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The Importance of Synchronized Observations in Coastal Seas with Large Intra-Tidal Temperature Variation and Intermittent Thermocline

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In coastal seas, the combination of influences from multiple forcing (e.g. tide, wind and river), the presence of complex topography and coastline, the coupling of multiple process coupling (e.g. stratification, air-sea heat exchange), and other factors often leads to strong variability of sea state. To demonstrate the importance of synchronized observations for synoptic description of sea state, a 21-vessel synchronized biogeochemical observation was carried out from Aug 17th to 20th 2009 in Jiaozhou Bay (JZB) of China with a surface area of about 400km^2. The observation provides high spatial and temporal resolution synchronized thermohaline data. The stations are positioned approximately 20 km^2 apart with at least 0.5m in depth. Continuous sampling was carried out in the shallow northern region with depth under 10m. The interval of profiles was one hour in regions deeper than 10m. We preliminarily analyzed the intra-tidal variation of seawater temperature structure and the first observed intermittent thermocline in JZB in summer. The maximum intra-tidal variation of seawater temperature can reach as high as 2.0˚C in JZB. Empirical Orthogonal Function (EOF) analysis shows that tide plays a key role in the intra-tidal variation; the seawater temperature shows obvious semidiurnal period and is out of phase with the elevation. The warm seawater temperature in the northern shallow region is about 2.0˚C higher than that in the southern deep region. In addition, the topography and coastline significantly affect the seawater movement and consequently shape the horizontal distribution of temperature, which is characterized by a varying range of cold water near the bay mouth. The stratification is weak in the northern shallow region and near the bay mouth due to the strong mixing of tide and wind. However, in the freshwater influenced southern deep region (>8m), thermocline can form (usually lasts for 2 to 3 hours) when tidal currents are small. Thermocline may occur under the combined effect of stratification as a result of lighter warm water transported over the heavier cold water by the vertical gradient of tidal current and weak tidal stirring. The results demonstrate that in coastal regions with large intra-tidal variation of sea temperature and intermittent thermocline such as the tide-dominated Jiaozhou Bay, it is necessary to carry out synchronized observations in order to depict and forecast the synoptic conditions of sea state and its short term change.