Global High-resolution Emissions for Soil NOx, Biogenic VOC, and Sea Salt

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Why global high-resolution emissions dataset is needed

For non-GC users:

- Long-term fine-scale dataset
  - Air quality
  - Climate
  - Carbon Cycle

For GC users:

- Non-linear parameterizations with met data of these emissions
  - Lead to
    - Resolutions-dependence of these emissions
    - Modify uncertainty
      - Run model with high-res emissions offline to ensure emissions consistent at different res
Create high-res emissions dataset and read offline emissions in GC

Create dataset

- 2D High-Res Met Fields
- HEMCO Standalone (v11-02-rc)
- Hourly, high spatial resolution Emissions

Read offline

- HEMCO
- GEOS-Chem
- Model Diagnostics

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Met product</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5° X 0.625°</td>
<td>MERRA2</td>
<td>1980-2017</td>
</tr>
<tr>
<td>0.25° X 0.3125°</td>
<td>GEOS-FP</td>
<td>2014-2017</td>
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</tbody>
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Emissions variables

- **Soil NOx**
  - Isoprene
  - Acetone
  - Acetaldehyde
  - Propene
  - Ethene
  - Ethanol
  - Monoterpenes
  - Sesquiterpenes

- **Biogenic VOCs**
  - Isoprene
  - Acetone
  - Acetaldehyde
  - Propene
  - Ethene
  - Ethanol
  - Monoterpenes
  - Sesquiterpenes

- **Sea salt aerosols**
  - Accumulation mode sea salt
  - Coarse mode sea salt
With the seasonal variation of temperature, the high soil NOx moves from southern hemisphere to northern hemisphere.

Jan: Total: 0.42 TgN/month
July: Total: 0.91 TgN/month

Monthly temporal profile from 1980 to 2017
Isoprene is mainly emitted in the southern-tropical region. In July, isoprene will expand to the whole tropical region.

Monthly temporal profile from 1980 to 2017

- January: Total: 17 TgC/month
- July: Total: 23 TgC/month
Sea Salt at MERRA-2 0.5x0.625 (1980-2017)

In Jan, the high sea salt occurs in Atlantic
In July, the high value occurs in Indian Ocean

Jan
Total: 307 Tg/month

July
Total: 315 Tg/month

Monthly temporal profile from 1980 to 2017
Resolution-dependence of these emissions is obvious (mean annual 2014-2017)

Due to non-linear parameterizations, the res-dependence is obvious! The higher res, the more global total emissions!
Resolution-dependence of these emissions is obvious (mean annual 2014-2017, S.E. Asia)

The res-dependence of emissions may be more obvious in some regions! The higher res, the more total and the more detailed spatial distribution information!
Offline emissions vs Online emissions (Soil NOx, 2016)

Offline(400km) – Online(400km)

Offline(25km) – Online(400km)

Surface NO

Soil NOx emission

Surface NO

Absolute

Minor Difference

Fraction

Minor Difference

Huge Difference

Huge Difference

Absolute

Minor Difference

Fraction

Minor Difference

Huge Difference
Conclusion

• 1、Using HEMCO standalone, we generate global hourly, high spatial resolution emissions for soil NOx, biogenic VOC and sea salt
• 2、The higher resolution, the greater total emissions and the more detailed spatial distribution information of emissions
• 3、We alter the model HEMCO Configuration file to switch off these emissions module and to read these emissions instead

Offline Emissions will be included in GEOS-Chem v12.4.0

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\[ S_{NOx} \text{ Flux} = A'_{biome}(N_{avail}) \times f(T) \times g(\theta) \times P(l_{dry}) \]

\[ F_i = \gamma_i \sum \varepsilon_{i,j} X_j \]

\[ \frac{dF}{dr_{80}} = (0.3 + 0.1 \times T - 0.0076 \times T^2 + 0.00021 \times T^3) \]

\[ 1.373 u_{10m}^{3.41} r_{80}^{-A} (1 + 0.057 r_{80}^{3.45}) \times 10^{1.607 e^{-B^2}} \]
Published estimates of global soil NOx emissions
Comparisons with TD-OMI ISOP (2005-2014)