Long-term Variation of Temperature in the Ulleung Basin of the East/Japan Sea

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SEES/Seoul National University

W4: Recent advances in monitoring and understanding of Asian marginal seas:
5-years of CREAMS/PICES EAST-I Program
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North Pacific Ecosystem Status Report – Japan/East Sea

NPESR - JES (I. Climate and Physical Ocean),

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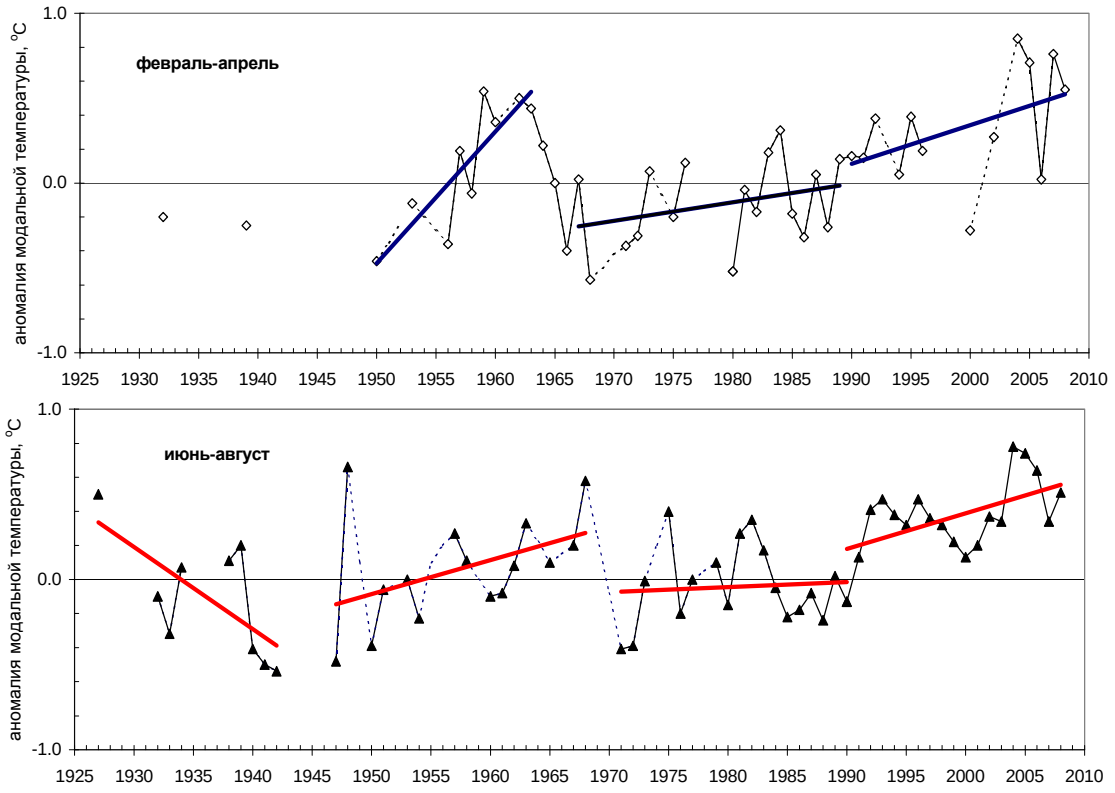
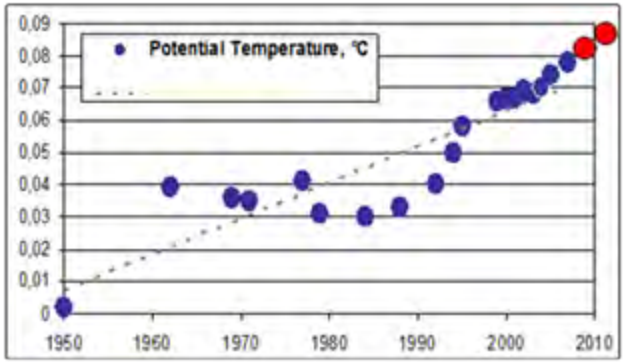
Sections	Subsections	Contributors	Periods of synthesis
I.1. Atmosphere and Surface Fluxes	I.1.1. Atmosphere I.1.1.1. Long term variability of winter processes I.1.1.2. Long term variability of spring-summer processes I.1.2. Surface wind I.1.3. Surface heat flux I.1.4. River discharge	Svetlana Glebova Olga Trusenkova Kyung-Il Chang	1974~2011 1999~2009 2000~2010 General (seasonal)
I.2. Sea Level		Olga Trusenkova	1992~2009
I.3. Surface Mixed Layer		Chan Joo Jang	1931~2005 (seasonal)
I.4. Temperature and salinity	I.4.1. Water masses I.4.2. Sea surface temperature I.4.3. Regional characteristics I.4.3.1. Japan Basin (Slava) I.4.3.2. Yamato Basin I.4.3.2. Ulleung Basin	Yury Zuenko, Vyacheslav Lobanov Sang-Wook Yeh, Kyung-Il Chang, Tomoharu Senjyu	General 1891~2009 1925~2009 1970~2004 1976~2010
I.5. Circulation and Currents	I.5.1. Upper circulation I.5.2. Deep currents	Kyung-Il Chang	2000~2010 1996~2009
I.6. Hydrography and Fluxes in the Straits	I.6.1. Hydrography in the Tsushima Strait I.6.2. Korea Strait Bottom Cold Water I.6.3. Fluxes through the Straits I.6.3.1. Volume transports through the straits I.6.3.2. Volume transports in the Tsushima/Korea straits I.6.3.3. Freshwater, temperature, and salinity transports	Tomoharu Senjyu, Kyung-Il Chang, Olga Trusenkova, Ken-ichi Fukudome	1971~2000 1962~2008 General 1976~2006 General (seasonal)
I.7. Mesoscale Eddies	I.7.1. Eddy kinetic energy I.7.2. Japan Basin I.7.3. Ulleung Basin	Young-Tae Son, Vyacheslav Lobanov, Kyung-Il Chang	1993~2007 General 1992~2007
I.8. Coastal Upwelling and Cross Shelf Exchanges	I.8.1. Primorye coast I.8.2. Southeastern coast of Korea I.8.2.1. Upwelling along the coasts of Ulgi and Gampo I.8.2.2. Upwelling favorable wind at Busan I.8.2.3. Coastal upwelling indices at Ulgi-Gampo and Uljin coasts	Yury Zuenko, Chang-Woong Shin	General 1967~2006
I.9. Sea Ice		Elena Ustinova	1960~2011

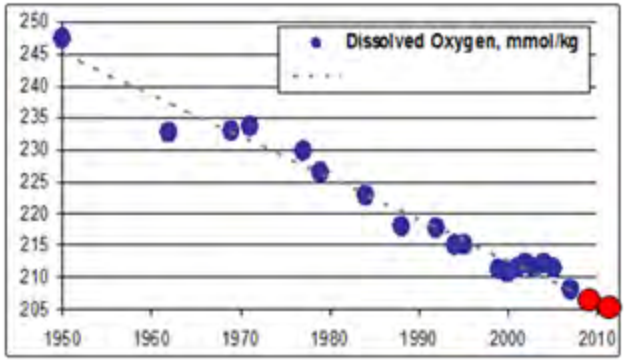
Temperature & DO changes in the Japan Basin



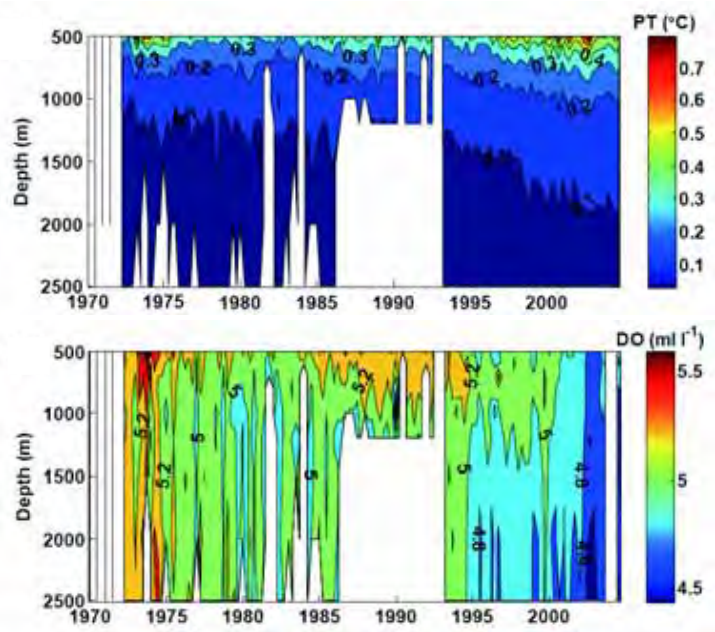
Temperature anomalies for the layer from seasonal thermocline to 200 m at the standard section 41°30′—43°00′ N 132°00’ E averaged for February-April and June-September. (Yury Zuenko)

Long-term trends of potential temperature and dissolved oxygen contents of bottom water in the Japan Basin (Vyacheslav Lobanov)

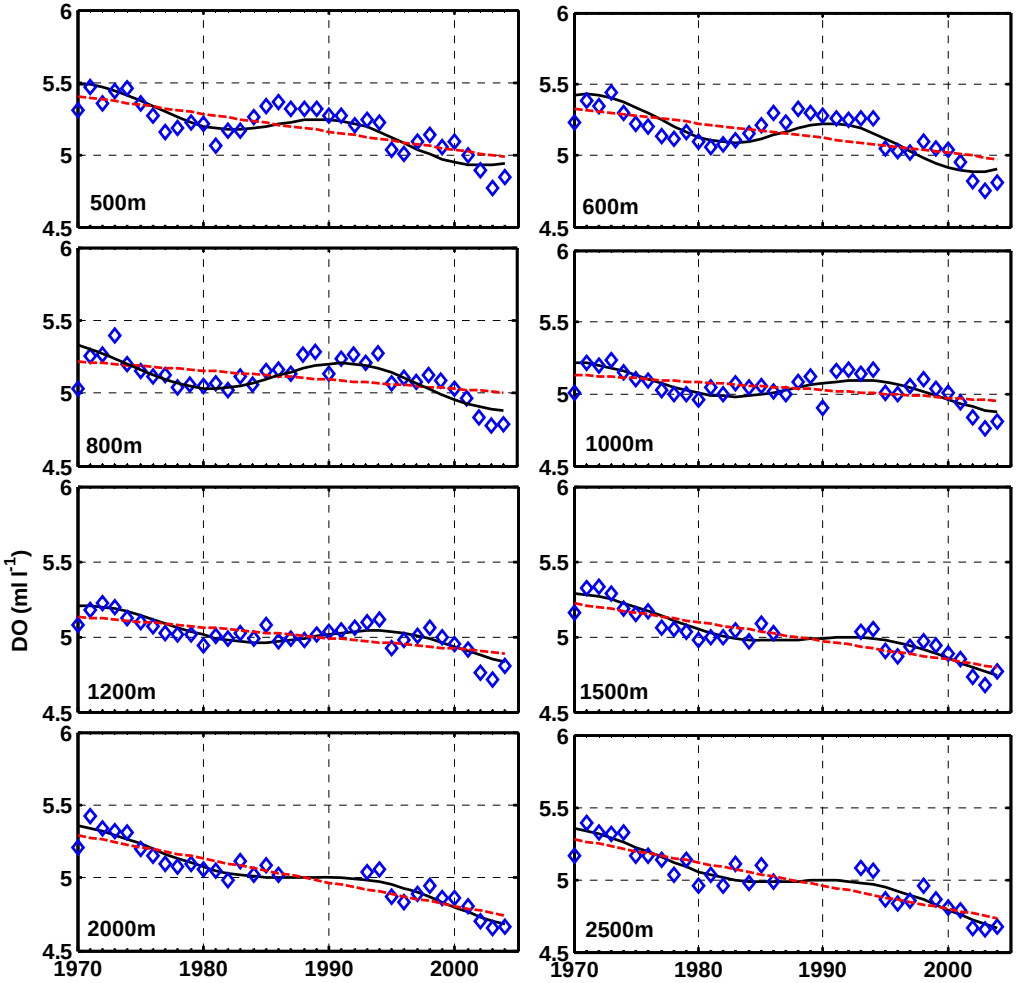




Temperature & DO changes in the Yamato Basin

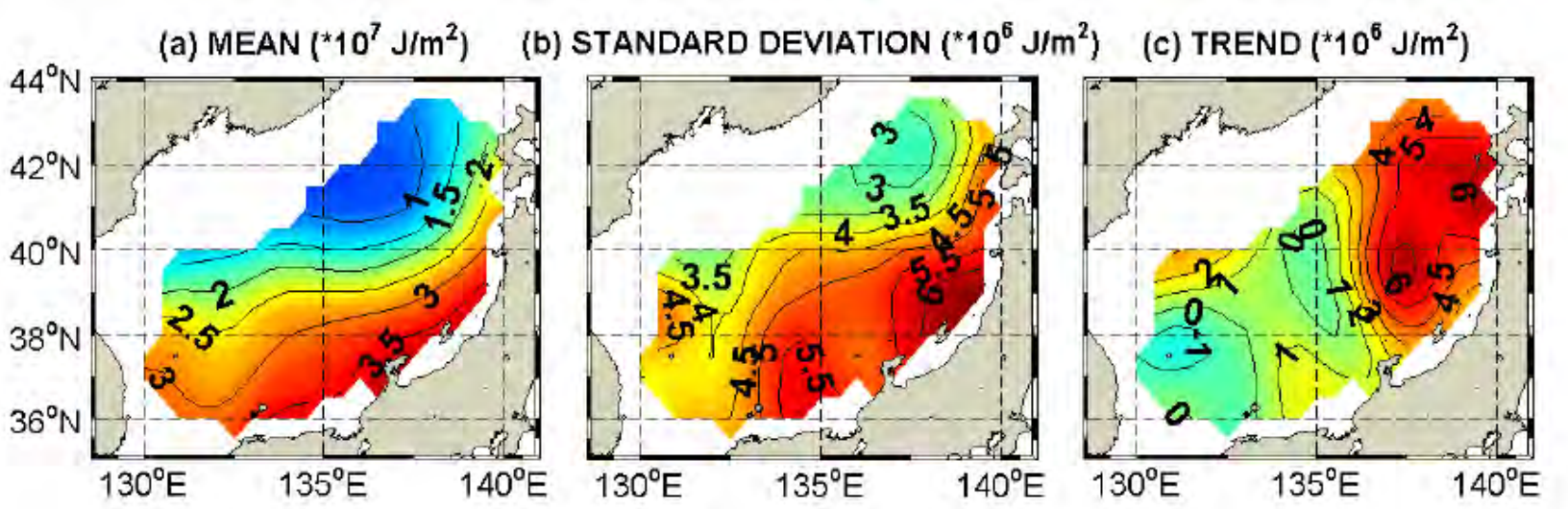


Time series of the vertical profiles in potential temperature and dissolved oxygen below the depth of 500 m measured in the Yamato Basin (Tomoharu Senjyu).



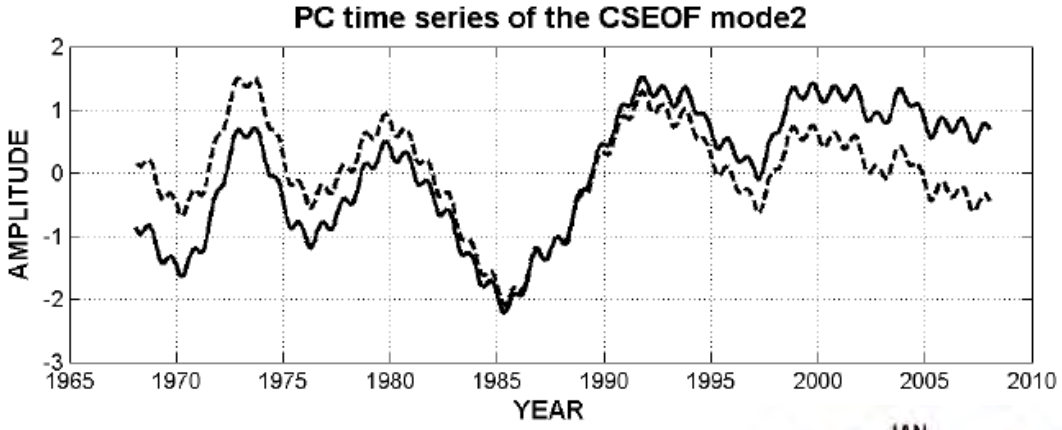
Upper Ocean Heat Contents 1968-2007

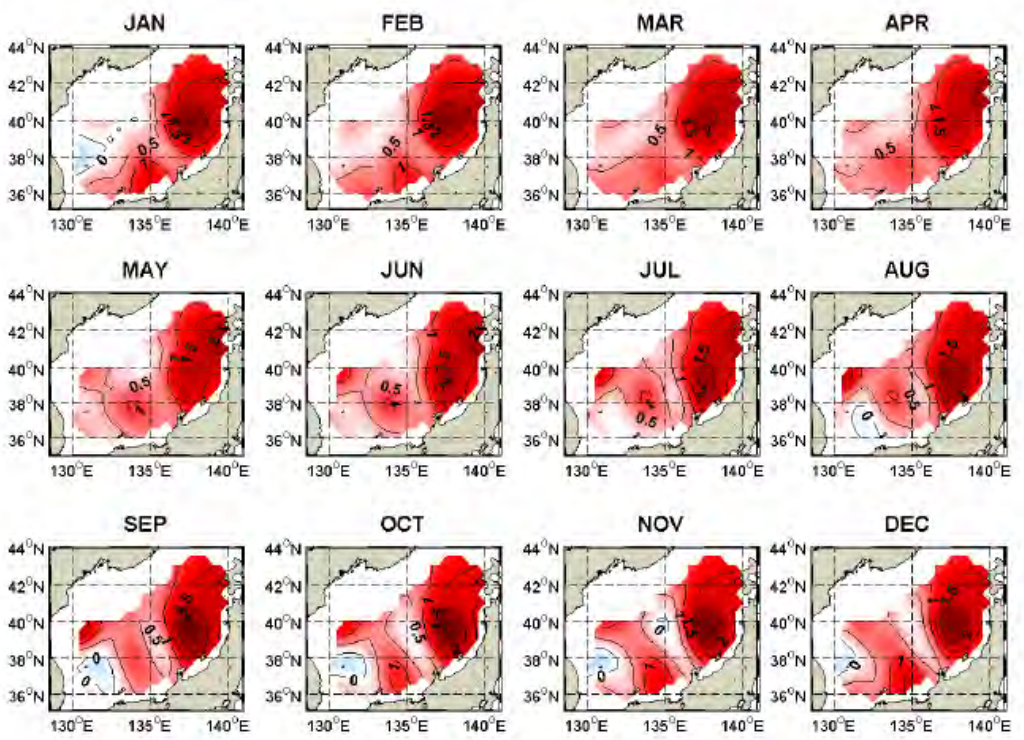
$$Q = \int_{-300}^{0} \rho(T,S,0) c_p(T,S,0) T(z) dz$$



(Na et al., 2011)

2nd CSEOF Mode –Decadal mode with linear trend





(Na et al., 2011)

Hydrography & Circulation of the Ulleung Basin

Mitchell et al. (2005)

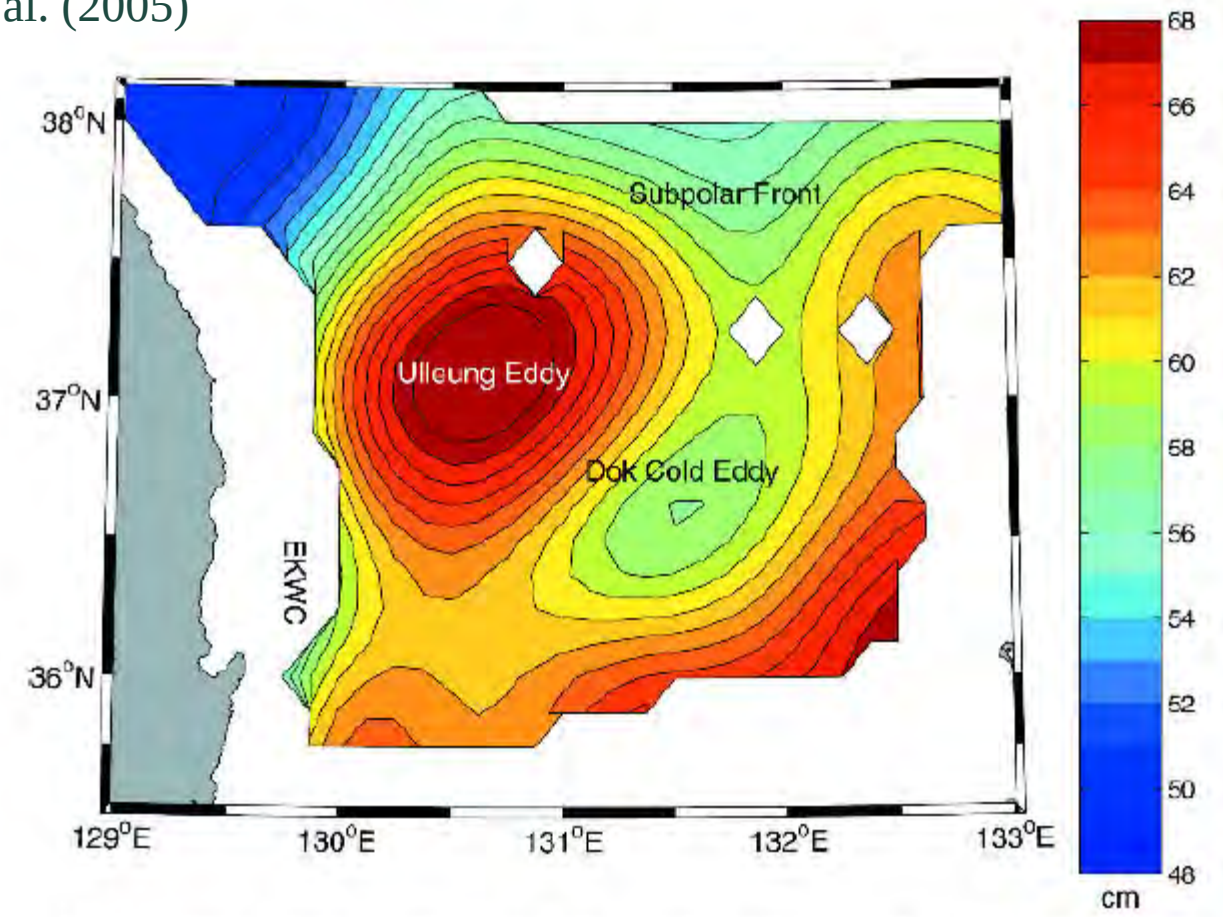
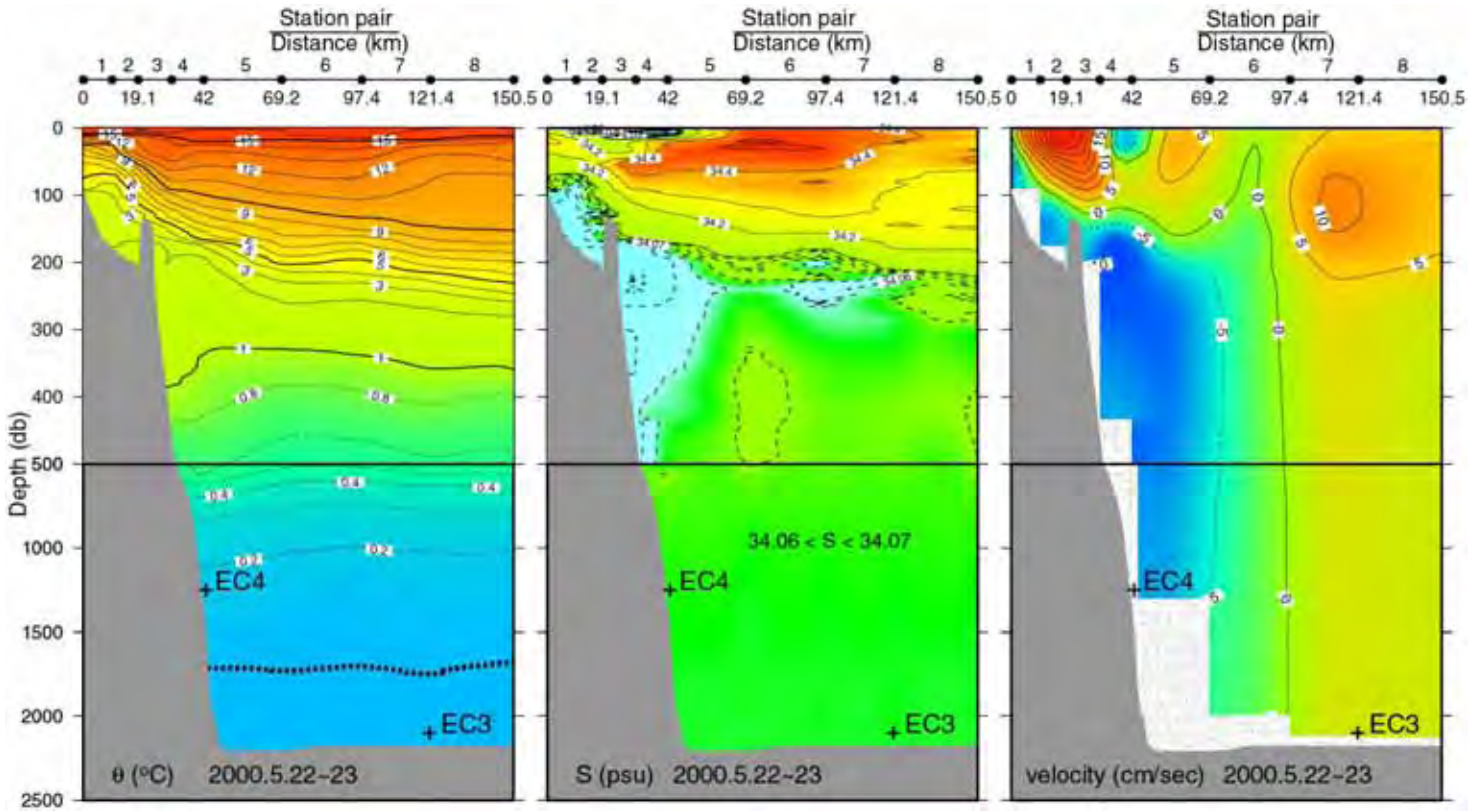


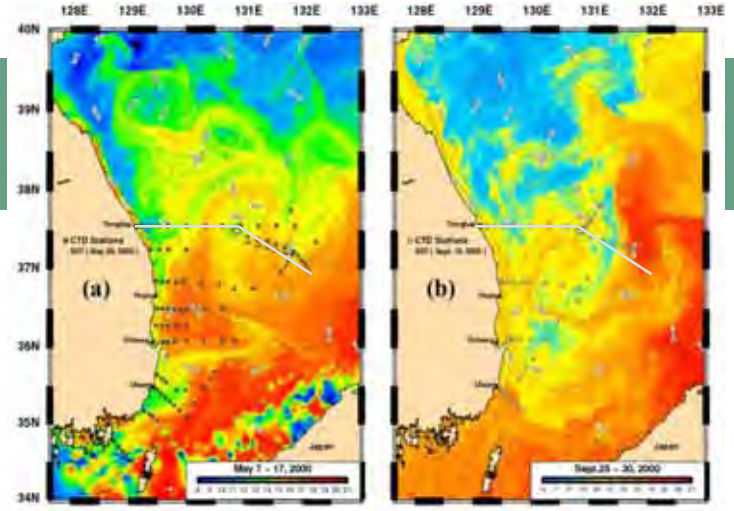
FIG. 2. Average dynamic height (geopotential height anomaly at surface relative to 500 dbar divided by the acceleration of gravity; cm) over the 2-yr deployment in the Ulleung Basin. The mean positions of the EKWC, Ulleung Eddy, Subpolar Front, and the Dok "Cold Eddy" are labeled. The white diamonds, from left to right, are Ulleung Island, Dok Island, and a seamount that reaches within 500 m of the surface.

Hydrography & Circulation of the Ulleung Basin

Chang et al. (2002)

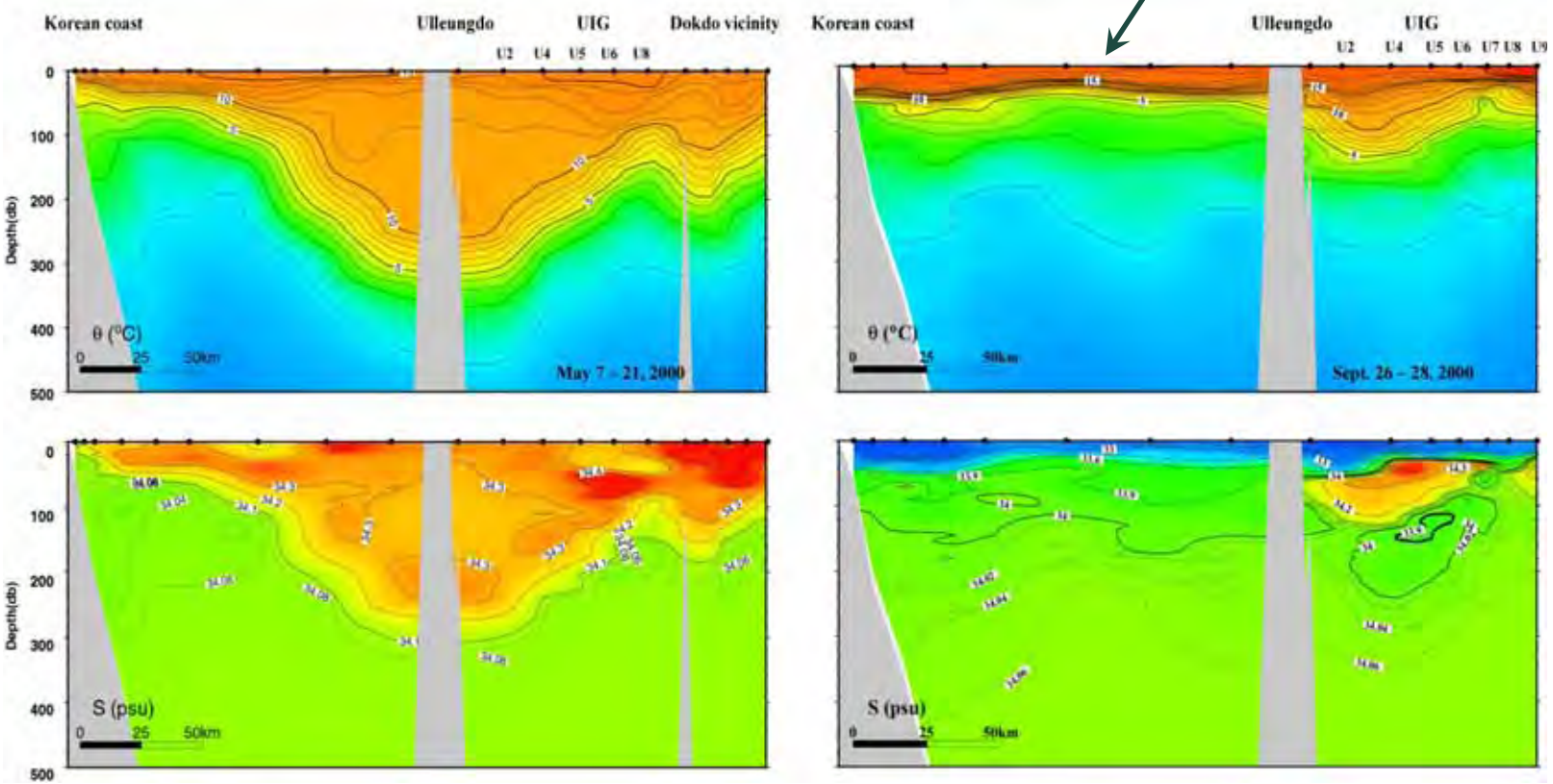


EKWC: 1.4 Sv
NKCC: 0.8 Sv

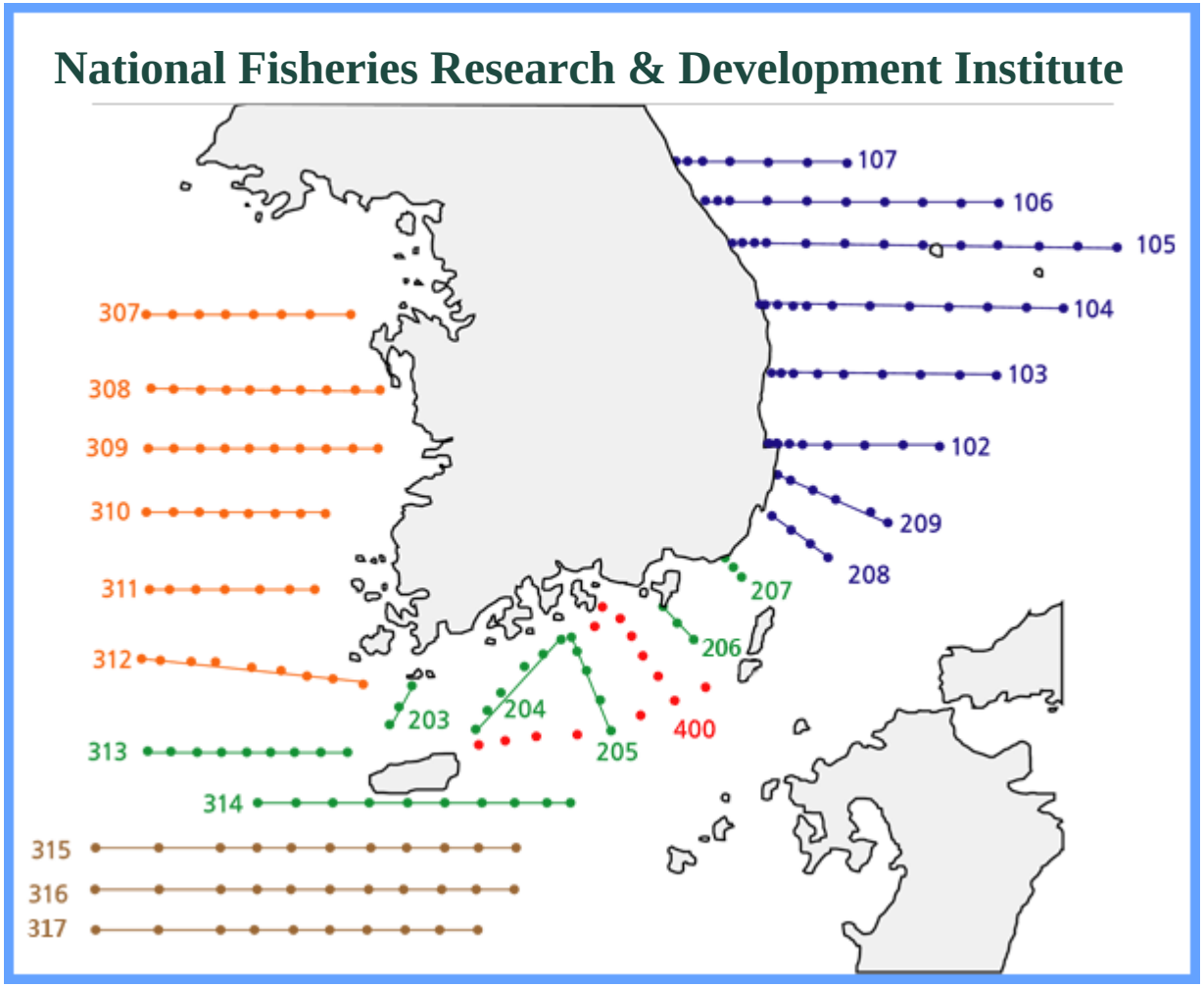


EKWC & UWE

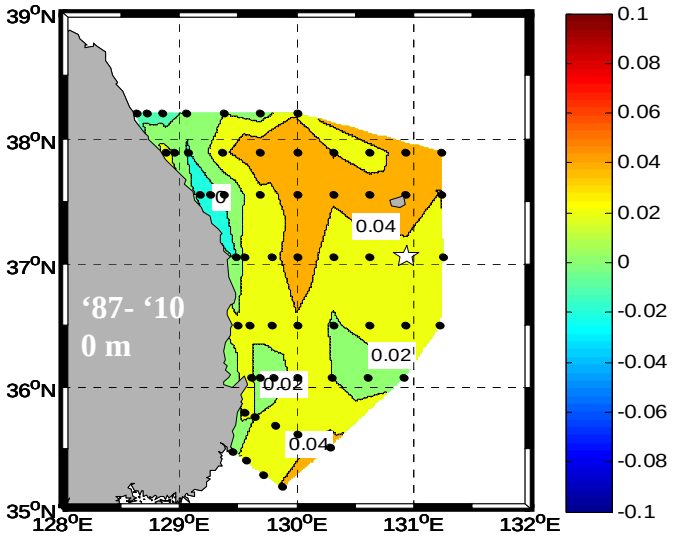
Neither EKWC nor UWE

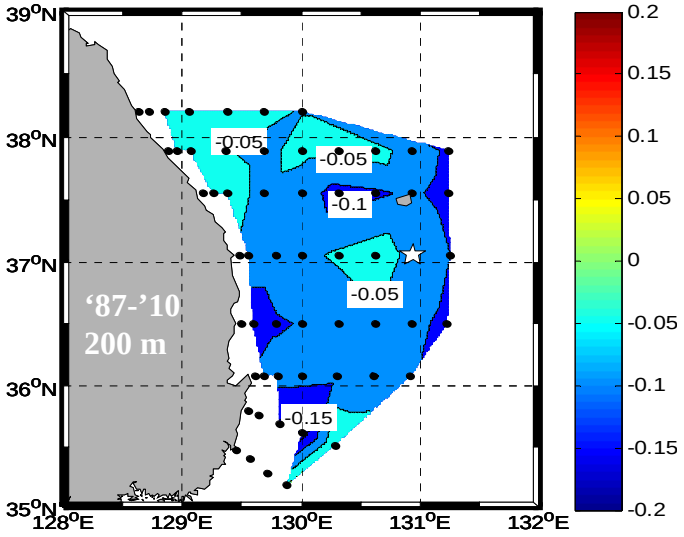


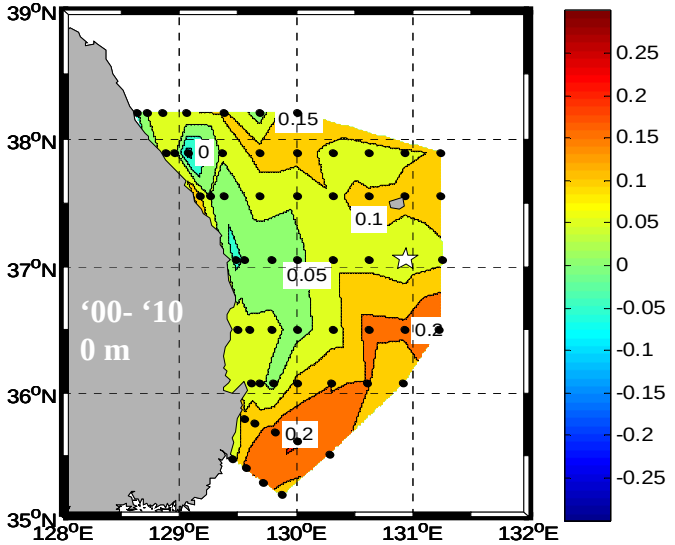
Regular bimonthly hydrographic stations since 1961

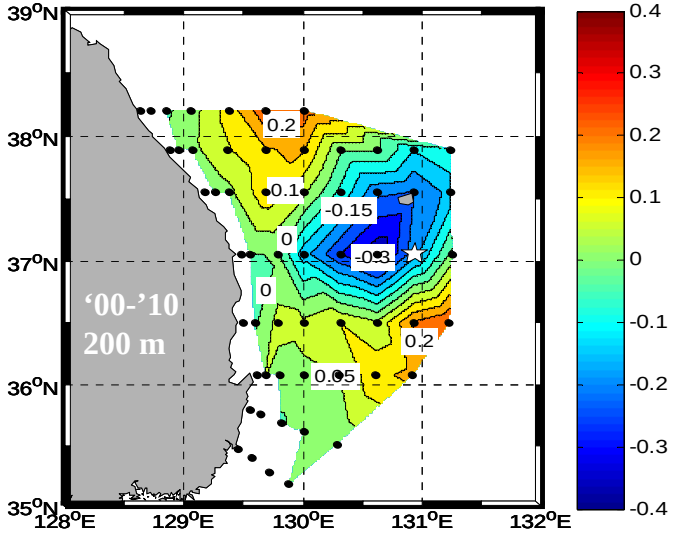


Temperature trends

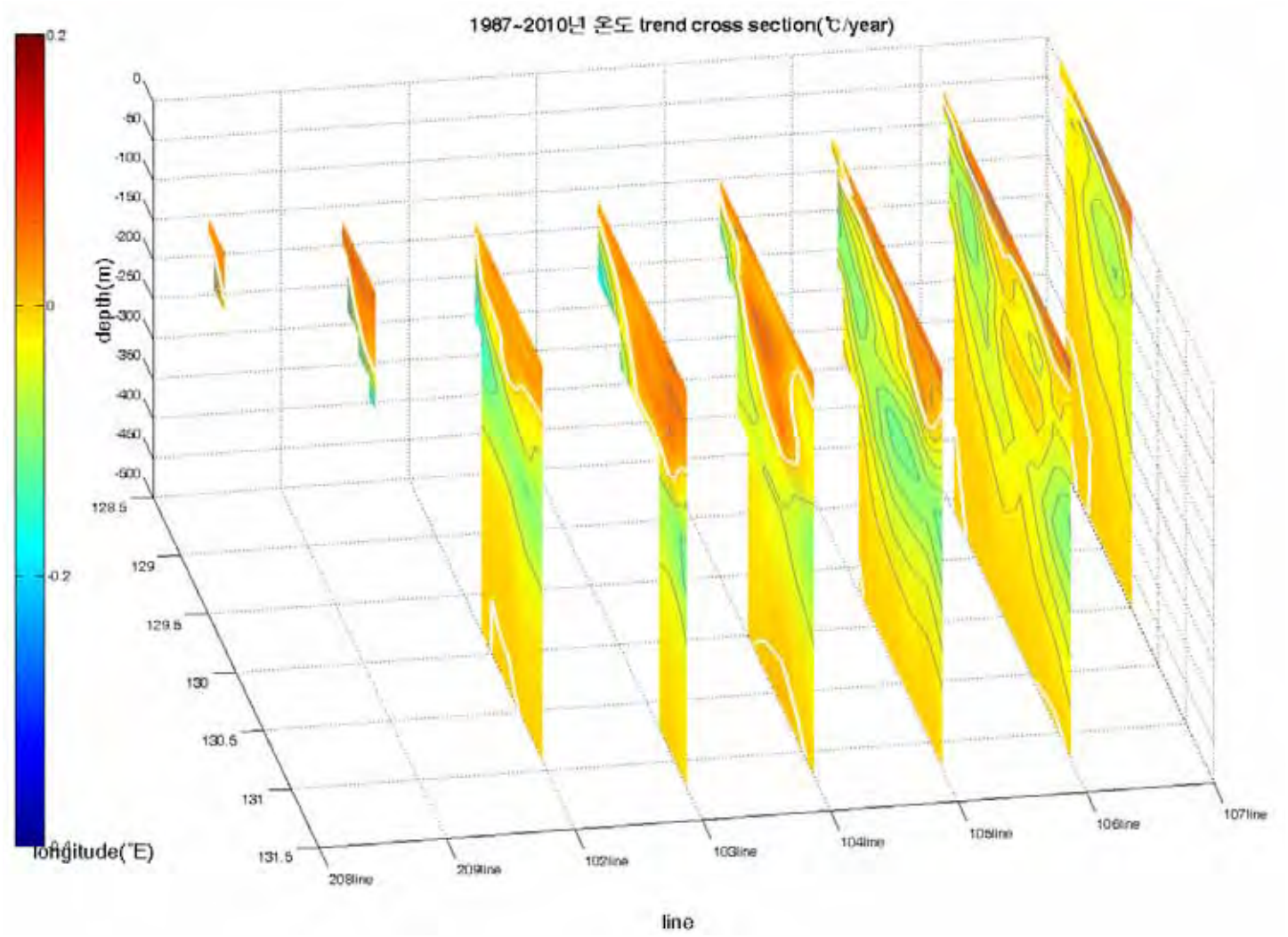




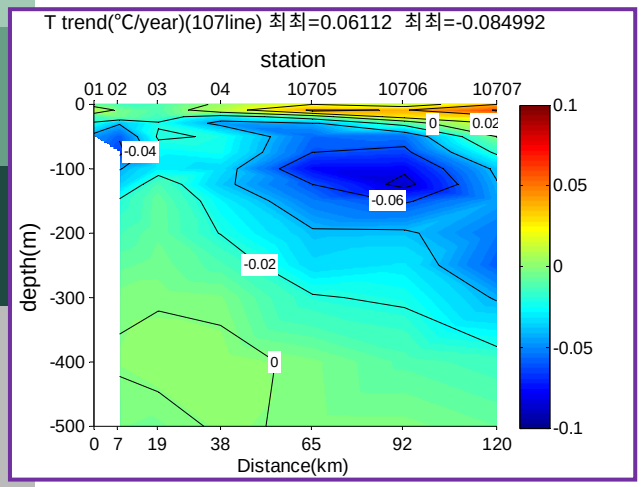


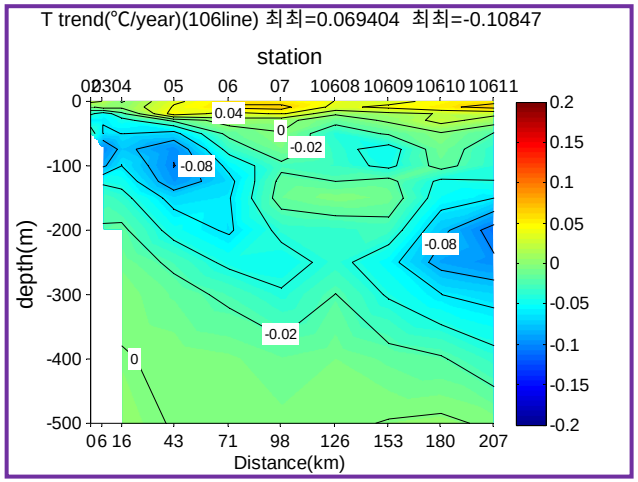


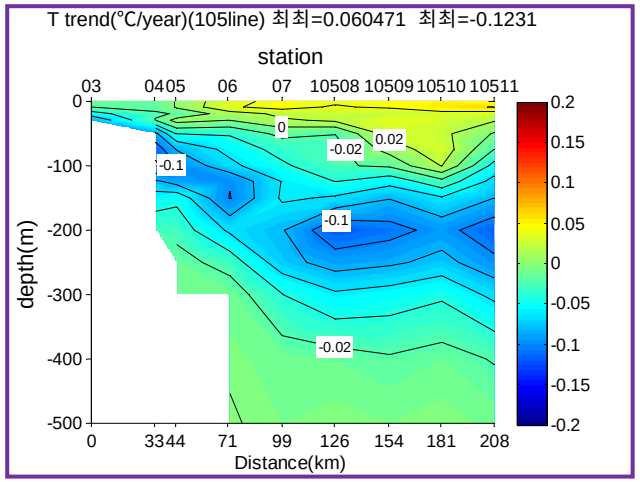
Temperature trends along sections

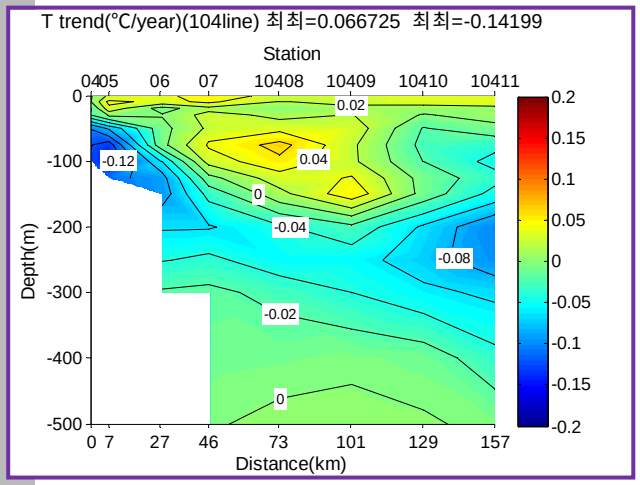


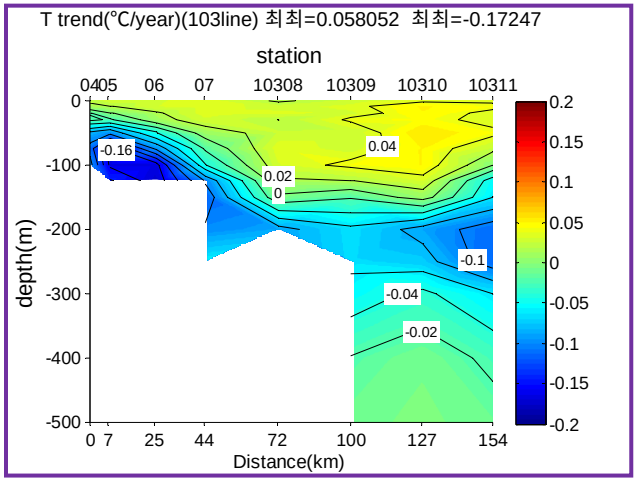
Temperature trends along sections

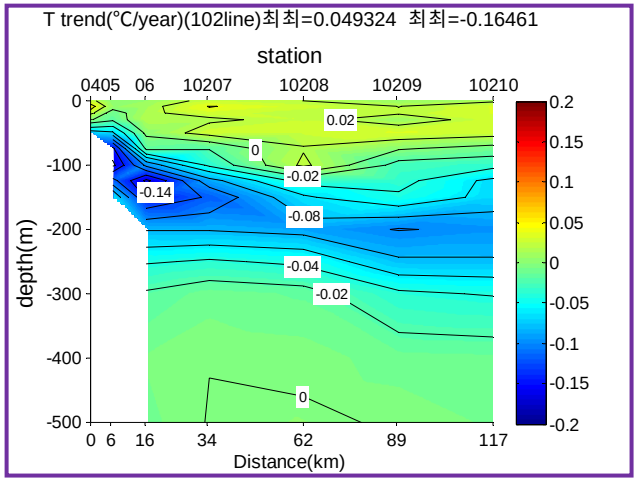




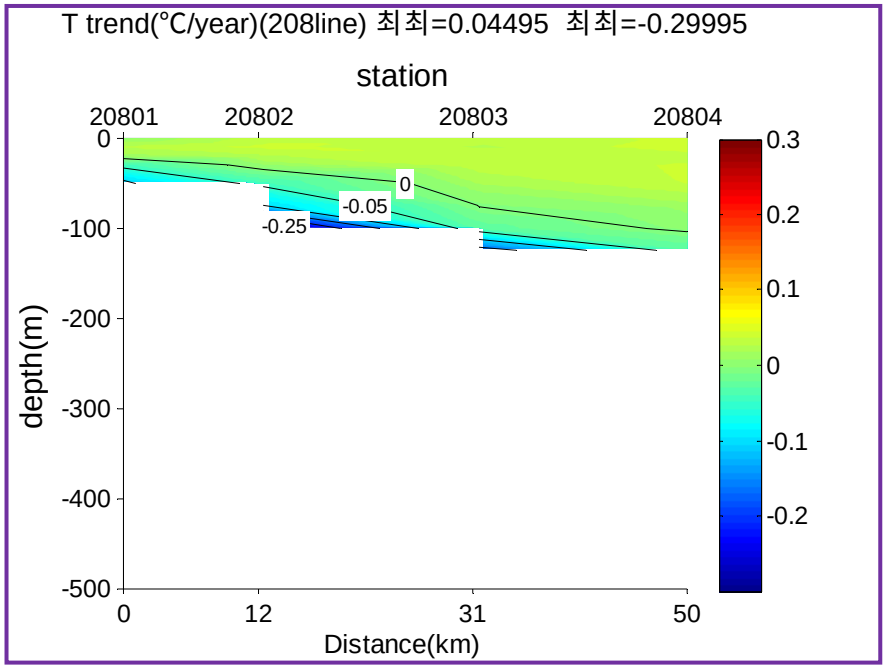


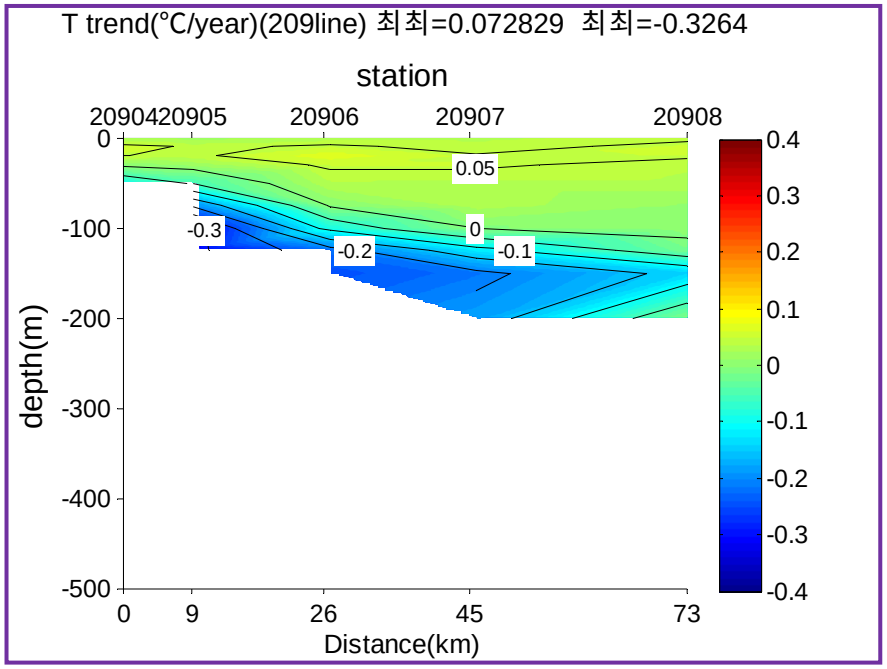




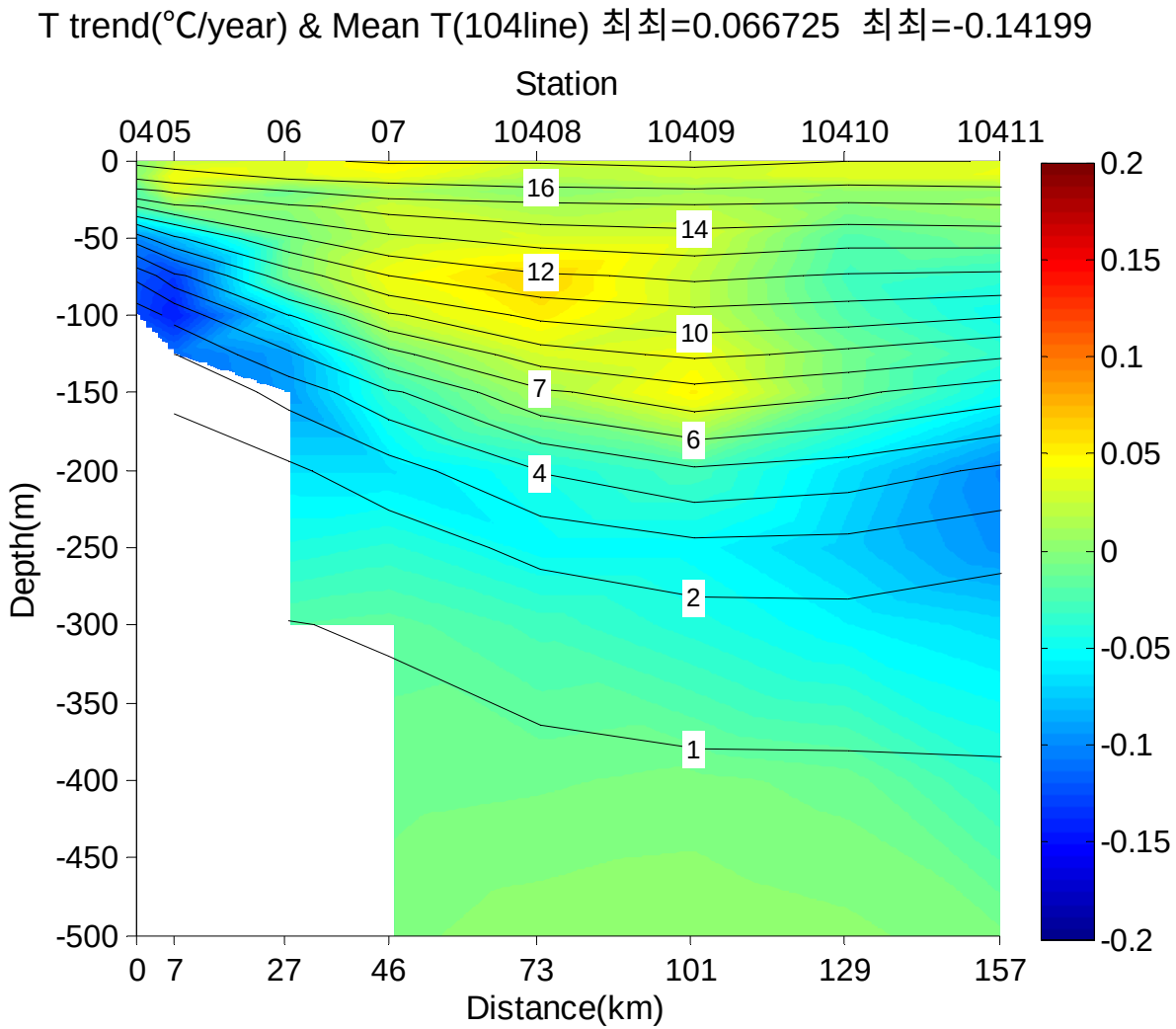


Temperature trends in Korea Strait

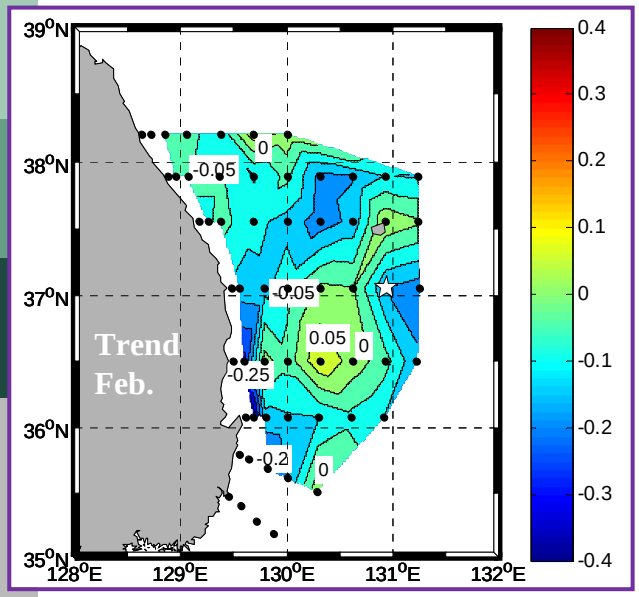


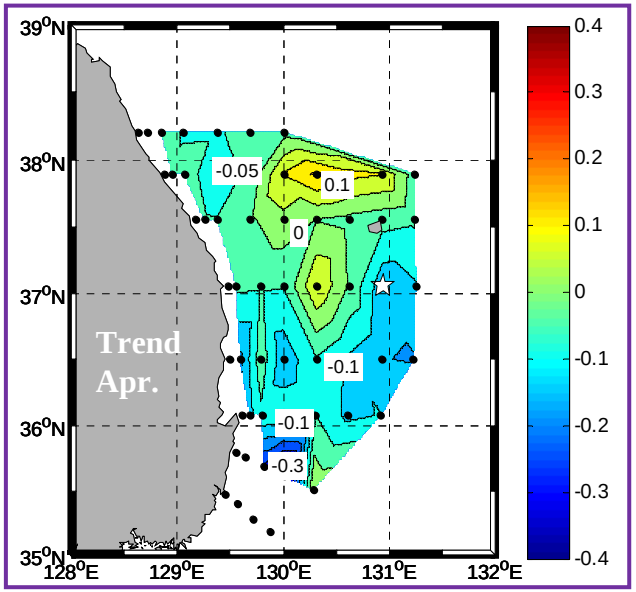


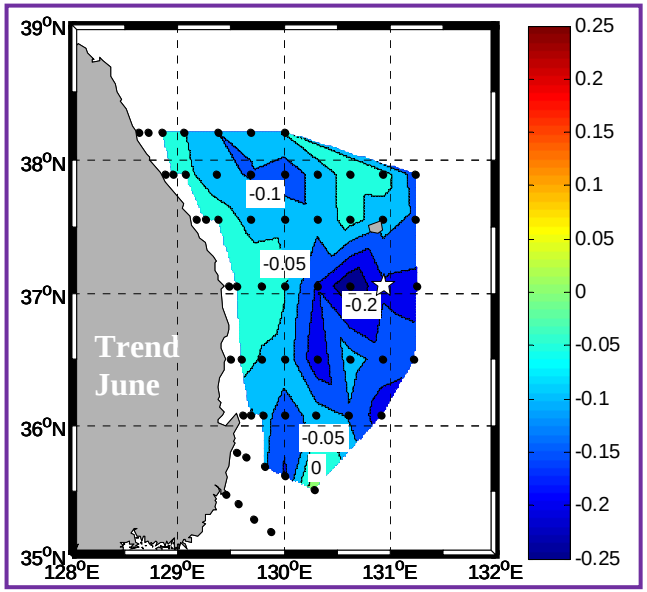
Mean temperature & trends (line 104)

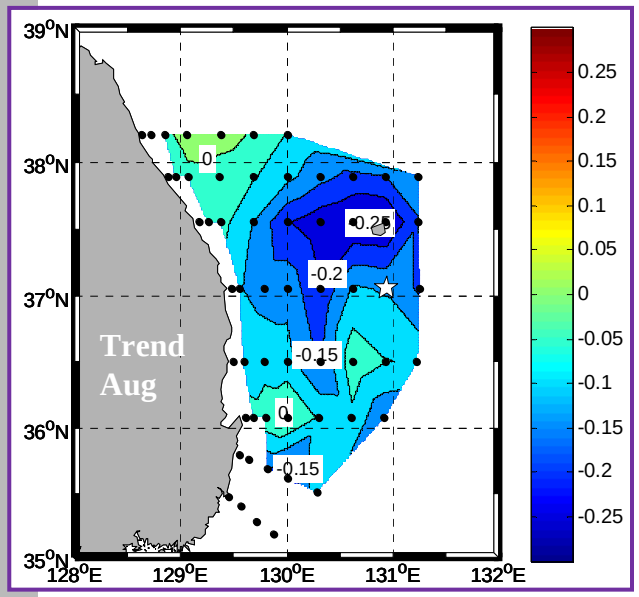


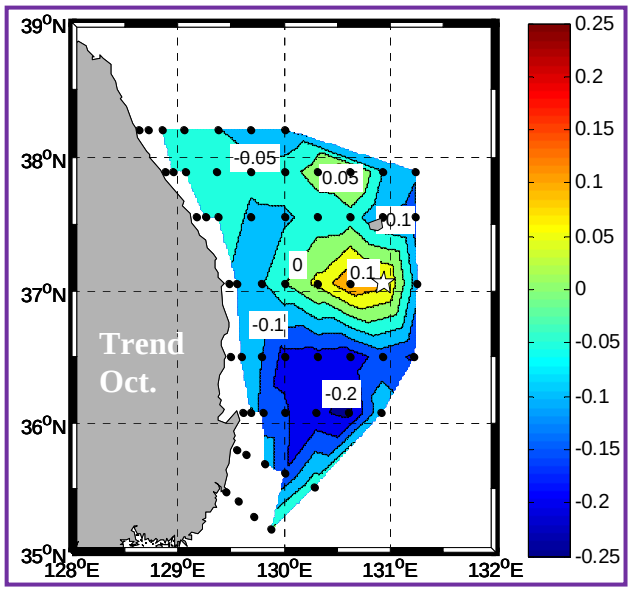
Seasonal temperature trends

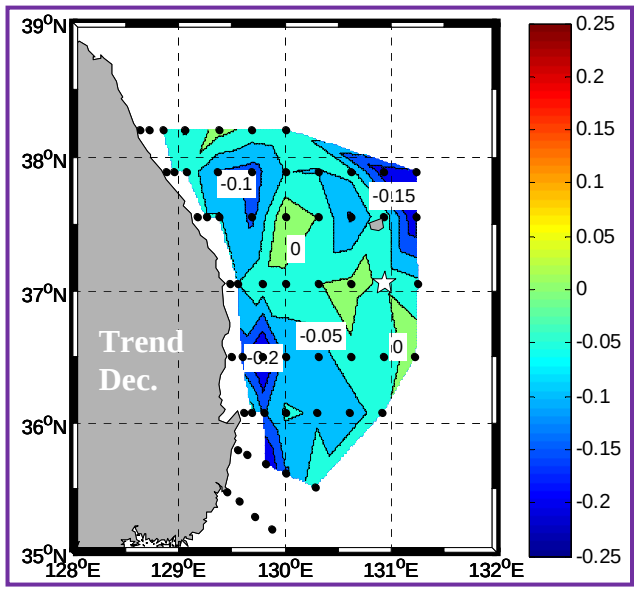




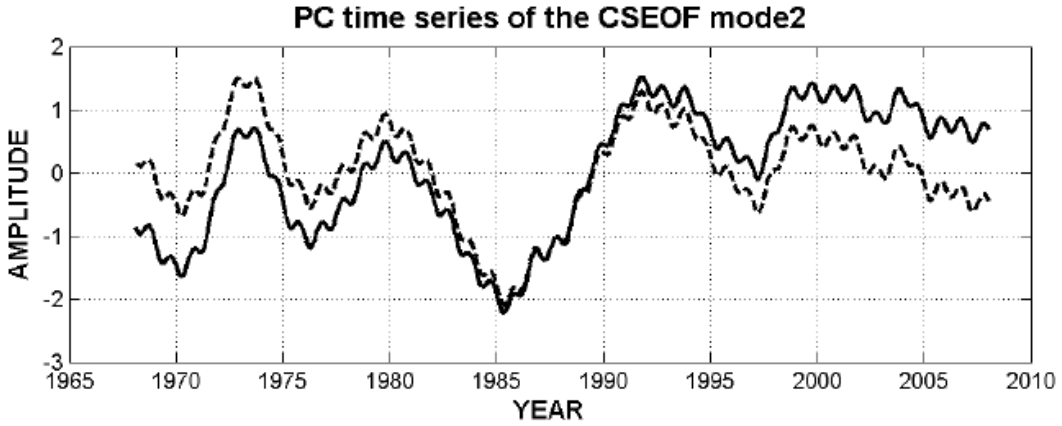


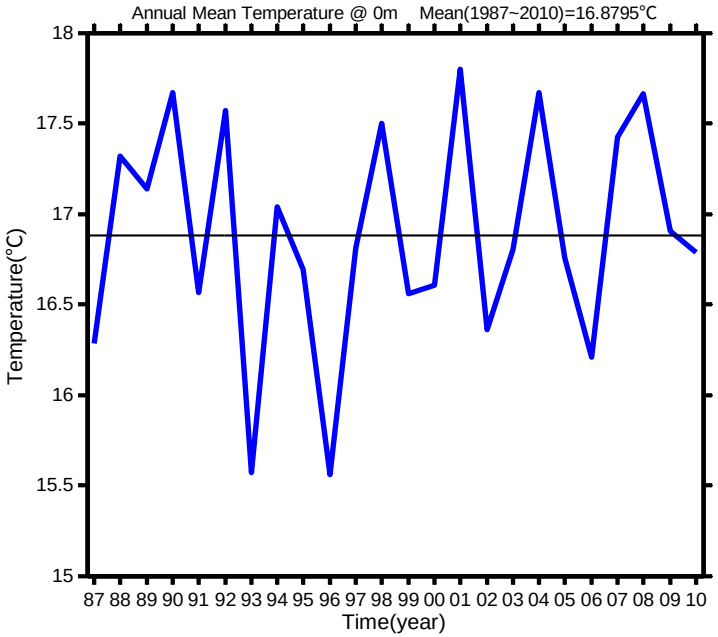


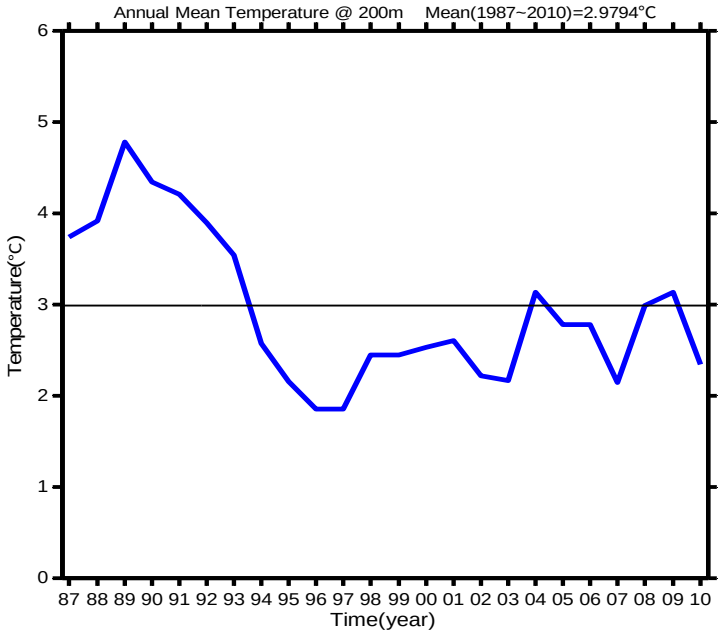




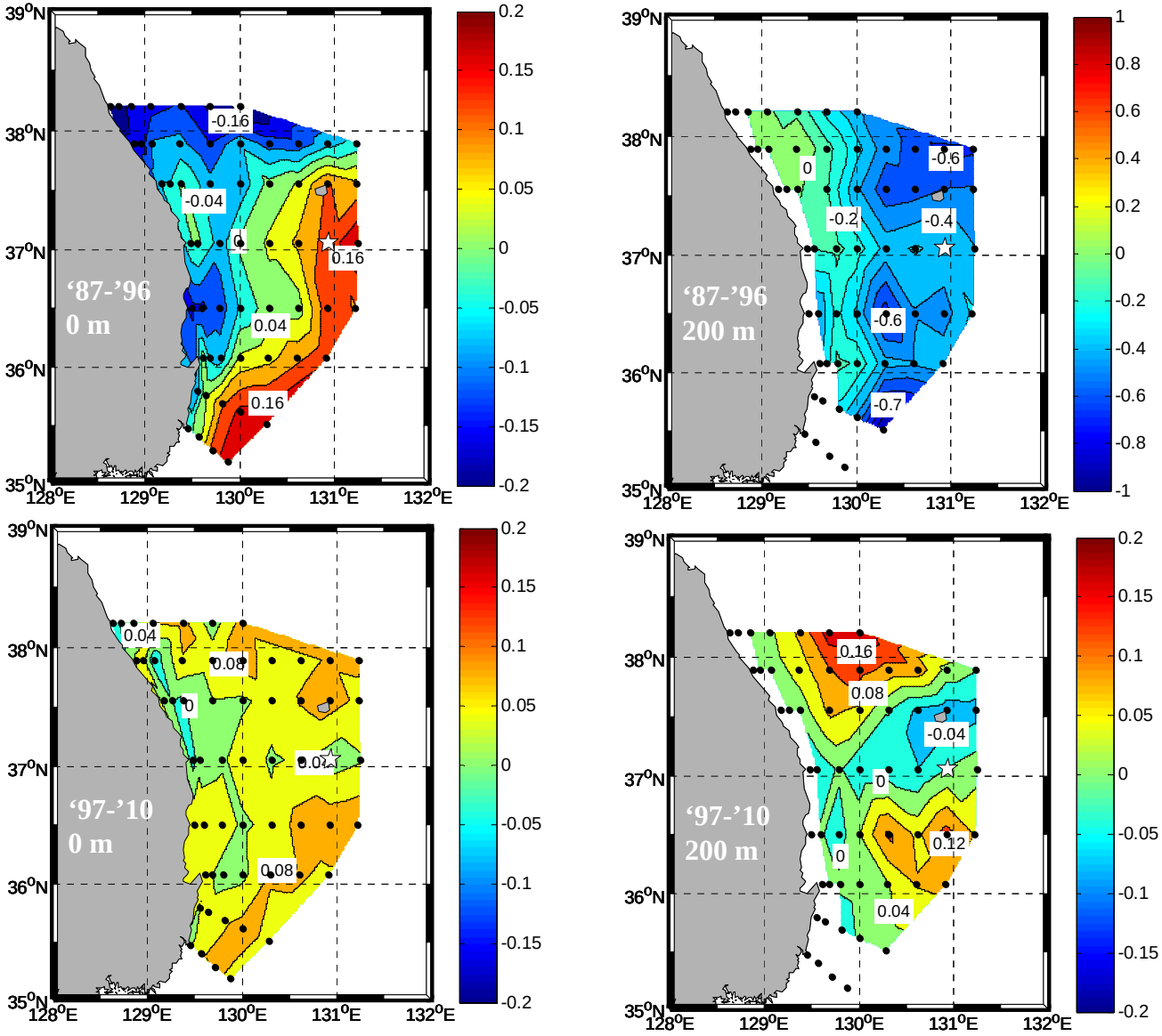
Basin-averaged annual mean temperature







Decadal temperature trends



Possible causes of subsurface cooling

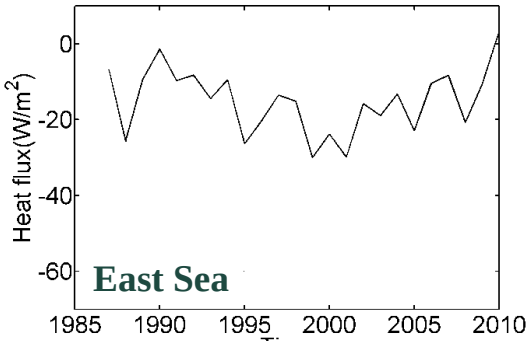
- Changes in eddy statistics and structure
- Upper circulation variability
- Air-sea interaction (local & remote)
- Colder water advection (ESIW, NKCC)

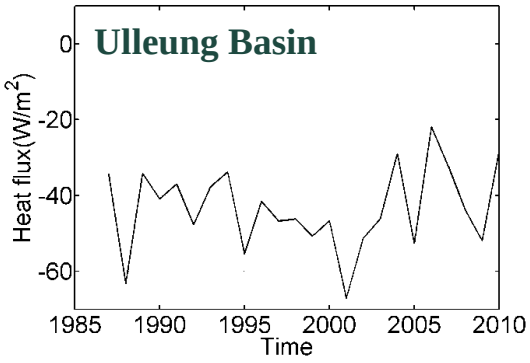
Mean net surface heat flux (MERRA)

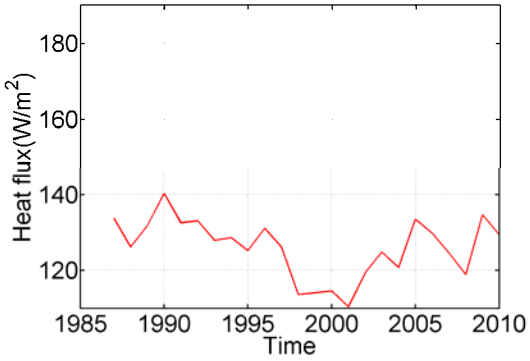
Annual

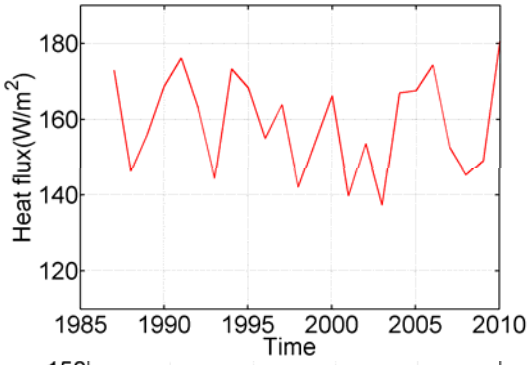
Summer

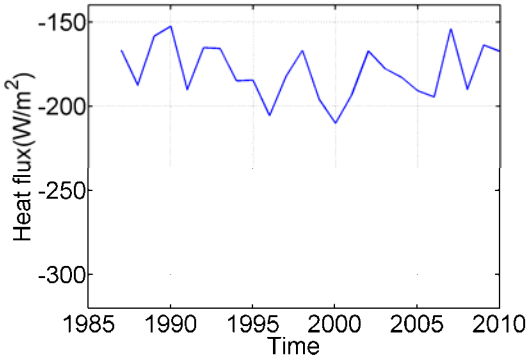
Winter

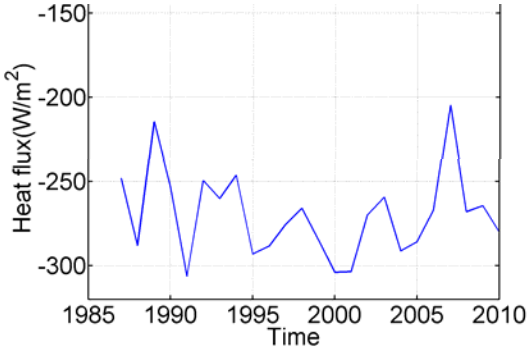




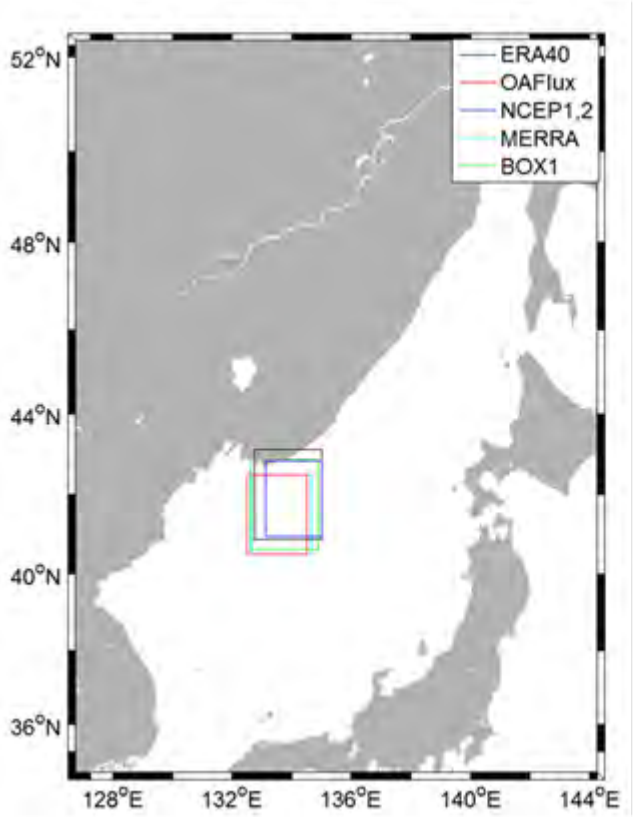


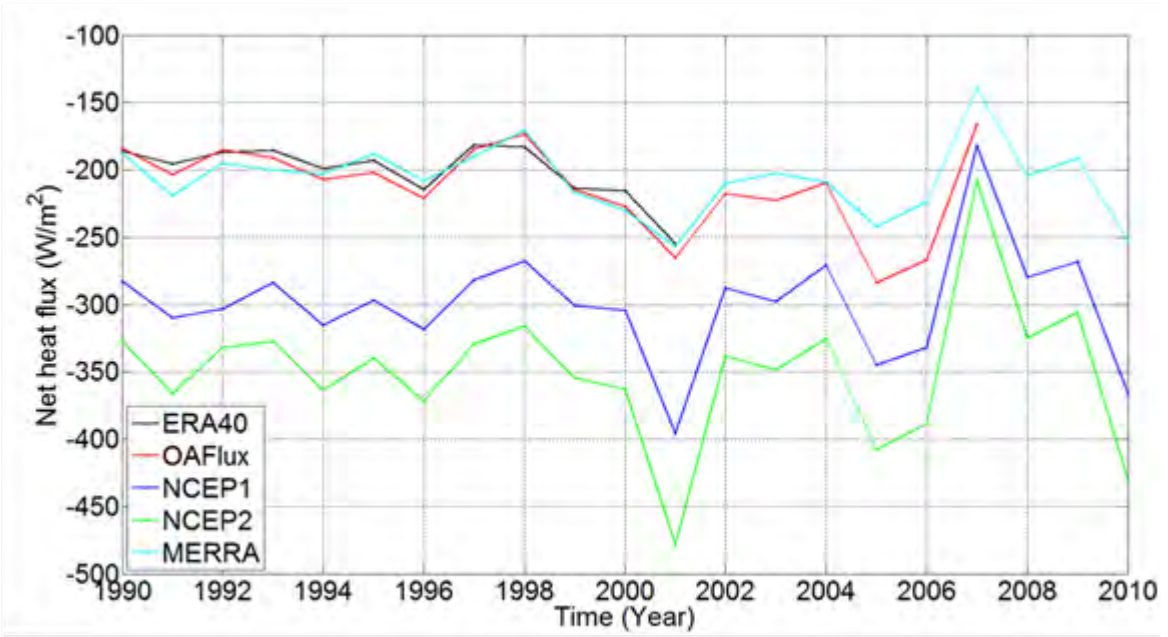




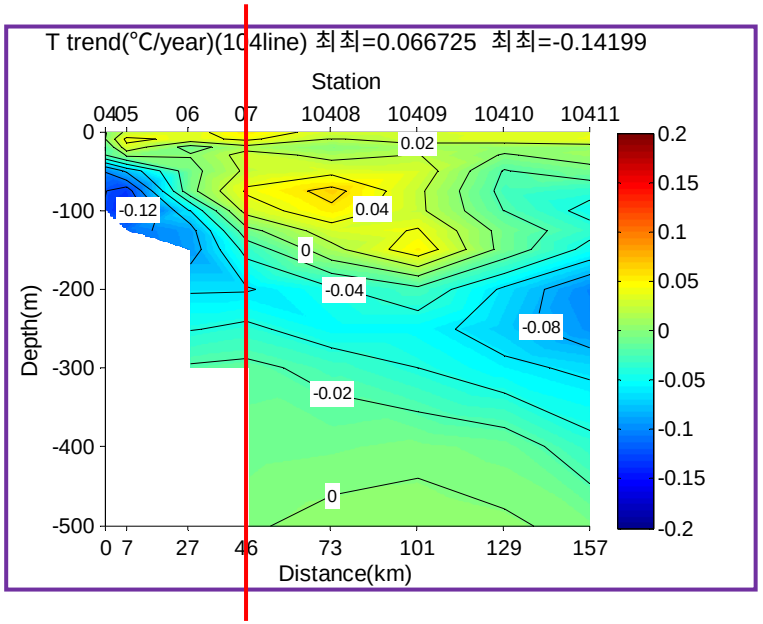


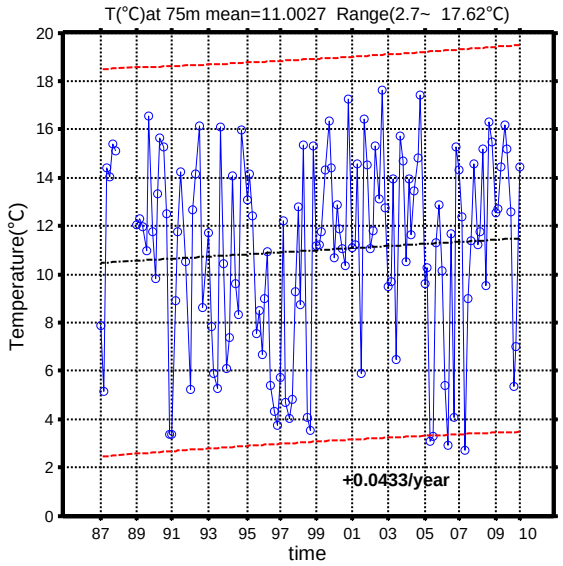
Mean net surface heat flux (MERRA)

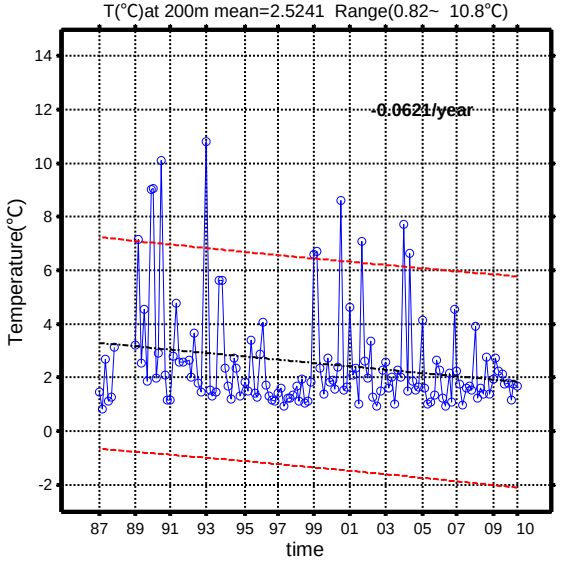




Time series at 104-07



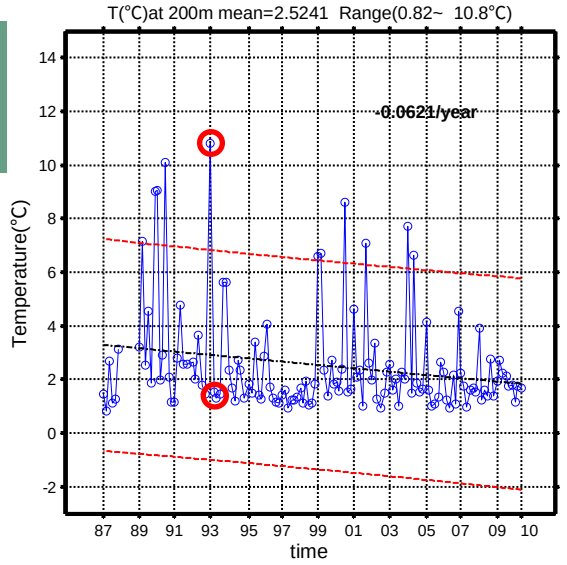


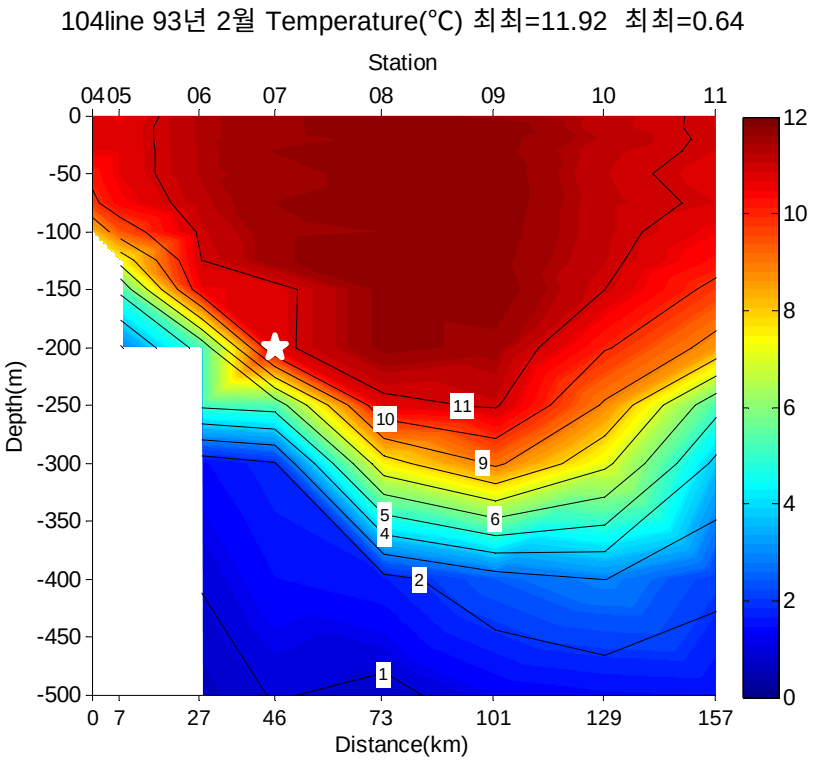


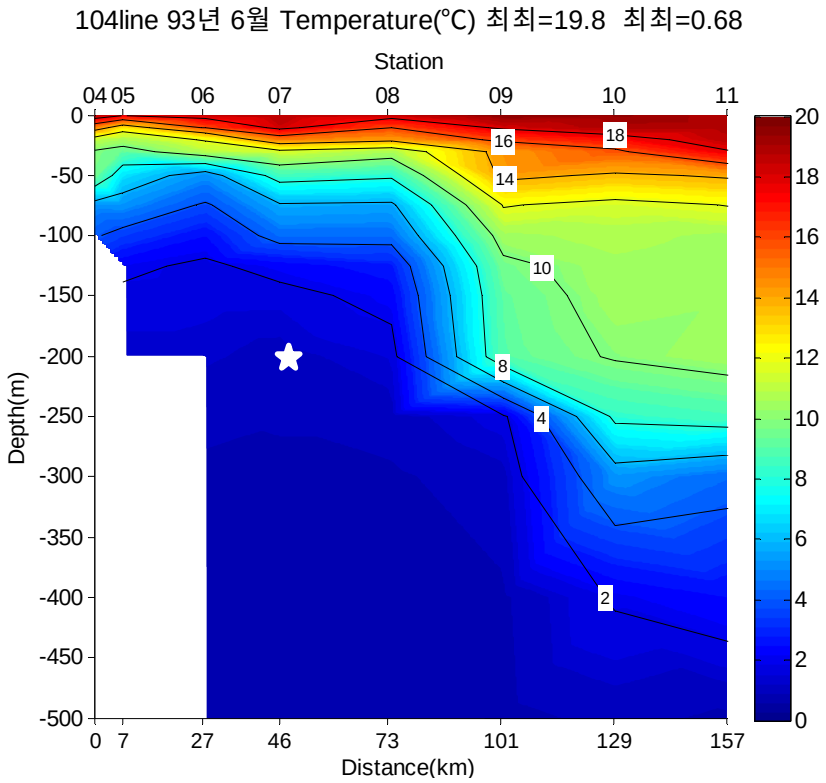
T_{mean} = 2.5°C

0.8 °C < T < 10.8 °C

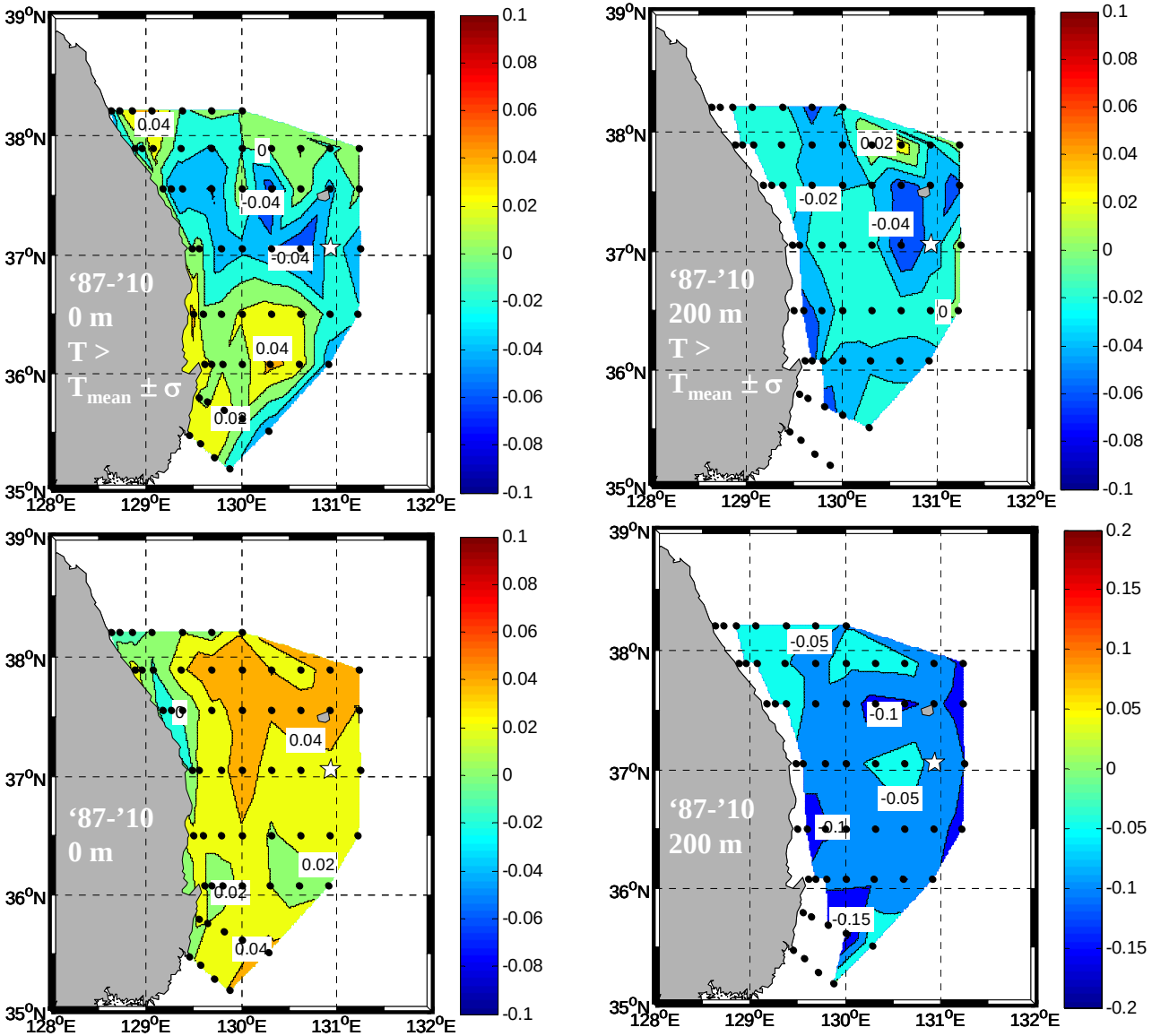
Temperature sections along 104-line



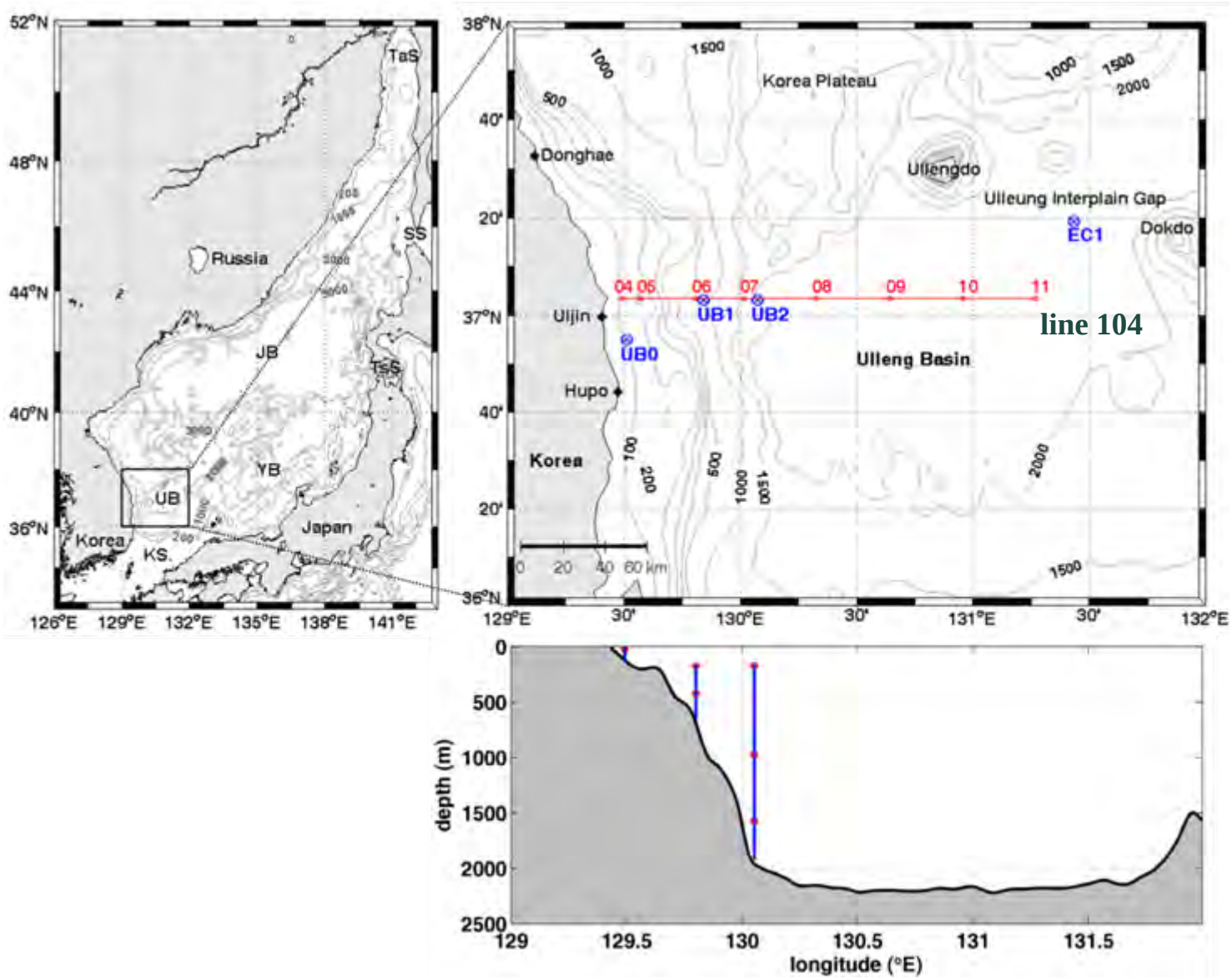




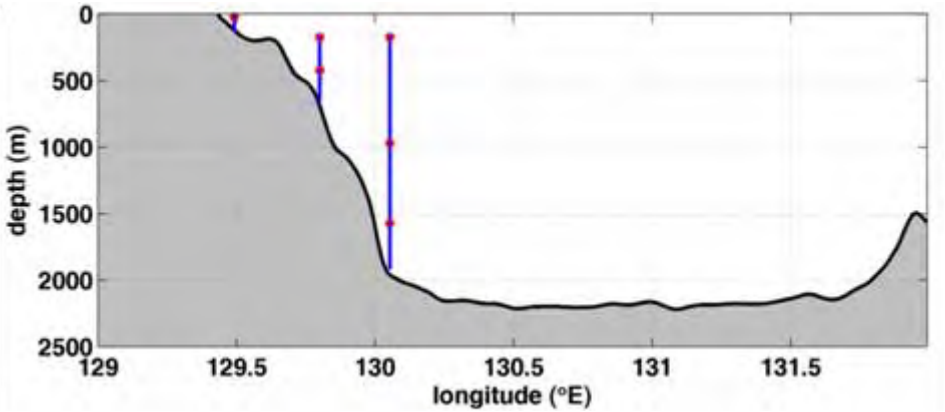
Temperature trends excluding $T > T_{mean} \pm \sigma$



Current Measurements



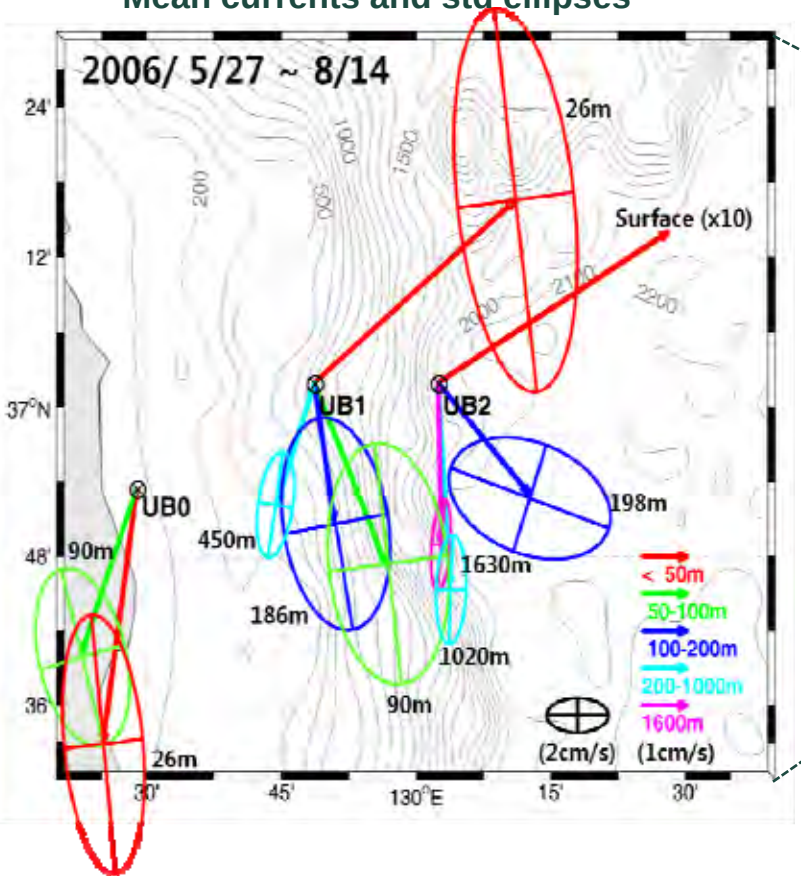
Current Measurements

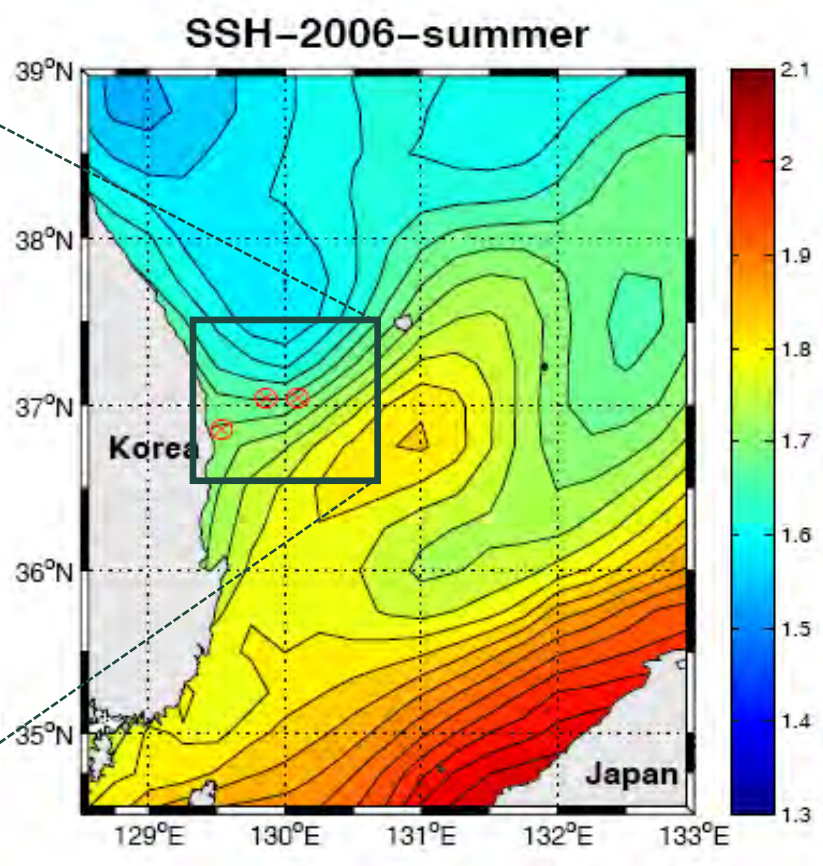


	norminal depth(m)	Instrument	Leg - 12	Leg - 13	Leg - 14
			2007 M J J A S O N D / 2008 J F M A M J J A S O N D	2008 J F M A M J J A S O N D / 2009 J F M A M J J A S O N D	2009 J F M A M J J A S O N D / '10 J F
UB0	1	ADCP	'06/ 5/27 - '06/10/23 2 : 4 : 90 m		
UB1	200	ADCP	'06/ 5/27 - '06/ 8/14 26 : 16 : 186 m		
	450	RCM7	'06/ 5/27 - '06/ 8/14 435 m		
UB2	200	ADCP		'07/ 5/31 - '08/ 6/ 7 26 : 8 : 162 m	'08/10/31 - '10/ 2/20 22 : 8 : 190 m
	200	RCM7	'07/ 5/31 200 m	'06/ 5/26. - '08/ 8/ 7 190 m	
	200-300	TR7	'07/ 5/31 205 : 12.5 : 305 m	'06/ 5/26. - '08/ 8/23 200 : 12.5 : 300 m	'08/10/31 - '10/ 2/20 225 : 10 : 305 m
	300	RCM7			'08/10/31 - '10/ 2/20 310 m
	1000	RCM9	'07/ 5/31 1045 m	'08/10/31 1000 m	'06/ 5/27 - '10/ 2/20 1021 m
	1600	RCM11	'07/ 5/31 1663 m	'08/10/31 1600 m	'06/ 5/27 - '10/ 2/20 1624 m

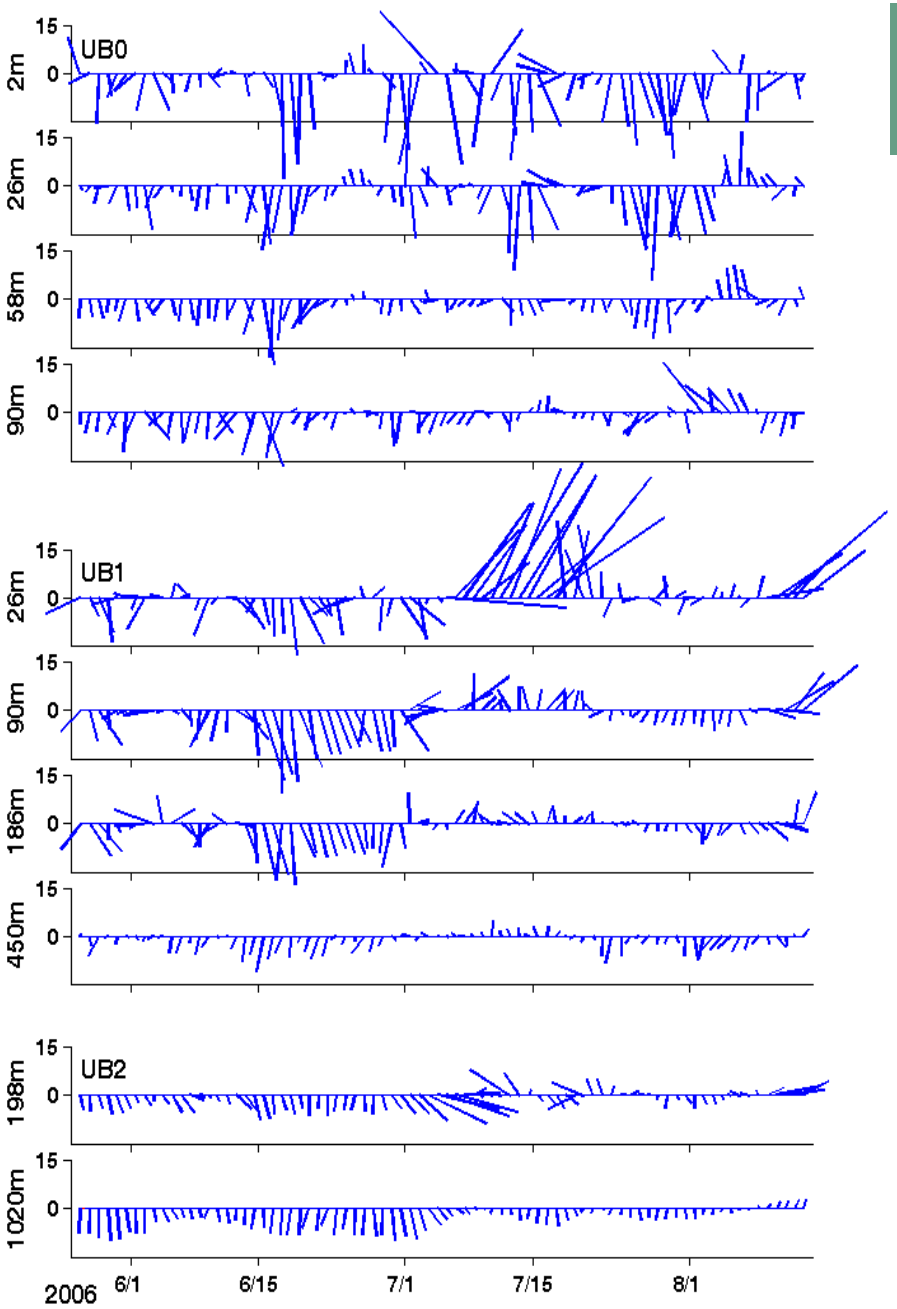
Mean Currents – Common period

Mean currents and std ellipses

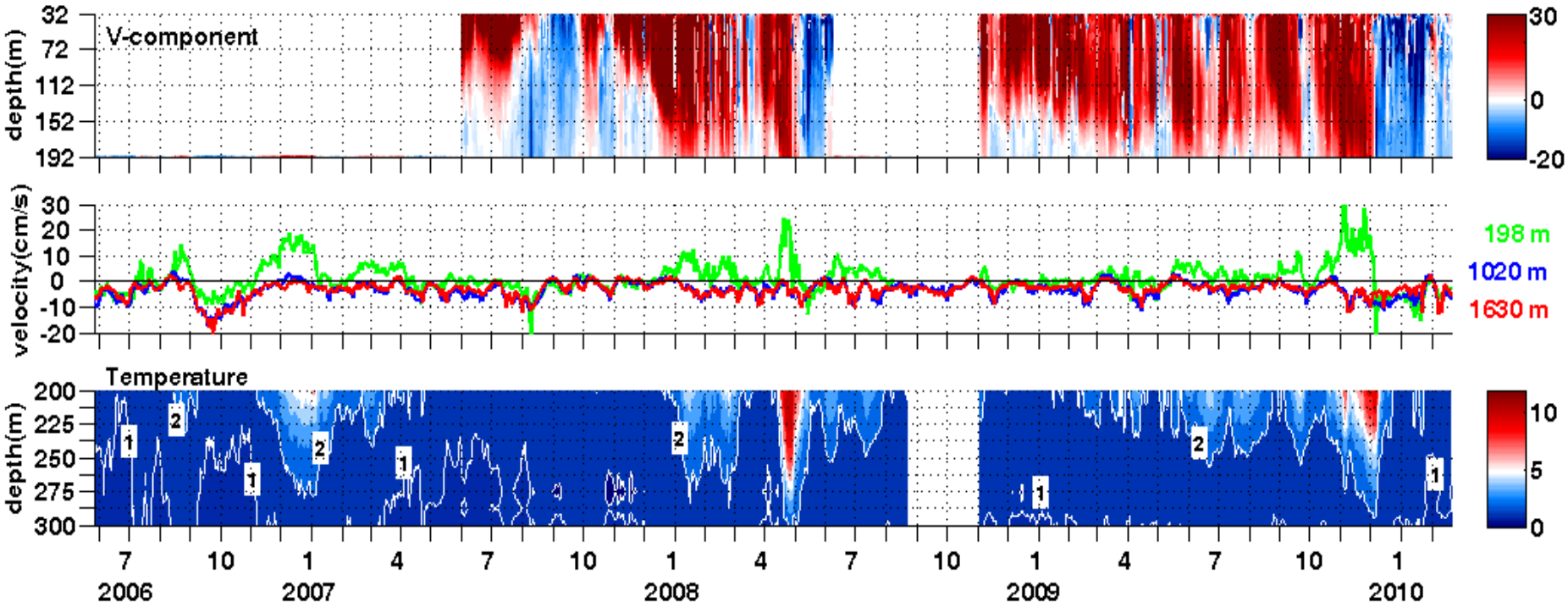




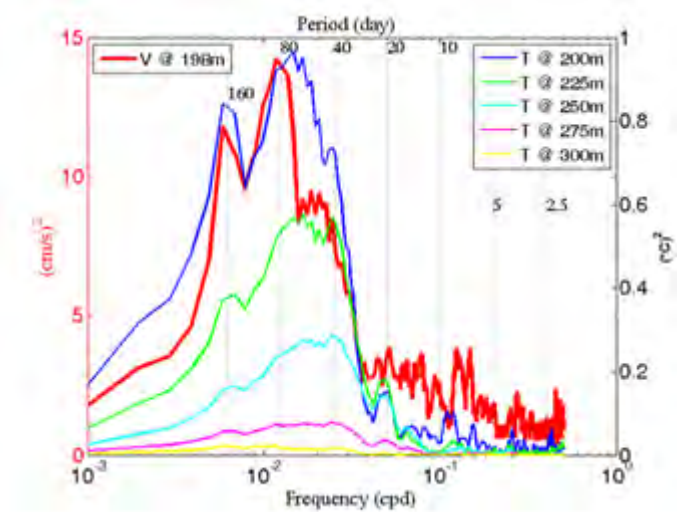
Time series of low-passed currents

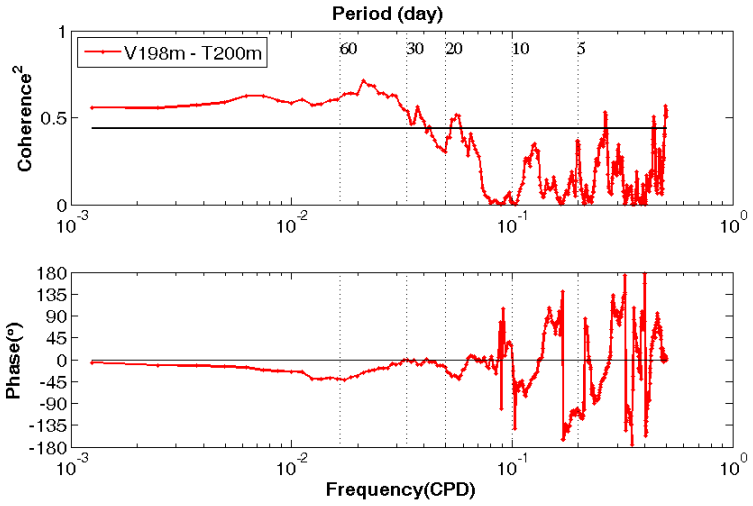


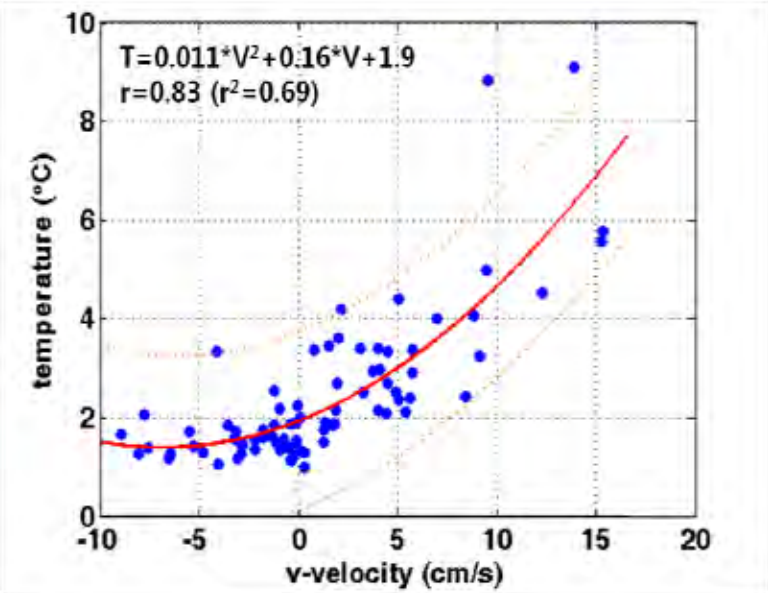
Time series of U, V, T at UB2



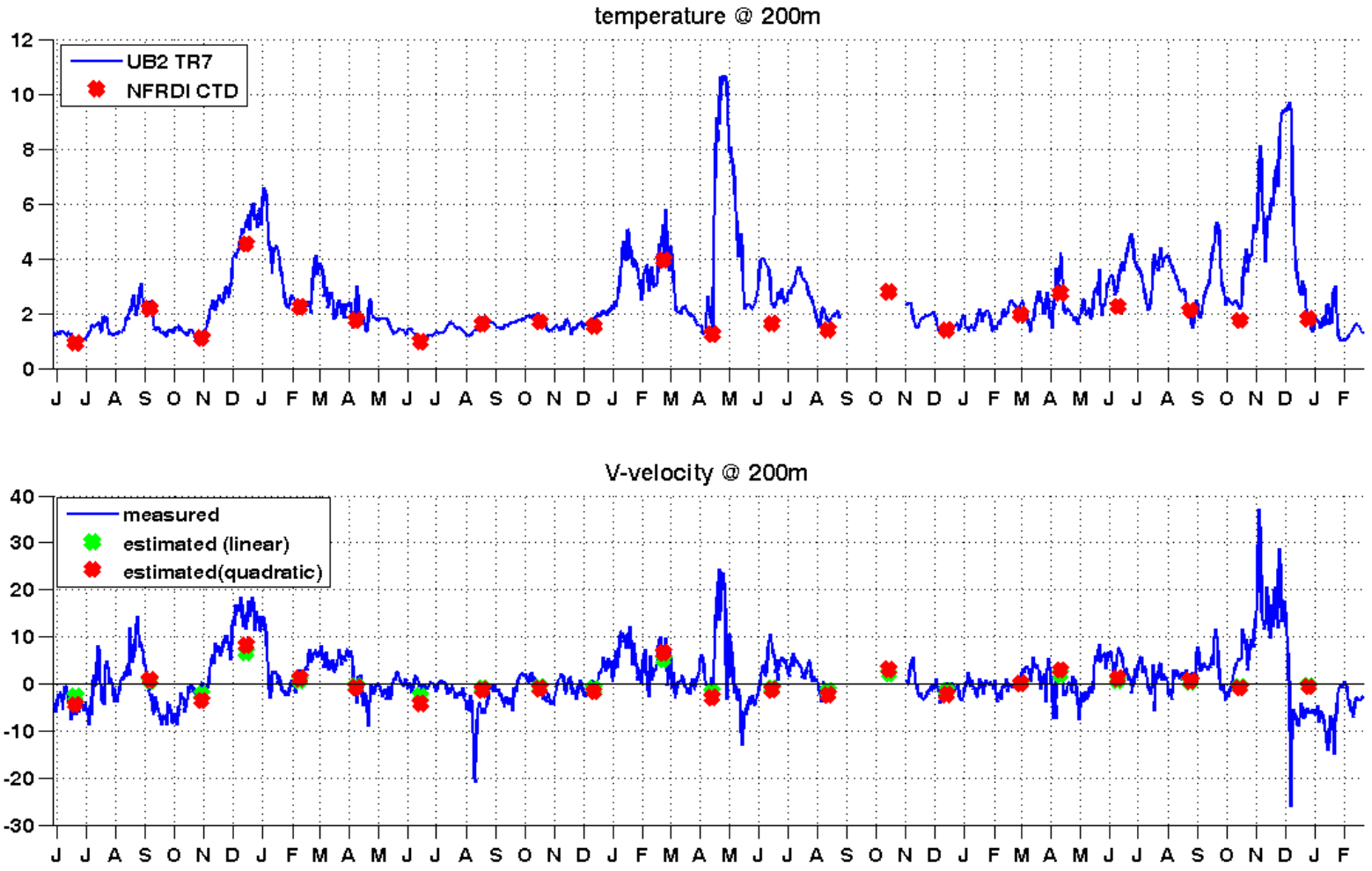
Correlation and Regression between V_{198} & T_{200}



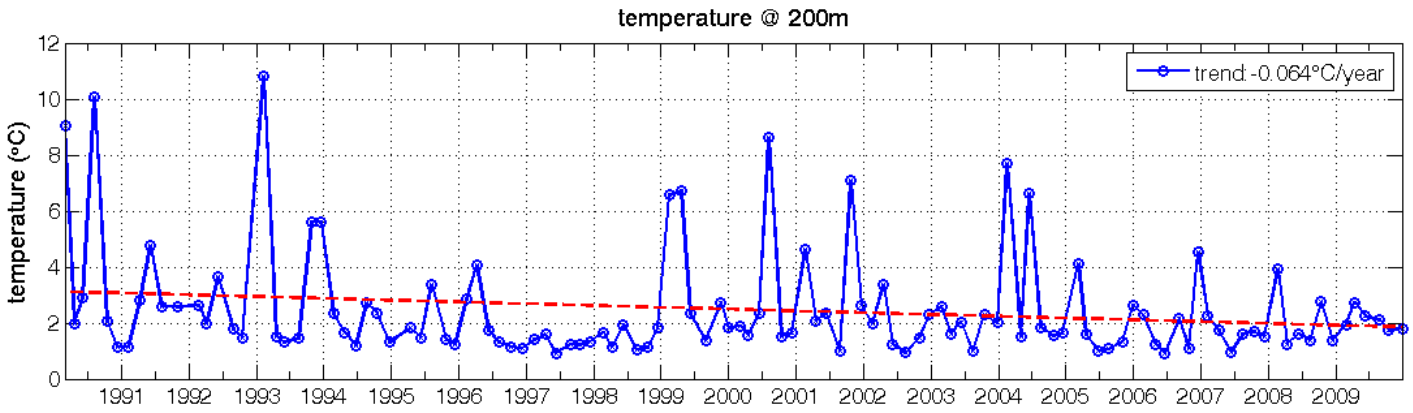


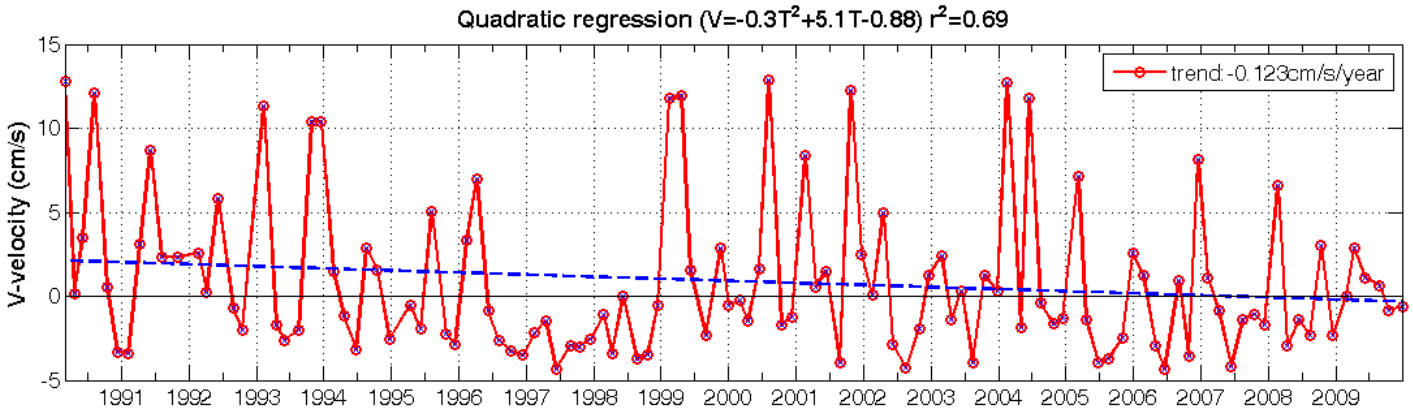


Observed & Estimated V



Observed & Estimated V





Linear trends

- **T : -0.064 ℃/year**
- **V : -0.123 cm/s/year (80 km*50 m*0.1*0.01 = 0.04 Sv/yr)**

Summary

- Data: NFRDI, 1987~2010 (CTD data)
- Decreasing trend of subsurface temperature in the Ulleung Basin below 100 m.
- The cooling is pronounced in water layers occupied by the ESIW and the NKCC water.
- The decreasing rate is higher in summer as compared to that in other seasons.
- Decadal variation at 200 m, a sharp decrease before 1996 and gradual increase afterwards.
- Eddy variability seems little influence the decreasing trend.
- Temperature and north-south velocity are well correlated at the base of the continental slope.
- Decreasing trend of temperature accompanies with an intensification of southward flows.