Spatial distribution of fish stocks in a climate perspective

Nordic Climate Fish Conference 2011, Solstrand

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Overview

- FishExChange objectives
- The FishExChange database
- Data examples
- Looking for important factors influencing the variation in geographical distribution
- Ambient temperature
- The complex interplay
- Conclusions

FEC principal objective

- Evaluate the effect of climate change in the Barents Sea and adjacent areas on distribution of fish stocks, in perspective of national marine areas
- Further, evaluate what effect this will have on division of national fish quotas and economical consequences for the fisheries

Spatial approach

FEC Task 2

- The fish stocks
  - Based on deliverables from Task 1 (oceanography)
  - Age specific spatial fields (maps) of historical fish distributions
    - Mechanisms behind spatial distribution
      - Links to climate indicators
      - Interactions between species
      - Cover most of the life history
  - Spatial fields (maps) of most likely future fish distribution

Challenge

Data heterogeneity in space and time

Horizontal, vertical, and temporal structure on different scales

Climate data

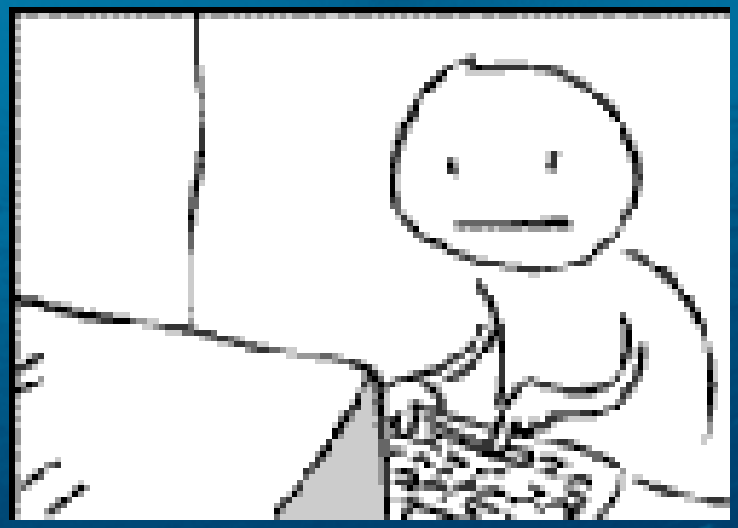
Model output

Allowing data to meet in a common framework and making them talk together!

Fish survey data

Fisheries data

Data from fish surveys in the FEC database



Data from fish surveys in the FEC database

- Commercial species
- Based on different sources of raw data
- Synoptic surveys for abundance estimation
- Trawl catches corrected for swept area
- Comprehensive metadata
- Protocols for planning, preparation of data and input
- Data catalogues with temporal coverage

Data from fish surveys in the FEC database

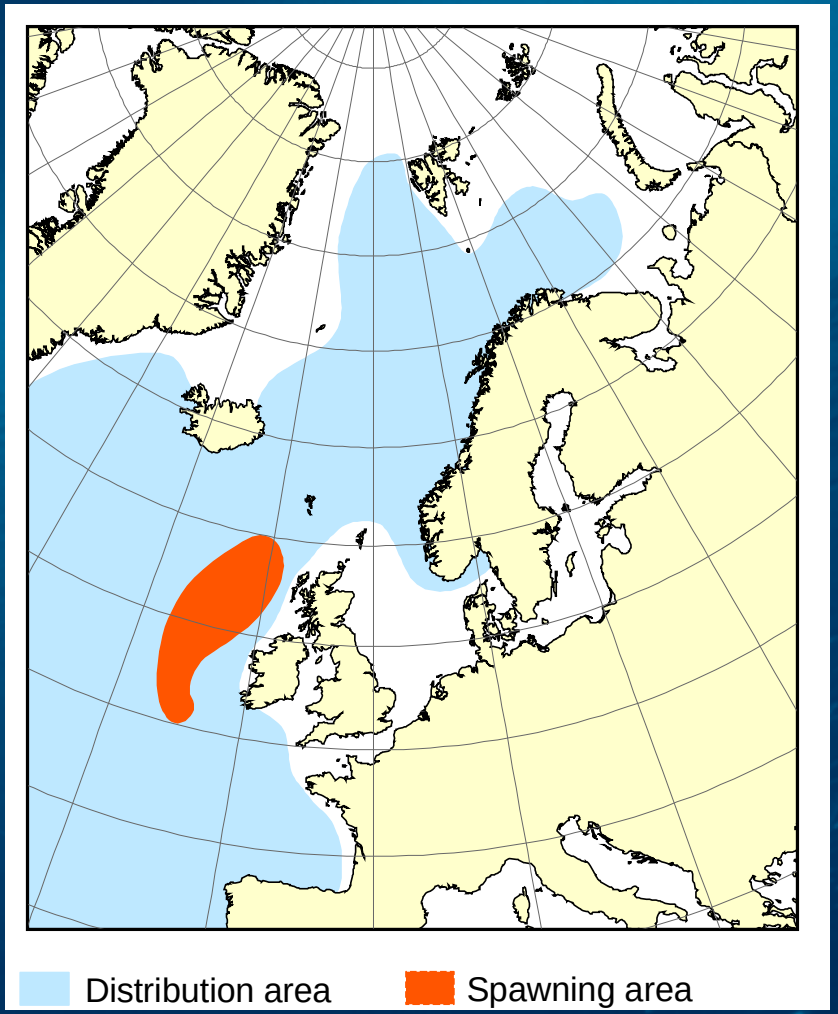
- 0-group autumn, pelagic trawl
  - Blue whiting, capelin, cod, Greenland halibut, haddock, herring, mackerel, redfish, saithe and polar cod
- Cod, bottom trawl
  - Winter survey, 5 cm size groups, age 1-13+
  - Summer/autumn/ecosystem surveys 5 cm size gr.
- Haddock, bottom trawl
  - Winter survey, 5 cm size groups, age soon
  - Summer/autumn/ecosystem surveys 5 cm size gr.

Data from fish surveys in the FEC database

- Capelin, acoustic surveys autumn
  - Age 1-5
- Polar cod , acoustic surveys autumn
  - Age 1-5
- Saithe, acoustic survey autumn planned
  - Winter survey, 5 cm size groups, age soon
  - Summer/autumn/ecosystem surveys 5 cm size gr.
- + T, salinity and catch data

Other interesting species

- Blue whiting (*Micromesistius poutassou* Risso, 1827)
- Entering the BS from south-west
- High abundance in 2001-2007
- Interact with other species



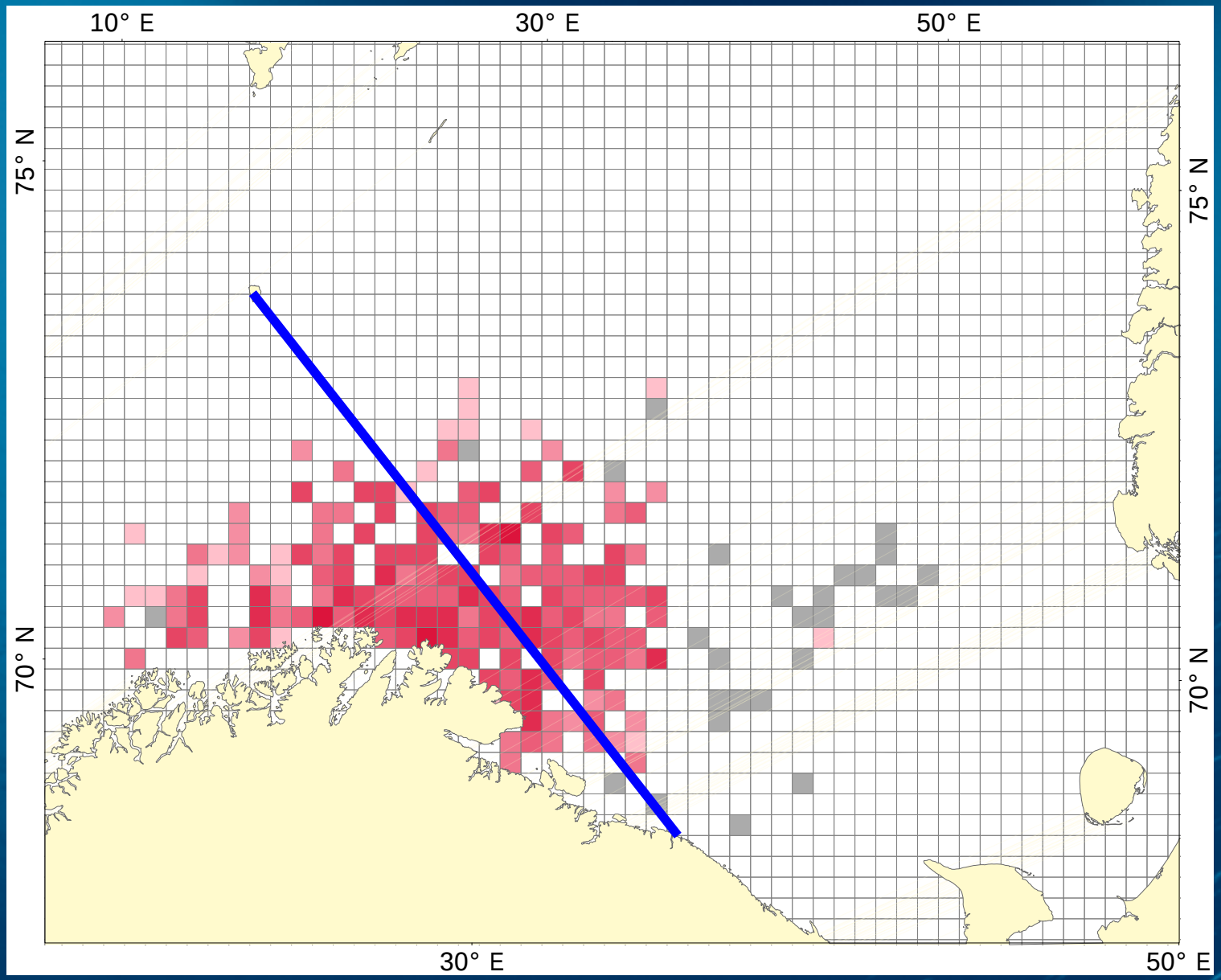
Other interesting species

- Atlantic mackerel (*Scomber scombrus* L.)
  - Observed at least as north as 74°N
  - Recently caught off the Murman coast
- Several fish species related to benthic habitats (e.g. eelpouts (*Zoarcidae*) and sculpins (*Cottidae*)
  - Habitat specific
  - Sensitive to temperature variation

What about the data?

- Example: Winter bottom trawl survey in the Barents Sea
- 1981-2009
- Cod ≥ 45 cm (~ catchable size)
- Density (No. Fish / nmi^2)

1981



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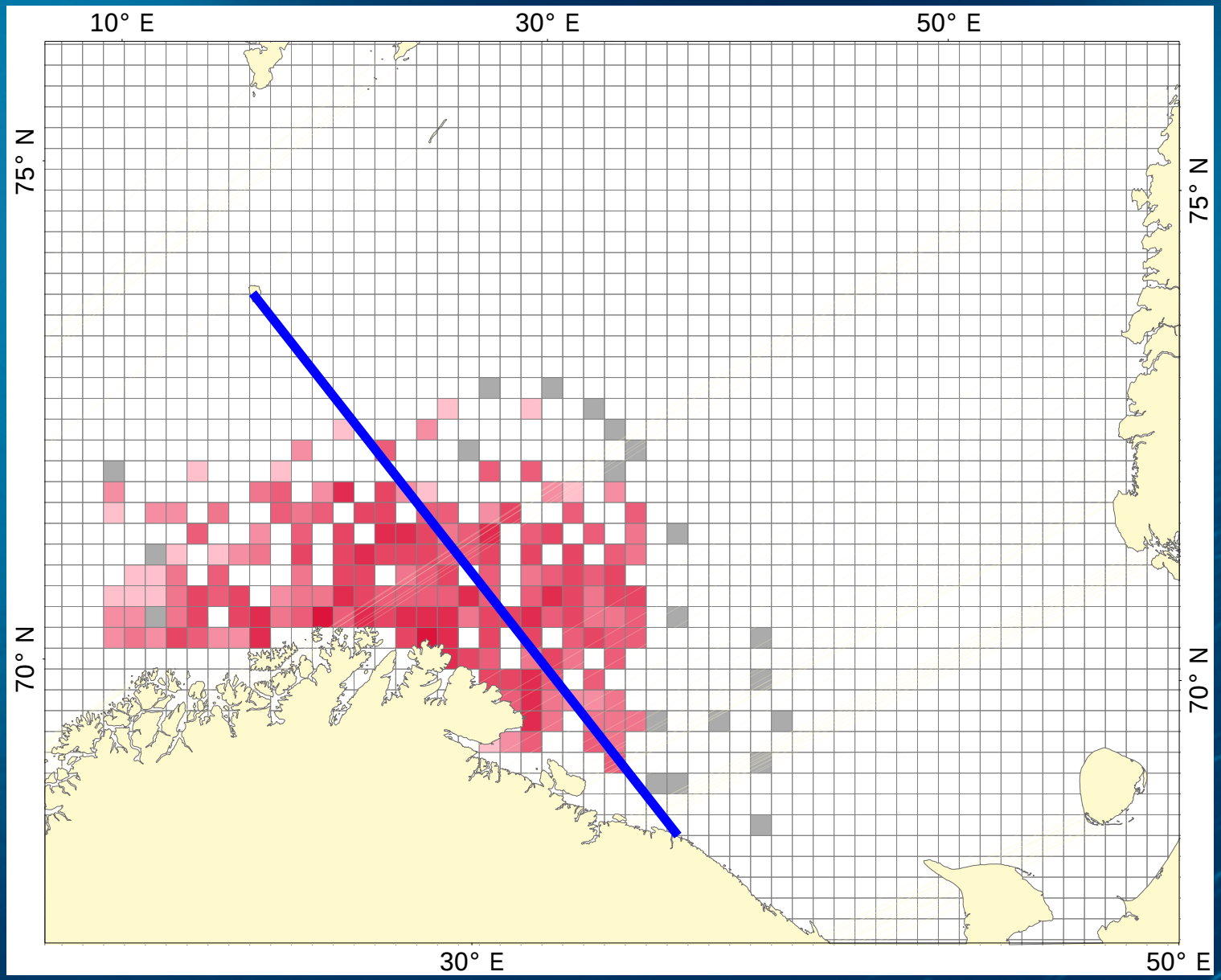

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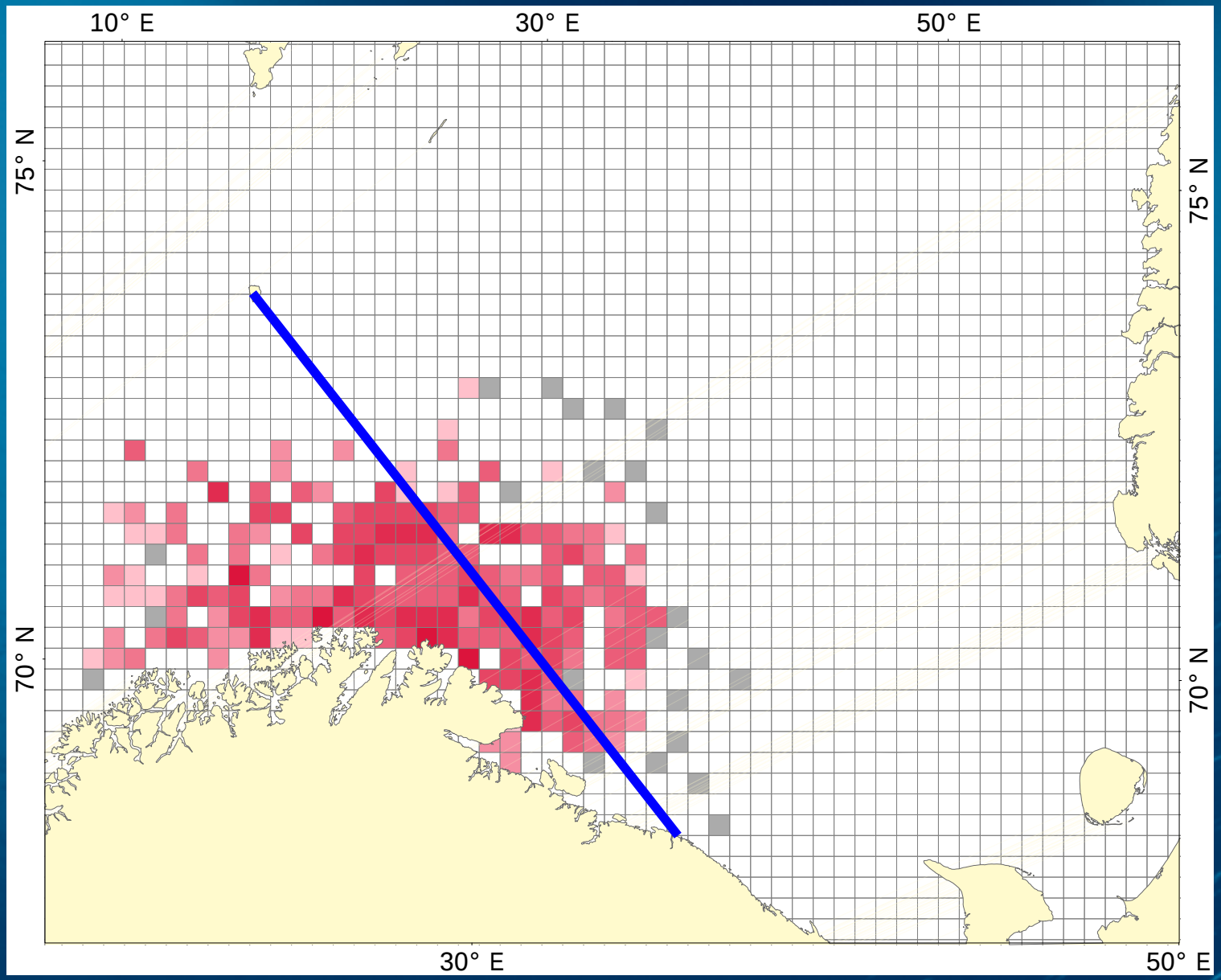

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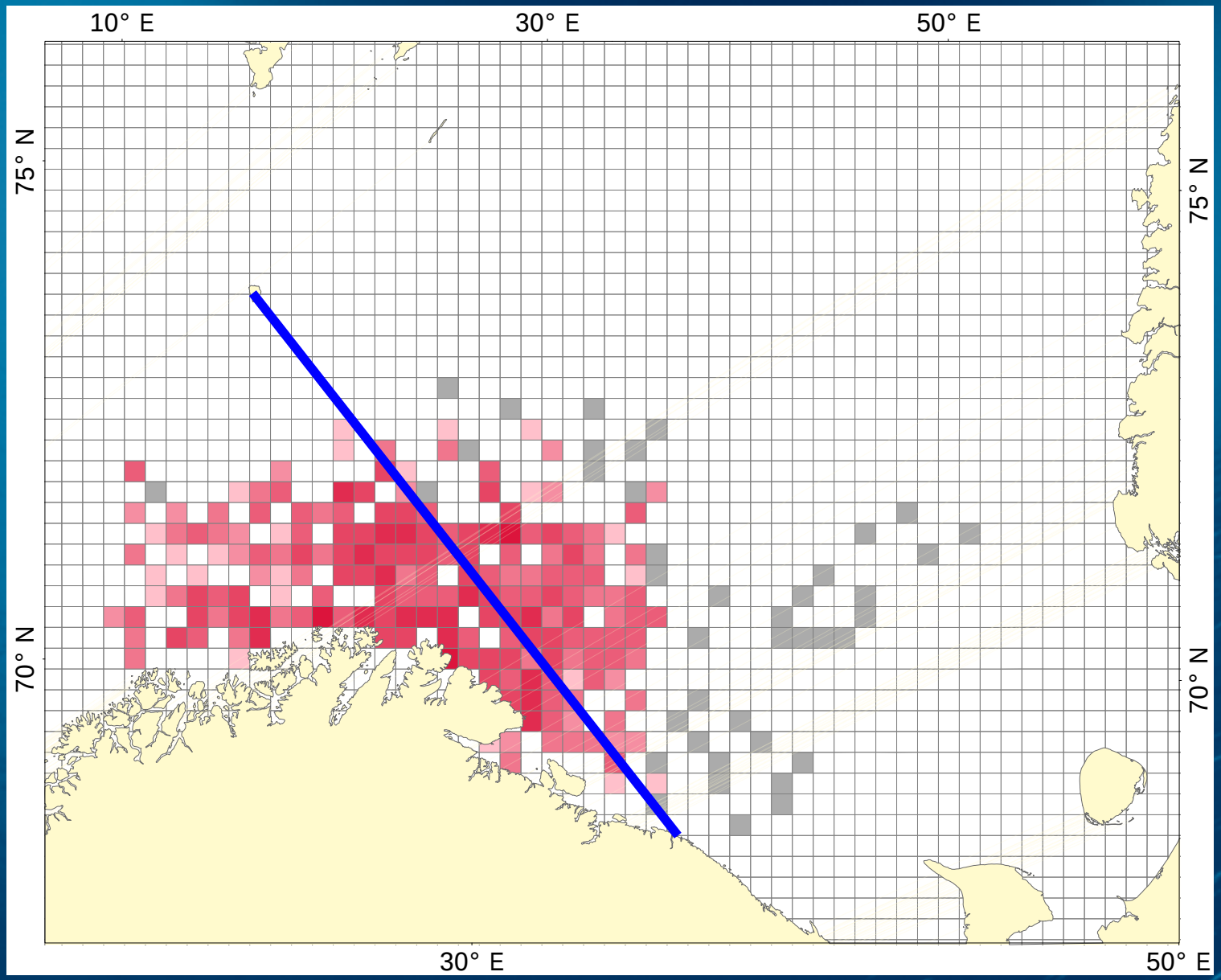

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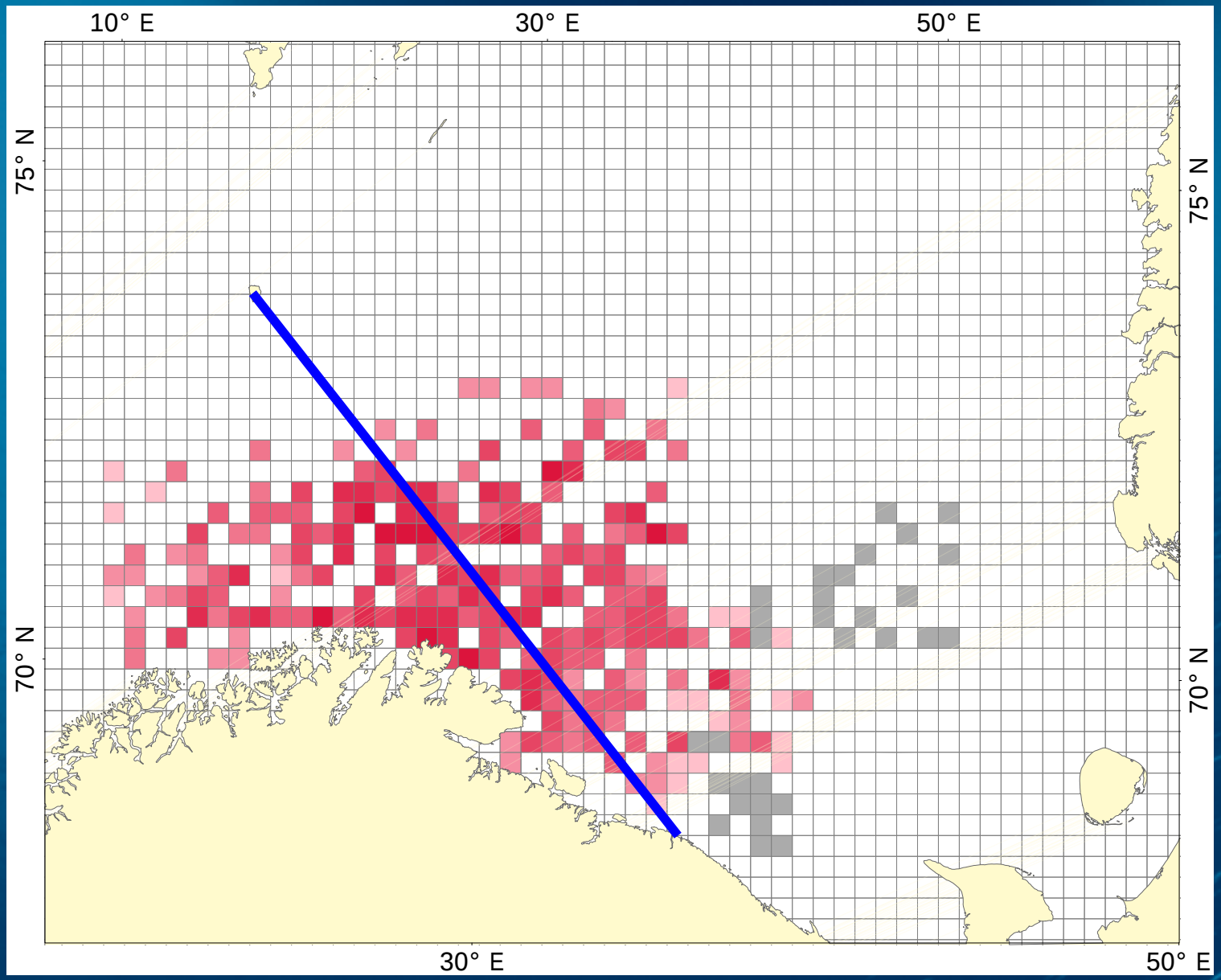

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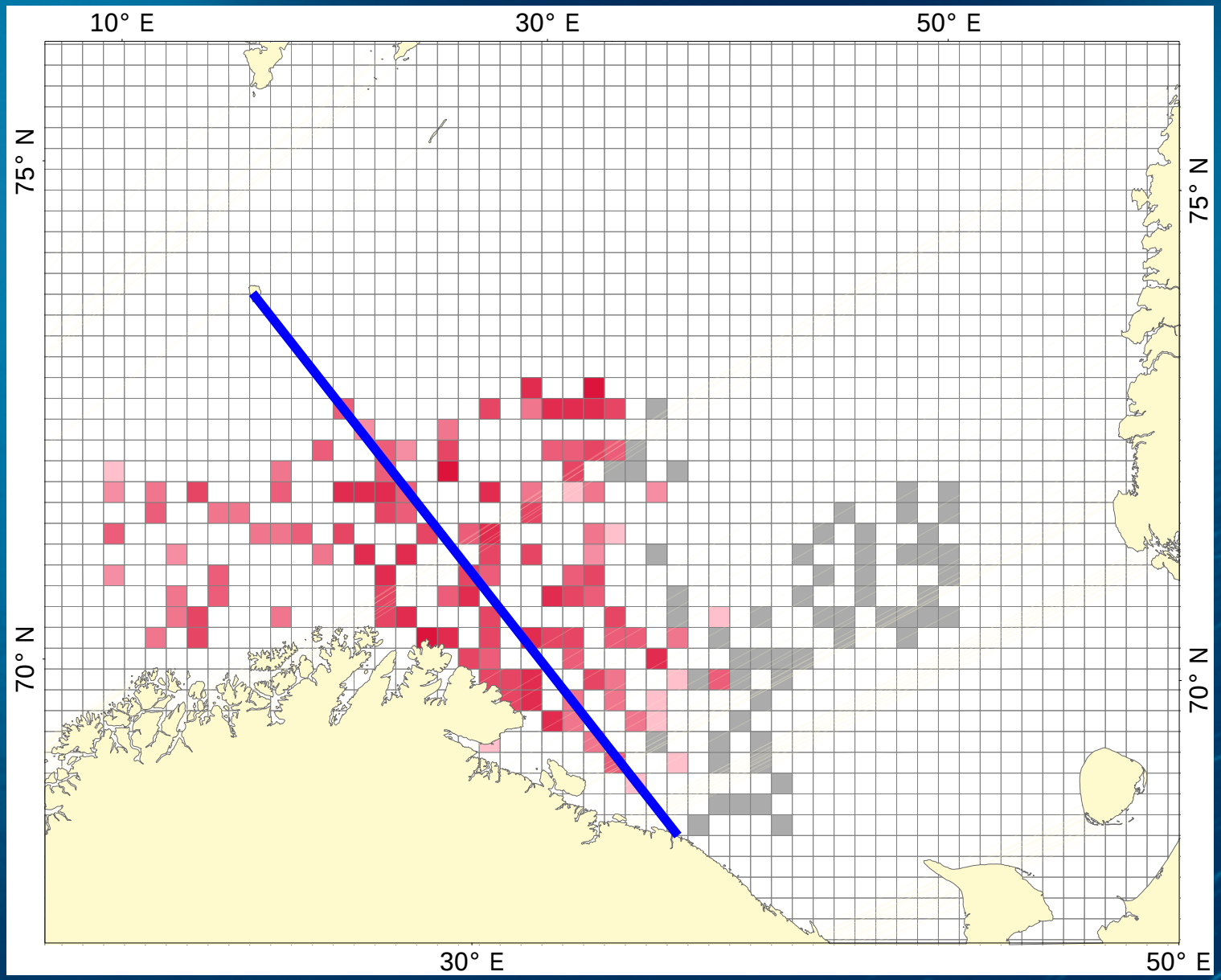

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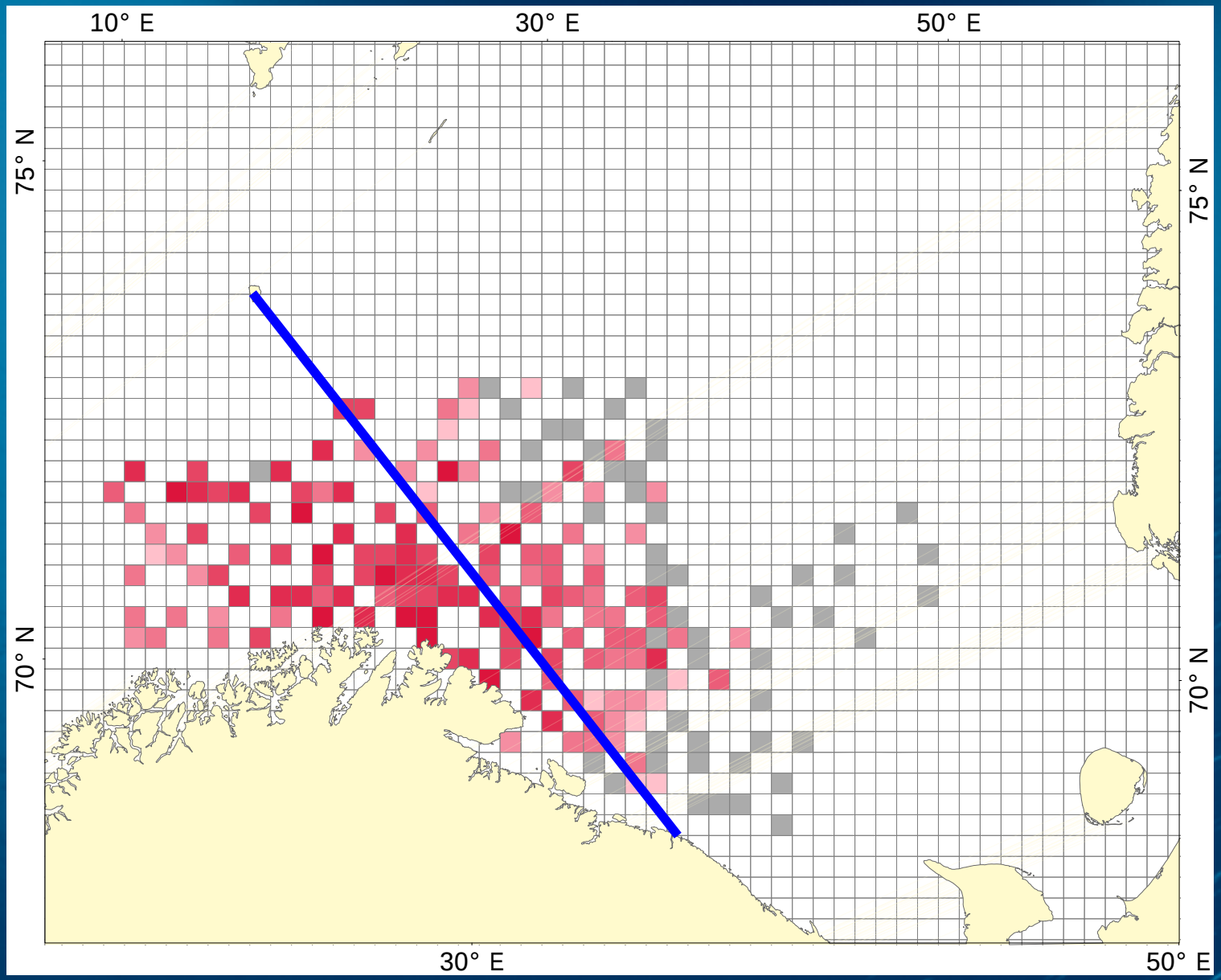

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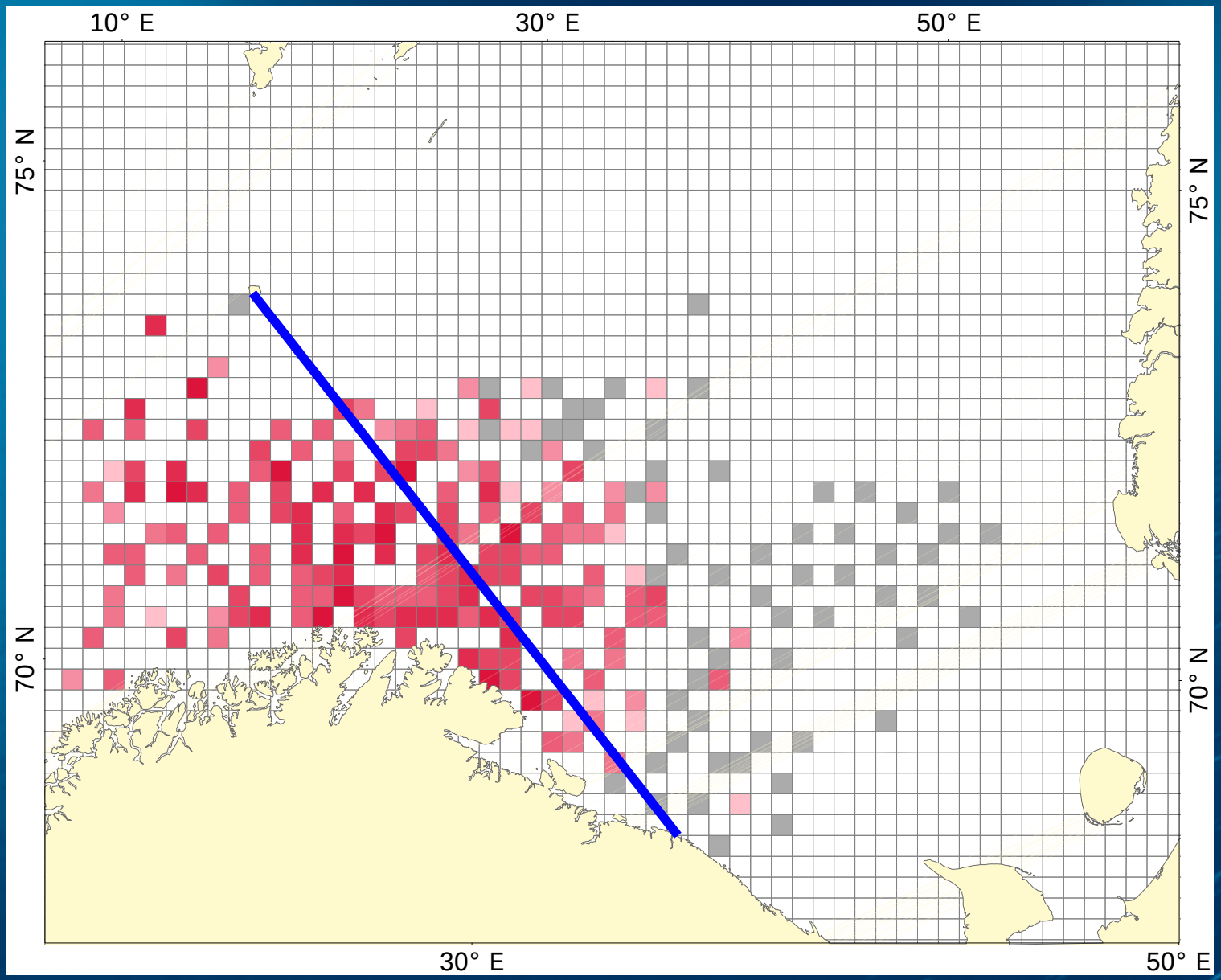

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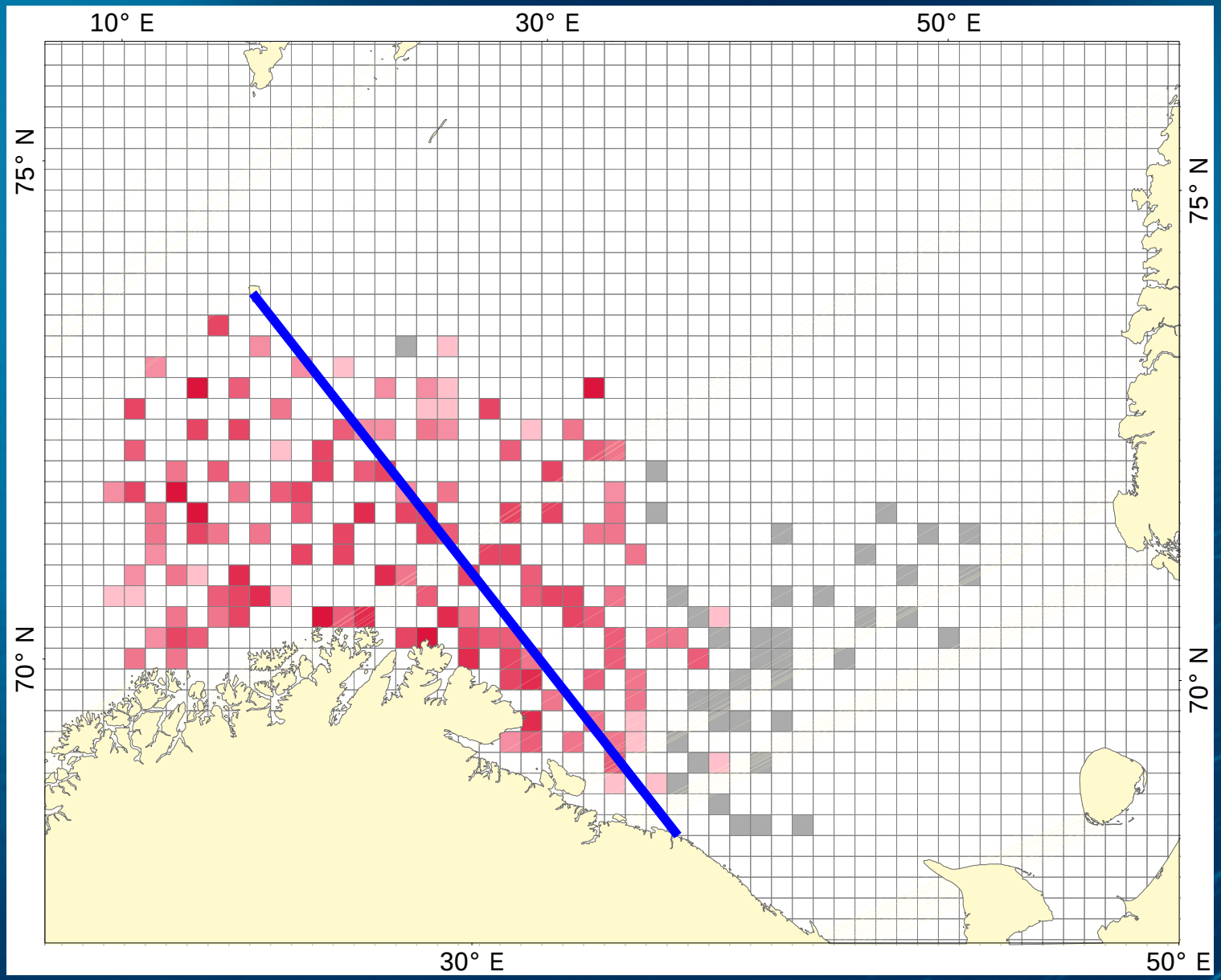

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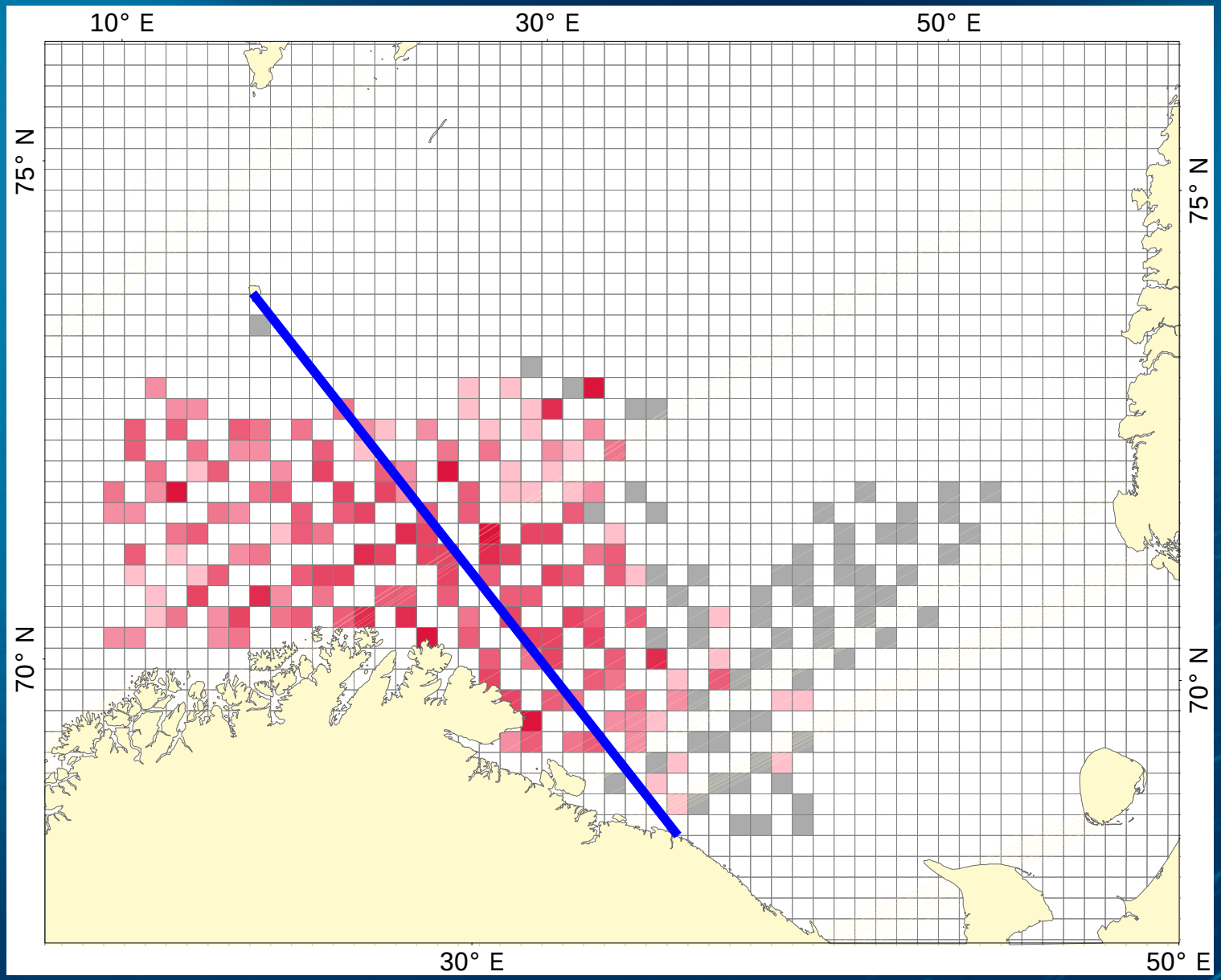

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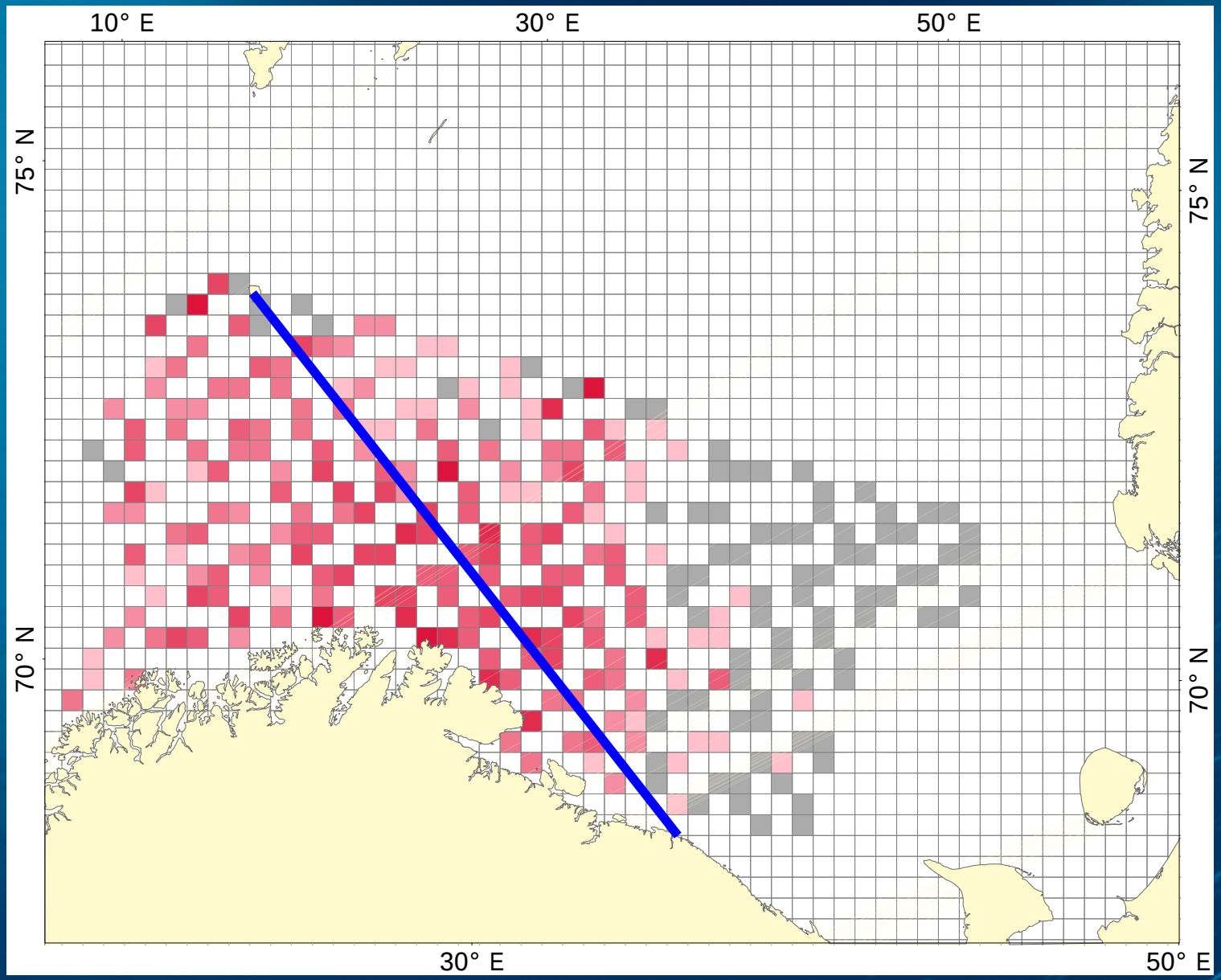

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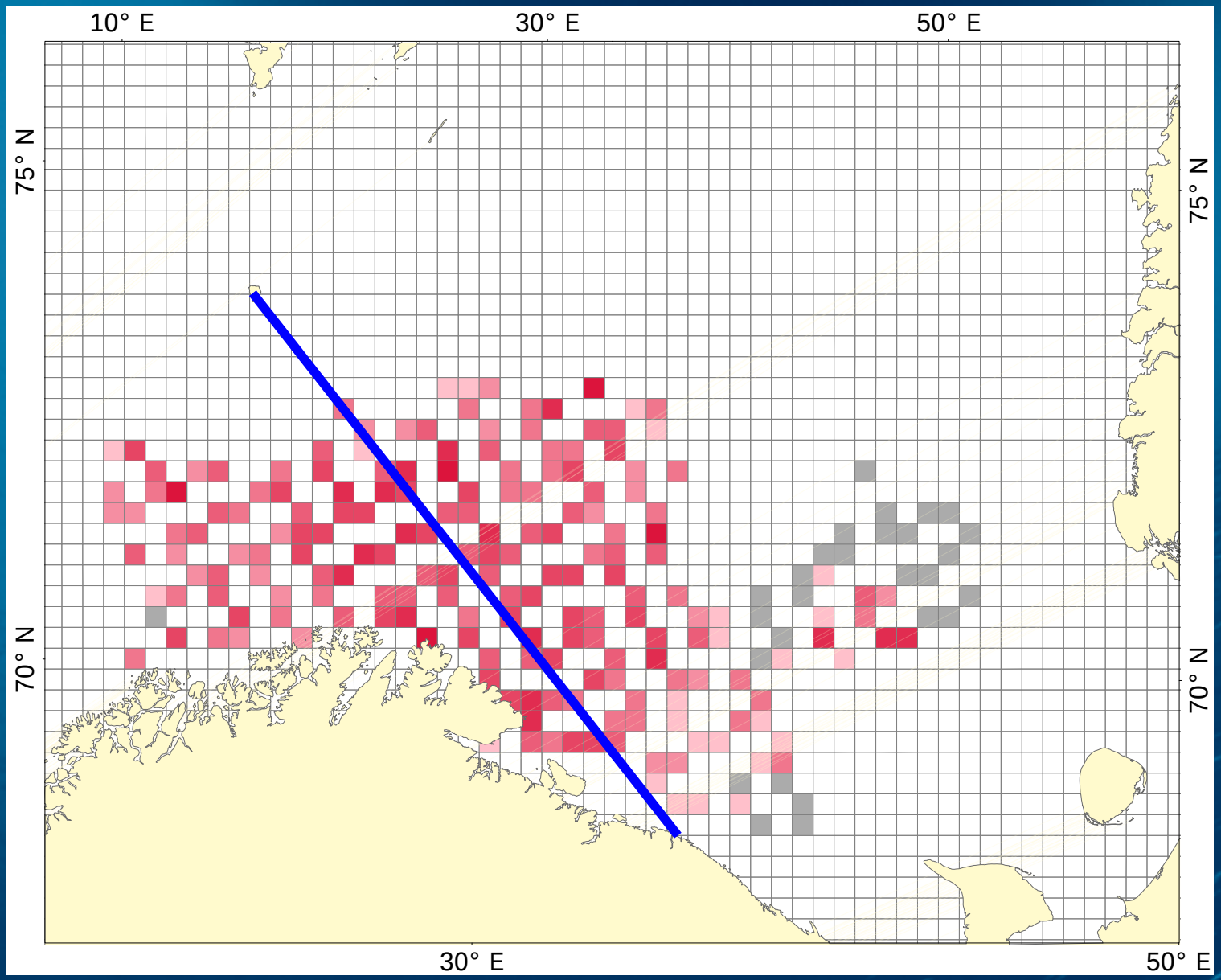
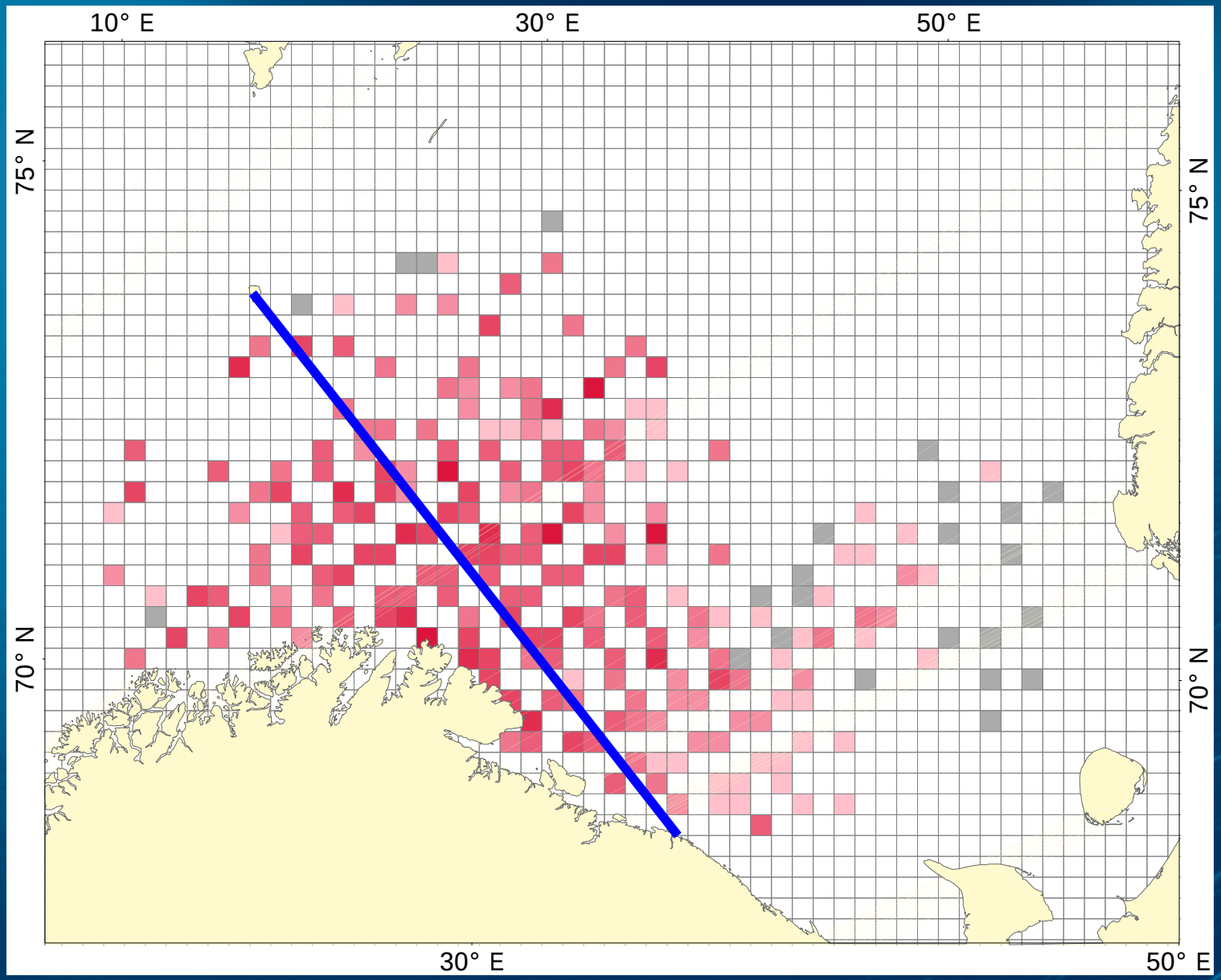


Expansion of survey area from 1993 and onwards!

1993



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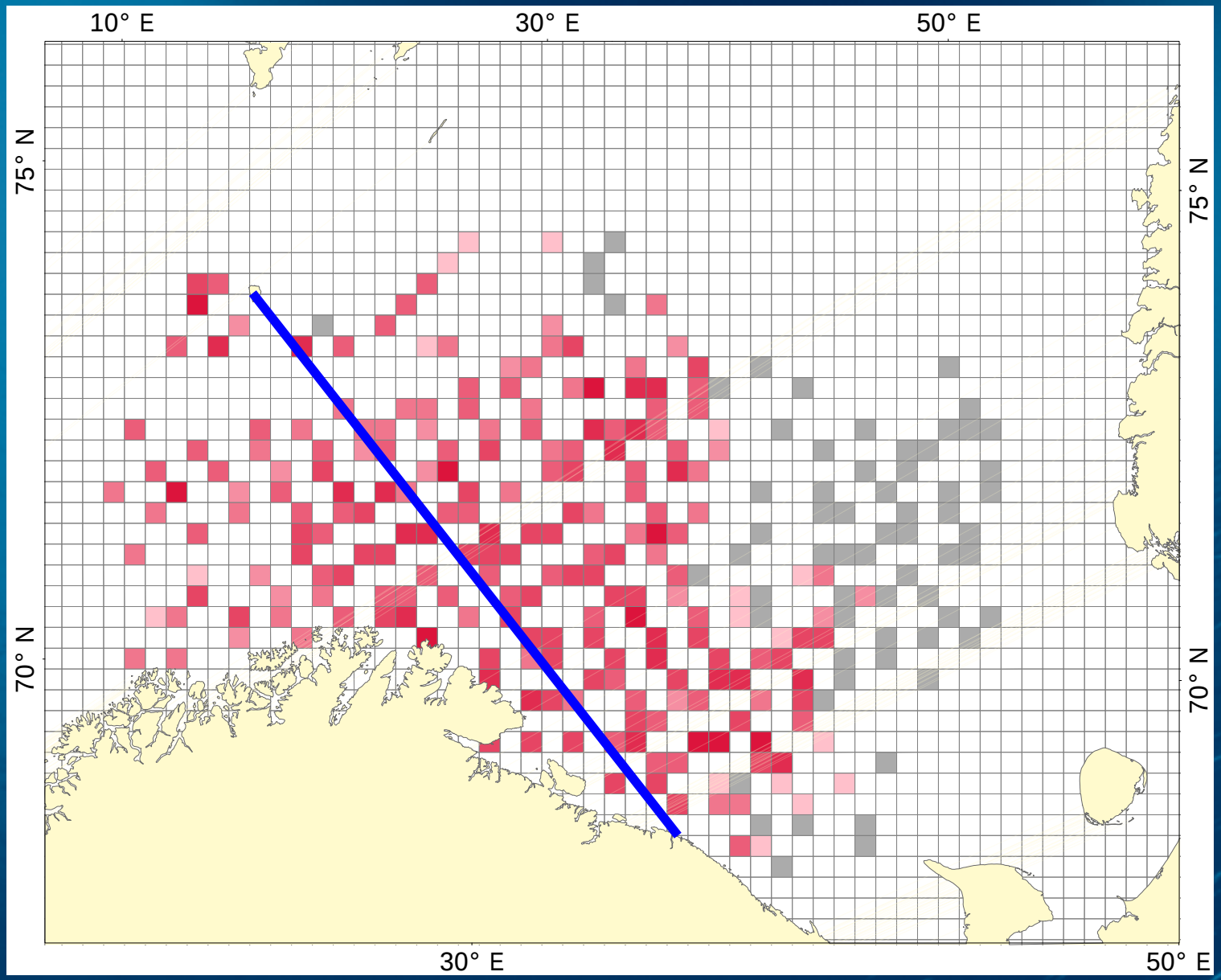

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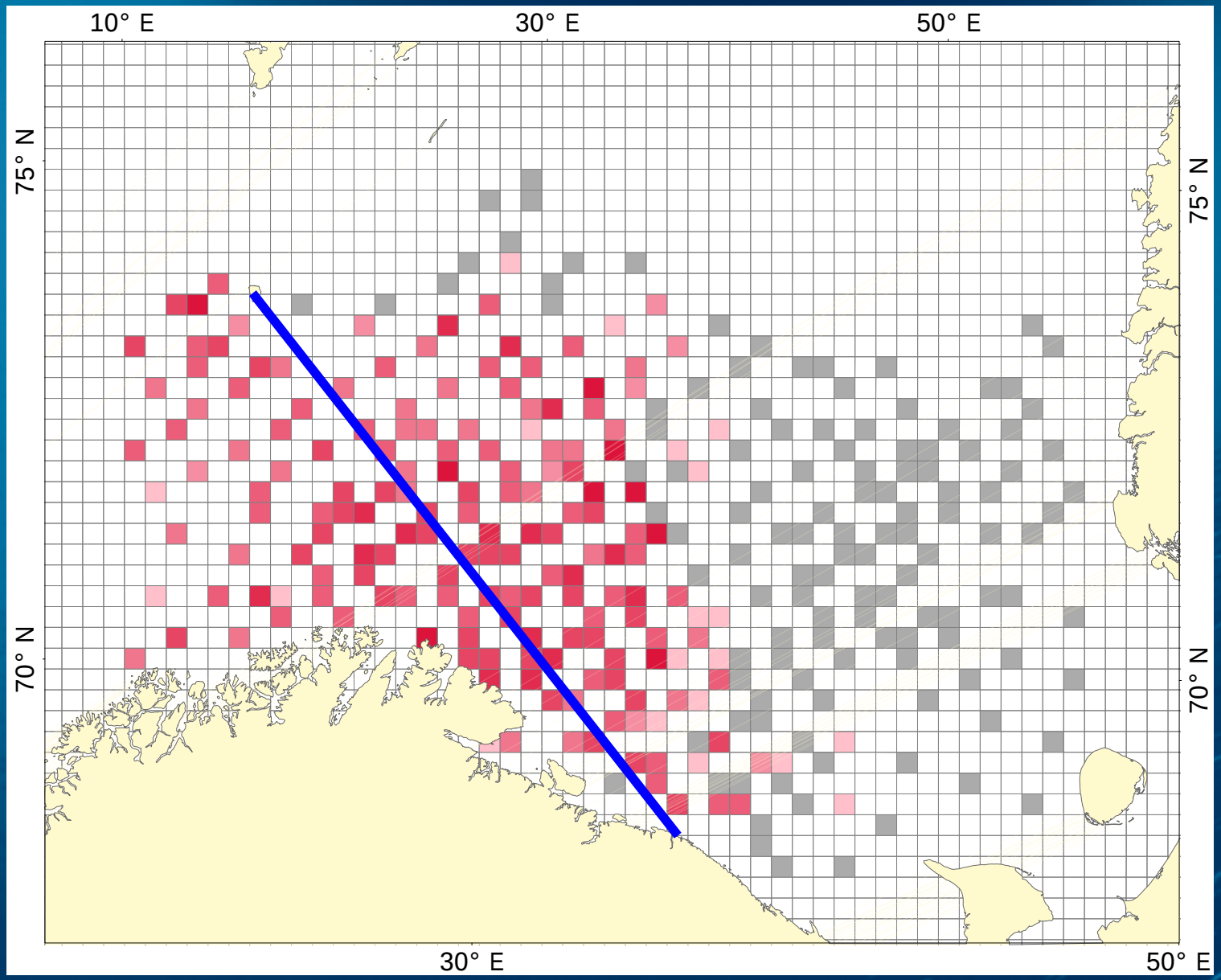

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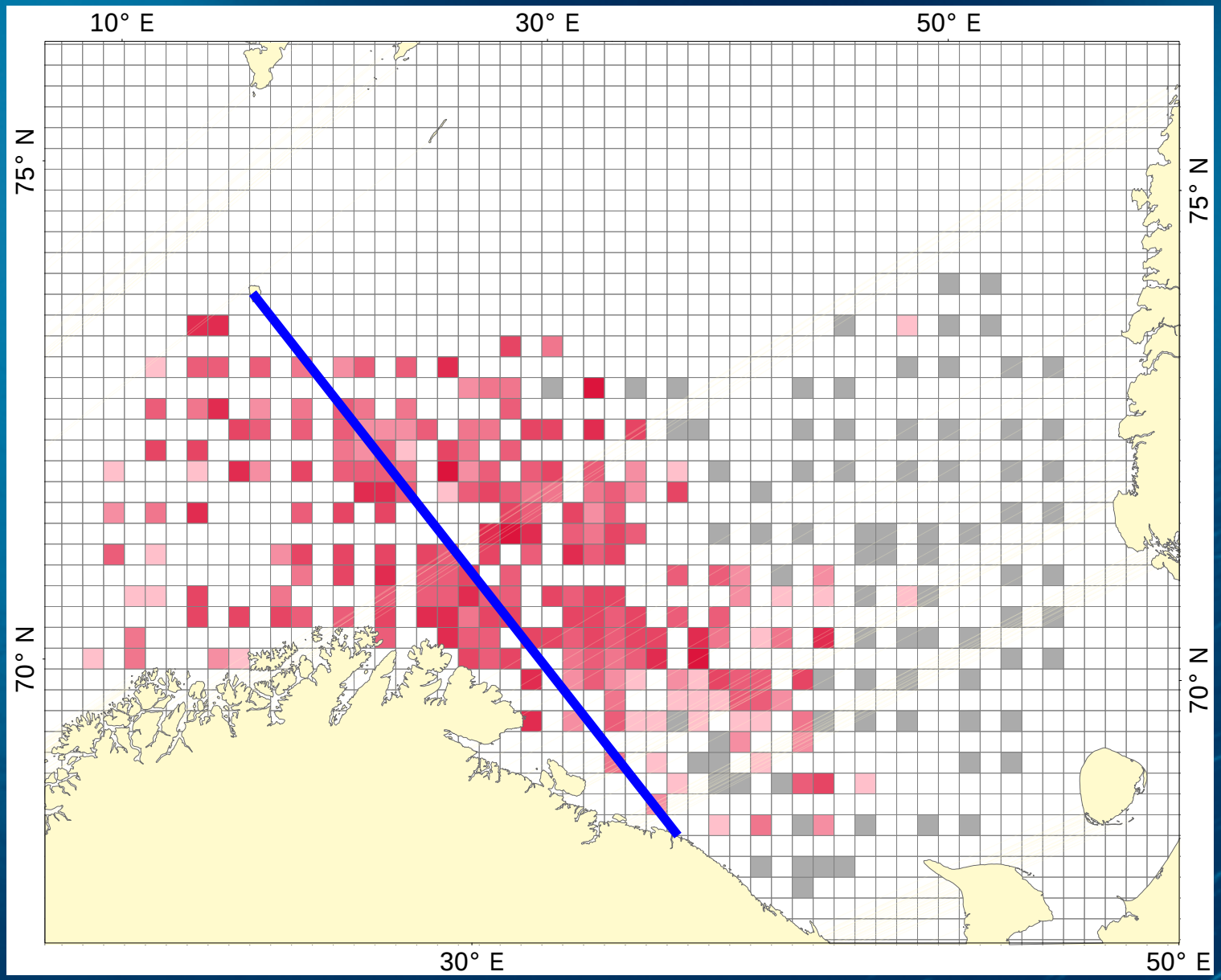
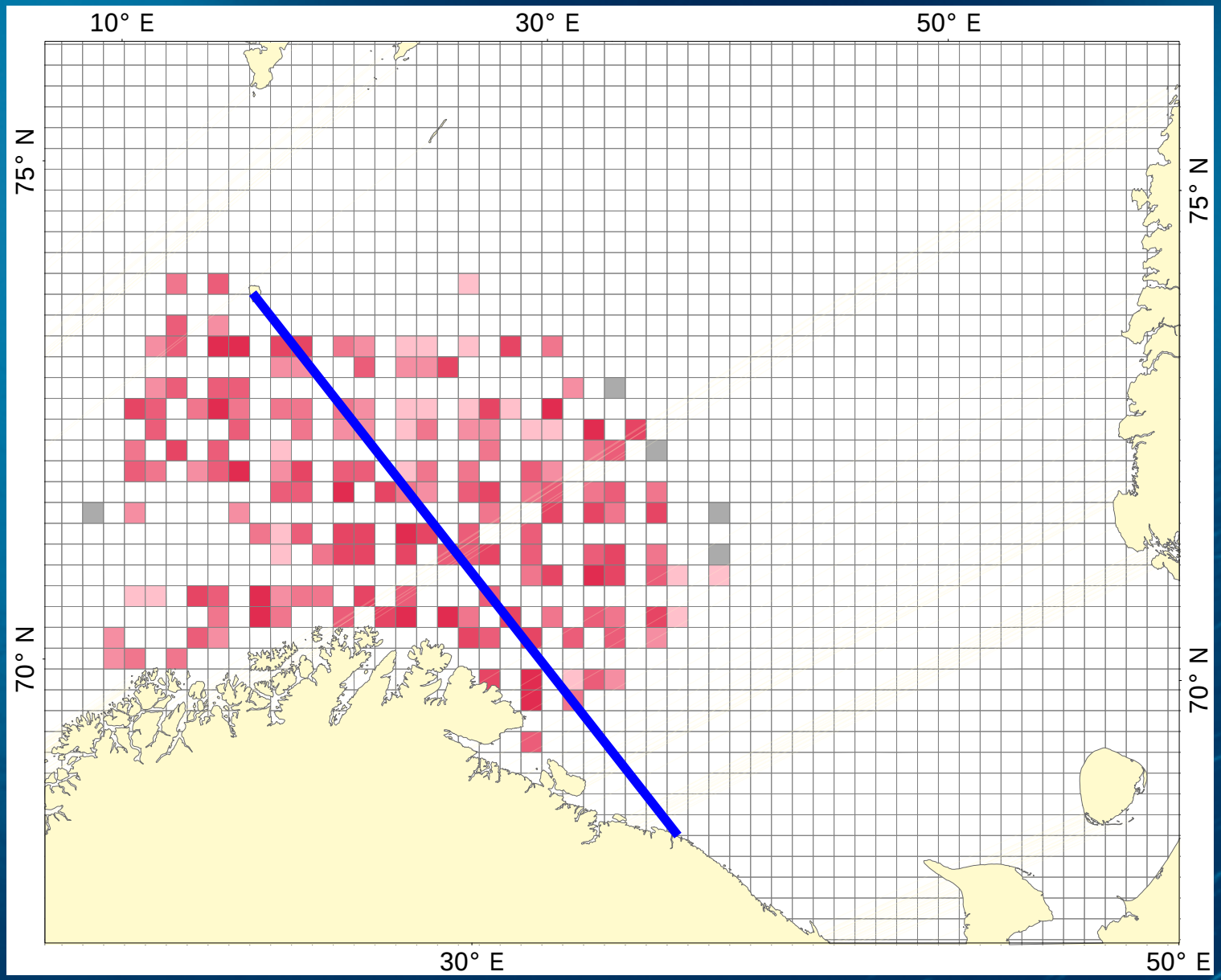
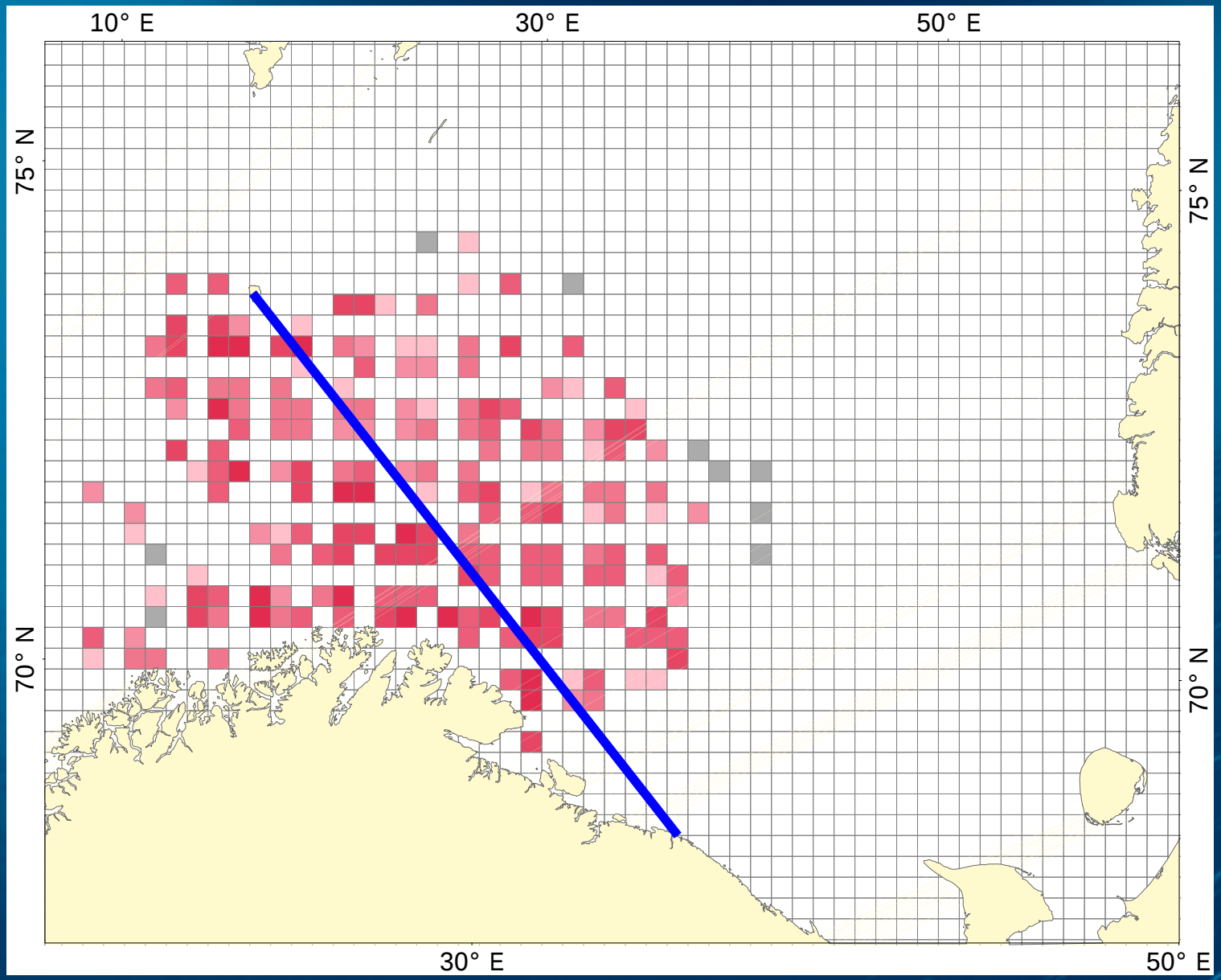


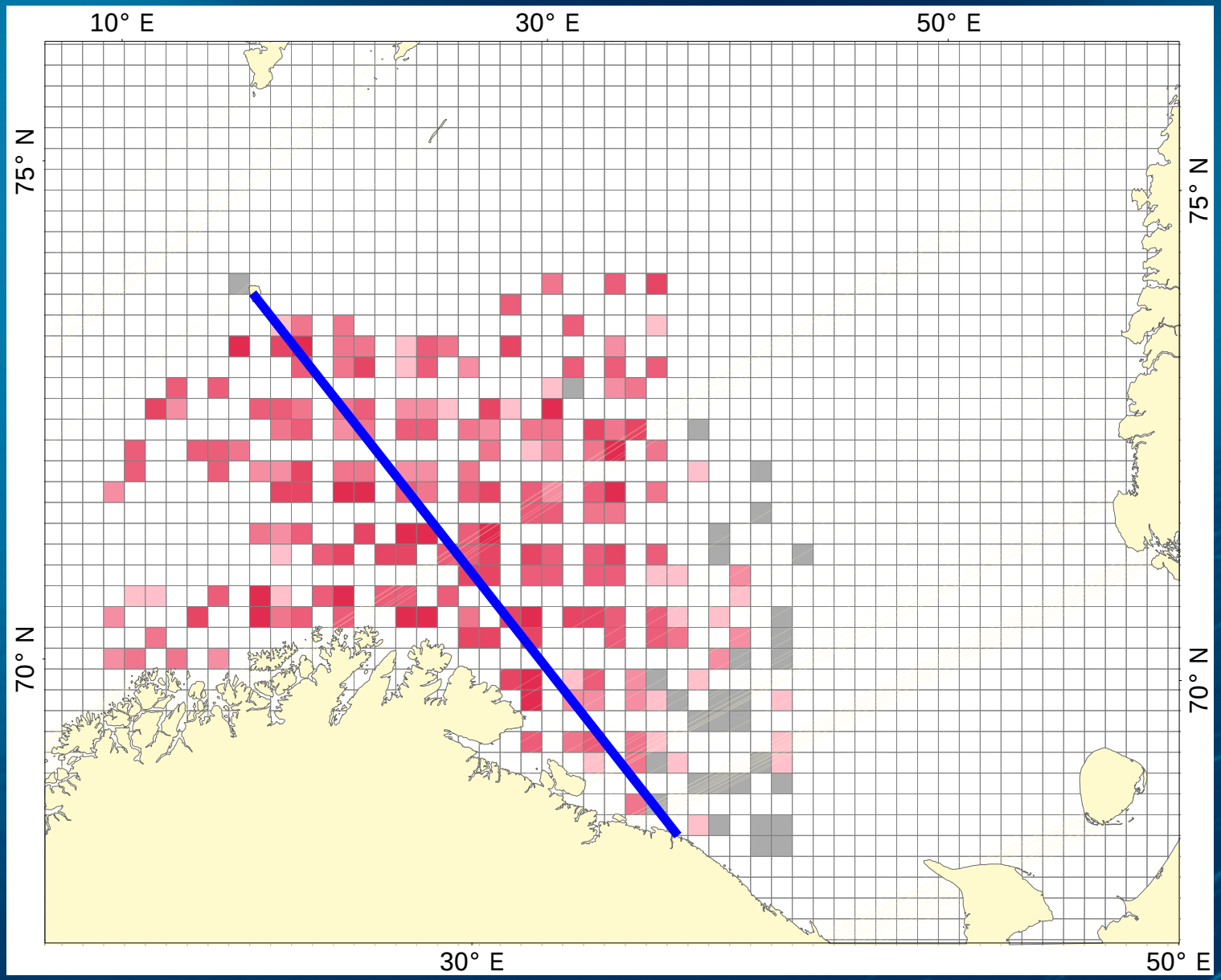
1997 Limited survey coverage



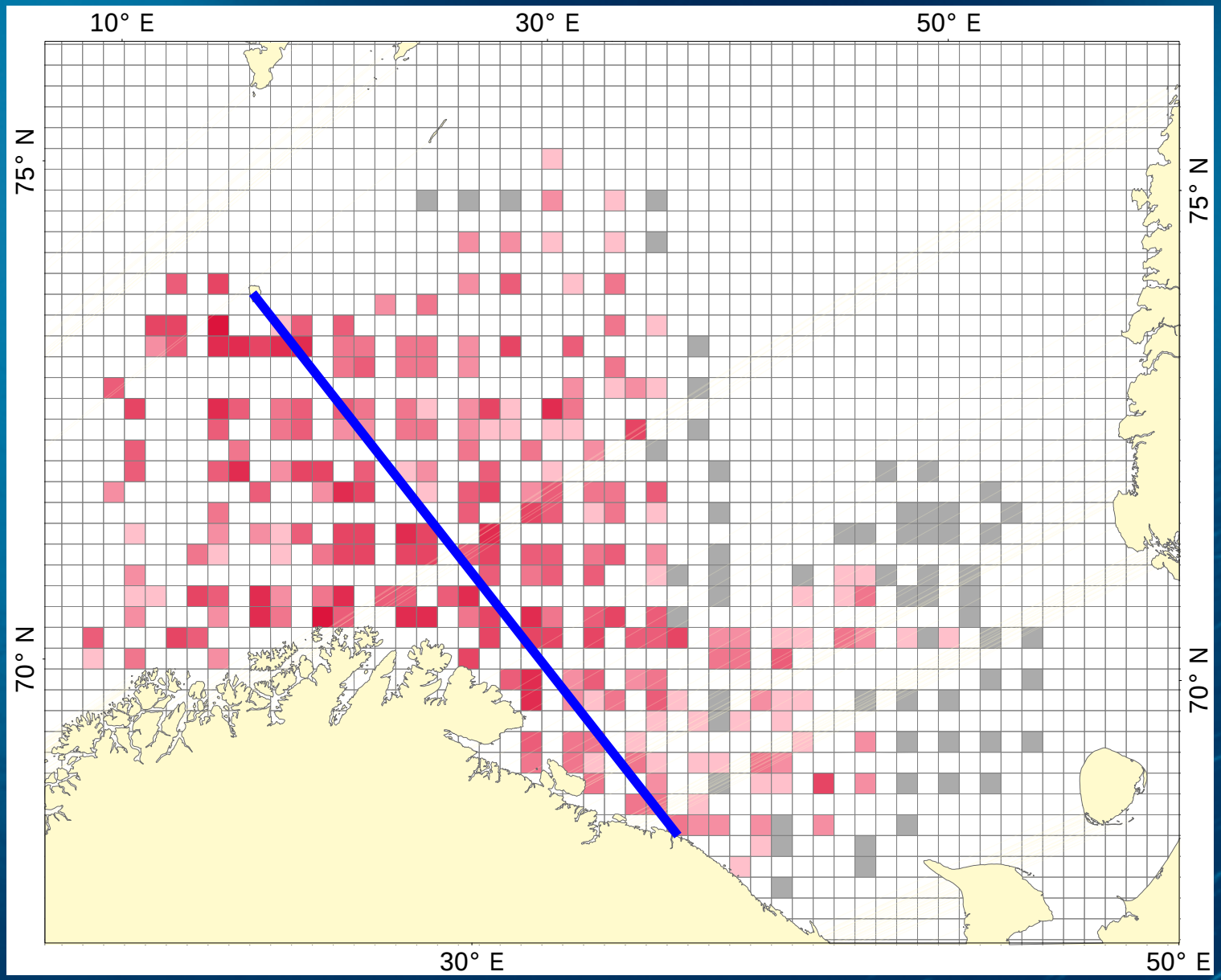
1998 Limited survey coverage



1999 Limited survey coverage



2000



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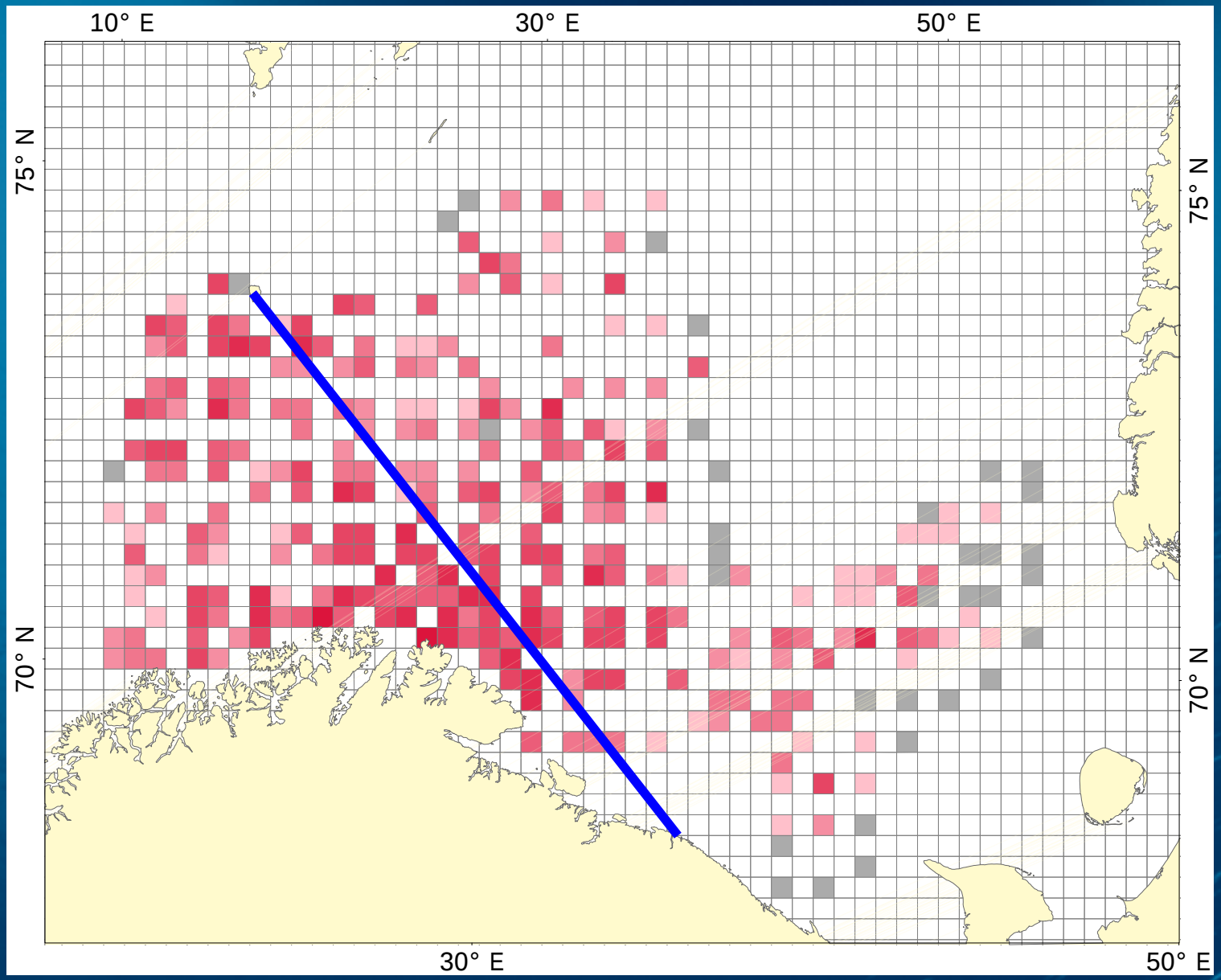

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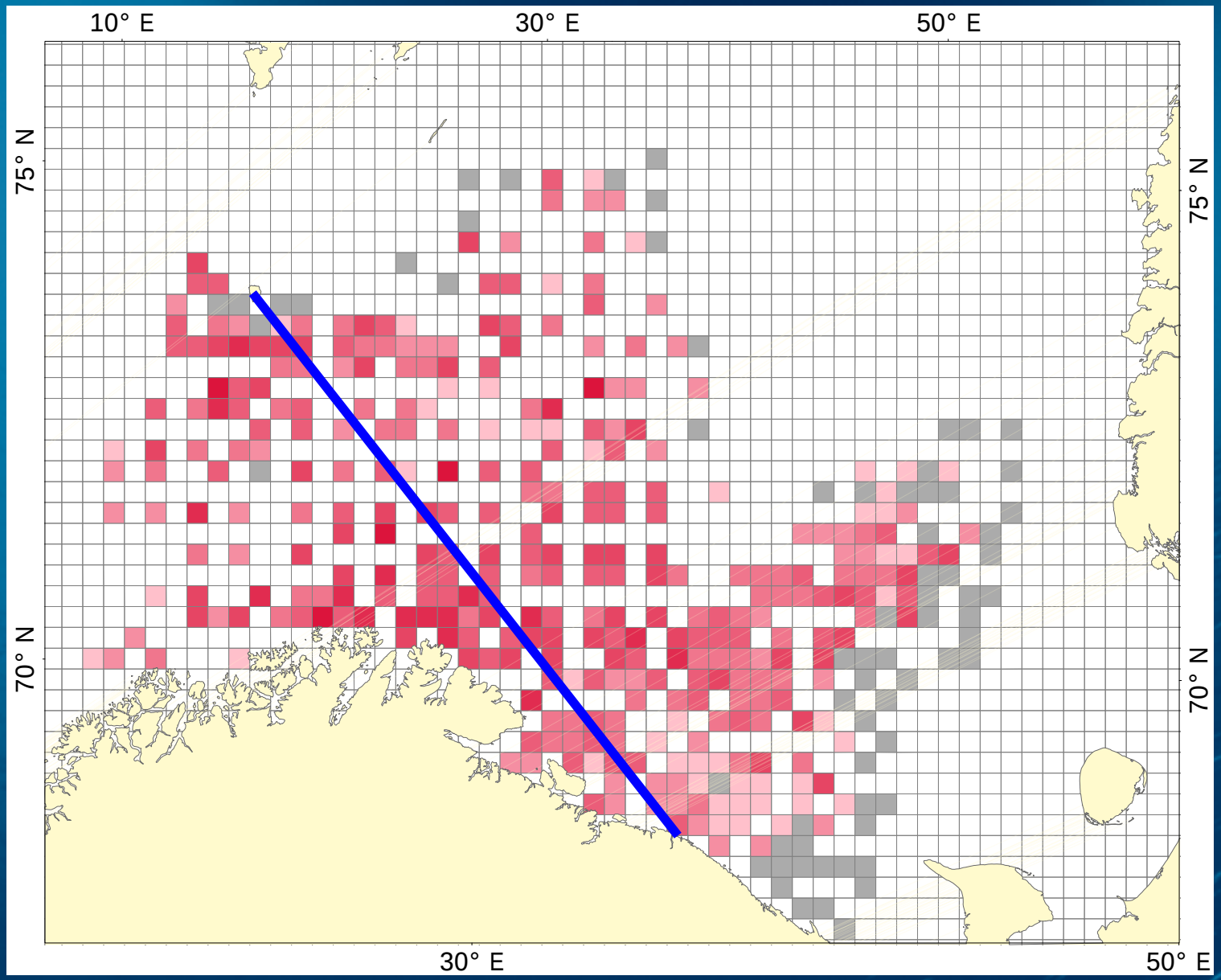

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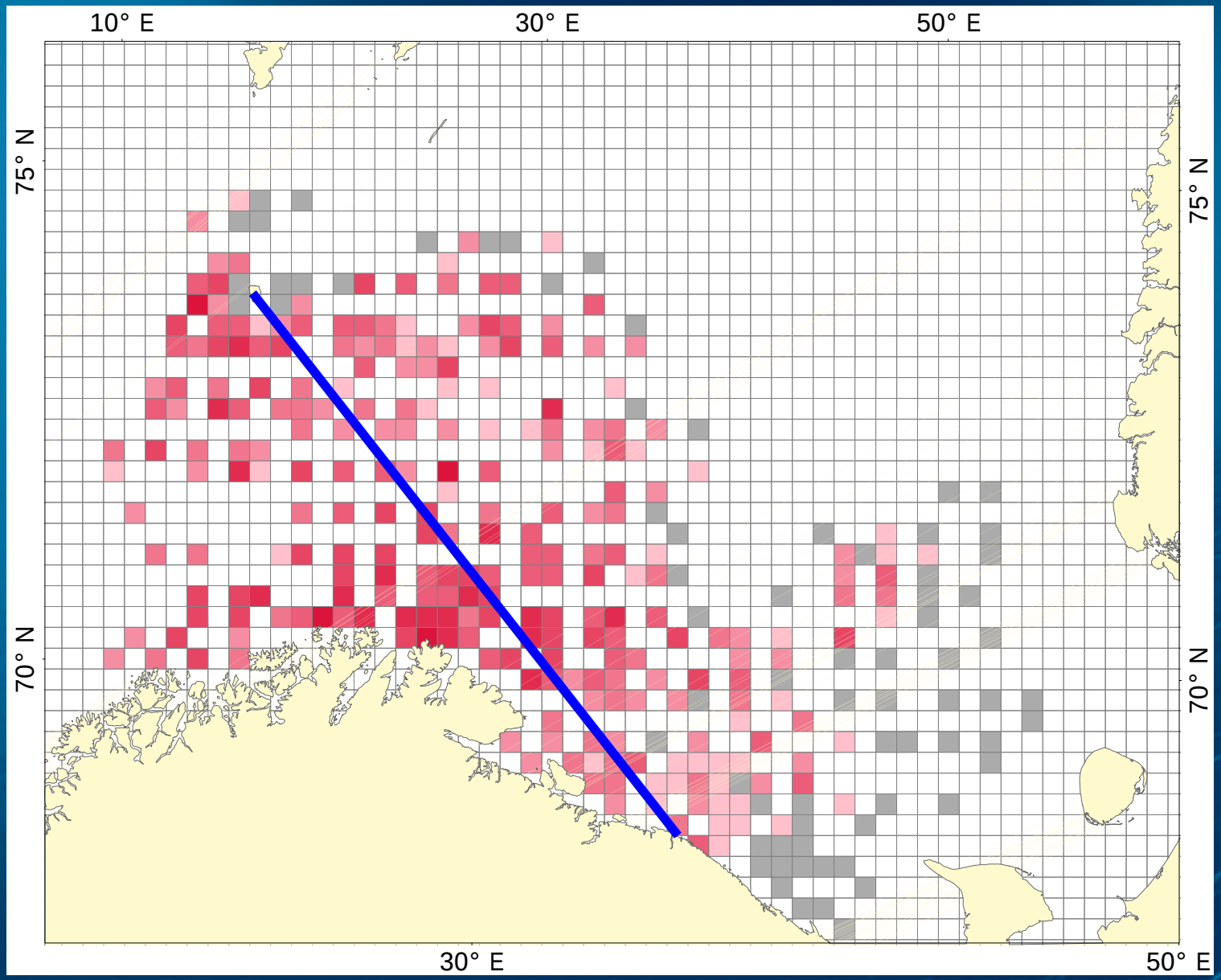

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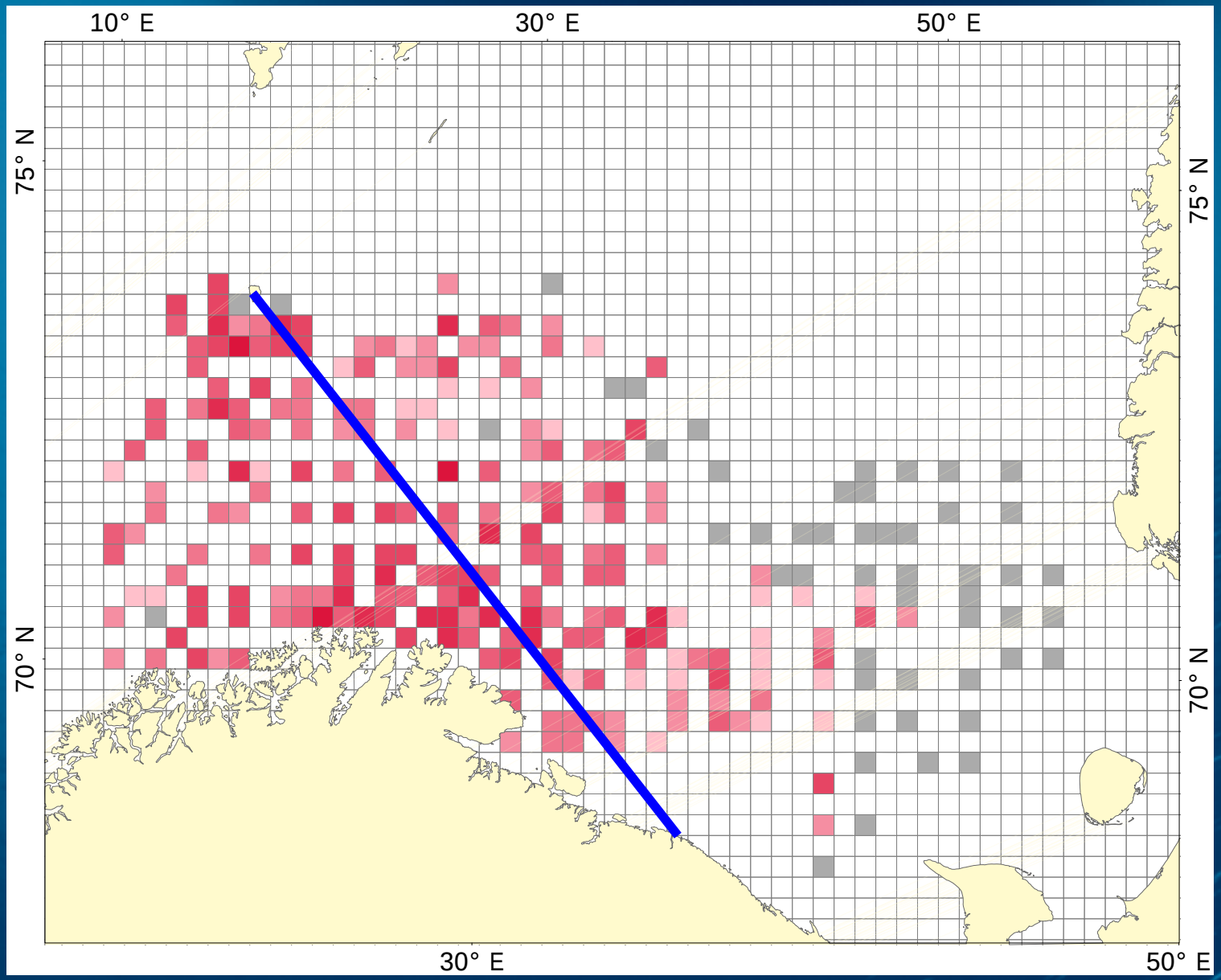
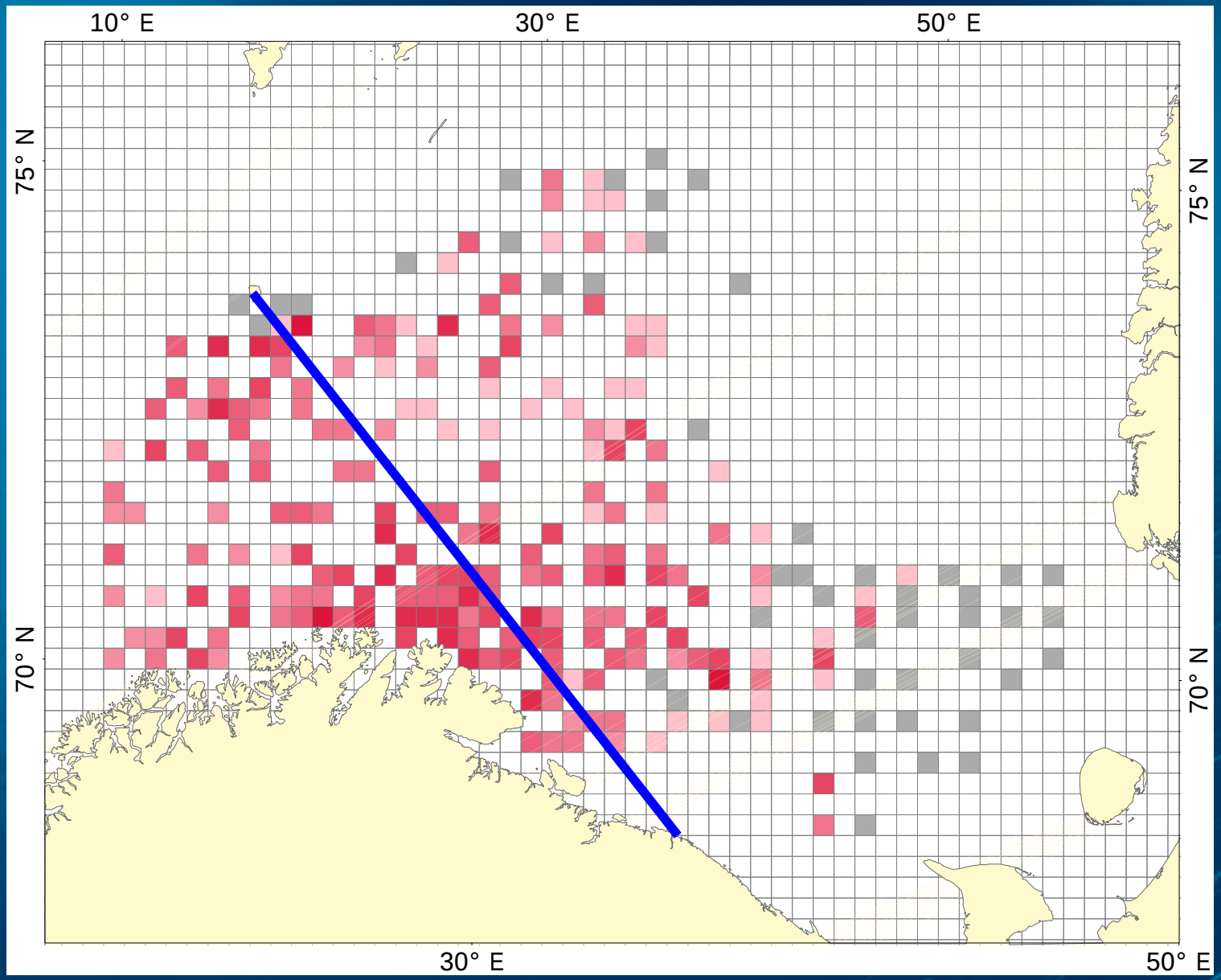
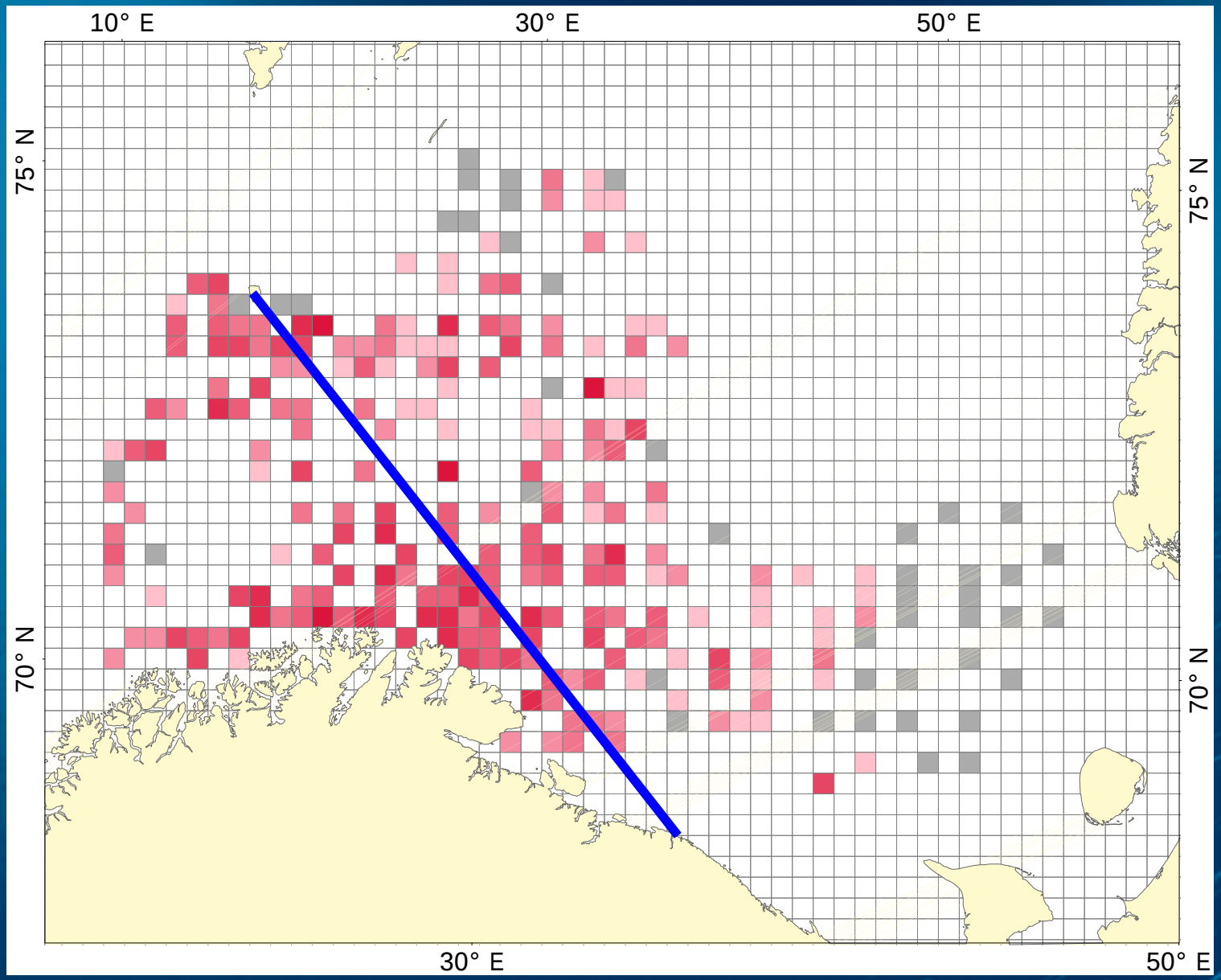


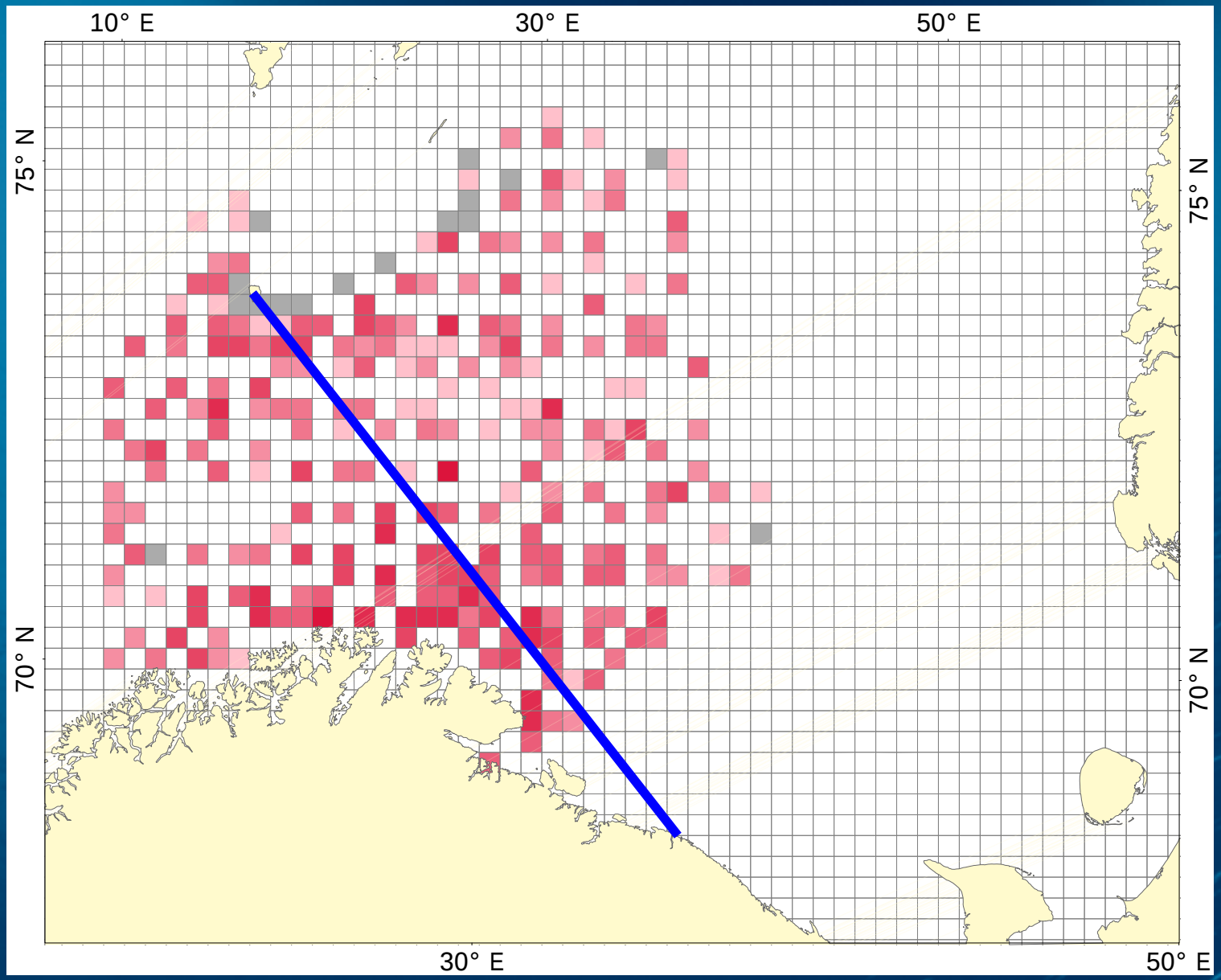
2005



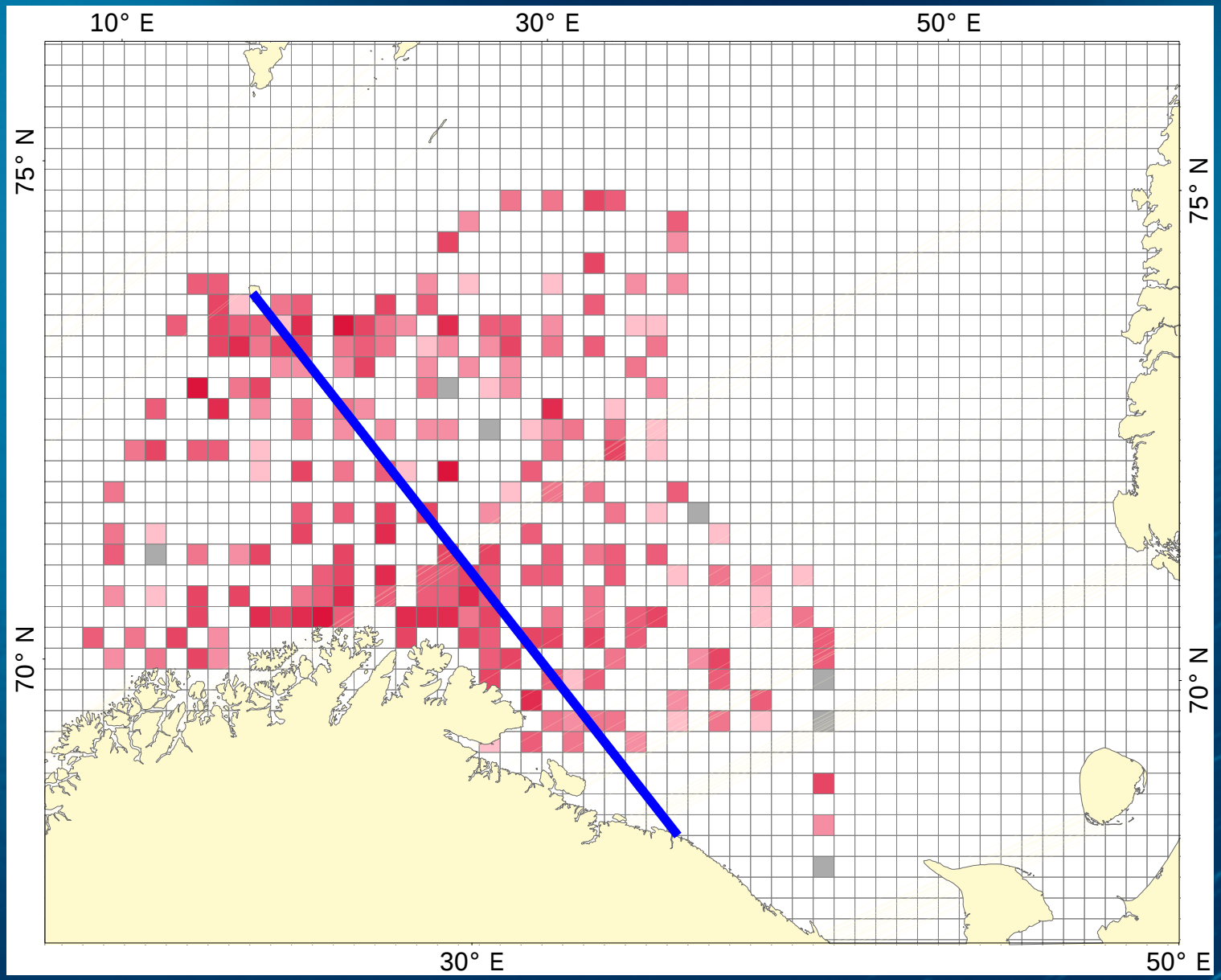
2006



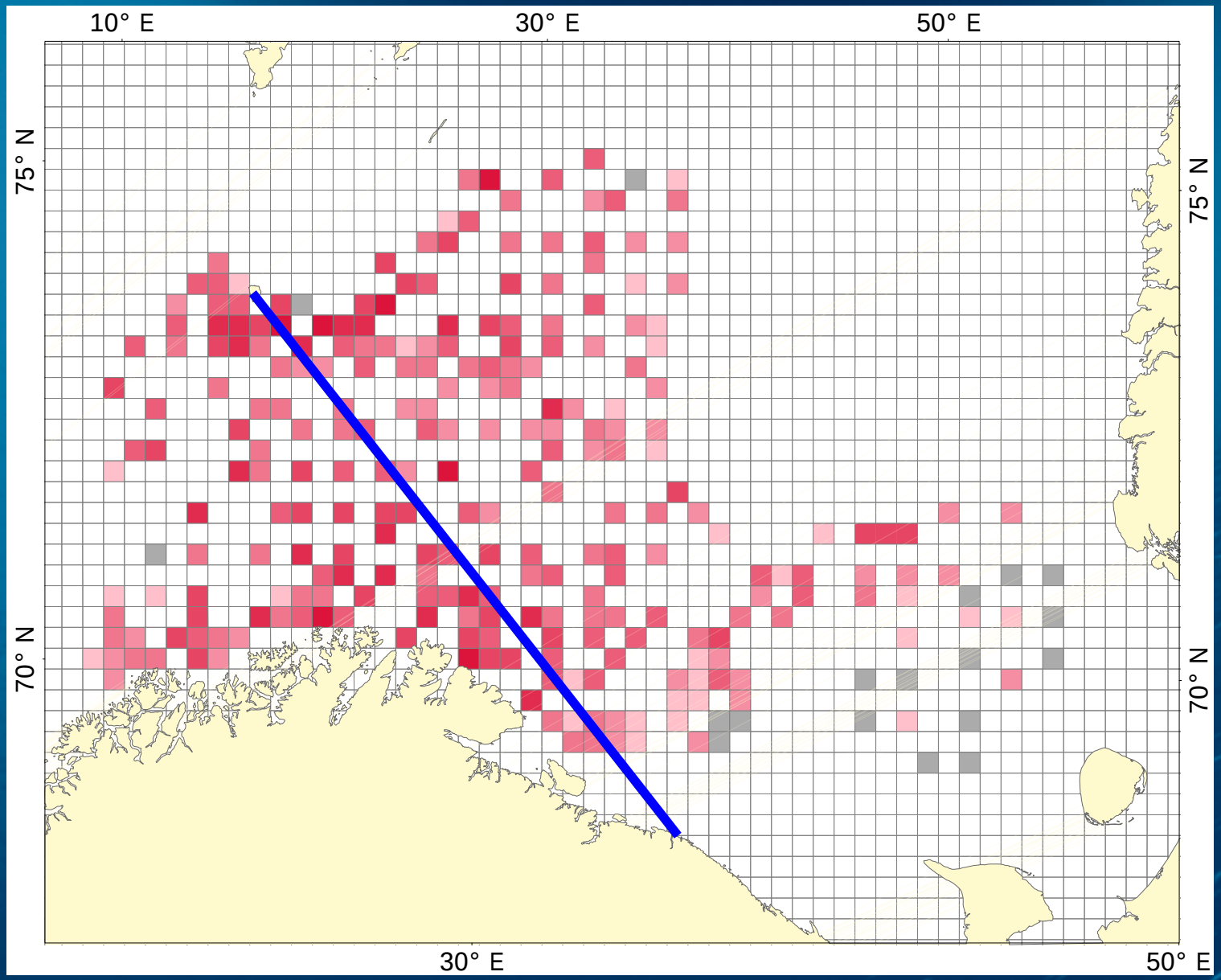
2007



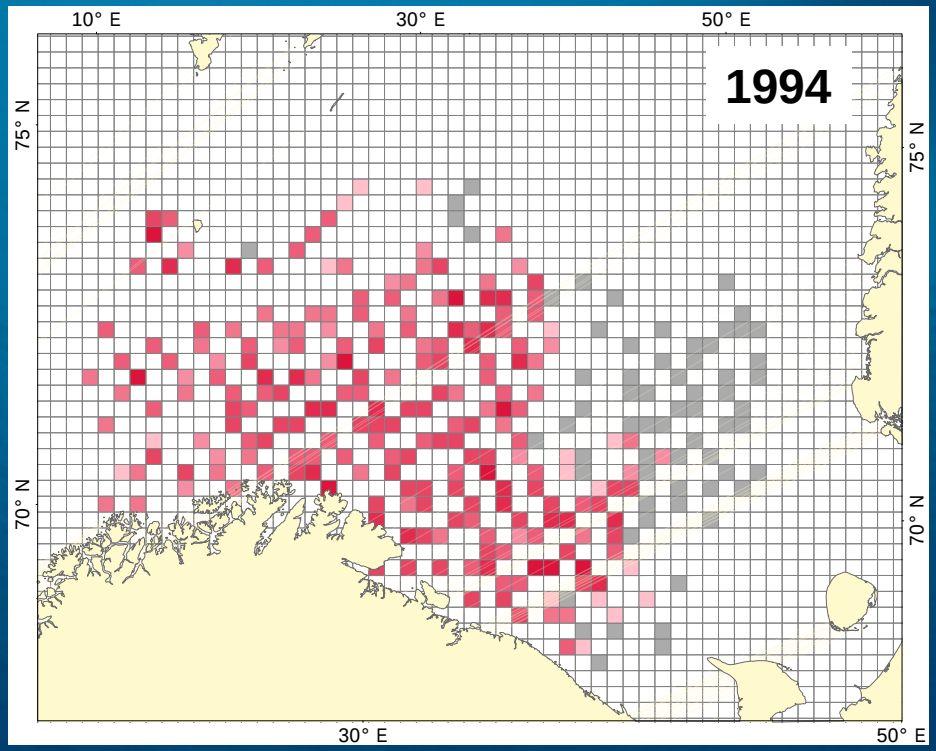
2008

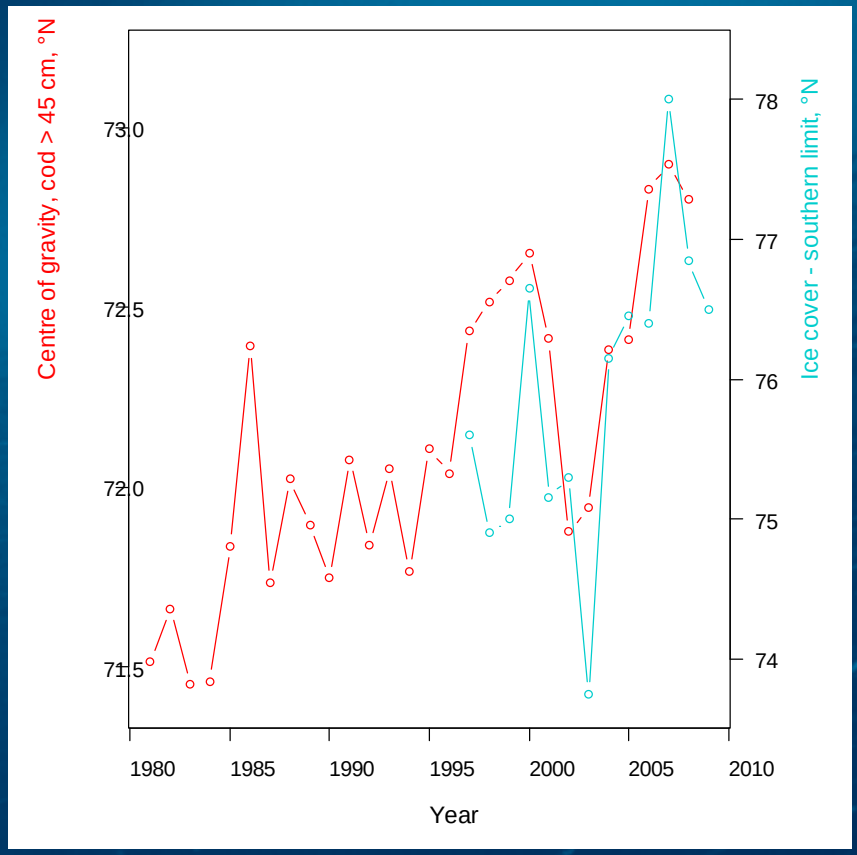


2009



Distribution of NEA cod





Distribution of NEA cod

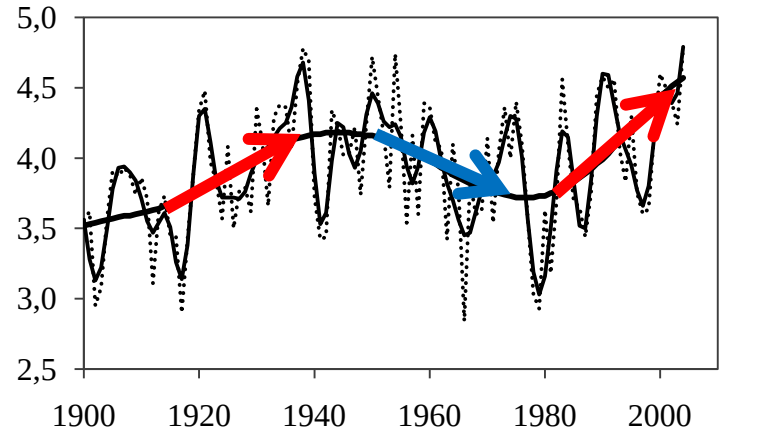
In the Barents Sea, cod appeared in large quantities on Bear Island Bank in response to the warming of the early 20th century, resulting in the reestablishment of a cod fishery there after an absence of almost 40 years (Blacker, 1957). Cod also penetrated farther east to Novaya Zemlya and north of West Svalbard, during the 1920s (Beverton and Lee, 1965). Similar effects at west Greenland and Iceland.

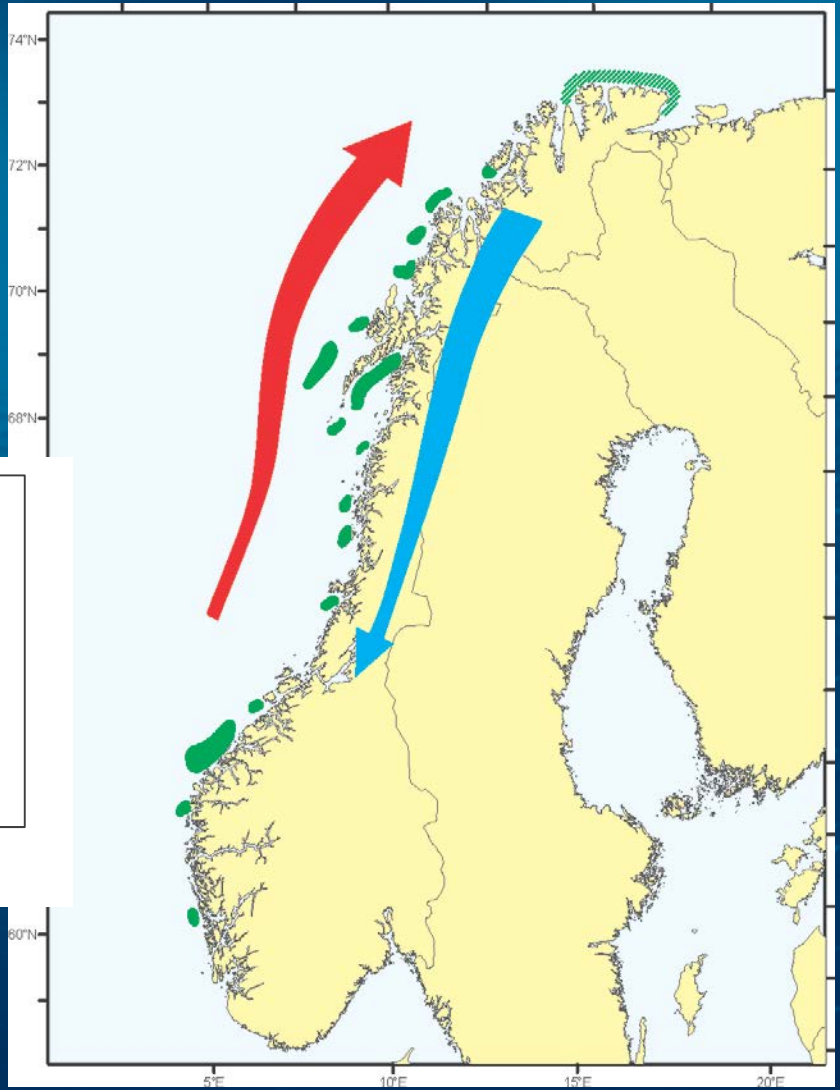
Drinkwater 2005

Spawning sites of NEA cod

Hot periods
- Northwards displacement
- Increasing spawning biomass

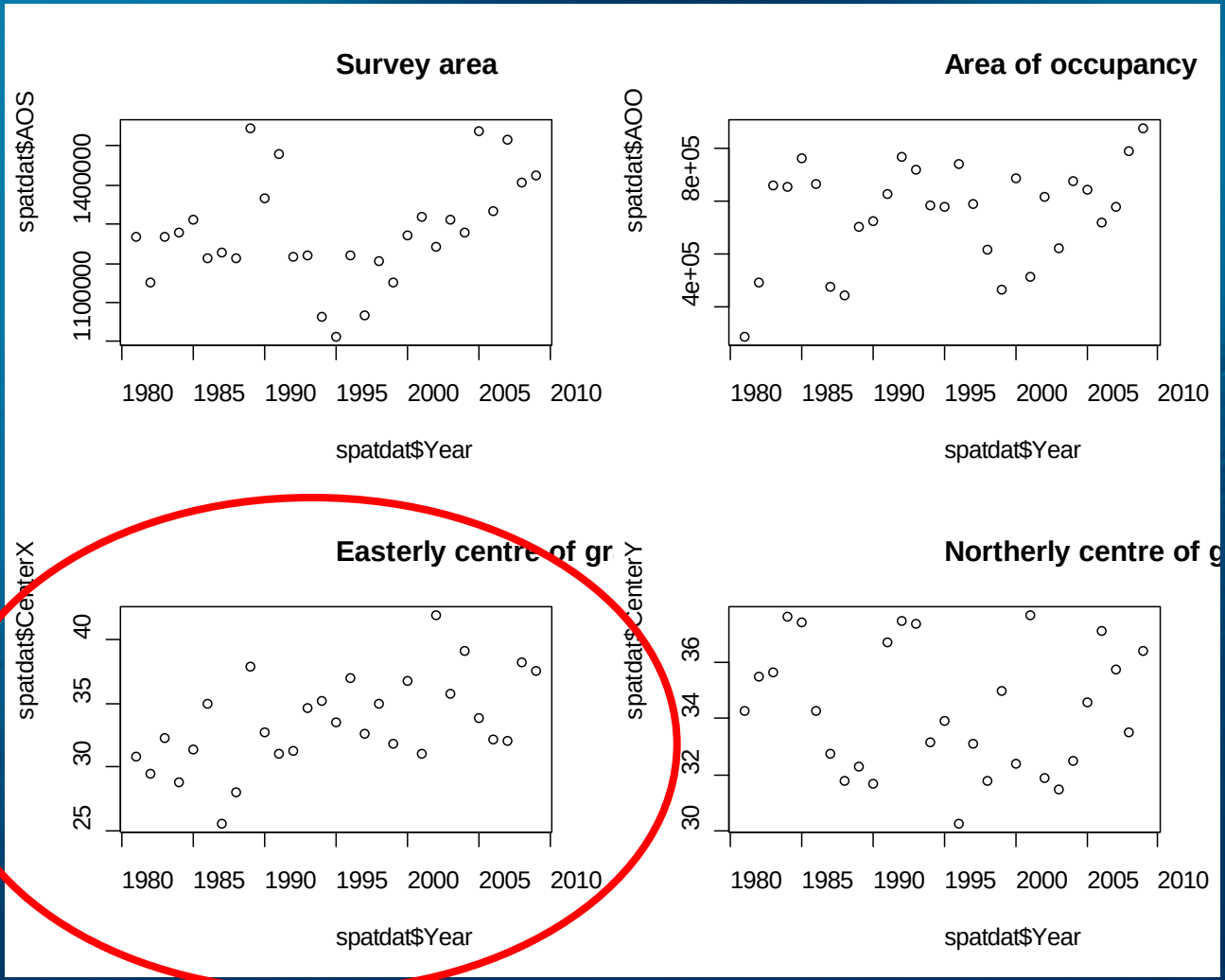
Cold periods:
- Southwards displacement
- Decreasing spawning biomass



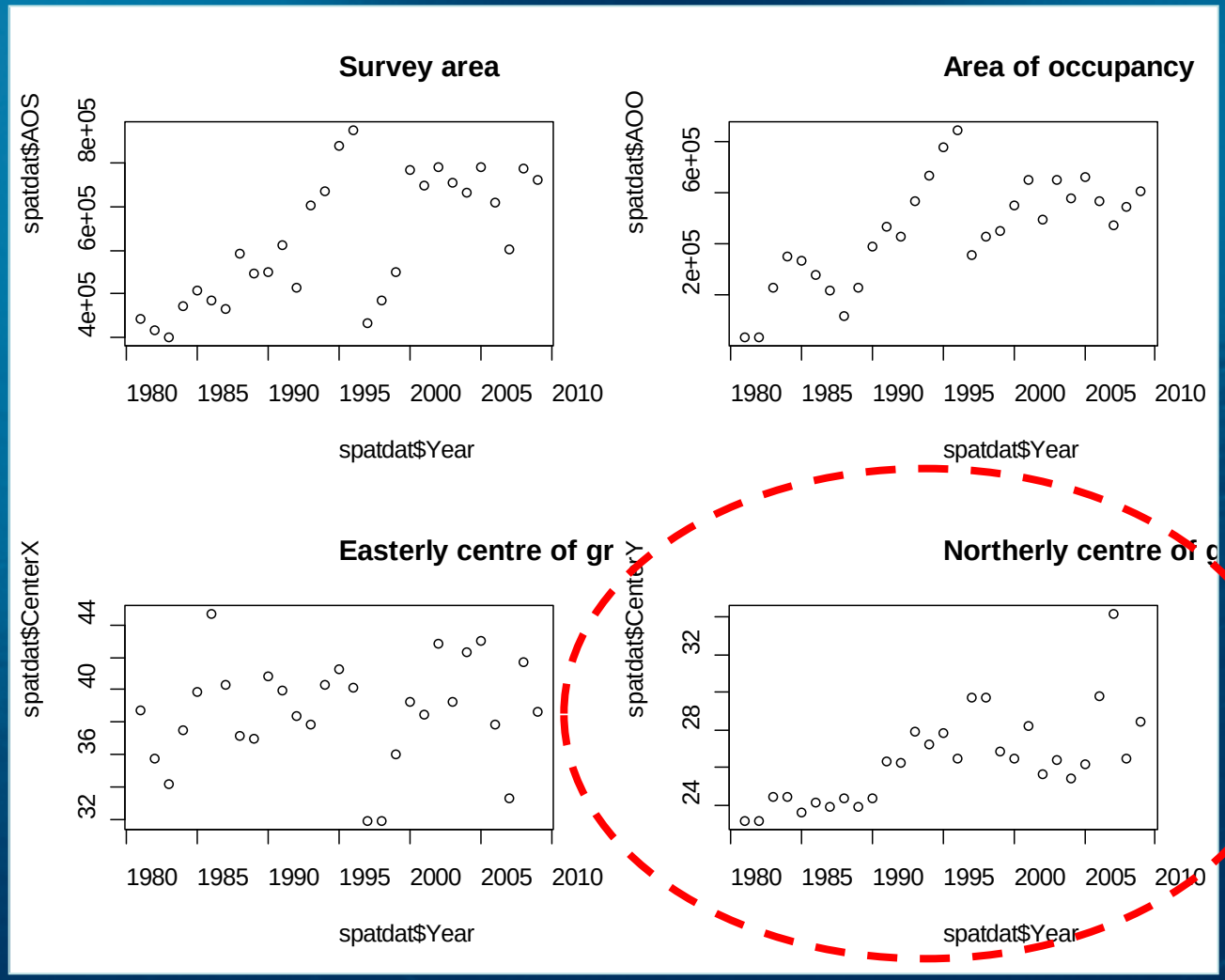


Sundby and Nakken (2008) IJMS

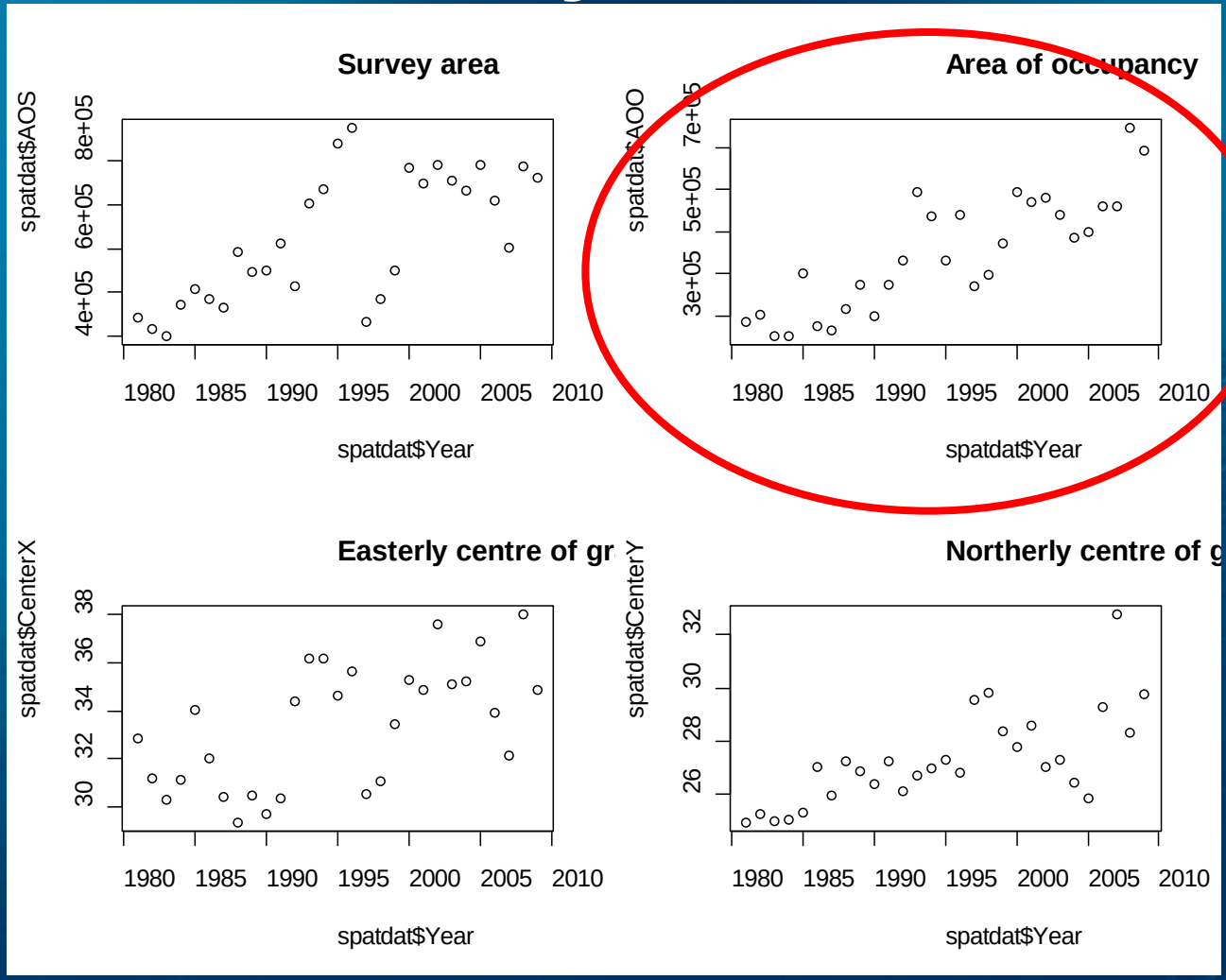
NEA cod the first year of life



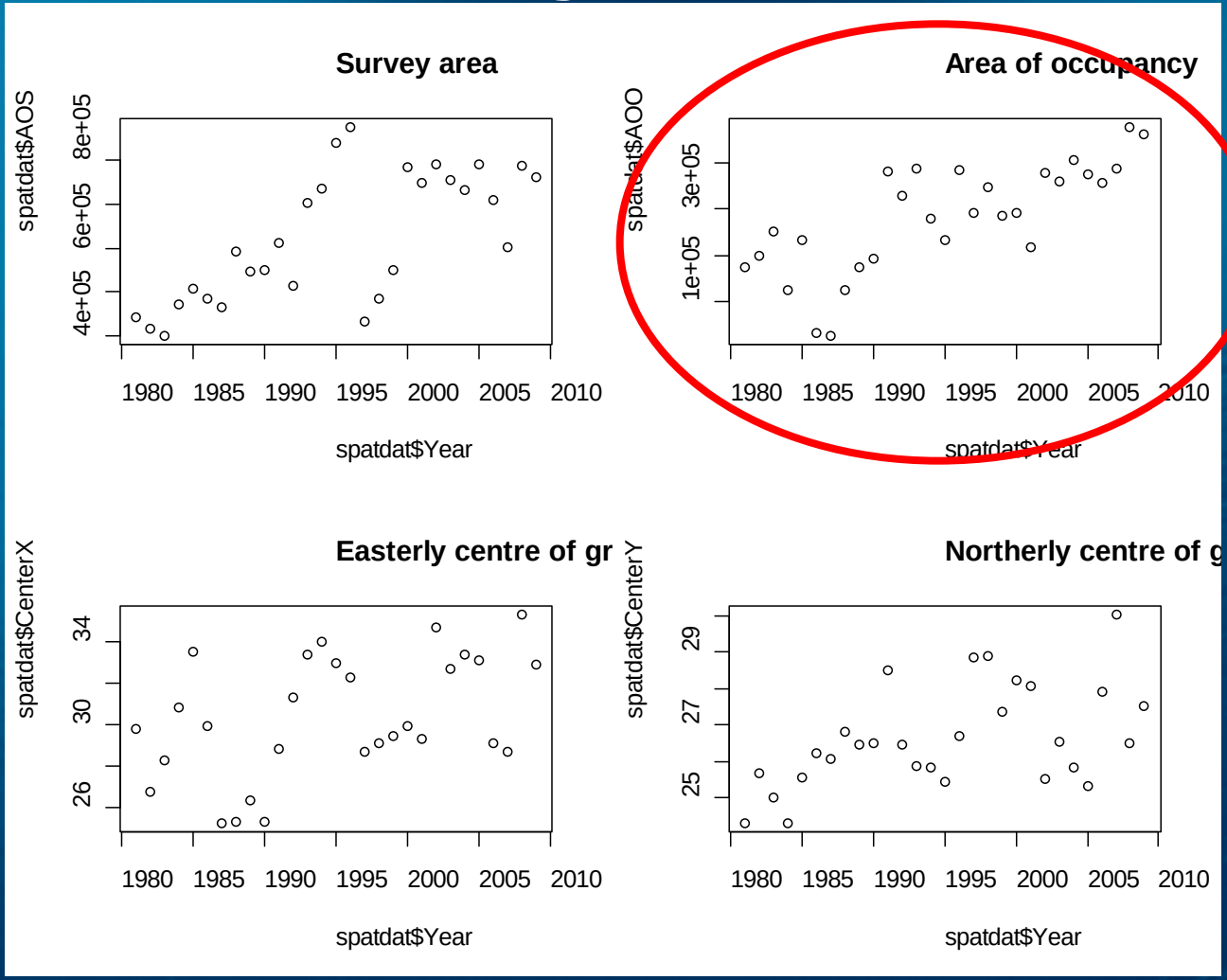
NEA cod 1 yr old, winter



NEA cod 4 yr old, winter

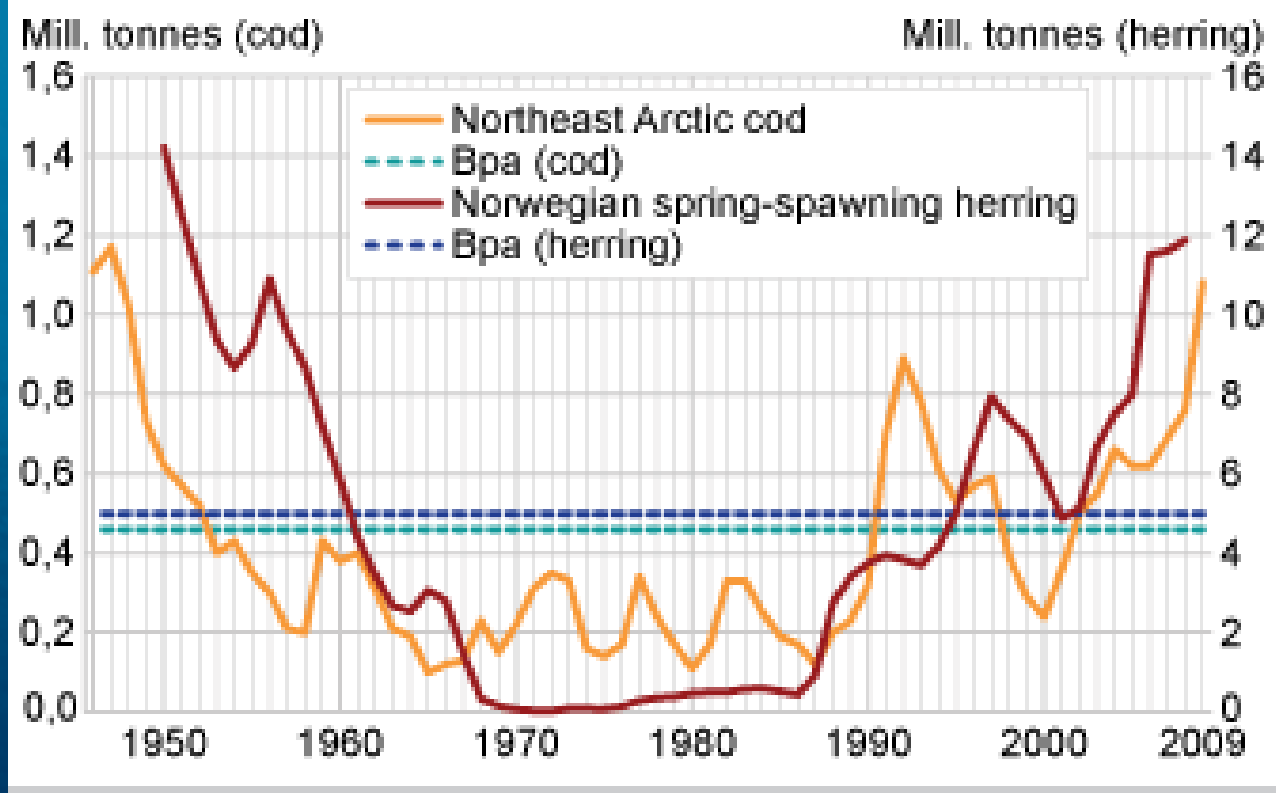


NEA cod 8 yr old, winter



Stock abundance

Size of spawning stock of Northeast Arctic cod and Norwegian spring-spawning herring, compared with the precautionary reference points (Bpa). 1946-2009. Million tonnes



Source: Institute of Marine Research and ICES.

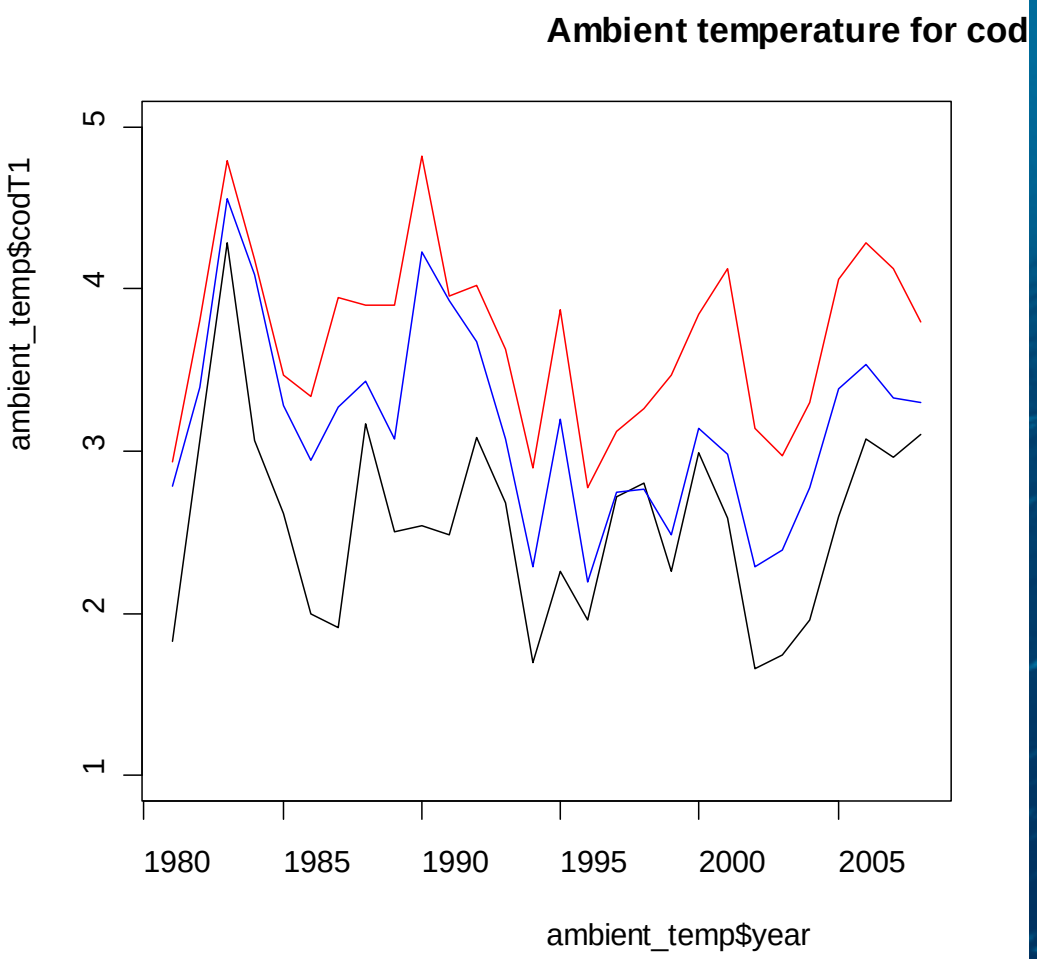
Ambient temperature

Based on bottom temperatures in winter

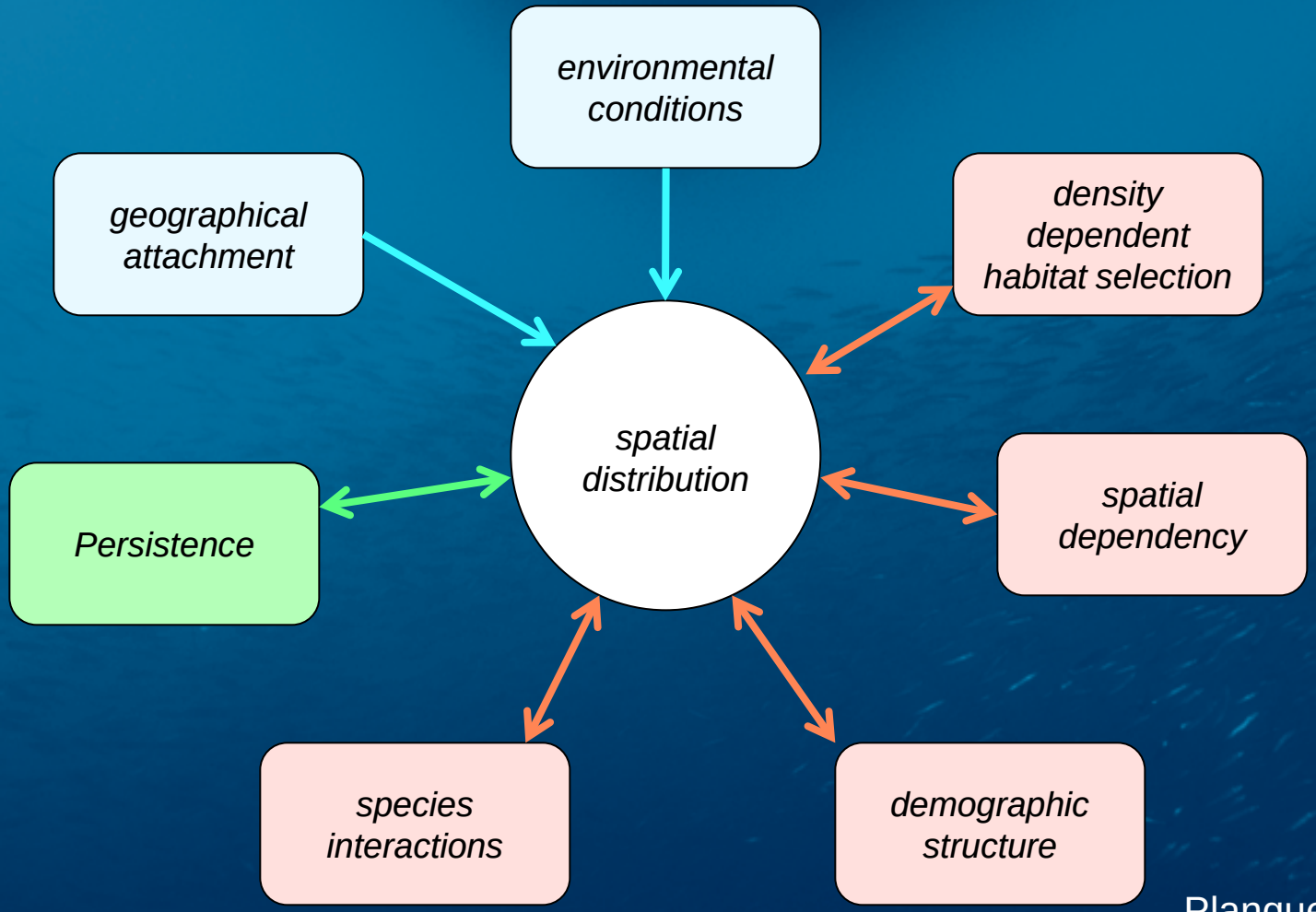
1 yr old, winter

4 yr old, winter

8 yr old, winter



Factors influencing geographical distribution

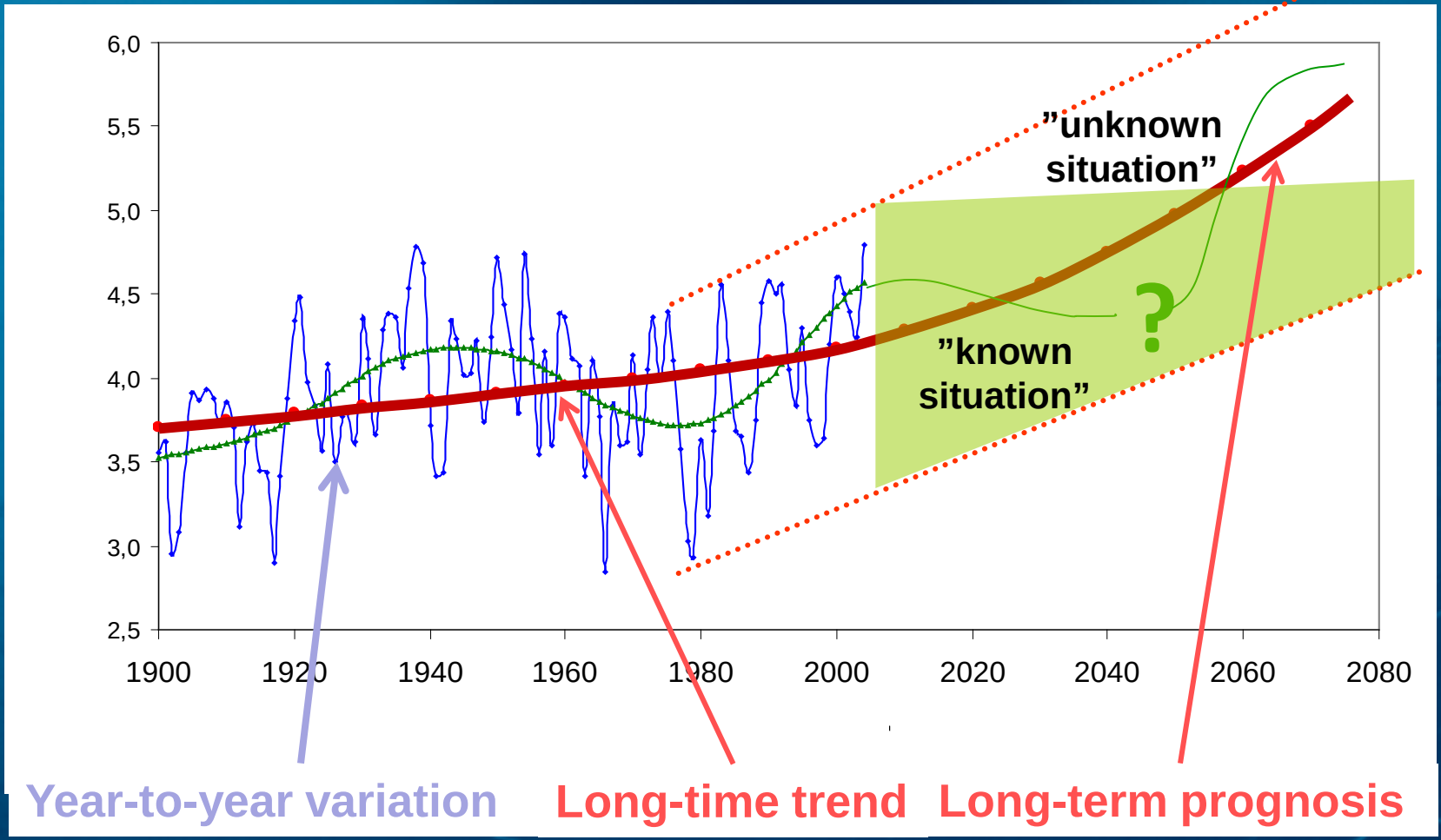


Planque et al. 2010

Conclusions

- Cod does not show signs of moving out of Norwegian exclusive economic zone - - - yet
- The period 1980-2010 is short in a global climate perspective
  - Study effects of climate variation
- Abundance is important for area of occupancy of a fish stock
- Important fish stocks for at least 1000 years
  - “Always” present even if climate varies?

Temperature in the Kola hydrographic section



“Prediction is very difficult, especially of the future”

Niels Bohr, Danish physicist (1885 - 1962)