

ENVIRON

MEMORANDUM

To: Bill Gill and Mark Estes, TNRCC
From: Greg Yarwood and Gerry Mansell
Date: 17 May, 2001
Subject: Comparisons of biogenic emissions between the PC-BEIS and GloBEIS models for five Texas counties.

Background

The TNRCC requires estimates of biogenic emission rates both for periodic emission inventories and photochemical modeling. In the near term, periodic inventories are needed for submission to EPA's 1999 National Emission Trends (NET99) database for which the emissions estimates must be for individual counties for representative summer day conditions. In contrast, biogenic emission inventories for photochemical modeling must be gridded and represent day specific conditions. The TNRCC prepares biogenic inventories for photochemical modeling using the GloBEIS model with locally specific landuse/landcover (LULC) data as described in a recent report (Yarwood et al., 2001). In the past, periodic biogenic emissions have been estimated using the PC-BEIS model from EPA. However, the PC-BEIS emissions are based on different LULC data than are being used for photochemical modeling in Texas. Developing periodic inventories for the NET99 using GloBEIS offers the following advantages:

- Periodic and modeling emission inventories for biogenic sources will be from the same model.
- The periodic inventories will use the updated LULC data developed for Texas by the TNRCC (Yarwood et al., 1999a; Wiedinmyer et al., 1999) as is being used for photochemical modeling.
- GloBEIS provides options to use the updated BEIS99 emission factor algorithm (Guenther et al., 1999a and 1999b) for isoprene or the older BEIS2 algorithm.

Objectives

The purpose of this memorandum is to compare emissions from GloBEIS and PC-BEIS for several representative counties in Texas. The following types of comparisons are made:

1. Compare GloBEIS and PC-BEIS emissions model with the same emission factor algorithms, LULC data and environmental data.
2. Show the impact of updated LULC data in GloBEIS (i.e., compare the TNRCC's LULC data to EPA's BELD2 LULC data as provided with PC-BEIS).

3. Show the impact of updated isoprene emission factor algorithms in GloBEIS (i.e., compare the BEIS99 and BEIS2 algorithms).

Comparison Methods

Comparisons were performed for five counties associated with urban areas where ozone modeling is being performed: Bexar (San Antonio); Brazoria (Houston); Harrison (Longview); Tarrant (Dallas/Fort Worth); Travis (Austin). These counties cover a range of conditions across eastern Texas. All comparisons were made for a constant temperature of 300 K and clear sky conditions for August 21, 1999 (solar equinox).

Biogenic Emissions Models

- Version 2.2 of GloBEIS (Yarwood et al., 1999a, 1999b, 2001; Guenther et al., 1999a and 1999b) available at www.globeis.com. Version 2.2 of GloBEIS has two updates from version 2.1. (1) Includes additional data tables to accommodate the PC-BEIS BELD2 LULC data. (2) The report to calculate tons of other VOC emissions was corrected to use a molecular weight of 148 for other VOC rather than 138 resulting in a 7 % increase in the mass of other VOC. This change does not affect modeling inventories or CB4 emission totals.
- Version 2.3 of PC-BEIS, see www.epa.gov/asmdnerl/beis_bkgrnd.html

Landuse/Landcover (LULC) Data

- The PC-BEIS version of EPA's BELD LULC data, see www.epa.gov/asmdnerl/beis_bkgrnd.html. These data are directly compatible with PC-BEIS and can be reformatted for use with GloBEIS.
- The latest TNRCC LULC data for biogenic emissions (Yarwood et al., 1999a; Wiedinmyer et al., 1999) processed to county level. PC-BEIS can't use these data.

Comparison of GloBEIS and PC-BEIS Emissions

Emissions for five Texas counties were calculated using PC-BEIS and GloBEIS with:

- Same LULC data (BELD2 from PC-BEIS).
- Same isoprene emission factor algorithm (BEIS2).
- Same temperature and solar radiation.

The emissions of isoprene, total monoterpenes, other VOC and NO are compared in Figure 1. The agreement is excellent for all of the VOC emission types with GloBEIS showing a small bias of 3% for isoprene, -2% for total monoterpenes and -2% for other VOC relative to PC-BEIS. For NO_x, GloBEIS emissions were biased about 9% higher than PC-BEIS. The source of the discrepancy for NO_x is unknown, but this difference is small compared to the uncertainties in the calculation methodology and different sources of LULC data. We conclude that GloBEIS provides equivalent emission estimates to PC-BEIS when using the same LULC data and environmental conditions.



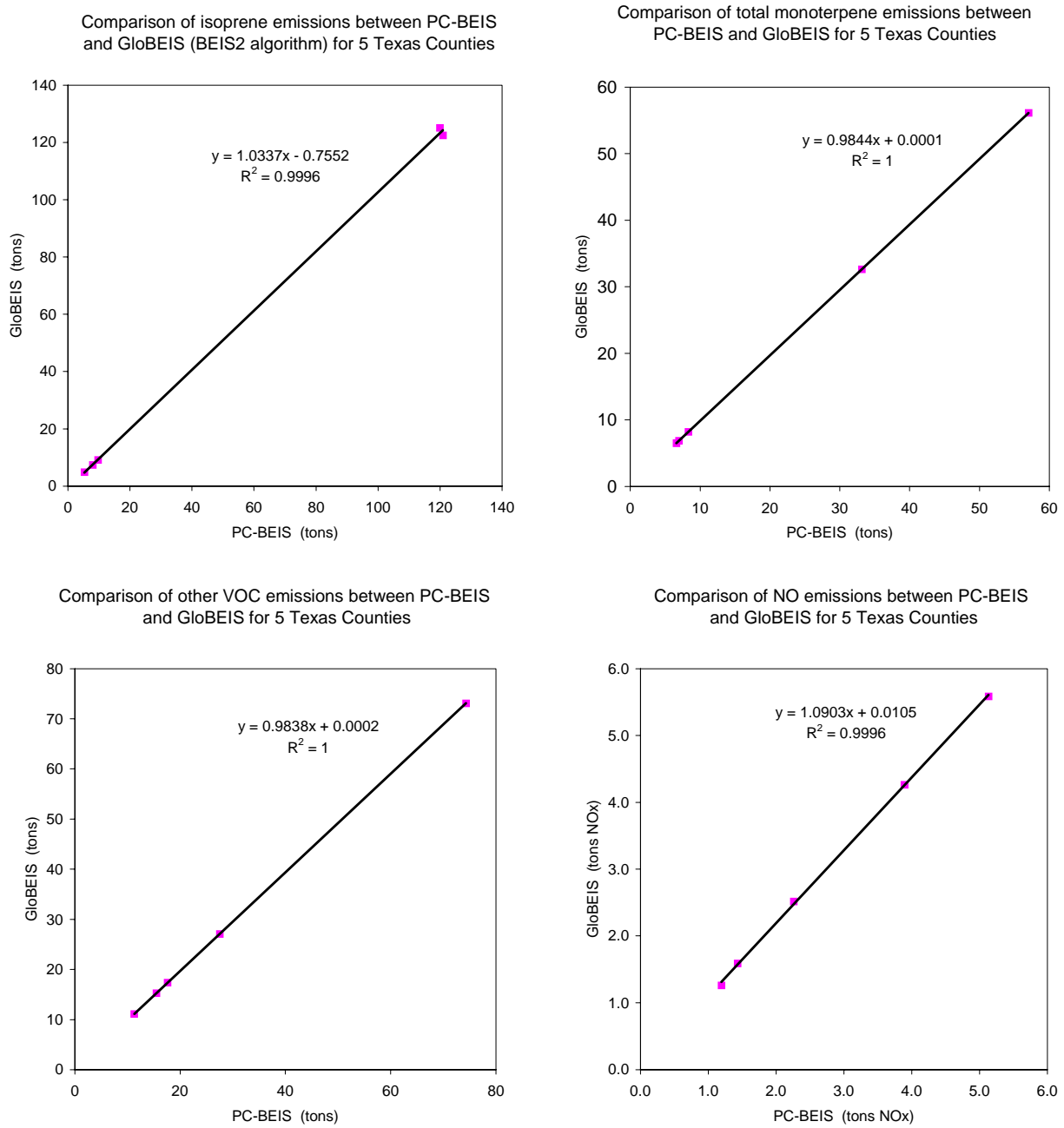


Figure 1. Emissions of isoprene, total monoterpenes, other VOC and NO from GloBEIS to PC-BEIS for five Texas counties. Emissions are based on BELD2 LULC data and BEIS2 emission factor algorithms.



Comparison of LULC Data and Isoprene Emission Factors

Emissions were calculated using different LULC data (BELD2 vs. TNRCC) and emission factor algorithms for isoprene (BEIS2 vs. BEIS99). The emissions for 5 Texas counties are compared in Figures 2-4 for isoprene, VOC and NO (as NO_x) respectively. The bars in each figure are:

1. PC-BEIS with BELD2 LULC data (blue).
2. GloBEIS with BEIS2 emission factor algorithms and BELD2 LULC data (dark red).
3. GloBEIS with BEIS2 emission factor algorithms and TNRCC LULC data (yellow).
4. GloBEIS with BEIS99 emission factor algorithms and TNRCC LULC data (light blue).

PC-BEIS vs. GloBEIS. As discussed above, emission estimates are equivalent for GloBEIS and PC-BEIS when both models are run with the same data and assumptions.

TNRCC vs. BELD2 LULC data. There are significant differences between emission estimates based on the TNRCC and BELD LULC data for isoprene, VOC and NO_x. For the five counties selected here, emissions are generally higher with the TNRCC data than the BELD2 data, though there are cases where emissions are lower with the TNRCC data for isoprene, VOC and NO_x. Systematic differences between the TNRCC and BELD data are more readily apparent from gridded emission density plots. Gridded isoprene emissions density may be compared between the TNRCC and BELD LULC data in Figures 5 and 6. These comparisons are from a separate study (Yarwood et al., 2001) and used a later version of the BELD data (Version 3.1), however they do illustrate the differences in spatial distributions of biomass density between the BELD and TNRCC LULC databases. Comparisons were performed using GloBEIS with environmental conditions held constant for both sets of LULC data. The area shown in Figures 5 and 6 includes Austin and San Antonio (Travis and Bexar counties). There are significant differences in the locations of high isoprene emission areas (deciduous trees) reflecting differences in the LULC data. Extensive field studies were performed to support the development of the TNRCC LULC data, and the TNRCC staff believes that these data are more representative of Texas.

BEIS99 vs. BEIS2 algorithms for isoprene. Changing between the BEIS2 and BEIS99 algorithms in GloBEIS changes the emissions of isoprene, but not total monoterpenes, other VOC or NO_x. Isoprene emissions with the BEIS99 algorithm are 25% to 30% lower than with the BEIS2 algorithm for the five counties studied here. The BEIS99 algorithm (Guenther et al., 1999a and 1999b) is an update to the BEIS2 algorithm and represents an improvement in the science. The 25-30% reduction in biogenic isoprene emissions with BEIS99 is likely to have a significant impact on the development of ozone control strategies and the TNRCC staff believes that the updated BEIS99 algorithm should be used for estimating biogenic emissions in Texas.



Comparison of Isoprene emissions for the PC-BEIS2 and GloBEIS models and BELD2 vs. TNRCC LULC data

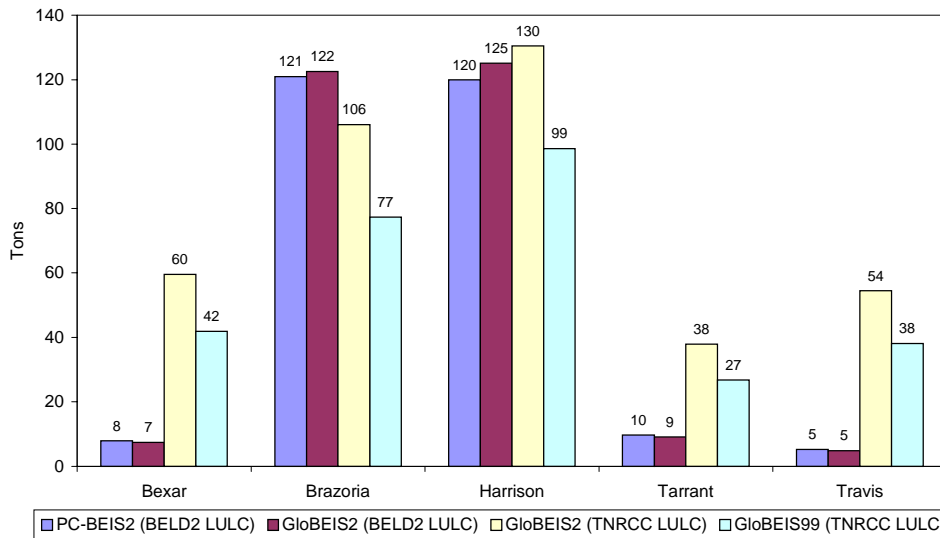


Figure 2. Comparison of isoprene emissions between PC-BEIS with BELD2 data, GloBEIS with BEIS2 algorithm and BELD2 data, GloBEIS with BEIS2 algorithm and TNRCC LULC data, and GloBEIS with BEIS99 algorithm and TNRCC LULC data.

Comparison of VOC emissions for the PC-BEIS2 and GloBEIS models and BELD2 vs. TNRCC LULC data

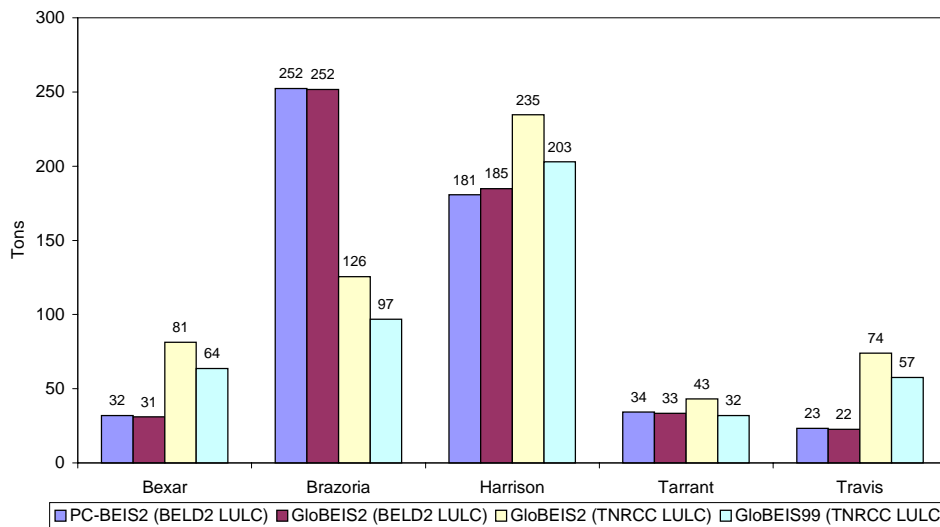


Figure 3. Comparison of VOC emissions between PC-BEIS with BELD2 data, GloBEIS with BEIS2 algorithm and BELD2 data, GloBEIS with BEIS2 algorithm and TNRCC LULC data, and GloBEIS with BEIS99 algorithm and TNRCC LULC data.



Comparison of NOx emissions for the PC-BEIS2 and GloBEIS models and BELD2 vs. TNRCC LULC data

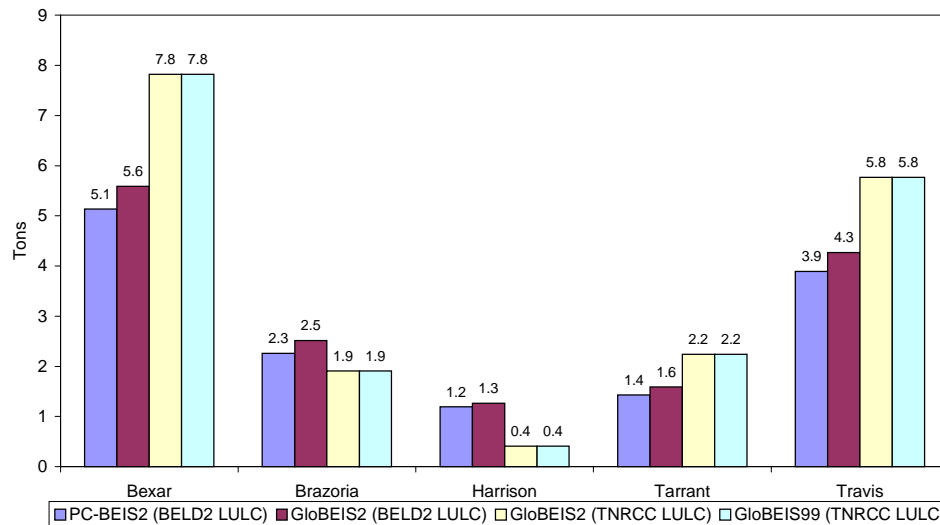


Figure 4. Comparison of NOx emissions between PC-BEIS with BELD2 data, GloBEIS with BEIS2 algorithm and BELD2 data, GloBEIS with BEIS2 algorithm and TNRCC LULC data, and GloBEIS with BEIS99 algorithm and TNRCC LULC data.

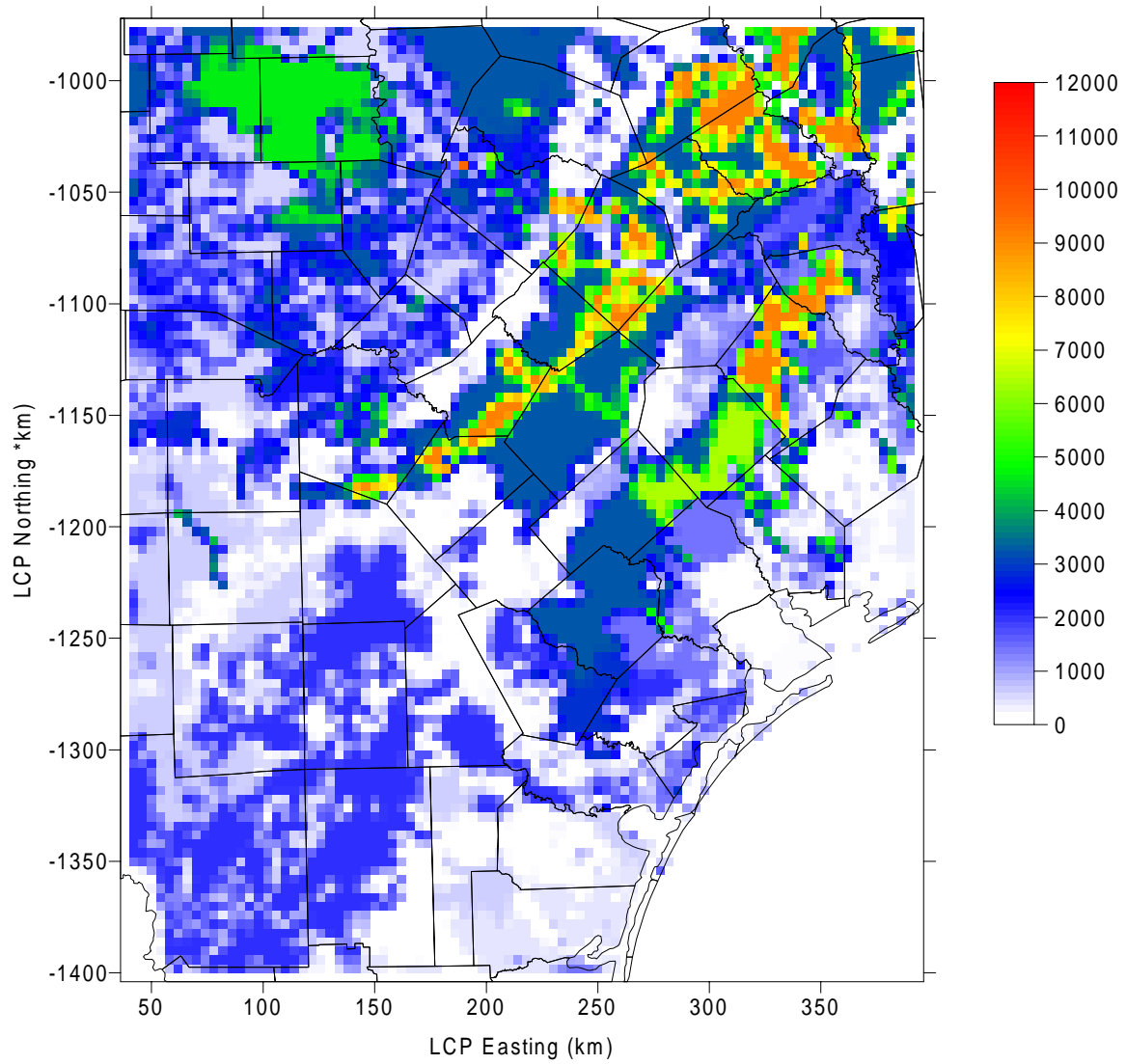


Figure 5. Isoprene emissions (g-moles/grid cell/day) for the South Central Texas 4-km grid based on the TNRCC LULC database (Yarwood et al., 2001).

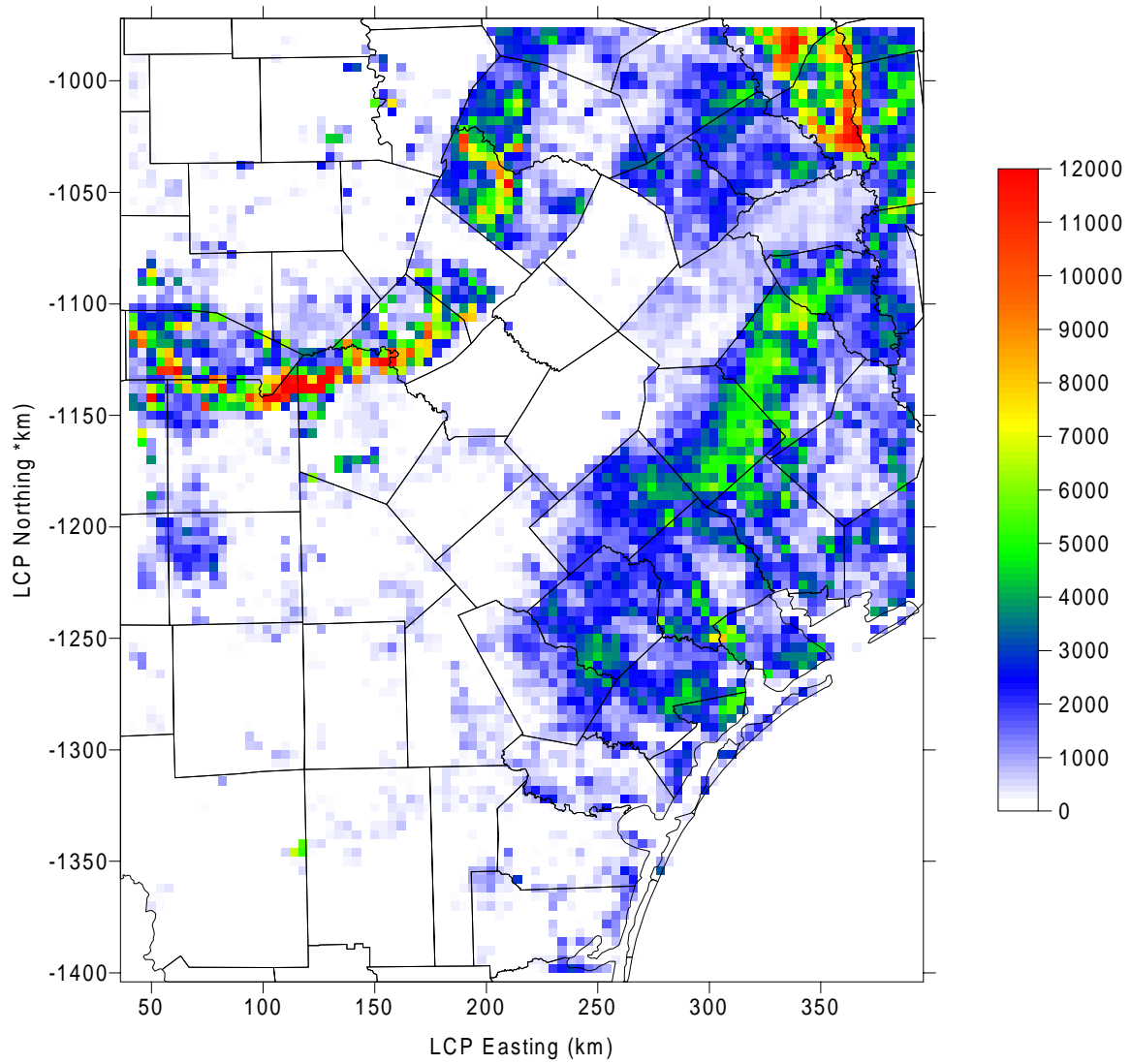


Figure 6. Isoprene emissions (g-moles/grid cell/day) for the South Central Texas 4-km grid based on the EPA BELD3.1 LULC database (Yarwood et al., 2001).

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