Possible change in distribution of seaweed, Sargassum horneri, in East Asia under A2 scenario of global warming and its impact on fishes

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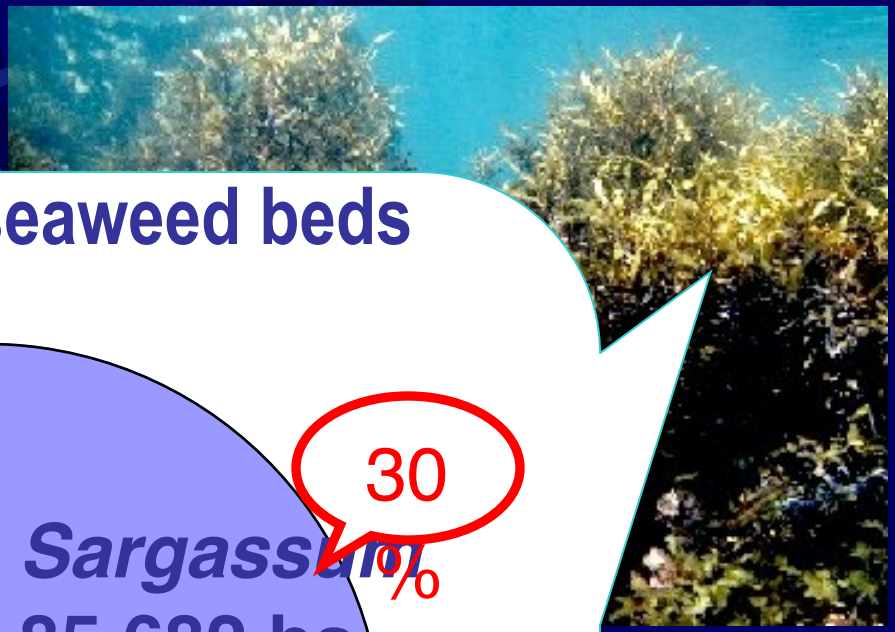
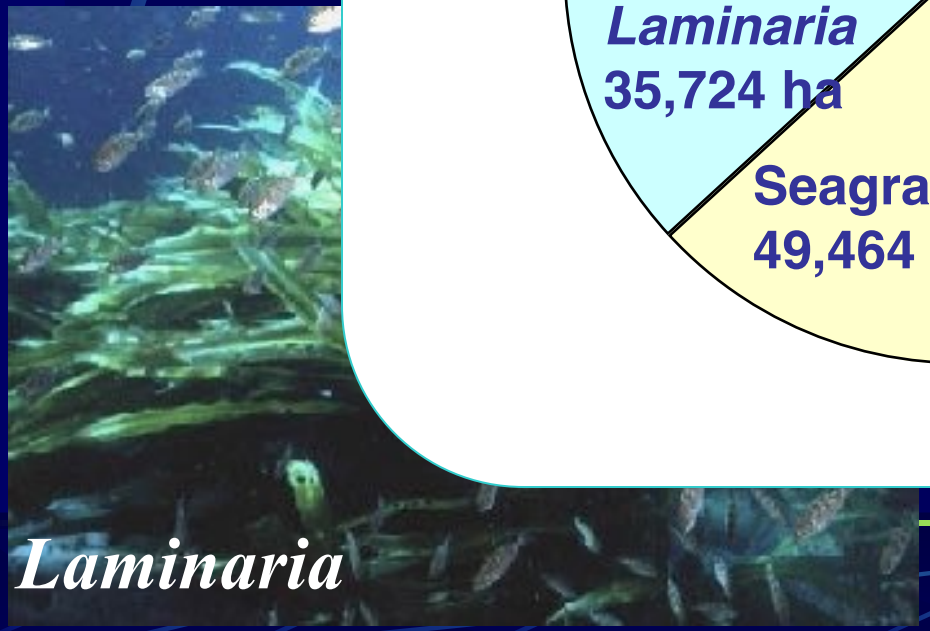
- Sargassum forests in Japan
- Floating seaweeds: their ecological roles and distributions in East China Sea
- Influence of global warming on seaweed beds in Japan at present
- Influence of global warming on Sargassum horneri in future

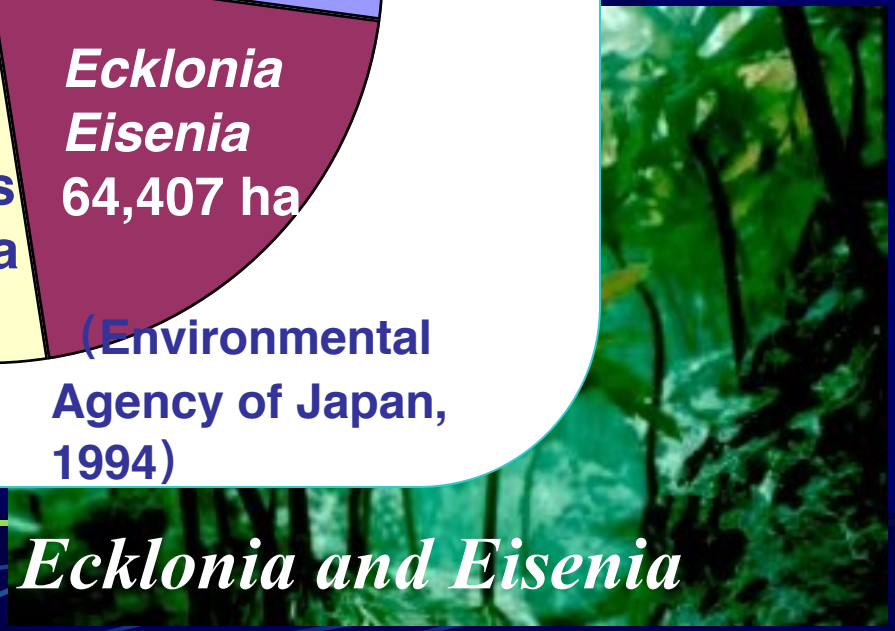
Seagrass



Sea eds

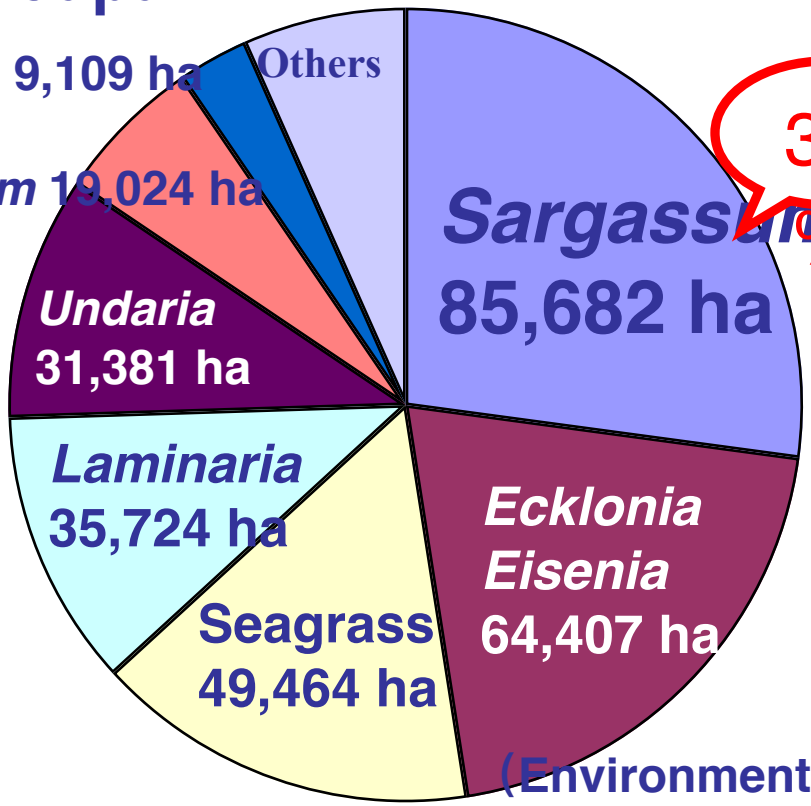


Laminaria



Ecklonia and Eisenia

Seagrass and seaweed beds in Japan



(Environmental Agency of Japan, 1994)

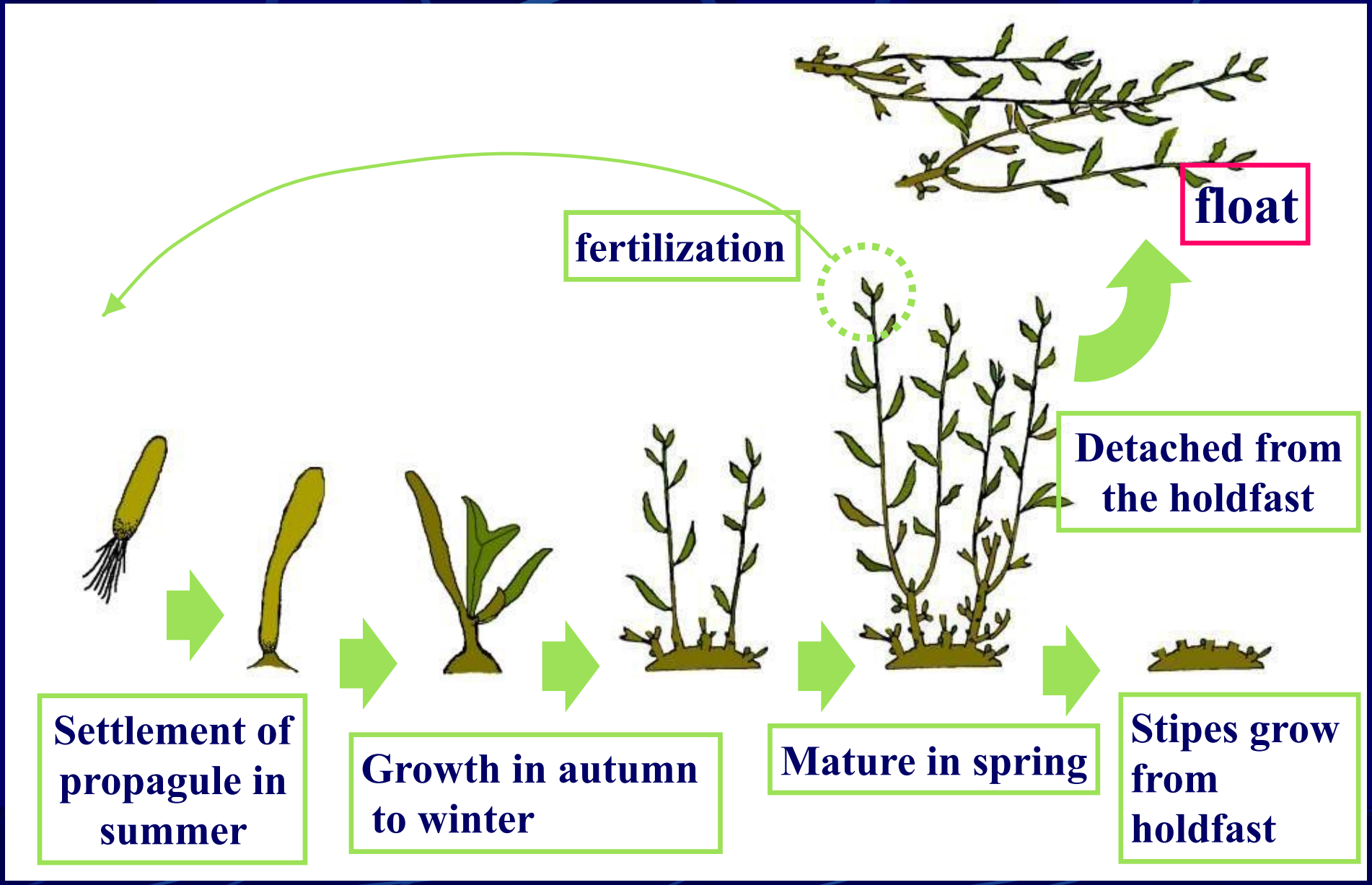
Sargassum forest

気胞

Vesicle

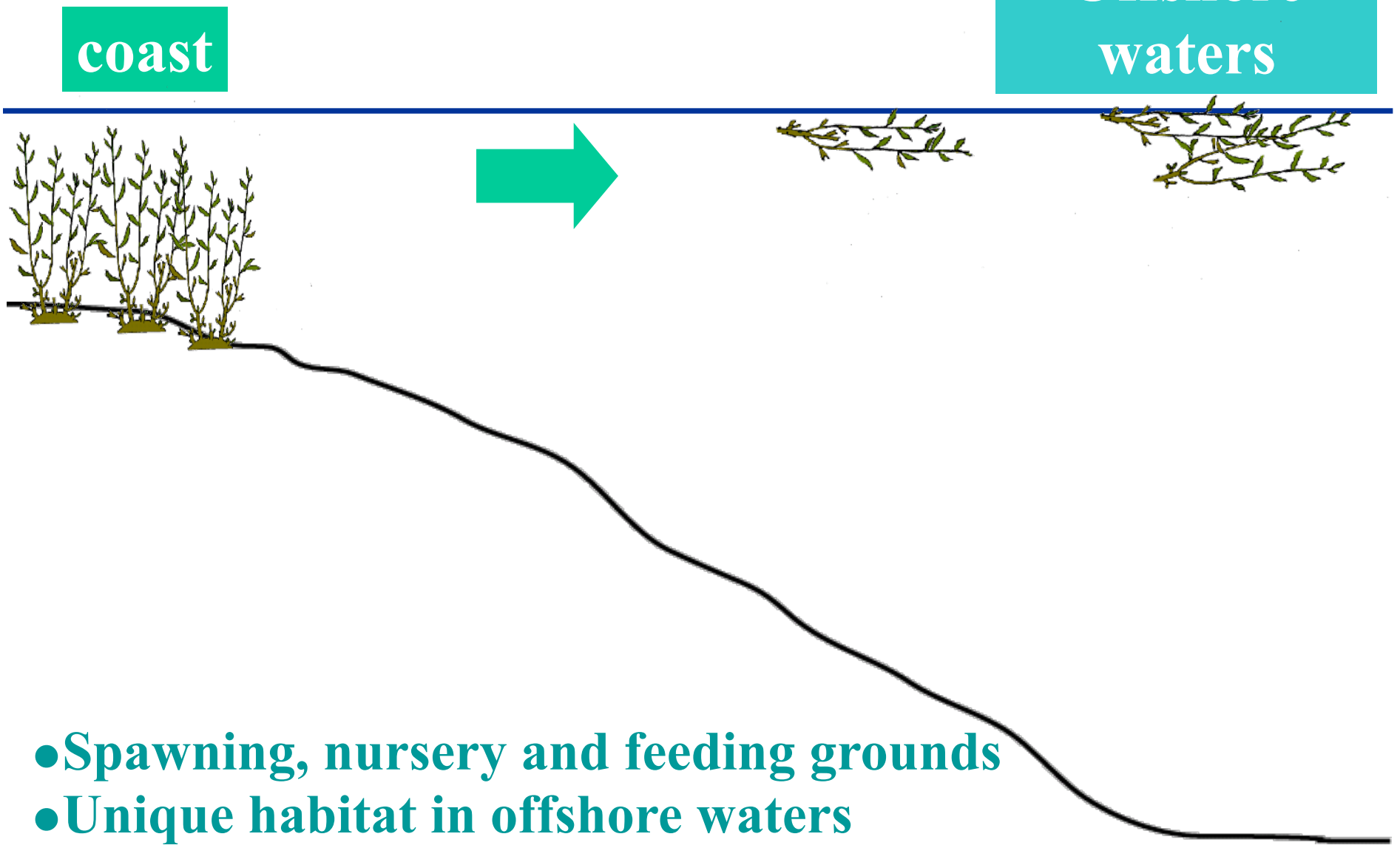
Luxuriant growth season from February to May

Life history of perennial *Sargassum* species



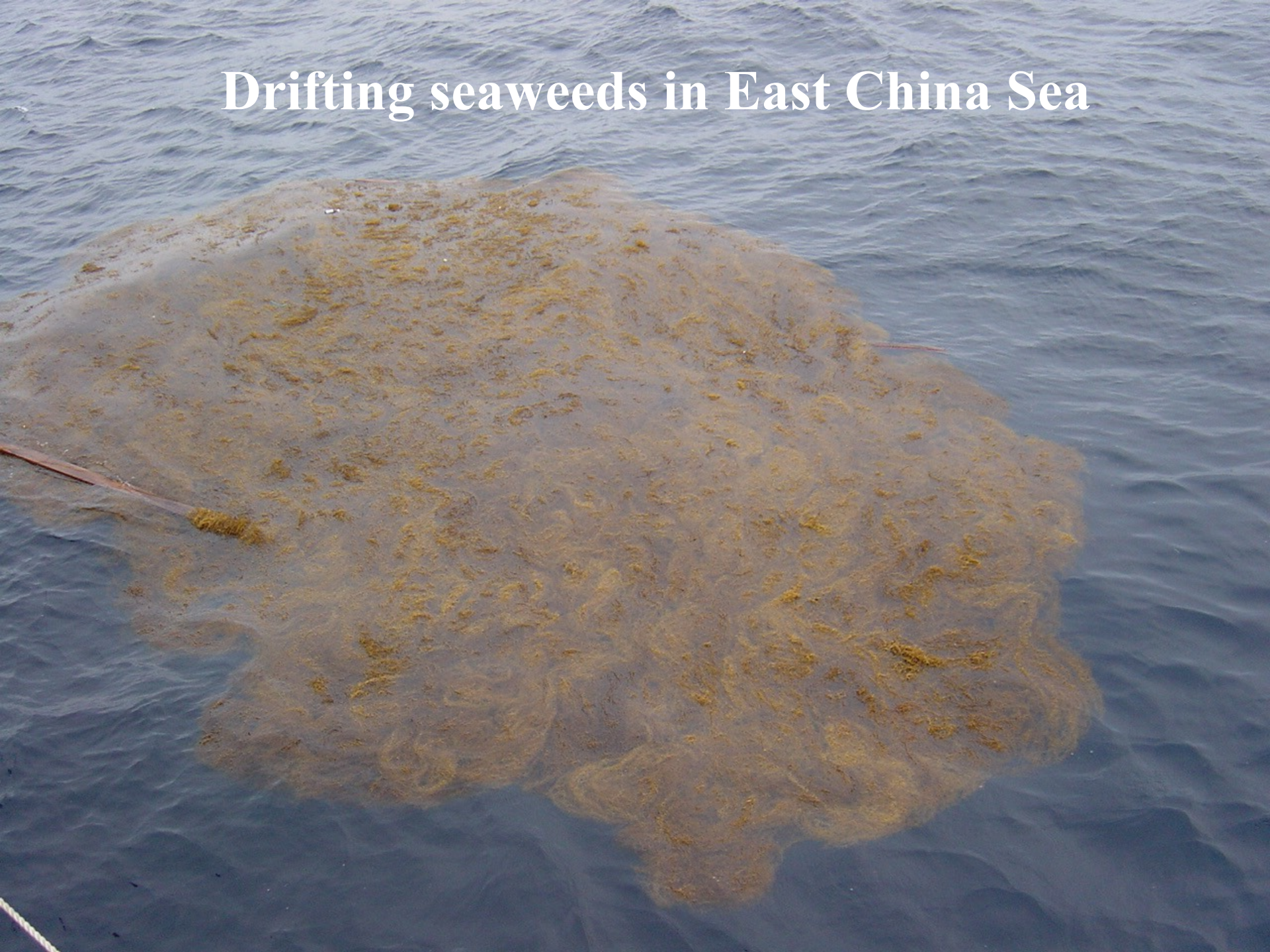
Floating seaweeds: their ecological roles and distributions in East China Sea

Ecological roles of floating seaweed rafts



- Spawning, nursery and feeding grounds
- Unique habitat in offshore waters

Drifting seaweeds in East China Sea



Important fish species using floating seaweeds

Use as a spawning ground

Pacific saury, flying fish, Japanese halfbeak



Use as a nursery

Yellowtail, Japanese jack mackerel, rockfish

(Sebastes)



Temporally use of adult fish

Dolfinfish, Skipjack tun


Eggs spawned on floating *Sargassum* by Japanese saury (left) and Japanese halfbeak (right)

Source http://www.volvox.co.jp/umi/23_seri/seri0504.html

Yellowtail juveniles

- Nursery ground for juveniles of yellow tail, jack mackerel and *Sebastes*

Objective of the study

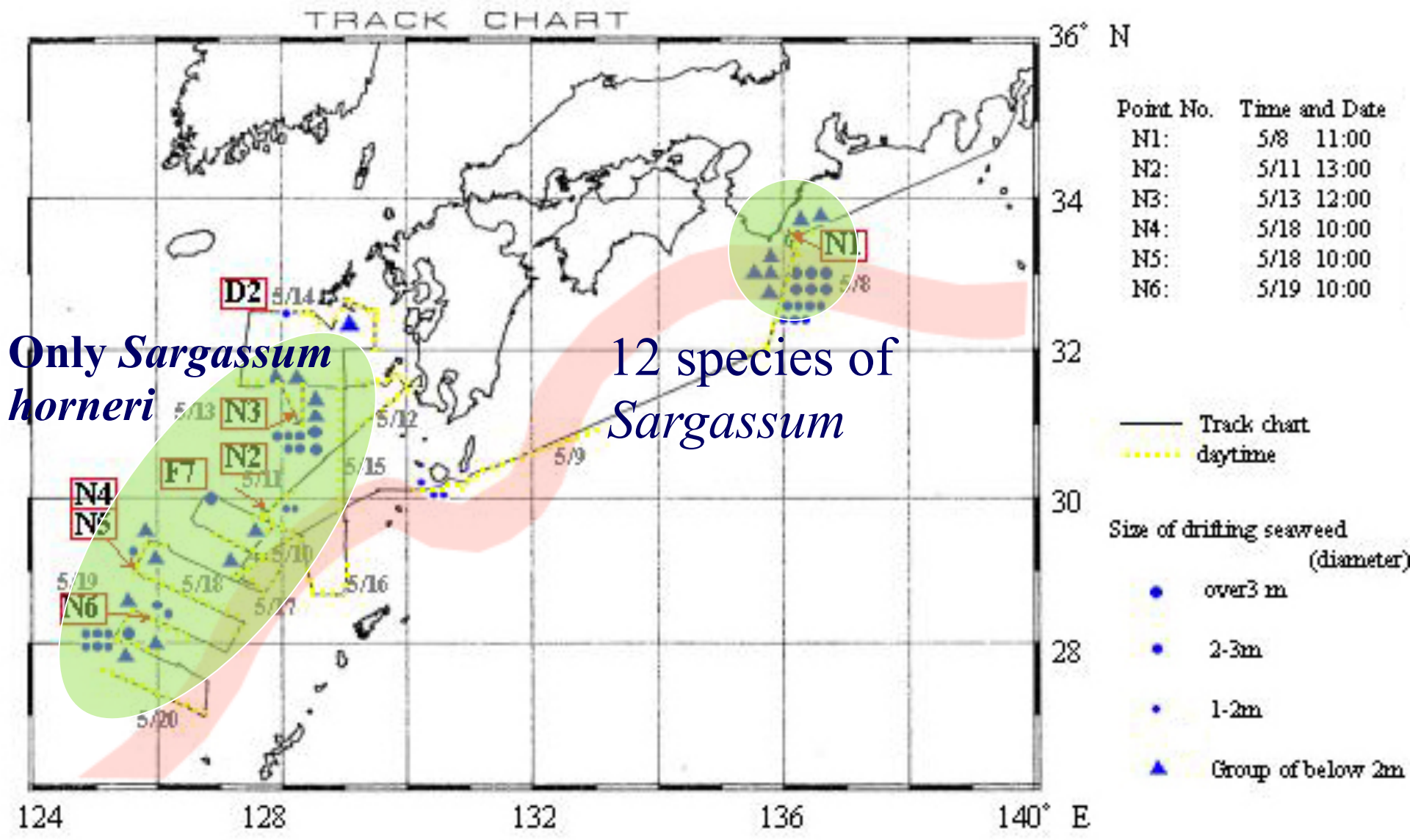
- Distribution and species composition of drifting seaweeds in East China Sea
- Abundance and standing crop of drifting seaweeds in East China Sea
- Origin of drifting seaweeds
- Fate of drifting seaweeds: where they go?

R/V Hakuho Maru 白鳳丸

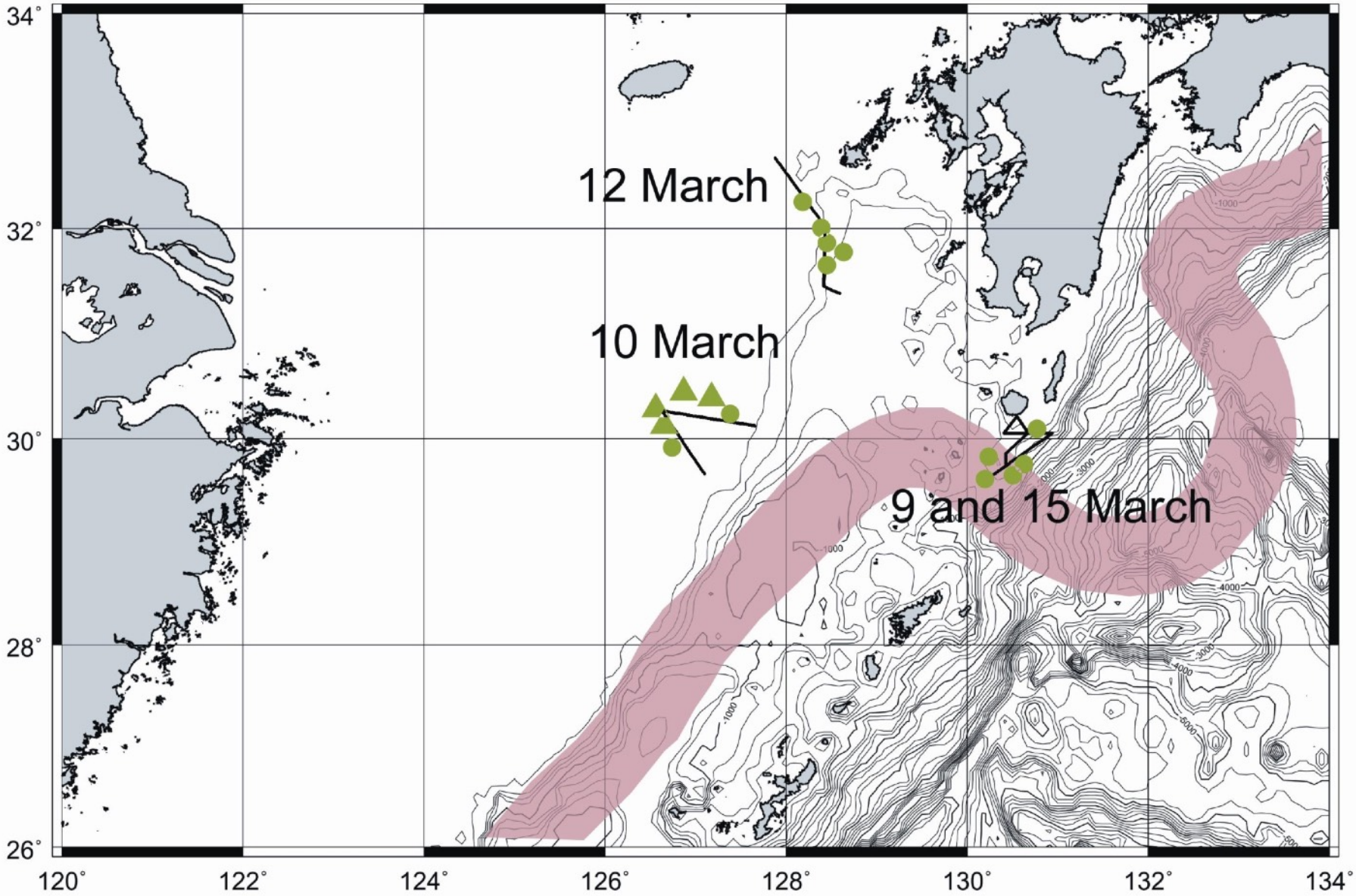
Sampling of drifting seaweeds

Identifying species

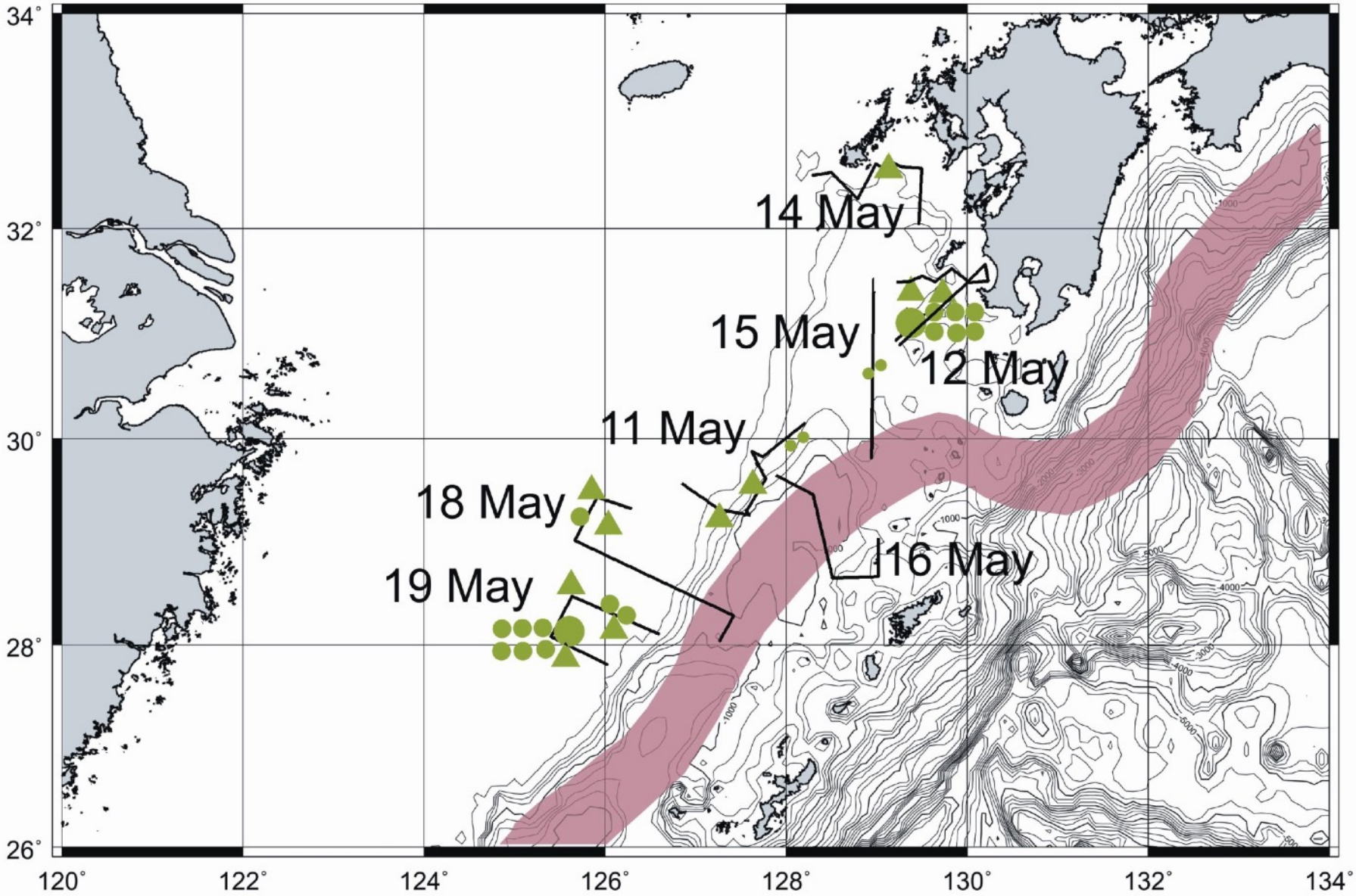
Measuring the maximum stipe length



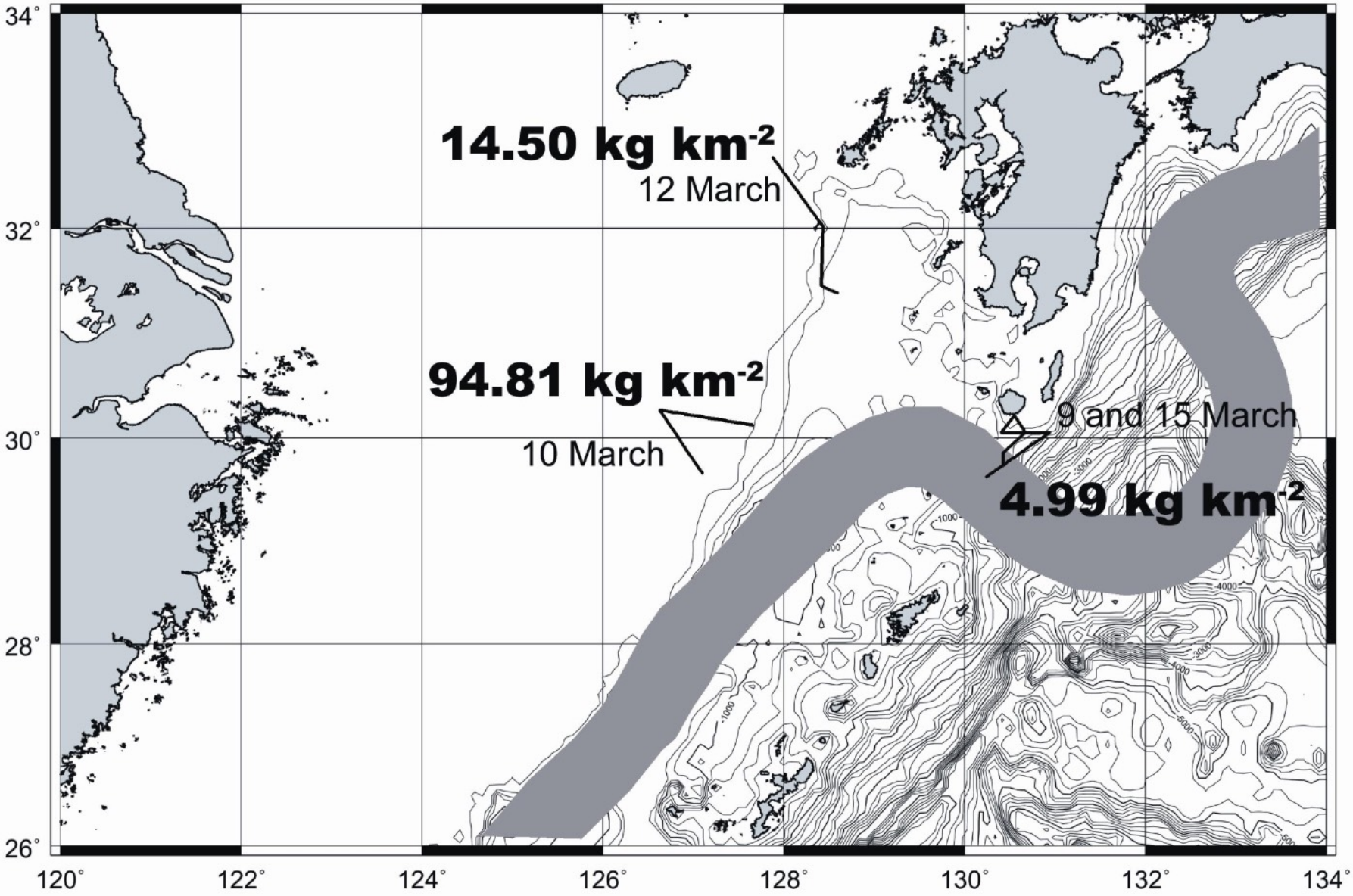
Drifting seaweeds found during May 2002



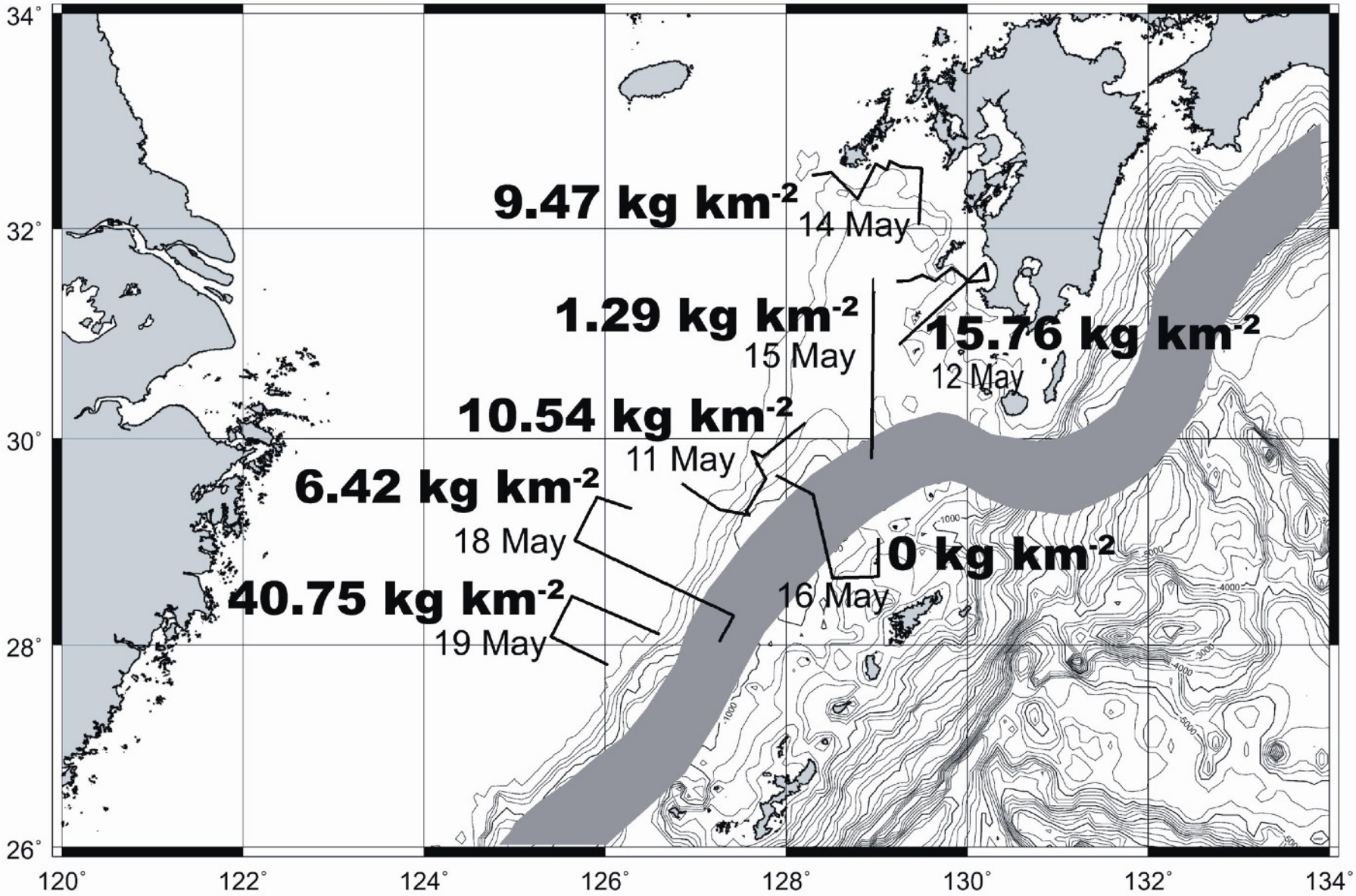
Distribution of drifting seaweeds in East China Sea in March 2004



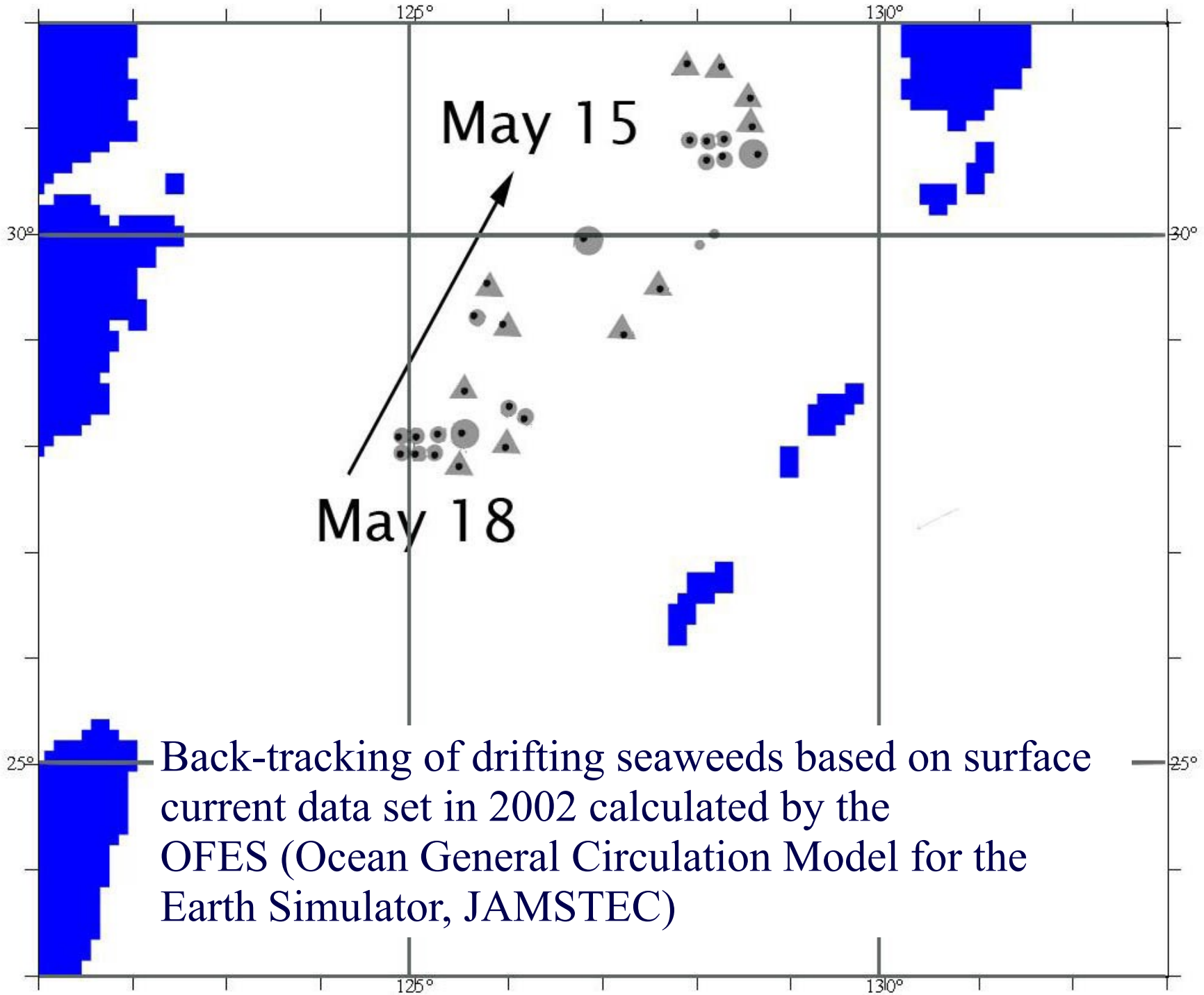
Distribution of drifting seaweeds in East China Sea in May 2002



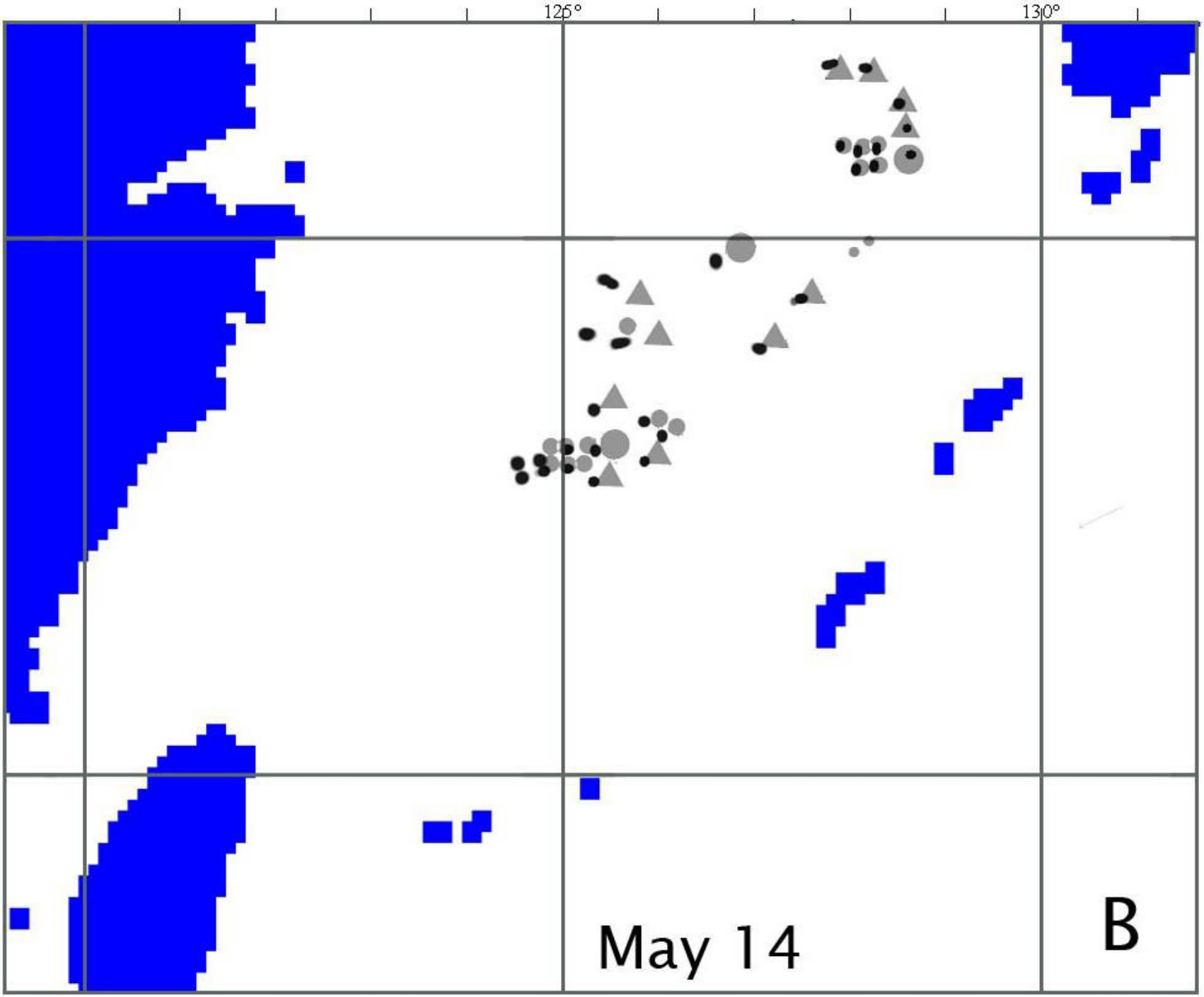
Standing crop of drifting seaweeds in East China Sea in March 2004

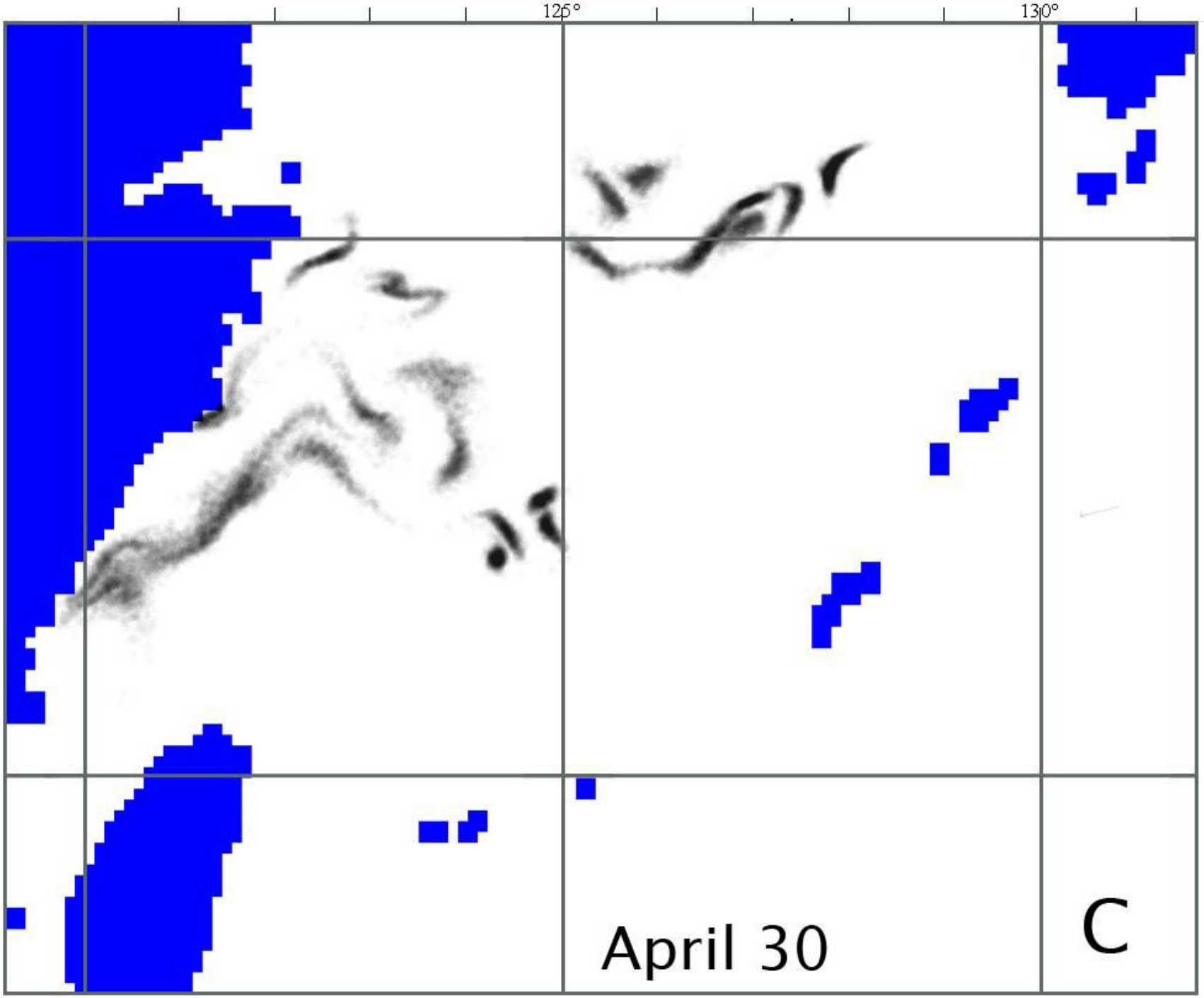


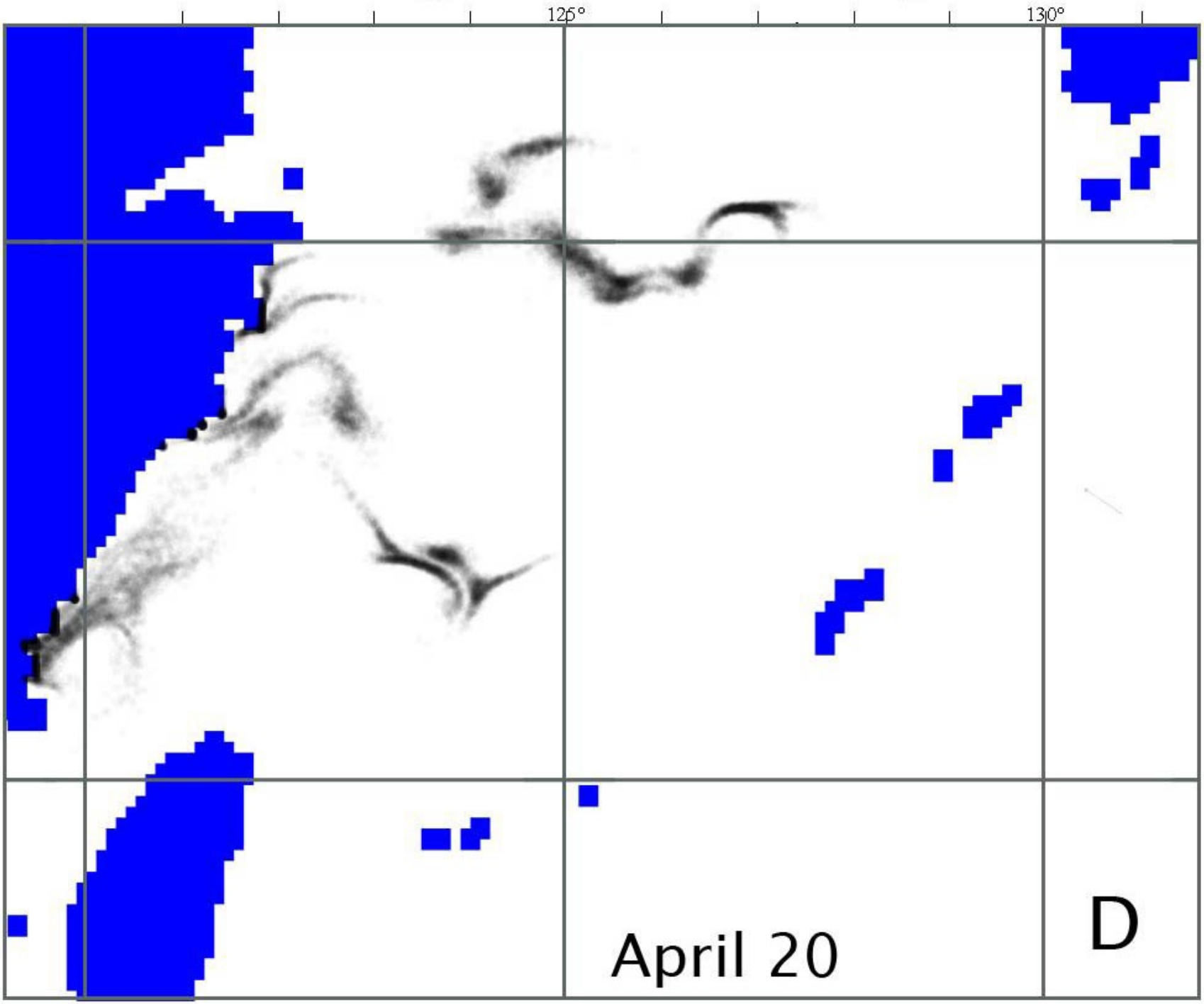
Standing crop of drifting seaweeds in East China Sea in May 2002



Back-tracking of drifting seaweeds based on surface current data set in 2002 calculated by the OFES (Ocean General Circulation Model for the Earth Simulator, JAMSTEC)


125°
130°
May 14
B


125°
130°
April 30
C


125°
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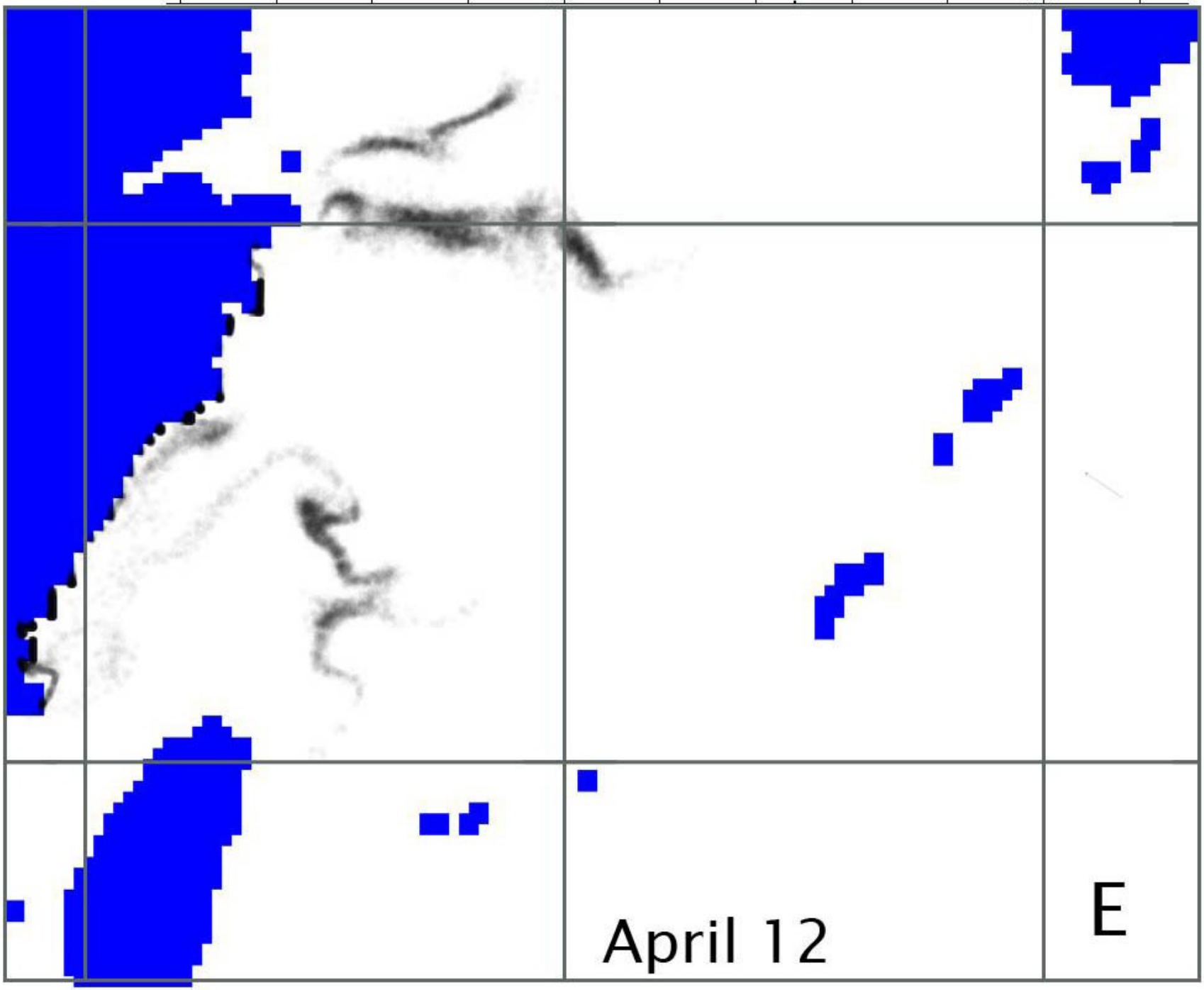
April 20
D


125°
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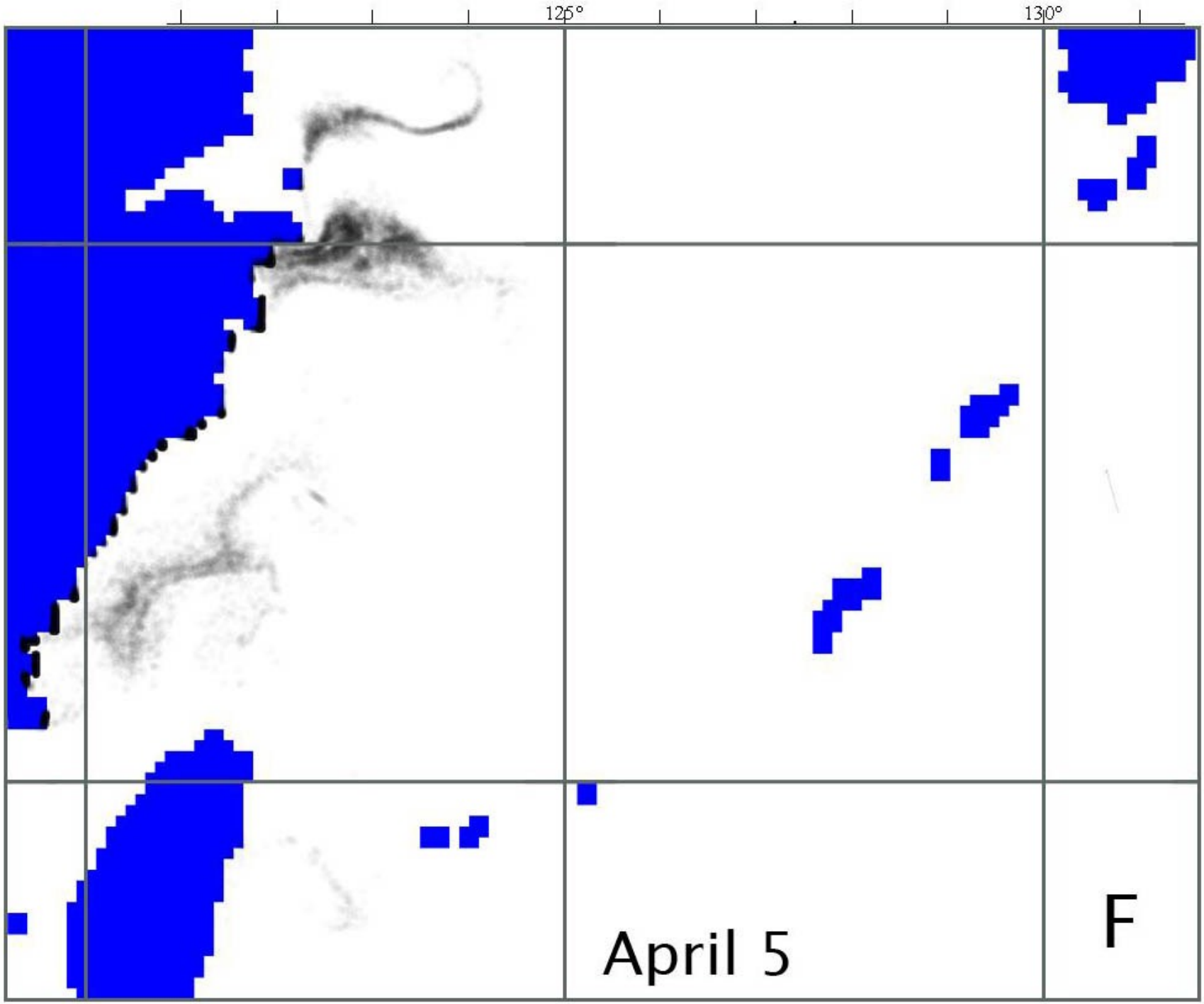
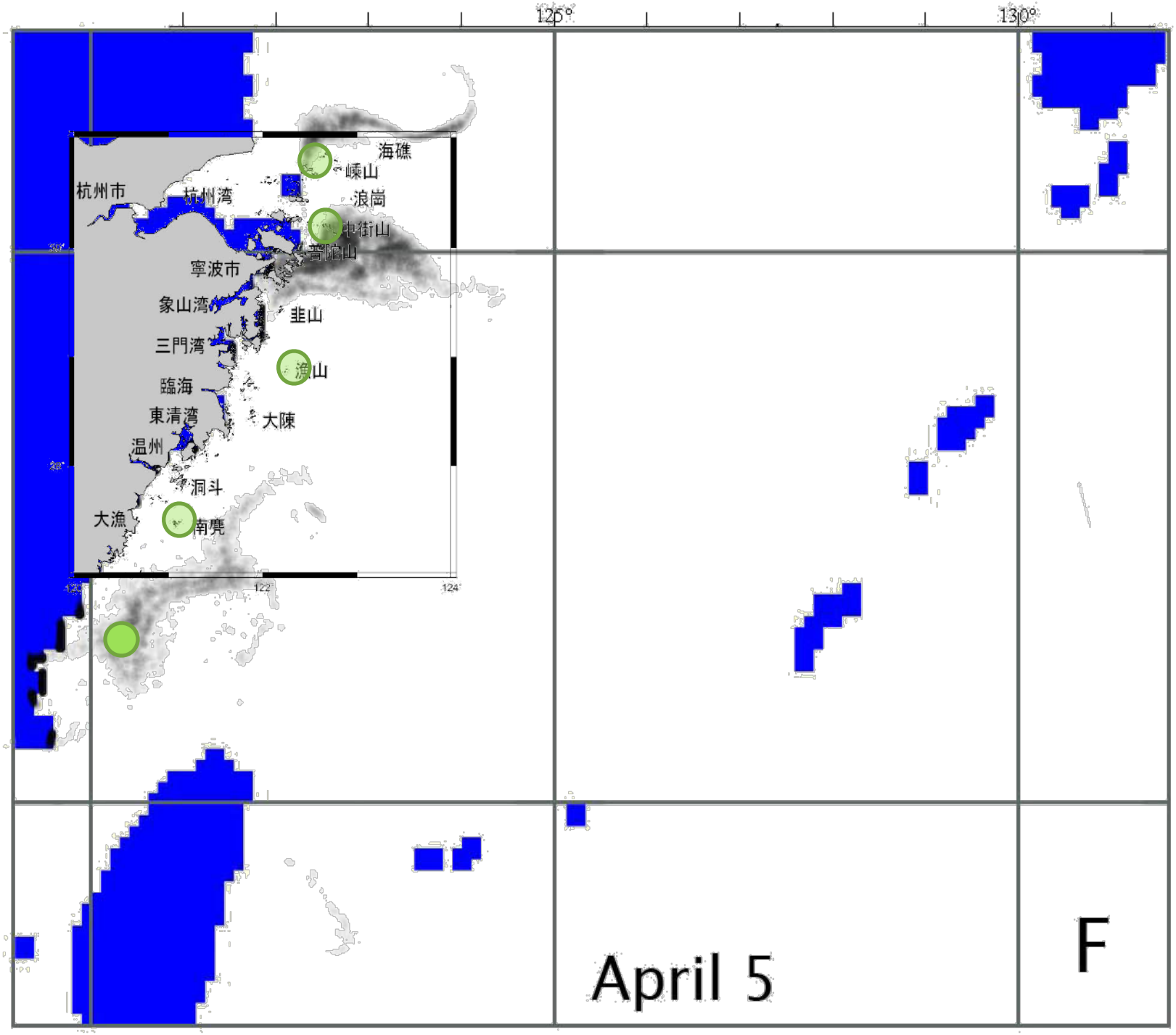
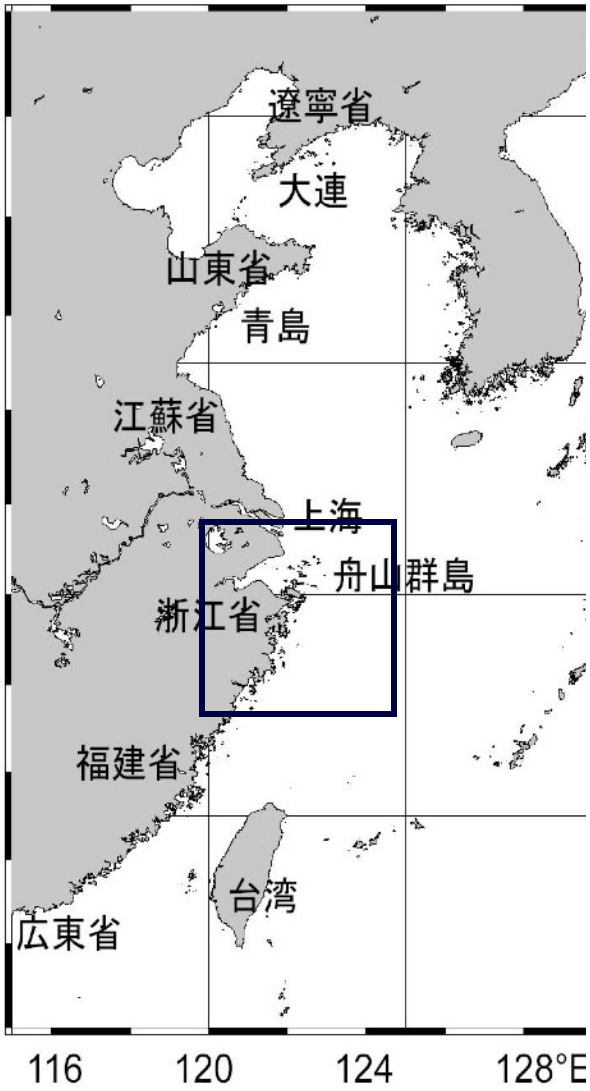
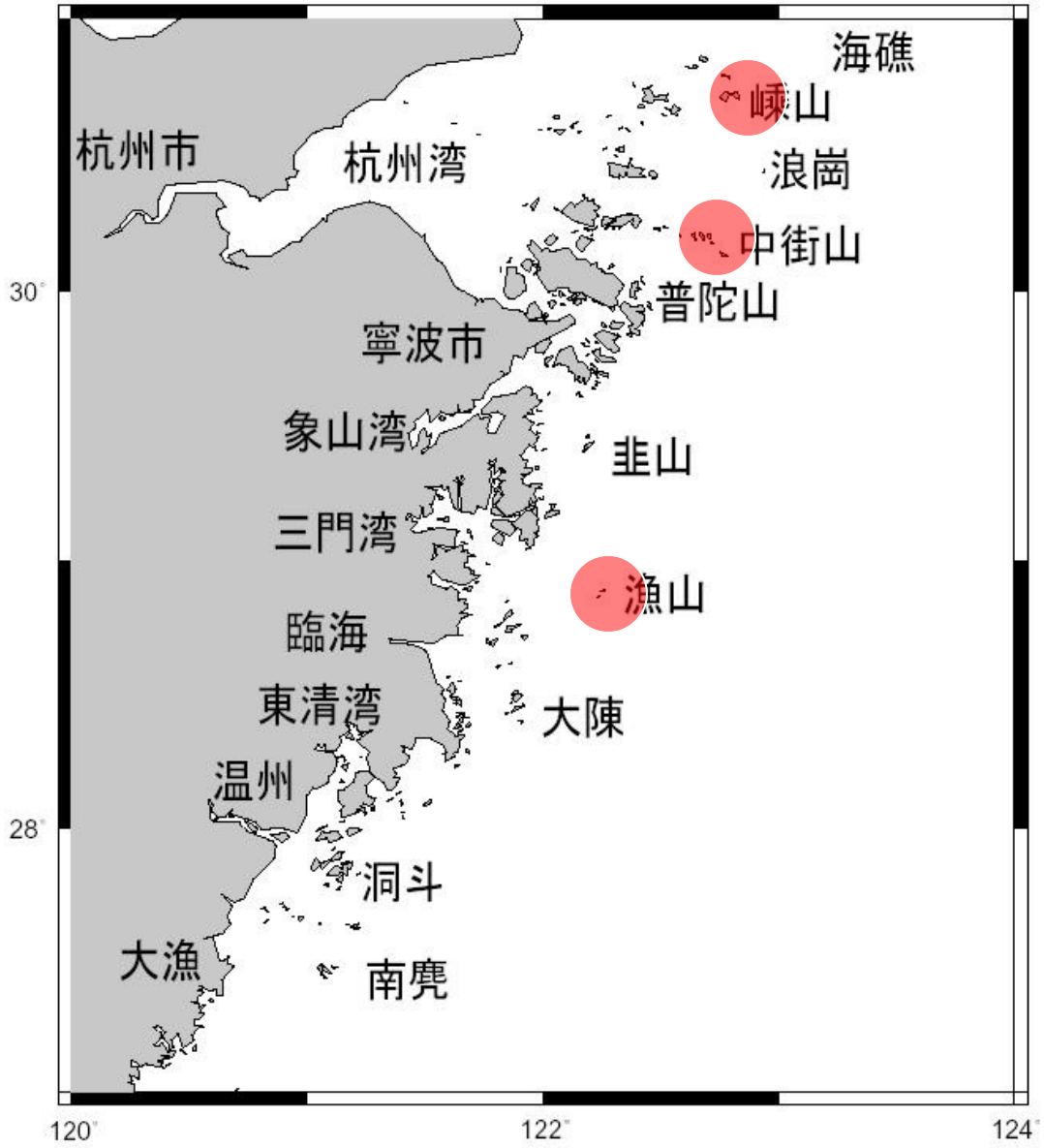
April 12
E

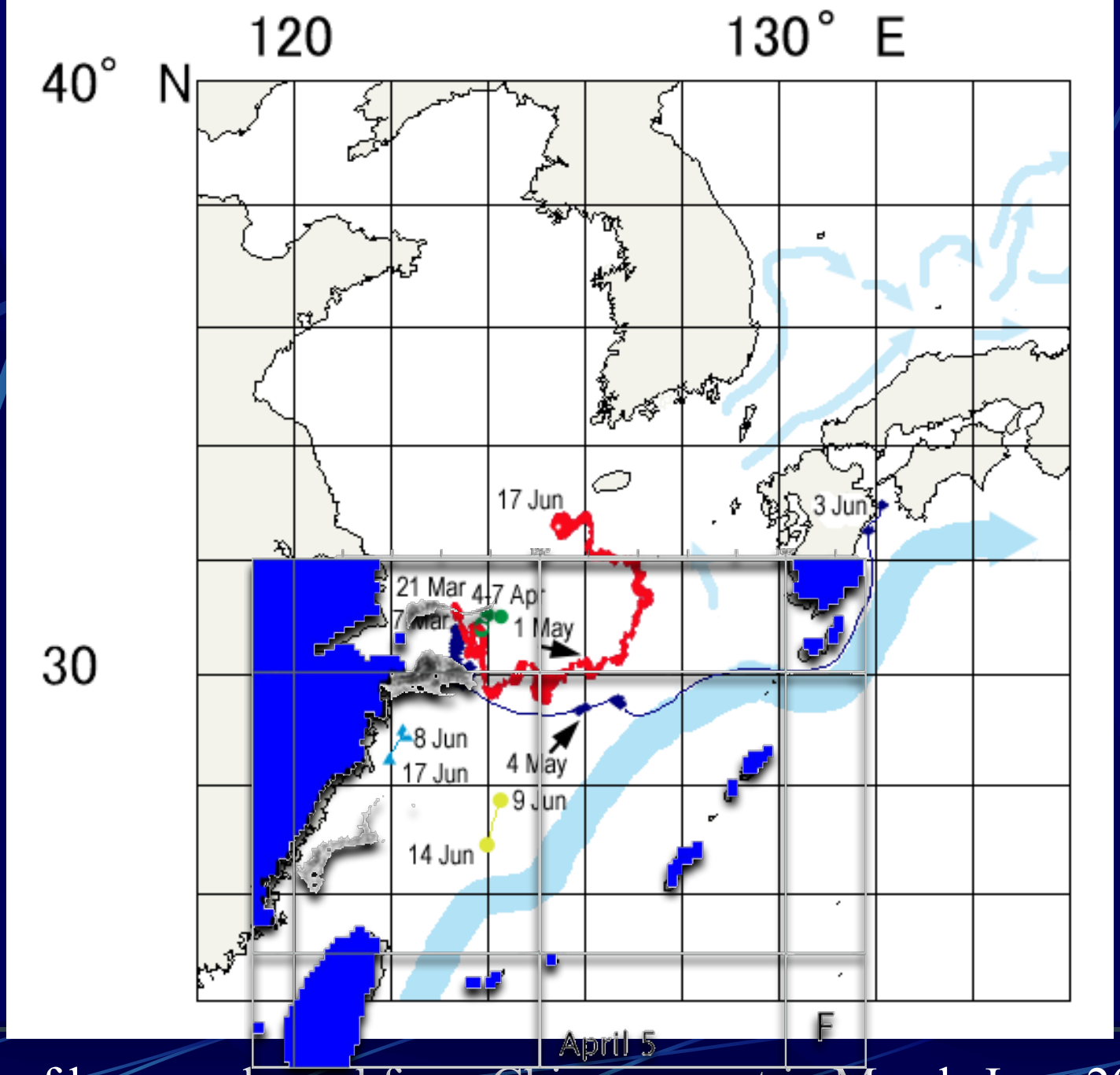

125°
130°
April 5
F


125°
130°
海礁
嵊山
杭州市
杭州湾
浪崗
中街山
普陀山
寧波市
象山湾
韭山
三門湾
浪山
臨海
東清湾
大陳
温州
洞斗
大漁
南麂
122
124
April 5
F



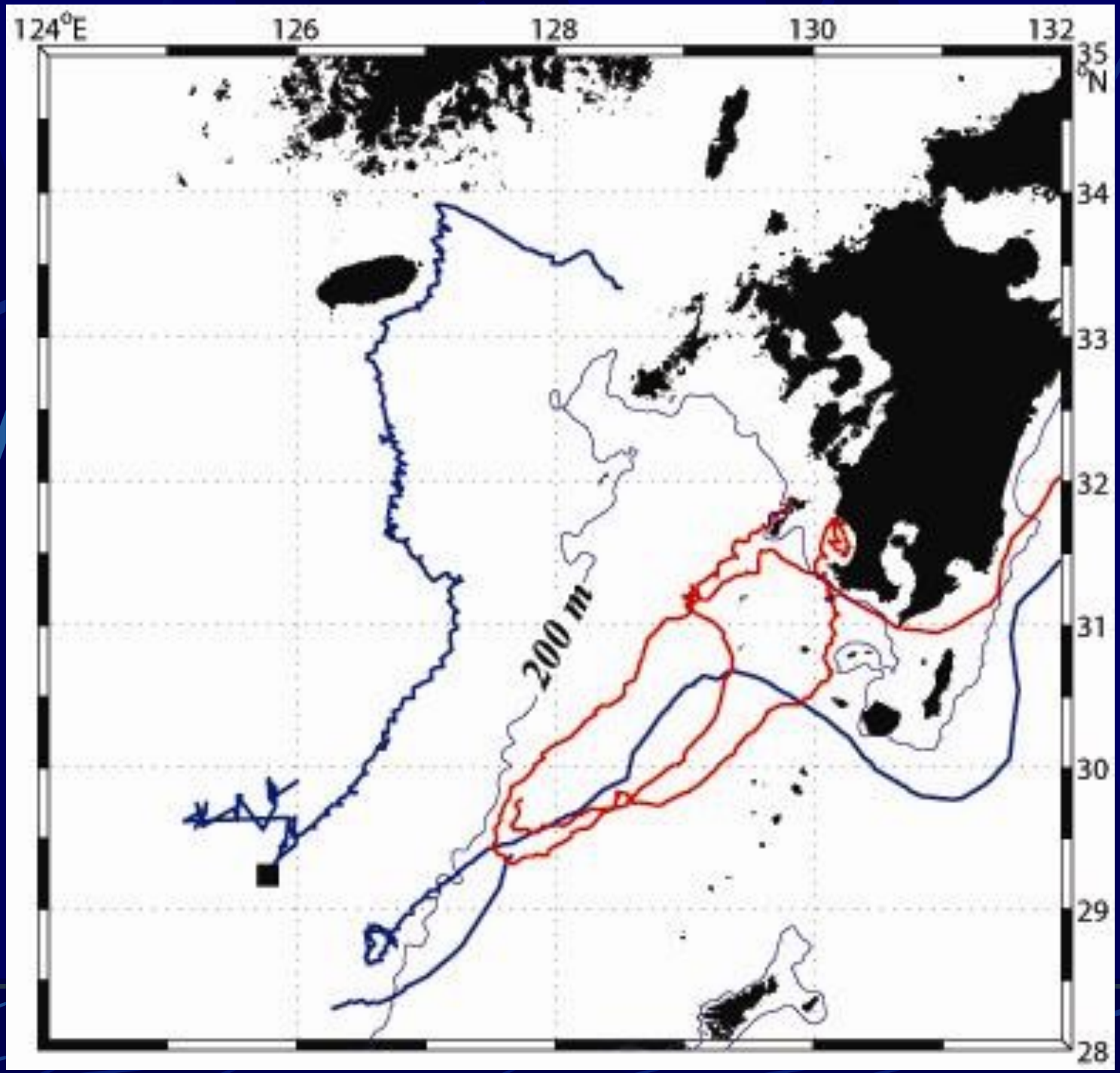


Japan-China Joint survey



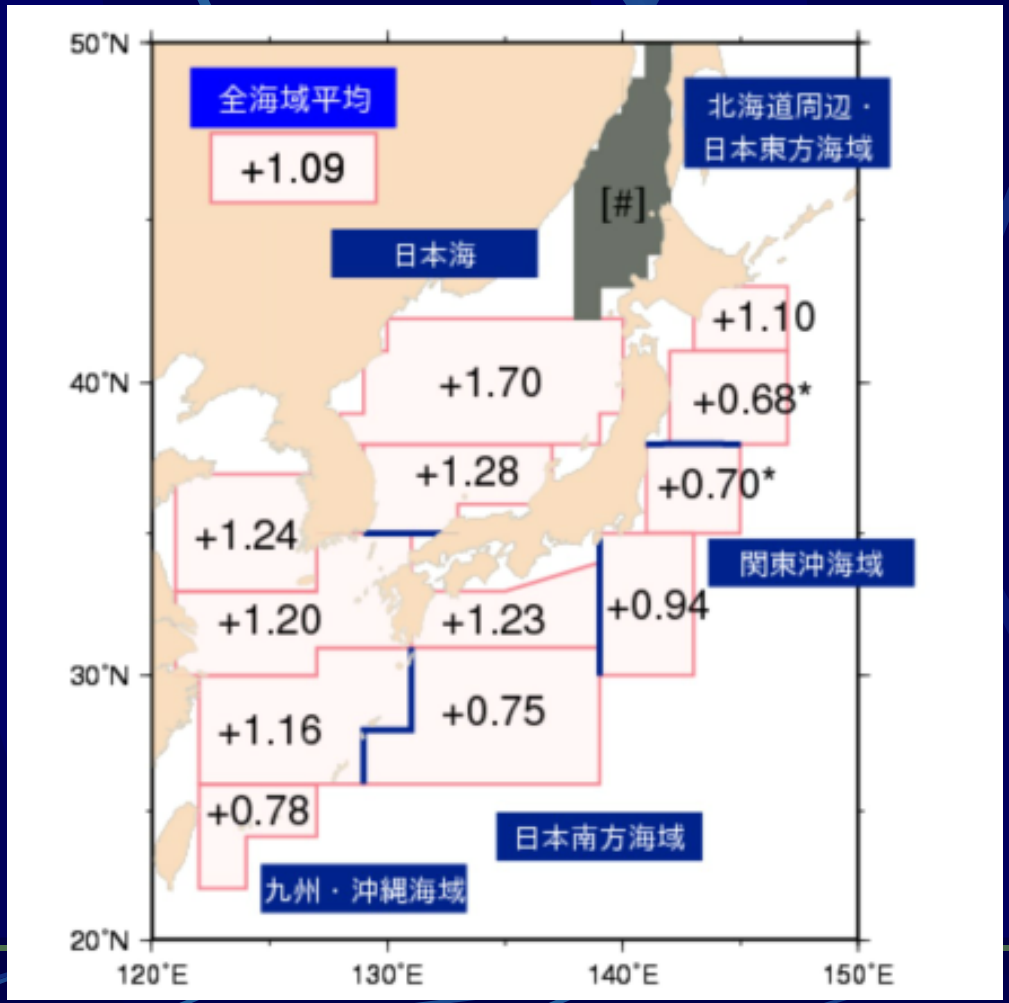
Traces of buoys released from Chinese coast in March-June 2006

Buoys released from R/V Hakuho Maru in May 2002


124°E
126
128
130
132
35°N
34
33
32
31
30
29
28
200 m

Impact of global warming on seaweeds around Japan at present

Increase in surface water temperature around Japan



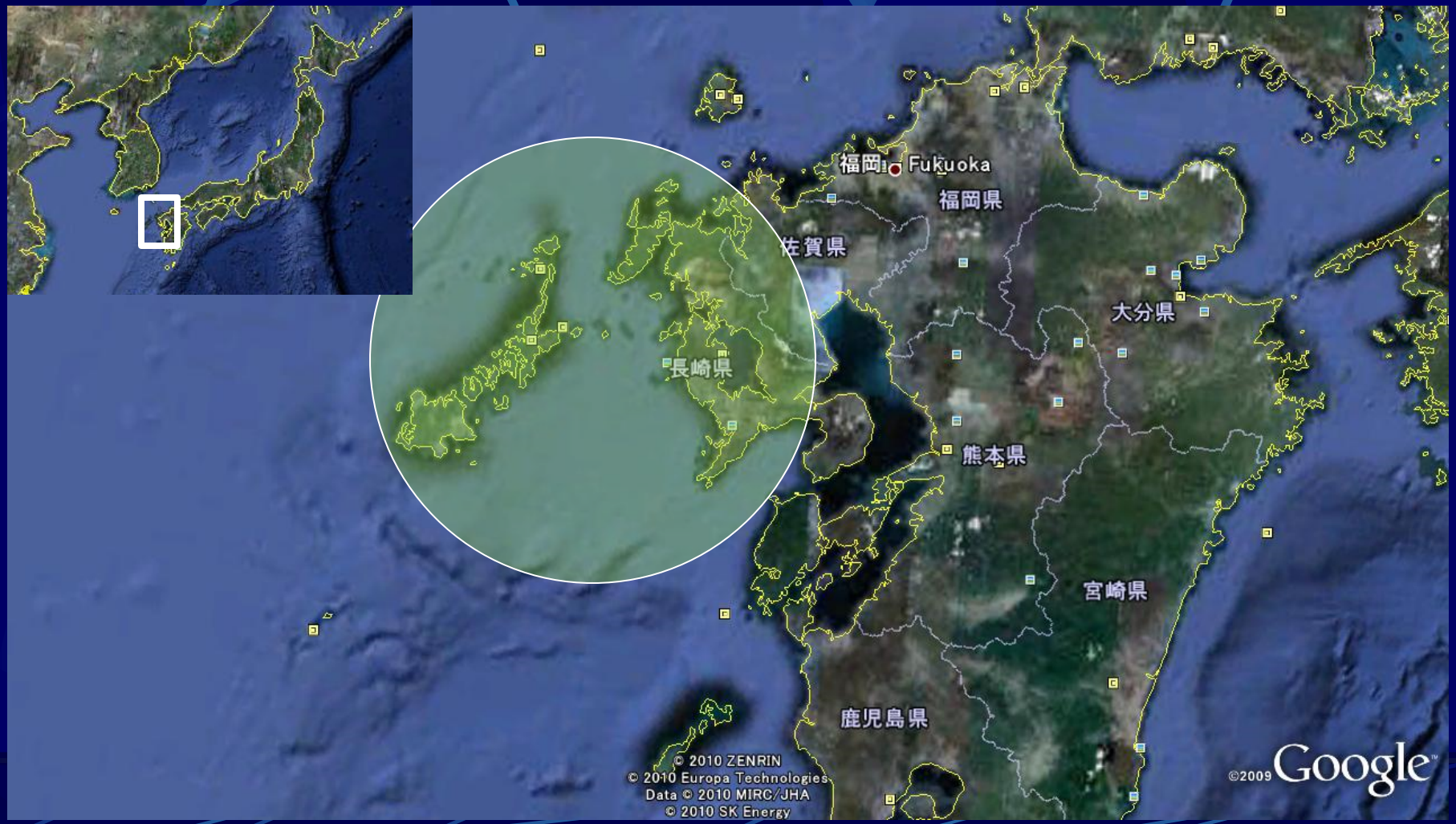
http://www.data.jma.go.jp/kaiyou/data/shindan/a_1/japan_warm/japan_warm.html

Impacts of global warming on seaweed beds

- Impacts are greater on seaweeds and sessile animals fixing on the sea bottom

Ecklonia cava, laminaria species, forest died due to high water temperature by warm Kuroshio water intrusion into the Izu Peninsula coast south of Tokyo, Honshu Island

Increase in subtropical *Sargassum* species in Nagasaki Prefecture, Kyushu Island, west Japan



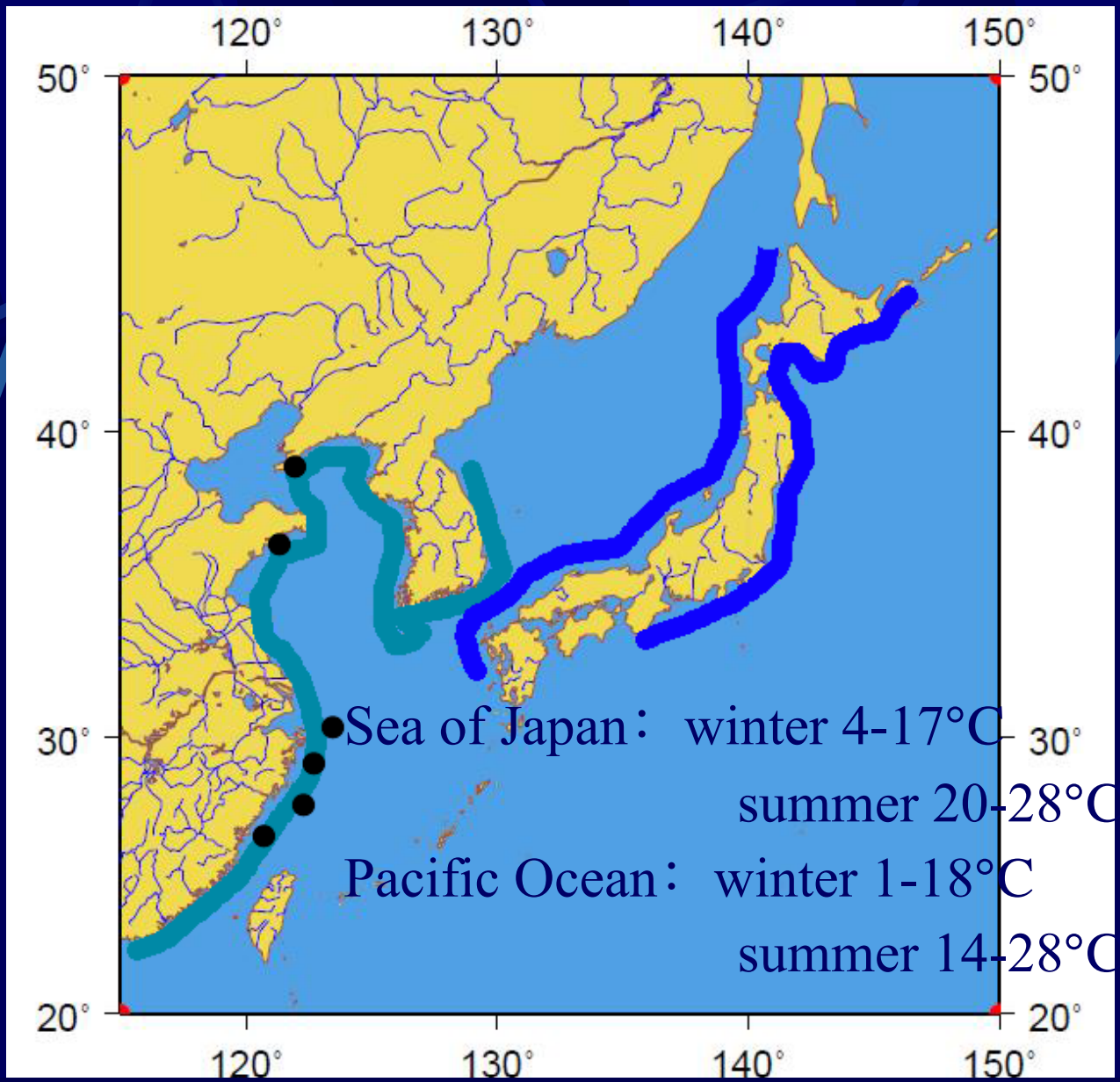
Increase in subtropical *Sargassum* species

Species	Site numbers	
	Nov.1981	Feb. 2004
Sargassum horneri	44	44
Sargassum hemiphyllum	33	67
Sargassum thunbergii	22	33
Sargassum ringgoldianum	33	
Myagropsis myagroides	11	
Sargassum micracanthum	22	
Sargassum macrocarpum	33	
Sargassum fusiforme	56	78
Sargassum fulvellum	56	
Sargassum piluliferum	56	33
Sargassum patens	56	
Sargassum siliquastrum	67	
Subtropical *Sargassum* species	0	44
Total number of temperate species	12	5

- Increase in predation damage of seaweed forests by some warm water migrating fishes staying longer than in 1990s

Influence of global warming on *Sargassum horneri* in future

Sargassum horneri forest



Distribution of *Sargassum horneri* and its growing temperature range based on Umezaki (1984) and other references

Objectives of the study

- Prediction of changes in *Sargassum horneri* distributions due to global warming

- Influences of their changes on fish

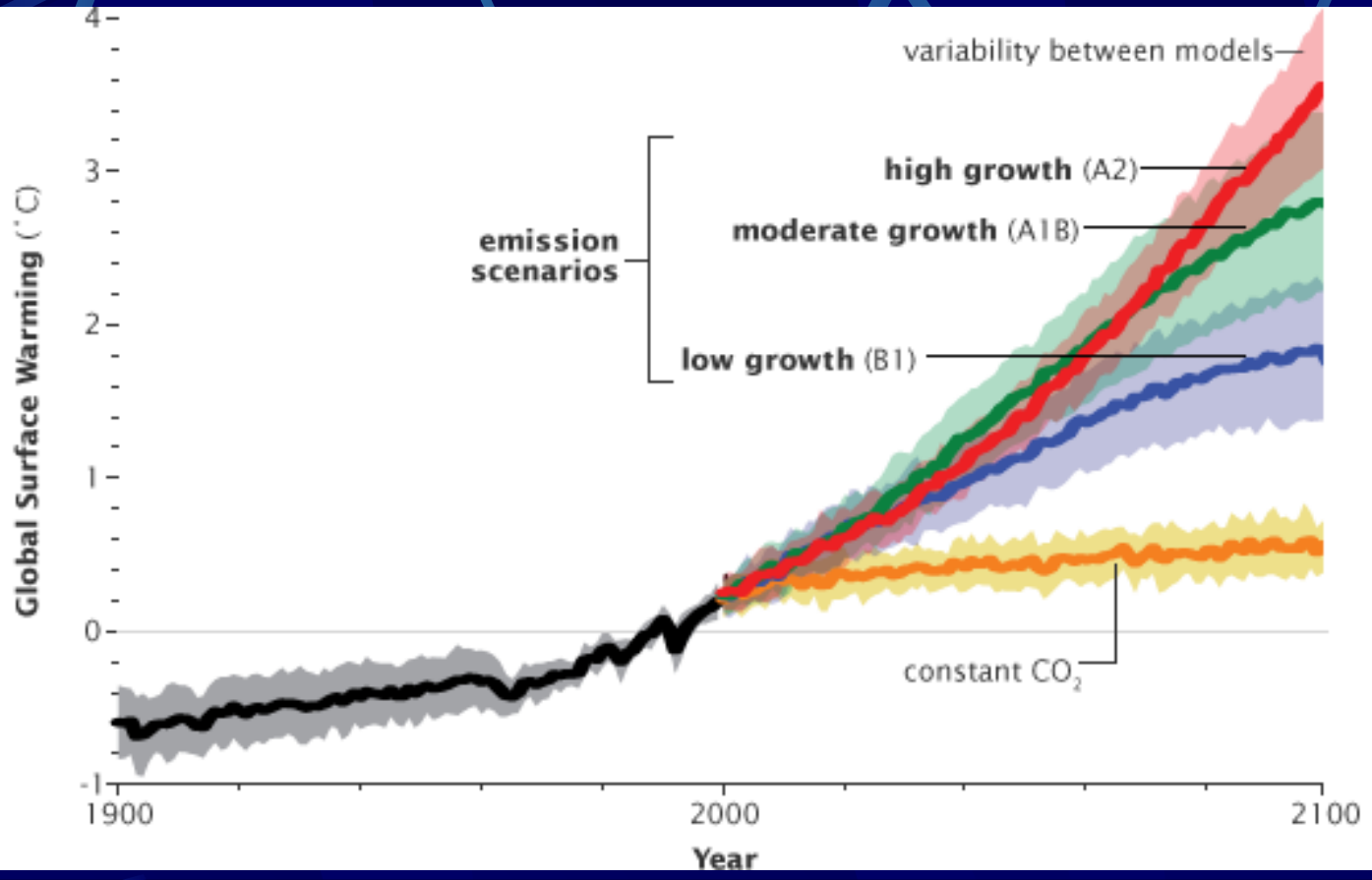
Methods

- Collection of data about temperature ranges of dominant *Sargassum* species, *Sargassum horneri*
- Estimation of spatial distribution of Sargassum *horneri* based on water temperature distribution predicted with the A2 model
- Estimation of spatial distribution of Sargassum *horneri* based on spatial distribution of averaged water temperatures predicted with the A2 models （A2 Mean)

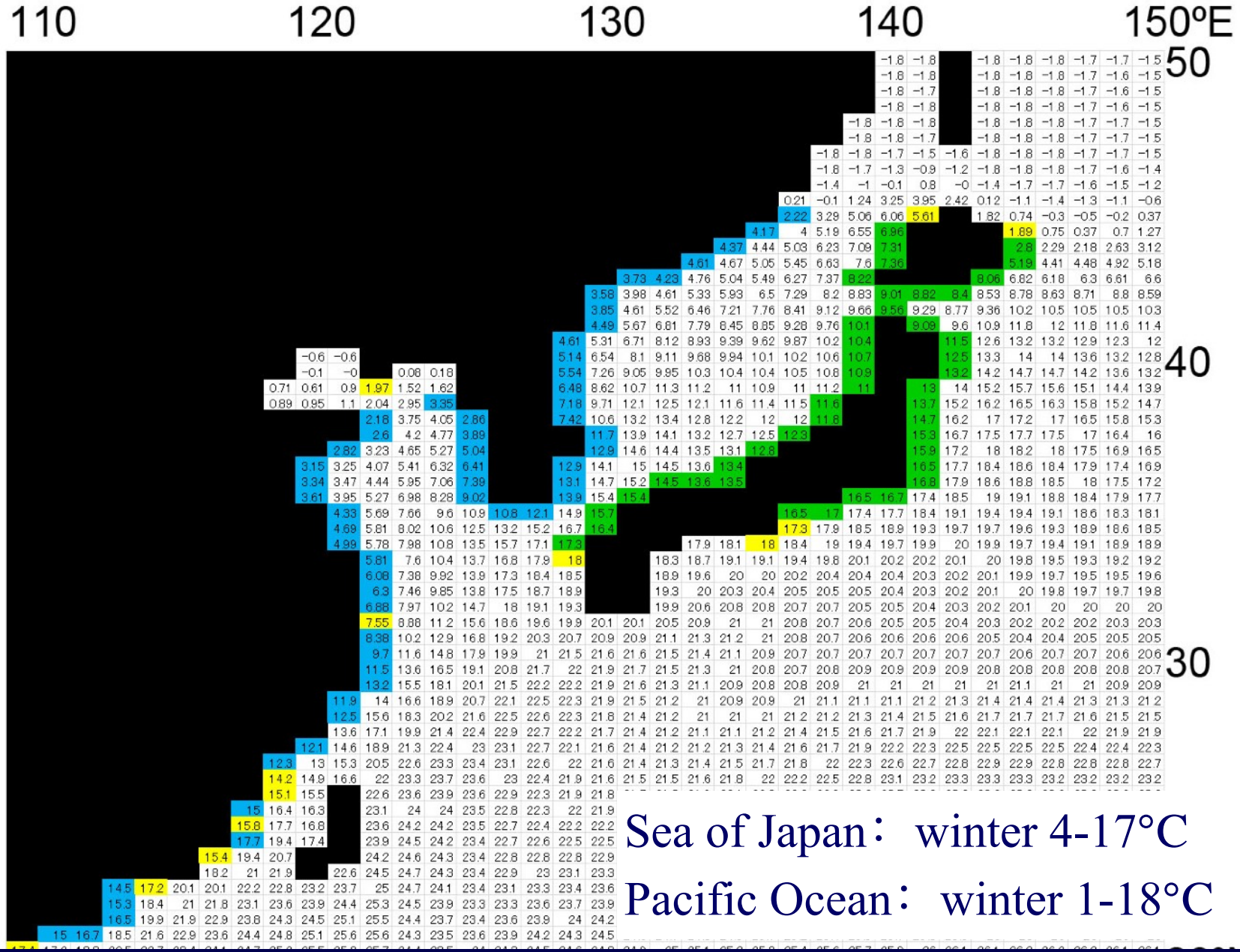
The A2 world has less international cooperation than the A1 or B1 worlds. People, ideas, and capital are less mobile so that technology diffuses more slowly than in the other scenario families.

Originating Group(s)	Country	CMIP3 I.D.
Bjerknes Centre for Climate Research	Norway	BCCR-BCM2.0
Canadian Centre for Climate Modelling & Analysis	Canada	CGCM3.1(T47)
Météo-France / Centre National de Recherches Météorologiques	France	CNRM-CM3
CSIRO Atmospheric Research	Australia	CSIRO-Mk3.0
Max Planck Institute for Meteorology	Germany	ECHAM5/MPI-OM
US Dept. of Commerce / NOAA / Geophysical Fluid Dynamics Laboratory	USA	GFDL-CM2.0
Institute for Numerical Mathematics	Russia	INM-CM3.0
Institut Pierre Simon Laplace	France	IPSL-CM4
Center for Climate System Research (The University of Tokyo), National Institute for Environmental Studies, and Frontier Research Center for Global Change (JAMSTEC)	Japan	MIROC3.2(hires)
Meteorological Research Institute	Japan	MRI-CGCM2.3.2
National Center for Atmospheric Research	USA	PCM
Hadley Centre for Climate Prediction and Research / Met Office	UK	UKMO-HadGEM1

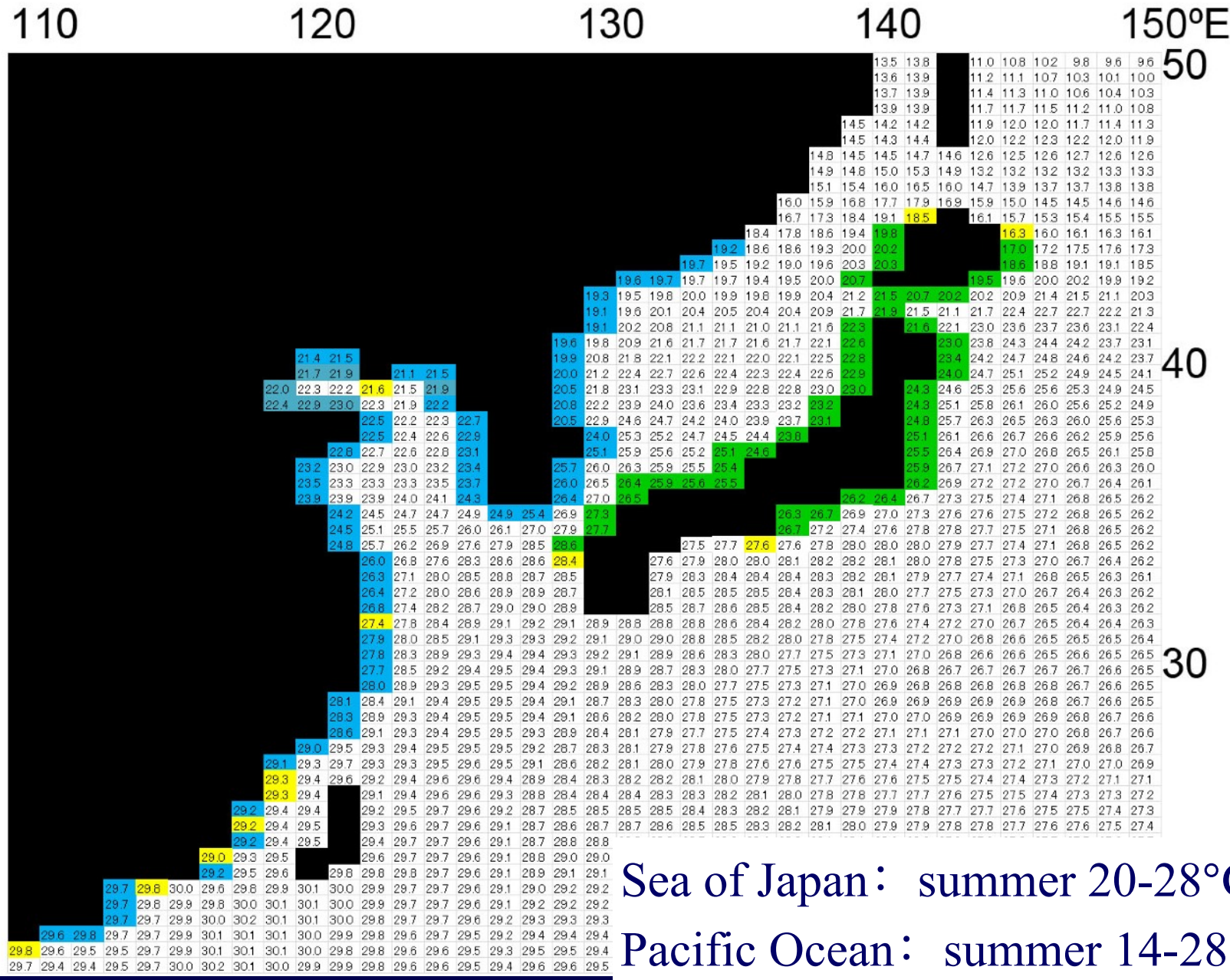
Global surface warming by scenarios



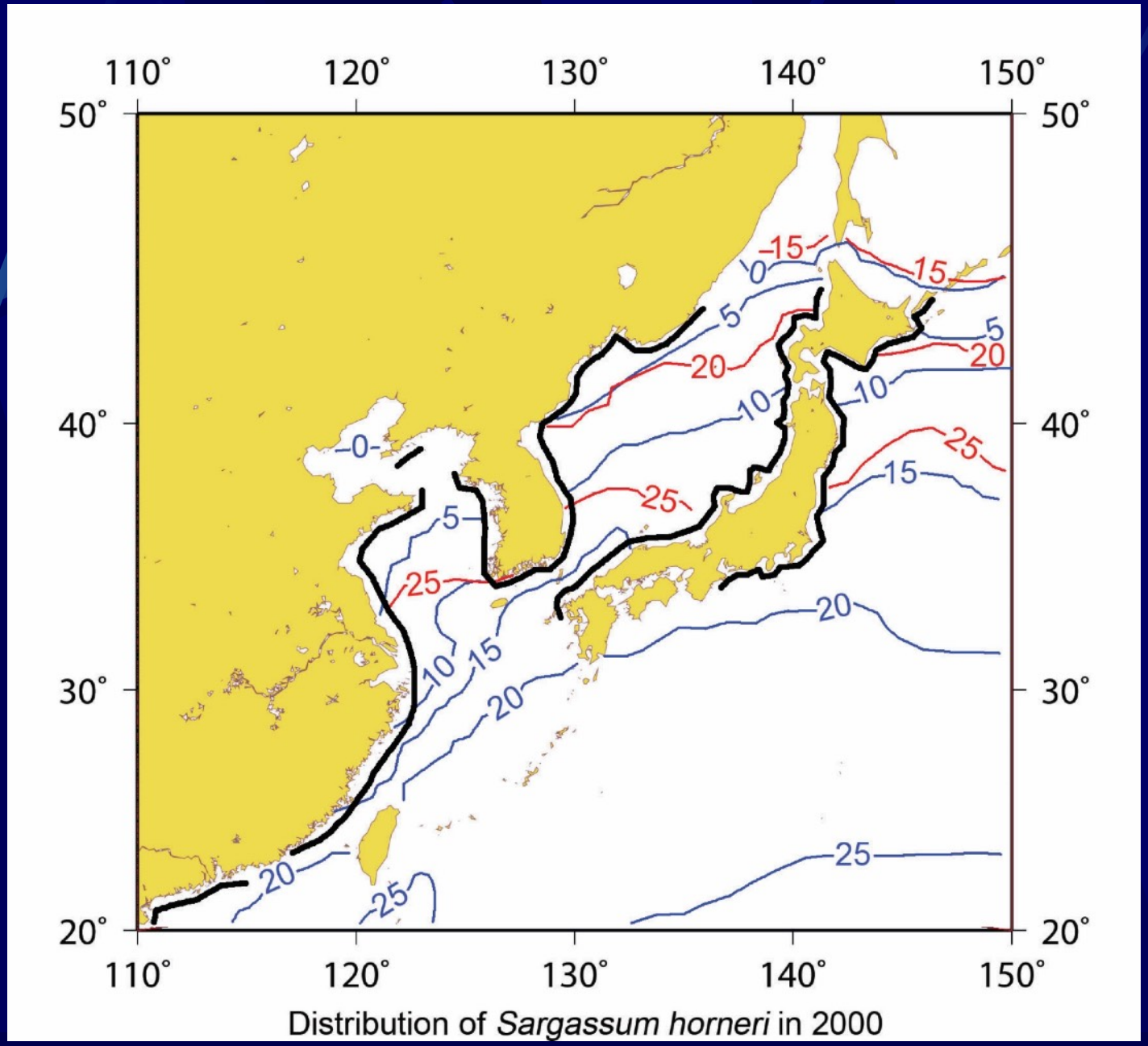
https://earthobservatory.nasa.gov/Features/GlobalWarming/page5.php



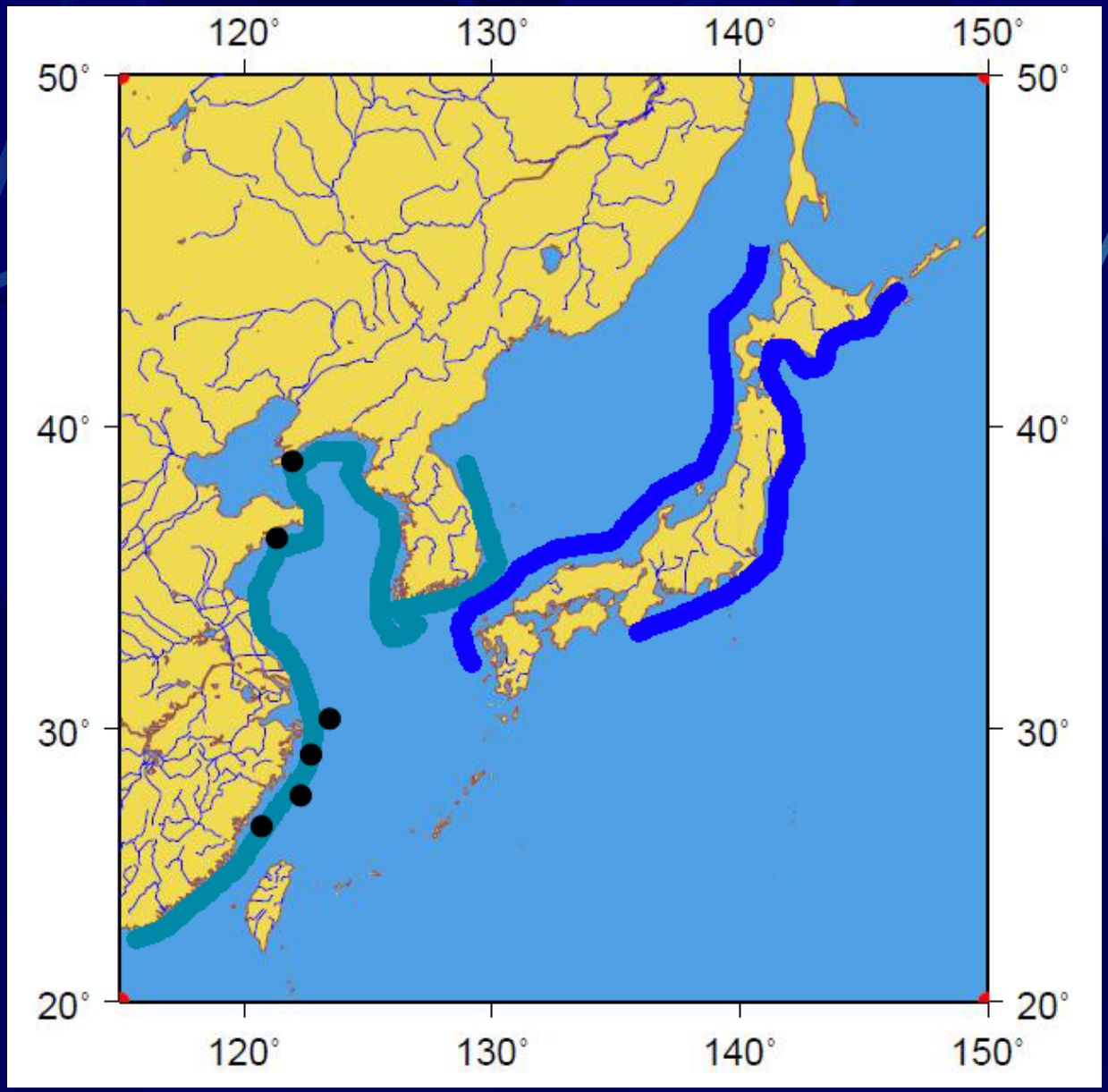
Potential growing area of *Sargassum horneri* based on surface water temperature in February 2000



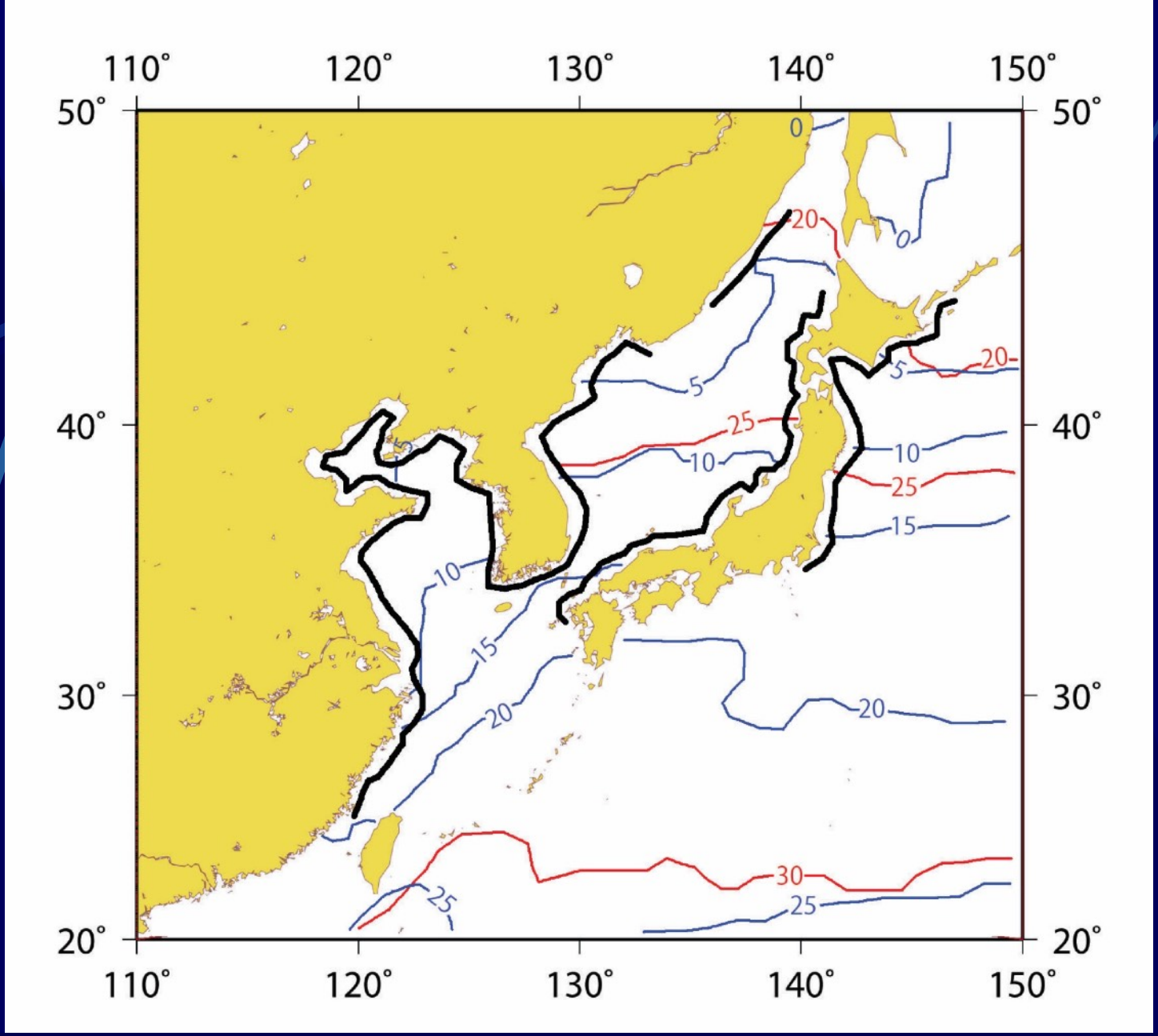
Potential growing area of *Sargassum horneri* based on surface water temperature in August 2000



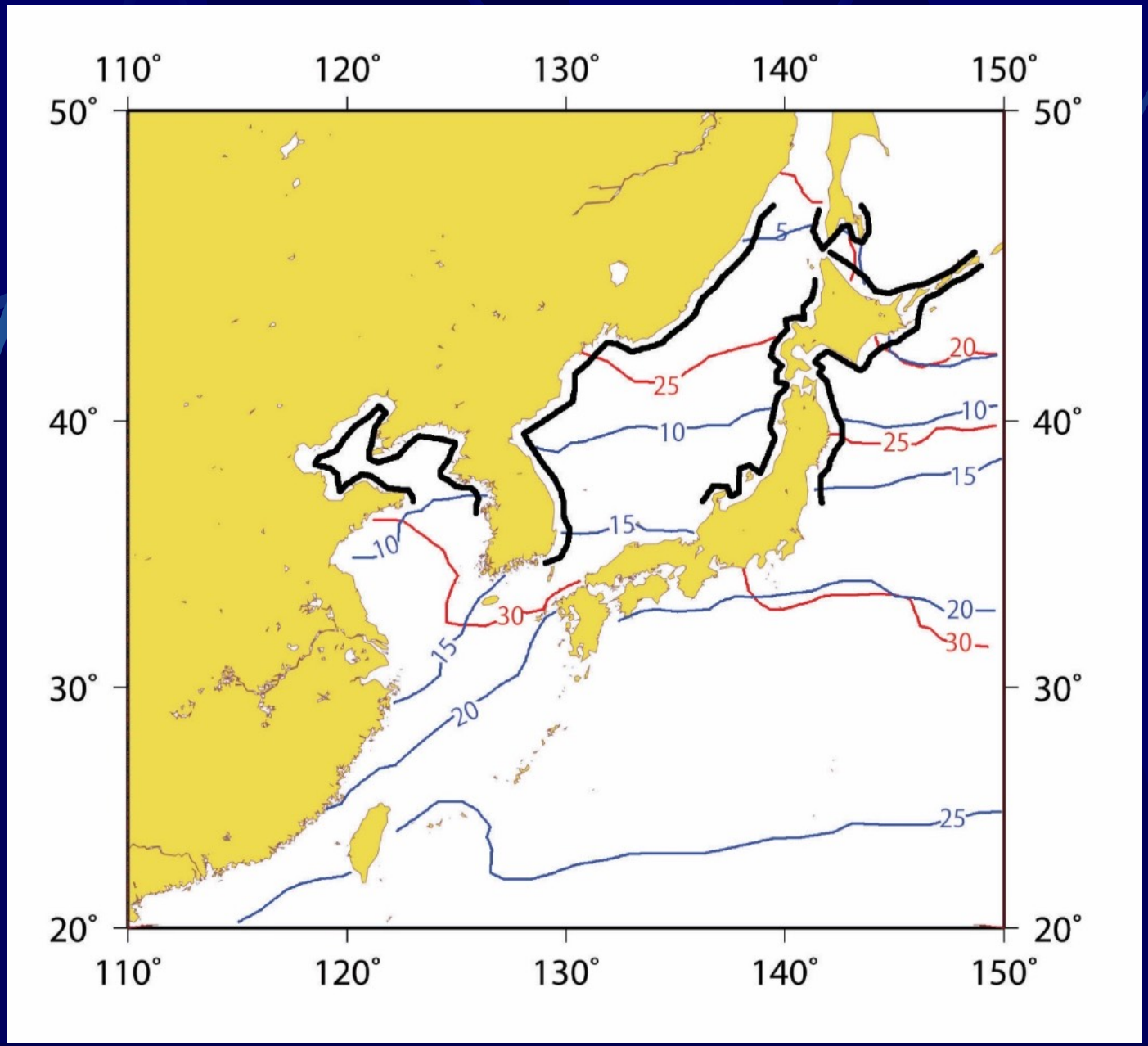
Potential growing area of *Sargassum horneri* based on surface water temperature in February and August 2000



Spatial distribution of *Sargassum horneri* based on the literatures



Potential growing area of *Sargassum horneri* based on surface water temperature in February and August 2050

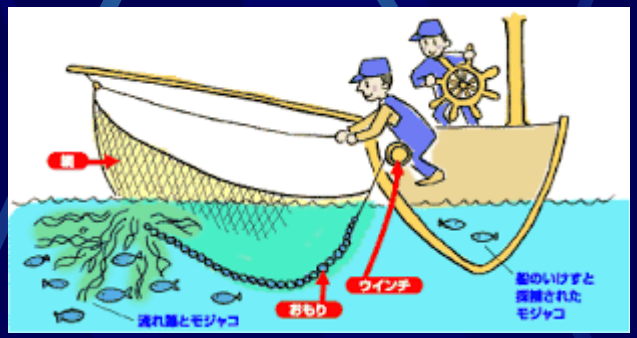


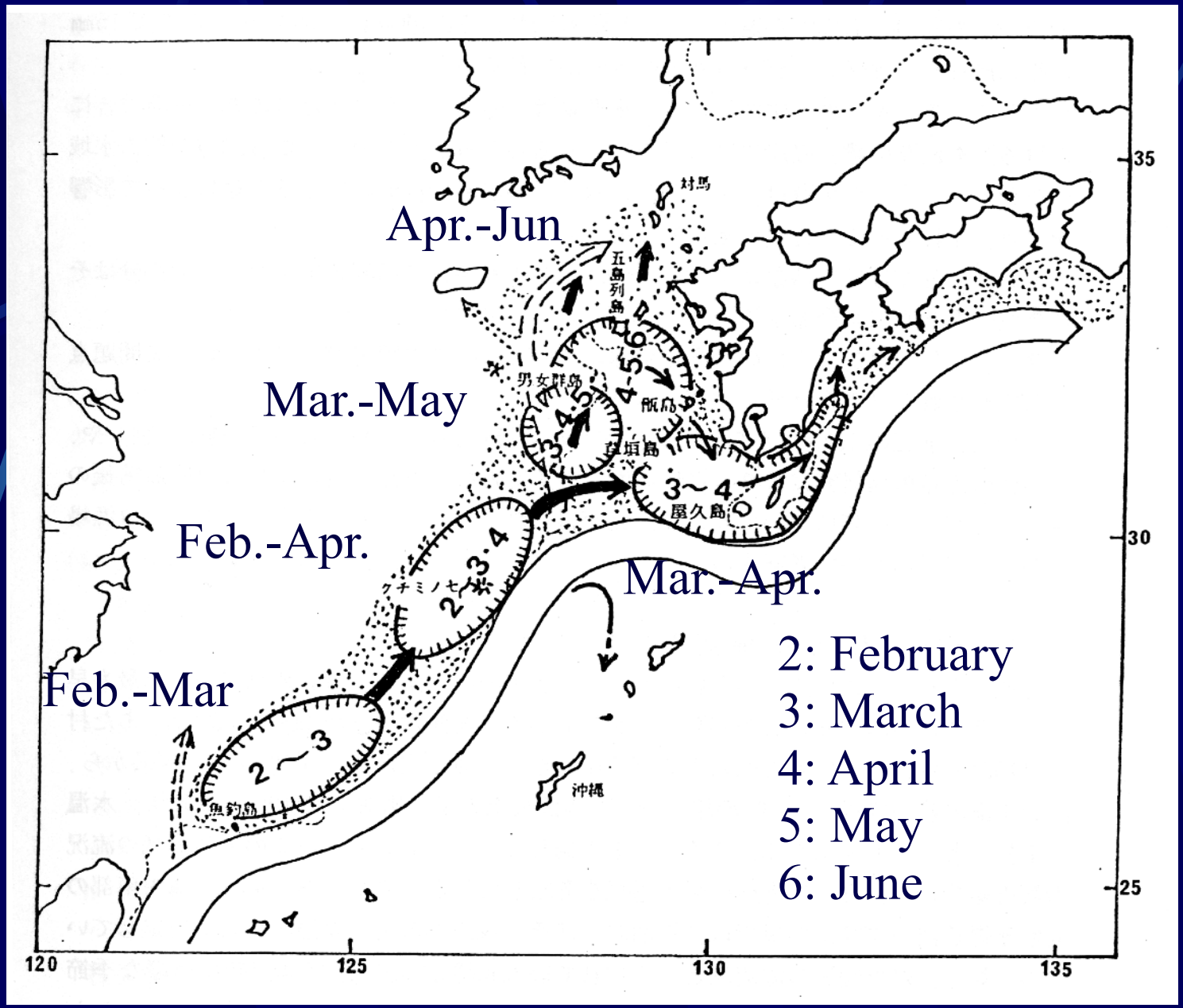
Potential growing area of *Sargassum horneri* based on surface water temperature in February and August 2100

Juveniles of yellow tail collected with drifting seaweeds

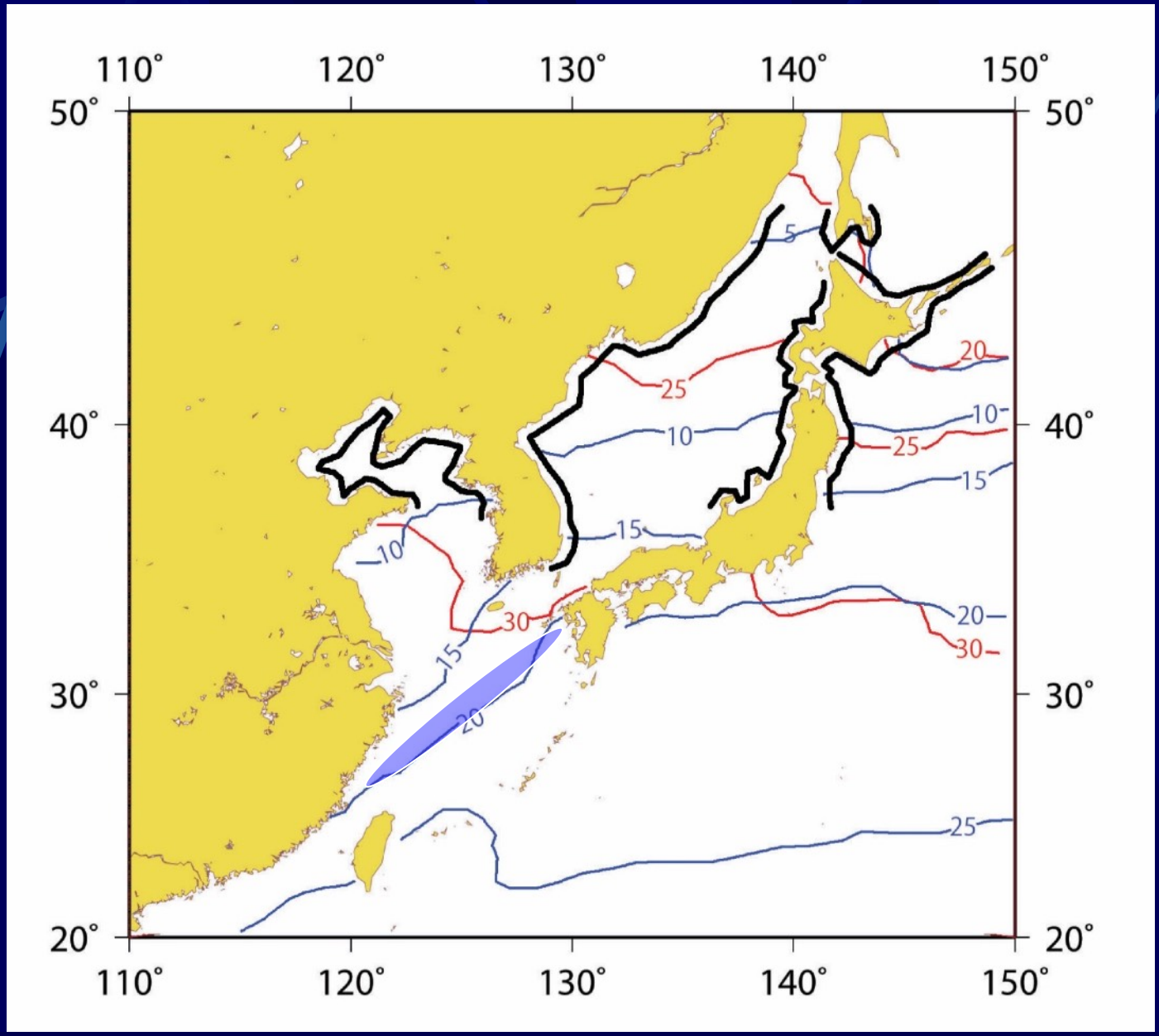
Aquaculture of yellowtail

Aquaculture of yellow tail

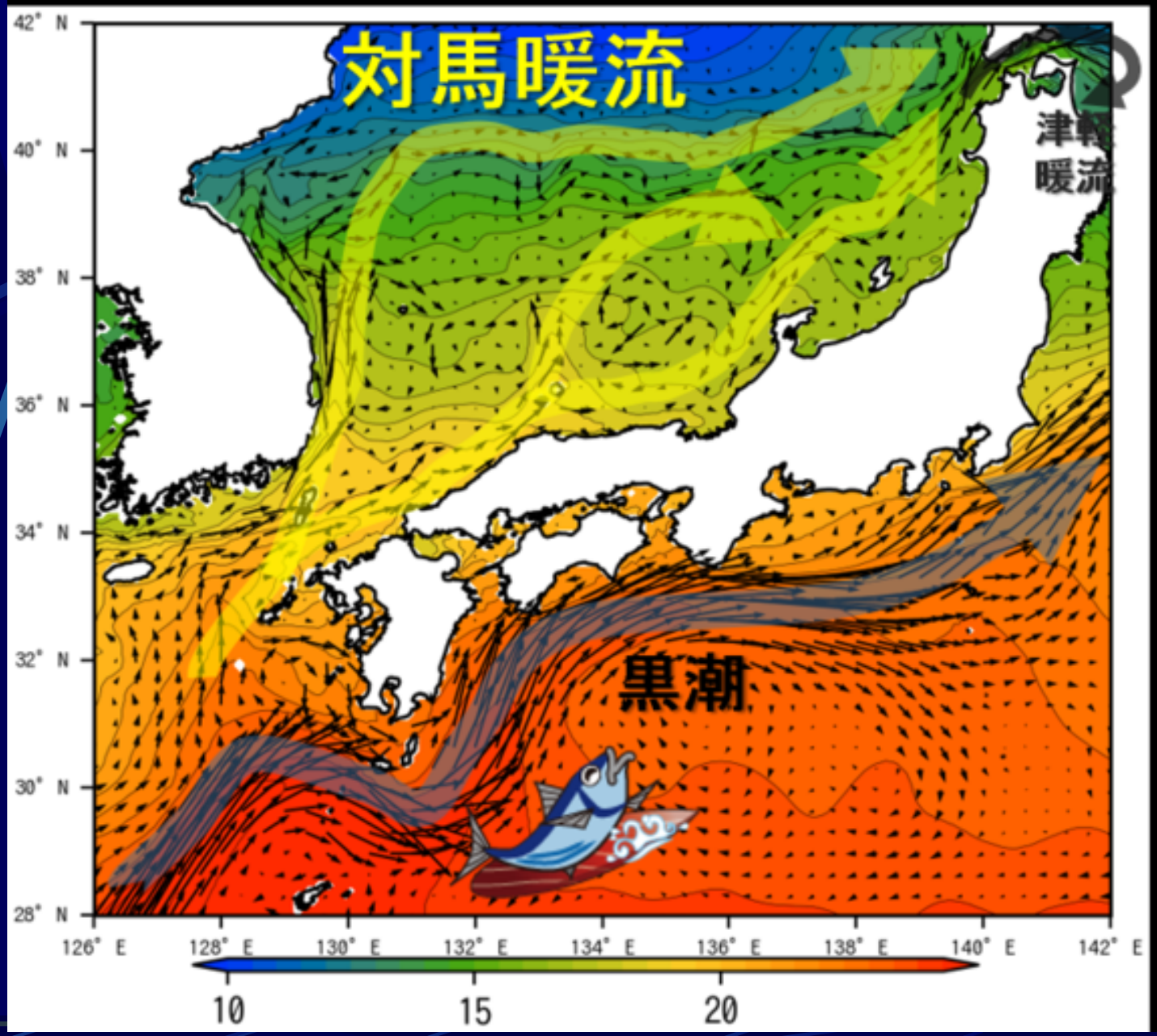




Spawning grounds of yellowtail in East China Sea

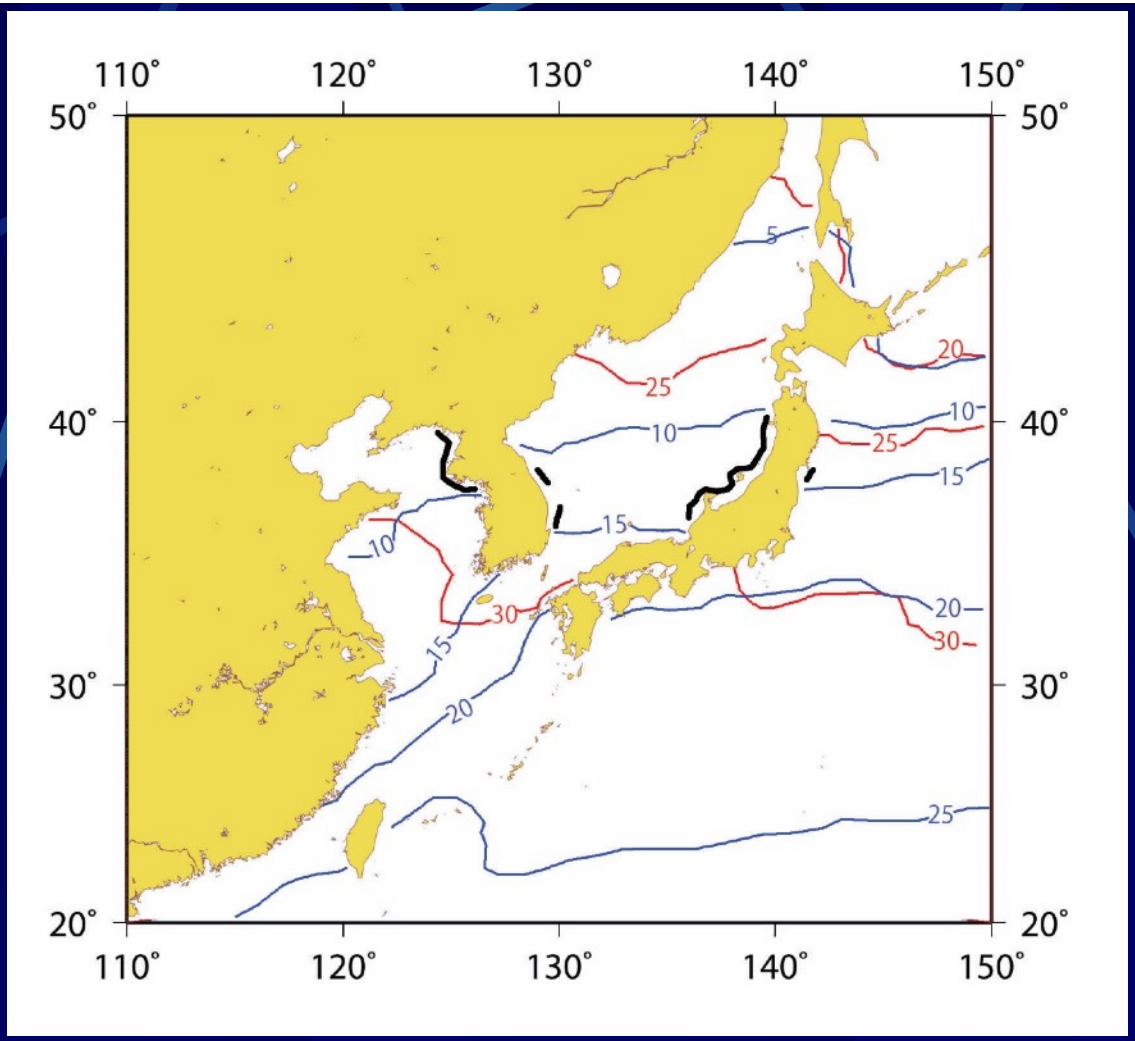


Potential distribution area of *Sargassum horneri* and spawning ground of yellow tail in 2099 based on the surface water temperature



http://www.jamstec.go.jp/aplinfo/kowatch/?p=4406

Subtropical Sargassum species may not be source of drifting seaweeds in 2100



http://snf.fra.affrc.go.jp/sargasso/usubamoku/usubamoku.html

Spatial distribution of subtropical *Sargassum* species, *Sargassum tenuifolium*, in 2100 predicted with A2 scenario mean

Summary

- Similar tendency of decrease in spatial distribution of *Sargassum horneri* forests due to global warming predicted with A2 Mean was obtained.
- Southern limit of *Sargassum horneri* growing in wide temperature range was clearly moved northward.
- Source of drifting seaweeds will be disappeared around East China Sea, south Sea of Japan and Pacific coast of south Honshu Island
- Negative influence of fish spawning on *Sargassum* species will occur
- Survival rates of fish larvae accompanying drifting seaweeds are decreased due to decrease in drifting seaweeds

Merci beacoup de votre attention!

Typical Japanese cooking of yellowtail: buri no teri-yaki