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An online spatio-temporal prediction model for dengue fever epidemic in Kaohsiung,Taiwan

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Dengue Fever (DF) is one of the most serious vector-borne infectious diseases in tropical and subtropical areas. DF epidemics occur in Taiwan annually especially during summer and fall seasons. Kaohsiung city has been one of the major DF hotspots in decades. The emergence and re-emergence of the DF epidemic is complex and can be influenced by various factors including space-time dynamics of human and vector populations and virus serotypes as well as the associated uncertainties. This study integrates a stochastic space-time "Susceptible-Infected-Recovered" model under Bayesian maximum entropy framework (BME-SIR) to perform real-time prediction of disease diffusion across space-time. The proposed model is applied for spatiotemporal prediction of the DF epidemic at Kaohsiung city during 2002 when the historical series of high DF cases was recorded. The online prediction by BME-SIR model updates the parameters of SIR model and infected cases across districts over time. Results show that the proposed model is rigorous to initial guess of unknown model parameters, i.e. transmission and recovery rates, which can depend upon the virus serotypes and various human interventions. This study shows that spatial diffusion can be well characterized by BME-SIR model, especially at the district surrounding the disease outbreak locations. The prediction performance at DF hotspots, i.e. Cianjhen and Sanmin, can be degraded due to the implementation of various disease control strategies during the epidemics. The proposed online disease prediction BME-SIR model can provide the governmental agency with a valuable reference to timely identify, control, and efficiently prevent DF spread across space–time.