HYCOM for HAWAII

Yanli Jia

International Pacific Research Center
University of Hawaii at Manoa

LOM Workshop, Copenhagen, 2015

HYCOM + NCODA
Global 1/12° Analysis

- **Direct use of the output for research**
- **As boundary conditions for regional Studies**

ftp ftp.hycom.org
cd pub/hawaii

Eddies as offshore foraging grounds for melon-headed whales

Woodworth et al., 2012, Marine Mammal Science

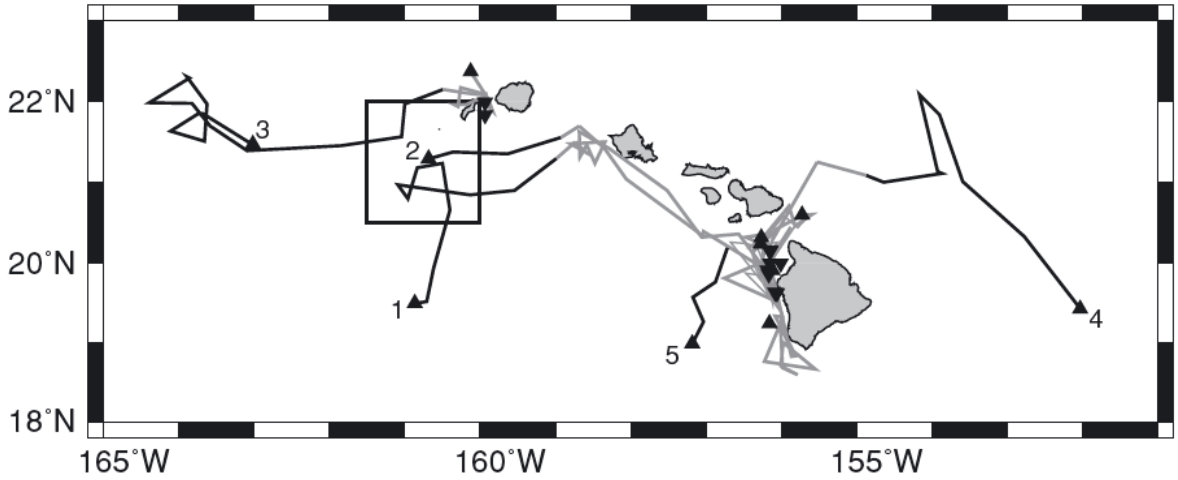
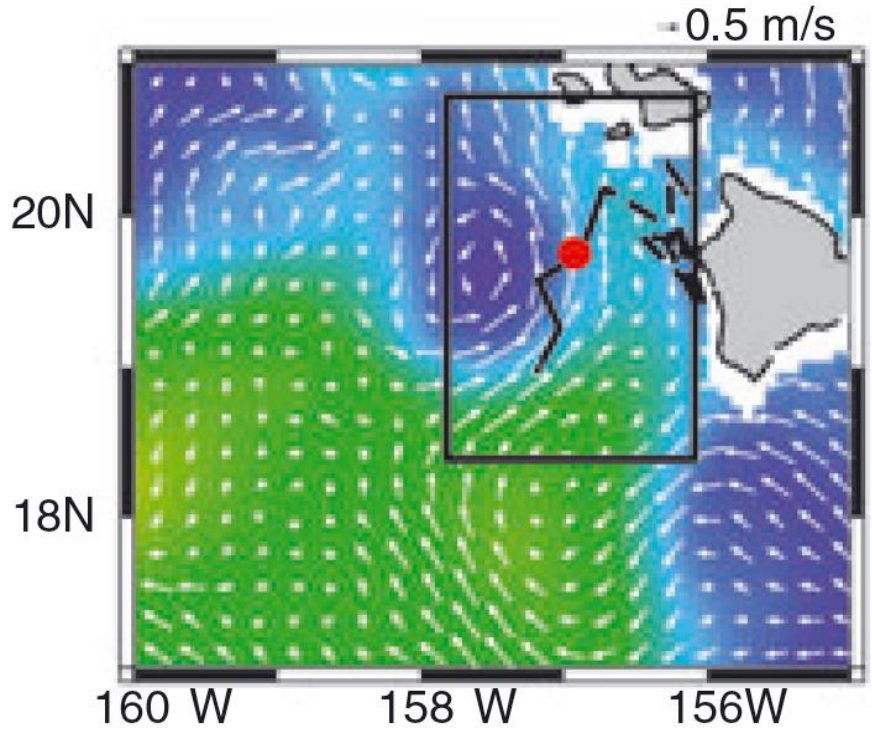
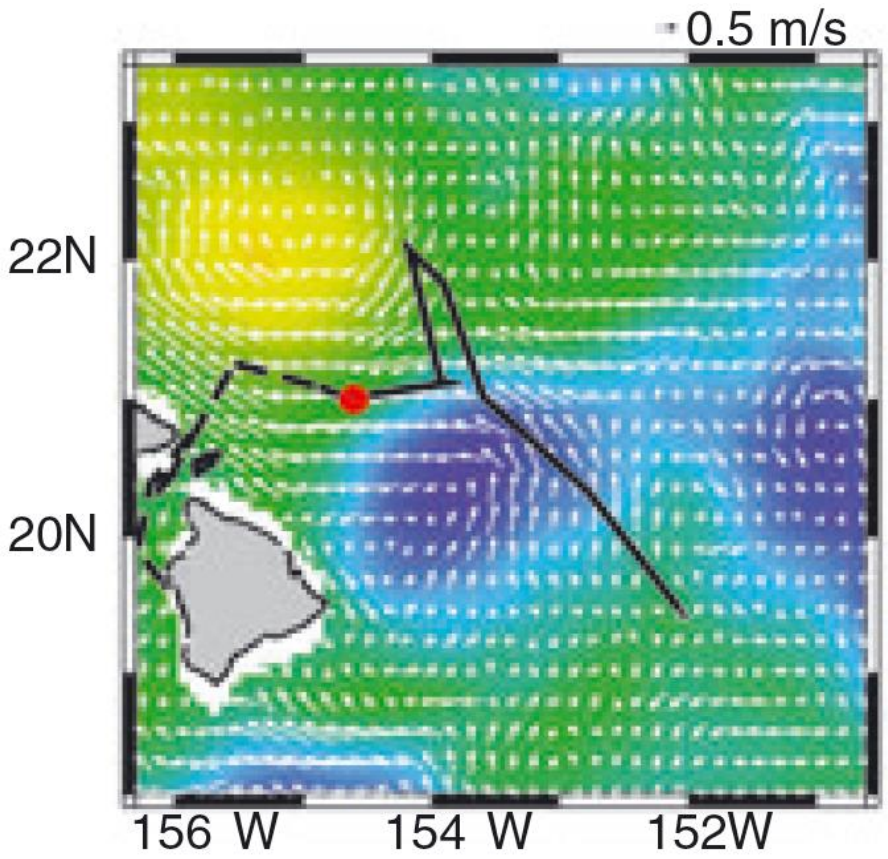


Figure 1. Tracks of all 10 melon-headed whales from the main Hawaiian Islands population with nearshore portions in gray and offshore portions in black. Downward-pointing triangles represent tag-deployment positions while upward-pointing triangles represent final recorded track positions. The five offshore tracks are numbered near their final recorded track positions. The rectangle represents the boundaries of the Ni'ihau Box.


0.5 m/s
20N
18N
160 W
158 W
156W


0.5 m/s
22N
20N
156 W
154 W
152W

Mapping available Ocean Thermal Energy Conversion resources around the main Hawaiian Islands with state-of-the-art tools

Gérard C. Nihous

JOURNAL OF RENEWABLE AND SUSTAINABLE ENERGY **2**, 043104 (2010)

OTEC Resource: Temperature difference, ΔT, between 20 and 1000 m water depths

"Theoretically, an OTEC system is based on the well-established thermodynamic principles of a heat engine. Warm water is used to vaporize a working fluid with a low-boiling point such as ammonia in an evaporator (or to directly produce water vapor under low-pressure). This vapor drives a turbine that generates mechanical energy. Cold water is needed downstream to condense the vapor back into liquid form that can be pumped back into the evaporator." *Jia et al. (2012)*

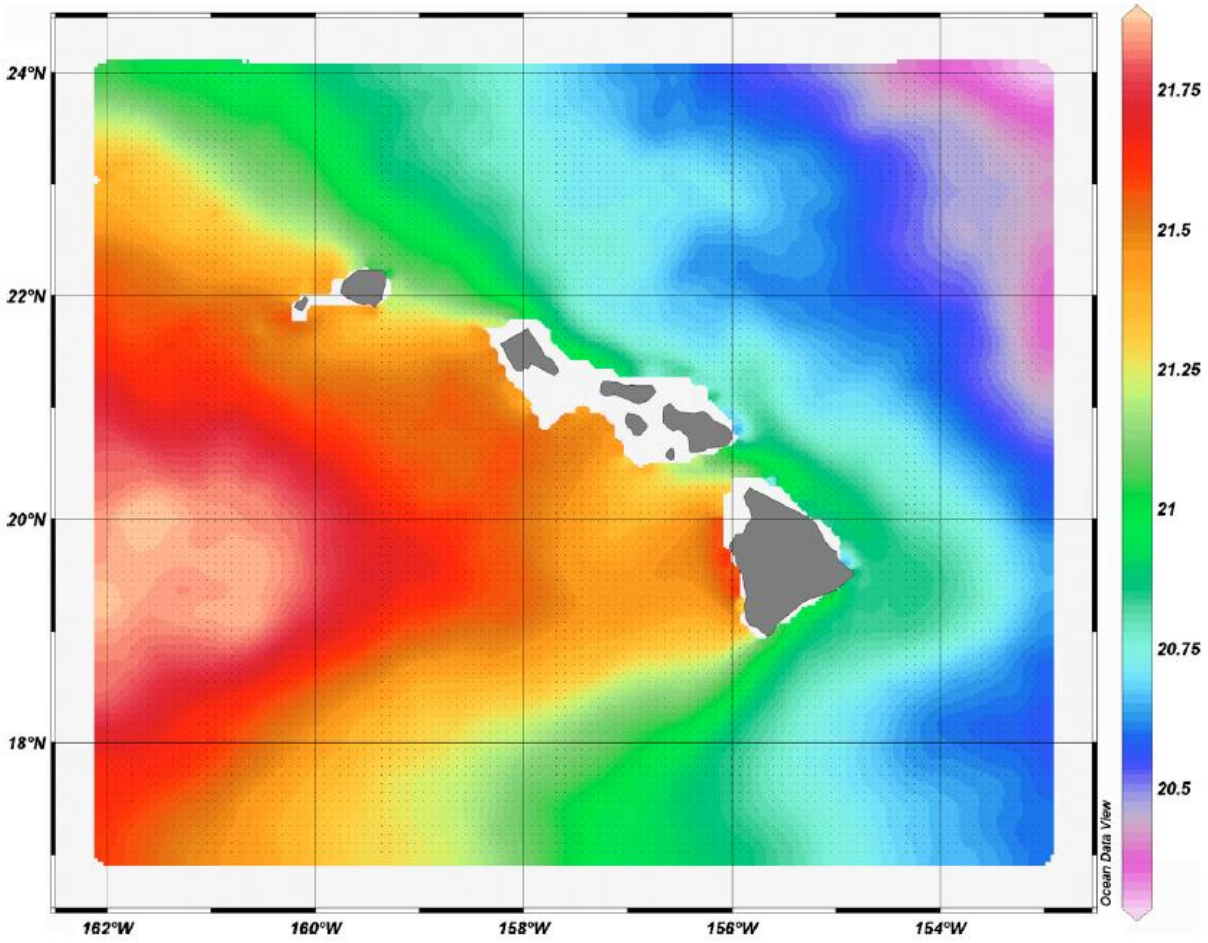


FIG. 2. Average ocean temperature differences (between 20 and 1000 m water depths) around the main Hawaiian Islands from HYCOM+NCODA (1/12°) data for the period 1 July 2007 through 30 June 2009 (color palette in °C).

HYCOM + NCODA
Global 1/12° Analysis

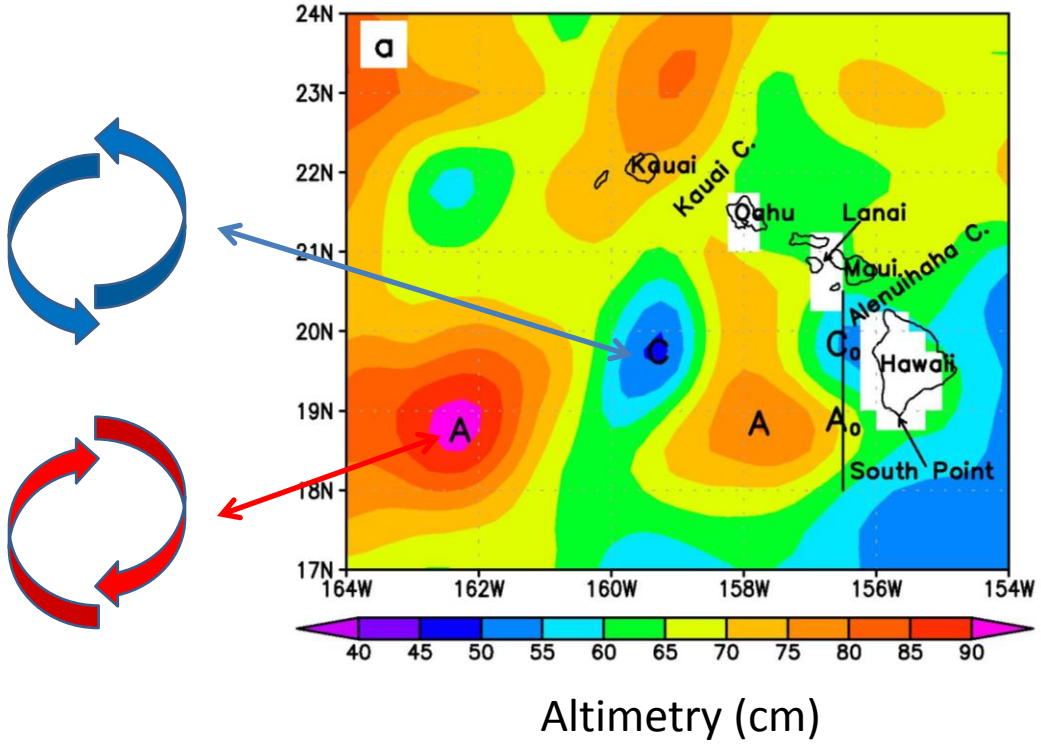
- **Direct use of the output for research**
- **As boundary conditions for regional studies**

ftp ftp.hycom.org
cd pub/hawaii

Mesoscale Eddies west of the Hawaiian Islands

Cyclonic
(Anti-clockwise)

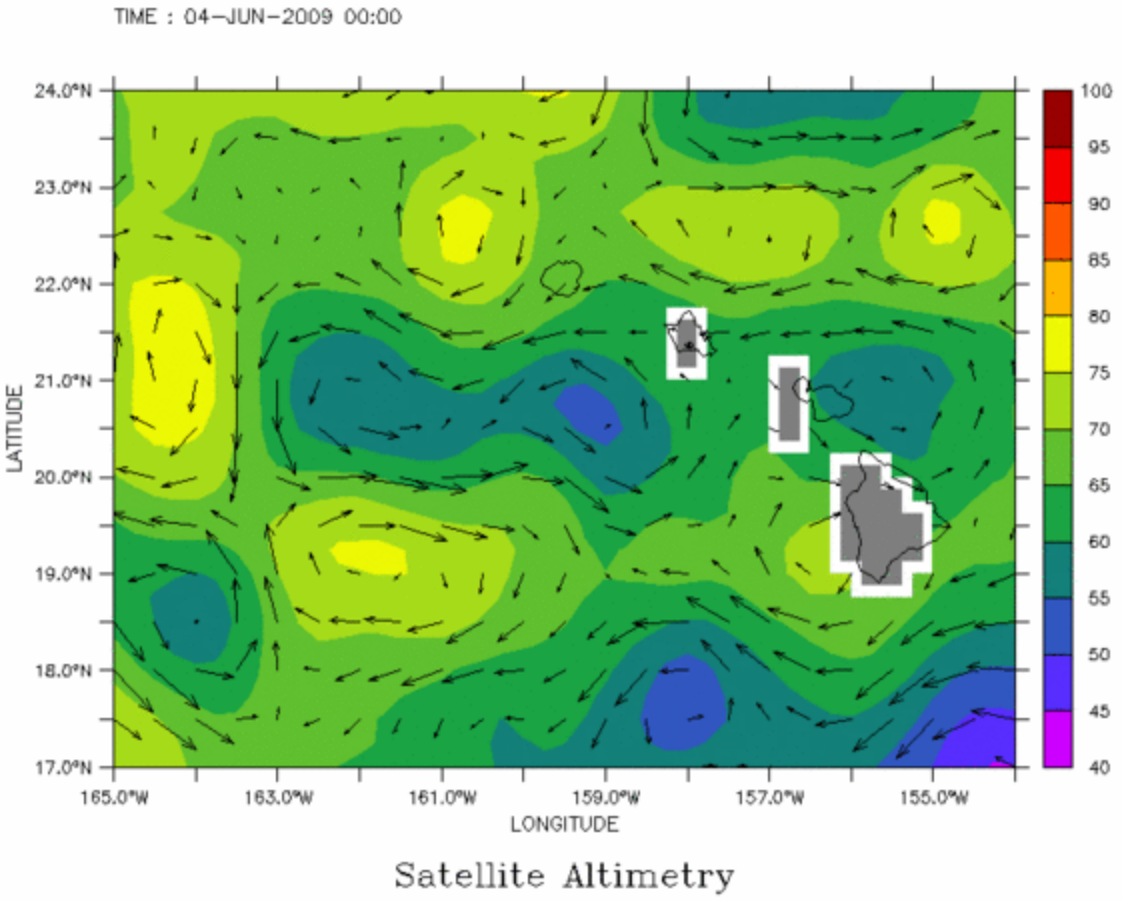
Anti-cyclonic
(Clockwise)



Altimetry (cm)

Main Eddy Characteristics

1. **Where from?**
   The Kona coast.
2. **When?**
   Year around.
3. **Where to?**
   Westward mostly.
   Cyclonic eddies move southward sometimes.
4. **For how long?**
   Two weeks to months.
   Anti-cyclonic eddies are stronger and longer-lasting than cyclonic ones.



How are they generated?

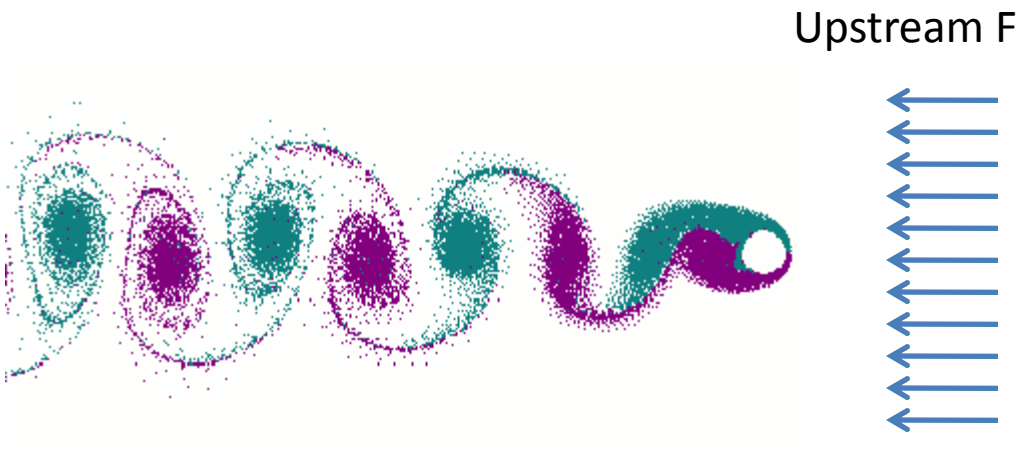
- Oceanic flow passing by a barrier
- Atmospheric flow passing by a barrier

How are they generated?

- Oceanic flow passing by a barrier
- Atmospheric flow passing by a barrier

Kármán vortex street

(From Wikipedia, courtesy Cesareo de La Rosa Siqueira)



Reynolds number: $$Re = \frac{Vd}{\nu} > a\ limiting\ value$$

d: the diameter of the cylinder

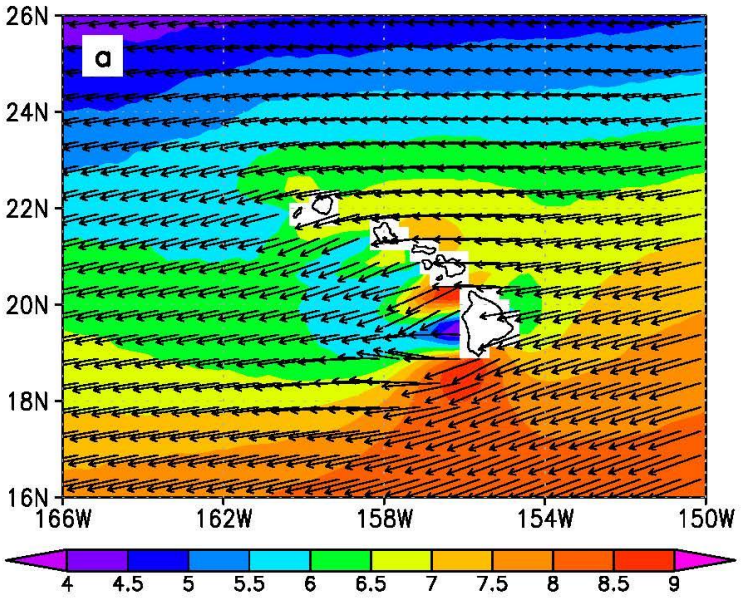
V: the steady velocity of the flow upstream of the cylinder

ν: the kinematic viscosity of the fluid

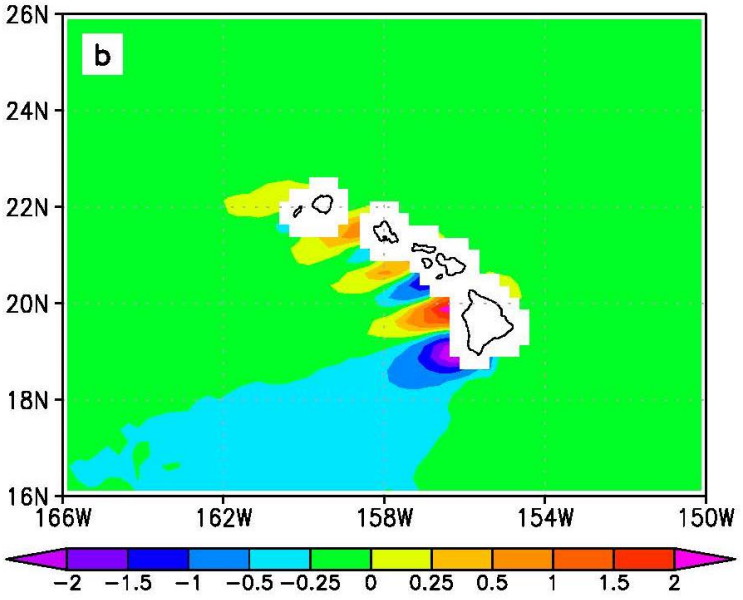
How are they generated?

- Oceanic flow passing by a barrier
- Atmospheric flow passing by a barrier

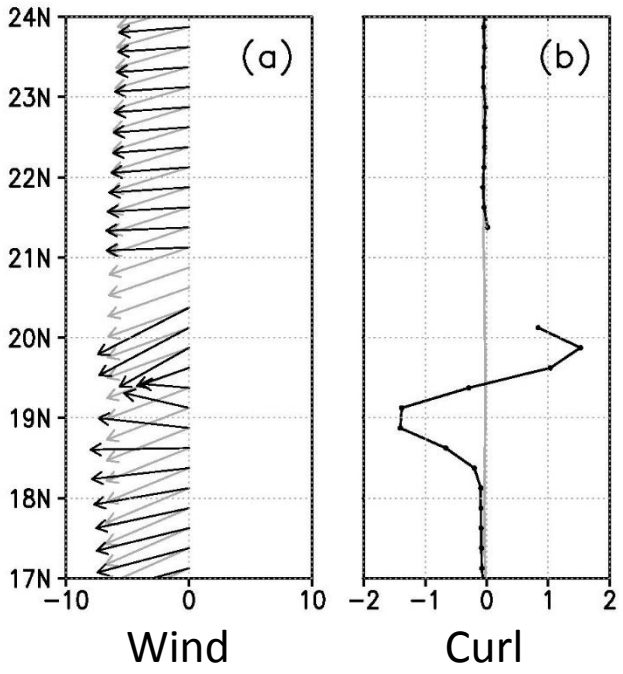
Wind Stress → Ekman Drift → Divergence Convergence → Upwelling Downweling

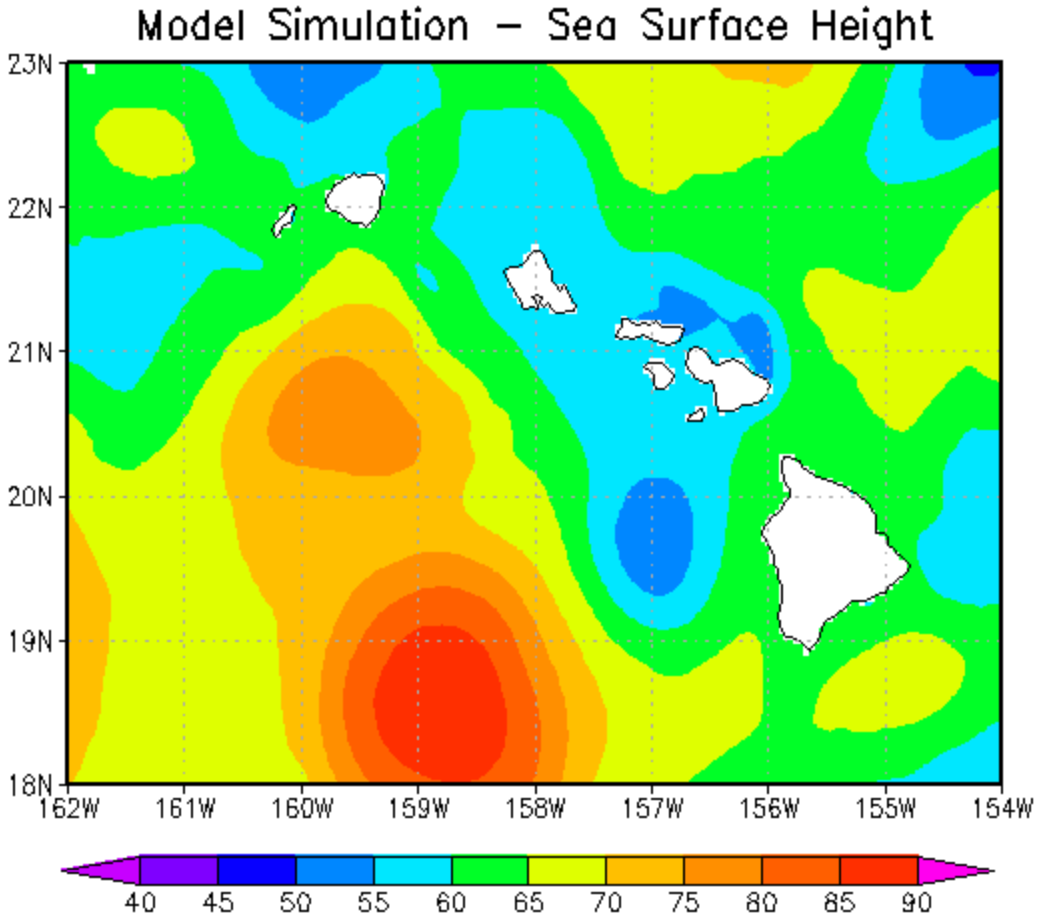


QuikSCAT Wind (m/s)



Ekman Pumping (m/day)





Jia et al. (2011), JGR – Oceans

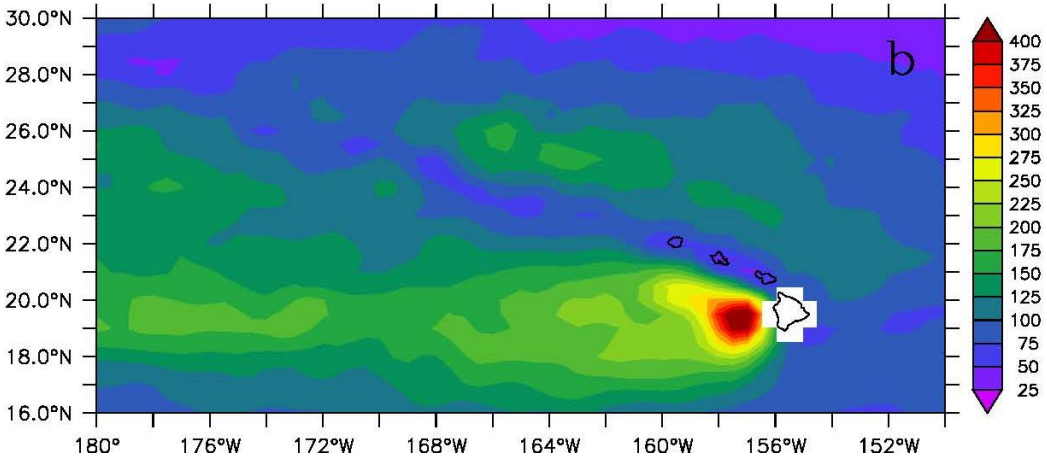
Co-authors:
P. H. R. Calil, E. P. Chassignet,
E. J. Metzger, J. T. Potemra,
K. J. Richards, and A. J. Wallcraft

Eddy Kinetic Energy

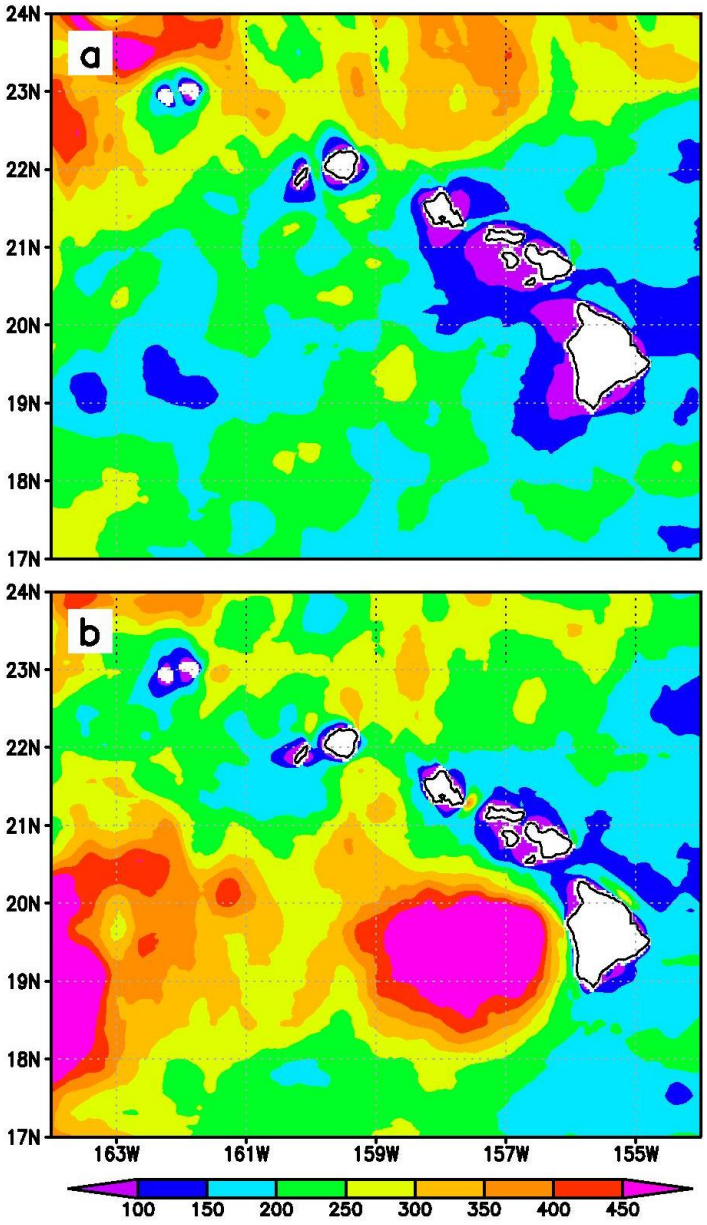
No wind wake

With wind wake

Observation



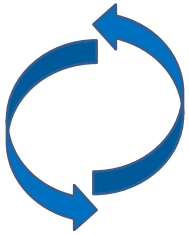
Altimetry



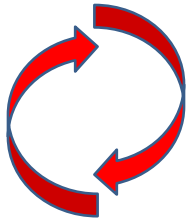
$(cm^2\ s^{-2})$

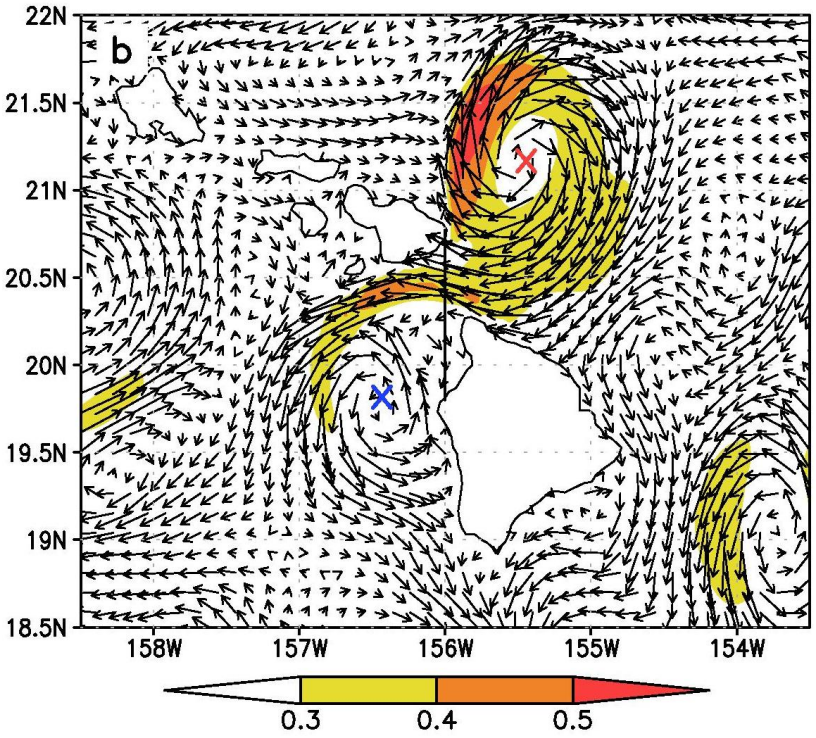
Eddies induced by current

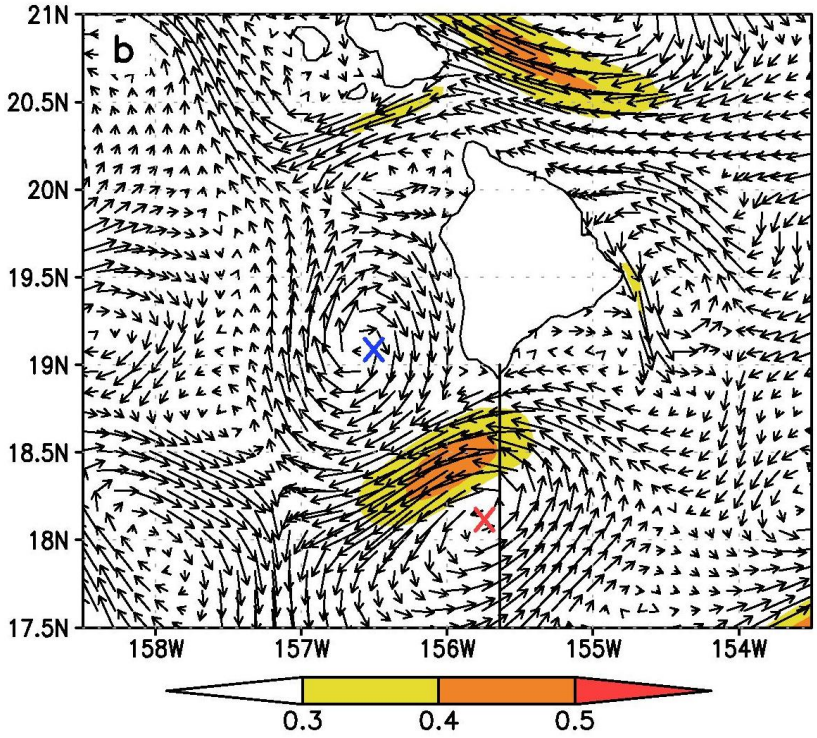
Cyclonic
(Anti-clockwise)



Anti-cyclonic
(Clockwise)

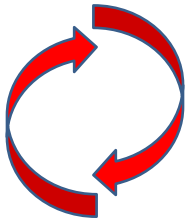




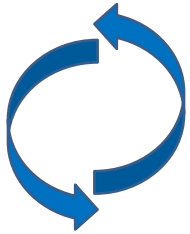


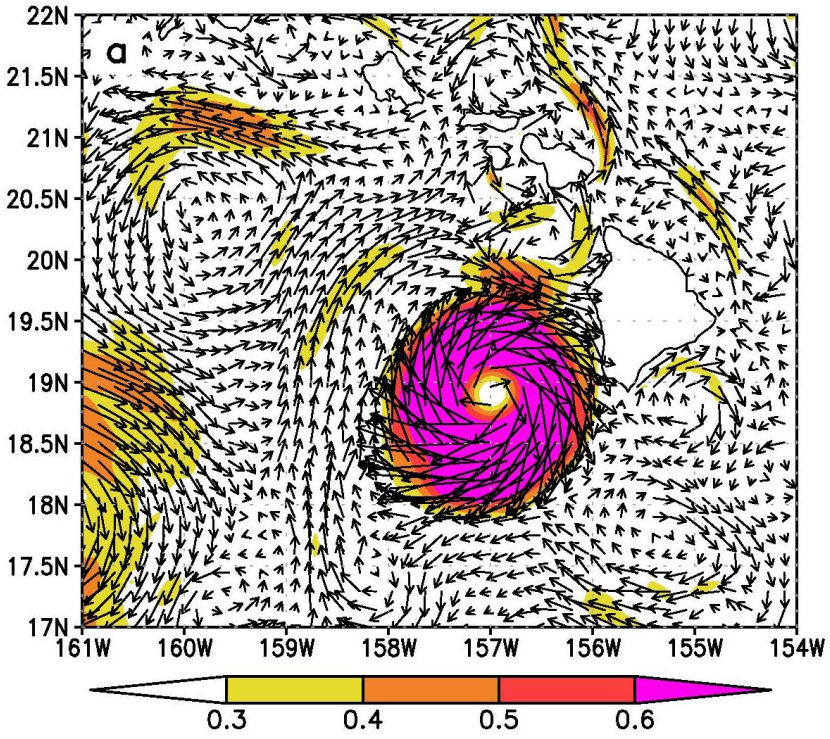
Eddies induced by wind

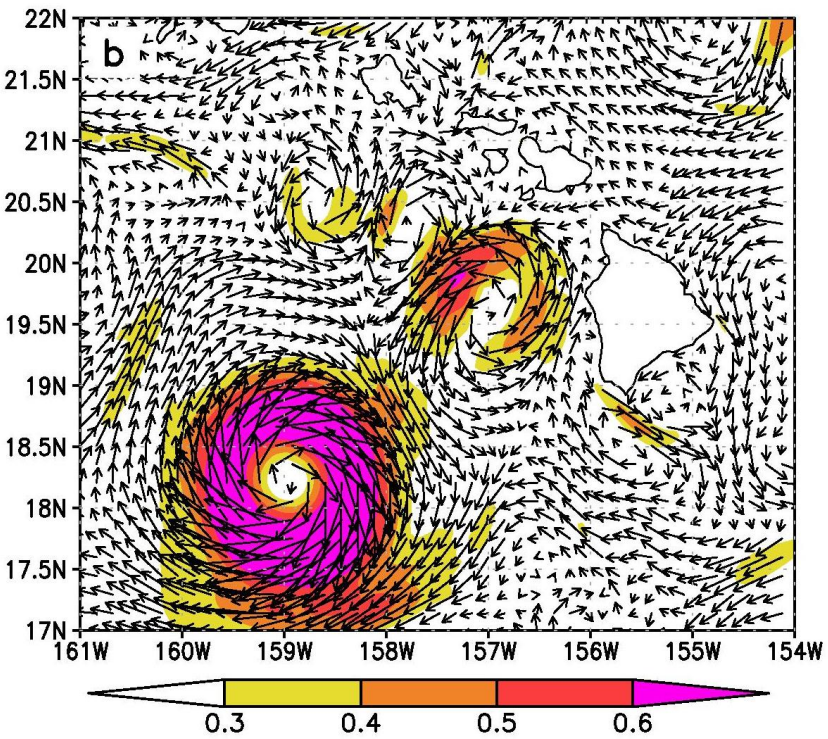
Anti-cyclonic
(Clockwise)



Cyclonic
(Anti-clockwise)







OPEN ACCESS Freely available online

PLoS one

Larval Connectivity in an Effective Network of Marine Protected Areas

Mark R. Christie[1]*, Brian N. Tissot[2], Mark A. Albins[1], James P. Beets[3], Yanli Jia[4], Delisse M. Ortiz[5], Stephen E. Thompson[6], Mark A. Hixon[1]

Figure 1. Adult yellow tang (*Zebrasoma flavescens*) photographed off the western (Kohala where they occur at high densities. Approximately half a million juvenile yellow tang (representing r from the island by the aquarium industry each year. Photo: W.J. Walsh.
doi:10.1371/journal.pone.0015715.g001

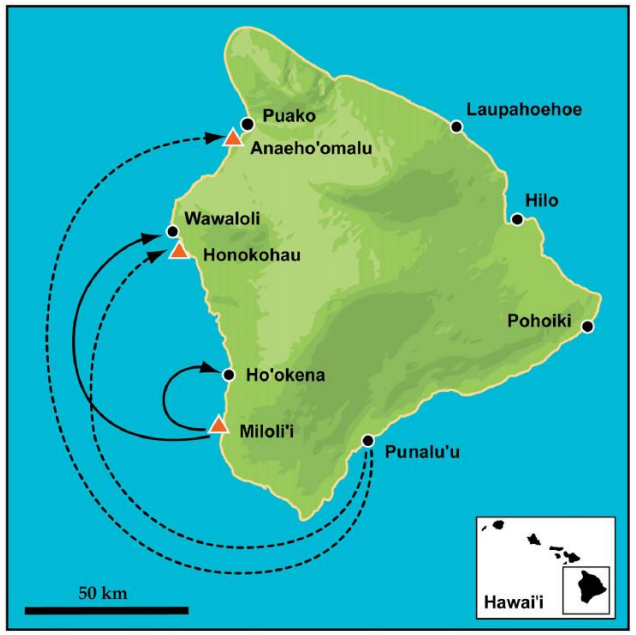
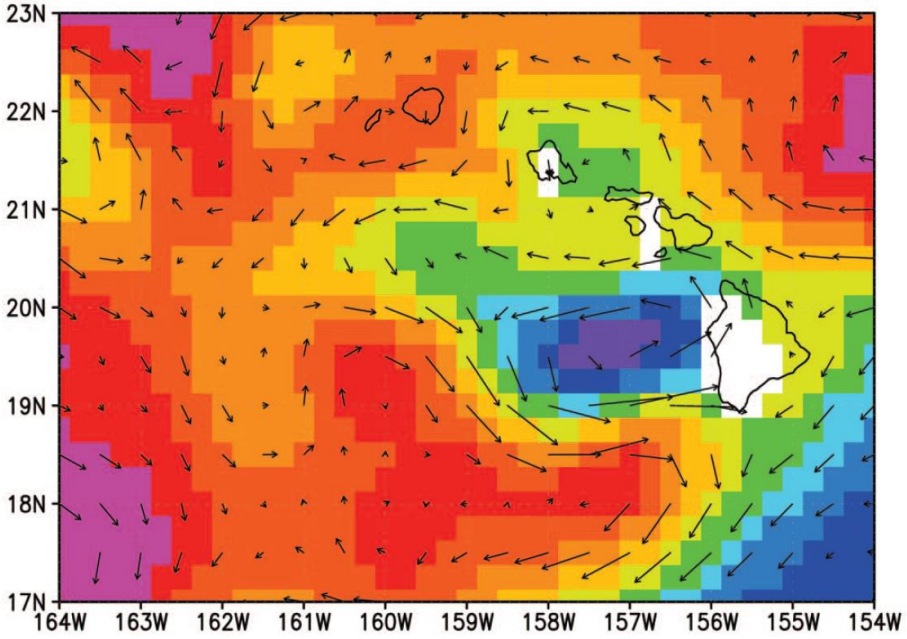
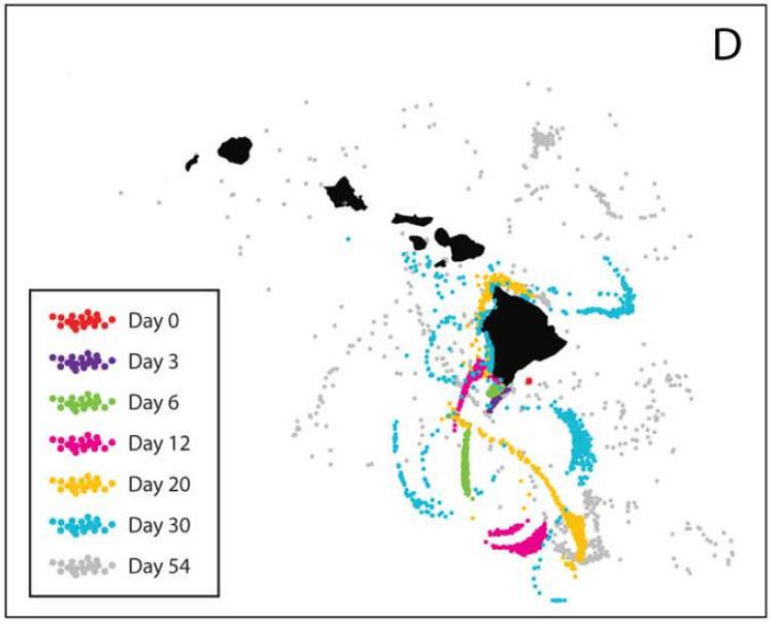


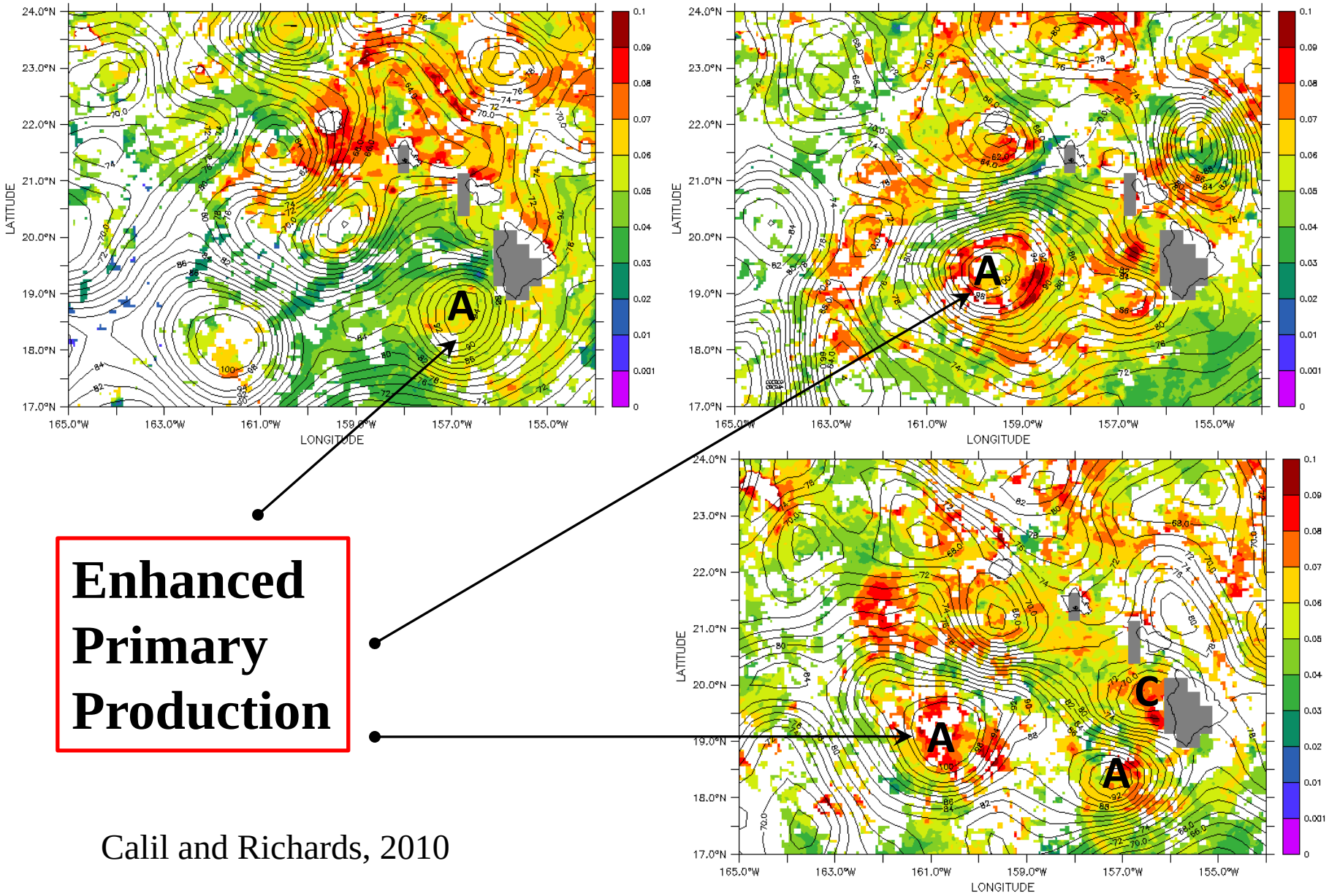
Figure 2. Patterns of larval connectivity in yellow tang off the Island of Hawai'i as determined by direct detection of four different parent-offspring pairs. Sample reefs are indicated by triangles and circles, where triangles represent marine protected areas (MPAs) and circles represent unprotected areas. The identified parents were sampled at Miloli'i and Punalu'u. Arrows point to the settlement site of the offspring. Solid lines indicate the first unequivocal evidence of an MPA seeding unprotected sites.
doi:10.1371/journal.pone.0015715.g002



Altimetry



Model Simulation



Enhanced Primary Production

Calil and Richards, 2010

Chlorophyll–a (color), Sea Surface Height (contour)

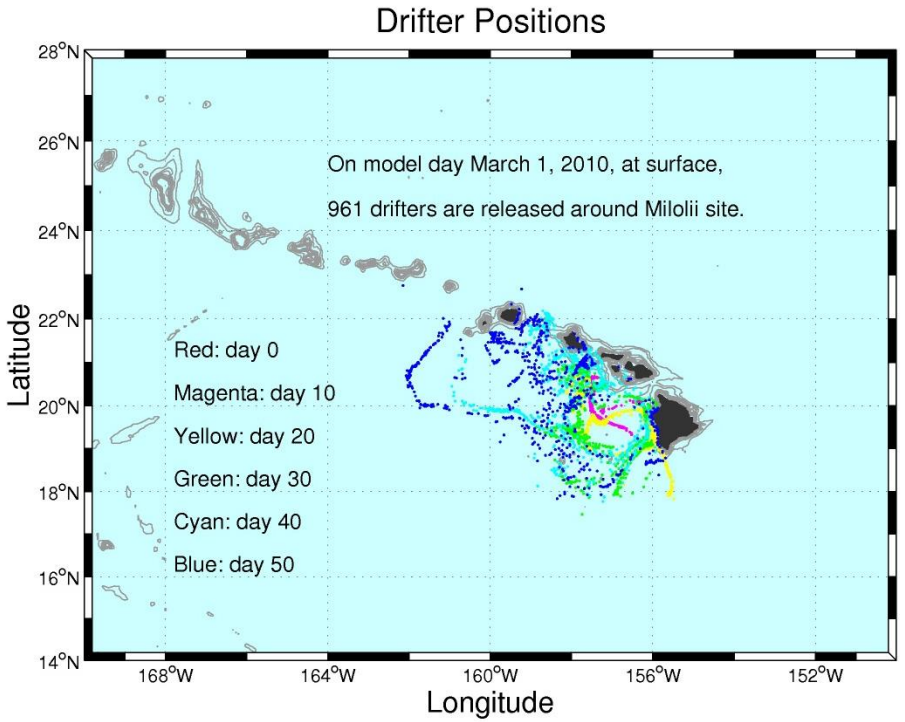
Summary

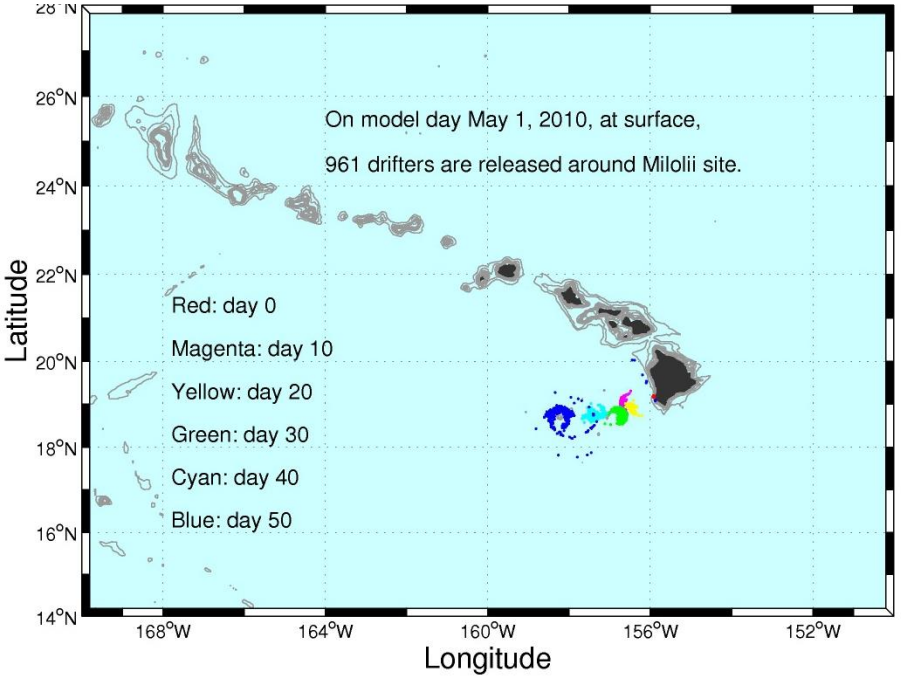
- Eddies are generated frequently in the region west of the island of Hawaii.
- Wind is the primary driver of these eddies.
- Oceanic flow makes a minor contribution.
- They have a strong impact on the marine ecosystem of the region.

Cyclonic
(Anti-clockwise)

Effects on Larval Connectivity

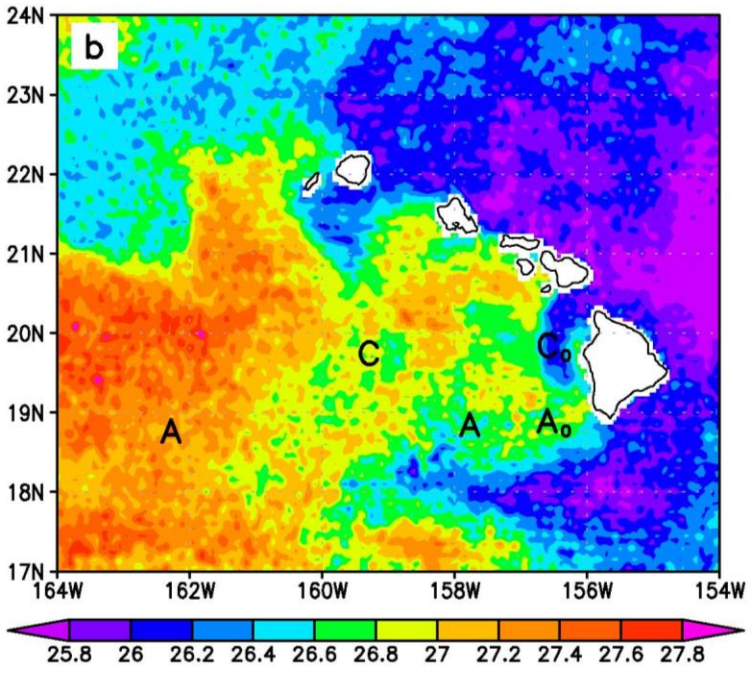
Anti-cyclonic
(Clockwise)



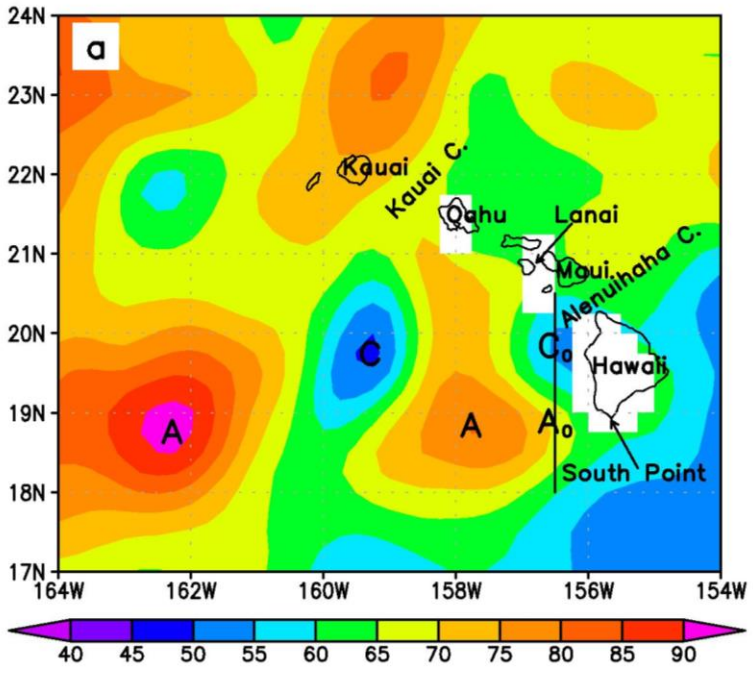


Signatures in Surface Temperature

(NOAA OceanWatch – *Eddy Watch Hawaii*)



Temperature (°C)



Altimetry (cm)