Particulate flux studies at continental shelf margin using sediment traps

The continental shelves have been suggested to give strong impacts on the global marine carbon cycles due to their high rates of biological production and large amounts of dissolved and particulate matter. In recent years, there have been several large research programs focussing on the studies including continental shelf margins such as SEEP (Shelf Edge Exchange Processes), ECOMARGE (Ecosystems of Continental Margins), MASFLEX (Marginal Sea Flux Experiment) and KEEP (Kuroshio Edge Exchange Processes). The aims of the continental margin studies are summarized by the JGOFS/LOICZ task term (SCOR, 1994) and the sediment trapping technology has been recognized as one of useful tools to study the following aims:

1. to quantify exchanges of carbon at given marginal zones between shelves and the open ocean;
2. to understand seasonal and interannual fluctuations of vertical and horizontal carbon fluxes and nutrient cycles due to physical and biogeochemical variations;
3. to evaluate the importance of carbon deposition and benthic processes on the continental slope.

Here, we present the brief results of sediment trap experiments at MASFLEX project (Iseki 1994, Iseki et al. 1994), and summarized some of the major conclusion of the continental margin flux studies.

In the MASFLEX project, conventional and time series sediment traps were used to collect settling samples; the former was seasonally deployed at three mooring sites on the shelf (Sts. 5, 8 and 12 along the PN cruise track) for a couple of days during each cruise, and the latter was deployed at the Okinawa Trough (Sts. SST1 and SST2) and the adjacent Pacific Ocean (Sts. SST3 and SST4) for one year (Figure 3).

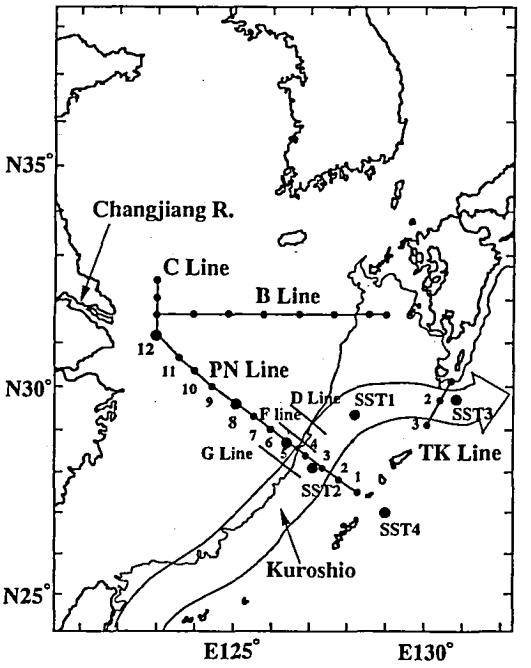

Fig. 3. Locations of the sampling sites for the MASFLEX-I and -II in the East China Sea.

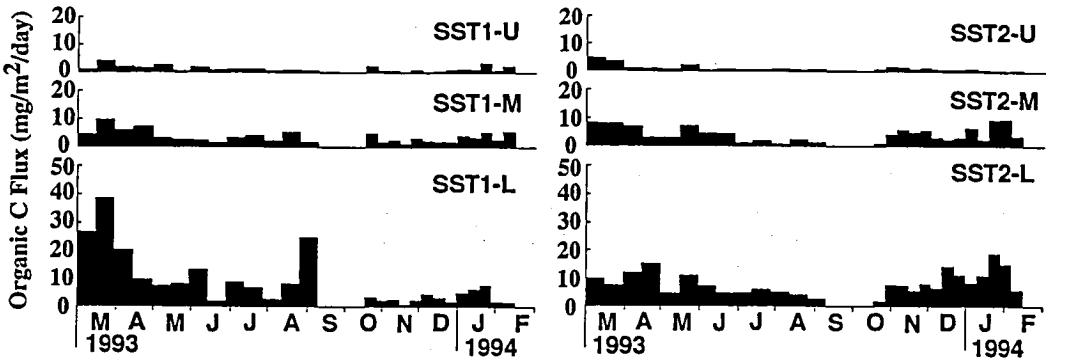

Fig. 4. Seasonality in vertical fluxes of particulate organic carbon at St. SST 1 and SST 2 (ca. 1,100 m) in the Okinawa Trough. Trap depths: U = 600 m, M = 800 m and L= 50 m above the bottom (Iseki et al. 1994).

At the shelf stations, particulate fluxes rapidly increased near bottom thoughout the year, probably due to resuspension of bottom sediments. At the shelf edge station at St. 5, the fluxes in the bottom layer were significantly higher in autumn and winter than those in spring and summer. At the Okinawa Trough Stations (ca. 1,100 m), particulate fluxes at 600 m depth was extremely low but increased noticeably with depth (800 m and 50 m above the bottom) (Figure 4). The flux generally showed a peak from late autumn to early spring and was lowest during summer with a unusual large peak in the early September although there was no data from the middle of September to the middle of October. High particulate fluxes observed at the deep Trough in winter have been attributed to the wind-induced downwelling cell (Hu 1994), because downwelling induced by the northeasterly monsoon wind in winter favors the offshore transport of bottom water rich in particulate matter.

These results indicate that the seasonality of particle fluxes in the deep Trough waters are apparently linked to seasonal events in shelf waters, and resuspension and near-bottom transport may be key processes for cross shelf transport of particles. Similar results were obtained in the other continental shelf margins and the flux generally increases shoreward and toward the seafloor, suggesting possible predominant transports of lateral and along the seafloor (Biscaye et al. 1988, Monaco et al. 1990).

The significance of continental shelf margins in global carbon cycle is yet difficult to quantify due to their complexity and variability for each coastal unit, and so the sediment trapping approaches should be supplemented by carbon budgeting to constrain the estimation and by regional models (Liu et al. 1995).

Figure 5 shows the preliminary results of

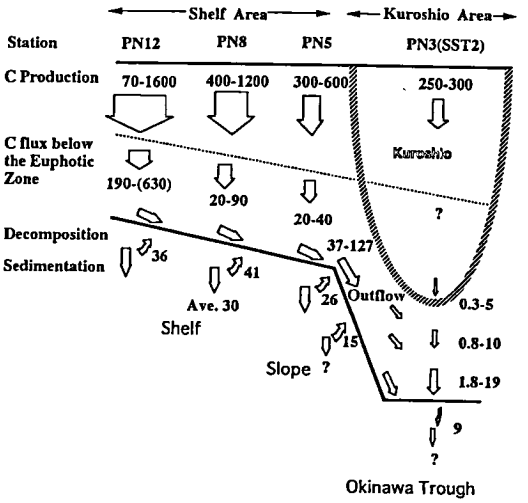

Fig. 5. Preliminary result of the carbon budget in the East China Sea. C production (C-13 uptake experiment); bottom decomposition and sedimentation were calculated from the data of Hama, Ito, Kato, Matsumoto & Hoshika (personal comm.). C flux below the euphotic zone on the shelf and the fluxes at the Trough were obtained by sediment trap experiment. This figure should be refined later by further observations.

the carbon budget in the East China Sea. The exported organic carbon was calculated from this carbon budget, indicating 37–217 mgC m^{-2} d^{-1} (4–22% of the overlying water column primary productivity of the shelf sea assuming the productivity of the shelf of about 1 gC m^{-2} d^{-1}) is exported from the shelf. However, these budgeting approaches are also undoubtedly suffered from some inaccuracies due to imprecision in each component, insufficient temporal and spatial coverages, and insufficient understanding of processes involved in continental carbon fluxes as estimated in the Mid-Atlanitic Bight at SEEP project (Walsh 1981, Rowe et al. 1986). Further, the studies are mainly focused on POC fluxes but for the exported organic carbon should be also assessed DOC fluxes. Thus, the carbon flux estimates of Figure 3 should be reformed in the future. In addition, the regional models coupling with physical and biogeochemical processes must be employed to overcome the limited observations and the inaccuracies.

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