Operational fish larval drift modelling - updates and validation

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...plus many more!

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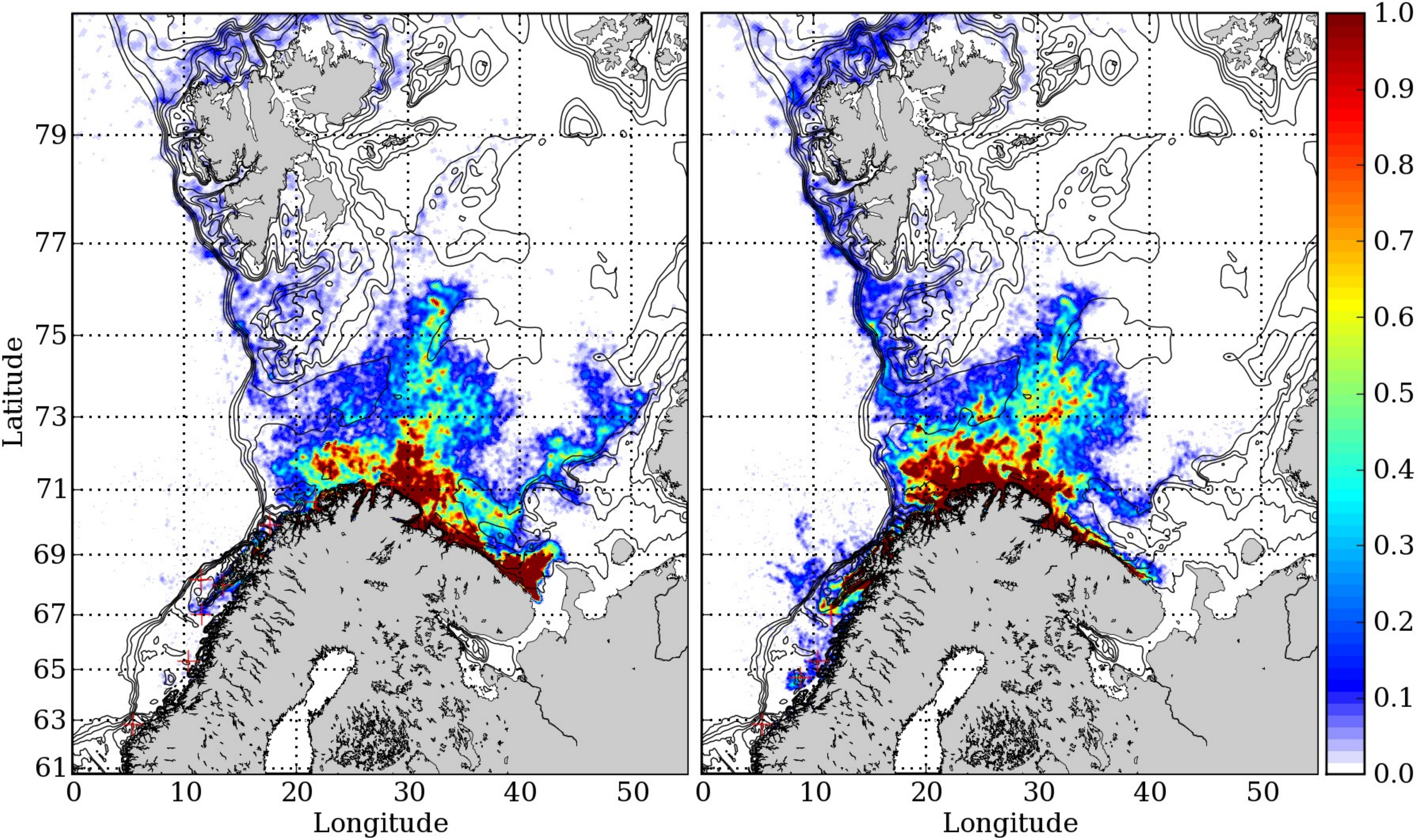
Why operational

- Fish eggs and larvae are vulnerable to oil spill accidents – what is the overlap between spawning products and spill?
- Adaptive sampling strategies for fish larval surveys.
- ...

Practical implementation

- Daily download operational ocean model forecast (Nordic Seas 4km) from met.no to IMR.
- Run offline larval drift simulation from historic (observed) spawning/hatching.
- Make plots and put results on a web site.

Cod and Herring early October



To do list (Geilo May 08)

- Improve the design of the web site
  - Now home made, get help from info dep.
- Give the web site a more prominent (and permanent) URL at www.imr.no
- Implement larval drift into operational model suite at met.no
  - 24/7 operational organization
  - More frequent updates of current forcing

Limitations and challenges

What is the procedure going from the ocean model forecast to the modelled abundance distributions of cod and herring?

- Sampling of daily mean ocean model forecast and interpolation to hourly time step of Lagrangian Advection and Diffusion Model.
  - Is spatial and temporal resolution a severe limitation?

Limitations and challenges

- Tides contribute to mixing in the ocean model and is the source of residual currents. However, they do not contribute to the dispersal of particles or tidal pumping through narrow channels.
    - Could tides be added to the daily mean velocities?
- Additional mixing is provided as random walk equivalent to 20m^2/s.
    - What is the correct value to use?
- Particles are advected by a 4'th order Runge Kutta advection scheme.

Vertical habitat selection

- Temperature is logged for each individual particle and utilized for temperature-dependent food-unlimited growth of cod (Folkvord 2005), while herring growth is simply a function of time and current weight. A simple weight - length relation gives length.
  - What implications do these simplifications have for larval drift?

Vertical habitat selection

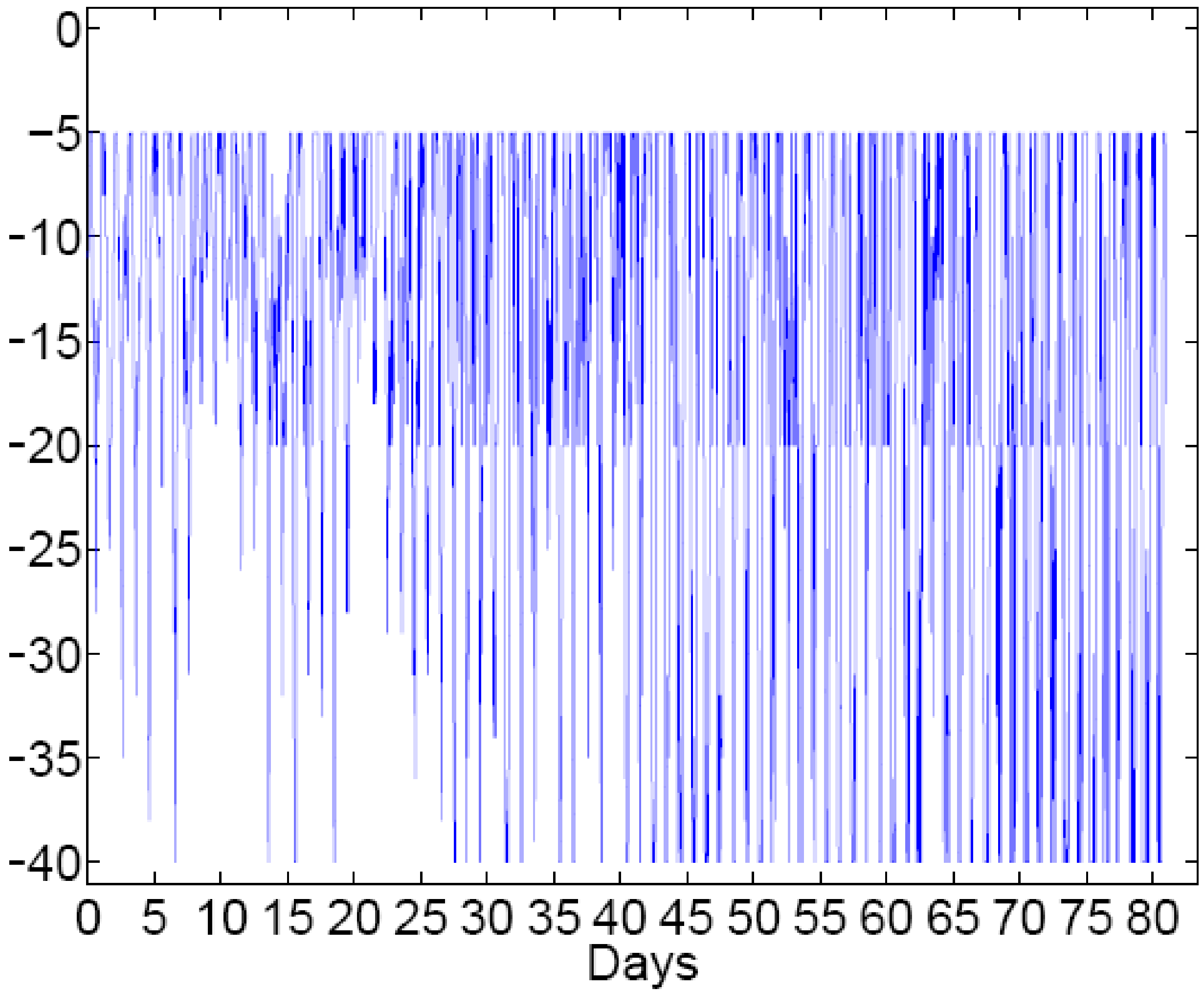
- Implemented vertical habitat selection is shaped by swimming capability and level of light. More realistically it should also be a function of the presence of prey and predators.

  - Based on a limited number of observations, we assume a diel migration between 5-40m.

	Day	Night
Cod	20 – 40	5 – 20
Herring	10 – 40	5 – 20

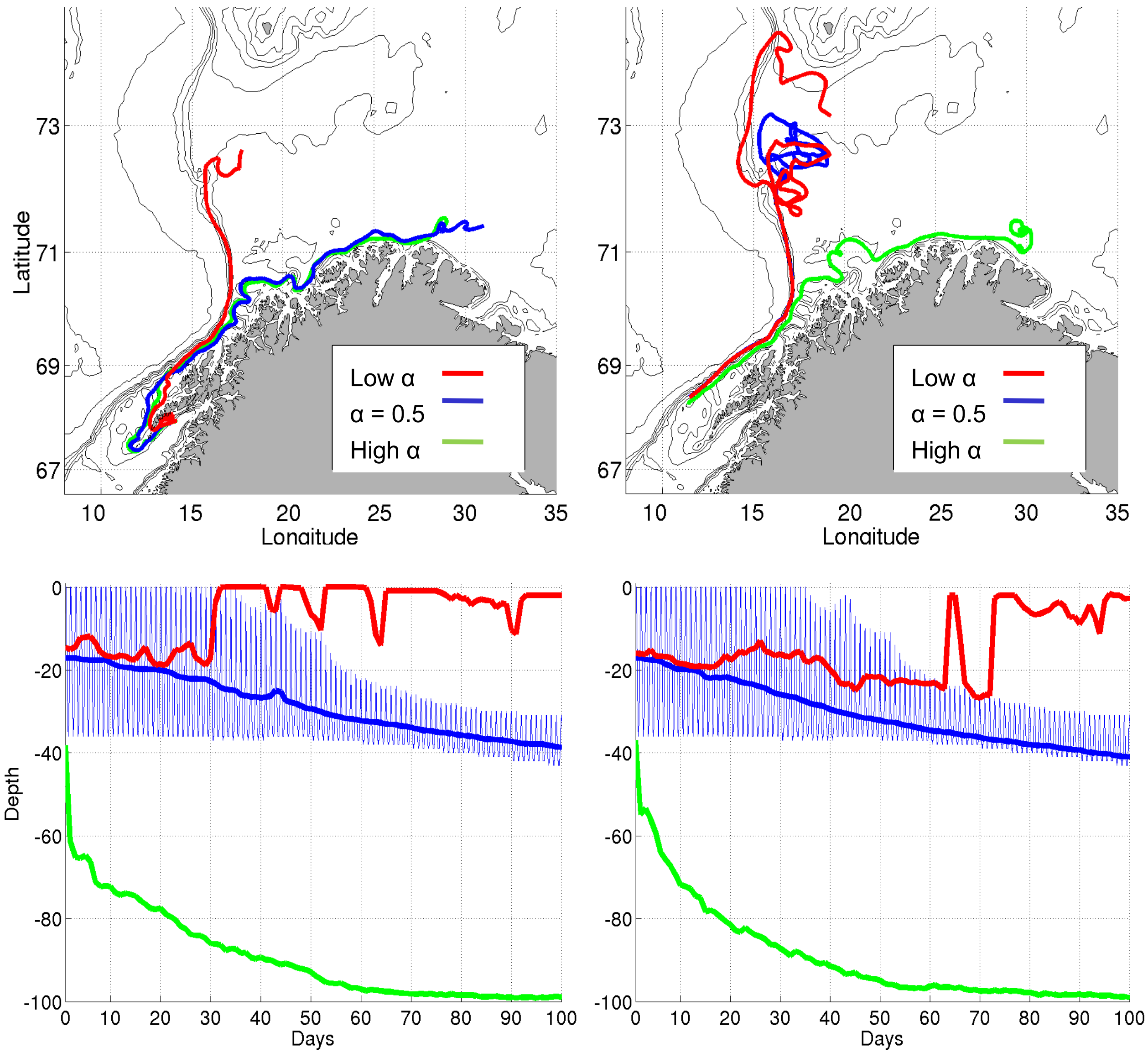
- Vertical swimming speed up to 1/6 of BL/s + random component.

Vertical habitat selection



Is this important for dispersal?

Vertical habitat selection



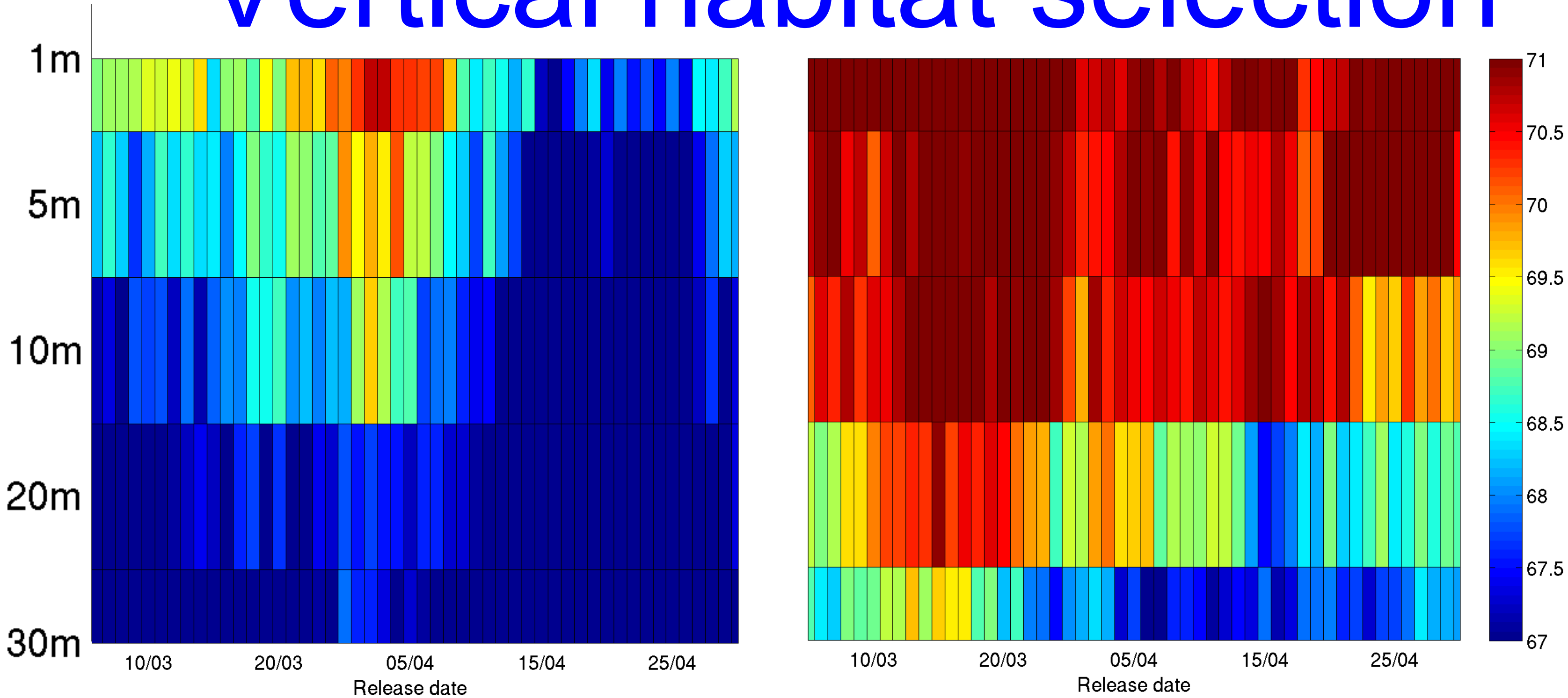
Vertical habitat selection of cod larvae may depend on the individuals preference for growth/survival.

$$z_i(t) = \max_z \left[(1-\alpha_i) g_z - \alpha_i m_z \right]$$

Each individual evaluates potential growth and mortality in the upper 100m of the water column and migrate vertically towards their optimal depth $z_i(t)$. Swimming speed is set to 1/3 L s^{-1}.

Vikebø et al. 2007 (MEPS);

Vertical habitat selection



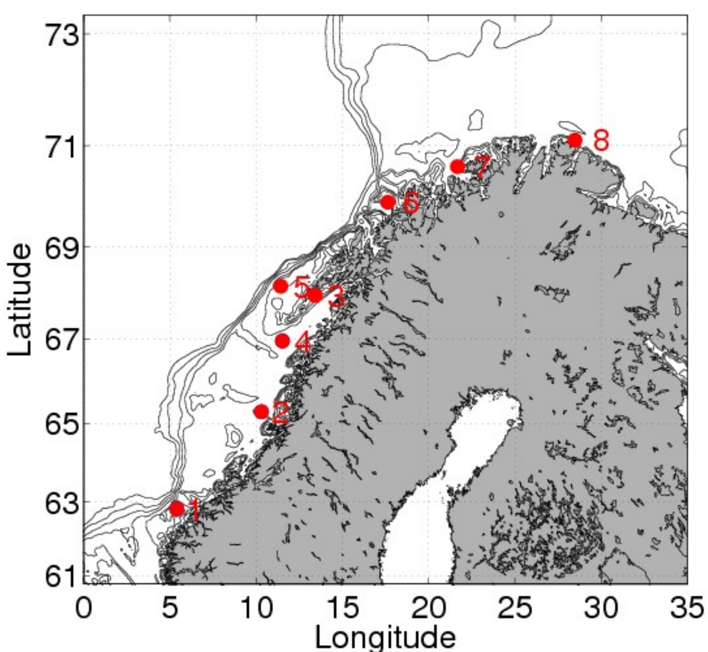
1984 1988

- Particles released at Møre (62.5N 5E) equally distributed at 1, 5, 10, 20, 30 m and each hatching days from March 5th to April 25th.
- Estimated average latitude after 100 days of drift as funtion of hatching day and drift depth.
- Large intra- and inter-annual variations in dispersal.
- An apparent trend towards decreasing advection velocity with increasing depth.

Initial conditions

- Cod and herring are each represented by 100 000 particles.
- Initial distribution of particles are based on historic spawning sites and intensity.

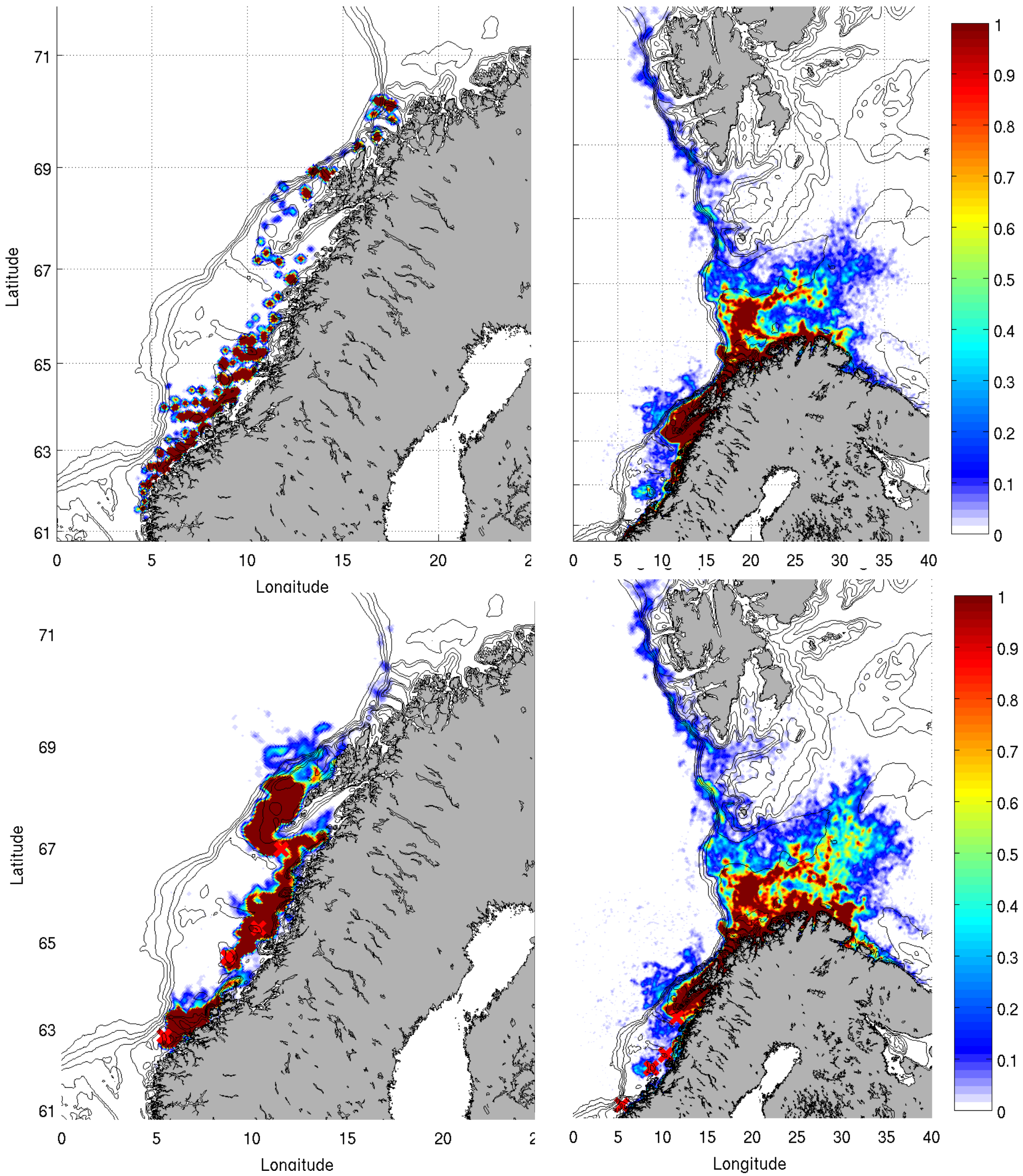
	Møre	Halten-banken	Sklinna	Røst	Vestfjorden	Moskenes-grunnen	Malangs-grunnen	Breivikbotn	Nordkyn
Cod	5		5	10	20	20	25	10	5
Herring	50	20	10	20					



Initial conditions

- Spawning distribution and timing varies between years, but significant changes seem to occur on time scales of several years. Hence, using the observed spawning history of recent years should work well.
  - Can this be verified?

Initial conditions



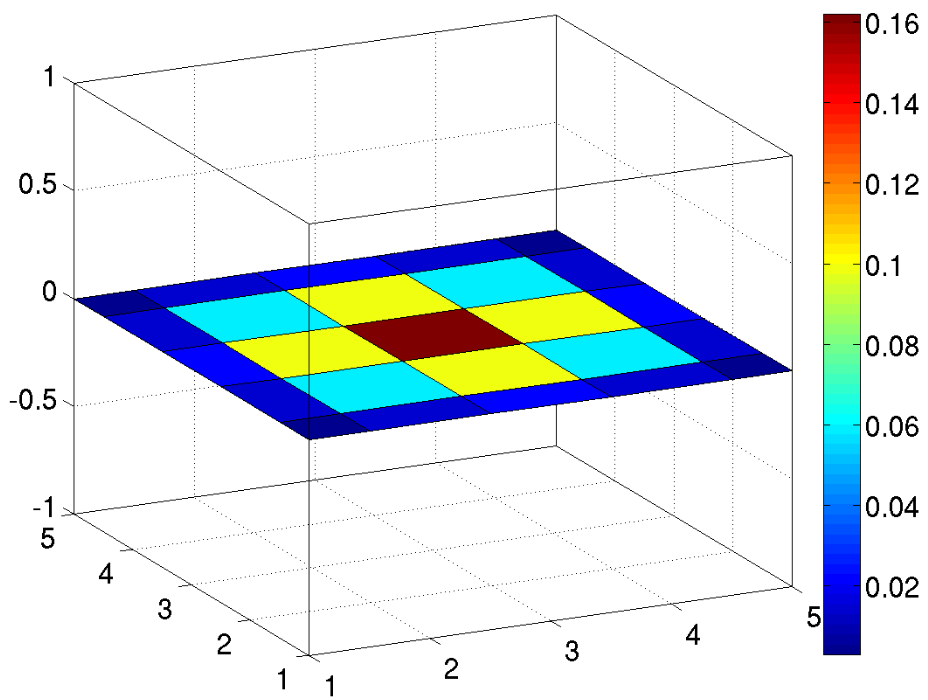
Sampled herring larvae mid April (left panel) and modelled larval/juvenile distribution late August (right panel).

Modelled herring larvae mid April based on historic spawning records (left panel) and modelled larval/juvenile distribution late August (right panel).

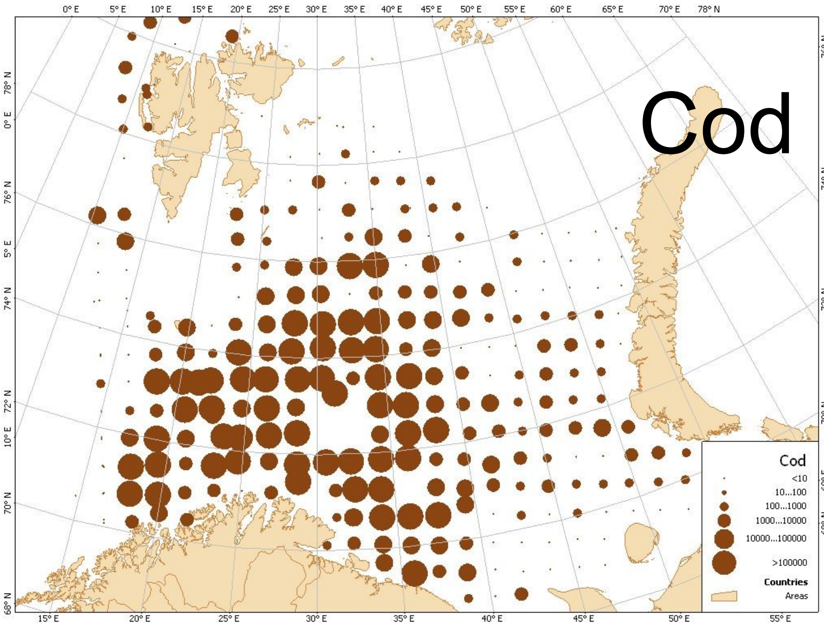
DO THEY MATCH??

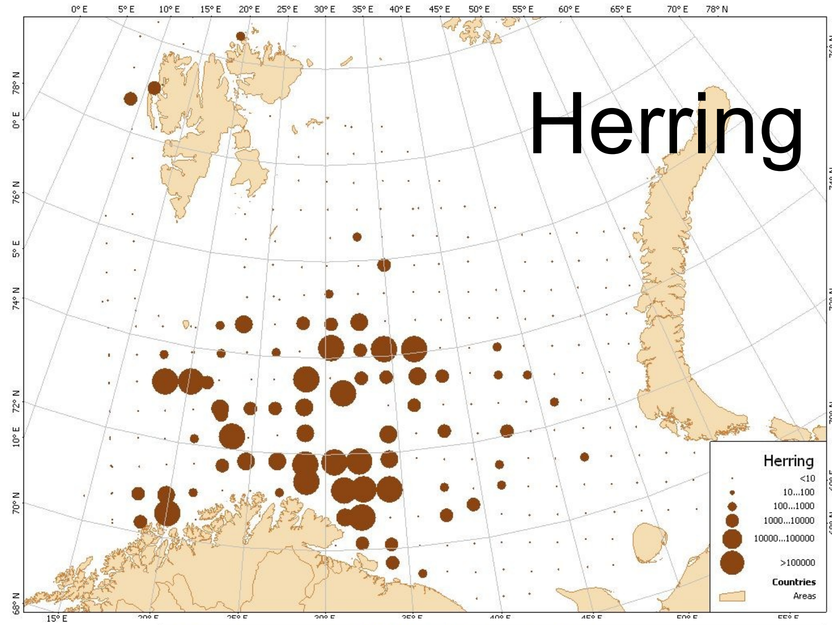
Smoothing techniques

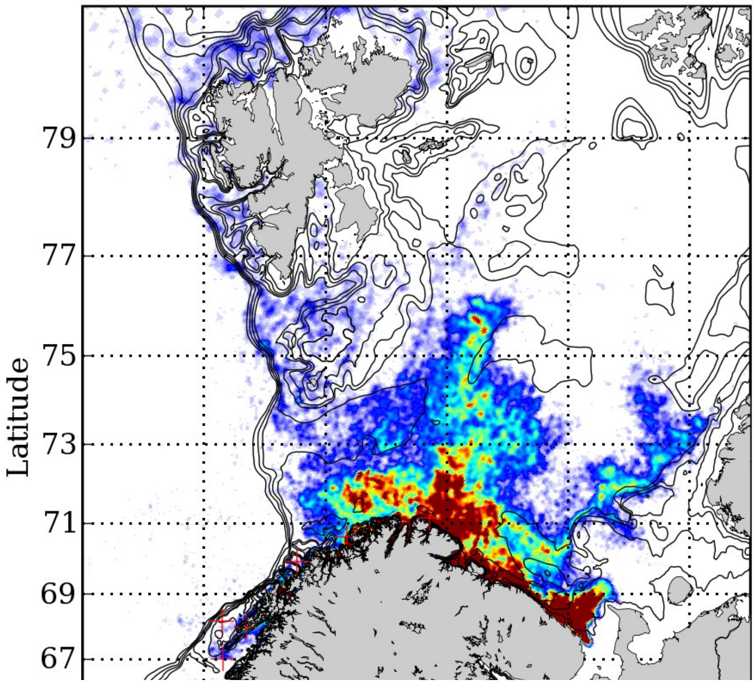
- The modelled larval abundences are patchy.
- Data are smoothed by multiplying each cell abundance with a gaussian weight matrix distributing the particles across 25 cells.

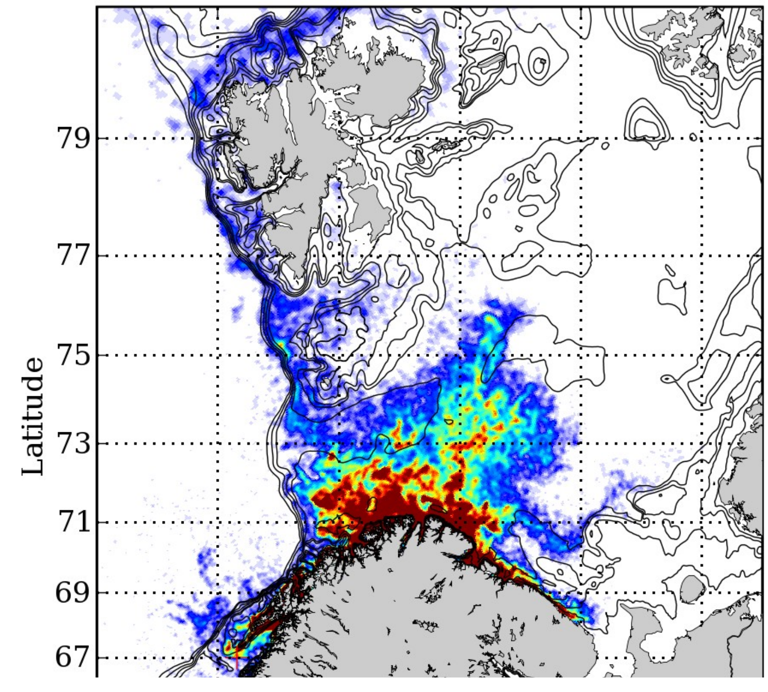


Larval drift validation



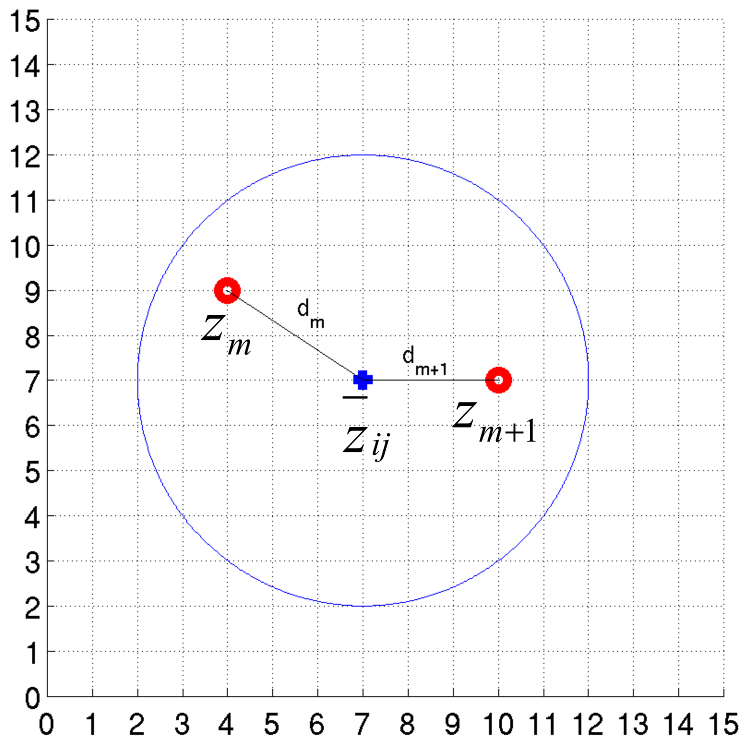






Larval drift validation

- Resample observed 0-group abundance to model grid or resample model estimates to observational grid.
- Use inverse-distance-weighted spatial averages.



$$\bar{z}_{ij} = \sum_{m=1}^{N} w_m z_m$$

$$w_m = \frac{1/d_m}{\sum_{m=1}^{N} 1/d_m}$$

With observations and modelled abundances at the same grid one can do a simple linear correlation analysis.

Any better suggestions?

Status of web pages

- The info department holds back until new web pages are up and running.
- Matlab routines are replaced by python scripts. Hence, python rules!
- Web pages should include a figure archive, zooming controls and a possibility of animating the results.
- ....