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Evaluation of global ocean tide models based on tidal gravity observations in China

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Solid Earth is affected by tidal cycles triggered by the gravity attraction of the celestial bodies. However, about 70% the Earth is covered with seawater which is also affected by the tidal forces. In the coastal areas, the ocean tide loading (OTL) can reach up to 10% of the earth tide, 90% for tilt, and 25% for strain (Farrell, 1972). Since 2007, a high-precision continuous gravity observation network in China has been established with 78 stations. The long-term high-precision tidal data of the network can be used to validate, verifying and even improve the ocean tide model (OTM).

In this paper, tidal parameters of each station were extracted using the harmonic analysis method after a careful editing of the data. 8 OTMs were used for calculating the OTL. The results show that the Root-Mean-Square of the tidal residuals (M_0) vary between 0.078-1.77 μgal , and the average errors as function of the distance from the sea for near(0-60km), middle(60-1000km) and far(>1000km) stations are 0.76, 0.30 and 0.21 μgal . The total final gravity residuals (T_x) of the 8 major constituents (M_2 , S_2 , N_2 , K_2 , K_1 , O_1 , P_1 , Q_1) for the best OTM has amplitude ranging from 0.14 to 3.45 μgal . The average efficiency for O_1 is 77.0%, while 73.1%, 59.6% and 62.6% for K_1 , M_2 and T_x . FES2014b provides the best corrections for O_1 at 12 stations, while SCHW provides the best for K_1 , M_2 and T_x at 12, 8 and 9 stations. For the 11 coastal stations, there is not an obvious best OTM. The models of DTU10, EOT11a and TPX08 look a little better than FES2014b, HAMTIDE and SCHW. For the 17 middle distance stations, SCHW is the best OTM obviously. For the 7 far distance stations, FES2014b and SCHW model are the best models. But the correction efficiency is worse than the near and middle stations'.

The outcome is mixed: none of the recent OTMs performs the best for all tidal waves at all stations. Surprisingly, the Schwiderski's model although is 40 years old with a coarse resolution of $1^\circ \times 1^\circ$ is performing relative well with respect to the more recent OTM. Similar results are obtained in Southeast Asia (Francis and van Dam, 2014). It could be due to systematic errors in the surroundings seas affecting all the ocean tides models. It's difficult to detect, but invert the gravity attraction and loading effect to map the ocean tides in the vicinity of China would be one way.