

A stylized map of East Asia, including Japan, Korea, and parts of China, rendered in a light blue color against a dark blue background. The map is positioned behind the text elements.

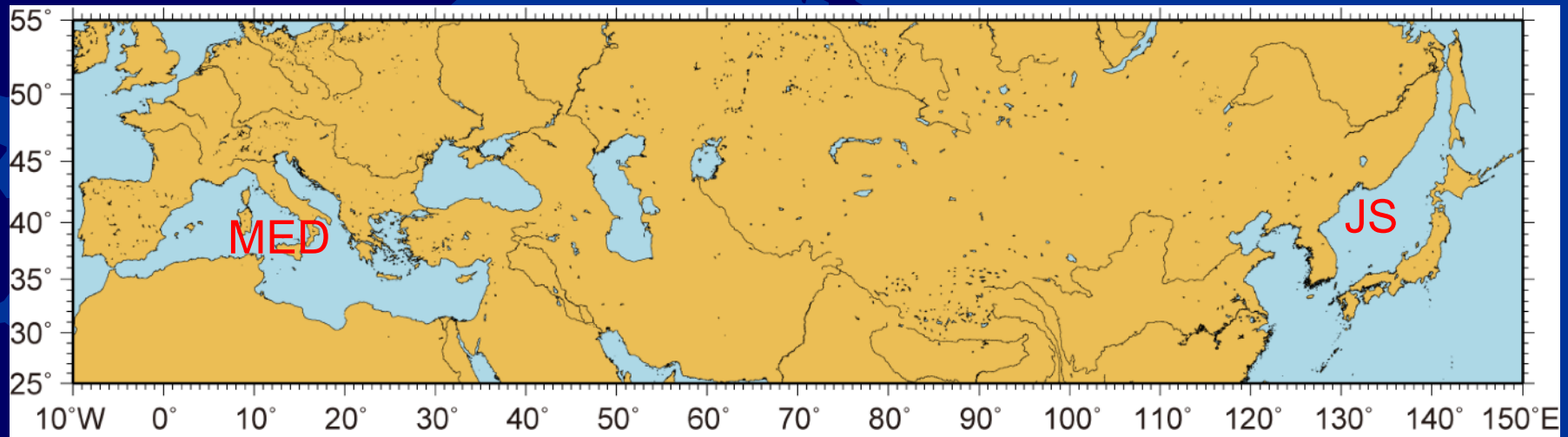
Coast Bordeaux 2017

The Japan Sea, a changing Pacific Asian marginal sea

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Japan Sea & Mediterranean Sea



- Semi-closed marginal seas
- Locating in almost the same latitude band
- Deep water formation mechanism

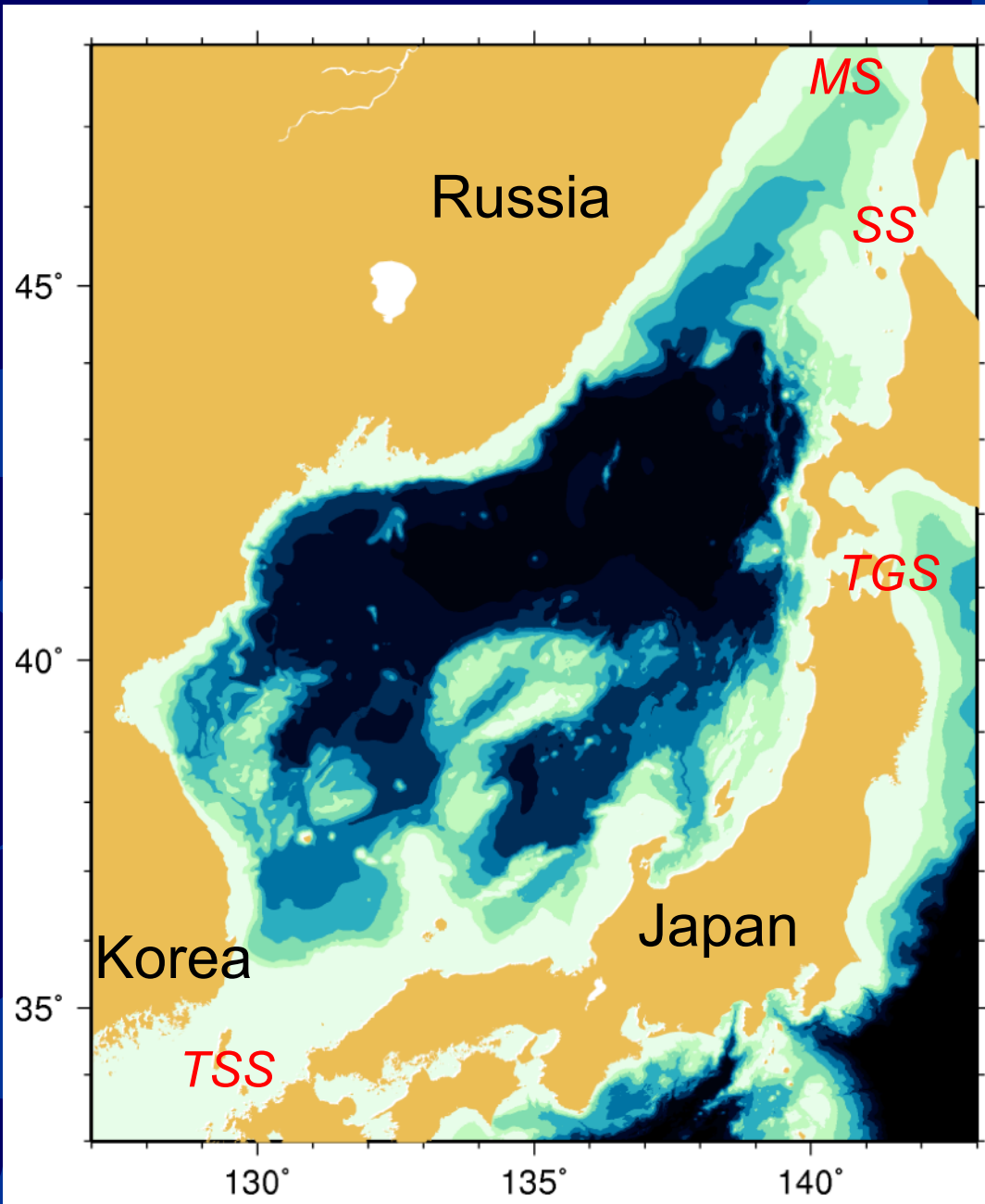
The Japan Sea

Max. depth : 3796m

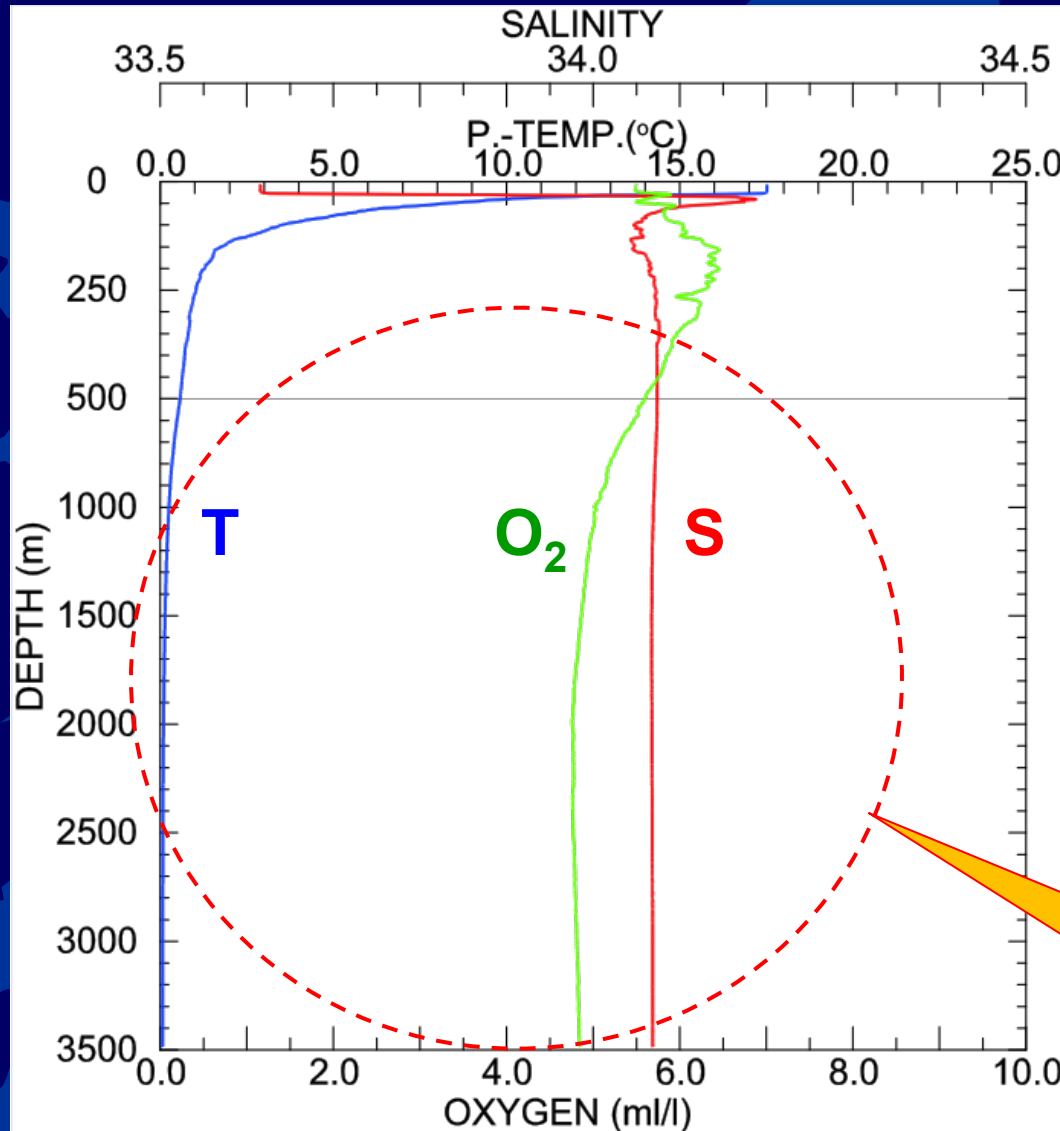
Mean depth : 1350m

Connected with other seas through shallow and narrow straits.

The water deeper than 200 m is originated within the Japan Sea.



Vertical distribution of T, S & DO



Very narrow range of
T (0.0-1.0 °C)
S (34.06-34.07)

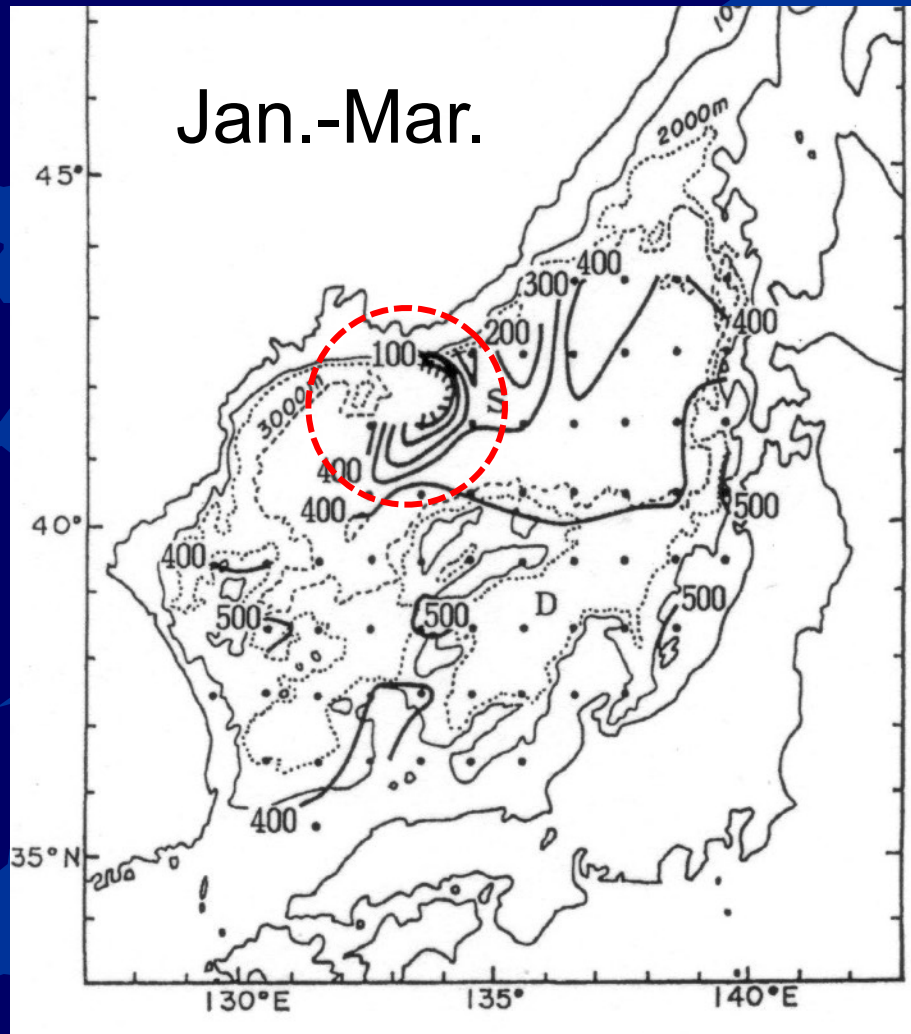
“one of the most homogeneous
water masses in the
world” (Worthington, 1982)

High DO

(> 200 $\mu\text{mol} / \text{kg}$:
4.5 ml / l)

**The Japan Sea
Proper Water**

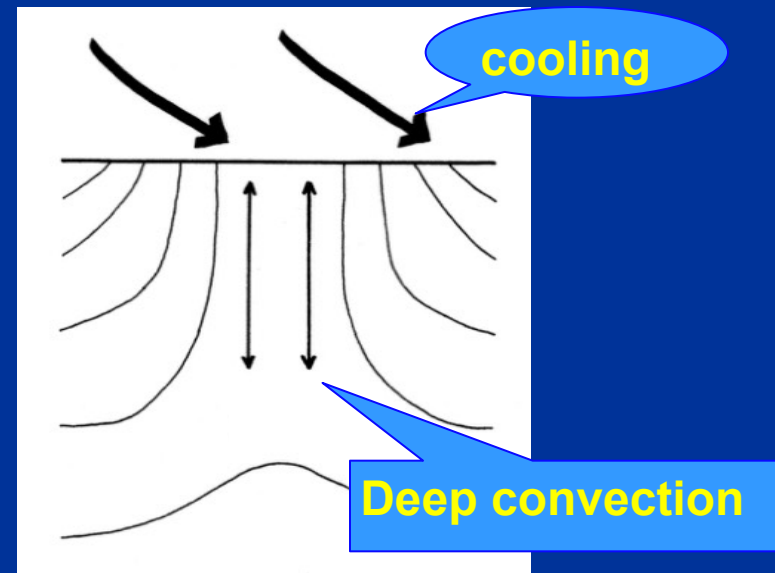
Formation area of the JSPW



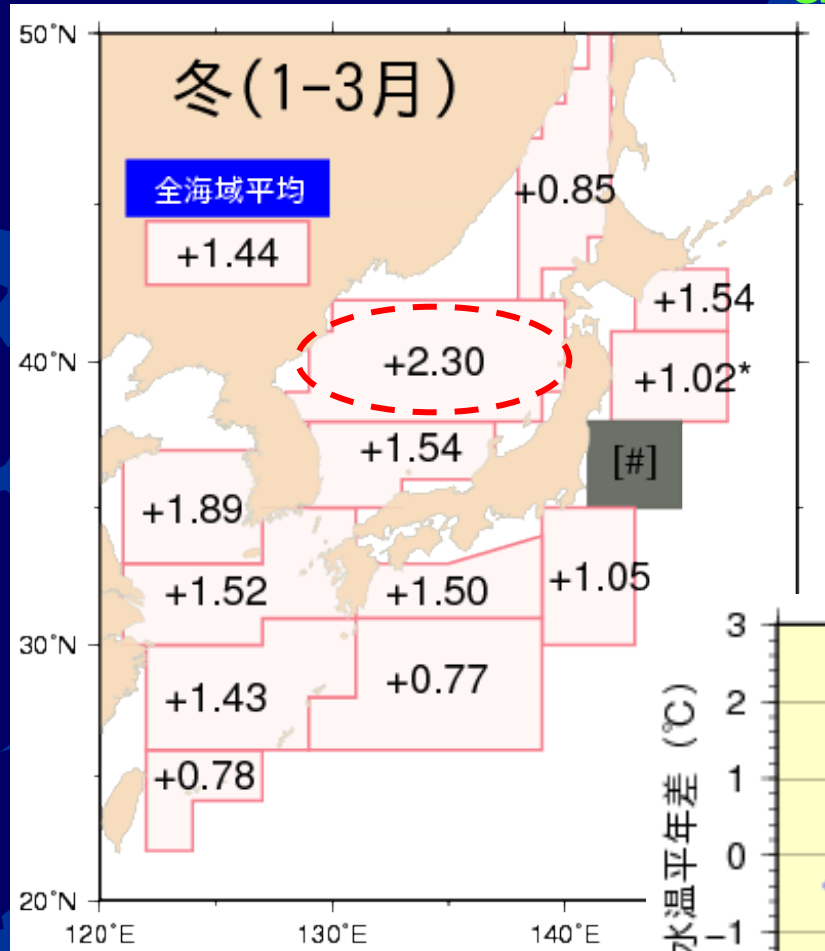
Senjyu and Sudo (1994)

The JSPW is

formed in the NW
Japan Sea in winter
by deep convection
due to surface cooling.



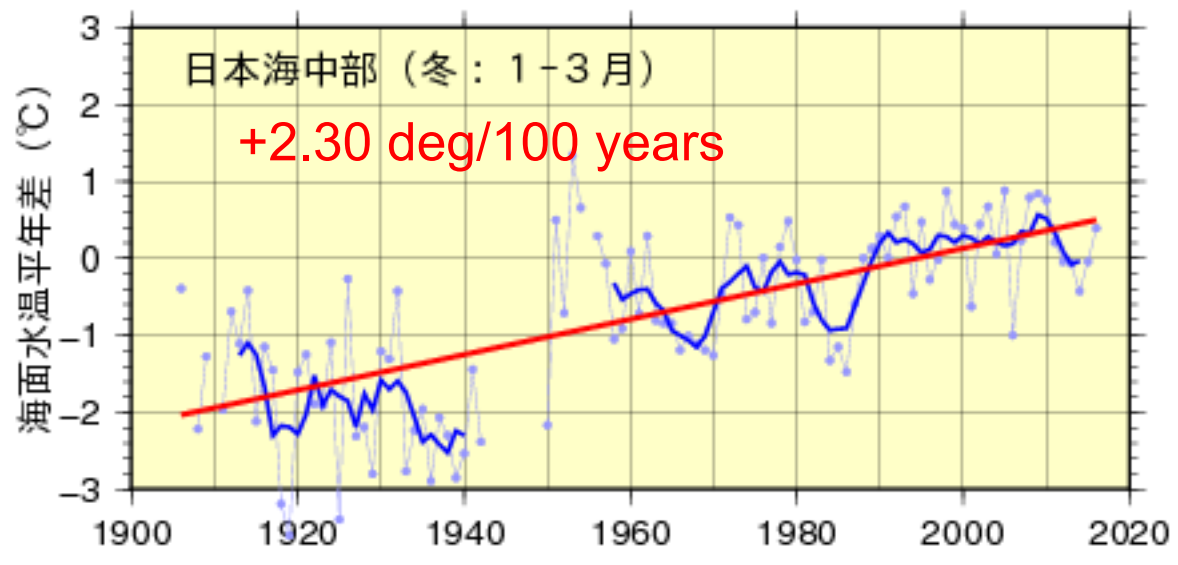
Trends of SST in winter around Japan



(Unit: C. deg / 100 years)

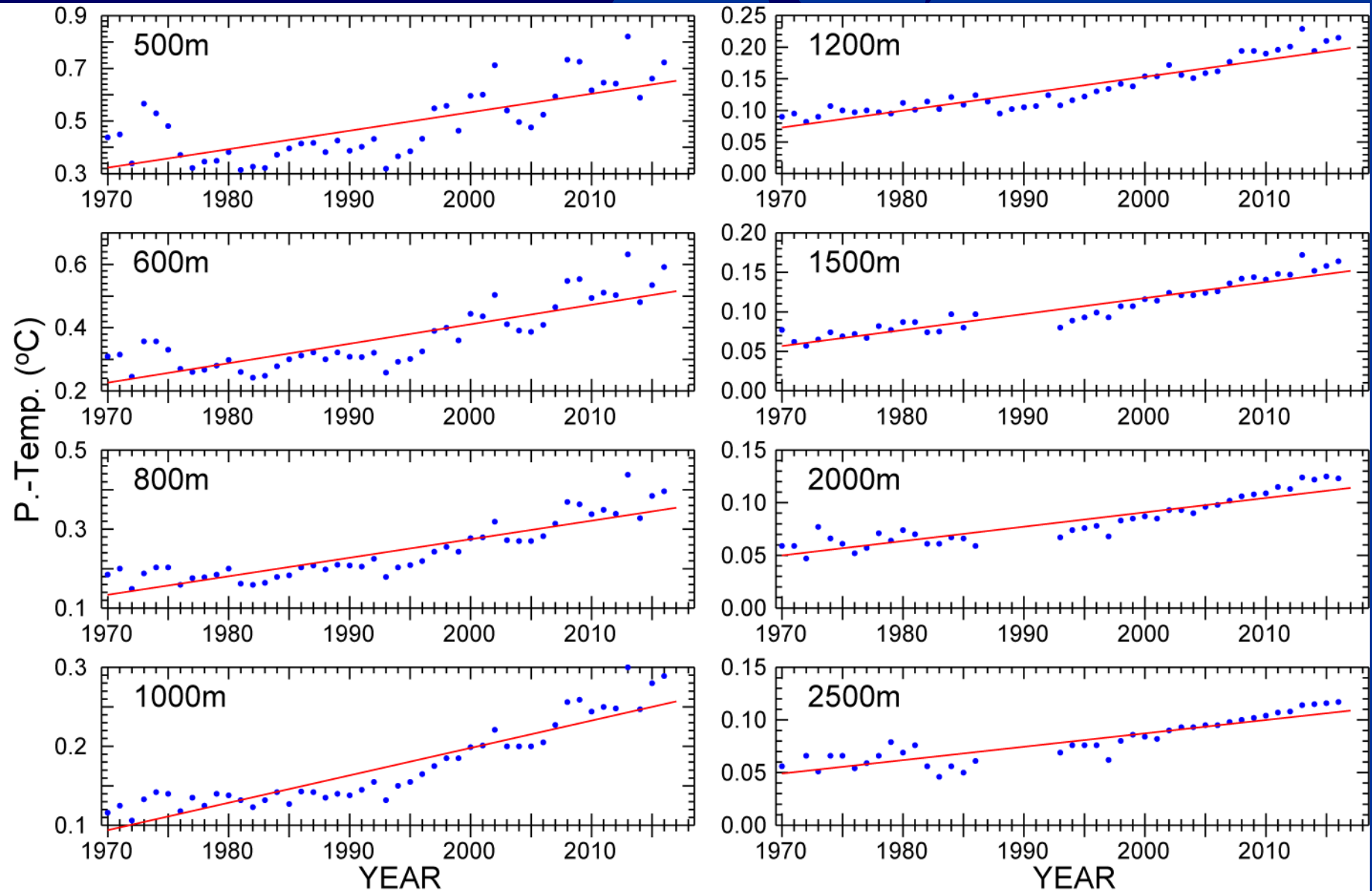
Global mean : +0.53 deg/100 yrs

SST in the Japanese waters is increasing at higher rates than that of the global mean

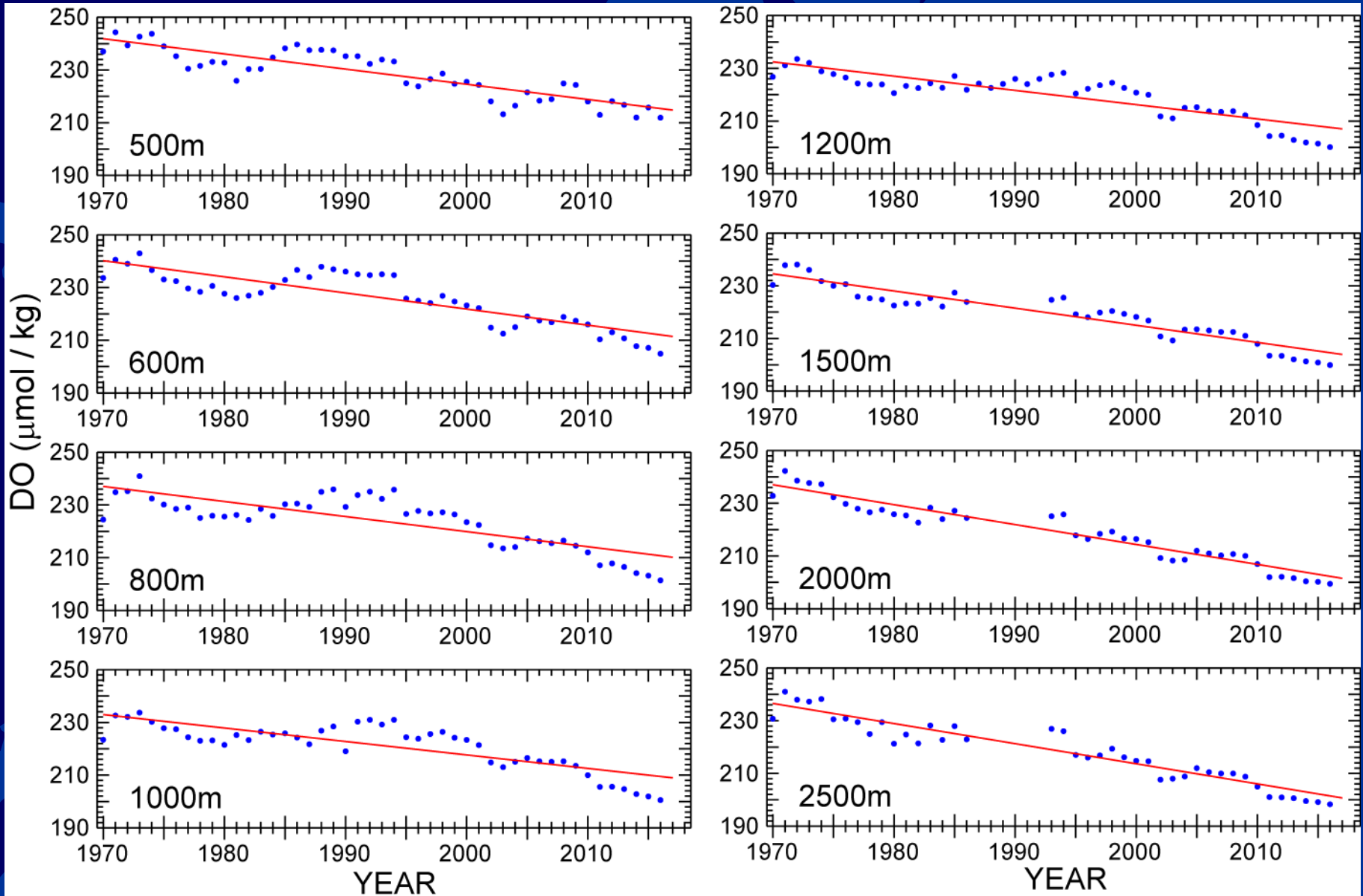


Web page of the Japan Meteorological Agency

Time series of **PT** in the abyssal JS



Time series of DO in the abyssal JS

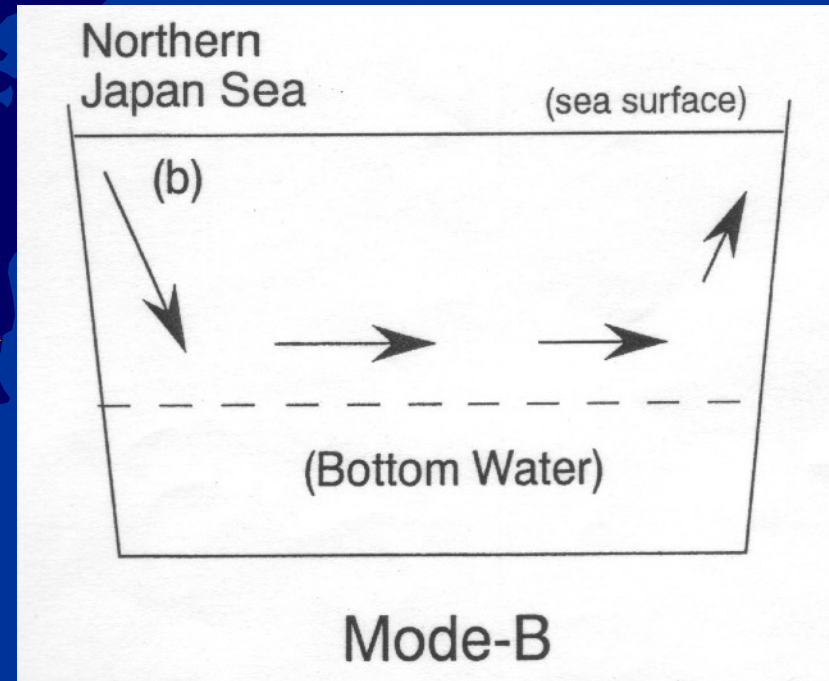
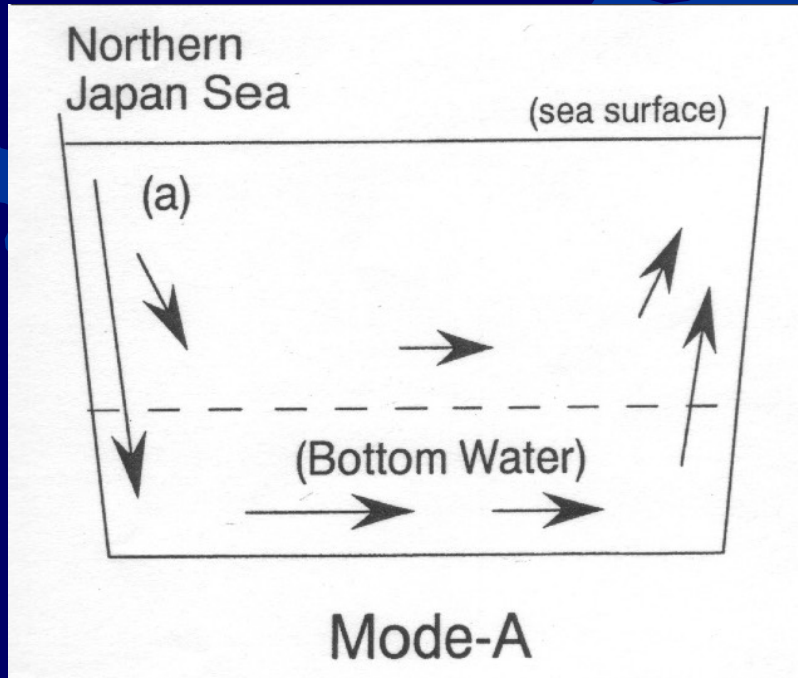


Liner trends of PT and DO with 95% confidence interval

Depth (m)	PT (°C year ⁻¹)	DO (μmol kg ⁻¹)
500	0.0072±0.0015	-0.5880±0.1001
600	0.0063±0.0011	-0.6246±0.1083
800	0.0048±0.0008	-0.5841±0.1080
1000	0.0035±0.0006	-0.5218±0.0956
1200	0.0027±0.0004	-0.5529±0.0946
1500	0.0021±0.0004	-0.6647±0.1130
2000	0.0014±0.0002	-0.7718±0.1284

Oxygen supply into the intermediate layers?

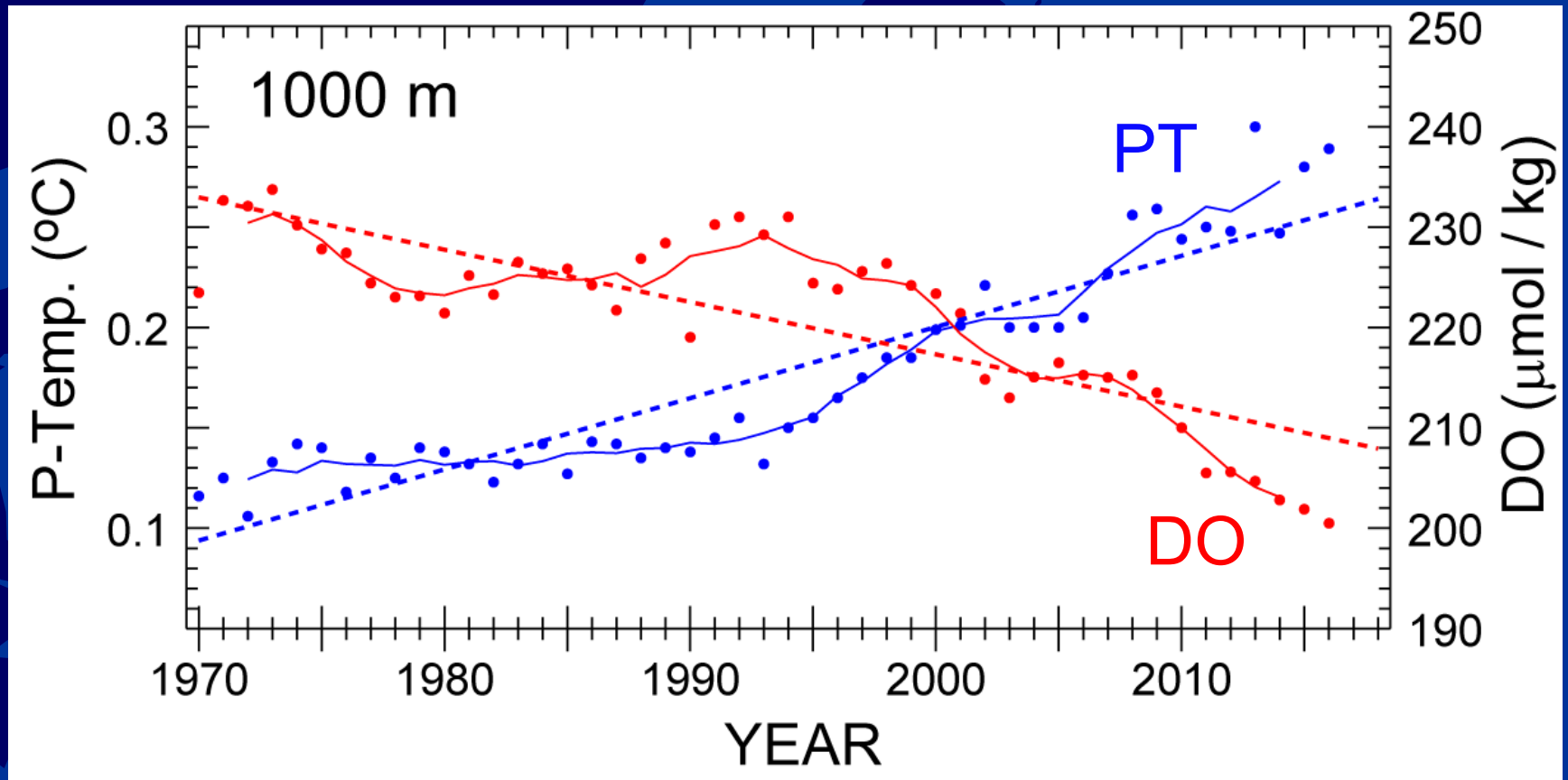
Mode shift of the deep convection system in the Japan Sea



Gamo et al. (2001)

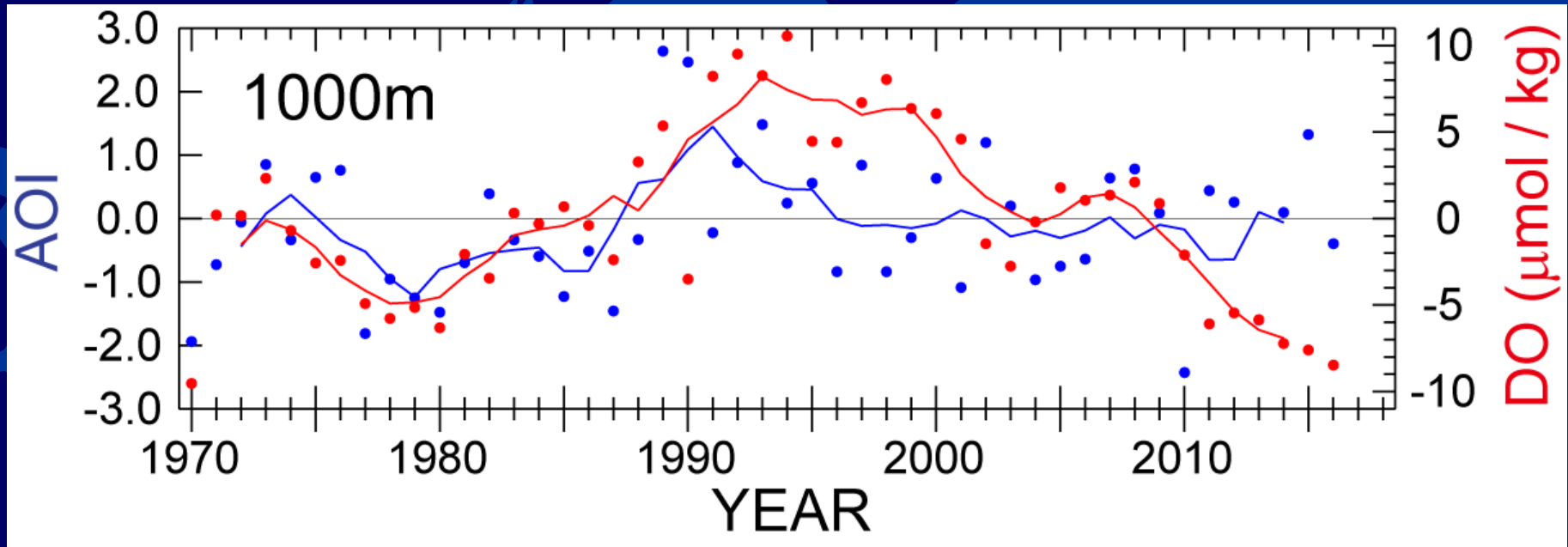
Instead of weakening of the bottom water formation, the intermediate water formation is reinforced.

Interdecadal variation of DO & PT



Decadal-scale variations are superimposed on the linear trends in PT and DO

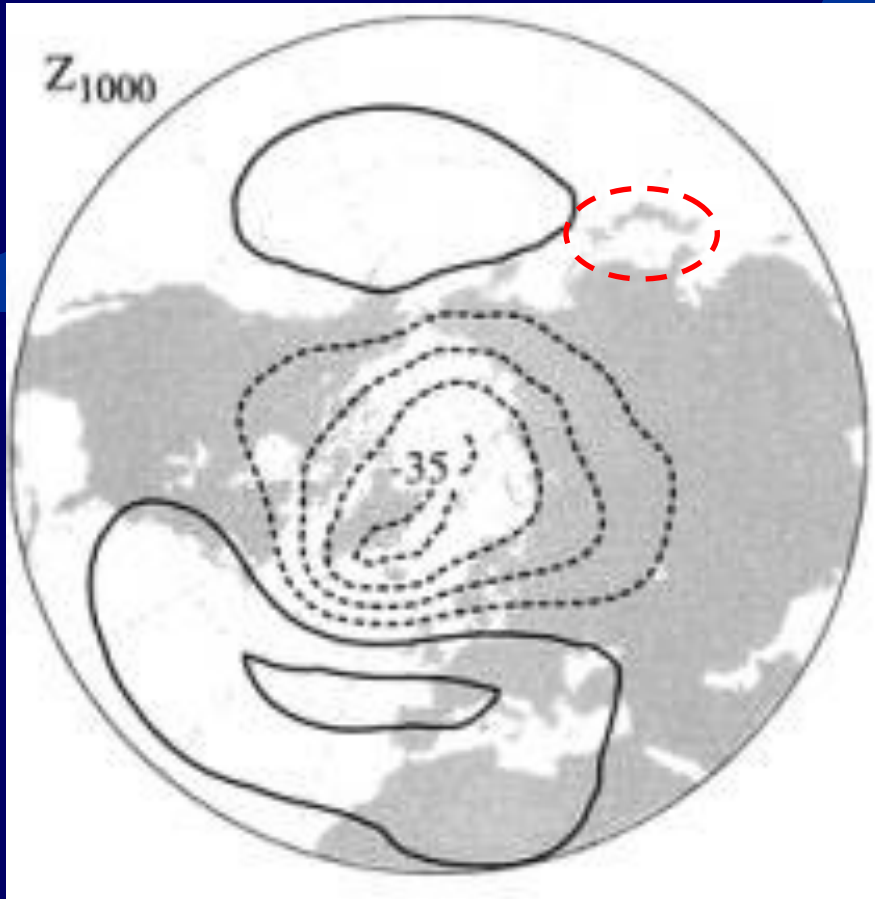
DO anomaly vs AO Index



$$r = +0.629 \text{ (} p < 0.01, n = 47 \text{)}$$

**The formation of JSPW is
modulated by AO!**

Arctic Oscillation (Northern Annular Mode)



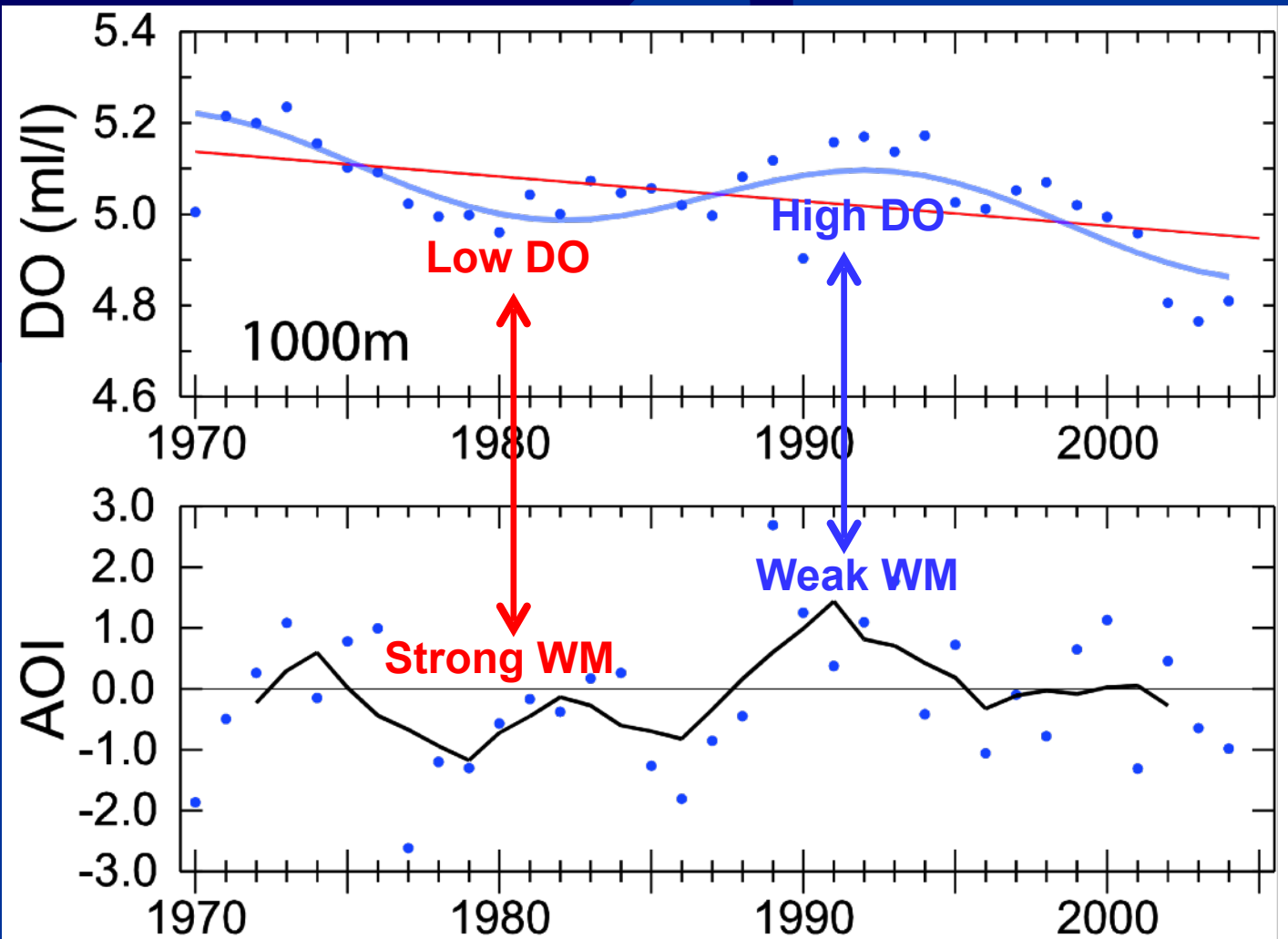
Anomaly of 1000 hPa surface associated with the Arctic oscillation

Thompson and Wallace (2000)

Climatic oscillation pattern with opposite polarity between the North pole and mid-latitude areas.

Positive anomaly in the Aleutian Low and negative in the Siberian High.

East-west atmospheric pressure gradient over the JS becomes large in the period of negative AOI, and vice versa.



**JSPW formation is preferable
in winters with weak monsoon
rather than winters with strong monsoon?**

2003

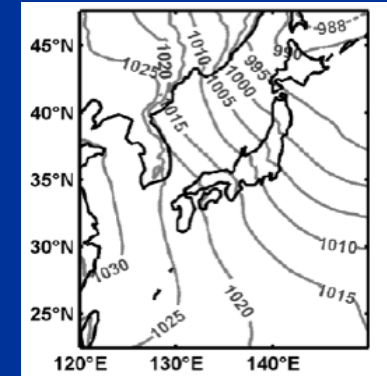
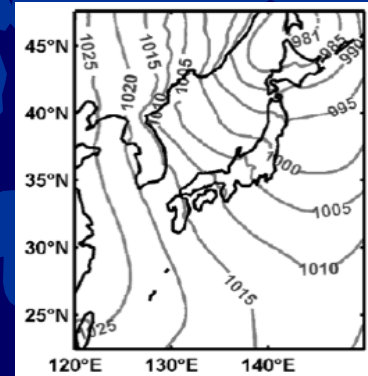
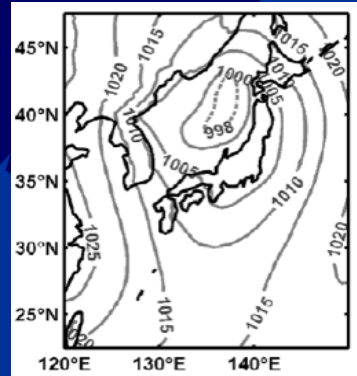
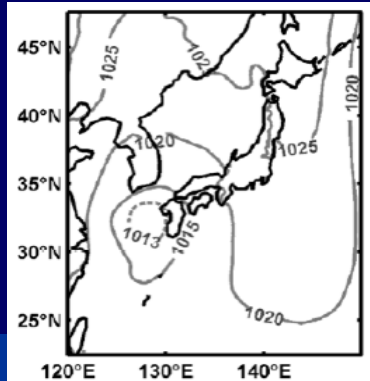
Jan 26

Jan 27

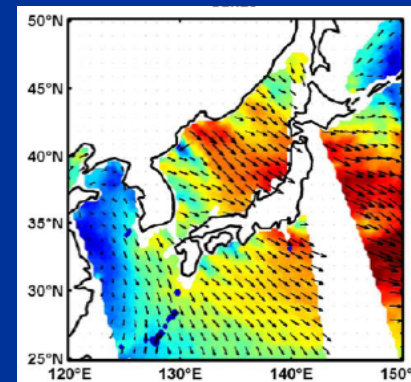
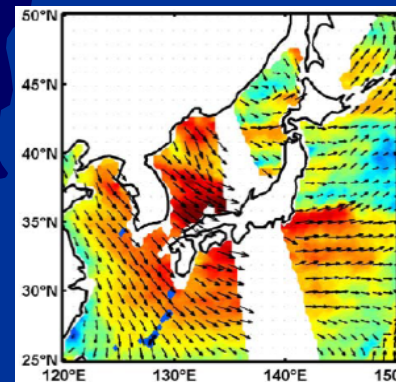
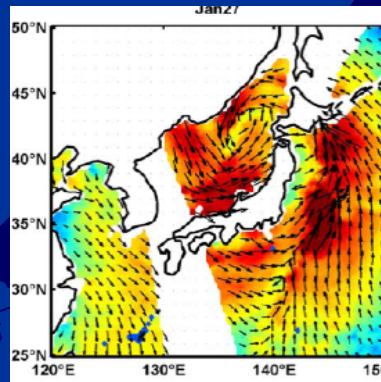
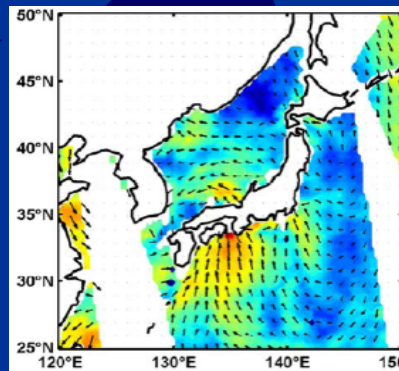
Jan 28

Jan 29

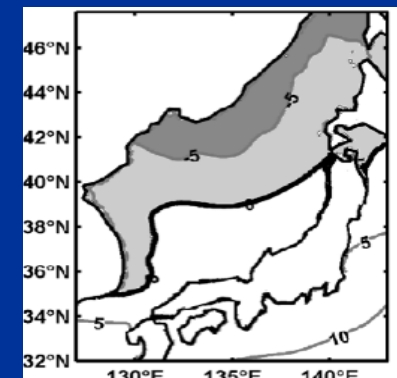
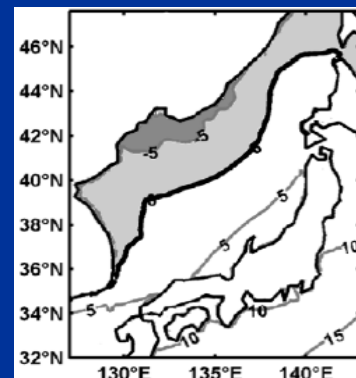
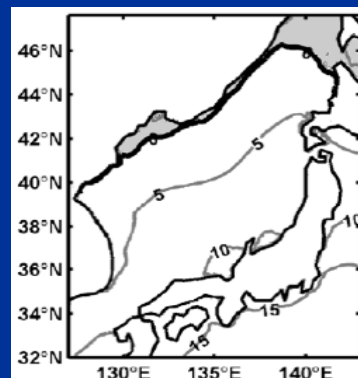
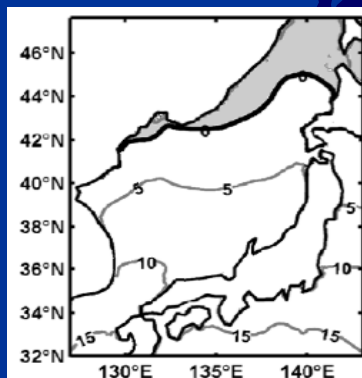
SLP



Wind



A.-
temp.



Cui & Senju (2008)

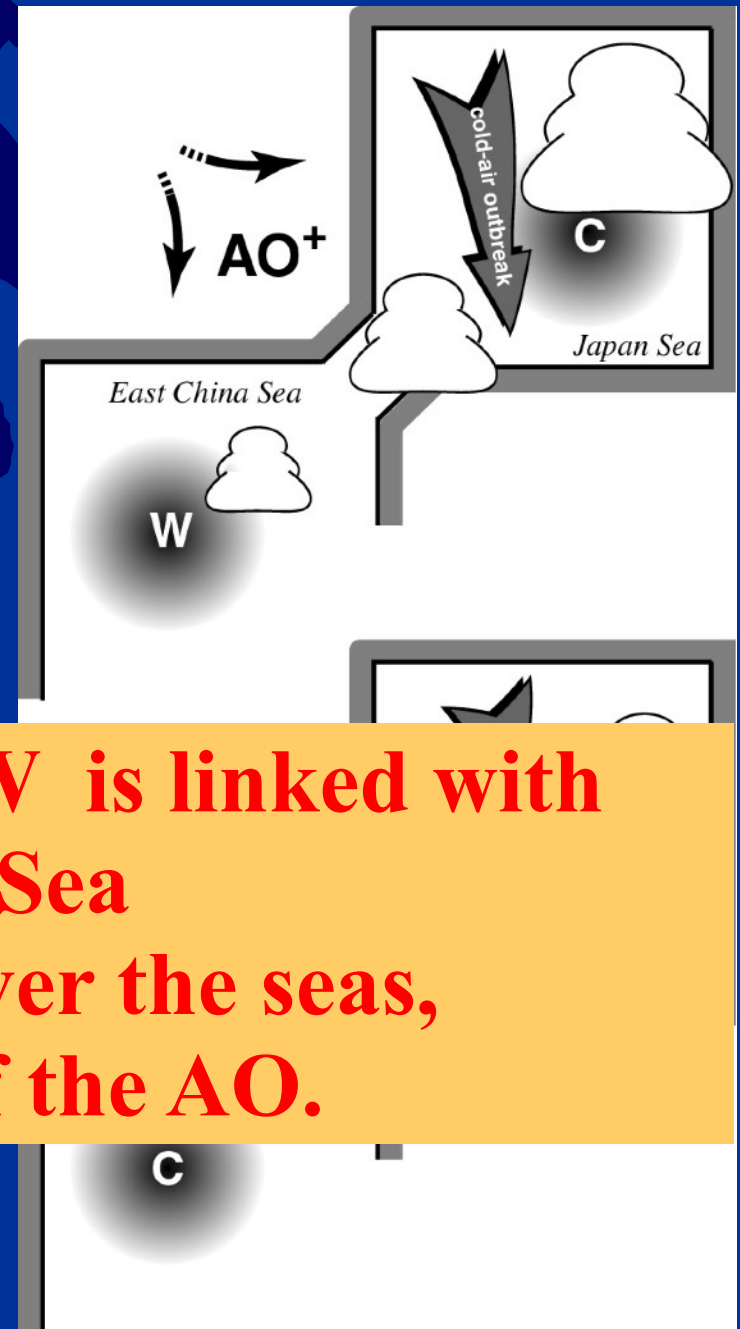
In the year of positive AOI,
the East Asian winter
monsoon is weak

The SST over the East China Sea is relatively warm, and atmospheric disturbances easily develop on the ECS.

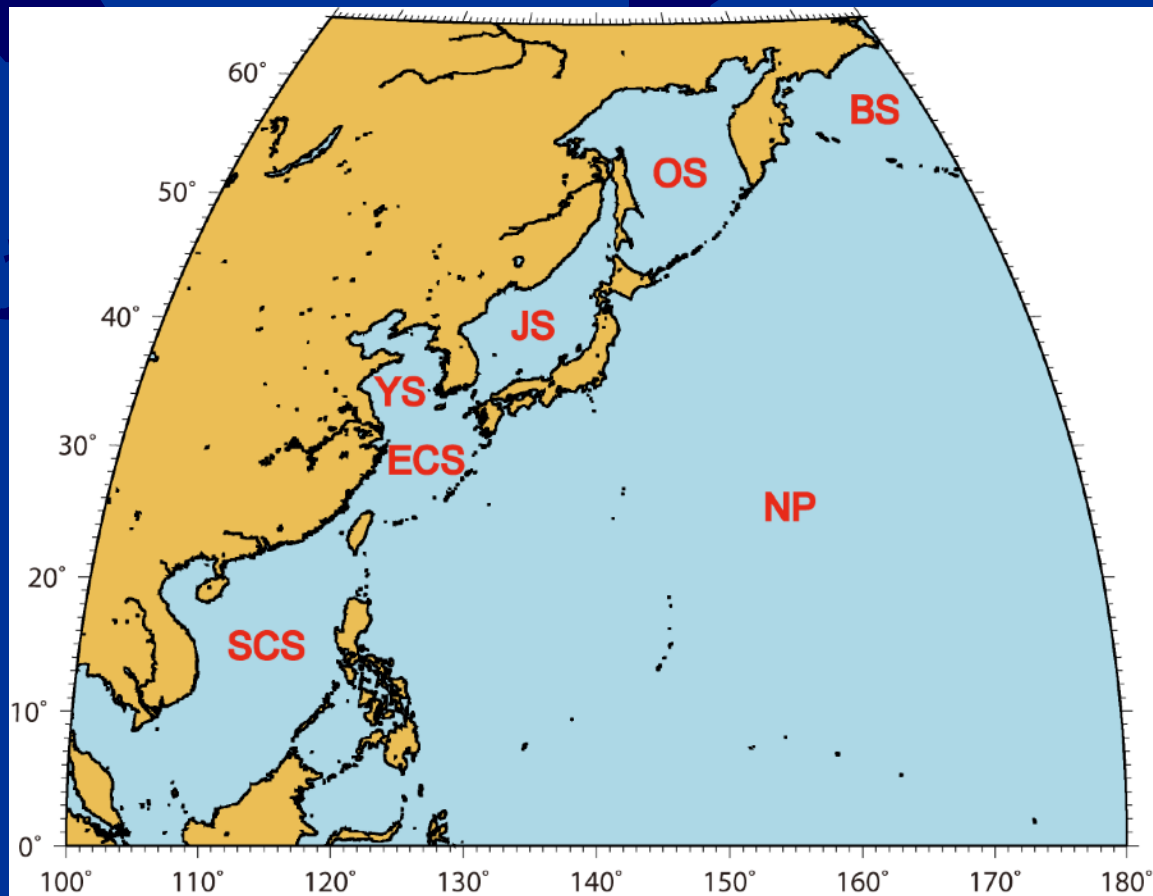
Since the atmospheric

The formation of the JSPW is linked with the SST in the East China Sea through the atmosphere over the seas, in the larger framework of the AO.

Isobe and Beardsley (2007)



The Pacific Asian Marginal Seas System





Thank you!