An integrated method consisting of a proper orthogonal decomposition (POD)-based reduced-order model (ROM) and a particle filter (PF) is proposed for real-time prediction of an unsteady flow field. The proposed method is validated using identical twin experiments of an unsteady flow field around a circular cylinder for Reynolds numbers of 100 and 1000. In this study, a PF is employed (ROM-PF) to modify the temporal coefficient of the ROM based on observation data because the prediction capability of the ROM alone is limited due to the stability issue. The proposed method reproduces the unsteady flow field several orders faster than a reference numerical simulation based on Navier–Stokes equations. Furthermore, the effects of parameters, related to observation and simulation, on the prediction accuracy are studied. Most of the energy modes of the unsteady flow field are captured, and it is possible to stably predict the long-term evolution with ROM-PF.