



UNIVERSIDAD TÉCNICA
FEDERICO SANTA MARÍA



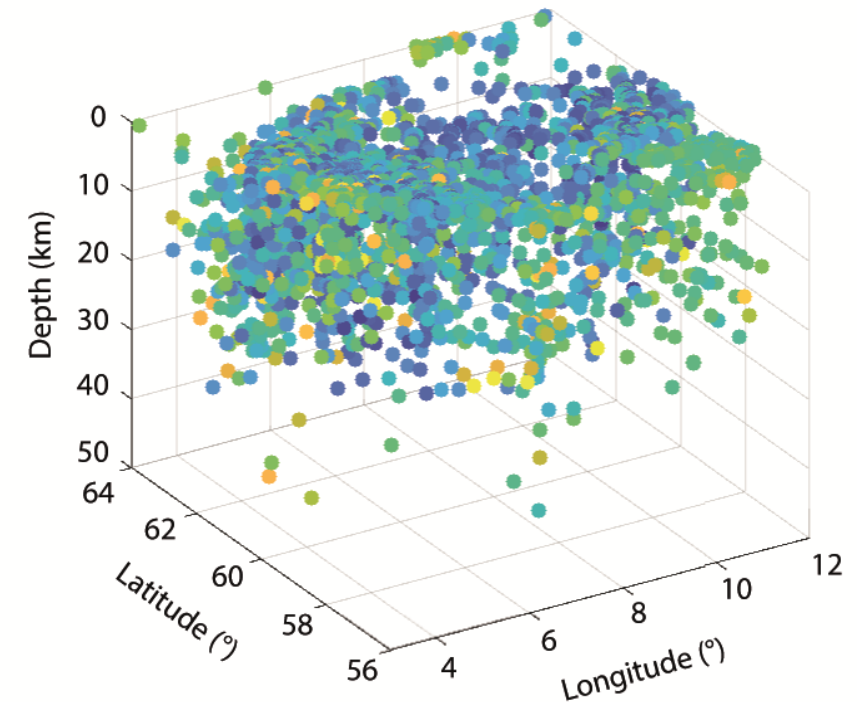
GEOLOGICAL
SURVEY OF
NORWAY
- NGU -

A grid-based *b-value* approximation through Southern and Northern Norway: preliminary results

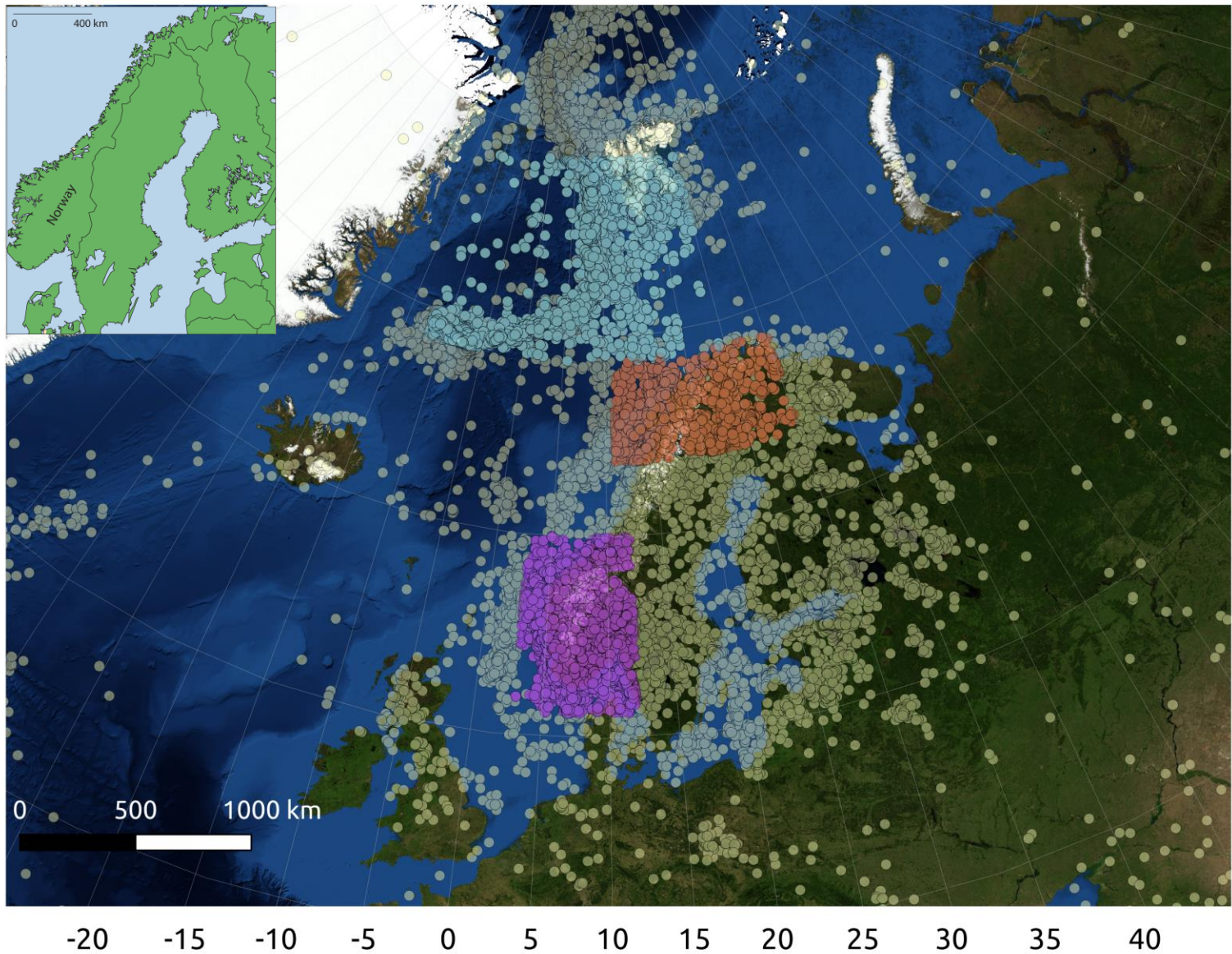
Rodrigo Estay^(a) & Claudia Pavez^(b)

(a) Universidad Técnica Federico Santa María, Valparaíso, Chile.

(b) Geological Survey of Norway, Trondheim, Norway.



Seismological setting & data



Total number of events per study area
Northern Norway 12,226
Southern Norway 2,772
Ridge 17,002

Seismological setting & data

Seismicity in the continental shelf

- Norway register the highest amount of seismic events in northern Europe.
- Low to intermediate magnitudes.
- Strictly intraplate and mostly shallow ($D < 20$ km)
- Earthquakes with magnitude $M_w=5.0$ occur between 80-90 years and $M_w=6.0$ between 90-100 years
- According to the 40 years catalog obtained from the EPOS-N portal, the mean magnitude are $\sim M 1.3$ and $\sim M 1.5$ for southern and northern Norway, respectively.

Seismicity in the Ridge

- Mid-ocean ridges are classified according to the spreading velocity: slow (20–55 mm/yr) and ultra-slow (< 20 mm/yr) full spreading rates (Dick et al., 2003).
- An example of the transitional regime can be found at the North Atlantic ocean, where the Mohns ridge joins with the Knipovich Ridge.
- Previous studies (Pirli et al., 2018) show that the whole region exhibit lowest magnitude thresholds ($\sim M 1.0$). The highest observed level of seismicity is located in the transition zone ($\sim M 4.3$).
- According to the 40 years catalog obtained from the EPOS-N portal, the mean magnitude for the whole ridge is $\sim M 2.1$

Methodology

- **Grid construction:** Grid search of seismic events with a minimum of **15 events** inside each grid to calculate the b-value.
 - Southern ($0.5^\circ \times 0.5^\circ$)
 - $[3^\circ, 12^\circ] \times [57^\circ, 64^\circ]$
 - Northern ($1^\circ \times 1^\circ$):
 - $[11^\circ, 30^\circ] \times [67^\circ, 71^\circ]$
 - Ridge ($0.5^\circ \times 0.5^\circ$):
 - $[-12^\circ, 25^\circ] \times [71^\circ, 79^\circ]$
- **Magnitude of completeness**
 - Goodness of Fit (*GoF*)
 - Maximum Curvature (*MaxC*)

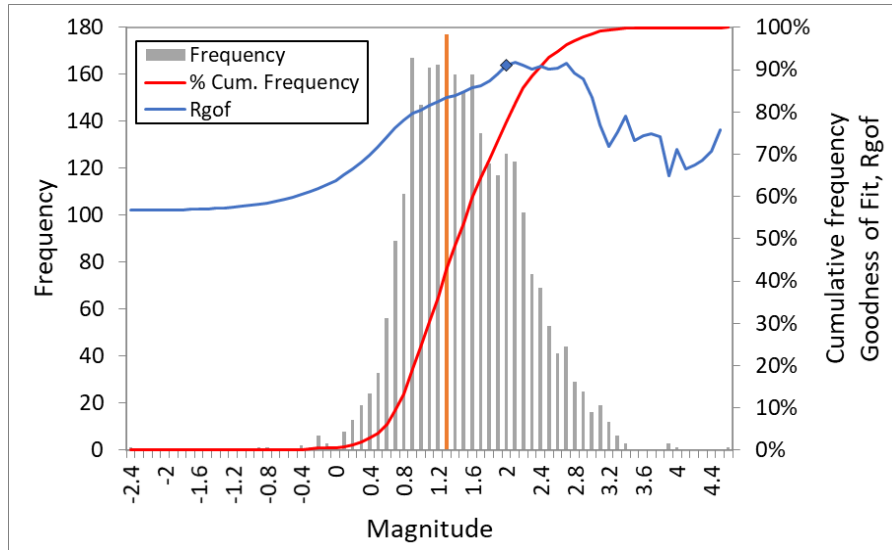
Area	$M_{c,GoF}$	$M_{c,MaxC}$	M_{mean}	$M_{mean} \geq M_{c,MaxC}$
Northern Norway	2.0	1.3	1.5	1.9
Southern Norway	1.2	1.1	1.3	1.5
Ridge	2.0	2.1	2.1	2.7

How to deal with the limited amount of seismic events?

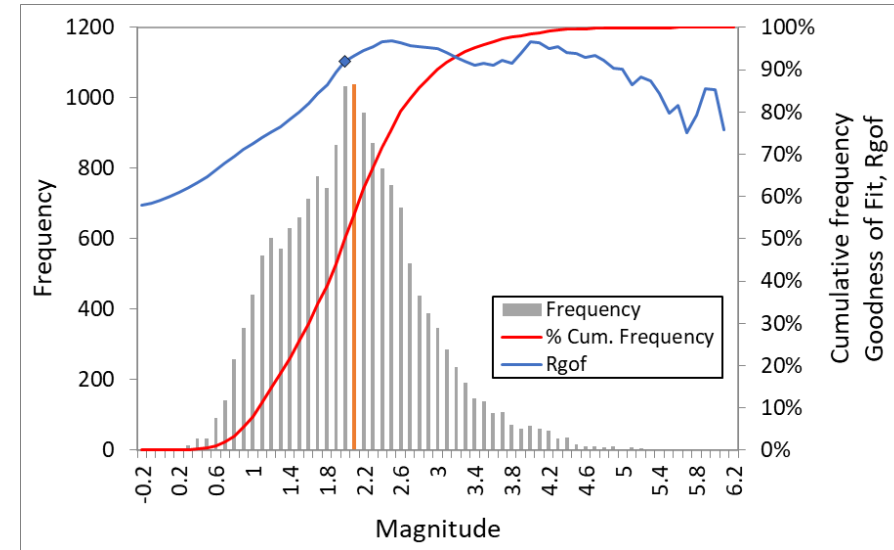
- The determination of the b-value follows a probabilistic approach which marks the direct relationship between this parameter and the number of seismic events Nava et al. (2017).
- Following the results of Nava et al. (2017) and considering a low amount of seismic events (less than 25 per cube), we incur in an estimation error for the b-value of around 0.1.
- It is recommended to use a minimum number of 500 seismic events to have a reliable estimation, which is impossible in this tectonic environment.

Results

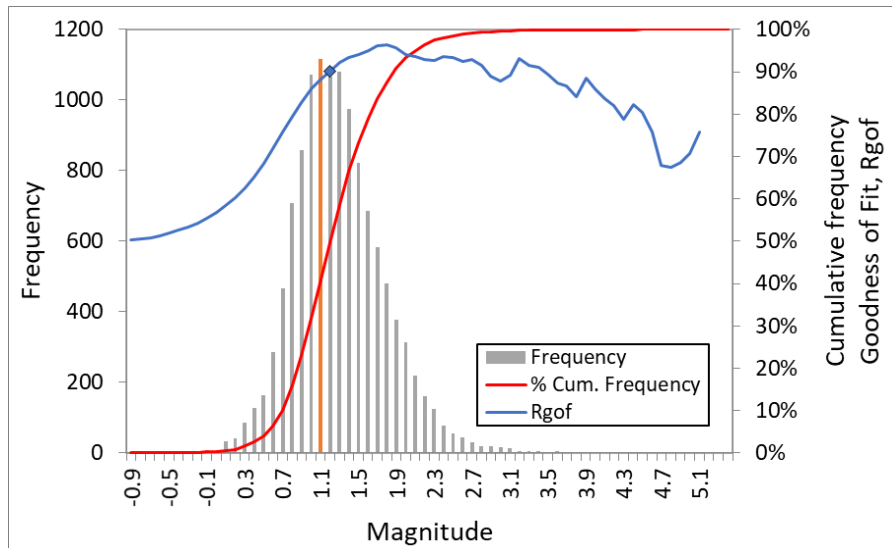
Northern



Ridge

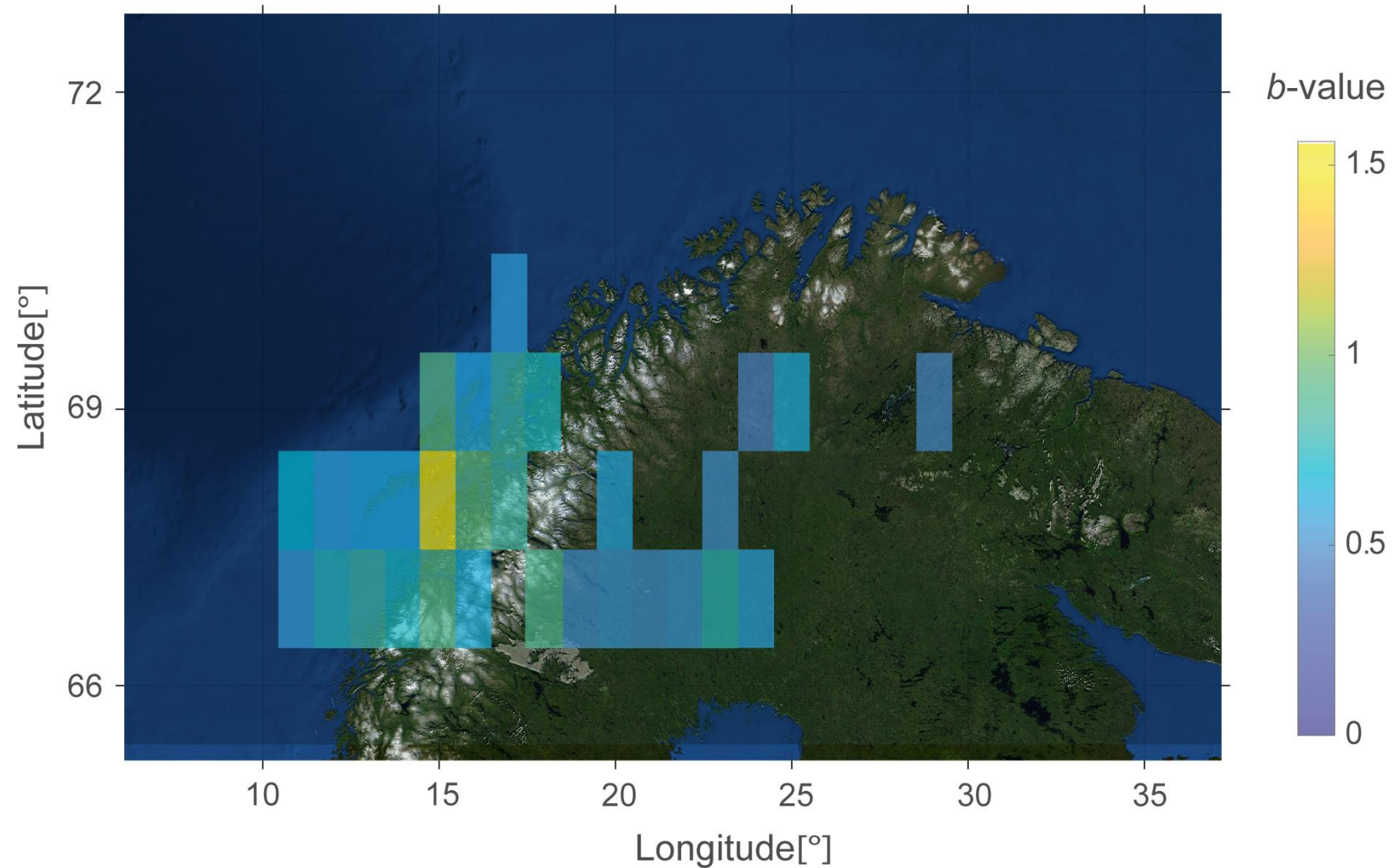


Southern



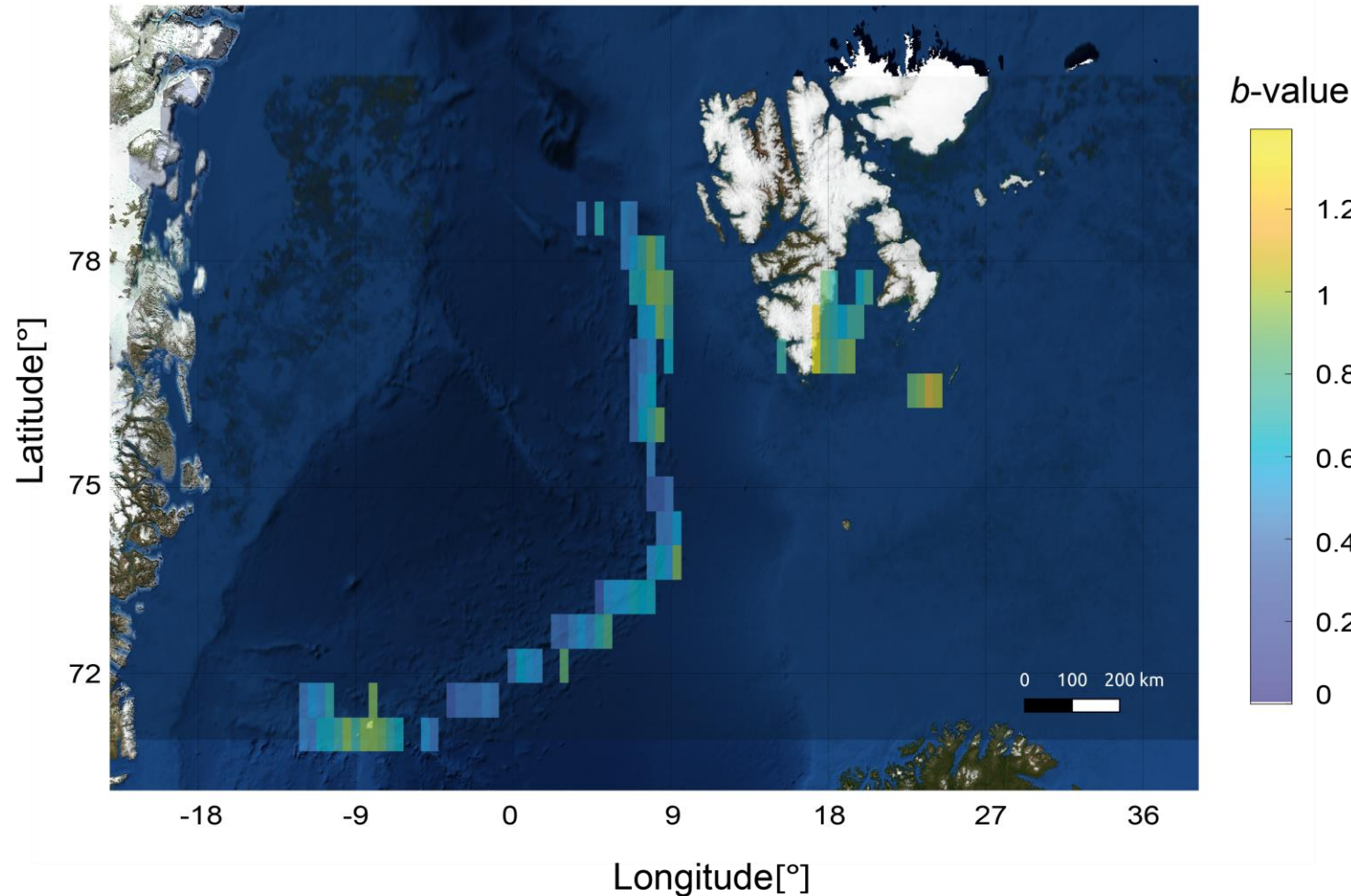
Area	b-value	N° of events $\geq M_{c,gof}$
Northern Norway	0.79	747
Southern Norway	0.93	7199
Ridge	0.66	9519

b –parameter: northern Norway



Shallow compression based on earthquake focal mechanisms (Olesen et al., 2013), agreeing with a low b-value equal to 0.79.

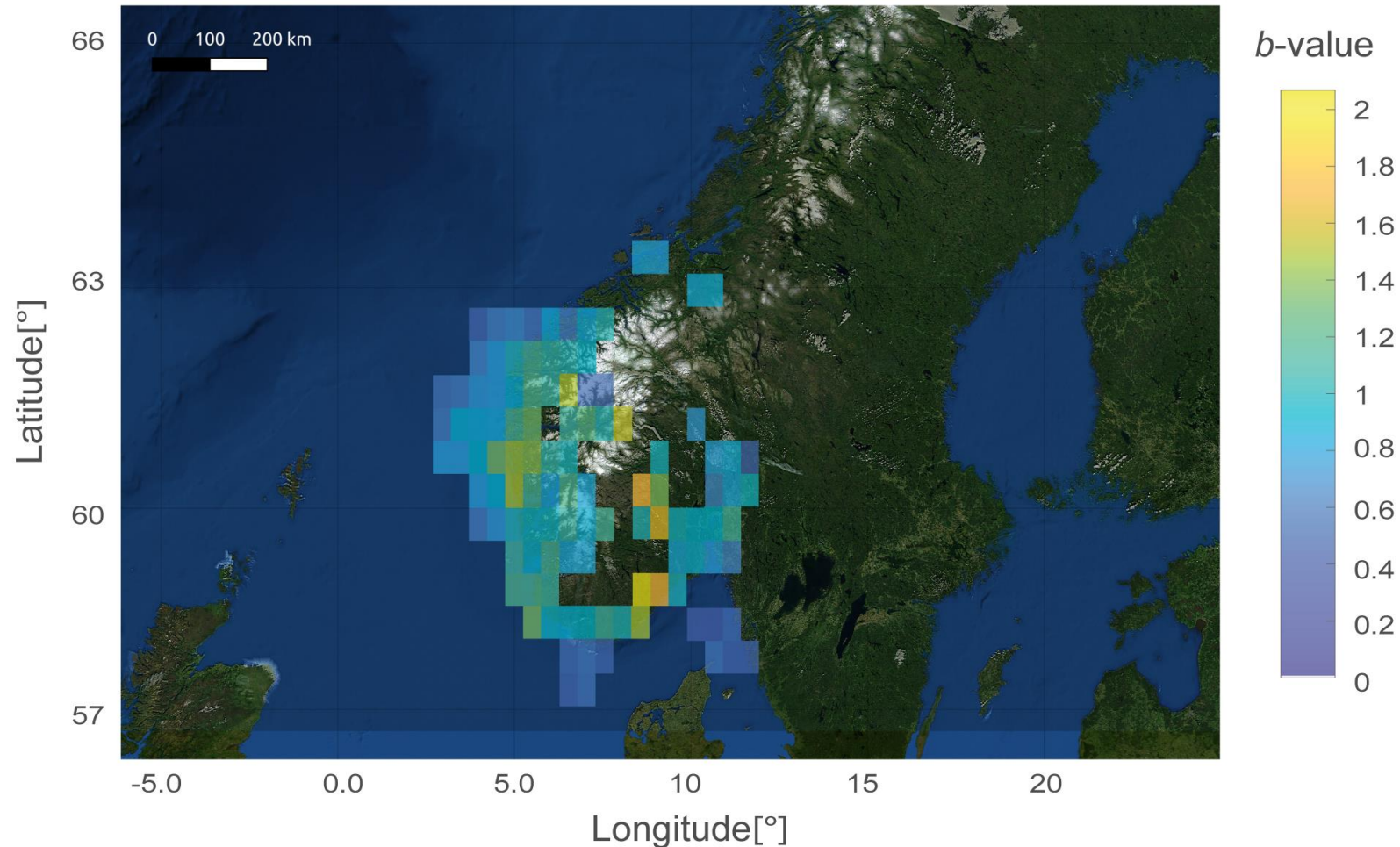
b -parameter map: ridge



A very low b-value was found in this area, which doesn't constitute a good approach considering the tectonic environment. Some possible explanations could be:

- (i) a faulty seismicity location
- (ii) the grid-based method is inappropriate for this tectonic environment.
- (iii) b-value determination small datasets above the completeness threshold may result in very large uncertainties

b -parameter map: southern Norway



Deep compression in southwestern and southeastern areas.

Shallow extension in the central areas (Olesen et al., 2013). The *b*-value is close to unity, probably reflecting the strike-slip behaviour of deeper earthquakes.

Additionally, the higher amount of seismic events registered in southwestern Norway affect the obtained *b*-value, which at the same time has a tendency to reflect thrust environments.

References & contact

1. Dick, H., Lin, J. & Schouten, H. 2003. An ultraslow-spreading class of ocean ridge. *Nature* 426, 405–412.
2. Nava F., Márquez-Ramírez, V., Zúñiga, F., Ávila-Barrientos, L. & Quinteros, C. 2017: Gutenberg-Richter b-value maximum likelihood estimation and sample size, *Journal of Seismology* 21, 127 – 135.
3. Olesen, O., Bungum, H., Dehld, J., Londholm, C., Pascal, C. & Roberts, D. 2013b: Neotectonics, seismicity and contemporary stress field in Norway, mechanisms and implications. In Olsen, L., Fredin, O. & Olesen, O. (eds.): *Quaternary Geology of Norway*, Geological Survey of Norway Special Publication 13, pp. 145 – 174.
4. Pirli, M., Schweitzer, J., IPY project consortium. 2018. Seismicity along the Mohns—Knipovich Ridge Bend and its correlation to ridge spreading rate. *Journal of Geodynamics* 118, 182 – 196.
5. Schorlemmer, D., Wiemer, S. 2005. Microseismicity data forecast rupture area. *Nature* **434**, 1086.
6. Olesen, O., Bungum, H., Dehld, J., Londholm, C., Pascal, C. & Roberts, D. 2013b: Neotectonics, seismicity and contemporary stress field in Norway, mechanisms and implications. In Olsen, L., Fredin, O. & Olesen, O. (eds.): *Quaternary Geology of Norway*, Geological Survey of Norway Special Publication 13, pp. 145–174.

Rodrigo Estay: rodrigo.estayh@usm.cl

Claudia Pavez: claudia.pavez@ngu.no