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Nonlinear Evolution Characteristics of the NCEP Ensemble Forecast Products

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Abstract

By using NCEP/NCAR reanalysis products to forecast the nonlinear evolution of the spatial and temporal characteristics, the results shows that on the Spatial dimensions, NCEP ensemble forecast that the products of nonlinear evolution have obvious zonal features. The overall distribution situation is the nonlinear evolution of the southern hemisphere, which is larger than that of the northern hemisphere. In the same hemisphere, low value area is near the equator, and high value area for middle and high latitude area. On the time dimension, the nonlinear evolution of NCEP ensemble prediction products will increase with the extension of the forecast period. In addition, the nonlinear evolution of NCEP ensemble forecast products in North America is greater than the Asian region.

Keywords

NCEP Ensemble Forecast, Nonlinear Characteristics, Evolution

1. Introduction

Ensemble forecast can convert traditional deterministic prediction to multiple values of probability forecast, and provide a method that can be used to estimate the uncertainty of forecasts. NECP ensemble forecasts show that the atmosphere has an initial value of uncertainty. This concept breaks the traditional concept of numerical prediction to the initial value. Ensemble forecast not only can estimate the uncertainty of the initial value, but also can use patterns which are better than the method of physical process and numerical model on the estimation of uncertainty. In a word, ensemble forecast can effectively compensate the defects of single deterministic prediction [1] [2] [3] [4]. Therefore, ensemble forecasting is very beneficial to improve the forecast effect.

The nonlinear Evolution of NCEP ensemble forecast products will affect the

effect of forecast based on the above products [5] [6] [7]. In order to be able to understand the characteristics of the ensemble forecast effectively, studying the nonlinear change of ensemble forecast quantity along with the change of forecasting aging is very necessary. The initial NECP ensemble forecast system, undisturbed field adding and subtracting the perturbation field can constitute a set composed of members of the initial field. In the process of forecast, it will work with members of a collection of the initial field in pairs, and corresponding pairs of two prediction field in arithmetic average. Their linear growth will be offset; the rest will remove forecast average field again; then we can get the results of the nonlinear [8]. Based on the NCEP ensemble forecast system of nonlinear evolution analysis and the nonlinear evolution characteristics, the analysis method of nonlinear evolution was the first time concluded in this paper.

2. Data and Methods

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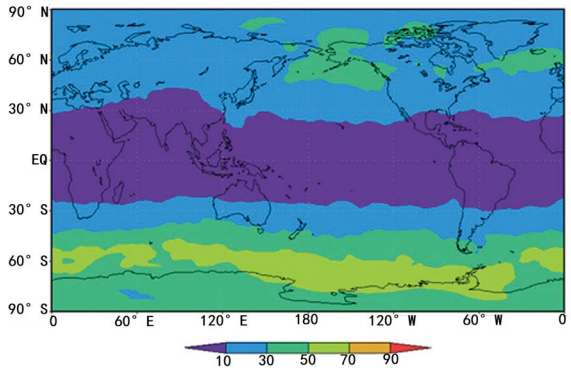
To calculate the nonlinear evolution characteristics and save computing resources, in this section, the NCEP/GEFS early 500 hpa height field forecast data every day are selected, and selecting only data of forecast starting time is day 00 to analysis. For each forecast starting moment, forecast memberships are 12, No. 1 - 12. Among them: No. 1 member of GFS hi res ens_control; No. 2 member of GFS low res ens_control; No. 3 ~ 12 members of 5 disturbance forecast (ens_perturbation = + 1, 1, +, − 2, + 3, 2 − 3, + 4, 4, + 5, 5), forecast step and resolution of this 10 ensemble members are same as the No. 2 member. The research objects of this section for the collection of disturbance forecast members, are named 3 - 12 members. In order to facilitate for statistical analysis, trailer step of Members are united to 12 hours in this section. Prediction time of Members are united to 0 - 384 hours (*i.e.*, 0 - 16 days). Horizontal resolution is united to 2.5˚ × 2.5˚ latitude and longitude. In this way, to forecast the starting moment, each set disturbance forecast members have 33 times forecast fields around the world. Each global forecast field is 144 × 73 = 10,512 grid points.

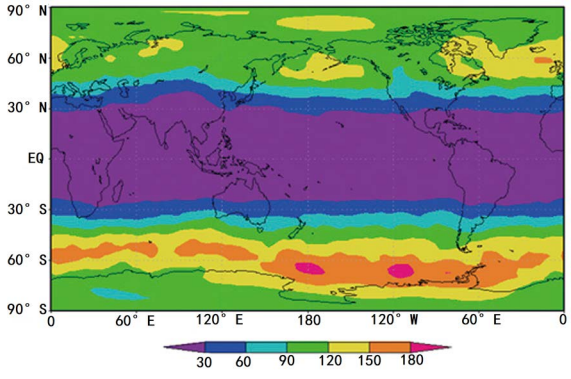
In NECP Ensemble Prediction System, undisturbed field adding and subtracting the perturbation field can constitute a set composed of members of the initial field. In the process of forecast, it will work with members of a collection of the initial field in pairs and corresponding pairs of two prediction field in arithmetic average. Their linear growth will be offset; the rest will remove forecast average field again; then we can get the results of the nonlinear [8].

3. Global and Regional Analysis of Characteristics of Nonlinear Evolution throughout the Year

The annual average nonlinear evolution of global range forecast for the 3 day (**Figure 1(a)**) shows that Global annual average field of nonlinear evolution has obvious characteristics of zonal distribution. The overall distribution of characteristics is as follows: Low value area is located in the tropics; High value area is



(a)



(b)

Figure 1. (a) Global annual average 3 day forecast of nonlinear evolution; (b) Global annual average 7 days forecast of nonlinear evolution.

in the northern hemisphere near to the Bering strait, Alaska and the North Pacific and North Atlantic near to Iceland, the British Isles, high value area in the southern hemisphere is mainly located in the ocean near the Antarctic continent, and to the north and south on both sides of the decreasing. In other areas, the northern hemisphere is a more uniform zonal distribution. The southern hemisphere is obvious zonal zonal distribution. Also it can be seen from the picture. When forecasting aging for 3 days, the nonlinear evolution of the southern hemisphere is larger than that of the northern hemisphere.

3.1. ABB

Then looking at the global annual average 7 days forecast limitation of nonlinear evolution (**Figure 1(b)**), the area between north and south tropic of cancer in the same low is the emergence of a large area, at the same time. Nonlinear evolution of the meridional gradient than the forecast period increased 3 days. In the northern hemisphere, there is a high value area of the North Atlantic and North Pacific, respectively. The rest substantially shows relatively uniform latitudinal distribution. In the southern hemisphere, there were two significant high value areas in Antarctica near the south Pacific. The nonlinear evolutions of the two hemispheres of the north and south were compared. The results show that the nonlinear evolution of the southern hemisphere is the same as that of the north-

ern hemisphere for 3 days. And the gap between the two increased with the extension of the forecast period. Compared to the full year global forecast period for 3 days and forecasting timeliness for 7 days of the nonlinear evolution found, between high and low values of the distribution area there is a rough correspondence. General distribution is low and near the equator, high in middle, and high in latitudes and the southern hemisphere is larger than the north. The results show that the nonlinear evolution of NCEP ensemble forecast has obvious regional characteristics.

Above, the global scale nonlinear evolution feature analysis found that different regions of nonlinear evolution characteristics were not the same, which were largely in the southern hemisphere ocean nonlinear evolution of maximum, but the regions as a result of forecast service object are little than NCEP set focused on the application of forecast products area. NCEP ensemble forecast products in the northern hemisphere are more densely populated, which aggregate large Asian and North America and are used most widely. Therefore, the analysis and comparison of NCEP ensemble prediction products in the two regions of nonlinear evolution are very necessary.

First of all, from the 3 days of the forecast period for the Asian region of the nonlinear evolution of the annual average distribution of the situation (**Figure 2(a)**) can be easily found that the distribution of nonlinear evolution of the

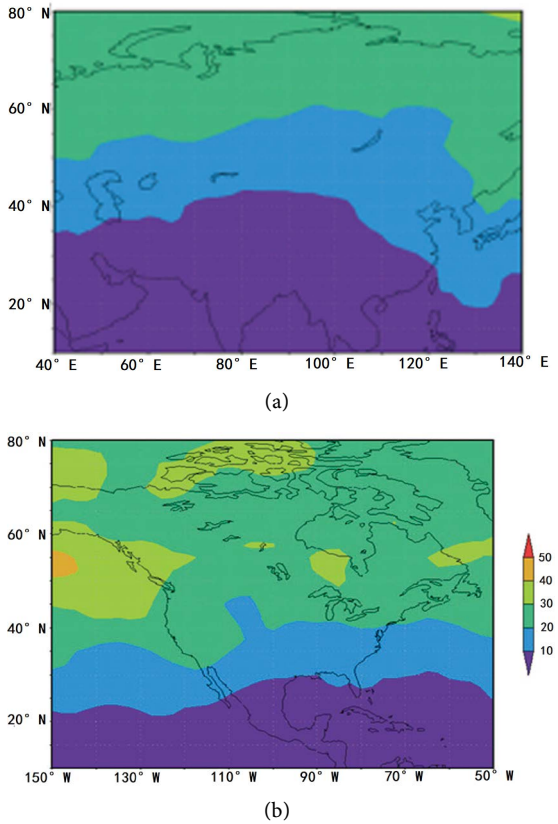


Figure 2. (a) 3 days annual forecast period nonlinear evolution of Asia; (b) 3 days annual forecast period nonlinear evolution of North America.

Asian region is from the southwest to the northeast direction. Most of our country is located in low value areas, only in North China and Northeast China. North America annual average forecast period for 3 days of nonlinear evolution of distribution (Figure 2(b)) shows that nonlinear evolution generally presents the a North South high low distribution form, on the west coast of Canada and Alaska to the south of the sea. There are a piece of high value and the low value area located in the area of Mexico and its surrounding waters and the Caribbean islands. Through comparison of Asia and North America of the forecast period for 3 days, the nonlinear evolution shows that the west coast of North America is a high value area. Asia does not have obvious high value. In the annual average figure North America nonlinear evolution is generally larger than in Asia.

3.2. Viatio

Forecast time for 7 days in Asia nonlinear evolution of annual average distribution (Figure 3) showed: North South high low trend on the whole, in the Novaya Zemlya area to the south appeared a small area of high value. The evolution of nonlinear in the Far East is more evenly distributed, and in the vicinity of the 40 - n the evolution of nonlinear forms a distinct zonal distribution area. In most

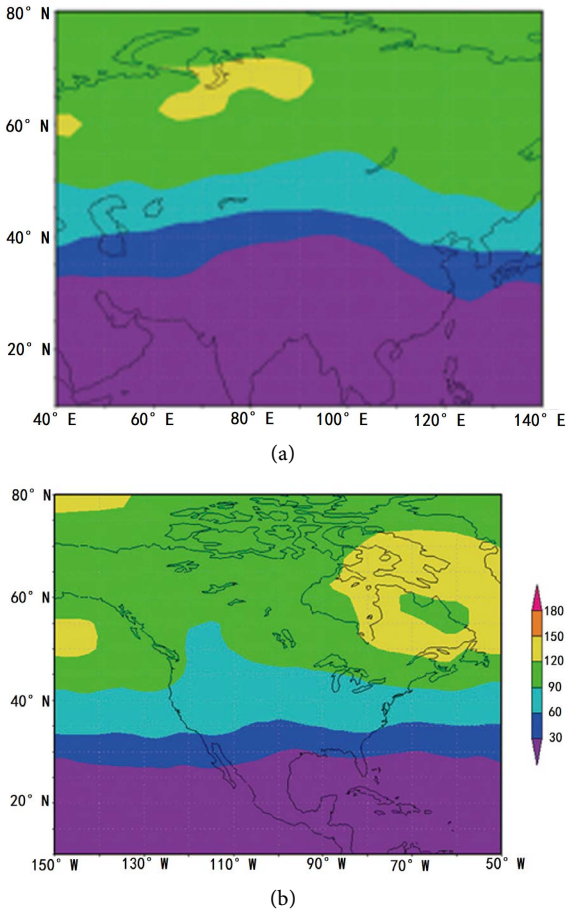


Figure 3. (a) Annual average 3 days forecast of nonlinear evolution of Asia; (b) Annual average 3 days forecast of nonlinear evolution of North America.

parts of the south the evolution of nonlinear is located in low value area. For North America forecast period for 7 days, the annual average nonlinear evolution is shown in Figure 3. The high value area and its adjacent waters are located in the North Pacific near the waters of Alaska and Northeastern Canada, and in the mid and low latitudes, it has obvious zonal distribution. Compared with the nonlinear evolution of North America, the nonlinear evolution of the North Atlantic is significantly increased, while the North Pacific is relatively slow growth in the North Pacific. Asia and North America, the 7 day of the nonlinear evolution of the annual average distribution of the situation is more consistent, but the North American region's annual average nonlinear evolution is high.

In order to make a more intuitive analysis of the nonlinear evolution in different regions of the world, this section will use the nonlinear evolution to calculate and draw a one-dimensional curve (Figure 4). The results show that the global and regional annual average nonlinear height field changes show a consistent trend with the increase of the aging time. Nonlinear evolution can be regarded as a linear function of the prediction of aging, but the coefficients of different regions are different, and the growth rate of the nonlinear evolution is different. The growth rate from fast to slow respectively is: the southern hemisphere and the northern hemisphere, global, North America, Asia, tropical.

4. Conclusions

In this paper, the NCEP/NCAR reanalysis data are used to predict the nonlinear evolution of its spatio-temporal features. At present, the development of ensemble forecasting system is at a relatively preliminary stage all over the world. The results of this paper are of great theoretical significance not only for the understanding of the initial and lateral boundary perturbation methods for ensemble forecasting of convective scales, but also for the future development of this type of business System providing a certain basis. The results are as follows:

1) In space dimension, the NCEP ensemble prediction shows that the nonlinear evolution products have obvious zonal characteristics. The overall distribution is the nonlinear evolution in the southern hemisphere, larger than the

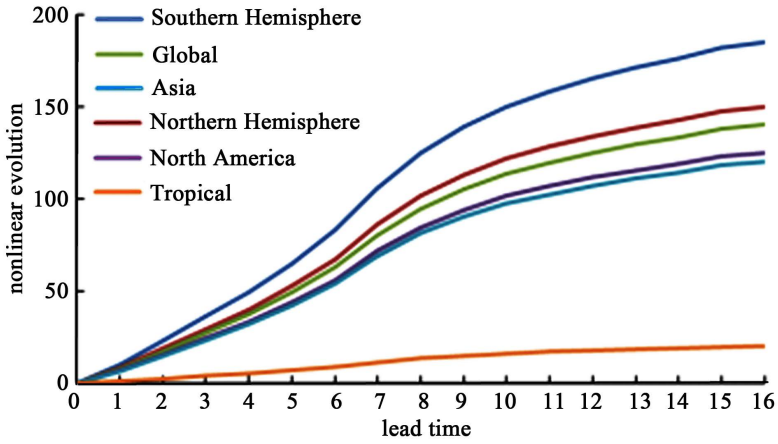


Figure 4. The average annual temporal regions of nonlinear evolution.

northern hemisphere. In the same hemisphere, the low value region is near the equator and the high value region is at the middle and high latitude region.

2) In the time dimension, the nonlinear evolution of NCEP ensemble forecasting products will increase with the forecasting period. In addition, the nonlinear evolution of NCEP ensemble forecasting products is smaller in North Asia than in North America, and the non-linear evolution in summer in Asia and North America is small.

3) The NCEP set average forecast has better forecast consistency than the corresponding control forecast. Aggregate average forecast can effectively reduce the occurrence of forecast jump. When the forecasting time exceeds 240 h, the average forecast jump index of the set average forecast is usually only 25% - 50% of the control forecast, which greatly increases the forecast stability. The frequency of forecast jumping in summer fluctuated at 17.5%, which was not significantly different from the annual frequency range (10% - 20%).

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