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夏季青藏高原地区近地层水汽进入平流层的特征分析

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On the characteristics of water vapor transport from atmosphere boundary layer to stratosphere over Tibetan Plateau regions in summer

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摘要 青藏高原为亚洲季风区的典型代表区域,研究其水汽进入平流层的过程和机理对认识全球气候和大气环境变化具有一定的现实意义. 本文基于中尺度气象模式(WRF)的模拟输出结果(2006年8月20日至8月26)驱动拉格朗日大气输送模式FLEXPART,通过追踪并解析气块的三维轨迹以及温度、湿度等相关物理量的相关变化特征,初步分析了夏季青藏高原地区近地层-对流层-平流层的水汽输送特征. 研究结果表明,源于高原地区近地层的水汽在进入平流层的过程中受南亚高压影响下的大尺度环流和中小尺度对流的共同影响.首先,在对流抬升作用下,气块在短时间内(24 h)可抬升到9~12 km的高度,然后在南亚高压闭合环流影响下,相当部分气块在反气旋的东南侧穿越对流层顶进入平流层中,并继续向低纬热带平流层输送,进而参与全球对流层-平流层的水汽循环过程. 在对流抬升高度上气块位置位于高原的西北侧,然而气块拉格朗日温度最小值主要分布于高原南侧,两个位置上气块的平均位温差值可达15~35 K,这种显著的温度差异将导致气块进入平流层时"脱水". 比较而言,夏季青藏高原地区近地层水汽进入平流层的多寡主要和大尺度汽流的垂直输送有关,而深对流的作用相对较弱.

关键词 青藏高原, 平流层, 水汽输送

Abstract: Identification of the main mechanism of water vapor transportation from atmosphere surface layer into stratosphere over Asian monsoon region, especially for the region of Tibetan Plateau (TP), plays a significant role in understanding the global climate change and global environment. In order to investigate the possible mechanism of water vapor transportation from the surface layer to upper troposphere and stratosphere, we used the Lagrangian particle dispersion model FLEXPART driven by the hourly output generated by the weather research and forecasting (WRF) model for the period from 20 to 26 August, 2006. Based on the three-dimensional trajectories backward tracing analysis and their changes in temperature, humidity and other physical variables, our results show that small-scale convection lift and the large-scale transportation are the two main factors responsible for the water vapor entry from surface layer to stratosphere. Air parcels from the surface layer could be lifted up to 9~12 km height via active convention within 24 hours, and then passed through the tropopause in the Tibetan Plateau southeast, which was driven by the large scale advection associated with the south Asian anticyclone circulation. Most air parcels could further transport to lower latitudes and impact the global troposphere-stratosphere water vapor budget. Air parcels on the cloud top height were largely located over the northwest of TP, whereas their locations of Laglangrian minimum temperature, i.e., where the air parcels dehydration happened, were mostly located in the south of TP. The potential temperature difference between these two regions is about 15~35 K, implying a significant dehydration processes for all air parcels. This result indicates that that the mechanism of water vapor transportation from atmosphere surface layer to stratosphere over Tibetan Plateau regions in summer is potentially controlled by large scale circulation associated with southern

Asian monsoon, while the small scale circulation caused by convections plays a secondary role.

Keywords Tibetan Plateau, Stratosphere, Water vapor transport

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