Royal Netherlands Navy

TWCWG3

North Sea Hydrographic Commission – Tidal Working Group 22

Ostend, Belgium
25, 26 October 2017

Hydrographic Service
Geodesy and Tides

Work plan items

WP18/01 Improve North Sea wide realisation of reference surfaces

WP18/02 Improve methodologies for GNSS surveys

WP 22/01 Follow developments of European initiatives on new LAT surfaces

- Share new developments on tide gauges and current meters

Improve North Sea wide realisation of reference surfaces

Background

October 2008: NSHC tasks Tidal Working Group (TWG) to study a seamless LAT for the North Sea.

TWG22 - Ostend

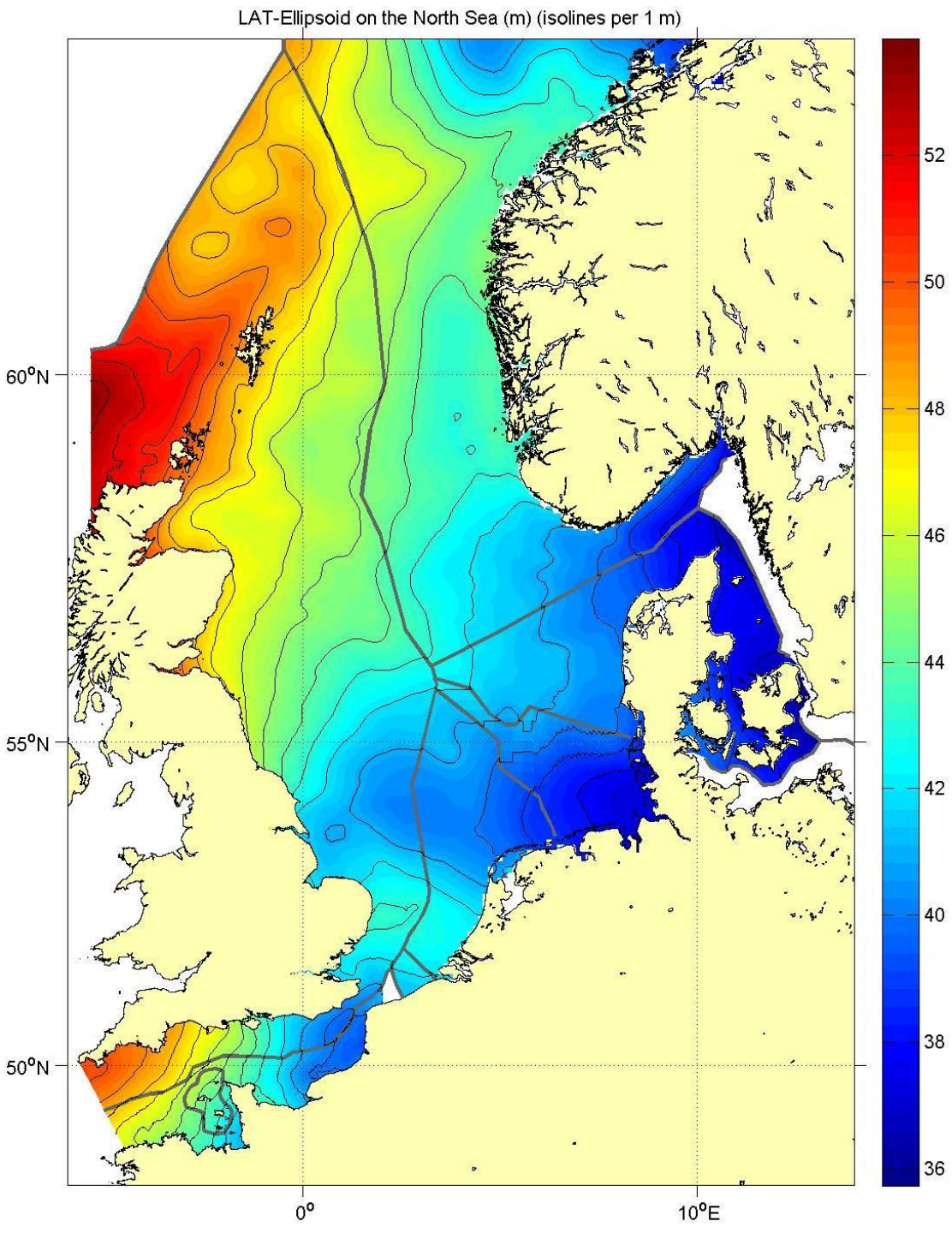
The TWG has continued to work to combine existing national models in order to develop a common reference surface for tidal reduction to Chart Datum in the North Sea.

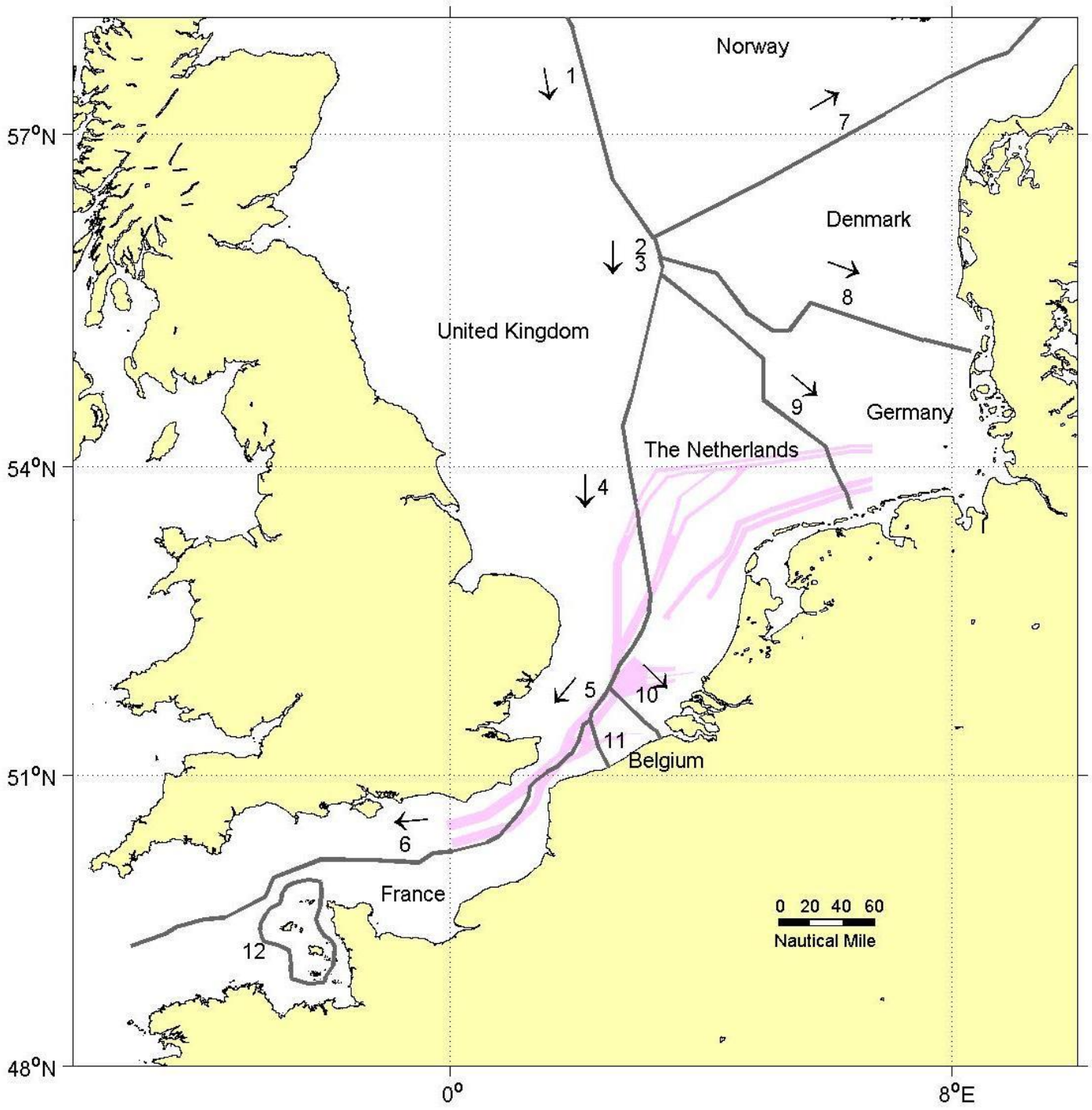
Several countries have their own reference surface related to the ellipsoid. There are discontinuities at adjacent boundaries. During 22nd NSHC-TWG meeting, the updates of the member country's reference surfaces (LAT) were discussed together with their impact on the difference calculated as *LAT difference / depth.*

Result 2017

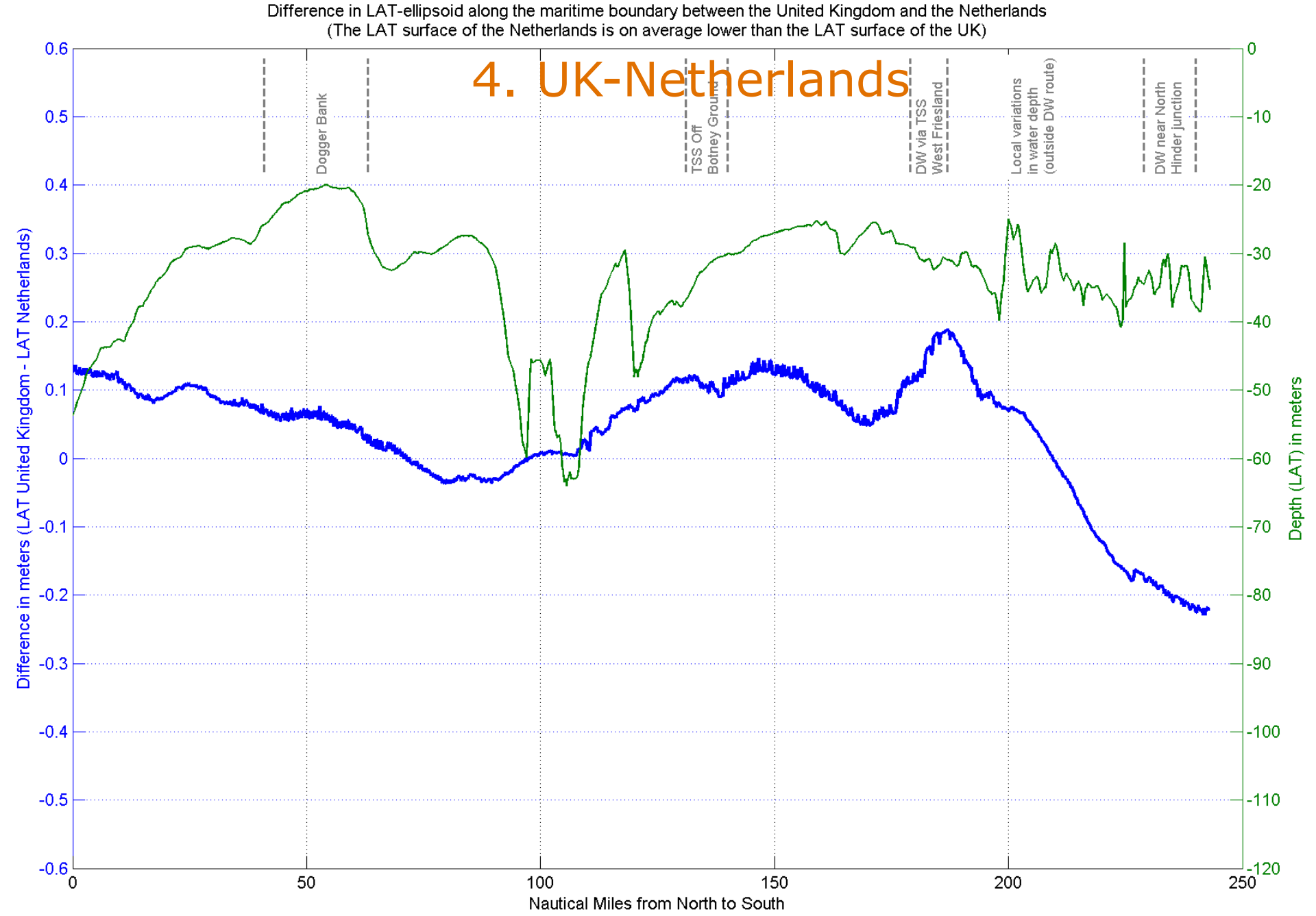
Almost full coverage
NO – new data 2017. LAT was calculated using the Danish MSS and modeled tides.
UK – Vertical Offshore Reference Frame (VORF)
FR – BathyElli --> new SurfRef project
DK – Worldwide model
DE – LAT model with two different granularities and with overlap is used.
BE – GEONZ97 and EGM96 → new data in 2018 (LAT irt ellipsoid)
NL – LAT2013 → LAT 2018 (NEVREF results)

A20/02 Show insight in the status of all bilateral boundaries

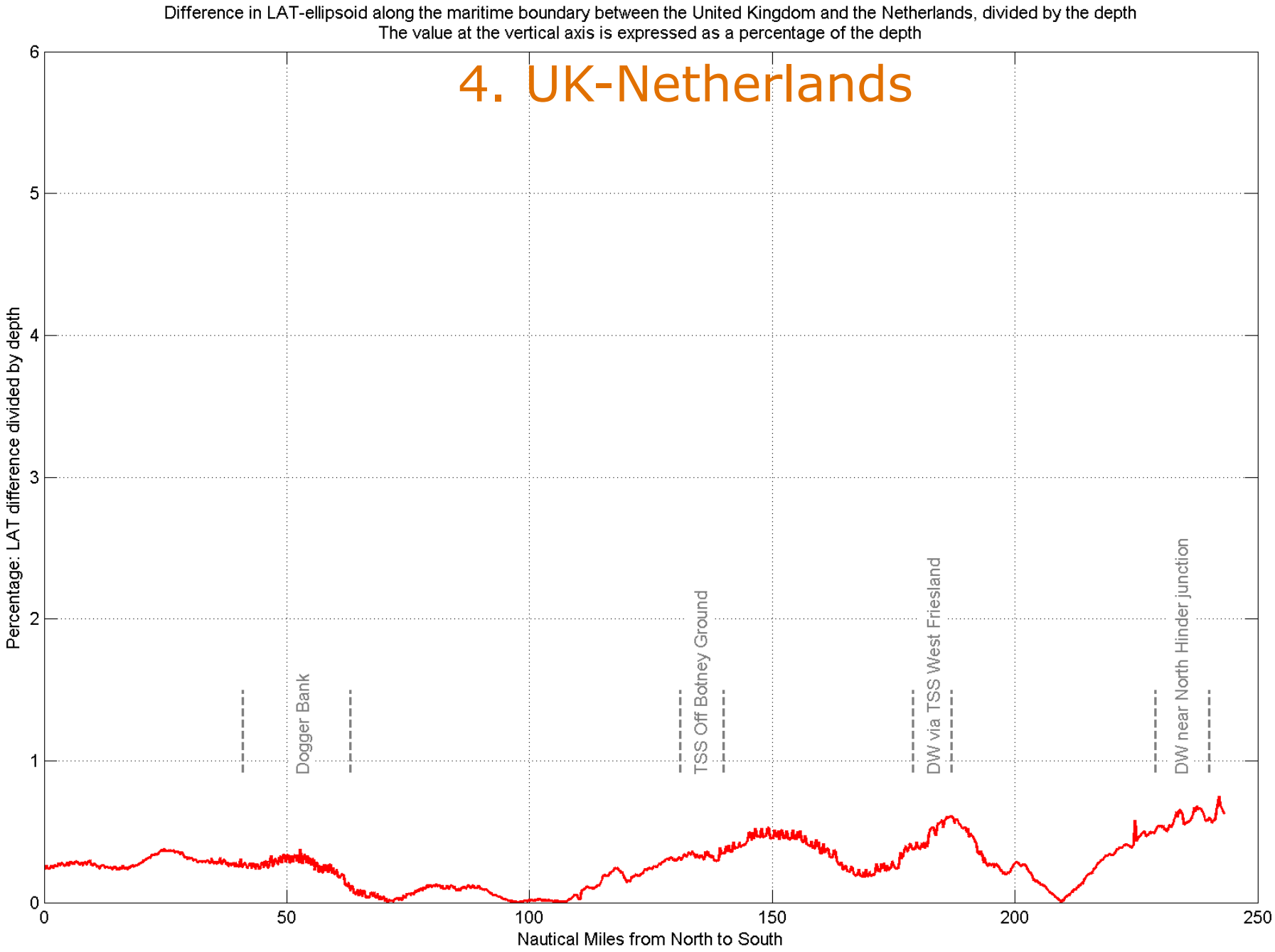



Norway
Denmark
United Kingdom
Germany
The Netherlands
Belgium
France
1
2
3
4
5
6
7
8
9
10
11
12
57°N
54°N
51°N
48°N
0°
8°E
0 20 40 60
Nautical Mile

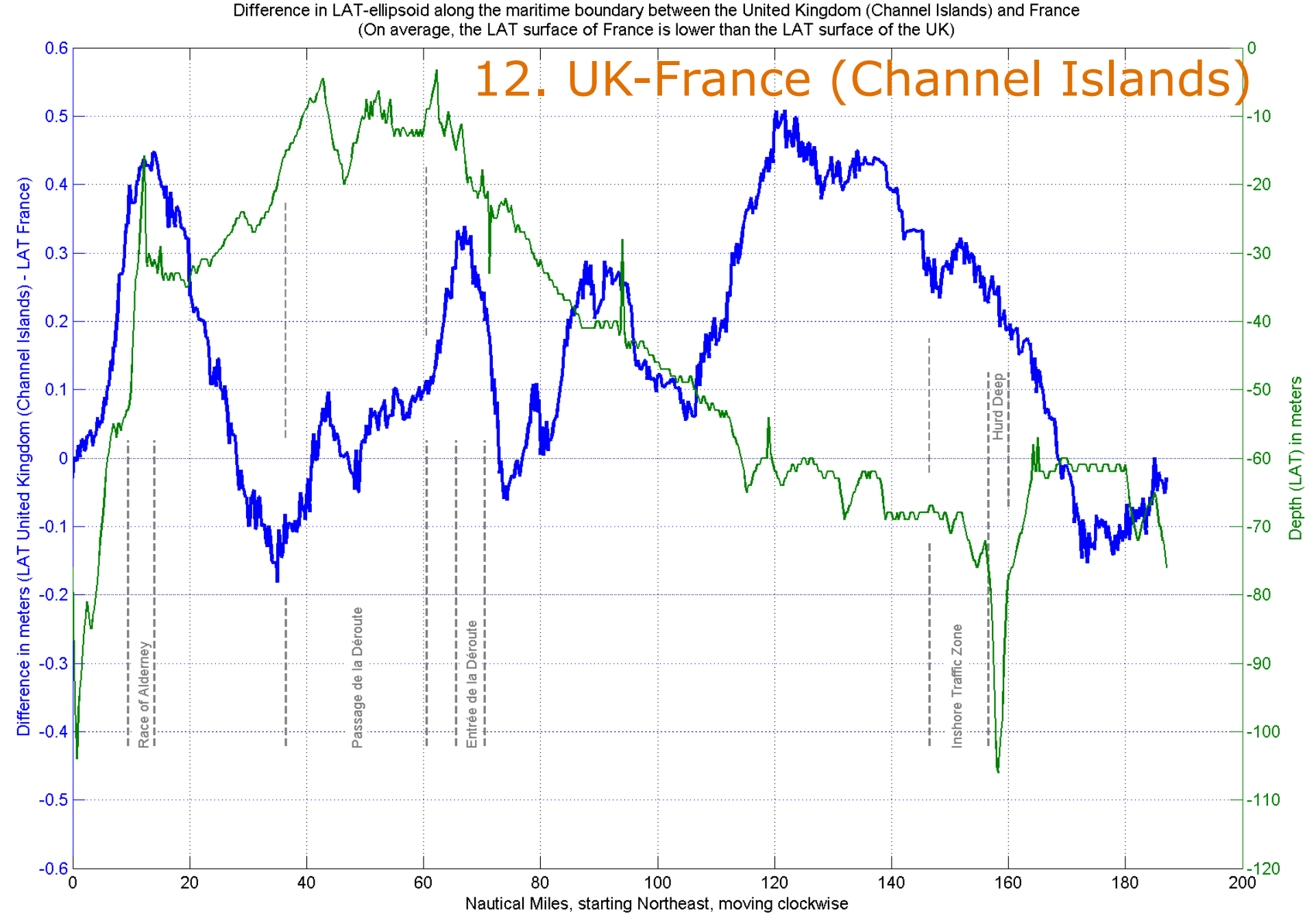
4. UK-Netherlands



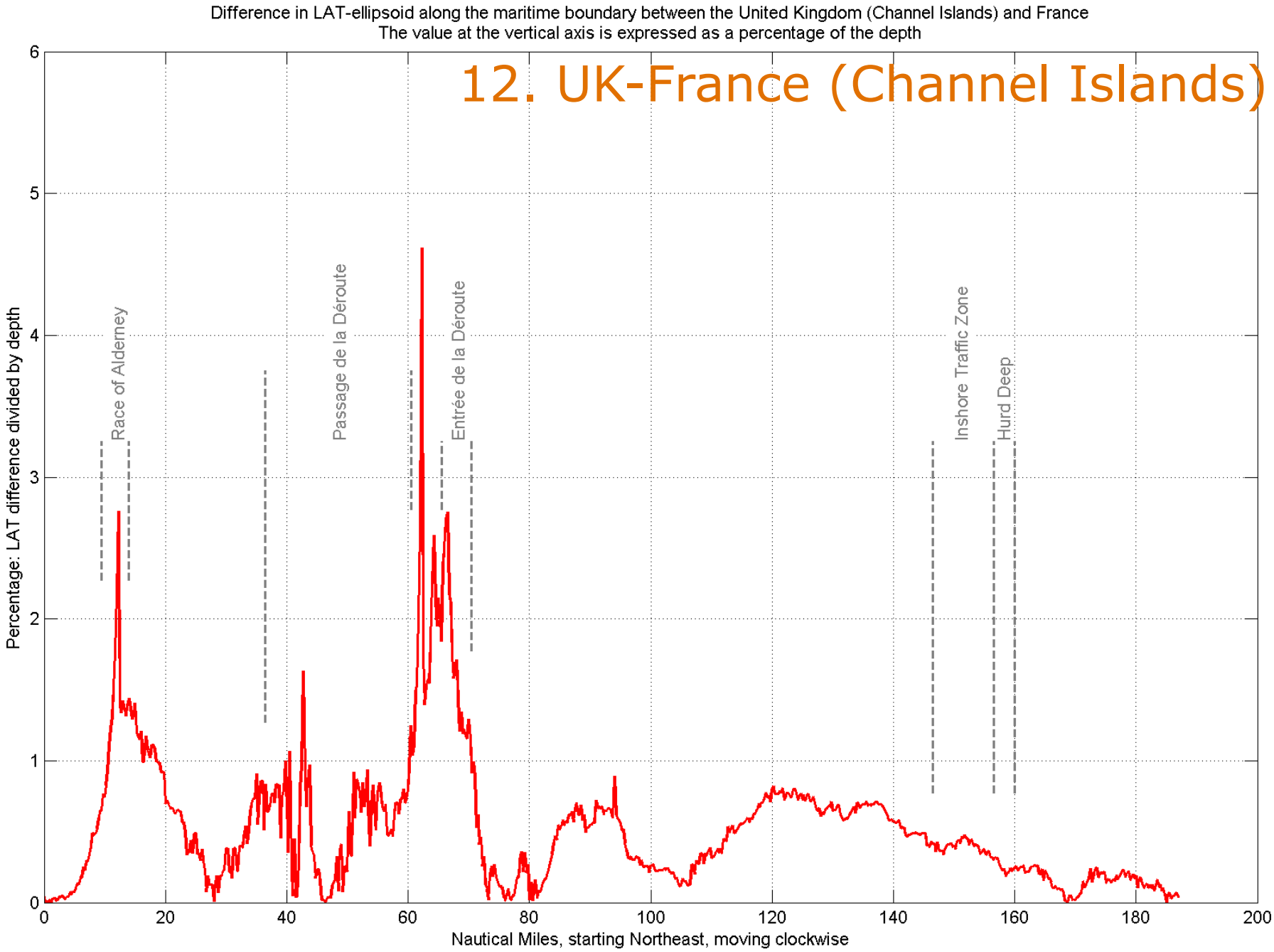
4. UK-Netherlands



12. UK-France (Channel Islands)



12. UK-France (Channel Islands)



Status differences at all boundaries wrt LAT - 2017

LAT

	BE	DK	FR	GE	NL	NO	UK	SW	IC
BE									
DK	1								
FR	2	1							
GE	1	4	1						
NL	4	1	1	4					
NO	1	2*	1	1	1				
UK	3	3	4	3	3	2*			
SW	1	2*	1		1	2*	1		
IC	1	1	1	1	1	1	1	1	

At WP 20/02 the following options are identified:

1. no common LAT boundary
2. differences on a common boundary but not checked

2*. differences on a common boundary, not checked, different CD

3. differences on a common boundary checked to be not significant
4. differences on a common boundary checked to need to be reduced

1 Percent Norm (LAT difference divided by depth)

2016 there was unanimous agreement that a rate of 1 percent or less (LAT difference divided by depth) was acceptable for the TWG members.

The objective of action item A18/01 is: *explain the differences in realization of LAT.* When the TWG members have explained the LAT differences along the boundaries the next question is to which level do we have to reduce the differences. The rate of 1 percent was arbitrarily chosen.

The IHO Chart Specification S4-Part B and IHO standards for Hydrographic surveys S-44 provide guidelines for:

1) Rounding of depths
2) ZOC categories
3) Maximum allowable TVU 95% confidence level

1. Rounding of depths

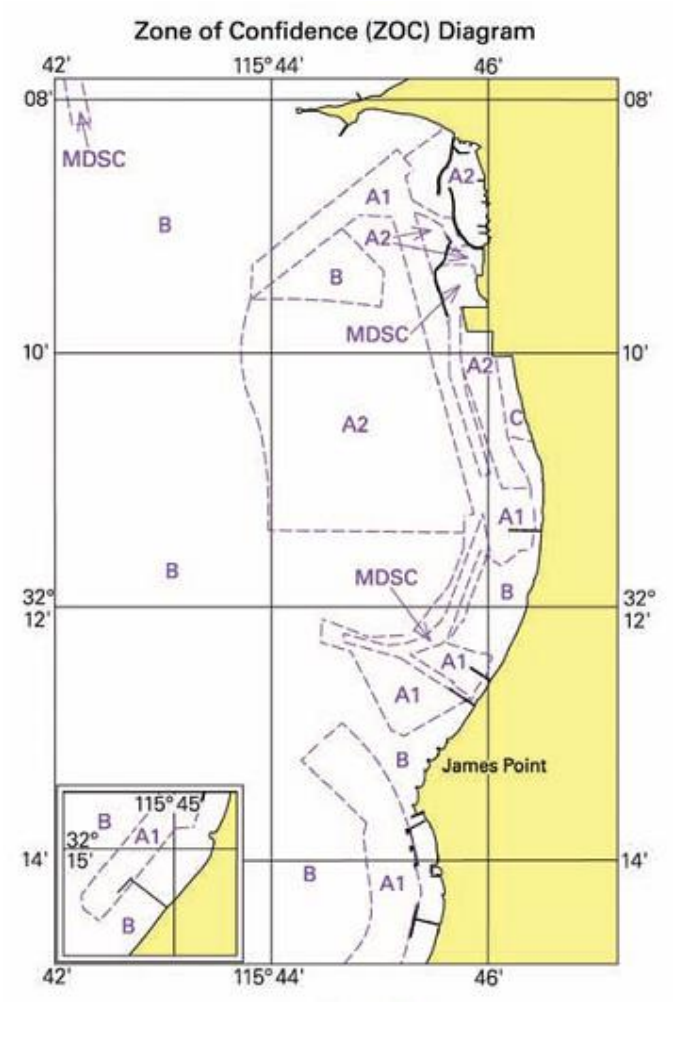
- To the nearest decimeter between 0,1 and 21m:
- To the nearest half metre from 21 to 31m:
- Thereafter, to the nearest metre:

Depth (m)	Rounding of depths (m)	Rounding of depths / depth (%)
1	0,1	10,0
10	0,1	1,0
30	0,5	1,7
50	1,0	2,0

2. Chart Specifications of the IHO S4 Part B-297 Zones of Confidence (ZOC) Diagrams

Zones of confidence (ZOC) Diagrams (figure 1+2) enable mariners to assess the quality of the hydrographic data from which the chart was compiled. The use of ZOC diagrams provide consistency in the display of source data between digital and paper charts, as the Category of Zones of Confidence (CATZOC) definitions are derived directly from S-57.

The quality of the hydrographic source data is assessed according to six categories: five quality categories for assessed data (A1, A2, B, C and D) and a sixth category (U) for data which has not been assessed.



B-297.9 CATEGORY OF ZONES OF CONFIDENCE IN DATA - ZOC TABLE
(S-57 Edition 3.1 Supplement No. 2 Appendix A Chapter 2)

1	2	3	4	5
ZOC [1]	Position Accuracy [2]	Depth Accuracy [3]	Seafloor Coverage	Typical Survey Characteristics [5]
A1	± 5 m + 5% depth	=0.50 + 1%d Depth (m) / Accuracy (m): 10 / ± 0.6; 30 / ± 0.8; 100 / ± 1.5; 1000 / ± 10.5	Full area search undertaken. Significant seafloor features detected [4] and depths measured.	Controlled, systematic survey [6] high position and depth accuracy achieved using DGPS or a minimum three high quality lines of position (LOP) and a multibeam, channel or mechanical sweep system.
A2	± 20 m	= 1.00 + 2%d Depth (m) / Accuracy (m): 10 / ± 1.2; 30 / ± 1.6; 100 / ± 3.0; 1000 / ± 21.0	Full area search undertaken. Significant seafloor features detected [4] and depths measured.	Controlled, systematic survey [6] achieving position and depth accuracy less than ZOC A1 and using a modern survey echosounder [7] and a sonar or mechanical sweep system.
B	± 50 m	= 1.00 + 2%d Depth (m) / Accuracy (m): 10 / ± 1.2; 30 / ± 1.6; 100 / ± 3.0; 1000 / ± 21.0	Full area search not achieved; uncharted features, hazardous to surface navigation are not expected but may exist.	Controlled, systematic survey achieving similar depth but lesser position accuracies than ZOC A2, using a modern survey echosounder [5], but no sonar or mechanical sweep system.
C	± 500 m	= 2.00 + 5%d Depth (m) / Accuracy (m): 10 / ± 2.5; 30 / ± 3.5; 100 / ± 7.0; 1000 / ± 52.0	Full area search not achieved, depth anomalies may be expected.	Low accuracy survey or data collected on an opportunity basis such as soundings on passage.
D	Worse than ZOC C	Worse than ZOC C	Full area search not achieved, large depth anomalies may be expected.	Poor quality data or data that cannot be quality assessed due to lack of information.
U	Unassessed - The quality of the bathymetric data has yet to be assessed			

depth (m)	ZOC A1 (m)	ZOC A1 / depth (%)	ZOC A2, B (m)	ZOC A2, B / depth (%)	ZOC C (m)	ZOC C / depth (%)
1	0,51	51,0	1,02	102,0	2,05	205,0
10	0,60	6,0	1,20	12,0	2,50	25,0
30	0,80	2,7	1,60	5,3	3,50	11,7
50	1,00	2,0	2,00	4,0	4,50	9,0

3. IHO STANDARDS FOR HYDROGRPHIC SURVEYS (S-44) 5th Edition February 2008 – Paragraph 3.2 Vertical Uncertainty

Vertical uncertainty is to be understood as the uncertainty of the reduced depths. In determining the vertical uncertainty the sources of individual uncertainties need to be quantified. All uncertainties should be combined statistically to obtain a total vertical uncertainty (TVU).

Recognizing that there are both depth independent and depth dependent errors that affect the uncertainty of the depths, the formula below is to be used to compute, at the 95% confidence level, the maximum allowable TVU. The parameters **a** and **b** for each order, as given in Table 1, together with the depth **d** have to be introduced into the formula in order to calculate the maximum allowable TVU for a specific depth:

Where:

a represents that portion of the uncertainty that does not vary with depth

b is a coefficient which represents that portion of the uncertainty that varies with depth

d is the depth

b x d represents that portion of the uncertainty that varies with depth

$$\pm \sqrt{a^2 + (b * d)^2}$$

The vertical uncertainty at the 95% confidence level should be recorded together with the survey data (see also 5.3).

TABLE 1

Minimum Standards for Hydrographic Surveys

(To be read in conjunction with the full text set out in this document.)

Reference	Order	Special	1a	1b	2
Chapter 1	**Description of areas.**	Areas where under-keel clearance is critical	Areas shallower than 100 metres where under-keel clearance is less critical but *features* of concern to surface shipping may exist.	Areas shallower than 100 metres where under-keel clearance is not considered to be an issue for the type of surface shipping expected to transit the area.	Areas generally deeper than 100 metres where a general description of the sea floor is considered adequate.
Chapter 2	**Maximum allowable THU 95% *Confidence level***	2 metres	5 metres + 5% of depth	5 metres + 5% of depth	20 metres + 10% of depth
Para 3.2 and note 1	**Maximum allowable TVU 95% *Confidence level***	a = 0.25 metre b = 0.0075	a = 0.5 metre b = 0.013	a = 0.5 metre b = 0.013	a = 1.0 metre b = 0.023
Glossary and note 2	***Full Sea floor Search***	Required	Required	Not required	Not required
Para 2.1 Para 3.4 Para 3.5 and note 3	***Feature Detection***	Cubic *features* > 1 metre	Cubic *features* > 2 metres, in depths up to 40 metres; 10% of depth beyond 40 metres	Not Applicable	Not Applicable
Para 3.6 and note 4	**Recommended maximum Line Spacing**	Not defined as *full sea floor search* is required	Not defined as *full sea floor search* is required	3 x average depth or 25 metres, whichever is greater For bathymetric lidar a spot spacing of 5 x 5 metres	4 x average depth
Chapter 2 and note 5	**Positioning of fixed aids to navigation and topography significant to navigation. (95% *Confidence level*)**	2 metres	2 metres	2 metres	5 metres
Chapter 2 and note 5	**Positioning of the Coastline and topography less significant to navigation (95% *Confidence level*)**	10 metres	20 metres	20 metres	20 metres
Chapter 2 and note 5	**Mean position of floating aids to navigation (95% *Confidence level*)**	10 metres	10 metres	10 metres	20 metres

Total vertical uncertainty (TVU)

Depth (m)	TVU 95% Special Order (m)	TVU 95% Special Order / depth (%)	TVU 95% order 1a, 1b (m)	TVU 95% Order`1a, 1b / depth (%)	TVU 95% order 2 (m)	TVU 95% order 2 / depth (%)
10	0,26	2,5	0,52	5,2	1,03	10,3
30	0,34	0,8	0,63	2,1	1,21	4,0
50	0,45	0,5	0,82	1,6	1,52	3,0

Redefine norm

- The group proposed to decide how the norm should be redefined before the next TWG meeting in 2019.

- To do this effectively, the TWG recommend to:

  1) Share information how each country built their respective reference surface as studying the used steps, the used bathymetry, the used numbers of in situ observations.
  2) Compare the surfaces.
  3)Make error estimates on each reference surface

- Ask the NSHC what is the goal of the Work Plan item;

  is it to obtain a seamless LAT surface for charting (for safe shipping) or for modelling as for charting the observed differences are acceptable, but for studying they are not?

- Ideas from TWCWG3?

New actions items

AP 22/01 – Each member state should supply information on how their LAT surface was built to NL who will analyse this information and compare the surfaces.

AP 22/02 – Each member state should supply all LAT updates to NL who will update the LAT differences matrix accordingly.

AP 22/03 – Make error estimates in LAT surfaces.

AP22/04 - decide how the arbitrary 1% norm should be redefined to be linked to something practical.

AP22/05 - Follow the developments of European initiatives on new LAT surfaces. The TWG recommends that any new LAT surfaces are marked as unofficial, not chart datum and not for navigational purposes.

Questions?