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CO_2 and temperature effects on global isoprene emissions from terrestrial vegetation

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In recent years evidence has emerged that atmospheric CO_2 concentration has a direct effect on leaf isoprene emission. Many (but not all) laboratory experiments indicate that emissions increase under below-ambient CO_2 levels and decrease with increasing CO_2.

We incorporate these effects into a mechanistically based leaf-isoprene model that calculates isoprene production from the amount of redox-equivalents required during its synthesis in the chloroplast [1]. The model is combined with the Farquhar et al. [2] photosynthesis scheme, to estimate isoprene from leaf electron transport, based on a fraction of electrons used for isoprene synthesis (ε). The leaf-scheme can be incorporated into the dynamic global vegetation model framework LPJ-GUESS [3] to investigate the effects of climate change and changing atmospheric CO_2 levels on ecosystem, regional and global isoprene emissions. When run in 'cohort mode', a mode particularly suitable for ecosystem level calculations since it specifically includes light-competition, the model compares well with the few published estimates of isoprene emissions that are based on flux measurements.

Run in 'population mode' the model demonstrates that the direct effects of high and low CO_2 concentration (decrease isoprene at high CO_2 and increase at low) can nearly cancel effects on gross-primary productivity and leaf area index (which work in the opposite direction). Regionally the picture, however, is more complex and depends for instance on vegetation type, interactions soil moisture etc. Additional complications arise if the fraction of electrons used for isoprene synthesis,ε, is assumed to depend on

temperature in addition to CO_2. These effects have so far not been considered in global estimates of isoprene emissions and may raise important questions for atmospheric chemistry and the contribution of the terrestrial carbon cycle to aerosol formation.

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