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NCEP 全球预报系统在ARM SGP站点预报大气温度、湿度和云量的检验

Temperature, Relative Humidity, and Cloud Fraction Predicted by the NCEP Global Forecast System at the ARM SGP Site during 2001－2008: Comparison with ARM Observations

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中文关键词: NCEP GFS模式 ARM CMBE观测数据 模式检验 云量

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中文摘要:

利用美国大气辐射测量项目（ARM) 制作的 “气候模拟最佳估计” （CMBE) 观测数据集, 检验美国环境预报中心 （NCEP) 全球预报系统 （GFS) 2001～2008年在ARM Southern Great Plains （SGP) 站点预报的大气温度、 相对湿度和云量的垂直分布, 主要结论如下: （1) NCEP GFS较好地预报出了温度和相对湿度的季节变化。就各个季节平均而言, NCEP GFS高估了1.5～12 km的大气温度, 同时低估了春冬季13～16 km和秋冬季1.5 km以下的大气温度, 各高度上温度偏差绝对值小于1℃; NCEP GFS预报结果再现了观测到的相对湿度垂直分布的双峰结构, 但是高估了4～12 km的相对湿度。模式分辨率提高 （T170L42更新为T254L64) 显著改进了14～18 km相对湿度的预报。（2) 预报的云量在10 km以下小于观测值, 在10～13 km则高于观测值, 而且, NCEP GFS没有预报出非降水性低云的云量, 其预报的降水云的云量在8 km以下也低于观测值, 反映出NCEP GFS模式中浅对流和深对流活动不够活跃。（3) NCEP GFS模式用预报的相对湿度和云水/云冰混合比 （qc) 诊断云量, 采用同样的诊断公式由观测的相对湿度和NCEP GFS预报输出的qc计算云量, 得到的云量在11 km以下所有高度上都更加显著地小于观测值, 即比NCEP GFS对云量的低估更加严重, 说明NCEP GFS可能低估了此高度区间的qc。 （4) 2001～2008年间NCEP GFS预报的温度、 湿度和云量改进不显著, 其预报云量和qc的误差很可能与模式中深对流和浅对流方案、 层云微物理方案的不确定性有关。

Abstract:

This study evaluates the performance of the Global Forecast System (GFS) of the U.S. National Centers for Environmental Prediction (NCEP) against the Climate Modeling Best Estimate (CMBE) observational dataset made by the U.S. Department of Energy Atmospheric Radiation Measurement (ARM) Program at the southern Great Plains (SGP) site for the years of 2001－2008. The investigation focuses on the vertical distributions of air temperature (T), relative humidity (RH), and cloud fraction. The major findings are as follows: (1) NCEP GFS was able to largely capture the seasonal variations of T and RH. However, on seasonal average, the model overestimated T at the heights of 1.5－12 km, while underestimated T at 13－16 km in spring and winter and at 0－1.5 km in autumn and winter, by less than 1℃. Both the predicted and observed RH had double peaks located near the surface and around 12 km, respectively. However, the model overestimated RH in the upper and middle troposphere (4－12 km). Increase of model resolution from T170L42 to T254L64 significantly improved the prediction of RH at 14－18 km. (2) NCEP GFS generally underestimated cloud fraction at heights below 10 km and slightly overestimated cloud fraction at 11－13 km. Moreover, the prediction missed the daytime nonprecipitating low-level clouds and underestimated precipitating cloud amounts below 8 km, indicating that activities of shallow convection and deep convection in the model were not active enough. (3) Using the observed RH and the predicted cloud water/ice mixing ratio (qc) to calculate cloud fraction with the diagnostic method in the NCEP GFS model, the result shows that cloud fraction from this calculation is more significantly underestimated compared to the NCEP GFS predicted cloud fraction, suggesting that the underestimation of cloud cover at heights below 11 km by the NCEP GFS is probably contributed by an underestimate of qc at these altitudes. (4) Improvements in the prediction of T, RH, and cloud fraction were insignificant during 2001－2008. The inaccurate prediction of cloud fraction and qc is probably related to uncertainties of parameterizations of deep and shallow convection, as well as cloud microphysics, in the NCEP GFS model.

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