Connectivity patterns of coastal and neritic fish larvae in deep waters in the western Gulf of Mexico: How ichthyoplankton surveys can be helpful to evaluate the reliability of the velocity fields provided by the circulation models?

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1. INTRODUCTION

Numerical circulation models have traditionally been used to examine the connectivity of marine populations of species with a pelagic larval stage [1,2,3]. However, to date, biological validation of connectivity and transport patterns inferred from circulation models is limited.

OBJECTIVE

To use larval fish distributions for assessing the reliability of velocity fields from a circulation model (HYCOM), using the western Gulf of Mexico as a model system.
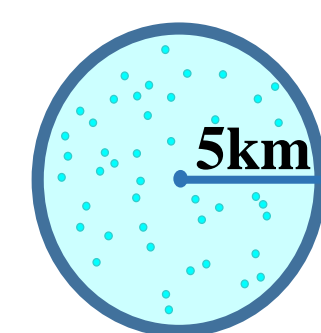
2. METHODS
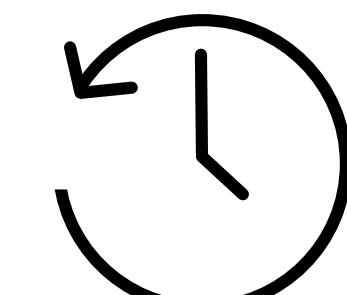
ICHTHYOPLANKTON SURVEYS
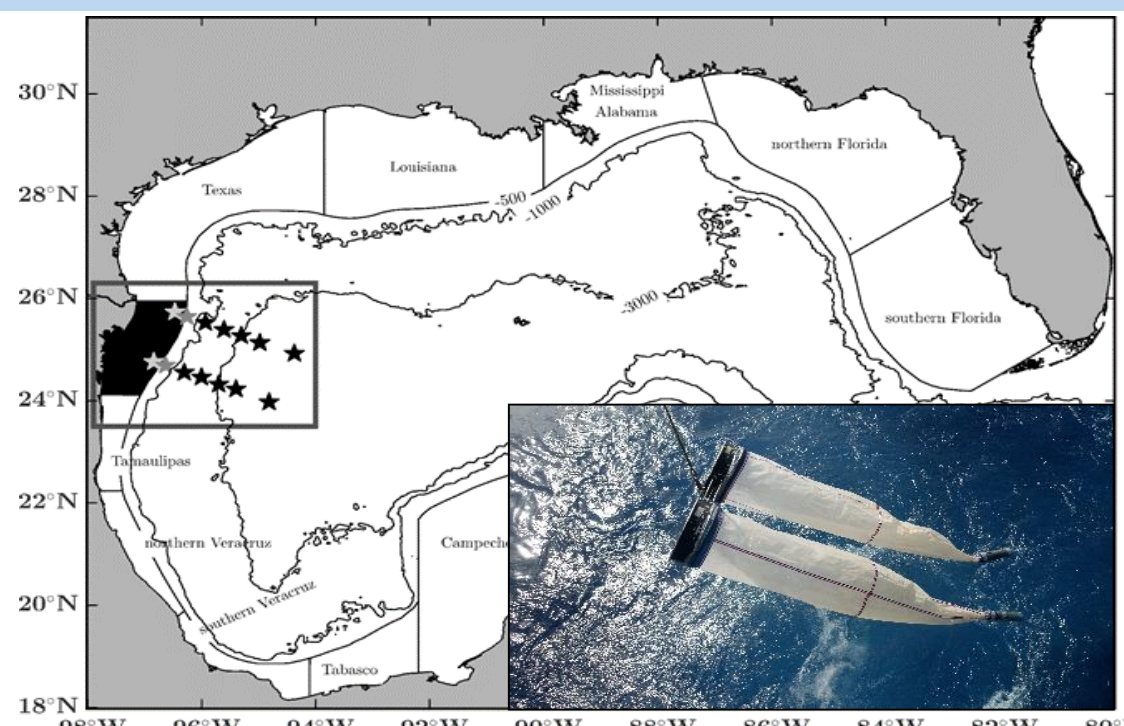
CRUISES
I) Jun 2016
II) Oct 2016
III) Apr 2017
IV) Nov 2017

Fig. 1. Sampling stations in which oblique 0-200 m bongo tows were performed.

BACKWARD PARTICLE TRACKING EXPERIMENTS

25500 passive particles randomly distributed from 0 to 200m (17 layers) per station and cruise

HY COM (+ NCODA) u − v (1/25°) t = 1 h

Backward T = 28 d

A. Percentage of particles coming from neritic provinces (depths <500 m)

B. Possible dispersal pathways of neritic fish larvae

3. RESULTS

(A) There was a higher (lower) percentage of particles originating in neritic provinces in the cruises in which more (less) fish larvae of neritic taxa were caught (Fig. 2).

$y = -0.638 + 10.988x$
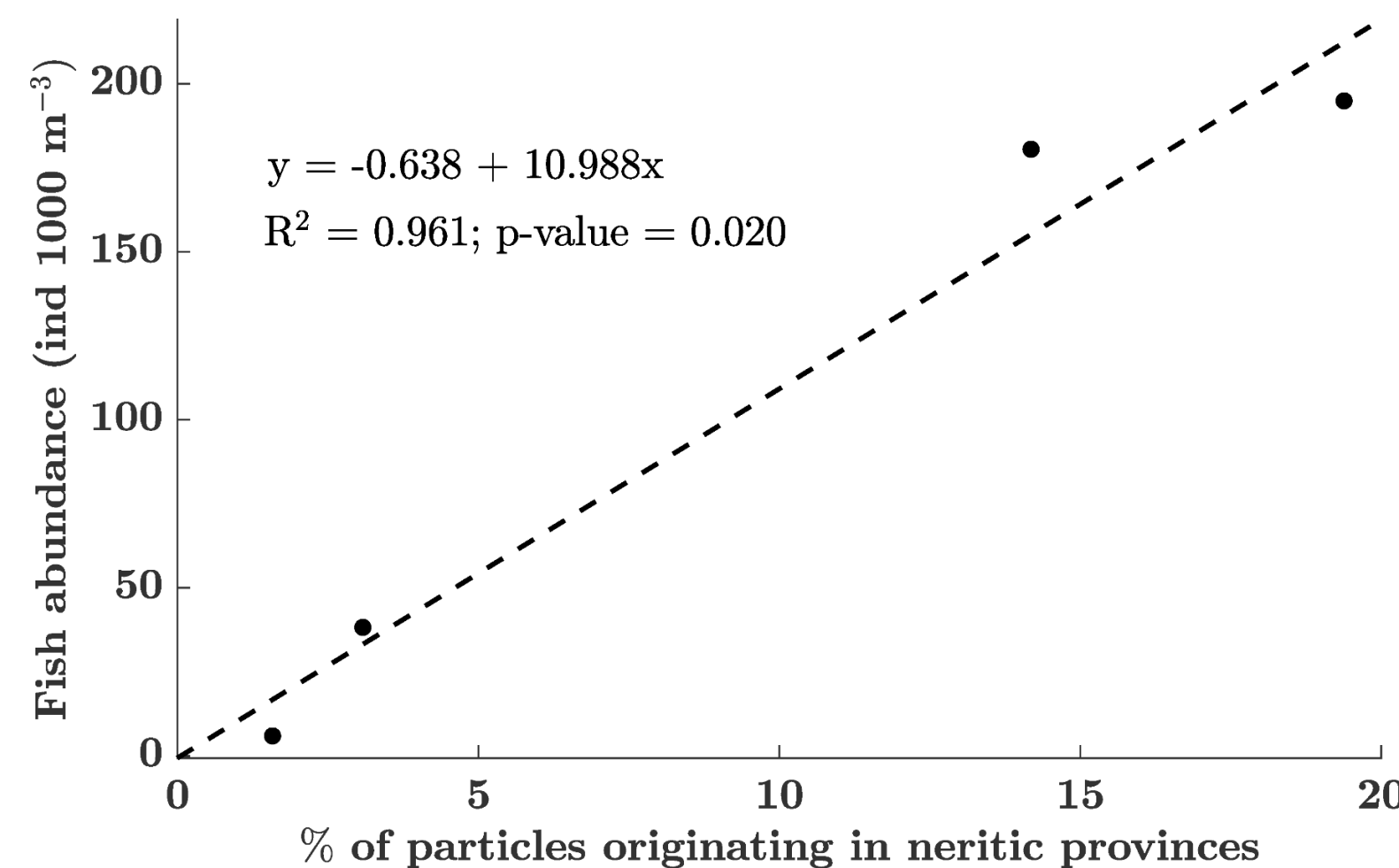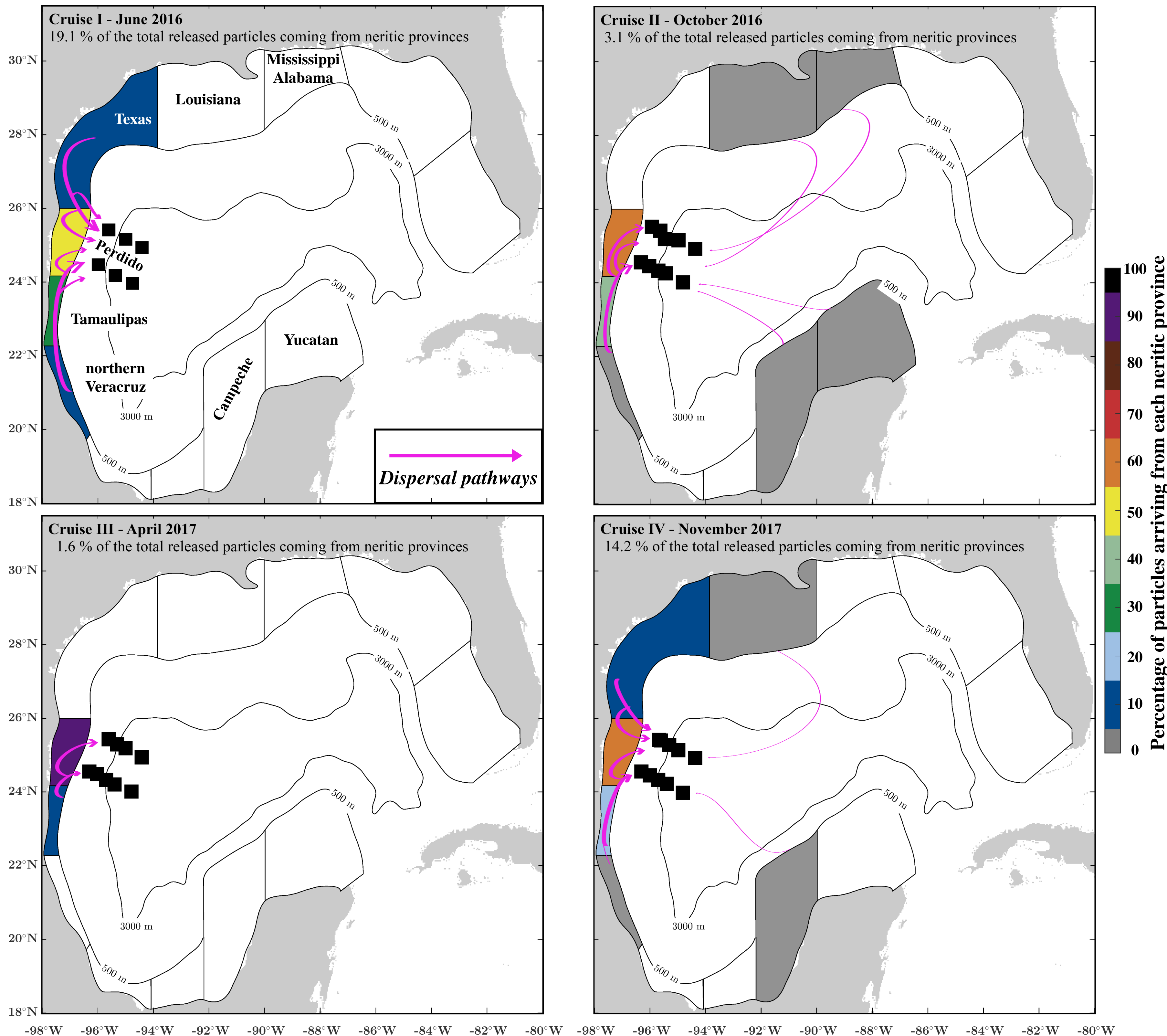$R^2 = 0.961$; p-value = 0.020

Fig. 2. Average percentage of particles originating in neritic provinces relative to all released particles vs the average abundance of fish larvae of taxa that inhabit the coast and shelf during the adult stage that were caught at oceanic stations (depths >1000 m).

(B) The Perdido, Tamaulipas and Texas neritic provinces are the main sources of particles to Perdido's deepwater region, while the contribution of northern Veracruz, Campeche, Yucatan, Louisiana, and Mississippi-Alabama were much lower (Fig. 3).

Fig. 3. The percentage of particles coming from all neritic regions with respect to the total number of particles released for each cruise is shown in the figure's header, while the percentage of particles coming from each province is shown according to the colour scale. The simplified results of dispersal pathways of passive particles are shown by arrows.

Cruise I - June 2016
19.1 % of the total released particles coming from neritic provinces

Cruise II - October 2016
3.1 % of the total released particles coming from neritic provinces

Cruise III - April 2017
1.6 % of the total released particles coming from neritic provinces

Cruise IV - November 2017
14.2 % of the total released particles coming from neritic provinces

Dispersal pathways

Percentage of particles arriving from each neritic province

4. CONCLUSIONS

There was high agreement between biological tracers and numerical experimental results. The Gulf of Mexico's HYCOM model is a suitable tool for evaluating the dispersal pathways of the larval stages of marine populations from the shelf to deep waters.

Fish larval distributions are a useful tool for evaluating the reliability of using 2-D velocity fields from circulation models to infer larval transport at time scales of several weeks.

References

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