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CAMS云微物理方案的改进及与WRF模式耦合的个例研究

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Improved CAMS cloud microphysics scheme and numerical experiment coupled with WRF model

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摘要 本文在中国气象科学研究院(CAMS)双参数云微物理方案的基础上,增加气溶胶粒子的活化过程,改进原方案中的水汽混合比、云水混合比及云滴数浓度的预报方程,实现对各种水成物(包括云水)的混合比和数浓度的预报.此外,改进后的CAMS云方案被成功耦合到了WRF v3.1中尺度模式.本文利用耦合模式对2009年4月23~24日发生在我国北方地区的一次降水天气过程进行了模拟,将新方案的模拟结果与WRF自带的3个微物理方案进行了比较.结果显示,新方案能够合理地描述地面降水特征,其模拟的雨带分布范围与实测接近,降水中心的强度和位置优于其他3个方案.新方案模拟的云滴数浓度与WDM6方案基本一致,表明加入的气溶胶活化过程是合理的.新方案模拟的其他水成物粒子数浓度与Morrison方案相比有时会有量级的差别,说明粒子数浓度的模拟目前还存在着很大的不确定性,这也是云微物理模式进一步发展的难点.

关键词 CAMS, 微物理方案, WRF, 耦合

Abstract: The Chinese Academy of Meteorological Sciences (CAMS) two-moment bulk microphysics scheme was employed in this study, and a new parameterization approach to simulate the heterogeneous droplet activation was introduced into the scheme. The proposed scheme predicts both the mixing ratio and the number concentration for five hydrometeor species (cloud water, rain, cloud ice, snow, and graupel). Moreover, the improved CAMS scheme was coupled with the Weather Research and Forecasting model (WRF v3.1), which makes it possible to investigate the effects of aerosol on clouds and precipitation. The rain event occurring on 23~24 April 2009 in north China was simulated using the coupled CAMS scheme and three sophisticated microphysics schemes in the WRF model. Results showed that the new scheme performed reasonably well in describing the characteristic of precipitation and the microphysics structure of cloud. The spatial pattern of precipitation, the intensity and position of precipitation center simulated by the new scheme were generally in agreement with the surface observation data. The simulated cloud droplet number concentration in the new scheme was close to that in WDM6 scheme, which suggests that the involved approach of aerosol activation is basically reasonable. The simulated number concentration of other hydrometeor species in the new scheme was sometimes one order of magnitude different from that in Morrison scheme, which indicates that there is still some inherent uncertainty in simulating the hydrometeor number concentration in cloud physics research.

Keywords CAMS, Microphysics scheme, WRF, Coupling

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