Detection of low salinity water in the northern East China Sea in summer using ocean color remote sensing

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ABSTRACT

In summer season of 1998, a huge flood occurred around the Yangtze River in the eastern China. The low salinity water less than 28 psu from the river was detected around the southeastern part of the Jeju Island which is located in the southern part of the Korean peninsula. We studied how to detect low salinity water from the Yangtze River, which gives terrible damages to the Korean fisheries.

We got the relationships between low surface salinity, turbid water from the Yangtze River and digital ocean color using remote sensing of SeaWiFS satellite in the northern East China Sea in summer seanson of 1998, 1999, 2000 and 2001. The charts of salinity in the northern East China Sea were made by the regenerating of the satellite ocean color data with the formula from the relationships between low salinity, *in situ* turbid water (transparency) and satellite ocean color.

Keyword: salinity, ocean color, remote sensing, Yangtze River, SeaWiFS

INTRODUCTION

The East China Sea is important not only as a good fishing ground but also nursery and spawning area for many kinds of fishes. A great variety of marine environments occur in the northern East China Sea specially, ranging from the Kuroshio-dominated edge of the Pacific Basin to the Shallow, run off-freshened reaches of the Yellow Sea and East China Sea. There are severe atmospheric forcing and time-grained-sediment fluxes on the vast shallow water less than 100m depth.

During summer season the overall heating of surface water and the following stratification of surface layer water does not allow convection to mix up sea water from the surface to bottom. Therefore, the surface temperatures are considerably higher in August ; 27～29℃, but the surface salinities are very lower in August ; 25～28 psu in the East China Sea because of the run off from the Yangtze River with turbid fresh water (Chikuni, 1985).

The low salinity water less than 19 psu from the Yangtze River hit to the coastal water around the Jeju Island which was located in the southern part of Korean peninsula in the summer of 1996. Marine organisms around the coastal area of the Jeju Island were severely damaged by the low salinity water. After that event, we have set up the monitoring system on semi-real time base with the survey of research vessels. However, something we need is real time monitoring system to detect low salinity distribution around the waters of the Jeju Island.

The salinity itself has no direct colour signal. However, Monahan and Pybus (1978) showed that yellow substance (the optically active component of DOC) in waters off the West Coast of Ireland could be related to the salinity through the colour signal. There were relationships between optical properties of coastal water and salinity observed in fileds. Spatial distributions of surface salinity matched the Secchi depth and the water colour determined using Forel scale (Steen and Hoguance, 1990; Hoguance, 1997).

The aim of this study is to relate the low salinity of the northern part of East China Sea to the turbid water from the Yangtze River using satellite ocean color and transparency in stead of Forel scale.

MATERIALS AND METHODS

The oceanographic data including salinity, transparency and suspended solid (SS) were collected in August 1996–2001 on board research vessels of the National Fisheries Research & Development Institute (NFRDI) in Korea. Secchi depths (transparencies) were measured using a standard white Secchi disc. The data of colour bands from SeaWiFS satellite were received through the antenna located at NFRDI during 1998-2001.

To relate the satellite ocean color to *in situ* salinity, we tried to get the several empirical relationships between *in situ* SS, transparency and *in situ* salinity, and between in situ SS, transparency and the ocean color (band ratio 490/550 nm) from the satellite.

RESULTS

Although the relationships between *in situ* SS and *in situ* salinity in the East China Sea were not obvious, we got the good relationships between *in situ* salinity and *in situ* transparency in the northern part of the East China Sea in 1996, 2000 and 1996-2001 (Fig. 1).

A close relationship between the *in situ* transparency and the ratio of SeaWiFS normalized water leaving radiance (nLw490/ nLw555) was also obtained in August 2000. So, we were able to set up the simple algorithm related to the estimating salinity using the relationships between *in situ* salinity and the estimated transparency(8.1698*SeaWiFS (nLw490/nLw555)-2.517) with the band ratio (nLw490/nLw555) from the SeaWiFS (Fig. 2).

When we used only the relationship (Salinity $_{(PSU)}$=0.4135(8.1698*SeaWiFS (nLw490/nLw 555)–2.517)+25.485, R^2=0.61) in 2000 among the relationships during 1998-2001, we were able to get a good matched results between the *in situ* and the estimated salinity.

The distributions of low salinity water in the East China Sea in August in 1998, 1999, 2000 and 2001 were generated by developed simple algorithm in this study. The result of comparison between the estimated salinity (PSU) derived form SeaWiFS satellite and the *in situ* salinity at the sations located between Yangtze River and the waters of Jeju Is (Fig. 3). The accuracy is less than 2.5 PSU (Fig. 4).

DISCUSSION

The study area off the coast of the Yangtze River is the one in which the clear Kuroshio warm waters (Secchi depths are higher than 25 m in the offshore stations) meet with the more turbid coastal waters from the Yangtze River. This makes it an ideal region for the salinity detection with ocean color.

Therefore, the detection of salinity through an optical signal (the estimated transparency from ocean color satellite) due to yellow turbid water from the Yangtze River would seem a sensible approach to monitor the low salinity in the northern part of the East China Sea in every summer season.

CONCLUSION

A simple algorithm that used the relationships between the measured salinity, transparency and the reflectance ratio of SeaWiFS shows good agreement with the real salinity distribution, which therefore confirms our hypothesis.

REFERENCES

Bowers, D. G., Harker, G. E. L., Smith, P. S. D. and Tett, P. (2000) Optical properties of a region of freshwater influence (The Clyde Sea). *Estuarine, Coastal And Shelf Science* **50**(5), 717-726.

Carder, K. L., Chen, F. R., Lee, Z. P. and Hawes, S. K. (1999) Semi-analytical moderate-resolution imaging spectrometer algorithm for chlorophyll *a* and absorption with bio-optical domains based nitrate-depletion temperatures. *Journal of Geophysical Research* **104**, 5403-5421.

Chikuni, S. (1985) The fish resources of the northwest Pacific. *FAO Fisheries Technical Paper* **266**, 6-7.

Monahan, E. C. and Pybus, M. J. (1978) Colour, UV absorbance and salinity of the surface waters off the West coast of Ireland. *Nature* **274**, 782-784

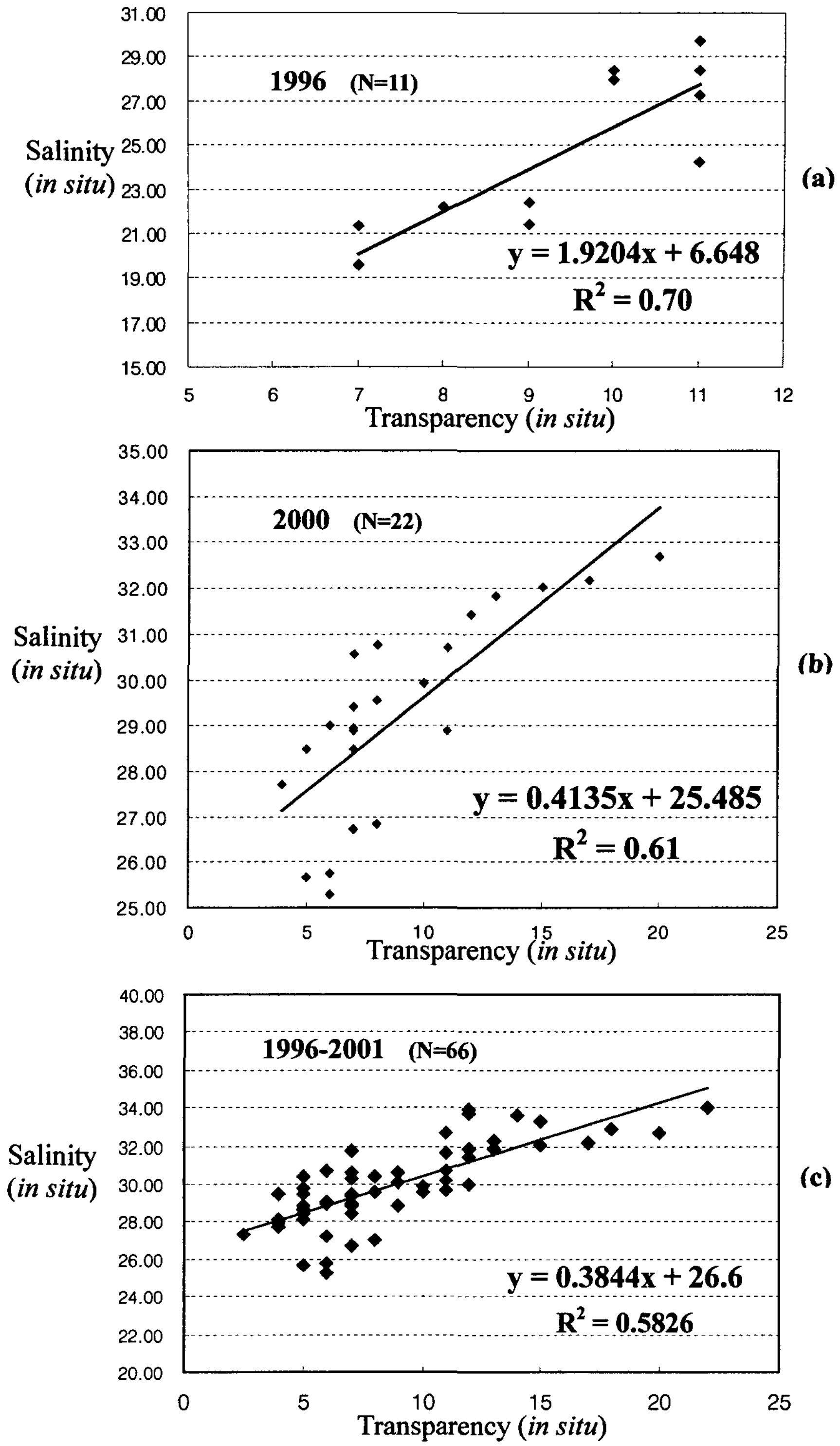

Fig. 1. Relationship between the measured field salinity (psu) and the *in situ* transparency (m) in August (a)1996, (b)2000 and (c)the years (1996~2001).

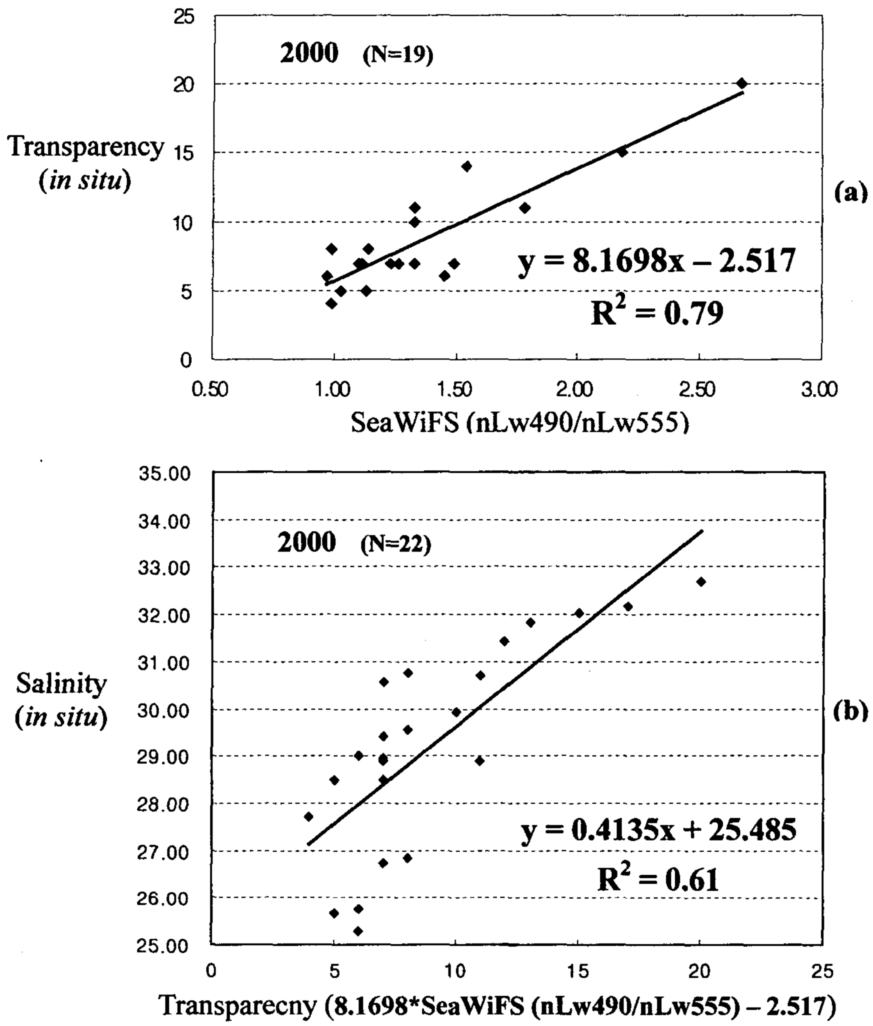

Fig. 2. Relationship between (a) the measured field transparency (m), (b) the in situ salinity (psu) and the estimated transparency using the band ratio (nLw490/nLw555) from the SeaWiFS satellite.

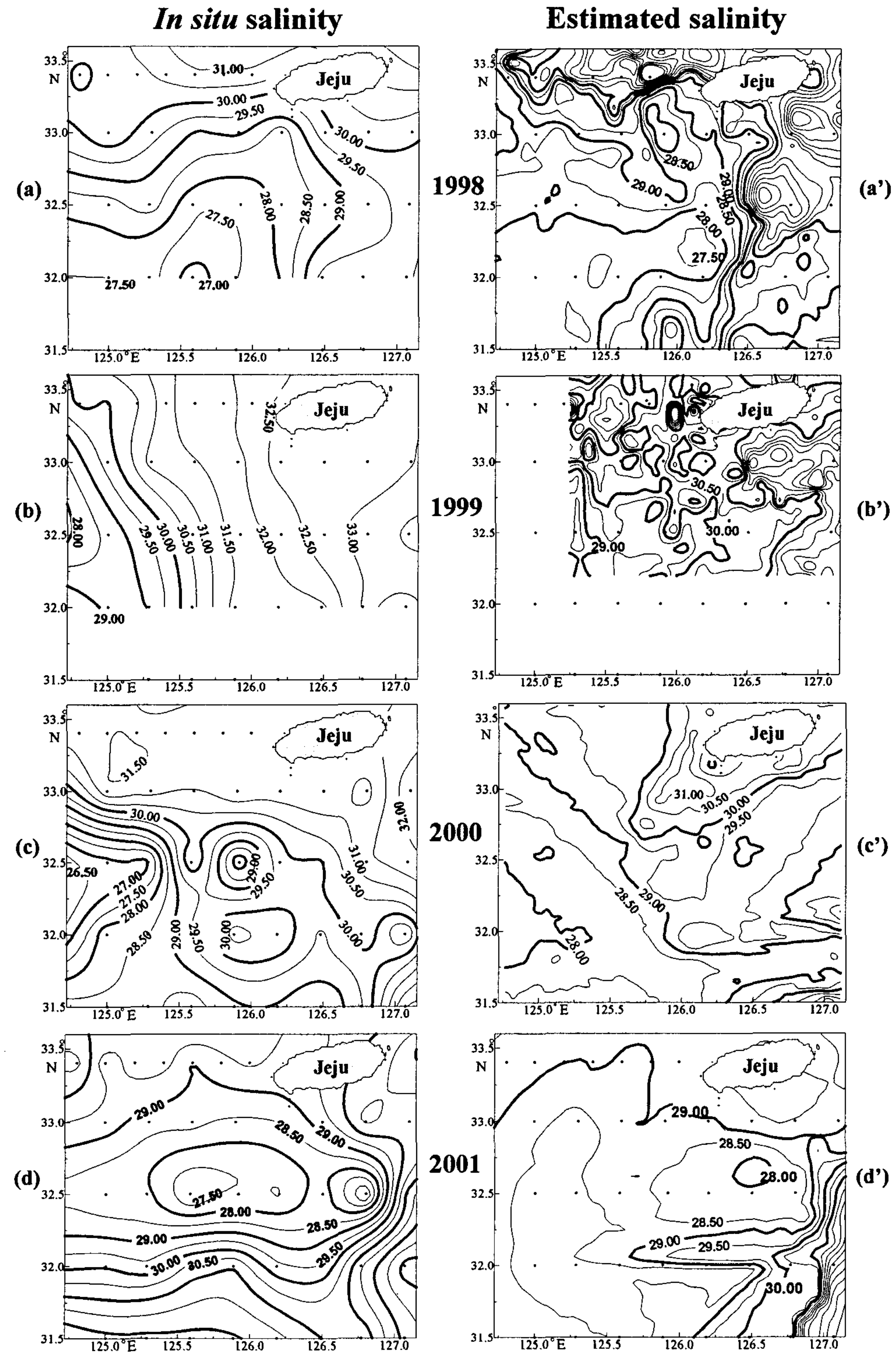

Fig. 3. Distribution of surface salinity (psu) in August during 1998-2001.
Measured field surface salinity in (a) 6-8 Aug., 1998, (b) 12-20 Aug., 1999, (c) 4-6 Aug., 2000 (d) 17-23 Aug., 2001.
Estimated surface salinity from the SeaWiFS data using the developed regional algorithm in (a') 4 Aug., 1998, (b') 19 Aug., 1999, (c') 6 Aug., 2000, (d') 16 Aug., 2001.

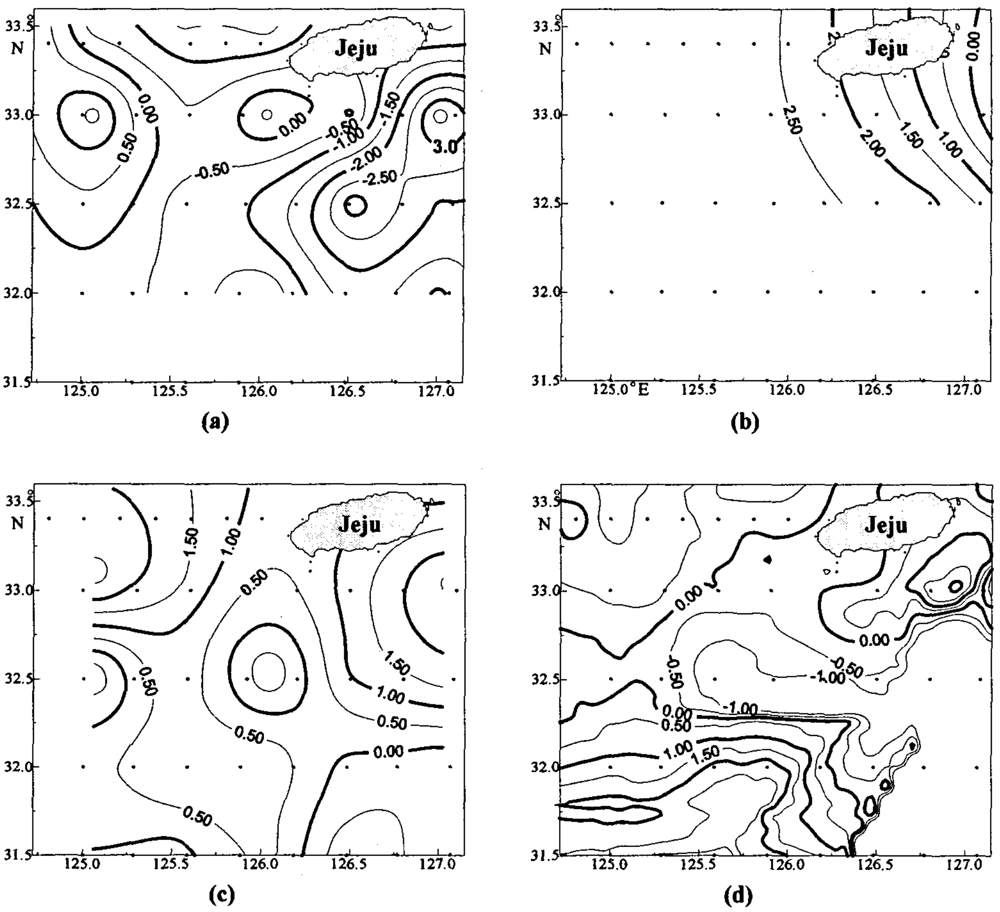

Fig. 4. Horizontal distribution of the differences in salinity (PSU) between the measured salinity in field and the estimated one from satellite data in (a) 1998, (b) 1999, (c) 2000 and (d) 2001.