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Estimation of biogenic volatile organic compound (BVOC) emissions from the terrestrial ecosystem in China using real-time remote sensing data

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Because of the high emission intensity and reactivity, biogenic volatile organic compounds (BVOCs) play a significant role in the terrestrial ecosystems, human health, secondary pollution, global climate change and the global carbon cycle. Past estimations of BVOC emissions in China were based on outdated algorithms and limited meteorological data, and there have been significant inconsistences between the land surface parameters of dynamic models and those of BVOC estimation models, leading to large inaccuracies in the estimated results. To refine BVOC emission estimations for China and to further explore the role of BVOCs in atmospheric chemical processes, we used the latest algorithms of MEGAN (Model of Emissions of Gases and Aerosols from Nature) with MM5 (the Fifth-Generation Mesoscale Model) providing highly resolved meteorological data, to estimate the biogenic emissions of isoprene (C5H8) and seven monoterpene species (C10H16) in 2006. Real-time MODIS (Moderate Resolution Imaging Spectroradiometer) data were introduced to update the land surface parameters and improve the simulation performance of MM5, and to modify the influence of leaf area index (LAI) and leaf age deviation from standard conditions. In this study, the annual BVOC emissions for the whole country totaled 12.97 Tg C, a relevant value much lower than that given in global estimations but higher than the past estimations in China. Therein, the most important individual contributor was isoprene (9.36 Tg C), followed by α-pinene (1.24 Tg C yr-1) and β-pinene (0.84 Tg C yr-1). Due to the considerable regional disparity in plant distributions and meteorological conditions across China, BVOC emissions presented significant spatial-temporal variations. Spatially, isoprene emission was concentrated in South China, which is covered by large areas of broadleaf forests and shrubs. On the other hand, Southeast China was the top-ranking contributor of monoterpenes, in which the dominant vegetation genera consist of evergreen coniferous forests (mainly Pinus massoniana). Temporally, BVOC emissions primarily occurred in July and August during periods of high temperatures, high solar radiation and dense plant cover, with daily emissions peaking at about 13:00$\sim$14:00 hours (Beijing Time, BJT) and reaching their lowest values at night. Additionally, emissions of volatile organic compounds (VOCs) of biogenic origin (14.7 Tg yr-1) were approximately one-third less than anthropogenic emissions (23.2 Tg yr-1) and showed distinct spatial distributions. We present a reasonable estimation of BVOC emissions, which provides important information for further exploration of the role of BVOCs in atmospheric processes.