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# 基于电离层反射的袖珍云闪(CID)三维定位研究

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# 3D location of compact intracloud discharge based on its ionospheric reflection pair

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摘要 袖珍云闪是一类区别于常规闪电放电过程的特殊放电现象,能够同时产生极强的高频和低频辐射信号,其低频辐射信号在电离层与地面之间反射后能够在电场变化波形上形成电离层反射脉冲对.电离层反射信号与原信号的时间差包含着放电三维位置和电离层高度的信息,而借助于多站闪电探测网络的同步观测就能够反演这些信息.基于这一规律,本文发展了一种对袖珍云闪实现三维定位的新方法.这种方法不仅能够对大范围内的袖珍云闪实现准确的三维定位,同时还能够反演电离层的高度,是一种潜在的研究电离层相关性质的有效手段.通过将定位结果与雷达回波比较,证明这种方法具有较高的精度.利用这种方法,计算了5489例正极性袖珍云闪和1400例负极性袖珍云闪的放电高度,发现正极性袖珍云闪主要集中在7~14 km,而负极性袖珍云闪达到了15~18 km.负极性袖珍云闪的放电高度总体上与对流层顶高度相当,其数量相比于正极性袖珍云闪明显偏少,因此很可能产生于较为罕见的极旺盛的雷暴过程中.

关键词 袖珍云闪, 双极性窄脉冲, 电离层, 云内放电, 三维定位

Abstract: Compact intracloud discharge (CID) is a special type of lightning discharge event that is different from regular lightning discharge processes. CIDs can produce powerful radiation on both HF and LF bands. The LF radiation signals can produce ionospheric reflection pairs on electric field change waveforms by propagating between the ionosphere and the ground. The time differences between reflection signals and the direct signal are determined by the 3D location of the CID and the height of the ionosphere, so these values can be retrieved by simultaneous observations of lightning detection network. Based on this relationship, a new method for determining 3D locations of CIDs is developed. This method can not only accurately determine 3D locations of CIDs but also calculate the virtual height of the ionosphere, which is potentially an effective way to study the characteristics of the ionosphere. By comparing locations of CIDs with radar echoes, this method proves to have high accuracy. Discharge heights of thousands of both positive and negative polarity CIDs are computed, and it is found that positive CIDs mostly occur at the height of 7~14 km, while negative CIDs are much higher, mostly in the range of 15~18 km. Discharge heights of negative CIDs are generally comparable to the height of the tropopause, and they are much fewer than positive CIDs, which indicate that negative CIDs are probably produced in extremely vigorous, though relatively rare, thunderstorm processes.

Keywords Compact intracloud discharge, Narrow bipolar event, Ionosphere, Intracloud discharge, 3D location

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