Quantification of the impact of lunar semidiurnal tides on groundwater dynamics in estuarine aquifers

Xiaoying Zhang, Zhenxue Dai, Bill Hu, Heng Dai, Ziqi Ma, Linlin Qi, Fan Dong, Yang Cao, and Funing Ma

Jilin University, changchun, China (xiaoyingzh@jlu.edu.cn)

The influences of lunar semidiurnal tides on coastal groundwater aquifers have been conceptualized for decades. However, in estuarine aquifers, comprehensive work is needed to quantify the impact of the tides on groundwater dynamics due to the widely distributed waterways and heterogeneous sediments. Taking the Pearl River estuary in southeast China as a study site, the tidal impacts on the groundwater dynamics have been investigated through wavelet and time series analysis. The groundwater level and electrical conductivity (EC) in four monitoring wells, along with waterway water level (tidal level) at three tidal stations, were monitored every 30 minutes over a 2-month period to determine how nearshore groundwater responds to tidal forcing. The results show that the estuarine groundwater fluctuations have two significant short periodicities (0.51 and 1 day), which correspond to the major tidal constituents in the tides: M\(_2\) (semidiurnal), K\(_1\), and O\(_1\) (diurnal) signals. The significant impacts decrease with increasing distance inland of the locations of the wells. Additionally, the coherence analysis displays a higher correlation between tides and groundwater levels for the spring tide than for the neap tide. The tidal influences on groundwater EC are weaker. In addition, when the tide level increases, the EC decreases in the wells located in the estuarine entrance. This phenomenon is related to the high salinity of retained paleo-seawater in the strata lens. A conceptual model is proposed to illustrate the complex groundwater flow dynamics, which provides useful insights into understanding groundwater systems in other geographically similar coastal estuarine regions.