Improving estimation of global BVOCs emissions

*Kengo Sudo[1,2], Kazuyuki Miyazaki[2], Akihiko Ito[3]

1. Graduate School of Environmental Studies, Nagoya University, 2. JAMSTEC, 3. NIES

This study improves model estimation of global BVOCs (Biogenic Volatile Organic Compounds) emissions using the ground observations of BVOCs extending over the globe. BVOCs emitted by plants, can affect largely atmospheric chemistry. Isoprene, the most dominant component of BVOCs, can be the precursor of Secondary Organic Aerosol (SOA), which plays a key role in climate change. Therefore, accurate calculation of BVOCs distribution and budget is very important for understanding and predicting climate change and atmospheric environment.

Current estimate of global BVOCs emissions exhibits a large uncertainty. In this study, global BVOCs emission estimate by a land-ecosystem model VISIT is evaluated using observations of concentration and emission of isoprene. This study further tries to optimize the BVOCs emission estimate using sensitivity simulations with a global chemistry climate model CHASER and formaldehyde observations by OMI.
First, this study, focused on uncertainty in the current estimates of BVOCs emissions, derives a correction factor for the emission estimate of the land ecosystem model VISIT by detailed comparison of BVOCs between the CHASER-VISIT model calculations and the ground-based BVOCs observations. For the current estimate of BVOCs emissions by VISIT, this study suggests a correction factor (CF) for isoprene emission as follows: Malaysia~0.1, Amazon and Africa~0.5, Europe~3, North-America~2.

In this study, satellite observation of formaldehyde (HCHO) which is one of the major products of BVOCs oxidation, is used to verify the above-derived correction factor. Sensitivity experiments with the CHASER model are performed with differentiating BVOCs emission input data and chemical yield (Y) of HCHO from the BVOCs oxidation. Comparison between the OMI HCHO data and sensitivity experiments by the model shows that the correction factor (CF) with 50% reduction of chemical yield of HCHO (Y) most successfully simulates the HCHO distribution. In this case, the global isoprene emission amount is largely reduced from the standard VISIT estimation of 518.5 TgC yr^{-1} to 371 TgC yr^{-1}.

This study performs another sensitivity experiment where tropospheric OH radical concentrations are significantly reduced by cutting down the global lightning NOx emission in the model by a factor of 6. In this simulation, it is found that HCHO simulation is improved in the tropics like Amazon due to suppressed HCHO production from oxidation of methane (CH_4+OH-->HCHO). This indicates that OH distributions can significantly affect estimate/validation of BVOCs emission using the observed HCHO distributions. Especially, in the Indian Ocean, Indonesia and western Pacific, all the sensitivity experiments obviously overestimate the HCHO observed by OMI, maybe suggesting that OH concentrations are overestimated in these areas.

Keywords: BVOCs, SOA, chemistry-climate model, HCHO, Isoprene

