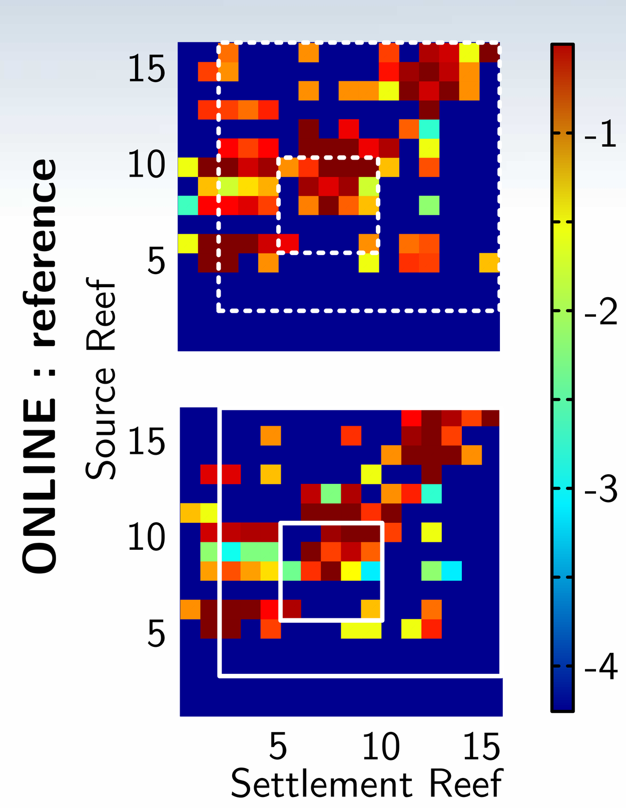
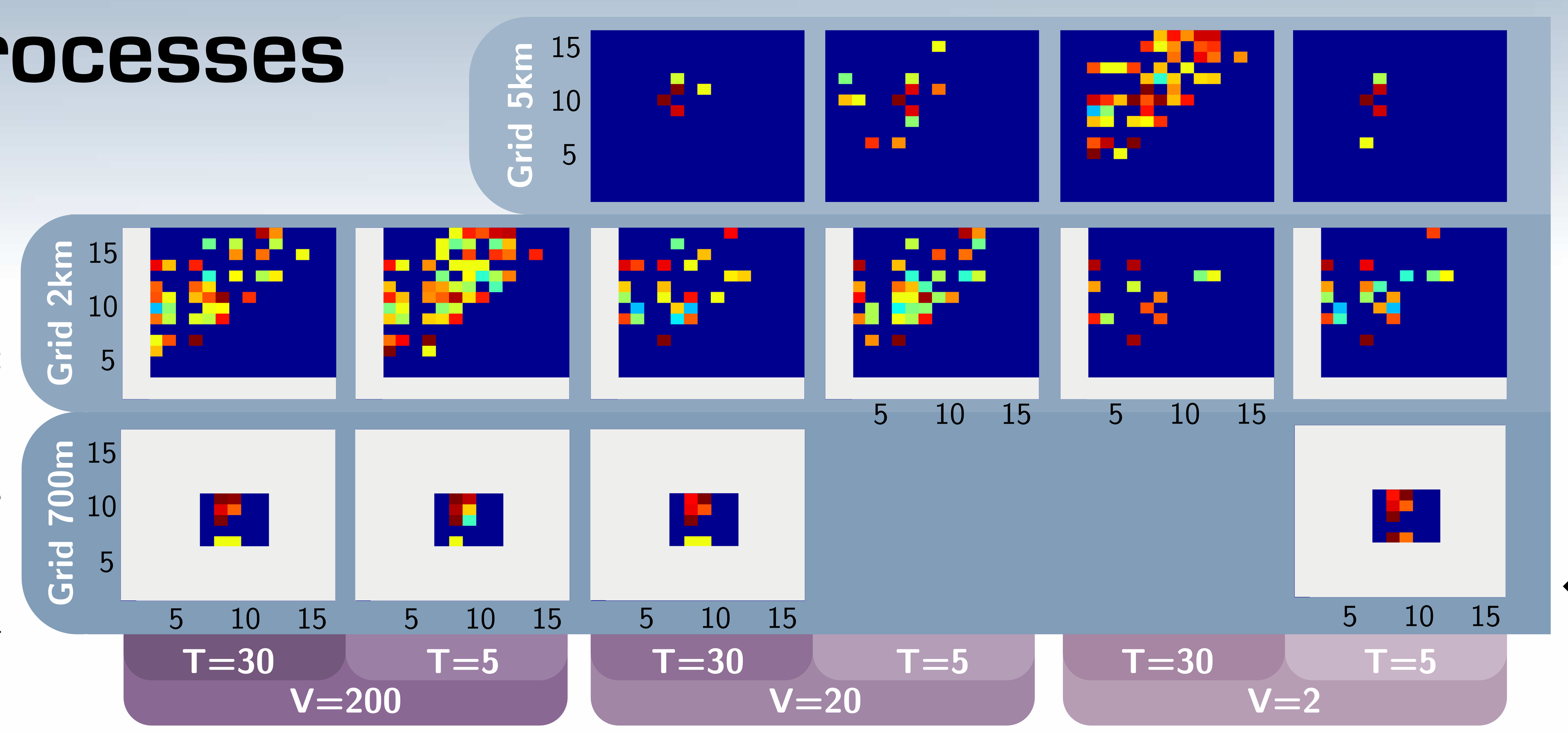
Relative influence of biophysical processes

The distance and direction of larval dispersal largely influence the demography and genetic structure of coral reef fish species. Their estimation *in situ* is difficult therefore models which aim at representing the whole larval phase and estimating connectivity on large regions are emerging. The interaction of physical and biological factors can influence the dispersal trajectories of larvae. All of them cannot be and probably do not need to be accurately represented in those models. Two approaches are used here to estimate the relative importance of various parameters during the early life history of fish. A Biophysical Offline Lagrangian Tracking System (BOLTS) allows to compute dispersal kernels and study connectivity patterns at various scales. A hybrid model operating on a small spatial scale serves to study more directly the influence of larval behavioral strategies in the pelagic environment.

Claire B Paris
cparis@rsmas.miami.edu
Ashwanth Snirivasan
asnirivasan@rsmas.miami.edu
Laurent M Cherubin
lcherubin@rsmas.miami.edu
Jean-Olivier Irisson
irisson@normalesup.org
Serge Planes
planes@univ-perp.fr
Robert K Cowen
rcowen@rsmas.miami.edu

Physical processes





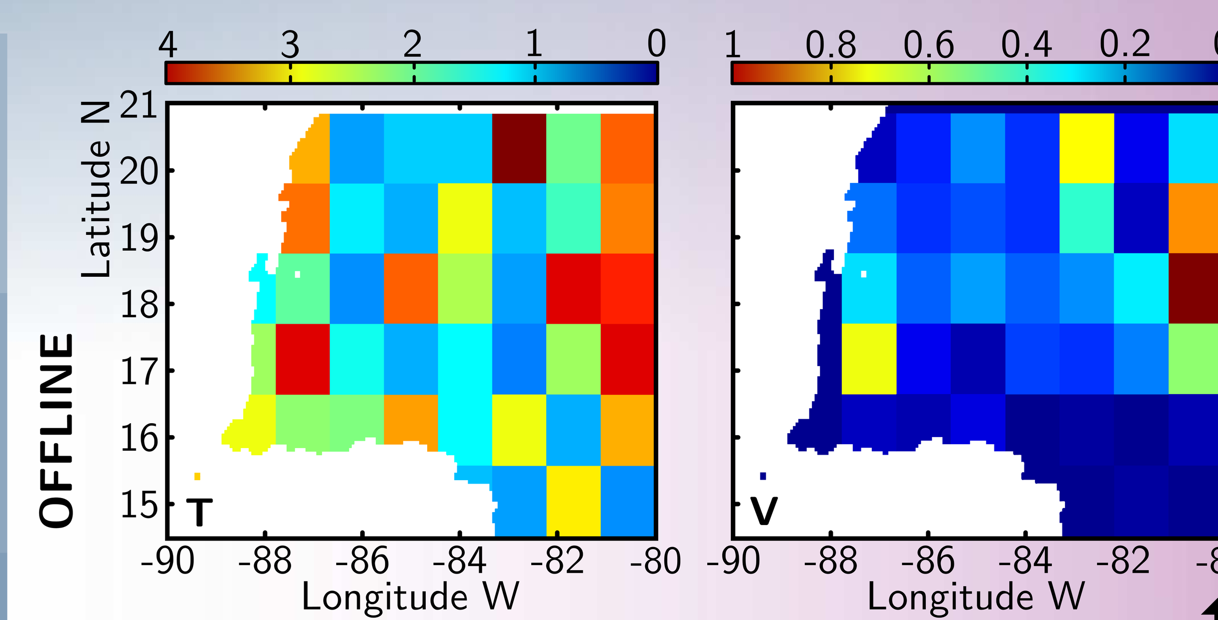


Fig 1.1: Spatial anisotropy of Lagrangian decorrelation time (T) and flow field variance (V) from ROMS 5km grid in the Mesoamerican region (Mexico, Belize, Honduras) in January

Fig 1.2: Influence of model parameters on connectivity patterns. Parameters are: grid size (G), Lagrangian time scale (T) and velocity variance (V). The online nested simulation is the reference to which offline simulations are compared. Correct parameters for this case scenario (Jan. climatology) are G=5,V=2,T=30 or G=2,V=200,T=5

Biological processes

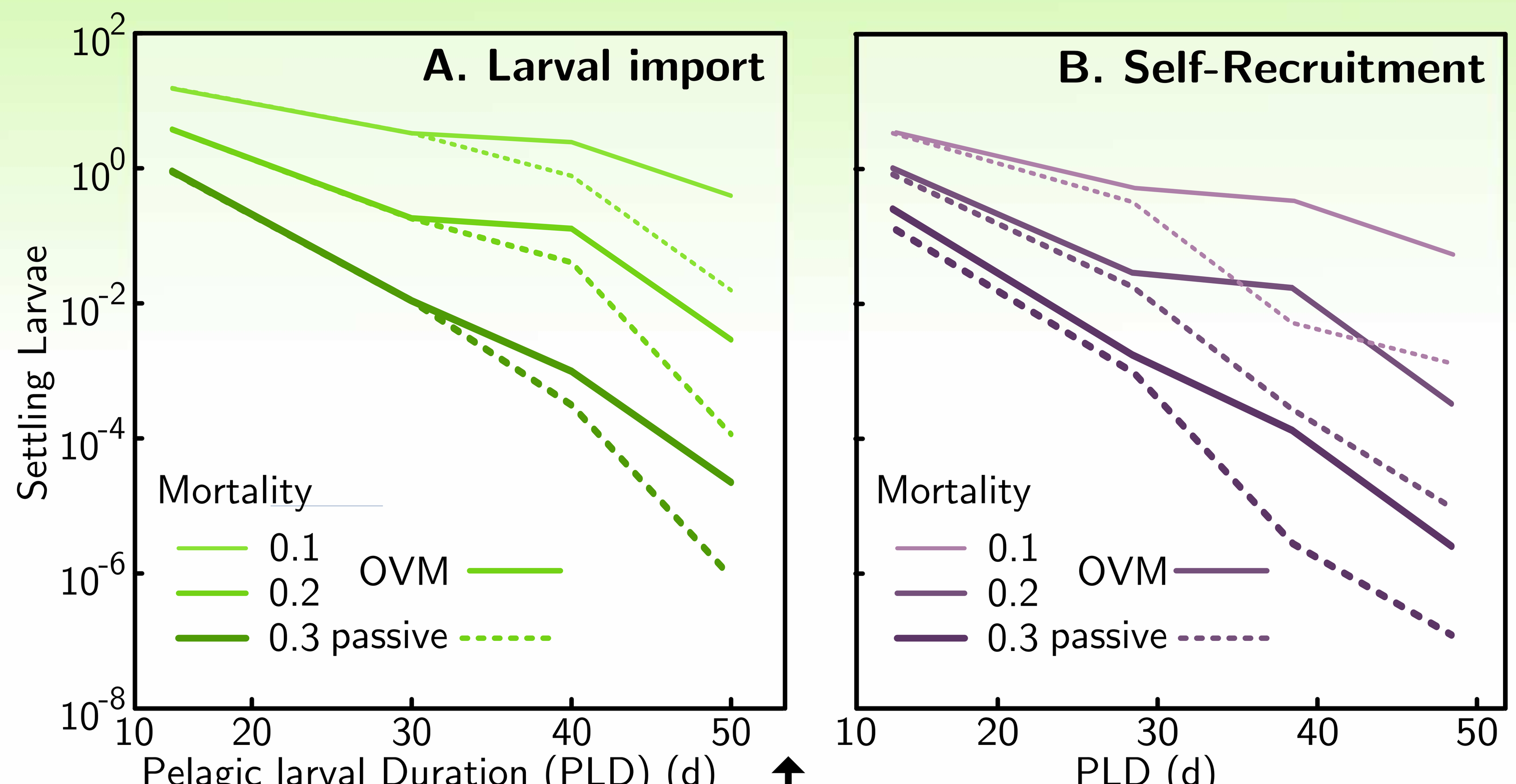
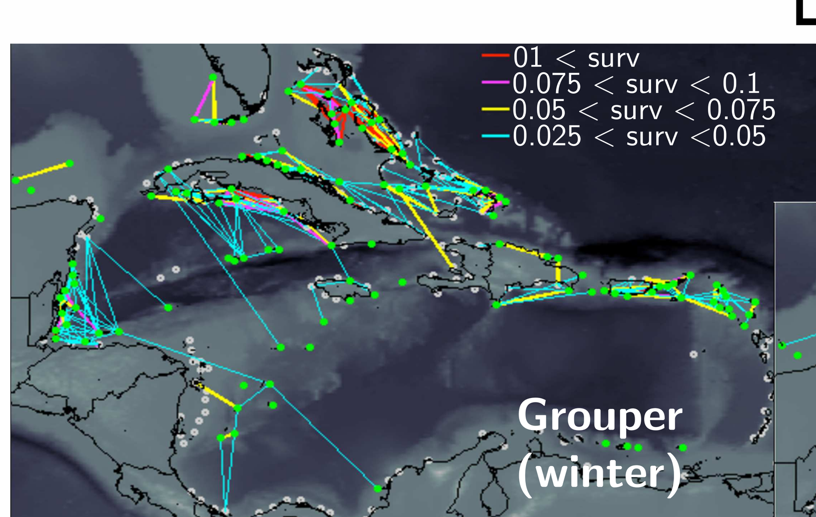


Fig. 2.1: Influence of life history traits (PLD, OVM to 50 m, Mortality) on recruitment success for (A) larval subsidy and (B) self-recruits. Based on 24 runs, each: 260 locations x 12 release time x 500 npart.



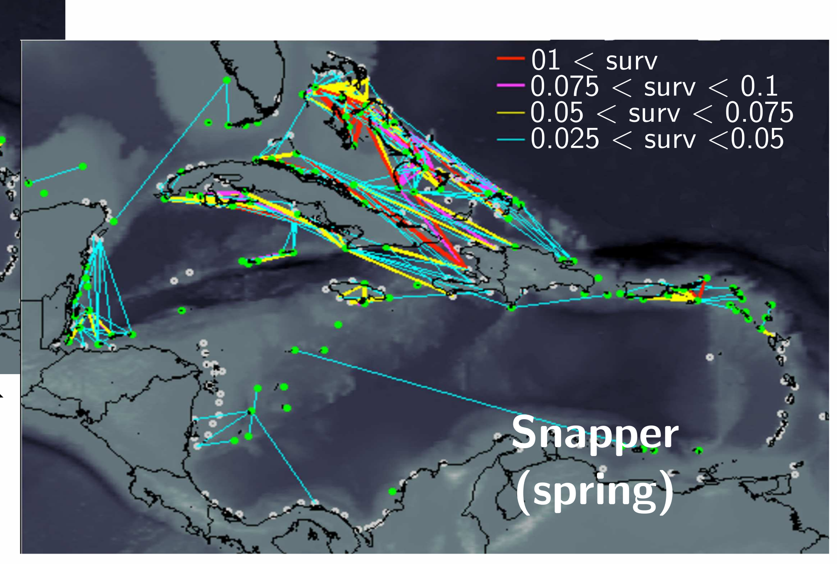


Fig 2.2: In the Caribbean, while grouper have longer PLDs, they show stronger regional isolation than snapper which highlights the influence of seasonality.

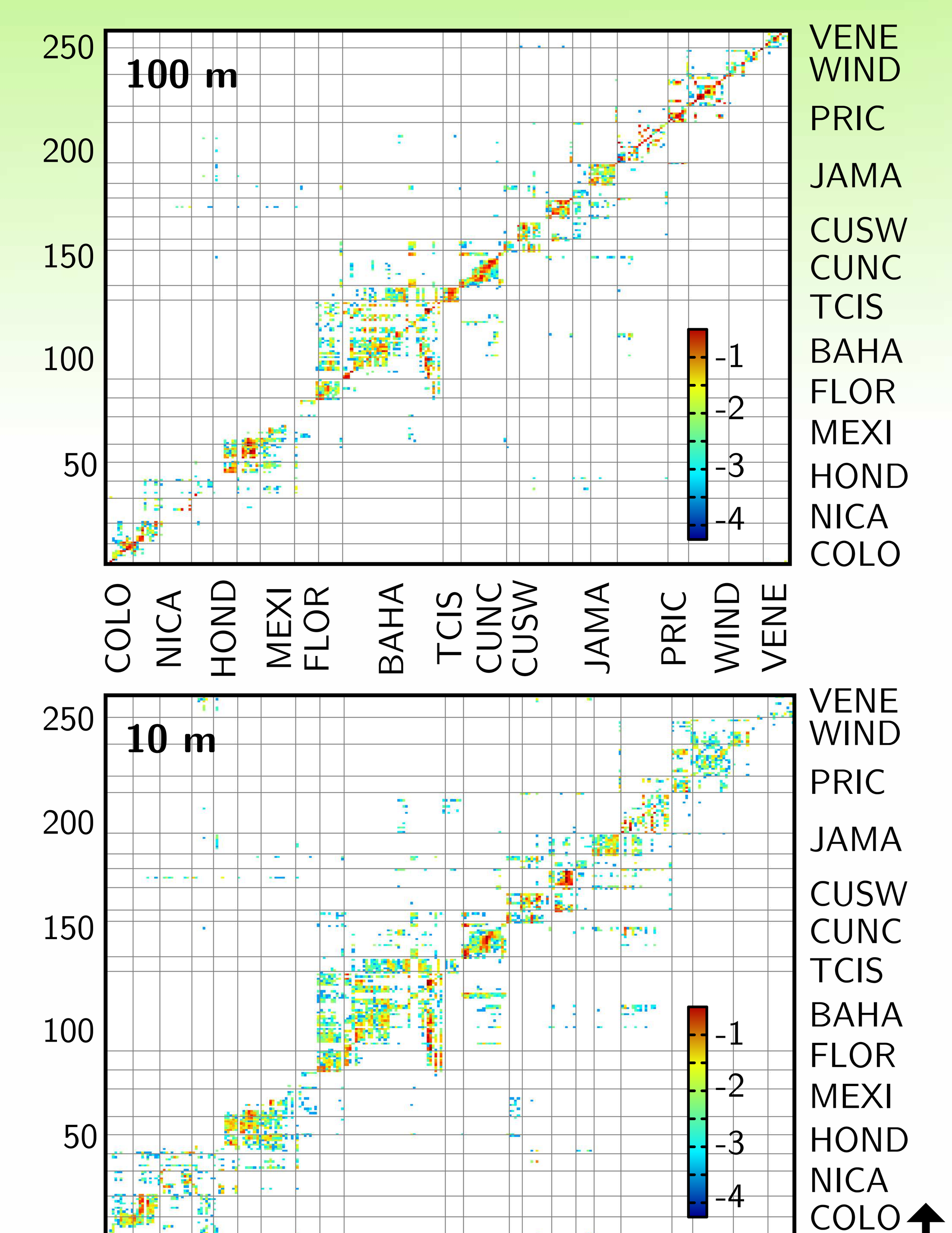
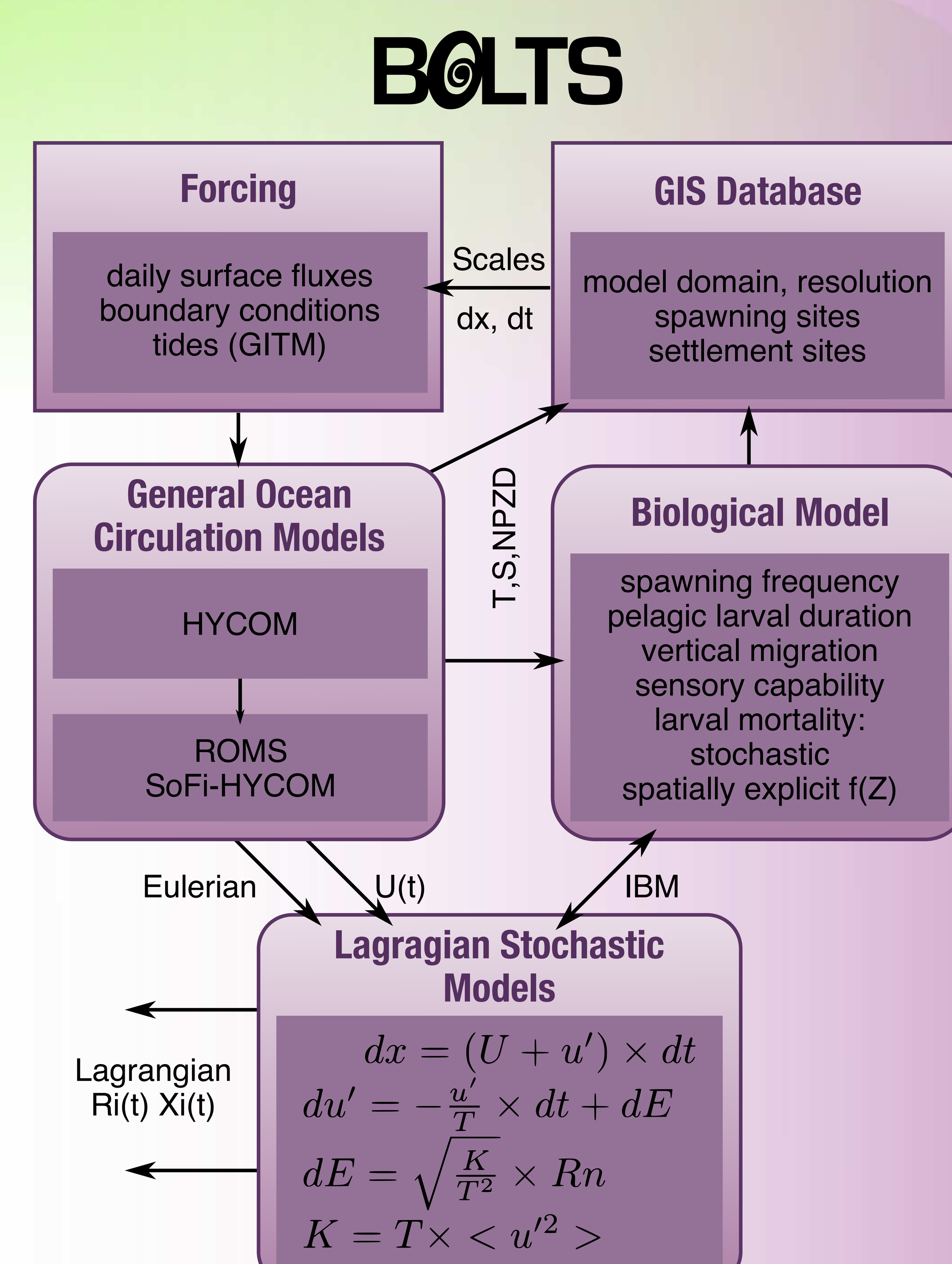


Fig 2.3: Dispersal kernel (i.e. prob. successful dispersal) estimated for larval transport in the upper 10 m and OVM to 100 m. Colors represent the probability of transition from node Ni (lines) to node Nj (columns) after a 30-d PLD. Monthly releases of 500 particles at 260 locations using HYCOM 1/12 degree, year 2004. Total particles tracked simultaneously offline = 1.56 Million.



Summary

- Long decorrelation times and weak variances characterize coastal waters, while small T and high V define the shelf break (Fig. 1.1)
- Connectivity patterns are more sensitive to Langrangian parameters (V,T) for large grid sizes (Fig. 1.2). Including K spatial anisotropy in critical in accurately estimating dispersal distances.
- Total recruitment levels (i.e. subsidy + self-recruitment (SR)) are sensitive to mortality rates and OVM with increasing PLDs, while OVM has more impact on SR even at short PLDs and changes connectivity patterns (Fig. 2.1,3)
- Differences in connectivity networks in the case of snapper and grouper in the Caribbean are mainly driven by the seasonality of spawning production rather than by PLDs (Fig. 2.2)
- Including vertical and horizontal swimming behavior of larvae is crucial in explaining self-recruitment in a small isolated island system (Fig 2.4)

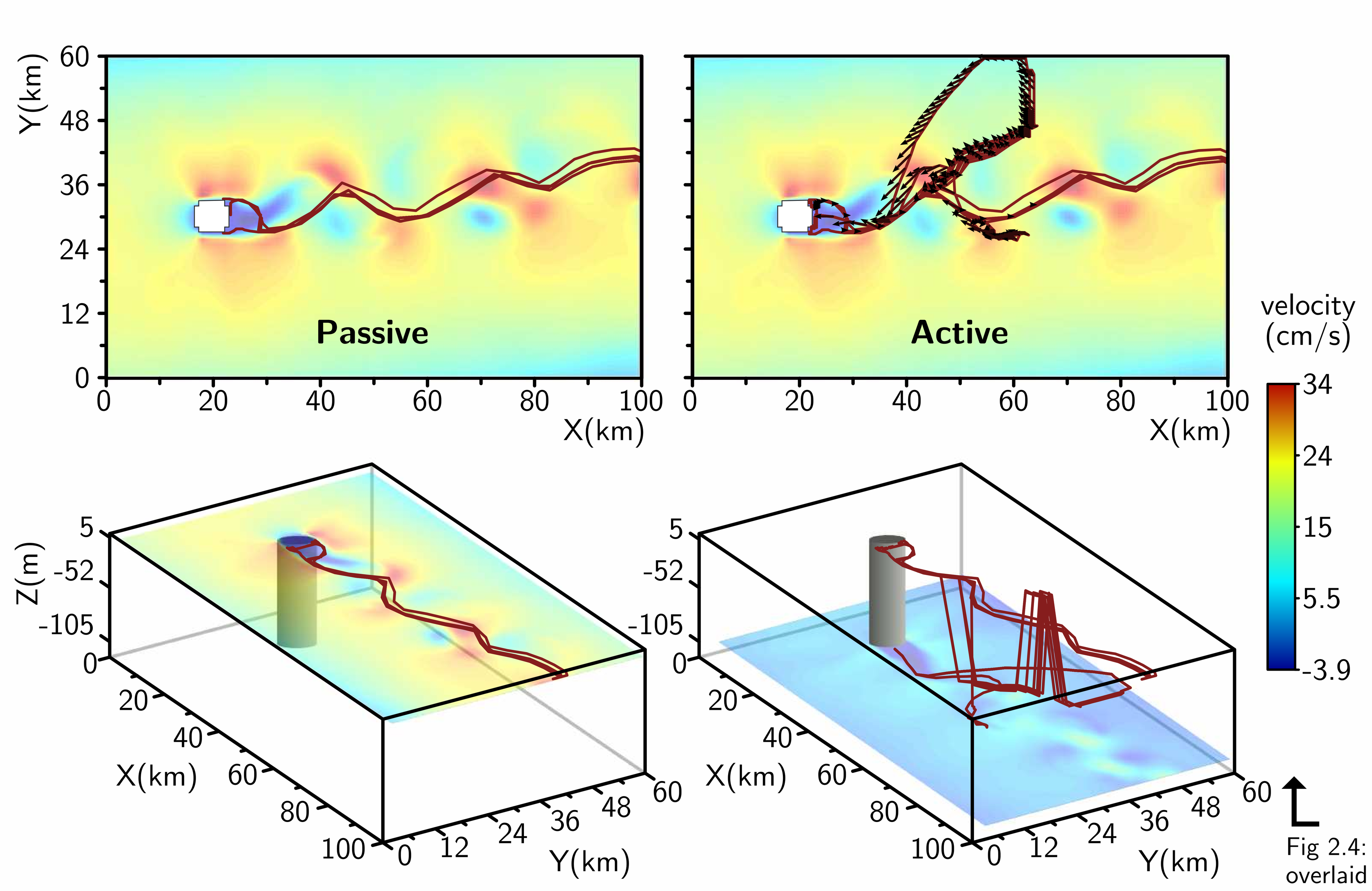


Fig 2.4: Passive and active larvae trajectories overlaid on X velocity field