JULES-ECOSSE methane model

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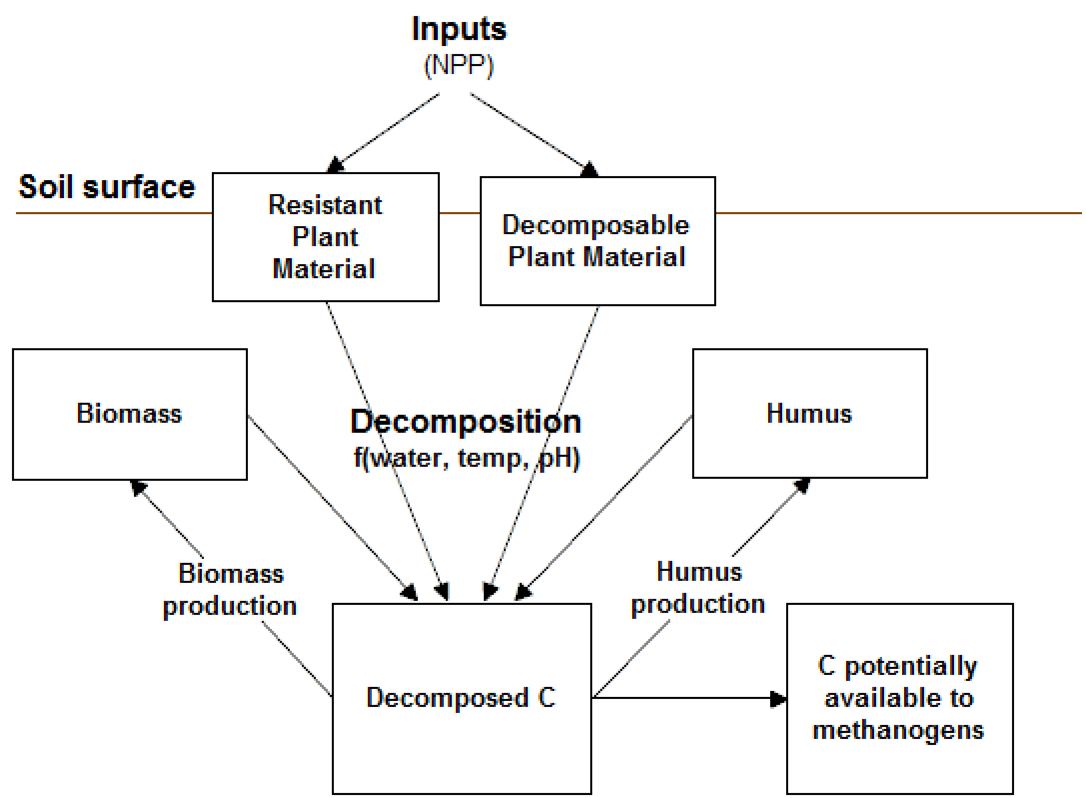
Introduction

- Methane submodel is for QESM-JULES
- Part of ECOSSE soil C & N
- Focus is peatland methane emissions
- Designed to be widely applicable
  - Simulates methane production and oxidation (including oxidation of atmospheric methane)
  - Source and sink soils

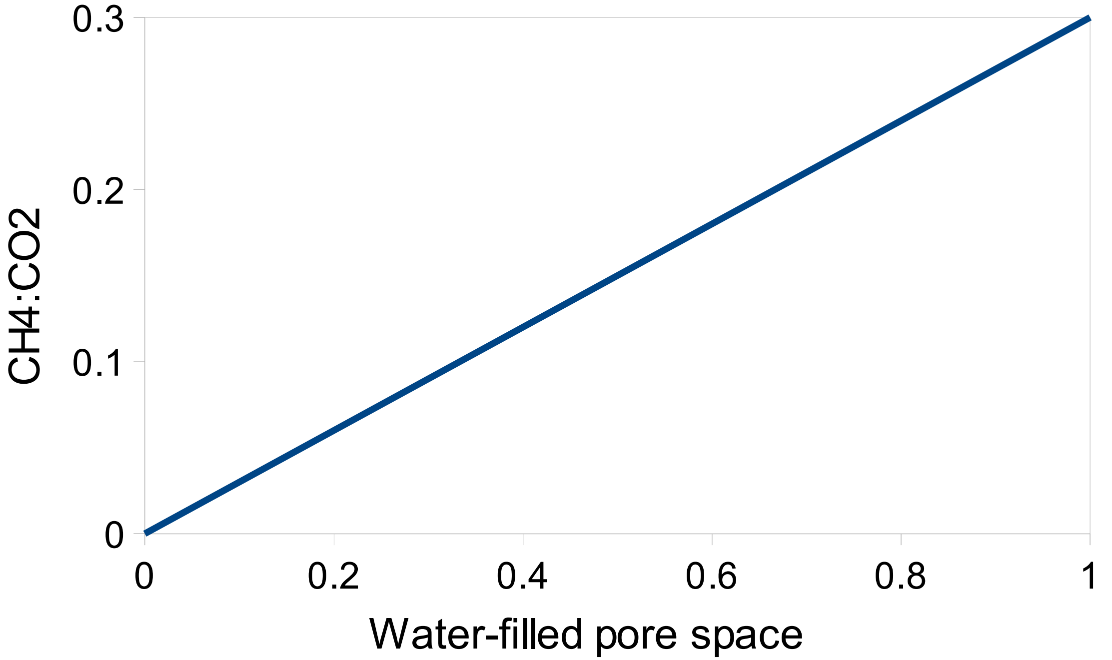
Decomposition

- ECOSSE carbon model based on RothC
- Models decomposition in 4 C pools
- Decomposed C is turned into both CO_2 and CH_4



Methane production

- Reported values of CH_4:CO_2 are 0.001 to 1.7
- CH_4:CO_2 set to 0.3 under fully anoxic conditions
- CH_4:CO_2 is weighted by the water-filled pore space (as a proxy for anoxia) following Wania (2007)



- Assumes methane production still takes place in water-filled microsites even when the soil is relatively dry

Methane oxidation

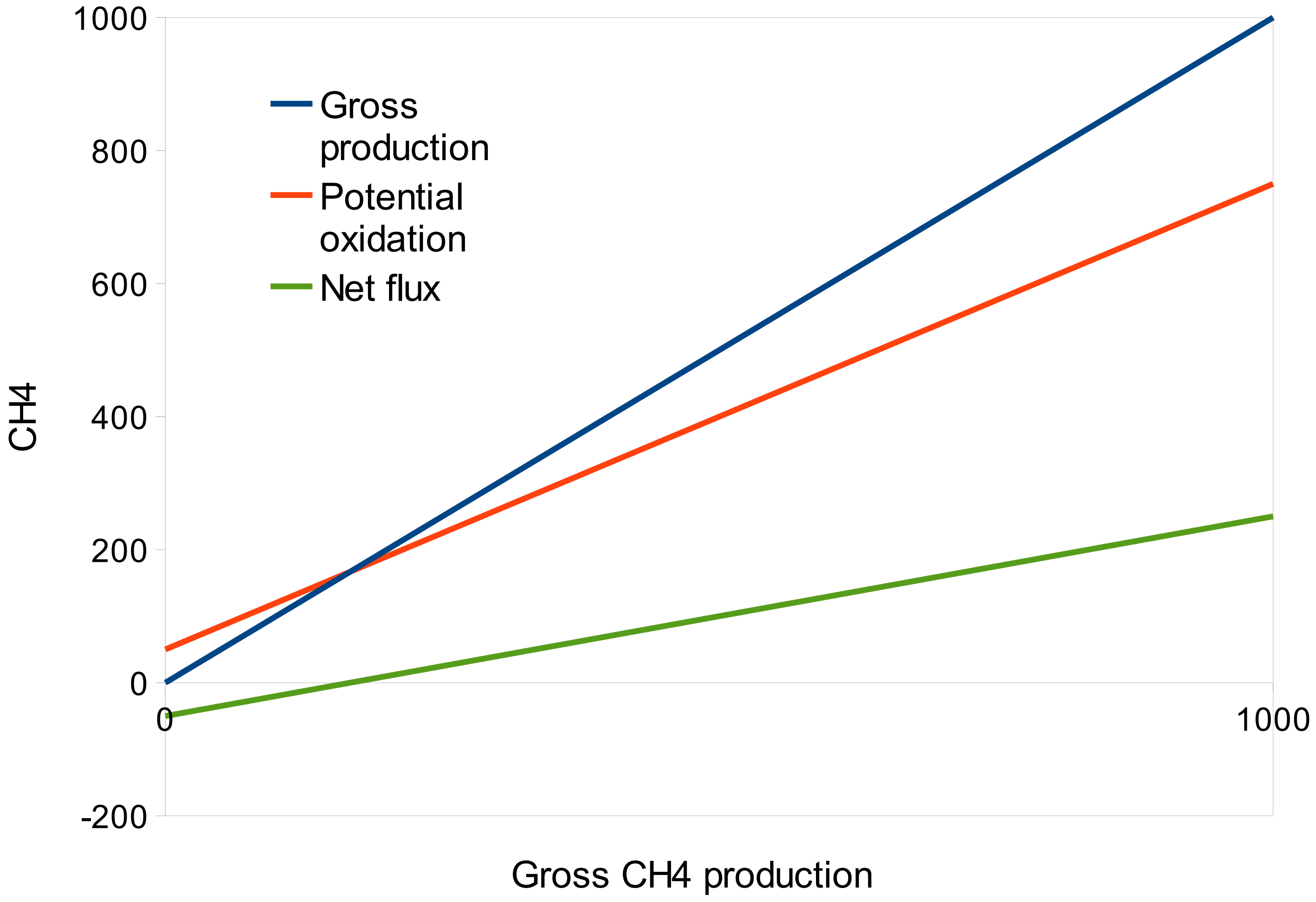
- Some soils (e.g. forests) act as methane sinks, consuming atmospheric methane
- High % of methane produced in the soil can be oxidised before it escapes to the atmosphere
- Model includes oxidation of both soil and atmospheric methane

Potential oxidation

- Maximum rate of oxidation of methane from the atmosphere set to 0.067 kg C-CH_4 ha^{-1} day^{-1}
- Maximum fraction of CH_4 produced in the soil that can be oxidised = 0.95
  - Assumes strong correlation between potential production and potential oxidation

potential ox = 0.067 + (0.95 x CH_4 produced)

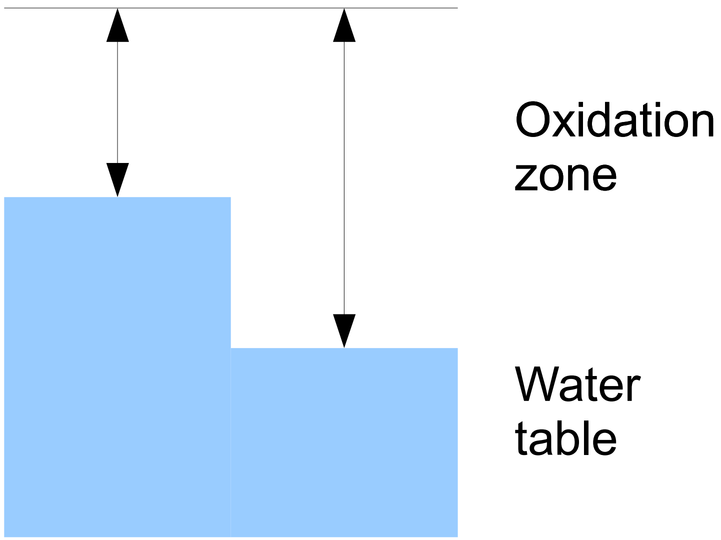
Potential oxidation, gross production and net flux



Actual oxidation rate

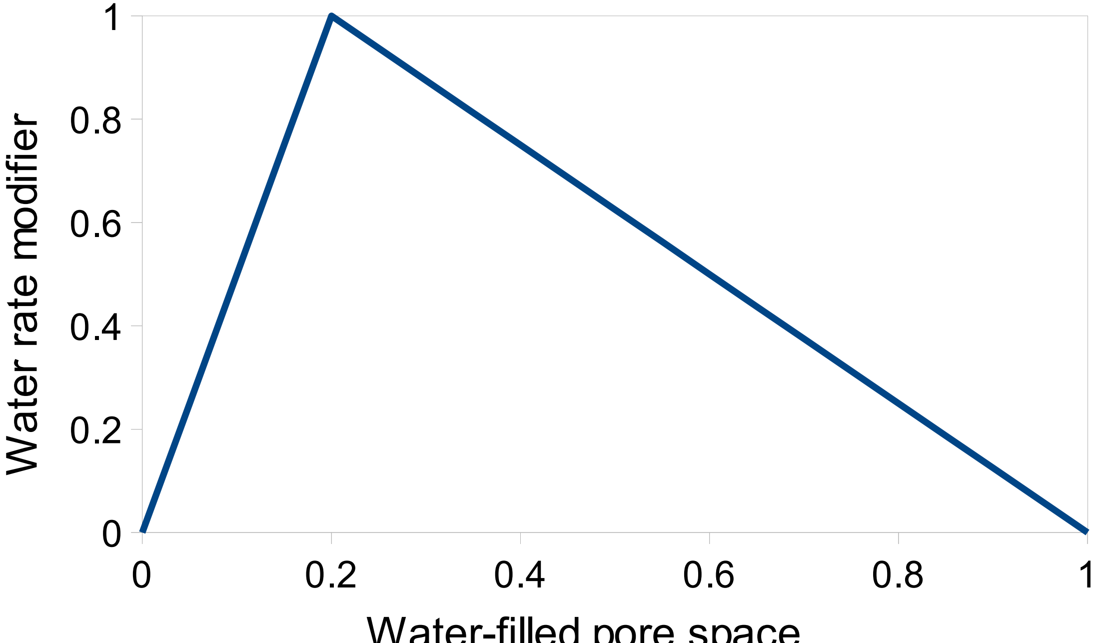
- Actual oxidation rate = pot. ox. rate x rate modifiers
- Rate modifiers based on mean conditions in the “oxidation zone”
  - Defined as the zone above the water table (to a maximum depth of 40 cm)
- Two rate modifiers
  - Mean WFPS (wR)
  - Mean temperature (wT)

actual ox = pot. ox * wR * wT



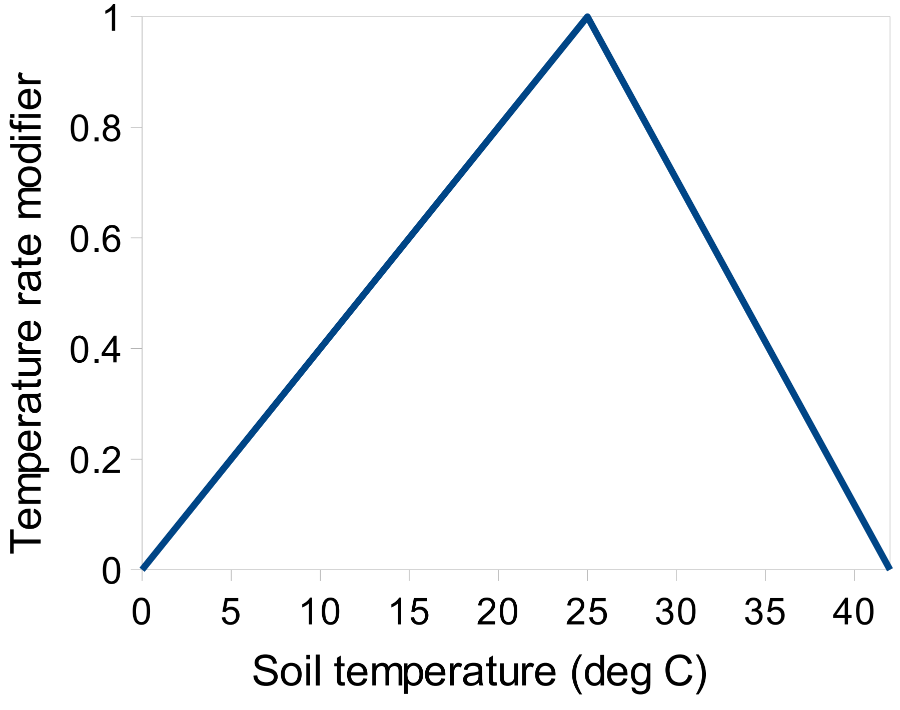
Oxidation water rate modifier

- Water-filled pore space (WFPS)
- WFPS < 0.2 – microbial oxidation activity is water limited
- WFPS > 0.2 – oxidation limited by gas diffusivity (O2 supply and/or CH4 supply if a sink soil)



Oxidation temperature modifier

- Reported oxidation rates follow a typical enzyme response to temperature
- Oxidation increases from zero at 0 ºC to maximum at 25 ºC
- Corresponds to a typical Q10 value of 2

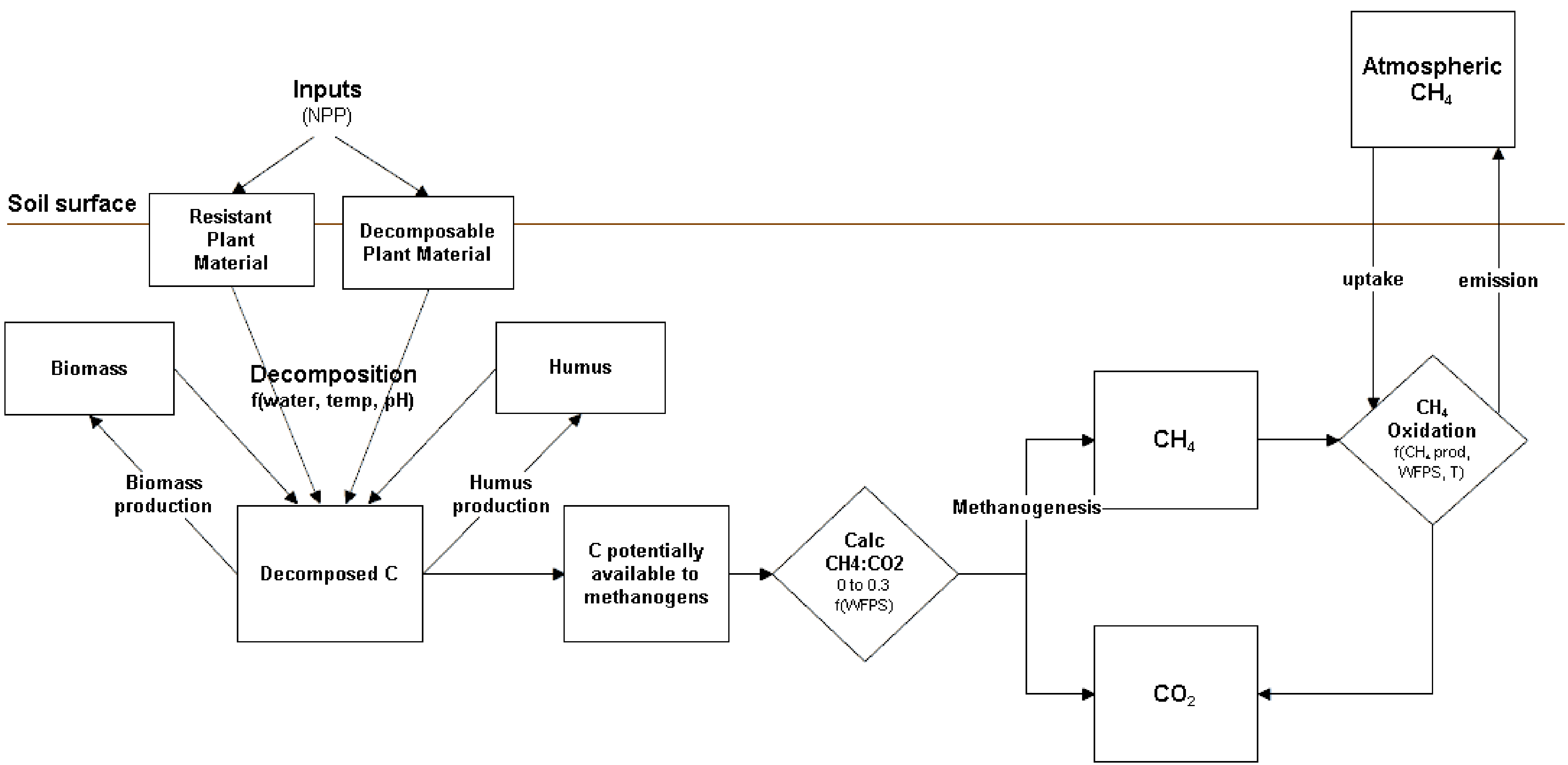


Net flux

net flux = total prod. – atmos. oxid – soil oxidation

- No attempt to model gas diffusion
- Flux is instantaneous
- Therefore best to evaluate emissions over a longer timescale

JULES-ECOSSE Methane Model

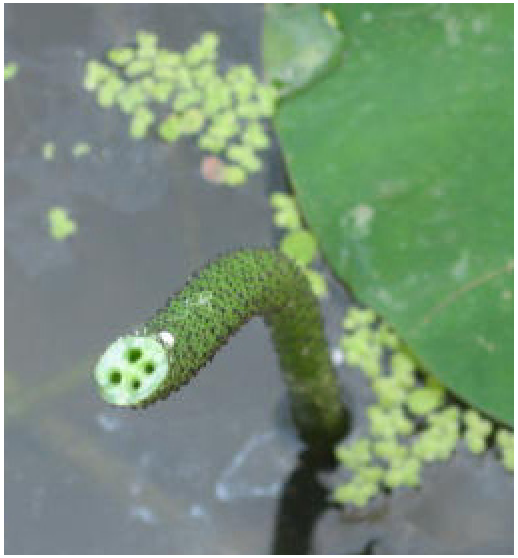


Future development - plant transport

- Some of the CH_4 produced in the soil escapes to the atmosphere via plant tissues, bypassing oxidation
  - Up to 90% in rice paddies

- % CH_4 escaping can be weighted by cross-sectional area of aerenchyma per unit land area

- But, no aerenchymous PFTs currently in JULES



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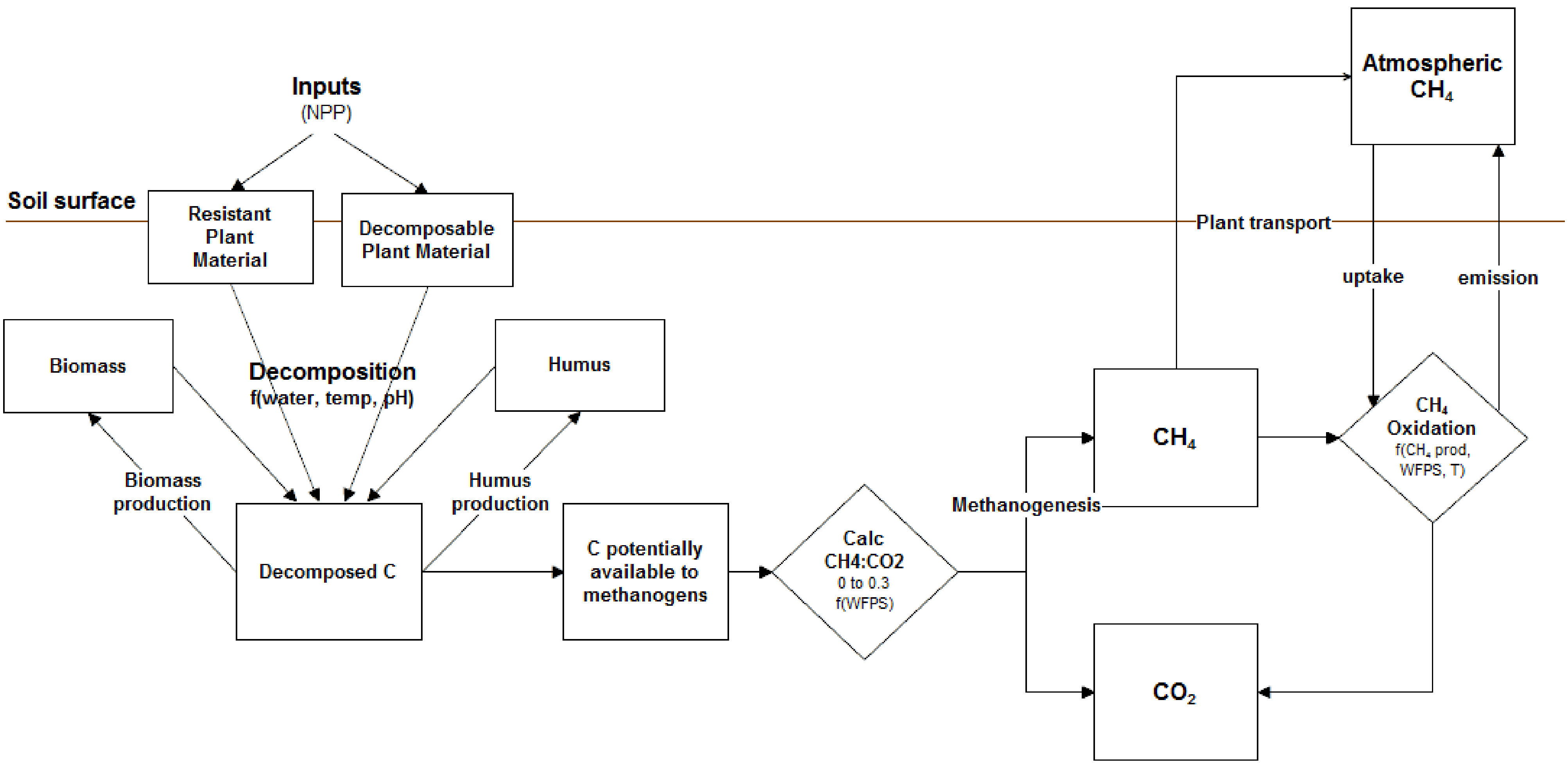

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