

Decadal trend of the tidally-induced stratification in Fukuoka Bay: Its potential cause and influences

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Harmonic constants of astronomical tides are not always “constant” in coastal waters where the geography and bathymetry have been anthropologically altered. In fact, it was shown that the tide has gradually decreased in recent years around Japan (e.g., Tokyo Bay, Ise Bay, Osaka Bay, and Ariake Sea) mainly owing to the changes of the resonant period of the bay in constructing large amount of man-made structure (Unoki, 2003). It is therefore valuable to investigate secular trend of tides presumably occurred in Fukuoka Bay because massive construction projects have proceeded in the past decades. Of note, the ocean environment in small bays would be easily affected by the change of the tides and tidal mixing. For instance, it is reasonable to consider that weakened tidal mixing at neap tides intensifies the estuarine circulation in the summer coastal waters, and thus, the water temperature (salinity) decreases (increases) owing to the inflow of the cool and saline subsurface water from the neighboring open ocean (hereinafter, “estuarine-circulation phase”). Meanwhile, it is also reasonable to consider that the weakened tidal mixing at neap tides increases (decreases) the sea surface temperature (salinity) owing to the weakened vertical mixing (“mixing phase”).

In this study, we focused on the changes in the tidally-altered stratification of Fukuoka Bay (facing to the Tsushima Strait) using archived water temperature (T) and salinity (S) observed by the Fukuoka Fisheries and Marine Technology Research Center. The T/S data observed during the summer (June - August) from 1982 to 1998 were categorized into data obtained at spring and neap tides. It is interesting that, in the 1980s (1990s), the sea surface temperature at neap tides was lower (higher) than that at the spring tides. The suggestion is that weak (strong) tidal mixing remains (destroys) the summer stratification at neap (spring) tides in 1990s, whilst this tidal mixing process did not work well in 1980s. Also of particular interest is that the salinity in the bottom layer at neap tides was higher in 1980s than that in 1990s. This suggests that Fukuoka Bay belonged to the estuarine-circulation (mixing) phase in 1980s (1990s). In conference, we will provide the analytical results of how spring/neap tide influence the T/S in the bay. Moreover, we will present the potential cause(s) of why the above phase change occurred in the Fukuoka Bay. In addition, we now attempt to uncover its influence(s) on the surrounding atmospheric condition (e.g., sea-breeze) as well as oceanic one. The response revealed in the lower-level atmosphere over the Fukuoka Bay (and neighboring land) might occur as in the Seto Inland Sea, where the fortnightly tidal cycle actually alters the air temperature and wind magnitudes over the sea via changes in the tidal mixing (Iwasaki et al., 2015).

Keywords: tide, estuarine circulation, air-sea interaction, Fukuoka Bay, tidal mixing