides are complicated
because of shallow
waters and long rivers

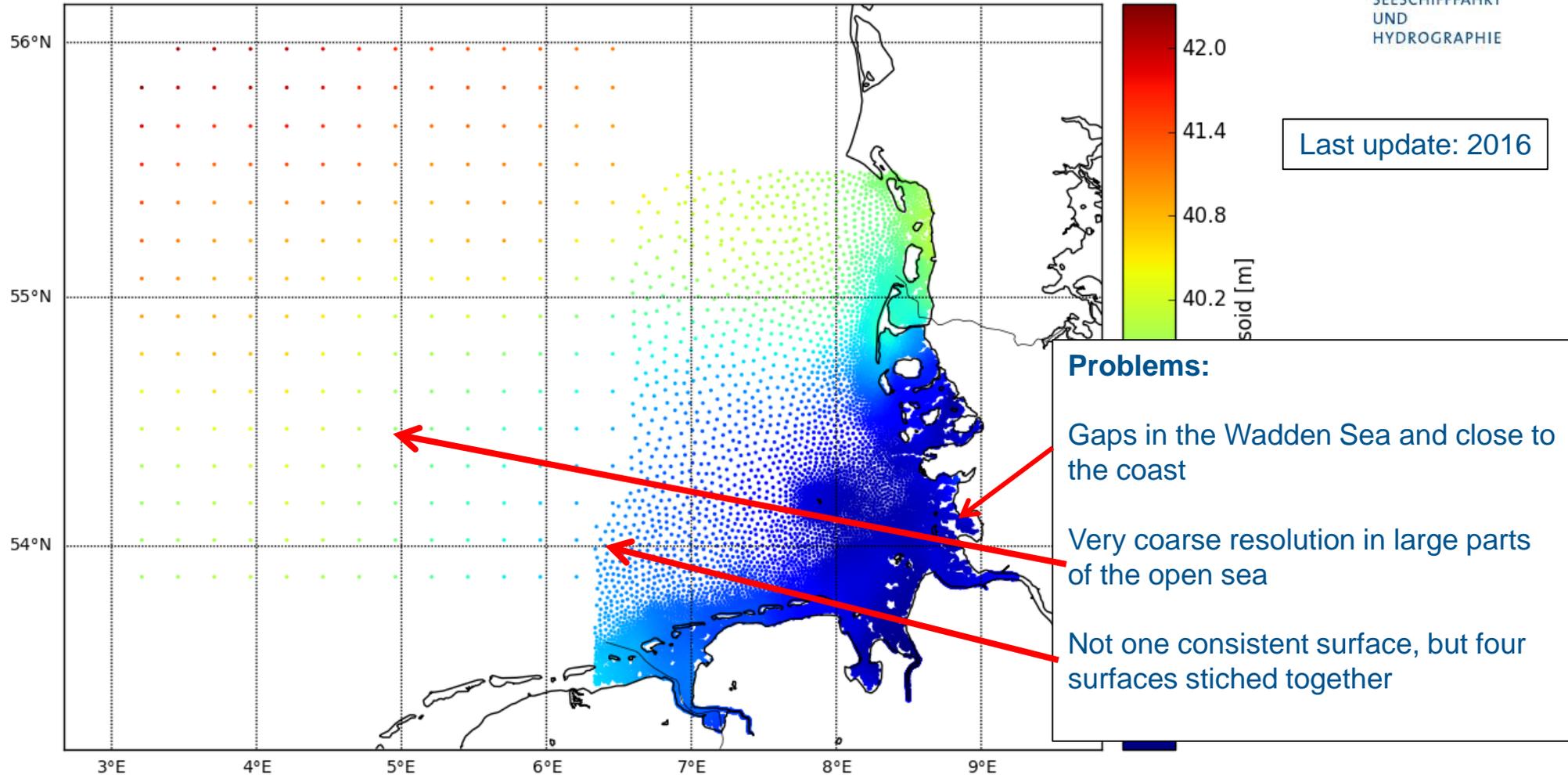


Current chart-datum-surface



Last update: 2016

Current chart-datum-surface



Considerations for new surface & LAT calculation

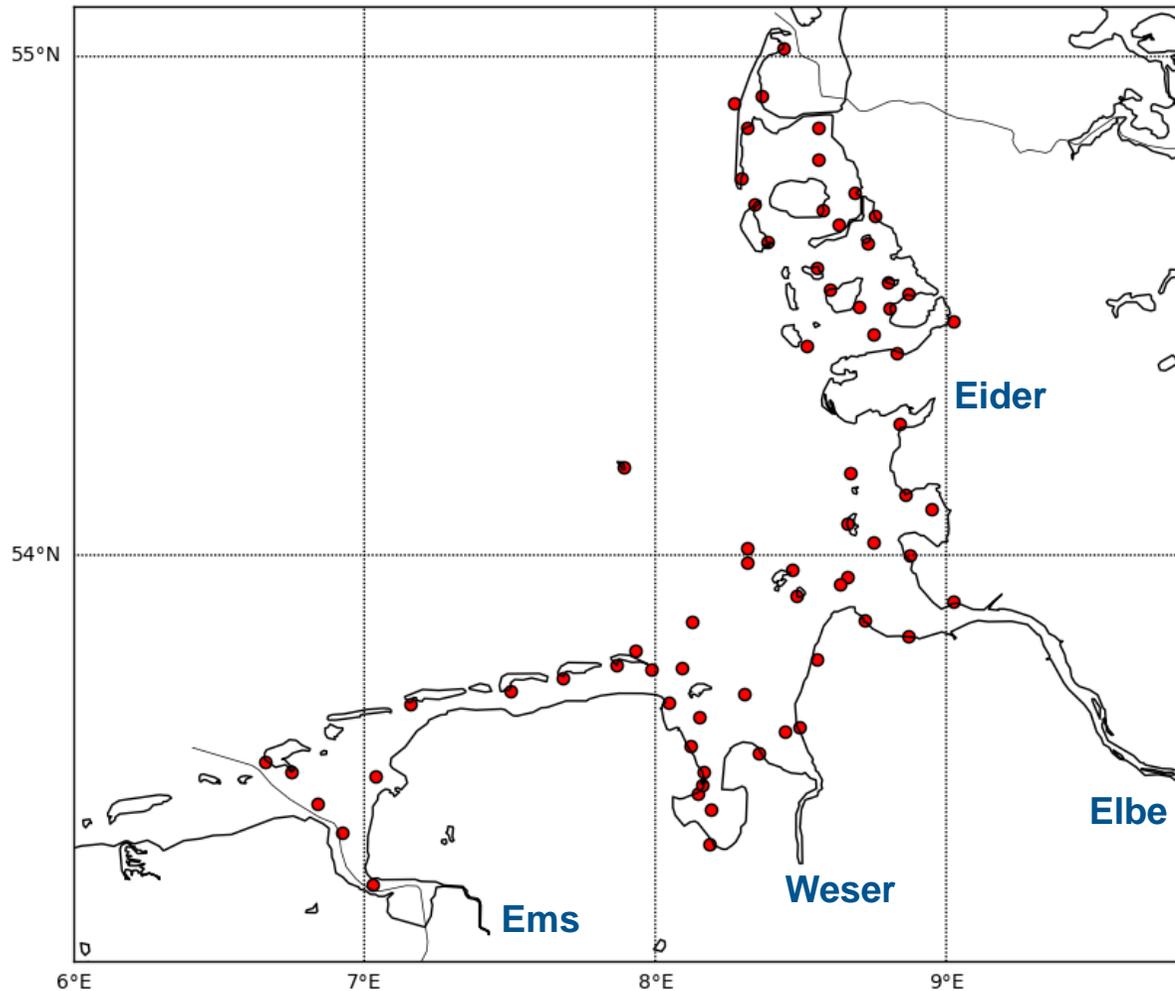
- **One consistent surface with appropriate spatial resolution and no gaps**
- Tides are difficult to simulate close the coast with numerical models
- LAT-values based on tide gauge observation are preferred
-> basis for chart datum (CD) at location of tide gauge
- **LAT calculation:**
Tidal analysis with method „harmonic representation of inequalities“ using 19 years of observational data. LAT is lowest low-water of tidal synthesis.

Boesch, A. & Müller-Navarra, S. (2019). *Ocean Sci.*, 15, 1363-1379.

Müller-Navarra, S. (2013). *Berichte des BSH*, 50.

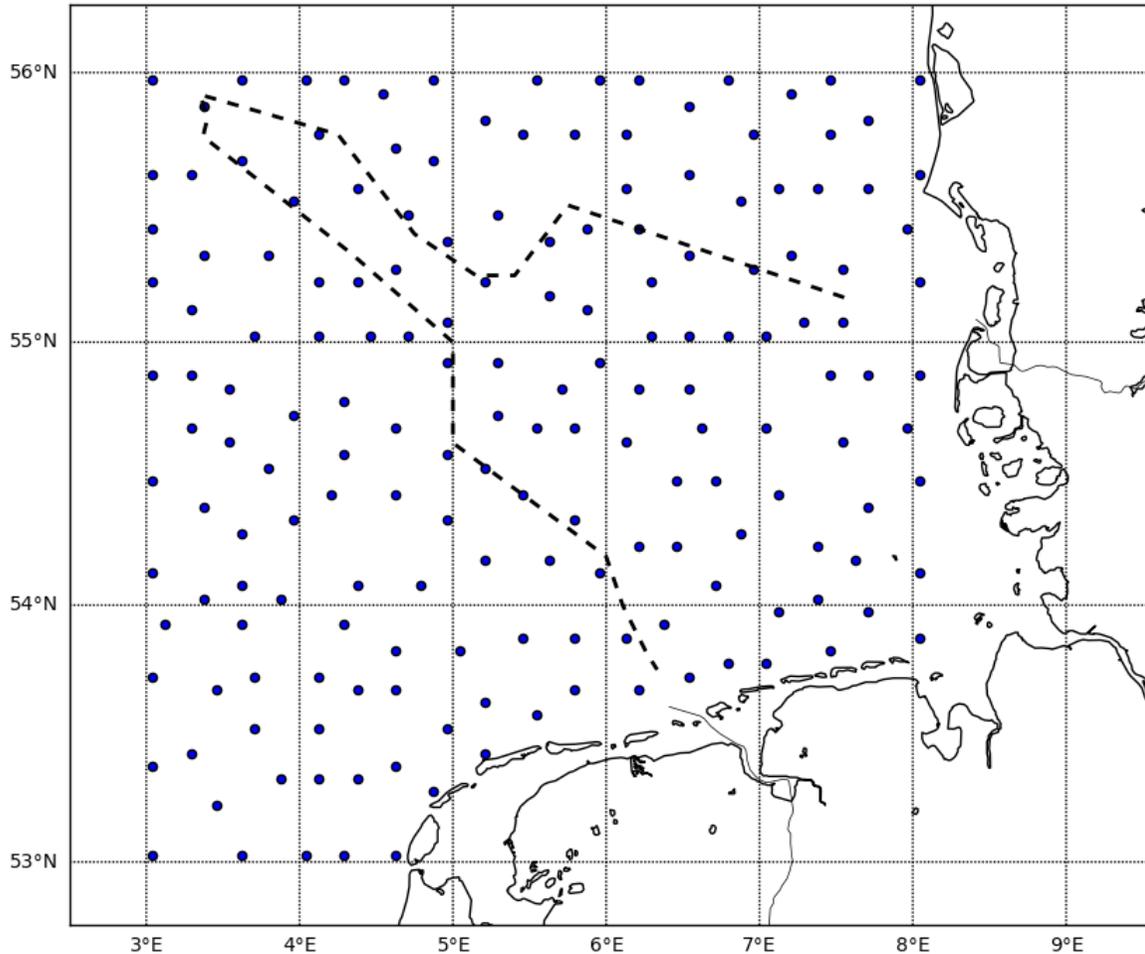
Horn, W. (1960). *Intern. Hydr. Rev.*, 37, 65-84.

Boundary conditions: tide gauges and estuaries



- North Sea CD is based on LAT
- Rivers Ems, Weser, Elbe and Eider have separate CD definitions
- CD at mouth of rivers and at tide gauges are boundary conditions for surface creation
- Tide gauges belong to either State agencies or the Federal Waterways and Shipping Authority (WSV)
- CD at tide gauges are set by different agencies

LAT from hydrodynamic model data

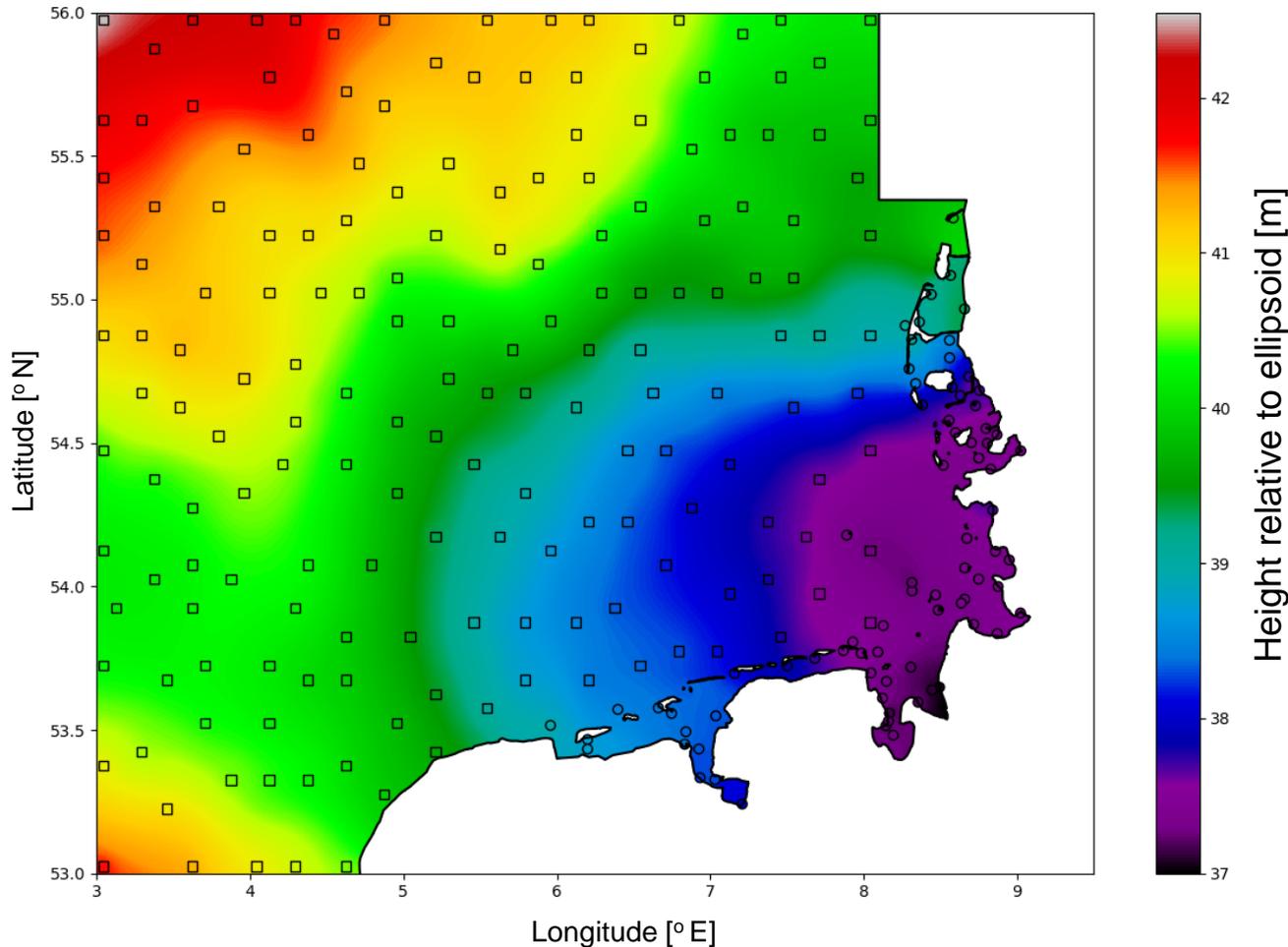


- BSH circulation model (cmod)
- 175 grid points used
- 19 years of simulated water levels at each point (1999-2017)
- Heights of time series corrected to be centered around MSL (\approx NHN)
- Reduction to ellipsoidal heights (ETRS89) using the geoid-model EGG2008

Draft for a new chart-datum-surface complete area



BUNDESAMT FÜR
SEESCHIFFFAHRT
UND
HYDROGRAPHIE



Spatial resolution: ~ 400 m

Input data:

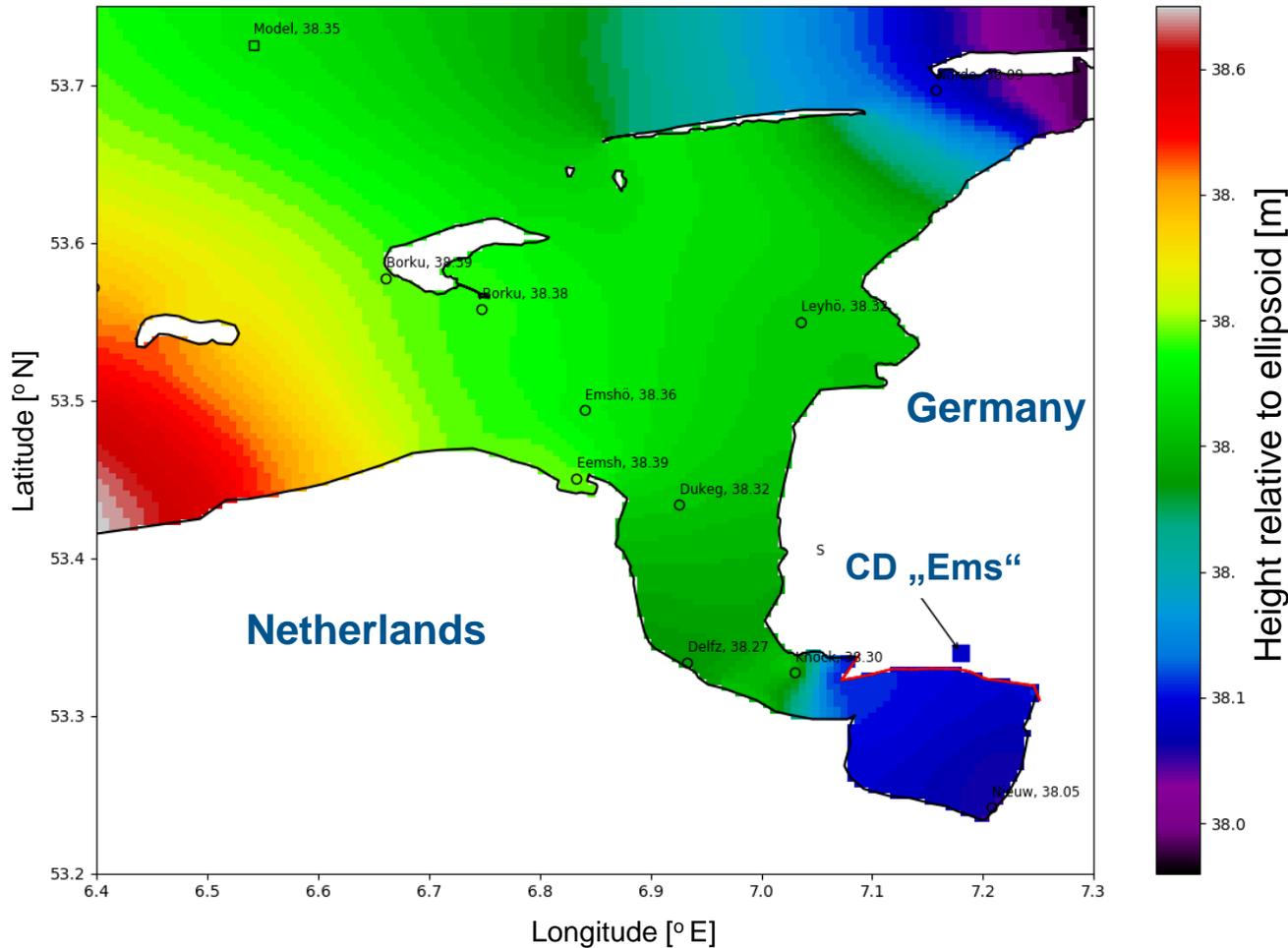
- CD at 66 German tide gauges
- CD datum at 3 Danish tide gauges
- CD at 7 Dutch tide gauges
- LAT at 175 model points

Surface construction method:

- Interpolation with minimal curvature taking into account boundaries (coast line, islands, ...)
- Method adopted from computer vision

Briggs, I.C. (1974), *Geophysics*, 39(1), 39-48
Terzopoulos, D. (1988). *IEEE Trans. Pattern Anal. Mach. Intell.* , 10(4), 417-438
Zoraster, S. (2003). *Computer & Geosciences*, 29, 1175-1182.

Draft for a new chart-datum-surface Mouth of Ems river

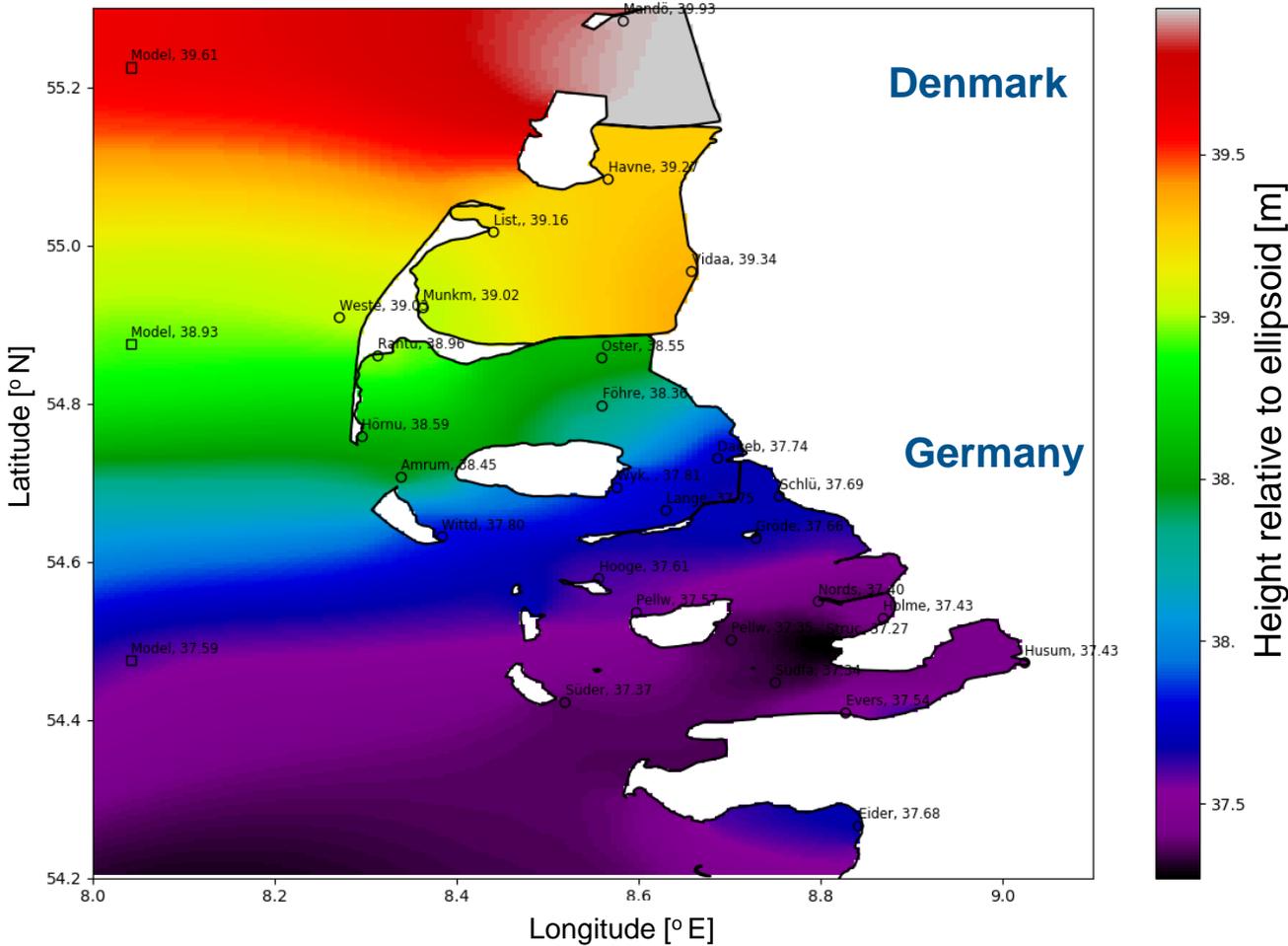


CD/LAT from 7 Dutch tide gauges as published in Dutch tide tables:

- Nieuwe Statenzijl
- Delfzijl
- Eemshaven
- Huibertgat
- Wierumergronden
- Schiermonnikog
- Lauwersoog

Surface matches separate chart datum of Ems river

Draft for a new chart-datum-surface North Frisian coast



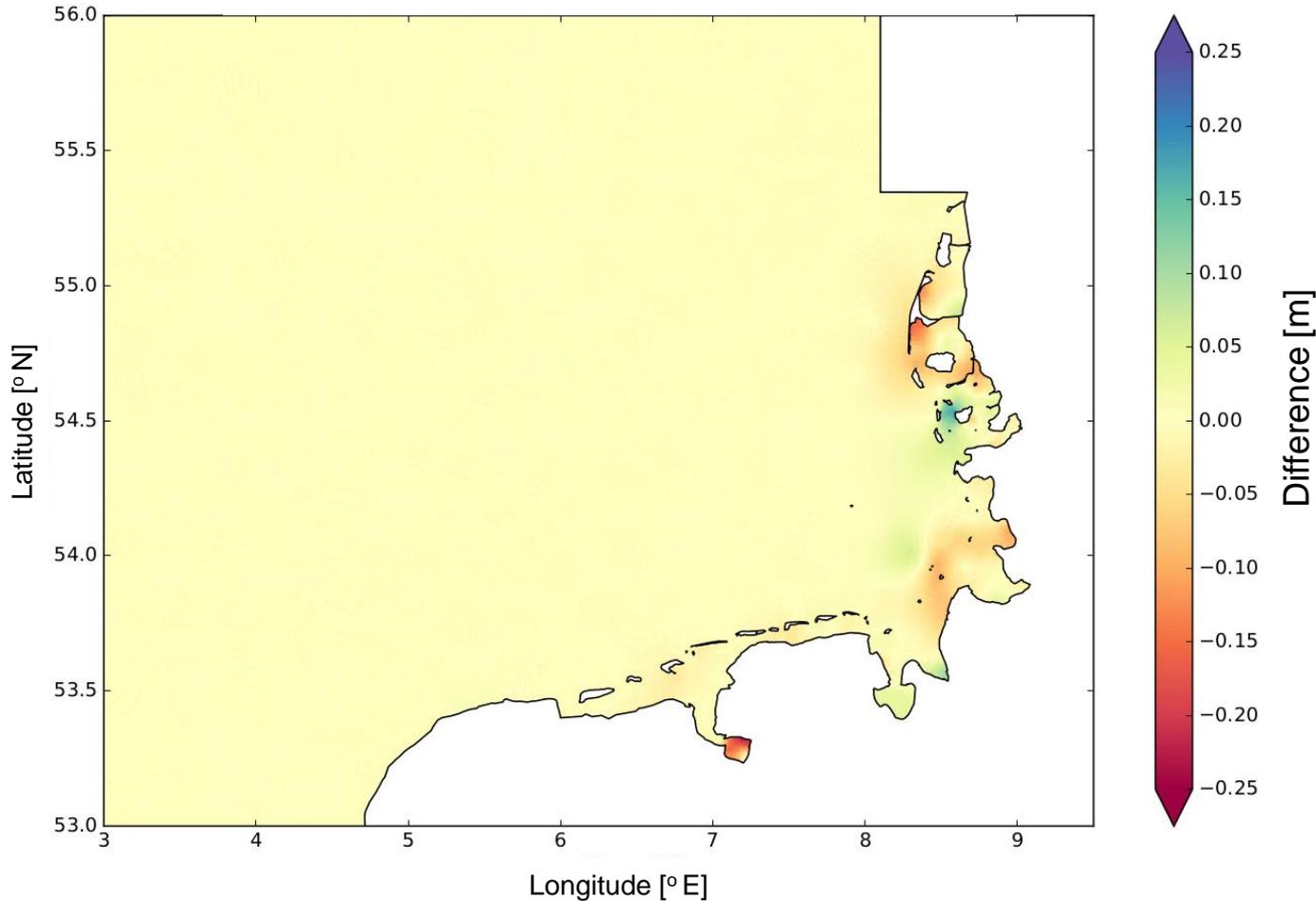
CD/LAT from 3 Danish tide gauges as published in Danish tide tables:

Havneby
Mandø
Vidaa / Hoyer

Surface takes into account dam between mainland and island Sylt

Chart datum vs. „pure“ LAT

LAT – CD

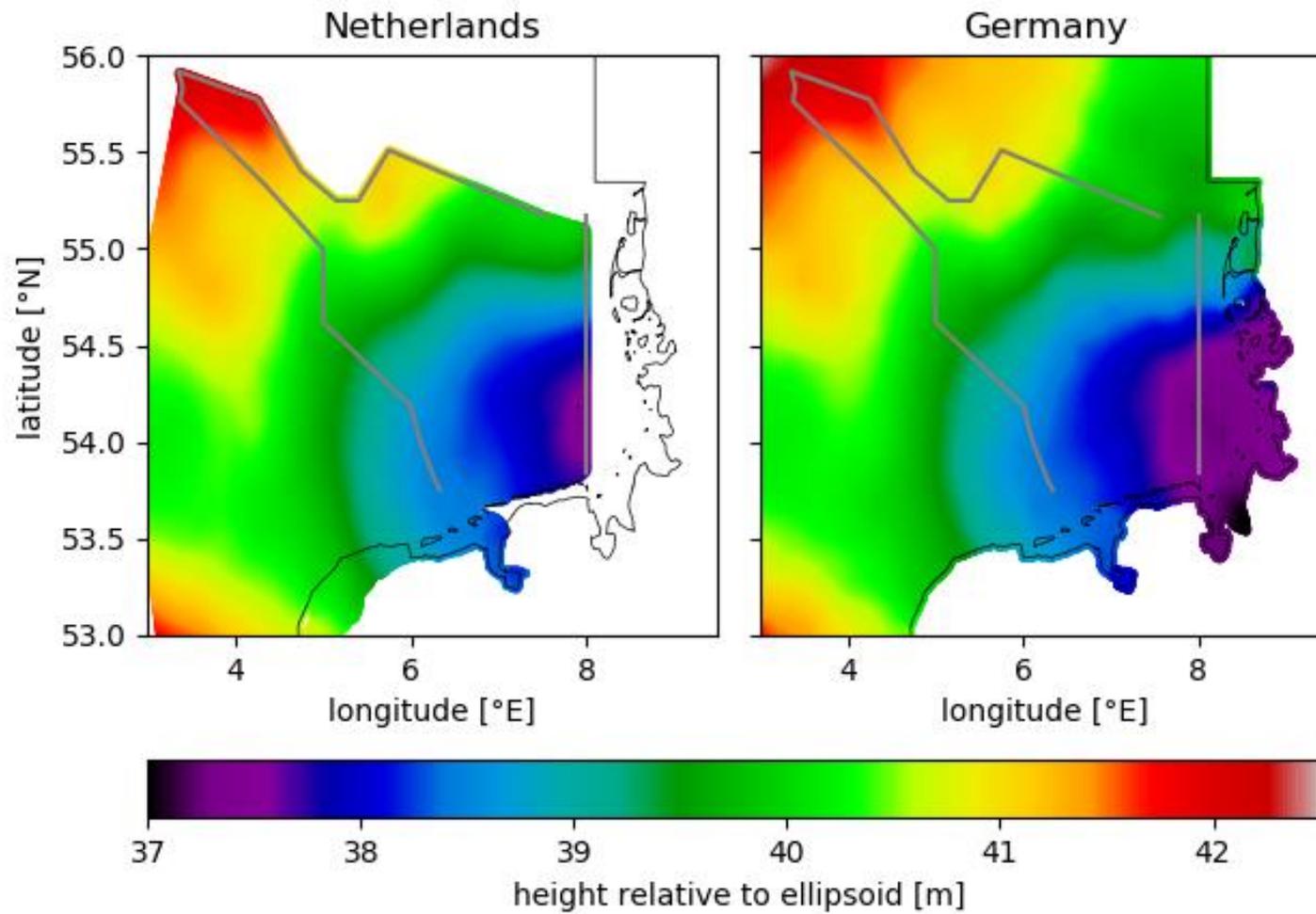


Differences along the coast where chart datum is set manually.

Difference surface:

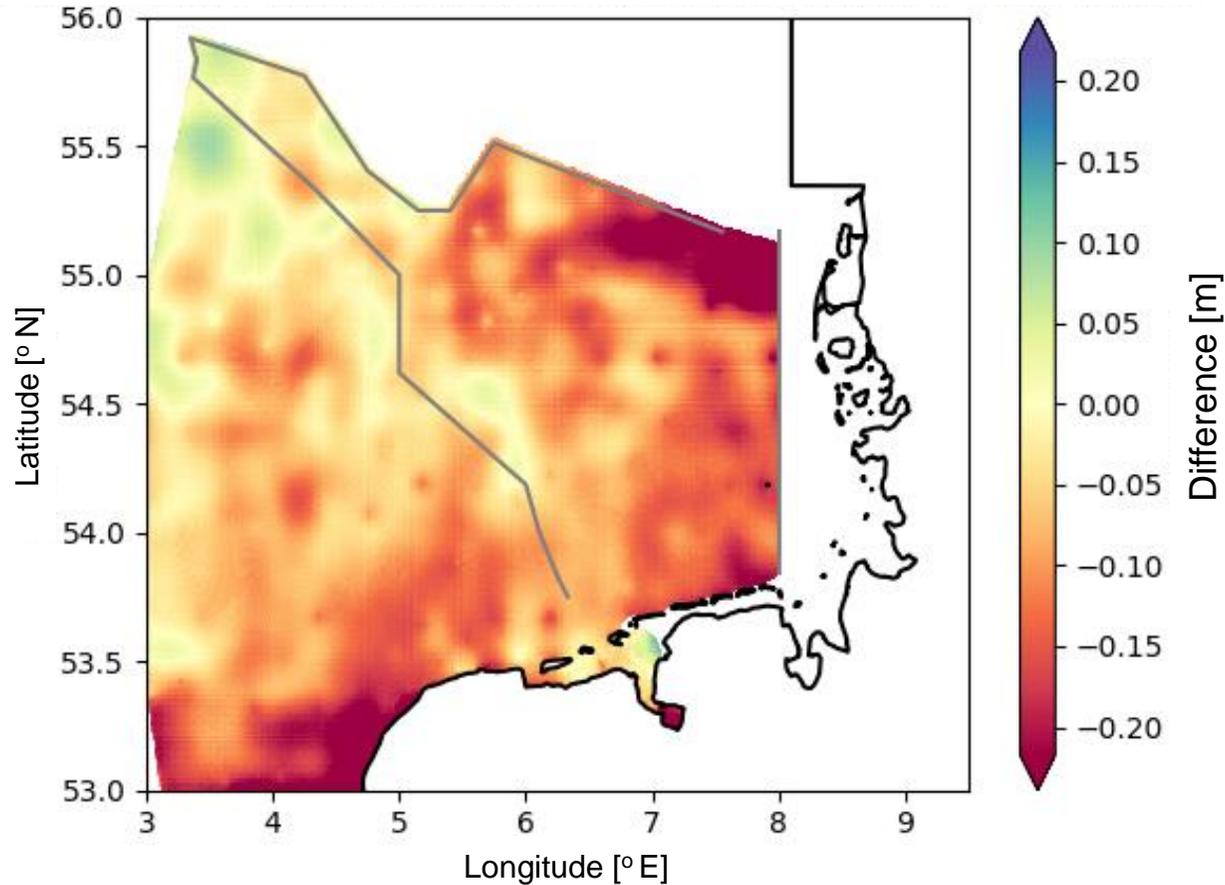
mean = 0.00 m
stand. dev. = 0.01 m
minimum = -0.24 m
maximum = 0.20 m

Dutch and German surfaces



Dutch and German surfaces: differences

Germany – Netherlands (next grid point)



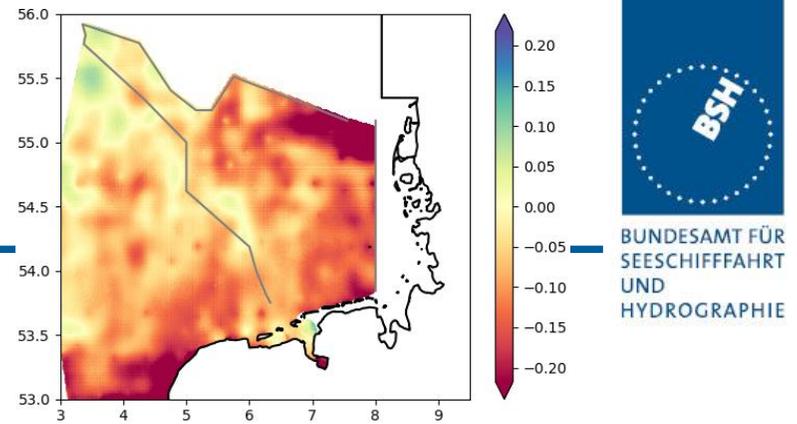
Difference surface:

median = -0.09 m
mean = -0.08 m
stand. dev. = 0.07 m
minimum = -0.55 m
maximum = 0.12 m

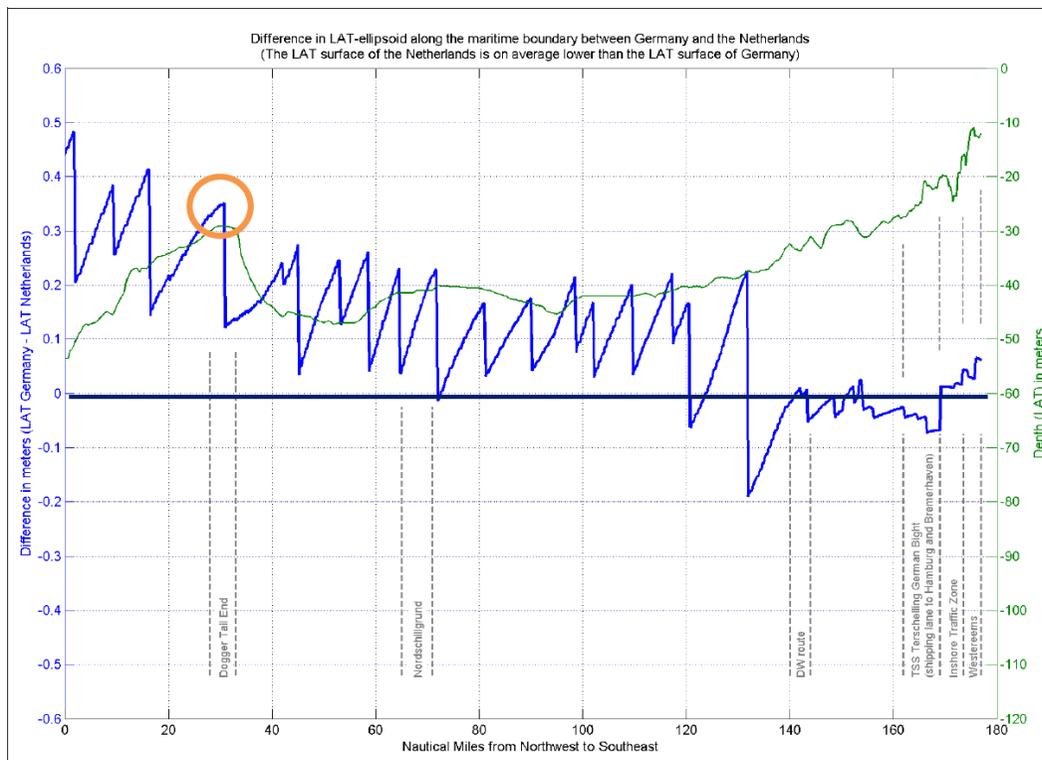
Examples of larger differences:

- Along Dutch coast
- Dollart / Ems estuary
- Danish-German border near island Sylt

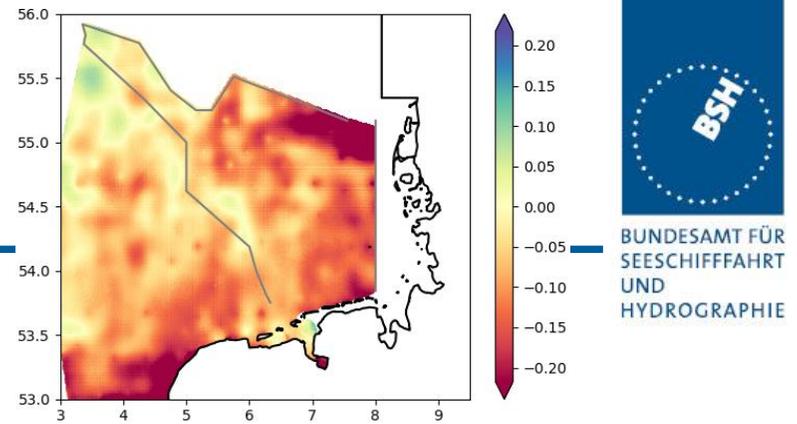
Dutch and German surfaces: differences along maritime border



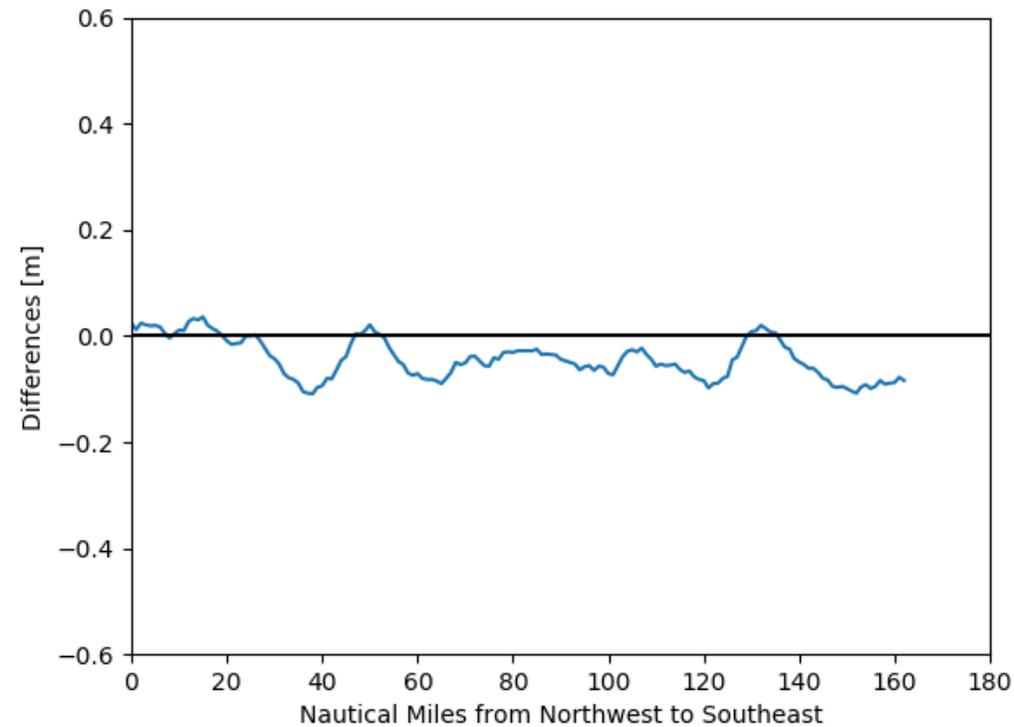
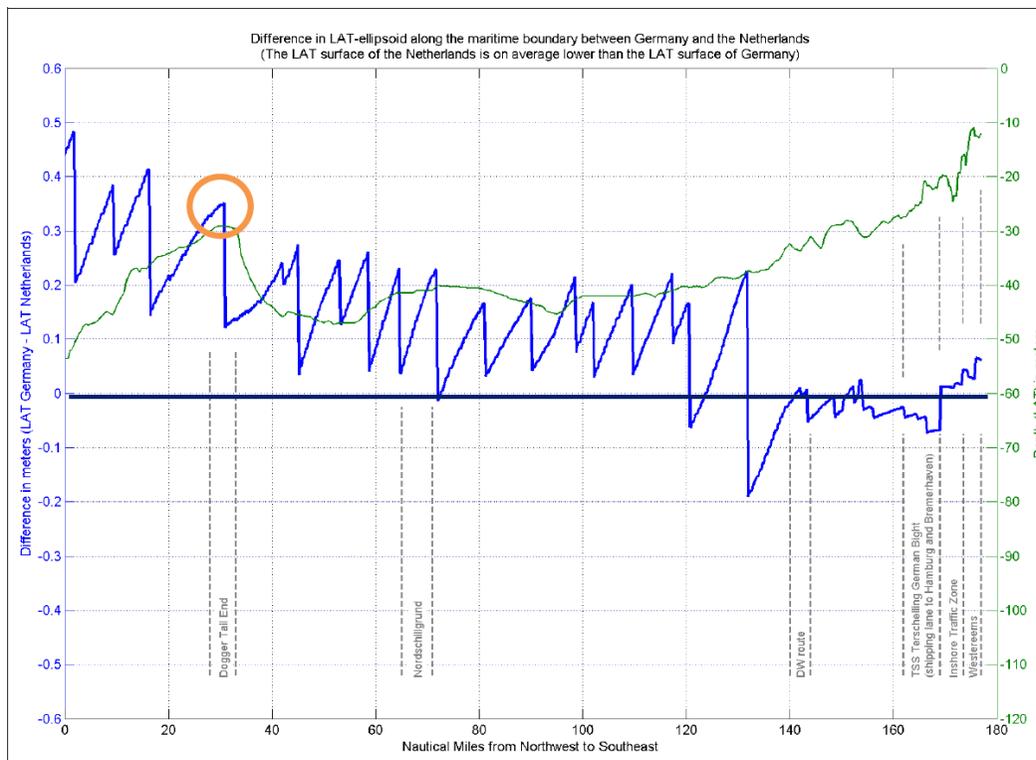
From: Document regarding „1 Percent Norm“
R. Kuilman, 11-10-2017



Dutch and German surfaces: differences along maritime border



From: Document regarding „1 Percent Norm“
R. Kuilman, 11-10-2017



Take-home-message

New version of chart-datum surface has been developed

Uses observations from tide gauges and results from numerical simulations

Differences along Dutch-German border will be smaller

