Comparison of Biogenic Emission Estimates from BEIS and MEGAN Models for Texas and the Continental USA

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BACKGROUND

- Biogenic emissions have a substantial influence on the production of ground-level ozone.
- Biogenic volatile organic compounds (BVOC) include emissions such as isoprene and terpenes emitted by vegetation and nitrous oxide compounds (NO_x) emitted by soil microorganisms.
- There are two well-known biogenic models with a variety of options and evaluating them is crucial for choosing the best biogenic model to use for air quality modeling.
- Biogenic models examined in this study:
  - Biogenic Emissions Inventory System (BEIS) is the model currently used to generate biogenic emissions by most states and the EPA within the continental U.S.
  - Model of Emissions of Gases and Aerosols from Nature (MEGAN) is another biogenic model that differs in several ways from BEIS.

METHODS

Different settings used and examined:

- Compounds examined: Isoprene and NO_x
- Domains: U.S. continental 12-km resolution and Texas 4-km resolution
- Impacts examined:
  - Soil NO_x algorithm:
    - YL is both in MEGAN and BEIS (Yienger and Levy 1995).
    - BDSNP is only in MEGAN (Berkeley-Dalhousie Soil NO_x Parametrization). It incorporates a more continuous soil temperature/moisture dependence function, wet and dry nitrogen (N) deposition, and utilizes soil moisture for more accurate pulsing.
  - Days chosen during ground-level ozone season to account for temperature influence:
    - July 15 and October 15 of the year 2022
  - Drought sensitivity setting inside MEGAN

Table 1. Main differences and attributes of the compared models

	BEIS	MEGAN
Version	4	3.2
Land Use	BELD6	Copernicus Global Land Service from 2022
Carbon Bond Mechanism	CB6R5 with alpha-pinene explicit	CB7 with alpha-pinene explicit
Soil NO_x Mechanism	YL	YL or BDSNP
Drought Sensitivity	N/A	On or Off

MODELING OUTPUTS

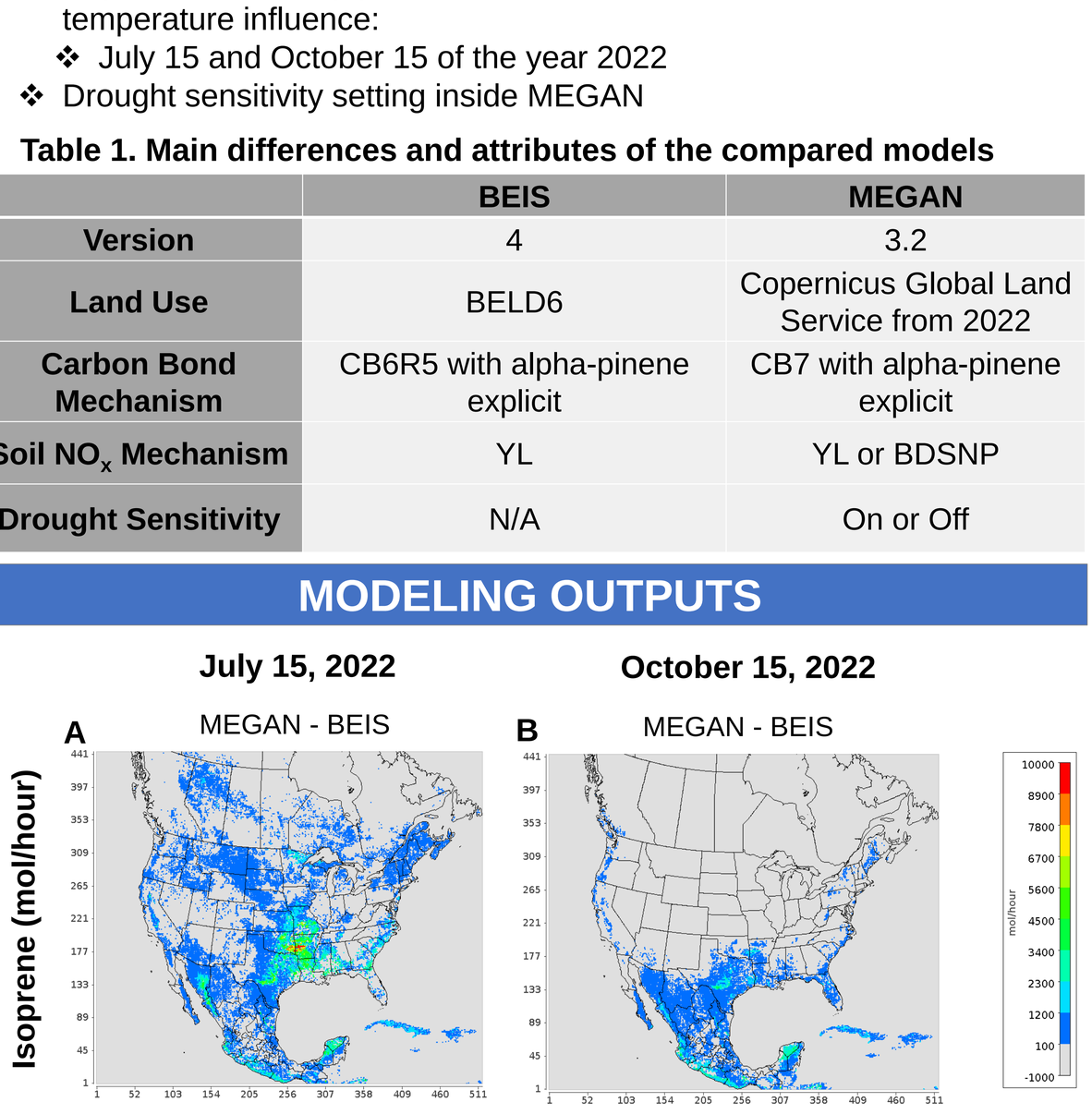

Figure 1. Spatial differences in average isoprene emissions between MEGAN (drought turned off) and BEIS in the US 12-km domain. Time is in UTC format.

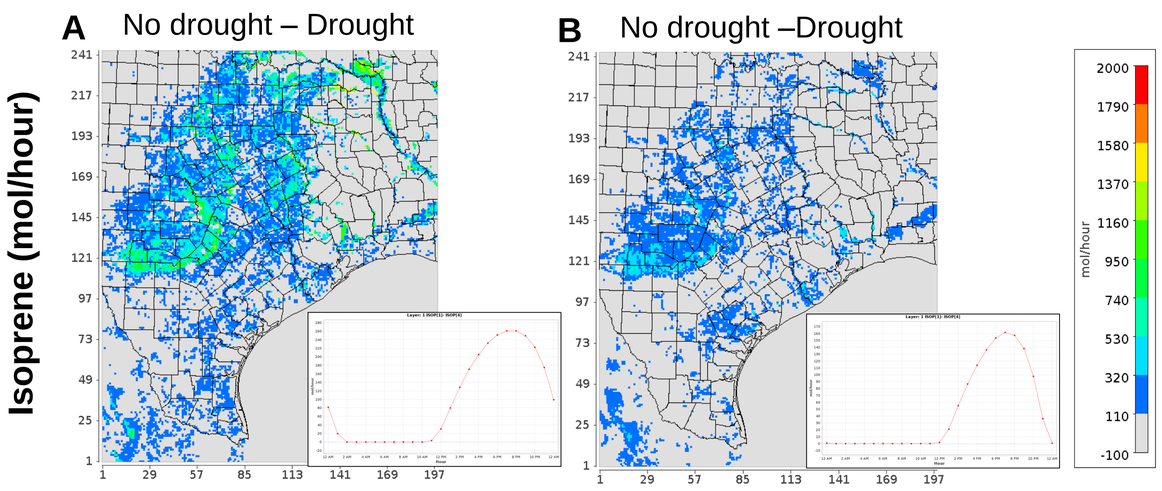

Figure 2. Spatial and diurnal differences in average isoprene emissions between MEGAN with and without drought for the 4-km domain. The insert shows diurnal average emissions differences. Time is in UTC format.

MODELING OUTPUTS

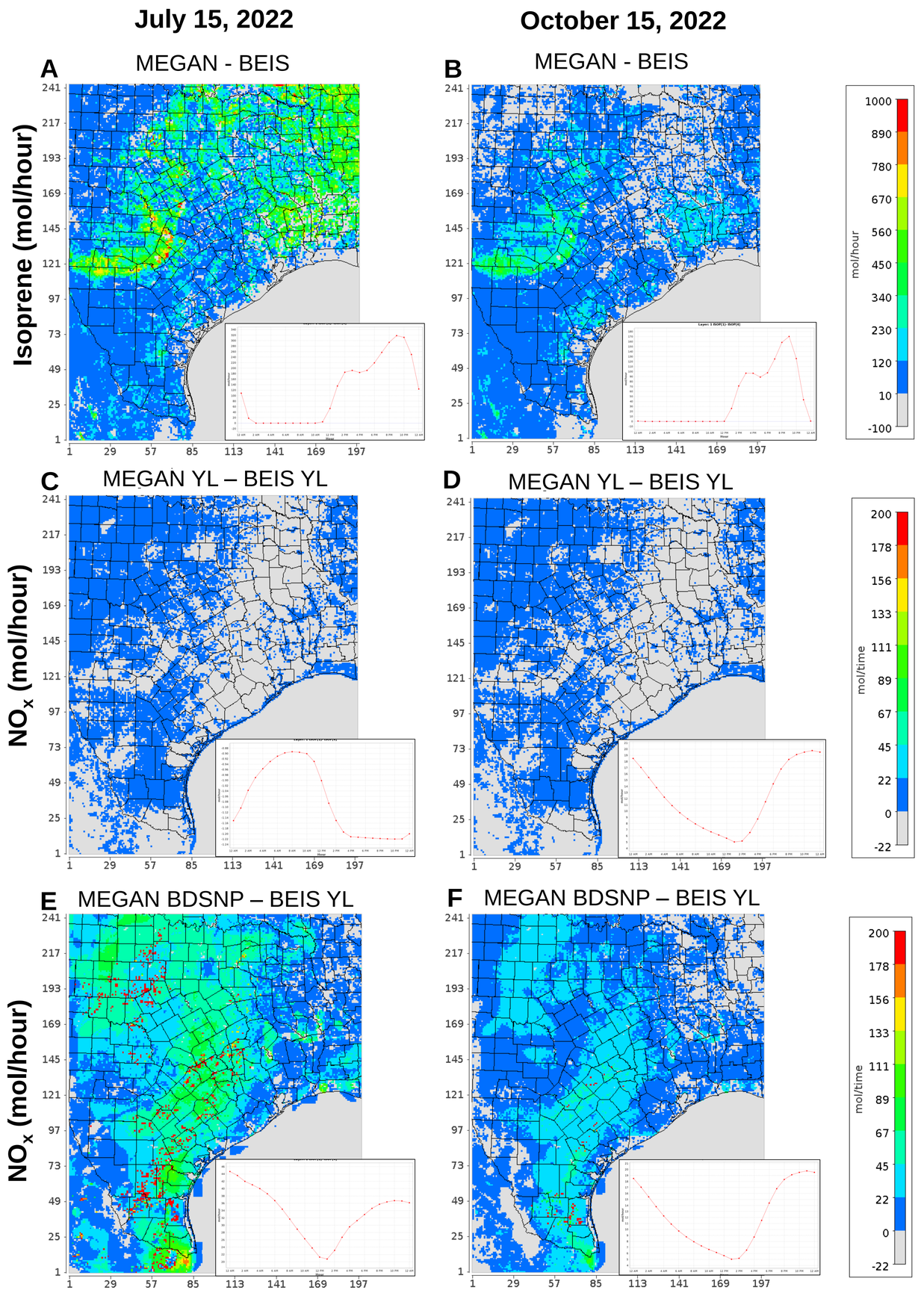

Figure 3. The difference in average isoprene emissions between MEGAN and BEIS (A-B), and NO_x emissions between MEGAN (drought turned off) and BEIS with either YL or BDSNP soil NO_x mechanism (C-F) for the 4-km domain. The insert shows diurnal average emissions differences. Time is in UTC format.

SUMMARY

Isoprene emissions:

- Tended to be higher during July 15 than during October 15 in both MEGAN and BEIS for both domains.
- MEGAN estimated 38% higher emissions on July 15 and 30% higher on October 15 than in BEIS for the 4-km domain.
- Peak average emissions were higher in MEGAN than in BEIS for both domains
  - 4-km domain: 59% higher on July 15; 44% higher on October 15
  - 12-km domain: 33% higher on July 15; 15% higher on October 15
- Drought sensitivity decreased average peak emissions by 41% on July 15 and by 44% on October 15 for the 4-km domain.

Soil NO_x emissions for the 4-km Texas domain:

- No major seasonal differences between July 15 and October 15 for either models using YL, however MEGAN with BDSNP showed higher emissions during July 15.
- Average NO_x emissions from MEGAN using the YL algorithm were 15% lower on July 15 and 27% lower on October 15 than from BEIS for the 4-km domain.
- MEGAN with BDSNP produced higher NO_x emissions overall, with peak daily emissions being 5x higher on July 15 and 3x higher on October 15 than in BEIS.

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