ALIASING DUE TO SAMPLING OF THE ADRIATIC DENSITY ANOMALY IN SPACE

Zoran Pasaric [1]*, Mirko Orlic [1], Craig M. Lee [2]

[1] Andrija Mohorovicic Geophysical Institute, Faculty of Science, University of Zagreb, Horvatovac bb, 10000 Zagreb, Croatia - *pasaric@rudjer.irb.hr, orlic@rudjer.irb.hr

[2] Applied Physics Laboratory, University of Washington, 1013 NE 40th St. Seattle, WA 98105-6698, USA - craig@apl.washington.edu

Abstract

Errors associated with coarse sampling of the sub-surface density anomaly over the middle and north Adriatic are analyzed, using underway data collected within the DOLCEVITA project. The errors are seasonally and spatially dependent. They are larger in spring then in winter and also over the shallow Italian part as compared to the deeper Croatian part of the basin. The results should be relevant for the planning of future CTD measurements in the region.

Keywords: spatial aliasing, density anomaly, Adriatic Sea

Introduction

The present work is based on the sub-surface temperature and conductivity data measured with high spatial resolution during two cruises (31 Jan – 24 Feb and 26 May – 15 Jun 2003) conducted by the *R/V Knorr* over the middle and north Adriatic within the DOLCEVITA project. High spatial resolution enabled *a posteriori* analysis of sampling errors that would occur if the same measurements were performed with coarser spatial sampling.

Data and Analysis Procedure

Underway sea surface temperature and conductivity were measured using a Falmouth Scientific thermosalinograph (OCM-TH-212) which is part of the *R/V Knorr* meteorological (IMET) sensor system. The sensors were mounted on the bow at 5 m depth. Readings were averaged and recorded at one-minute time intervals along the whole ship path (7000 km for the winter and 6700 km for the spring cruise) together with time and location. The typical cruising speed of 8 knots gives the distance between data samples of ca. 250 m.

After basic quality check, the density anomaly was calculated and subsequently analysed. First, the data measured while sailing speed was below 4 knots were discarded and linear interpolation was performed every 100 m along the ship track. Next, sub-sampling was performed with various spatial steps (Δx = 1, 2, 5, 10 km), the sub-sampled series were linearly interpolated back to 100 m intervals, and the squared differences were calculated between this and the original series. The starting point for sub-sampling was systematically varied within the first Δx kilometers of the sequence (with step of 100 m), and squared differences obtained were averaged. Finally, we covered Adriatic with rectangles (bins) of 2 by 2 km, averaged all the differences that fall within particular rectangle, and took square root. The root mean square (RMS) sub-sampling density anomaly error thus obtained was plotted as a 3D bar graph.

Discussion and conclusions

We discuss briefly results for 5 km sampling interval. Large sub-sampling errors are associated with the presence of small scale features in the density field. For winter situation (Fig. 1) the error is generally small. The 'island' of large errors in the middle part of northern Adriatic is associated with the light, Po River water that has been advected by bora (see e.g. [3]) which blew during the greater part of the February cruise. Other occurrences of large errors are also associated with the Po River outflow, aligned with the Italian coast. In spring (Fig. 2) large errors cover the wide area along the Italian coast, whereas maximum is reached in the front of the Po River mouth. In the middle part of the basin, as well as close to the Croatian coast, errors are generally small, except close to the cap of Istria peninsula (probably influence of bora) and at the very south-east corner (probably influence of Dalmatian rivers). For 1 km sampling interval the error is typically below 0.01 kg/m^3 in winter and 0.04 kg/m^3 in spring. However, it may still be very large over some small regions (not shown).

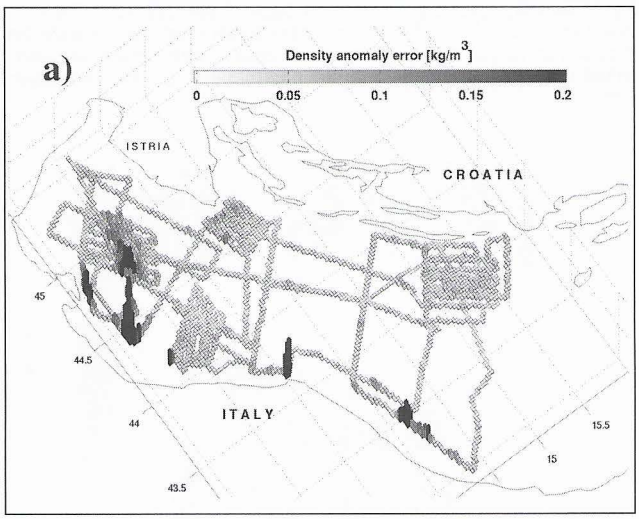

Fig. 1. Sub-sampling RMS error of density anomaly along the ship path for the winter. The error is proportional to the height of each bar and is also indicated by the gray level. Black bar implies error that is larger than 0.2 kg/m^3.

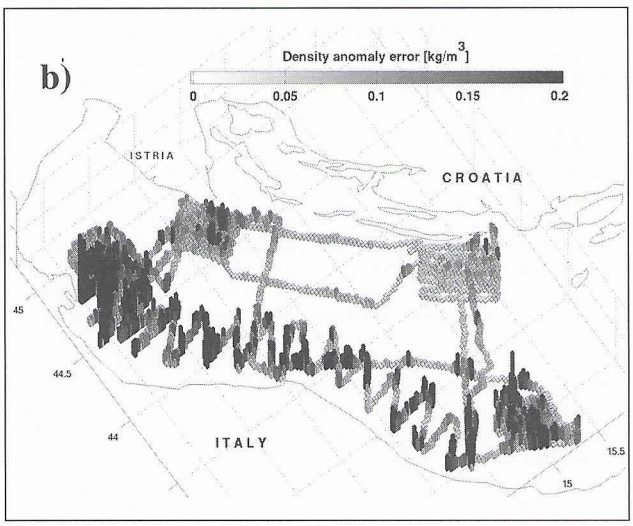

Fig. 2. Sub-sampling RMS error of density anomaly along the ship path for the winter for the spring cruise. The error is proportional to the height of each bar and is also indicated by the gray level. Black bar implies error that is larger than 0.2 kg/m^3.

It may be concluded that spatial variability of sub-surface density field over the middle and north Adriatic is much greater in spring (i.e. warm part of the year) than in winter (cold part of the year). Also it is bigger over the shallow, Italian part (influenced by the Po River) than over the deeper, Croatian part of the basin. The spatial aliasing error associated with this variability is quantified which, we feel, may be helpful for planning the future CTD measurements in the region.

References

1 - Orlic M., Kuzmic M., Pasaric Z., 1994. Response of the Adriatic Sea to the bora and sirocco forcing. *Continental Shelf Research*, Vol. 14, No 1: 91-116.