Distribution of *Nemopilema nomurai* occurred massively in the Korean waters in 2005 and its possible origin

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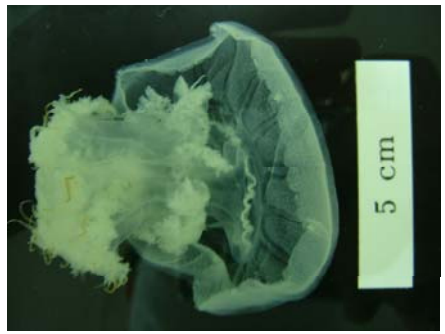
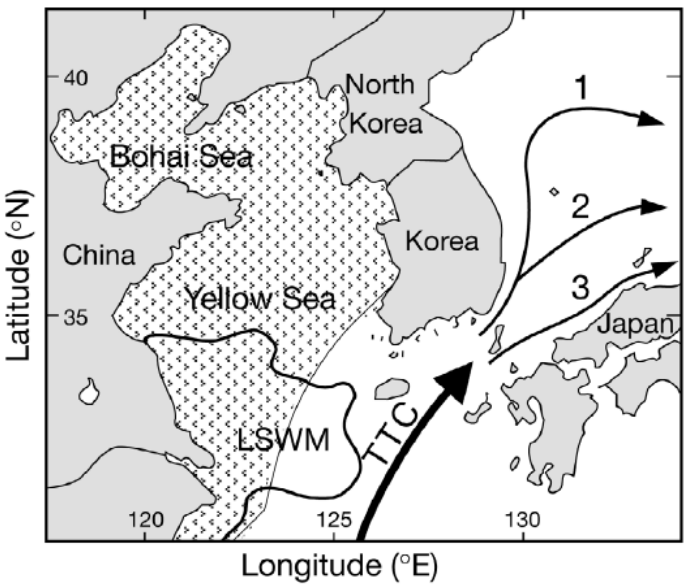
Contents

Introduction (1)

- **Surveys and studies**
  - First record in Korean waters : 玆山魚譜 (Jeong, 1814)
  - Distribution : East China, Yellow, East/Japan Seas (Omori and Kitamura, 2004)
  - Population explosion since 2002, causing severe damage to fishery (Kawahara *et. al.*, 2006)
  - Monitored since 2003 in Korean waters by NFRDI



- **Suggested Origins**
  - Production along the coasts of the Korean Peninsula and northern China in spring (Omori and Kitamura, 2004)
  - Young medusae (2-10 cm) off Gunsan in Korea in early June 2004 (NFRDI, 2004)
  - Origination from the coastal waters of China and Korea and drift along with the Taiwan-Tsushima Current, inferred by schematic of current system (Kawahara et. al., 2006)



from Kawahara *et. al.* (2006)

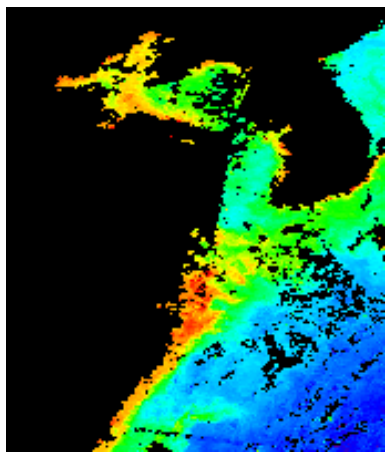
Introduction (2)

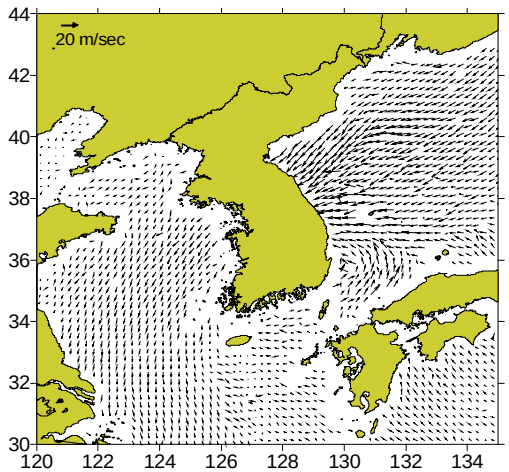
- The current system of the East China Sea (ECS) ; oceanic and coastal currents.
  - Warm and saline currents of oceanic origin flow from south to north or northeast.
  - Less saline coastal currents flow generally from north to south along the Korean and Chinese coasts.
  - The Changjiang Diluted Water (CDW) which is one of coastal water in the ECS has different seasonal paths; southward flow along the Chinese coast within a narrow band in winter and **northeastward flow to the Korea/Tsushima Strait in summer**.

⇨ We investigated the relationship between the oceanographic conditions and mass occurrence of the jellyfish in Korean waters in summer 2005 and conjectured its possible origins.

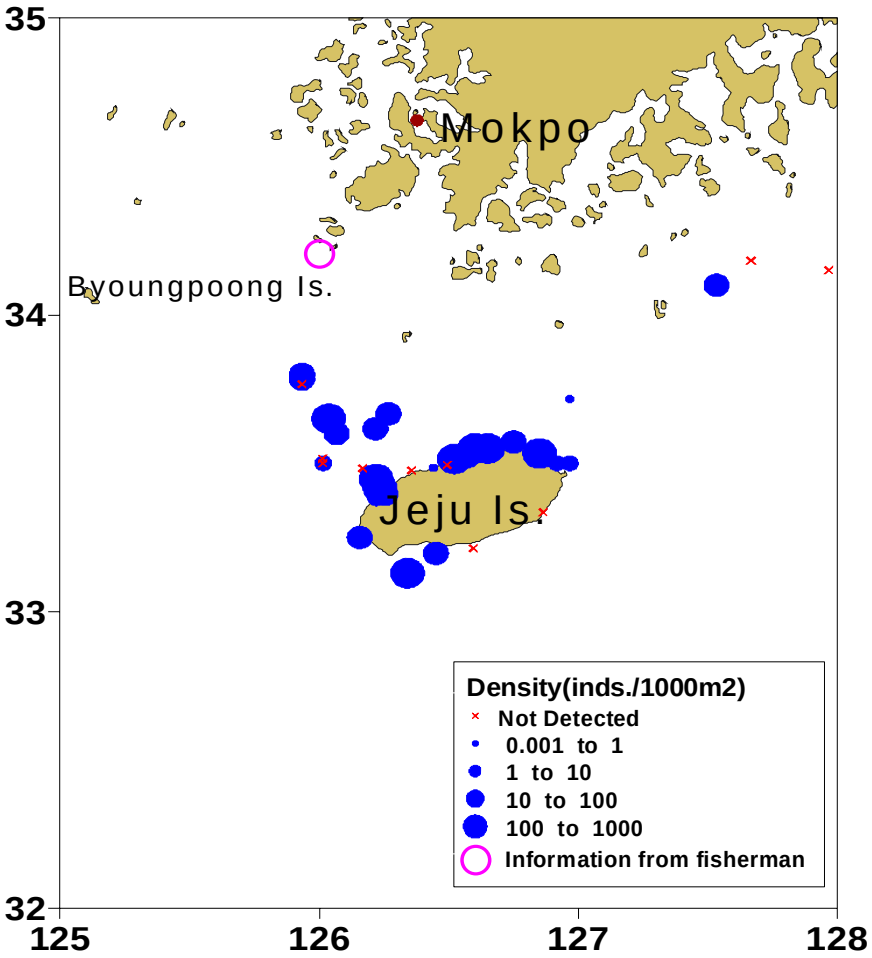
- Data and Method
  - Salinity by shipboard CTD
  - Ocean color by SeaWiFS
  - Surface wind by QuikSCAT

  - Numerical model : ROMS (Regional Ocean Modeling System)





Distribution of *N. nomurai* (1)



Visual measurement of the jellyfish in July 2005

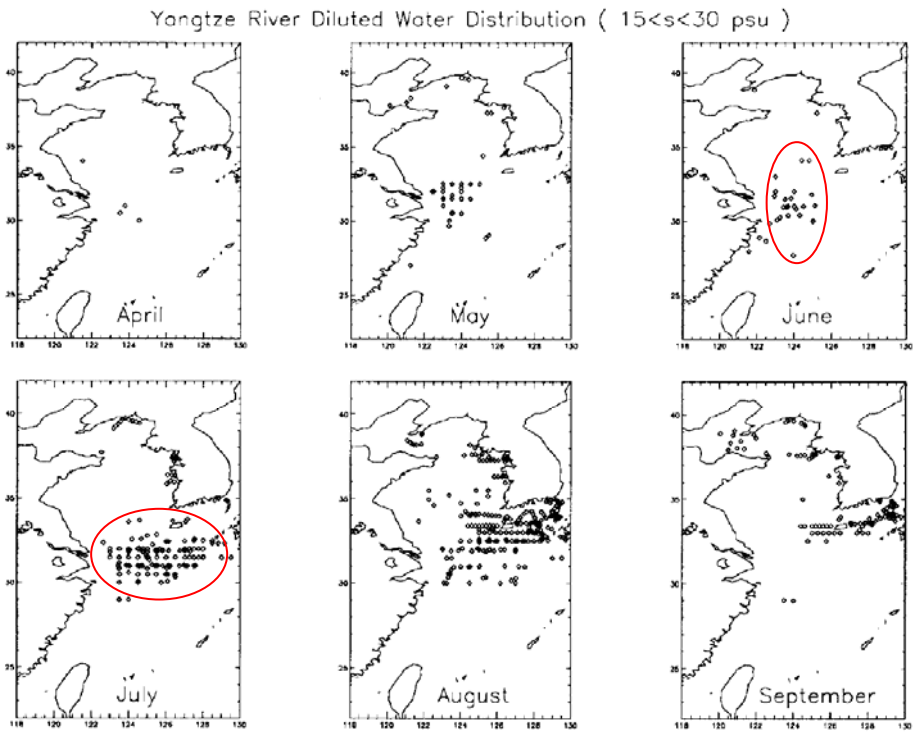
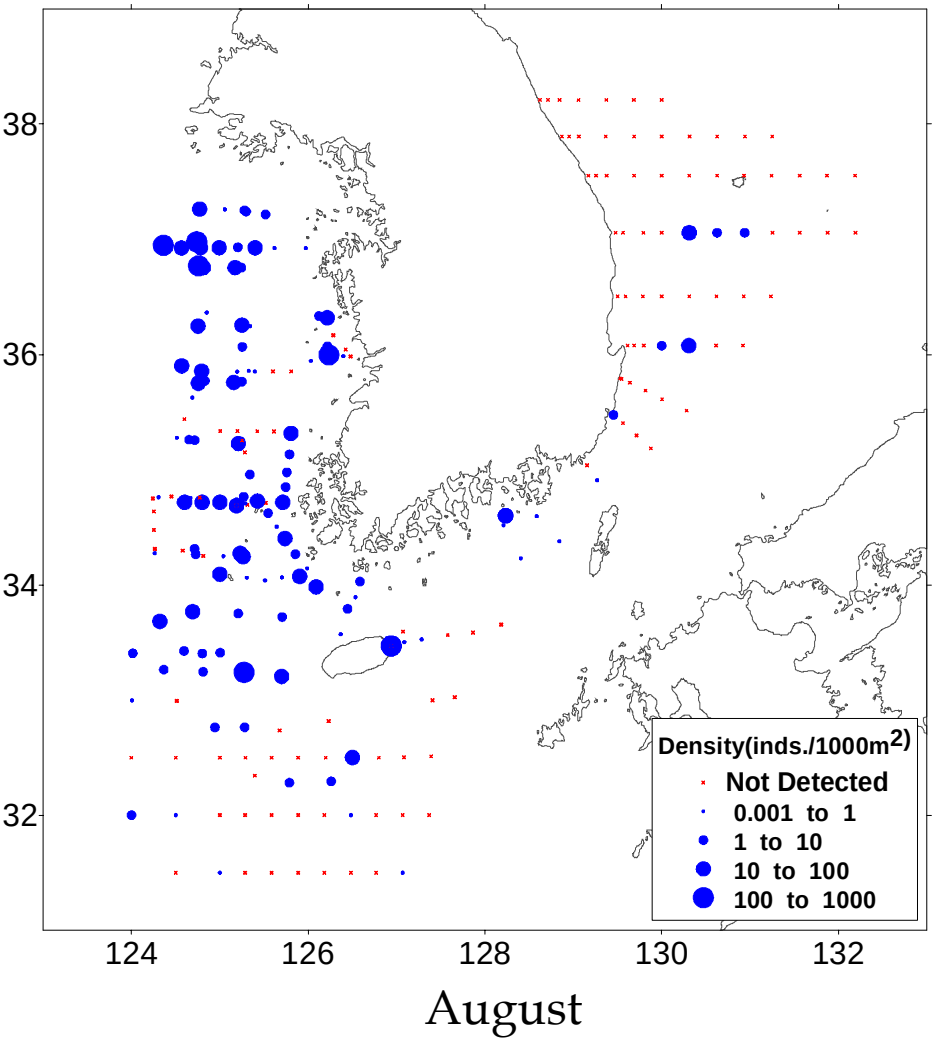
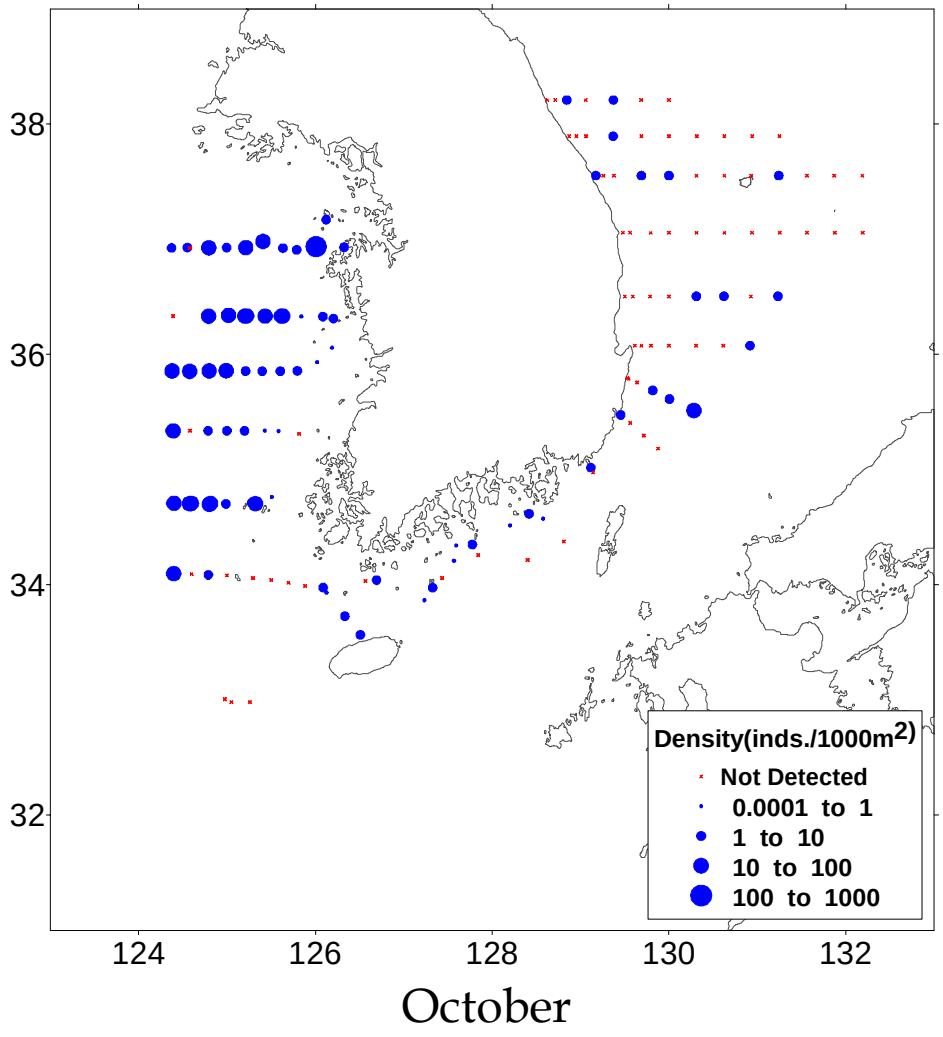


Fig. 5. Monthly distribution of the low salinity water salinity of 15–30 psu is shown. Only spring and summer months are depicted since low salinity water is generally not present in winter and fall months. The expansion of the Yangtze River plume is observed through the summer.

Monthly distribution of the low salinity water of 15-30 psu from 1950 to 1992 after Hur *et al*. (1999)

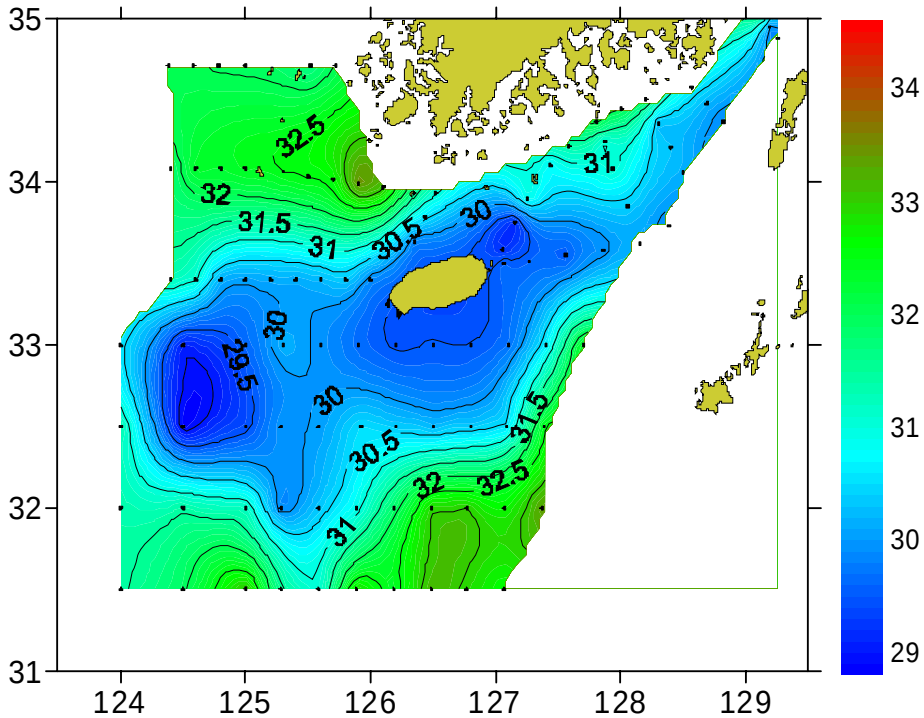
Distribution of *N. nomurai* (2)





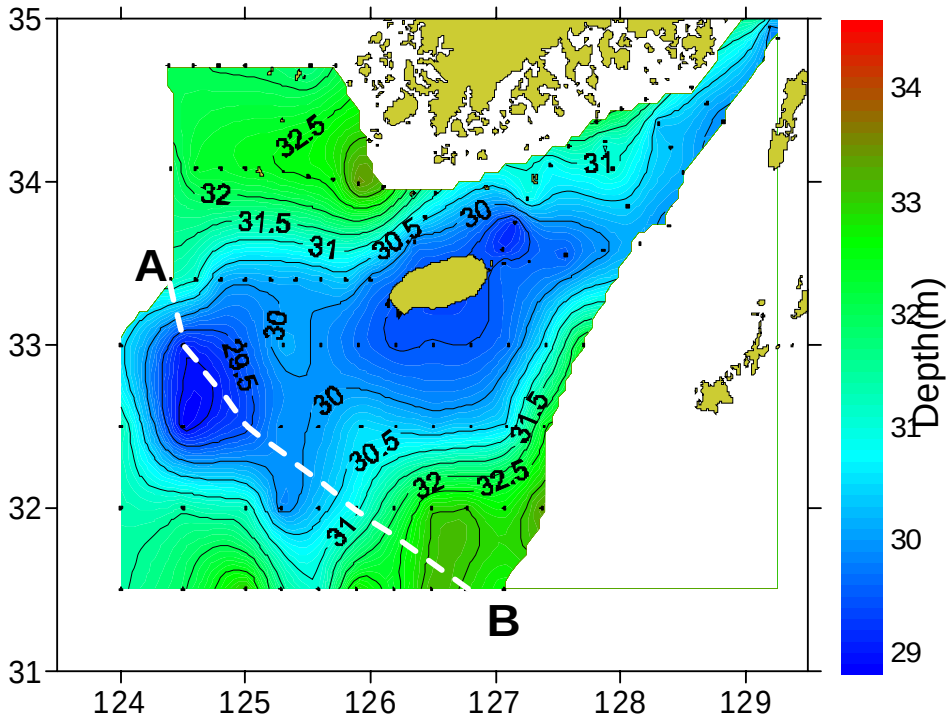
Visual measurement of the jellyfish in 2005

Oceanographic Conditions (1)

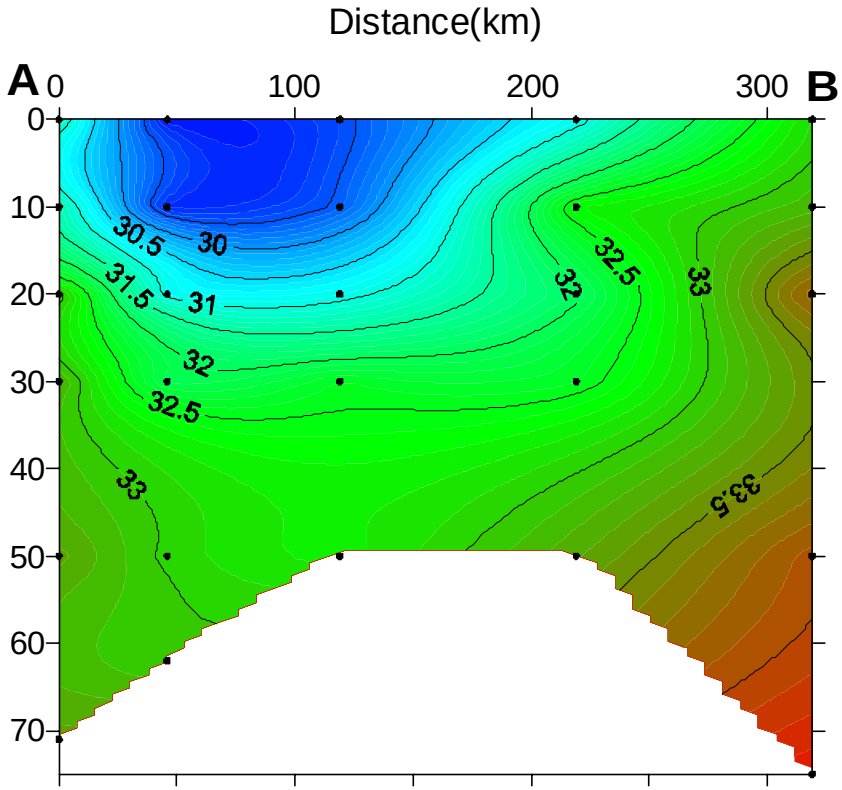


Horizontal distribution of surface salinity by shipboard CTD in the northeastern part of the East China Sea in August 2005

Oceanographic Conditions (2)

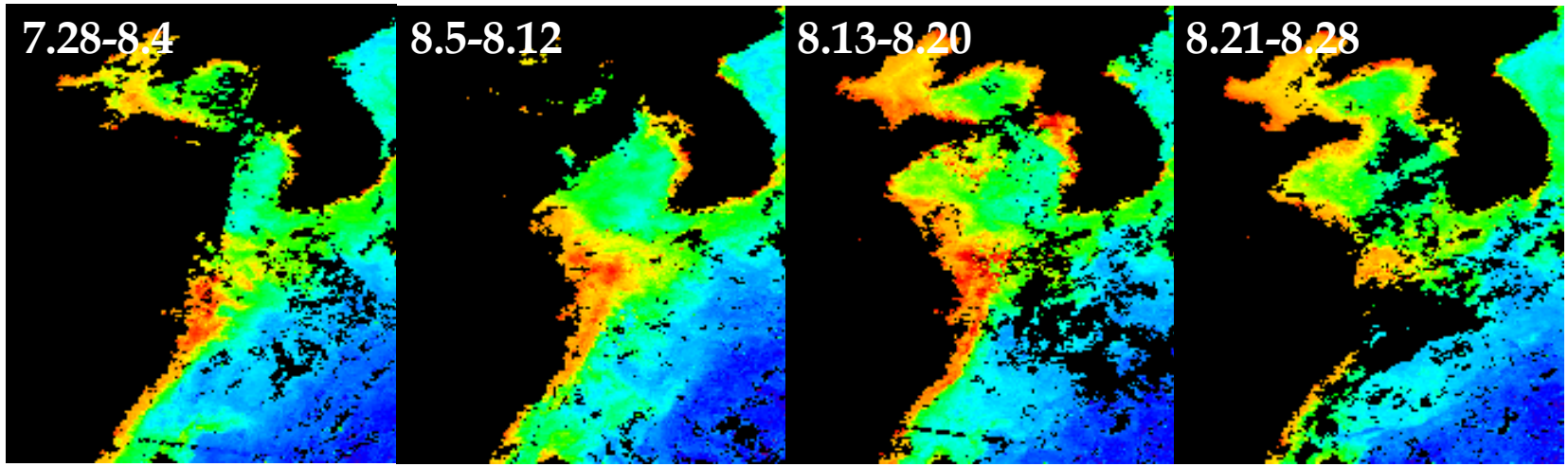


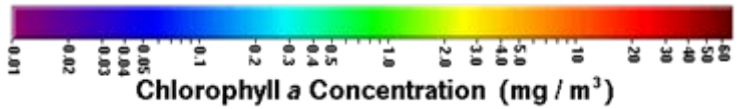
Horizontal distribution of surface salinity by shipboard CTD in the northeastern part of the East China Sea in August 2005

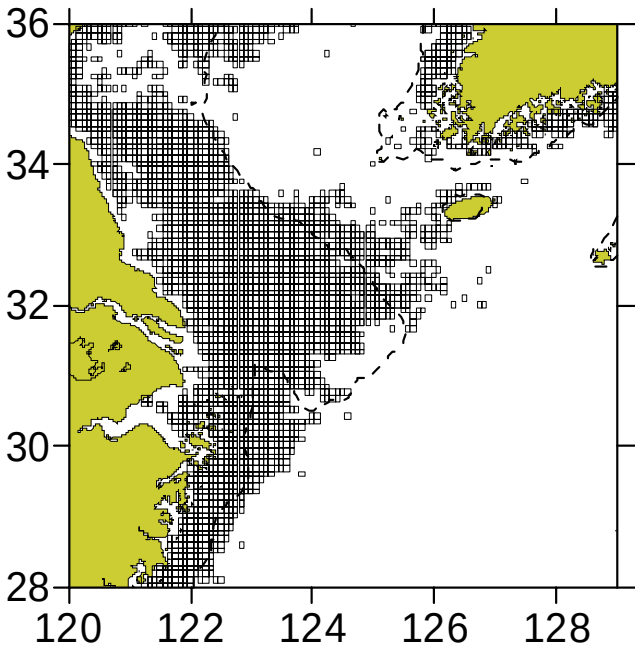


Vertical section of salinity along A-B

Oceanographic Conditions (3)



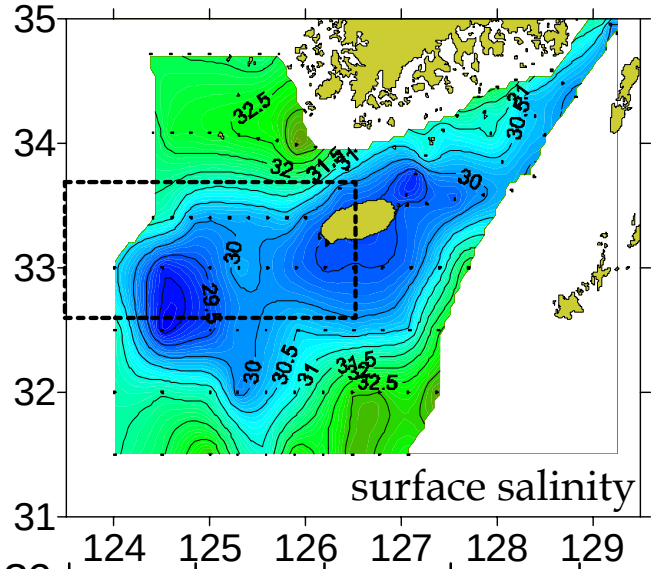


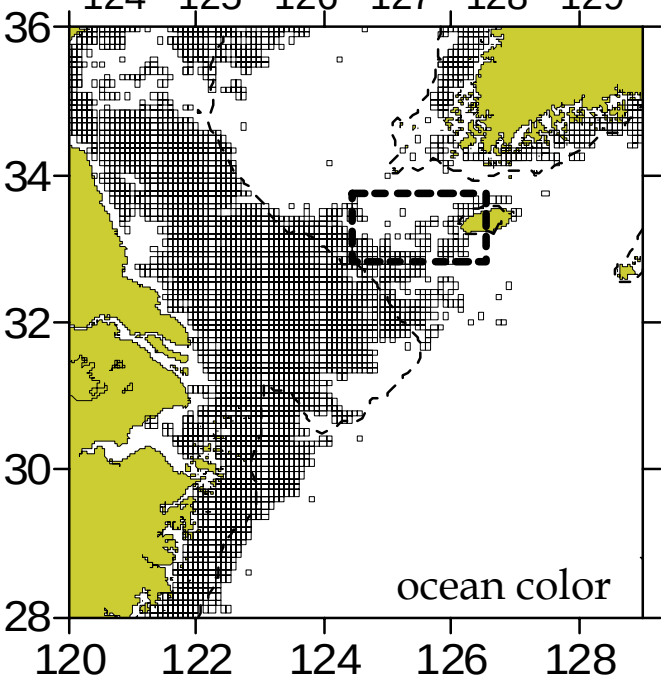


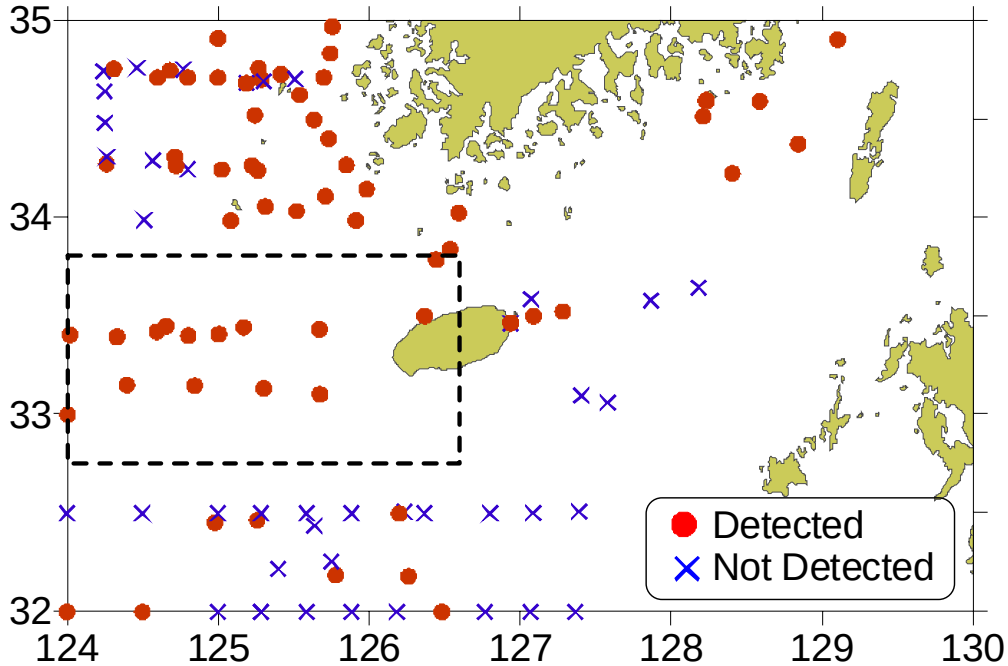
Embossing the influence of the CDW, the four weekly images just contained high chlorophyll *a* concentration (>2.0mg/m^3) were piled on all together.

Composite of four weekly ocean color images by SeaWiFS in August 2005

Possible Origins (1)



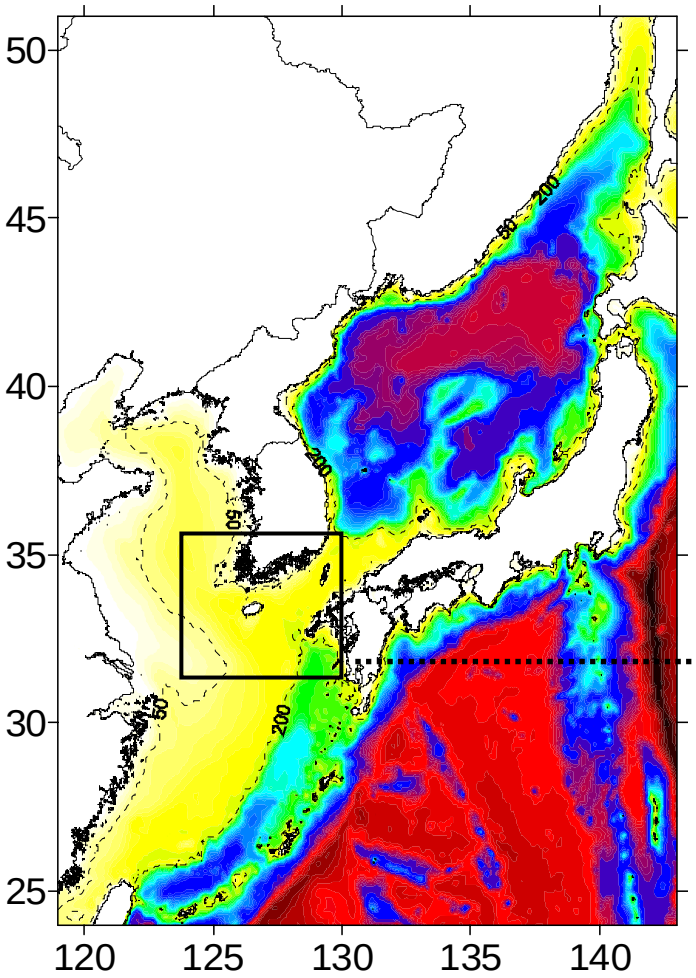




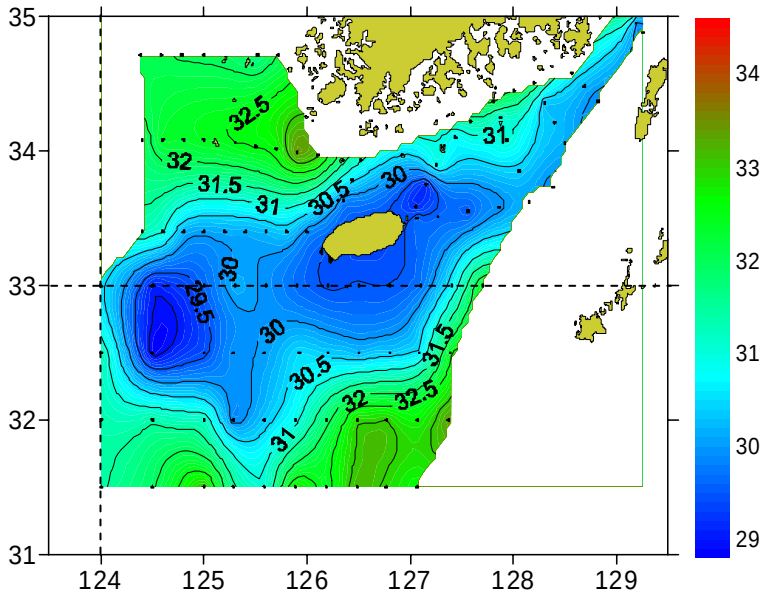
N. nomurai was found at all the stations on the CDW pathway confirmed by surface salinity and ocean color in August 2005 (dashed rectangle).

On the other hand, there were some stations where the jellyfish was not detected in the other area.

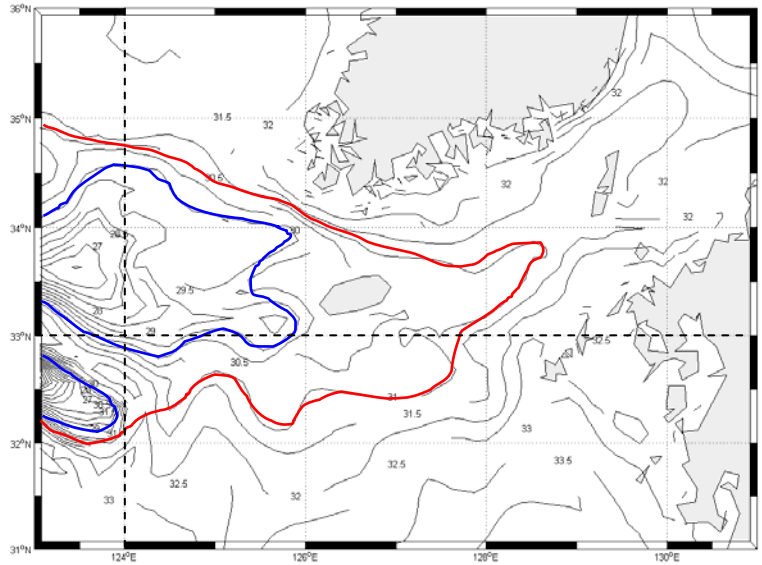
Possible Origins (2)



Model domain
Climatology
Wind in 2005

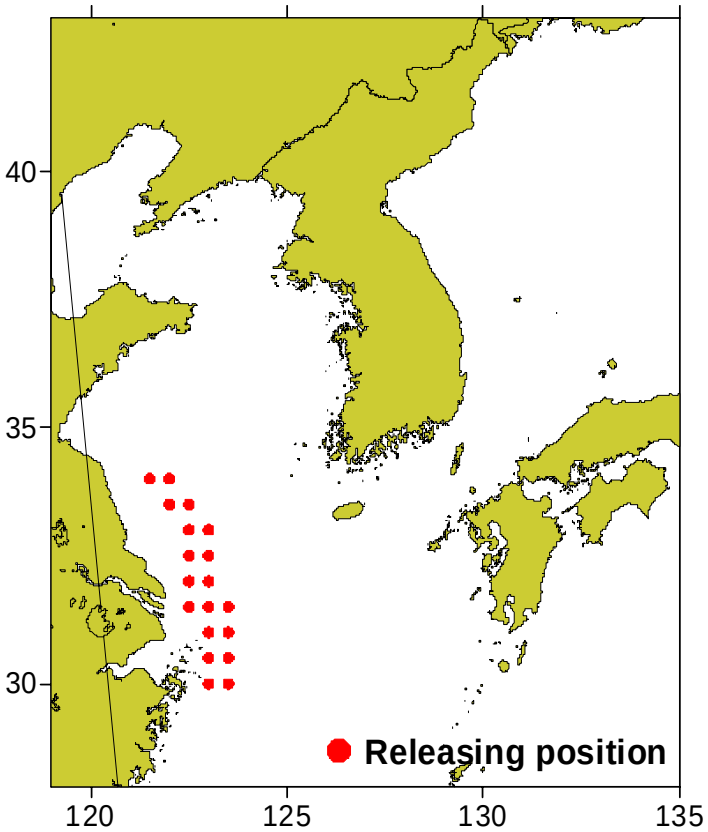


Horizontal distribution of Surface salinity by shipboard CTD in August 2005

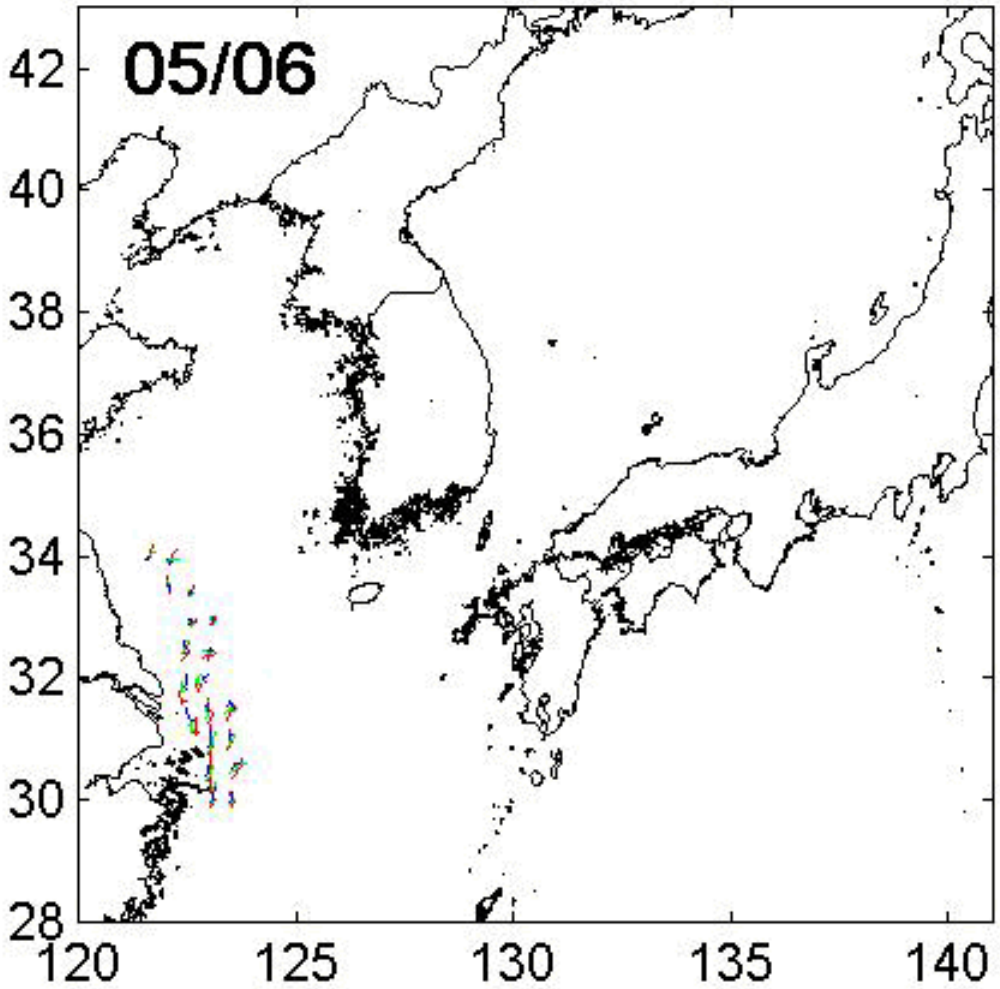


Simulation of surface salinity by a numerical model in August 2005

Possible Origins (3)

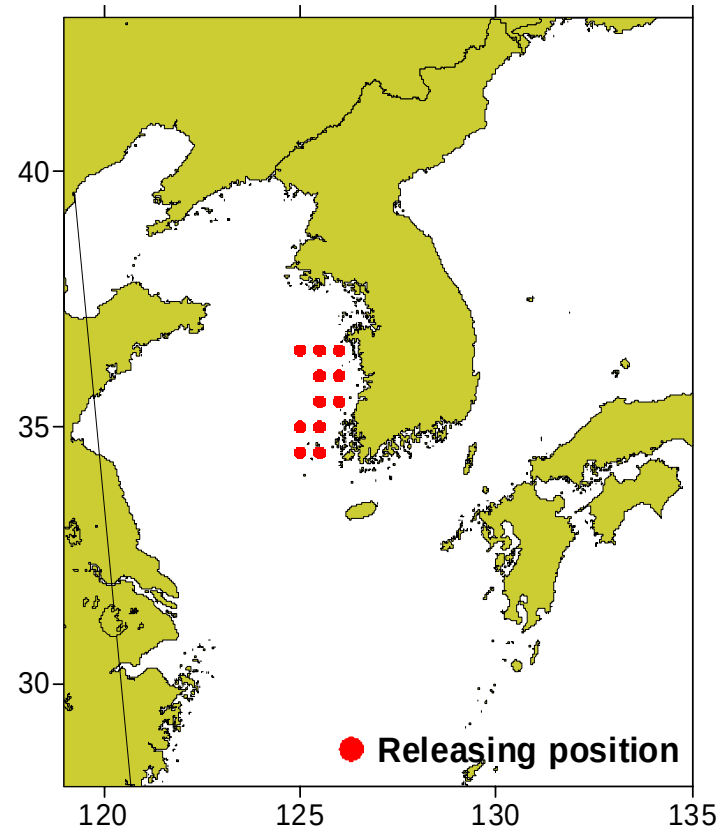


Deployed off Chinese coast at the surface (-), 5m (-) and 10m (-) depths during May-August

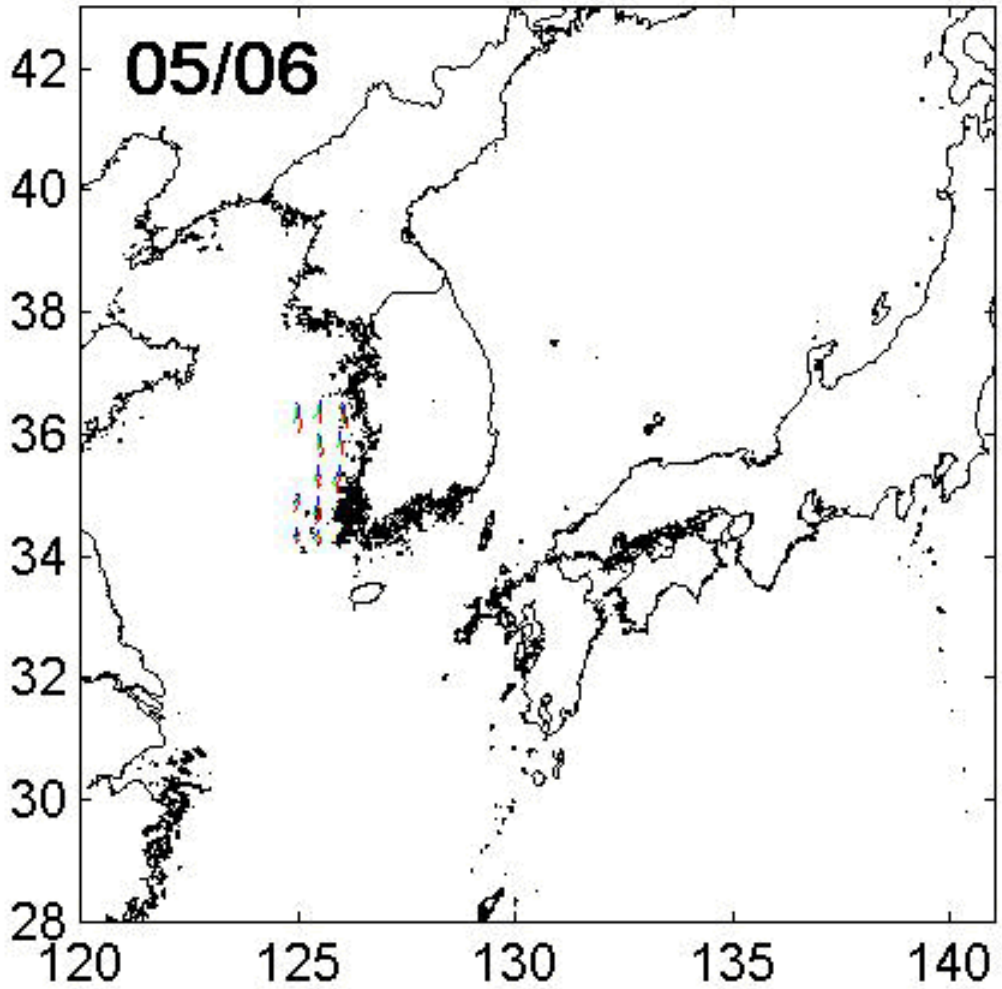


surface : - , 5m : - , 10m : -

Possible Origins (4)

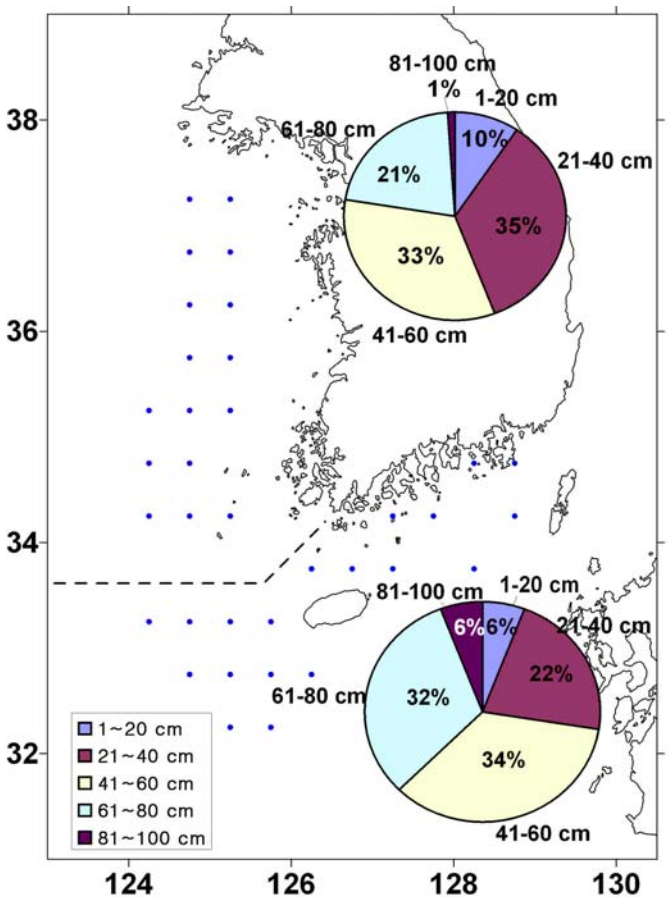


Deployed off Korean coast at the surface (-), 5m (-) and 10m (-), depths during May-August

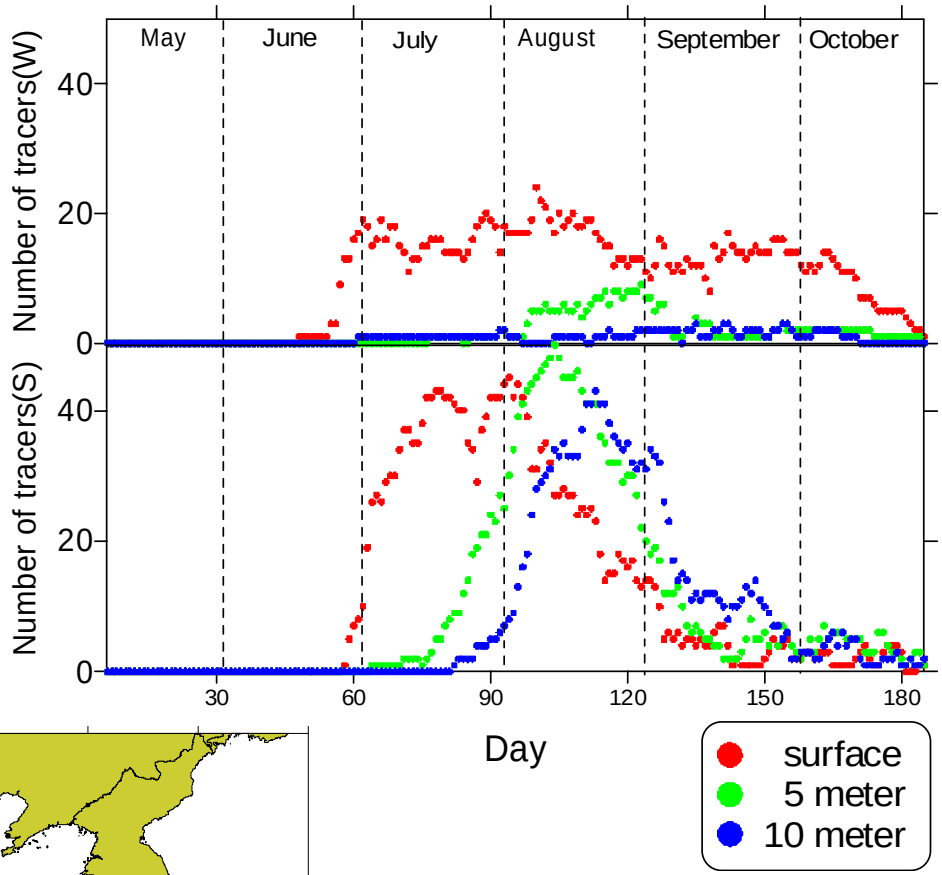


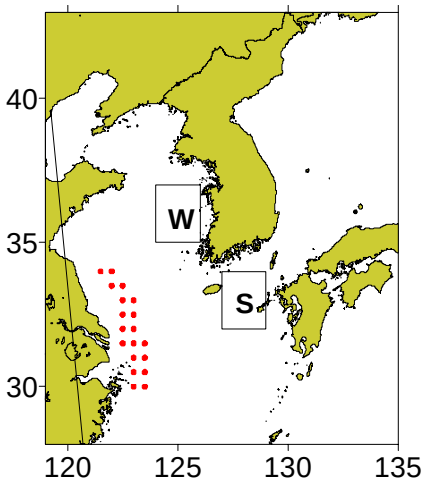
surface : - , 5m : - , 10m : -

Possible Origins (5)



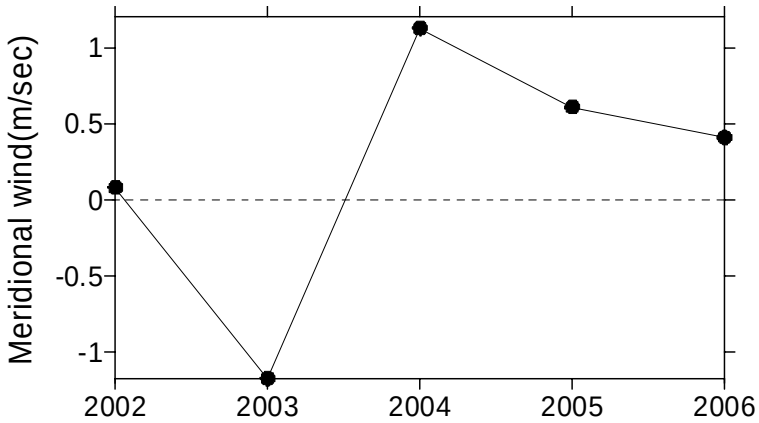
Percentage of the jellyfish in the West and the South Seas of Korea by size in August 2005 caught by trawl



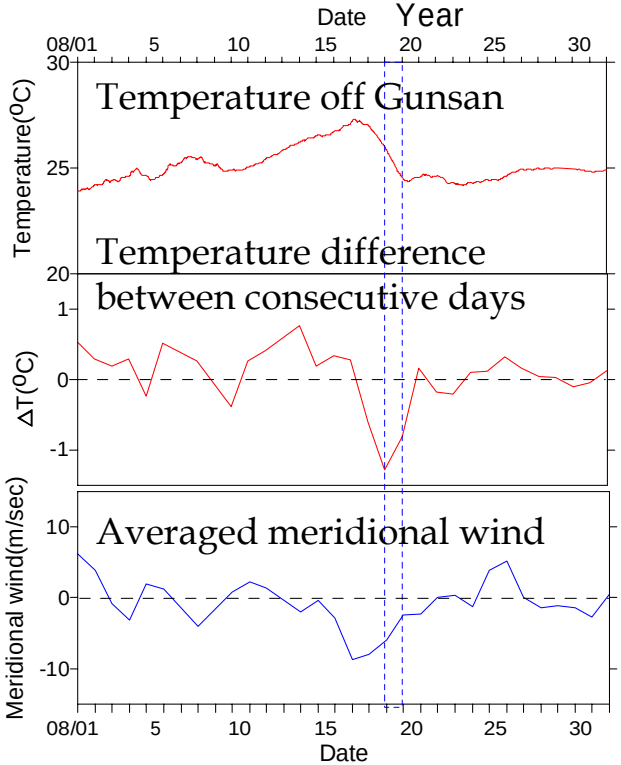


Tracers at the shallower depth enter the Yellow Sea much than the Korea/Tsushima Strait.

Possible Origins (5)

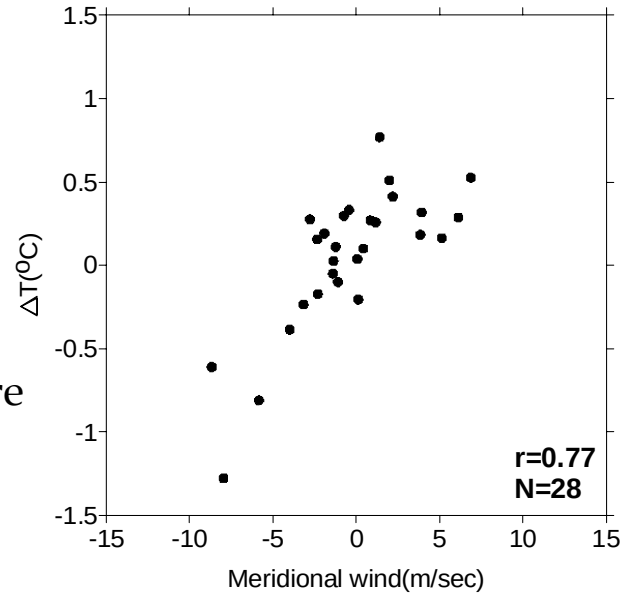


Monthly averaged meridional wind over the southern Yellow Sea in May from 2002 to 2006



Temperature and averaged wind off Gunsan in Augut 2006

Correlation coefficient between the temperature difference and meridional wind



Conclusion

- *Nemopilema nomurai* started to occur in early July 2005 near Jeju Island and occupied mainly in the West and South Seas of Korea in August, which is well-timed with the CDW expansion to the Korea/Tsushima Strait.

- According to analyses of appearance of the jellyfish and oceanographic conditions in the northern part of the East China Sea, the jellyfishes was likely to be transported along with the CDW into Korean waters.

- By numerical simulation, *N. nomurai* in Korean waters seemed to be originated from at least Chinese coast and not only West Sea of Korea.

- It is very careful to conclude that young medusae off Gunsan in 2004 indicate an origin because of the capability of carrying them by surface wind.

Thank you for your attention