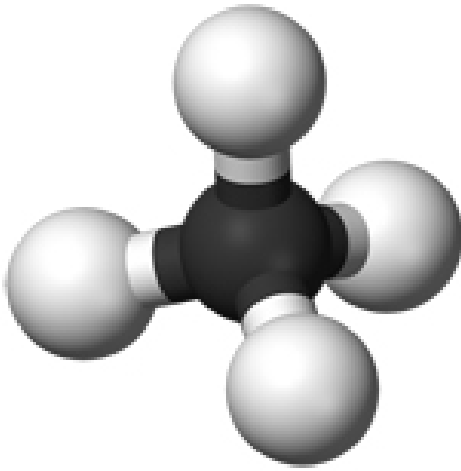
Tropical Wetlands as a Dominant Driver of Long-Term Atmospheric Methane Changes

Carrie Ann Sharitt and Ed Dlugokencky

NOAA Earth System Research Laboratory
Global Monitoring Division

Introduction

- Atmospheric methane CH_4 is a greenhouse gas with direct and indirect effects on climate
- Methane has radiative forcing of 0.5 W/m^2 which is second only to CO_2 (RF= 1.91 W/m^2)
- Global Warming Potential (GWP_{100}) for CH_4=28
  - GWP is climate impact of equal masses of emissions of CH_4 and CO_2 integrated over 100 years

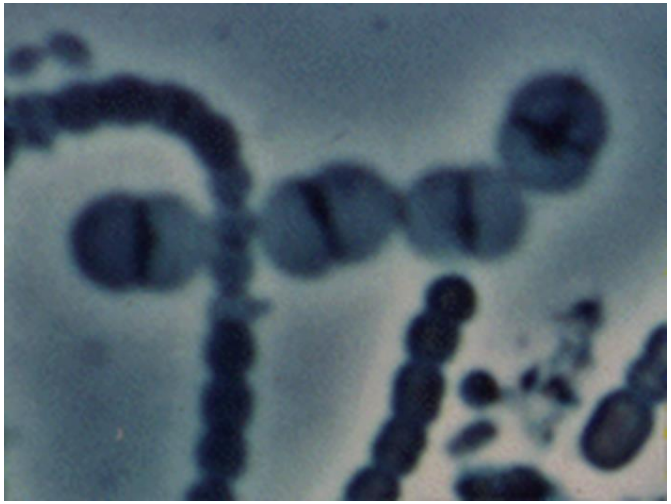


Introduction

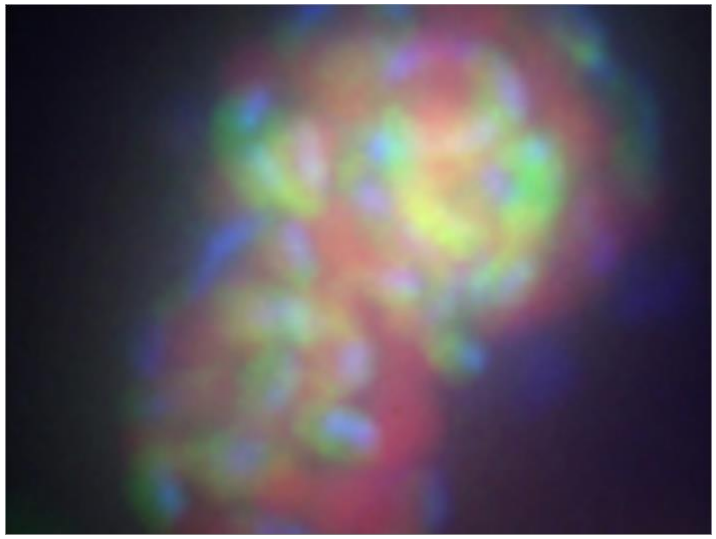
- CH_4 is important to atmospheric chemistry since it affects the oxidizing capacity of the atmosphere and results in increased tropospheric ozone and stratospheric water vapor (RF ~0.3 W/m^2)
- OH radicals in troposphere destroy CH_4 and other reduced long-lived GHG

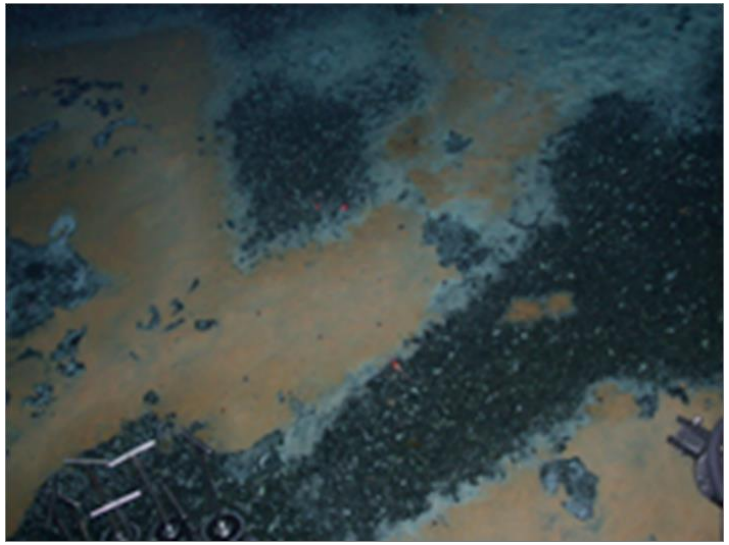
Process that Emit Methane

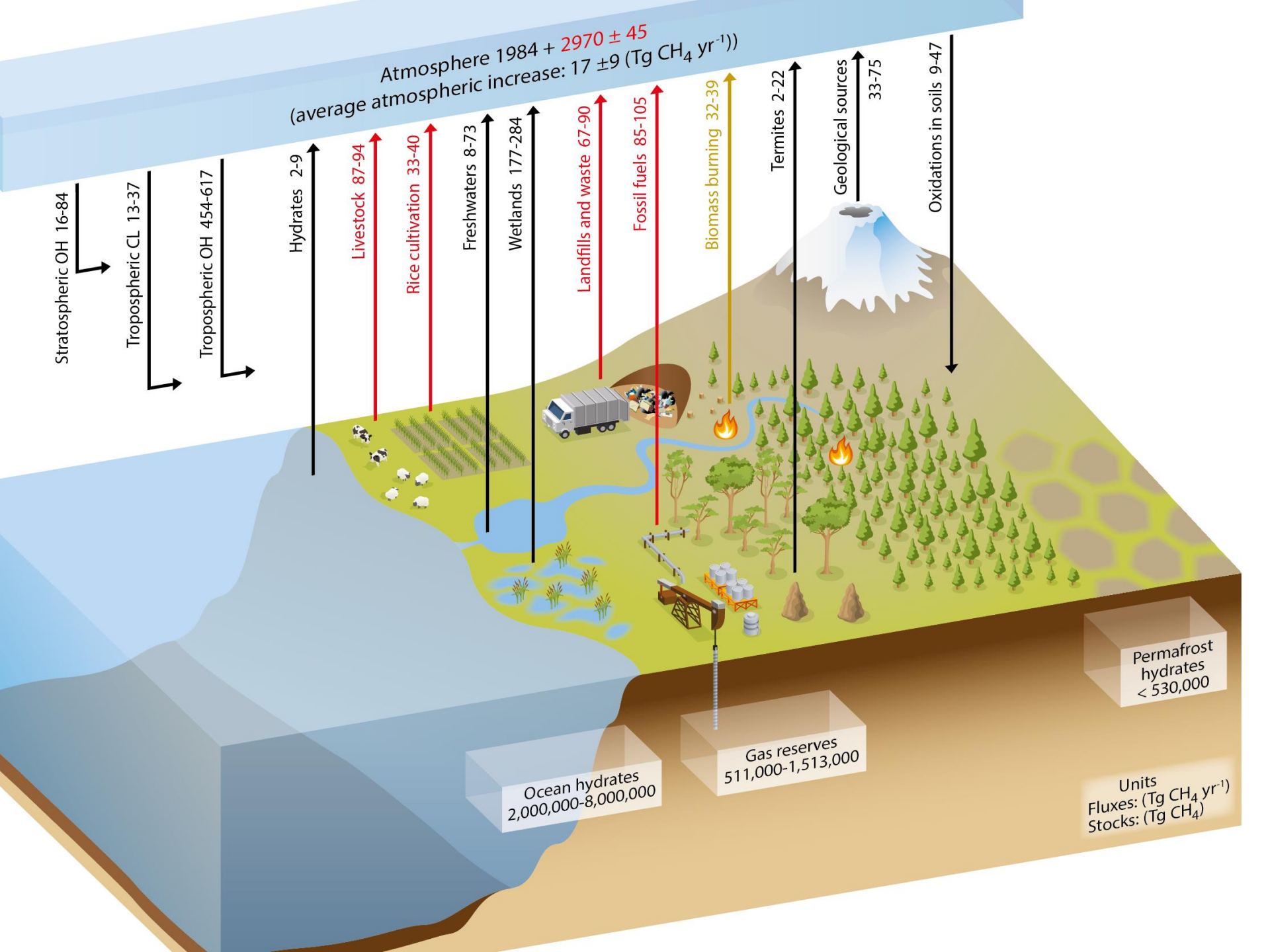
- 3 main processes:
  - Thermogenic
  - Pyrogenic
  - Microbial
- Produce and consume methane
- Rate of production is T dependent
- Methanogens: anaerobic methane producing microbes belonging to kingdom archaea



- Methanotrophs: methane consuming microbes
  - Archaeal methanotrophs: must be in symbiotic relationship with a bacteria which consumes sulfates; anaerobic
  - Bacterial methanotrophs: independent; aerobic

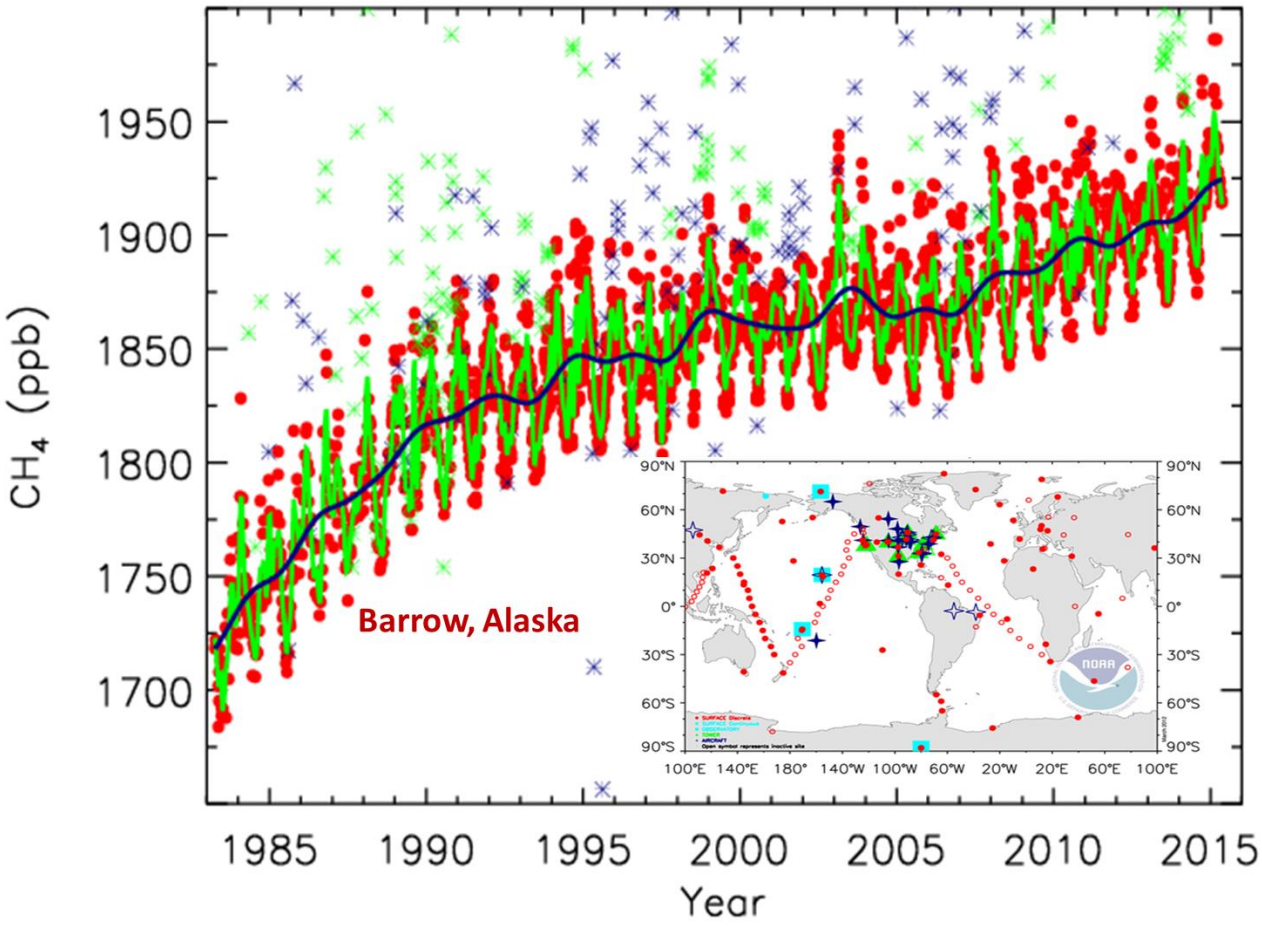




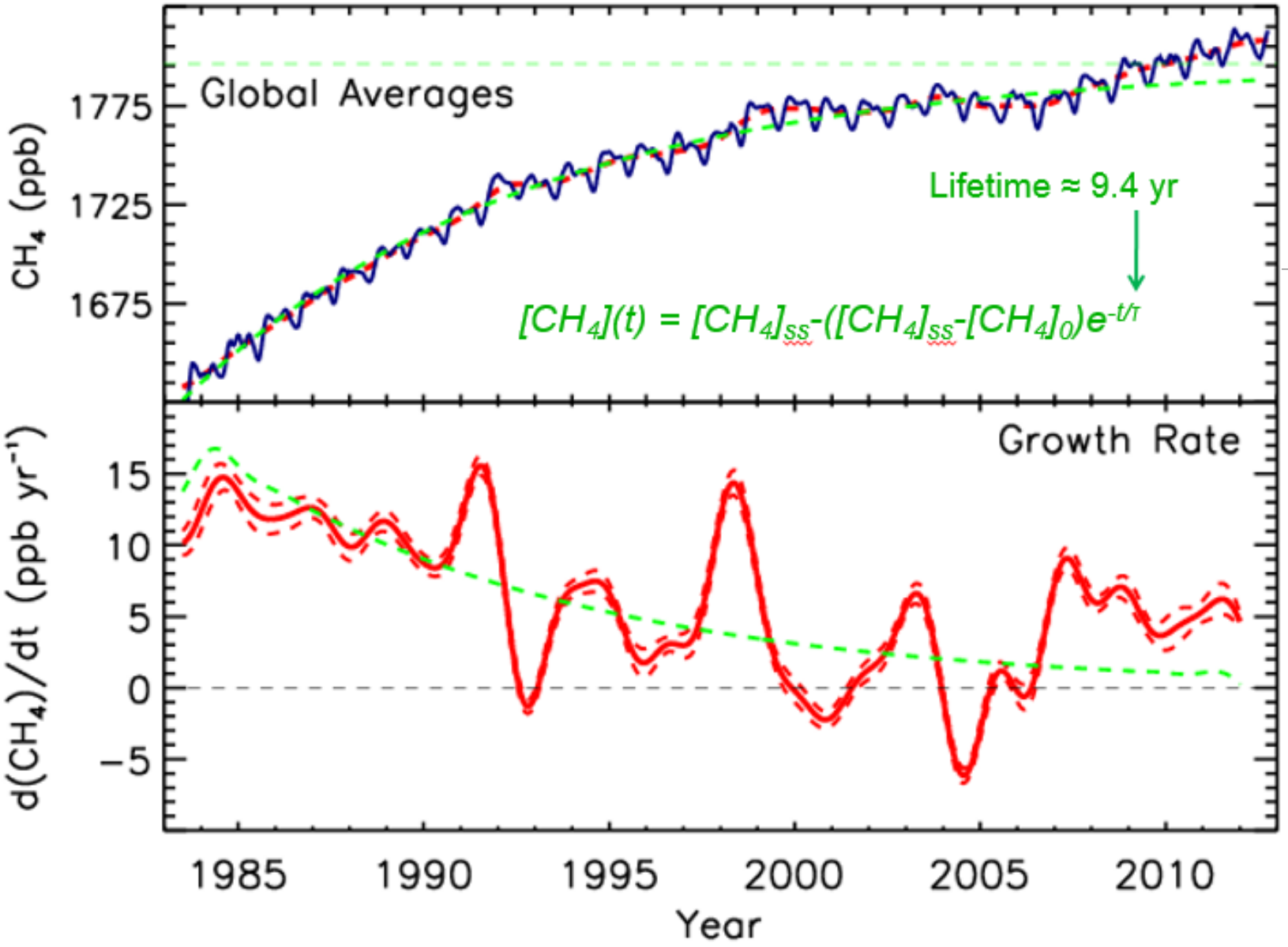

Atmosphere 1984 + 2970 ± 45
(average atmospheric increase: 17 ±9 (Tg CH_4 yr^{-1}))
Stratospheric OH 16-84
Tropospheric CL 13-37
Tropospheric OH 454-617
Hydrates 2-9
Livestock 87-94
Rice cultivation 33-40
Freshwaters 8-73
Wetlands 177-284
Landfills and waste 67-90
Fossil fuels 85-105
Biomass burning 32-39
Termites 2-22
Geological sources 33-75
Oxidations in soils 9-47
Permafrost hydrates < 530,000
Gas reserves 511,000-1,513,000
Ocean hydrates 2,000,000-8,000,000
Units
Fluxes: (Tg CH_4 yr^{-1})
Stocks: (Tg CH_4)

($Tg\ CH_4\ yr^{-1}$)	Top-down	Bottom-up
Natural	**218**	**347**
Wetlands	175	217
Other	43	130
Anthropogenic	**335**	**331**
Agriculture + Waste	209	200
Biomass Burning	30	35
Fossil Fuels	96	96
Total Emissions	**553**	**678**
Sinks	**550**	**632**
Imbalance	**3**	**46**

Methane Observations

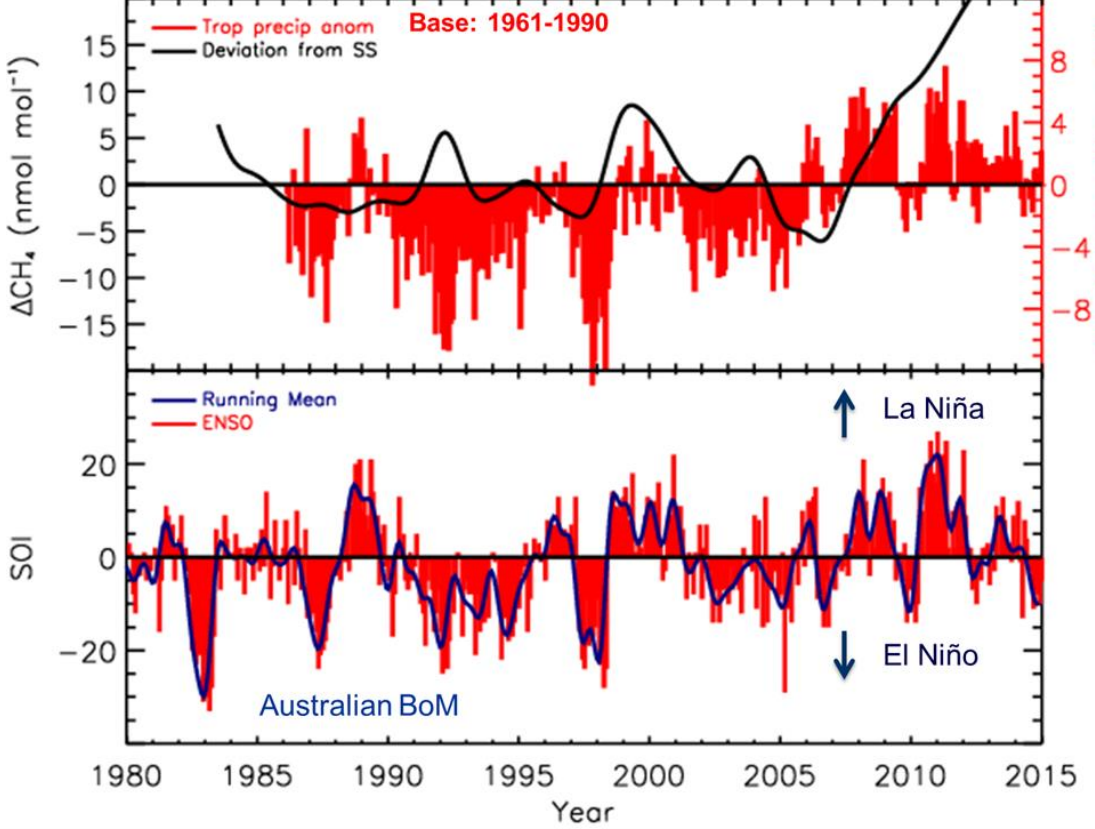


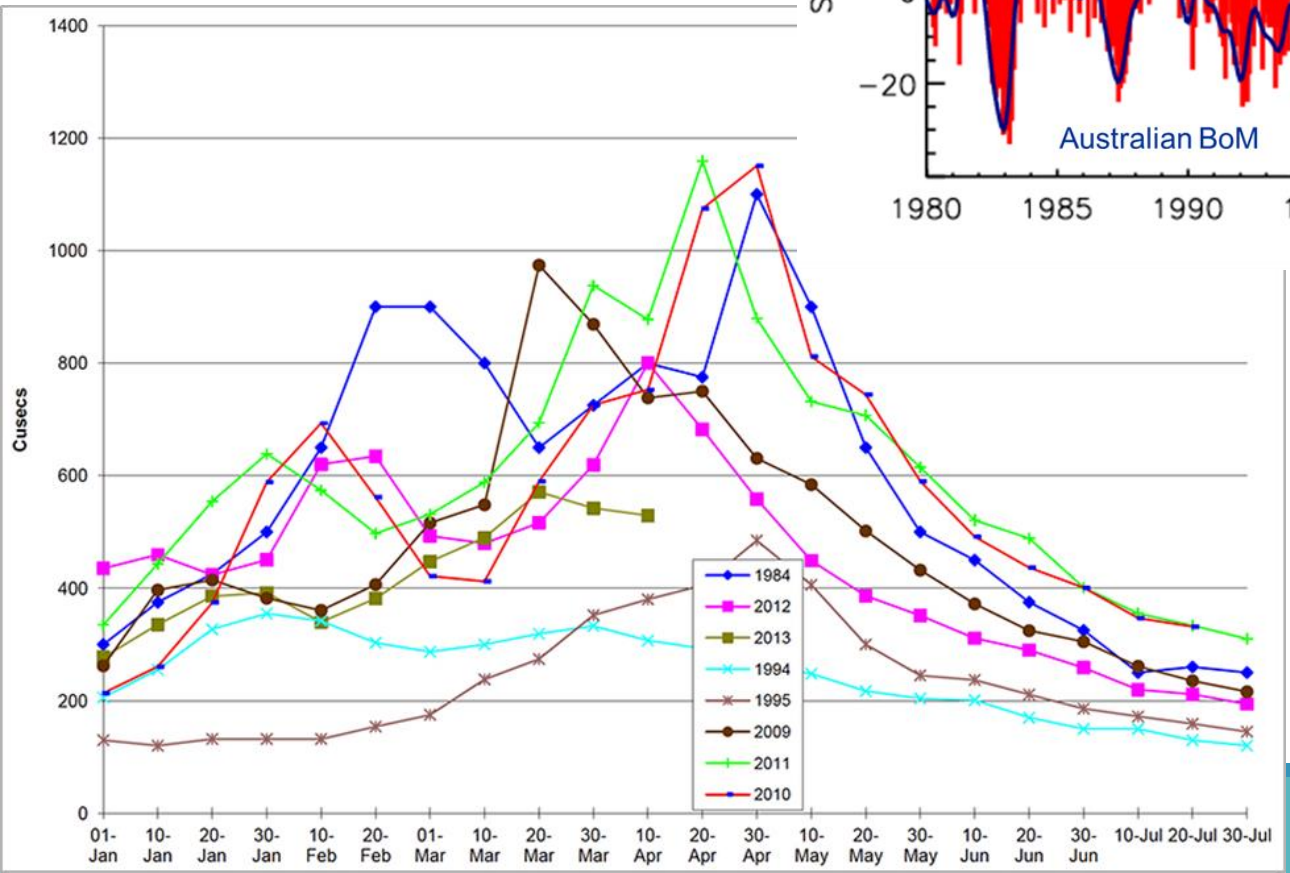
Weekly methane at Barrow, AK. The red symbols show retained values. The blue and green symbols show flagged values. A map of GMD air sampling sites is inset.



Globally averaged methane from 1983-2014.

Role of Wetlands





Conclusions

- Tropical wetlands were important in paleoclimate
- Believe wetlands also a main driver of methane changes in the last decade
- In many tropical countries, few resources are spent on data relevant to understanding large scale methane changes
  - Human activities impact streamflow
  - Testing for memory effects was limited by insufficient data and technical complications
- Limited understanding of production of methane from archaeal methanogens and oxidation by methanotrophs

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Sources

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