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东南沿海生物气溶胶的扩散模拟研究

Numerical study on bioaerosol dispersion over southeast coast of China

关键词：东南沿海 大气边界层 生物气溶胶 空气质量模式 扩散模拟

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摘要：将沿海扩散模式OCD与区域输送模式相嵌套,集成在区域空气质量模拟系统RegAQMS中,由天气研究和预报模式WRF提供气象场,大气边界层模式计算湍流场和边界层特征参数,并引入生物气溶胶的干湿沉积、生物学衰变、温度和湿度衰减、紫外辐射衰减等过程,使得RegAQMS具备模拟生物气溶胶浓度分布的能力.利用改进后的RegAQMS,以2008年7、8月为例,针对东南沿海地区,进行了口蹄疫病毒生物气溶胶扩散有关物理和生物过程的敏感性试验,对地面口蹄疫病毒浓度进行模拟和风险等级评估.敏感性试验表明,考虑干湿沉积、温度、湿度和生物学衰减过程之后,7、8月地面病毒平均浓度(≥0.01 μg·m^{-3}的网格点平均)分别减小61.9%和65.6%,污染区面积分别减小25.6%和50.1%,温度衰减是影响夏季病毒浓度的最主要过程,生物学衰减和干湿沉积也起着较大的作用,湿度衰减的影响很小.风险和感染评估结果表明,在与前人研究类似的源释放条件下,研究区域大部分为低等风险区和安全区,高等风险区以上的面积较小,呈条状分布在两个主要风频的下风向,7月和8月的风险区面积分别占整个区域面积的61.6%和54.2%,感染区面积占整个区域面积的不到1%.受海洋大气和海峡地形作用的影响,流场规则、日风向变化和水平湍流强度小,这些是引起病毒较高传播风险和感染的主要原因.

Abstract: In this study, the Offshore and Coastal Dispersion (OCD) was nested in a regional dispersion model and then integrated in the Regional Air Quality Model System (RegAQMS). Meteorological and turbulent fields needed for RegAQMS were calculated with the Weather Research and Forecasting (WRF) model and the Atmospheric Boundary Layer model, respectively. The process of dry deposition, wet scavenging, temperature decay, humidity decay, biological aging, and ultra-violet radiation decay of bioaerosols were also incorporated into RegAQMS to describe distribution patterns of bioaerosol concentrations. In the case study of July and August 2008 at southeast coast of China, sensitivity tests of physical and biological process of foot-and-mouth virus were conducted with the improved RegAQMS and the simulated virus concentrations were used for risk and infection assessments. Results of sensitivity tests showed that the average surface concentrations in July and August reduced by 61.9% and 65.6%, respectively, and the contaminated areas reduced by 25.6% and 50.1% if all biological and physical processes were taken into account. Temperature decay was the principal process which affected virus concentration in summer. Biological aging, dry deposition, and wet scavenging were also significant. Relative humidity however had little influence on the concentration. Results of risk and infection assessments showed that most of the research areas were safe or at low level of risk, as reported by previous study. The areas with high level of risk were small, which primarily concentrated at the downwind of two dominating flow directions in the form of narrow strips. The areas of risk regions in July and August were 61.6% and 54.2%, respectively. Infection regions accounted for less than 1% of the whole research region. Ordered flow fields from inshore water and strait terrain contributed to a small diurnal fluctuation of wind direction and horizontal turbulent intensity, which resulted in wider virus diffusion and higher infection risk.

Key words：southeast coastal area atmospheric boundary layer bioaerosol air quality model diffusion simulation

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