Satellite data constraints on the seasonal methane budget.

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Wetland CH$_4$ emissions: 20-40% of global CH$_4$ budget

- Magnitude, timing and location of wetland CH$_4$ fluxes uncertain
- Process controls on wetlands important to understand the CH$_4$ budget
- Process controls fundamental to understanding long-term climate feedbacks
Wetland CH$_4$ emission controls: $F_{CH4} = A \cdot C \cdot f(T) \cdot e$

- $A =$ Wetland Extent
- $C =$ Methanogen-available carbon
- $T =$ Temperature
- $e =$ Emission factor
GEOS-Chem: updated wetland CH$_4$ emissions inventory.

Satellite-based inundated area
(MEaSUREs & GIEMS: based on satellite active/passive microwave sensor data)

Wetland CH$_4$ emissions = $W_{\text{AREA}} \times C \times f(T) \times e$

Equation adapted from Pickett-Heaps et al., 2011

MsTMIP Terrestrial Biosphere models

Scaled to global total: 210 +/-50 Tg CH$_4$ yr$^{-1}$ (consistent with mean and std of IPCC 5th AR)

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1. Carbon and inundated area drive seasonal and inter-annual variability
2. Differences largely in the timing and magnitude of emissions
3. Larger fluxes in North America and Boreal Eurasia wetland areas & later fluxes (Aug-September) in temperate and boreal latitudes.

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• Updated CH4 inventory leads to overall improved CH4 variability
• Largest improvements in N. America within proximity of major wetland emissions
Boreal CH4 error could be explained by a systematic bias in the magnitude and timing of wetlands.
Temperate/Boreal CH4 error unlikely to be explained by differences in wetlands.

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Constant/No OH loss lead to lower mismatch between model CH₄ seasonality
Conclusions

- Improved seasonal agreement between surface observations and updated GEOS-Chem wetland CH$_4$ inventory.
- Temperate/boreal latitude GOSAT CH$_4$ seasonal cycle not explained by wetland emissions.
- GOSAT model mismatch could potentially be explained by a bias in Northern latitude OH
Wetland and fire emissions are derived from carbon pools with different residence times.
GEOS-Chem: Updated wetland CH$_4$ emissions inventory.

Wetland CH$_4$ emissions model = $W_{\text{AREA}} \times C_{\text{resp}} \times f(\text{Temp}) \times S$

Equation adapted from Pickett-Heaps et al., 2011

<table>
<thead>
<tr>
<th>Parameter $W_{\text{area}}$</th>
<th>Description</th>
<th>Original GEOS-Chem emissions</th>
<th>Updated (Bloom et al., 2015, in prep.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$W_{\text{area}}$</td>
<td>Wetland area</td>
<td>Based on GEOS-5 soil moisture</td>
<td>Based on satellite inundated area datasets: GIEMS and MEaSUREs.</td>
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<tr>
<td>$C_{\text{resp}}$</td>
<td>Heterotrophic respiration</td>
<td>Based on constant pools and fixed residence times</td>
<td>Based on heterotrophic resp. from 8 MsTMIP terrestrial biosphere model ensemble</td>
</tr>
<tr>
<td>$f(\text{Temp})$</td>
<td>CH$_4$ emission temperature dependence</td>
<td>Based on wetland temperature</td>
<td>Included in MsTMIP model structure.</td>
</tr>
<tr>
<td>S</td>
<td>Scale factor</td>
<td>Scaled to Amazon wetlands (Melack et al., 2004) and boreal wetlands (Hein et al., 1997; Wang et al., 2004).</td>
<td>Scaled to global total: 210 +/-50 Tg CH$_4$ yr$^{-1}$ (consistent with mean and std of IPCC 5th AR).</td>
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</tbody>
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