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IMPACT OF THE INITIALIZATION ON MESOSCALE MODEL PREDICTION IN SOUTH CHINA

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1 INTRODUCTION

The initial state of the atmosphere is one of the key factors that affect the result of NWP. With the development of increasingly finer NWP, the quality of initial atmospheric state has been drawing more and more attention[1-7]. GRAPES 3D- Var（Global and Regional Assimilation and Prediction Enhanced System，a three-dimensional variational data assimilation subsystem developed by the Chinese Academy of Atmospheric Sciences, makes a solution to the issue of NWP data vacancy in China. Owing to it, quantitative application of satellite and radar data in NWP has significant breakthroughs. With the assimilation system of GRAPES 3D-Var and GRAPES regional mesoscale model, this work compares a control and assimilation experiment with regard to a cold air surge affecting south China in late December 2004 and analyzes the sensitivity of mesoscale model forecast on initial values and the effect of initialization on the improvement of forecasting capabilities.

2 ACCOUNT OF COLD AIR SURGE

Due to the co-action of several waves of strong cold air in late December 2004, temperature dropped substantially in most parts of China. It is known from sounding data that the ridge of a cold high was controlling south China at the level of 1000 hPa, with northerly flow over Hunan, Jiangxi and Guangxi and northeasterly flow over the coastal areas of Fujian and Guangdong; air temperature was below 0°C in Jiangxi, Hunan and northern Guangxi, central Guangdong was in the control of a high pressure ridge and there was a shear in the form of a cold front on the northeast-southwest direction over Jiangxi, southern Hunan and northern Guangxi, which moved southward in the following two days to affect the weather to its south.

3 ANALYSIS OF ASSIMILATION RESULTS

The assimilation system used in this work is part of the GRAPES 3D-Var system. During its operational use, the authors not only added modules of unconventional data of the radar, tropical precipitation[5] and bogus typhoons[6], but also improved the system for localization. Only the sounding data are assimilated here. The assimilation is set at 12:00 December 25, 2004 and the background is the 12-h forecast field at 00:00 December 26, with a horizontal coverage of 100 – 130°E and 10 – 34°N, 0.125° of interpolation for horizontal resolution and 17 vertical layers.

Following the relation of hydrostatic equilibrium, temperature increments are calculated from those of geopotential field determined in individual steps of iteration, in the course of minimizing cost functions in the assimilation system.

Based on the increment field of the geopotential height, the increment of temperature field is derived that meets the hydrostatic equilibrium and the analyzed field of temperature is then sought from a background that has been superimposed with the temperature

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increments. By modifying the assimilation system in this way, the analyzed fields of both geopotential height and temperature can be known at once.

Comparisons of the field of increments with that of observations tell us more about the way observations affect the analyzed field. Take 1000 hPa for example. Northerly increments are found in both the observed wind field and background in continental areas north of 25°N, indicating that the northerly cold air has been described less by the background. In the meantime, the increments as shown in the observed geopotential height field are corresponding with lower southeastern coast and higher western continental background field. According to the geostrophic relationship between the geopotential field and wind field and with the joint effect of observed wind field, northerly increments are found in the analyzed field over Sichuan, Guangxi and eastern Guangdong. Although there are southerly increments on the coast of Guangdong in the observed wind field, westerly increments appear on the coast of southern Guangdong in the analyzed field in accordance with the geostrophic relationship, because the geopotential height in the background field is low over large areas of the southeastern coast but high over the South China Sea. It is then known that apart from the observed data, the adjustment of geopotential height and wind fields in the analyzed field is also restrained by the balance between them.

Following the assimilation scheme, the adjustment of moisture field does not have any direct links with quantities of physics other than observed moisture. It is seen that there is more moisture on the coast of south China and less moisture inland, with a low center in western Guangxi; the increments of the analyzed field distribute in much the same way as those of the observed moisture. The adjustment of temperature field is related with that of geopotential height field in two layers next to it. It is shown in our analysis that the observed increments of temperature are relatively low across a large area, especially in western Guangxi and southern Sichuan but are relatively high in parts of South China Sea. The temperature increments in the analyzed field also show a pattern of decreasing towards the north with negative increments on the ground. The low center does not agree completely with the observed one but tends to be consistent with the observed temperature increments. It indicates that the increments derived with the increments of the geopotential height field based on the hydrostatic equilibrium relation can in some extent give the variation of temperature that agrees with the observed tendency of variation.

4 CONCLUSIONS

(1) By assimilating conventional sounding data with GRAPES 3D-Var, prediction of cold air processes with the GRAPES mesoscale model can be improved.

(2) As the forecast of initialization sensitivity has greater effect at initial time and varies faster, other technical processing must be included if rapid updating assimilation cycle is used that employs high temporal resolution.

(3) As low-level, near-surface forecasts have relatively complicated sensitivity, the assimilation of surface will play an important role in the future operational assimilation system.

(4) Assimilated conventional sounding data do not improve the forecast of atmospheric physical quantities for the upper level as much as the middle and low levels, showing that the assimilated upper-level atmospheric observations are an important means to improve the forecast of physical quantities in upper atmosphere.

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