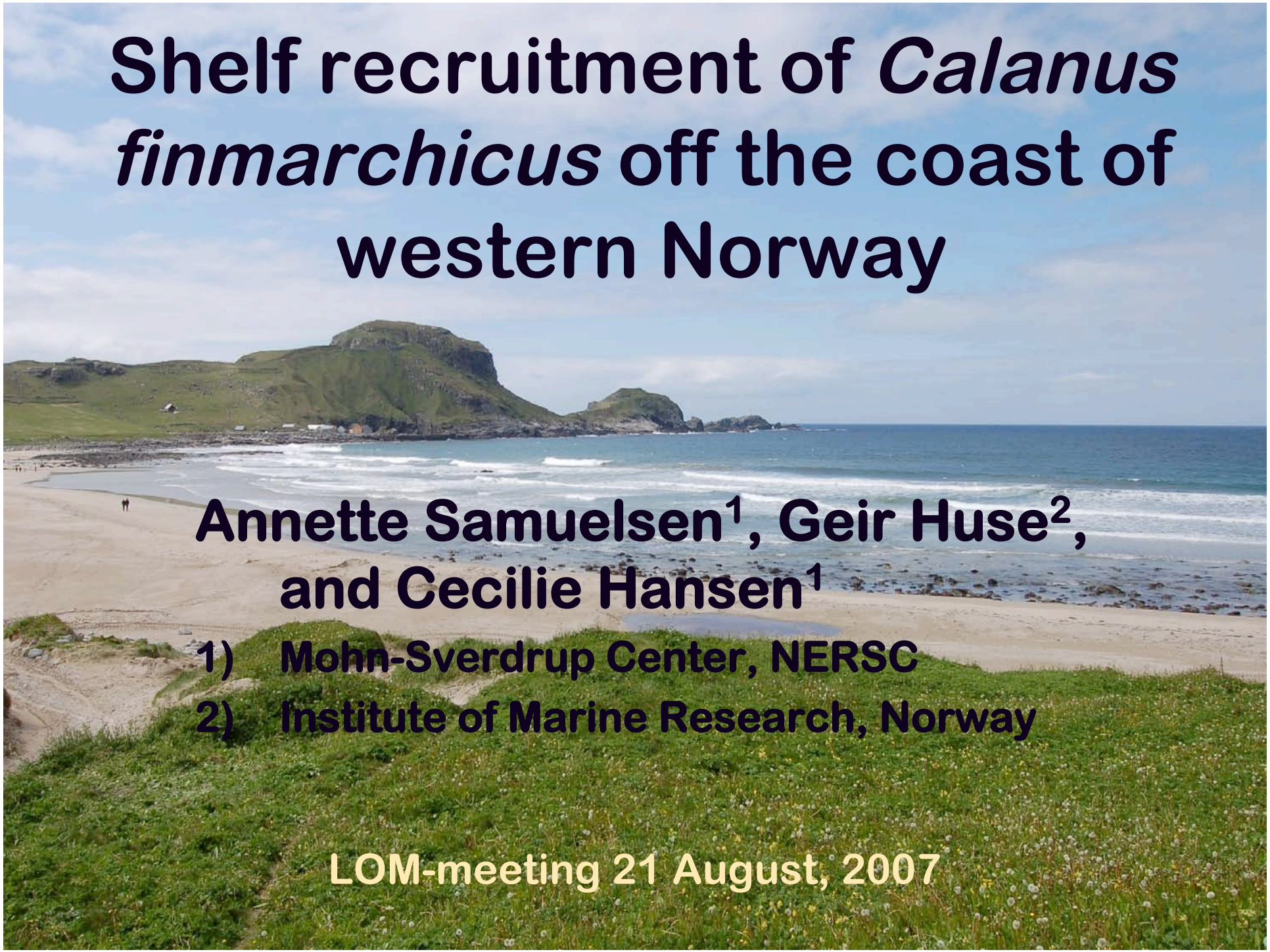

Shelf recruitment of *Calanus finmarchicus* off the coast of western Norway

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1) Mohn-Sverdrup Center, NERSC
2) Institute of Marine Research, Norway

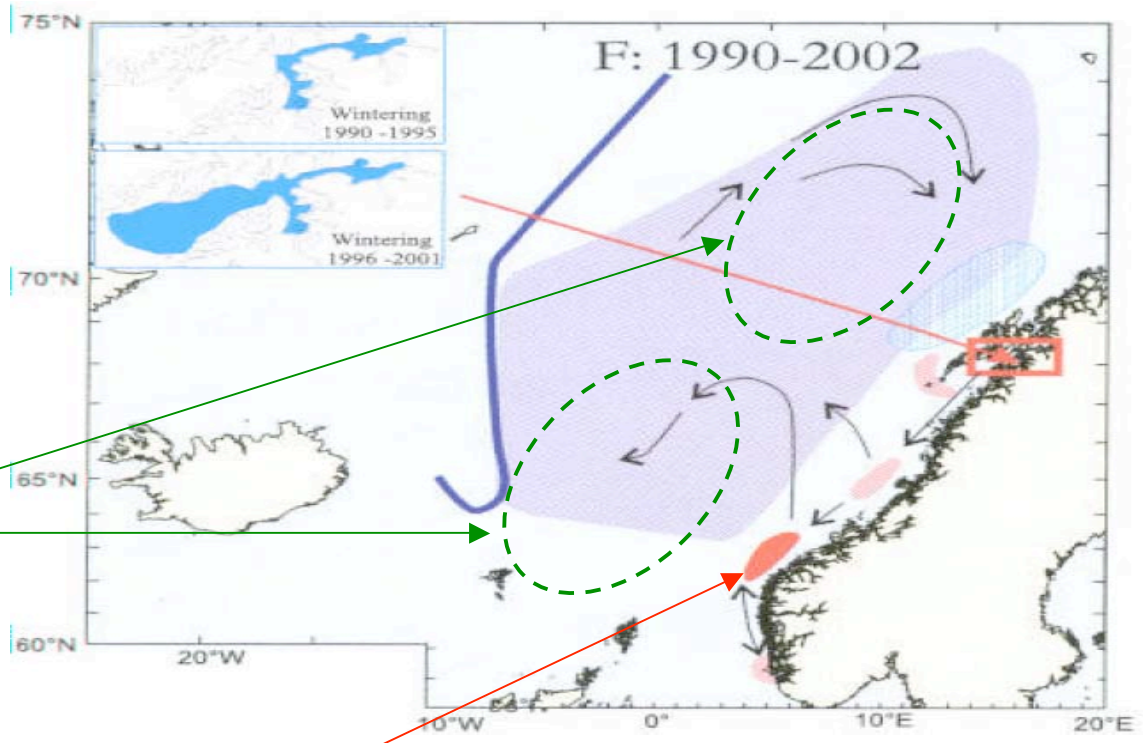
LOM-meeting 21 August, 2007

Calanus finmarchicus

- Key zooplankton species in the Norwegian Sea.
- Important food source for many species of fish.
- Life cycle of about a year.
- Survive winter by over-wintering at depth.
- Cannot over-winter on the shelf because of predators.
- Horizontal distribution decided by currents, temperature, food availability, and predators.
- 13 developmental stages.

Objective: To investigate the influence of wake-up day, food availability, and physical transport on the shelf recruitment of *C. finmarchicus*.

Why study shelf recruitment?



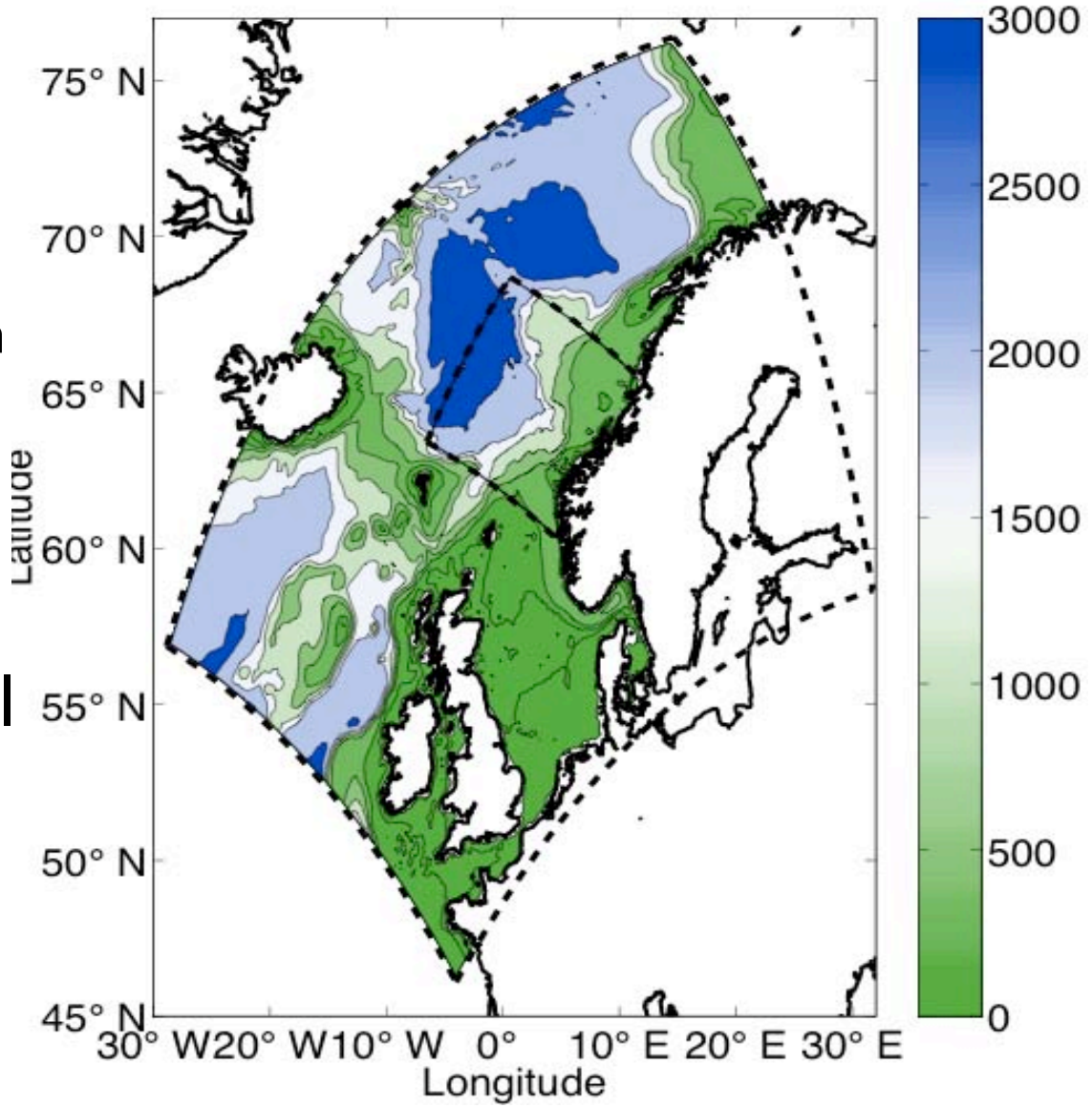
C. finmarchicus over-wintering areas

Main spawning area for herring

Figure from: The Norwegian Sea Ecosystem, Hein Rune Skjoldal (ed.)

Model setup - physical

- HYCOM
- Nested model:
  - Atlantic (30-140 km)
  - North Sea /Norwegian (15 km)
  - Norwegian Coast (4.5 km)
- 23 vertical layers
- The Atlantic model was spun up from 1958.



Calanus model

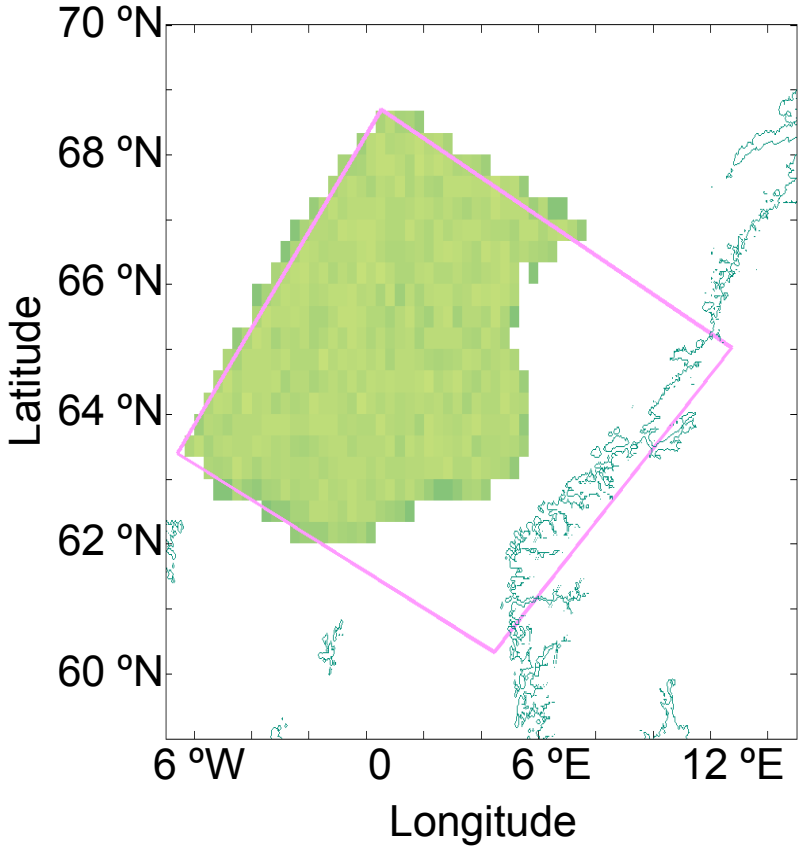
- Particle tracking code.
- Individual based model for *C. finmarchicus* developed by Geir Huse.
- Mortality from mesopelagic and tactile predators.
  - Predation pressure changes from day to night, but not seasonally.
- Fat reserve for egg production before the spring bloom.
- Phytoplankton density taken from NORWECOM run in the same model setup.

Calanus model

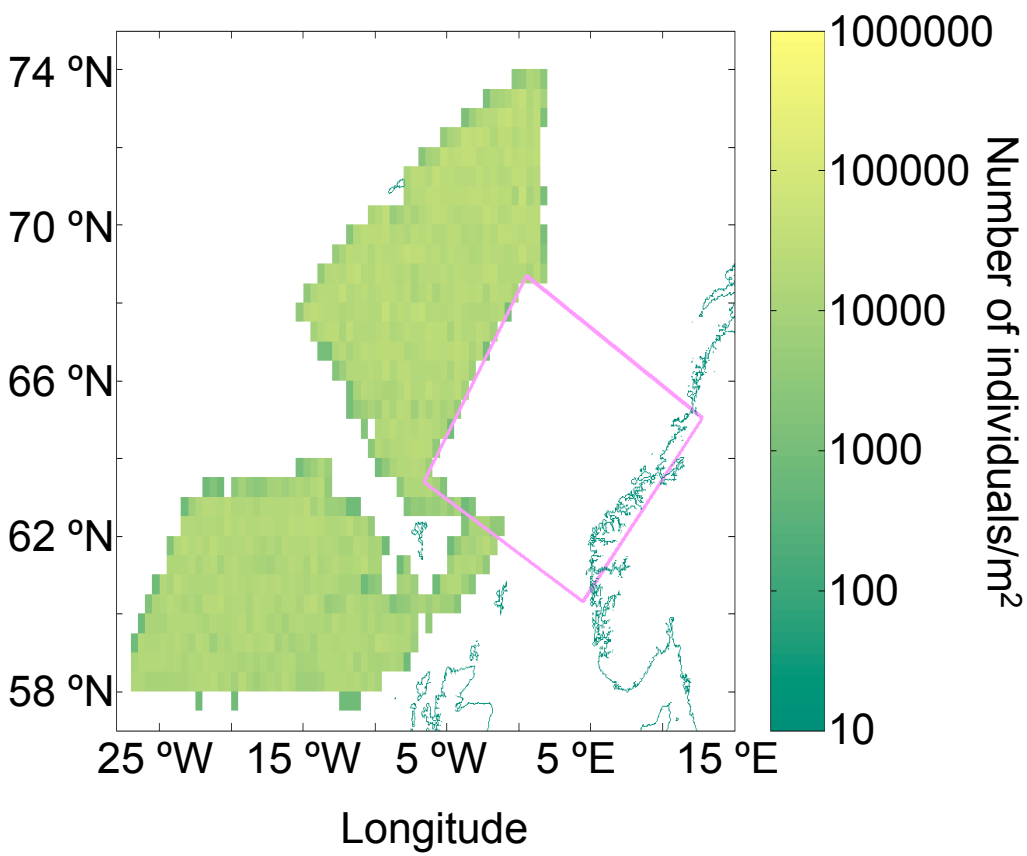
- Behavior:
  - Wake-up day.
  - Overwintering depth.
  - Diurnal migration (day depth is size-dependent).

Initial Conditions

Inner model:



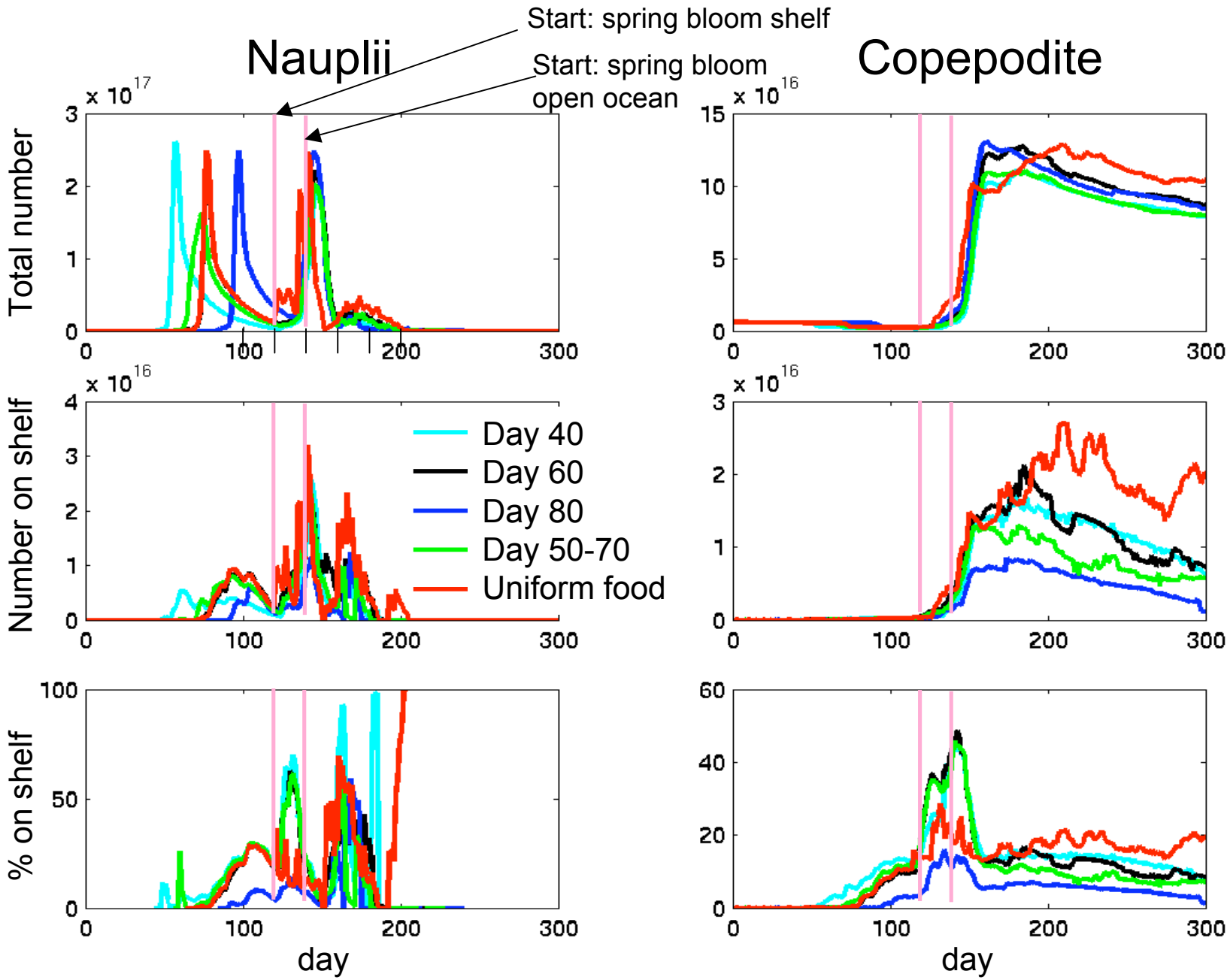
Outer model:

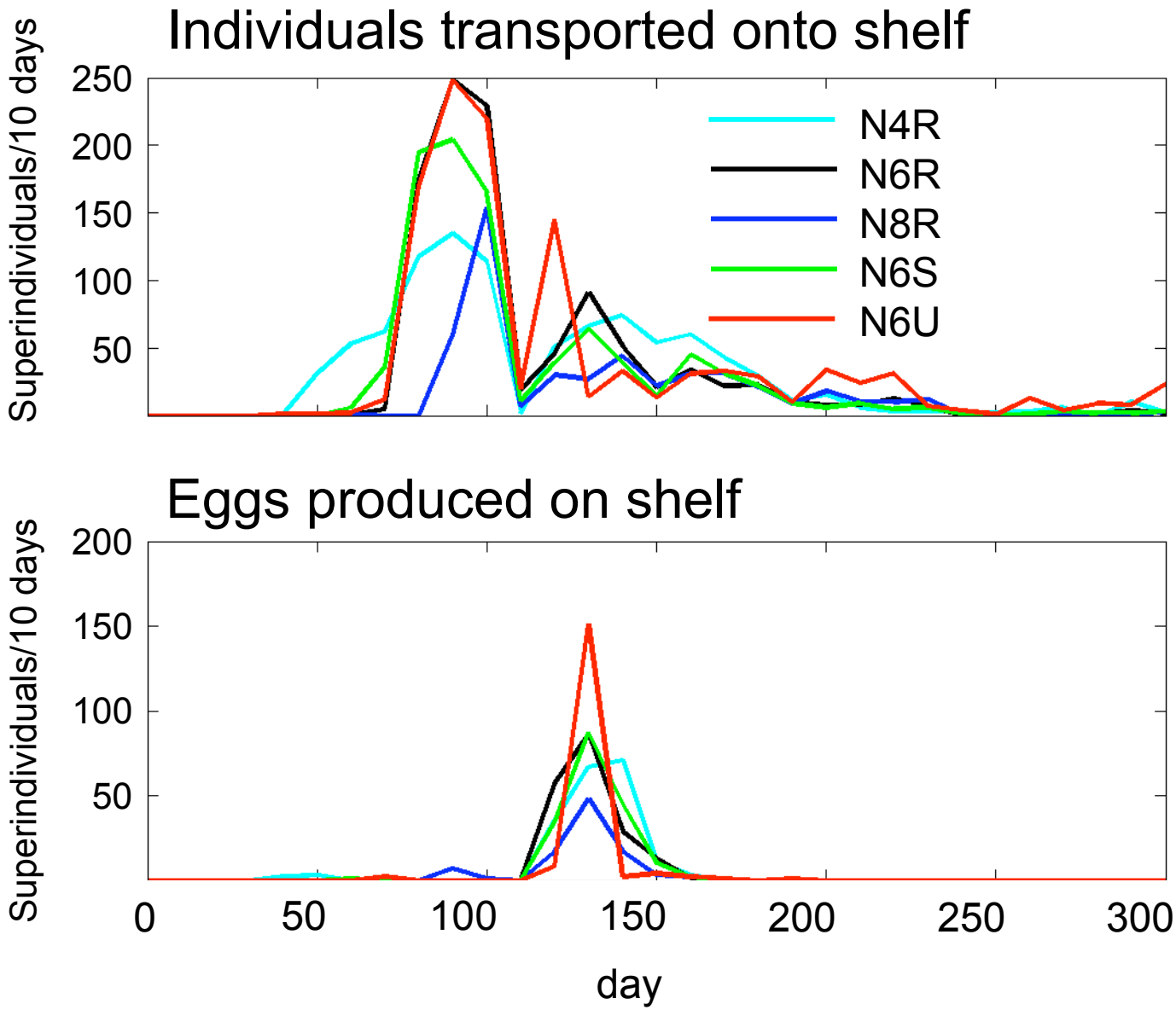


- Individuals were initialized between 880 and 680 meters.

Numerical experiments: Year: 1995

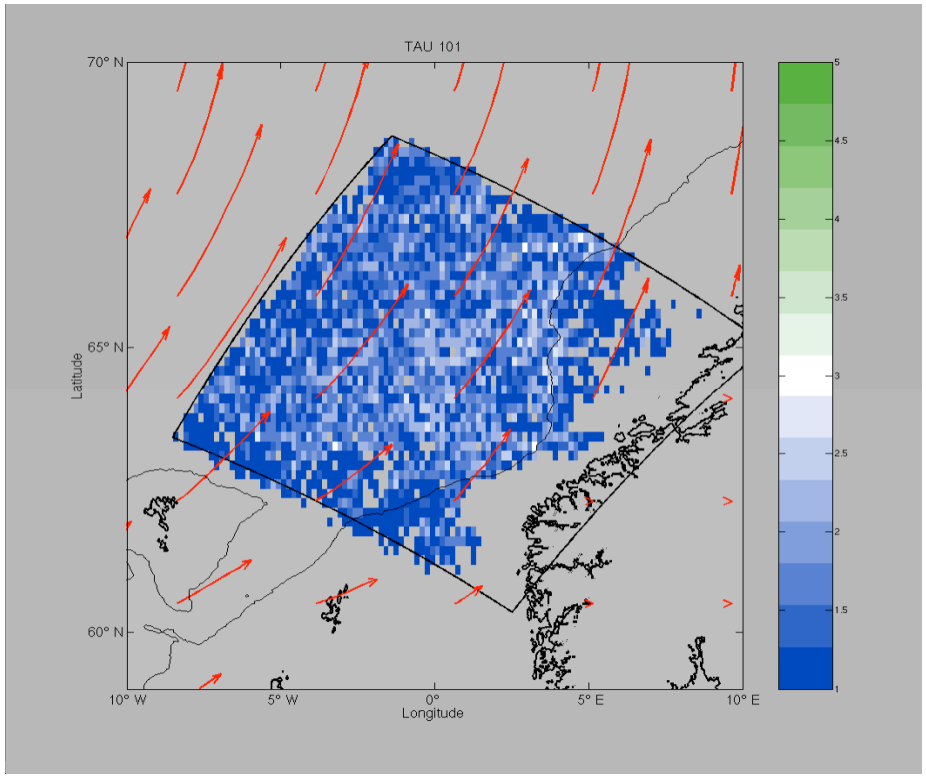
RUN	Wake-up day	Realistic food	Uniform food
N4R	40	x	
N6R	60	x	
N8R	80	x	
N6S	50-70	x	
N6U	60		x


Nauplii
Copepodite
Start: spring bloom shelf
Start: spring bloom
open ocean
Total number
Number on shelf
% on shelf
day
day
x 10^17
x 10^16
x 10^16
Day 40
Day 60
Day 80
Day 50-70
Uniform food

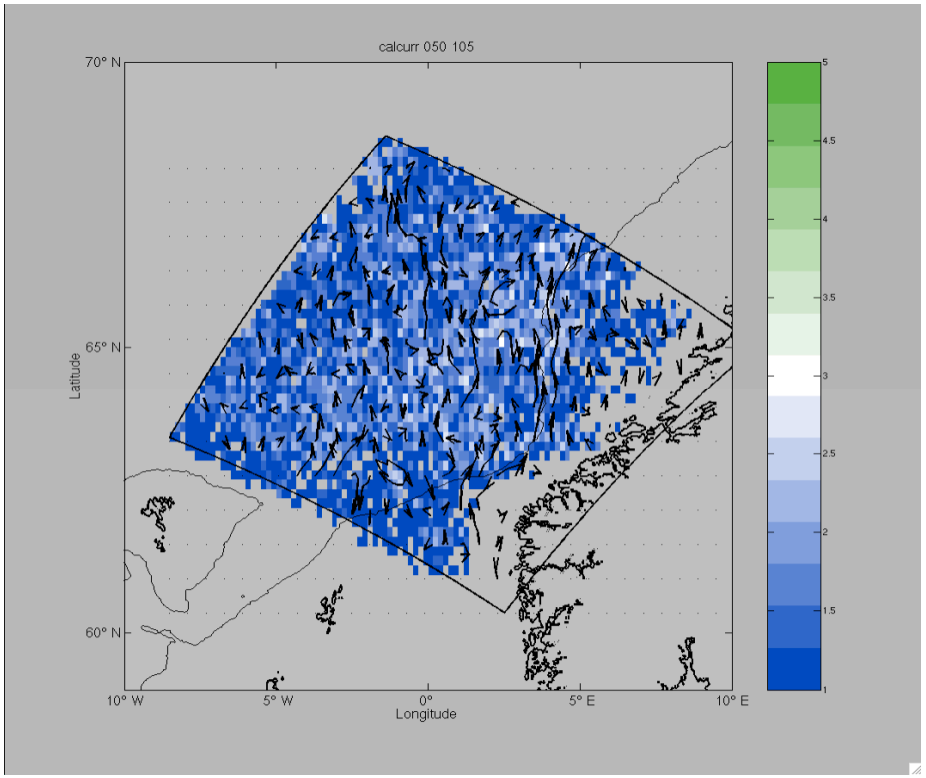


RUN	Wake-up day	Realistic food	Uniform food
N4R	40	x	
N6R	60	x	
N8R	80	x	
N6S	50-70	x	
N6U	60		x

Wind: day 101

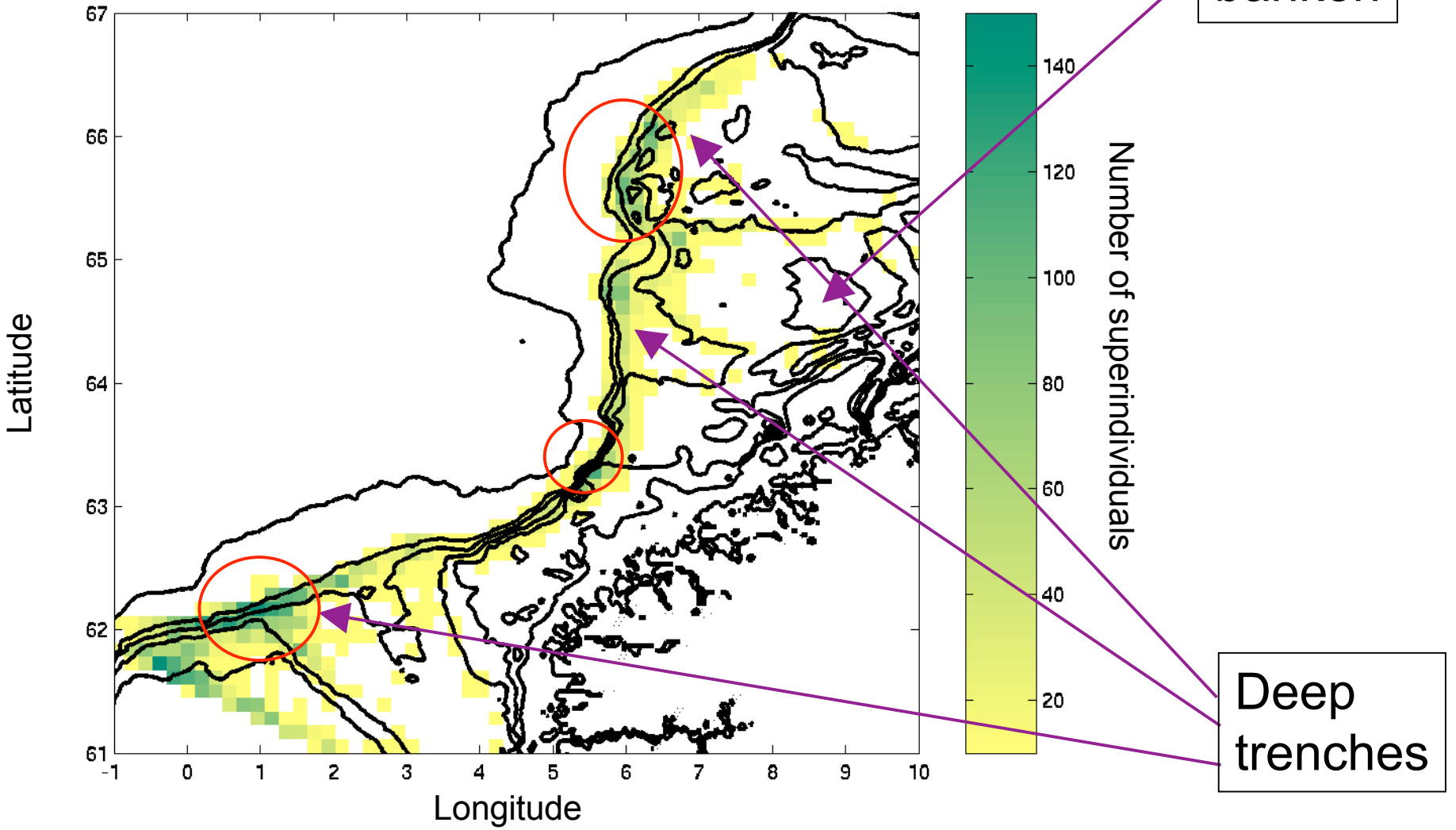


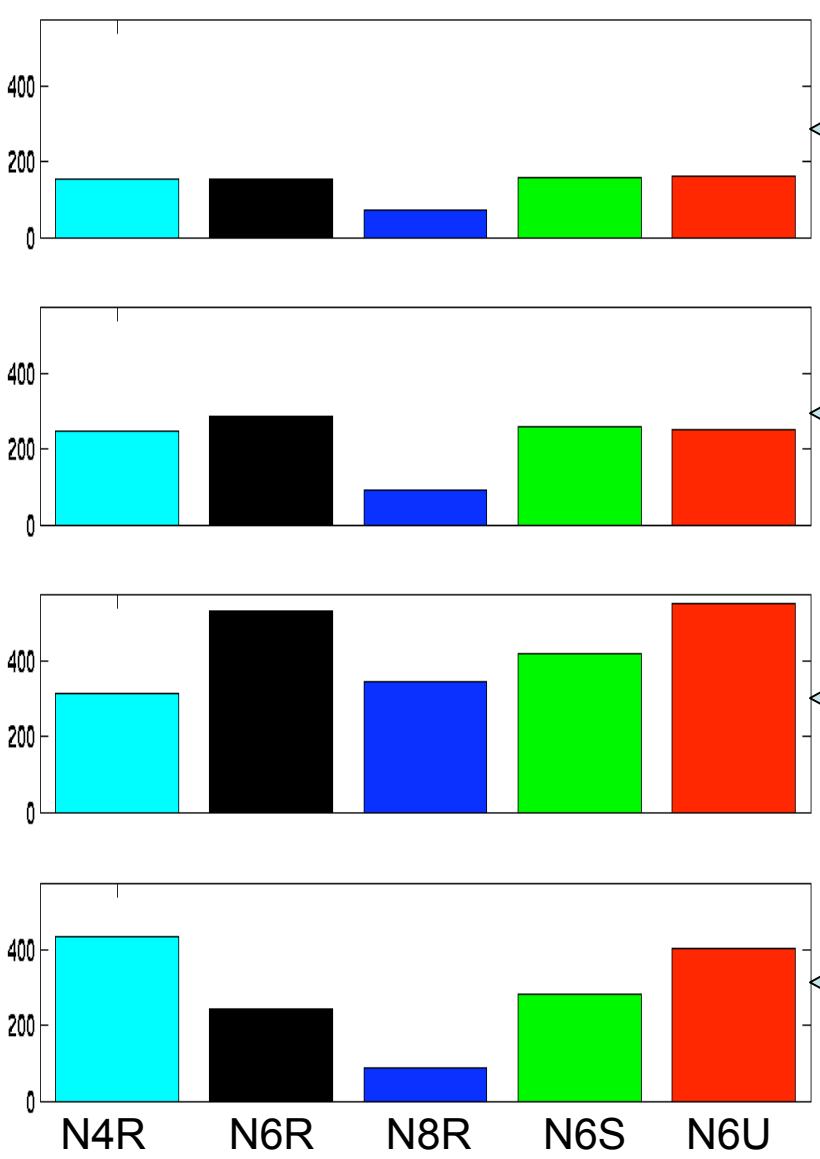
Currents: day 105



Concentration of *C. finmarchicus* (superindividuals/m^2)

Entry positions





Number of over-wintering adult super-individuals transported onto shelf

Number of super-individuals produced on the shelf

Number of super-individuals produced in spring off-shelf and transported onto shelf

Number of super-individuals transported onto shelf from outer model

RUN	Wake-up day	Realistic food	Uniform food
N4R	40	x	
N6R	60	x	
N8R	80	x	
N6S	50-70	x	
N6U	60		x

Conclusions

- The timing of ascent is important for the shelf recruitment of *C. finmarchicus.*
- The largest shelf recruitment is for wake-up day 60.
- The early spring bloom on the shelf leads to a temporary larger shelf-population, but has little long term effect.

Conclusions

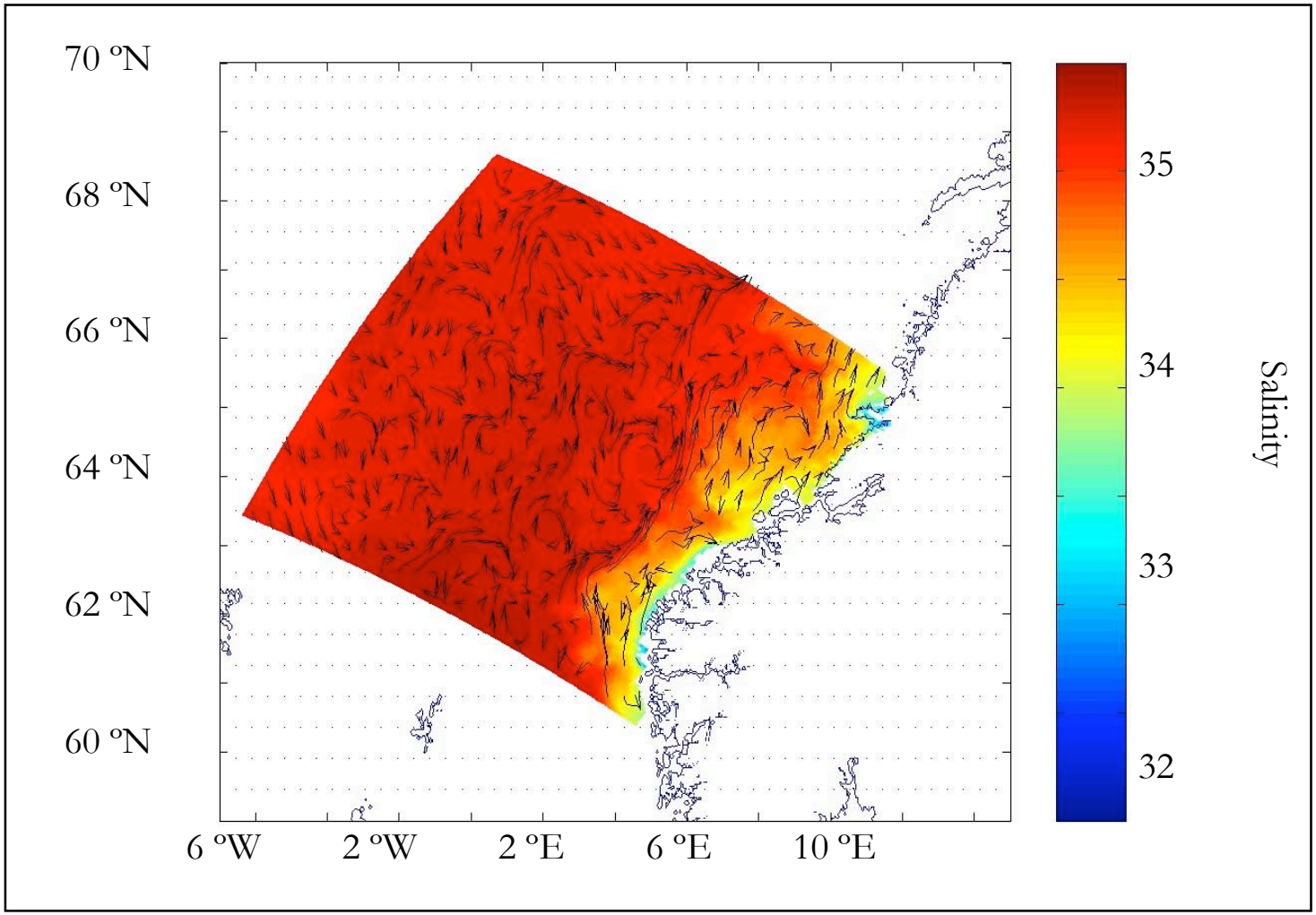
- Influx of individuals from the outside domain is much larger when the wake-up day is early.
  - Early spring bloom further south.
- Individuals that are produced off-shelf and transported onto the shelf is an important source for the summer shelf population.
- Entry positions are connected to shelf topography.
- Onshore transport is connected with passing of low pressure systems.


Thank you! Questions?

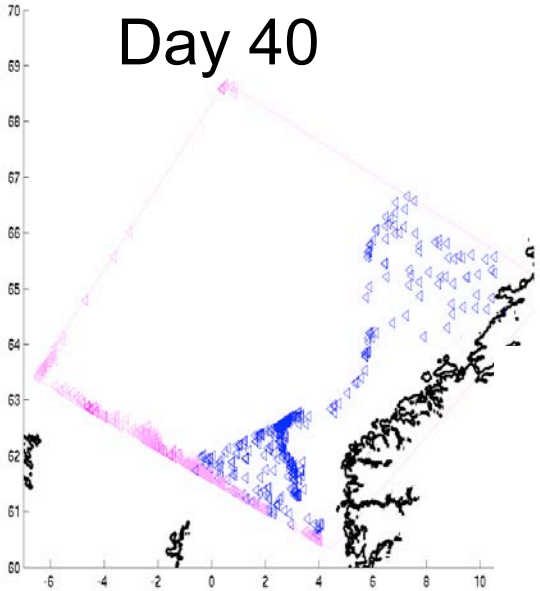
Future work

- Investigate the influence of the timing of spring bloom/ascent on the recruitment.
- Model validation.
- Compare different years.
- Fjord populations?

Model setup - physical

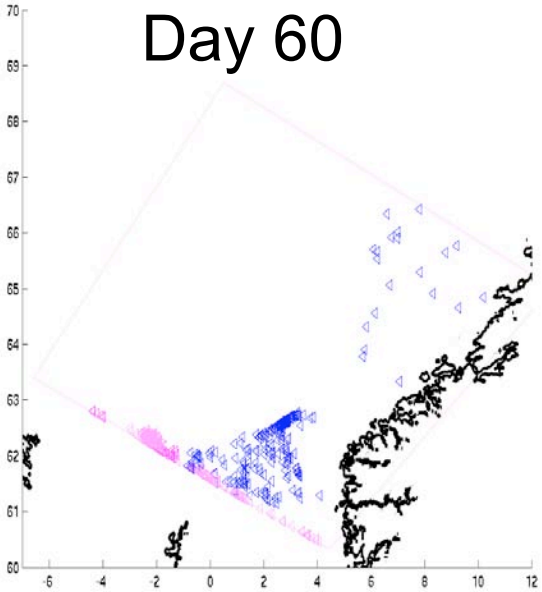


Day 40

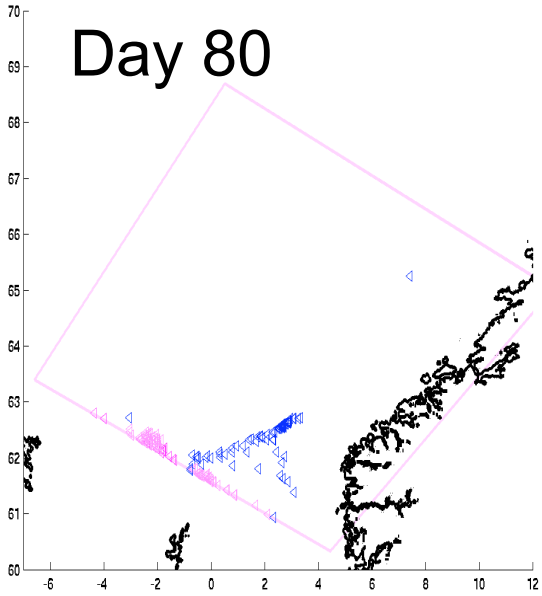


Shelf recruitment from outside the model domain and its variation with wake-up day

Day 60



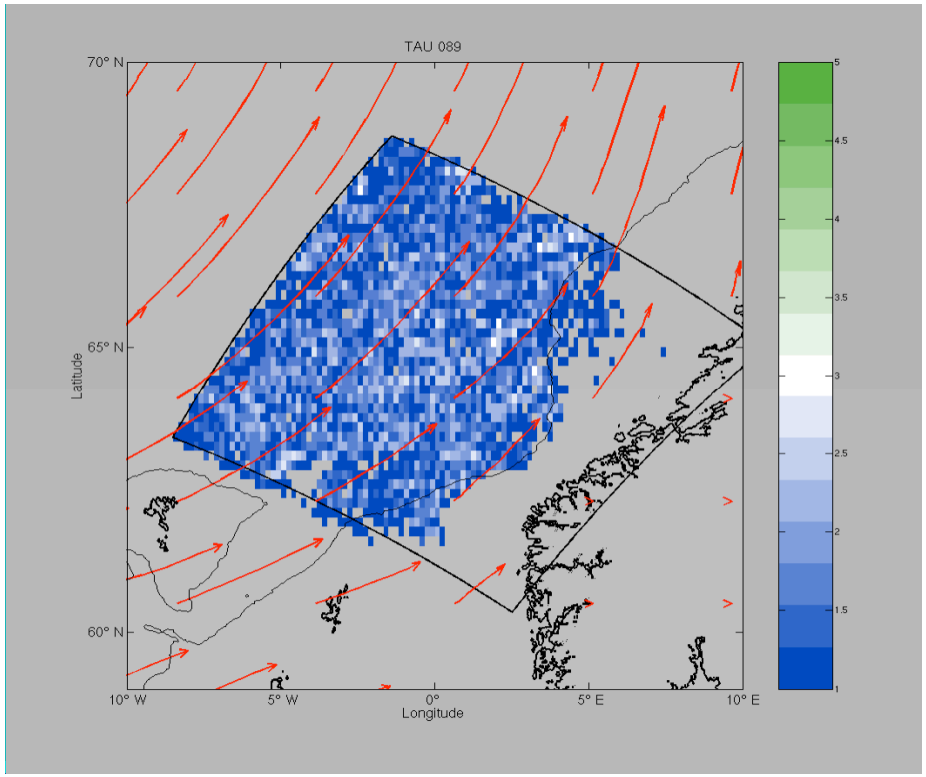
Day 80



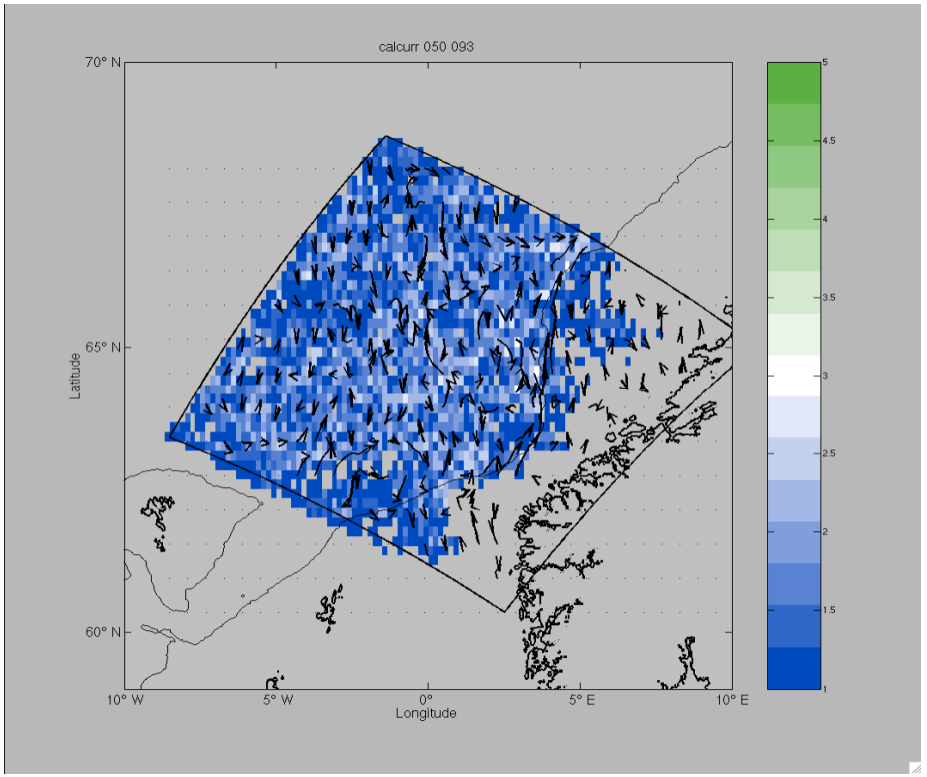
entry position

end position

Wind: day 89

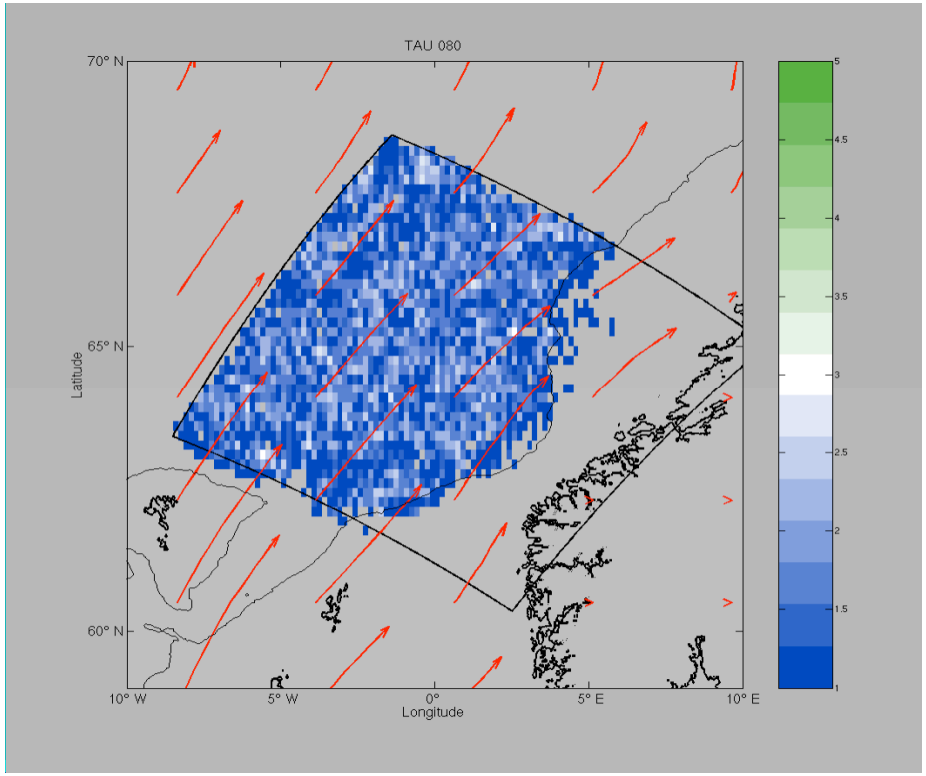


Currents: day 93

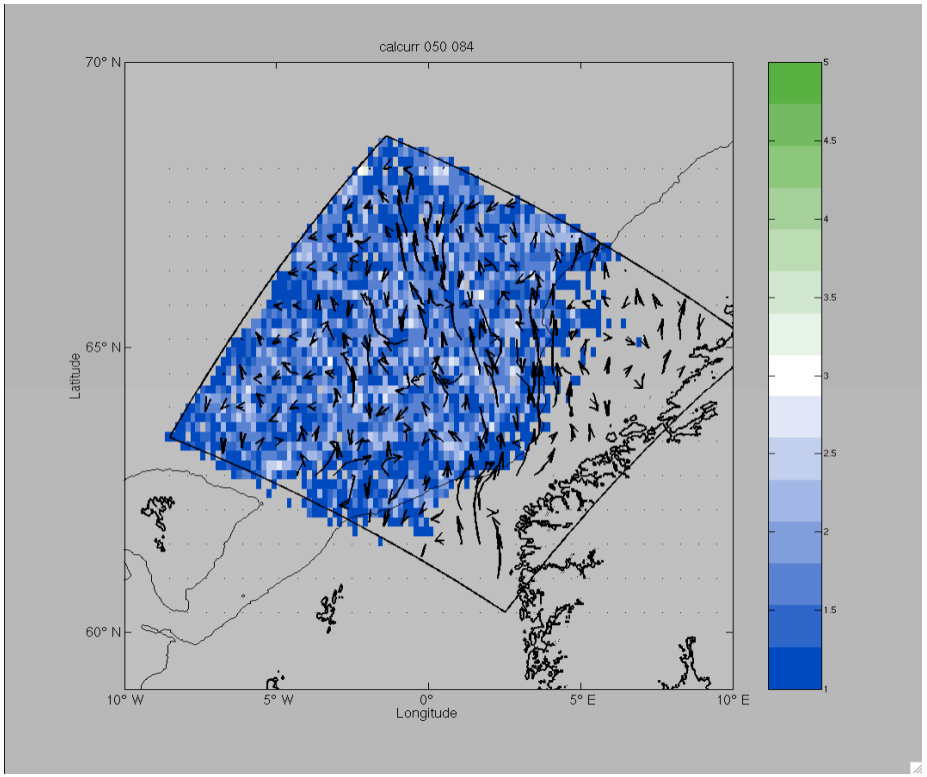


Concentration of *C. finmarchicus* (superindividuals/m^2)

Wind: day 80

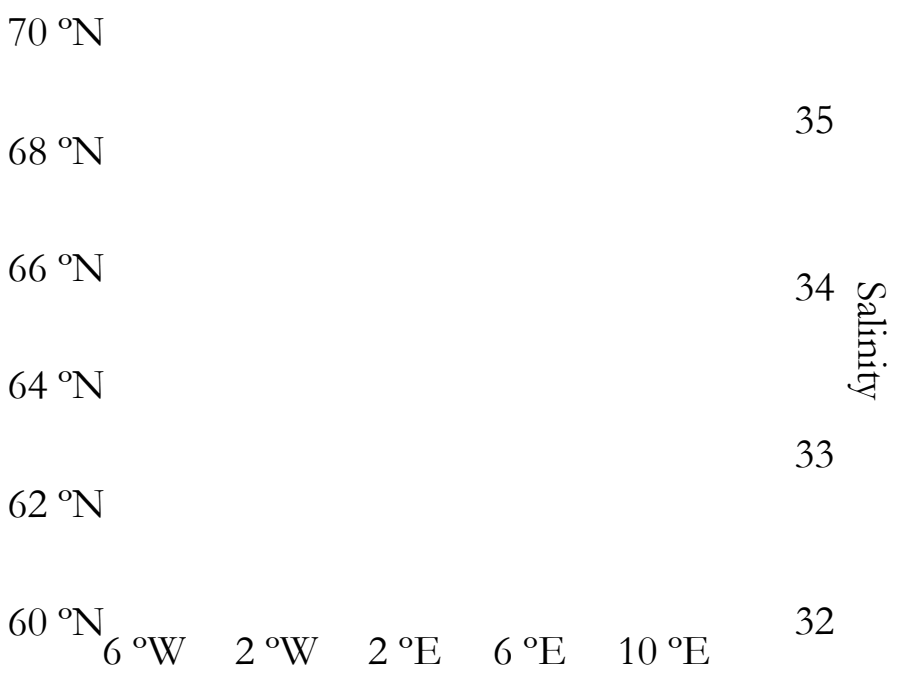


Currents: day 84

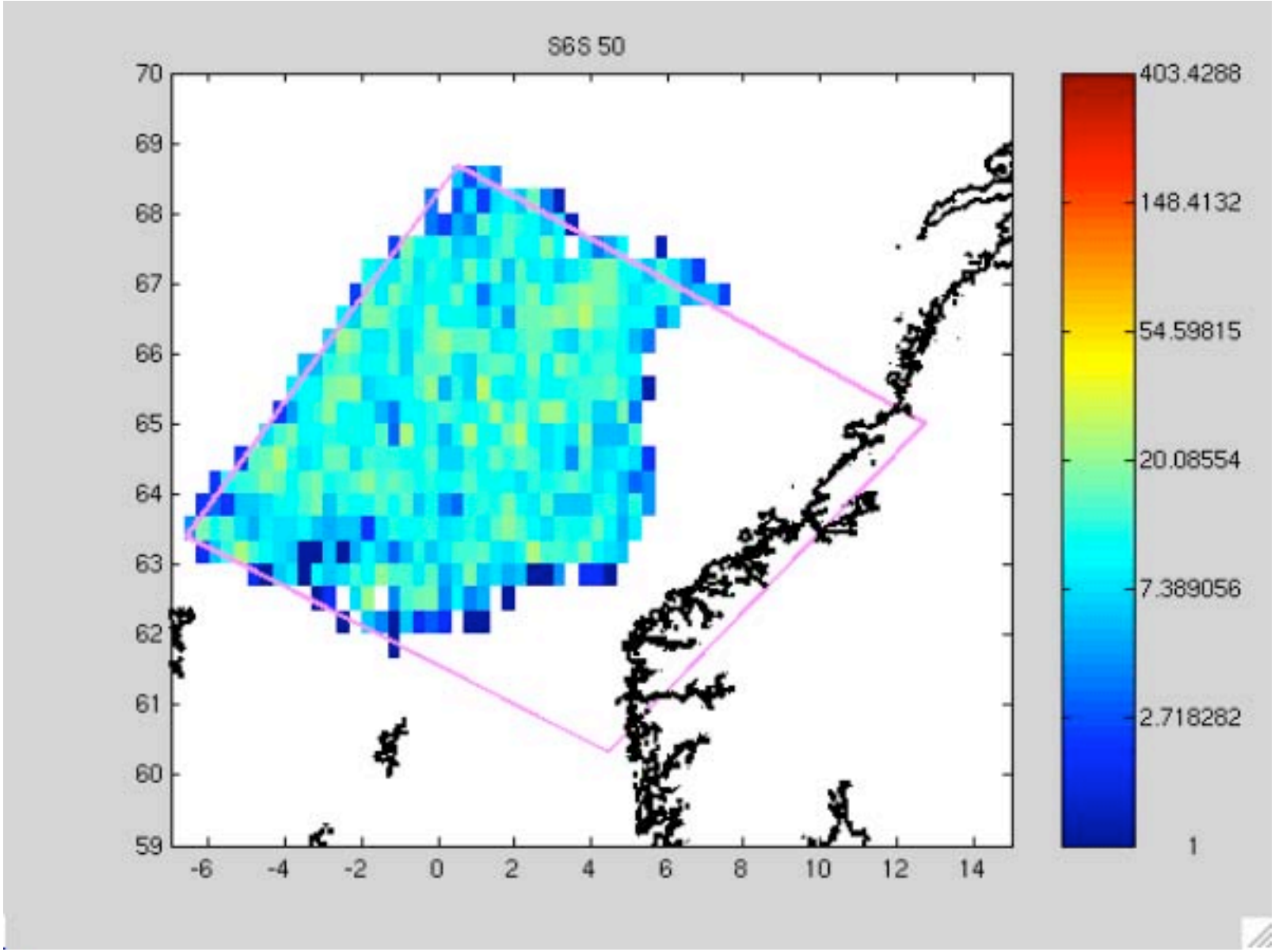


Concentration of *C. finmarchicus* (superindividuals/m^2)

Problems

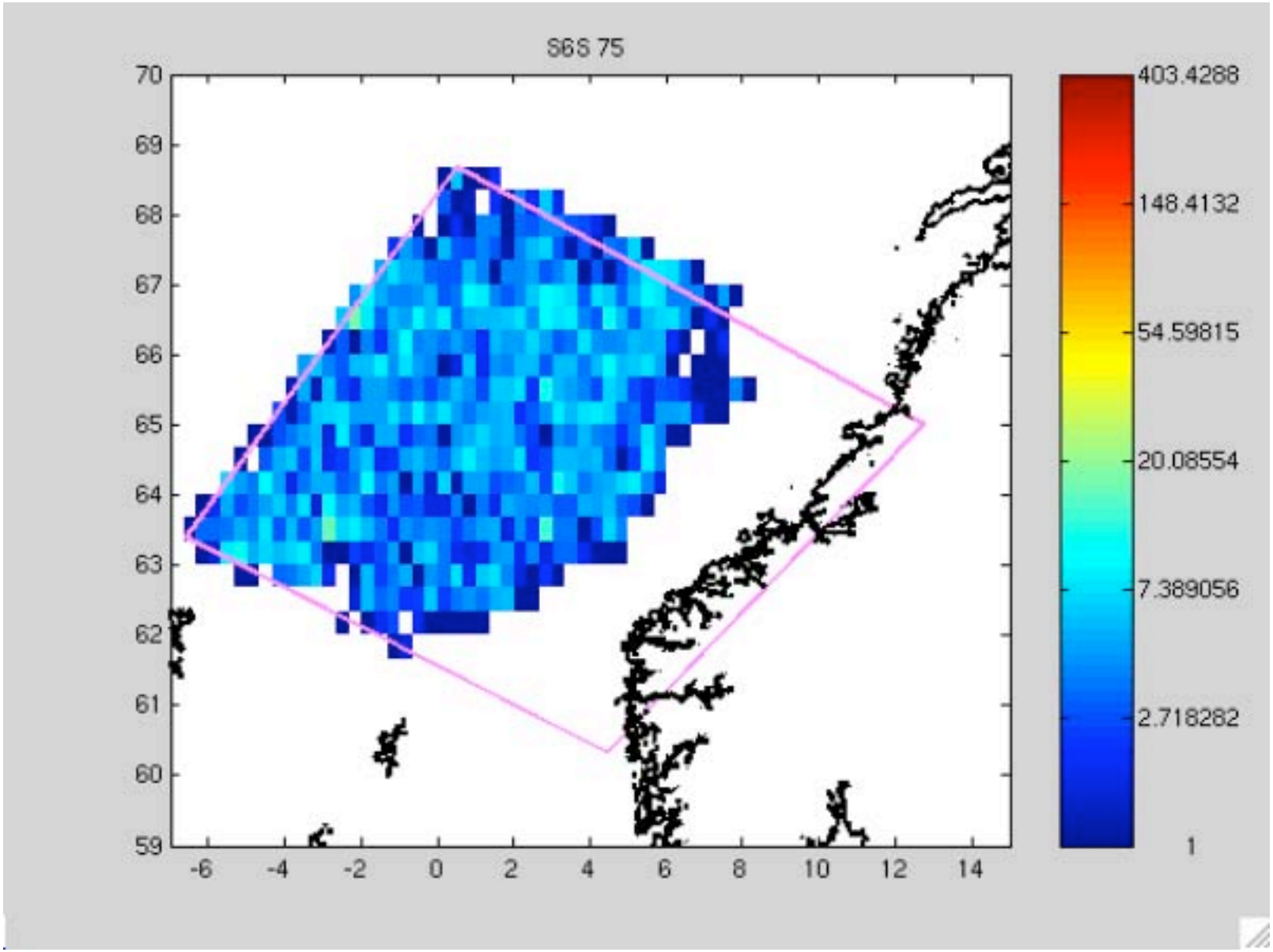

70 ºN
68 ºN
66 ºN
64 ºN
62 ºN
60 ºN
6 ºW
2 ºW
2 ºE
6 ºE
10 ºE
35
34
33
32
Salinity

Before ascent:



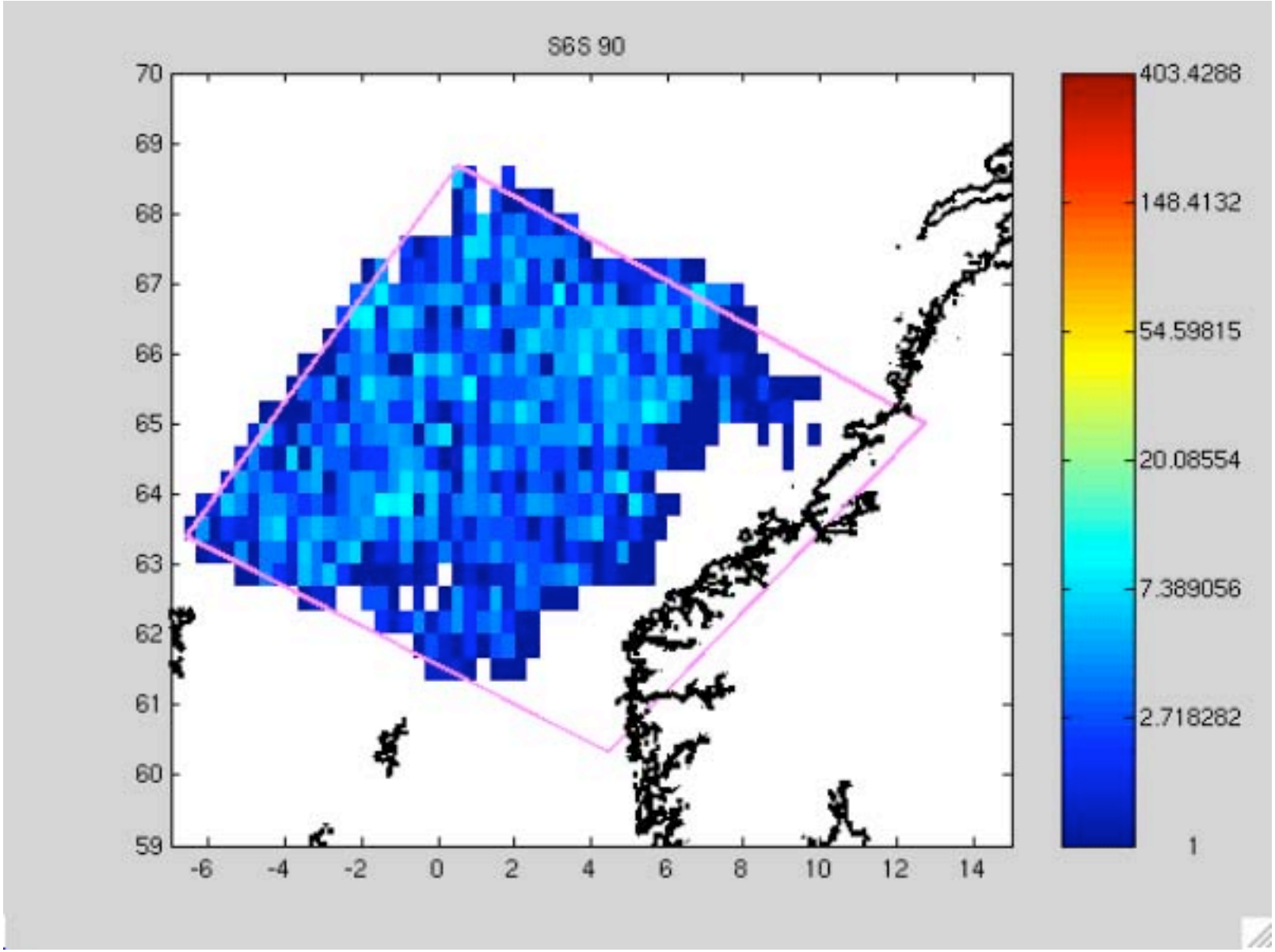
C. finmarchicus biomass (gC/m^2)

Upon reaching the surface:



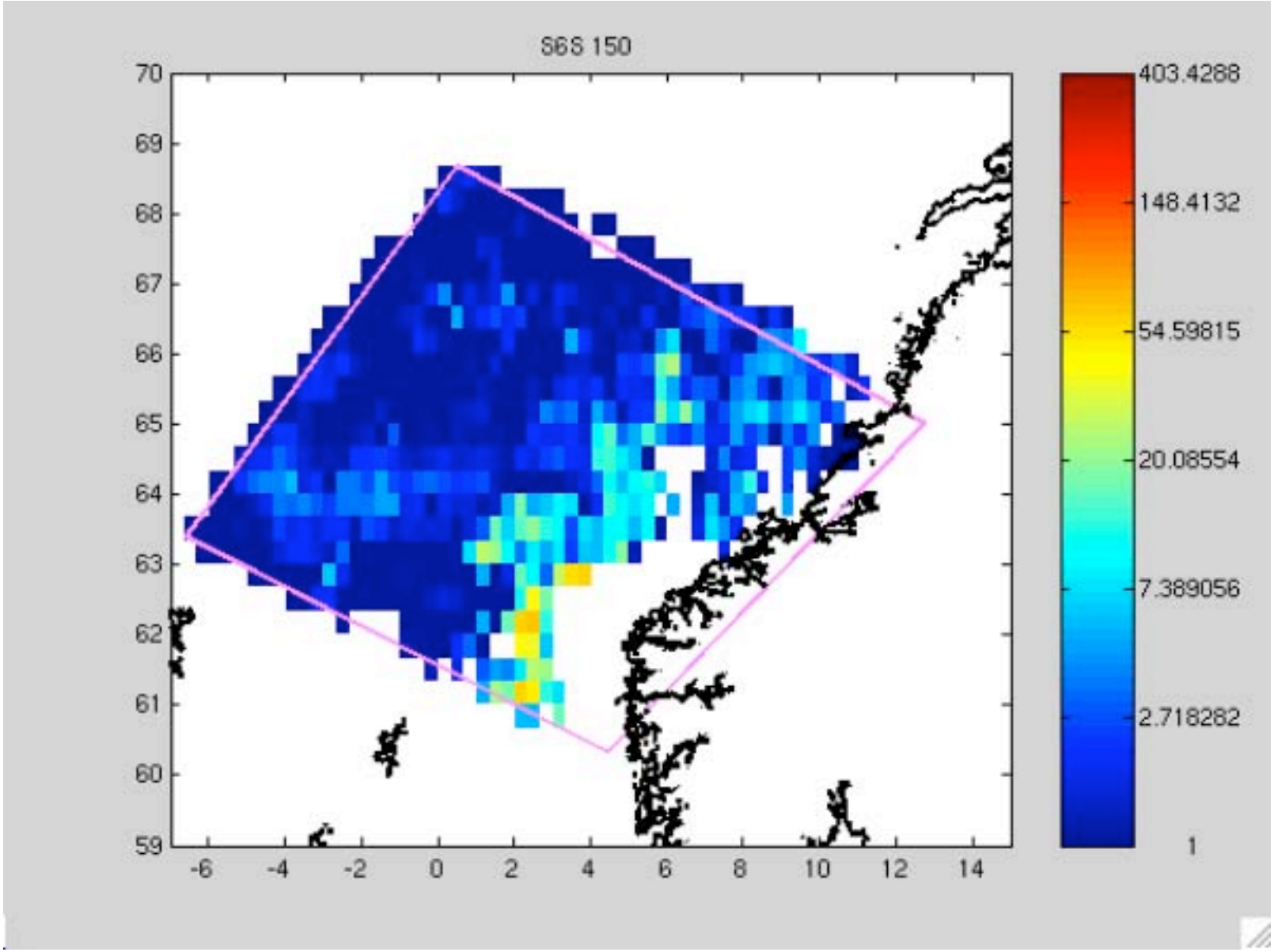
C. finmarchicus biomass (gC/m^2)

After a couple of weeks at the surface:



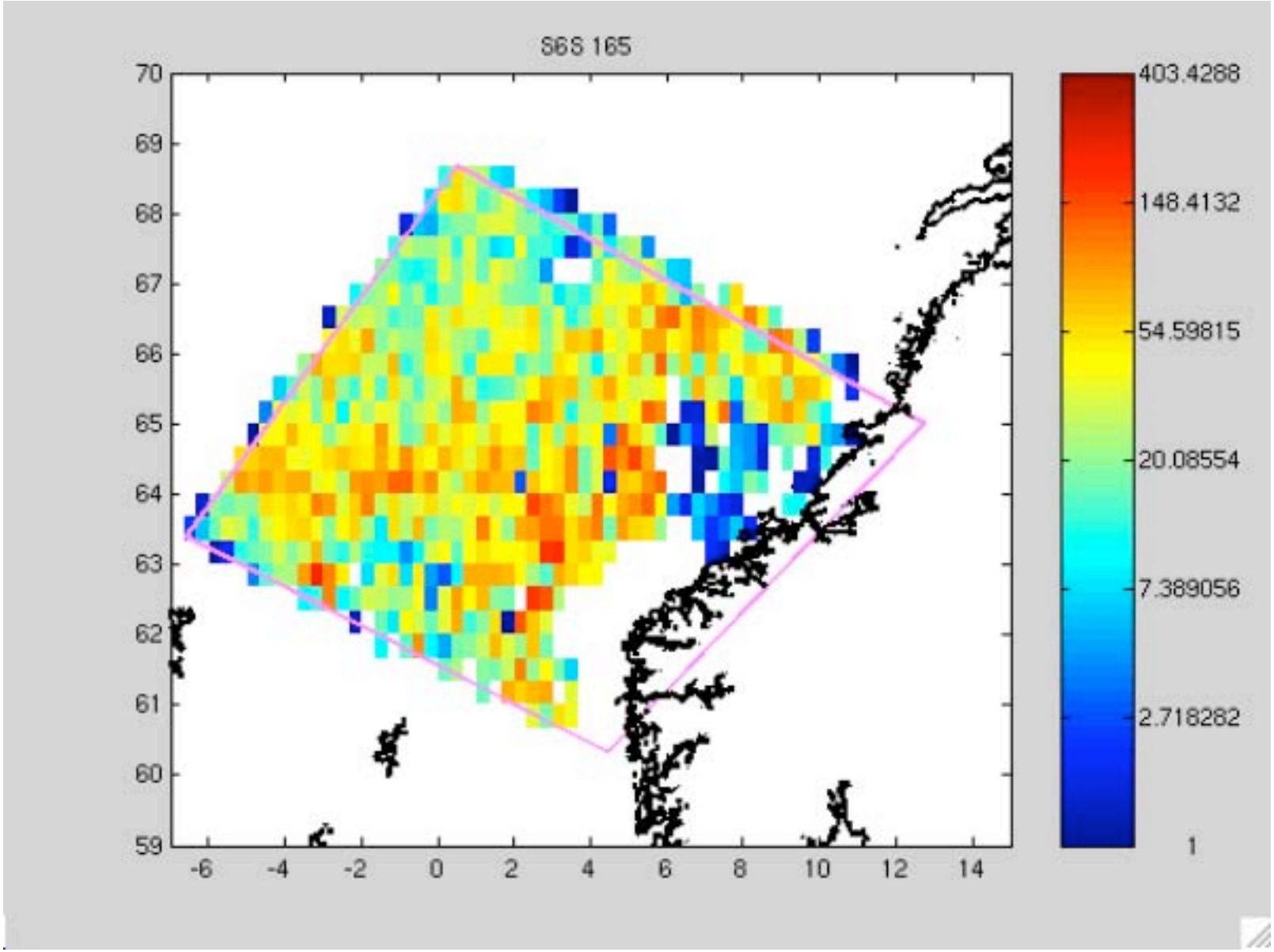
C. finmarchicus biomass (gC/m^2)

Biomass has started to increase along the coast:

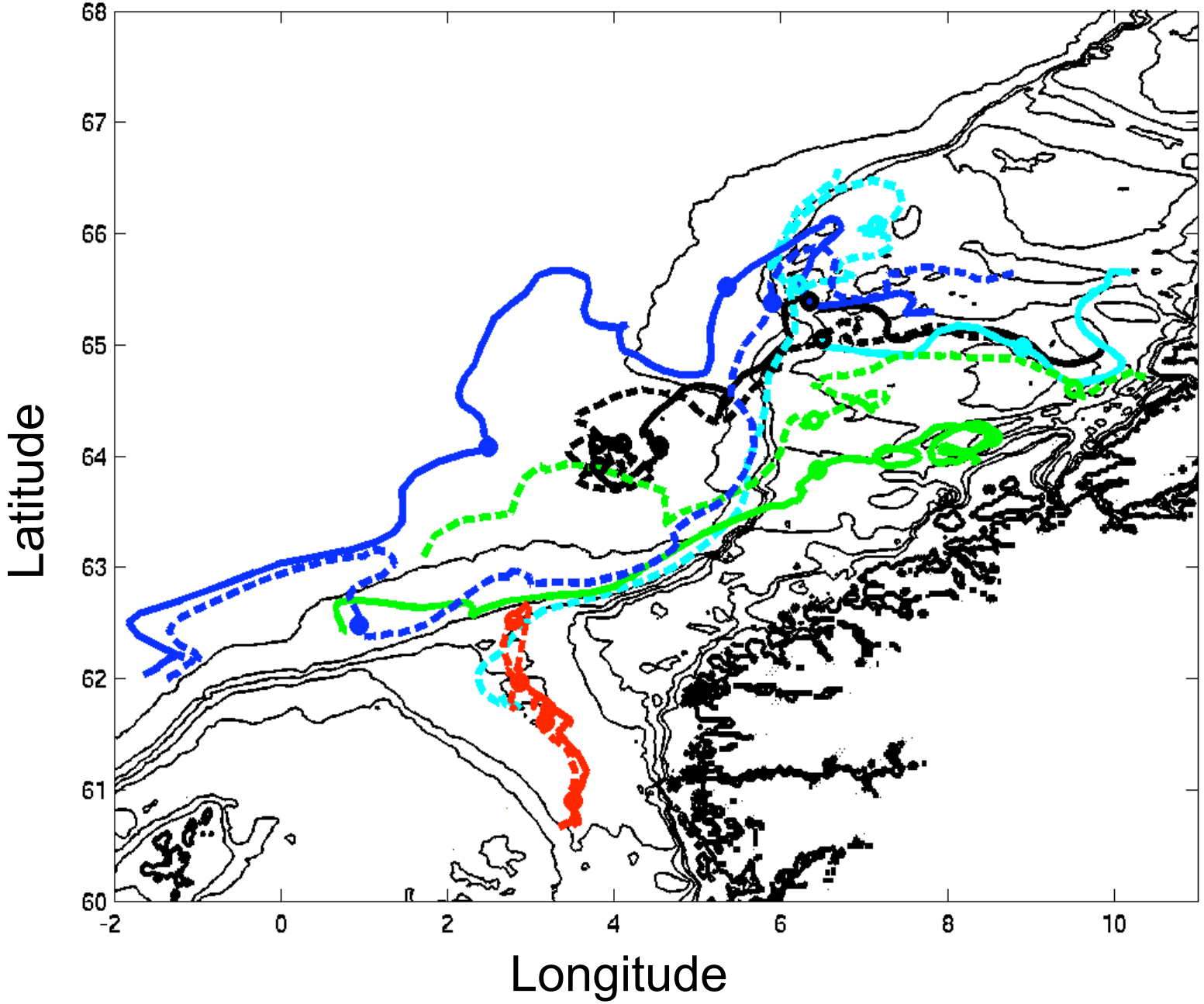


C. finmarchicus biomass (gC/m^2)

Biomass increases everywhere:



C. finmarchicus biomass (gC/m^2)


Latitude
Longitude
68
67
66
65
64
63
62
61
60
-2
0
2
4
6
8
10