Spatio-temporal patterns of potential fishing zones for Pacific saury (*Cololabis saira*) in a warming climate

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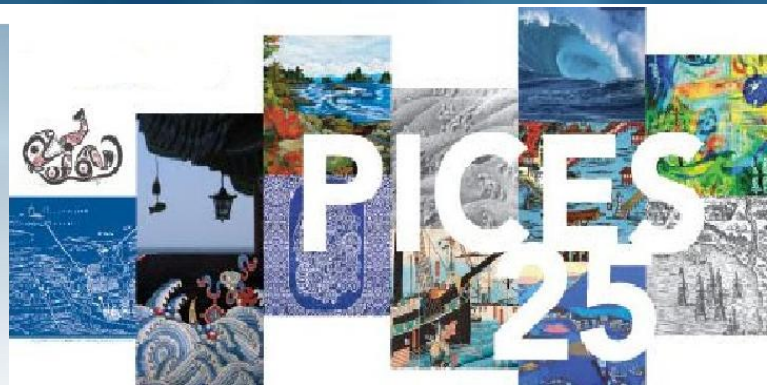

Outline

- Introduction
- Objectives
- Data and Methods
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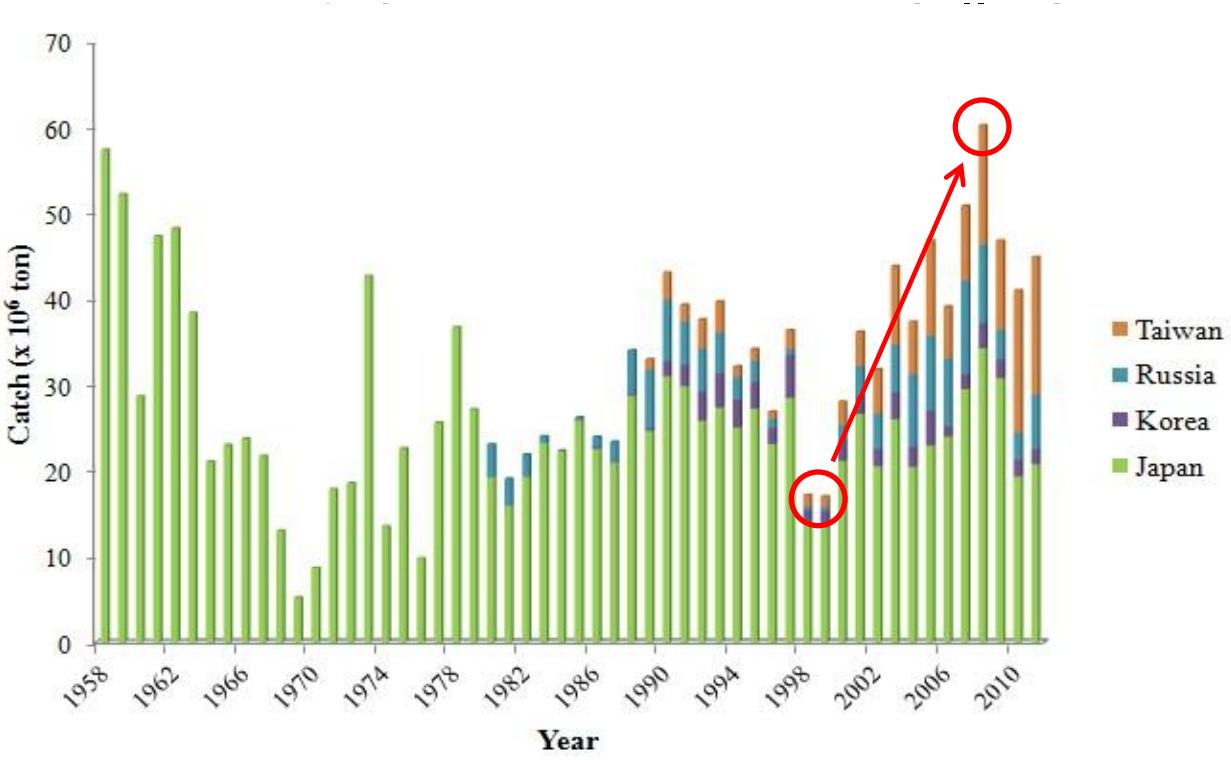
- Discussion
- Conclusion

Introduction

Why “Pacific saury” ?



Annual catches for Pacific saury in Japan, Korea, Russia and Taiwan

ant epi-pelagic fish
Korea and Taiwan

171,692 mt in 1998

603,700 mt in 2008

Fishing lights

❖In Japan, fishing vessels operate at night and use stick-held dip nets, local[illegible]quipped with lights to attrac[illegible]

❖The fishing [illegible]entified by nighttime visib[illegible]nsor.

➡The first s[illegible]ttime satellite images (DMS[illegible]t modeling to investigate th[illegible]ion of Pacific saury.

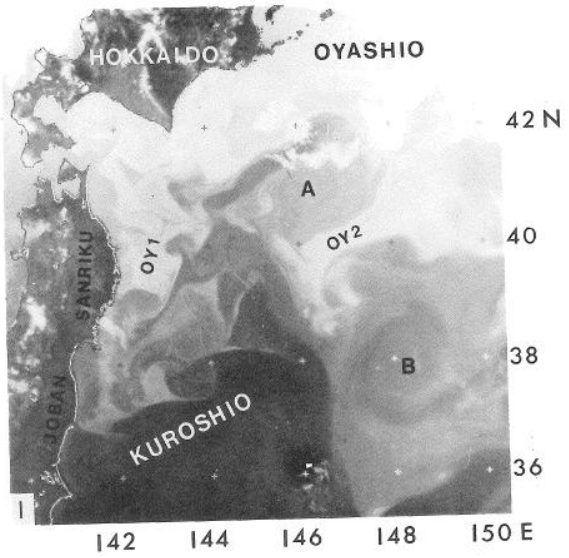
Old Study: Saitoh et al. (1986) DSR

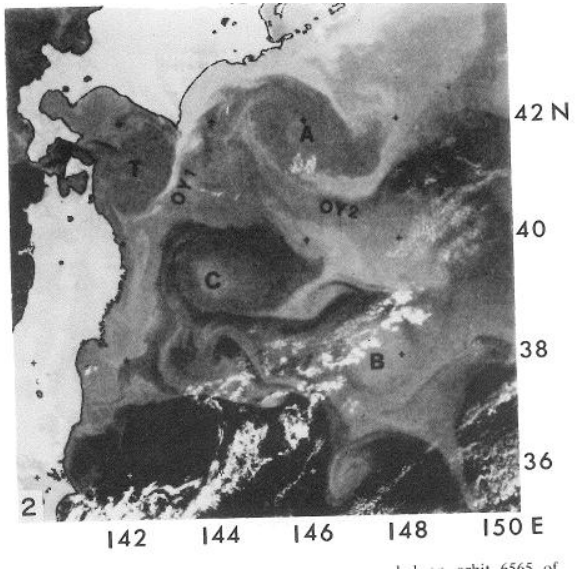
Deep-Sea Research, Vol. 33, Nos 11/12, pp. 1601–1615, 1986.
Printed in Great Britain.

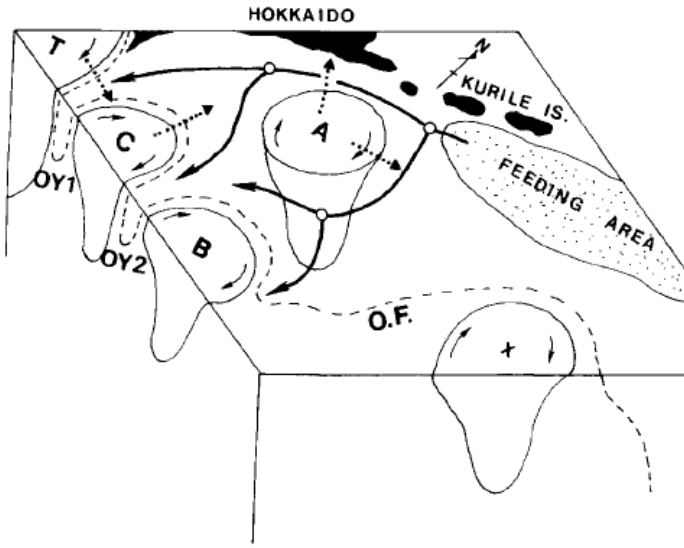
0198–0149/86 $3.00 + 0.00
Pergamon Journals Ltd.

Satellite infrared observations of Kuroshio warm-core rings and their application to study of Pacific saury migration

SEI-ICHI SAITOH,* SUNAO KOSAKA† and JOJI IISAKA‡





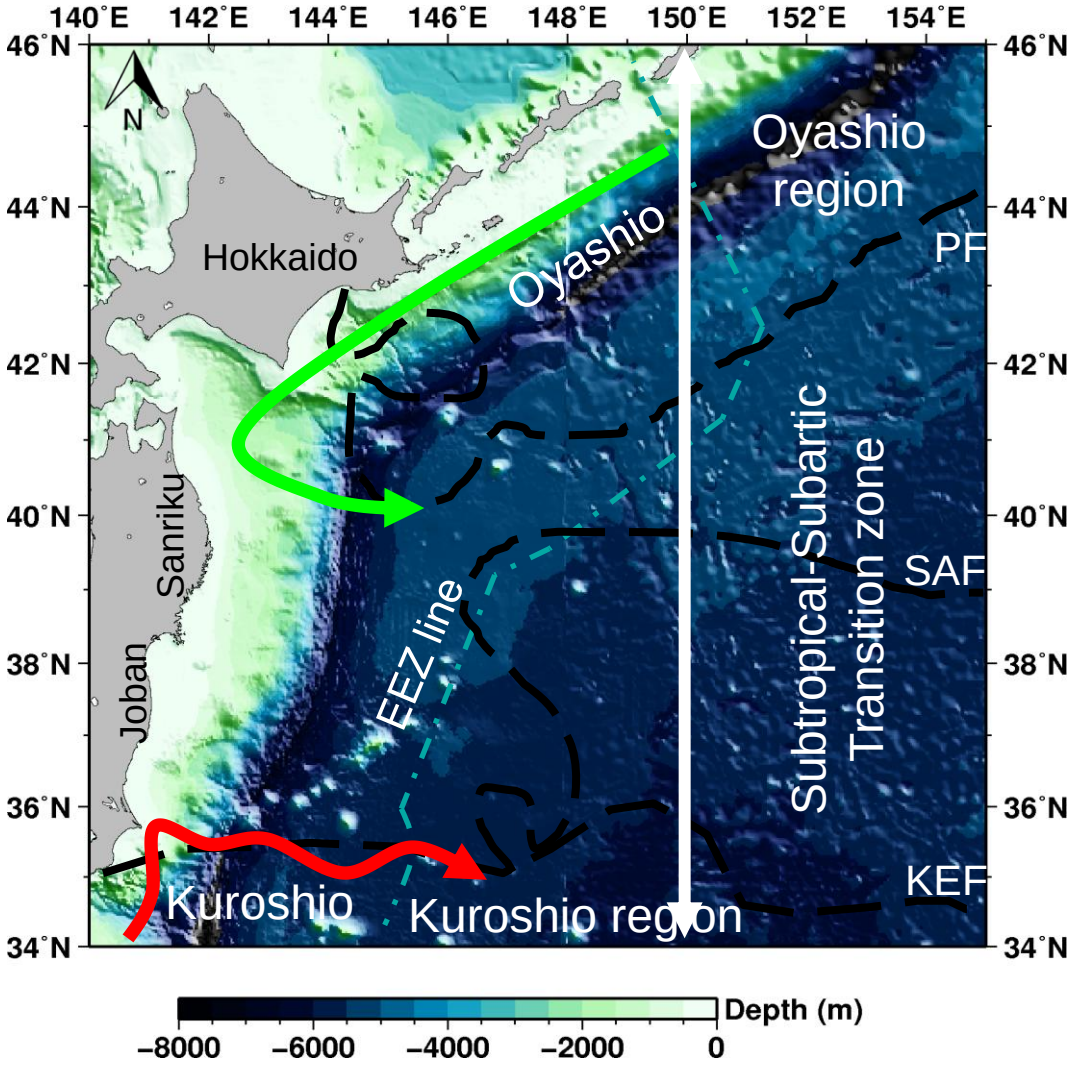


Objectives

- Construct statistical model based on habitat suitability index to link integrated oceanographic data with the Pacific saury fishing grounds.
- Evaluate the effects of oceanographic factors on the formation of Pacific saury potential fishing zones.
- Elaborate changes in Pacific saury potential fishing zone in response to future climate scenarios using the constructed habitat suitability index models.

Study area

Previous studies, including spawning area, feeding area, potential fishing areas, and preliminary analysis



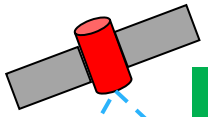
Physical dominant features:

- ✓Oyashio Current
- ✓Kuroshio Current
- ✓Eddies
- ✓Fronts :
  - PF = Polar Front
  - SAF = Subartic Front
  - KEF = Kuroshio Extension Front

Data and source

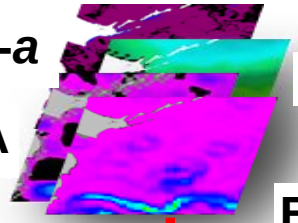
Data	Spatial Resolution	Temporal Resolution	Source
Remotely sensed			
Fishing location	2.7 km	Daily	DMSP/OLS
Chlorophyll-*a* (Chl-*a*)	1 km	Daily	MODIS
Sea surface temperature (SST)	1 km	Daily	MODIS
Sea surface height anomaly (SSHA)	0.33^{o} x 0.33^{o}	Daily	AVISO
Eddy kinetic energy (EKE)	0.33^{o} x 0.33^{o}	Daily	AVISO
Re analysis data			
SST (2025, 2050, 2100)	0.2^{o}x0.3^{o}	Monthly	MIROC-ESM

A schematic flow of methods and tools used in the analysis



DMSP/OLS

Sea light (Fishing Location)



Habitat Modelling (GAM)

Machine-learning (Maxent)

2

*P*value AIC, CDE

✓Relative contribution
✓Response curve
✓A jackknife test

AUC

Distribution map of Pacific saury fishing points 1

Potential fishing zones of Pacific saury 3

MIROC-ESM *RCP 4.5 (2025, 2050 and 2100)*

PFZ in future projection (2025, 2050 and 2100) 4

Separation and machine learning

- The OLS images contain at least the lights from the Pacific saury and squid fishing fleets (Saitoh et al., 2010; Mugo et al., 2014)

- Pacific saury prefers colder areas as migration routes (Saitoh et al., 1986)

- SST was used to split the night light images data into two categories (Mugo et al., 2014, Syah et al., 2016)

Presence-Pseudo-absence (2005-2010)

- **70% training data**
- **30% testing data**

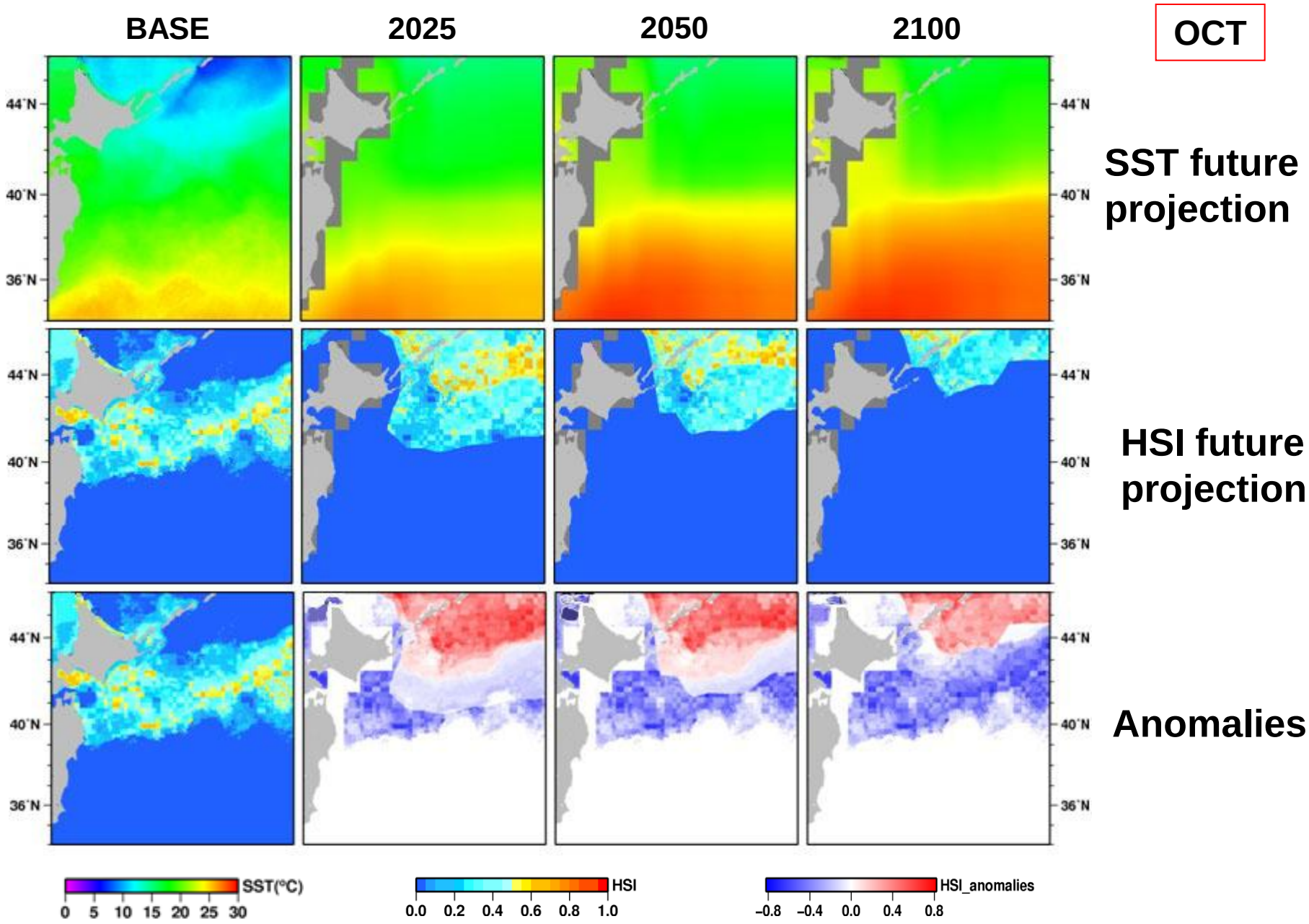
Maxent (Phillips, 2006)

Presence = *f*(Chl-*a*, SST, EKE, SSHA)

The contribution of each variable is visualized by means of its:

✓relative contribution,
✓response curve,
✓a jackknife test.

Results: Predicted HSI maps



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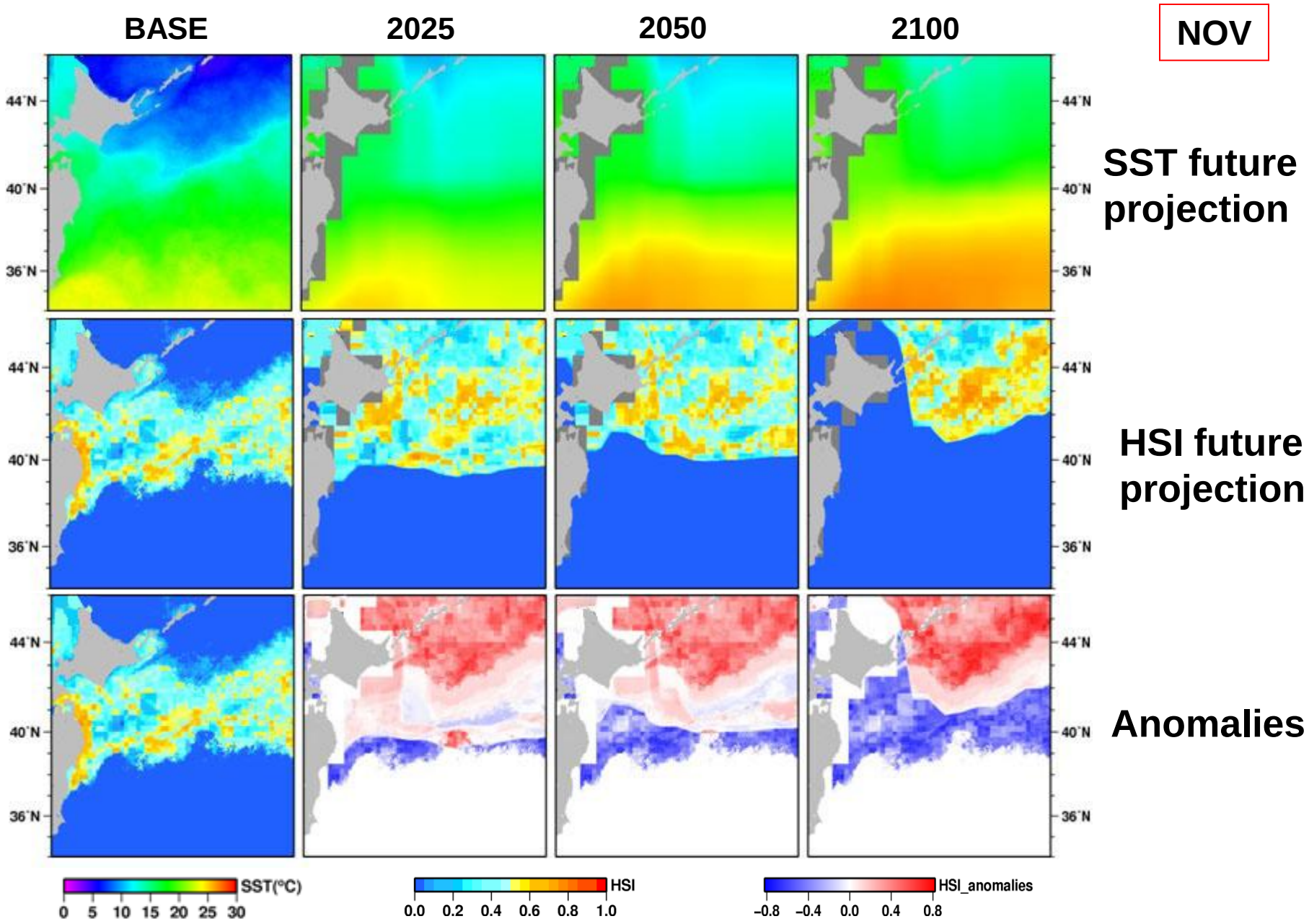

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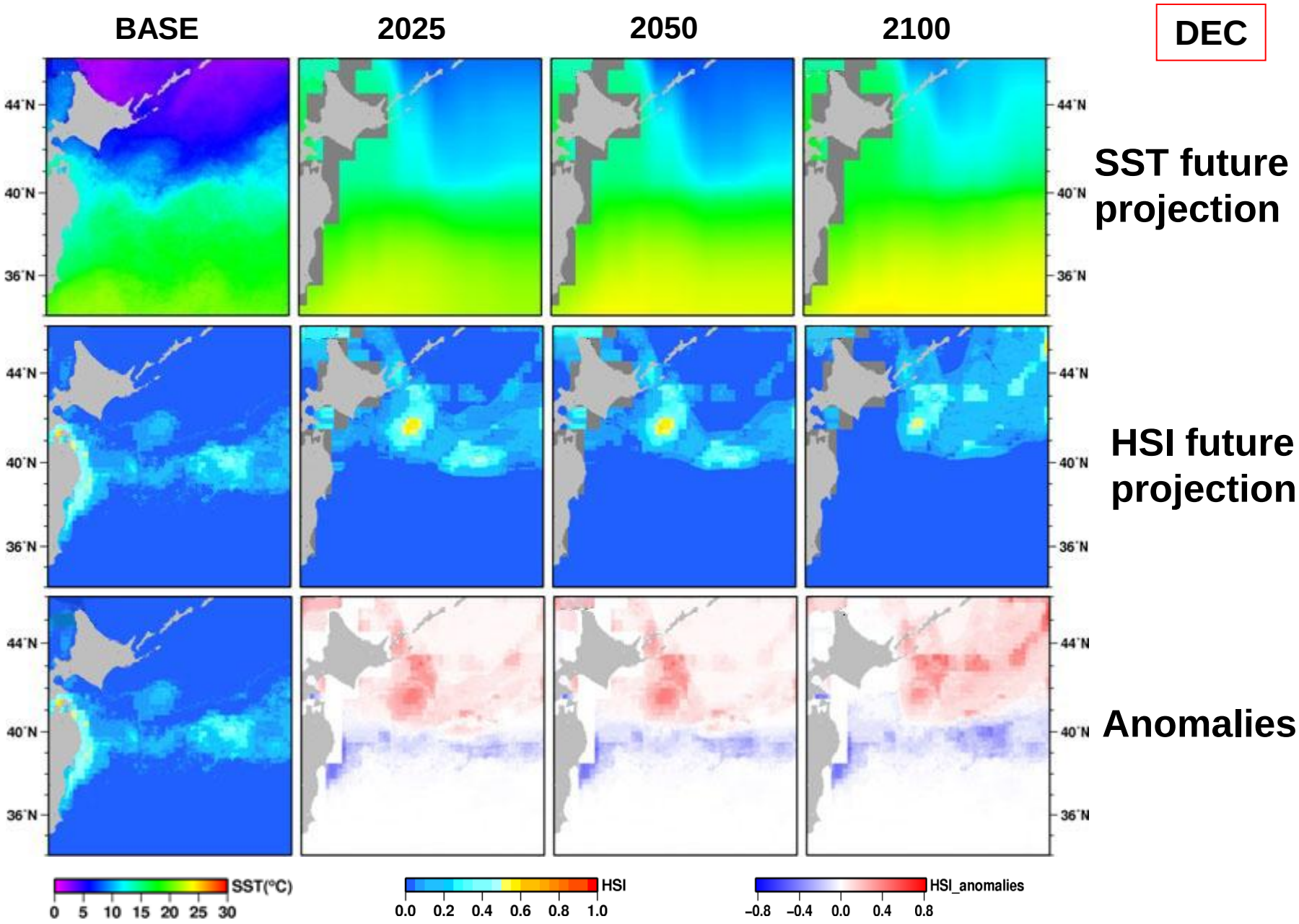
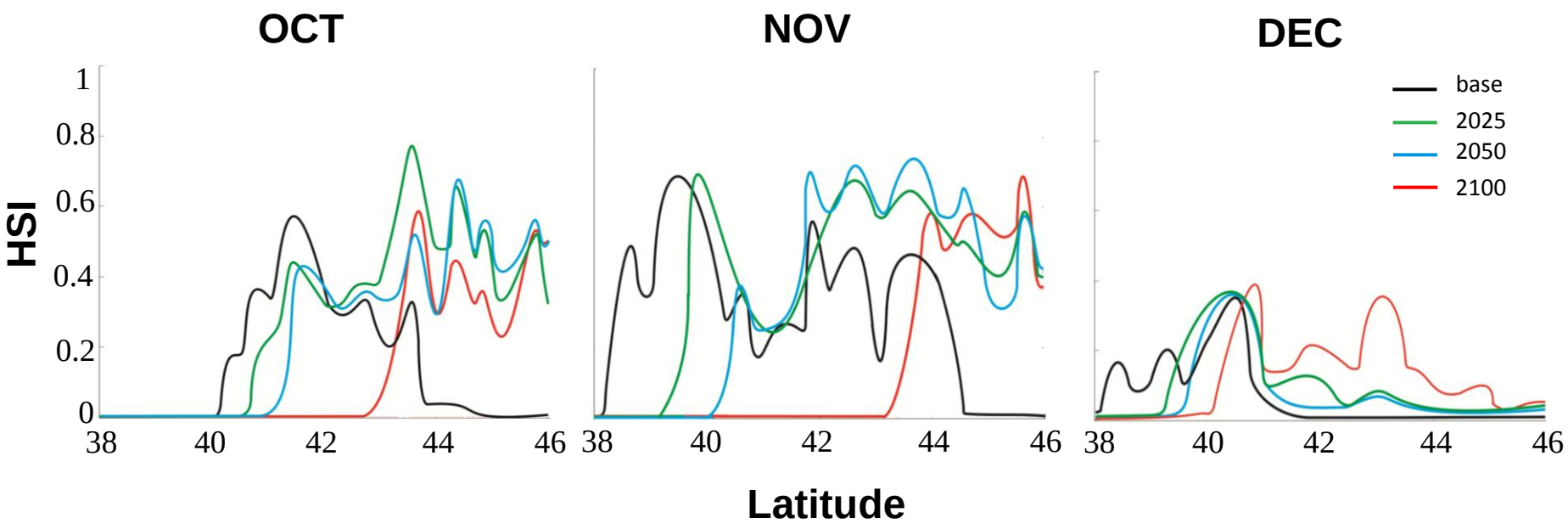


Latitudinal variability of HSIs

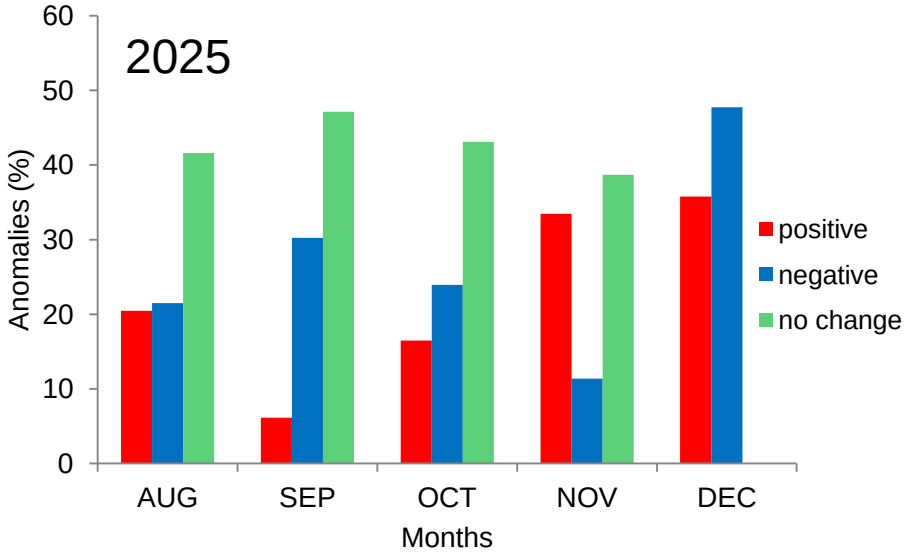
Along 150 E

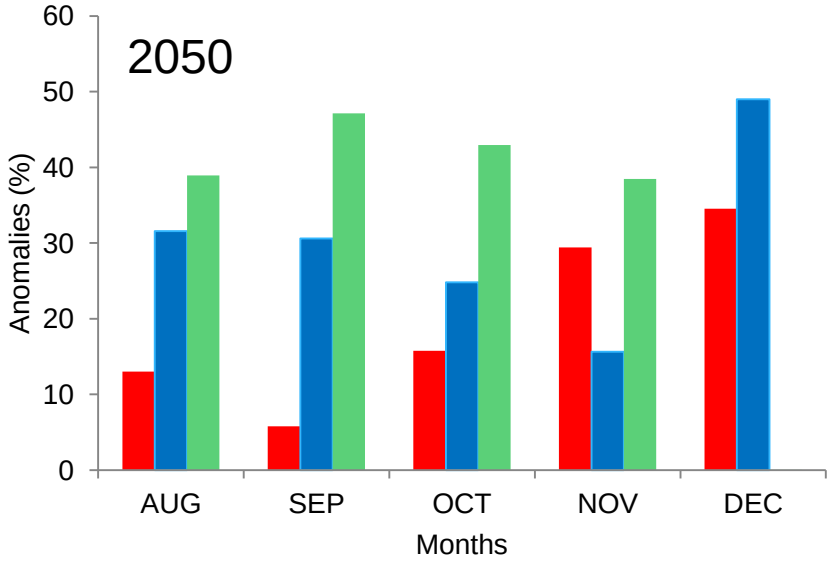


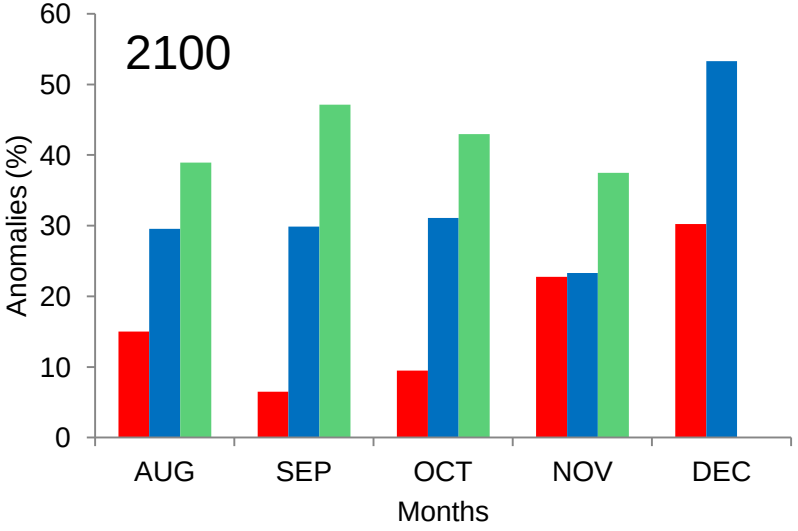
❑ Spatial changes showed the poleward shift in potential fishing zones.

❑ The largest maximum latitudinal displacements occurred between the 2100 scenario and recent years.

Frequency anomalies







- In general, negative anomalies accounted for a larger area than positive ones
- However, positive anomalies showed increasing trend from September to December

Discussion

- Kuwahara et al. (2006) pointed out the possibility of a northward shift of Pacific saury fishing ground and delay of the fishing ground formation around Japan under global warming.

- The latitudinal displacements of the poleward shift will occur from 2011 to 2100.

- High SST under global warming prevented or delayed the southern migration of Pacific saury in winter. Moreover SST increase will directly reduce juvenile growth (Ito et al., 2010, 2013).

Conclusions

- **Most important factor explain the distribution of Pacific saury is SST.**
- **The global warming state would delay of the fishing ground formation around Japan.**

Thank you for your kind attention !