

Influence of biophysical processes on coral reef fish population connectivity inferred by modeling

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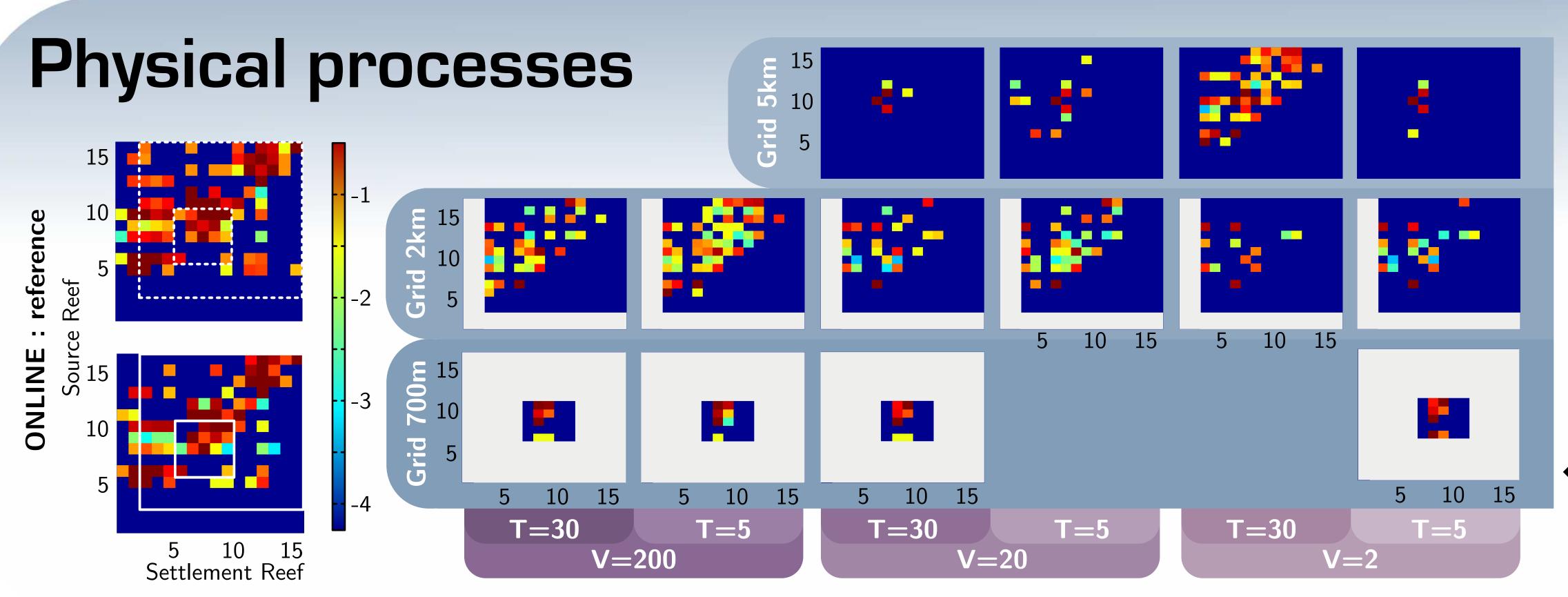
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Relative influence of biophysical processes

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.

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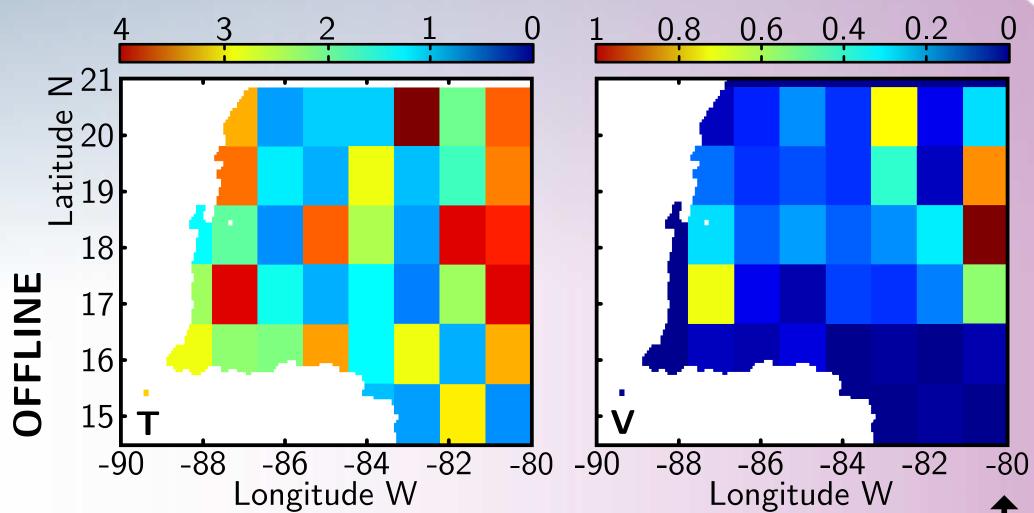
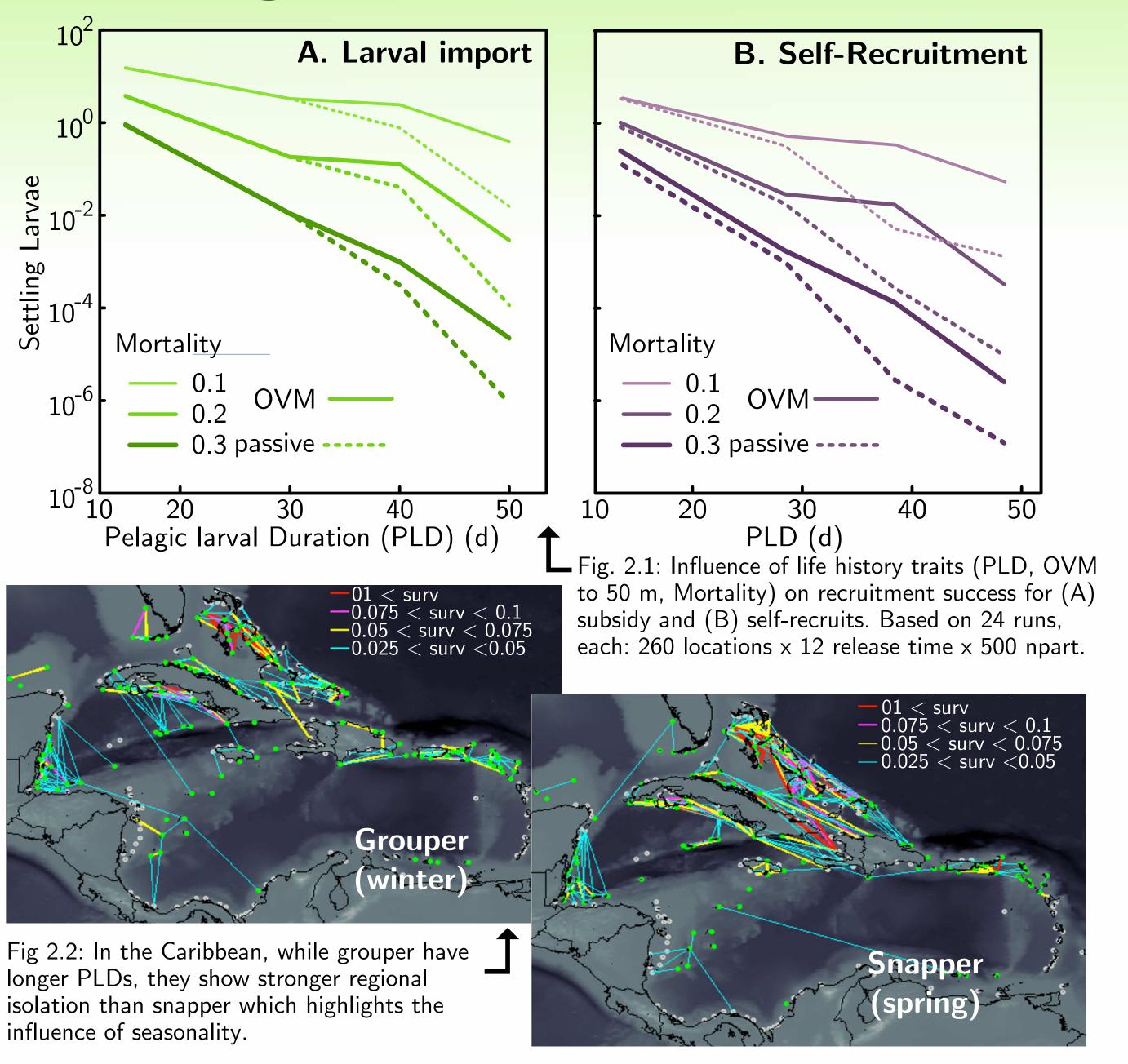


Fig 1.1: Spatial anisotropy of Lagrangian decorrelation time (T) and flow field variance (V) from ROMS 5km grid in the Mesoamerican region (Mexico, Belize, Honduras) in January

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

B@LTS

Biological processes



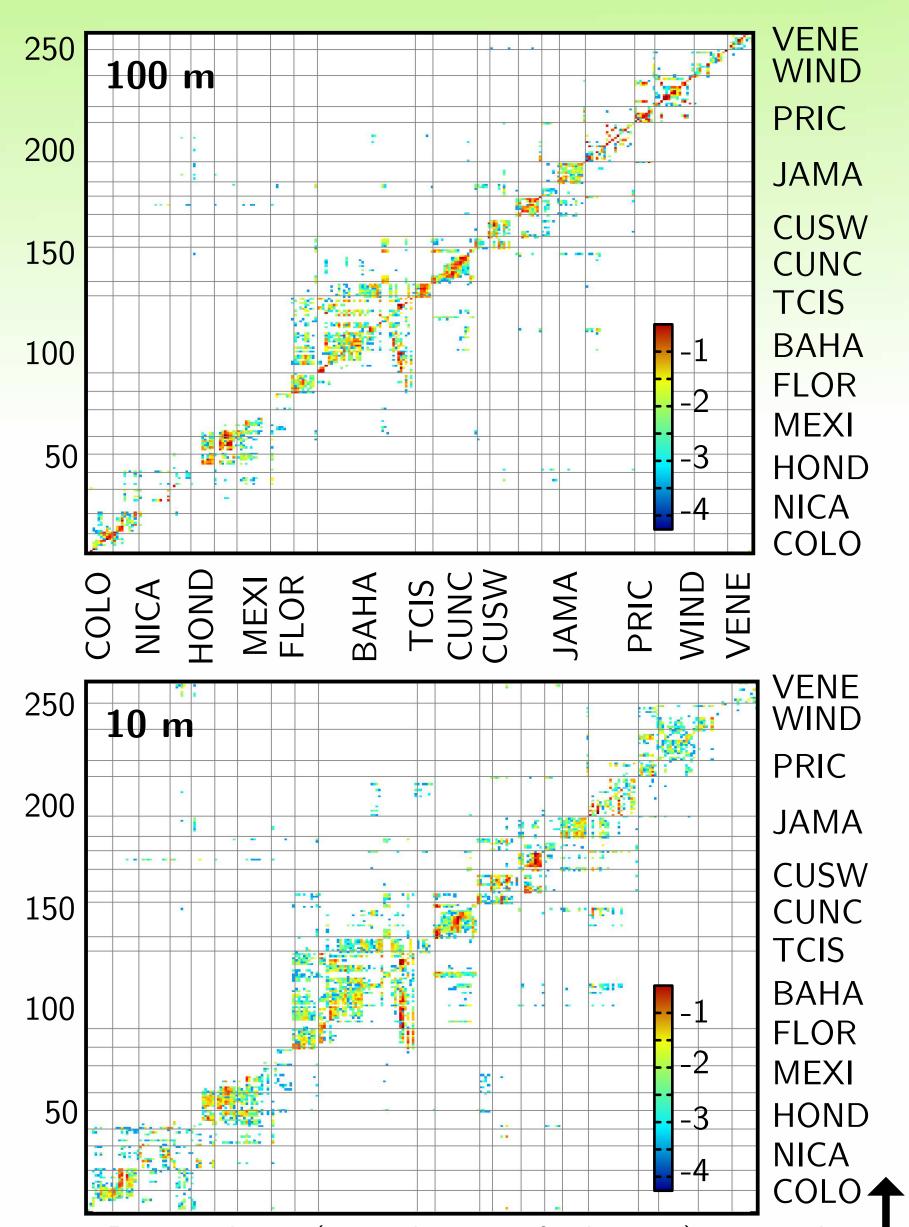


Fig 2.3: Dispersal kernel (i.e. prob. successful dispersal) estimated for larval transport in the upper 10 m and OVM to 100 m. Colors represent the probability of transition from node Ni (lines) to node Nj (columns) after a 30-d PLD. Monthly releases of 500 particles at 260 locations using HYCOM 1/12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

Forcing GIS Database Scales daily surface fluxes model domain, resolution boundary conditions dx, dt spawning sites tides (GITM) settlement sites **General Ocean Biological Model Circulation Models** spawning frequency pelagic larval duration HYCOM vertical migration sensory capability larval mortality: ROMS stochastic SoFi-HYCOM spatially explicit f(Z) Eulerian **IBM** Lagragian Stochastic Models $dx = (U + u') \times dt$ Lagrangian $du' = -\frac{u'}{T} \times dt + dE$ Ri(t) Xi(t)

 $dE = \sqrt{\frac{K}{T^2}} \times Rn$ $K = T \times \langle u'^2 \rangle$

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 + selfrecruitment (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 selfrecruitment in a small isolated island system (Fig 2.4)











