Executive Summary

Emissions of isoprene during 2011 (a severe drought year) and 2007 (a relatively wet year in Texas) were estimated using an updated MEGAN (v2.10) model that considers the drought impacts on isoprene emissions. The regional soil moisture field needed for the MEGAN model was estimated using the WRF model with the Noah land surface scheme initialized with the soil moisture field from NLDAS-2 with Noah-2.8. Wilting point data needed for the drought parametrization was estimated using the Penn State CONUS-SOIL database and the soil-related hydraulic parameters from Table 2 of Chen and Dudhia [1]. While the predicted soil moisture generally agrees with observations, field measurements of soil moisture and isoprene emission at three field sites in east Texas in 2011 indicated that root zone soil moistures may not be adequately represented in the model because (i) the model may over- or under-predict grid average rainfall and/or evapotranspiration, and (ii) it does not consider differences in rooting depth between isoprene emitters. Greenhouse measurements on potted oak species revealed that there does not appear to be major physiological differences between species and that the current factor scaling isoprene emissions to drought stress adequately represents observed responses. When those are applied to the field data, differences between isoprene emitting oak species do emerge, but are more likely be related to root structure (and depth) and physiology than to average soil moisture.

The MEGAN model with its own isoprene emission factor (EF) field severely over-predicts observed isoprene concentrations from Automated gas chromatograph (Auto-GC) instruments throughout the continental United States. Alternative EF fields generated from two different versions of the Biogenic Emissions Inventory System (BEIS) models (v3.14 and v3.61) and their accompanying land use data bases (BELD3 and BELD4, respectively) from US Environmental Protection Agency were applied in the updated MEGAN model. Comparison of predicted hourly and daily averaged isoprene concentrations at all isoprene monitors in and out of Texas in a total of 14 months in 2007 and 2011 showed that the MEGAN model with EF fields from BEIS v3.61 and its input data (BELD4) could significantly improve the model capability in reproducing the observed isoprene concentrations at all locations. Predicted isoprene emissions under drought conditions considering the impact on leaf temperature alone led to increases in isoprene emissions. The magnitude of the emissions increase was reduced when the soil moisture activity factor was also considered. When both factors were considered, the resulting isoprene and ozone concentrations in both 2007 and 2011 changed only slightly (less than 1 ppb for monthly average 1-hour isoprene at locations where drought was significant, and less than 1 ppb for monthly average peak ozone concentrations).