Seasonal Long-term Variation of Temperature in the Korean Waters

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Questions

SST increasing globally?

If SST increasing around Korean Waters, how about the water column?

How the temperature structure around Korean Waters changing in recent?

Therefore, Korean Waters is being changed as subtropical zone?

Data

- **Serial oceanographic investigations data by NFRDI**
  - **Period : 1970~2004 (35 years)**
  - **Items : temperature at standard depth**
  - **Frequency : bimonthly (2, 4, 6, 8, 10 and 12)**
  - **Stations : 164 stations**

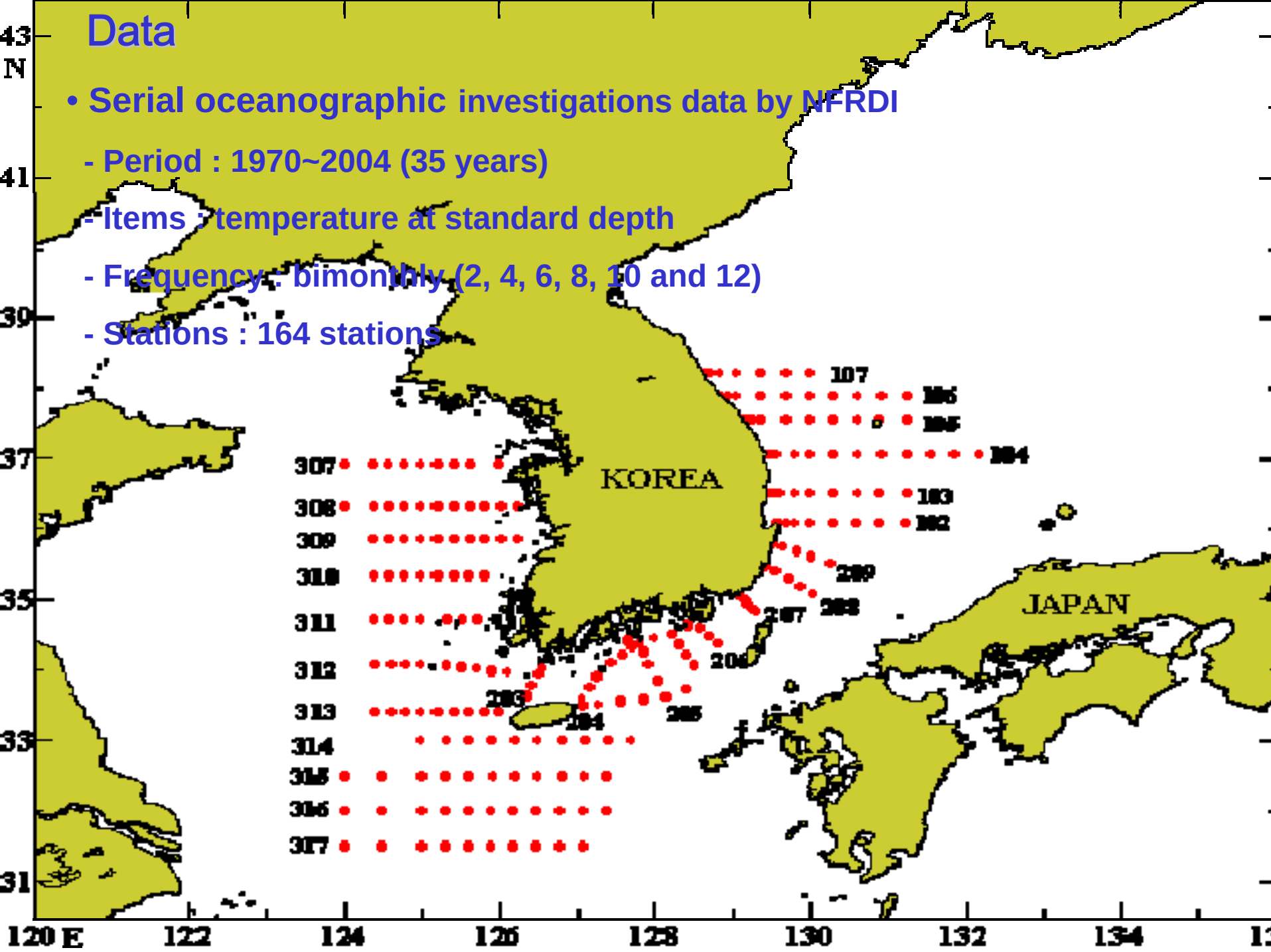


Fig. Schematic current systems around Korean Waters (Naganuma, 1973; Inoue, 1974).

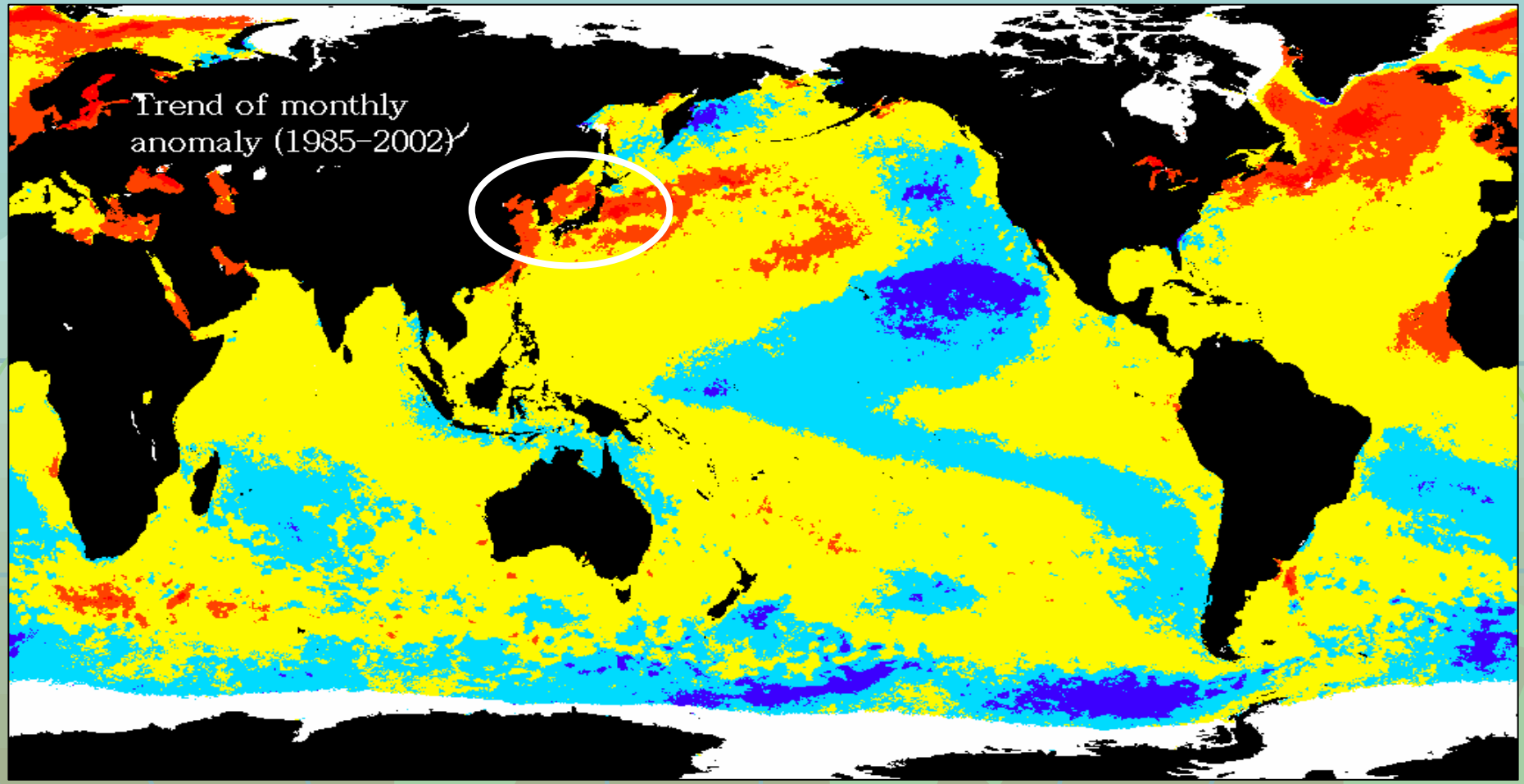
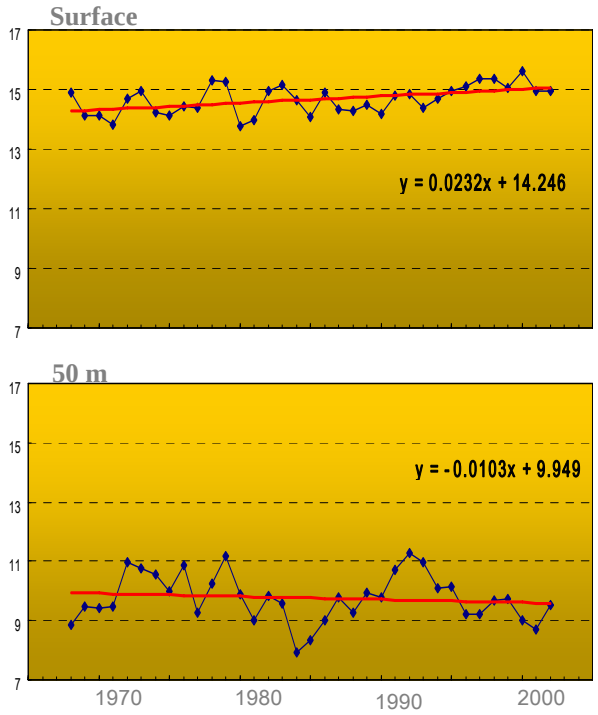


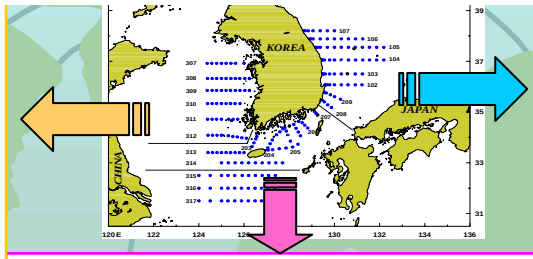
Fig. 18 years trend of monthly SST anomaly using AVHRR image during 1985-2002. (Red colored: over 0.1℃/year increase, Yellow: 0.05-0.1℃/year increase, Cyan: 0.05-0.1 ℃/year decrease, Blue: over 0.1℃/year decreasing area) (Kang, 2005).

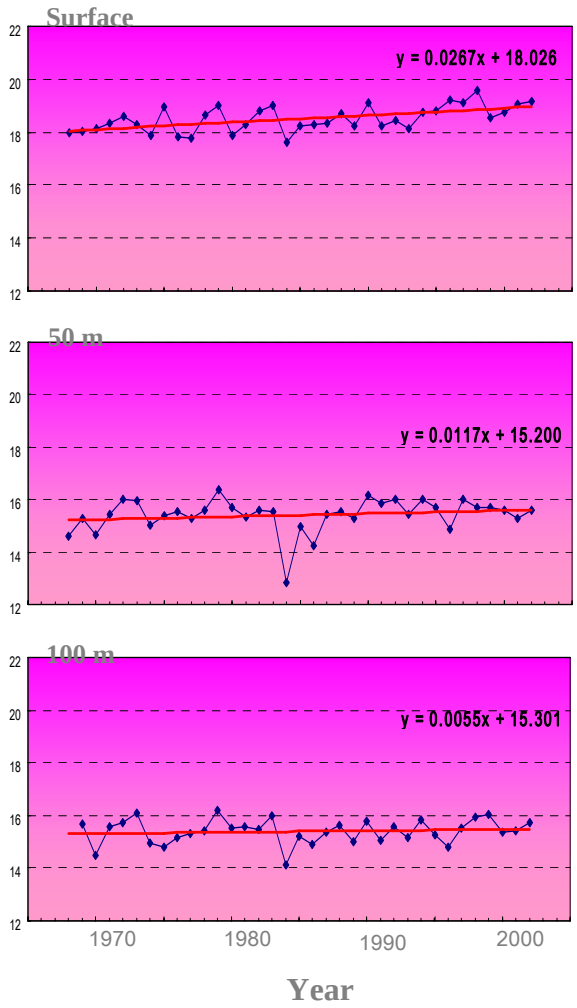
SST is not increasing globally!

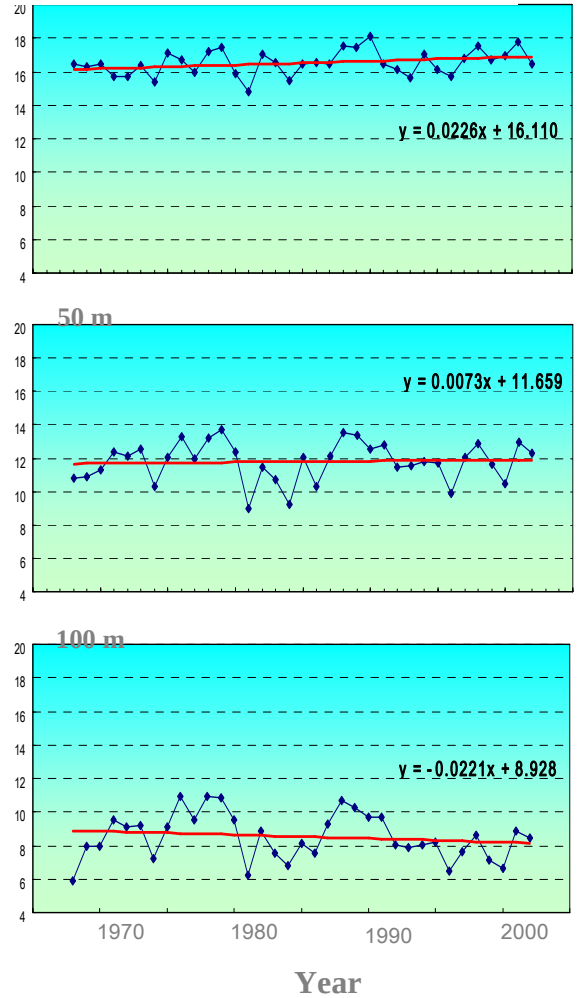
How about the water column around Korean Waters?

Long-term trends of annual mean temperature









West Sea

surface : 0.90℃ ↑ during 35yrs

50m layer : 0.49℃ ↓ during 35yrs

South Sea

surface : 0.93℃ ↑ during 35yrs

50m layer : 0.34℃ ↑ during 35yrs

100m layer : 0.37℃ ↑ during 35yrs

East Sea

surface : 0.91℃ ↑ during 35yrs

50m layer : 0.28℃ ↑ during 35yrs

100m layer : 0.84℃ ↓ during 35yrs

SST around Korean Waters increasing, but subsurface temperature has decreasing trend in Yellow Sea and East Sea.

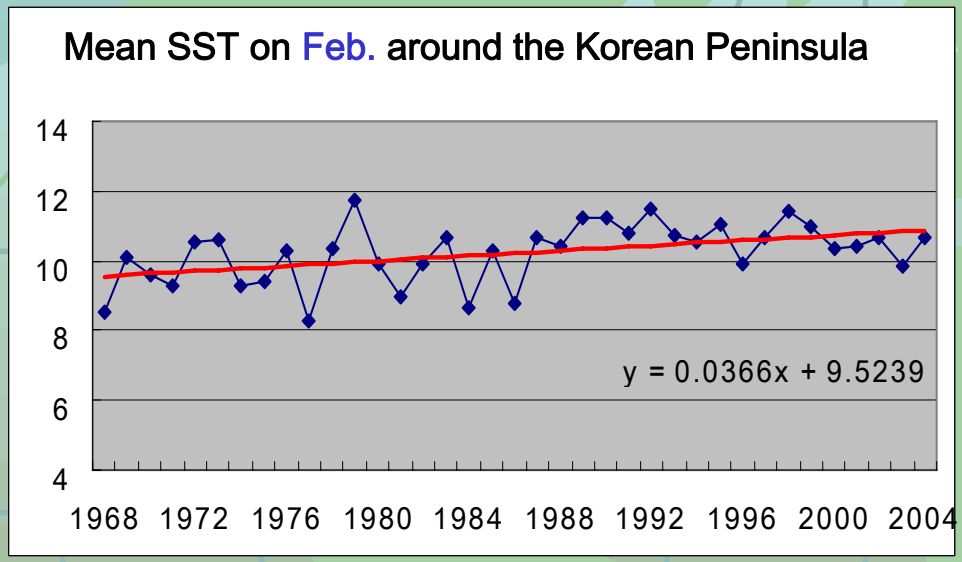
Then, how the temperature structure around Korean Waters changing in recent?

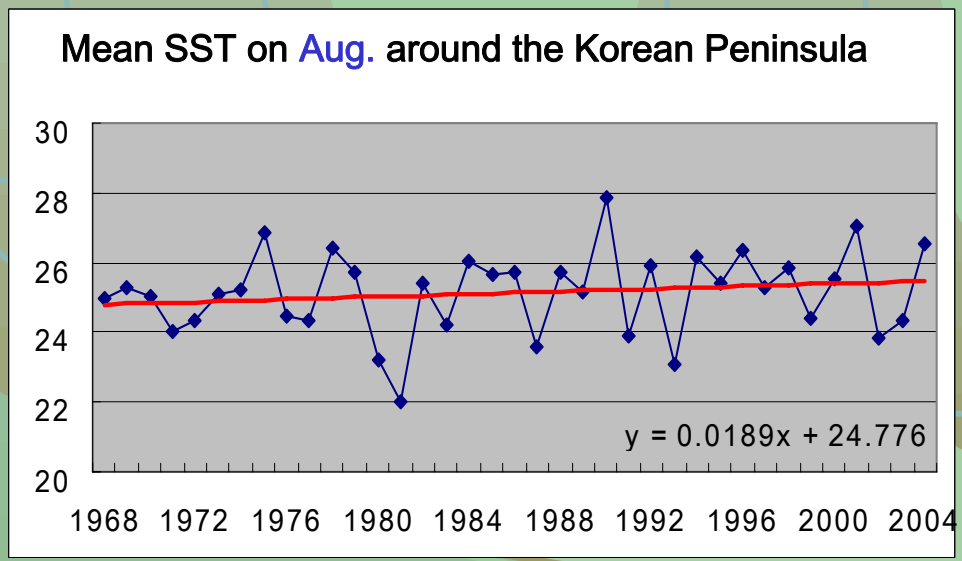
Examine the long-term trend for the annual amplitude change of SST and subsurface temperature by using harmonic analysis

$$T(t) = T_0 + A_1\cos(\omega_1 t - \varphi_1) + A_2\cos(\omega_2 t - \varphi_2)$$

And the Variation of thermocline by compute maximum temperature gradients, then examine the linear regression of it

Long-term trends of SST on Feb. and Aug.



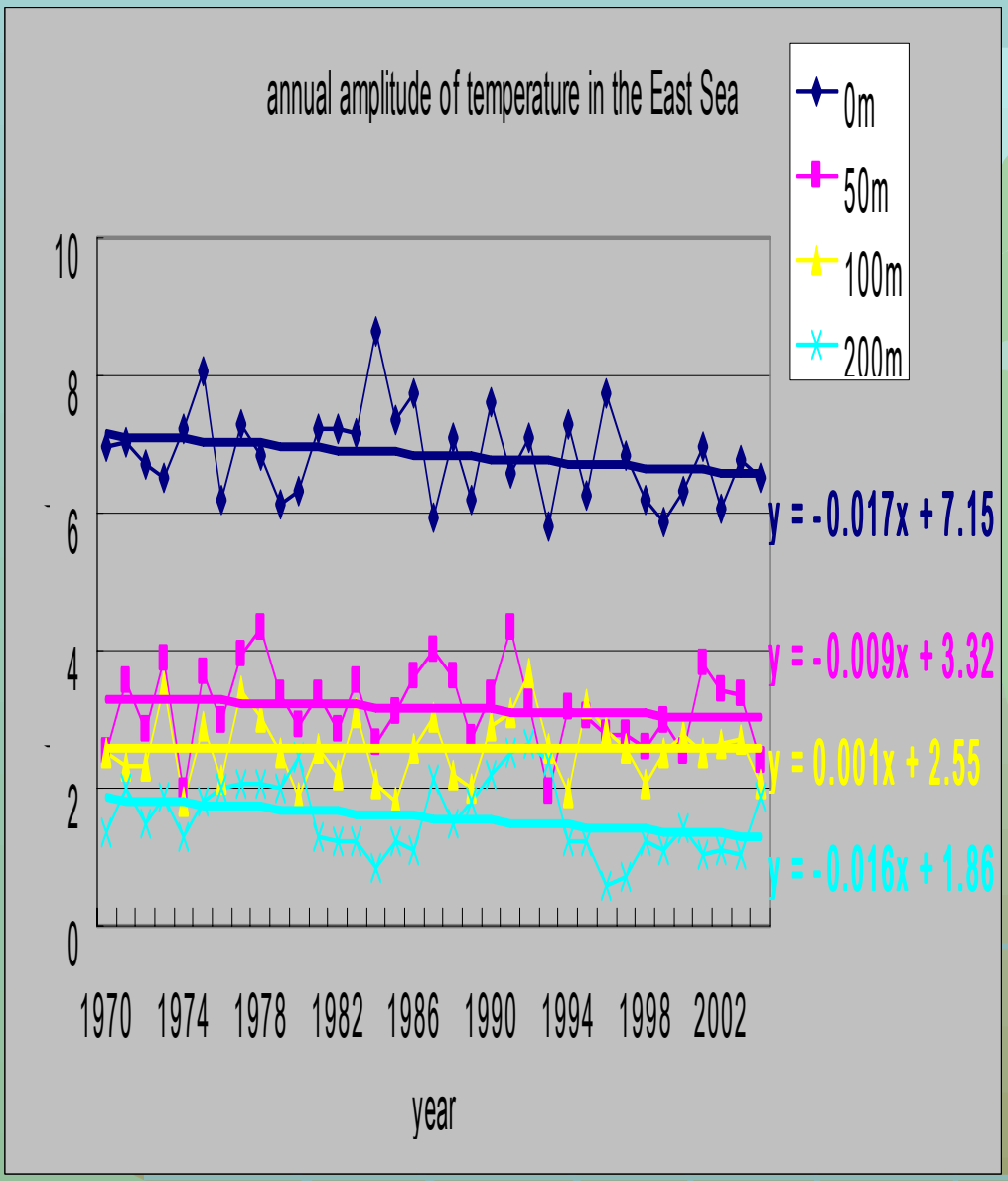


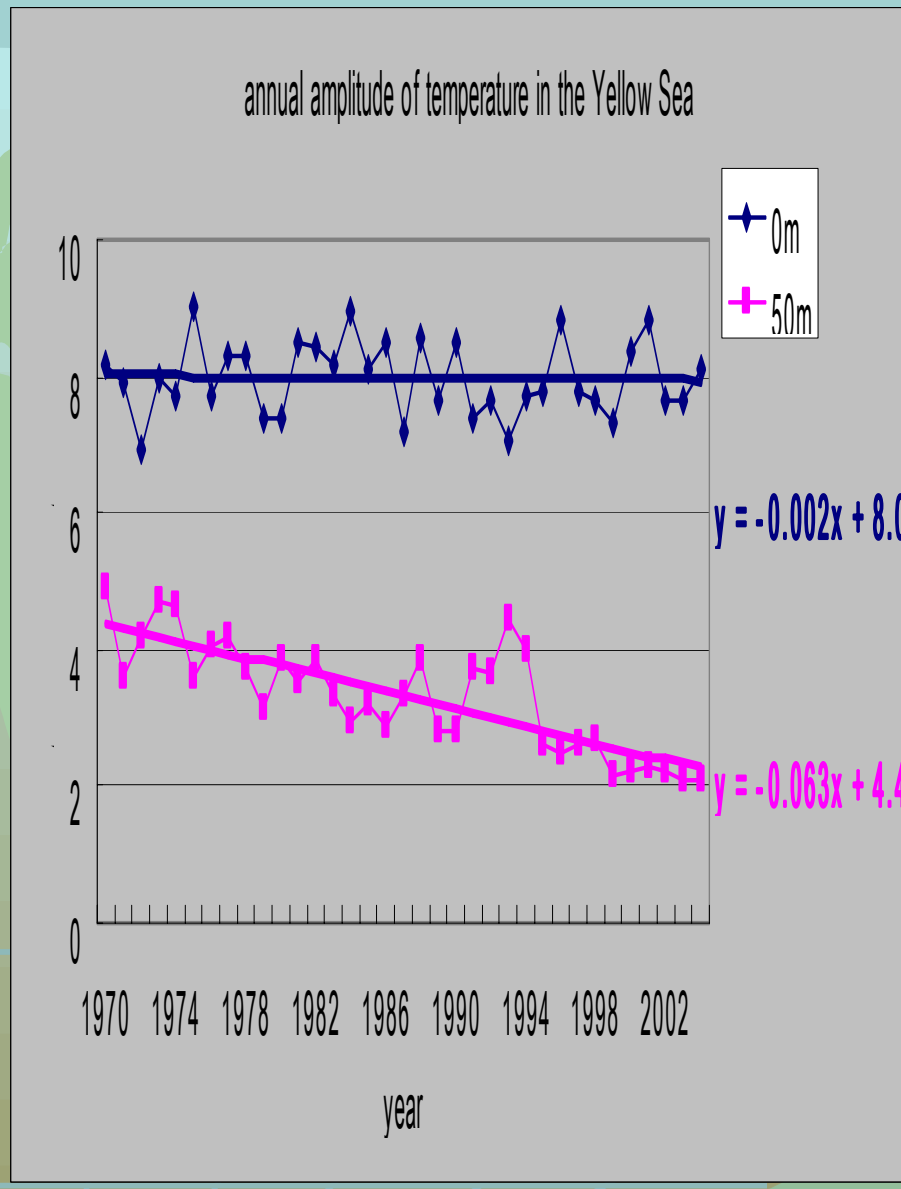
SST around the Korean Peninsula

- Feb. : Increase about 1.35℃ during last 35 years

- Aug. : Increase about 0.70℃ during last 35 years

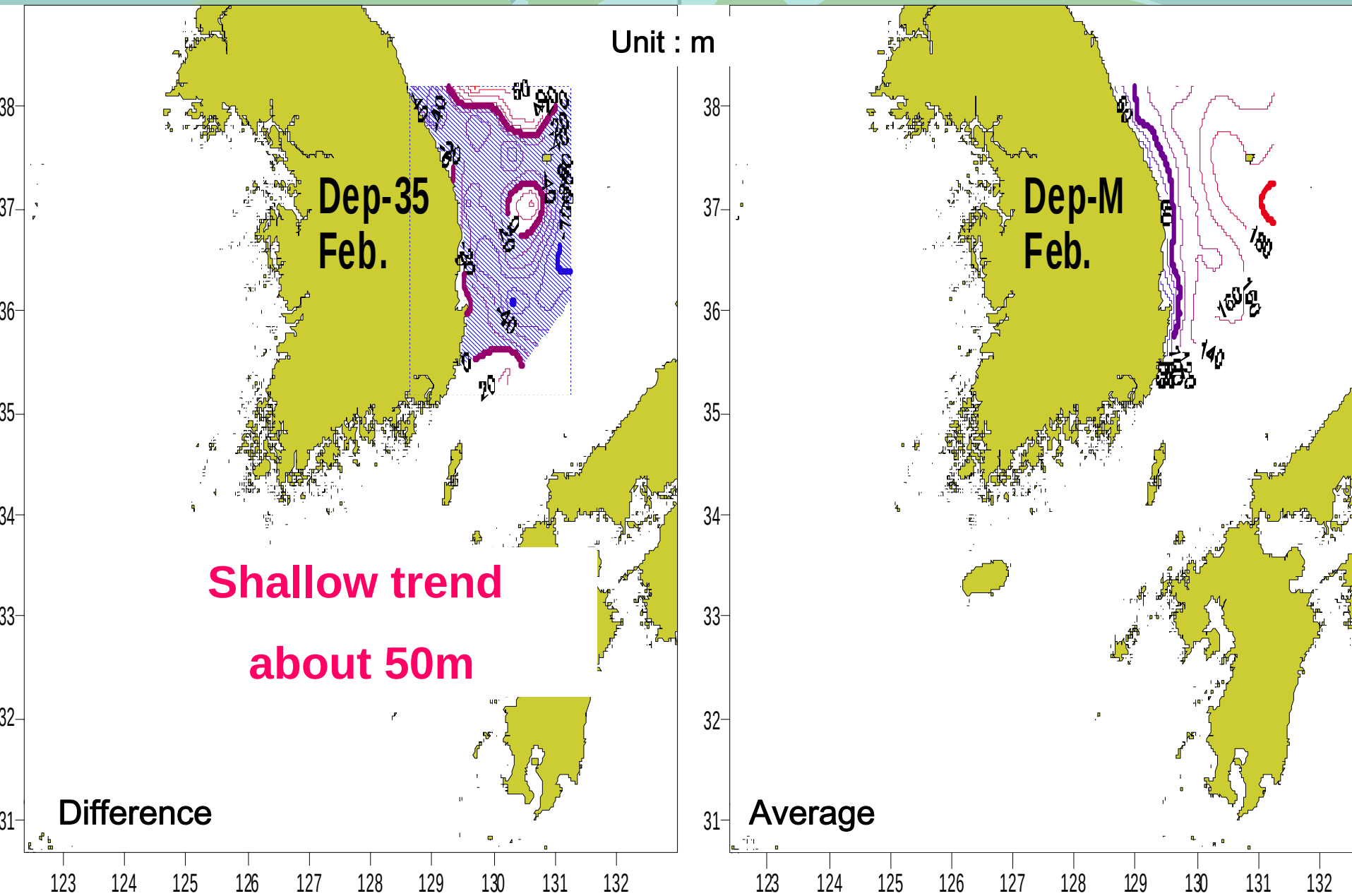
Annual amplitude of SST should be decreased by the stronger SST increase trend in winter than in summer



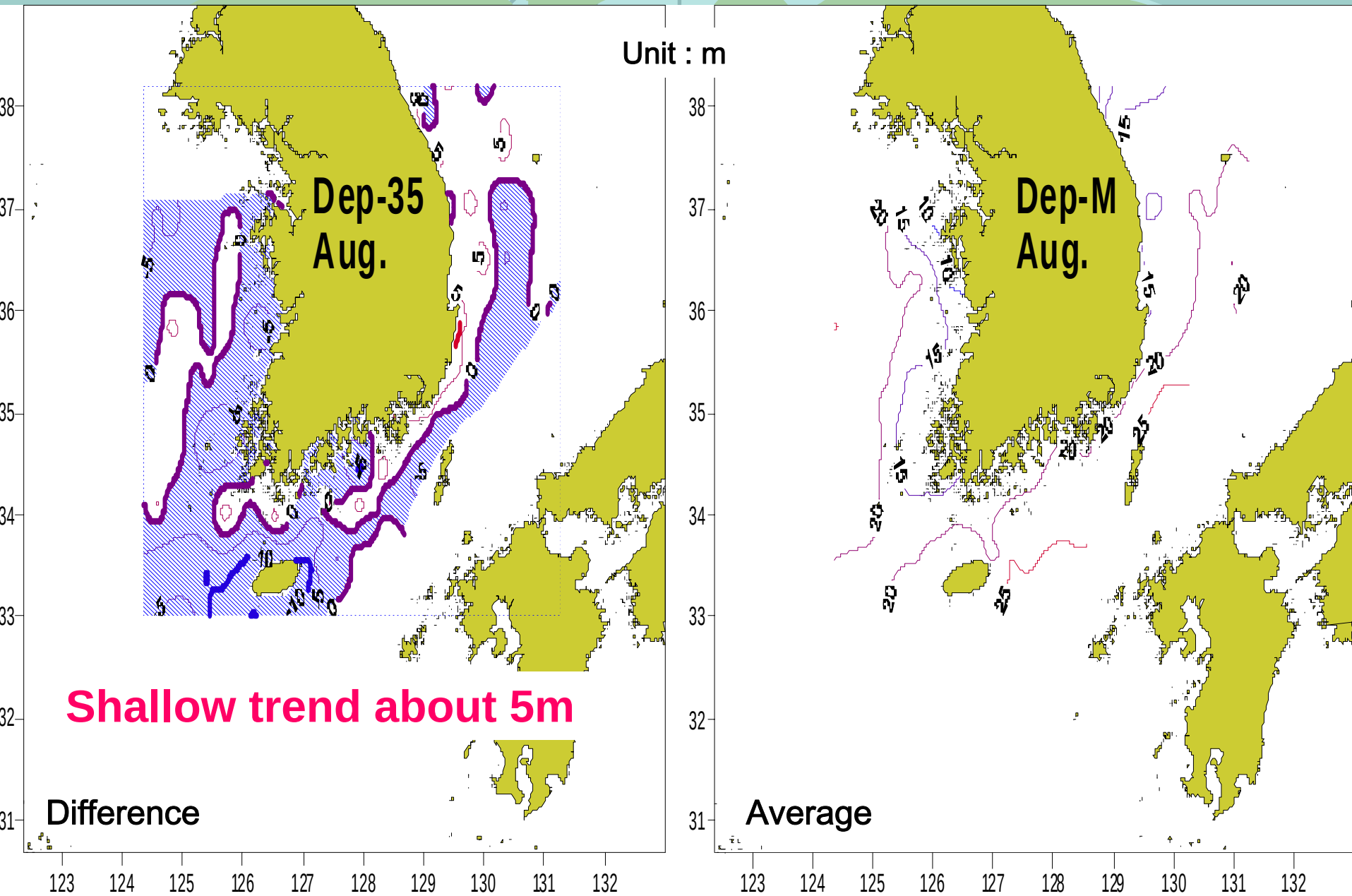


Annual amplitude of temperature is decreasing trend

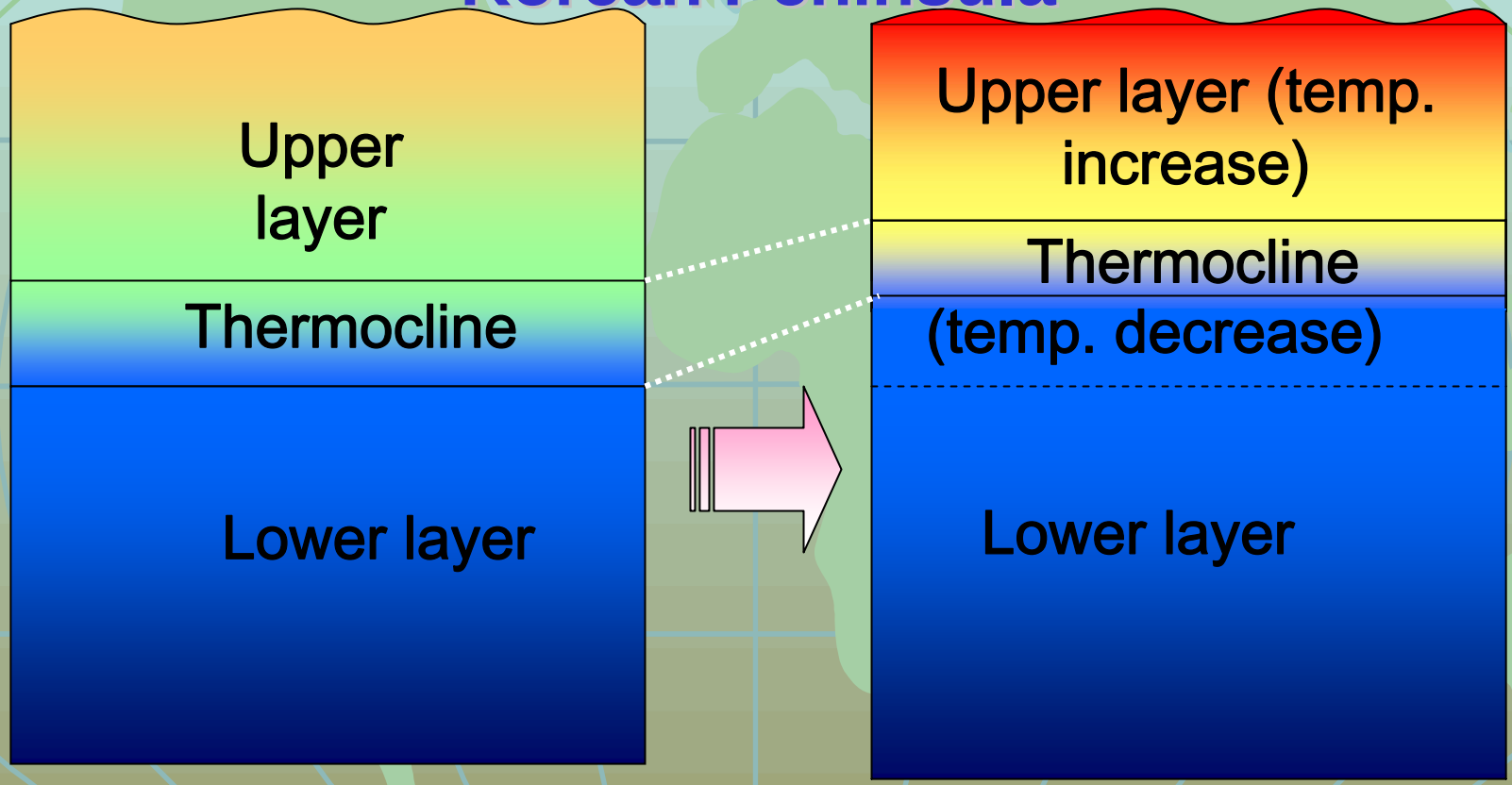
Variation of Permanent Thermocline Depth



Variation of Seasonal Thermocline Depth



An Assumable Schematic Diagram of Vertical Temp. Structure Variation around Korean Peninsula



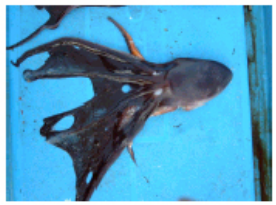
According to increasing SST, thermocline depth become shallower, the thickness become thinner

Therefore, Korean Waters is being changed as subtropical zone?

Subtropical species were frequently caught around Korean Waters in recent

동해 주요 아열대성 어종 사진

초대형 노랑가오리류



보라문어

대형해파리

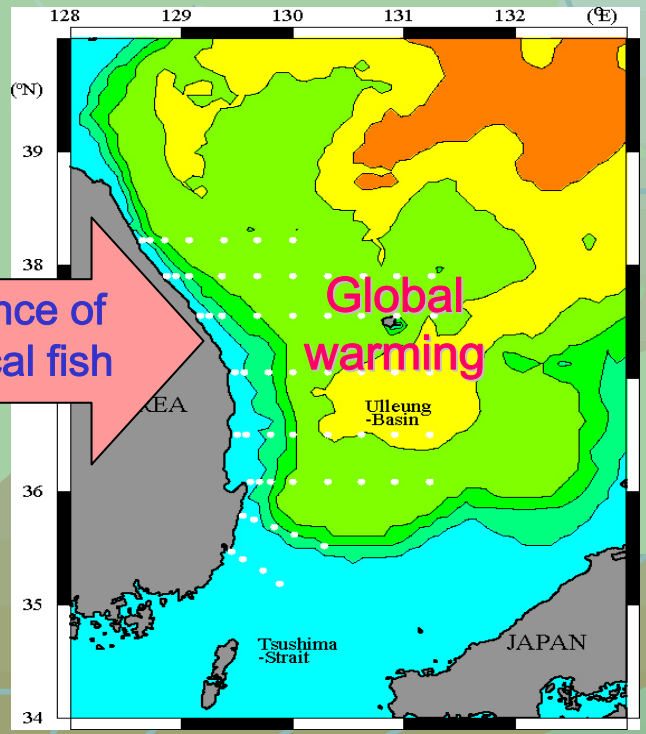
붉은바다거북

흑새치

은행게

백미돔

Appearance of subtropical fish



Conclusions

SST is increasing trend, but subsurface temperature decreasing around Korean Waters → It should be changed the long-term vertical temperature structure in the Korean Waters.

Amplitude for the annual variation of temperature decreases.

Permanent thermocline depth in the East Sea become shallower and the thickness become thinner.

It is possible that Korean Waters is being changed as subtropical zone.