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热源激发重力波特征以及波流作用的数值模拟研究

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A numerical simulation on gravity waves generated by thermal source and their influences on mean flow

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摘要 本文在二维等温可压大气中引入了一个随时间和空间变化的热源扰动,分别以静止风和中纬1月份月平均向东的纬向风急流为背景,对不同背景下热源激发的重力波的传播详细过程及其特性进行了数值模拟研究.热源激发出来的重力波在初始阶段有很宽的频谱范围,随后由于重力波的传播效应,水平波长和垂直波长分布范围随时间都有所减小.顺风传播的重力波的小尺度和低频部分会容易被急流吸收,从而加强了对流层急流,而逆风传播的重力波更容易上传,会导致中间层区域向西的背景风增强.这体现了低层大气急流对中间层大气风场结构的影响.热源的尺度直接决定激发波的尺度;激发波的垂直尺度和时间尺度对热源的变化比其水平尺度更敏感.

关键词: 重力波 热源 急流 数值模拟 波尺度

Abstract: In this study, a time-and space-dependent thermal forcing is introduced into a compressible and isothermal two-dimensional atmosphere. Stationary background and monthly averaged eastward horizontal wind at middle latitude in January are employed as two different background flows, respectively. The propagation and characteristics of gravity waves generated by thermal source in these two different background flows are numerically simulated. Gravity waves generated by thermal source have wide spectra in the earlier stage, but the spectra of horizontal and vertical wavelengths shrink when the excited waves propagate in the atmosphere. Small-scale and low-frequency parts in the excited downwind waves are easily absorbed by the eastward jet which will be enhanced consequently. Whereas the excited upwind (westward-propagating) waves can easily go through the jet, which will induce an enhancement of westward background in the mesosphere. This indicates that troposphere jet will influence the wind structure in the mesosphere. It is also found that the wavelengths/frequencies of the excited waves are dependent on the temporal and spatial scale of the thermal source; the vertical and temporal scales of the excited waves are more sensitive to the changes of thermal forcing than the horizontal scale of excited waves.

Keywords: Gravity waves Thermal source Jet Numerical simulation Wave scale

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