The temporal variability of particle composition in the river plume of a small mountainous river

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FATES-HYPERS: FAte of TErrestrial/Nonterrestrial Sediments in High Yield Particle-Export River-Sea Systems

Introduction

River plumes are important pathways for particulate terrestrial matters to enter the sea. Therefore, studying how the suspended particle composition of the river plume influenced by the tide, wave, wind and discharge is an important issue in the Source-to-Sink research. This study tries to characterize the particulate component variability of river plume when the river water enters the sea.

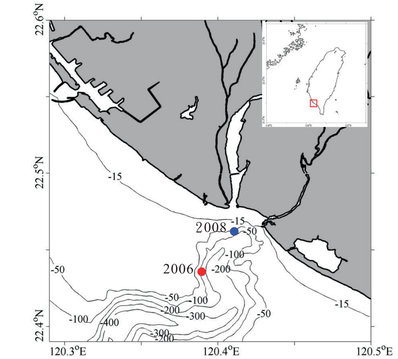


Fig1. Map of study area.

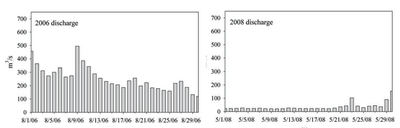


Fig2. River discharge.

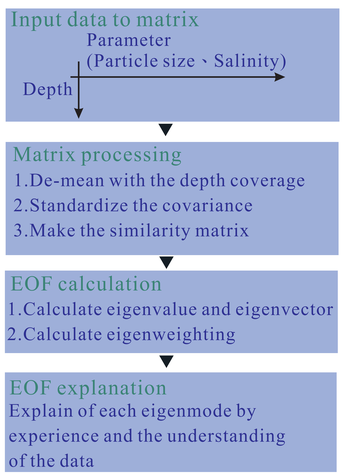


Fig3. The empirical orthogonal function (EOF) process flow chart.

Each profile has an EOF result including Eigenvectors and Eigenweightings. We use the example of profile1 on the 2006 cruise here. (Fig. 4) We can see the Eigenvectors of Mode 1 and Mode 2 then we use the eigenweight's zero-crossings to determine the thickness

Materials and methods

The study area was Gaoping River mouth which is located in southwestern Taiwan (Fig. 1). The Gaoping River had the largest basin area and in the second longest in Taiwan. The component of river plume was observed by using a CTD and LISST-100 on board R/V Ocean Researcher III between August 27 to 28, 2006 and between May 23 to 24, 2008 (Fig. 2). We collected upper-column data and used the empirical orthogonal function (EOF) technique to analyze (Fig. 3) the correlations among the structures of grain-size groups of 32 sizes suspended sediment particles (between 1.25-250 μm), salinity and water temperature on the hourly basis. The EOF method can effectively distinguish different modes of the grain-size variability in space and time in the river plume affected by different environmental factors.

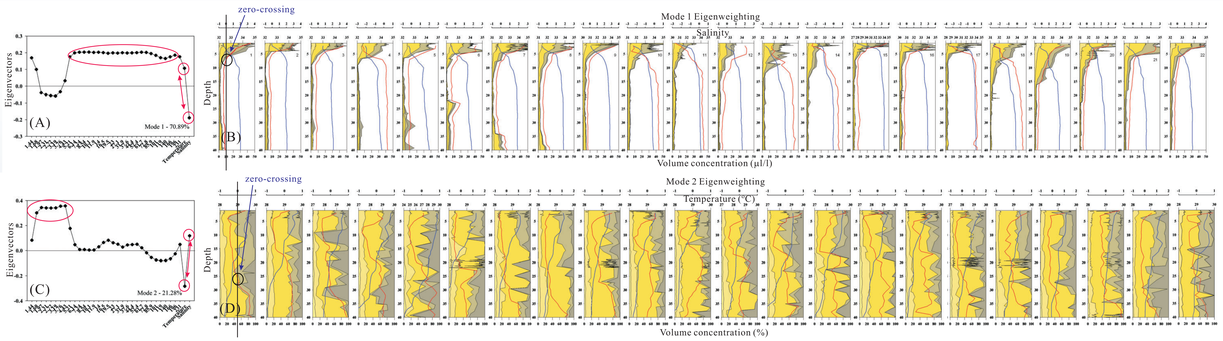


Fig4. The Eigenvectors and Eigenweighting on 2006 cruise data. The blue curve is salinity and temperature respective. The red curve is Eigenweighting.

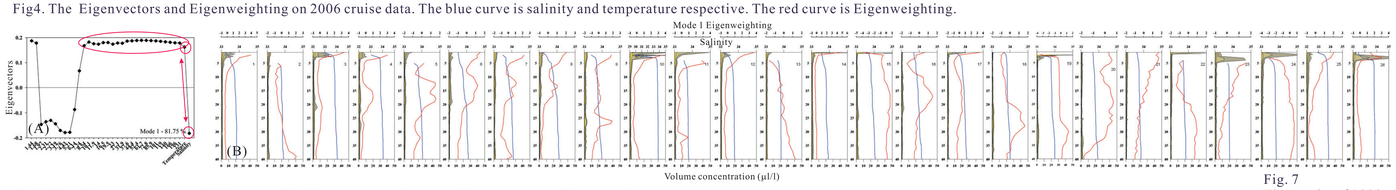


Fig5. The Eigenweighting on 2008 cruise. The blue curve is salinity and the red curve is Eigenweighting.

Results and discussion

The data showed that in both years, there was a high volume concentration layer on the surface. The layer in Aug. 2006 was thicker than that in May 2008. High temperature and low salinity value were also found in this high-concentration layer. This means that the surface layer of the water was related to the river plume. Then we use the empirical orthogonal function (EOF) to examine the correlation of analysis the data.

Since in the 2006 data set the 1st two eigenmodes explain over 90% of the correlations, only these two modes are presented in this abstract. The first eigenmode explains about 70 % of the correlations. This mode distinguishes the grain-sizes classes into two groups. The coarser (3-250 μm) group is associated with the high water temperature and low salinity. In this scenario, the river effluent lowers the salinity and increases the water temperature (Fig. 4 A). This mode suggests that the coarser group is of terrestrial origin, and is associated with the river plume. And we used the eigenweight's zero-crossings from the first eigenmode to determine the thickness of the river plume as co-defined by grain size, salinity and temperature (Fig. 4 B). The second eigenmode accounts for about 20 % of the correlations (Fig. 4 C, Fig. 6 A). This mode describes the dominant influence of water temperature affecting the finest grain-size classes (< 3 μm). When the colder water from submarine canyon welled up, the surface water temperature decreased, but the concentrations of the finest grain-size classes increased. We also used the eigenweight's zero-crossings from the second eigenmode to determine the upper boundary of the influence of the submarine canyon water (Fig. 4 D, Fig. 6 B).

Similar results appeared in the 2008 data set. The coarser (3-250 μm) group is associated with the high water temperature and low salinity in the first eigenmode about 80 % of the correlations (Fig. 5 A). The first eigenmode is the river plume mode like the first eigenmode of 2006 result. Sometimes the sampling station was not affected by the river plume. In this case, the 1st eigenmode describes the dominant influence of water temperature affecting the finest grain-size classes (< 3 μm). The 2nd eigenmode is the submarine canyon mode similar to that of 2006. We used the eigenweight's zero-crossing from the river plume mode (Fig. 5 B, Fig. 7 A) and the submarine canyon mode (Fig. 7 B), to determine the lower boundary of the plume domain and the upper boundary of the submarine canyon domain.

Fig. 6
The results of 2006 cruise (A)Salinity and plume depth variability. The blue curve is the 1st mode eigenweight's zero-crossing depths. (B)Temperature and variability of submarine canyon influence. The red curve is the 2nd mode eigenweight's zero-crossingdepths.

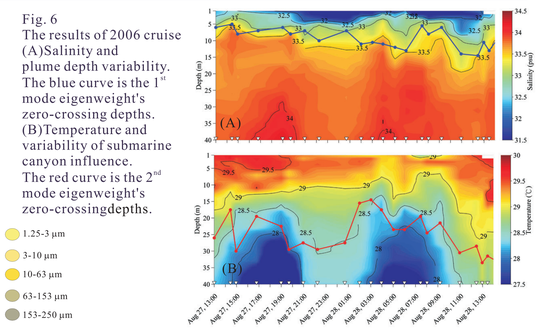
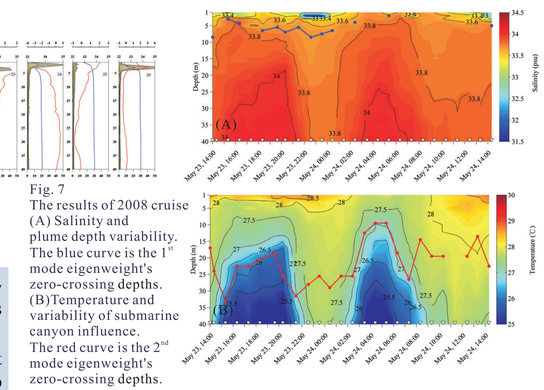


Fig. 7
The results of 2008 cruise (A) Salinity and plume depth variability. The blue curve is the 1st mode eigenweight's zero-crossing depths. (B)Temperature and variability of submarine canyon influence. The red curve is the 2nd mode eigenweight's zero-crossing depths.



Conclusions

The results suggest that the grain-size classes coarse than 3 mm size-classes are terrestrial suspended sediment exported by the river plume. The thickness of the river plume ranges from 2 to 15 m affected by the tide and discharge. Although, the station in 2008 is closer to the river mouth than 2006, the river plume in 2006 was thicker than that of 2008. This is because the discharge in 2006, 2008 were 210.4 (cms) and 71.97 (cms), respectively (Fig. 2). The grain sizes finer than 3 mm size-classes in the water column come from the submarine canyon below, whose effect can reach as shallow as 10 m below the surface especially under the offshore-directed wind conditions.