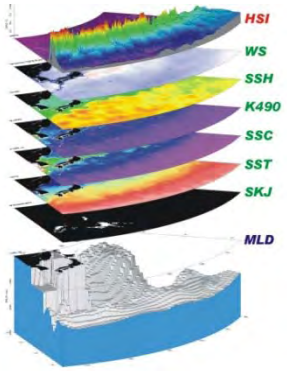
Second International Symposium
Effects of Climate Change on the World's Oceans

Session 4
16:20-16:35 May 16, 2012

Potential impact of global warming on skipjack tuna habitat in the w. North Pacific



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CONTENTS

- √ **Background**
  - Global warming & oceans
  - Impacts of GW on tuna habitat in higher latitudes
- √ **Habitat suitability models (e.g. ENFA)**
  - Presence only models
  - Test effect of habitat suitability with predicted SSTs
- √ **Results**
  - Habitat suitability models (ENFA)
  - Habitat features
  - Impact of global warming on habitat suitability
- √ **Key points**
- √ **Conclusions**

INTRODUCTION

IMPACTS-OCEANS

- √ Vertical stratification and surface mixing
  (IPCC, 2007; BARANGE & PERRY, 2009).

- √ Primary production at higher latitudes
  (RICHARDSON, 2008).

- √ Upwelling seasonality which may prompt changes in distributions of pelagic species
  (IPCC, 2007; HOBDAY, 2010).

- √ Changes in phytoplankton dominant groups.

- √ Ocean acidification and sea level rise
  (BARANGE & PERRY, 2009).

INTRODUCTION

THE BIG QUESTION

√IMPACTS ON SPECIES LIKE TUNA?

ECOLOGICAL

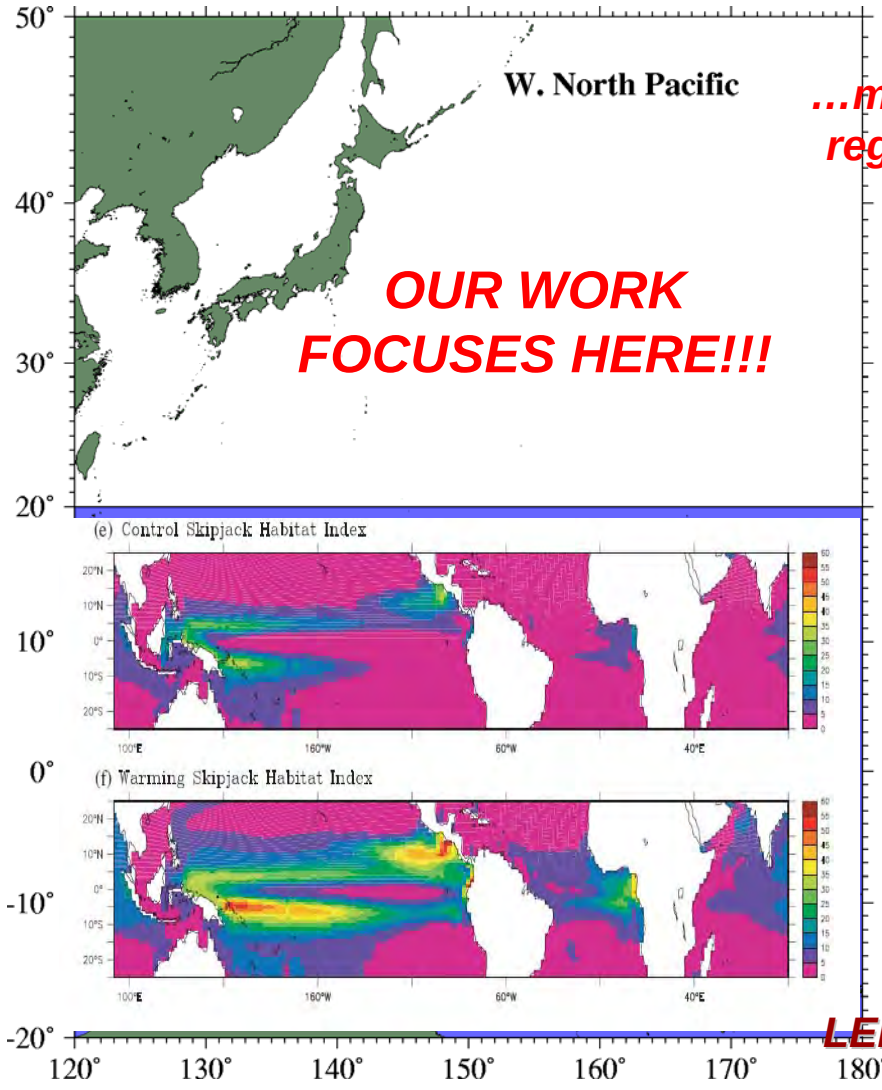
- Migration patterns
- Abundance
- Reproduction
- Fisheries
- Etc…

SOCIETAL

- Markets
- Infrastructure
- Livelihoods
- Etc…

INTRODUCTION

IMPACTS ON TUNA



…models were TOO COARSE for the Kuroshio region, where fishery is mainly influenced by SEASONAL WARMING…
LEHODEY ET AL. 2003; SENINA ET AL. 2008.

…significant large-scale changes of skipjack habitat in the equatorial Pacific… LOUKOS ET AL. 2003.

…Temp. and primary production are important factors for skipjack migration…
LEHODEY ET AL. 2003; SENINA ET AL. 2008.

OBJECTIVE

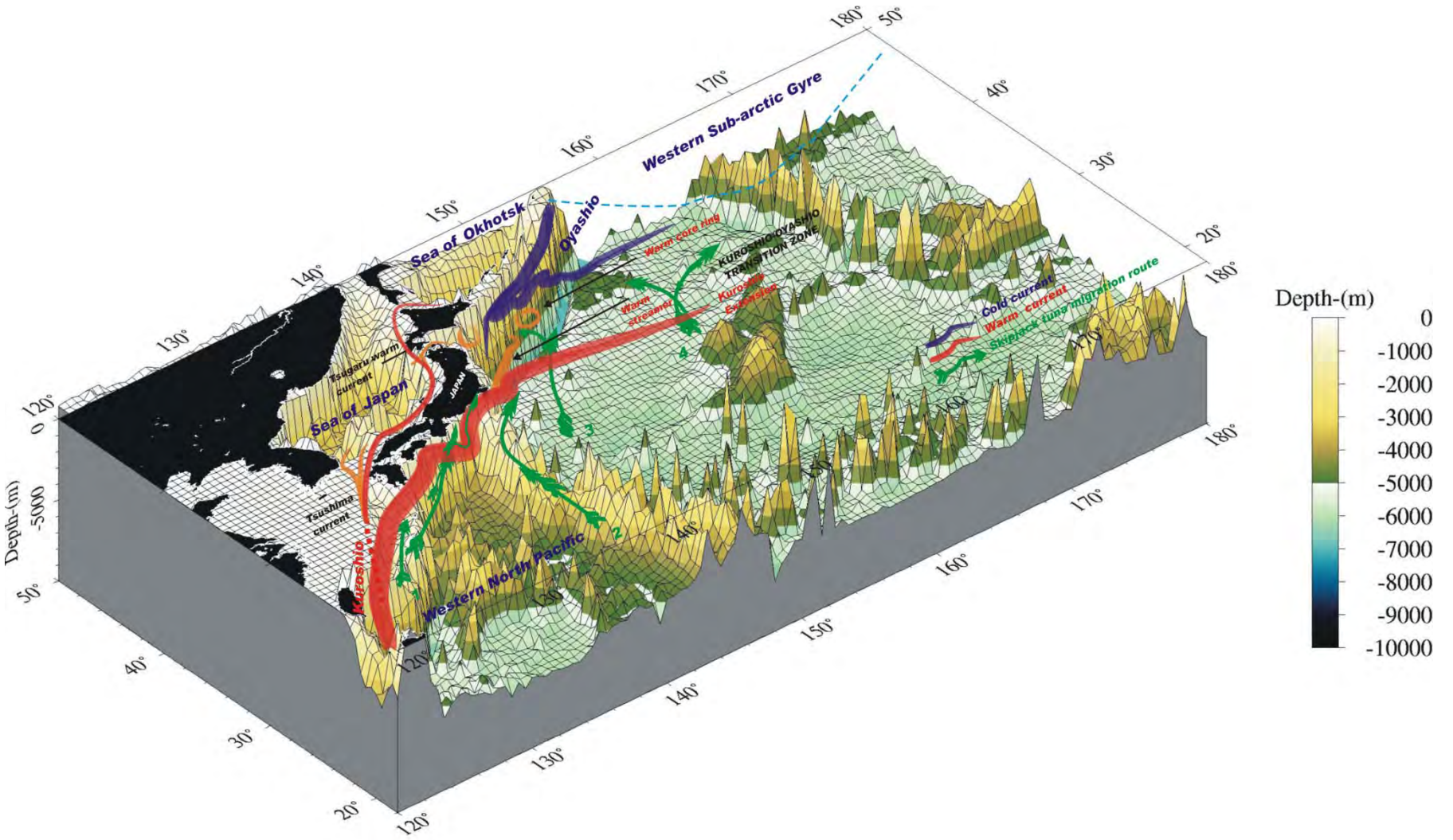
- √ **What will be the response of skipjack tuna habitat in the w. North Pacific under global warming?**

- √ **Hypothesis: Using habitat suitability index (HSI) and SST forcing, can we detect changes in skipjack tuna habitat?**

- √ **To evaluate the potential impact of GW on skipjack tuna habitat suitability in the western North Pacific using Ecological Niche Factor Analysis.**

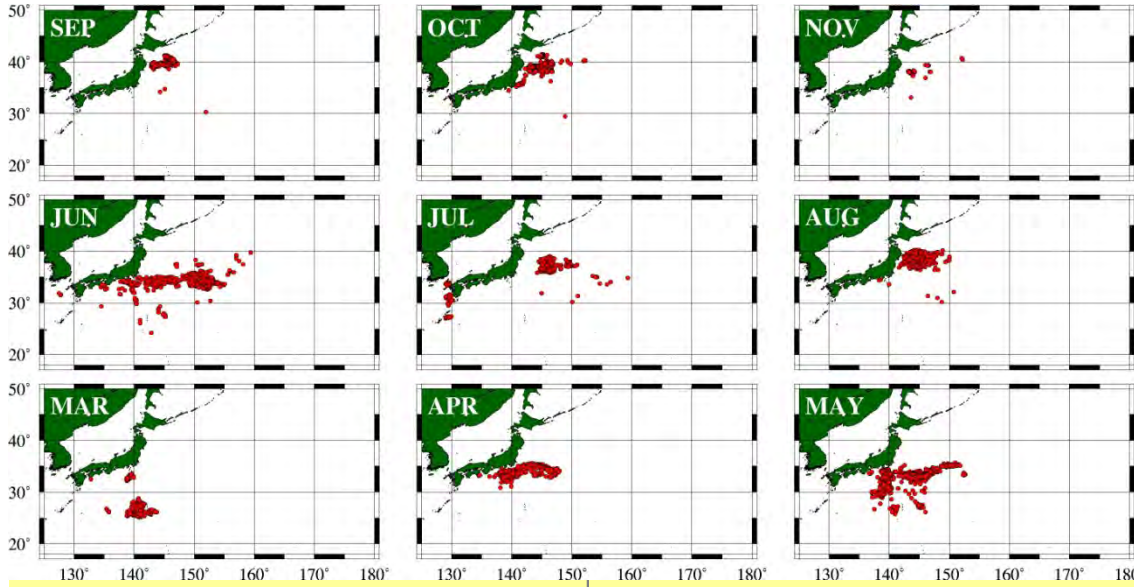
METHODS

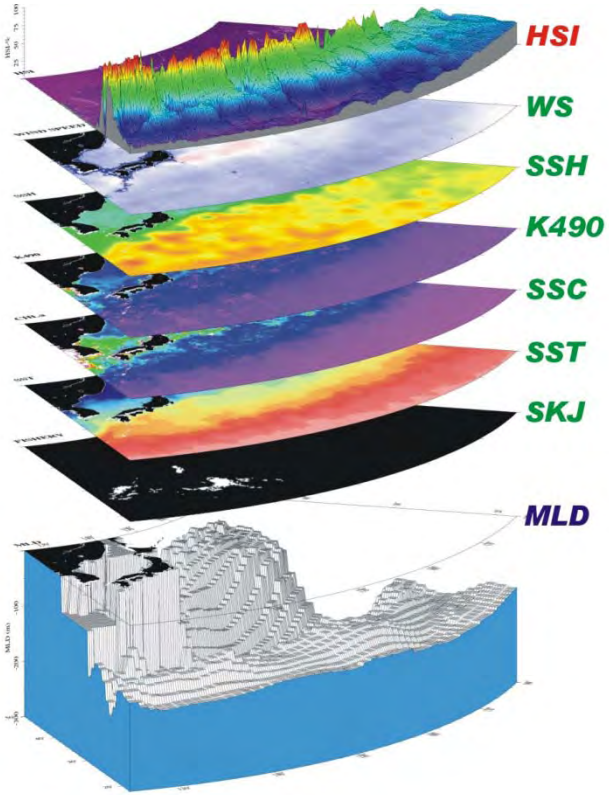
STUDY AREA



METHODS

DATA





SSC	MODIS-AQUA
K490	MODIS-AQUA

4D-VAR Model data (2004)

SUB-SURFACE Temp.	4D-VAR

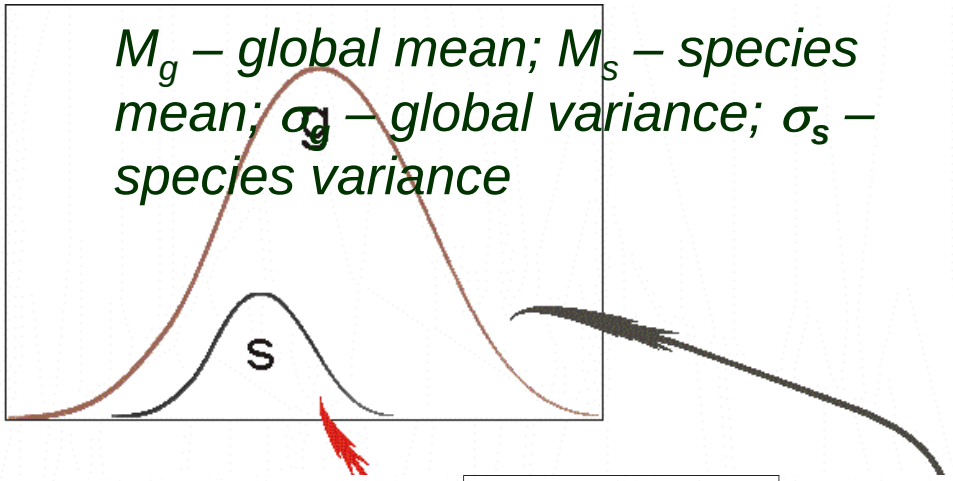
MIROC Model data (2025; 2050; 21

SST	HIRES MIROC3.2

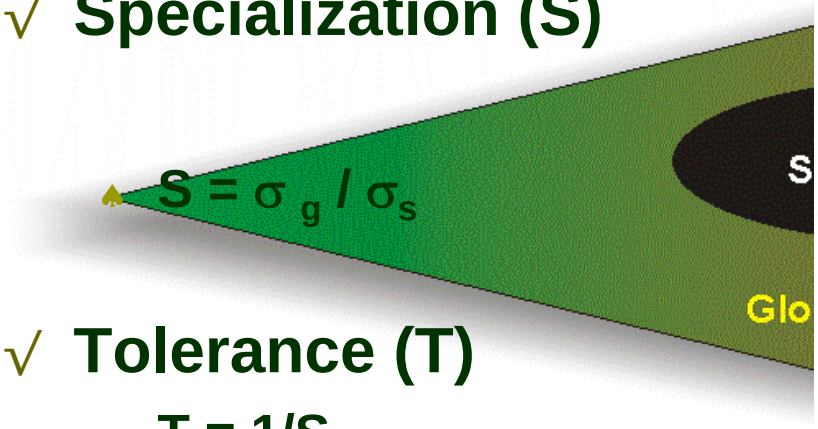
METHODS

ENFA

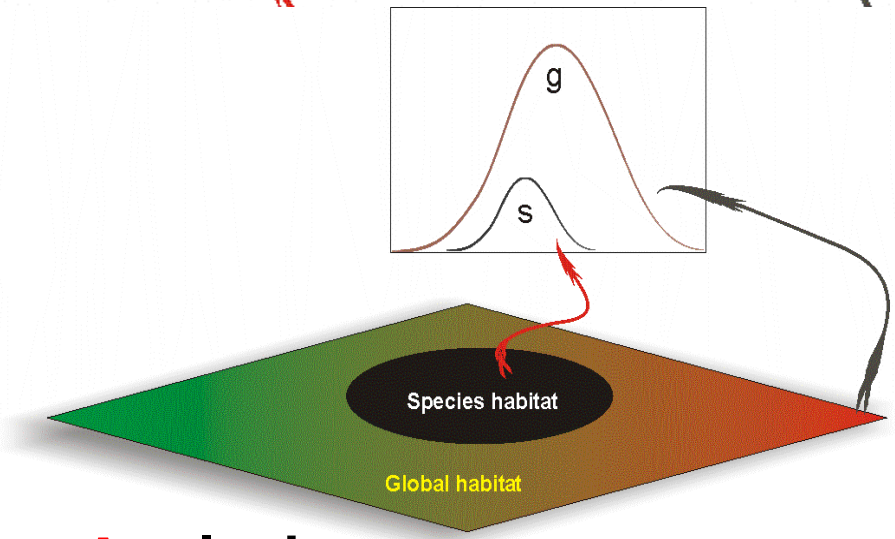
- √ **Marginality (M)**
  - ♠ $M = (M_g - M_s) / 1.96\sigma_g$



- √ **Specialization (S)**
  - ♠ $S = \sigma_g / \sigma_s$



- √ **Tolerance (T)**
  - ♠ $T = 1/S$

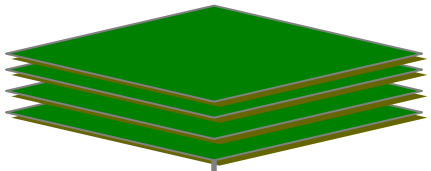


Ecological Niche Factor Analysis, *HIRZEL ET AL. 2002*

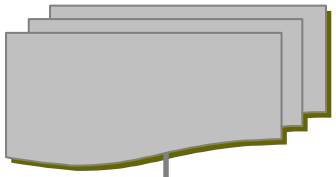
METHODS

MODEL DESIGN

ENVIRONMENT LAYERS



FISHERY LAYERS



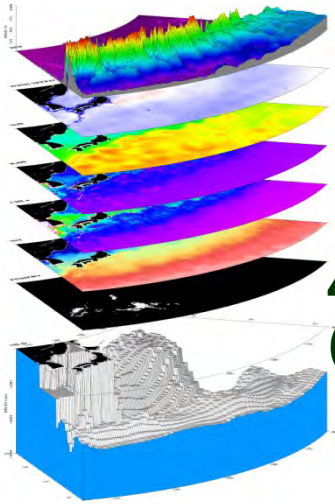
MIROC 3.2 SST

2025; 2050; 2100

1 ENFA MODELS

2 ENFA PREDICTIONS

3 HSI ANOMALIES

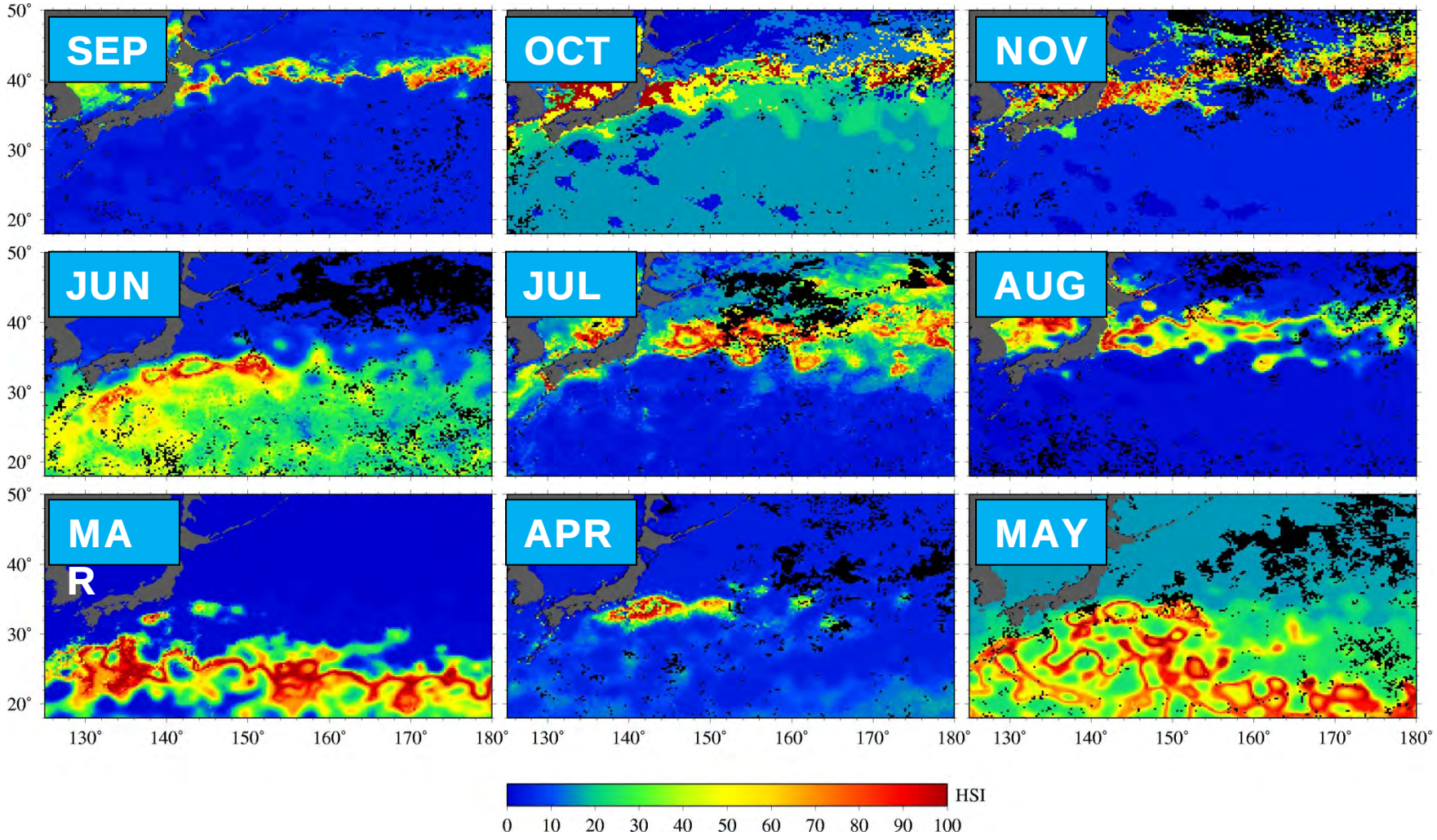


4-D VAR model Data (2004)

4 MLD; SUB-SURF. T

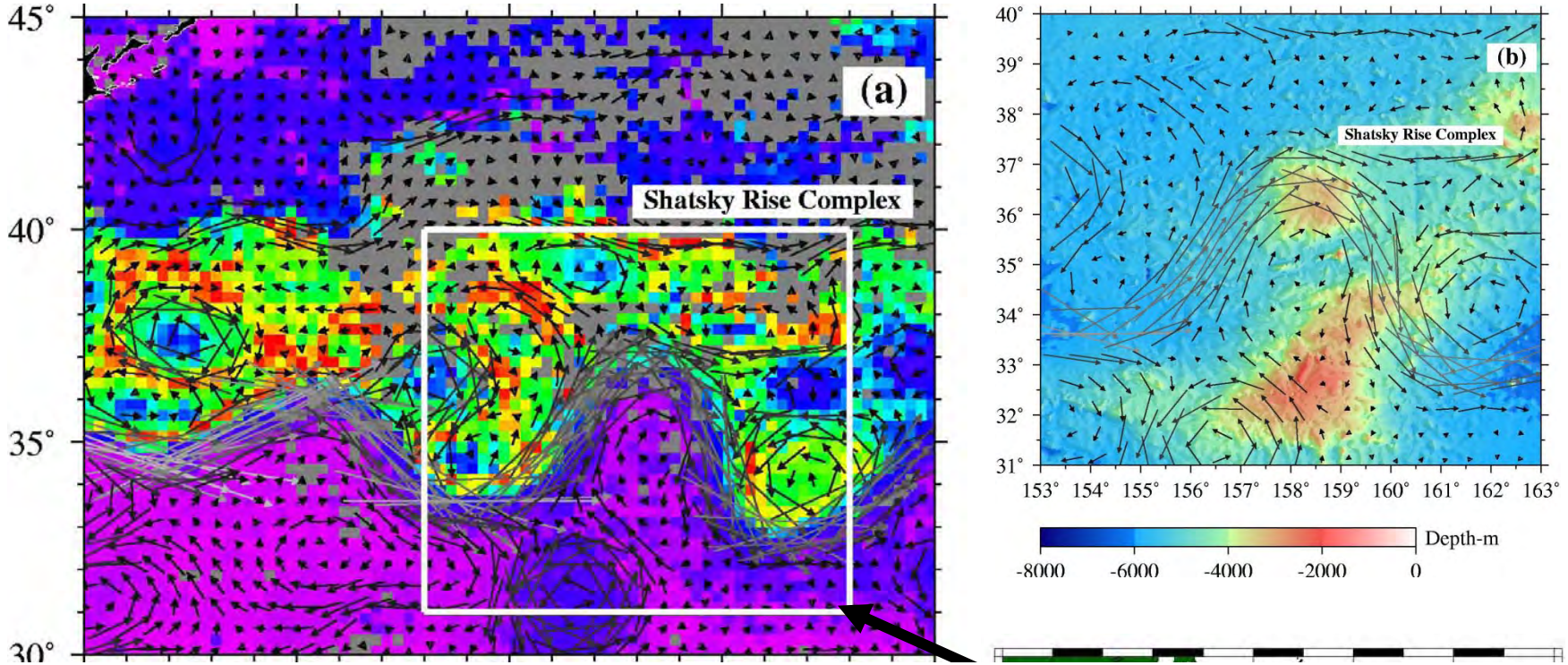
RESULTS

2004 MODELS



RESULTS

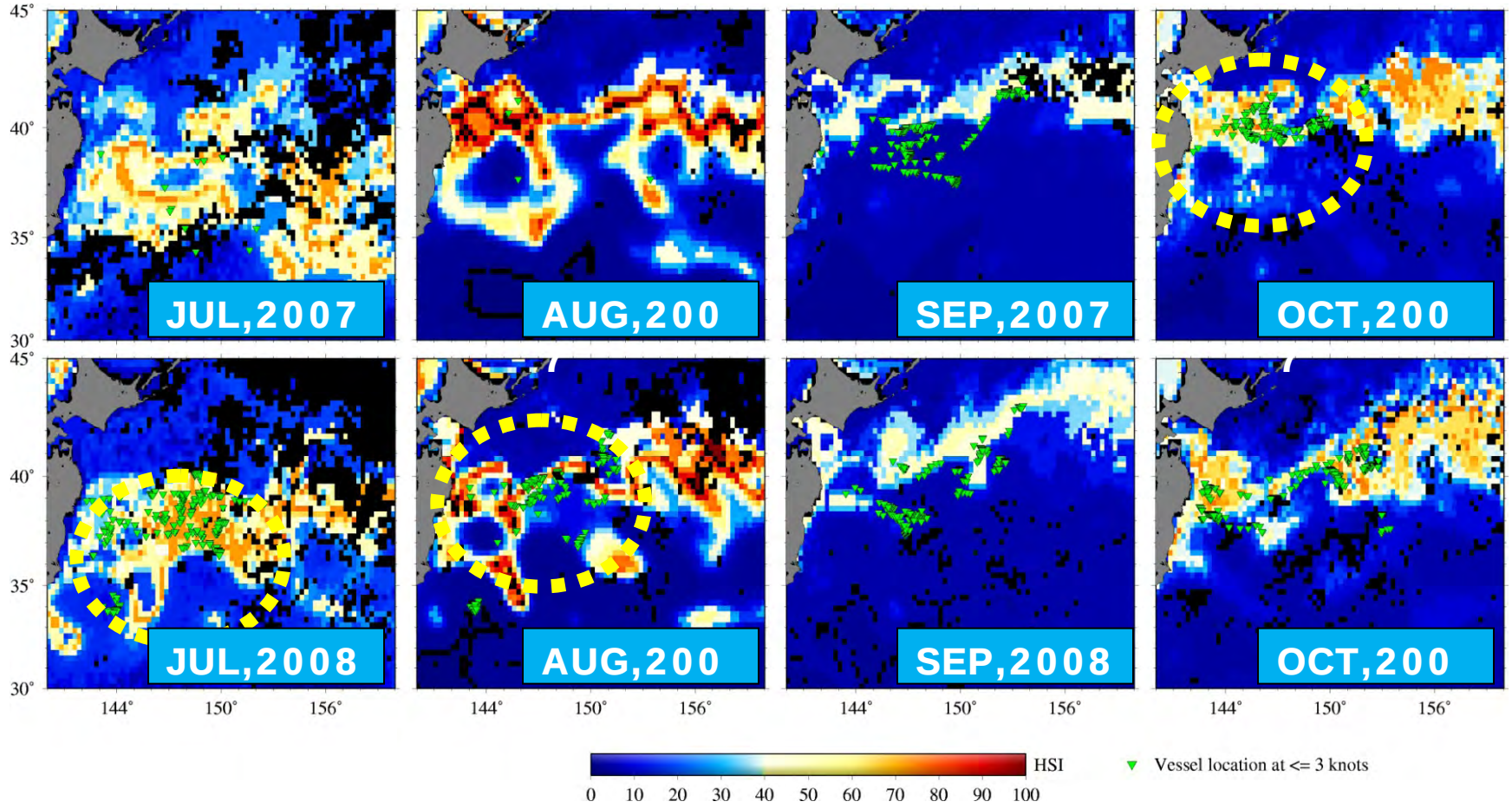
SHATSKY RISE EFFECT



Currents, **eddies**, **fronts** and "**streamers**" are some of the key features influencing formation of suitable habitat areas for skipjack tuna in the w. North Pacific

RESULTS

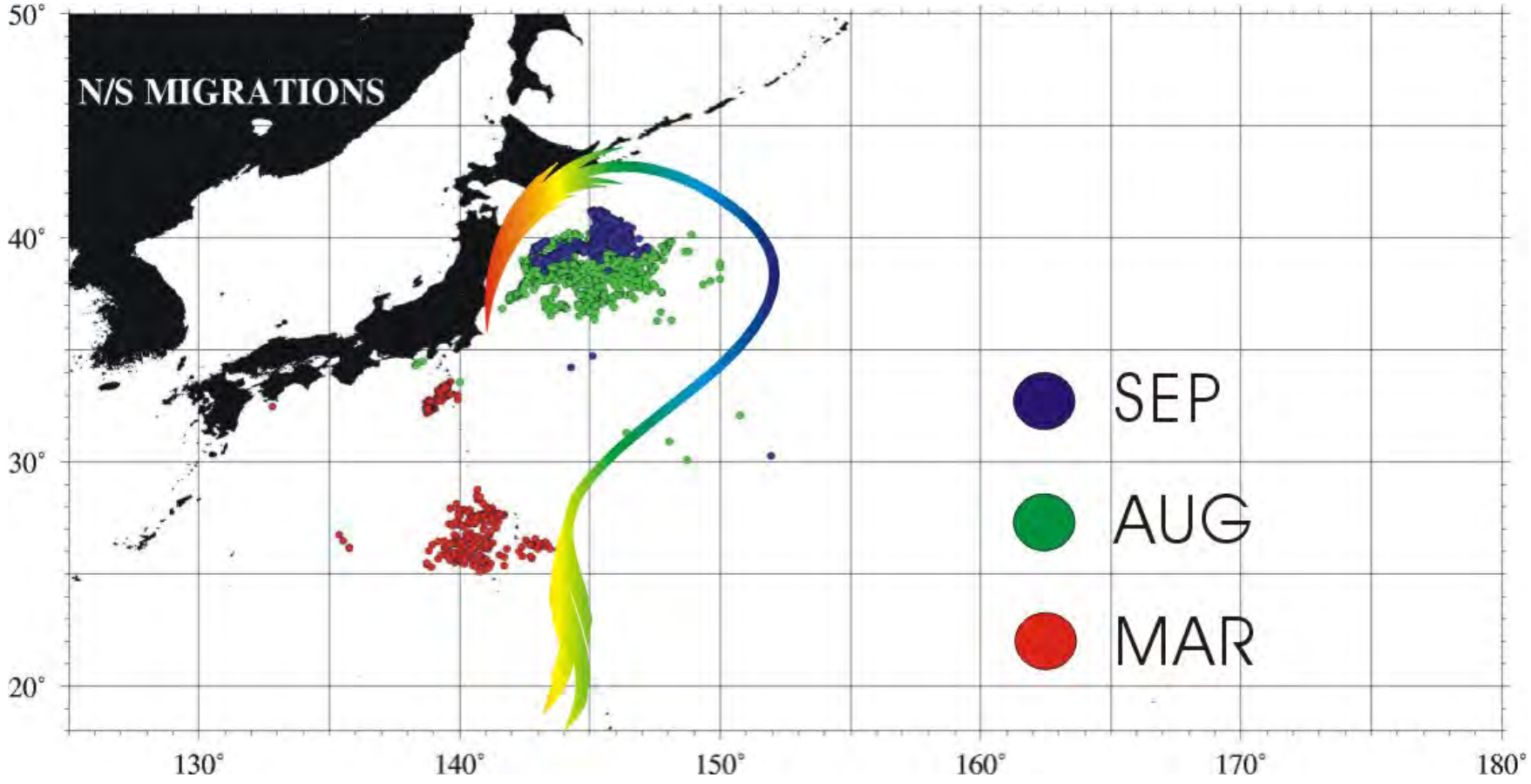
VALIDATION WITH VMS



Spatial overlap of predicted high HSIs with VMS locations!!!

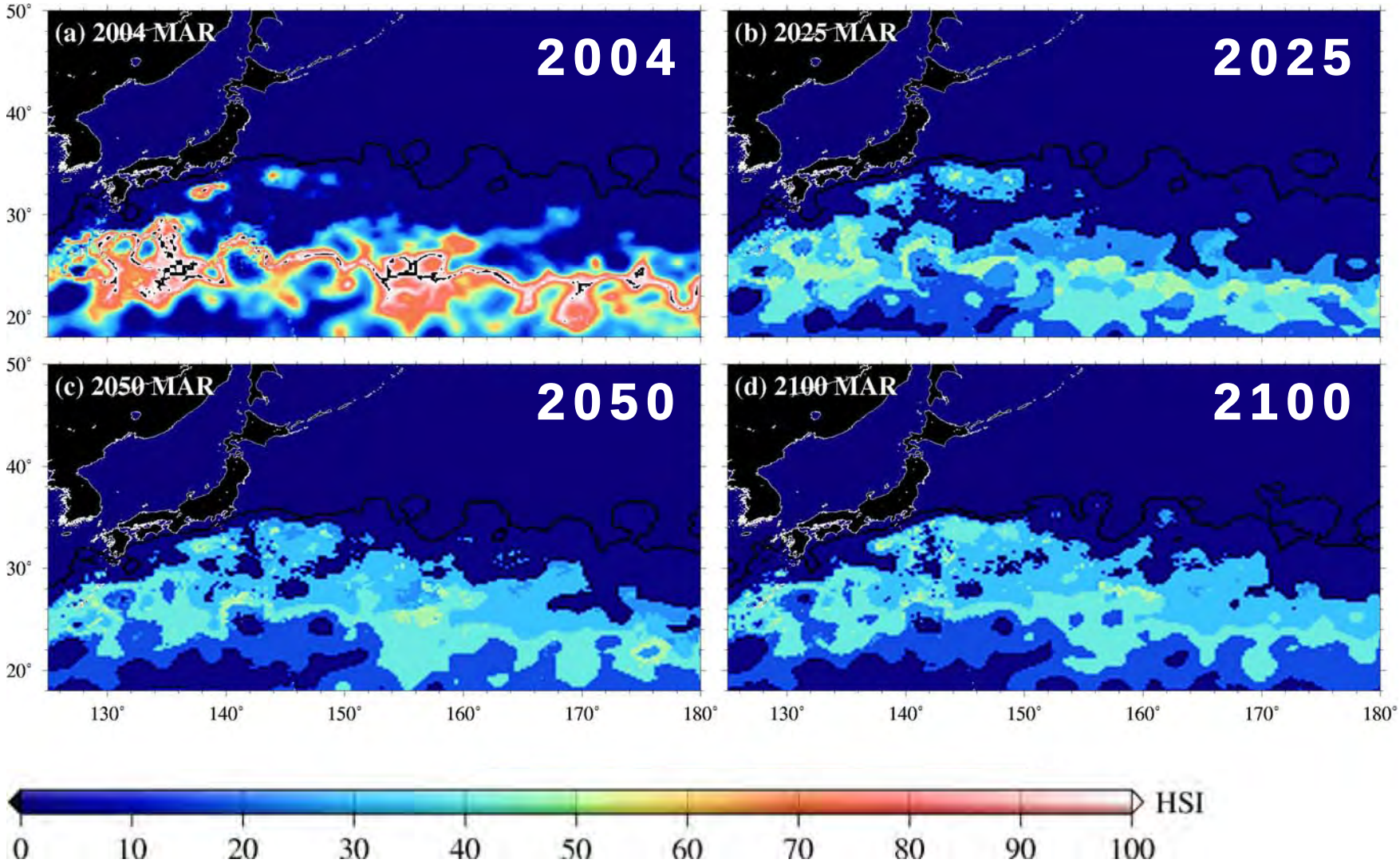
RESULTS

N/S MIGRATIONS



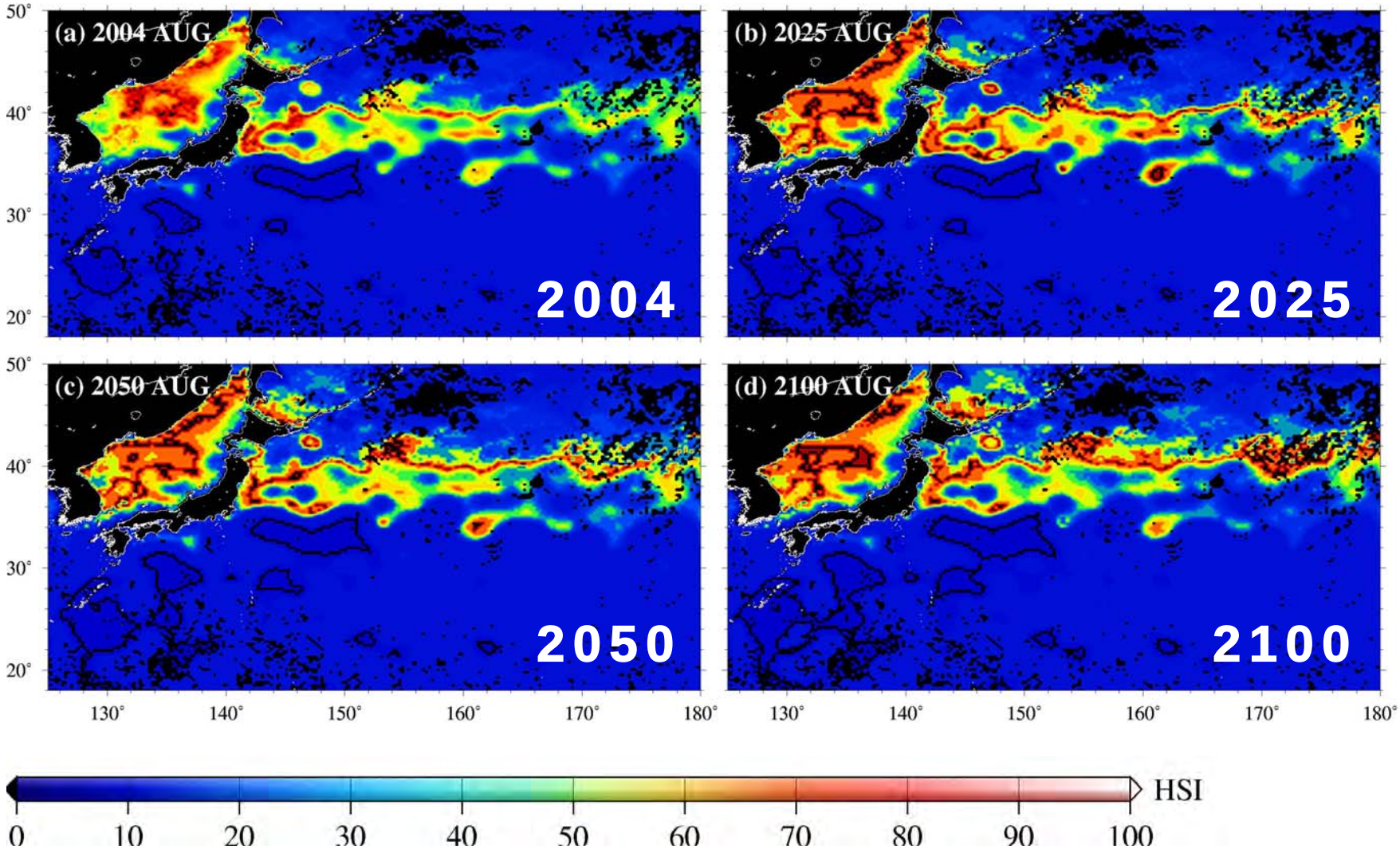
RESULTS

SPRING(March)



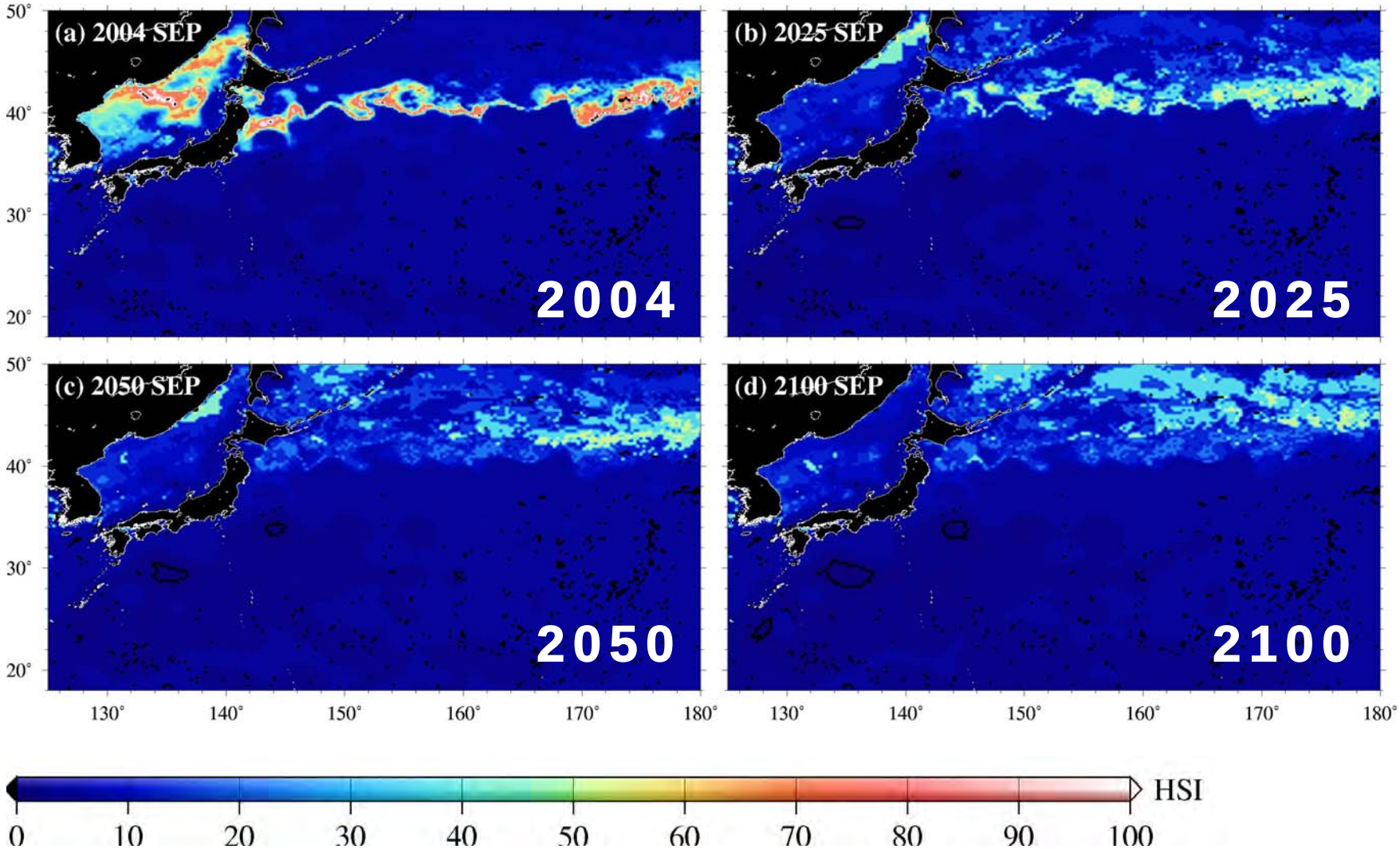
RESULTS

SUMMER(August)

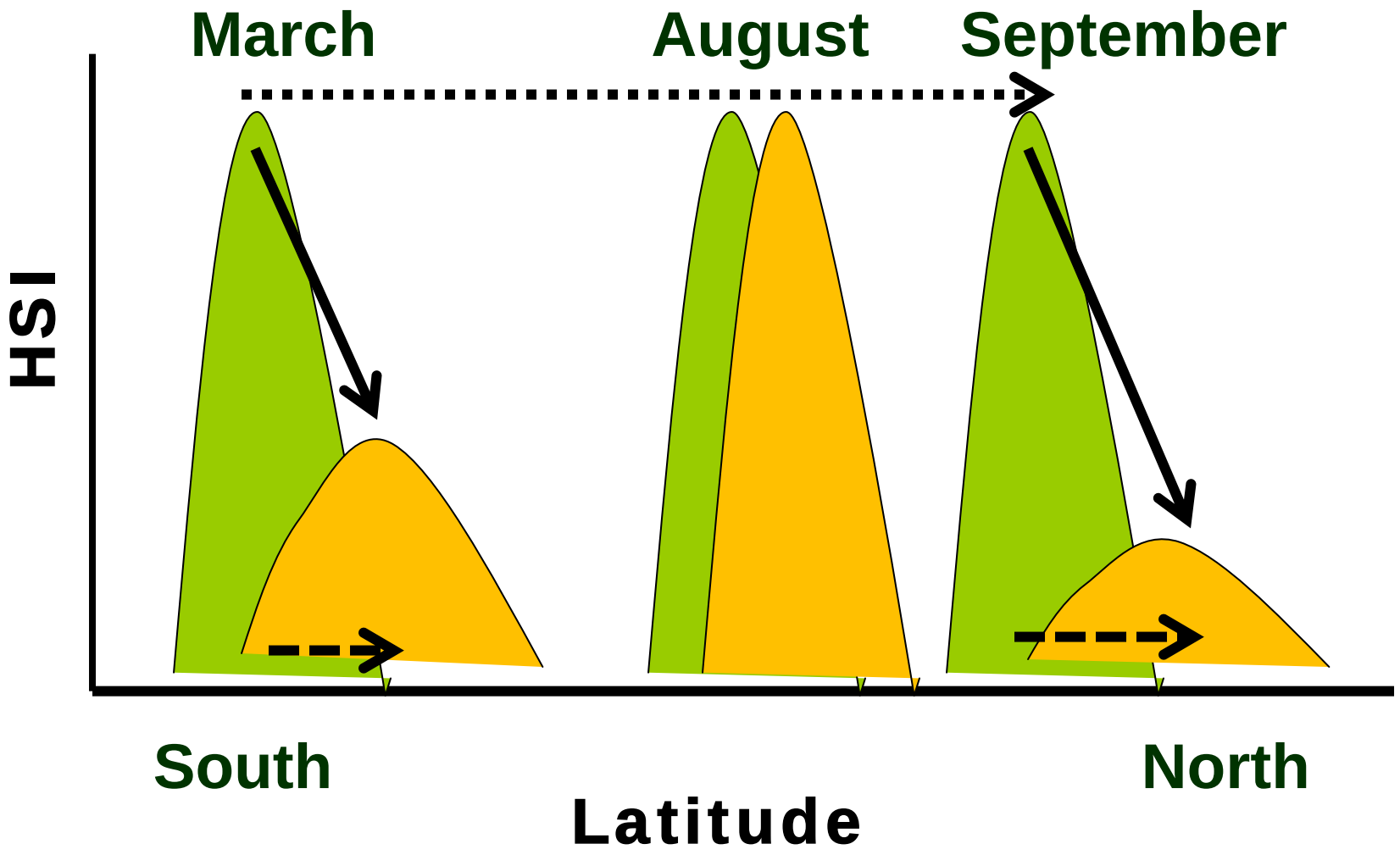


RESULTS

Autumn(September)

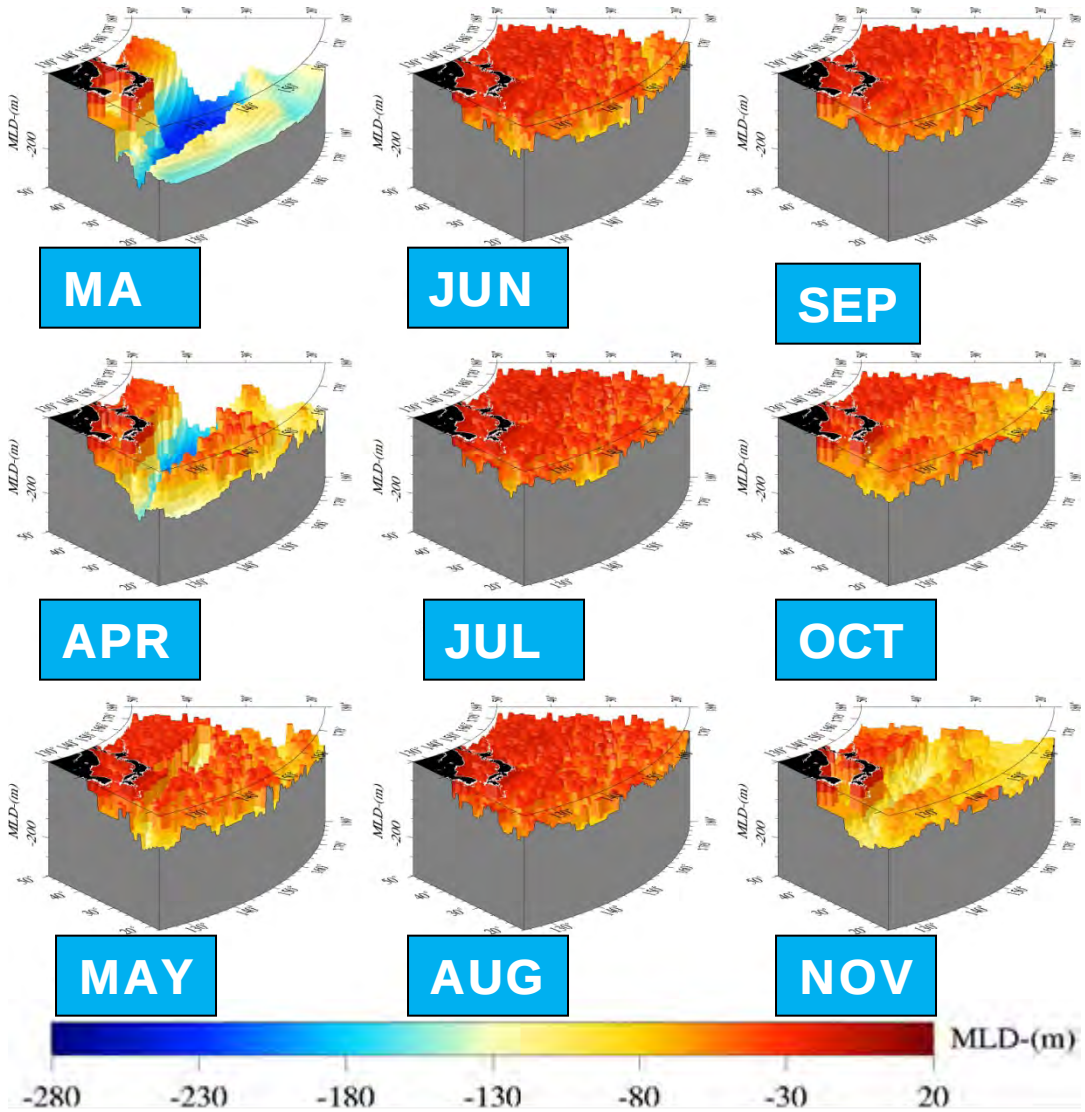


RESULTS



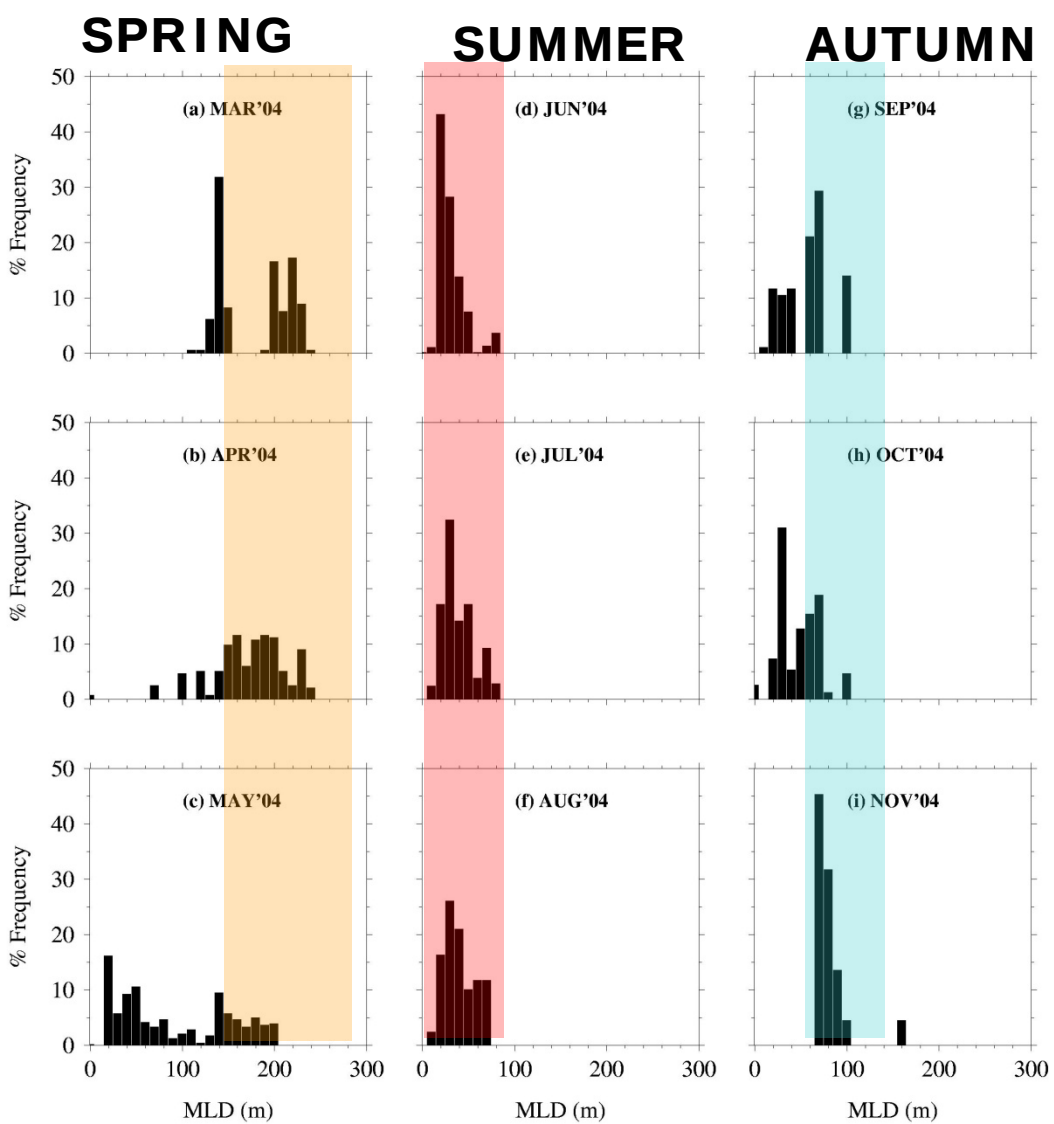
RESULTS

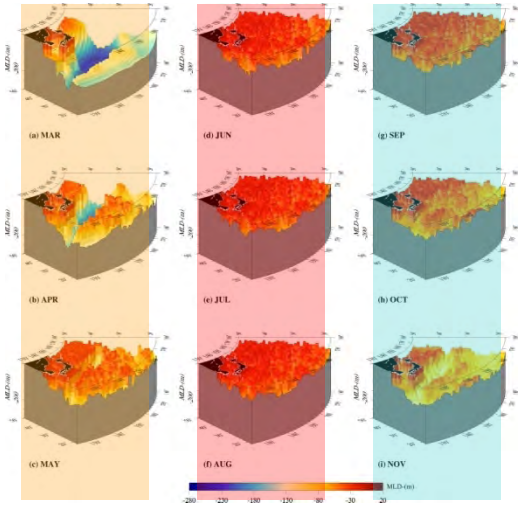
MLD VARIABILITY



RESULTS

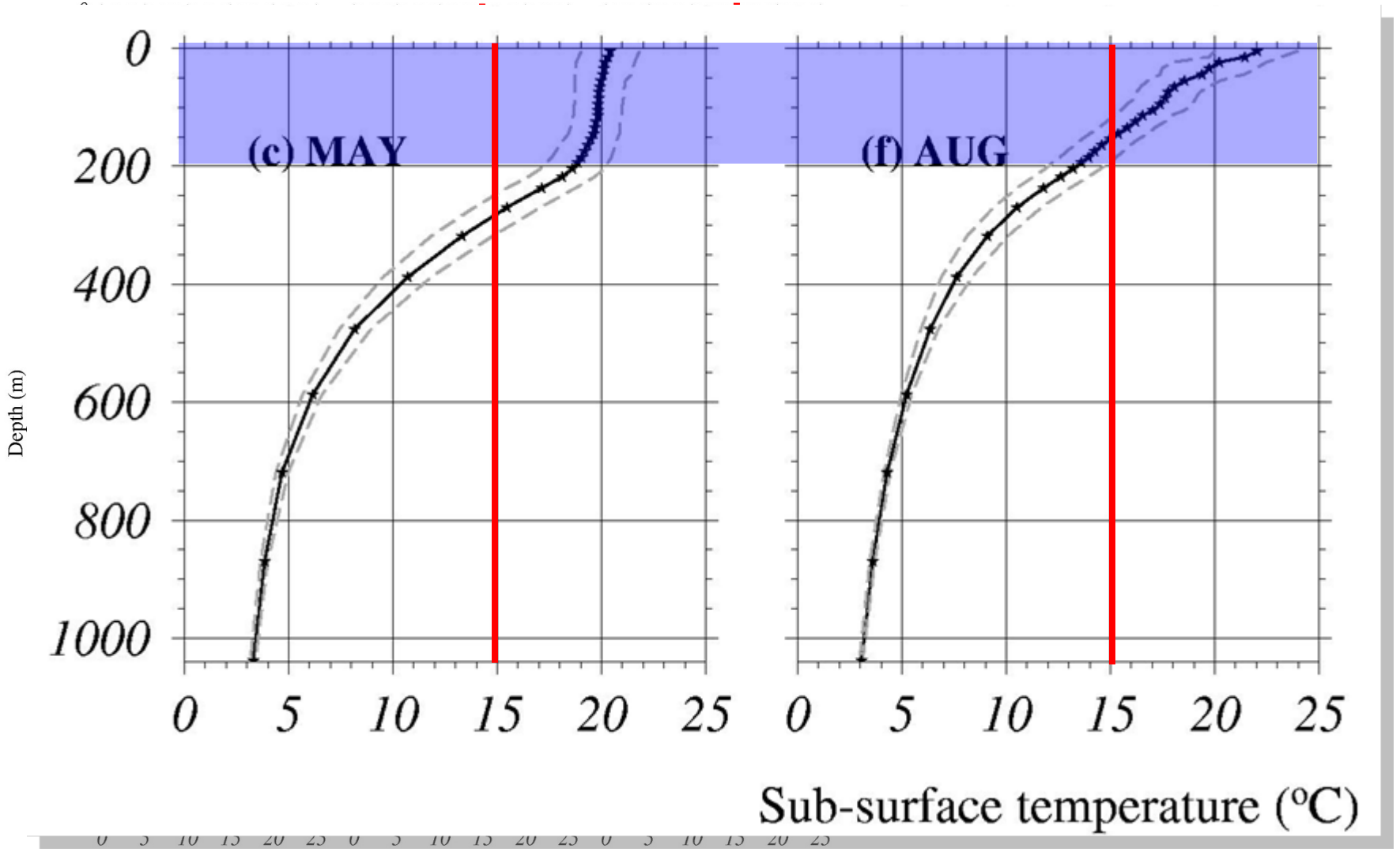
SKIPJACK & MLD CHANGES





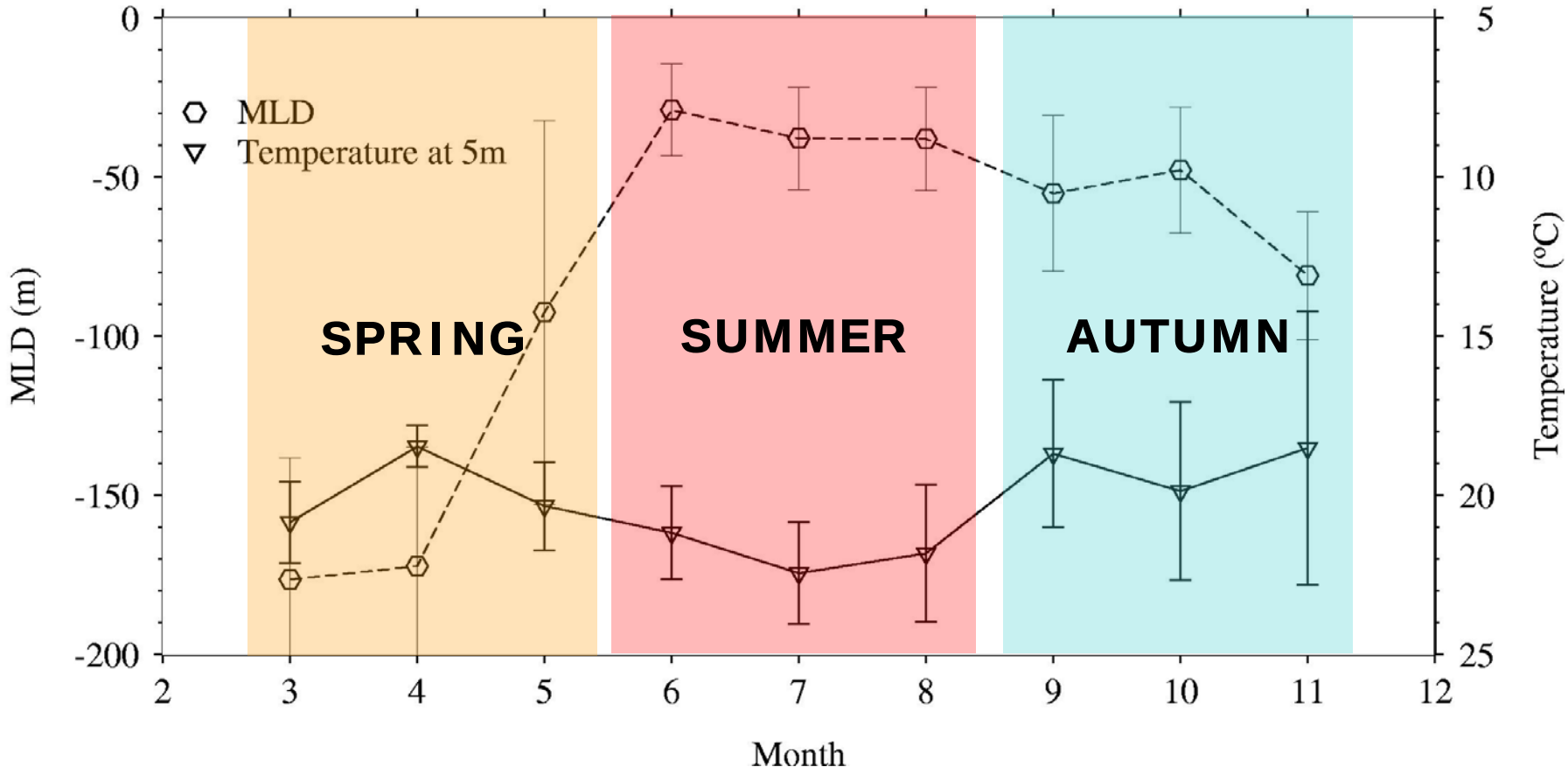
RESULTS

SUB-SURFACE TEMP.



RESULTS

MLD & TEMP.



✓ What will a warmer ocean with shallow MLDs mean for skipjack in the w. North Pacific?

KEY POINTS

ECOLOGICAL

- √ Skipjack tuna are projected to “arrive” in higher latitudes slightly earlier than is observed today.

- √ Migrations north of 40^{o}N in autumn will depend largely on surface warming of the Oyashio waters and the mixed zone.

- √ Adaptations by skipjack tuna are difficult to predict; implications of GW on Oyashio system further north in autumn will require further work.

KEY POINTS

SOCIETAL

- √ Fishermen in higher latitudes might benefit from early arrivals of skipjack tuna, especially in spring and summer.

- √ In autumn, if fishing grounds extend north of current ranges, fishing trips could be longer, incurring more fuel & labor costs.

- √ If GW results in low skipjack tuna abundances, fishermen might have to change to other fisheries in this area and time of the year.

CONCLUSIONS

- √ Global warming may cause migrations of skipjack tuna into sub-tropical areas earlier than observed today.

- √ Shallow MLDs and warmer surface waters will provide favorable habitat for skipjack to migrate northwards.

- √ Extent of migration in Oyashio region will depend on modification of surface waters in autumn.

THANK YOU