



BUNDESAMT FÜR
SEESCHIFFFAHRT
UND
HYDROGRAPHIE

Tidal Correction Using GPS – Determination of the Chart Datum



October 9, FIG Congress 2006



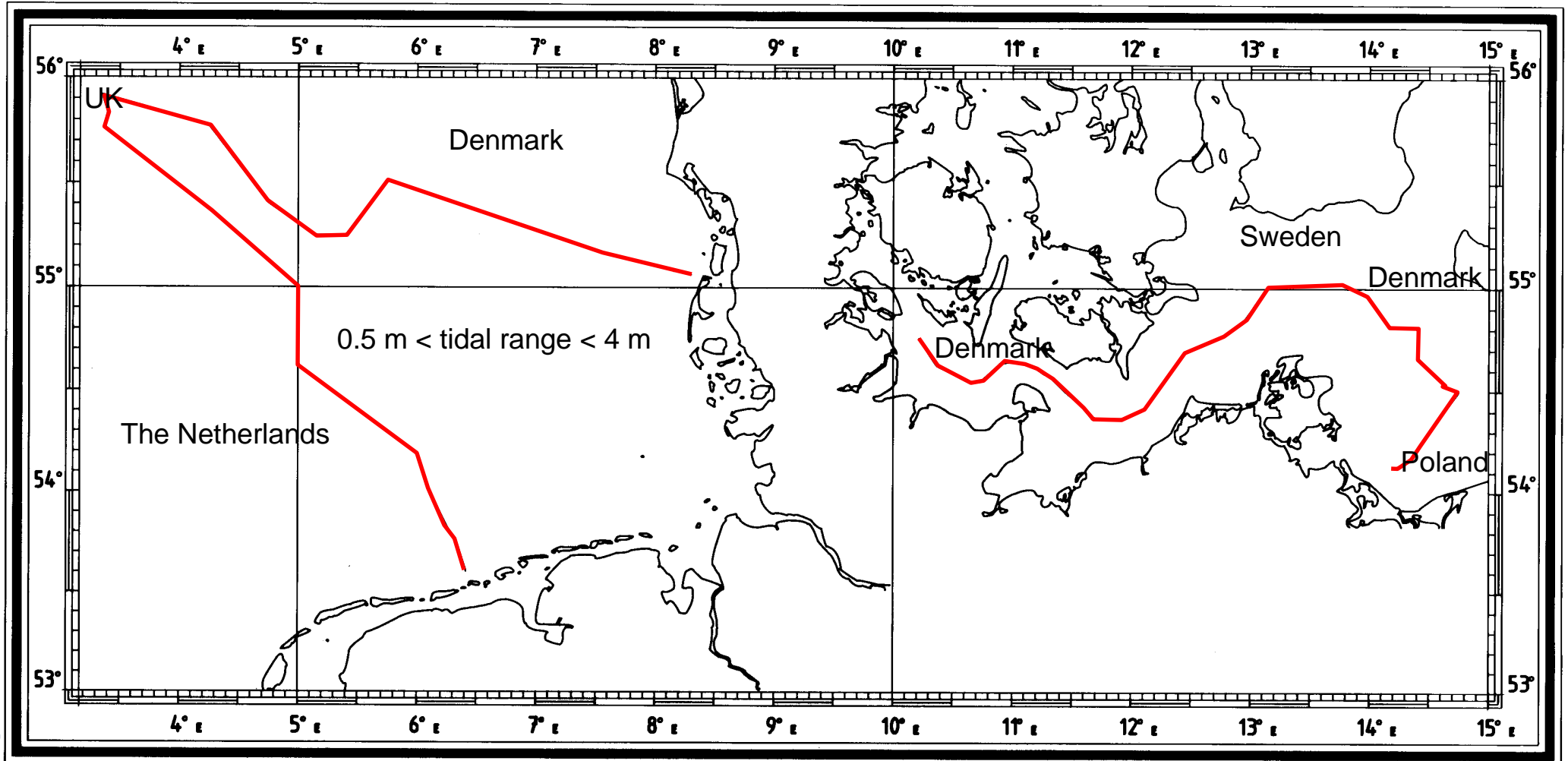
Inhalt

- The Traditional Way of Tide Correction
- Tide Correction Using GNSS
- **Task I: Realisation of the Chart Datum**
- Task II: Use of GPS Correction Data
- First Experience



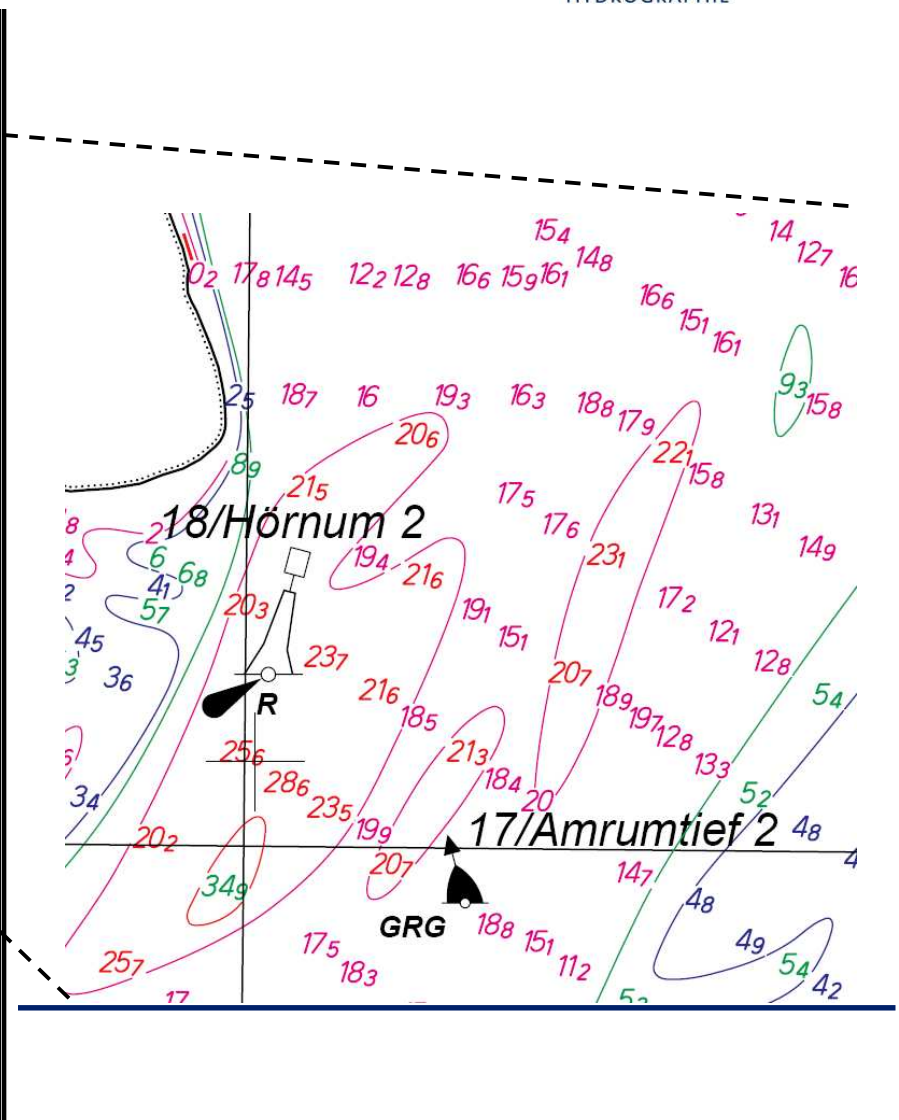
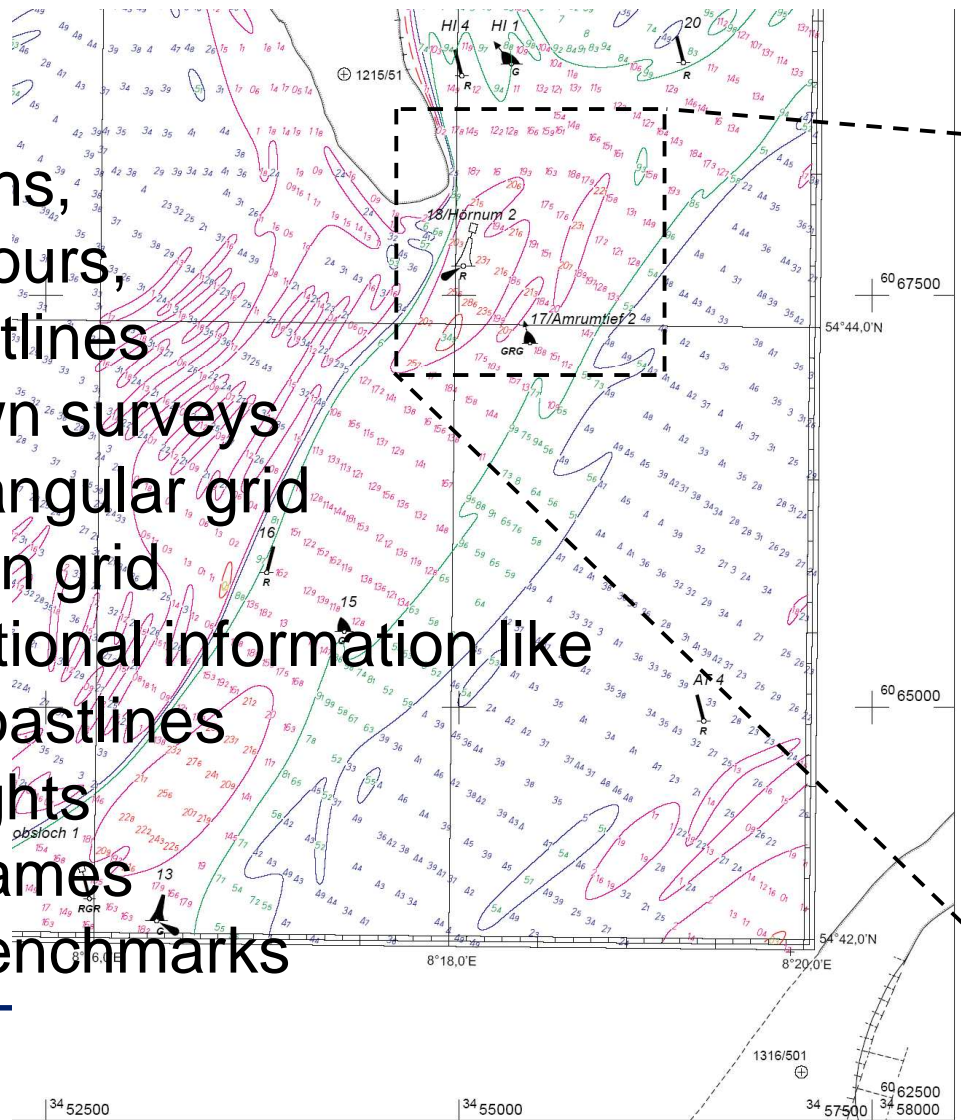
BUNDESAMT FÜR
SEESCHIFFFAHRT
UND
HYDROGRAPHIE

The Traditional Way of Tide Correction

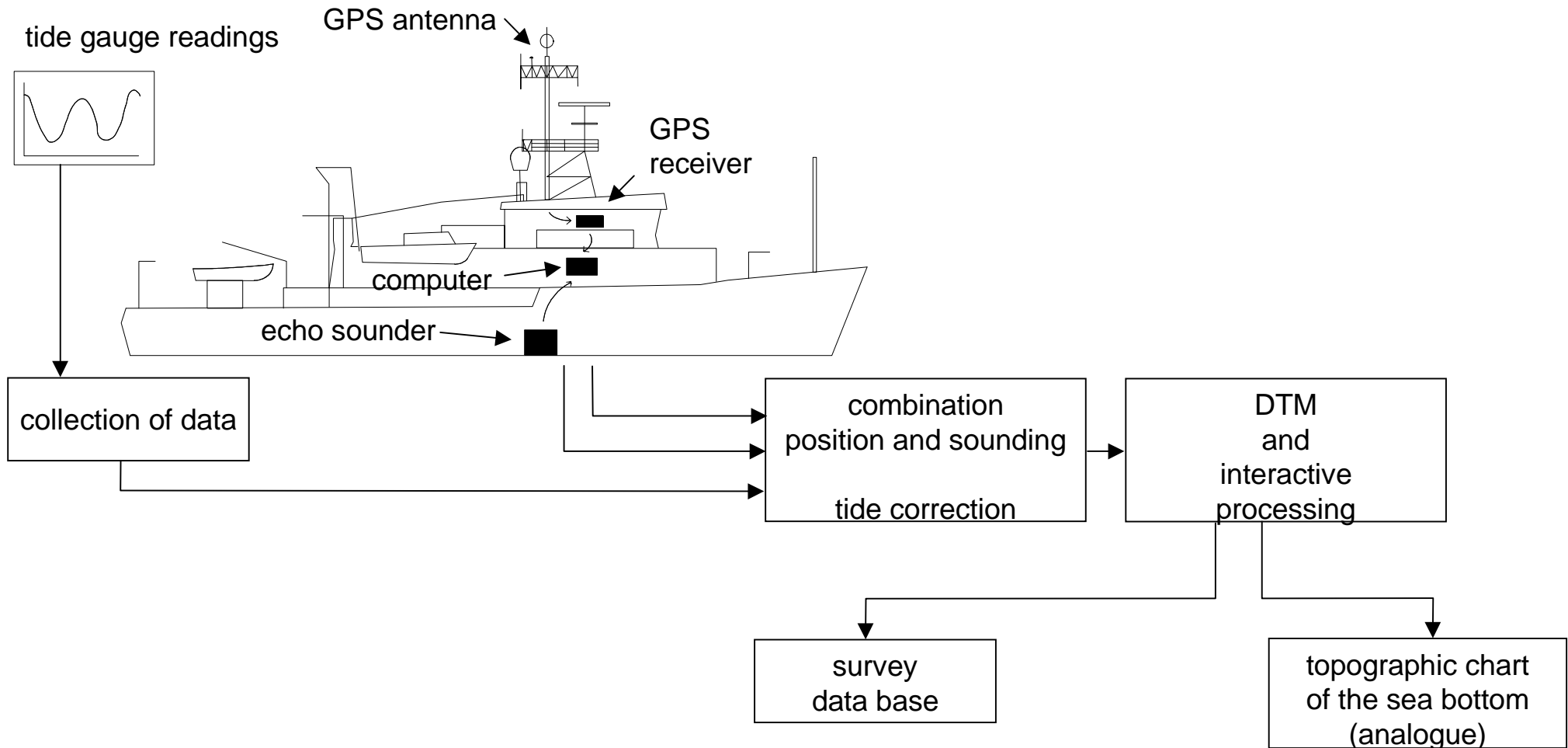


The Traditional Way of Tide Correction

- depths, contours, coastlines
- own surveys
- rectangular grid
- lat/lon grid
- Additional information like
 - coastlines
 - lights
 - names
 - benchmarks



The Traditional Way of Tide Correction



The Traditional Way of Tide Correction

Vertical Reference

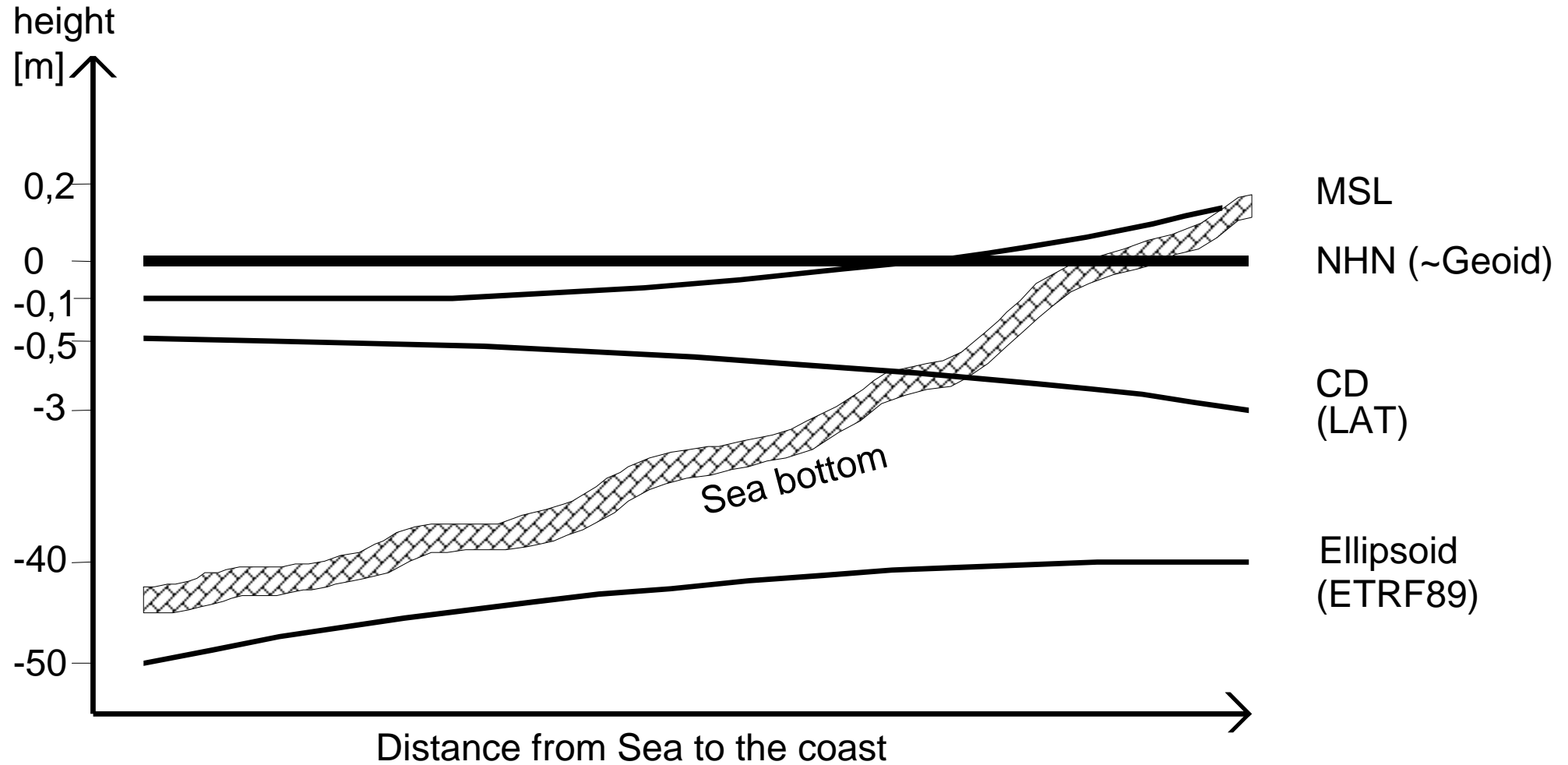
- Chart Datum (CD)
for mariners (charts, navigation, maintenance of fairways,...)
 - Baltic Sea (tidal range < 30 cm)
MSL, referred to terrestrial vertical datum:
Schleswig-Holstein: NN (Normal-Null)
Mecklenburg-Vorpommern: HN (Kronstadt) - 14 cm
 - North Sea (tidal range > 30 cm)
former: MLWSp (Mean Low Water Springs)
since 2005: LAT (Lowest Astronomical Tide)
- Terrestrial vertical datum (German State Survey)
for coastal engineering, ICZM,...
NN (or HN), in future: NHN (Normalhöhennull)



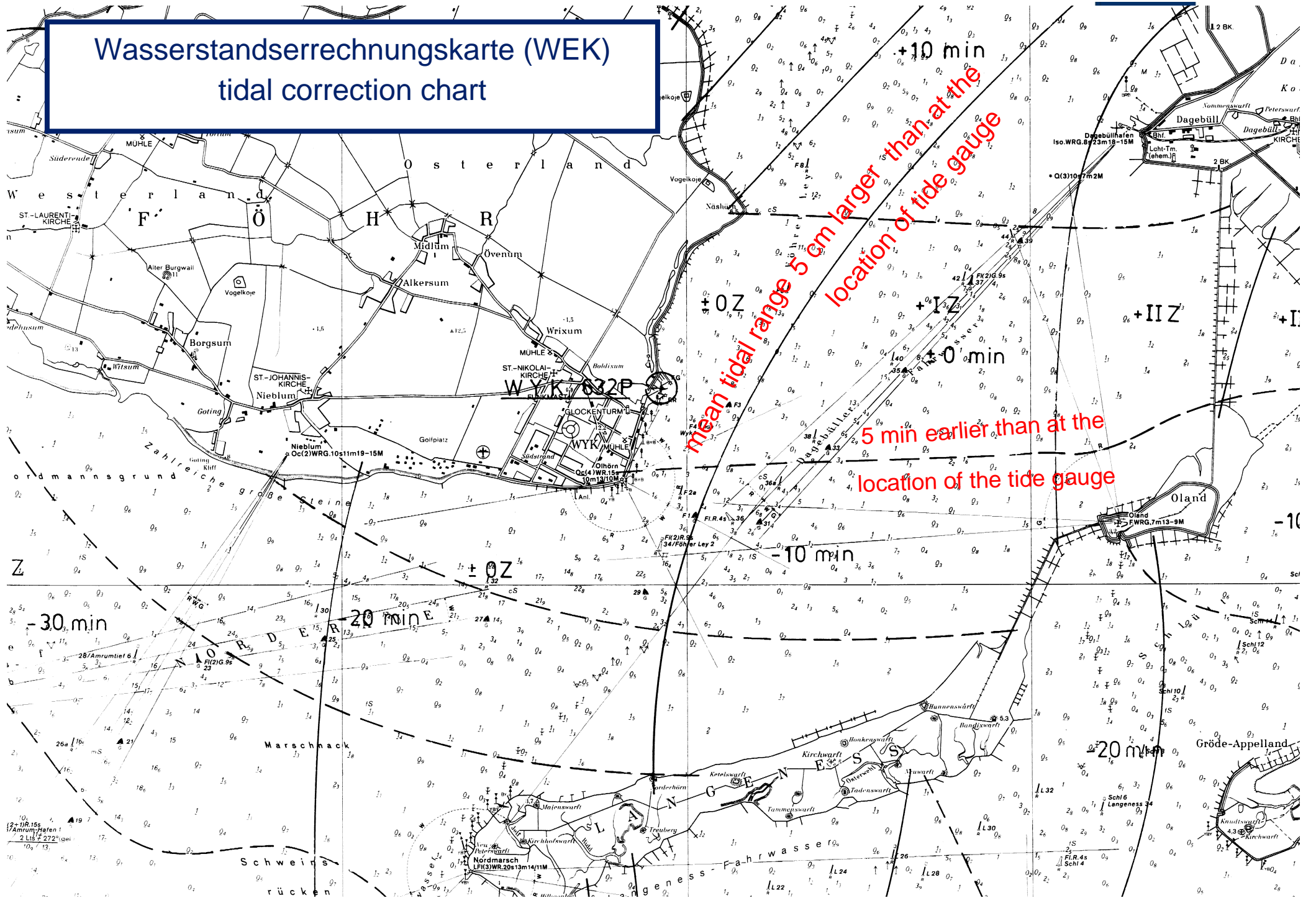


BUNDESAMT FÜR
SEESCHIFFFAHRT
UND
HYDROGRAPHIE

The Traditional Way of Tide Correction



Wasserstandserrechnungskarte (WEK) tidal correction chart



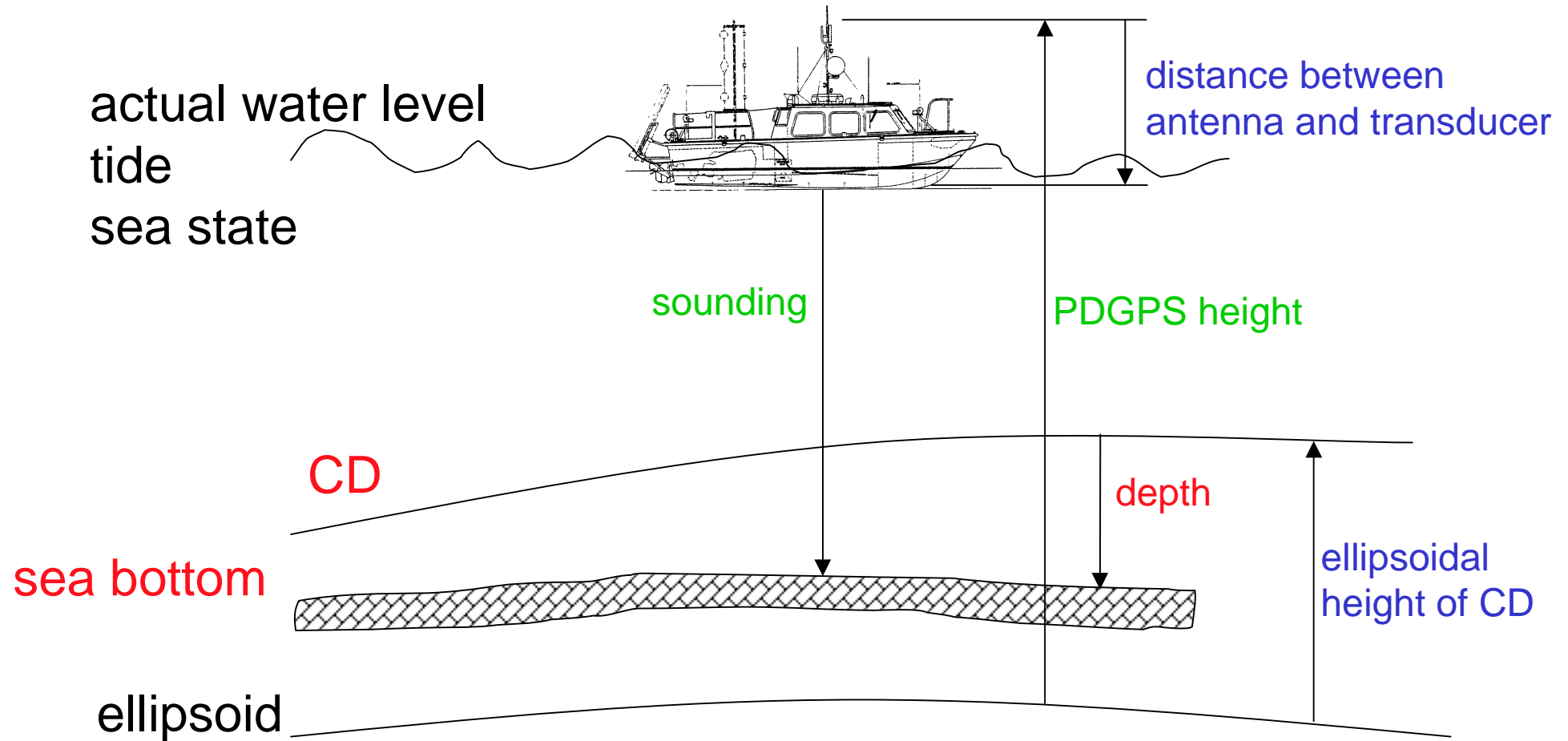


The Traditional Way of Tide Correction

- **advantage**
- suitable for all German tidal waters

- **deficiency of the tide correction using WEK**
- although seamless, the single WEK can be used only in the region of a single tide gauge
- limited accuracy
 - too few basic data to derive accurate and up-to-date WEK
 - net of tide gauges not dense enough
- **limited reliability**
 - **especially when wind direction changes**

Tide Correction Using GNSS

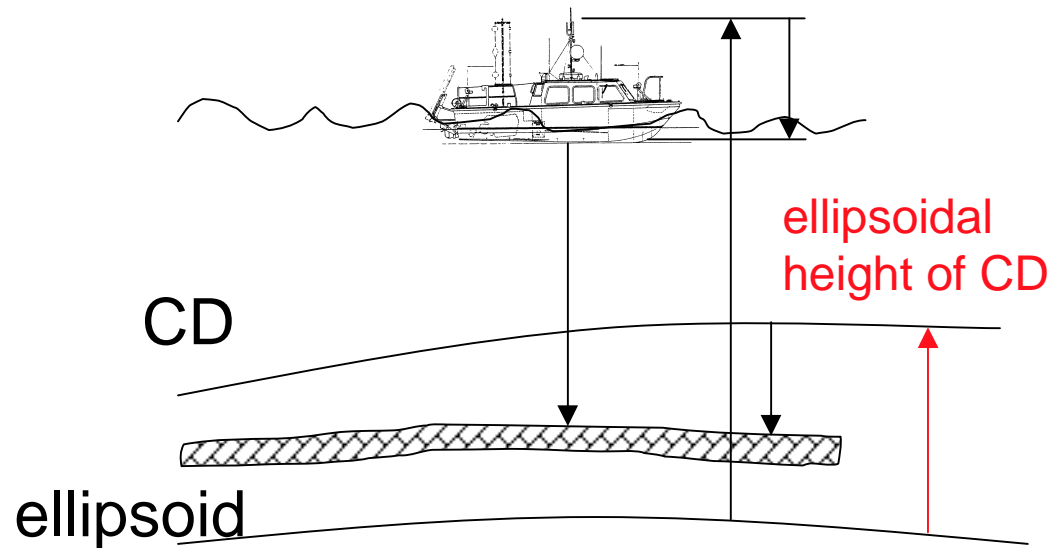


Tide Correction Using GNSS

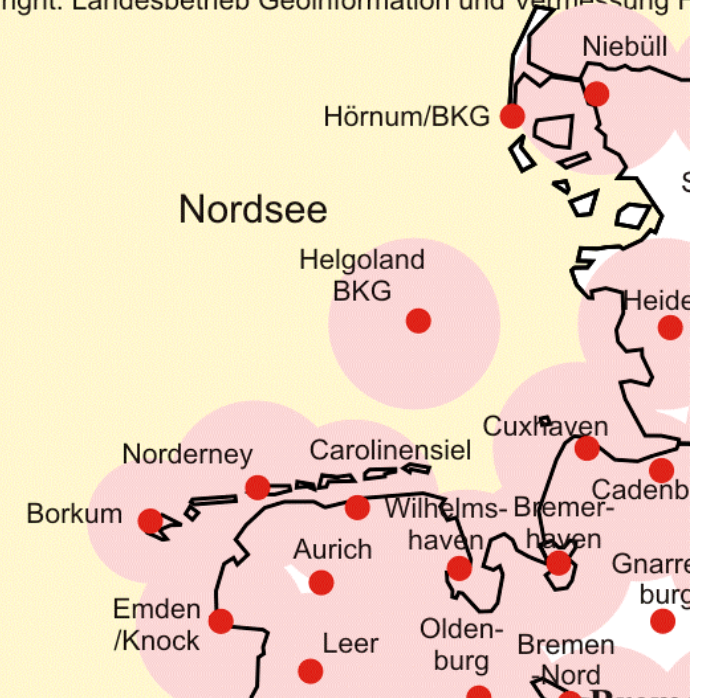
two tasks to be solved

- surface of ellipsoidal heights of the CD
- Production of GNSS heights of suitable accuracy

coverage of correction data services



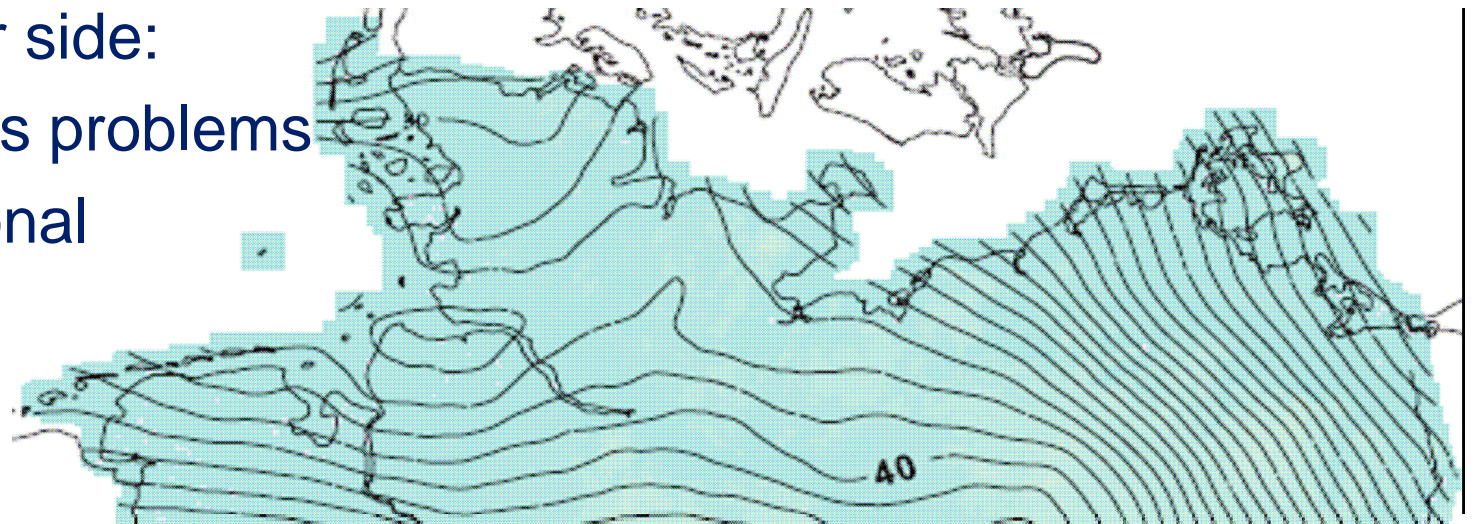
Copyright: Landesbetrieb Geoinformation und Vermessung



Task I: Realisation of the Chart Datum

Baltic Sea

- CD = NN resp. HN (Kronstadt)-14cm, in future NHN
- quasigeoid
 - EGG97 with correction term
 - GCG05 (German Combined Geoid) of the BKG
- but on the other side:
 - there are less problems with traditional correction



Task I: Realisation of the Chart Datum

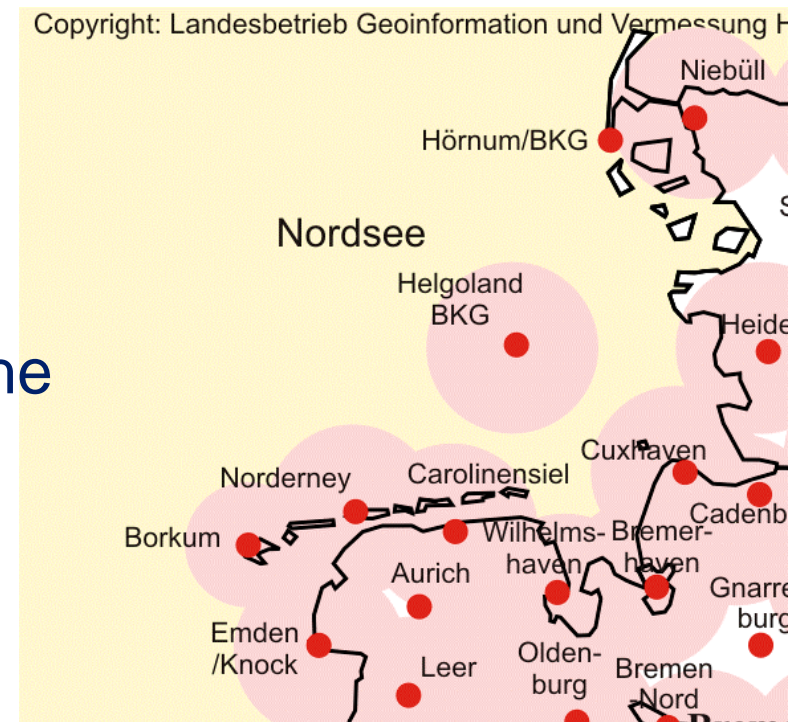
North Sea

- CD = Lowest Astronomical Tide (LAT)
 - up to end 2004: mean low water springs
- Project of the BSH
 - Absolute determination of CD surfaces for the tide correction procedure in the German Bight
 - 2002 - 2005

Task I: Realisation of the Chart Datum

Aim of the project:

- Seamless Chart Datum surface:
 - Lowest Astronomical Tide (LAT)
 - Mean low water springs
 - at least close to the coast
- Reference to the ellipsoid of SAPOS (Satellitenpositionierungsdienst) of the German State Survey (ETRF89)

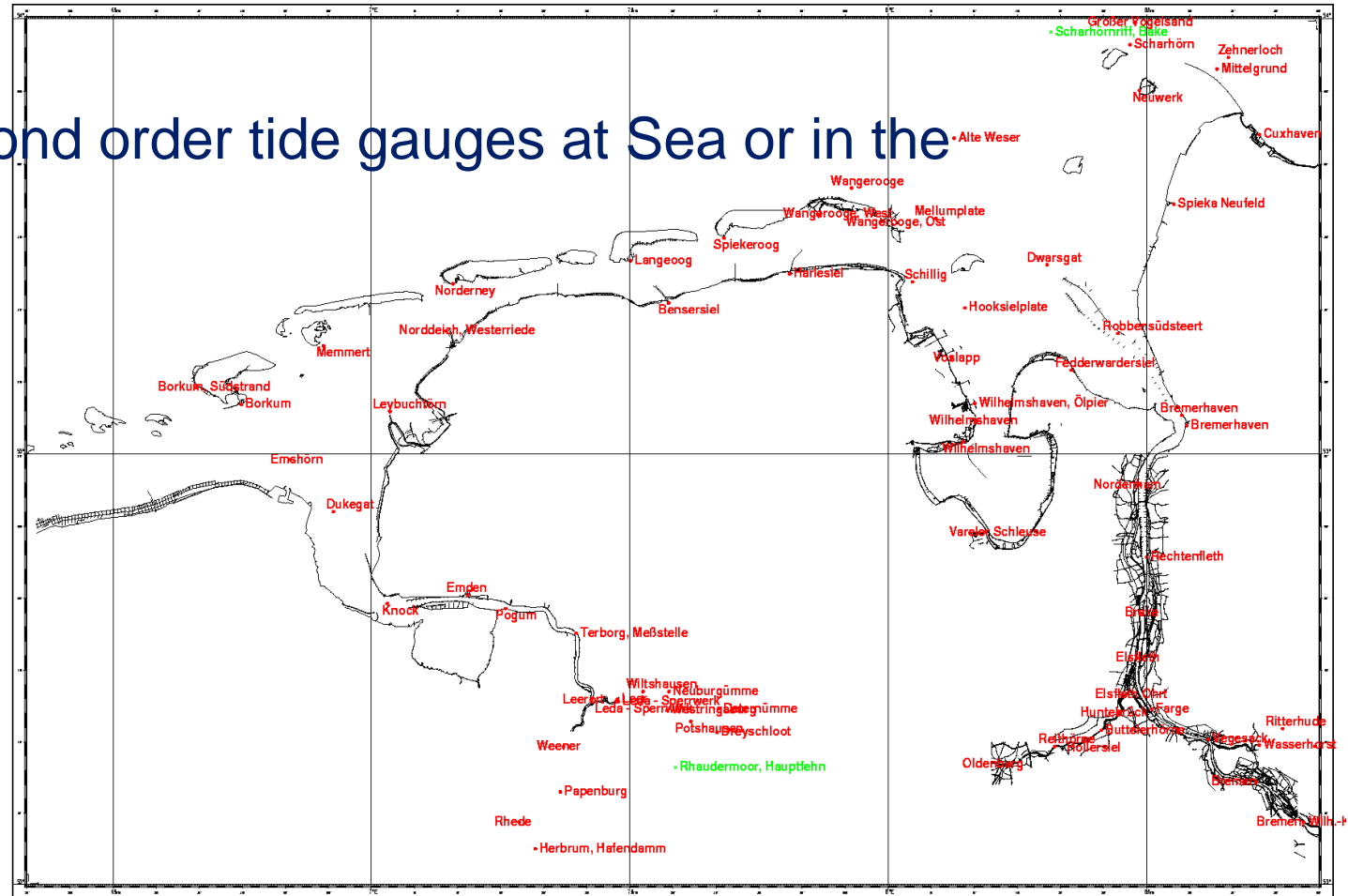


Task I: Realisation of the Chart Datum

Data input:

- 140 first and second order tide gauges at Sea or in the estuaries

- ...
- ...
- ...



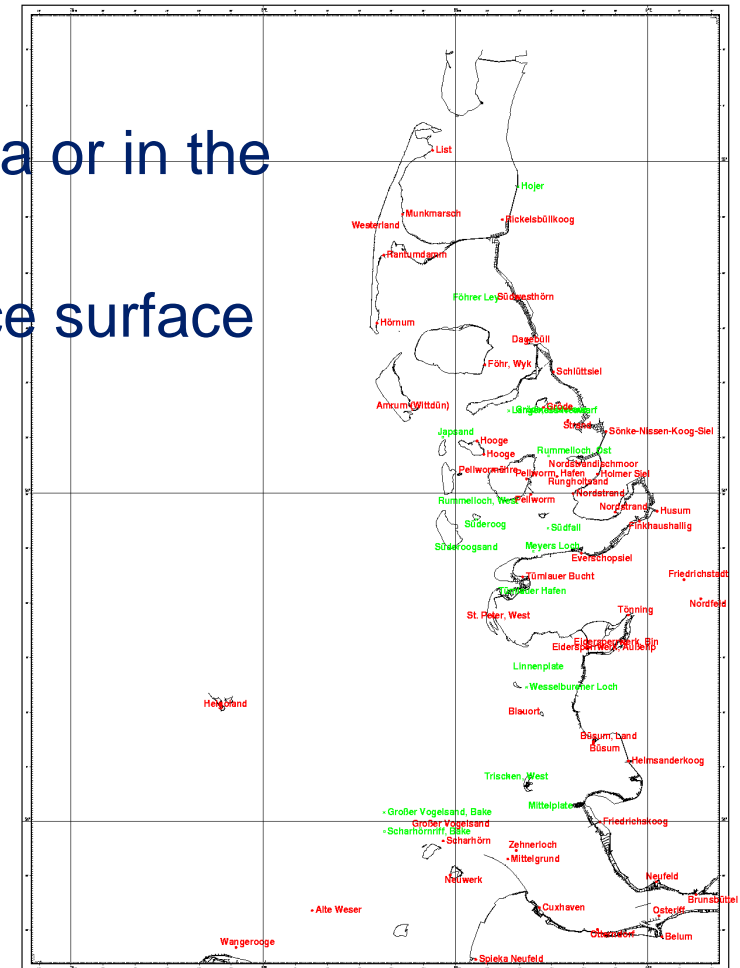


Task I: Realisation of the Chart Datum

Data input:

- 140 first and second order tide gauges at Sea or in the estuaries
- quasigeoid EGG97 as a preliminary reference surface
- ...
- ...

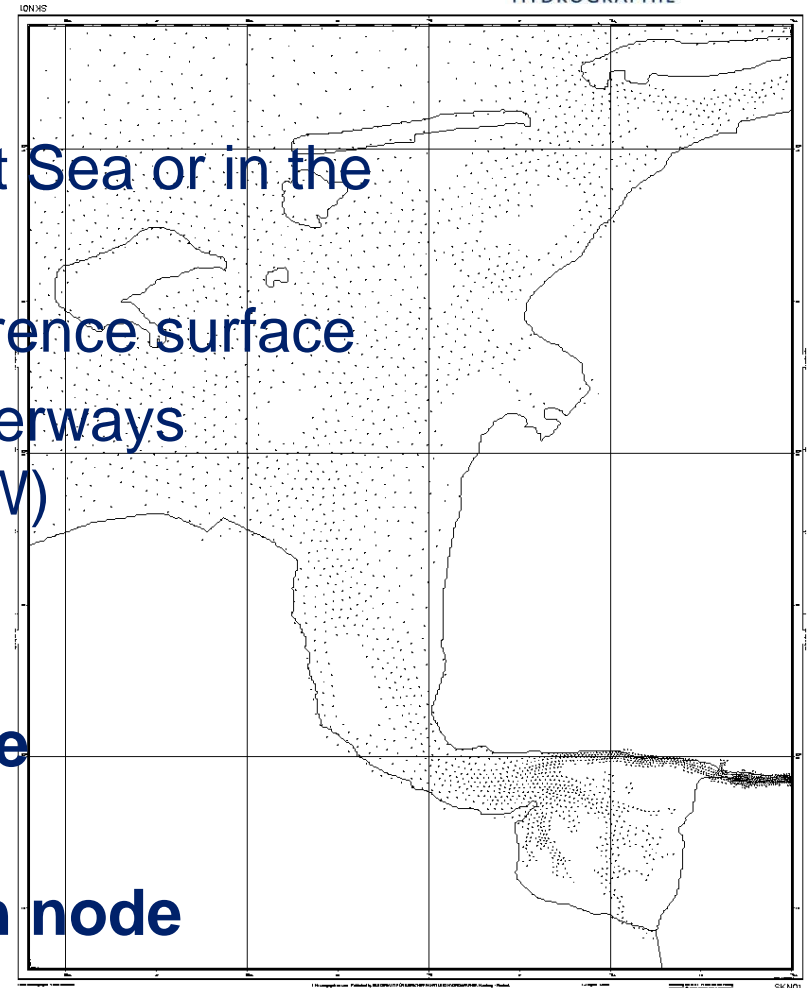
Tide gauges in Northern Frisia -->



Task I: Realisation of the Chart Datum

Data input:

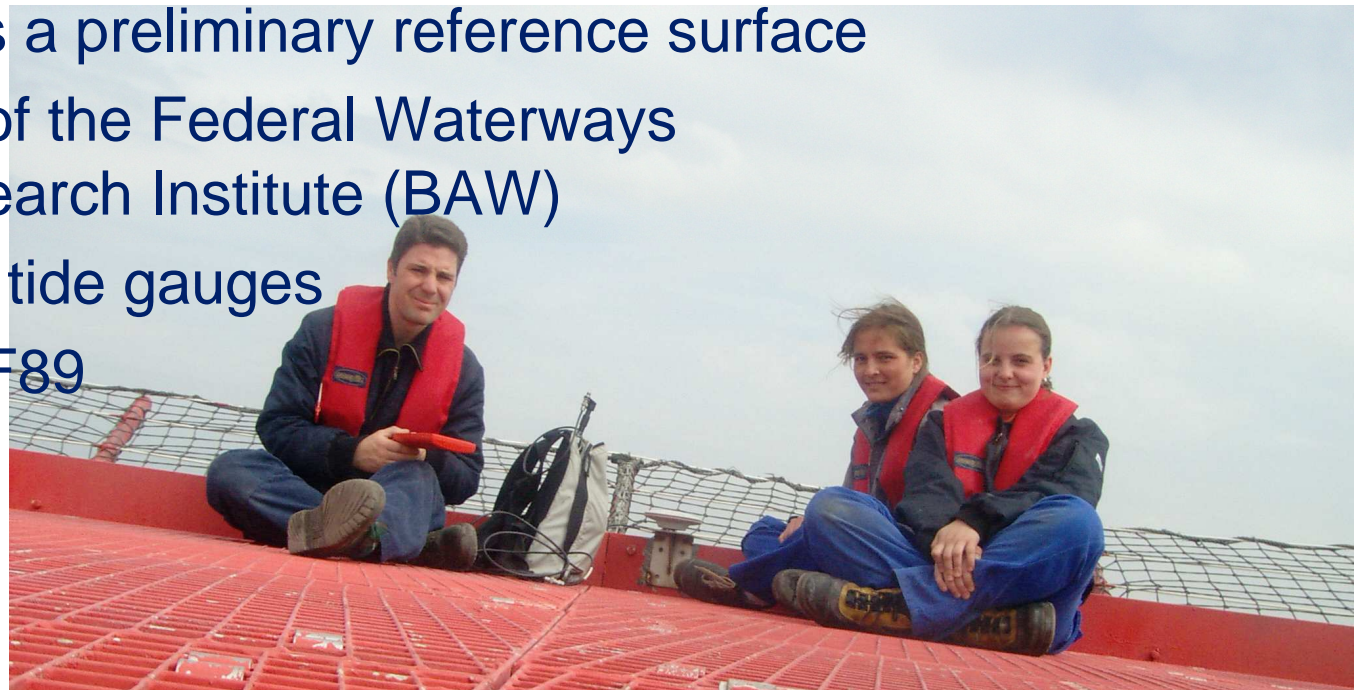
- 140 first and second order tide gauges at Sea or in the estuaries
- quasigeoid EGG97 as a preliminary reference surface
- Finite-element-Model of the Federal Waterways Engineering and Research Institute (BAW)
- ...
 - **32000 nodes**
 - **one year of hourly tide simulation per node**
 - **tidal analysis for each node**



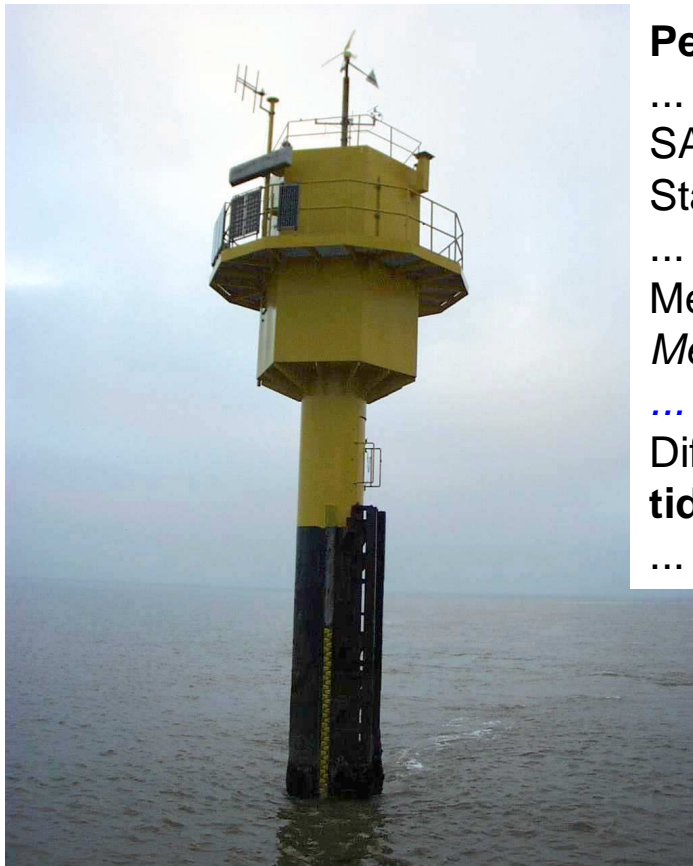
Task I: Realisation of the Chart Datum

Data input:

- 140 first and second order tide gauges at Sea or in the estuaries
- quasigeoid EGG97 as a preliminary reference surface
- finite-element-model of the Federal Waterways Engineering and Research Institute (BAW)
- GPS campaign at the tide gauges as reference to ETRF89



Task I: Realisation of the Chart Datum



Pegel Emshörn

...

SAPOS: Monitoring 15 min. with 1 obs./s

Static: 90 min. with 1 obs./s

...

Mean of the static measurements:

53,714m

Mean of the RTK measurement: (ellips. Höhe ref. ETRF89) 53,748m

...

Difference ETRF89 - point 2306/302 ,NN+13,505

40,209m...

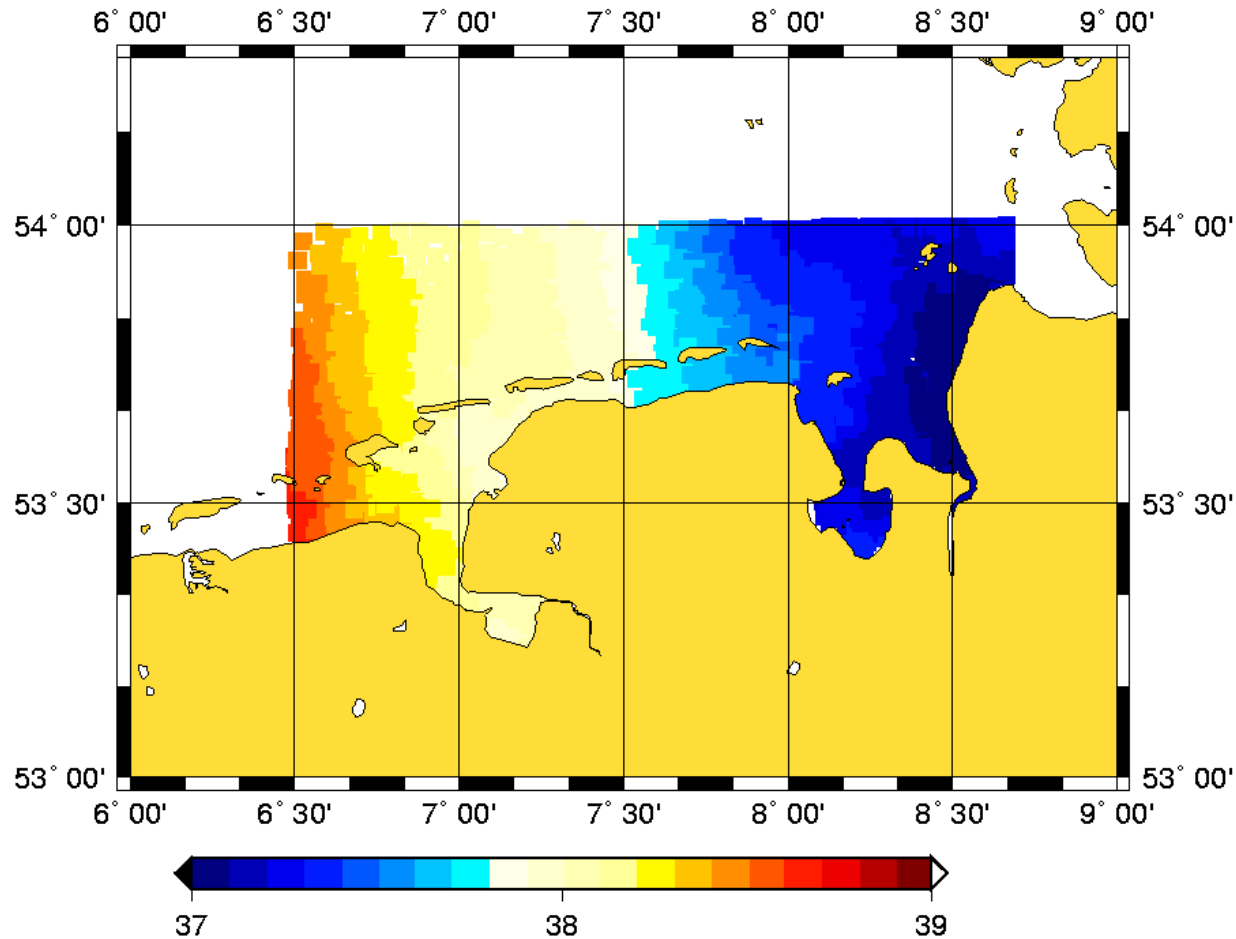
tide gauge zero above ETRF89:

35,189m

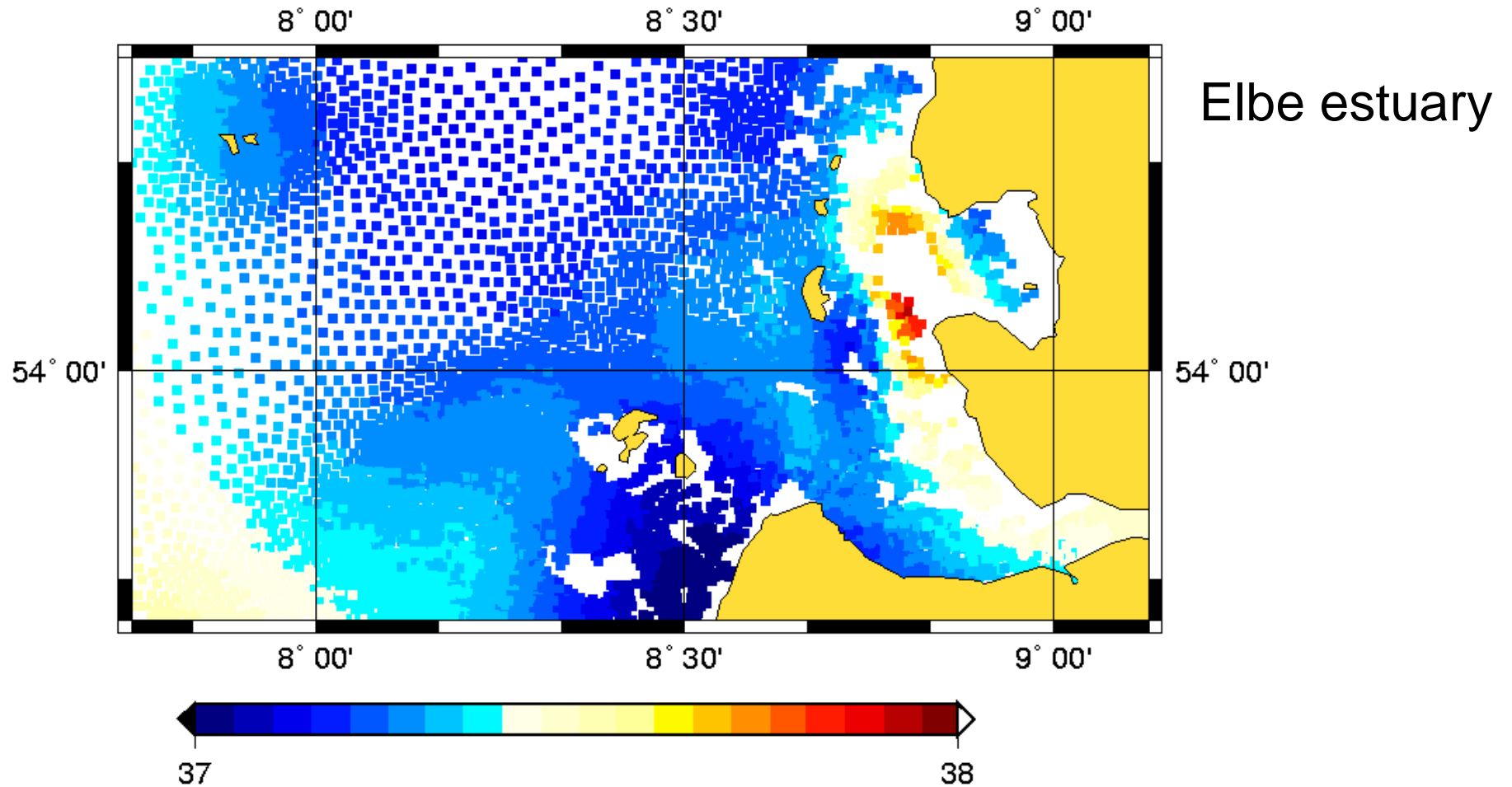
...

Task I: Realisation of the Chart Datum

East Frisia

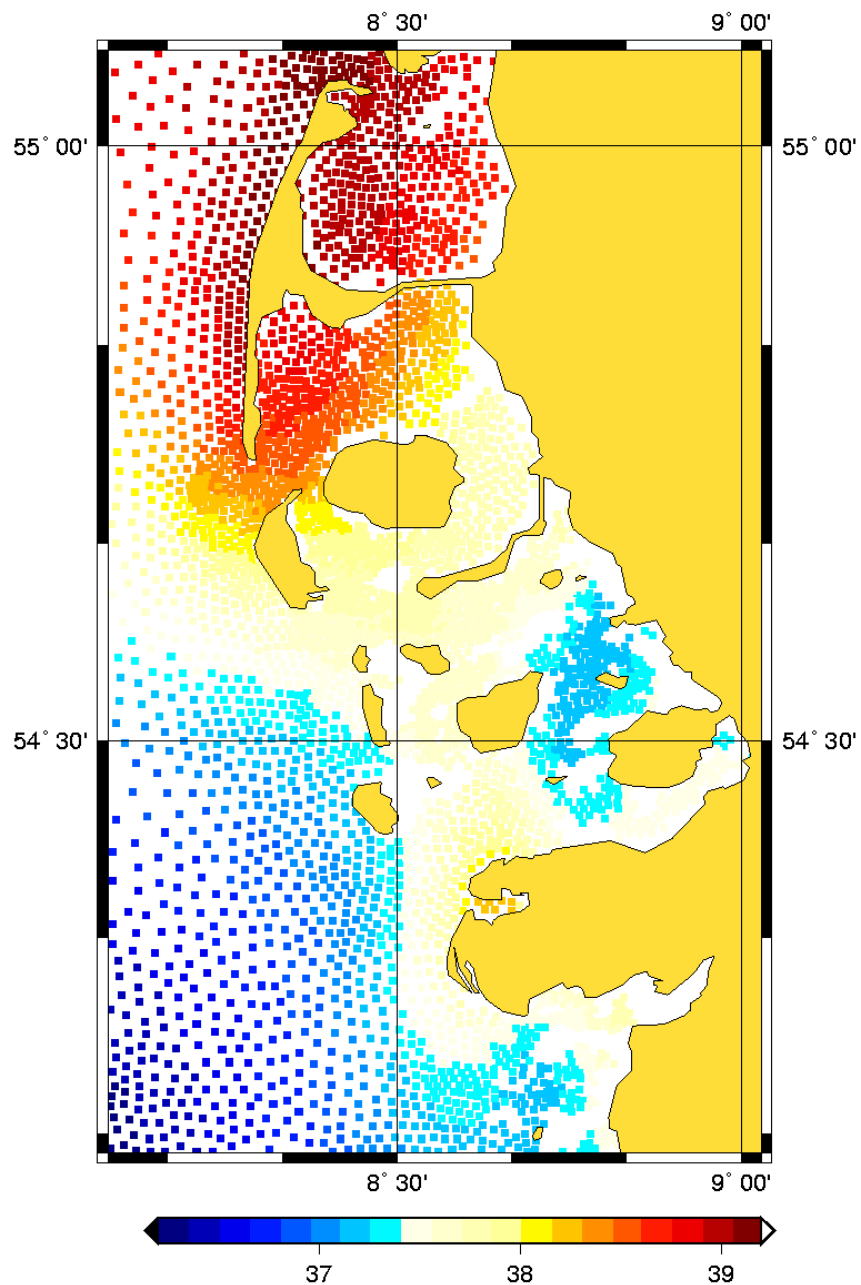


Task I: Realisation of the Chart Datum



Task I:

North Frisia



BUNDESAMT FÜR
SEESCHIFFFAHRT
UND
HYDROGRAPHIE



BUNDESAMT FÜR
SEESCHIFFFAHRT
UND
HYDROGRAPHIE

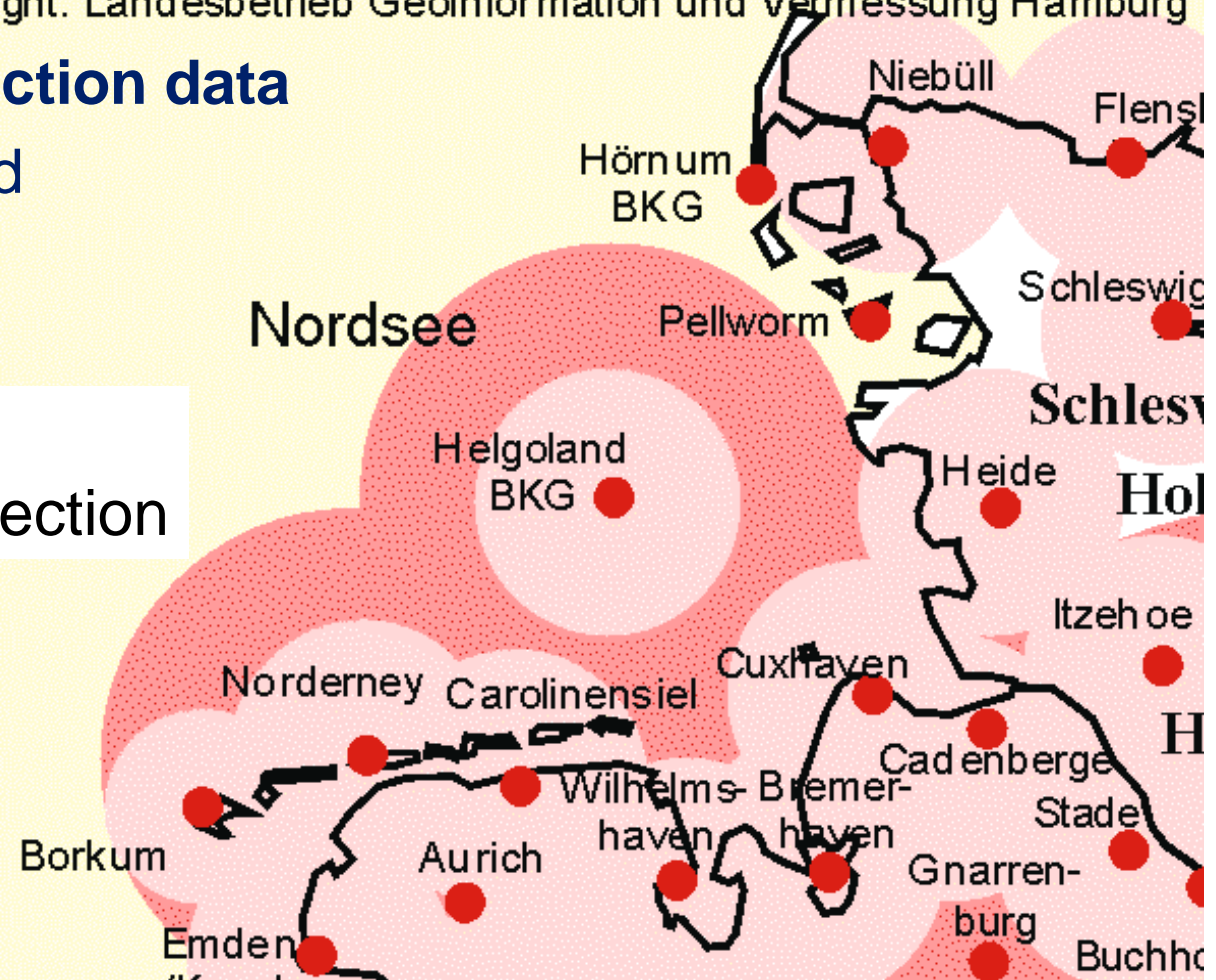
Task II: Use of GPS Correction Data

Copyright: Landesbetrieb Geoinformation und Vermessung Hamburg

3 ways of receiving correction data

- SAPOS HEPS 2-m-Band
- ...
- ...

Pellworm on air,
but without area correction





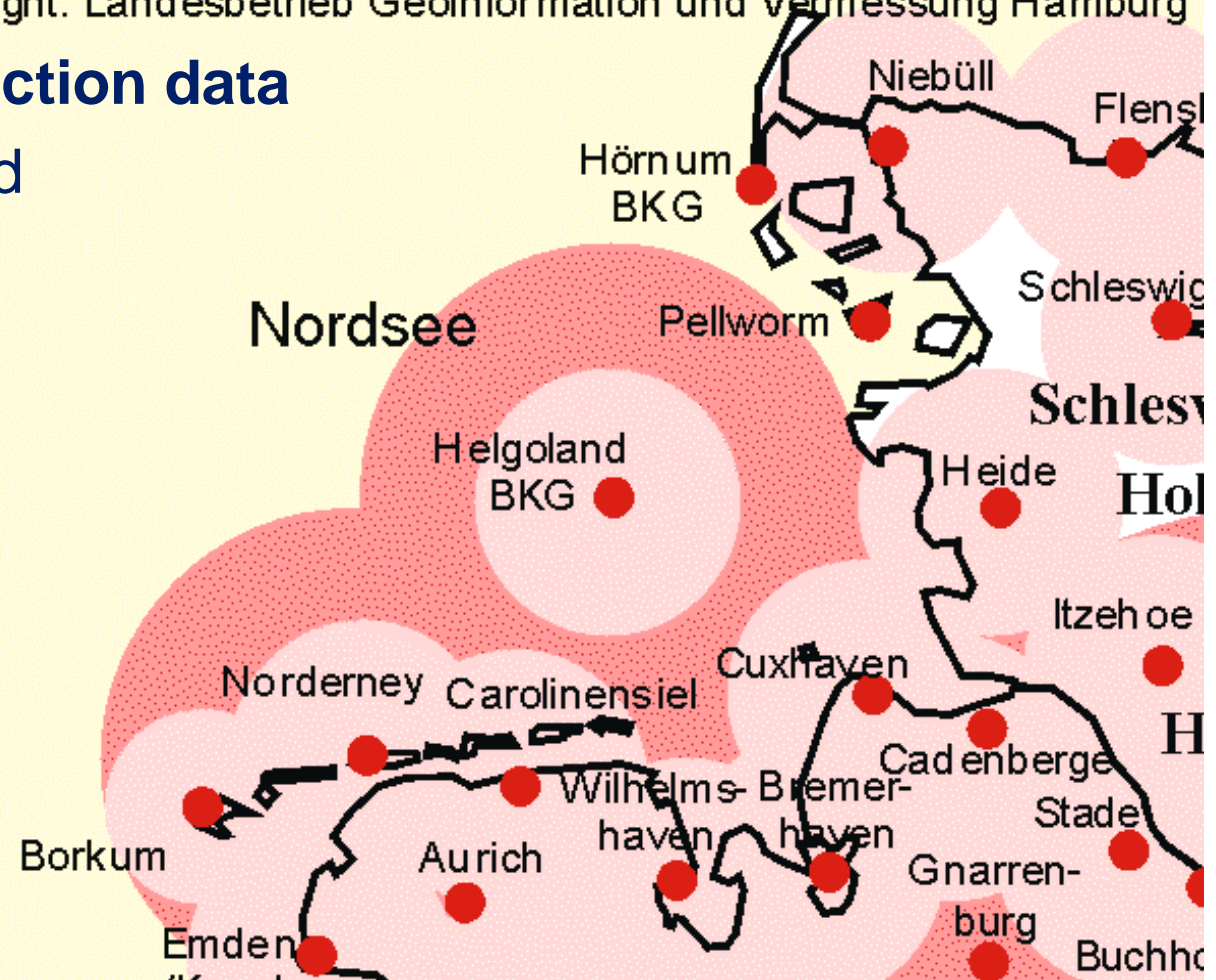
BUNDESAMT FÜR
SEESCHIFFFAHRT
UND
HYDROGRAPHIE

Task II: Use of GPS Correction Data

Copyright: Landesbetrieb Geoinformation und Vermessung Hamburg

3 ways of receiving correction data

- SAPOS HEPS 2-m-Band
- SAPOS HEPS GSM
- ...

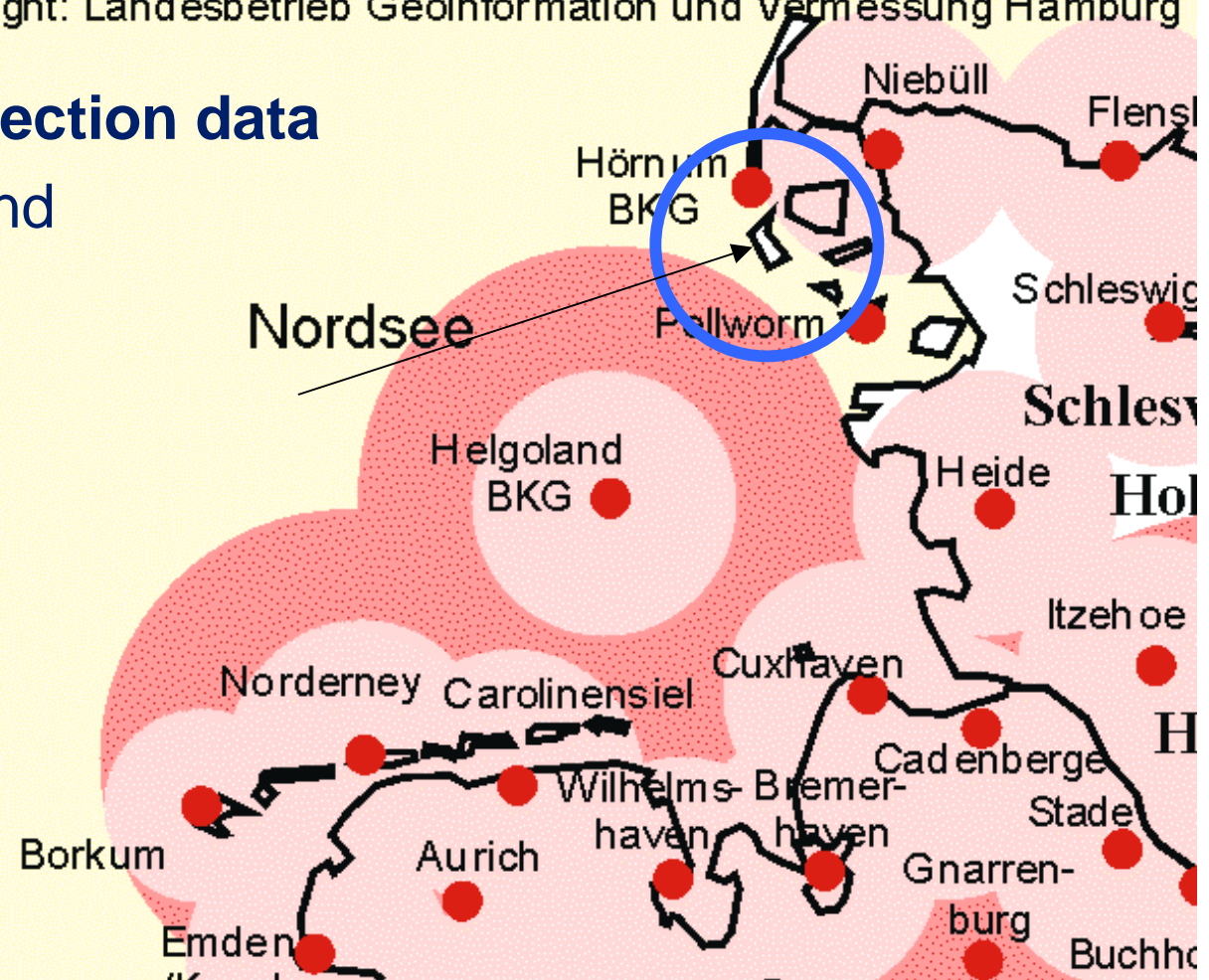


Task II: Use of GPS Correction Data

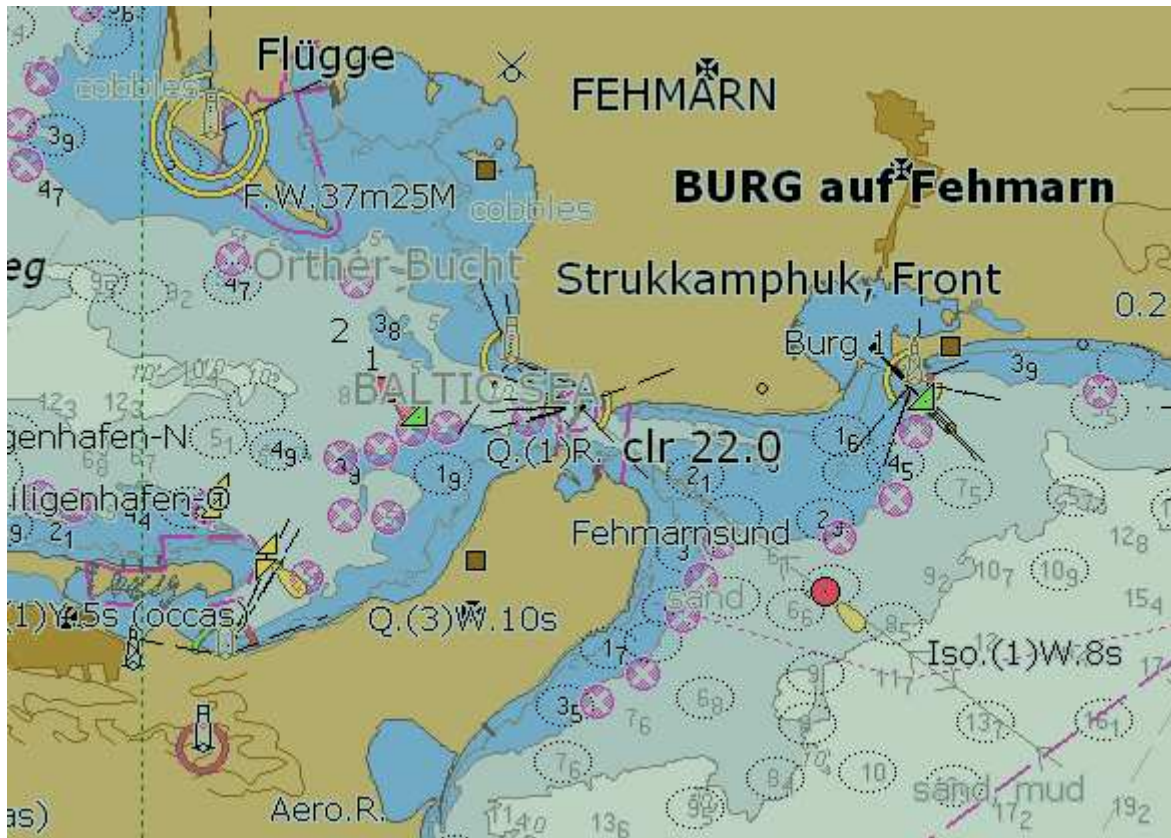
Copyright: Landesbetrieb Geoinformation und Vermessung Hamburg

3 ways of receiving correction data

- SAPOS HEPS 2-m-Band
- SAPOS HEPS GSM
- own reference station



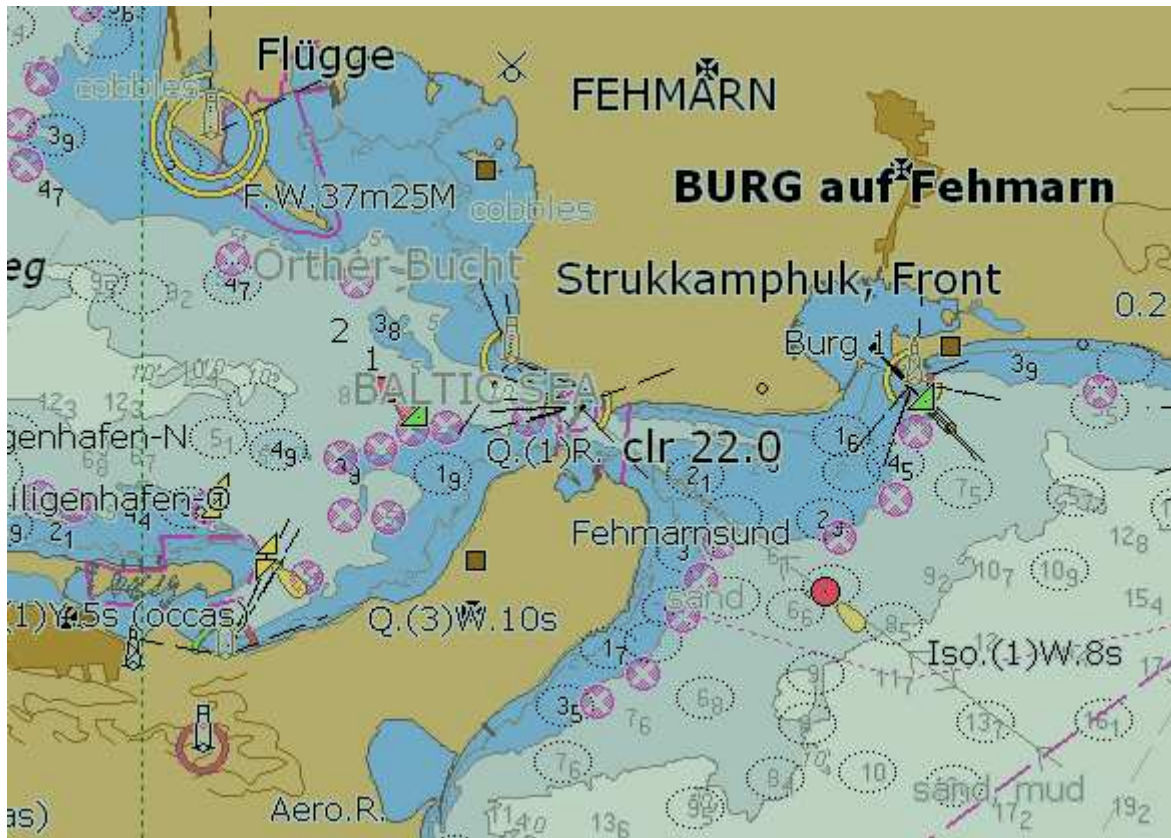
First Experience



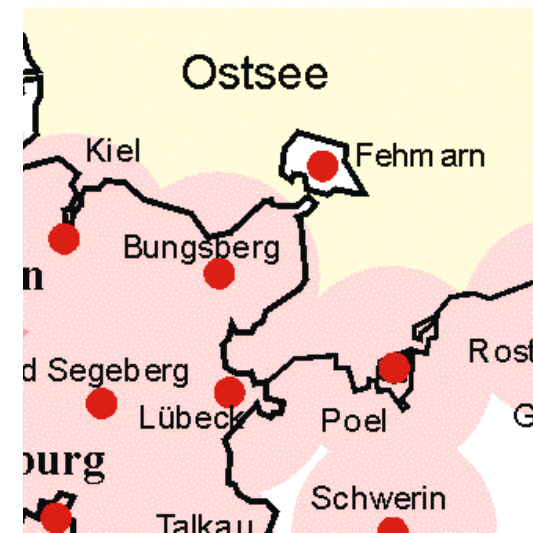
Baltic Sea: Fehmarn
CAPELLA survey
correction to GCG05



First Experience

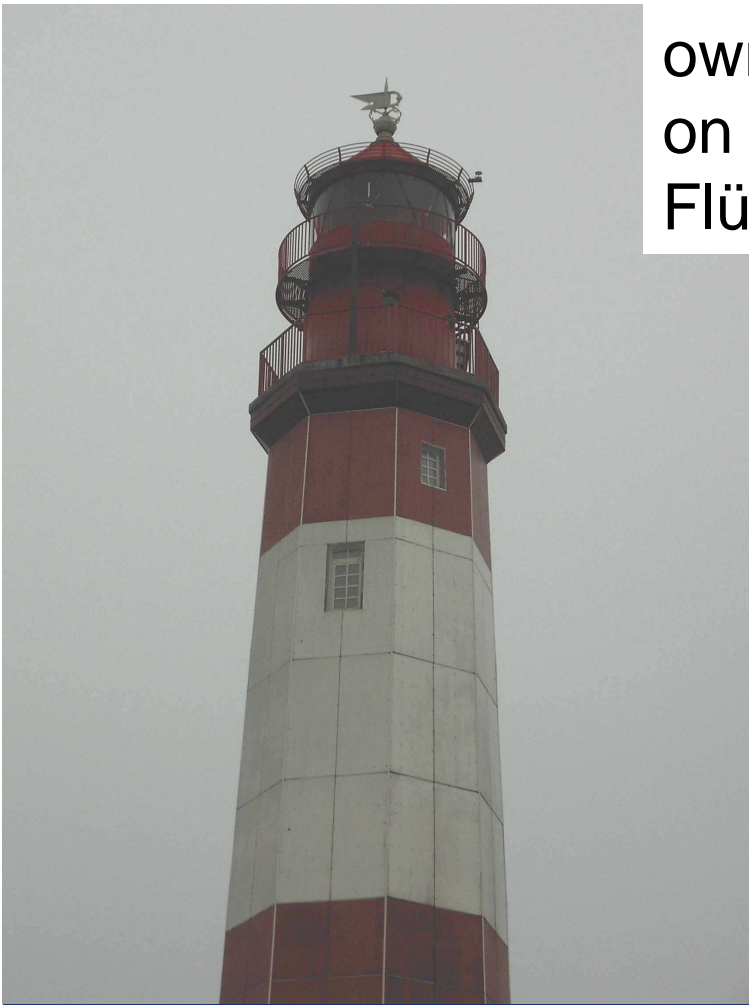


SAPOS 2 m-Band
no signal on air



First Experience

own reference
on Lighthouse
Flügge 39 m NHN



First Experience

Equipment had to be modified
on mother vessel max. 15 NM (ambiguities),
on the launch about 8 NM (reception of signal)
GPS and correction data all 0.1s



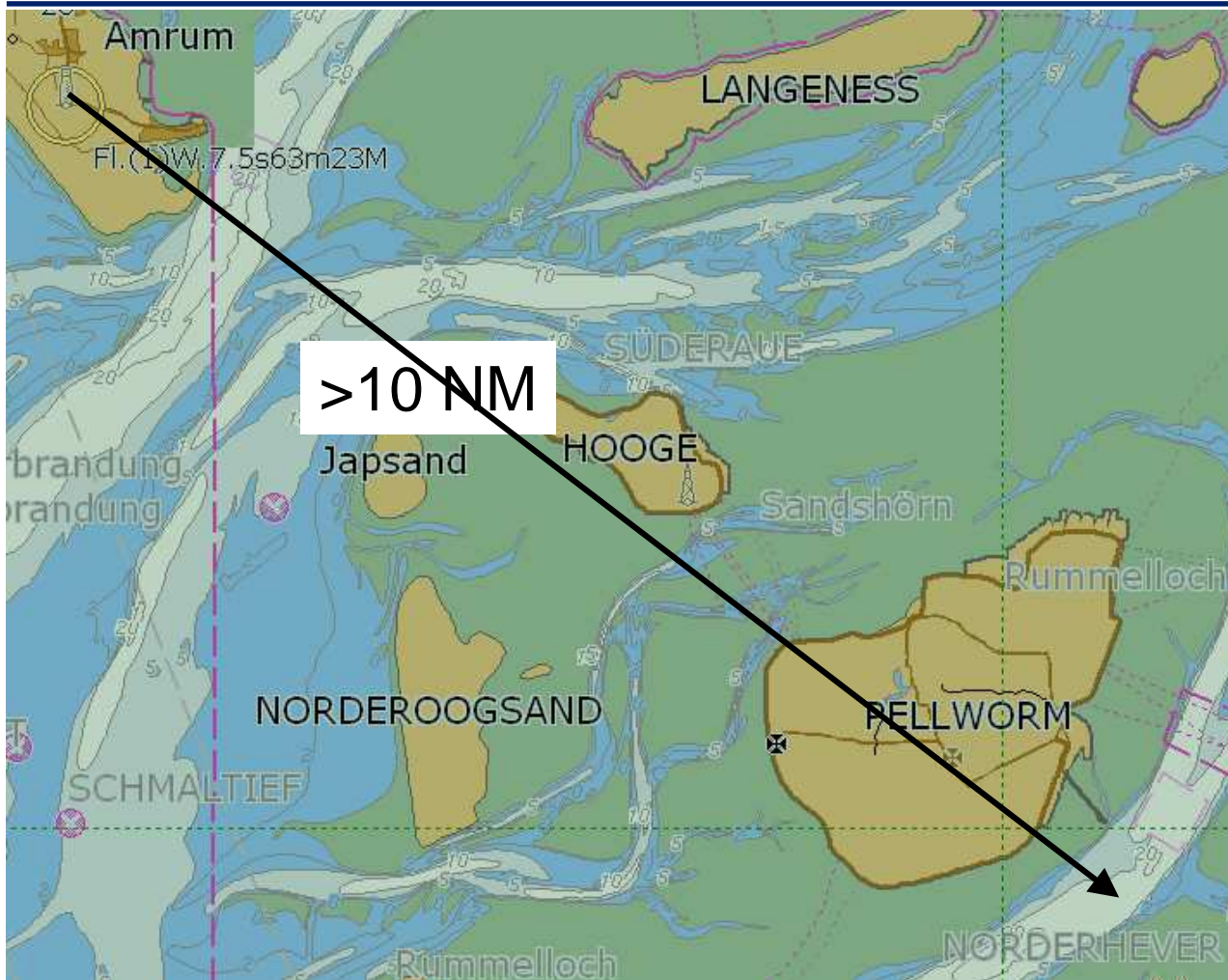
Problems with
interruption
when turning

First Experience

- Very good weather conditions
- max. 3 dm sea state

- Differences mainly < 2 dm against conventional correction
- some differences up to 9 dm to be clarified
- the actual processing software does not allow suitable control of the GPS measurements
==> no outlier detection
- Change to NMEA telegram GGQ (better quality information)

First Experience



North Frisia

SAPOS:
on Pellworm 2m-Band

own reference Amrum:
in Norderhever
ambiguities could
be solved

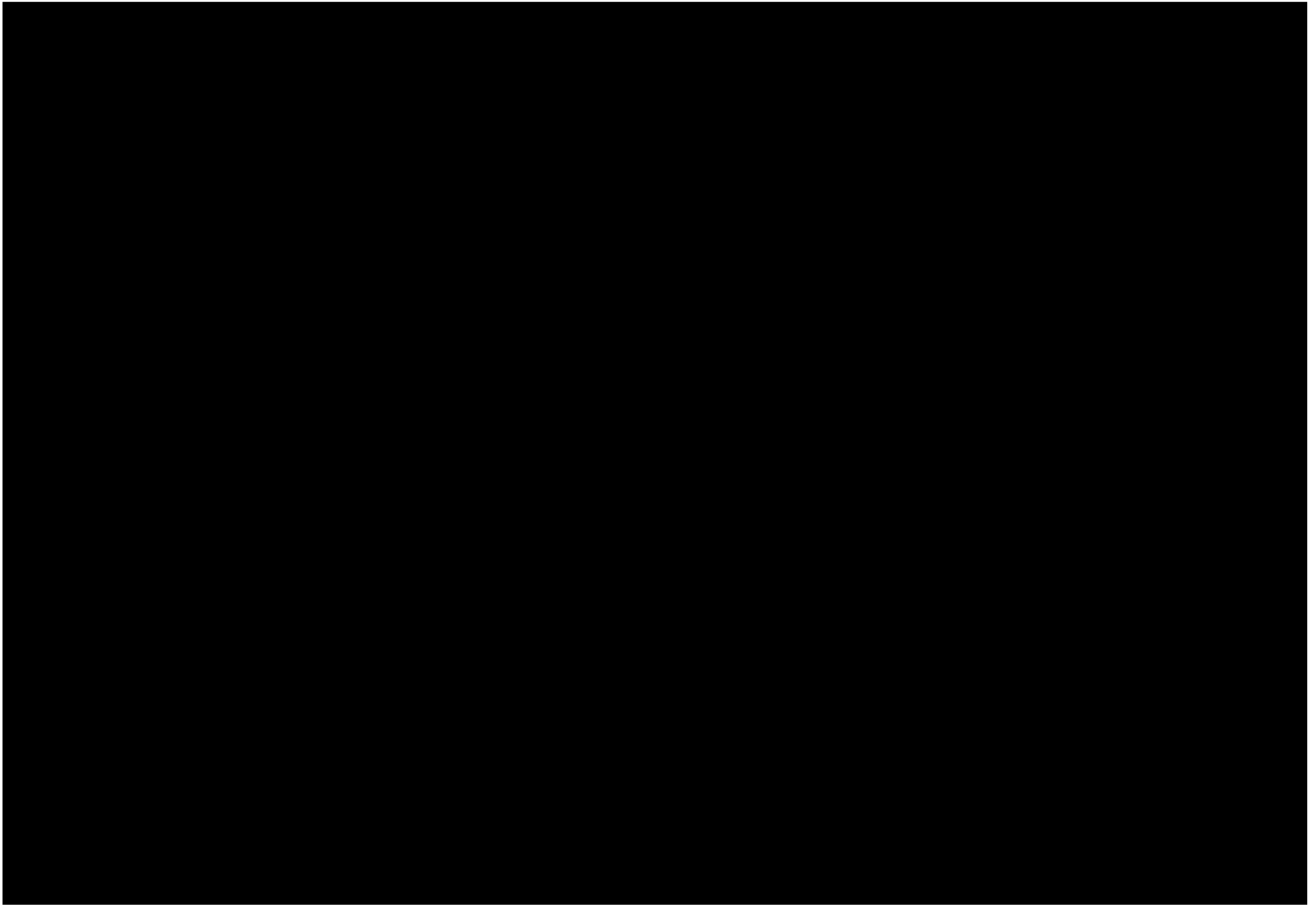


BUNDESAMT FÜR
SEESCHIFFFAHRT
UND
HYDROGRAPHIE

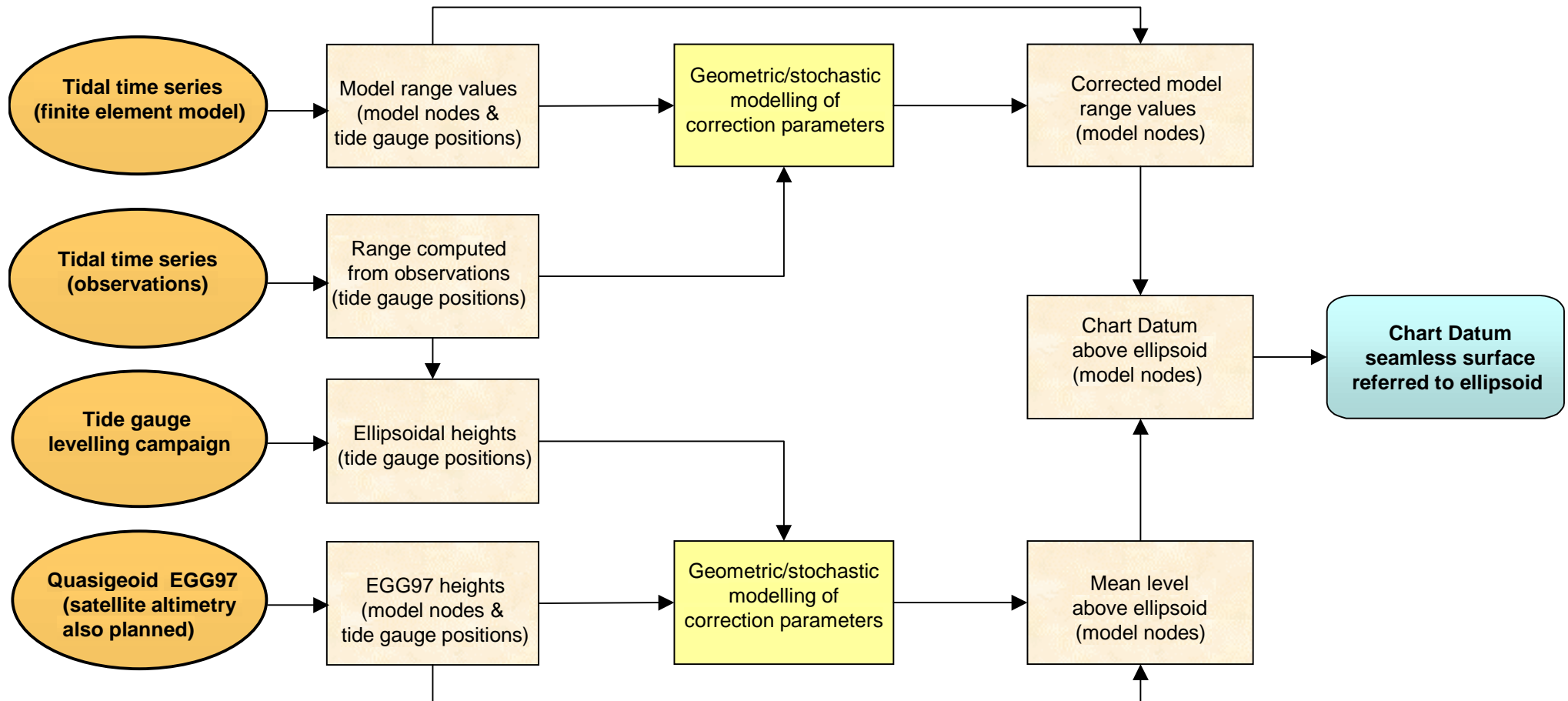
Conclusion

- Basic problems of CD reference are solved
- First experiences promising
- Some detail problems still to be solved
 - Problems of data reception and ambiguity solution
 - Problems in processing
- SAPOS:
 - GSM (cell phone) still to be tested
 - More important: improvement of FM 2-m-Band transmission





Processing



Tacheometer



BUNDESAMT FÜR
SEESCHIFFFAHRT
UND
HYDROGRAPHIE

