

NLGEO2018 & NLLAT2018

berekeningsstrategie en nauwkeurigheid

NEVREF research team



Philipp Rupprecht photography



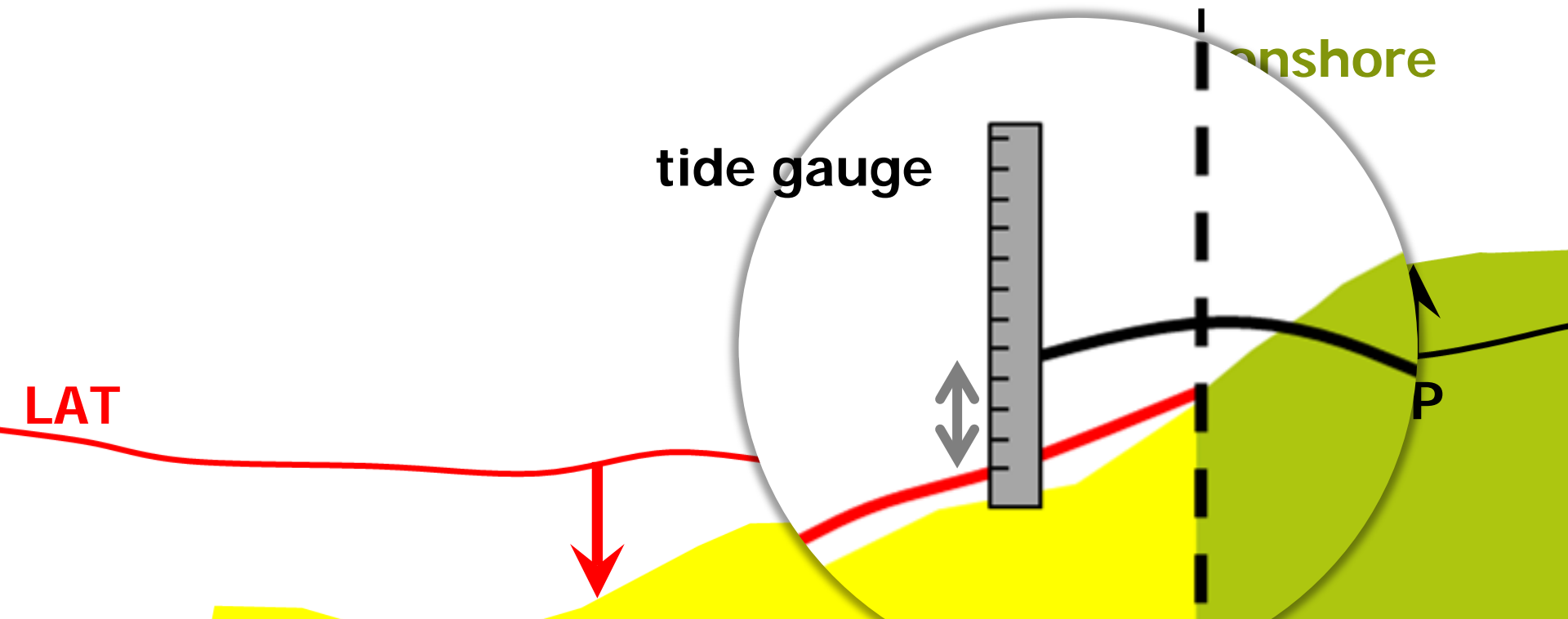




Outline

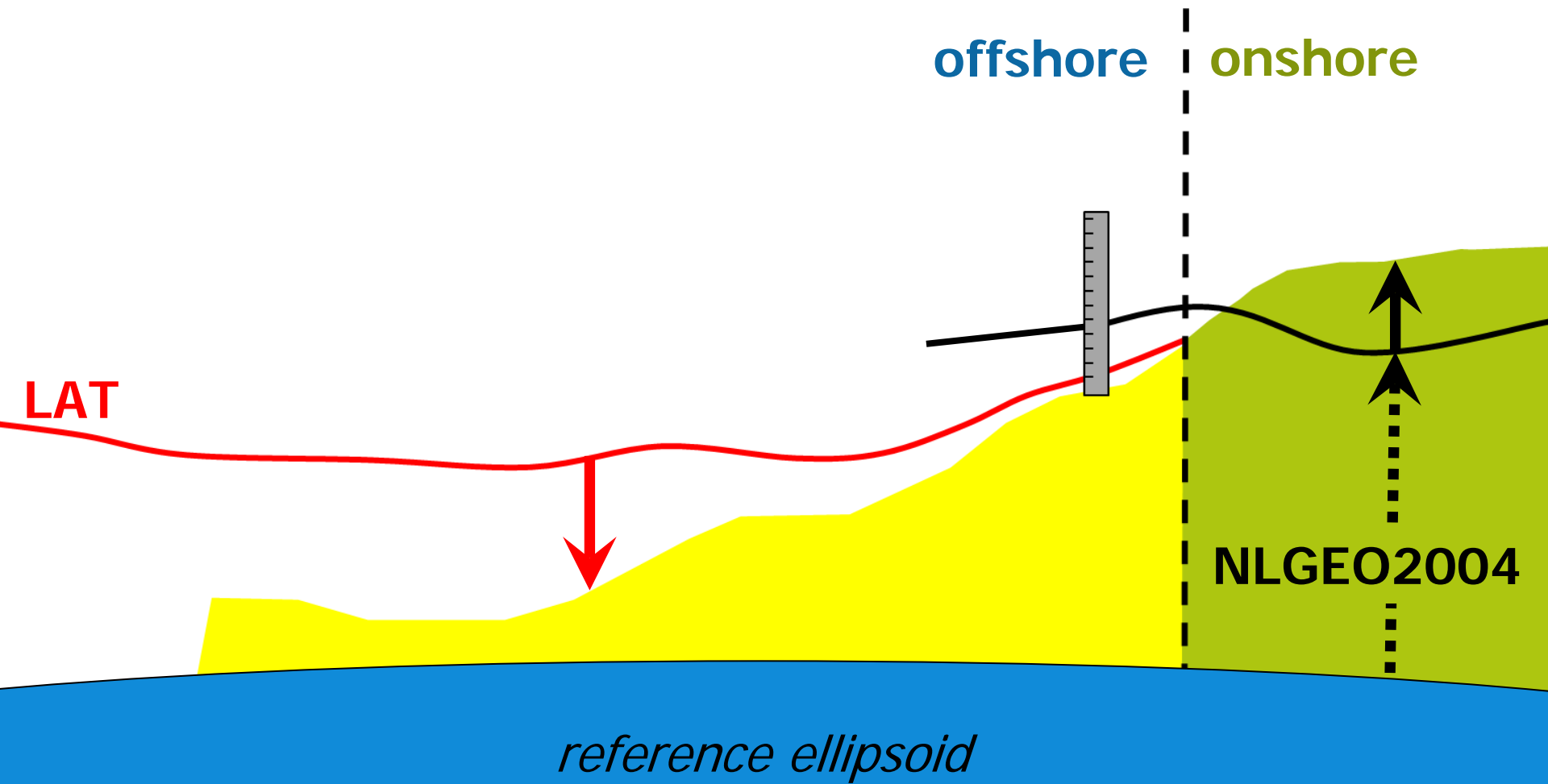
- Challenge & approach
- NLGEO2018, the new Dutch quasi-geoid model
- NLLAT2018, the new Dutch LAT model

The problem...



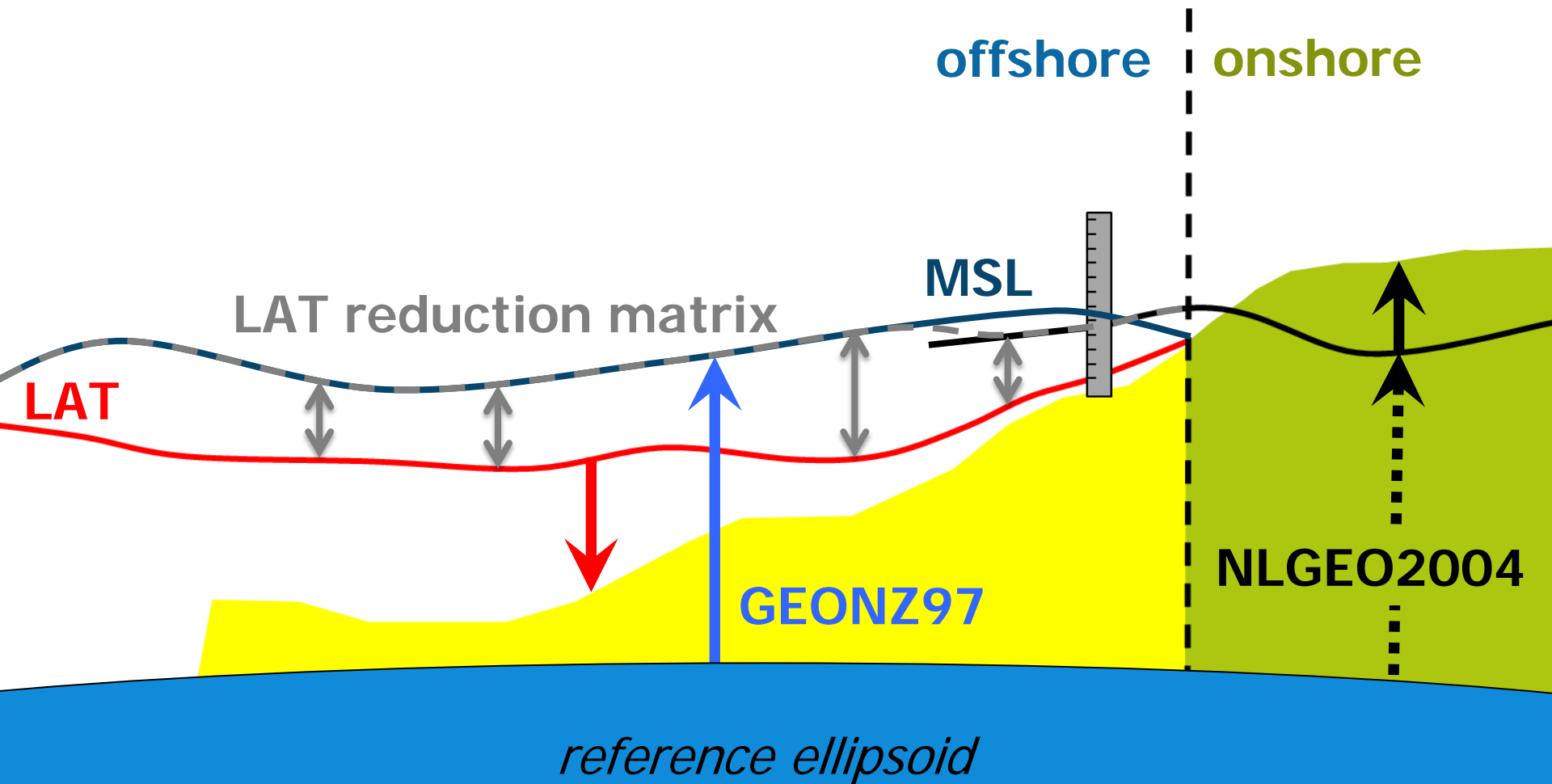
Typically, the separation chart datum/ height reference surface is a *spatially varying* function only known at the tide gauges!

The problem...



The problem...

LAT reduction matrix = difference LAT - "MSL" in open sea and LAT - NAP along the coast (smooth transition)



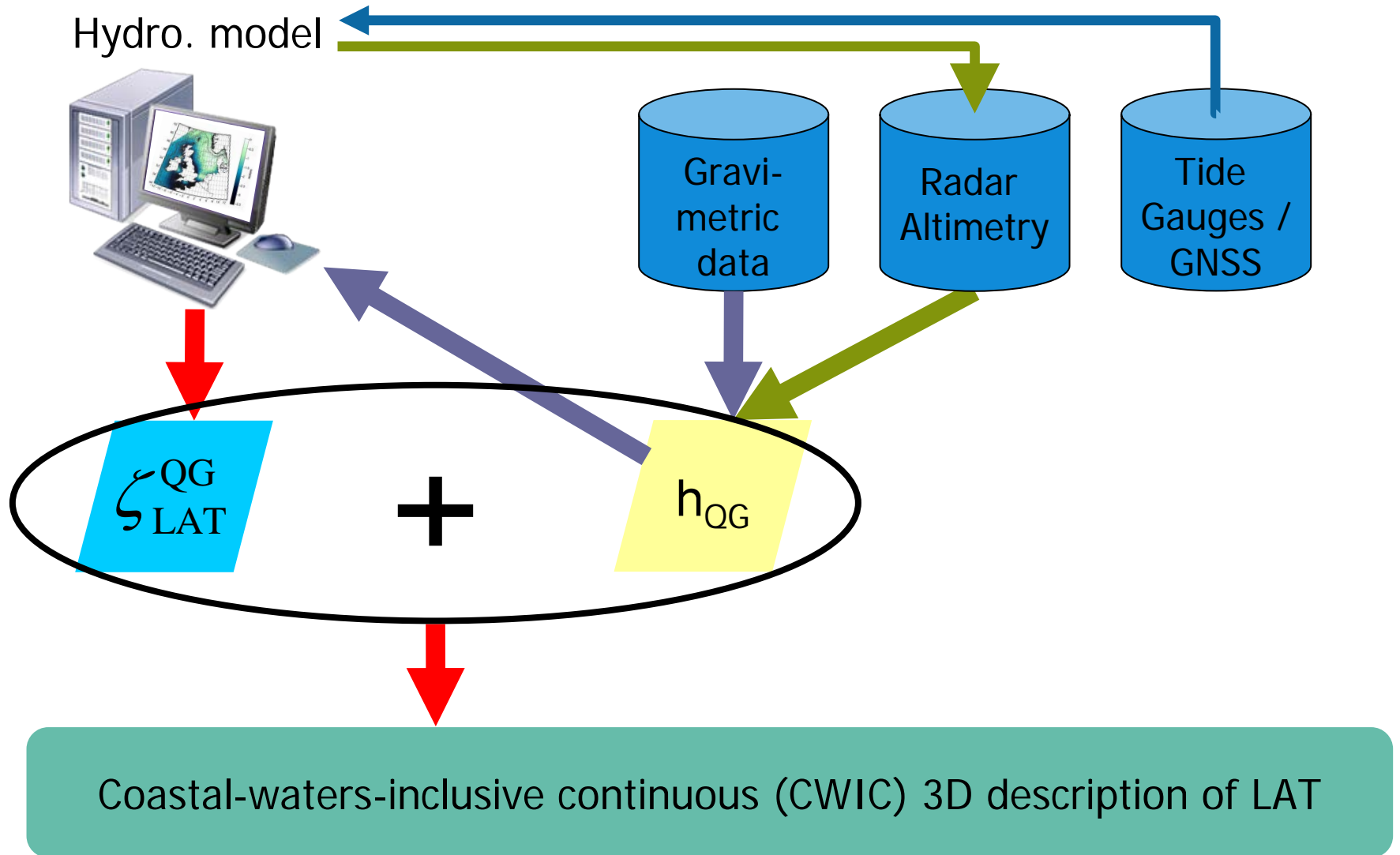
Main objective NEVREF project

Required with
cm accuracy ...

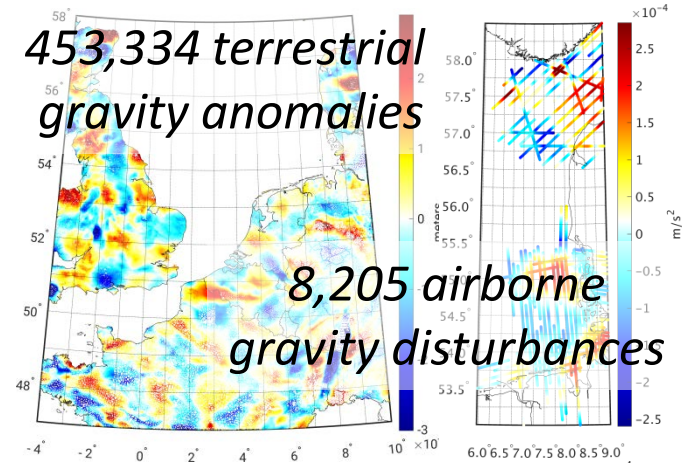
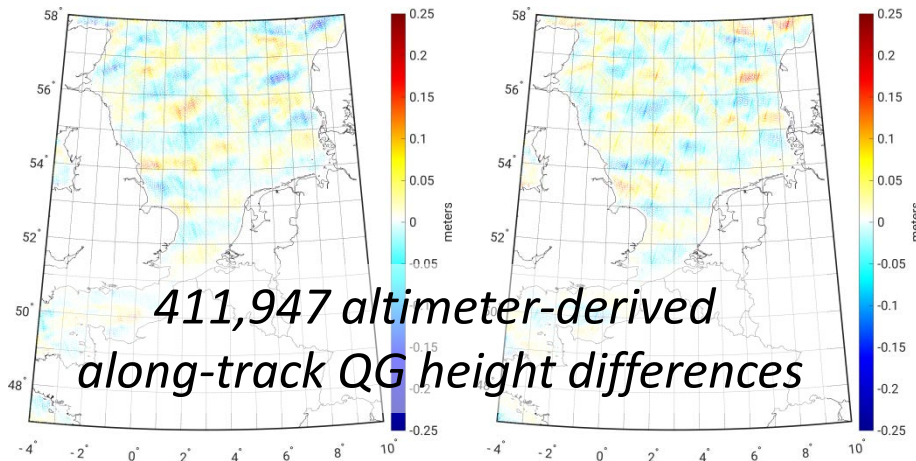
To obtain accurate realizations of the **quasi-geoid** and **lowest astronomical tide** surface, including the necessary **transformations** from/to all common land and marine vertical reference surfaces

...to obtain this one
with accuracy of 1 dm!

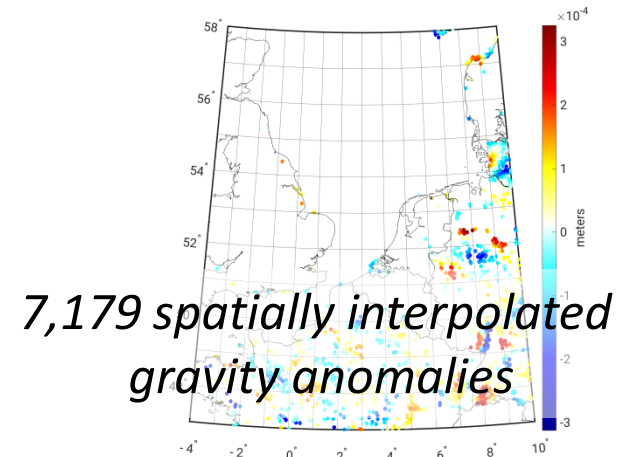
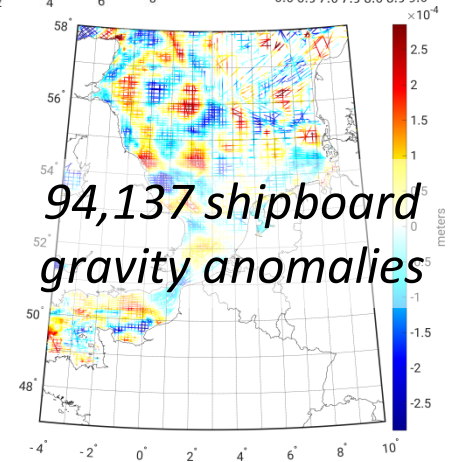
Approach

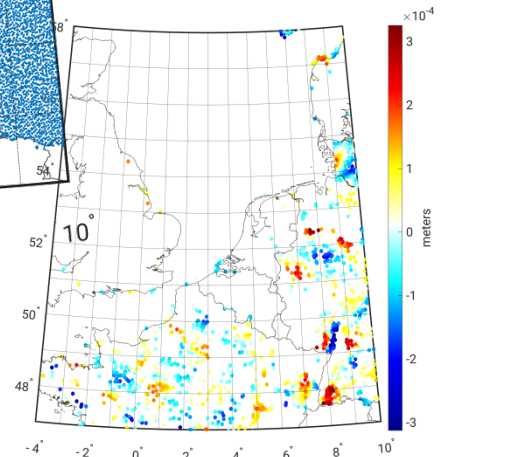
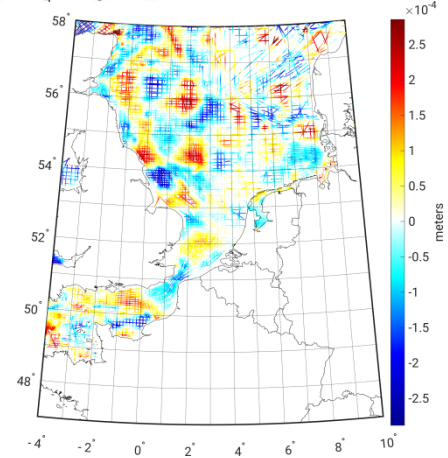
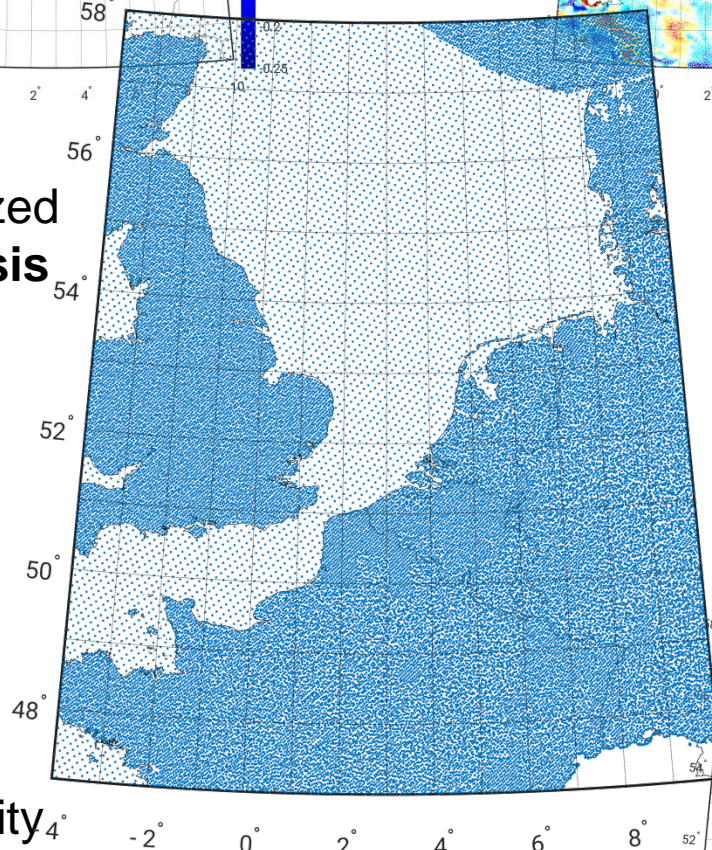
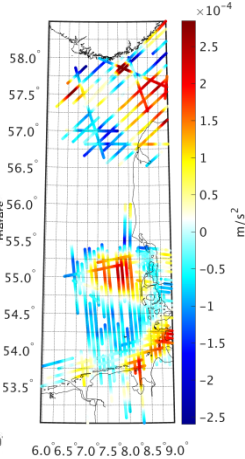
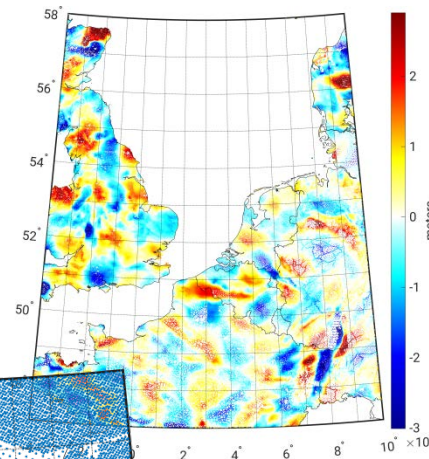
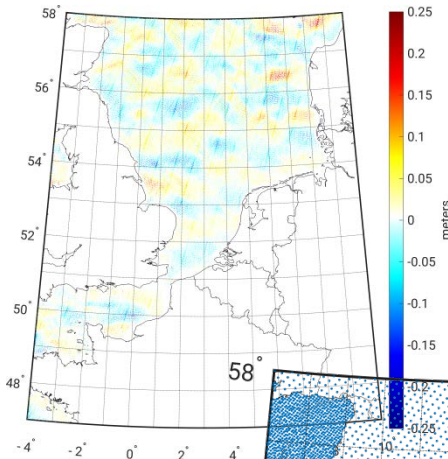
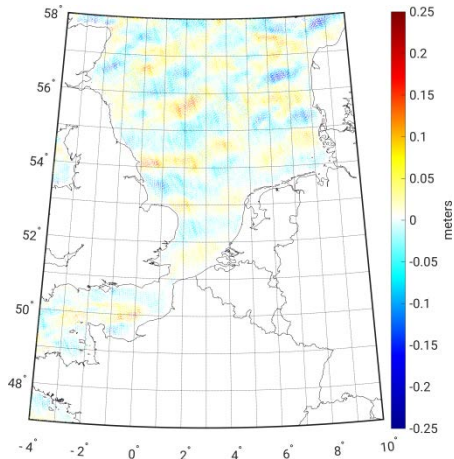


NLGE02018, the new Dutch quasi-geoid model...



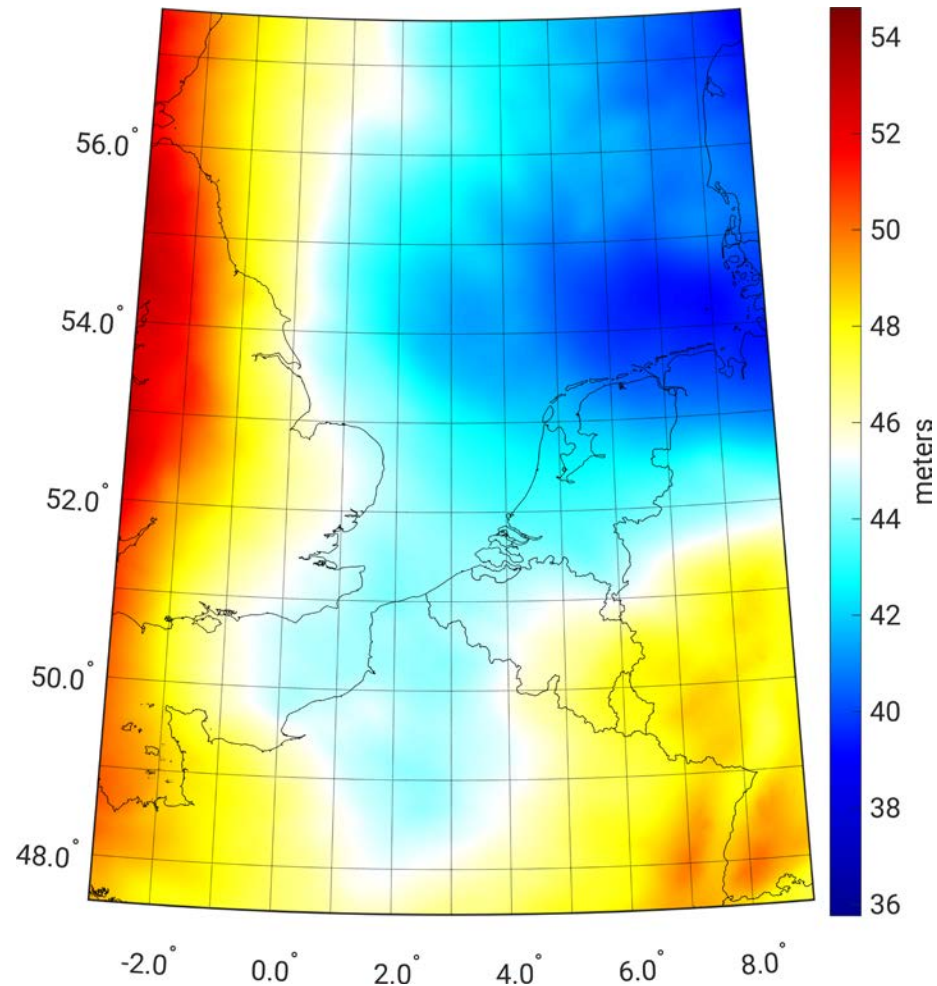
- Altimeter data corrected for dynamic topography from Dutch operational storm-surge model;
- **Colored noise** in altimeter-derived QG height differences accounted for;
- **New** terrestrial gravity data in Limburg, Germany, Belgium;
- **New** airborne data in German Bight;
- Shipboard data **re-processed**;
- Remove-compute-restore:
 - **GOCO05S** as a-priori gravity field;
 - **RTM** correction applied using the TS (tesseroid) software;





- Quasi-geoid is parameterized using **spherical radial basis functions**.
- Parameters are estimated using **weighted least-squares**.
- **Variance component estimation** is applied for proper weighting of all datasets.
- **Systematic errors** in gravity datasets are accounted for.
- **Full noise covariance matrix** of estimated quasi-geoid.

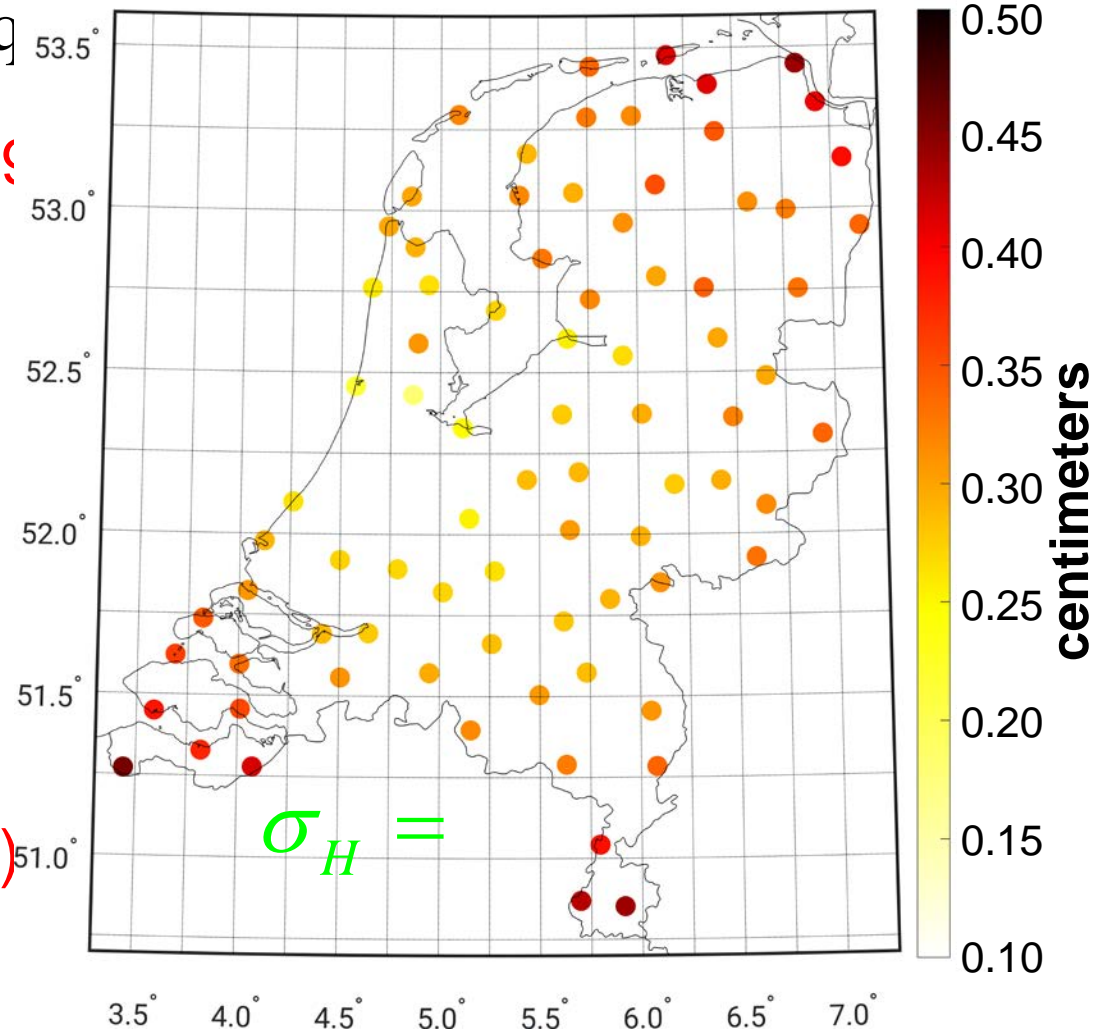
NLGEO2018 - gravimetric quasi-geoid



Validation - Netherlands

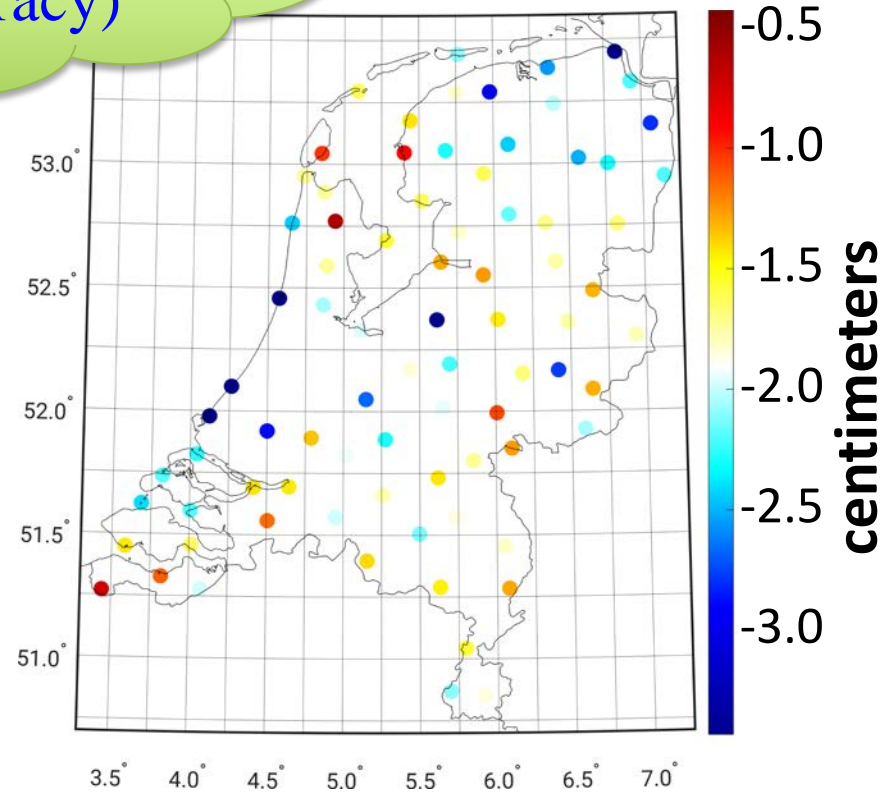
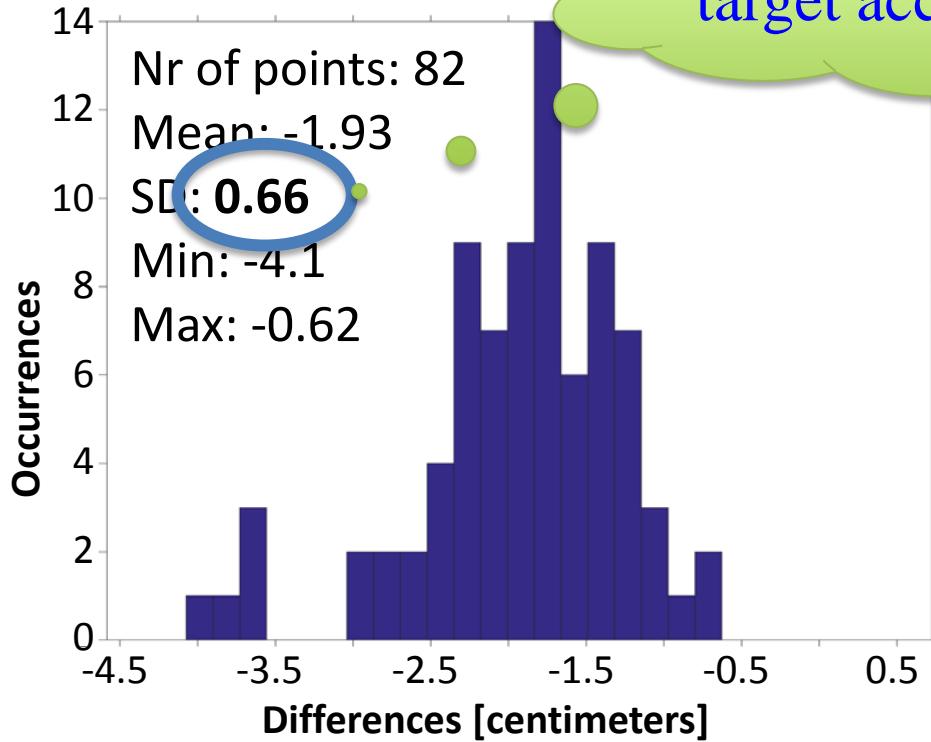
$$\varepsilon = (h_{\text{GNSS}} - H_{\text{NAP}}) - \varrho$$

- Acquired during 1996–1998 (5th primary leveling);
- Reprocessed by L. Huisman using Bernese Software Version 5.2;
- ITRF2005;
- Tide free → mean crust;
- $\sigma_h \approx 5 \text{ mm}$ (5 days data)



Validation - Netherlands

< 1 cm (better than target accuracy)



$$\mathcal{E} = \zeta_{\text{geometric}} - \zeta_{\text{gravimetric}}$$



A brief (historical) review on definitions and applications of the geoid

IX Hotine-Marussi Symposium, Rome, 18-22 June, 2018

prof. Tomislav Bašić, Matej Varga

June 18, 2018

Faculty of Geodesy, University of Zagreb

Accuracy of (quasi-)geoid models (I)

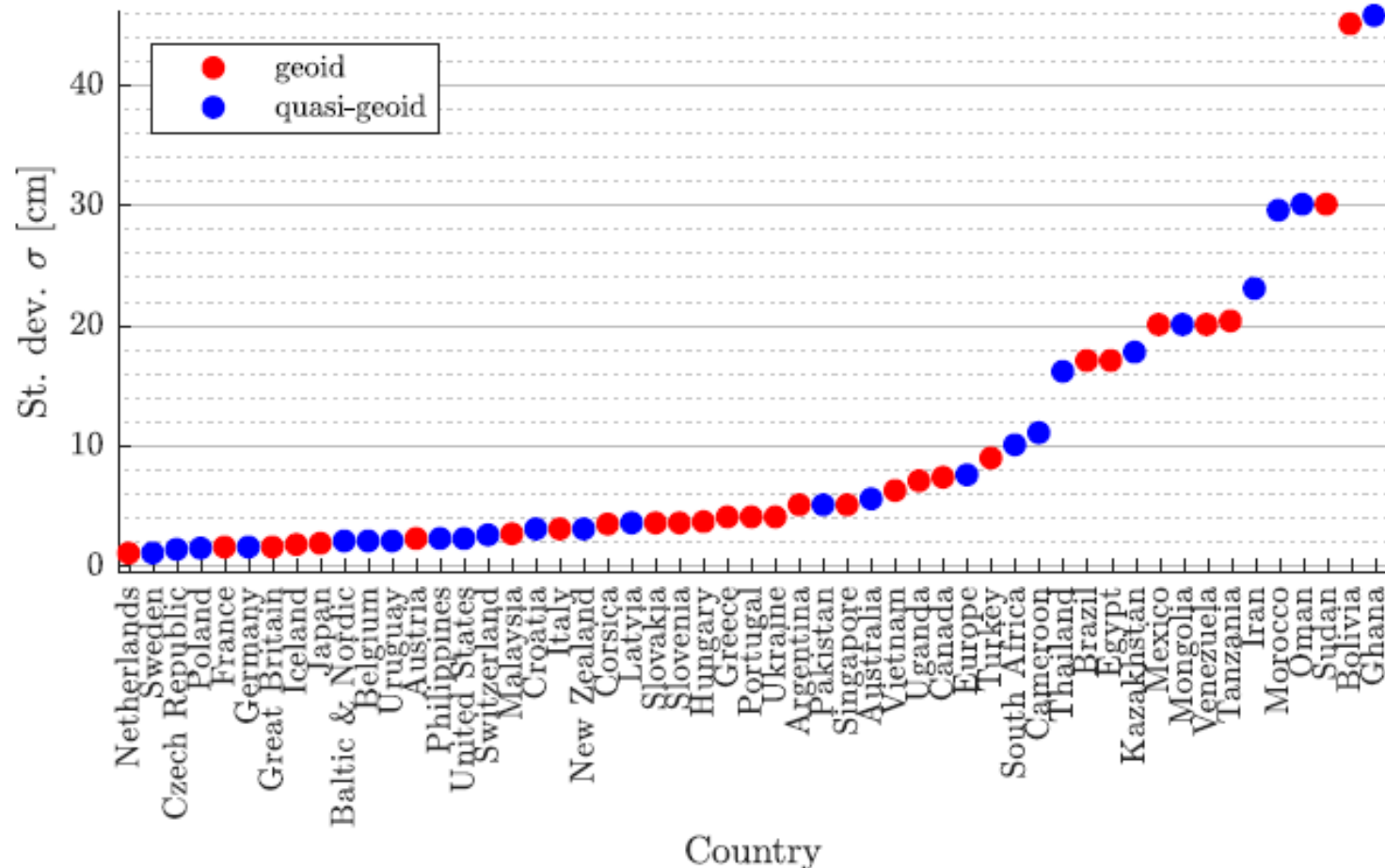


Figure 2: Accuracy of geoid and quasi-geoid models compared to GNSS/levelling for different countries

Accuracy of (quasi)-geoid models (II)

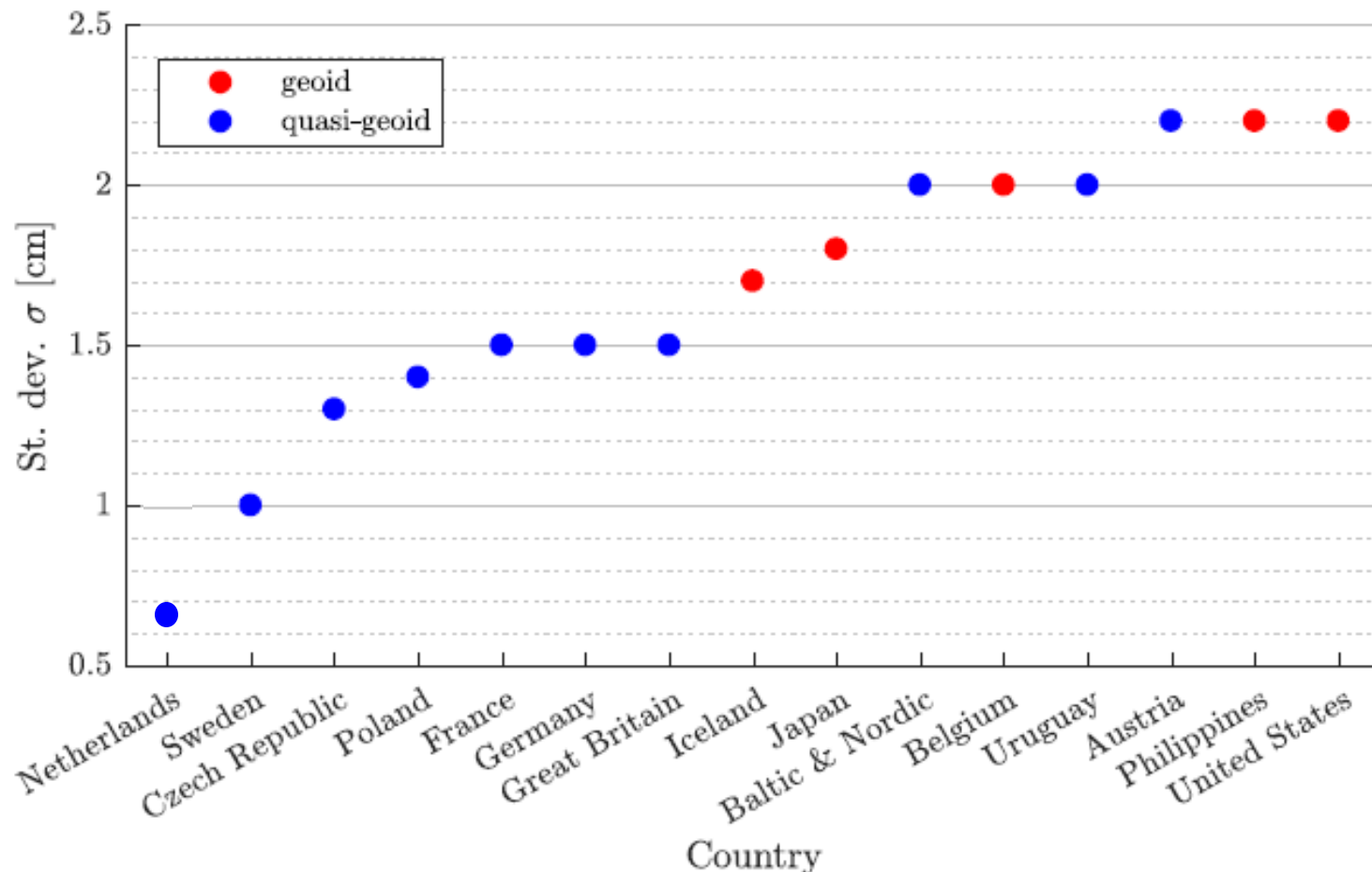
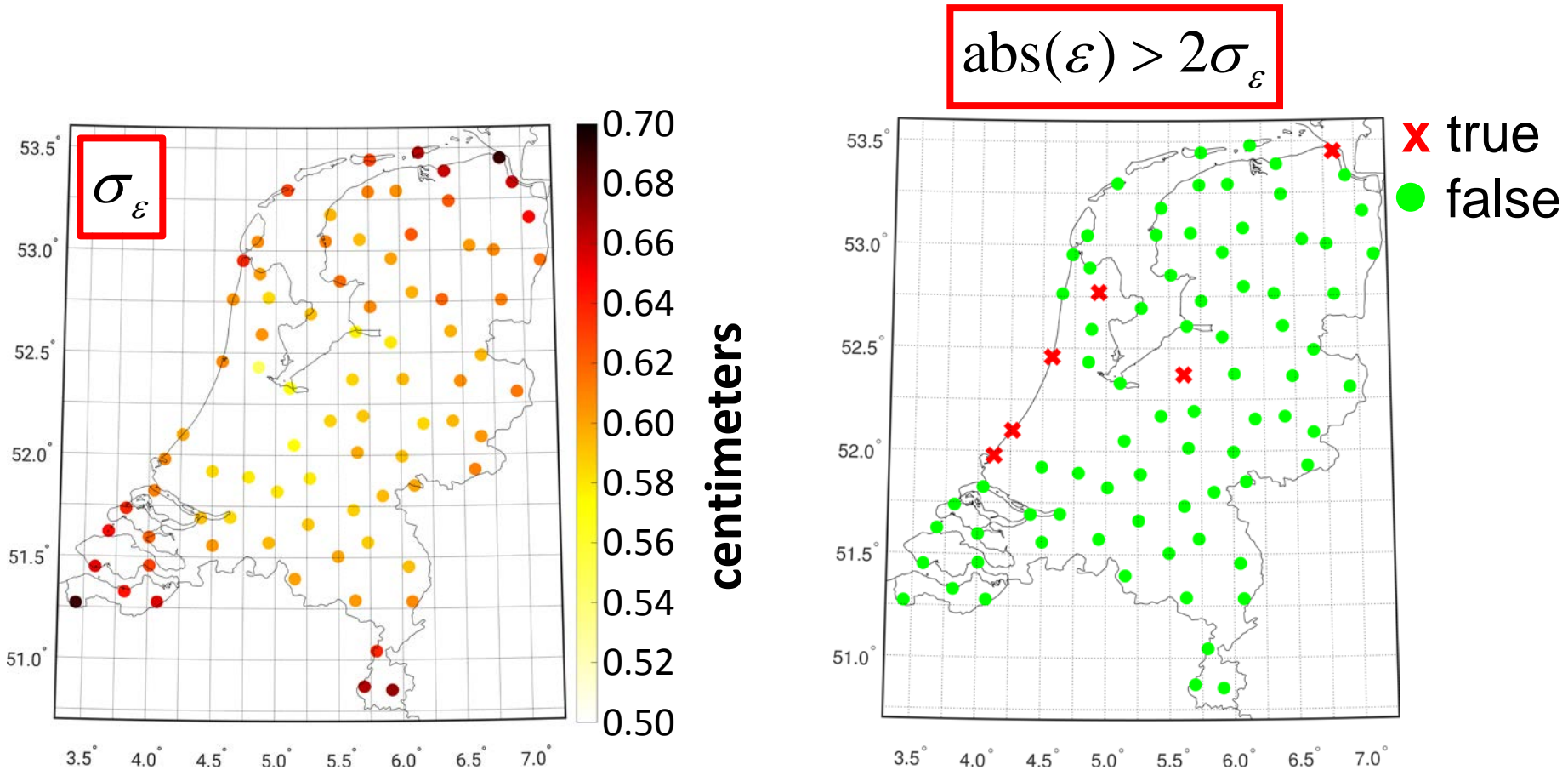


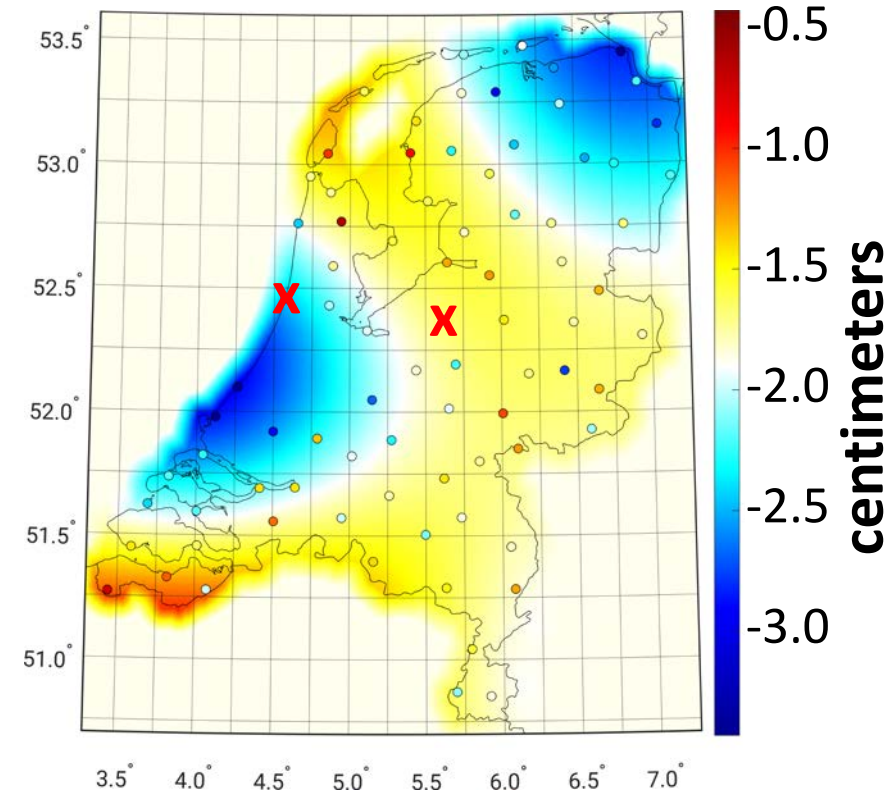
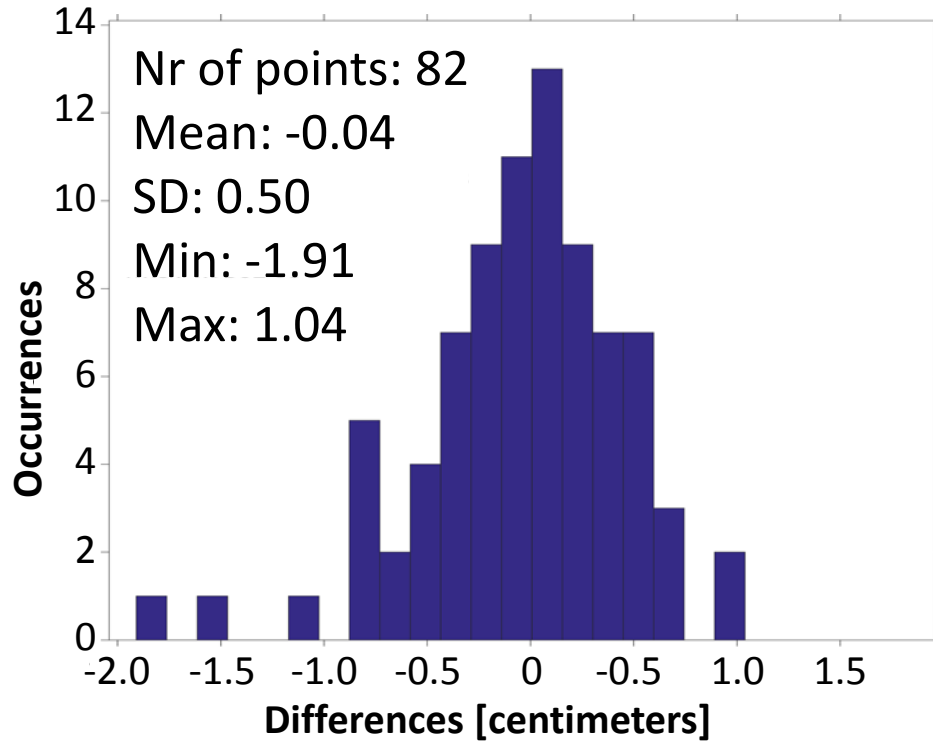
Figure 3: Accuracy of geoid and quasi-geoid models compared to GNSS/levellin

Validation - Netherlands



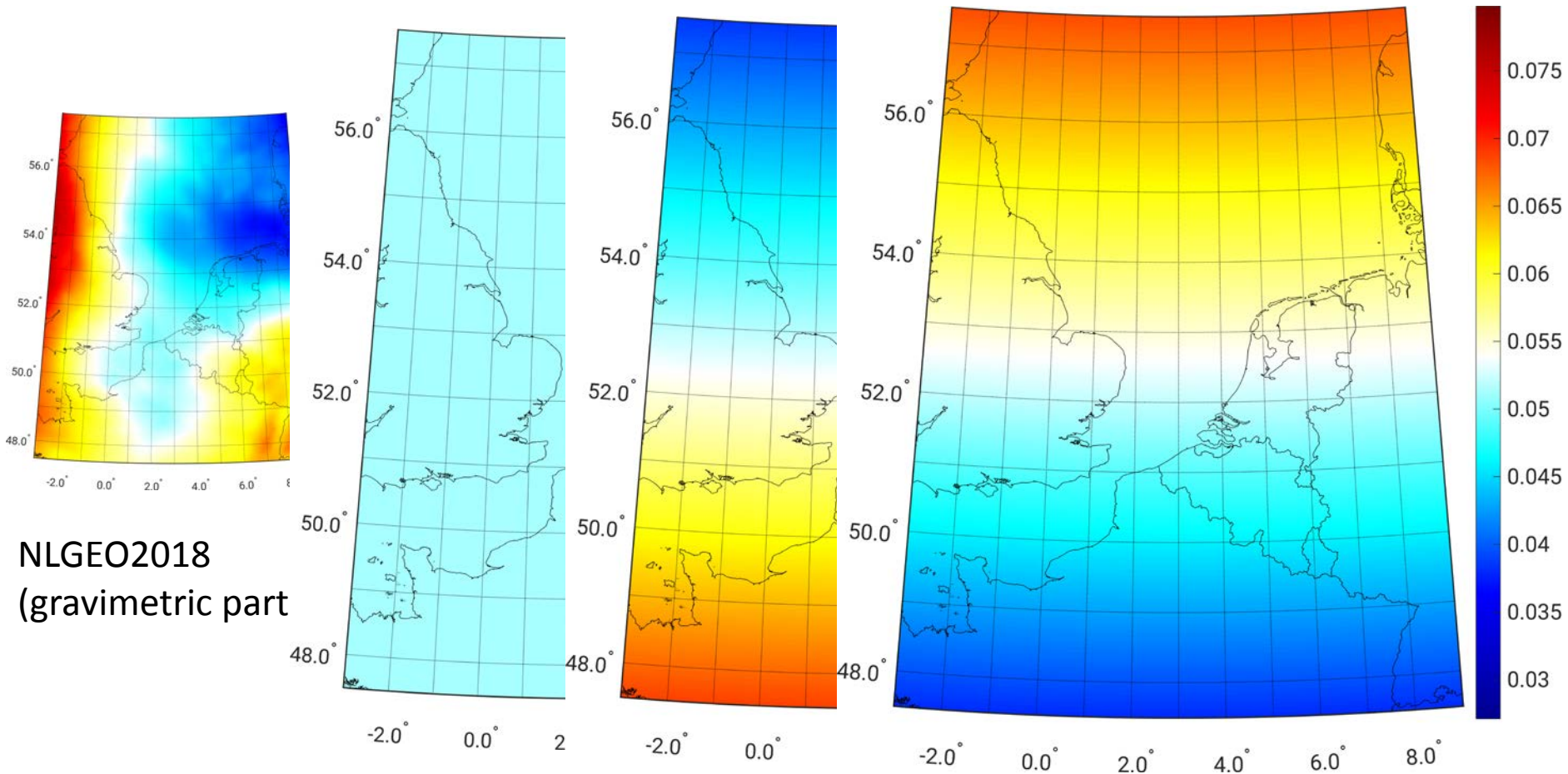
$$\epsilon = \zeta_{\text{geometric}} - \zeta_{\text{gravimetric}}$$

Corrector surface



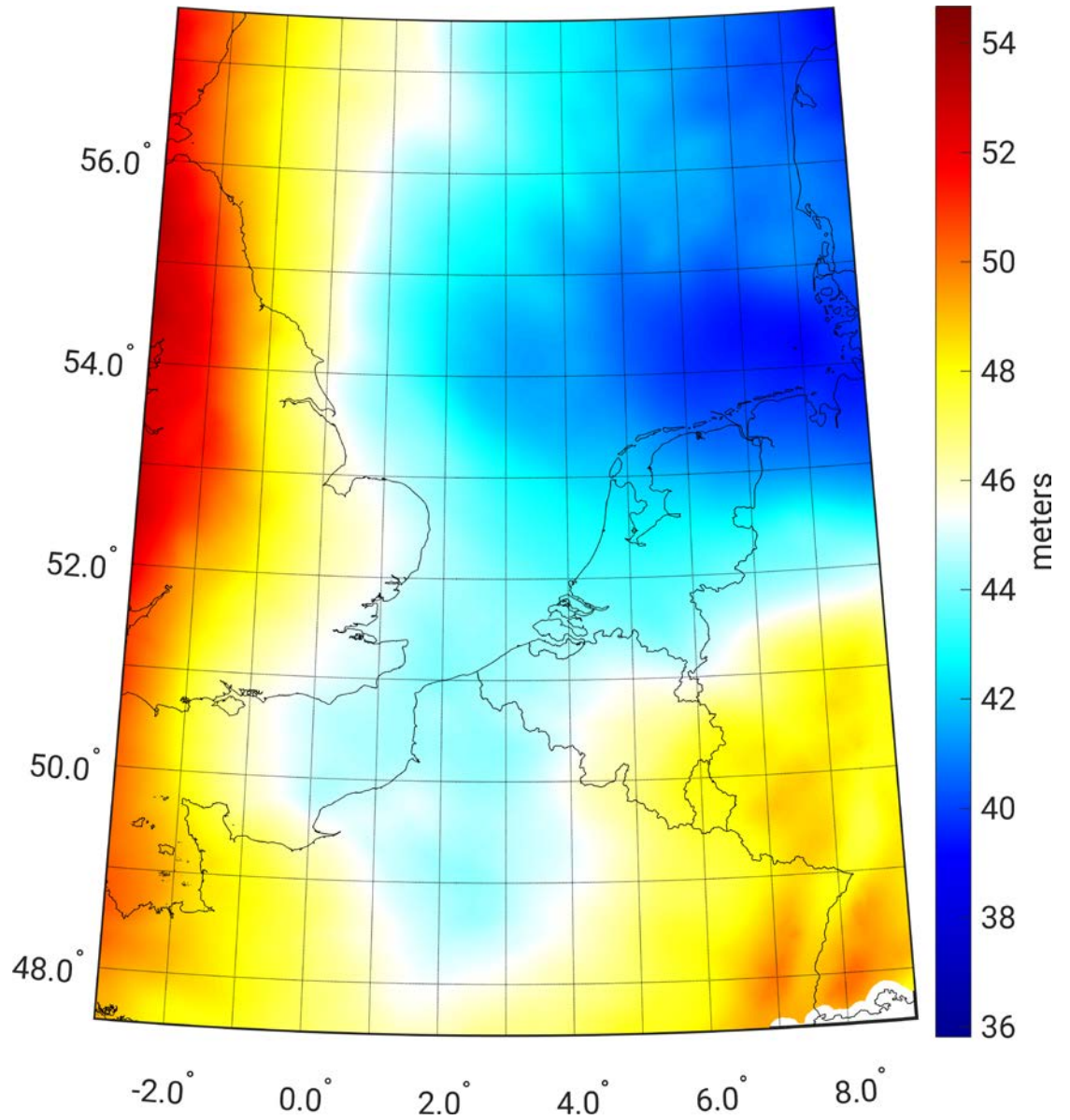
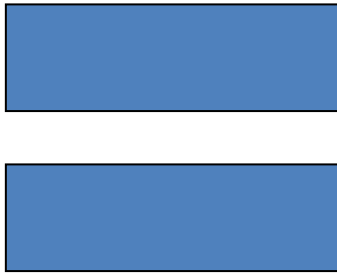
$$\varepsilon = \zeta_{\text{geometric}} - (\zeta_{\text{gravimetric}} + \text{CS})$$

NLGEO2018



NLGEO2018
(gravimetric part)

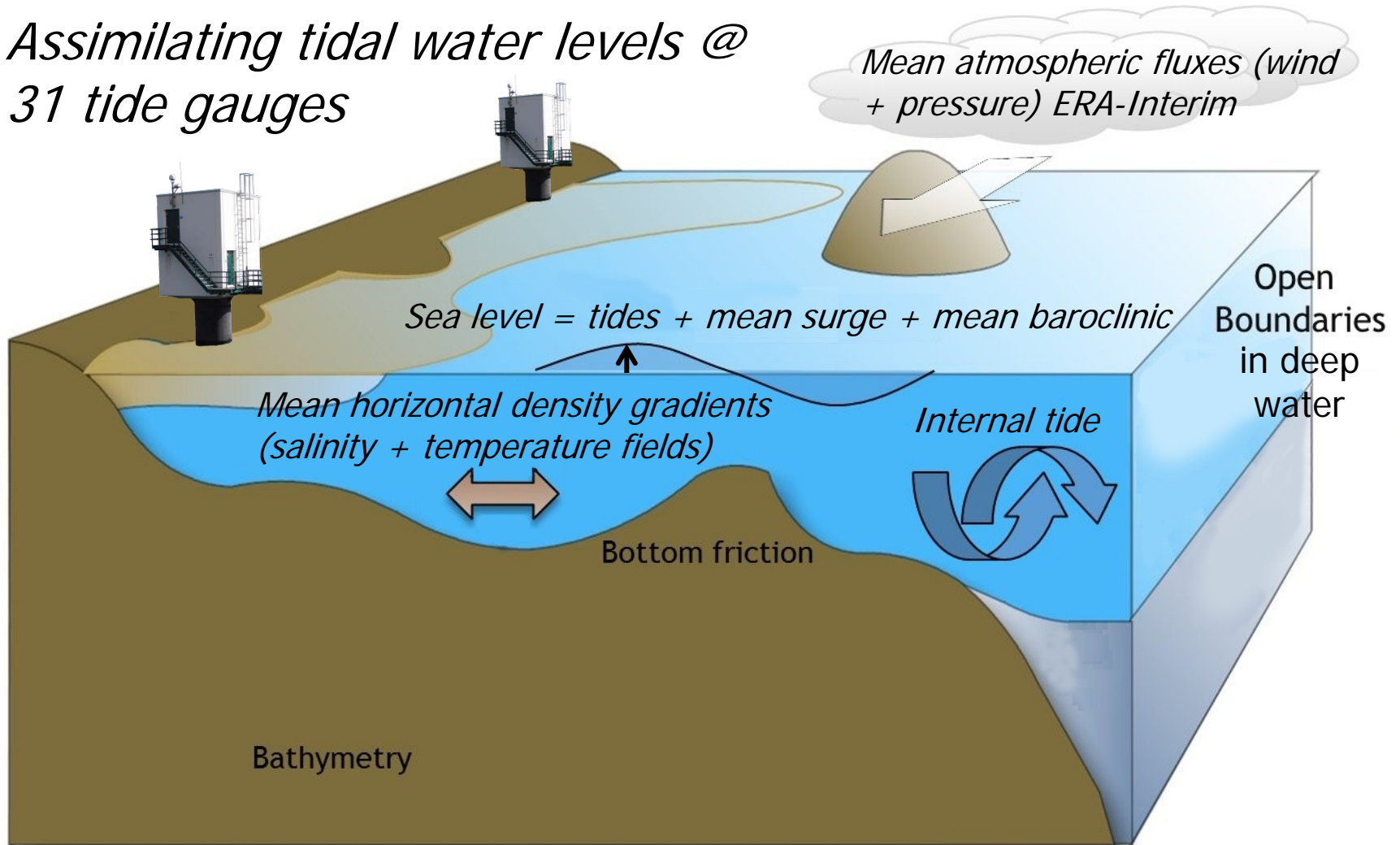
NLGEO2018



NLLAT2018, the new Dutch LAT model...

LAT computations: setup

*Assimilating tidal water levels @
31 tide gauges*

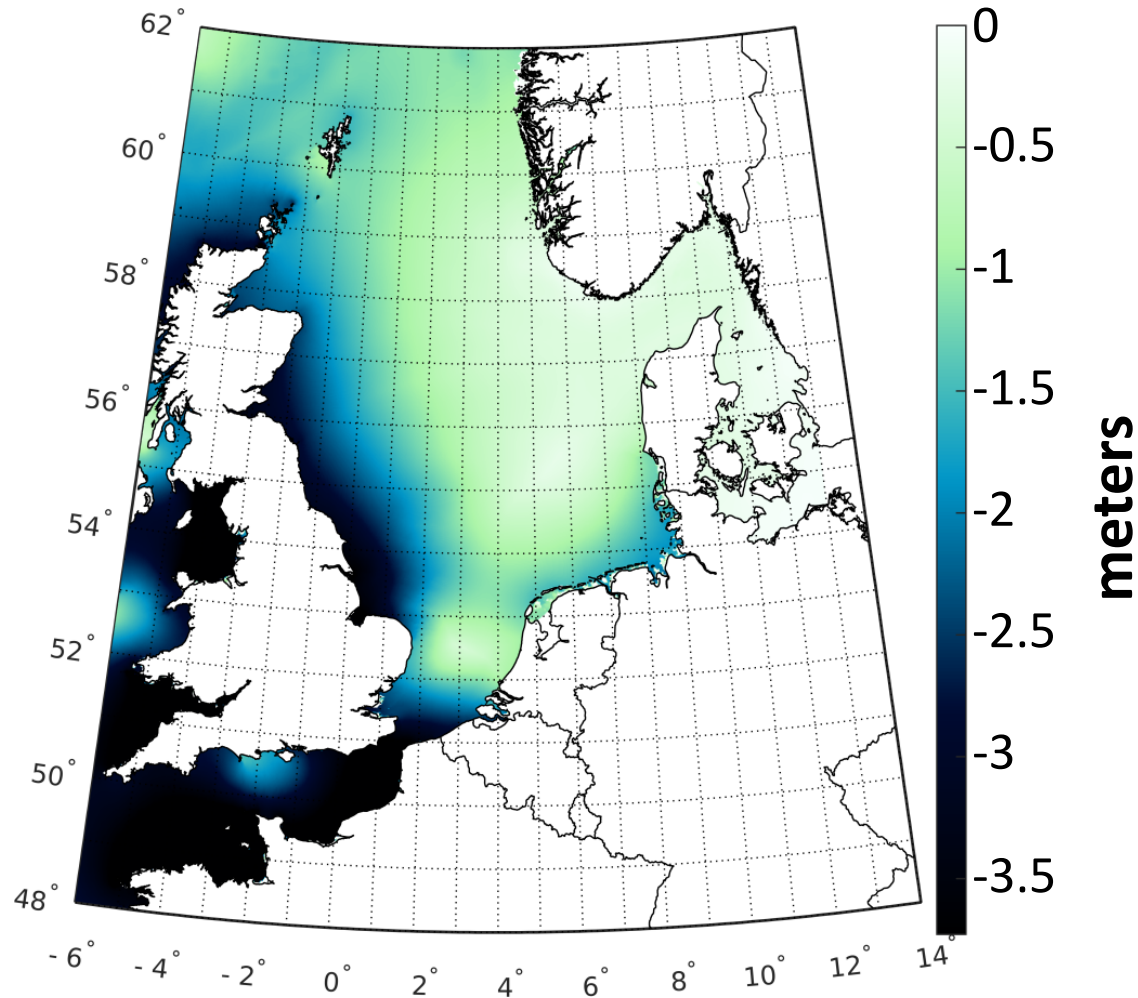


Vertical reference of hydrodynamic model → NAP

CONSISTENCY

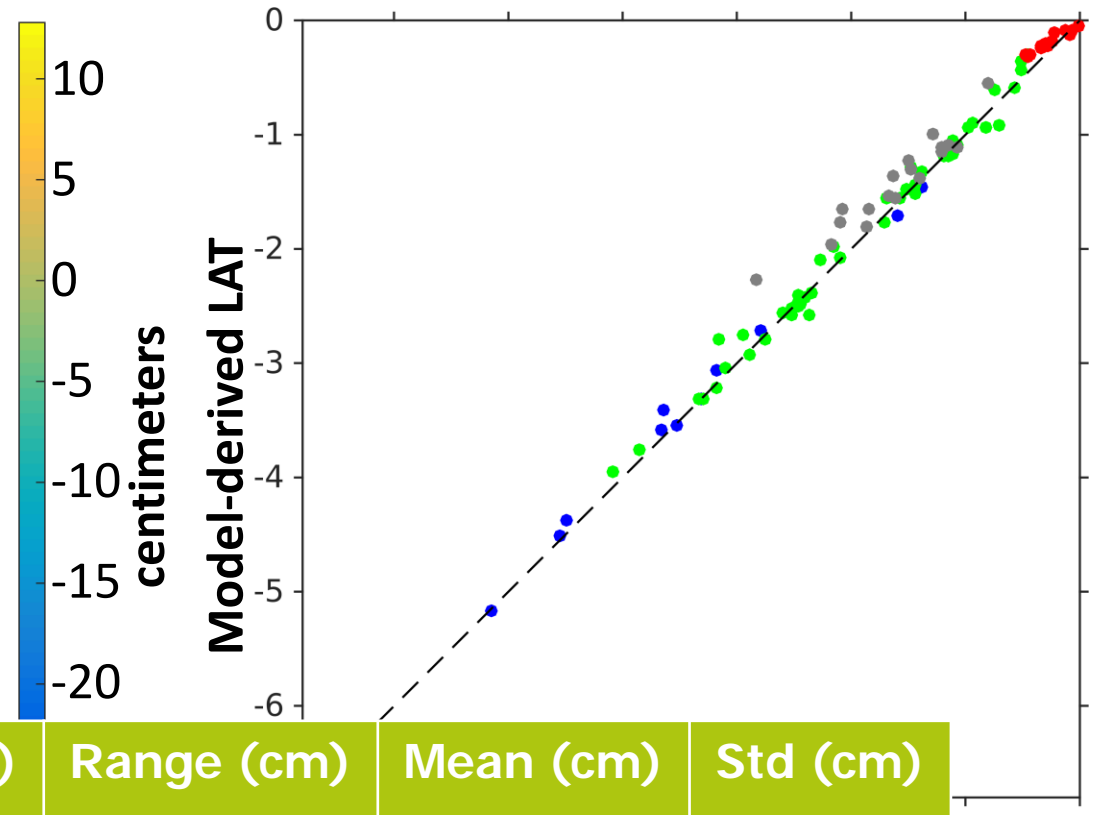
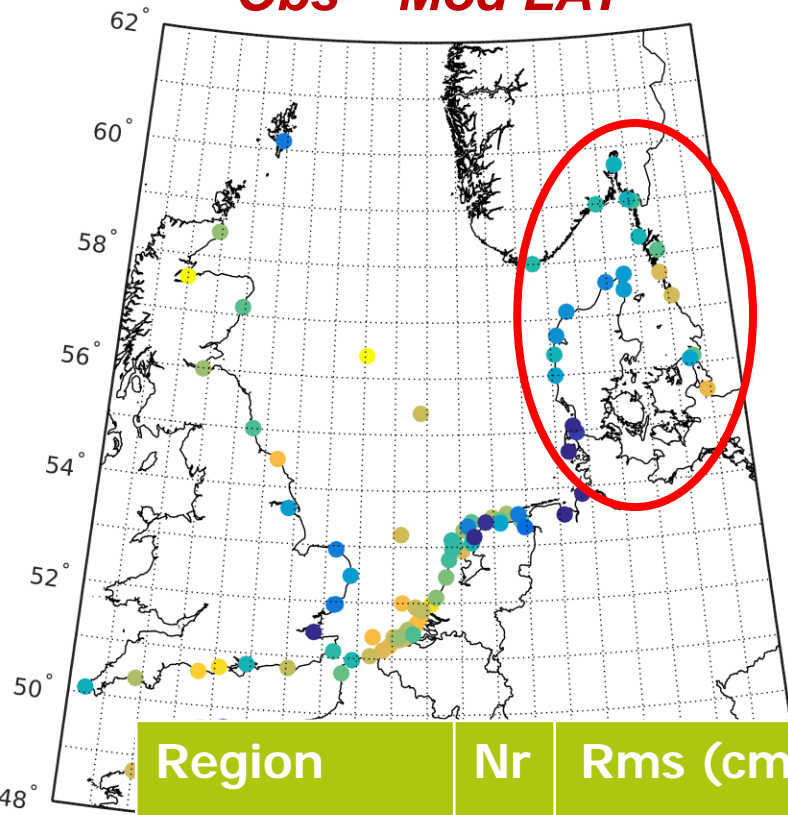


LAT w.r.t. quasi-geoid



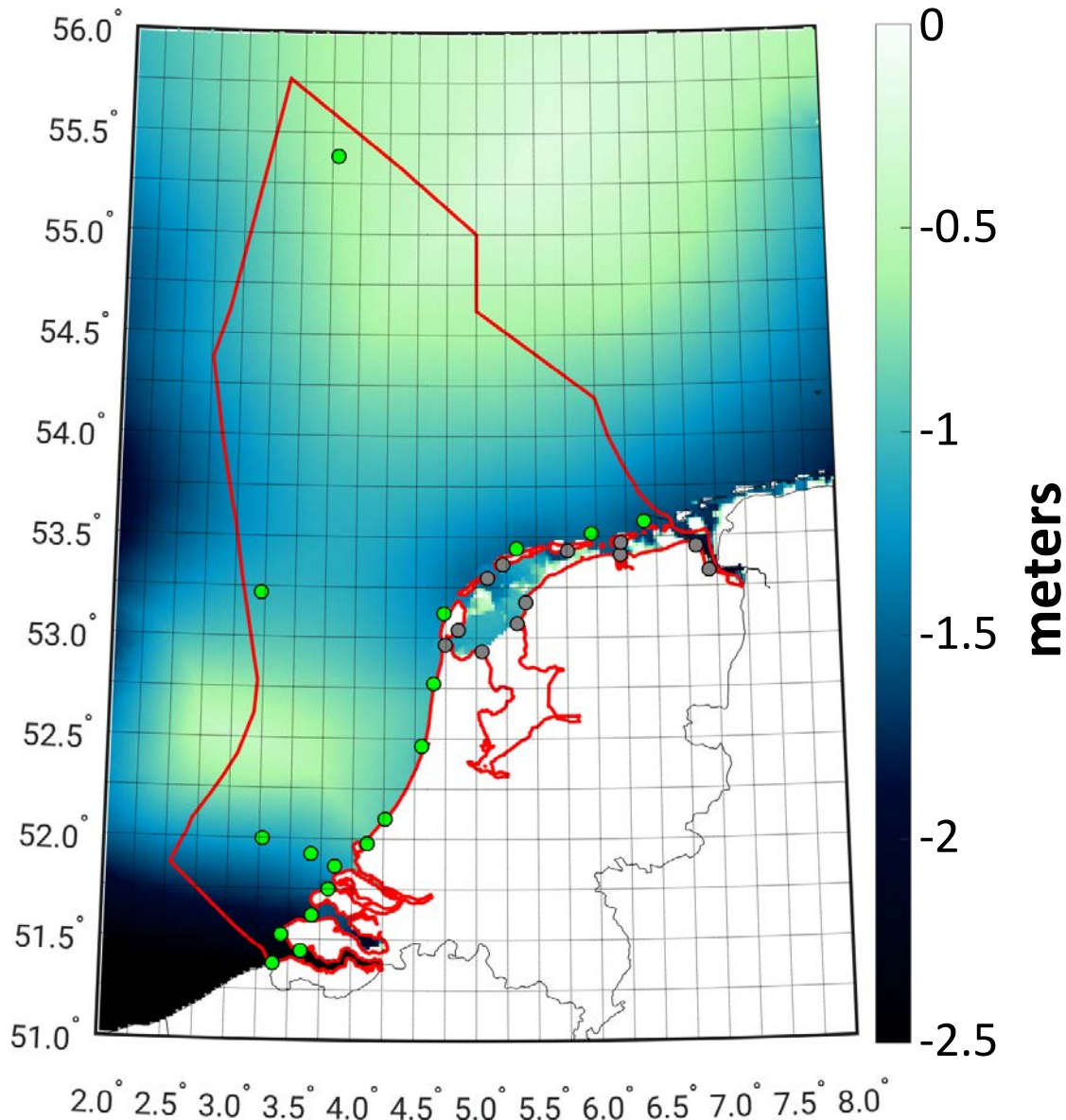
LAT w.r.t. quasi-geoid - validation

Obs – Mod LAT



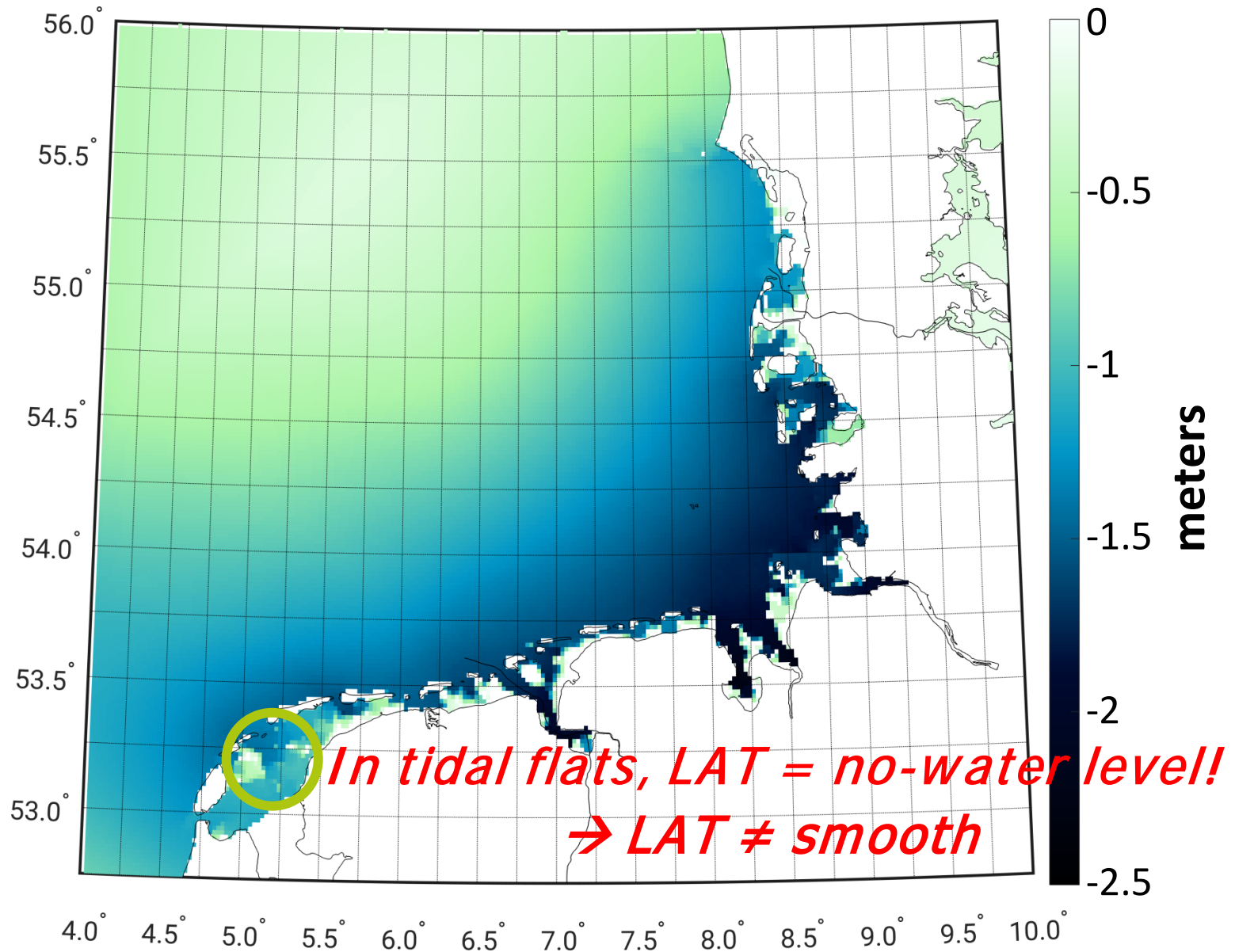
| Region | Nr | Rms (cm) | Range (cm) | Mean (cm) | Std (cm) |
|------------|----|-------------|-------------|--------------|-------------|
| North Sea | 47 | 10.6 | 57.6 | -2.7 | 10.4 |
| Wadden Sea | 18 | 24.0 | 59.5 | -18.7 | 15.4 |
| All | 92 | 14.9 | 77.6 | -7.2 | 13.1 |

LAT w.r.t. quasi-geoid – Dutch waters

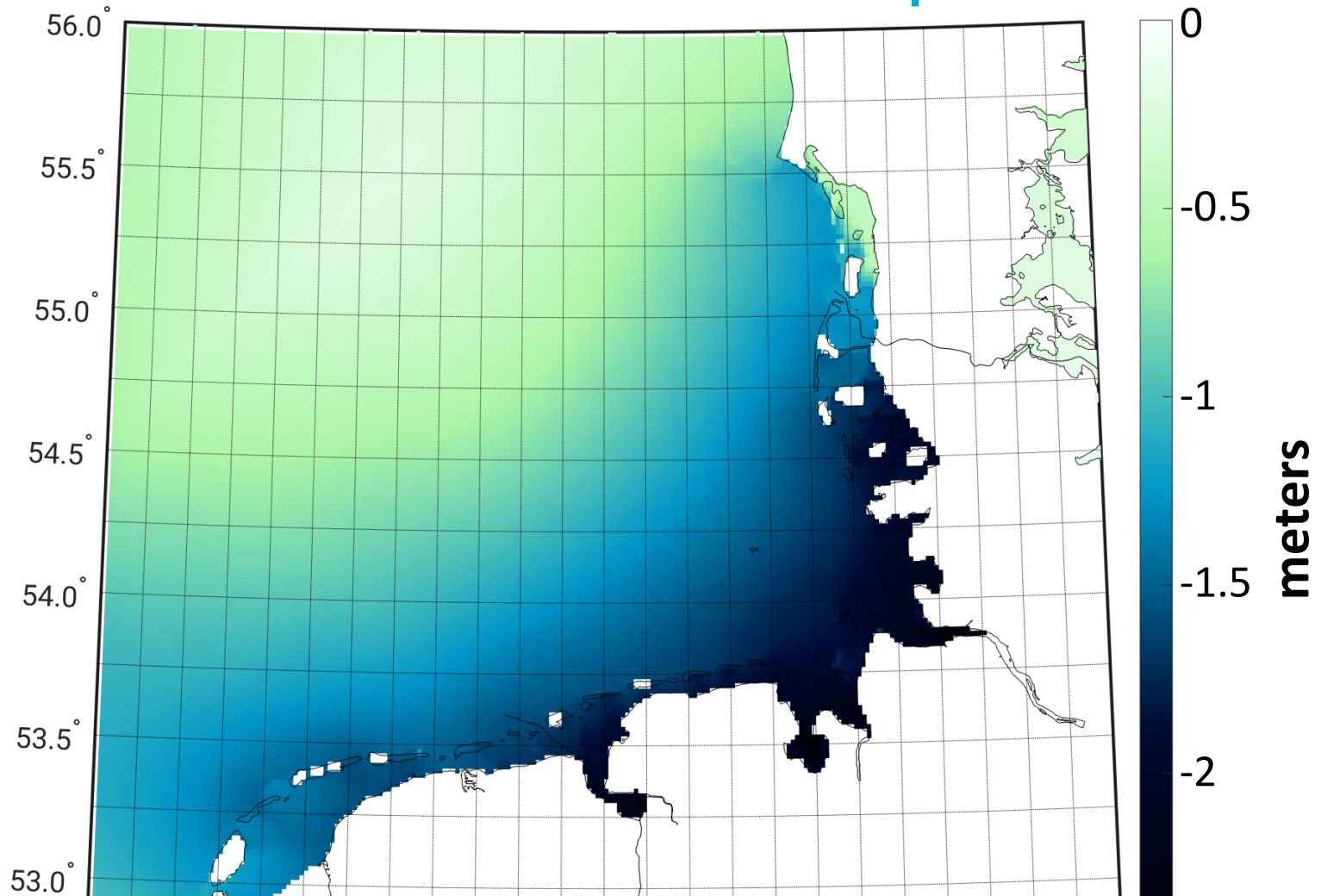


| Region | Nr | rms (cm) |
|------------|----|-------------|
| North Sea | 19 | 6.6 |
| Wadden Sea | 12 | 14.8 |
| All | 31 | 10.5 |

LAT in the Wadden Sea?

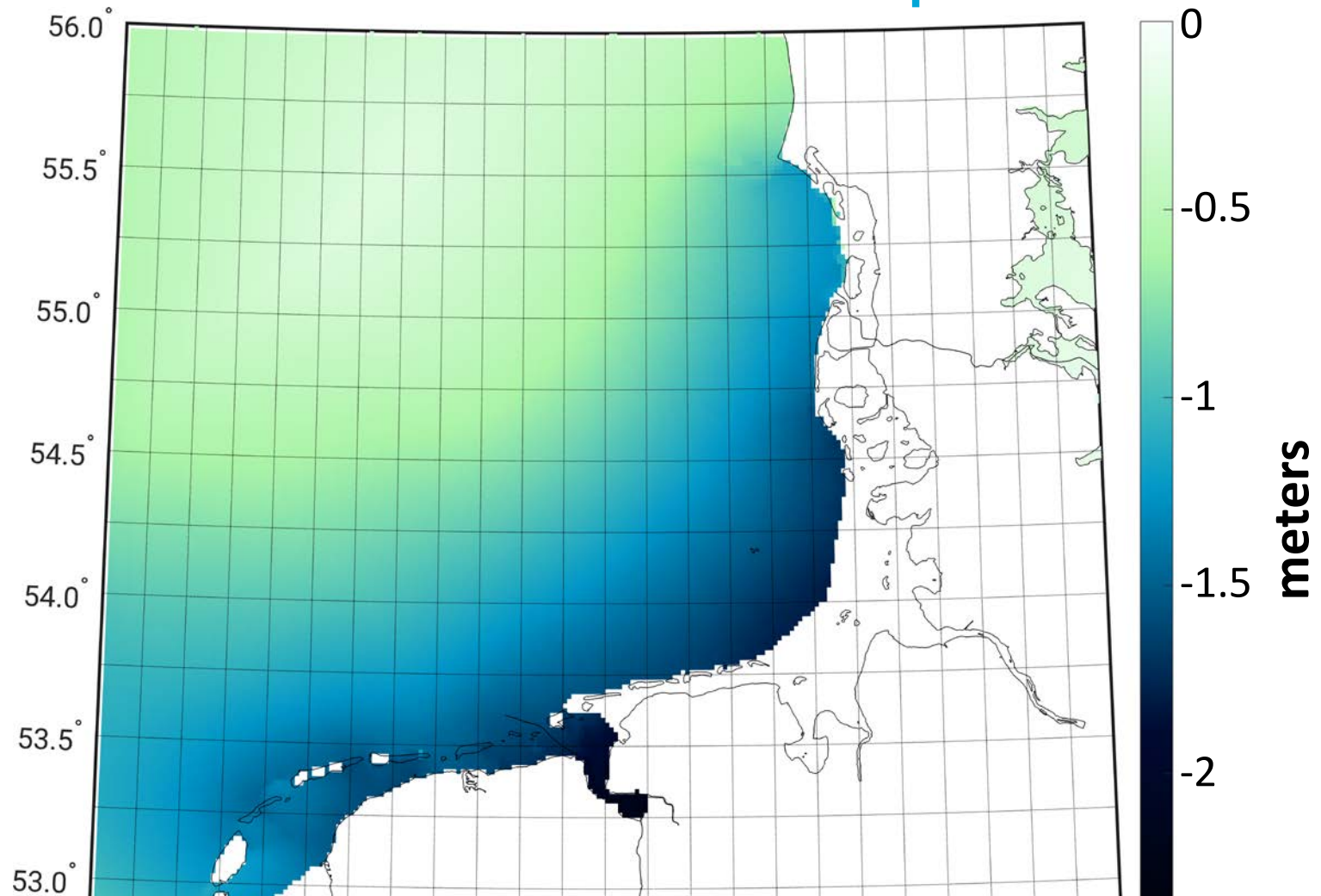


In the Wadden Sea LAT \rightarrow pseudo LAT



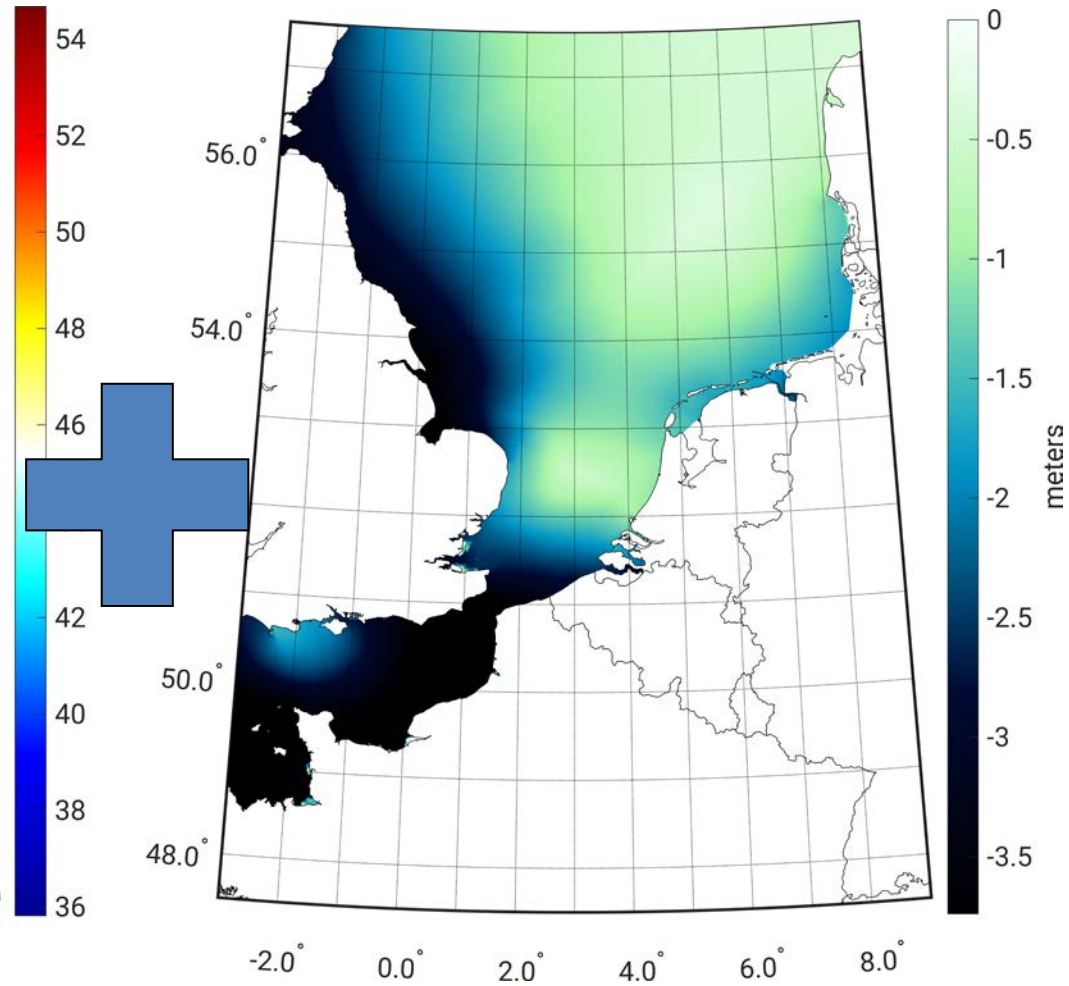
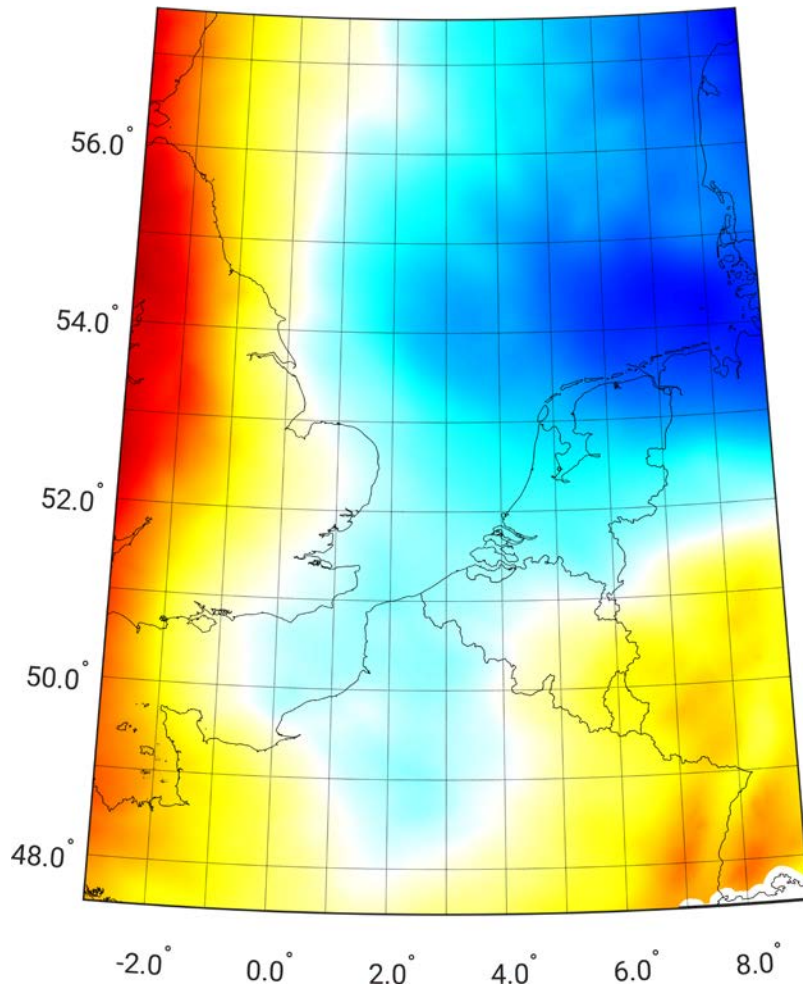
To obtain pseudo-LAT, we added 2 m of water to open boundary conditions & assimilated tidal water levels

In the Wadden Sea LAT → pseudo LAT

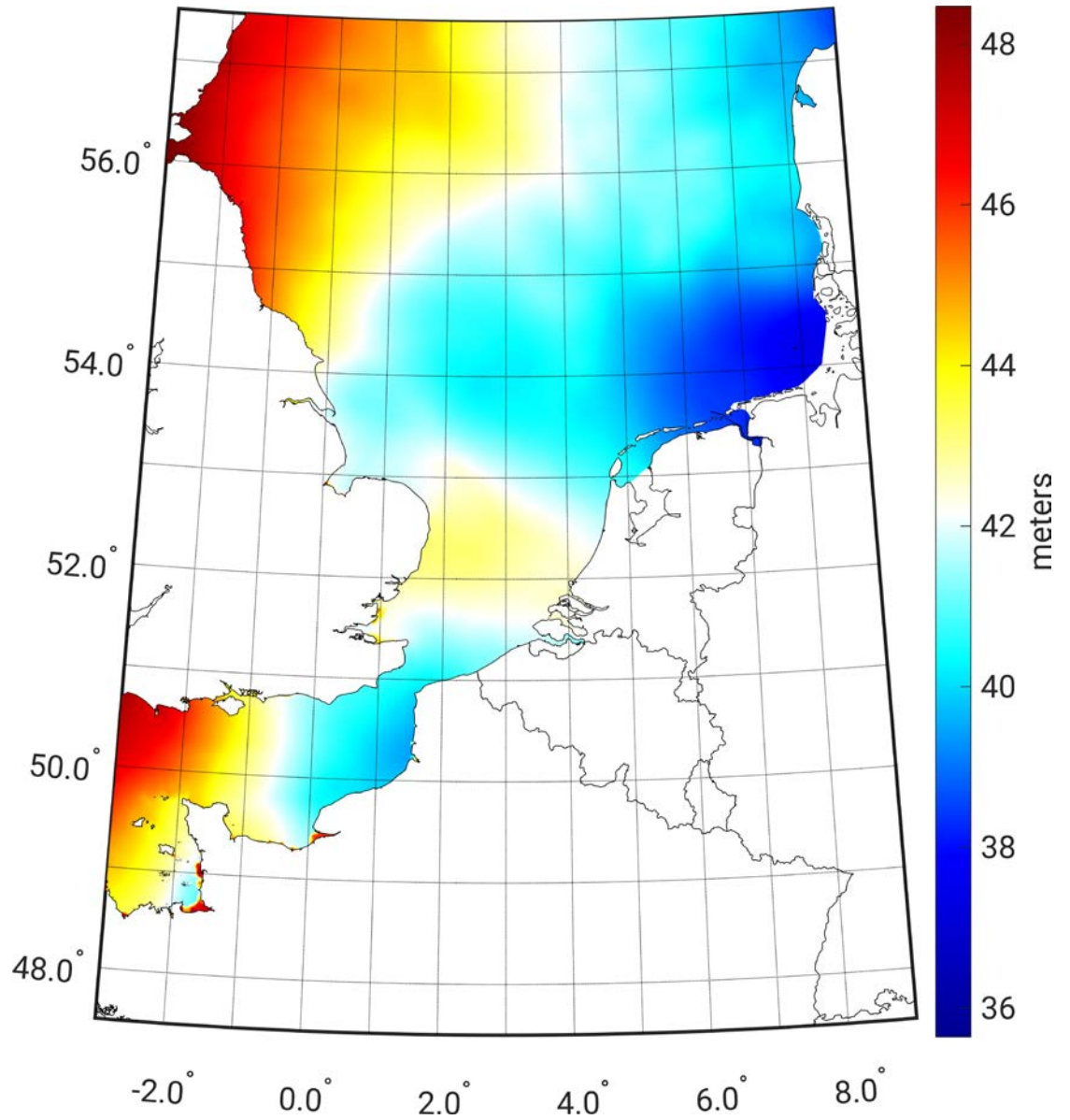


NOT valid outside Dutch waters!!!

NLLAT2018



NLLAT2018





<https://snapsbox.com/images/2018/01/29/lamborghini-terzo-millennio-promo.jpg>

Thank you!