Predicting summer pelagic habitat hotspots of neon flying squid (*Ommastrephes bartramii*) in the western North Pacific

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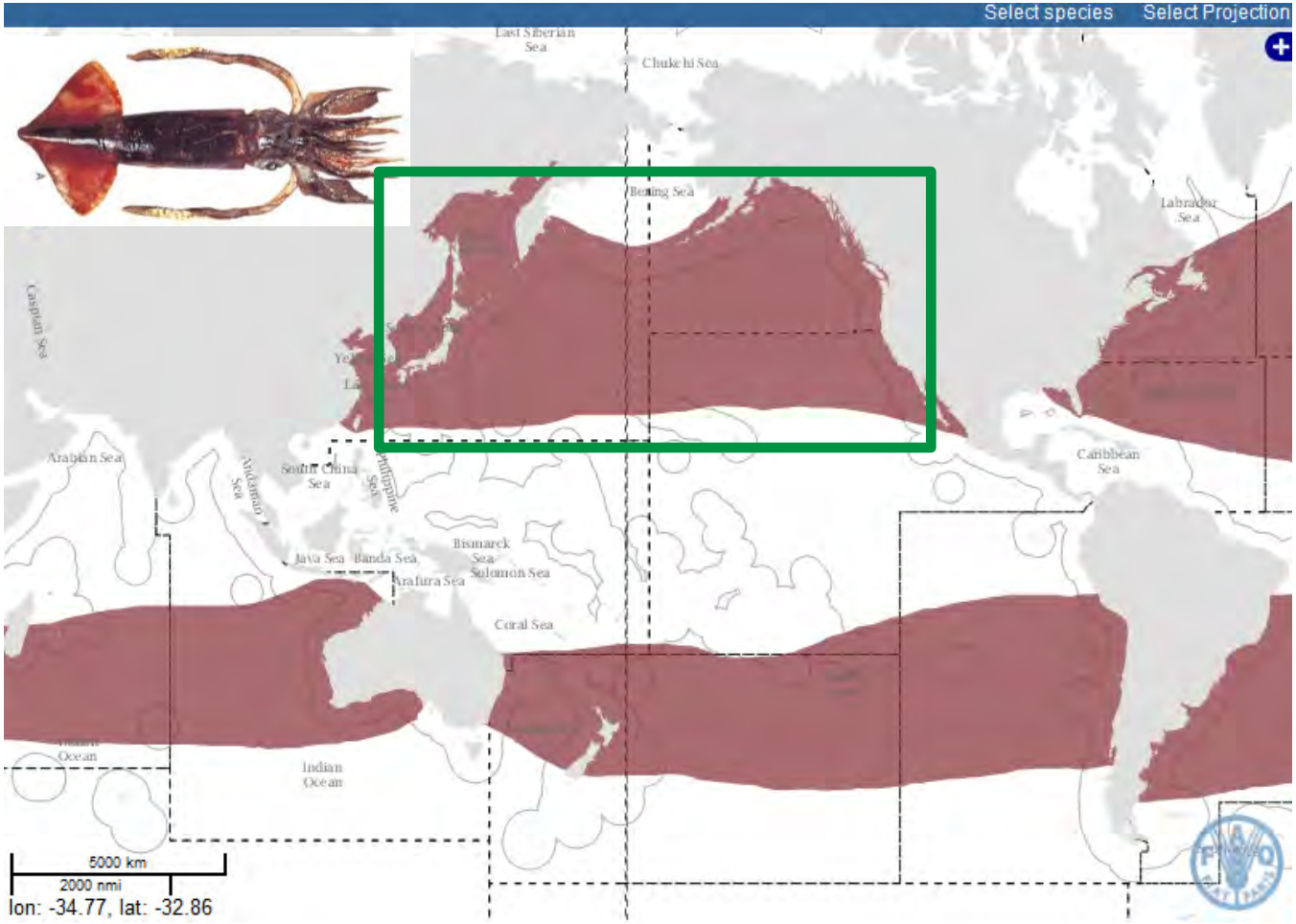
RECCA
Research Program on Climate Change Adaptation

BACKGROUND

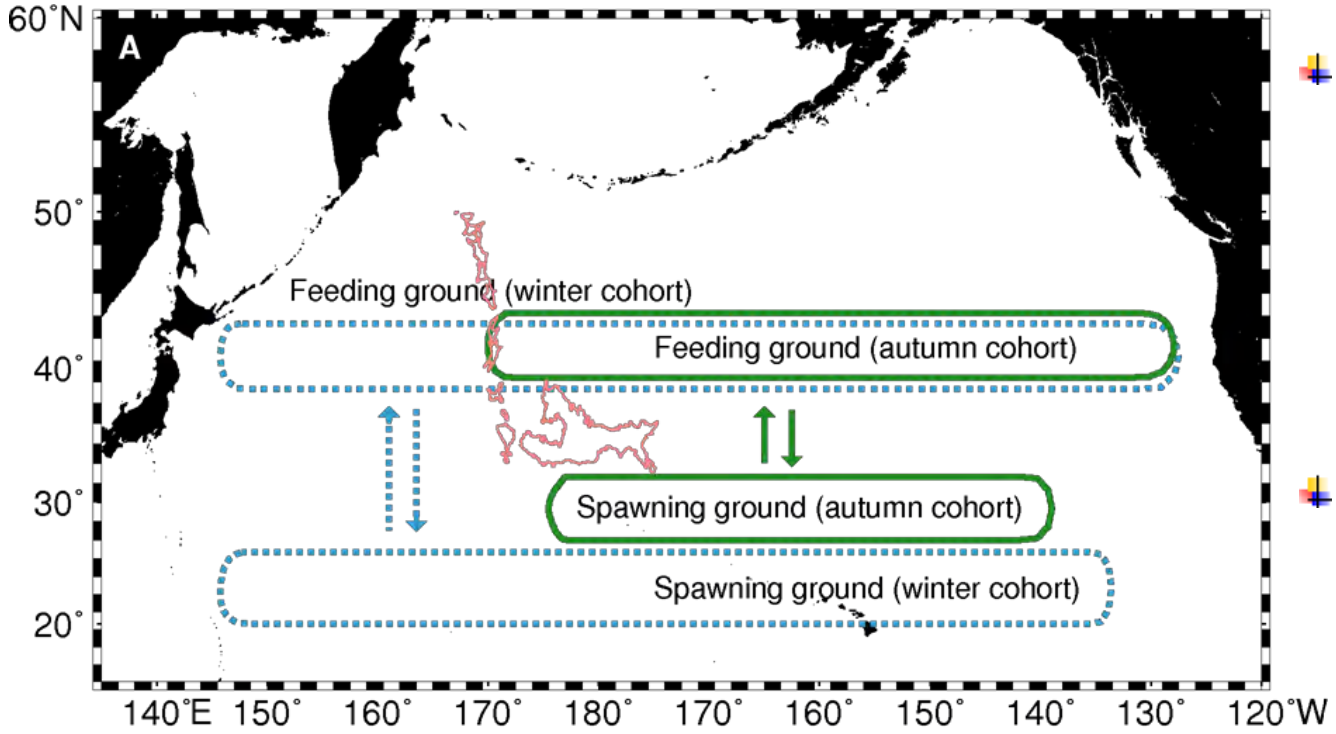
Neon flying squid distribution



http://www.fao.org/figis/geoserver/factsheets/species.html

BACKGROUND

North Pacific population & migratory patterns



Redrawn from Ichii et al. 2011

- Two spawning cohorts:
  - ✓ autumn cohort: zonal distribution east of seamounts[1]
  - ✓ winter cohort
- Seasonal migrations are regulated by **reproduction** and **foraging**[2]

[1] Chen & Chiu 2003; [2] Bower & Ichii,2005

OBJECTIVES

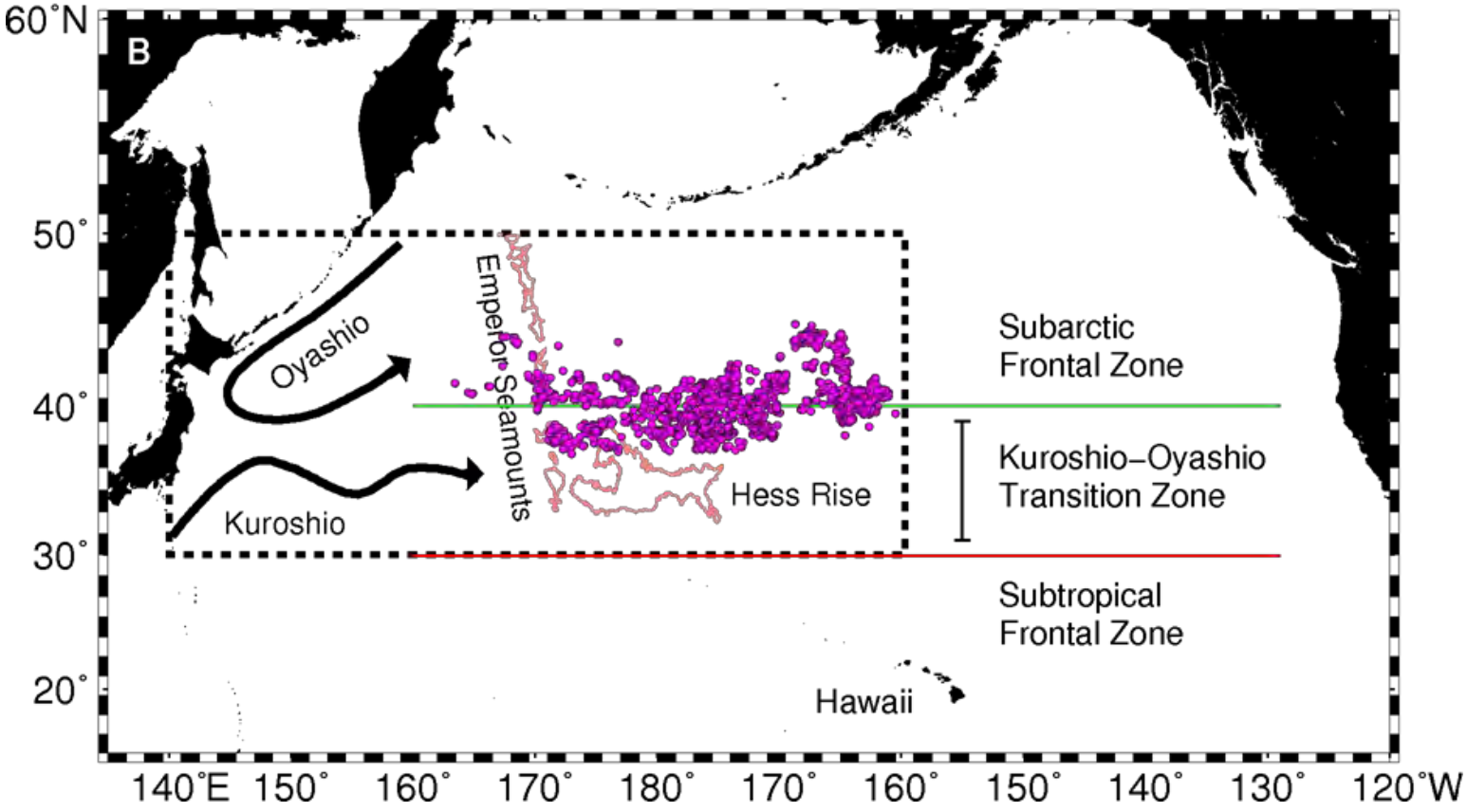
(1) Deduce the influence importance of oceanographic proxies to squids' pelagic habitat

(2) Characterize the spatio-temporal patterns of squids' pelagic habitat hotspots

(3) Understand the physical mechanism that relates to squid aggregations

DATA & METHODS

Study area



DATA & METHODS

Datasets

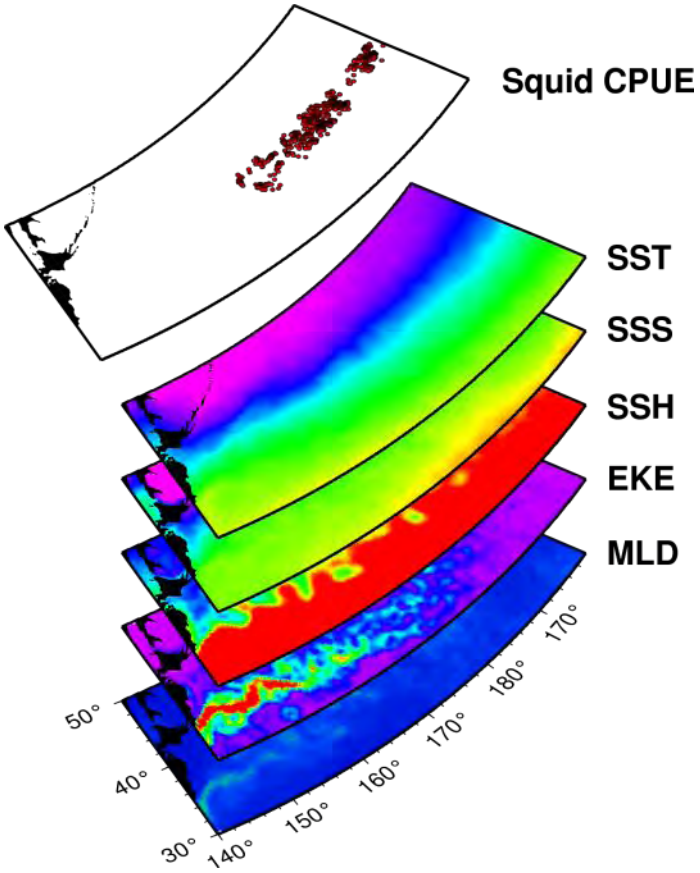
Environmental variables	Abbrev.	Unit	Source	Temporal Resolution	Source Resolution
Sea surface temperature	SST	^{o} C	AVHRR	daily	25 km
Sea surface salinity	SSS	PSU	MOVE-MRI[1]	5-day	10 km
Sea surface height	SSH	cm	AVISO	daily	25 km
Eddy kinetic energy	EKE	$cm^2 \cdot s^{-2}$	AVISO	daily	33 km
Mixed layer depth	MLD	m	MOVE-MRI	5-day	10 km

Squid Fishery Data	Description	Source	Temporal coverage
Squid CPUE (tons/day)	Daily point data	APITRC	May-July 2000-2004

[1]MOVE: Meteorological Research Institute Ocean Variational Estimation System

DATA & METHODS

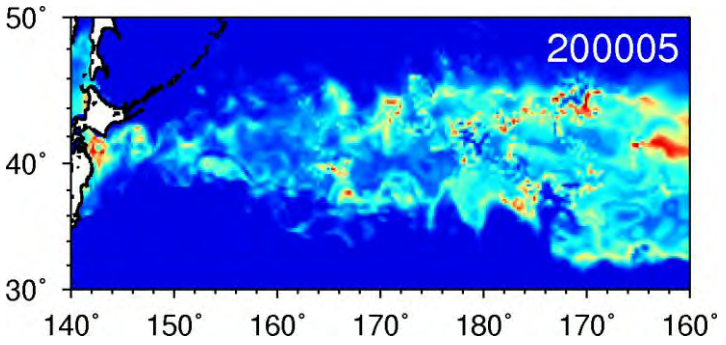
Squid habitat hotspots detection



Data extraction

GAM[1] construction

Monthly Predicted CPUE



$$\ln(CPUE) = a + s(SST) \ldots + s(SSS) \ldots + s(SSH) \ldots + s(EKE) \ldots + s(MLD)$$

DATA & METHODS

Persistence of squid habitat hotspots

Predicted CPUE normalization

$$HSI = \frac{Y_{fit} - \min Y_{fit}}{\max Y_{fit} - \min Y_{fit}}$$

Y_{fit} - predicted CPUE
Y_{min} - minimum predicted CPUE
Y_{max} - maximum predicted CPUE

HSI thresholding

(1) Quartile analysis
(2) Minimal Predicted Area [2]

Binary classification & grid operation

0.5	0.8
0.7	0.2

→

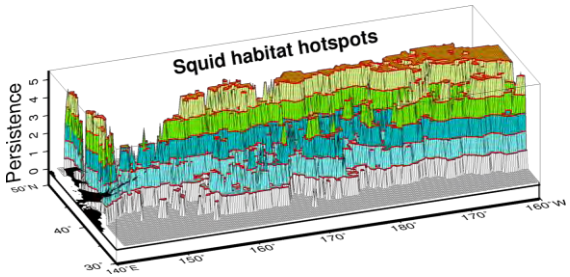
1	1
1	0

→ $\sum_{i=1}^{n} m_i$

m_i - monthly binary grid at year i

MPA HSI threshold ≥0.34

Persistent habitat hotspots mapping



[2] Engler et al 2004

RESULTS & DISCUSSION

Key findings: Relative importance of environmental factors to squid habitat – Objective 1

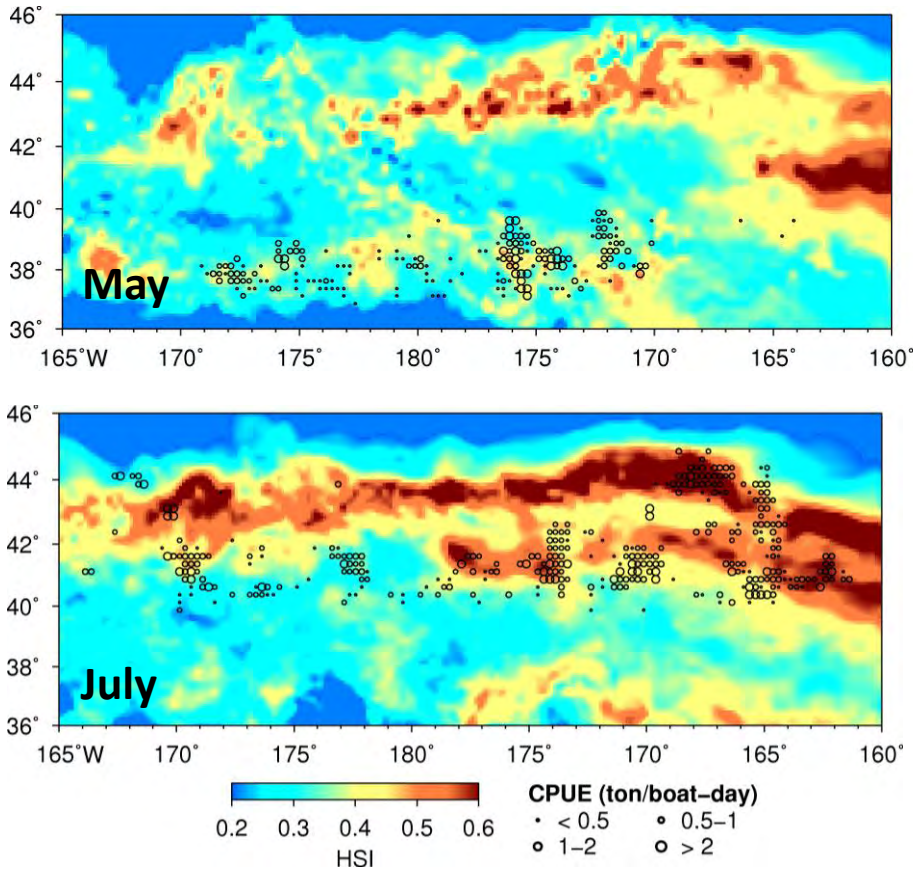
Environmental Covariates	With the variable		Without the variable		All variables	
	AIC	CDE (%)	AIC	CDE (%)	AIC	CDE (%)
SST	8657	0.28	8095	17.00		
SSS	8297	**9.64**	8318	**12.50**		
SSH	8543	5.01	8145	**15.00**	8067	17.8
EKE	8472	**6.61**	8114	16.20		
MLD	8487	6.20	8116	16.60		

- Primary contribution from SSS ,EKE and SSH: squid association with small-scale salinity fronts & eddies
- SST with lowest contribution: homogeneous spatial pattern due to increased insolation

CDE: Cumulative Deviance Explained

RESULTS & DISCUSSION

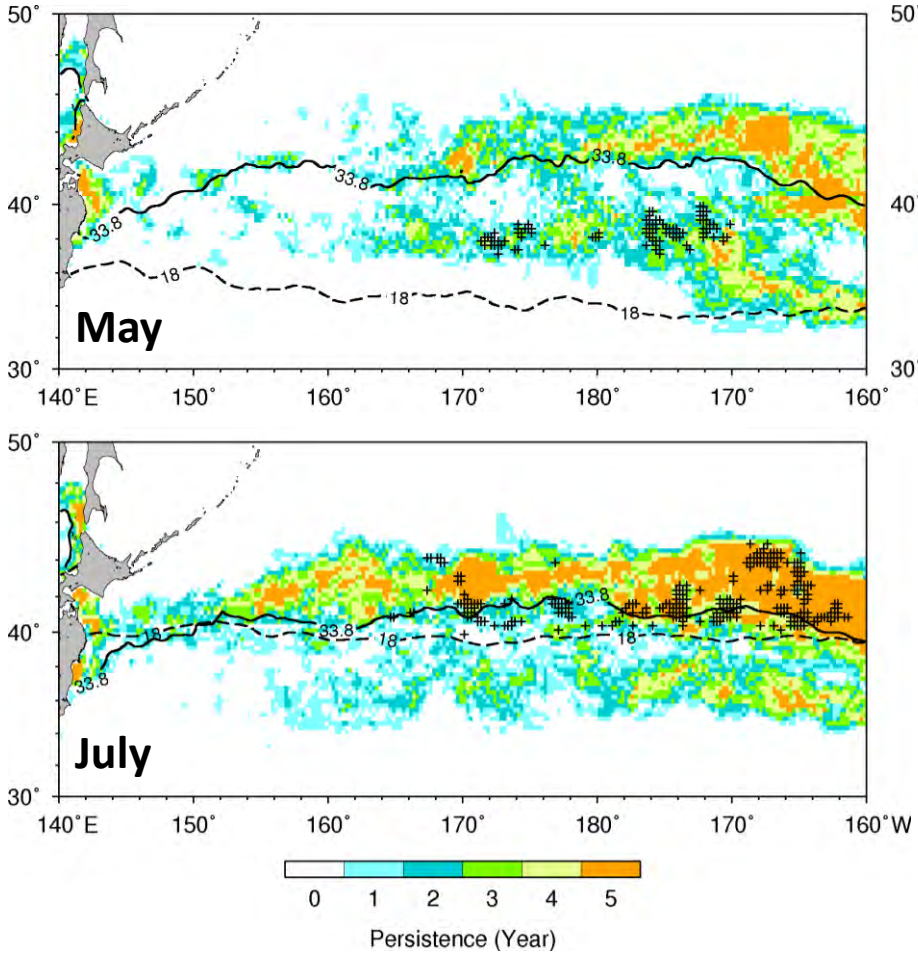
Key findings: **Spatial-temporal patterns of summer pelagic habitat hotspots** – Objective 2



- Potential squid habitat: Northern transition zone & SAFZ
- Northward retreat of fishing fleets from May-July

RESULTS & DISCUSSION (2)

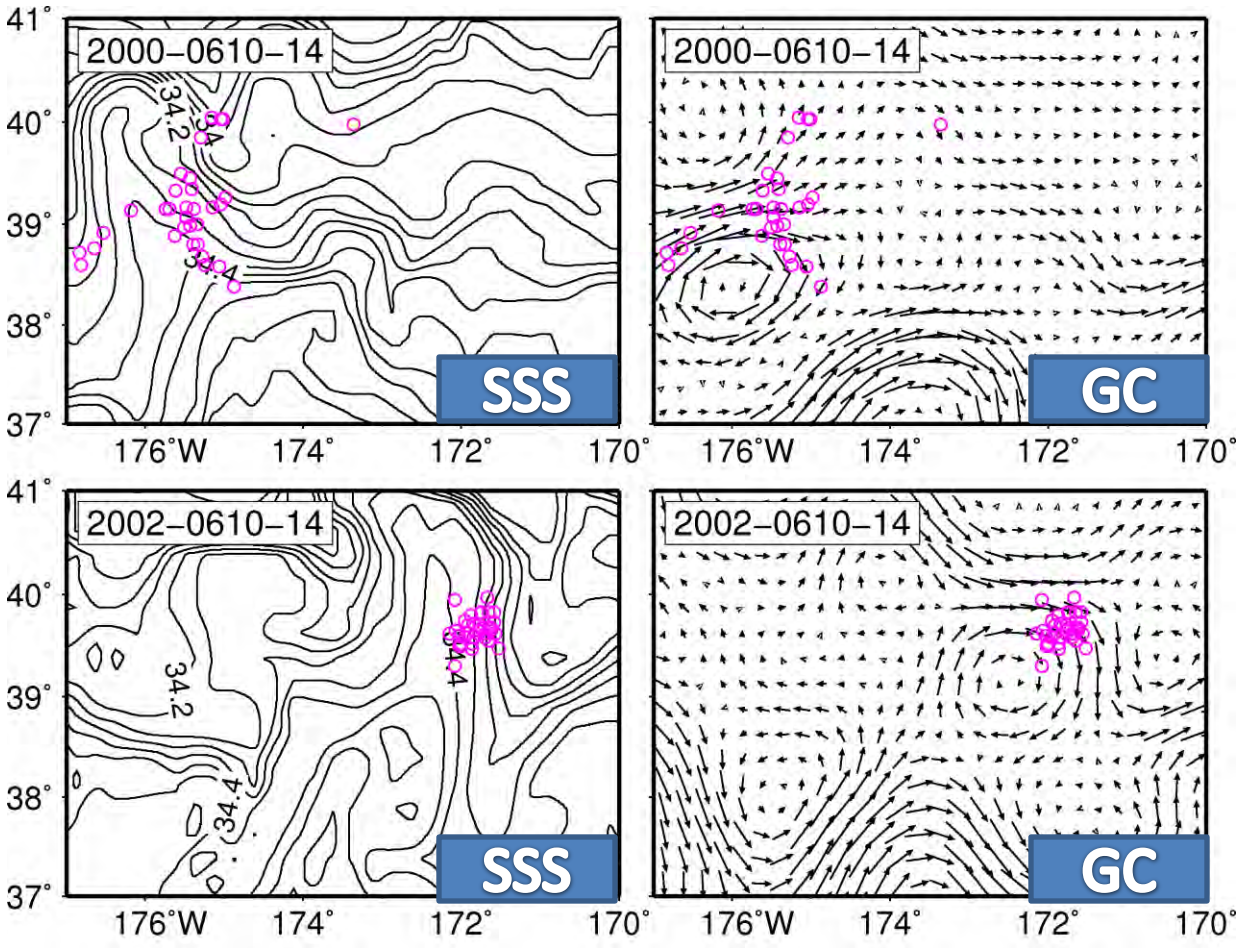
Key findings: **Persistence of summer squid pelagic habitat hotspots across years** – Objective 2



- Proximal to major frontal systems - subarctic front (33.8) & TZCF (18°C)
- Squid fishery (May-June) – Transition zone (36-40°N) ≈ eddies & fronts ≈ low hotspot persistence

RESULTS & DISCUSSION

Key findings: **Potential physical mechanisms of squid aggregations** – Objective 3



June 10-14 2000

June 10-14 2002

SUMMARY & CONCLUSION

- **While environmental proxies exhibit differences in model contribution, their combination shaped the squid pelagic habitat in the North Pacific.**
- **Squid hotspots persistence is associated with the predictability & dynamics of oceanographic features.**
- **Squids recognize & track persistent as well as ephemeral cues from its environment for optimal foraging.**

ACKNOWLEDGEMENT

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Thank you for
your attention