# Evaluation of fleet dynamics and oceanography as factors accounting for variations in black-footed albatross interactions in the Hawai‘i-based deep-set longline fishery, 2006-2017

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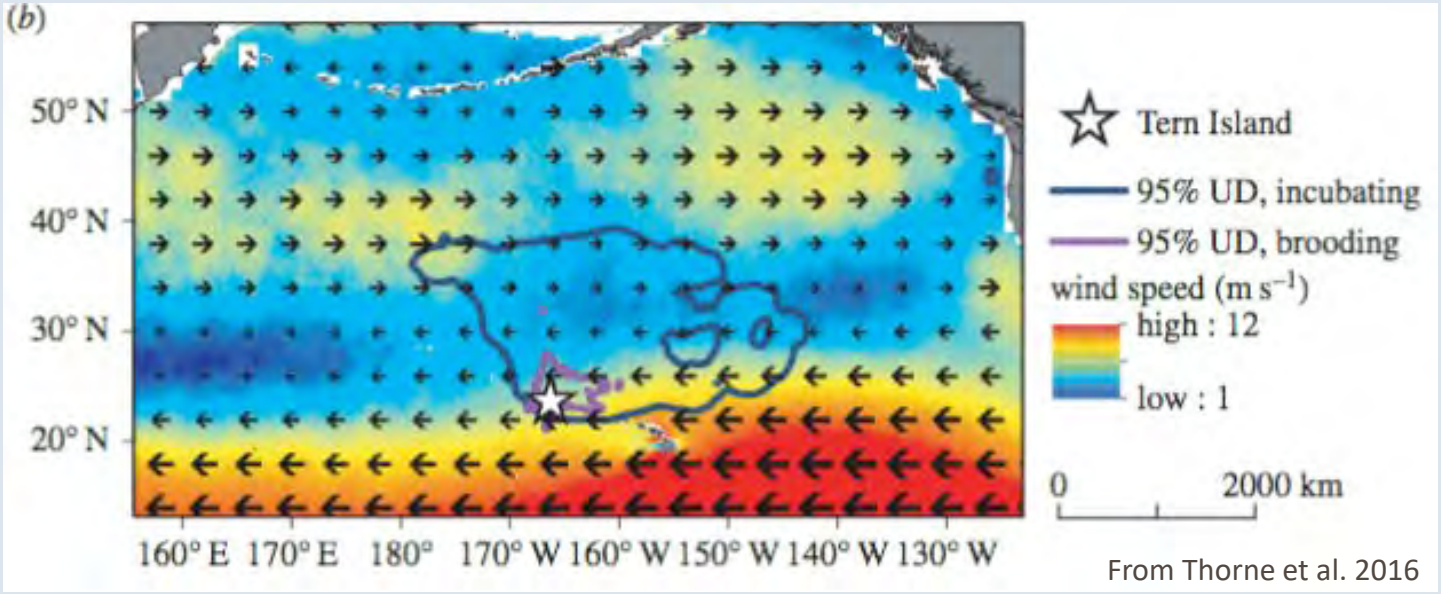
PICES transitional areas symposium

La Paz, Mexico, April 23rd, 2018

# Black-footed Albatross
## *(Phoebastria nigripes)*

- Nests in Northwestern Hawaiian Islands
  - Incubation – 10-30 day trips
  - Brooding – 1-3 day trips
  - Chick rearing – alternate short and long trips
- Forage in the productive transition areas to the north

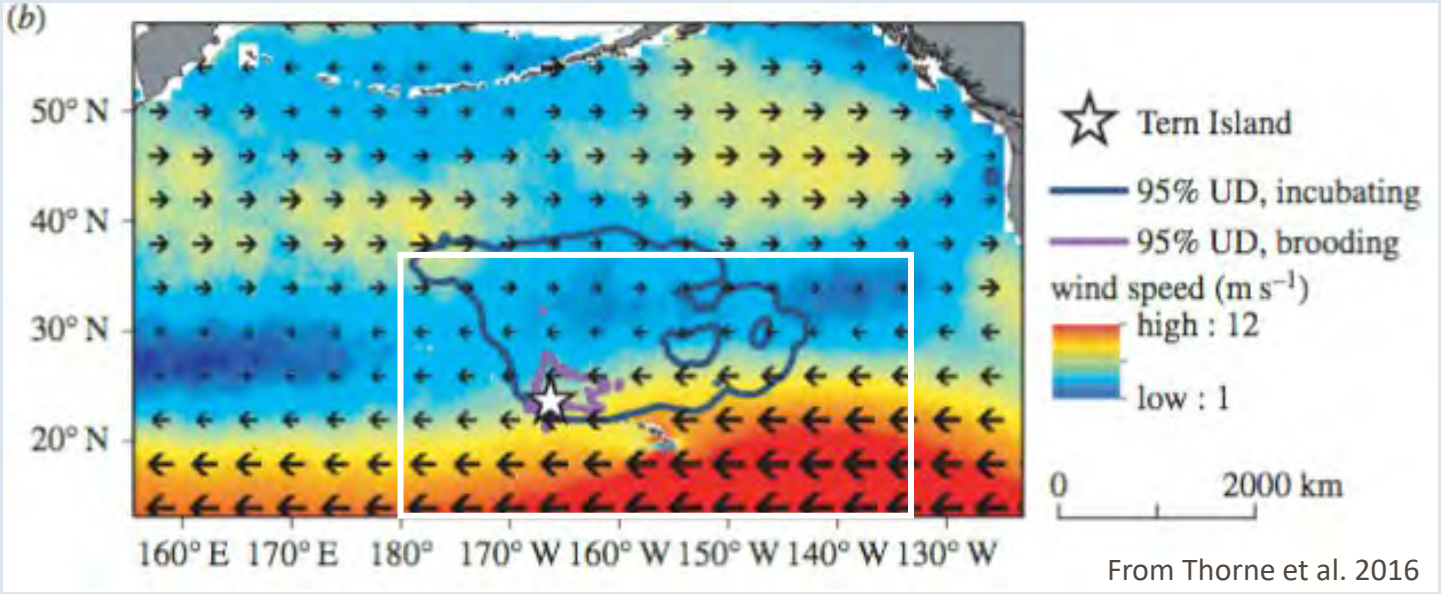



From Thorne et al. 2016

Photo: Brian E. Small

# Changes in albatross foraging behavior

- ENSO was the driver of the steady increase in interactions since 2000 of black-footed and Laysan albatross
- Forage further to the north during La Niña years




From Thorne et al. 2016

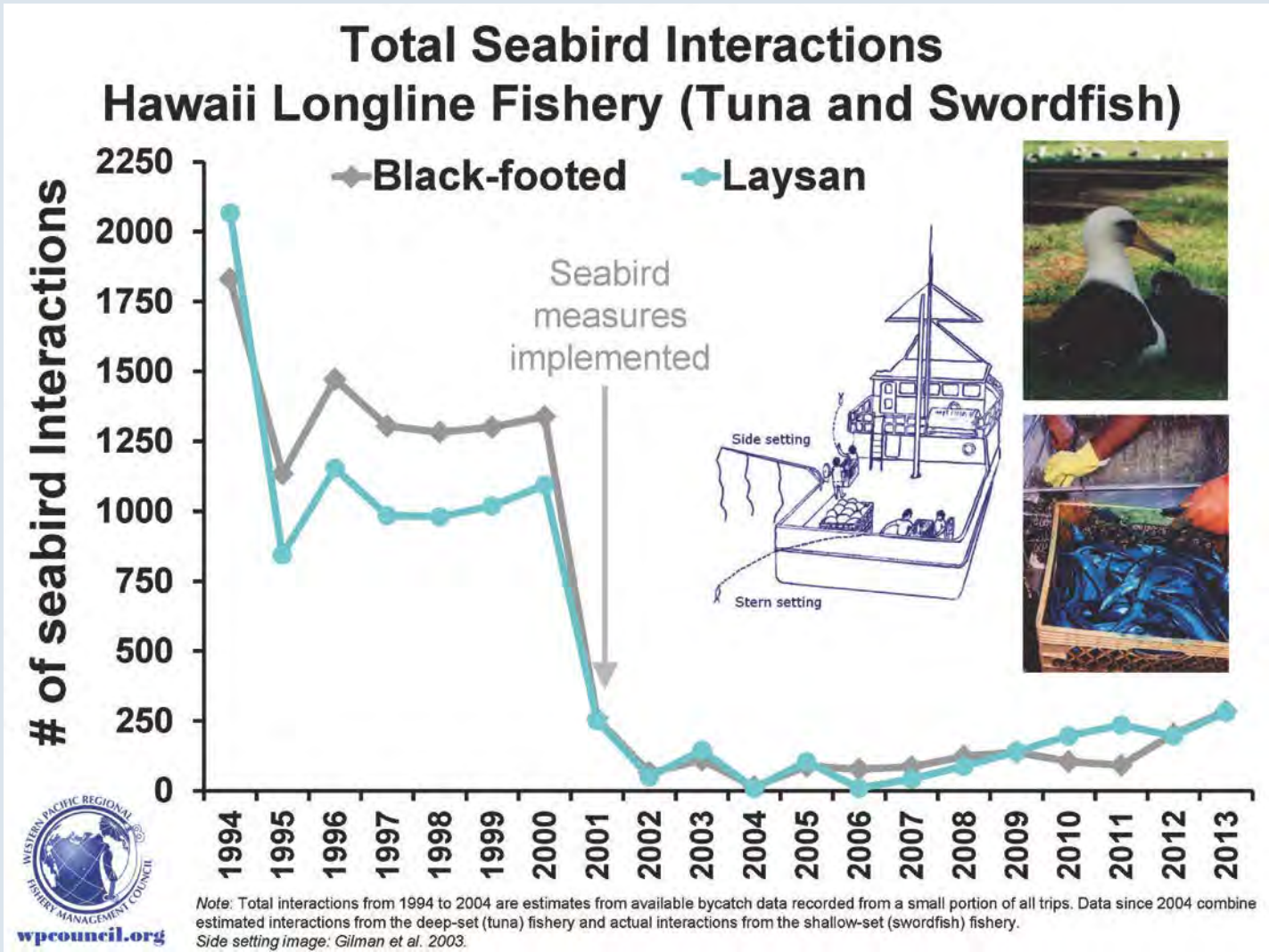
Gilman et al.,2016
Thorne et al. 2016

# Longline fishery interactions

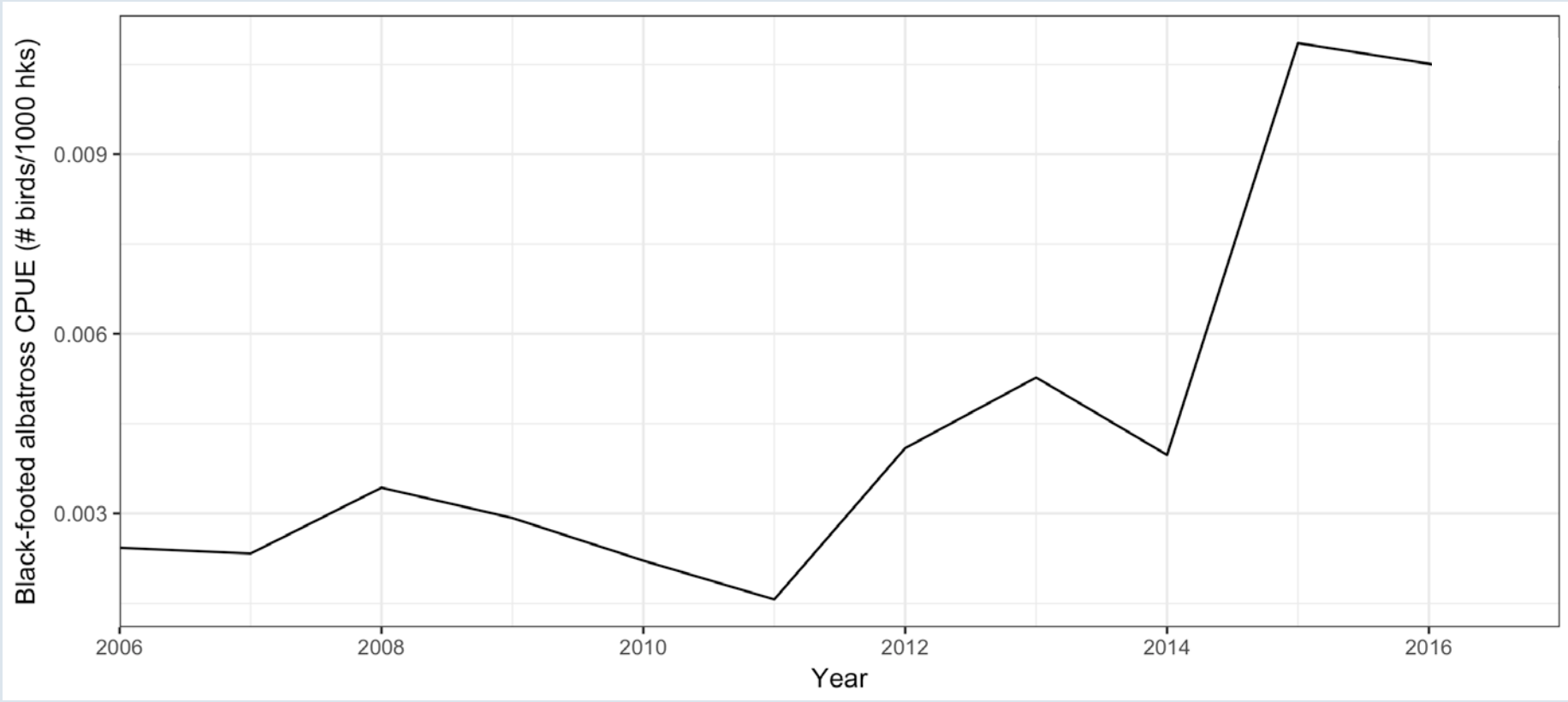
- Birds are hooked at the surface and pulled underwater as gear sinks
- Vessels fishing north of 23°N are required to use seabird mitigation measures in 2001
  - Side setting
  - Blue-dyed bait
- Mitigation measures reduced bycatch by 70-90%
- Record all hooked/entangled birds during gear haul
- Fisheries observers conduct bird scans 5 min after the start of the set

Gilman et al., 2015, 2016

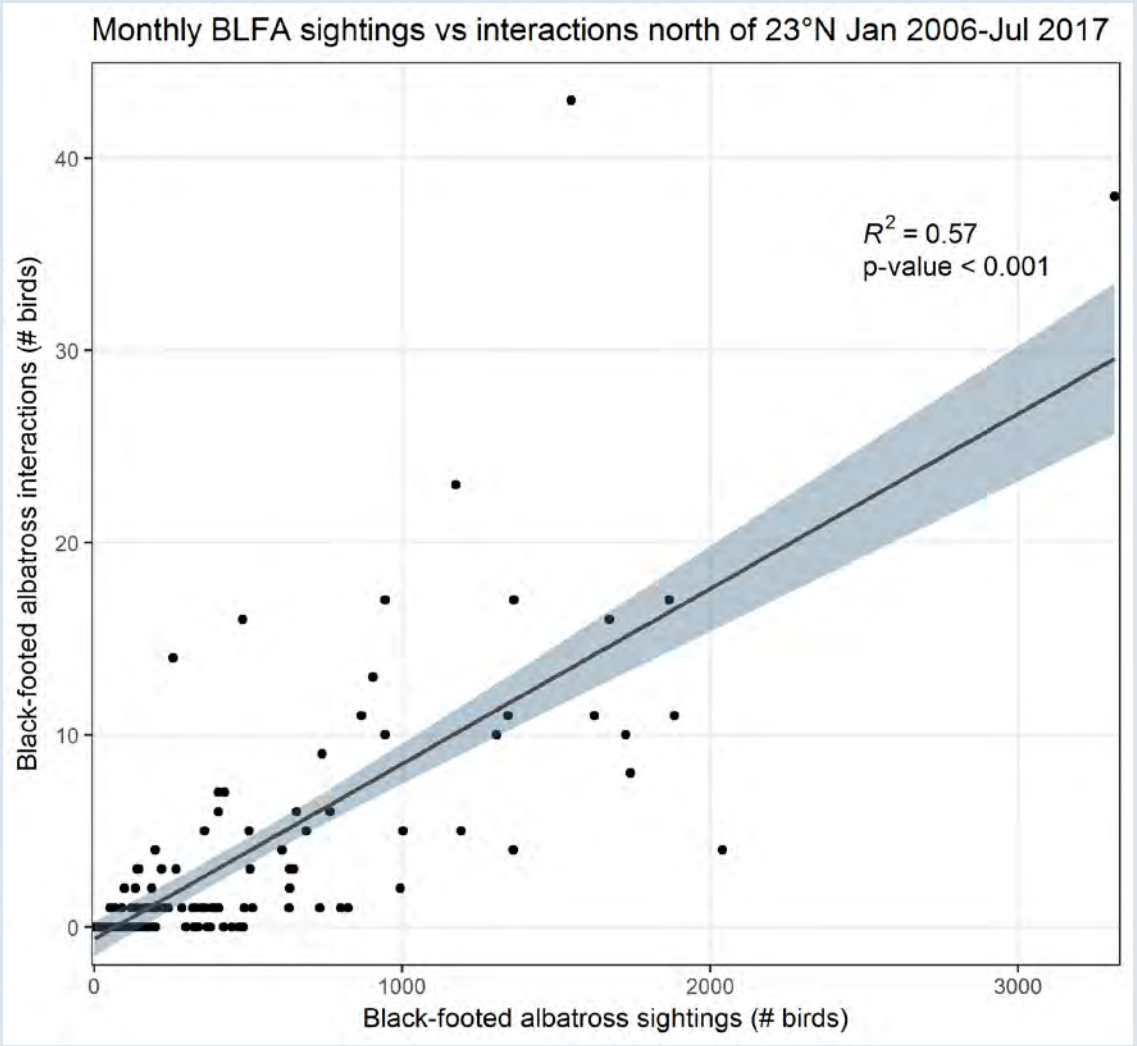
# Longline fishery interactions



# Increased interactions in the Hawai‘i longline fishery

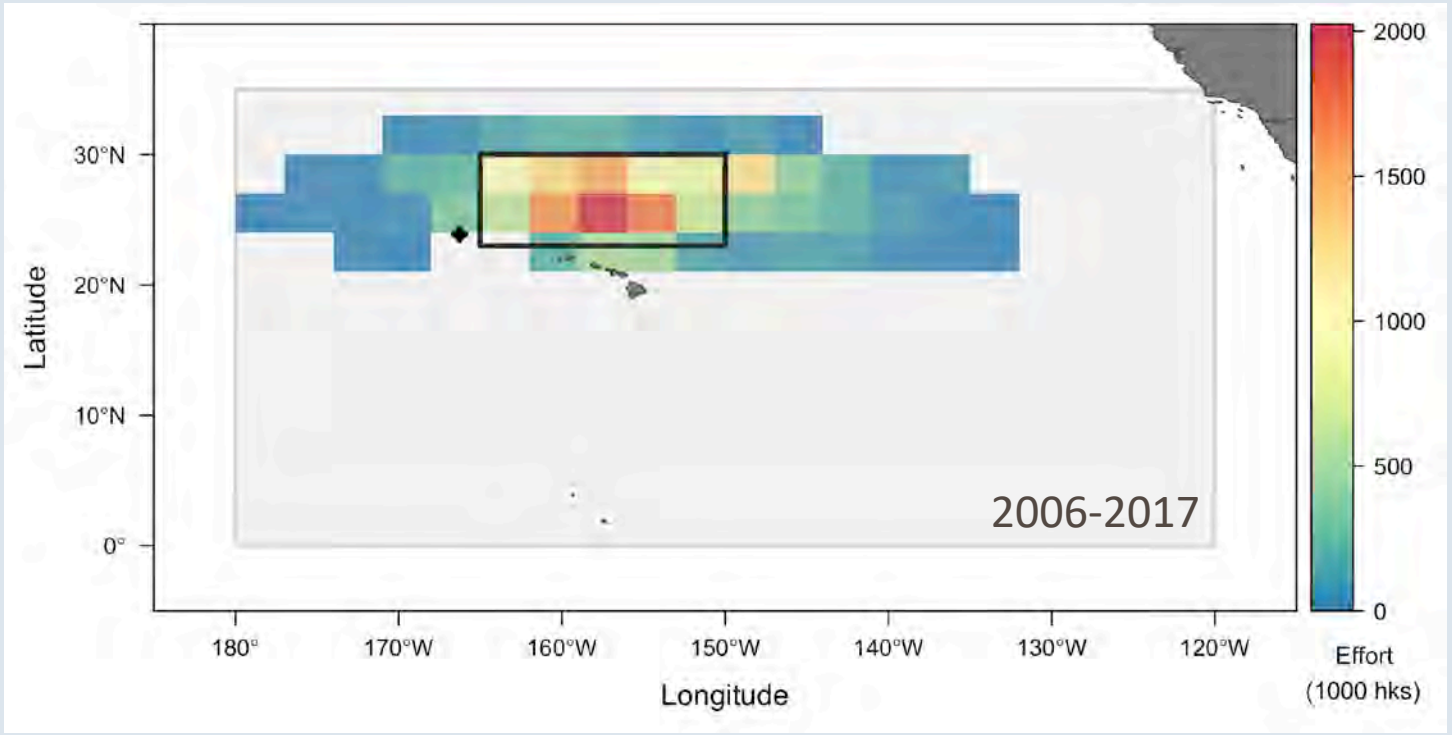


# Sightings vs. Interactions

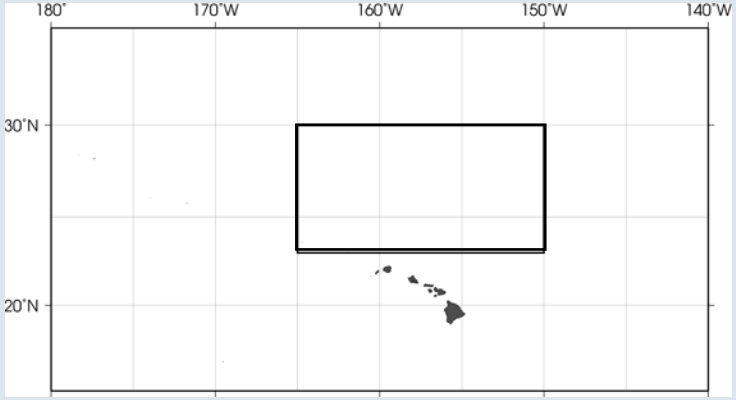


# What cause increase in interactions of BFAL?

- Used observer scan- and interaction data
- 2006-2016 time-series
- Focus on high interaction area 23-30°N and 150-165°W

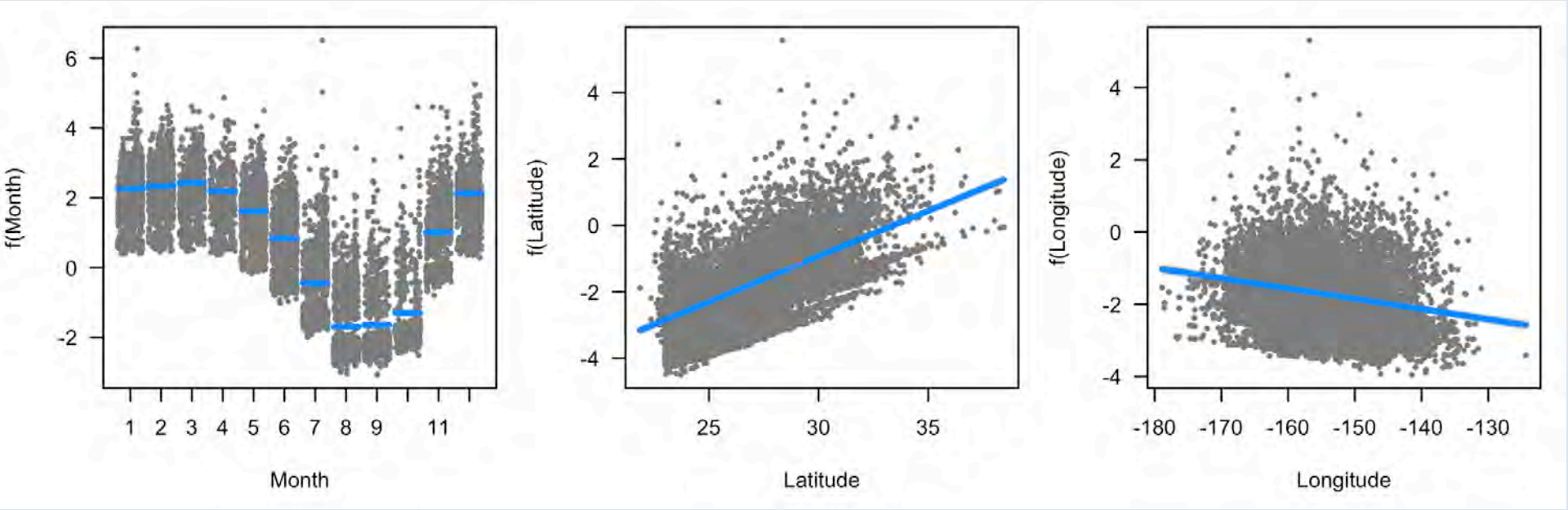


# GLM set up



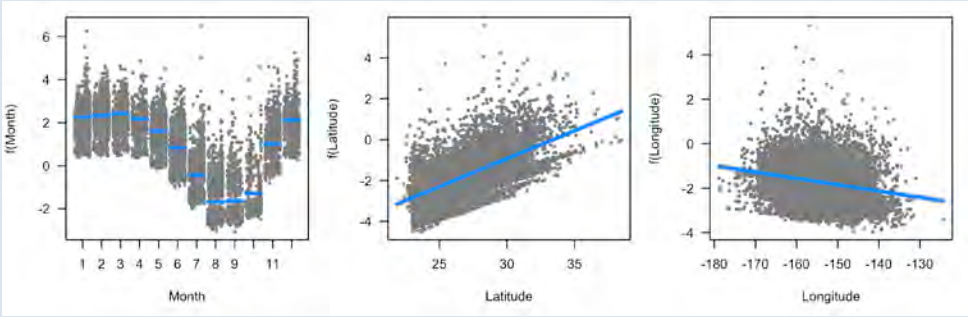

| Fleet dynamics | Local Climate Variables | Large-scale Climate Variables | Biological Variables |
|---|---|---|---|
| Seasonality: Month | Sea surface temperature (SST) | Pacific Decadal Oscillation index (PDO) | Nesting pair counts |
| Latitude & Longitude | SST standard deviation | Multivariate ENSO Index (MEI) | Reproductive success |
| Effort | Chlorophyll a | | Total fish catch |
| | Wind stress curl | | Total Mahimahi catch |
| | Meridional wind velocity | | |
| | Zonal wind velocity | | |

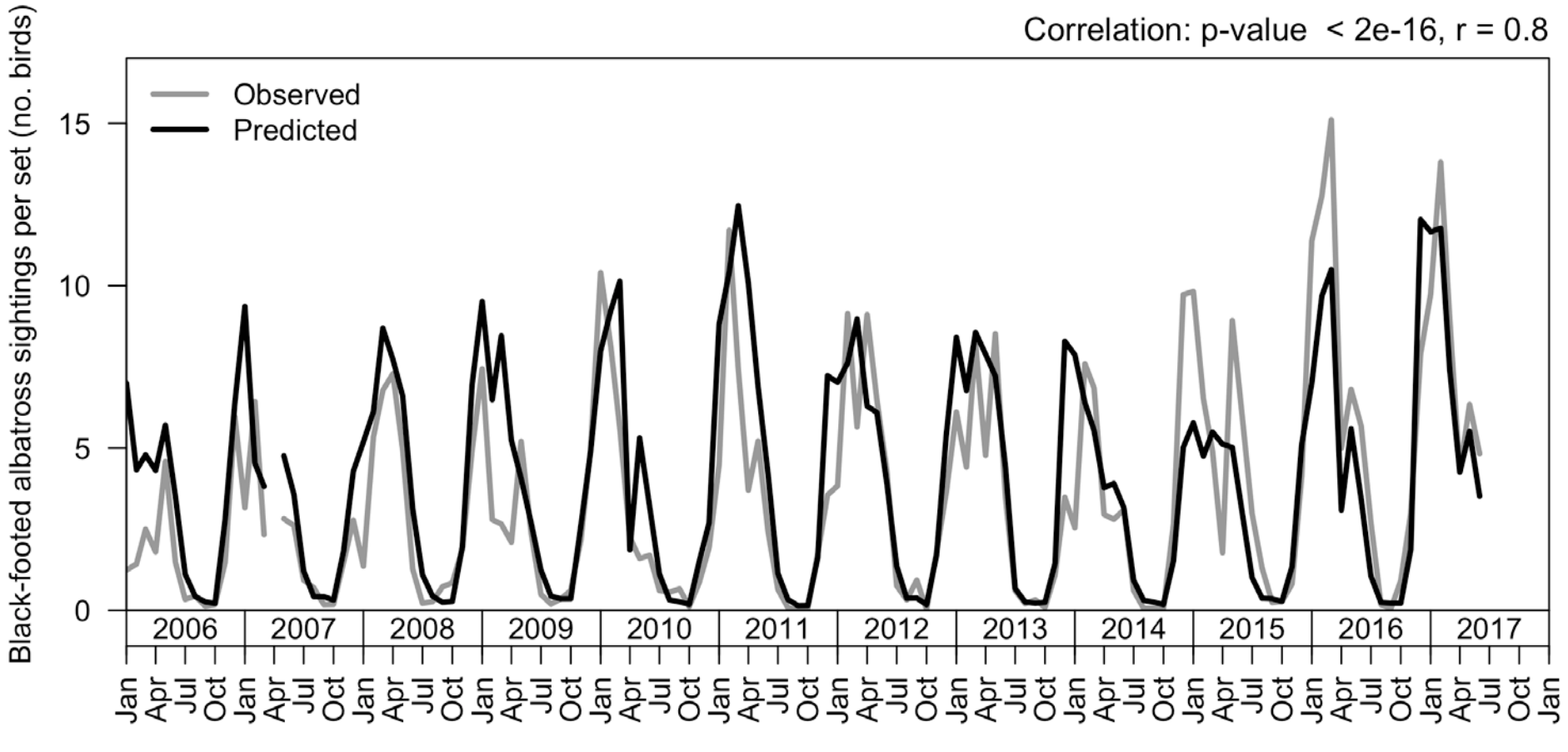
# Results:
# Fleet dynamics




- Strong seasonal patter
- Sightings increases closer to the breeding colonies
  - North
  - West

# Results:
# Fleet dynamics



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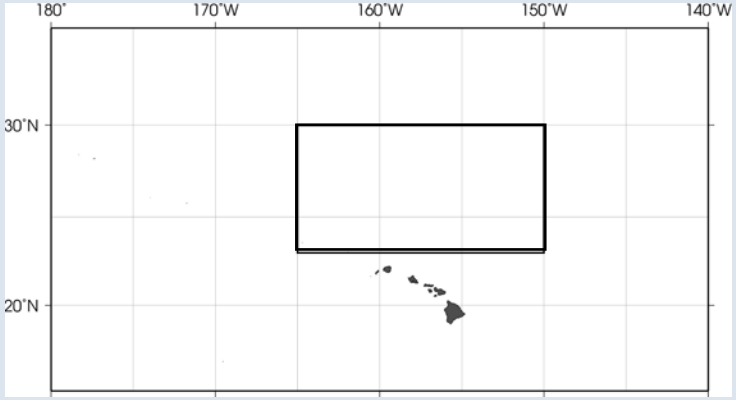


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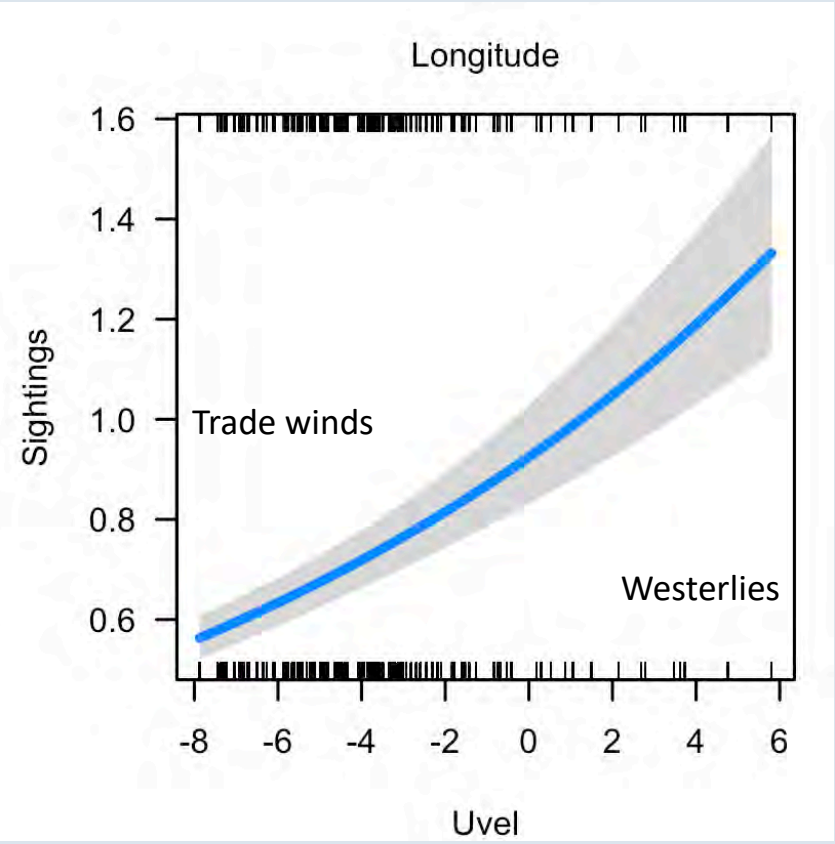
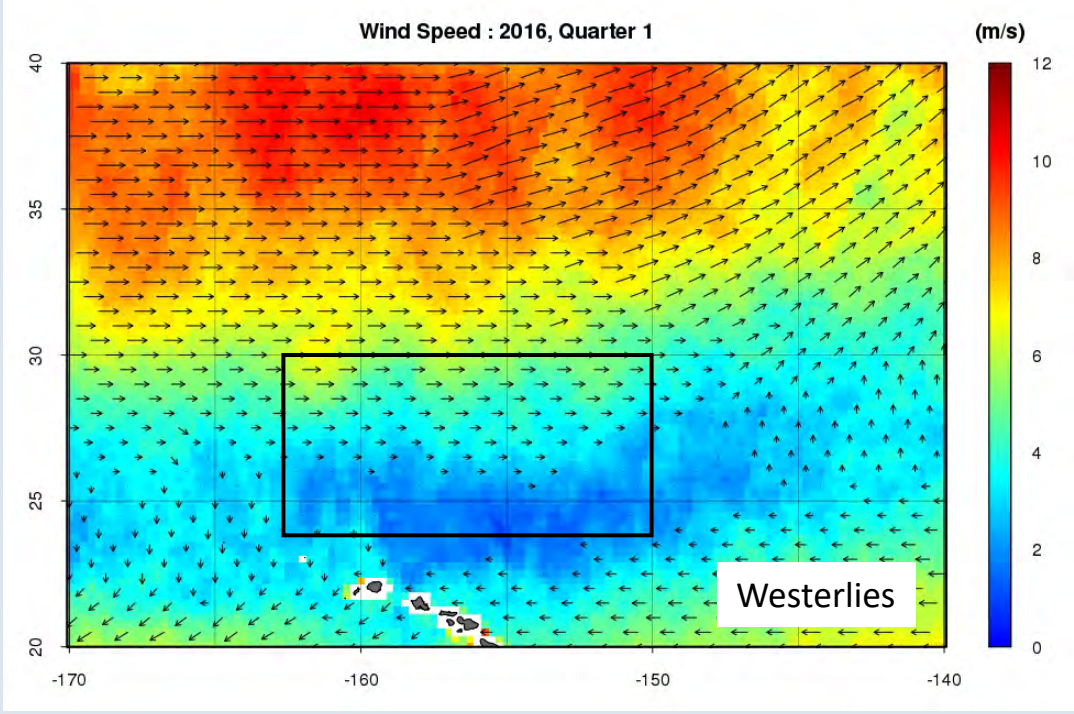
| | Meridional wind velocity | | |
| | Zonal wind velocity | | |

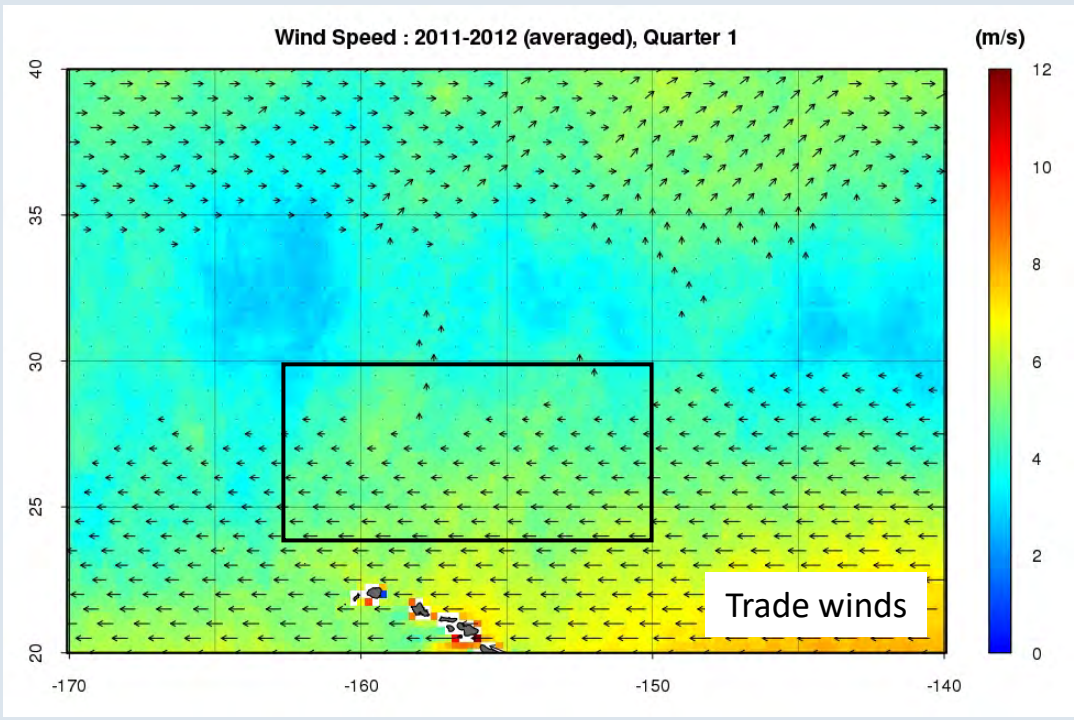
# Results:
## GLM performance

| Variable | AIC |
|---|---|
| **U velocity** | **67049.73** |
| V velocity | 67150.43 |
| Wind stress curl | 67500.32 |
| **PDO** | **67708.90** |
| MEI | 68063.88 |
| Chlorophyll a | 68200.24 |
| Fleet dynamics | 68436.97 |

# Local environment
## Zonal wind velocity



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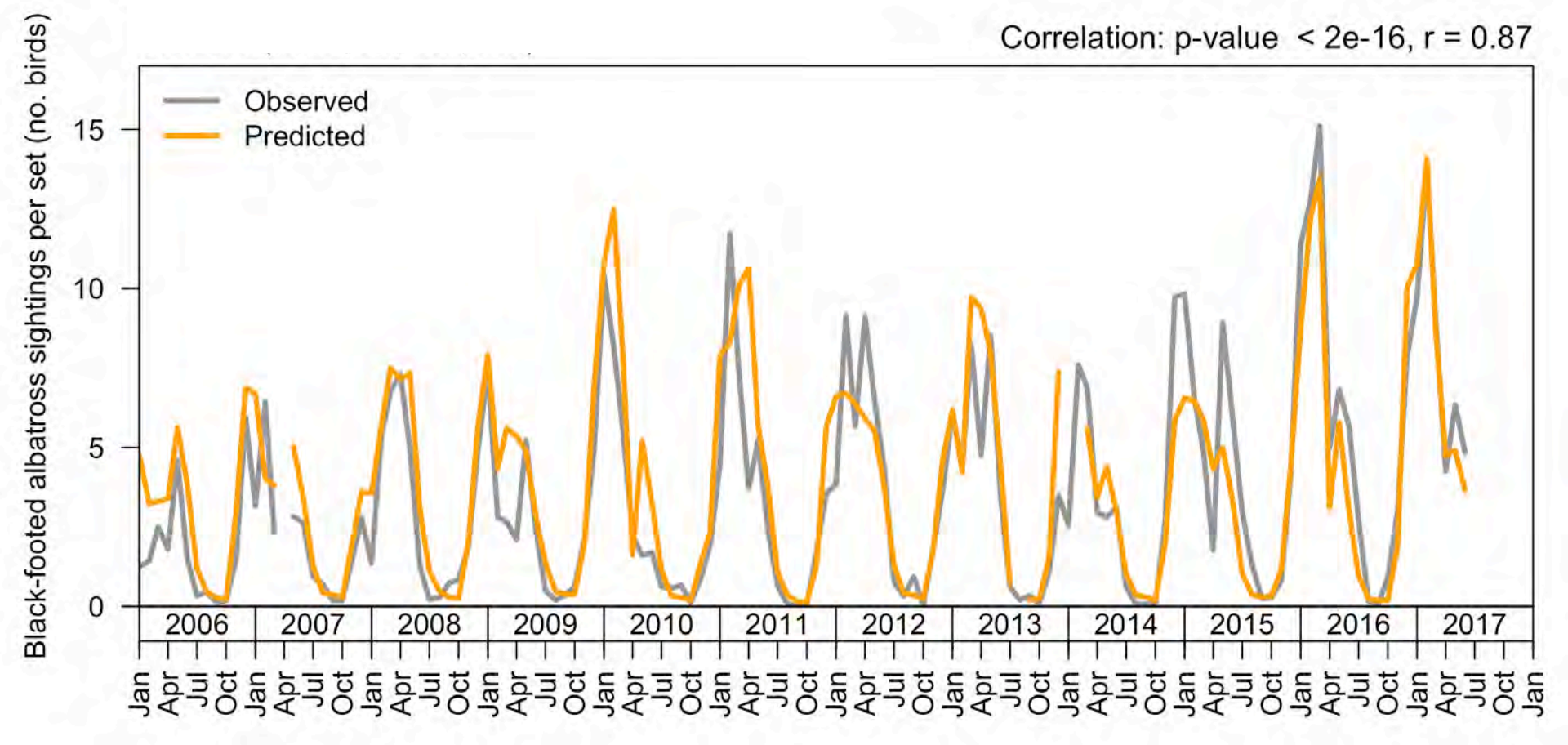
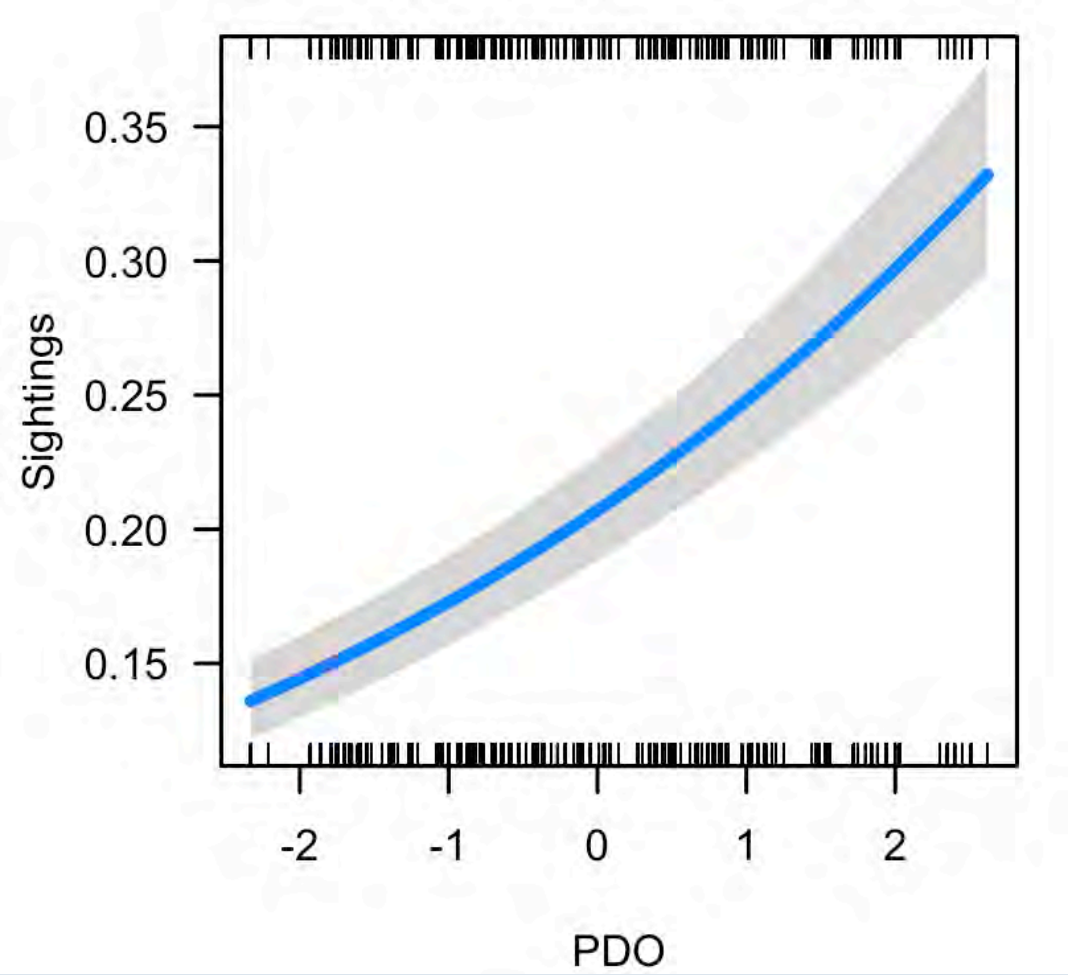


# Large scale climate
## Pacific Decadal Oscillation



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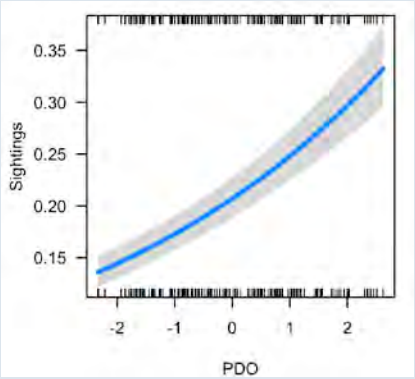
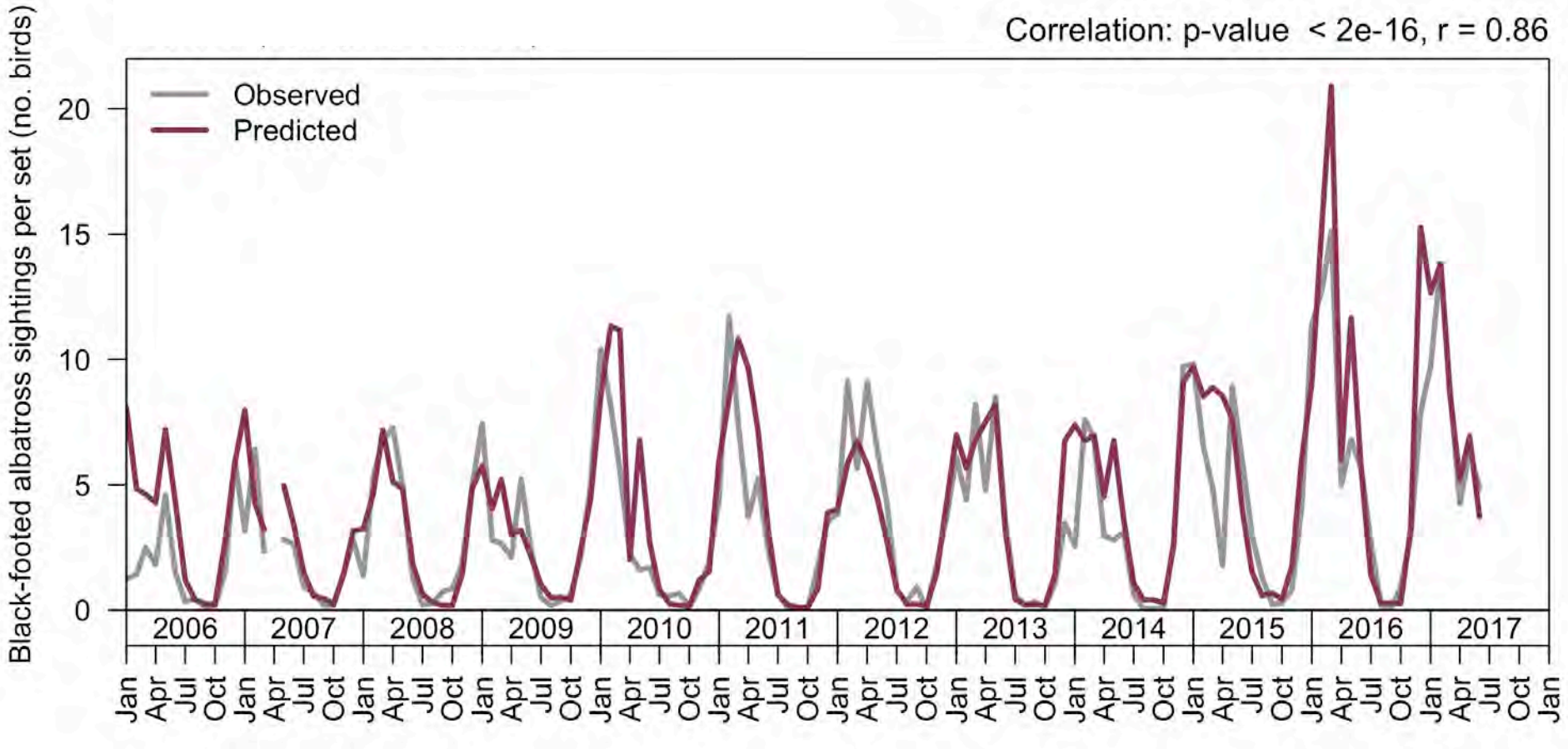
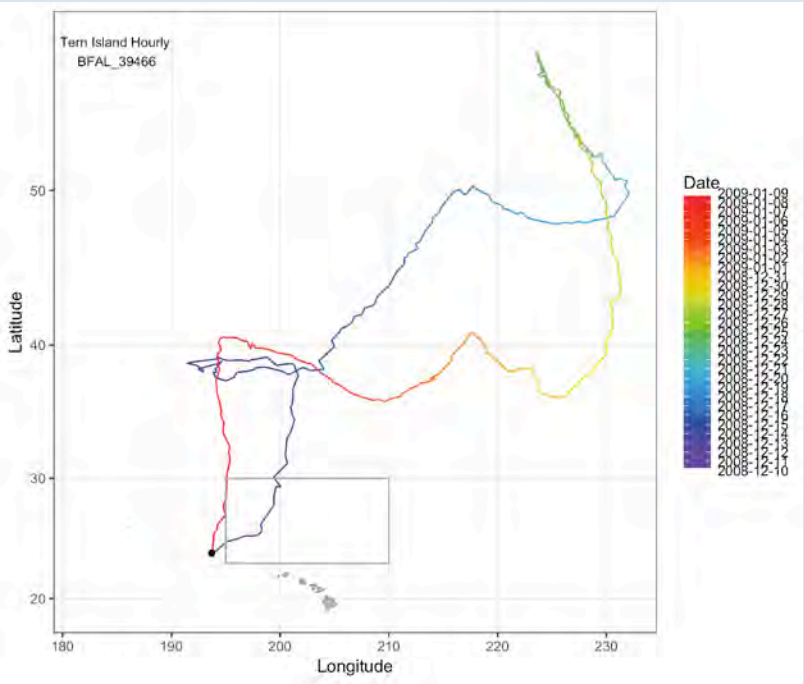
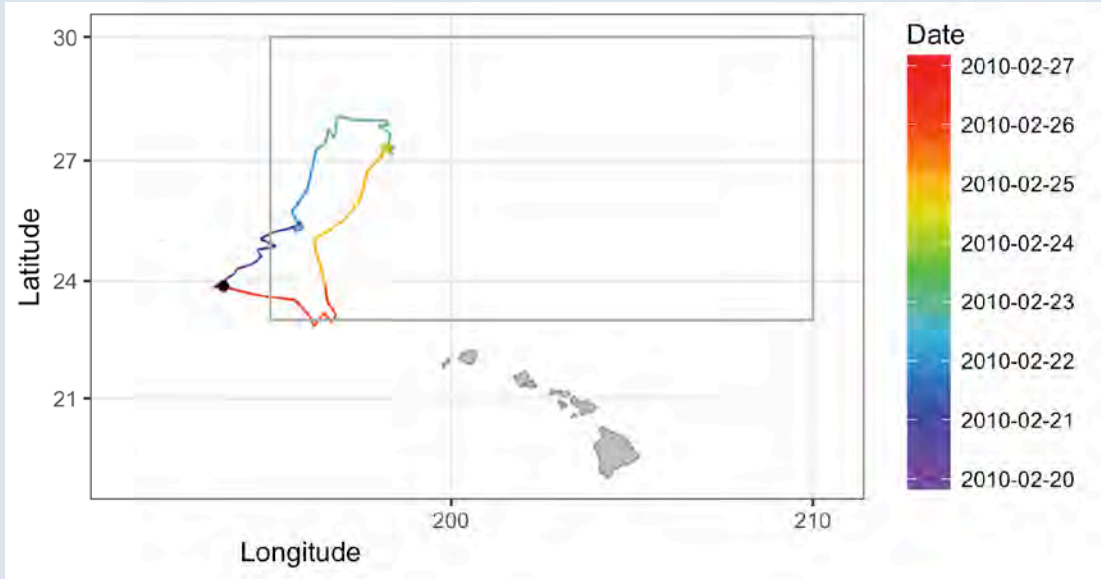


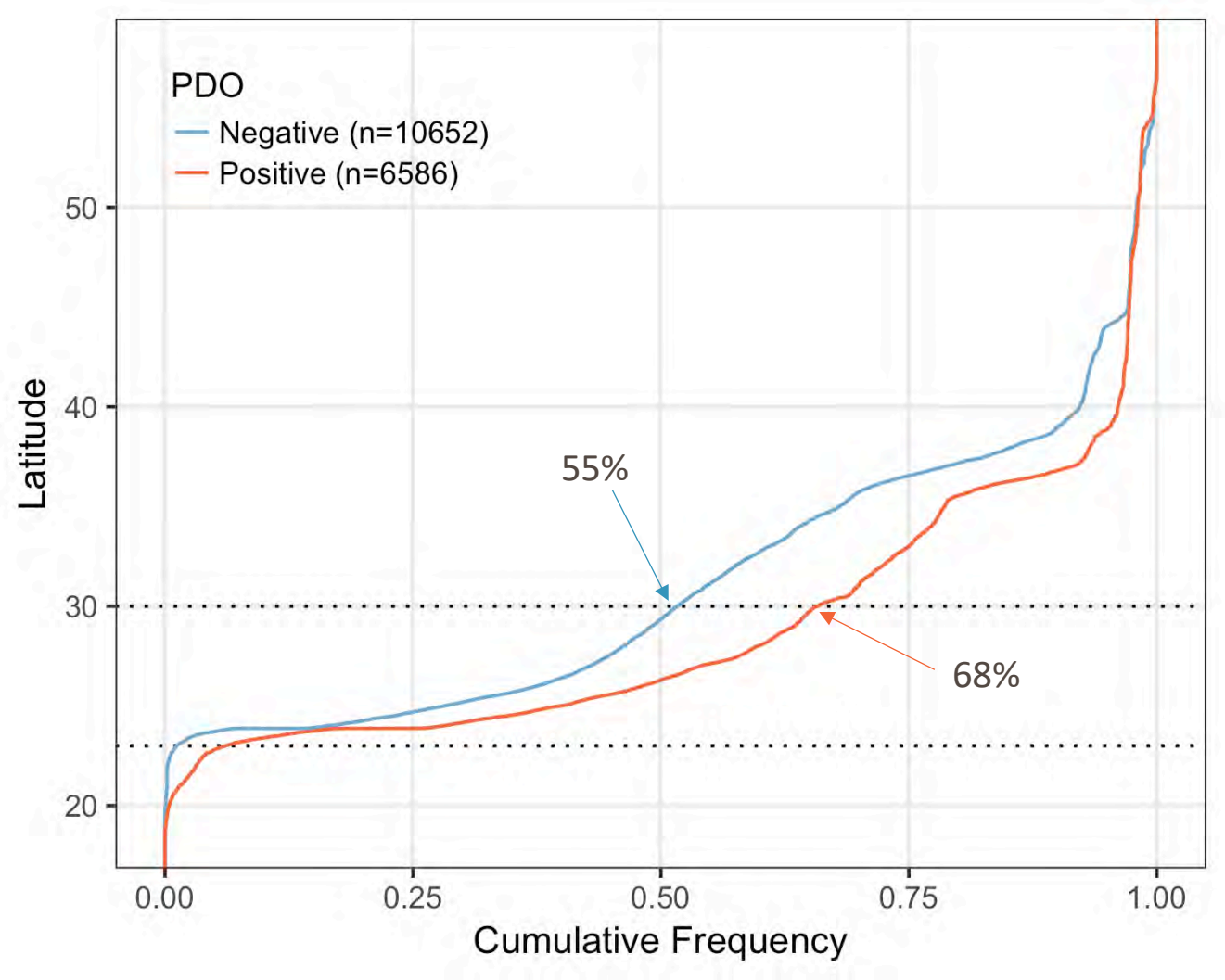
# Fisheries dependent data limitations

- Problems with fisheries dependent data
  - Only data where fishing happens
  - Fishers and BFAL forage on same resource
- GPS tag black-footed albatross nesting at Tern Island
  - Spend time foraging outside the 'high interactions' area

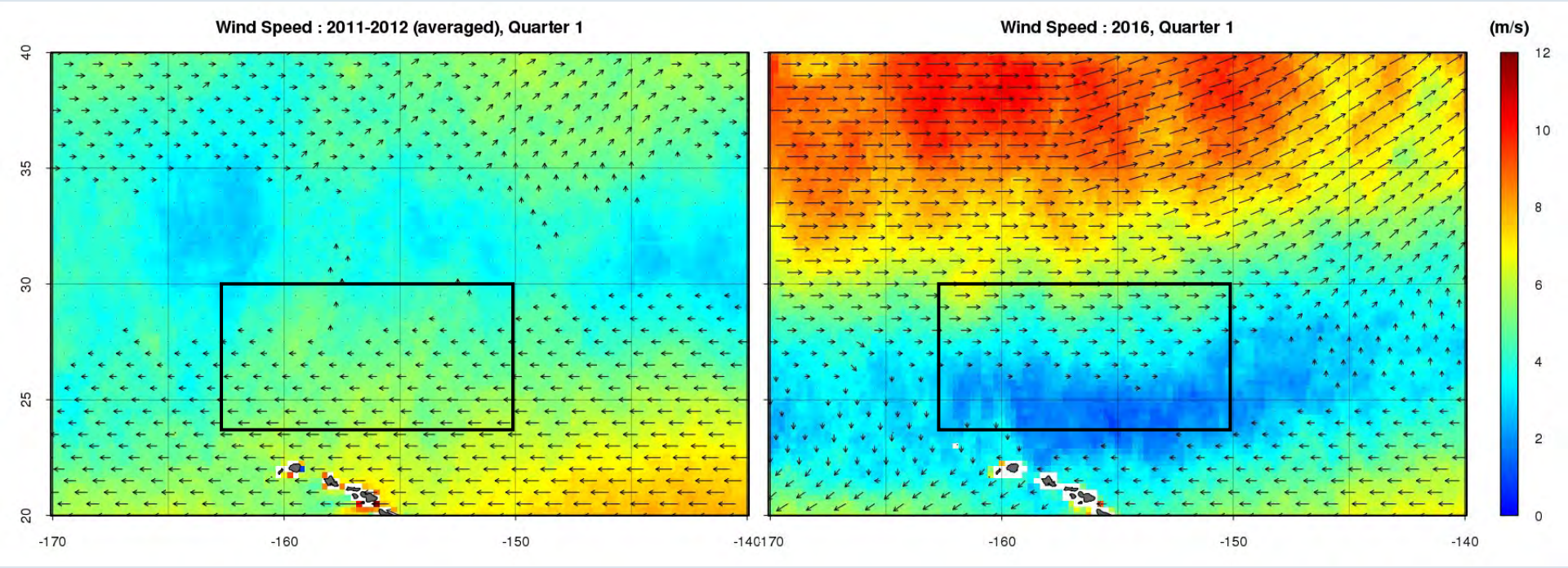


# Results:
## Tracking data



# Oceanographic conditions
## Pacific Decadal Oscillation

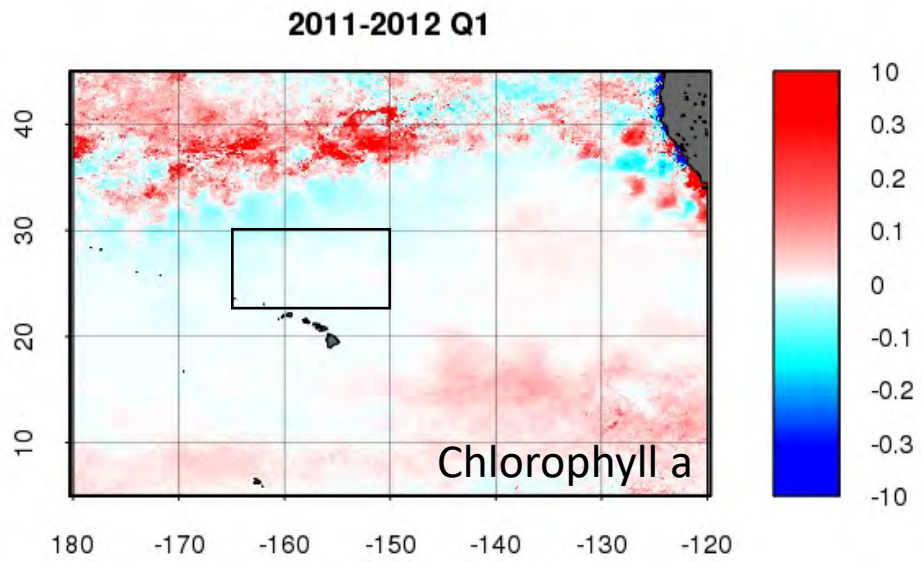


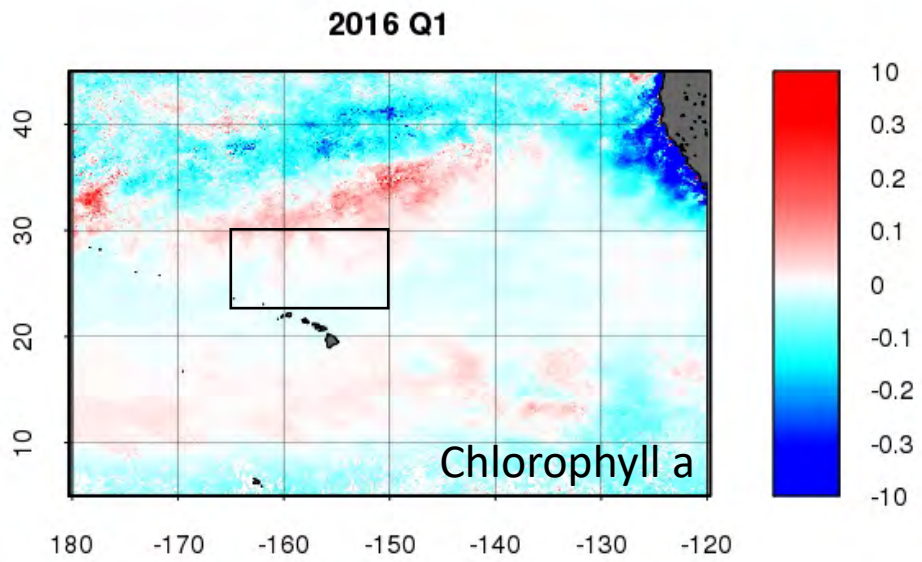

Low sightings and interactions

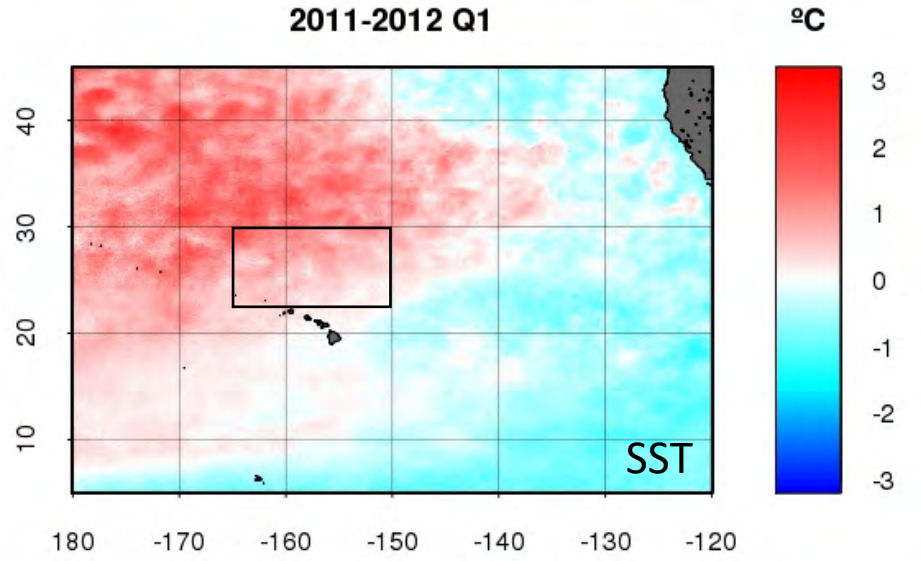
High sightings and interactions

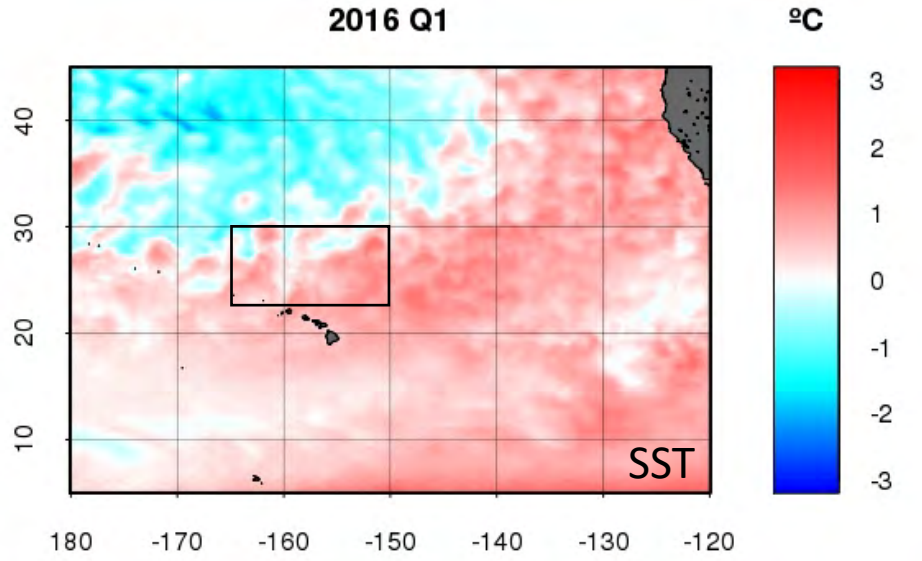
Negative PDO / La Niña

Positive PDO / El Niño



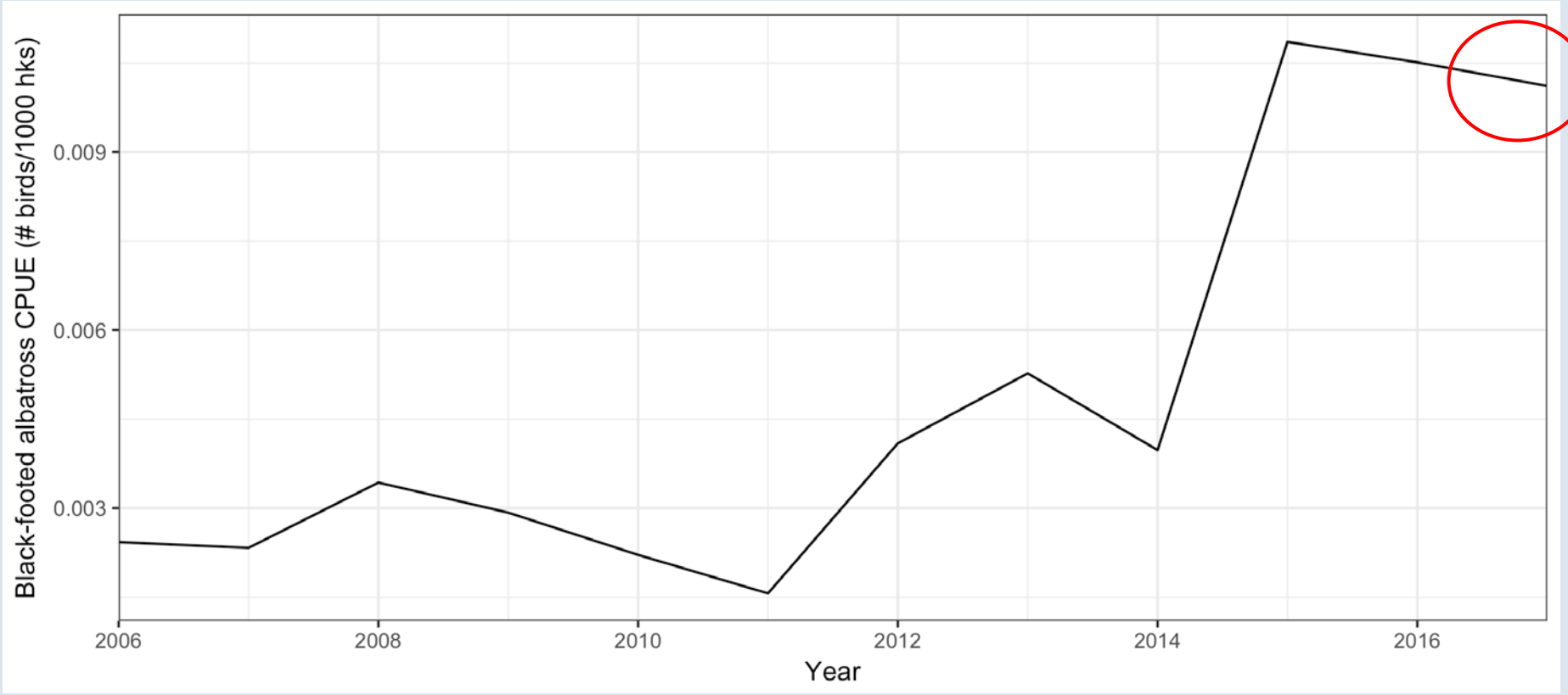

Low sightings and interactions

High sightings and interactions

# Conclusions

- Increase in BFAL interactions with increase in westerly winds
  - Cold, productive waters move further south
  - Strong Aleutian low during -> strong westerly winds
- Greater overlap between albatross preferred foraging habitat and the longline fishing fleet during +PDO years
- PDO is decadal pattern so increased interactions may persist and not merely a short term anomaly

# Conclusions



# Thank You!


- John Peschon, Eric Forney
- Felipe Carvalho, Michelle Sculley
- Melanie Abecassis, Phoebe Woodworth-Jefcoats
- David Hyrenback, Sarah Ellgen, Tamara Russell, Asuka Ishizaki, the 2017 Albatross Workshop in HNL





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