Geophysical Research Abstracts
Vol. 17, EGU2015-5317-2, 2015
EGU General Assembly 2015

The orthogonal conditional nonlinear optimal perturbations: application to generate ensemble forecast members

Zhenhua Huo (1,2) and Wansuo Duan (1,3)

(1) LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China (hzh11hzh@126.com), (2) University of Chinese Academy of Sciences, Beijing, China, (3) Ningbo Collaborative Innovation Center of Nonlinear Harzard System of Ocean and Atmosphere, Ningbo University, Ningbo, China

Conditional nonlinear optimal perturbation (CNOP) is the initial perturbation that satisfies a certain physical constraint and causes the largest nonlinear evolution. In this paper, we propose an approach to calculating orthogonal conditional nonlinear optimal perturbations (CNOPs). The orthogonal CNOPs are a generalization of orthogonal singular vectors (SVs) in nonlinear regime. We apply the orthogonal CNOPs to generate initial perturbations for ensemble forecasting, as compared to SVs and showed the usefulness of orthogonal CNOPs in improving ensemble forecast skill by a Lorenz-96 model. We also show that the ensemble forecast skills associated with orthogonal CNOPs depend on the types of initial analysis errors. When the initial analysis errors possess patterns bearing more similarities to that of leading CNOP, the ensemble forecasts with orthogonal CNOP-type initial perturbations perform much skillfully compared to those with orthogonal SV-type initial perturbations; nevertheless, when initial analysis errors are much similar to the leading SV, the ensemble forecasts with orthogonal SV-type initial perturbations achieve higher skills than those with orthogonal CNOP-type initial perturbations. In addition, we demonstrate that the ensemble forecasts with orthogonal CNOPs perform better than those with orthogonal SVs despite the initial analysis errors are random. This may be resulted from that CNOPs take the effect of nonlinearity into consideration. It is obvious that the skill of ensemble forecast is not only dependent of the types of initial analysis errors but also the effect of nonlinearity. The orthogonal CNOPs may provide a much useful approach to generate ensemble initial perturbations.