Nonlinear feature of the abrupt transitions between multiple equilibrium states of an ecosystem model

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Based on a five-variable ecological-hydrological interactive model of Zeng et al., four terms of the model and its parameters are explicitly presented. Sensitivity experiments of the parameters are held. The results show that the terms and the parameters are reasonable and robust for our studies. There exists multi-equilibrium with different moisture index for the five-variable ecological-hydrological interactive model. The stability of linearly stable equilibrium to finite amplitude perturbations under is studied by applying the approach of conditional nonlinear optimal perturbation (CNOP). The numerical results indicate that linearly stable equilibrium is nonlinearly stable to finite amplitude perturbations when constraint radius is less than and equal to critical value, and nonlinearly unstable to finite amplitude perturbations calculated by CNOP when constraint radius is great than critical value. The physical mechanisms are analyzed when transitions occur for two different basic states. It is shown that the soil moisture of surface layer acts a important role in two soil layers at initial period. The difference is analyzed between the CNOP and the LSV. Numerical experiments also validate shading effect of wilted biomass on the grassland and desert ecosystems.