Forecasting climate change impacts on distribution and abundance of jack mackerel around Korean waters

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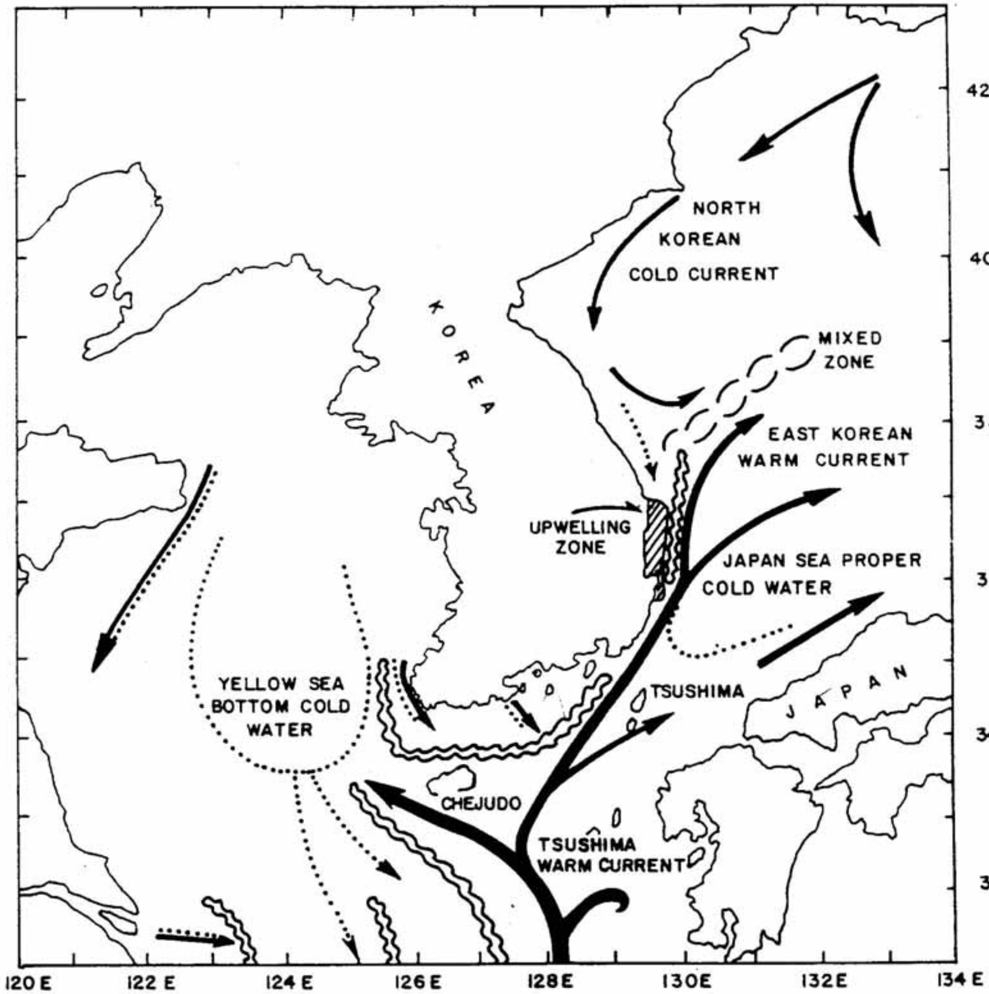
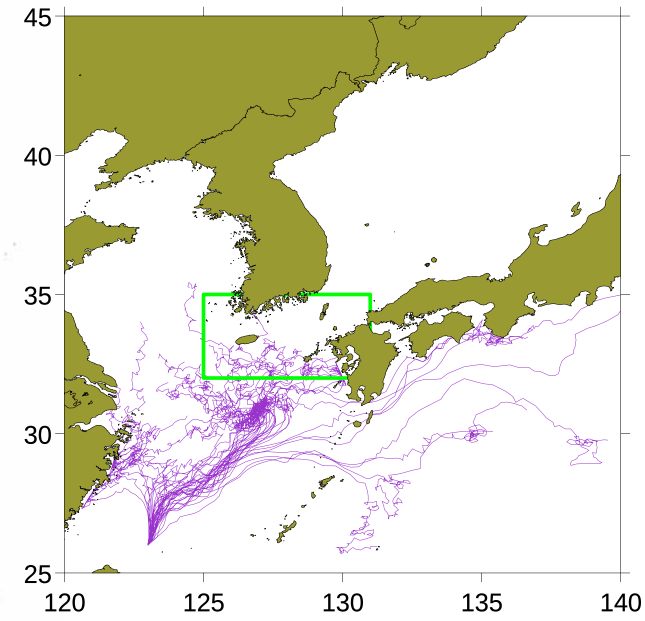
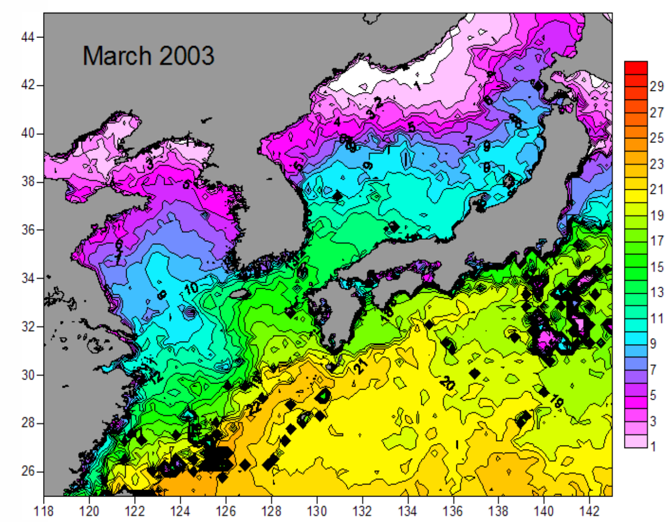
Contents

- Variations of ocean environments around Korean waters
- Influence of environmental variations to recruitment of jack mackerel
- Selection of environmental stock-recruit relationships
- Forecasting abundance and distribution of jack mackerel

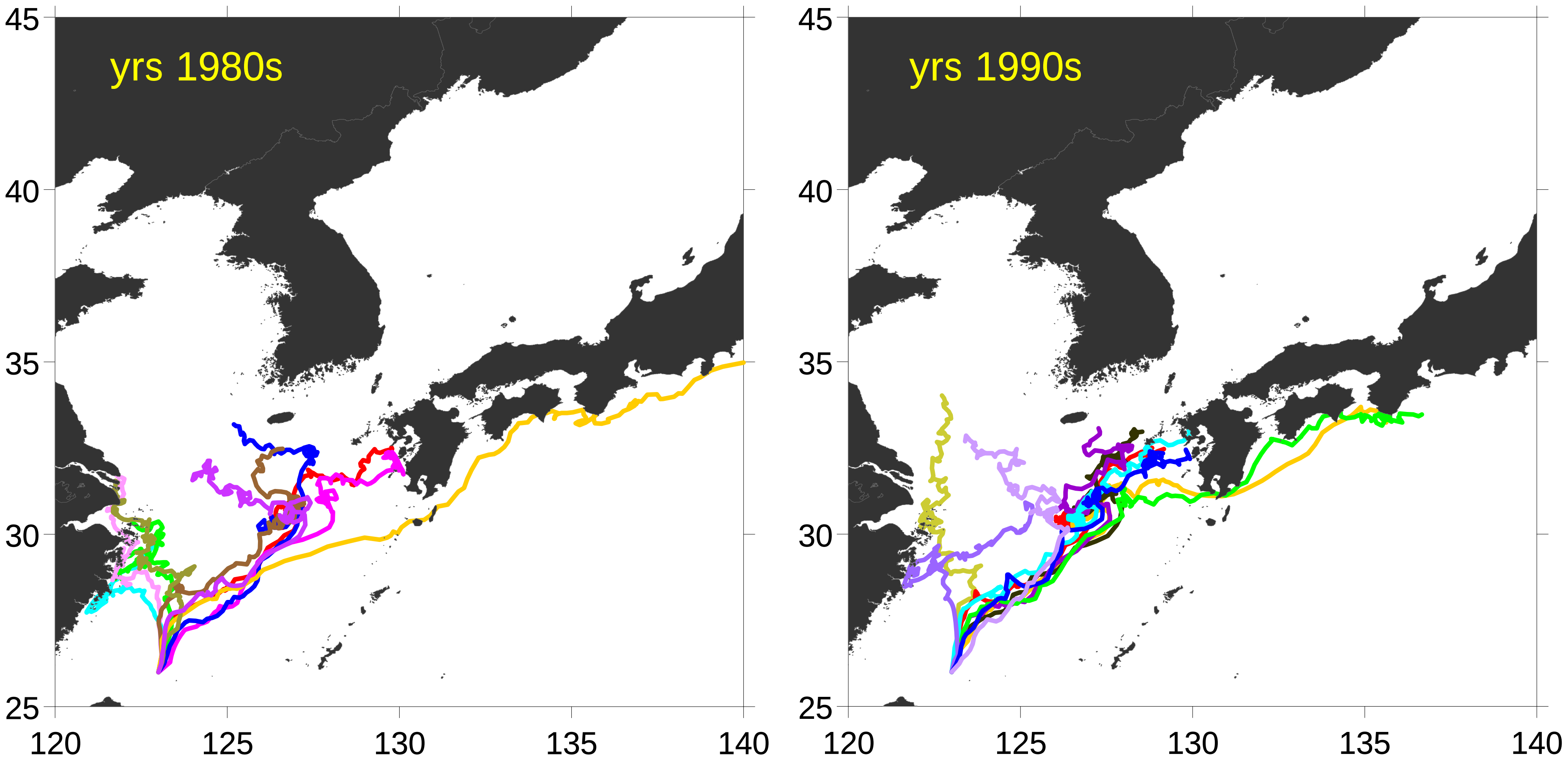
Currents around Korean waters



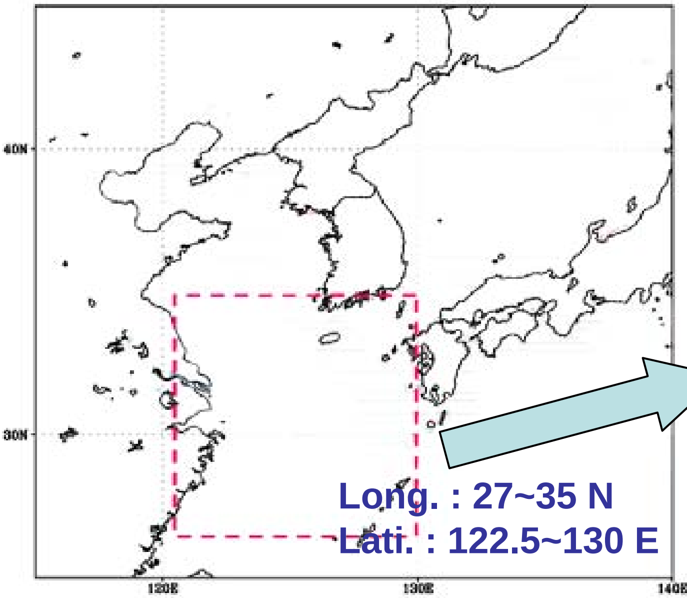


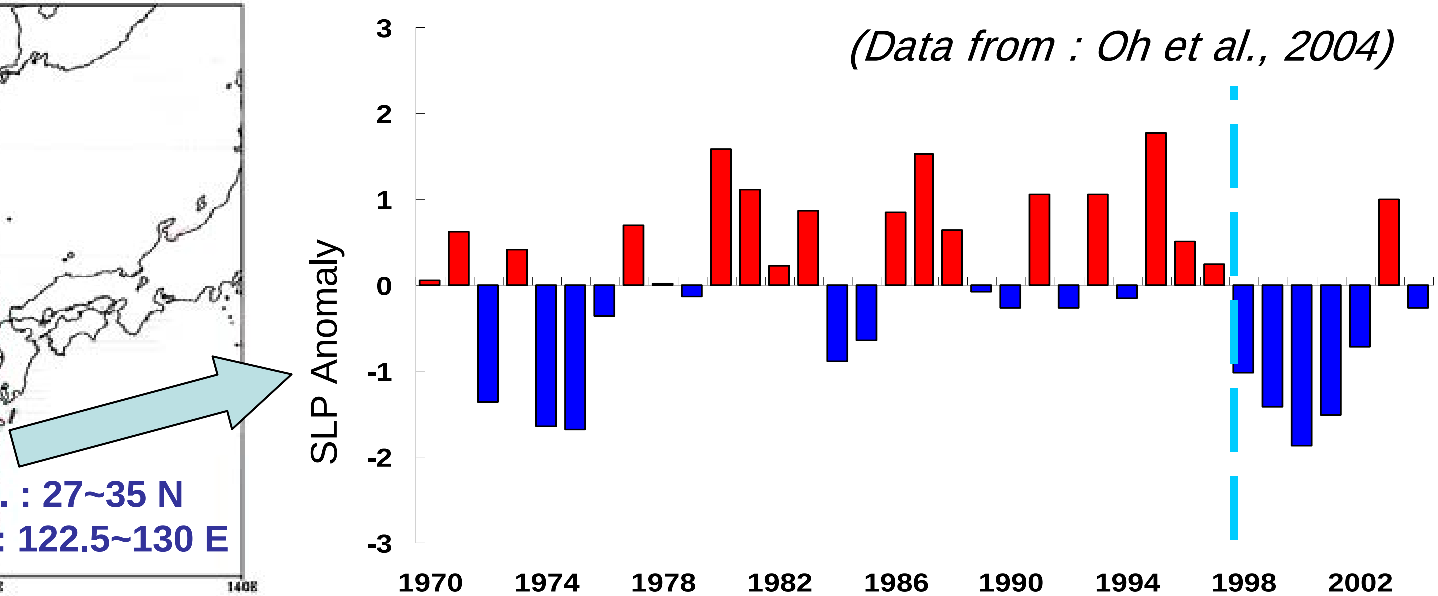


Ocean currents

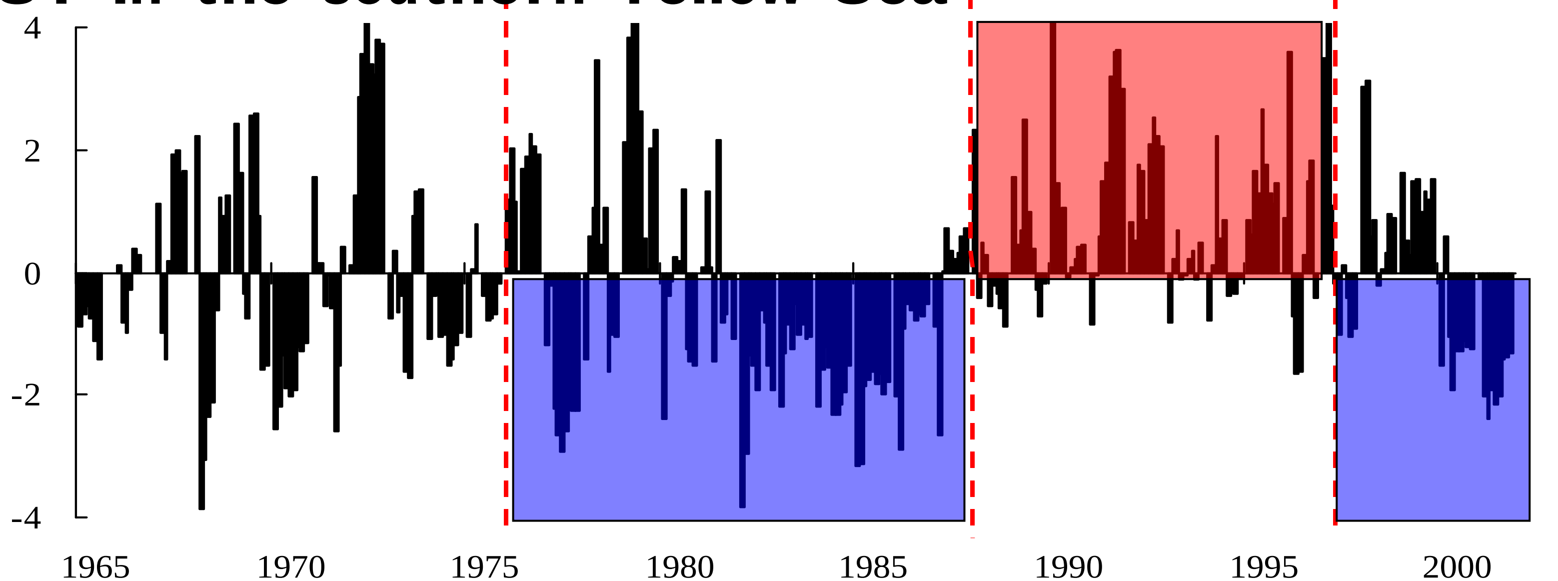


Sea Level Pressure in the ECS

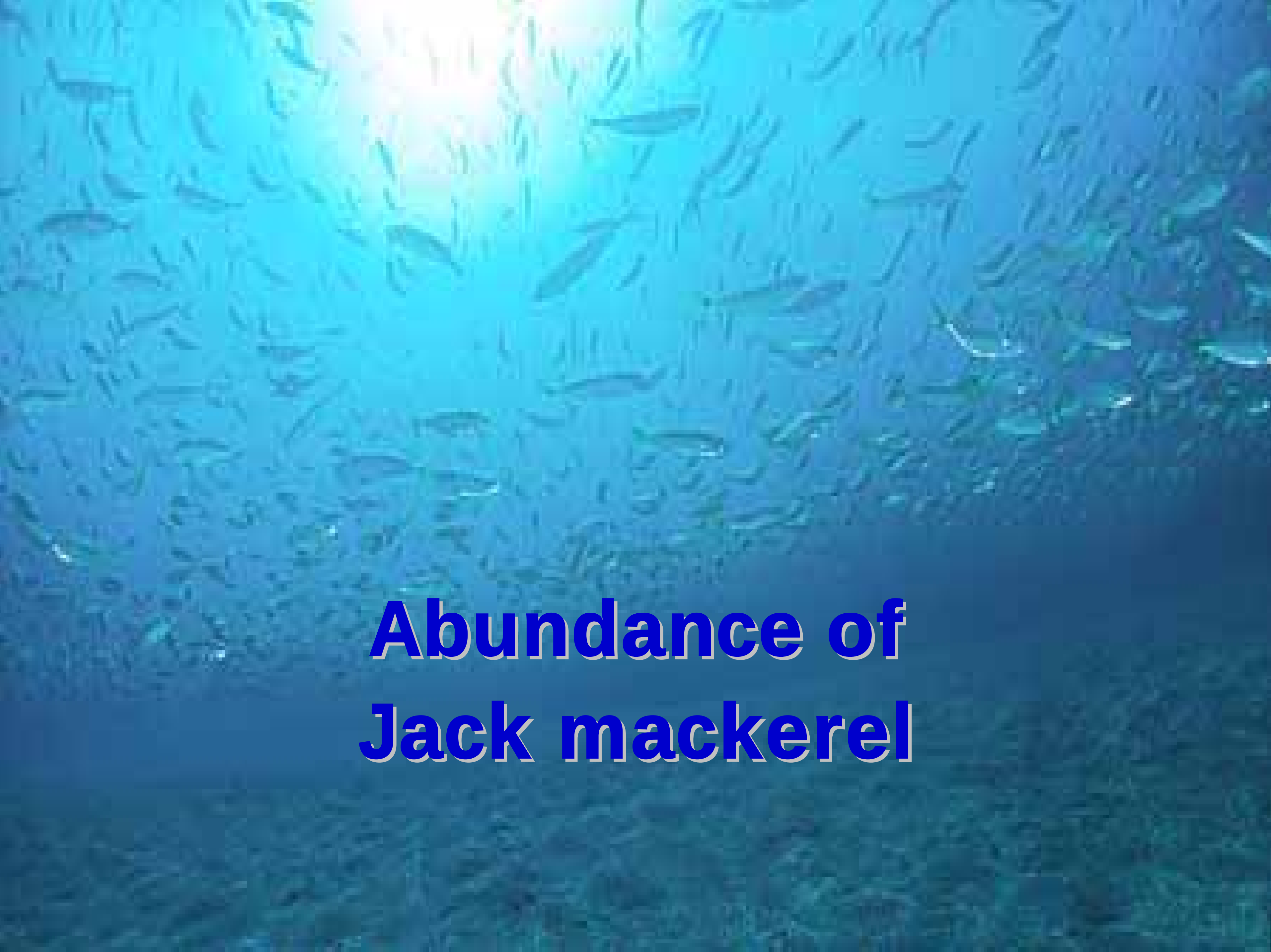




SST in the southern Yellow Sea



(from Lee, 2006)

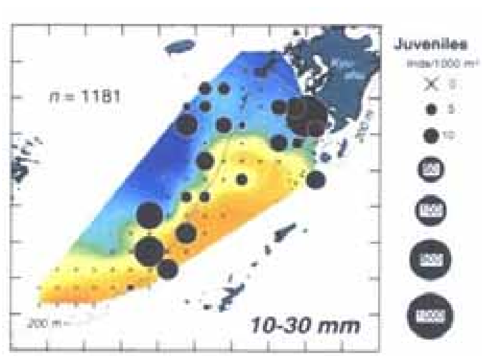


Abundance of Jack mackerel

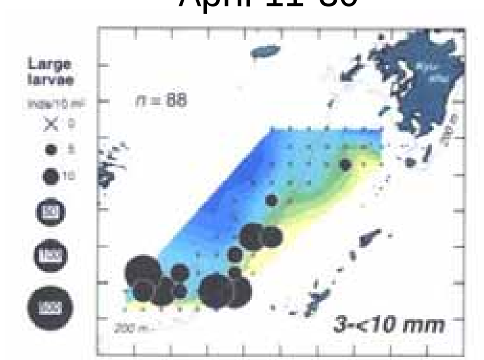
Transporting larvae/ juvenile of jack mackerel by the Kuroshio Current

Spawnig ground

Nursery ground

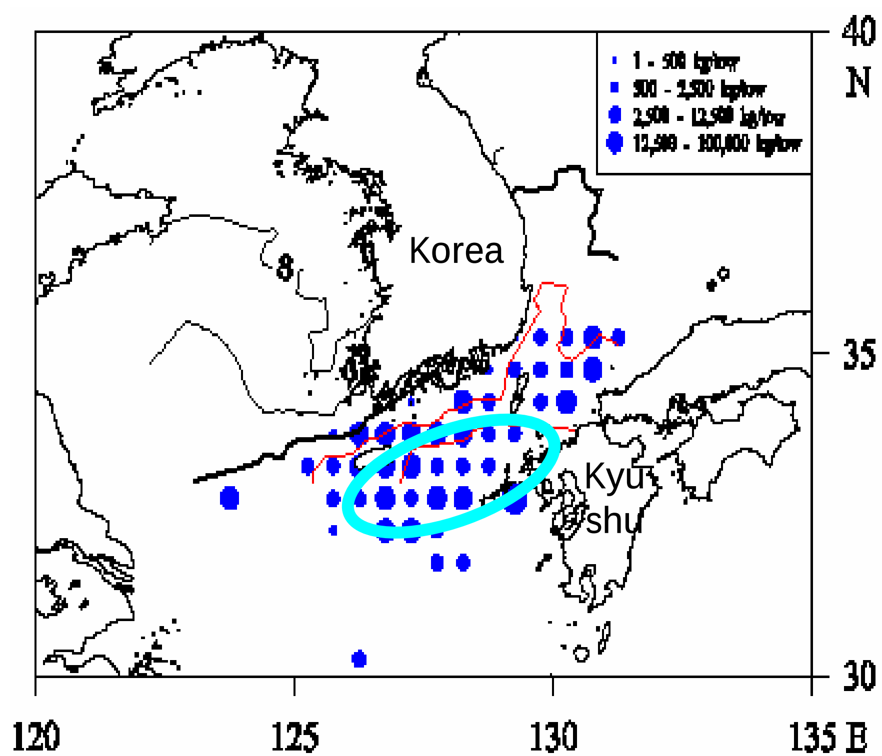


April 11-30



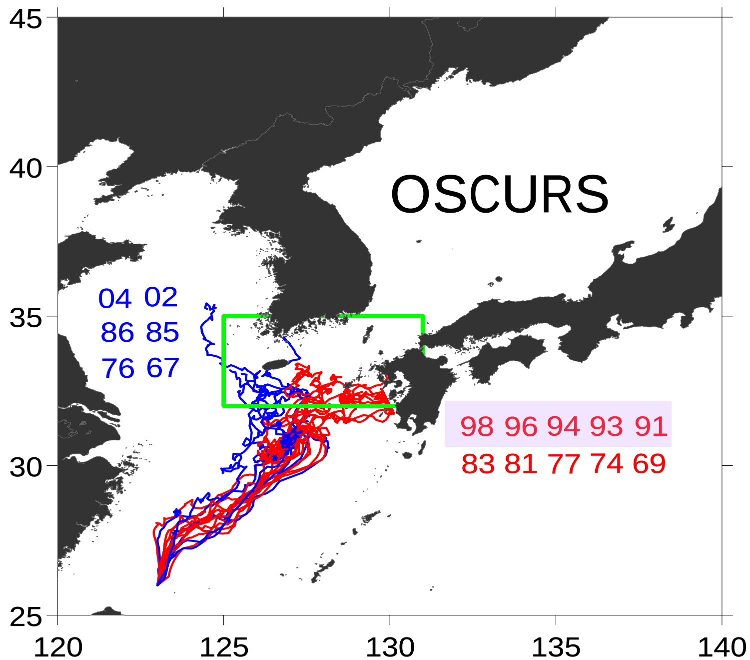
February 27-March 10

After Sassa *et al.* (2005)

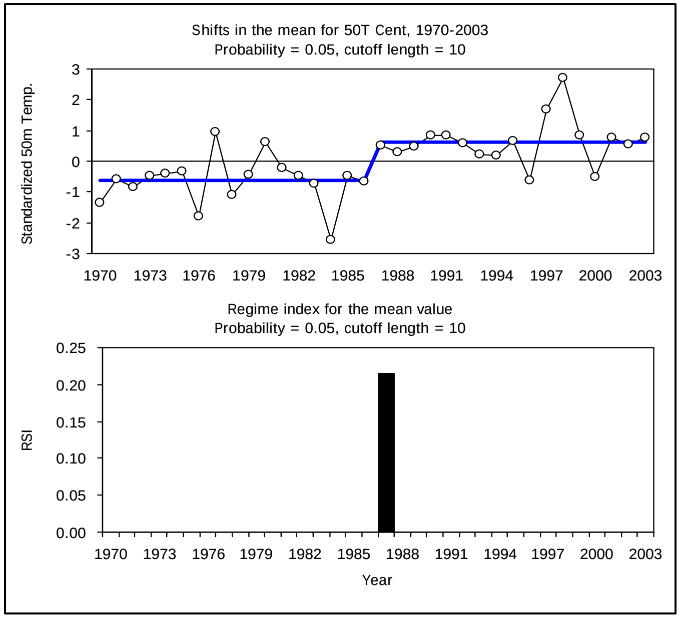


After Lee (2005)

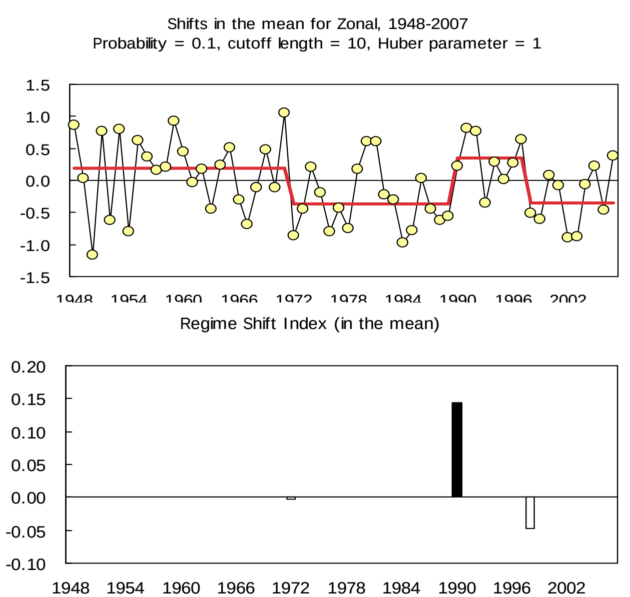
Jack mackerel



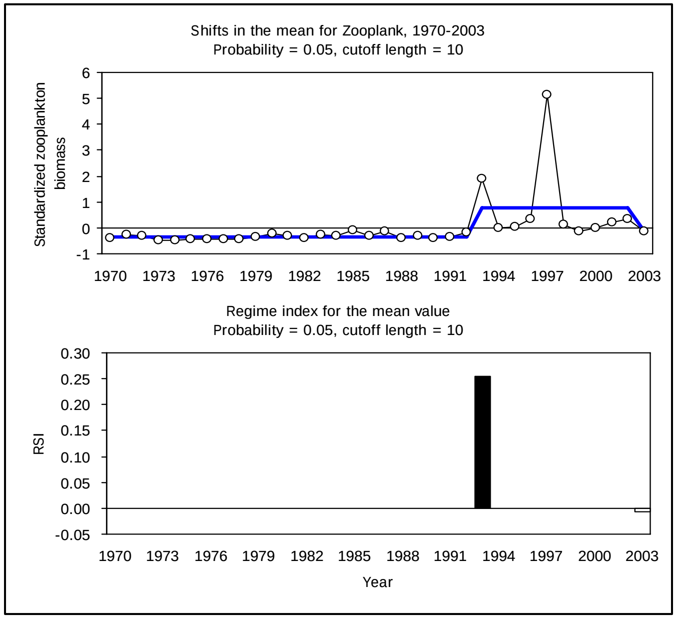
Temp. at 50m



Wind (zonal)

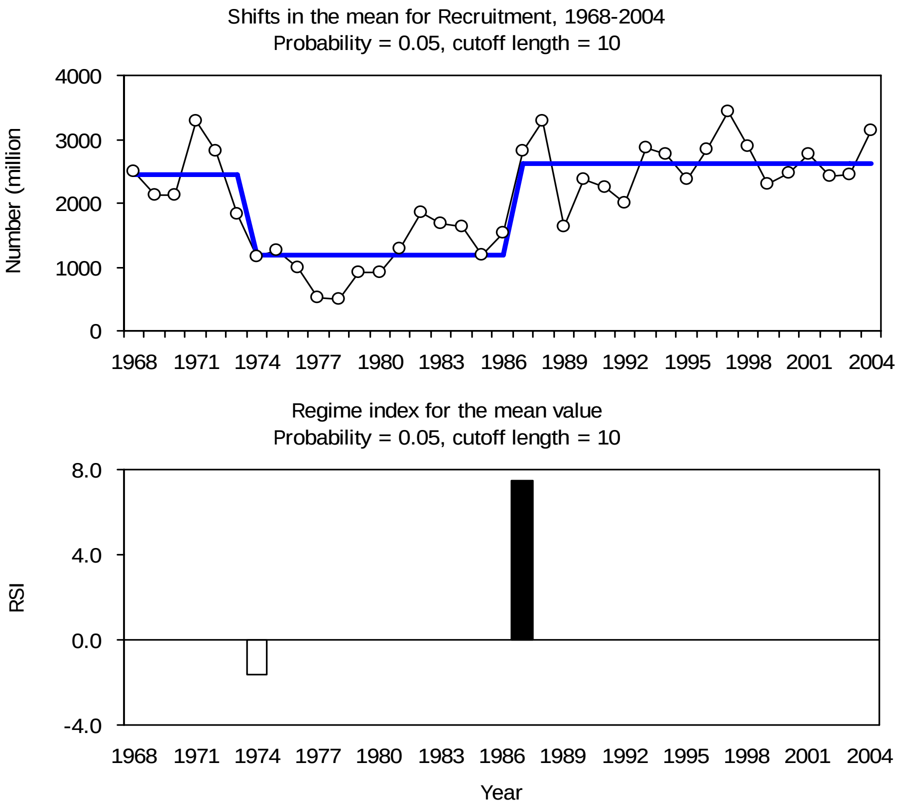


Zooplankton biomass

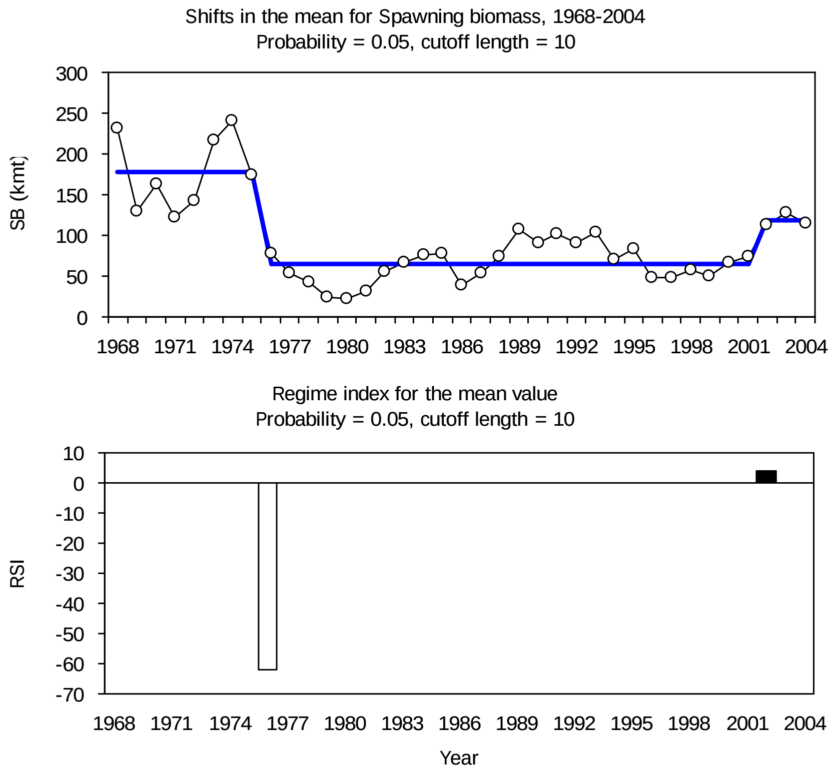


Jack mackerel

Recruitment of jack mackerel

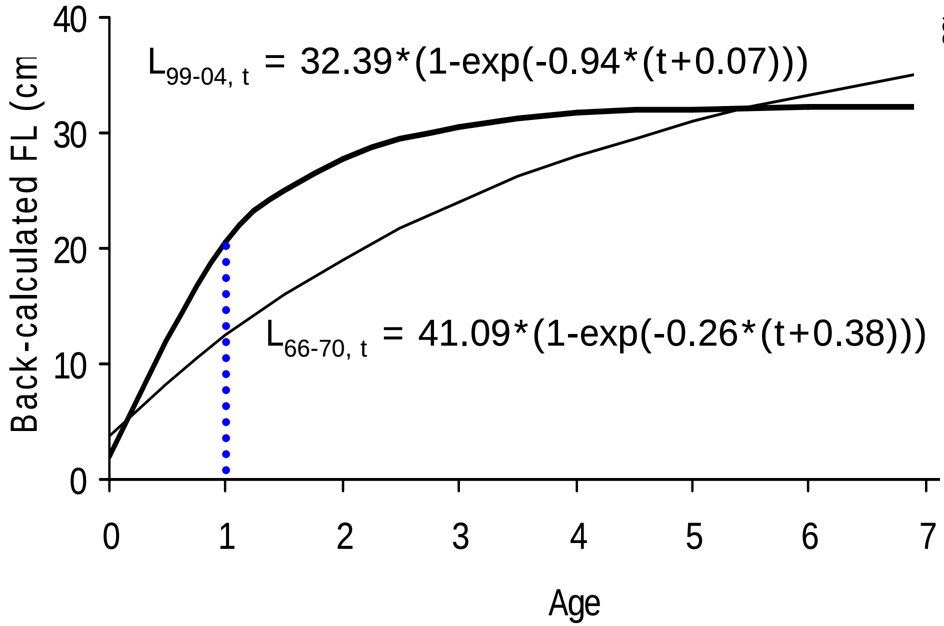


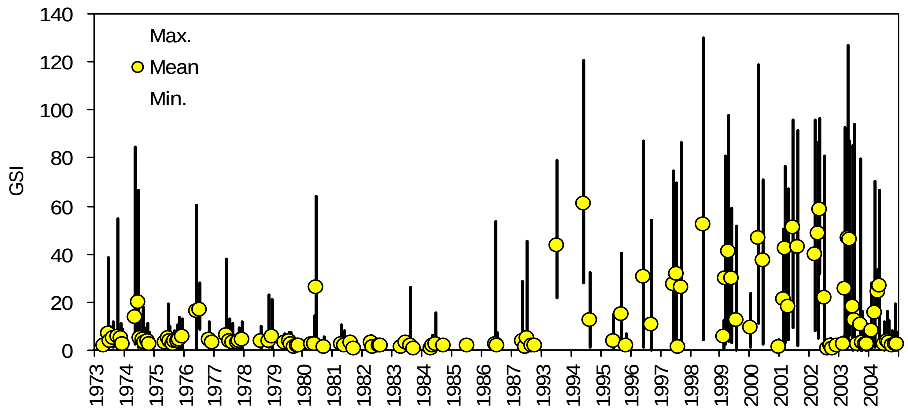
Spawning biomass of jack mackerel

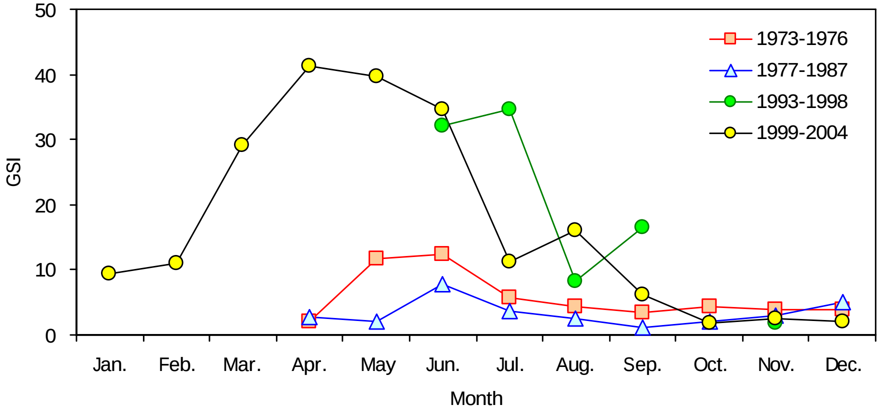


(from Lee et al., 2005)

Growth and Maturation of jack mackerel



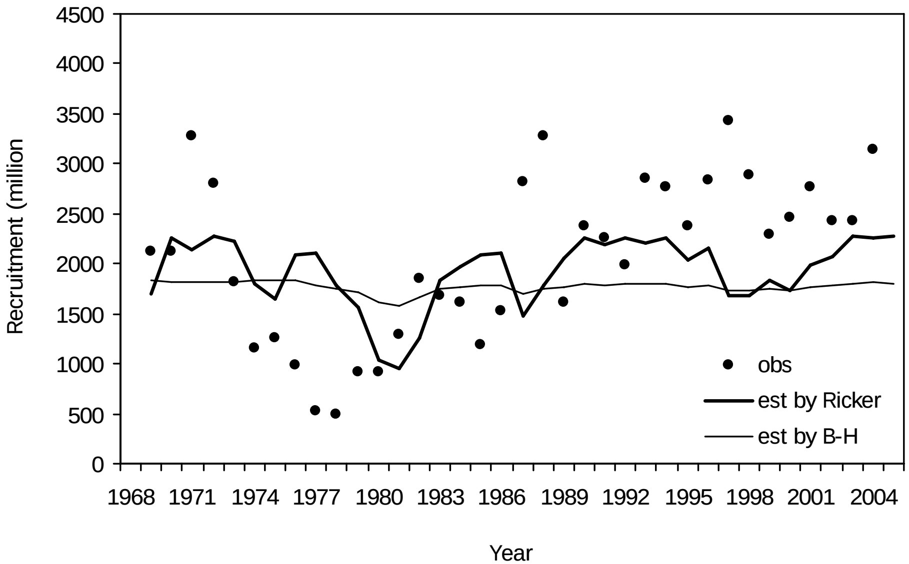




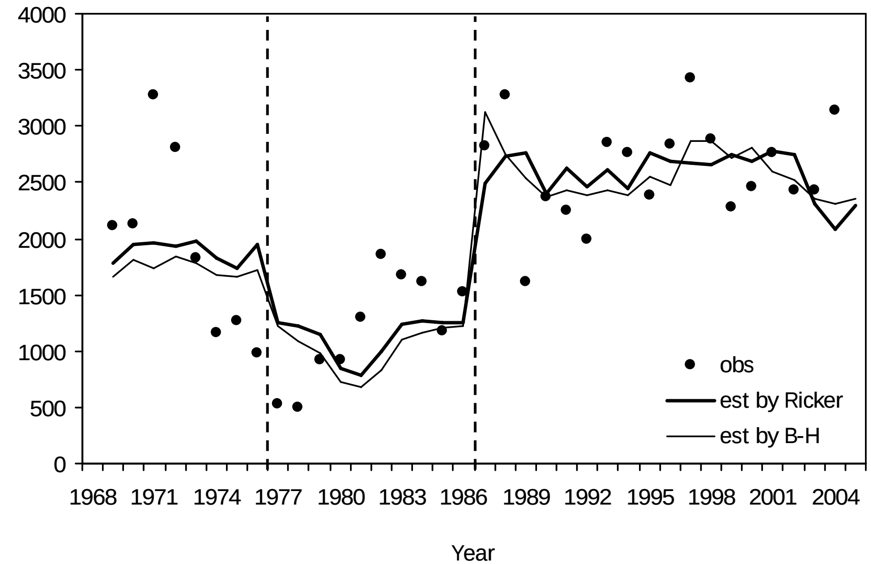
❖ Growth rate (K/Linf) :
0.006 (yr 66-70) < 0.029 (yr 99-04)

Recruitment estimates (I)

1969-2004

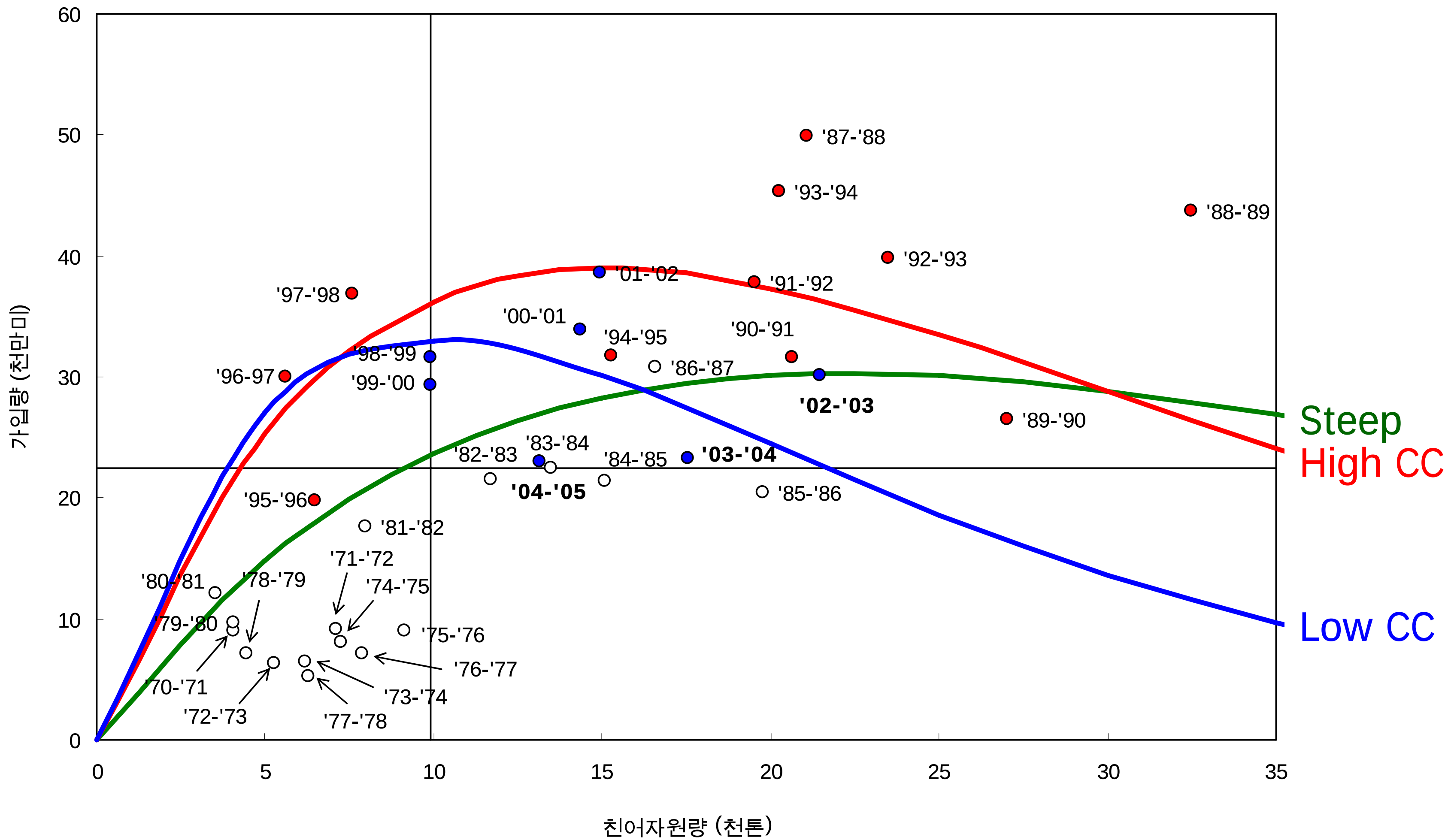


1969-76, 1977-86, 1987-2004



	One regime		Three regimes	
	Ricker	B-H	Ricker	B-H
r	0.289	0.171	0.721	0.73
P-value	<0.05	n/s	<0.001	<0.001

Spawner-Recruit Relationships of jack mackerel

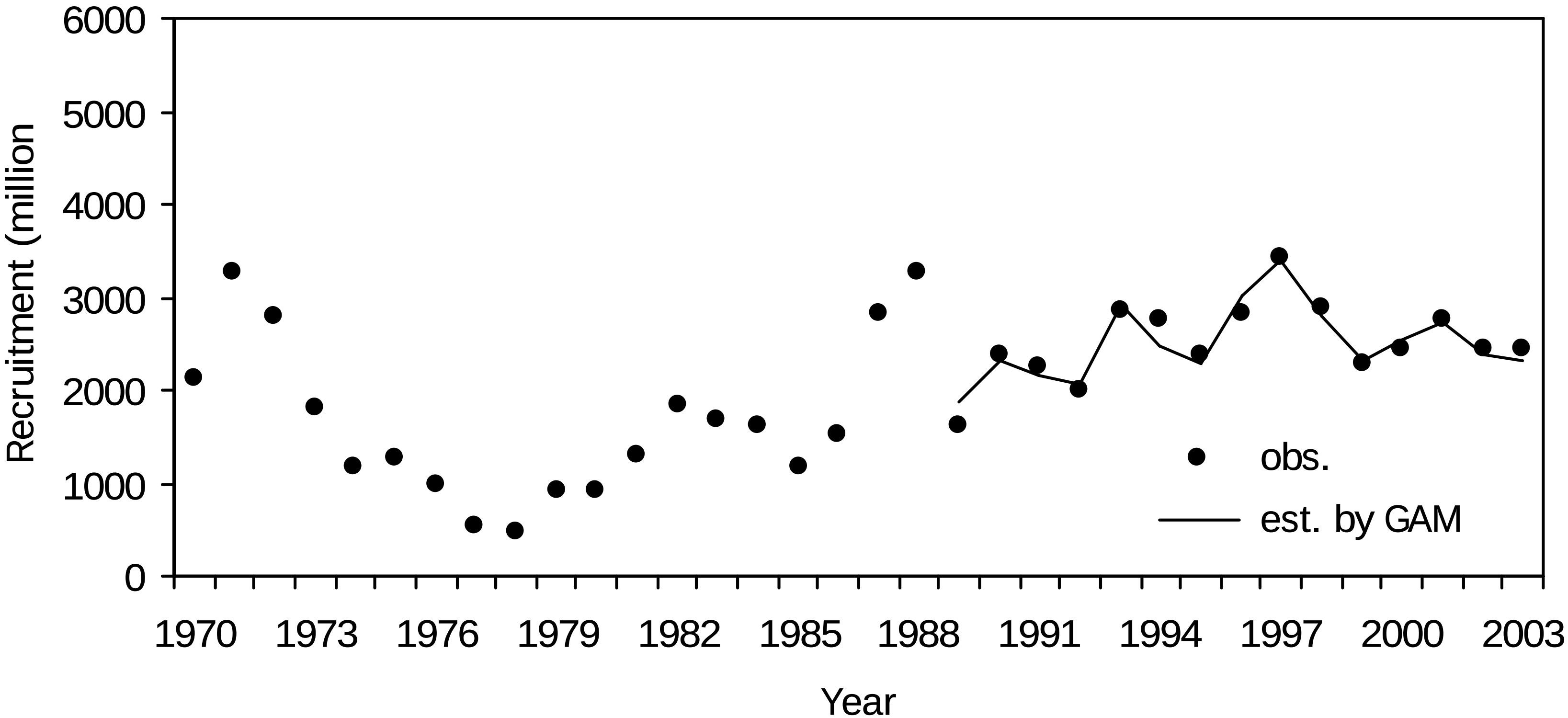


(from Lee et al., 2005)

Analysis of deviance of the fitted GAM

Models		Residual df	Deviance	AIC	rsq
n =	15				
null deviance =	0.4380993				
Response:	lnR				
1	lnS	13	0.3159742	26.3159742	0.27876109
2	lo(S,Z,Pdo)	4.030774	0.0485814	8.1101294	0.89395129
3	lnS+lo(Z,Pdo)	4.604726	0.0529183	9.2623703	0.87938396
4	lo(S,Z)	5.201238	0.1085168	10.5109928	0.76024637
5	lo(S,Pdo)	5.604726	0.0560394	11.2654914	0.8721641
6	lnS+lo(Z)	7.637916	0.124454	15.400286	0.71700909
7	lnS+lo(Pdo)	9.224373	0.1338425	18.5825885	0.70871962

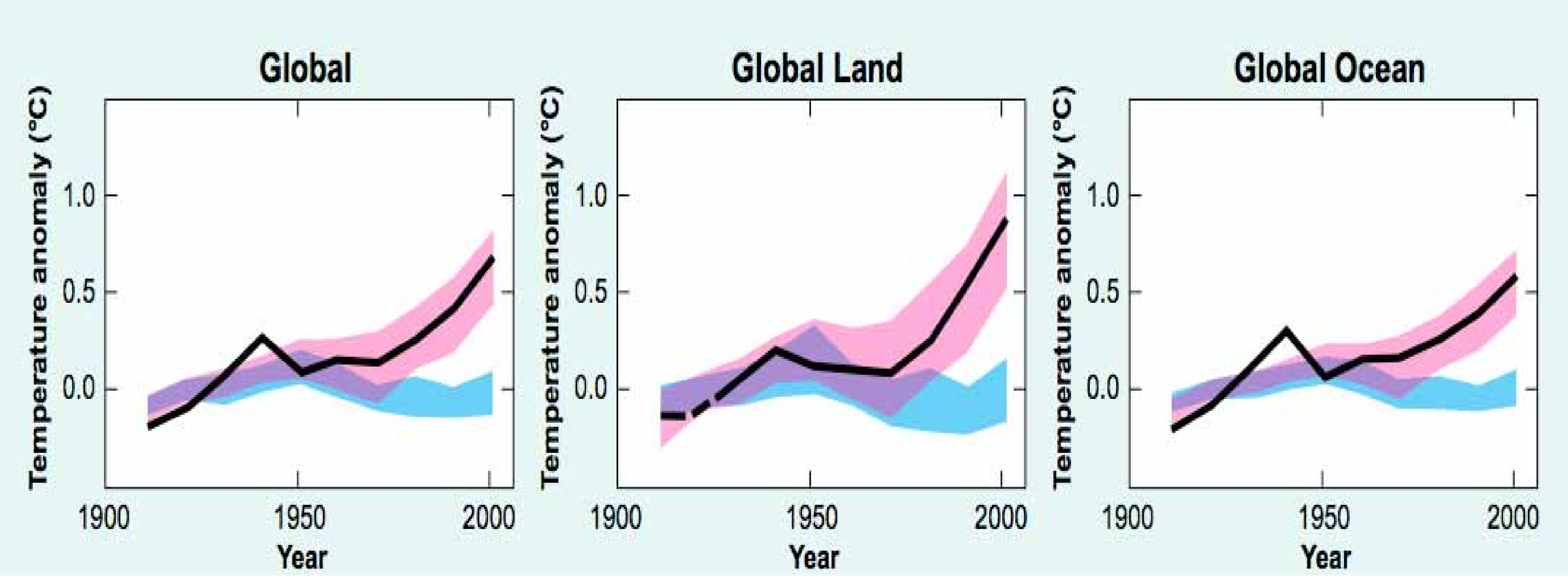
Recruitment estimates (II)



Ln(R) ~ lo(S, Z, PDO, span=0.75, degree=1)

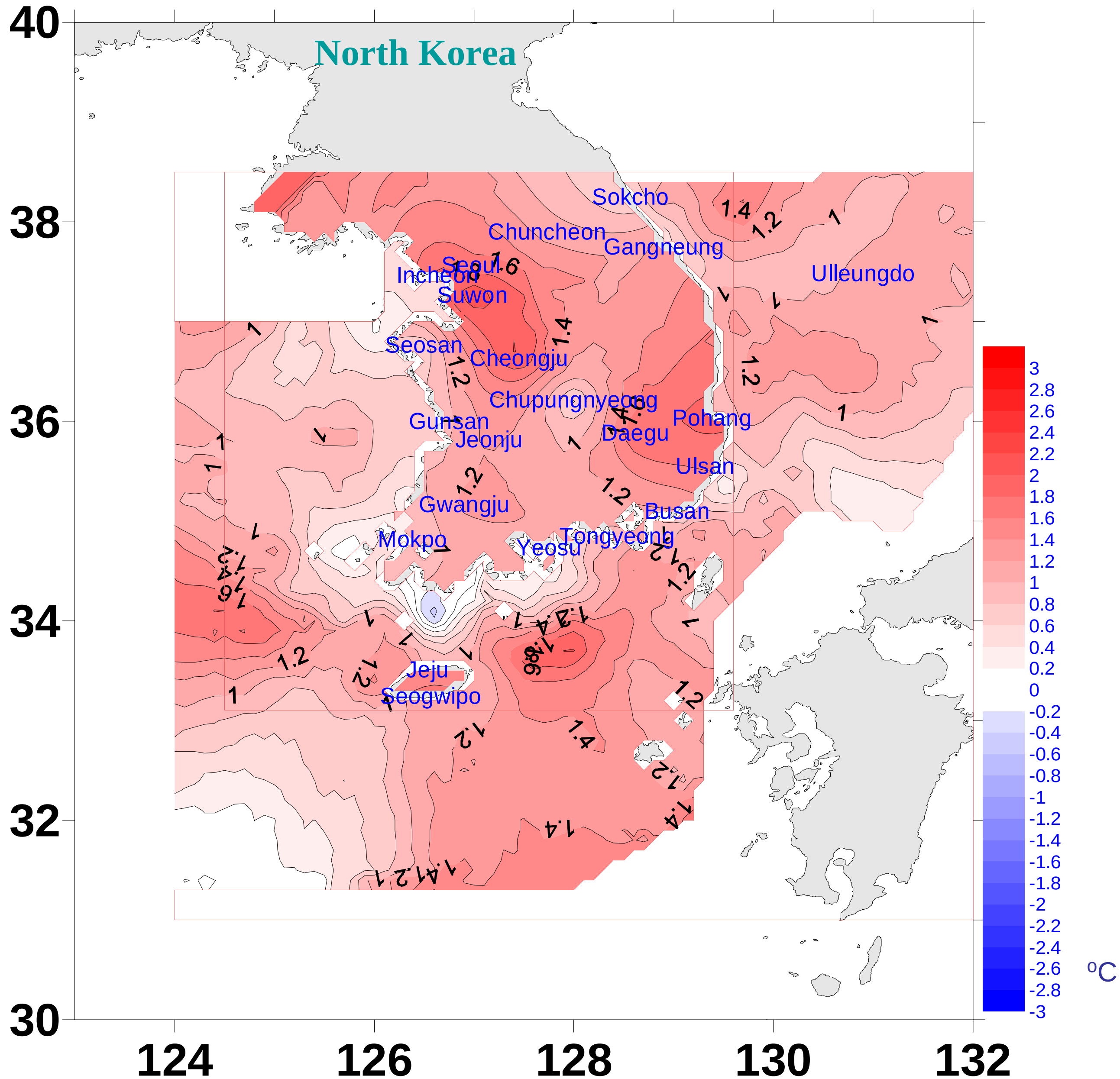
OBSERVATIONS

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level



WMO

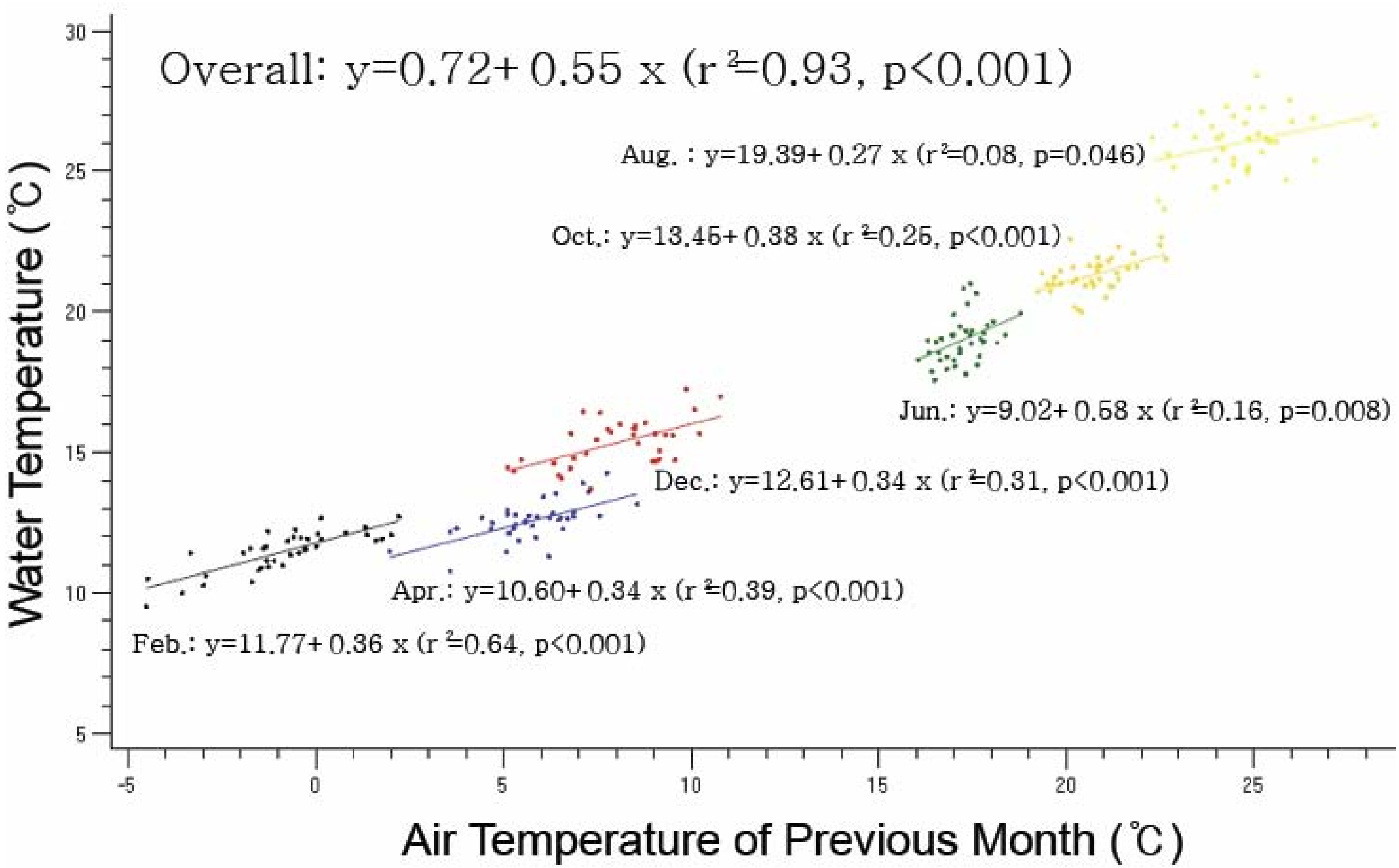
Linear trend of temperature change (^oC) in the land and sea surface (1968-2005)



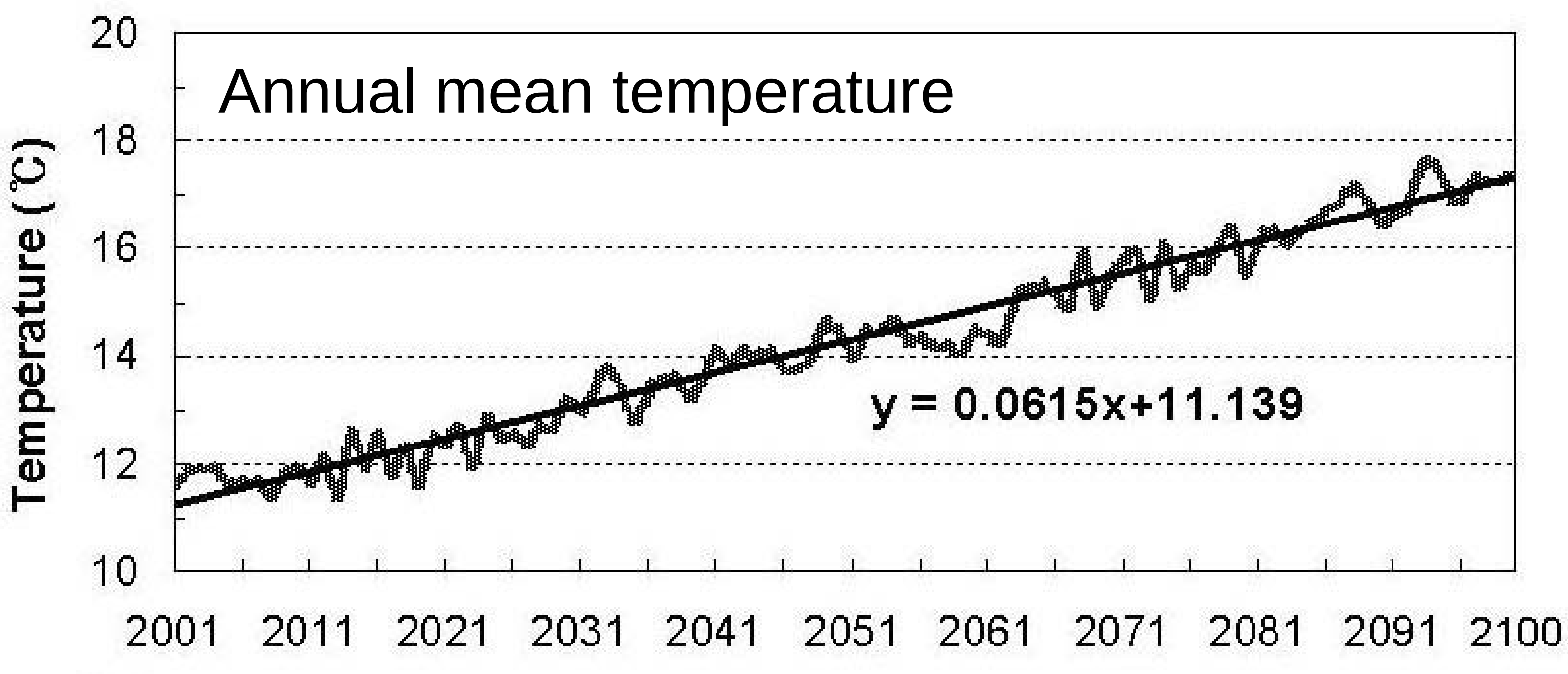
Temperature changes in Korea

- From 1968 to 2005, air temperatures increased on average by 1.3^oC, and SSTs by 1^oC.
- Additional increase by 1.3 – 1.0 = 0.3^oC in the land may have been caused by local factors such as industrialization and urban heat-island effect.
- The increasing trend diminished with water depth.

Monthly air temperature and SST over Korean Peninsula



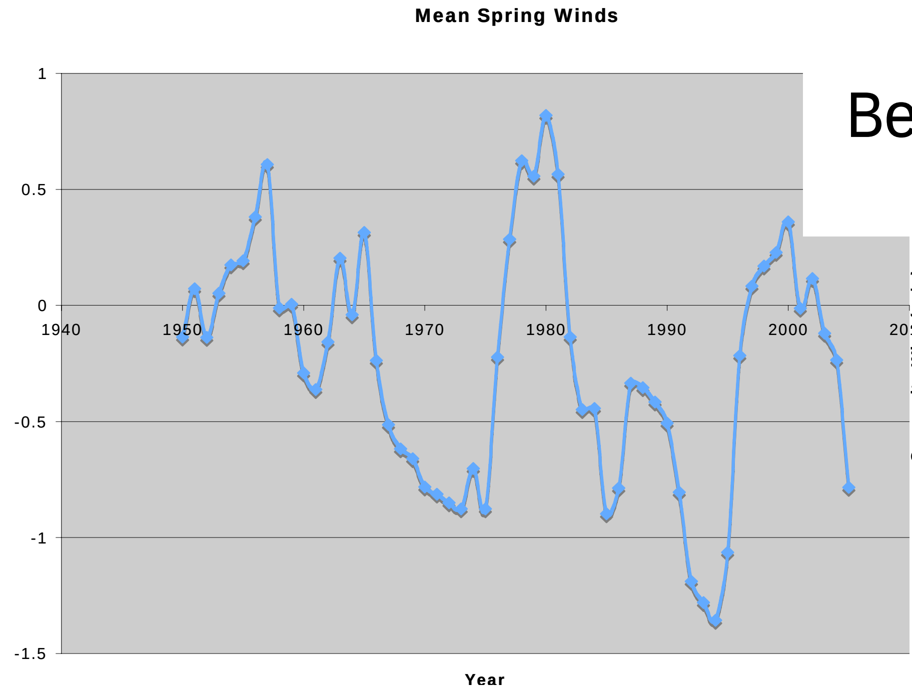
Air temperature forecast over Korean Peninsula
(based on IPCC SRES A2 CO_2 emission scenario)

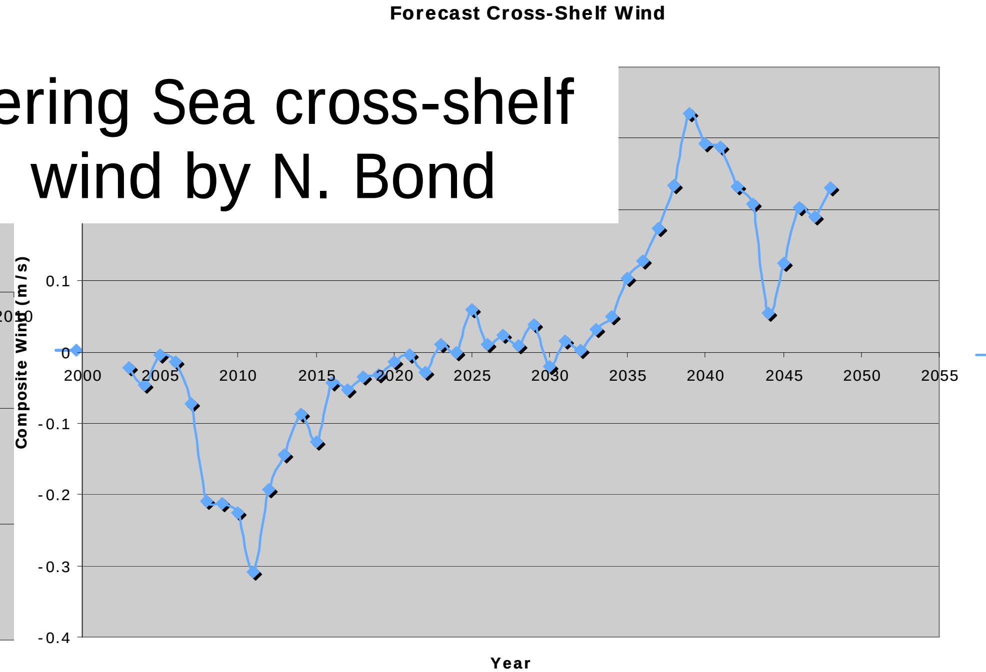


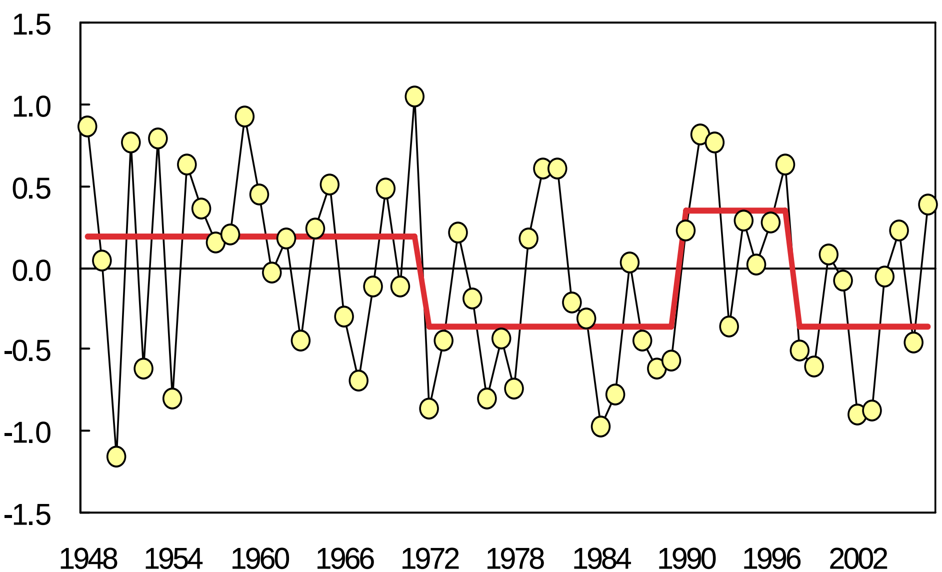
Warming rate (from Kim et al., 2007)

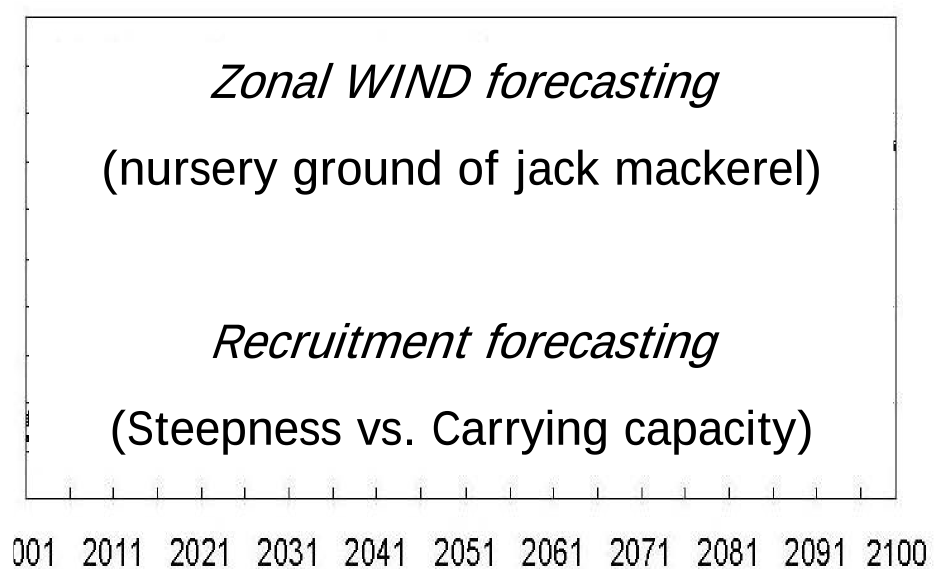
0.61 degree/decade, 5.5 degree/century

Bering Sea cross-shelf wind by N. Bond









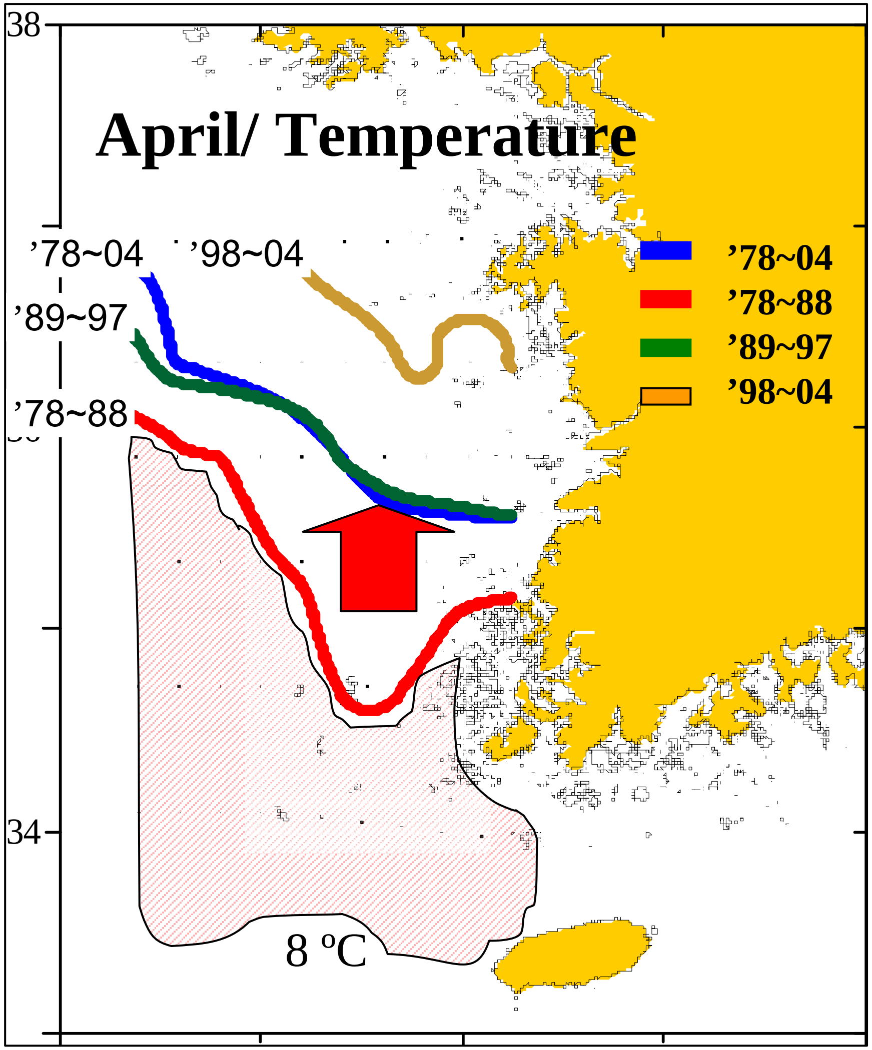
Zonal WIND forecasting

(nursery ground of jack mackerel)

Recruitment forecasting

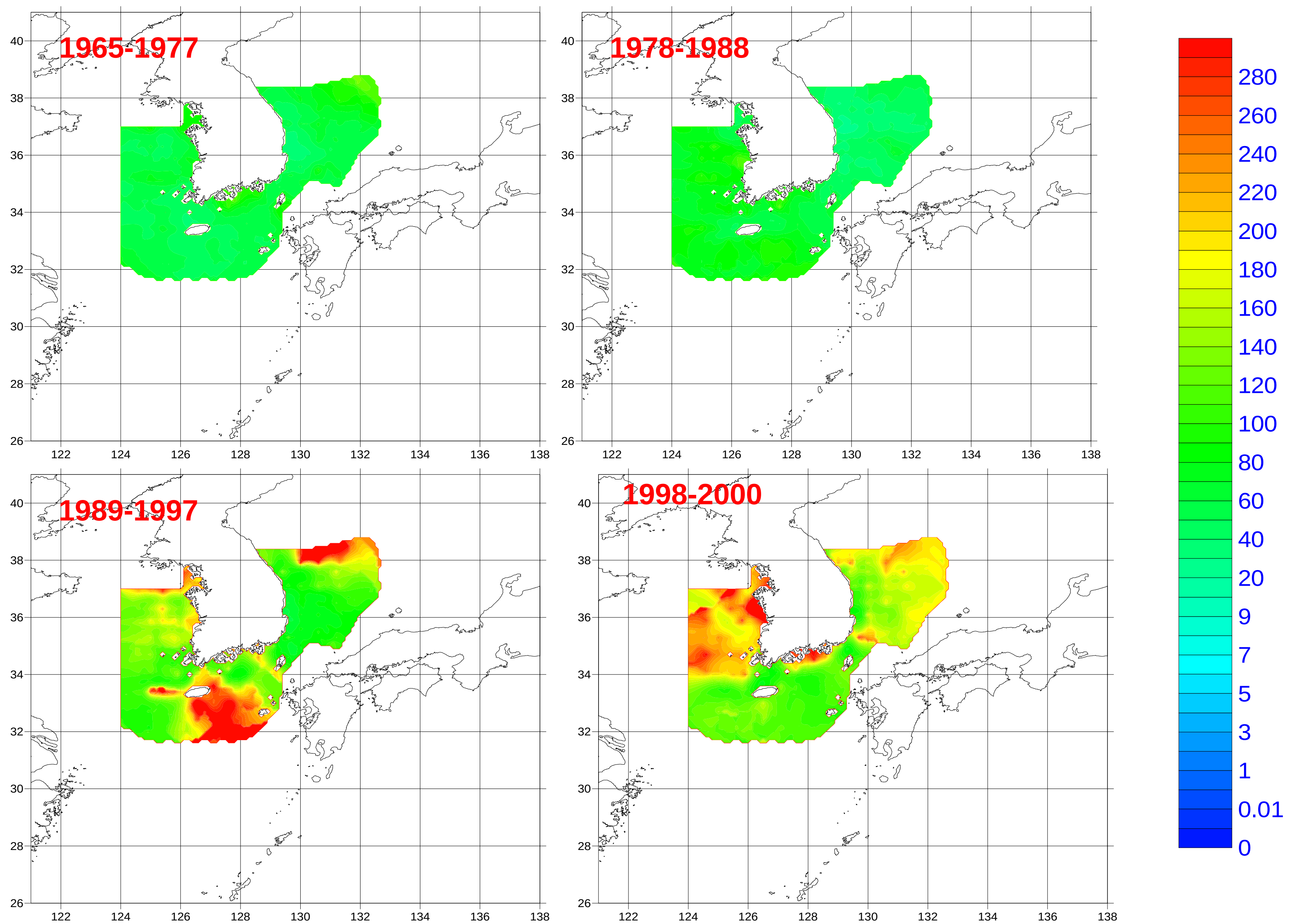
(Steepness vs. Carrying capacity)

Distribution of jack mackerel



- Getting warm at surface in April

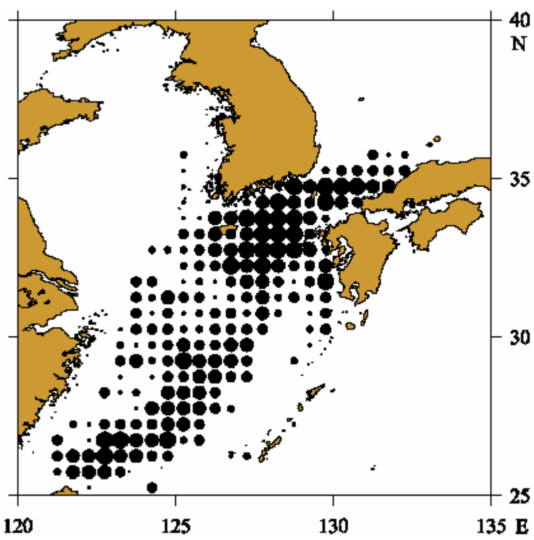
Geographical distribution of mean surface temperature in April in each period separated by regime shifts.



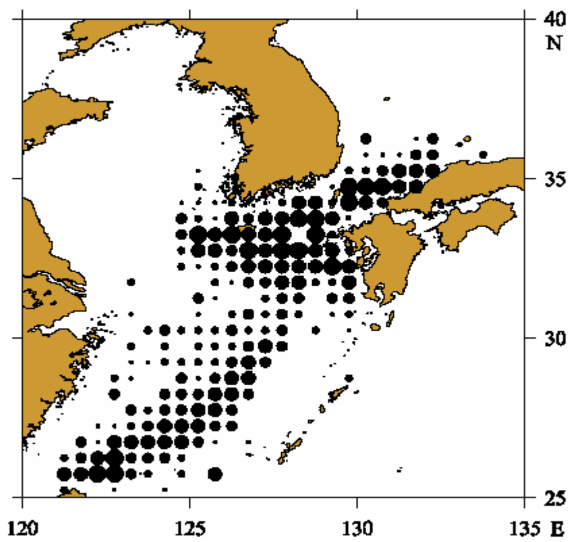
Geographical distribution of mean zooplankton biomass in each period separated by regime shifts.

Spatial distributions of jack mackerel around Korean waters

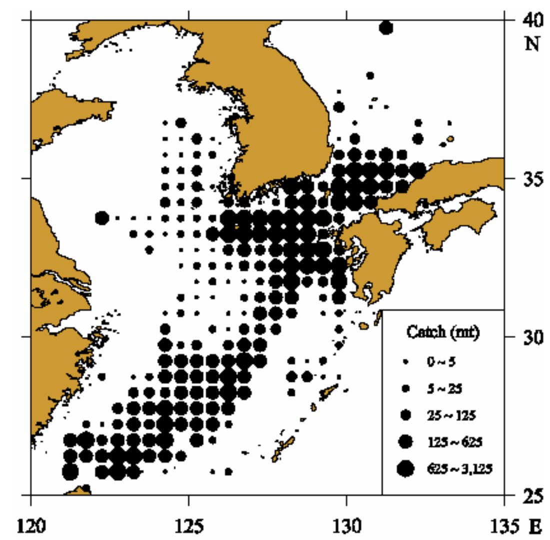
1971-79



1980-87

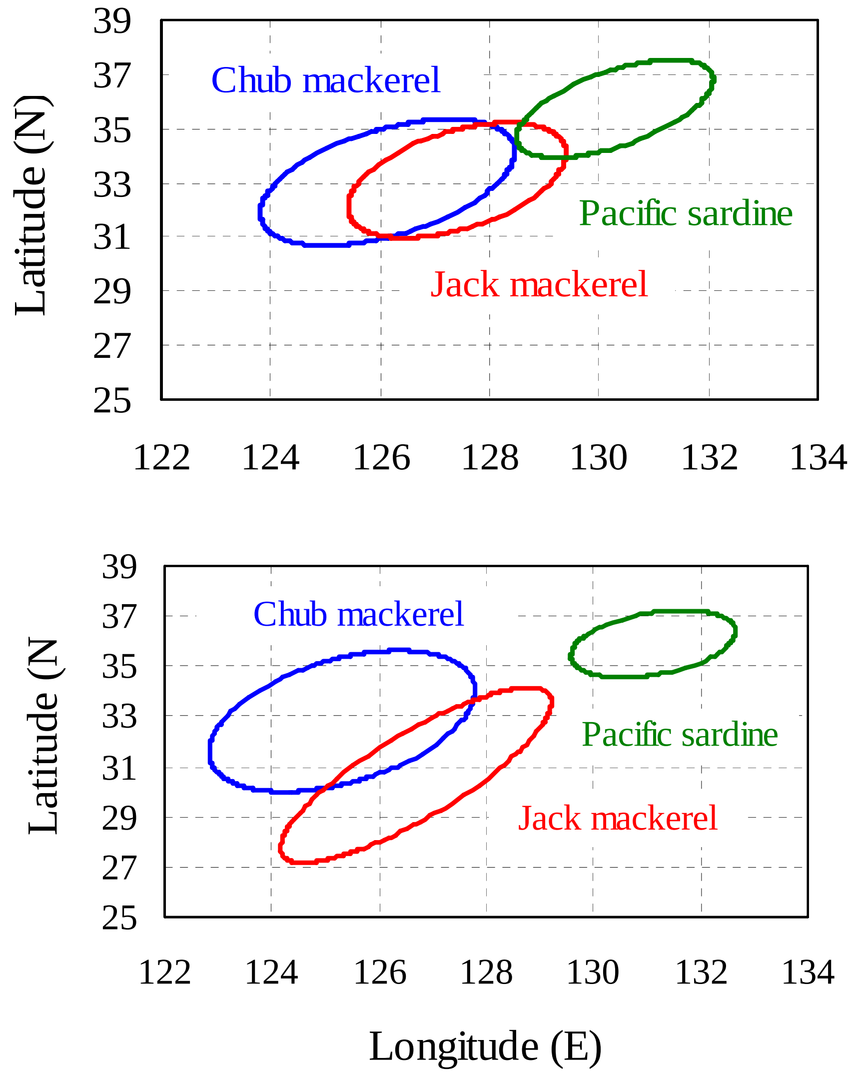


1990-96



(a) 1980-1988

(b) 1989-1998



Joint confident regions in the habitat of major small pelagics in Korean waters during the periods of (a) pre- and (b) post-1988 CRS (Zhang, Yoon and Lee, 2006).

Summary

- Temperature and zonal wind in the nursery ground of jack mackerel are major environmental factors to forecast future her abundance and distribution.
- In Korean waters, the increase of temperature by 1^{o}C in both of the land and sea seems to be related with global factors, but 2 x higher than the global mean reported by IPCC .
- Favorable ocean environmental shifts influenced growth and reproductions of jack mackerel, and in the short-term future her distribution would be extended northward.