Large Methane Emissions from Palm Stems in Amazonian Peat and Flood Lands


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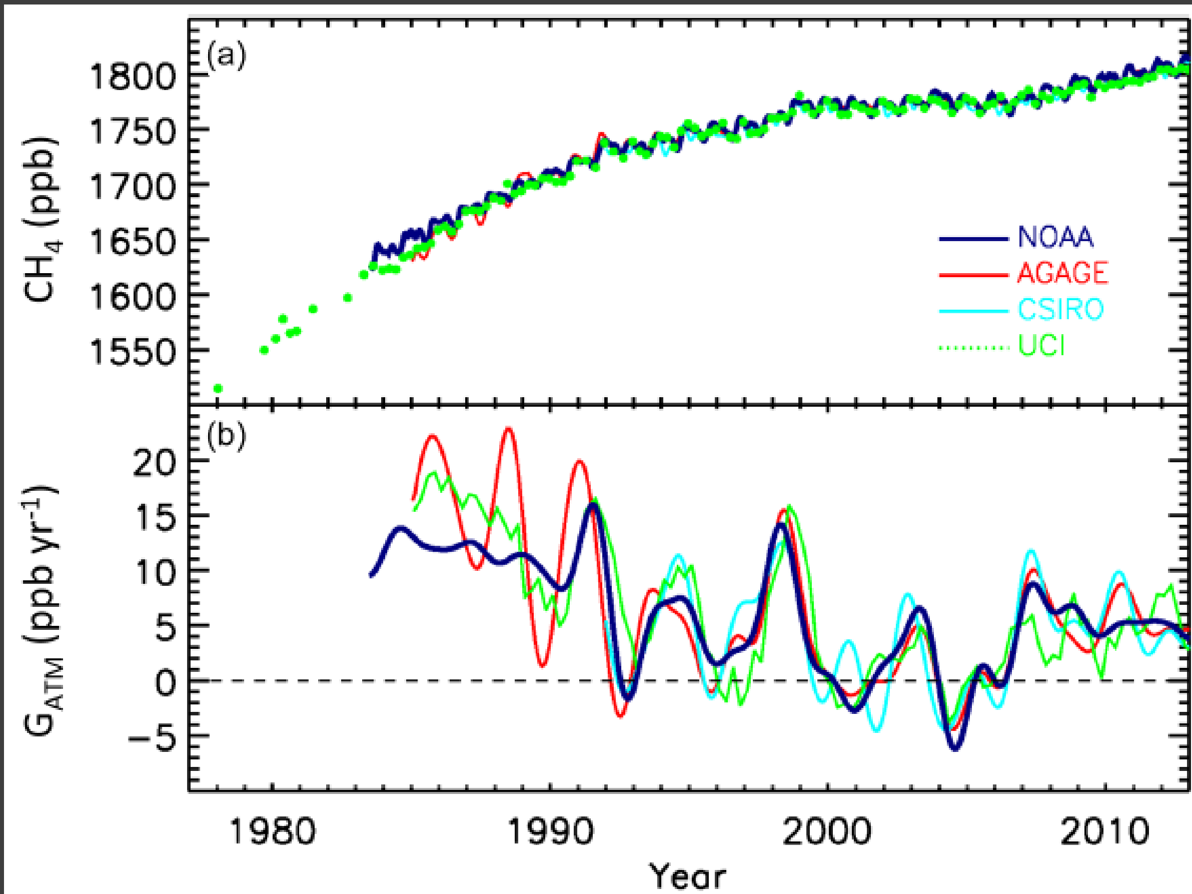
Global atmospheric methane

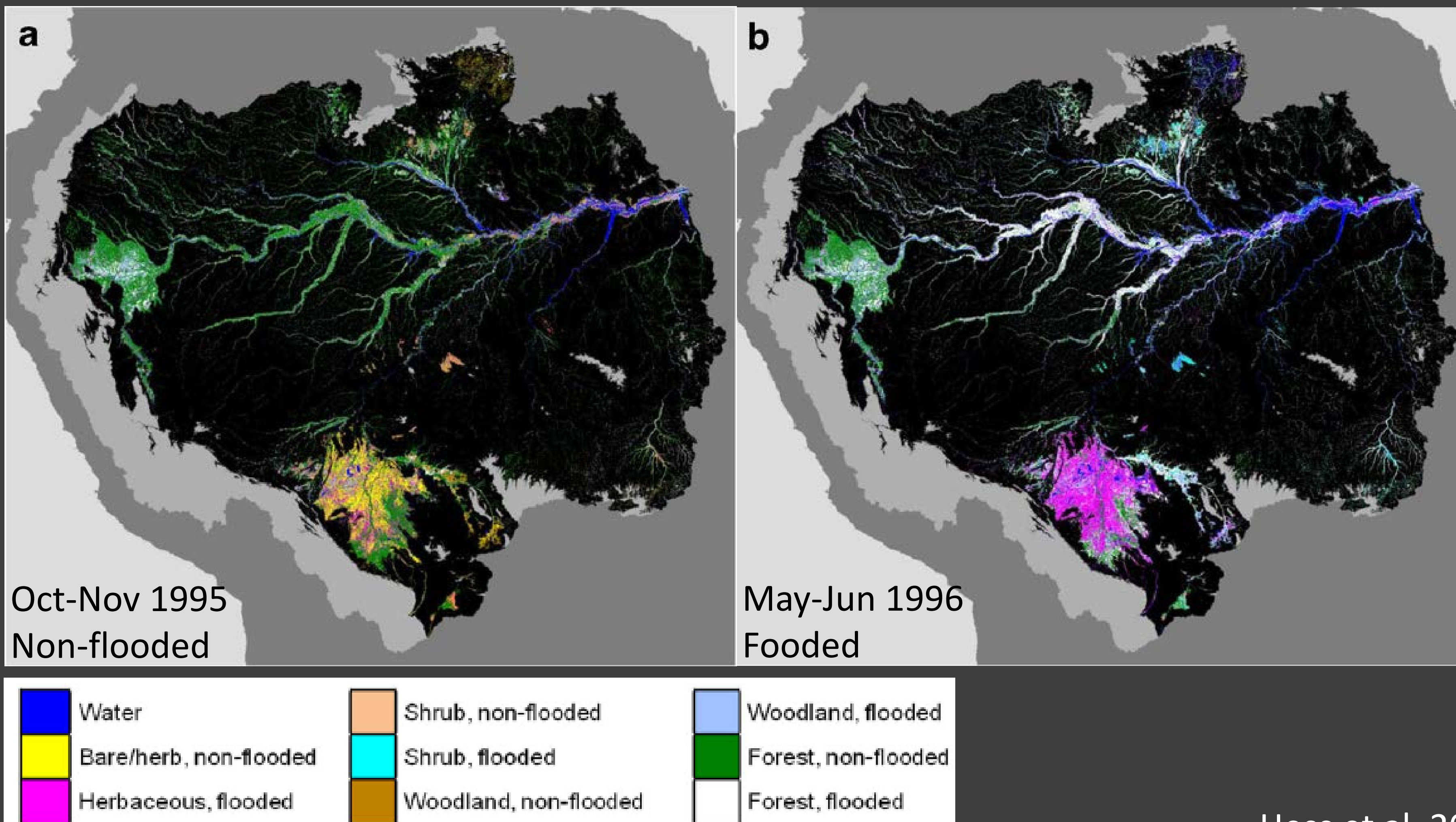


Saunois et al. 2016

Tropical wetlands have been implicated as the main source for this variability

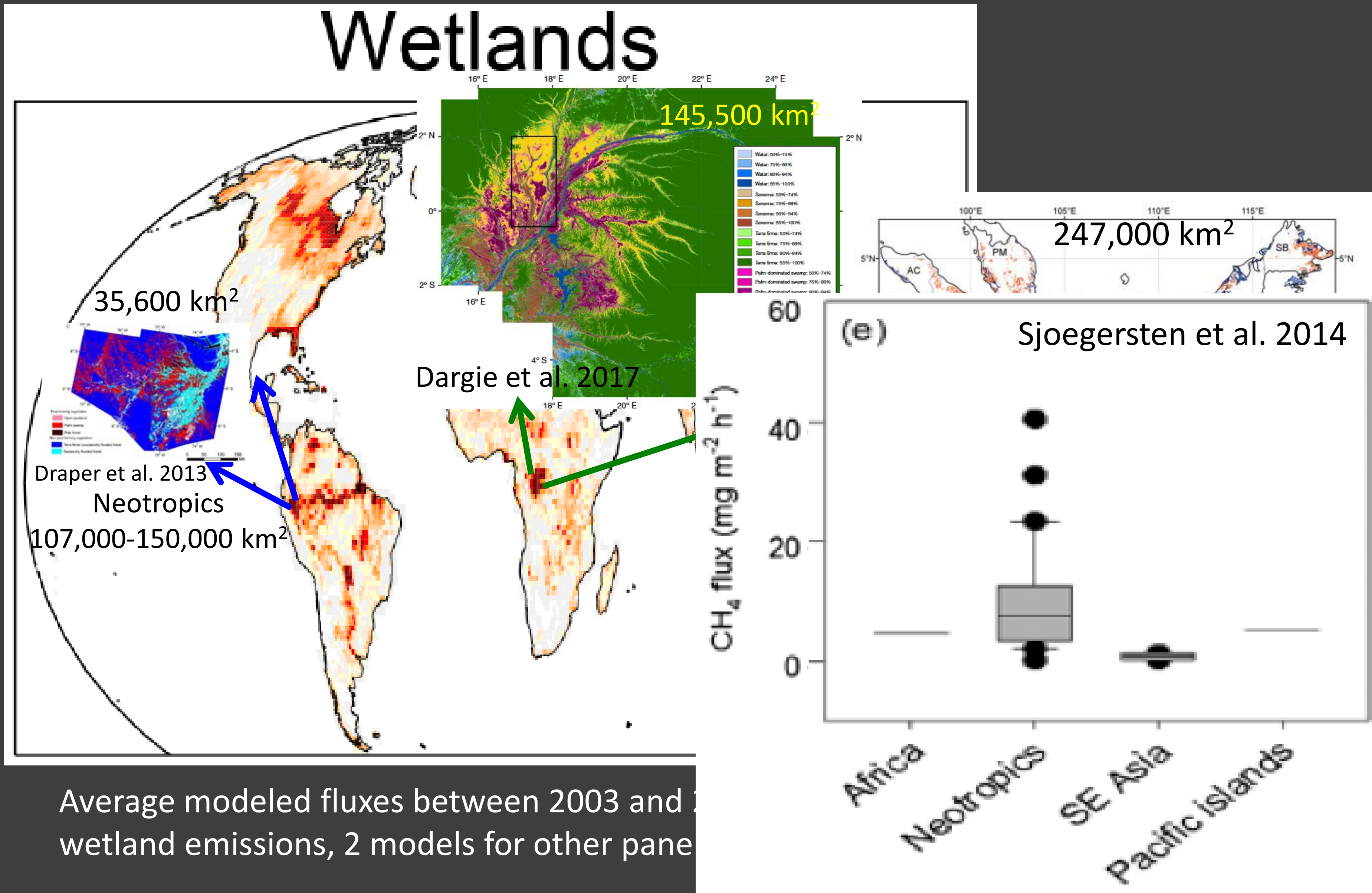
Dlugokencky et al. 2016

Seasonal inundation



Hess et al. 2015

Potential regional methane sources



Average modeled fluxes between 2003 and 2
wetland emissions, 2 models for other pane

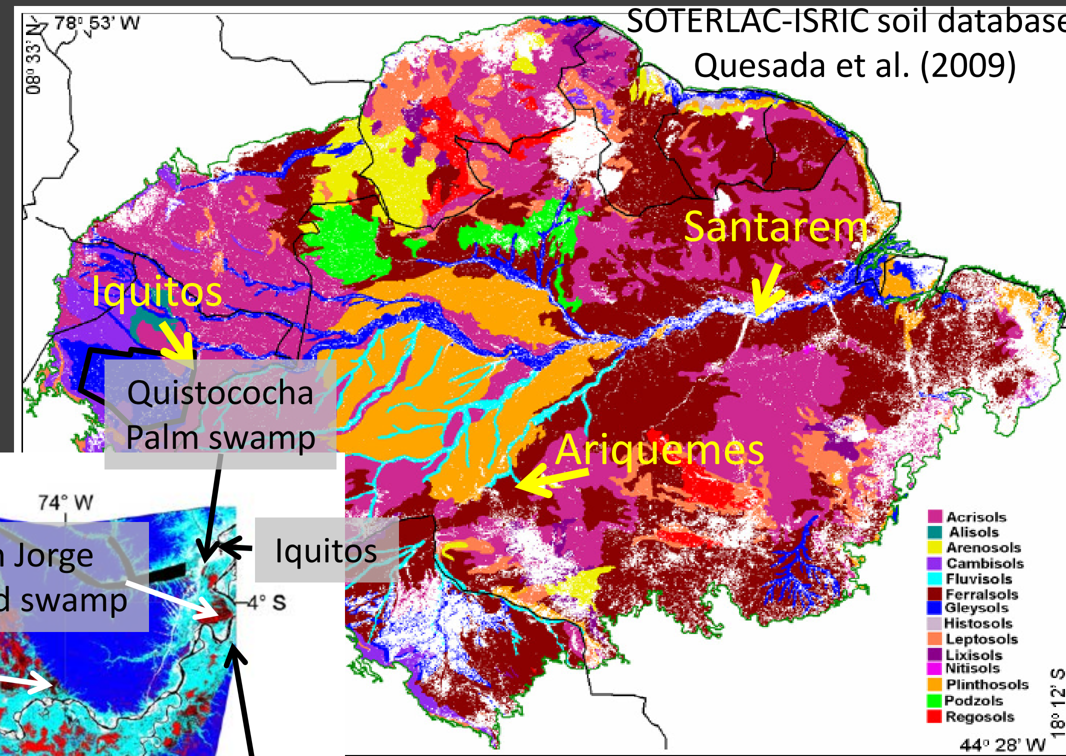
Palm contributions to methane emissions from tropical peatlands.

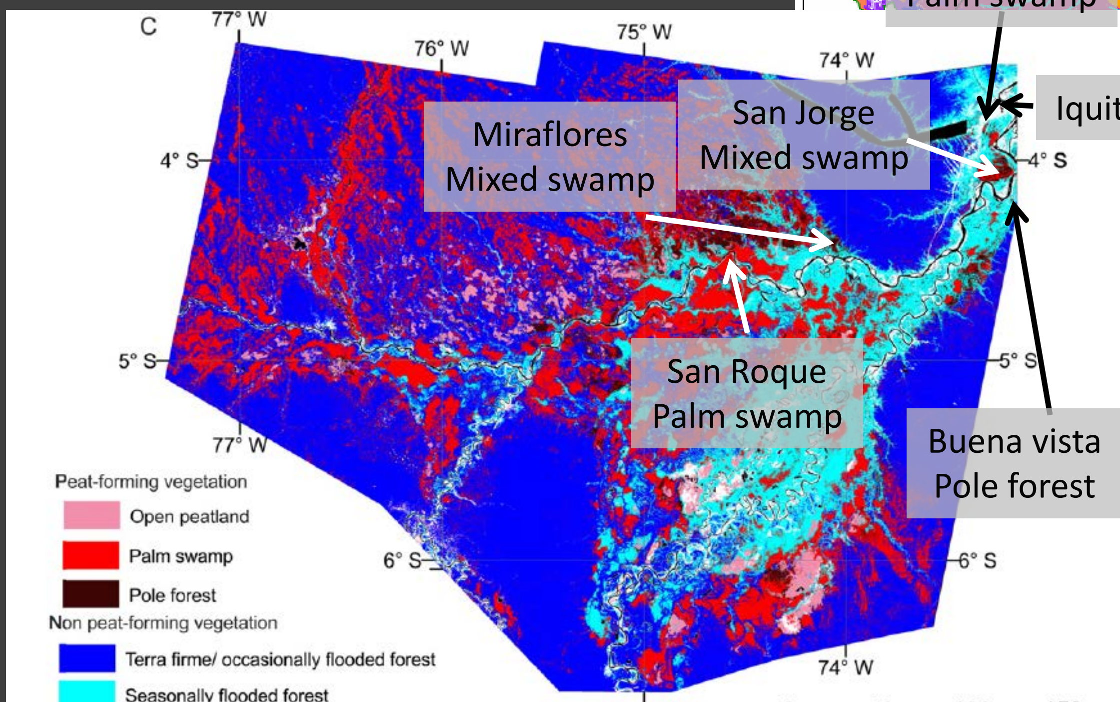
- Do palm trees (*Mauritia flexuosa*) emit CH_4?
- What processes control the CH_4 plant flux?
  - Soil CH_4 production
  - Tree/palm species } Please see my poster tonight
  - Species traits }
  - Daily/annual variability
- How large is the plant contribution relative to the soil flux?
  - How can tree fluxes be scaled to the ecosystem level?
  - Tree flux complications?

Amazon basin peat/wetlands

~107,500 km^2 (Page et al. 2011)
~150,00 km2 (Lahteenoja et al. 2009)
~ tropical (528,000 km^2)

Peat: up to 7.5m, most <5m





Draper et al. 2013

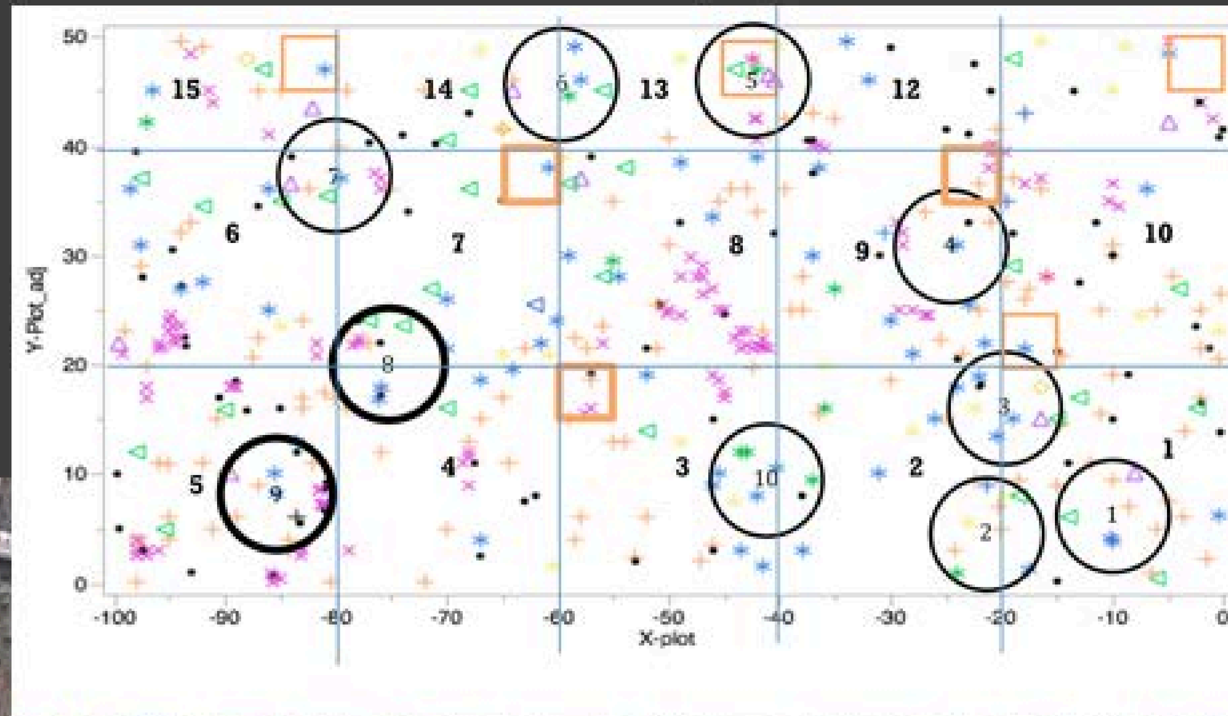
Type	Area
Open peatland	4181± 222 km^2
Pole Forest	3686± 810 km^2
Palm swamp	27732±1101km^2

Operation: Research plots

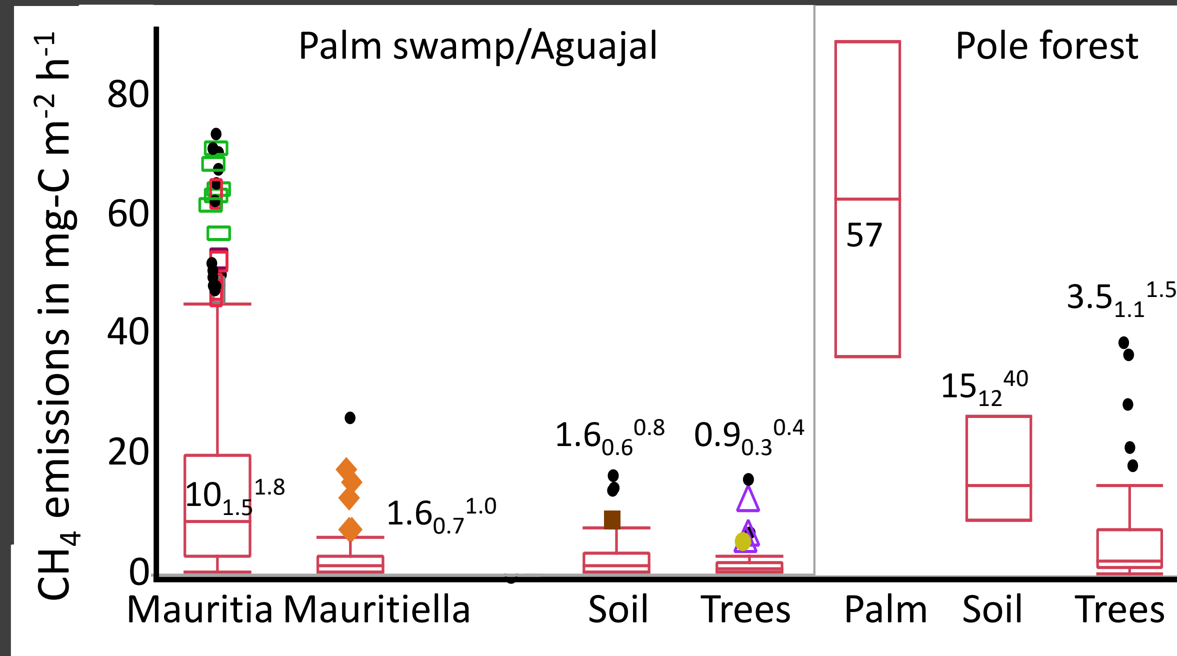
Two 0.5 ha carbon cycling plots installed based on Rainfor protocol

- ☐ Undisturbed flux plots
- ○ Tree flux plots

Smaller symbols denote tree species



Stem fluxes



CH_4 fluxes from *Mauritia flexuosa* stems at (<1.5m height) 6x greater than soil CH_4 fluxes

- Custom made flexible chambers
- Gasmet DX4015 FTIR gas analyzer
- Portable generator

van Haren et al., in review

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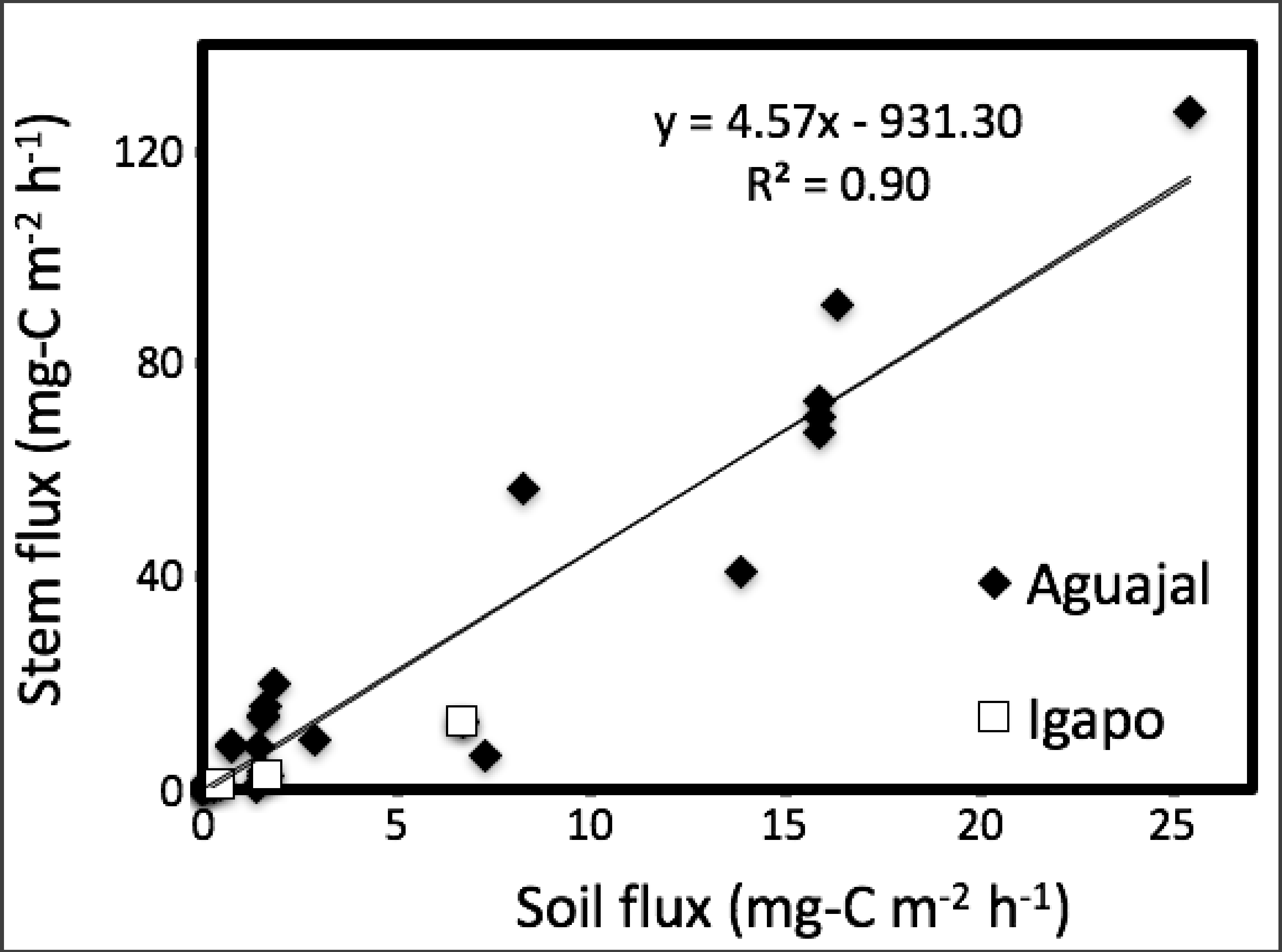
Palm CH_4 flux soil derived



van Haren et al., in prep

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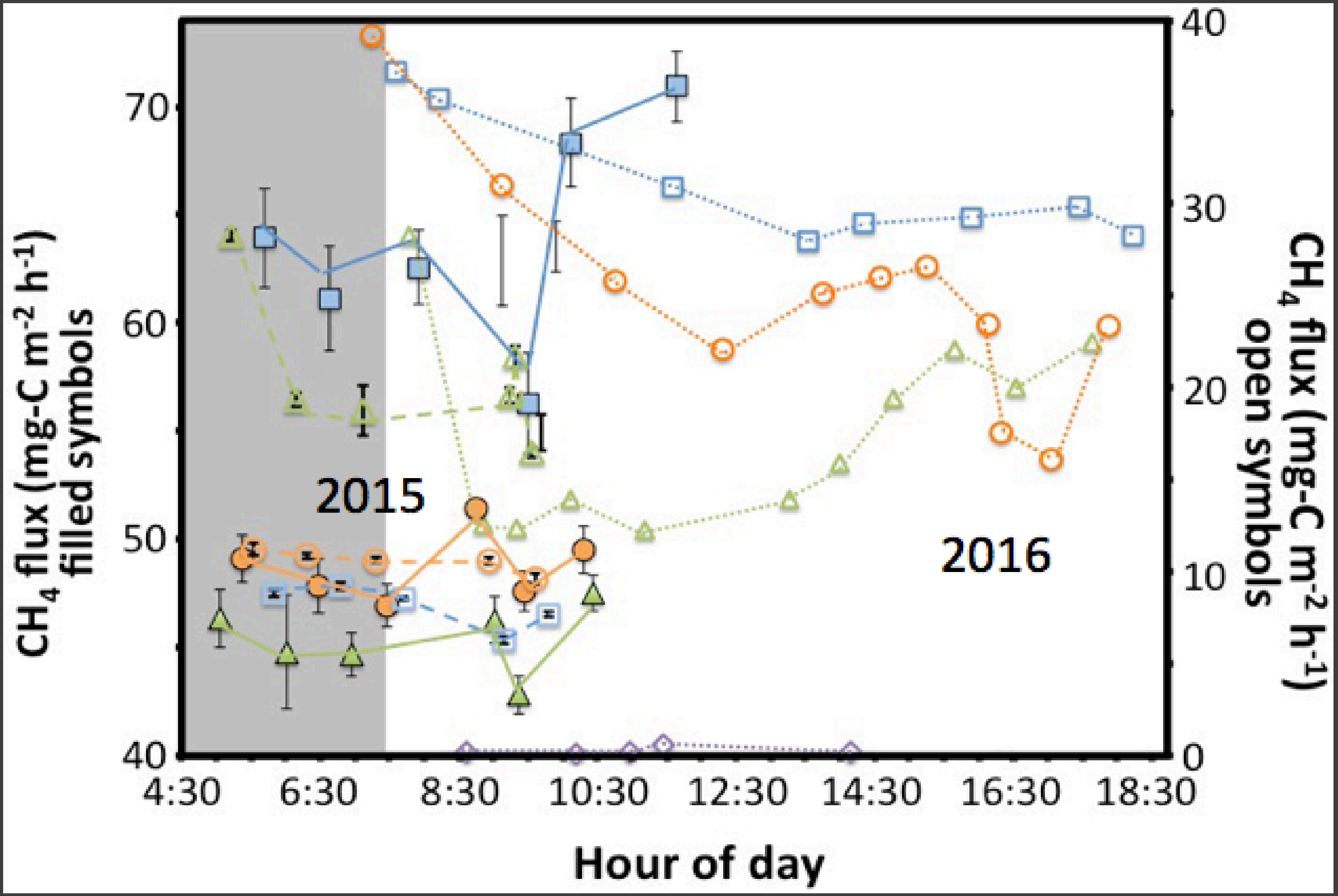
Circadian rhythm flux?



2015
Filled symbols 0.5m
Open symbols 1.3m

2016
Open symbols 0.5m

- No consistent changes before and after dawn
- Large variability between different years

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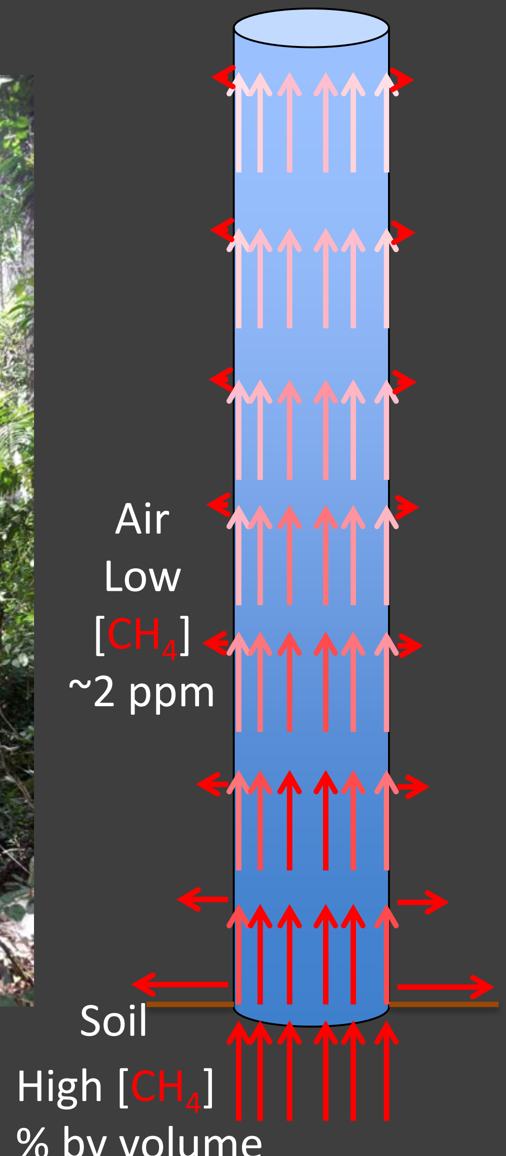
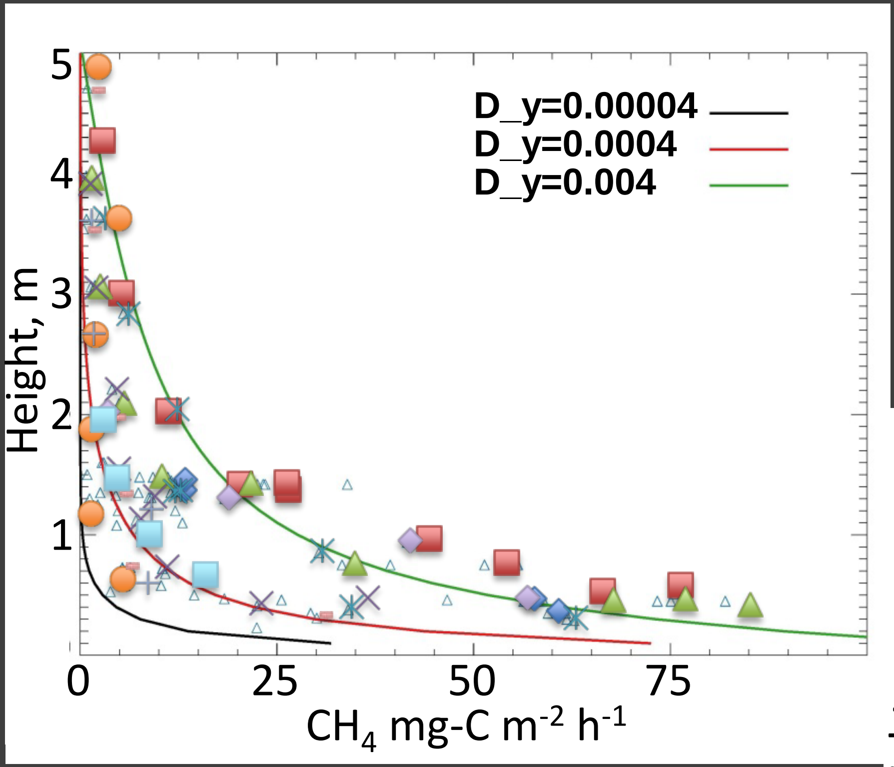
CH_4 diffusion out of Mauritia palm stems

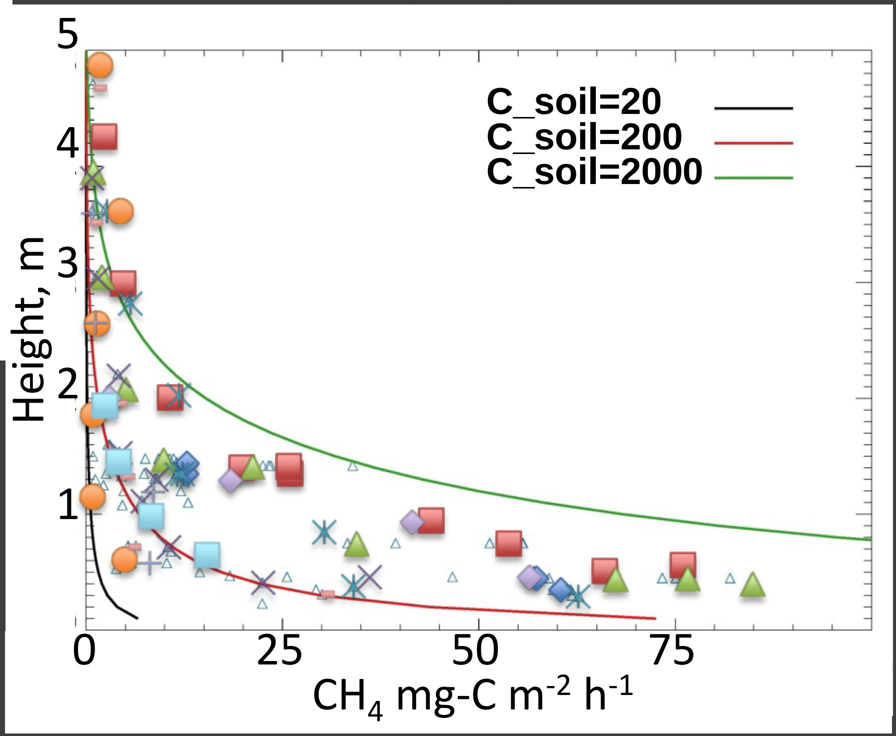


Mauritia palms are cylindrical and do not taper with height, thus upscaling relatively easy

Whole tree flux



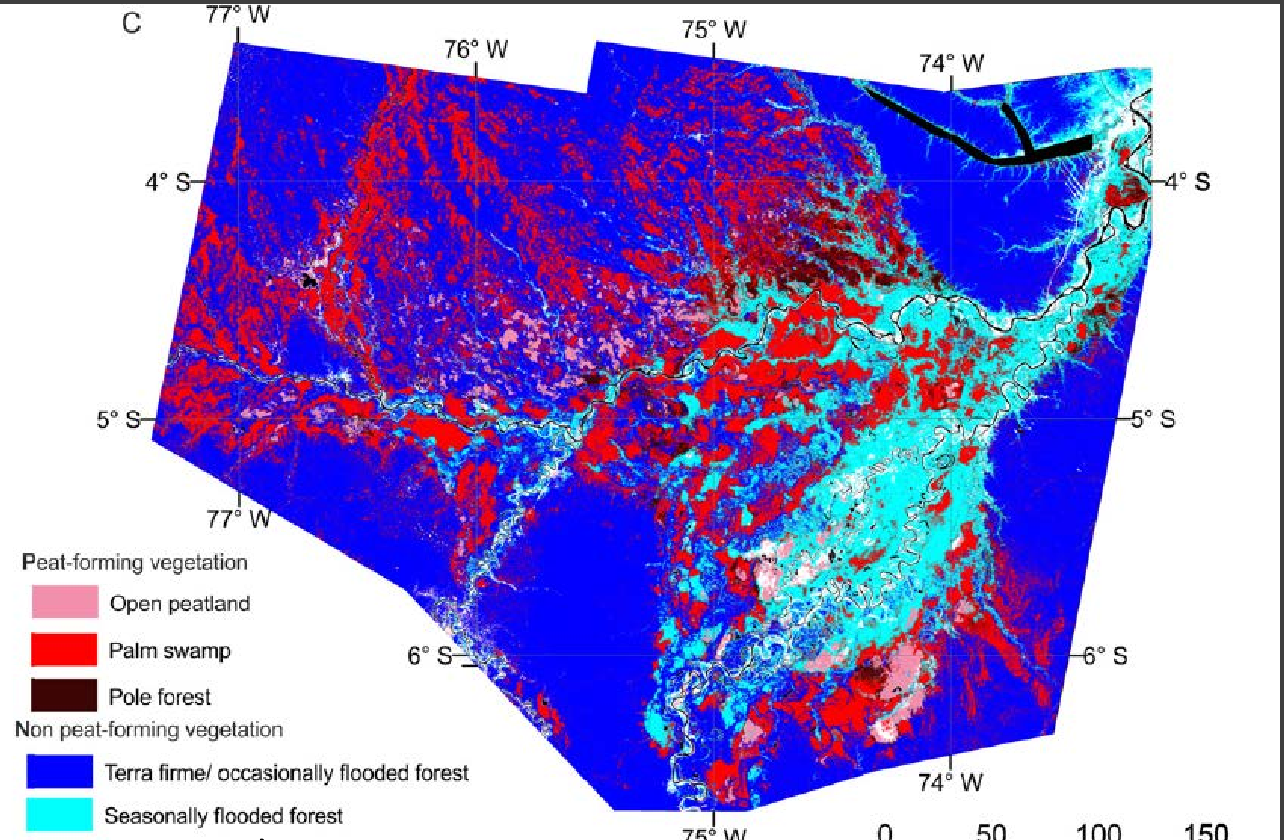
Soil CH_4 concentration (C-soil)
200ppm
Horizontal diffusion coefficient (D_x)
0.000015 m^2/s



Vertical diffusion coefficient (D_y)
0.0004 m^2/s
Horizontal diffusion coefficient (D_x)
0.000015 m^2/s

Average Mauritia flux based on diffusion modeling of stem profiles 1386_{300}^{370} mg-C d^{-1}

Does the palm flux matter?



Draper et al. 2013

Average Mauritia flux
1386_{300}^{370} mg-C d^{-1}

Number of palms in swamp:
130-250 ha^{-1} (Kuhn 1999)

	Area km^2	Soil CH_4 kg-C ha^{-1} y^{-1}	Stem CH_4 kg-C ha^{-1} y^{-1}	Total Tg-C y^{-1}
Open peatland	4181± 222	NA	NA	NA
Pole Forest	3686± 810	190_{58}^{65}	NA	0.1-0.7
Palm swamp	27732±1101	140_{54}^{70}	51-160	0.4-1.1

Basin scale fluxes

- Mauritia is very common in water logged soils and can form mono-dominant stands:
  - Kahn (1991): Amazon basin 1.95 to 3.75 billion stems
    - 0.8 – 2.4 Tg-C y^{-1}
  - Ter Steege et al. (2013): Mauritia one of the hyperdominants ~1.5 billion stems
    - 0.76 Tg-C y^{-1}
  - Ter Steege et al. (2013): Palm (Mauritia, Mauritiella, and Astrocarium) hyperdominants ~11.9 billion stems
    - 5.75 Tg-C y^{-1}

- Soil and Mauritia stem fluxes for the whole Amazon basin
    - 2.1-13.9 Tg-C y^{-1}

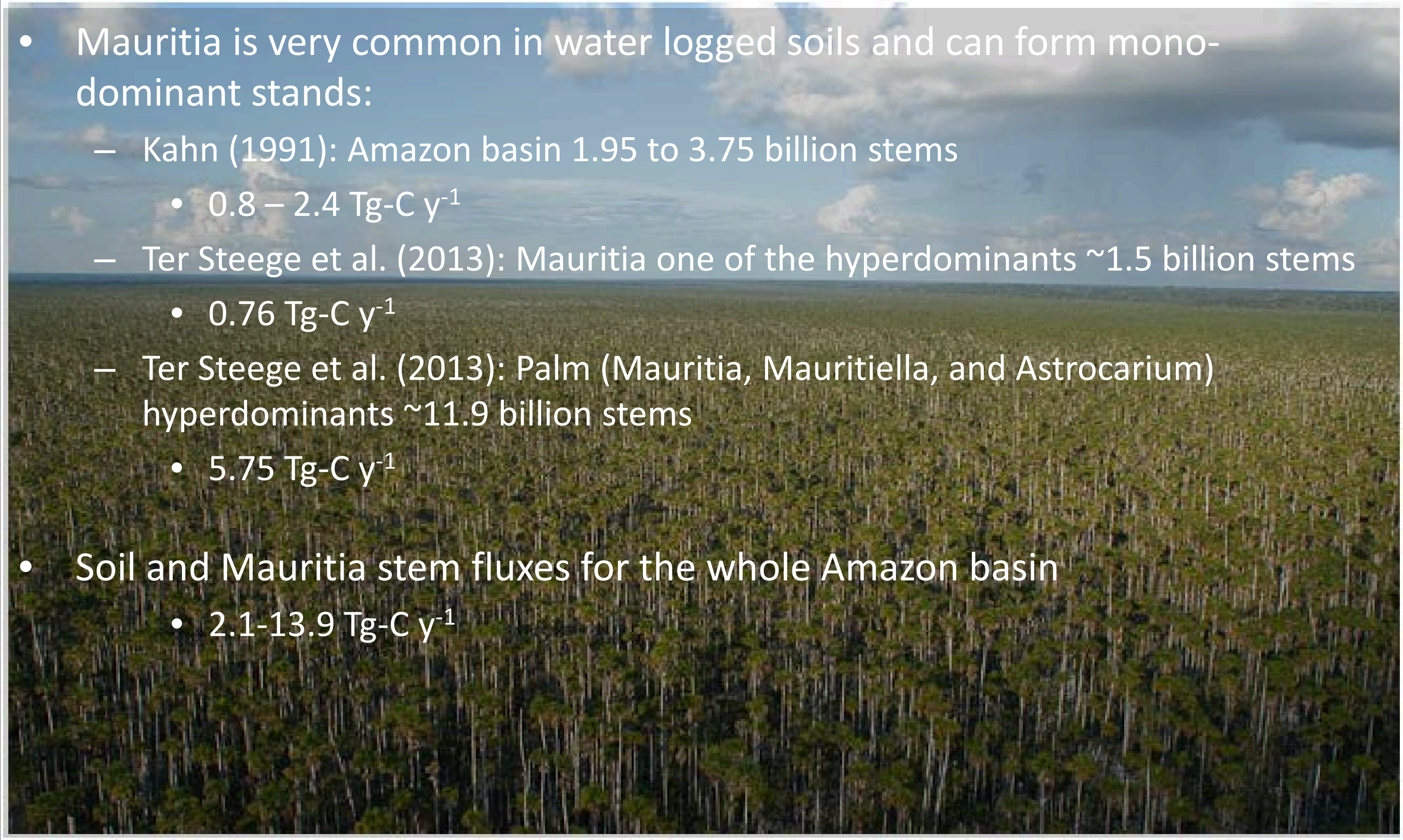


Fig. 47.6 Black water palm swamp dominated by *Mauritia flexuosa*. Tahuamanu River, Pando, Bolivia, 5-29-05

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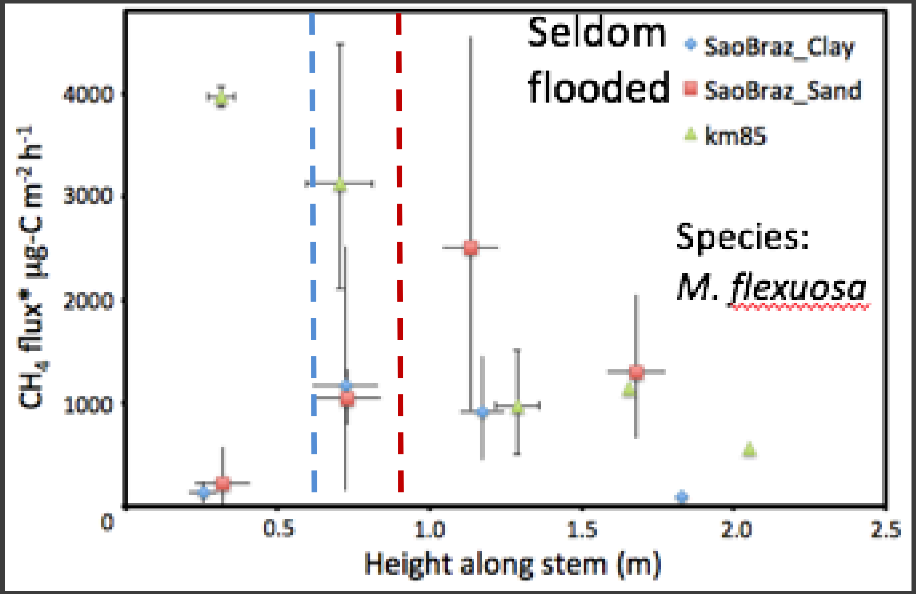
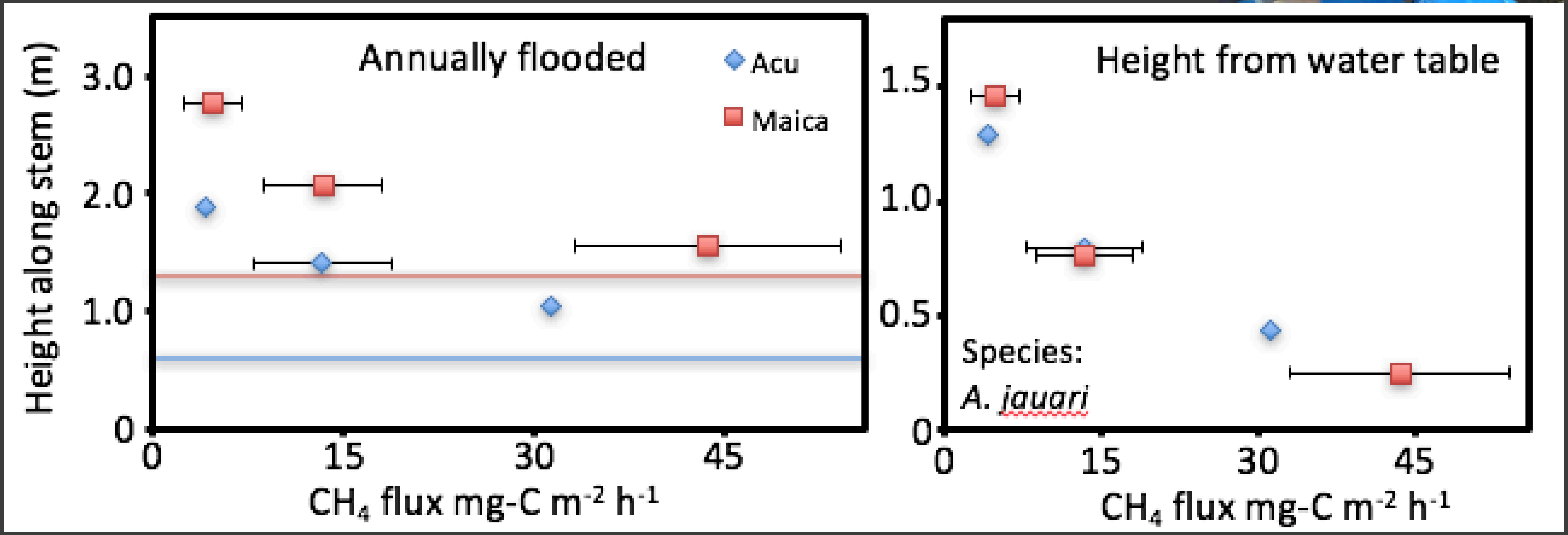
Control of flooding on CH_4 flux



Flooding can result in decrease CH_4 flux in flooded part trunk

but not in annually flooded areas



Conclusions

- Stem CH_4 fluxes are strongly correlated with soil CH_4 fluxes
- CH_4 emission potential appears to be conserved at the family level
- Palm fluxes are easy to scale up due to the cylindrical stem and lack of branching
- Stem CH_4 fluxes can be very significant for peatland ecosystem CH_4 fluxes

Thanks to:

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