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台风外围下沉区大气波导成因的数值模拟

Numerical Simulation of Atmospheric Duct in Typhoon Subsidence Area

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摘要：

受台风鹿莎影响，处在其西侧外围下沉区域的南京地区于2002年8月31日出现了一次大气波导过程，利用大气中尺度模式WRF对其成因进行了详细的数值模拟研究。WRF数值模拟较好地再现了此次波导的演变过程，即波导在31日傍晚开始形成，次日凌晨达到最强，日出后迅速减弱消失。基于数值模拟高时空分辨率的输出结果，对波导成因进行细致分析，结果表明：湿度突变层和逆温层的同时存在导致了波导的发生，前者是其形成的关键因素，而后者的作用主要体现在增强其强度；台风前期流场从海上带来大量的水汽，台风后期流场将北方高空干空气输送到受高压下沉运动控制的南京地区，造成近地层出现下湿上干的剧烈湿度梯度；下沉运动强度并不足以直接导致南京地区的逆温层，但其控制下的晴朗天气非常有利于夜间地面长波辐射冷却而形成逆温。

关键词：台风 外围下沉 大气波导 WRF数值模拟

Abstract:

The atmospheric duct is a kind of anomalous refraction phenomena in the troposphere atmosphere. It can change the normal propagation characteristic of the electromagnetic wave, and has a significant influence on radar detections and radio communications. The emergence of duct strongly depends on the weather conditions and it often occurs in the subsidence area west to a typhoon.With the rapid development and extensive application of atmospheric numerical models, high resolution numerical modeling has become an important tool to get insight of duct.Using the WRF model, the atmospheric duct process occurred on 31 August 2002 over Nanjing region in a subsidence area west to Typhoon Rusa is studied in details. The WRF numerical simulation reproduces well the evolution of the duct, which starts to form in the evening of 31 August, reaches the strongest level the next early morning, weakened and disappeared rapidly after sunrise. Based on numerical simulation output with high spatial temporal resolution, results show that humidity gradient is a key factor to the formation of this duct, and the humidity invertion enhances its strength. The outside low level flow in the typhoon early stage brings plenty of moisture from the sea to Nanjing region in the near surface layer. The typhoon moves northeastward and dry air mass is transported from the north by the outside high level flow in the typhoon late stage, and sink down due to high pressure, so an intense gradient of humidity which is prerequisite for the formation of duct appears in the near surface layer. The subsidence itself is not strong enough to directly cause the inversion, but the clear sky weather caused by it is favorable for long wave radiation cooling during night time, which is the primary cause for the inversion formation. The inversion formation hinders the upward transport of water vapor, so that the humidity gradient develops further. Besides, the simulation results also reflect the marine atmospheric duct. These results also show that the high resolution atmospheric meso scale numerical simulation can be used as an effective means of studying and forecasting duct.

Keywords:typhoon subsidence atmospheric duct WRF numerical simulation

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