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Tidal elevation, current, and energy flux in the area between the South China Sea and Java Sea

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Abstract. The South China Sea (SCS) and the Java Sea (JS) are connected through the Karimata Strait, Gaspar Strait, and the southern Natuna Sea, where the tides are often used as open boundary condition for tidal simulation in the SCS or Indonesian seas. Tides, tidal currents, and tidal energy fluxes of the principle constituents K_1, O_1, Q_1, M_2, S_2, and N_2 at five stations in this area have been analyzed using in situ observational data. The results show that the diurnal tides are the dominant constituents in the entire study area. The constituent K_1 has the largest amplitude, exceeding 50 cm, whereas the amplitudes of M_2 are smaller than 5 cm at all stations. The amplitudes of S_2 may exceed M_2 in the Karimata and Gaspar straits. Tidal currents are mostly of rectilinear type in this area. The semi-major axes lengths of the diurnal tidal current ellipses are about 10 cm s^{-1}, and those of the semidiurnal tidal currents are smaller than 5 cm s^{-1}. The diurnal tidal energy flows from the SCS to the JS. The semidiurnal tidal energy flows from the SCS to the JS through the Karimata Strait and the eastern part of the southern Natuna Sea but flows in the opposite direction in the Gaspar Strait and the western part of the southern Natuna Sea. Harmonic analysis of sea level and current observation also suggest that the study area is located in the antinodal band of the diurnal tidal waves, and in the nodal band of the semidiurnal tidal waves. Comparisons show that the existing models are basically consistent with the observational results, but further improvements are necessary.

1 Introduction

The tidal system in the Indonesian seas is the most complex one in the world, due to its rugged bottom topography, complicated coastline, and the interference of tidal waves propagating from the Pacific Ocean, Indian Ocean, and South China Sea (SCS). The earliest reports of tidal characteristics in the Indonesian seas can be traced back to the colonial period in the early twentieth century, which were recompiled by Wyrtki (1961) to construct diurnal and semidiurnal cotidal charts based on all available coastal and island observations. Although the results of Wyrtki (1961) are impressively reasonable in the Indonesian seas, mapping of the Indonesian tides are still incomplete owing to lack of observations. During the past decades, remarkable progress of investigations about tidal phenomena is benefited by use of satellite altimeter measurements and high-resolution numerical simulation, and with no exception in the Indonesian seas. Based on tide gauge observations and TOPEX/Poseidon (T/P) satellite altimeter data, Mazzega and Berge (1994) have produced the cotidal charts of M_2 and K_1 in the Indonesian seas using an inversion method. Using a barotropic tide model, Hatayama et al. (1996) investigated the characteristics of M_2 and K_1 tides and tidal currents in the Indonesian seas, which shows that the tidal currents in the Java Sea (JS) and in the vicinities of narrow straits, i.e., the Lombok and Malacca straits, are relatively strong.

Egbert and Erofeeva (2002) have assimilated satellite altimeter data into an inverse barotropic ocean tide model, pro-

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