

论文

三维分层流动过双山脉地形激发的大气船舶重力波动力学理论和数值试验

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摘要 利用我们建立的三维分层线性理论计算模式和中尺度数值模式ARPS, 分别研究了三维分层流动过双山脉地形产生的三维线性和非线性山脉重力波和大气船舶的结构特征及其形成机制. 线性理论计算结果表明三维三层流动过双山脉地形时, 两个山脉各自强迫出一个发散模态的山脉背风波, 在第二个山脉背风面, 三维三层流动过双山脉地形可以强迫出两个发散模态的拦截背风波, 大大加强了对大气环流的拖曳作用. 非线性数值模拟结果表明, 流动过山所产生的非线性山脉重力波和大气船舶完全不同于三维分层线性理论计算模式所产生的山脉重力波和大气船舶的结构和特征, 由于分层流体之间的非线性相互作用, 三维三层流动过双山脉地形时, 可在第二个山脉背风面激发4个发散模态的拦截背风波. 三维三层流动过双山脉地形所强迫的山脉重力波和大气船舶, 具有同三维三层流动过孤立山脉所产生的山脉重力波和大气船舶完全不同的结构和特征, 三维流动过双山脉地形对两个山脉之间的距离表现出极大的敏感性. 对于相距较远的两个山脉, 流动过双山脉所强迫的山脉重力波表现为4个发散模态的拦截背风波, 波动的能量相对于相距较近的两个山脉能传播到更高的高度.

关键词 [大气船舶重力波](#) [分层流动](#) [双山脉地形](#) [多层线性理论模式](#) [非线性数值试验](#)

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Theory and numerical simulation of atmospheric ship waves generated by 3 D layered flow over double hills

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Abstract The theoretical calculation of mountain gravity waves and atmospheric ship waves generated by three dimensional multi layer flow over double hills are investigated. Using the three dimensional multi layer linear theory model to calculate the atmospheric ship wave fields, the atmospheric ship waves characteristics of two diverging modes are obtained where the three dimensional multi layer flow over the double mountains under the various stability condition. And the complex terrain plays a significant role in the propagation of the ship waves in the troposphere and stratosphere. The dynamical mechanism of the three dimensional atmospheric ship waves generated by three layer flow over double hills is investigated using the advanced regional prediction system (ARPS). The results show that there are four diverging modes of the atmospheric ship waves generated by three layer flow over double hills, where there are two diverging lee wave modes generated by layered flow over each isolated hill, for the nonlinear interaction between the layered flows. Most importantly, the intensity and amplitude of mountain gravity waves generated by flow over double hills are greater than those by flow over the isolated hill. Furthermore, the characteristics of the atmospheric ship waves show a significant sensitivity to the distance between the two hills, and longer distance of the two hills can induce longer wavelength of the gravity waves generated by layered flow over double hills than the shorter case. Then, the waves of longer wavelength can propagate to higher altitude.

Key words [Atmospheric ship wave](#); [Layered flow](#); [Double hills](#); [Theoretical calculation](#); [Numerical simulation](#)

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