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Impacts of BVOCs changes on global atmospheric chemistry: off-line coupling of CHASER and VISIT

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Biogenic volatile organic compound (BVOC) is one of important factors to control global atmospheric environment and climate change, affecting tropospheric chemistry which involves ozone production/loss, OH radical abundance (atmospheric oxidizing power), and global production of secondary organic aerosols (SOA). Emissions of BVOCs are basically determined by land ecosystem processes, but also tightly linked to climate factors (such as temperature and precipitation), atmospheric CO2 concentration, and deposition of nitrogen species. Therefore, a modelling framework to couple atmospheric chemistry with land ecosystem is needed for considering BVOCs changes and associated impacts. In this study, coupled simulation of global atmospheric chemistry and terrestrial ecosystem has been developed by combining atmospheric chemistry model CHASER (Sudo et al., 2002, 2007) and land ecosystem/trace gas emission model VISIT (Ito et al., 2008). The CHASER model, also developed in the framework of the MIROC earth system model (MIROC-ESM-CHEM), simulates detailed chemistry in the troposphere and stratosphere with an on-line aerosol simulation including SOA production. The VISIT model calculates terrestrial emissions of CO_2, CH_4, N_2O, and BVOCs. This paper focuses on isoprene as a proxy of BVOCs, and discusses the impacts of the past isoprene emission changes on global atmospheric chemistry using the CHASER model constrained with off-line input from the VISIT simulation. VISIT calculates an increase in global isoprene emissions from 420 to 520 TgC a^{-1} (24%) from the first half of the 20th century to 2011. As a response to this emission change, CHASER simulated a ˜2% increase in global ozone production causing ˜4% increases in ozone concentration in the tropical middle-upper troposphere. The model also showed that OH decreases by 5-10% in the most of NH due to the isoprene emission change, resulting in 2-4% decreases of CO in NH. Also, SOA is largely increased by more than 30% in the major part of the troposphere (especially in the tropics).

Keywords: biogenic VOCs, chemistry climate model, land ecosystem model, secondary organic aerosol, atmosphere-land interaction