Geophysical Research Abstracts
Vol. 16, EGU2014-1914, 2014
EGU General Assembly 2014

Influence of bottom topography on dynamics of river plumes in semi-enclosed domains: Case study in Taiwan Strait

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This paper summarizes the results of a Russian-Taiwan research project focused on the role of continental discharges into the Taiwan Strait, an important channel in the western Pacific Ocean transporting water between the South China Sea and the East China Sea. Another critically important hydrographic feature in the area is the discharge of freshwater from multiple rivers of the western coast of Taiwan. With its long-term average discharge rate of 210 m3/s, the Zhuoshui River is the biggest of the rivers bringing a large amount of pollutants and nutrients into the Strait. The northern extremity of Zhuoshui River's plume often merges with that of the Wu River (also known as Dudu River) whose average discharge rate is about 120 m3/s.
Oceanic waters in the area experience significant anthropogenic pressures, traceable to the distance of a few km offshore and tens of km along the shore. This is manifested, in particular, in strongly elevated concentrations of copper, iron, and other trace metals. The corresponding quantitative estimates are obtained. The newly obtained in situ data from a field campaign were also used to implement 2 numerical models aimed at simulating the pathways of the continental waters in the study region. One of them, based on the Princeton Ocean Model, was coupled with a regional barotropic tidal model for the Taiwan Strait. The other one, a fully Lagrangian model STRiPE is based on applying a complete set of momentum equations to individual "particles" of river water released into the ocean. Both models demonstrated reasonable good agreement with the in situ data and each other. The bathymetry, tides and winds significantly affect the dynamics of the Wu and Zhuoshui river plumes, acting together in a complex interactive manner. The Zhuoshui River plume stretches in a narrow alongshore belt both to the south and north from the river mouth while the larger, round-shaped Wu River's plume elongates mostly north of its mouth. The difference is explained through the bottom topography: while near the Zhuoshui mouth the bottom is very flat and shallow, the terrain adjacent to the Wu mouth is much steeper and deeper. Bottom topography and tidal inundation also play an important role in the plume dissipation: due to enhanced mixing in shallow areas subject to tidal drying/flooding of the bottom, such as the area north of the Zhoushui mouth, the salinity anomaly is generally smaller and the plume is narrower and dissipates faster than in the deeper near-mouth areas like that of Wu River. Under the NE wind conditions, the Wu and Zhuoshui plume almost merge and form a unified low salinity belt. In contrast, action of SW wind causes effective separation of river plumes. In the case of NW winds, the plumes are pressed towards the shore and trapped at the mouths, while in the case of SE wind they stretch towards the ocean. The daily mean area of the plumes under the SE wind conditions is about 6 times larger than that under the NW wind.