

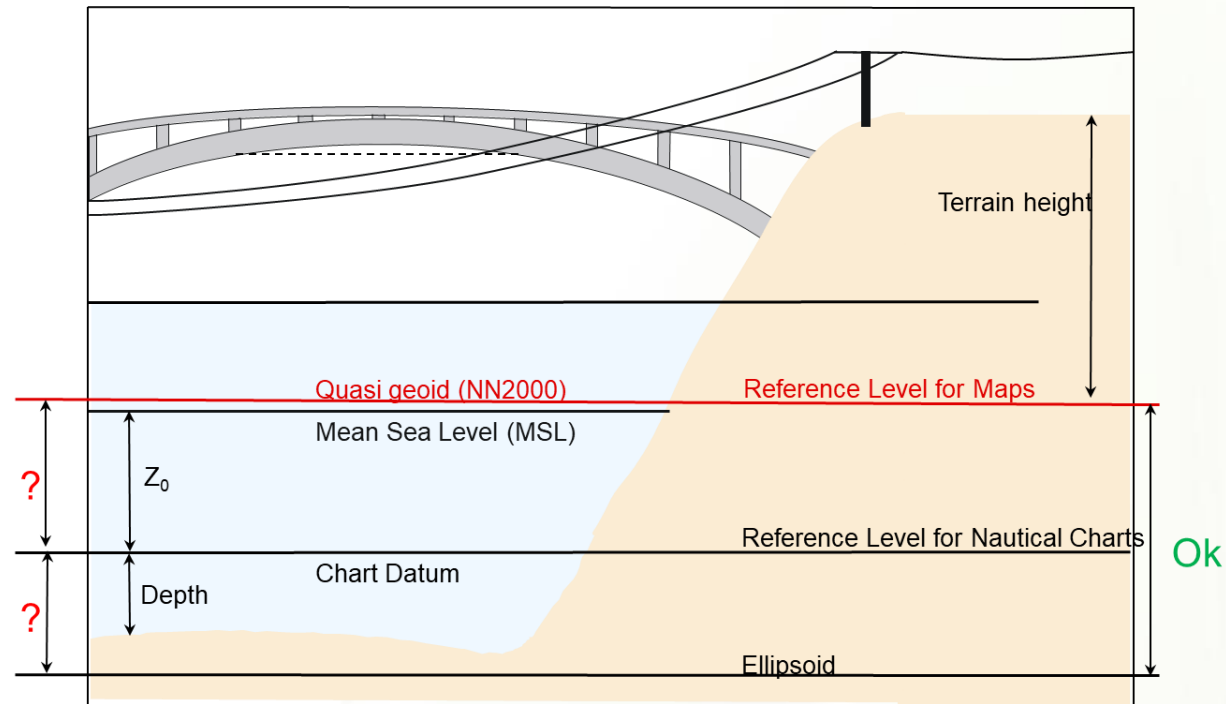
# Common reference frame for Norway – ocean topography in a long fjord

*Oda R. Ravndal, TWCWG and GLOSS joint session,  
April 11, 2019*



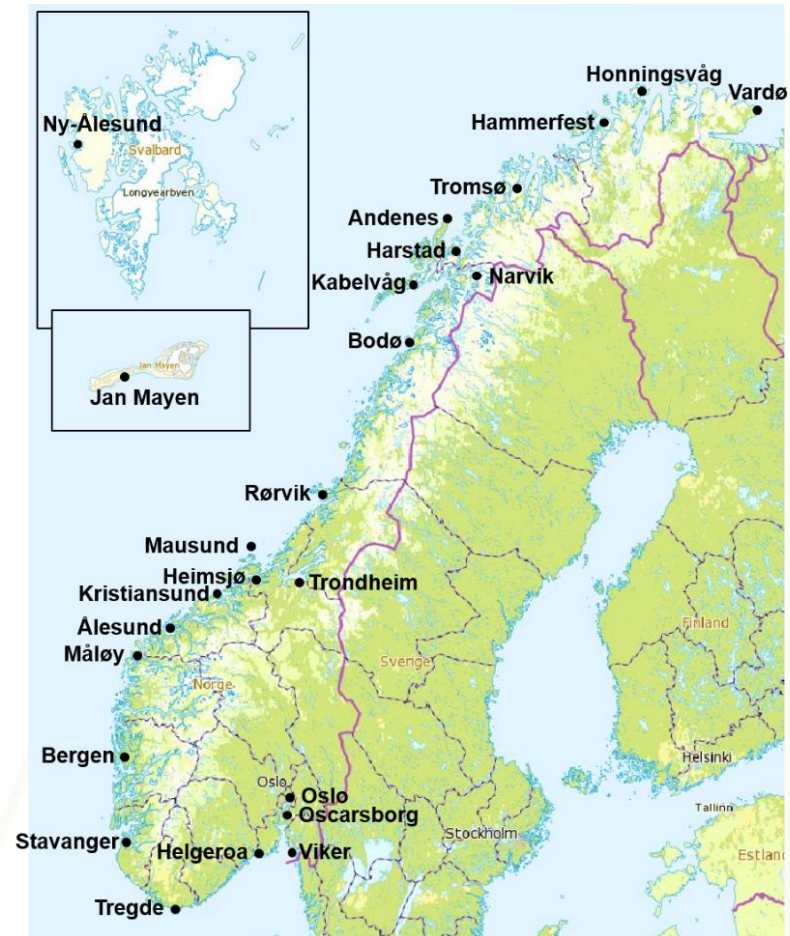
# Project objective

- Determine the relationship between the height datum on land and the Chart Datum
- Collaboration between the Hydrographic Service and the Geodetic Institute
- Develop a method that can be used along the entire Norwegian coast



# Project objective

- Water level observations in Norway
  - Permanent gauges
  - Temporary gauges
- Complicated coastline and limited resources





# Focus areas

First phase (2015-2017)

- Many types of measurements
- Managed to deliver requested surfaces

...but...



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First phase (2015-2017)

- Many types of measurements
- Managed to deliver requested surfaces

...but...

Focus area too «kind»



# Focus areas

Second phase:  
2018-19

Study in the  
Sognefjord





# The Sognefjord

- Longest fjord in Norway (204 km)
- Challenging topography
  - 1300 m deep
  - 1700 m mountains
- 1-2 km broad at the most narrow



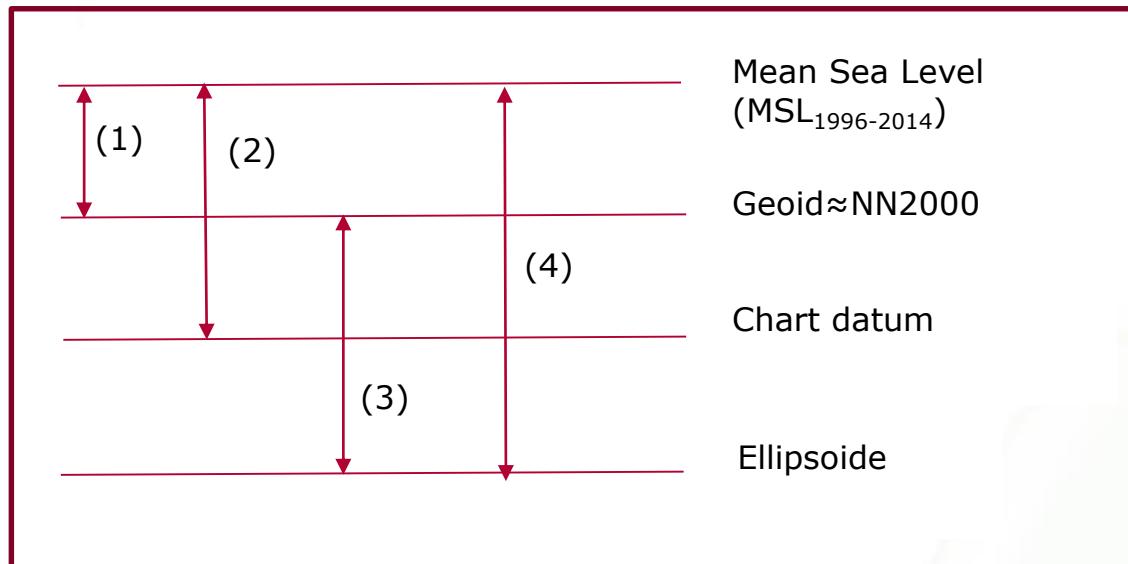
# The Sognefjord

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# Surfaces and models involved



- (1) = Mean dynamic topography model
- (2) = Z0-model
- (3) = Href-model
- (4) = Mean sea level model

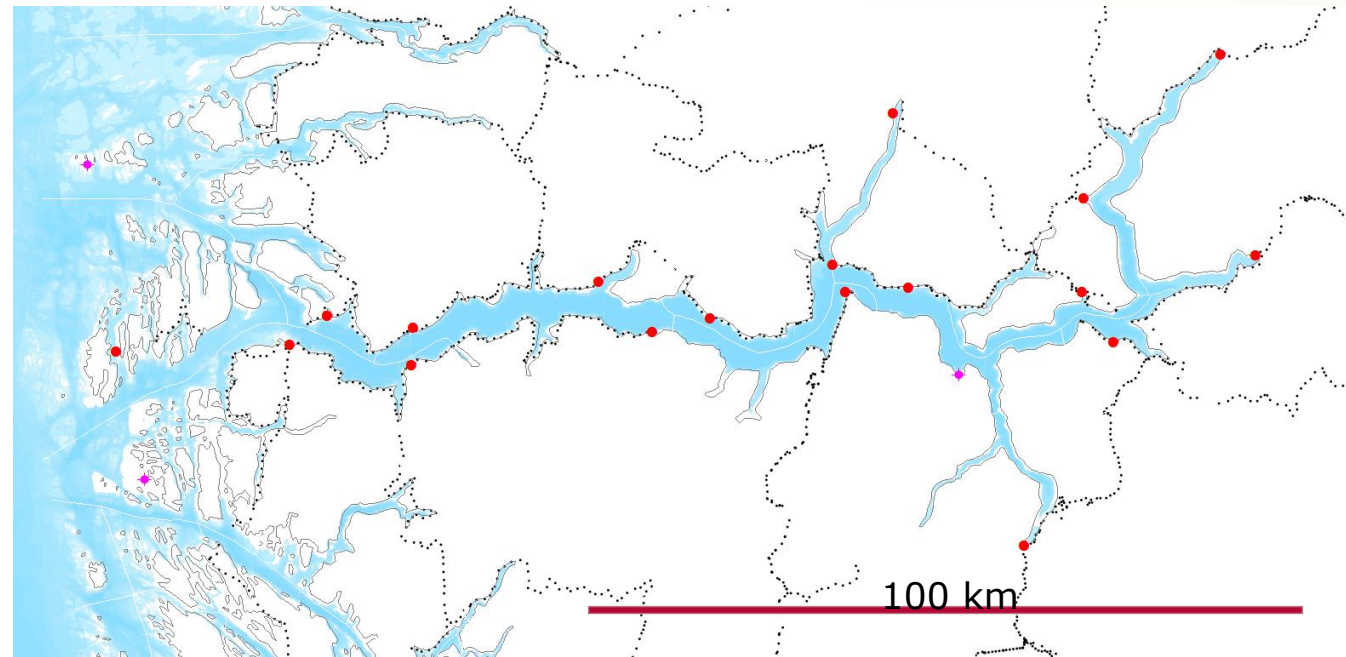
# Field work and measurements

- Temporary tide gauges
- Levelling campaigns
- GNSS measurements
- Altimetry
- Hydrodynamical modelling



# Temporary tide gauges

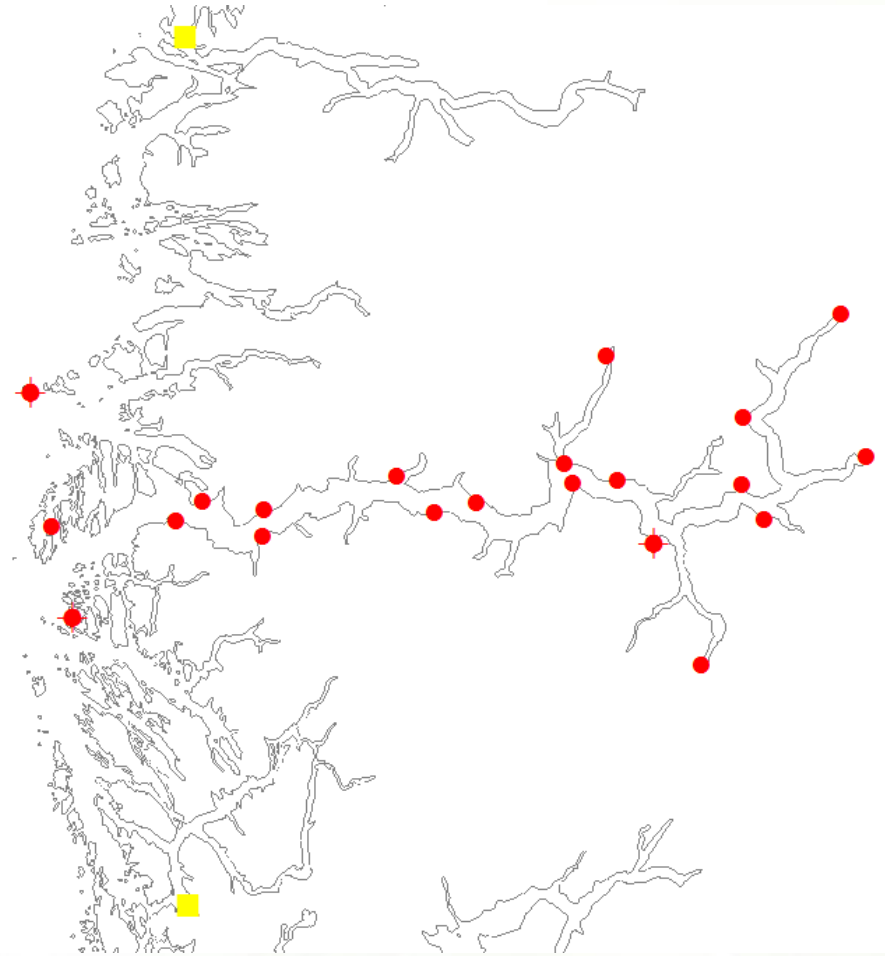
- 21 temporary tide gauges
- 3 not connected to the levelling network
- The TGs have recorded for seven months





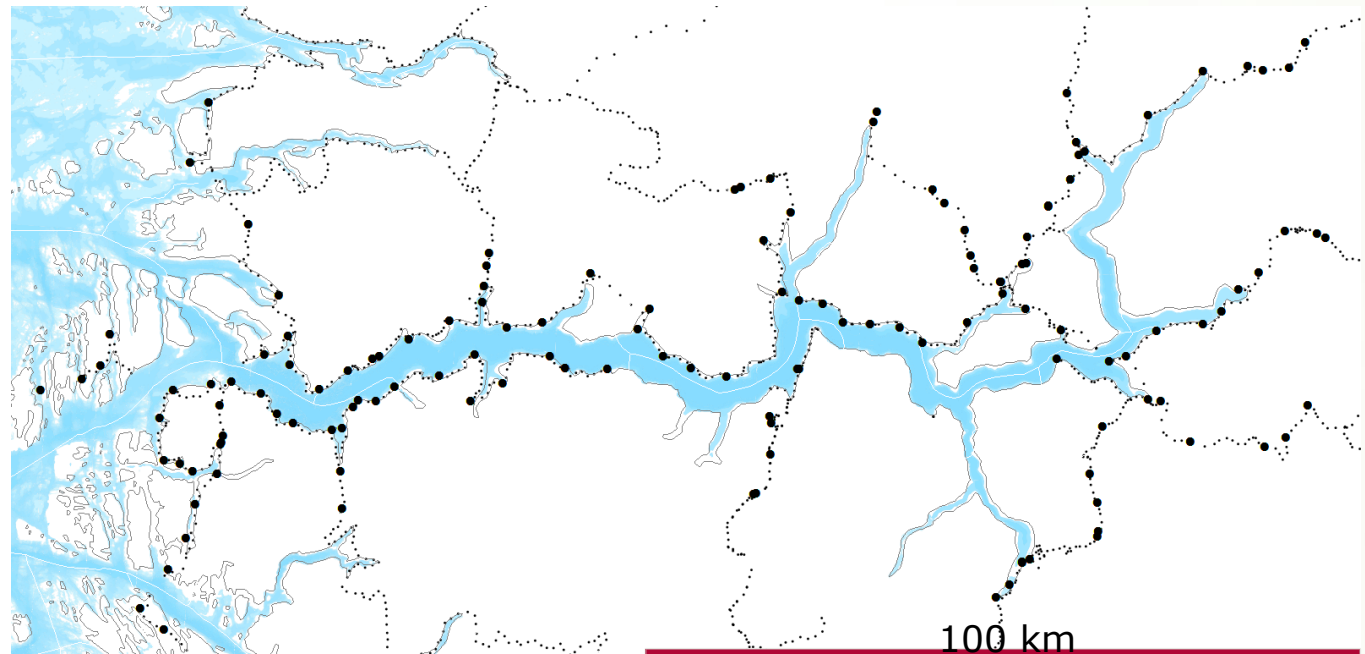
# Permanent tide gauges

- About 80 km north and south of the outlet of the fjord we have the permanent tide gauges Måløy and Bergen, respectively.

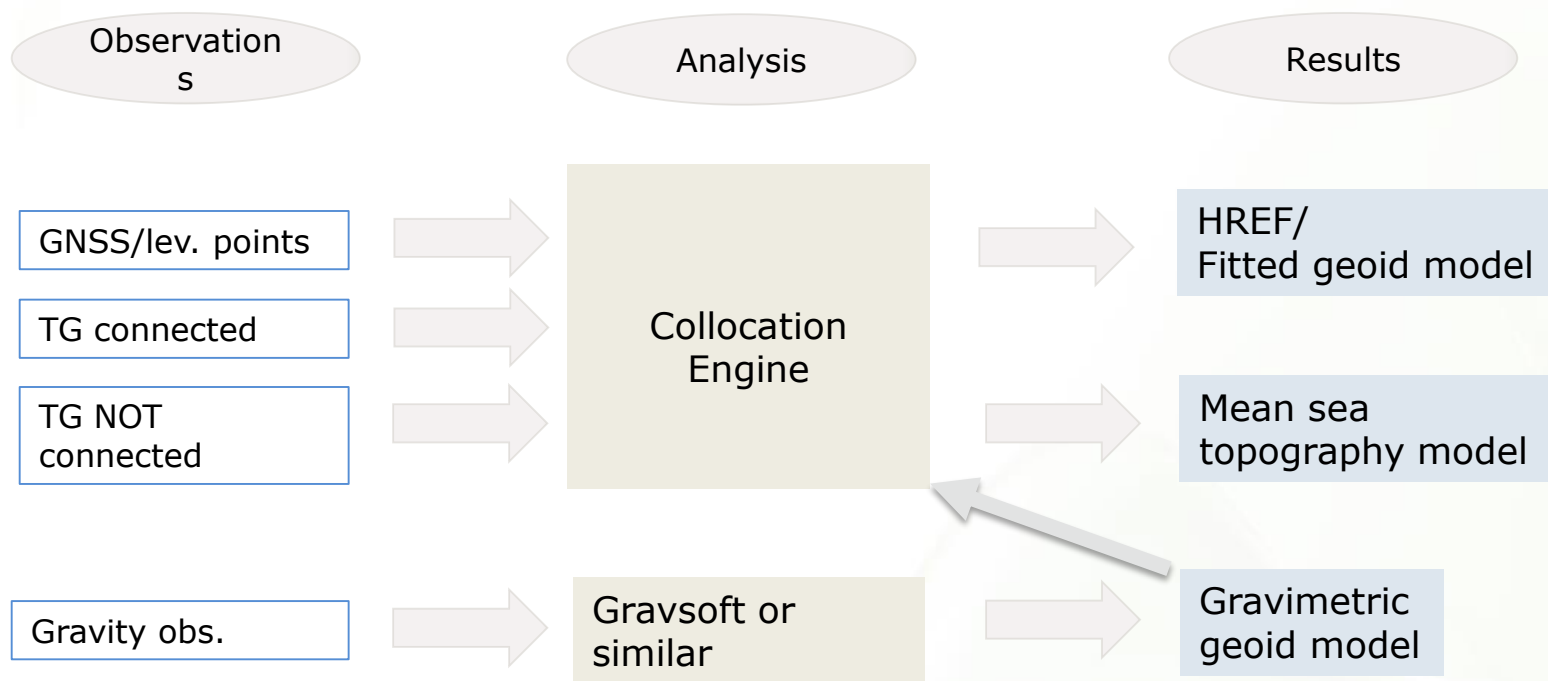


# GNSS/levelling points

- Mainly levelled points in the national network
- Some are levelling benchmarks measured in a five days GNSS campaign



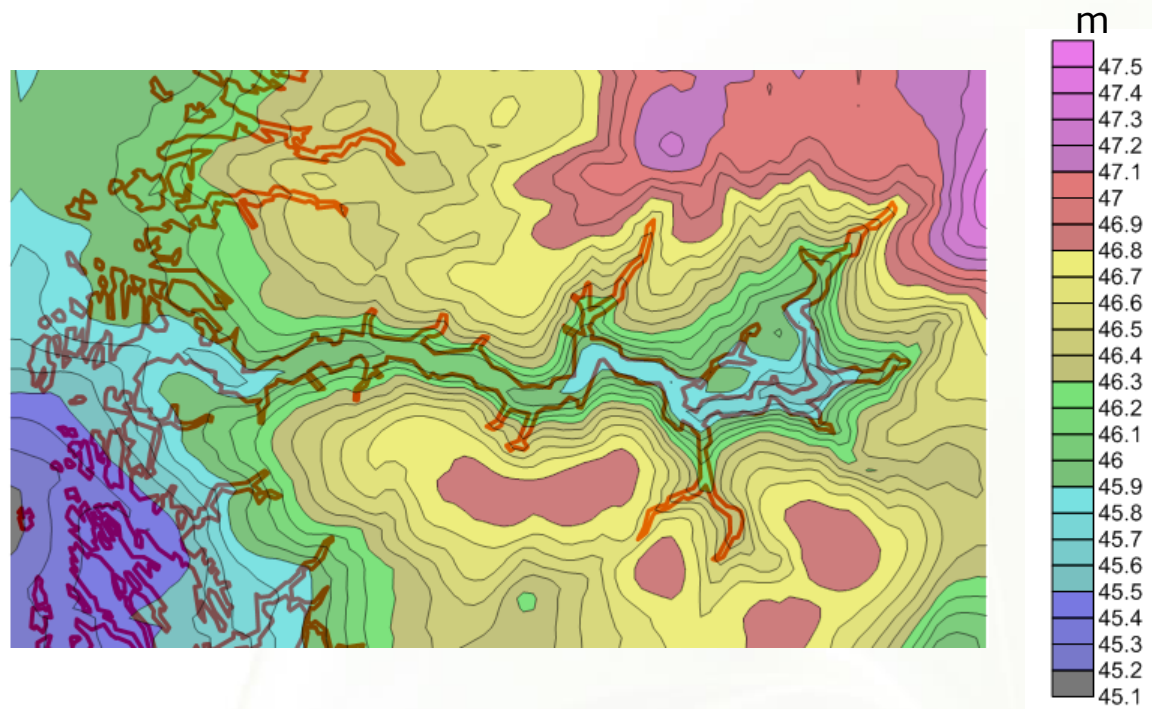
# Calculation strategy



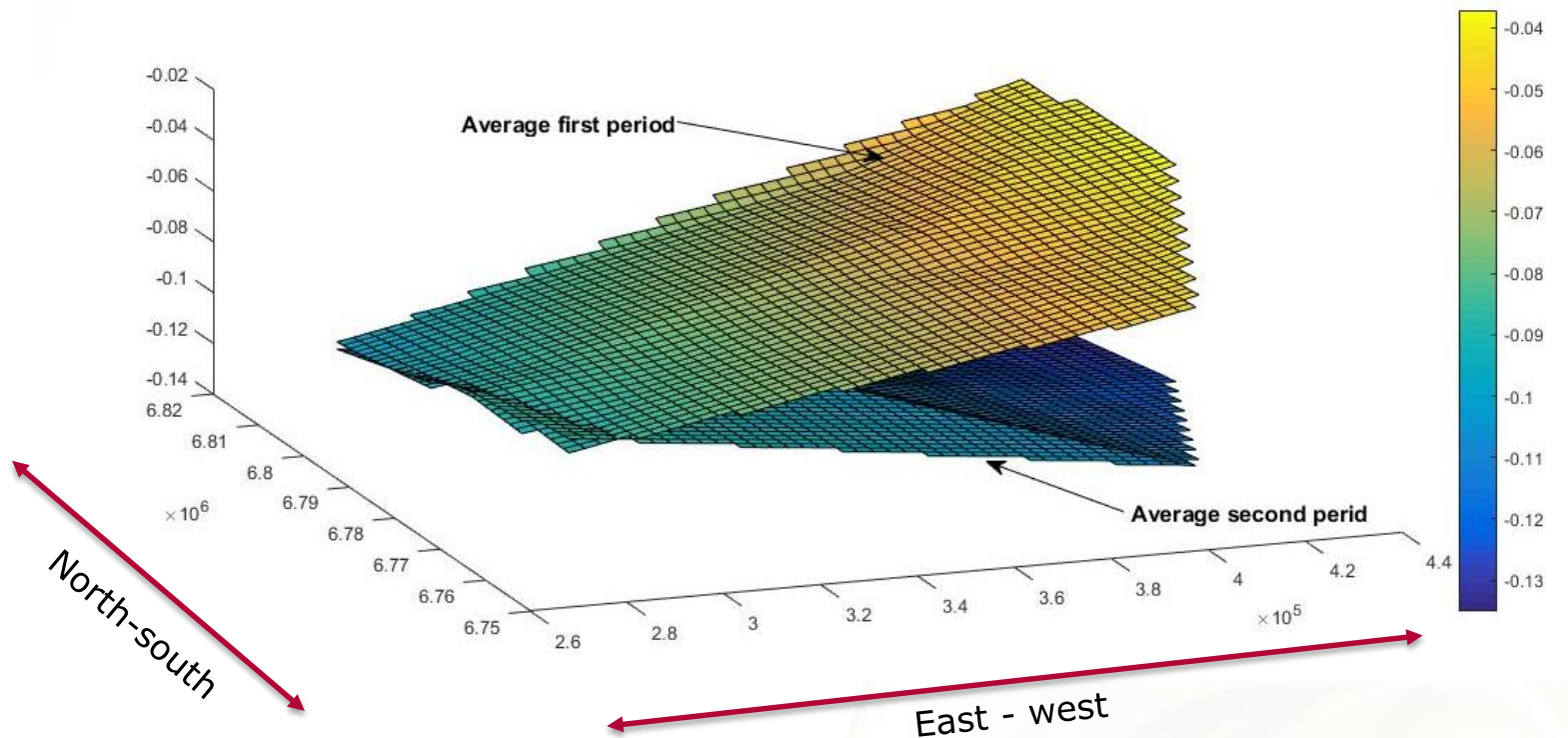


# Final fitted geoid model

- The deepest depths reflect the fjord.
- A local minimum at the almost innermost end
- Little variation along the main fjord, more along the fjordarms



# Mean for the two periods, aligned to MSL<sub>1996-2014</sub>



# Summary and further work

- In the Sognefjord the average mean sea level over three months periods have variations relative to the MSL at the mouth of the fjord
  - The spatial variation seems to be a tilt – without undulations
  - The difference between two successive three month periods is 9 cm in the innermost part and close to nothing at the outlet.
  - To estimate a MSL model (through mean dynamic topography) we need to understand the behavior in the fjord



# Summary and further work

- All tide gauges remain in place until June
- Subset of tide gauges remain in place
- Work on altimetry and hydrodynamic modelling will continue