



Comparison of Regional and Global Land Cover Products and the Implications for Biogenic Emissions Modeling

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Introduction

- Isoprene and monoterpenes are among the most significant biogenic volatile organic compounds (BVOCs) emitted globally each year.¹
- Annual biogenic emissions in Texas ranked first within the continental U.S. in the 2011 National Emissions Inventory.
- Texas has highly diverse land use/land cover profiles over its ten climate regions.
- Land cover characterization is an essential driving variable that determines the phenological emission potential of a region in biogenic emission models.

Research Objectives

- This work investigated the influences of land cover characterization on estimates of isoprene and monoterpene emissions using the MODIS global land cover product (MCD12Q1) and a regional product developed by Popescu et al.² for the Texas Commission on Environmental Quality (TCEQ).
- Simulations with the Model of Emissions of Gases and Aerosols from Nature (MEGAN) were conducted for eastern Texas (Fig. 1) and influences on the standard emission potential (SEP) and emission activity factor were explored both separately and simultaneously.

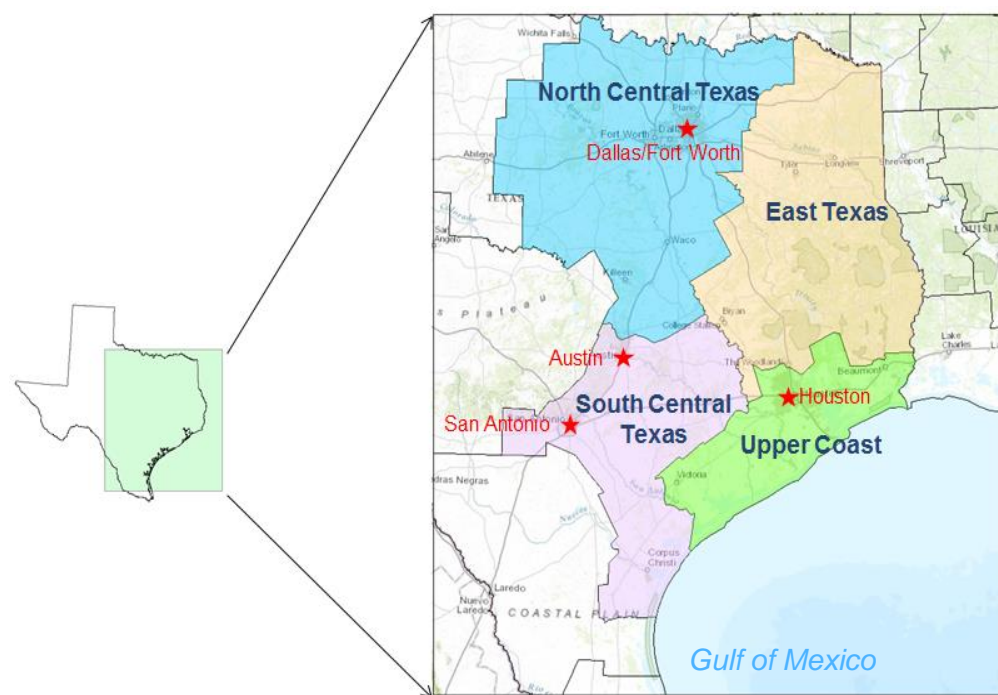


Fig. 1 MEGAN domain for eastern Texas including the four climate regions – North Central Texas, South Central Texas, East Texas and Upper Coast. Red stars represent major metropolitan areas.

MODIS and TCEQ Land Cover Products

• MODIS Land Cover Product (MCD12Q1)

The MODIS product (MCD12Q1) provides five types of land cover schemes at annual time steps and 500-m spatial resolution since 2001. Type 3 is the LAI/fPAR biome scheme³ and was used for comparisons with TCEQ data. The plant functional type (PFT) scheme⁴ (Type 5) was mapped to MEGAN's default 16 PFT scheme.

• TCEQ Land Cover Product

The TCEQ regional land cover product was developed by combining three existing databases² from the Landscape Fire and Resources Management Planning Tools Project (LANDFIRE), 2001 National Land Cover Dataset (NCLD), and Texas Parks and Wildlife Department Texas Ecological System Classification Project. This product consisted of 36 land cover categories with a spatial resolution of 30 m.

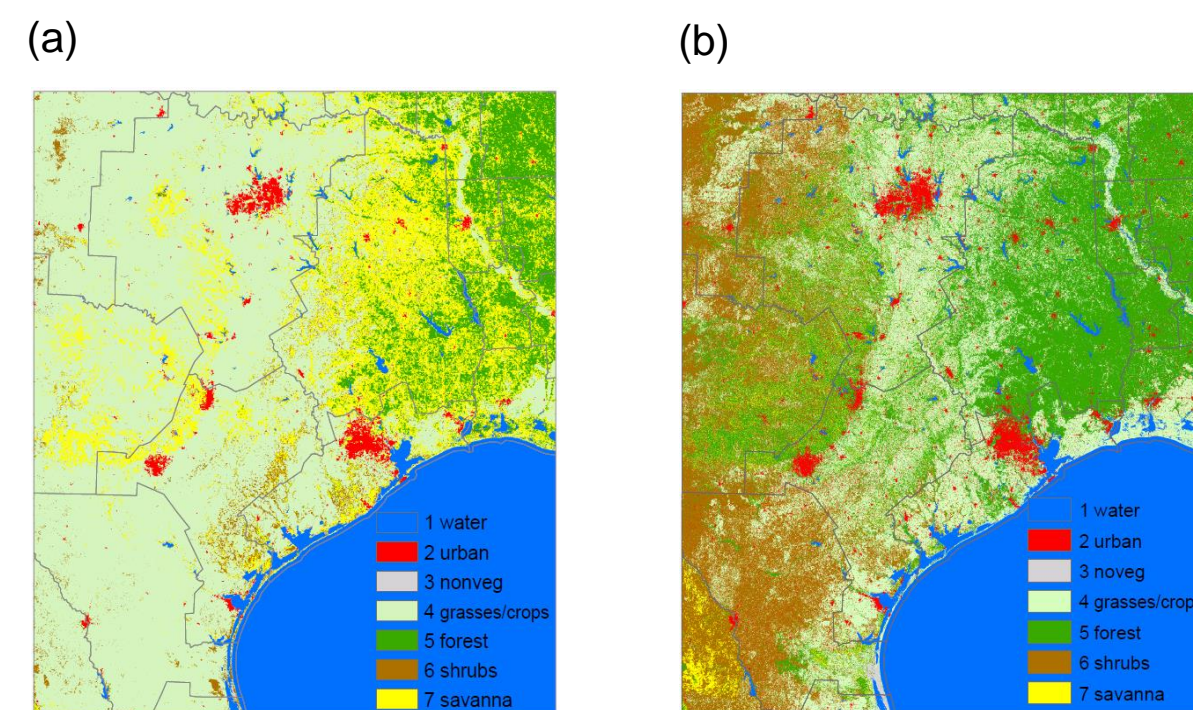


Fig. 2 The (a) MODIS (year 2011) and (b) TCEQ products for a simplified set of seven land cover categories: water, urban, non-vegetated, grasses and crops, forest, shrubs and savanna.

MODIS indicated negligible forest coverage in North/South Central Texas while the TCEQ product suggested substantial forest coverage (~23%). In East Texas and Upper Coast, MODIS estimates of forest coverage were lower by factors of 3.6 and 4.8, respectively, relative to the TCEQ product. Area coverage of the land cover category, savanna, were much greater in the MODIS product.

Discrepancies between the two datasets may be caused by differences in the classification methodology, the types of satellite sensors used, uncertainties associated with the reprojection, and differences in the spatial resolutions of the products⁵⁻⁷.

MEGAN Configuration

Isoprene/monoterpene emissions were calculated as⁸:

$$F = \gamma \cdot \sum \epsilon_j \chi_j$$

where ϵ is the basal emission factor for vegetation type j with fractional coverage χ_j within a model grid; γ is the overall emission activity factor that accounts for variations in environmental conditions. The standard emission potential (SEP) is used in replacement of the summation term. The MEGAN configuration follows the approach of Huang et al.⁹ Three sets of simulations were conducted for March-October during 2006-2011, with a focus on the Standard Emission Potential, emission activity factor, and both.

Standard Emission Potential (SEP)

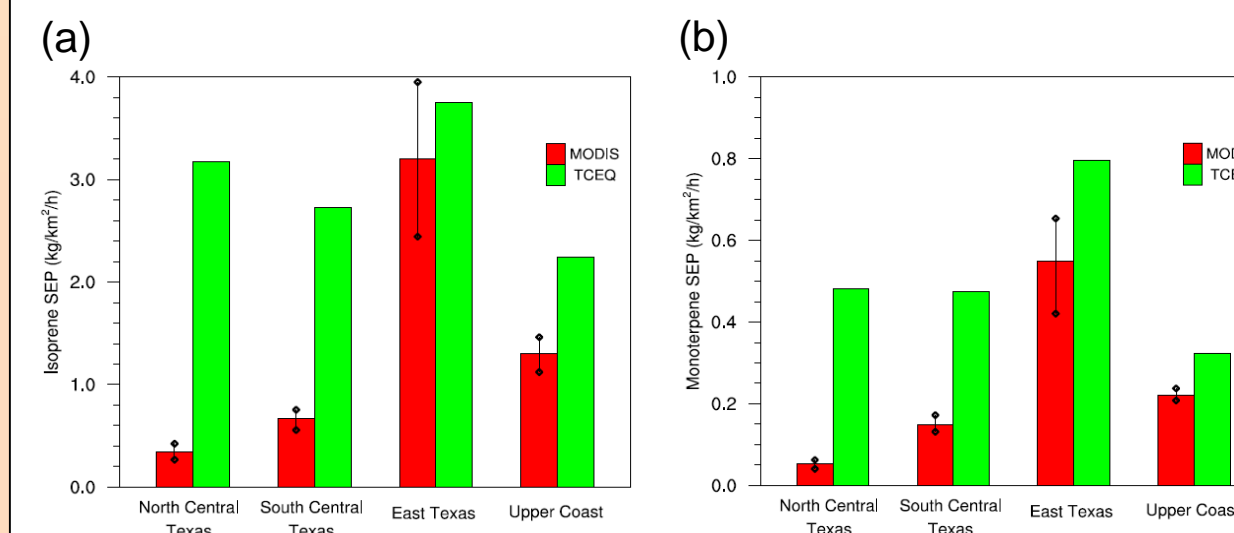


Fig. 3 Area-averaged (a) isoprene and (b) monoterpene SEPs (in kg/km²/h) generated using the MODIS (averaged over 2006-2011) and TCEQ land cover products. Black lines define the maximum and minimum range during 2006-2011.

East Texas had the highest SEPs, as well as interannual fluctuations, due to dense forest coverage.

In North and South Central Texas, the MODIS product resulted in significantly lower estimates of isoprene (by 75%-90%) and monoterpene (by 70%-90%) SEPs, due to relatively less forest coverage than the TCEQ product.

The higher coverage of savanna in the MODIS product in East Texas and Upper Coast resulted in better agreement between area-averaged SEPs than in central Texas.

Emission Activity Factor (γ)

Differences in the emission activity factor associated with the two datasets were negligible, yet could be large at a finer spatial scale. As a conceptual example, changing the PFT from 100% crop to 100% broadleaf evergreen tropical trees for a sample grid cell resulted in a 27% increase in γ .

Isoprene/Monoterpene Emissions

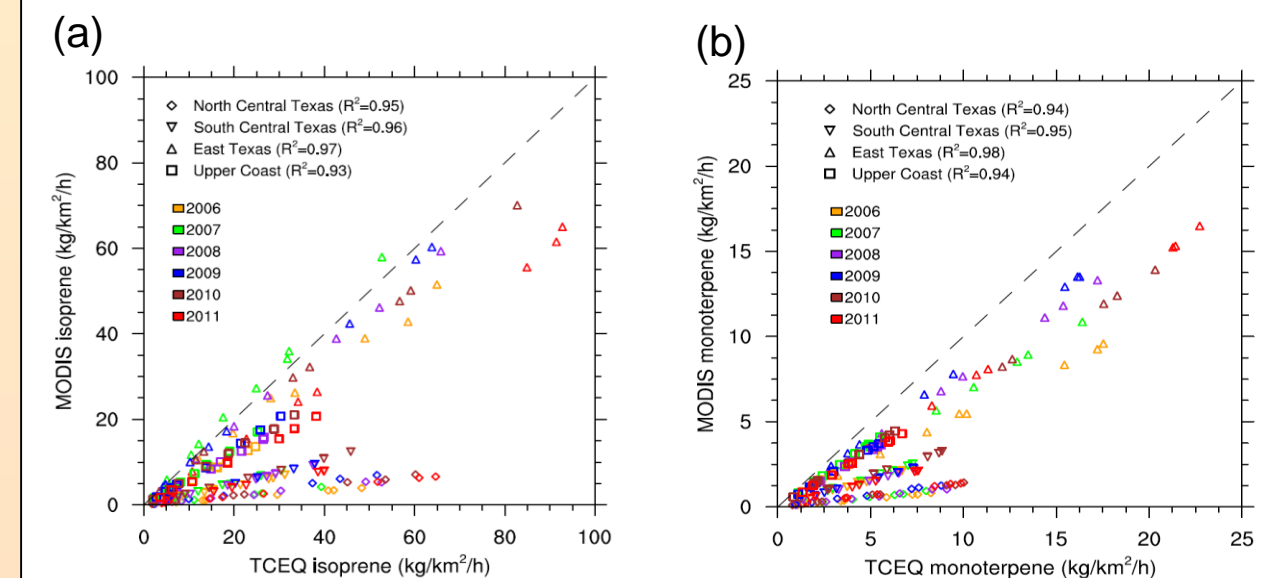


Fig. 4 Scatter plots of monthly area-averaged (a) isoprene and (b) monoterpene emissions generated from the MODIS and TCEQ products for March-October during 2006-2011.

In central Texas, the significantly lower (by as much as 90%) isoprene and monoterpene emissions generated from the MODIS product compared to the TCEQ product were primarily due to differences in the SEPs associated with differences in land cover characterizations. Relative differences in East Texas ranged from -35% to 45%. Even when the products predicted similar area-averaged monthly emissions, substantial differences could exist spatially.

Conclusions

Large discrepancies exist in some areas of eastern Texas between the MODIS MCD12Q1 global and regional TCEQ land cover products.

Isoprene and monoterpene emissions differ by as much as a factor of ten in central Texas due to different PFT distributions.

Influences of land cover characterization on biogenic emissions are dominated by differences in SEPs that are PFT-dependent.

Improved validation of land cover products at regional scales or use of prescribed emission factor maps from in-situ measurements could reduce uncertainties in modeled biogenic emissions.

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