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Process based inventory of isoprenoid emissions from European forests: model comparisons, current knowledge and uncertainties

T. Keenan[1], Ü. Niinemets[2], S. Sabate[1,3], C. Gracia[1,3], and J. Peñuelas[1,4]
[1]CREAF, Autonomous University of Barcelona (UAB), 08193 Barcelona, Spain
[2]Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences, Kreutzwaldi 1, Tartu 51014, Estonia
[3]Department of Ecology, University of Barcelona (UB), 08007 Barcelona, Spain
[4]Global Ecology Unit CSIC-CEAB-CREAF, CREAF, Edifici C, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain

Abstract. Large uncertainties exist in our knowledge of regional emissions of non-methane biogenic volatile organic compounds (BVOC). We address these uncertainties through a two-pronged approach by compiling a state of the art database of the emissions potentials for 80 European forest species, and by a model assessment and inter-comparison, both at the local and regional scale, under present and projected future climatic conditions. We coupled three contrasting isoprenoid models with the ecophysiological forest model GOTILWA+ to evaluate leaf and ecosystem isoprenoid emissions, build an emissions inventory for European forests, and to consider model behaviour in present climate and under projected future climate change conditions. Hourly, daily and annual isoprene emissions as simulated by the models were evaluated against flux measurements. The validation highlighted a general model capacity to capture gross fluxes but inefficiencies in capturing short term variability. A regional inventory of isoprenoid emissions for European forests was created using each of the three modelling approaches. The models agreed on an average European emissions budget of 1.03 TgC a^{-1} for isoprene and 0.97 TgC a^{-1} for monoterpenes for the period 1960 – 1990, which was dominated by a few species with largest aerial coverage. Species contribution to total emissions depended both on species emission potential and geographical distribution. For projected future climate conditions, however, emissions budgets proved highly model dependent, illustrating the current uncertainty associated with isoprenoid emissions responses to potential future conditions.

These results suggest that current model estimates of isoprenoid emissions concur well, but future estimates are highly uncertain. We conclude that development of reliable models is highly urgent, but for the time being, future BVOC emission scenario estimates should consider results from an ensemble of available emission models.

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