CH$_4$ Biogeochemistry in CLM4

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Overview

• A component of DOE IMPACTS project
  – Global methane emissions model
  – Thermokarst lake model
  – High-latitude dynamic vegetation model
  – Atmospheric coupling and feedbacks

• Collaborating with Cornell group to analyze tropical CH$_4$ emissions

• Feedback analyses in CCSM
Outline

• CH$_4$ BGC model integrated in CLM4
• Inundated fraction
• Global spin-up with changes
• Aerenchyma effects
• Comparison to site observations
• Comparison to global inversions
CH₄ Biogeochemistry

Diagram showing the biogeochemistry of CH₄, including processes such as oxidation, diffusion, and production in different soil conditions (Saturated and Variably Saturated).
- Comparison to satellite inferred inundation (Prigent et al. 2007)
- Inverted with CLM predicted water table depth and overland flow
Global Spinup

- Hydraulic changes for frozen soils
- C$_3$ arctic grass rooting depth
- Hydraulic and thermal property for high organic matter soil
Ice Hydraulic Impedance, Perched Water Table
Change in NPP

NPP Change in New Spinup (1980–2004) (gC m⁻² yr⁻¹)
Aerenchyma

Prognostic Aerenchyma Oxidation Fraction
Comparison to Site Data
Comparison to Global Inversions

• Model broadly matches inversion estimates of zonal CH$_4$ emissions
• Southern Tropics discrepancy
  – Analysis underway to better understand discrepancies
Next Steps

- Finalize sensitivity analysis and model parameters
- Improvements in next phase
  - Proper treatment of inundated C cycle
  - Depth and vegetation representation
  - Permafrost soil C
  - Inundated fraction
  - Redox and pH prediction and effects on CH$_4$ emissions
NPP

New NPP (1980–2004) (gC m$^{-2}$ yr$^{-1}$)
Global CH$_4$ Emission Prediction