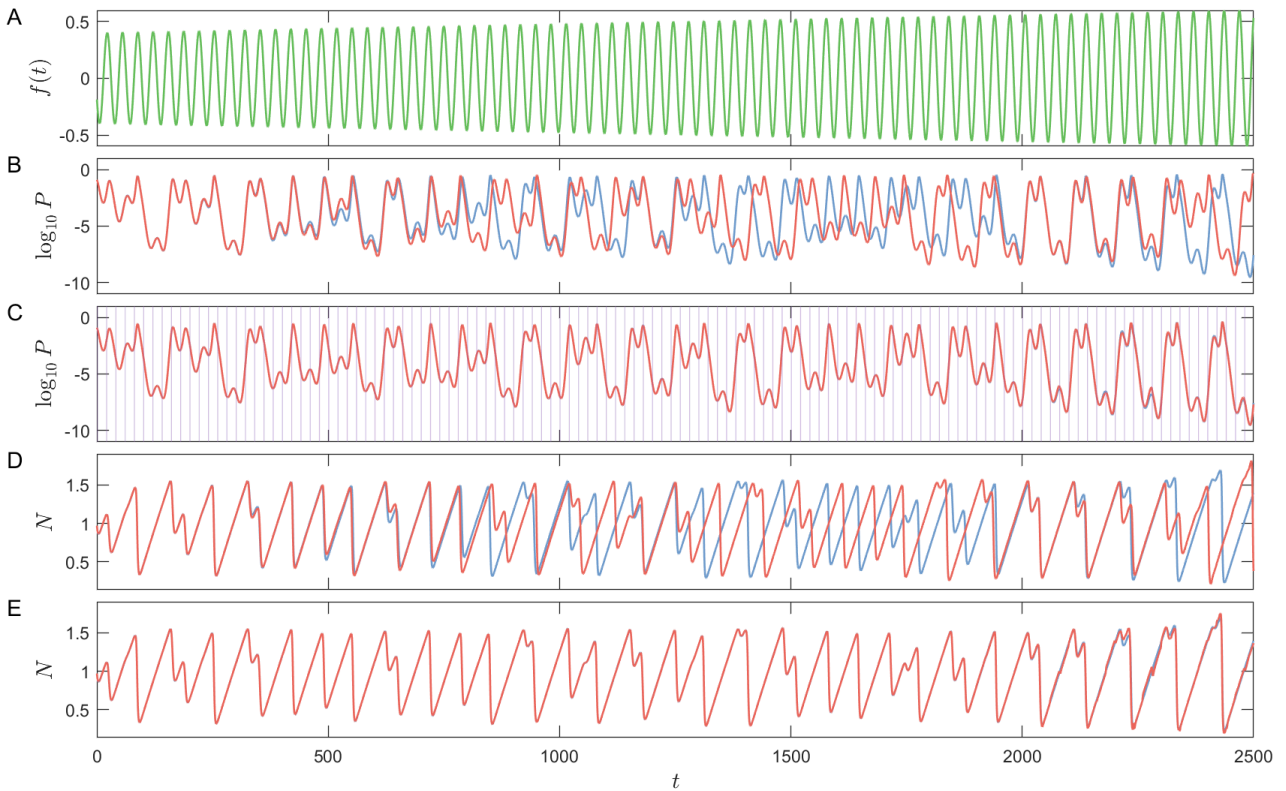

FIG. 10. Continual forecasting and monitoring of a hidden dynamical variable in the chaotic ecological system under non-stationary external driving with sparse updates from the observable. The system is described by Eqs. (B1) and (B2). The dynamical variable $N(t)$ is hidden, and the other variable $P(t)$ is externally accessible but only sparsely sampled measurement of it can be performed. (A) The non-stationary sinusoidal driving signal $f(t)$ with a time-varying amplitude. (B) Digital-twin generated time evolution of the accessible variable $P(t)$ (red) in comparison with the ground truth (blue) in the absence of any state update of $P(t)$. The predicted time evolution quickly diverges from the true behavior. (C) With sparse updates of $P(t)$ at the times indicated by the purple vertical lines (10% of the times steps), the digital twin is able to make an accurate forecast of $P(t)$. (D) Digital-twin generated time evolution of the hidden variable $N(t)$ (red) in comparison with the ground truth (blue) in the absence of any state update of $P(t)$. (E) Accurate forecasting of the hidden variable $N(t)$ with sparse updates of $P(t)$.