bushfire CRC

PROGRAM B

Alpine soil as a methane sink: controlling factors and fire effects.

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CRC AUSTRALIA

THE UNIVERSITY OF MELBOURNE

Does
fire and climate change affect CH_4 oxidation?

What controls CH_4 oxidation?

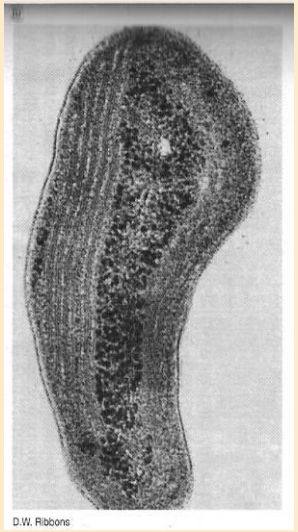
CH_4 ?

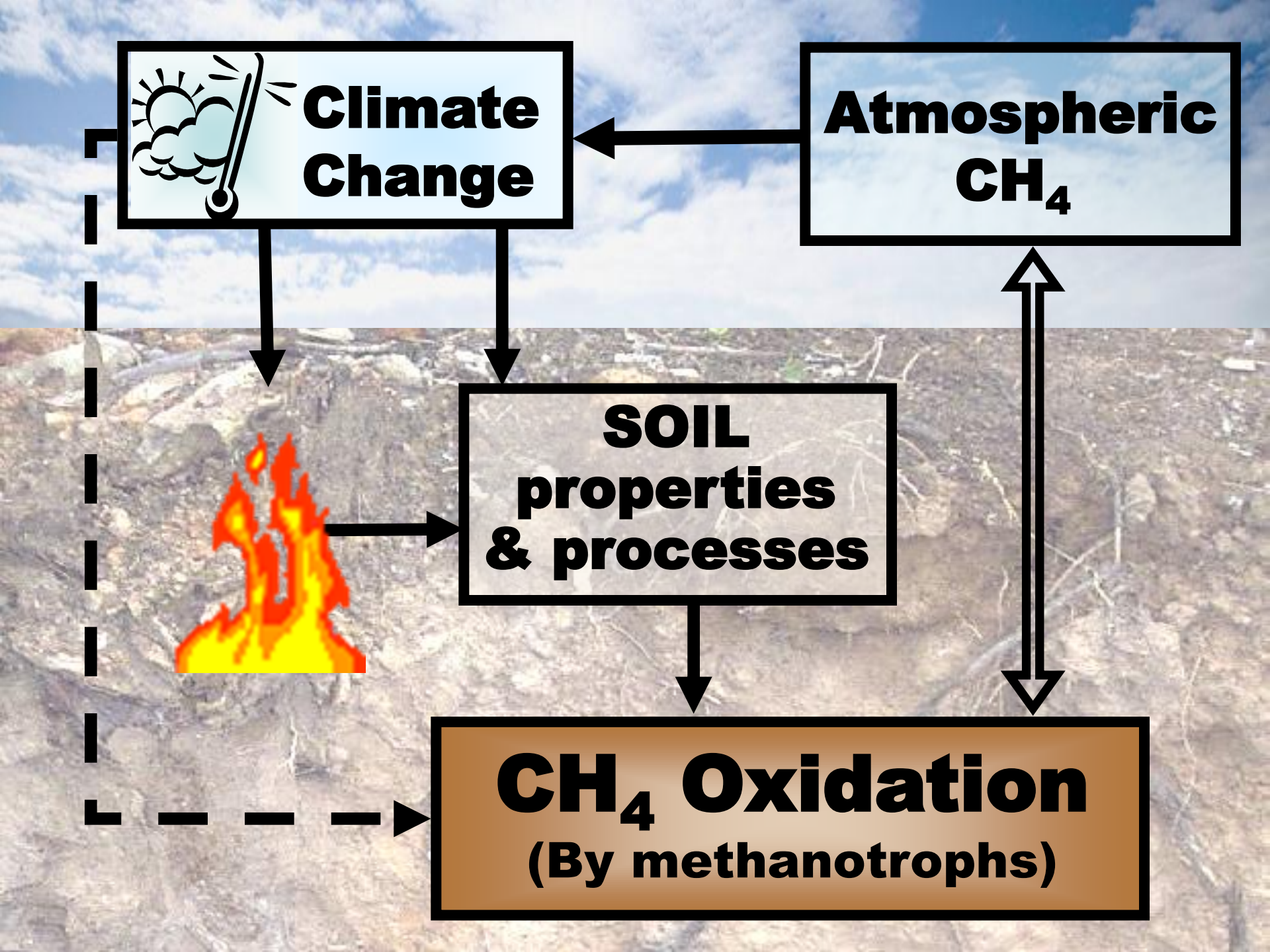
Methanotrophic bacteria

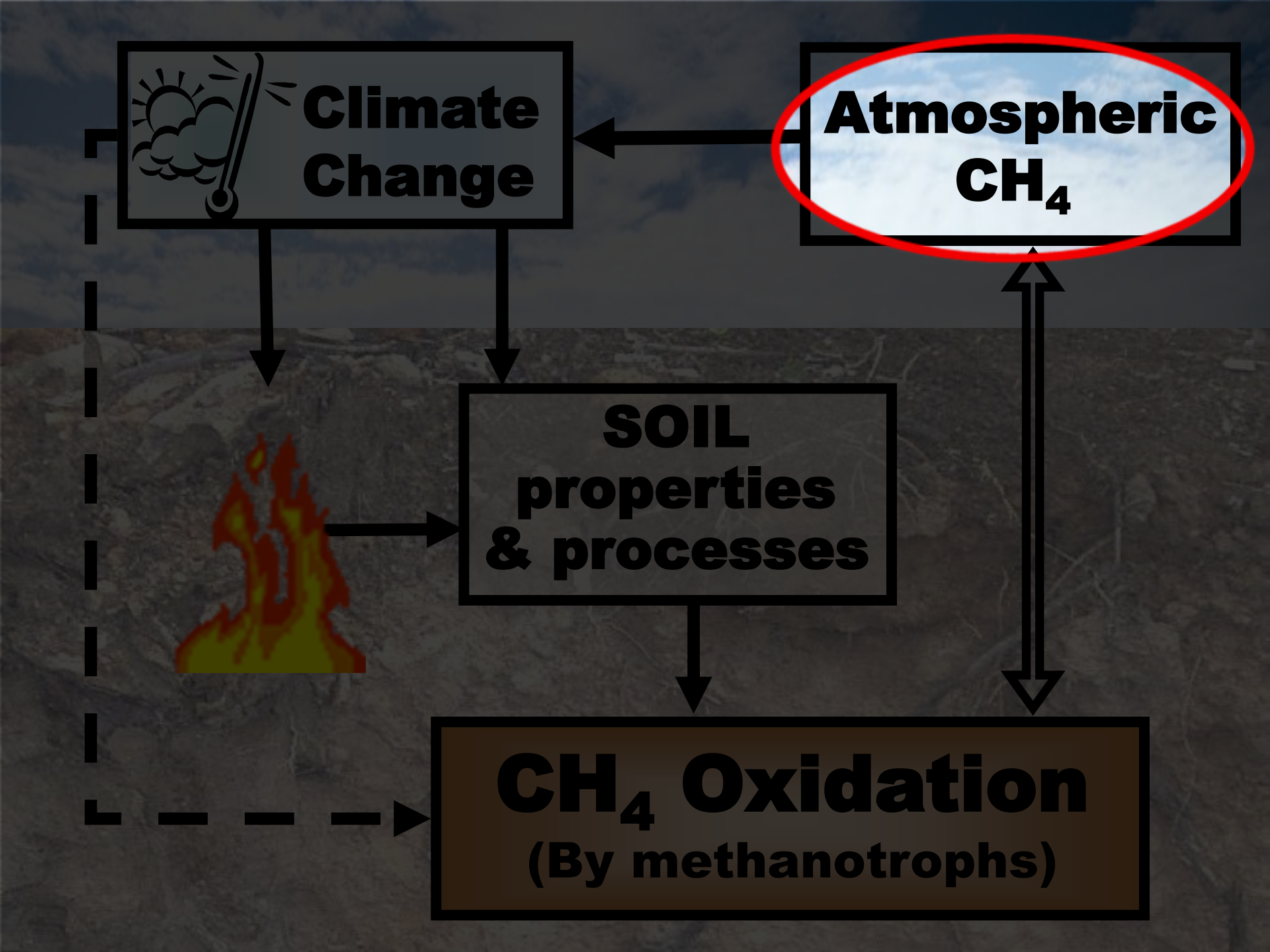
- Oxidizes (consumes) methane (CH_4); consuming 3-10% of emissions

- Only occurs in aerobic soils (O_2)

$$CH_4 + 2O_2 \xrightarrow{k} CO_2 + 2H_2O$$




Climate Change
Atmospheric CH_4
SOIL properties & processes
CH_4 Oxidation
(By methanotrophs)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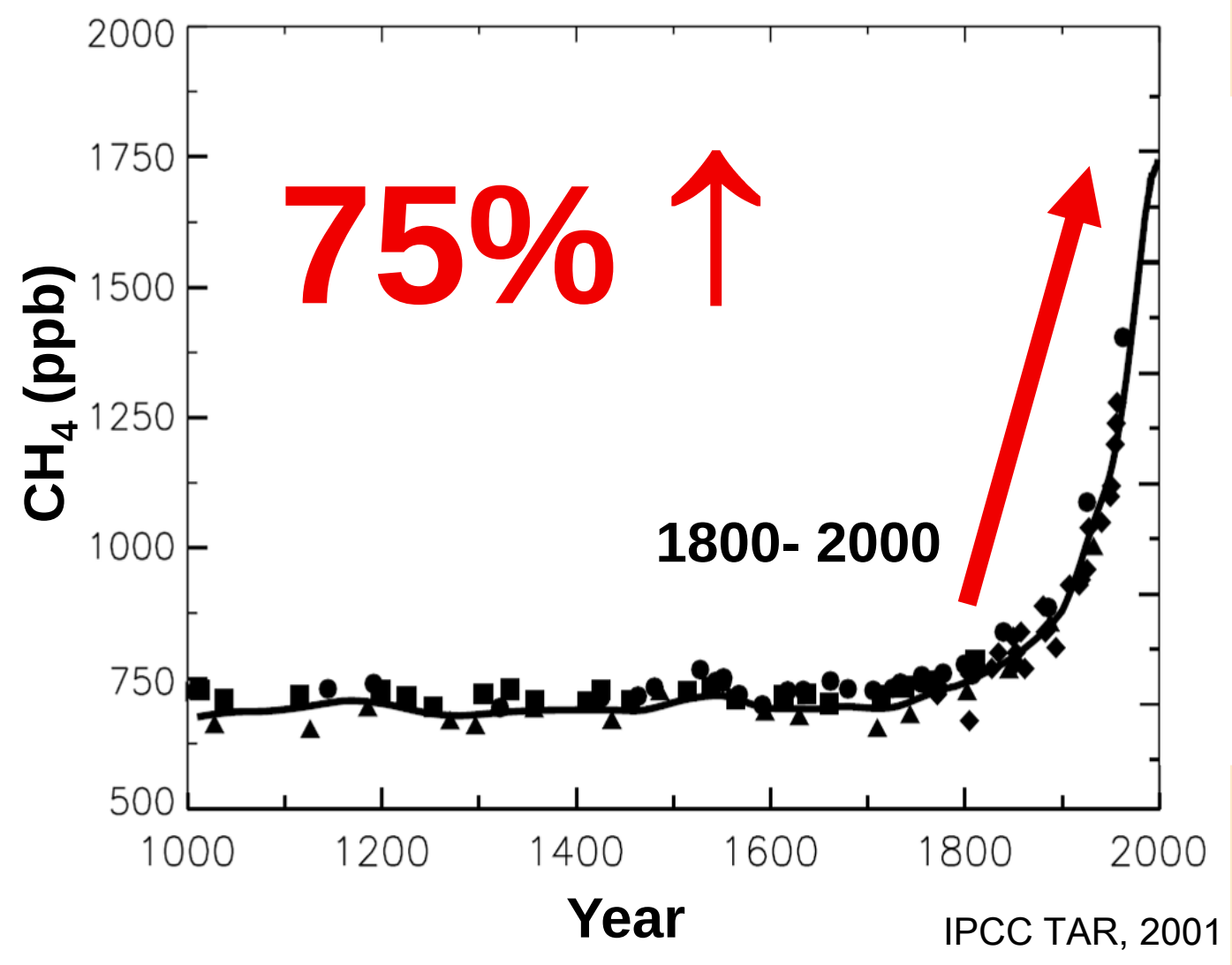
Atmospheric CH_4 has increased….



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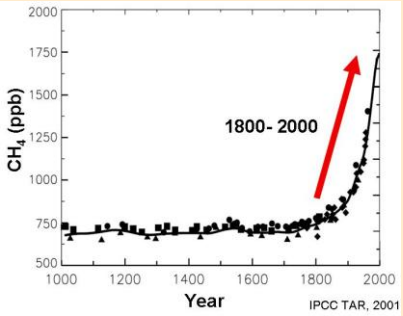
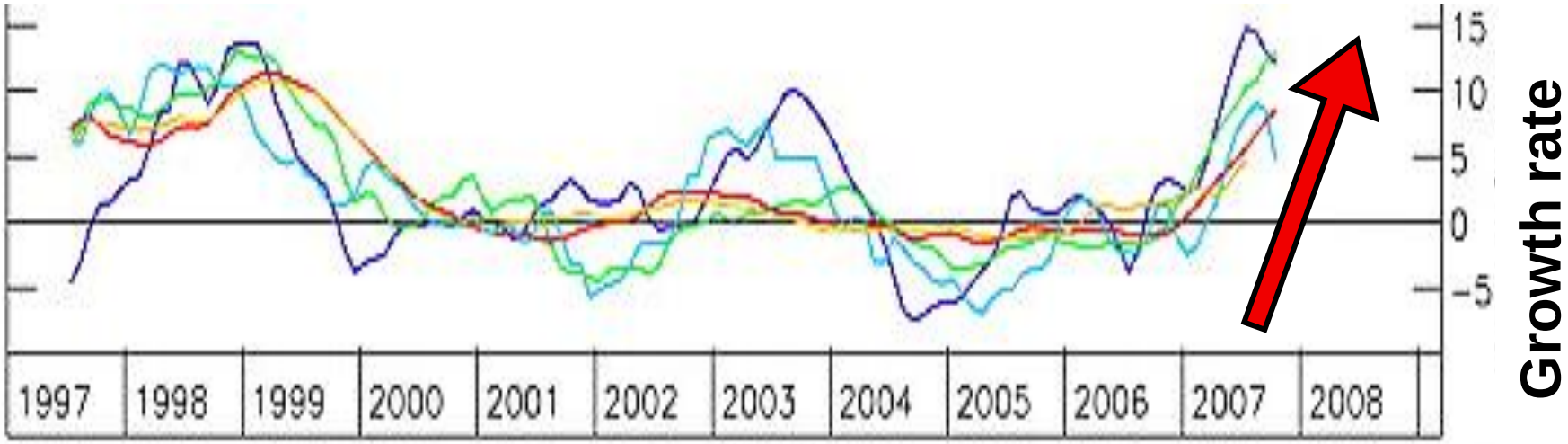


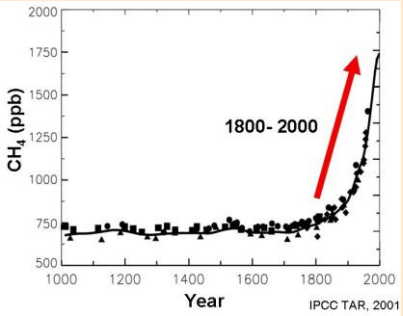


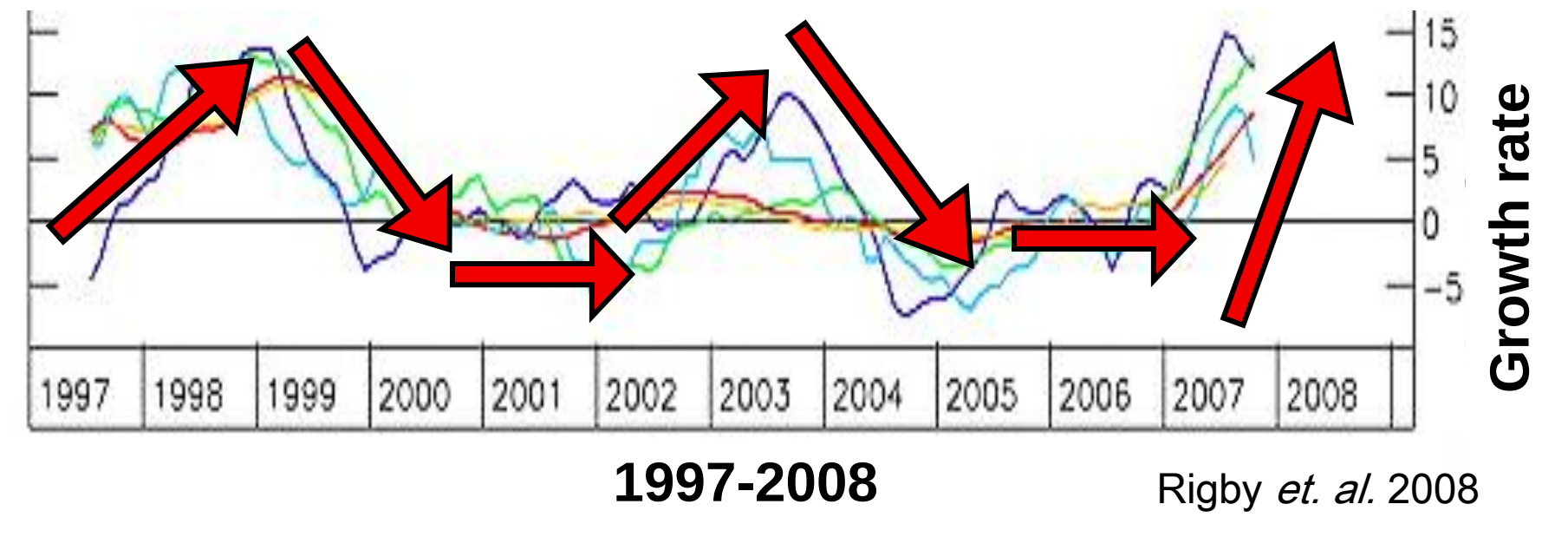
1997-2008

Rigby *et. al.* 2008

….and is still increasing?

Atmospheric CH_4 has increased….





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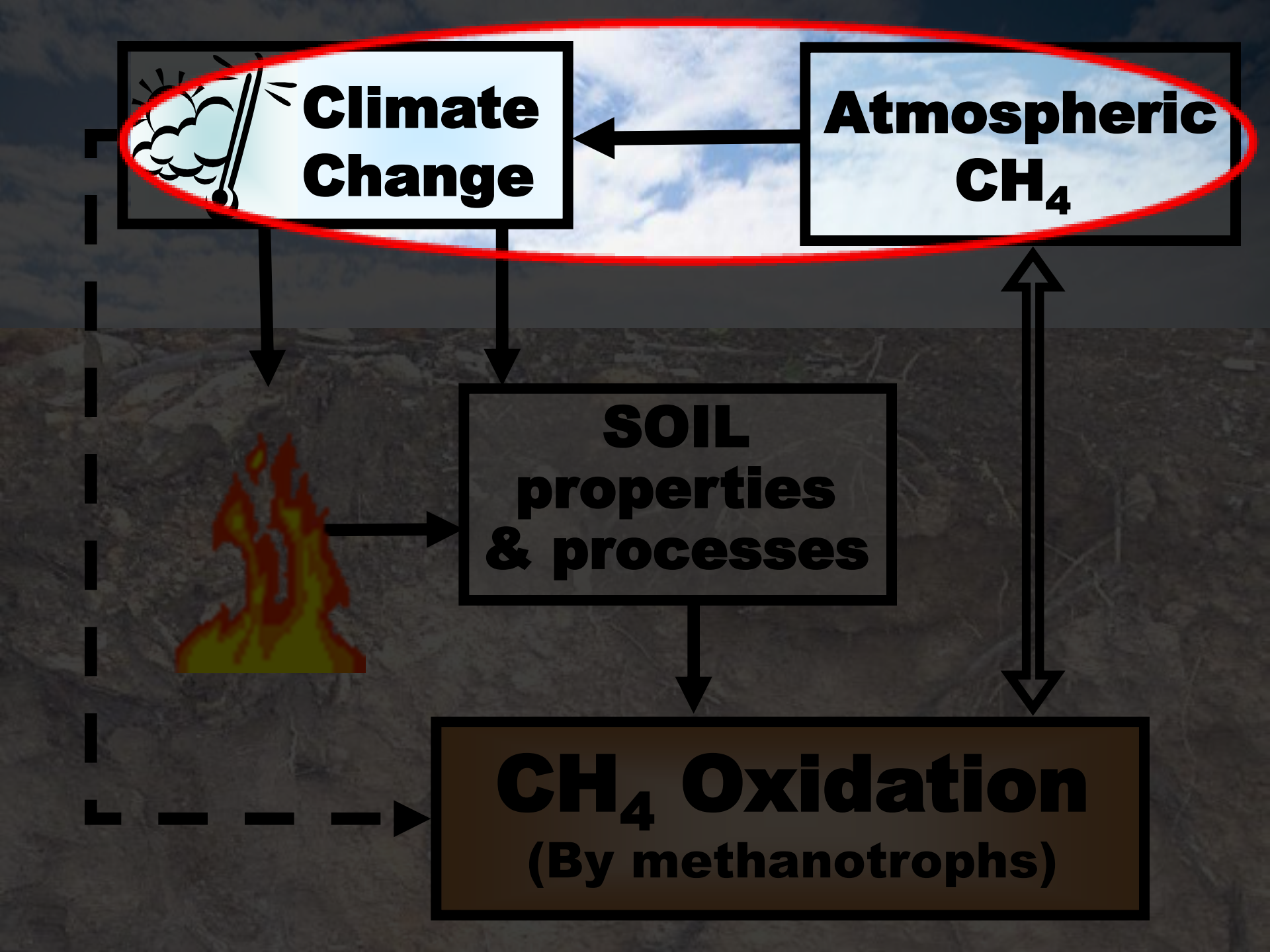
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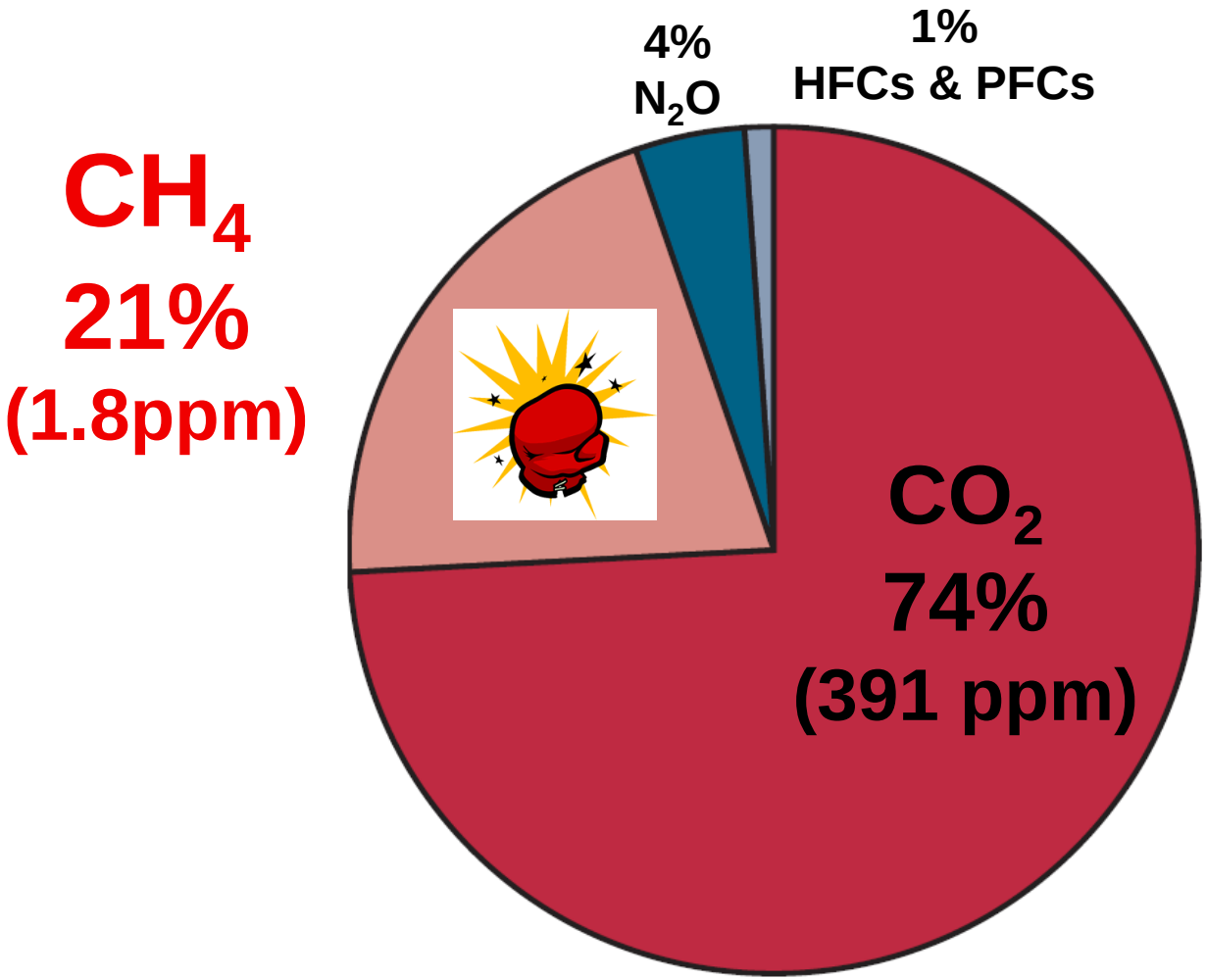
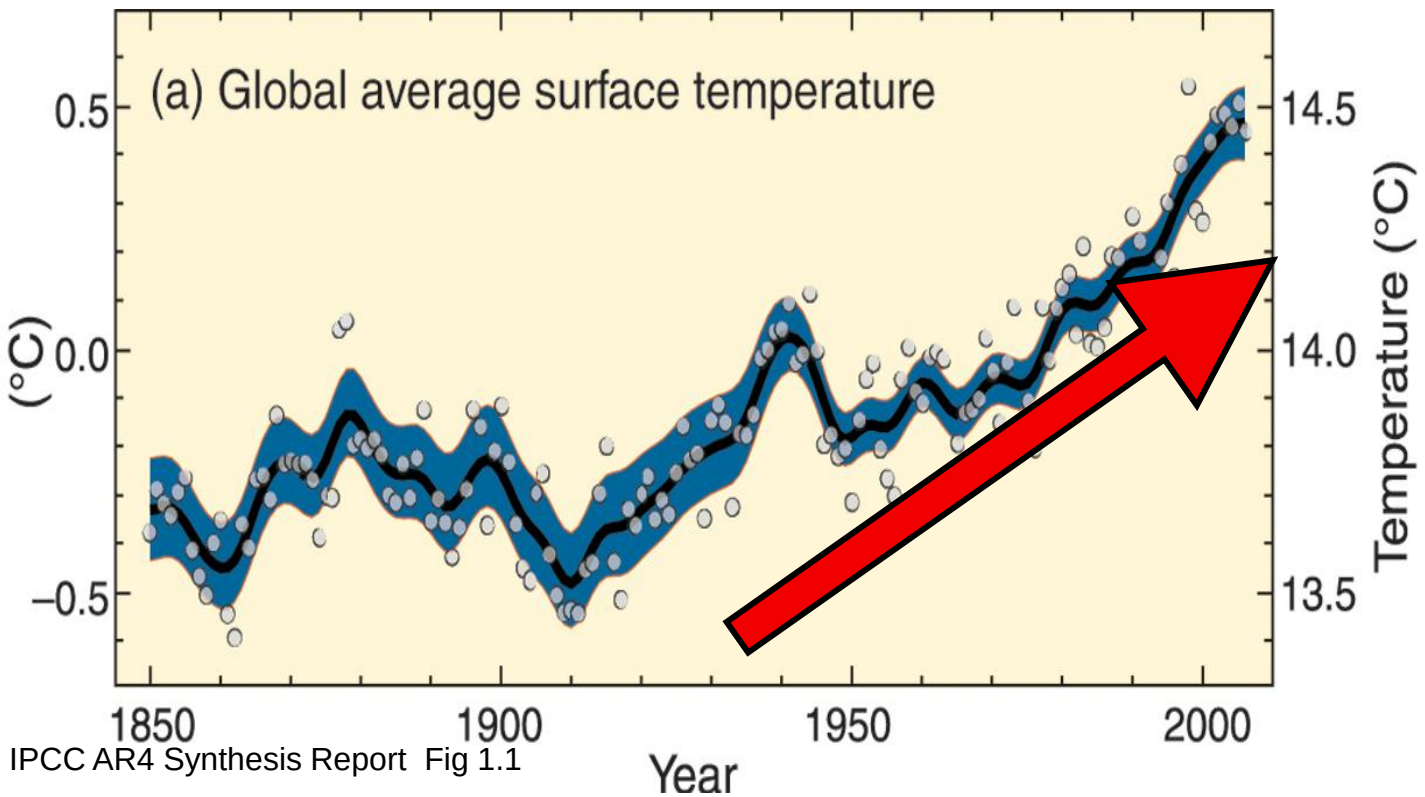
21% of Australia's total net **CO_2 equivalent** green house gas emissions

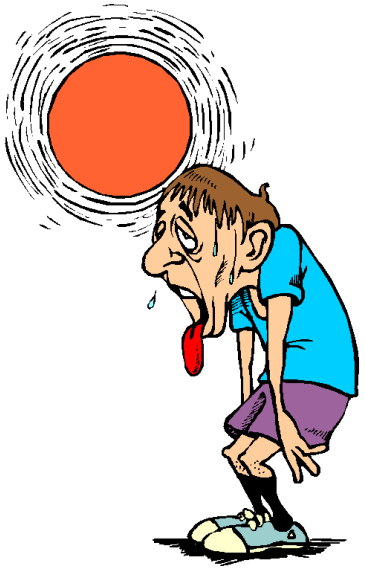


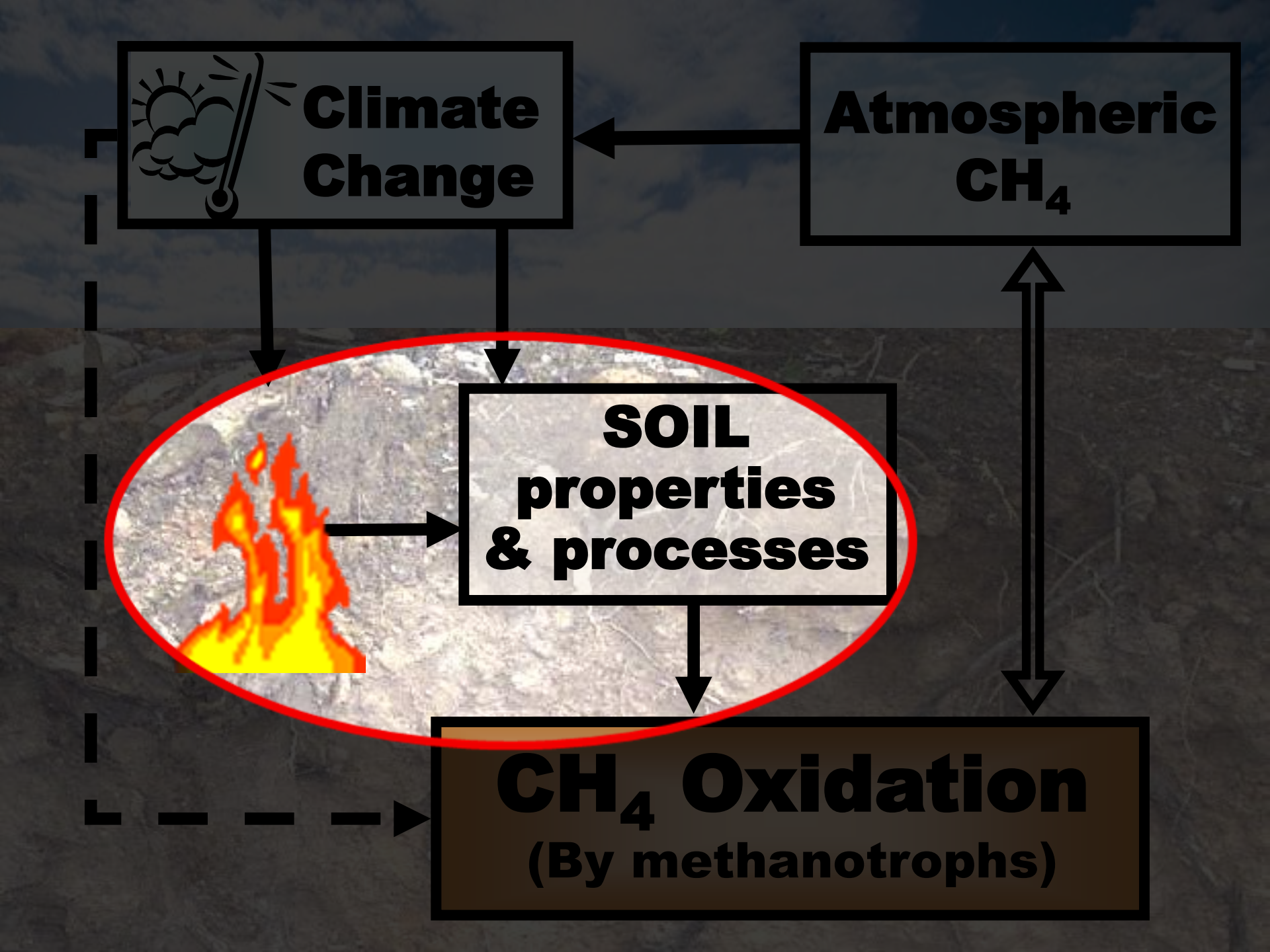
Measured using Kyoto accounting provisions, National Greenhouse Gas Inventory 2006

CH_4 contributes to 20% of temp ↑



IPCC AR4 Synthesis Report Fig 1.1




Climate Change
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Fire affects Alpine Ash soil

Mean (± s.e)	Pre-Fire Nov 2002	~1 year post fire April 2004	Difference
pH	4.58 (.28)	5.58 (.033)	↑
Conductivity (us)	118 (26.2)	184 (17.2)	↑
Ammonium (ppm)	37.4 (8.7)	149 (40)	↑
Nitrate (ppm)	7.05 (4.6)	4.02 (1.9)	-
Total N (g C 100g soil^{-1})	0.68 (0.04)	0.72 (.1)	-
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Data from Robert Simpson's PhD thesis

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Why study methane oxidation?.....

- Powerful GHG contributing to climate change

  Changing atmospheric concentrations ?

- Australian soils are important sink. How will this sink be effected by change?

  Little research

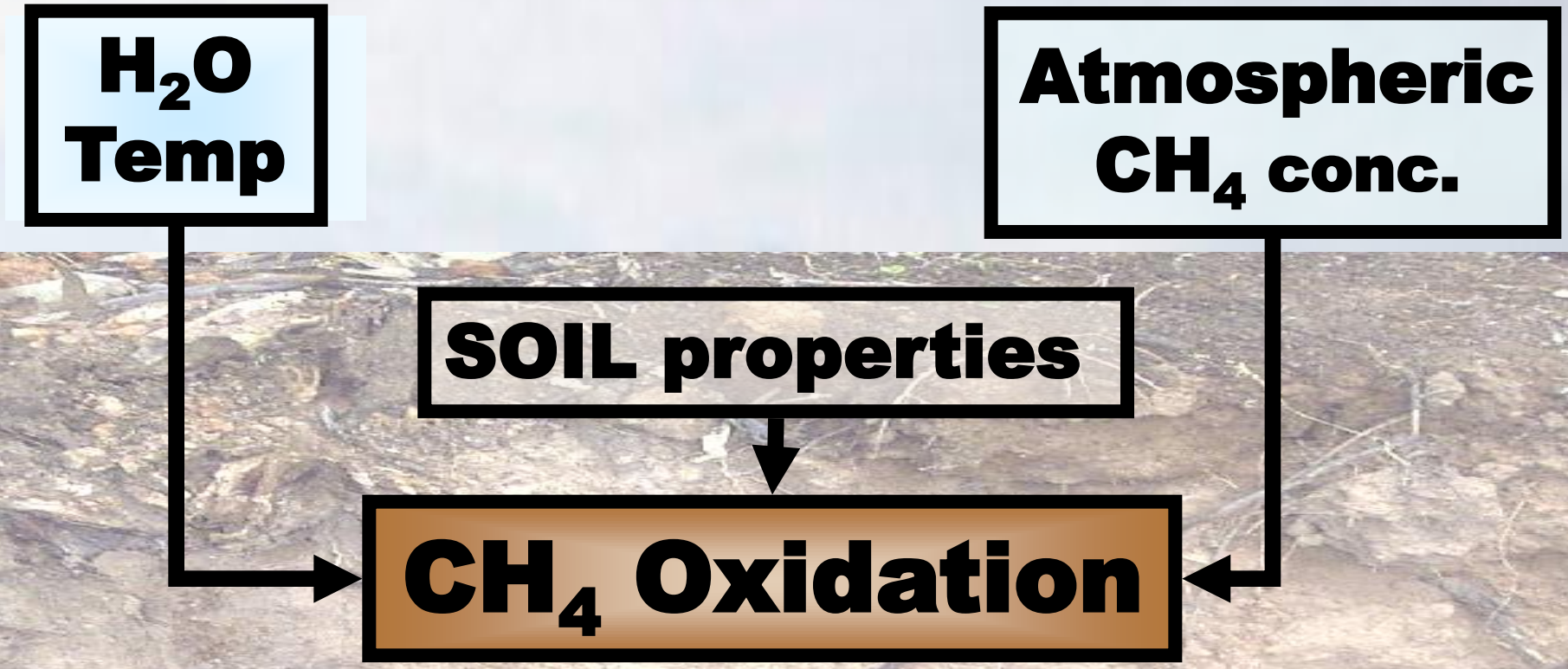
  Sink NOT accounted for in GHG inventory

  Controlling factors UNKNOWN

.....How do soil properties effect this sink?

WHICH properties

MAGNITUDE of their effects

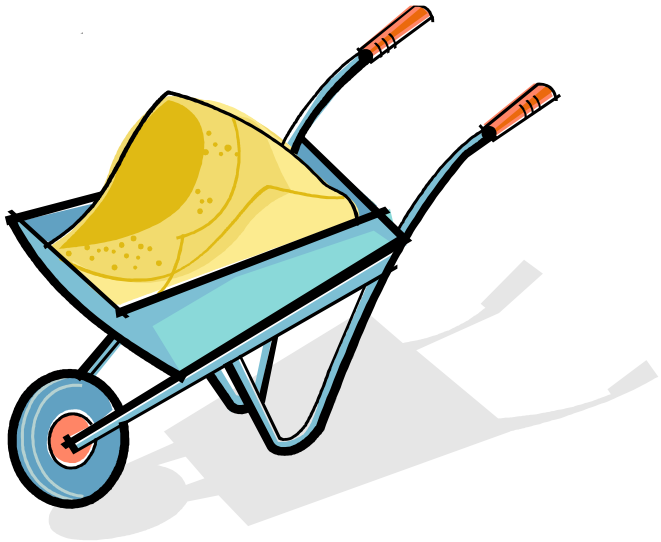


Alpine ash
(*Eucalyptus delegatensis*)
Montane forests

Burnt 2003, canopy not killed

Burnt 2003 & 06, canopy not killed

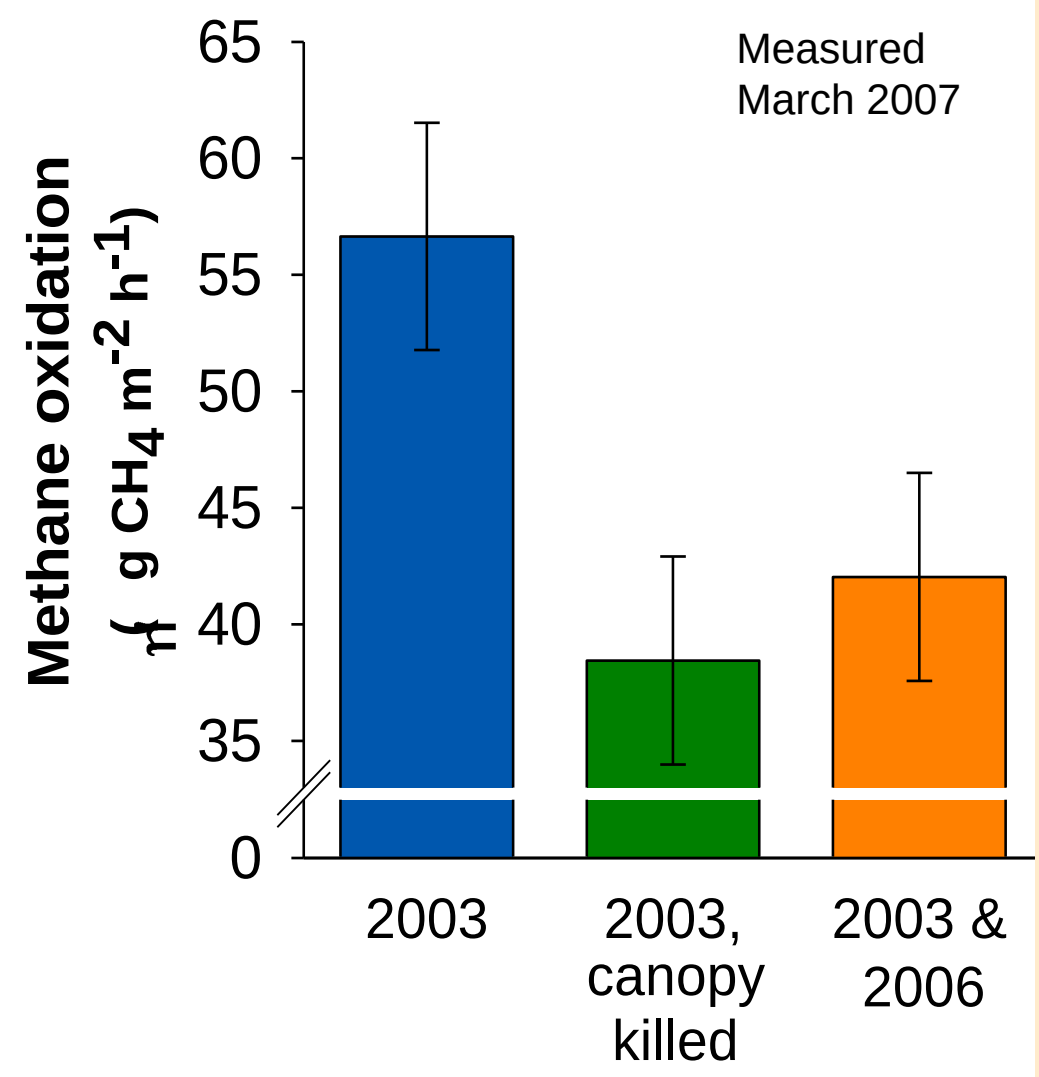
Part 1: Field Studies



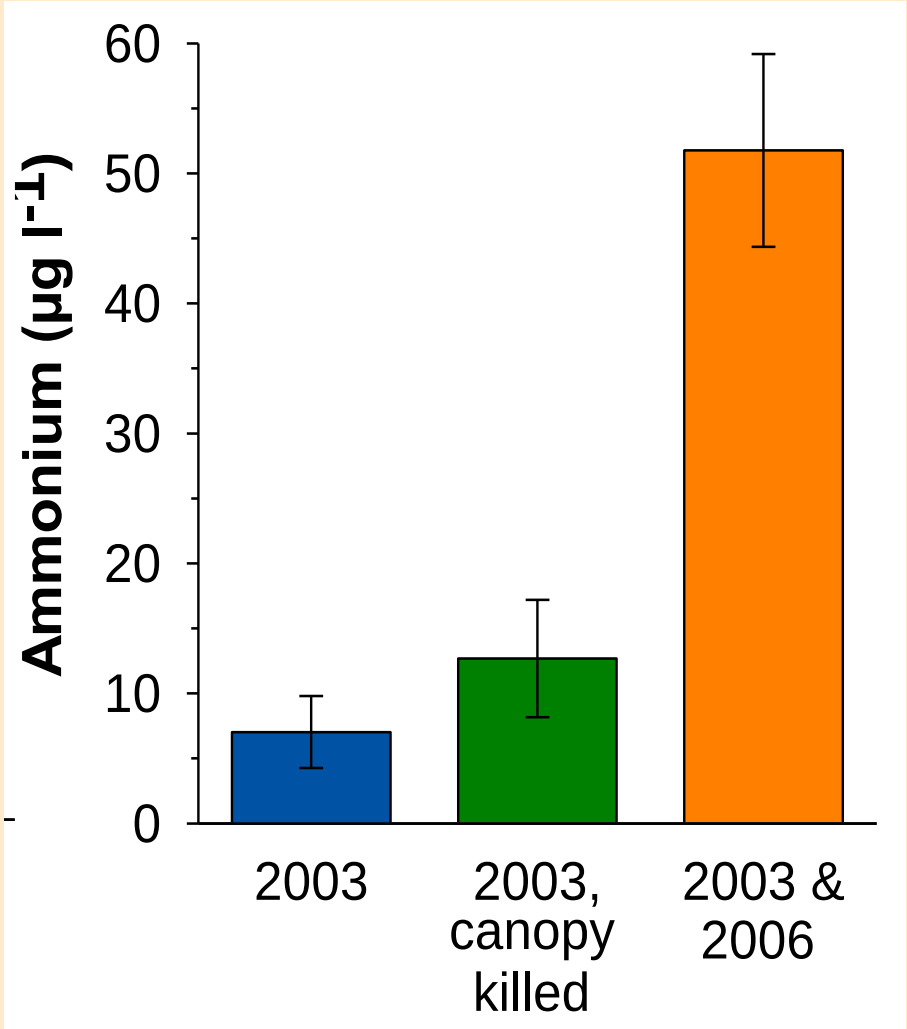
Comparisons between ecosystems

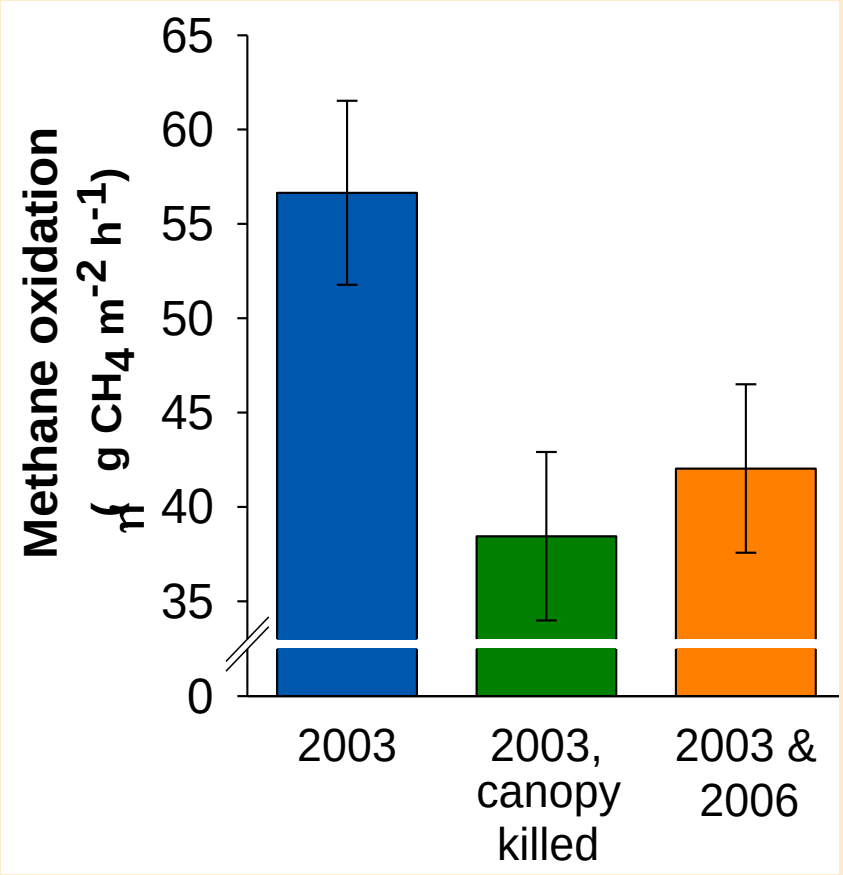
Ecosystem	CH_4 ox rate µg CH_4 m^{-2} h^{-1}	Reference (example)
Forest Boreal	65	Bradford *et al*. 2001
Alpine Ash	**59**	**This Study**
Pasture-Temperate	55	Meyer *et al*. 2001
Forest Temperate	44	Castro *et al*. 1995
Grassland	44	Moiser *et al*. 1996
Forest sub/tropical	24	Prieme & Christensen 1997
Desert	24	Striegl *et al*. 1992
Savannas -global	20	Castaldi *et al*. 2006
Pasture-tropical	8	Steudler *et al*. 1996

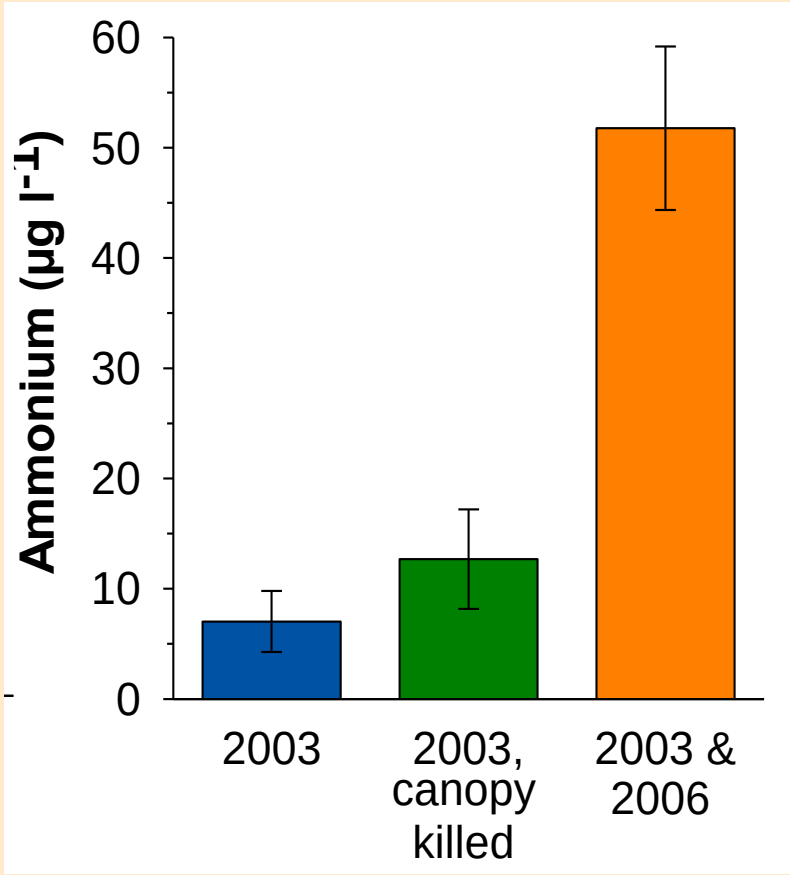
CH_4 oxidation was the **lowest** at sites **more severely or recently burnt**



Soil ammonium was the **highest** at sites **more recently burnt.**



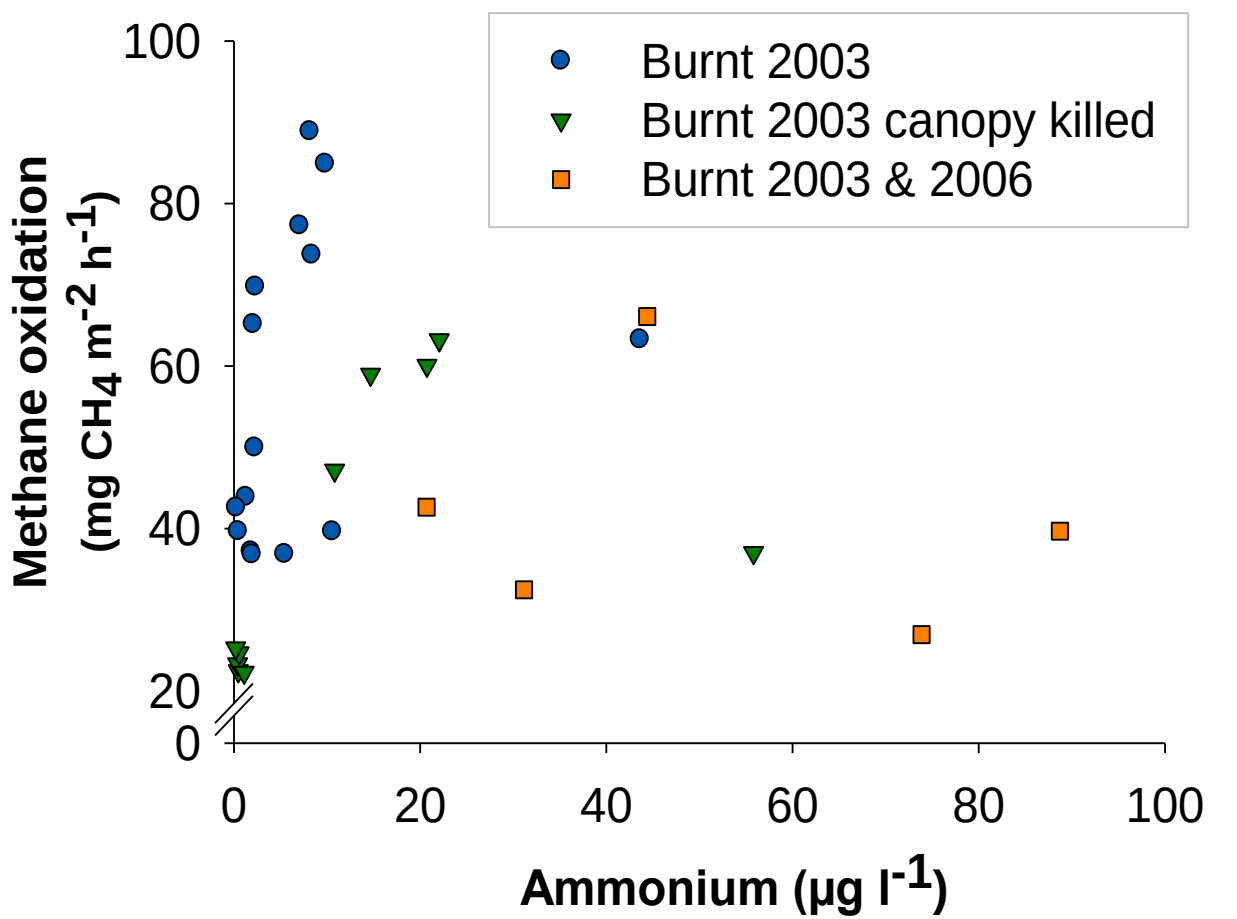




Methane oxidation was the **lowest** at sites more recently burnt

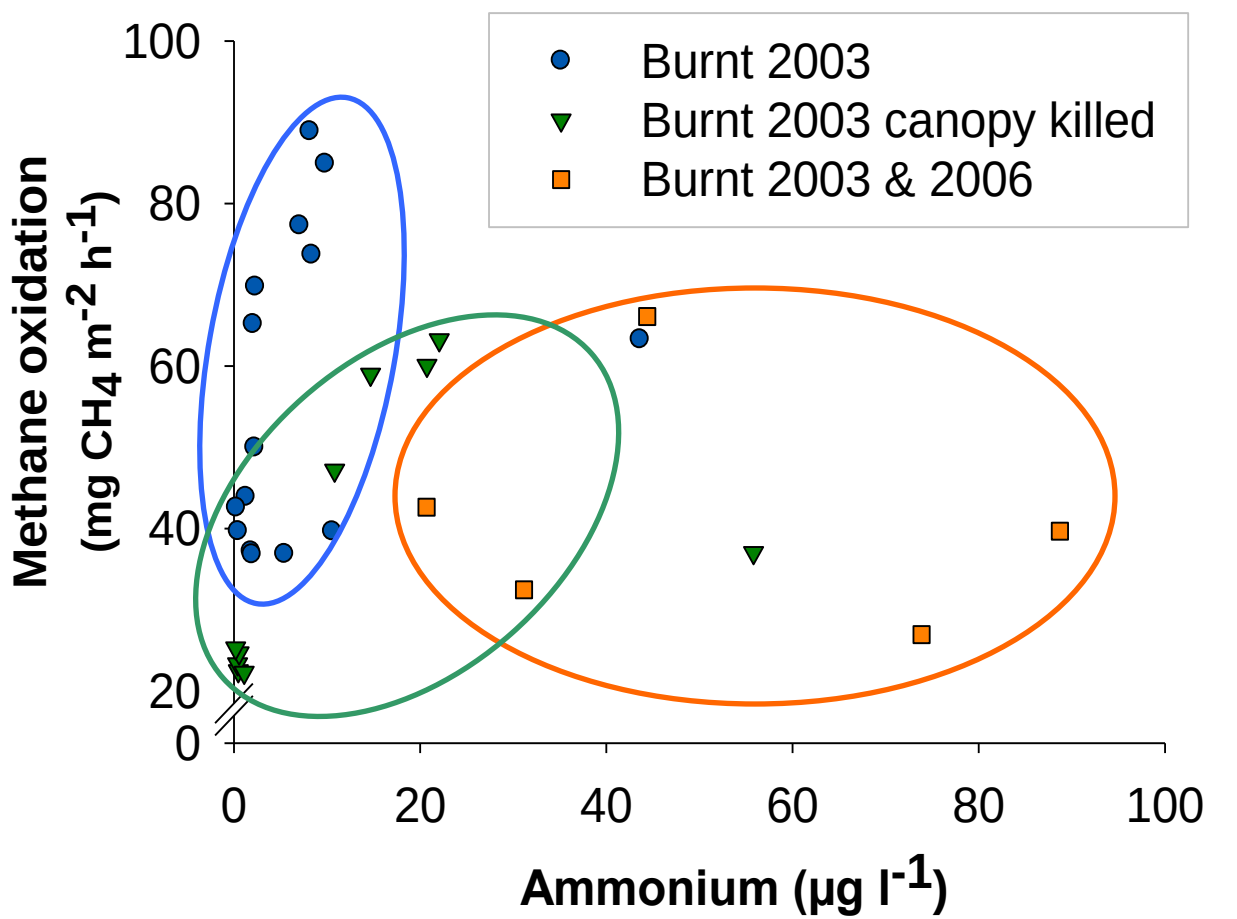
Soil ammonium was **highest** at sites more recently burnt.

Field methane oxidation vs. soil ammonium



Methane decreases as ammonium increases.
However, this relationship is not statistically significant.

Field methane oxidation vs. soil ammonium



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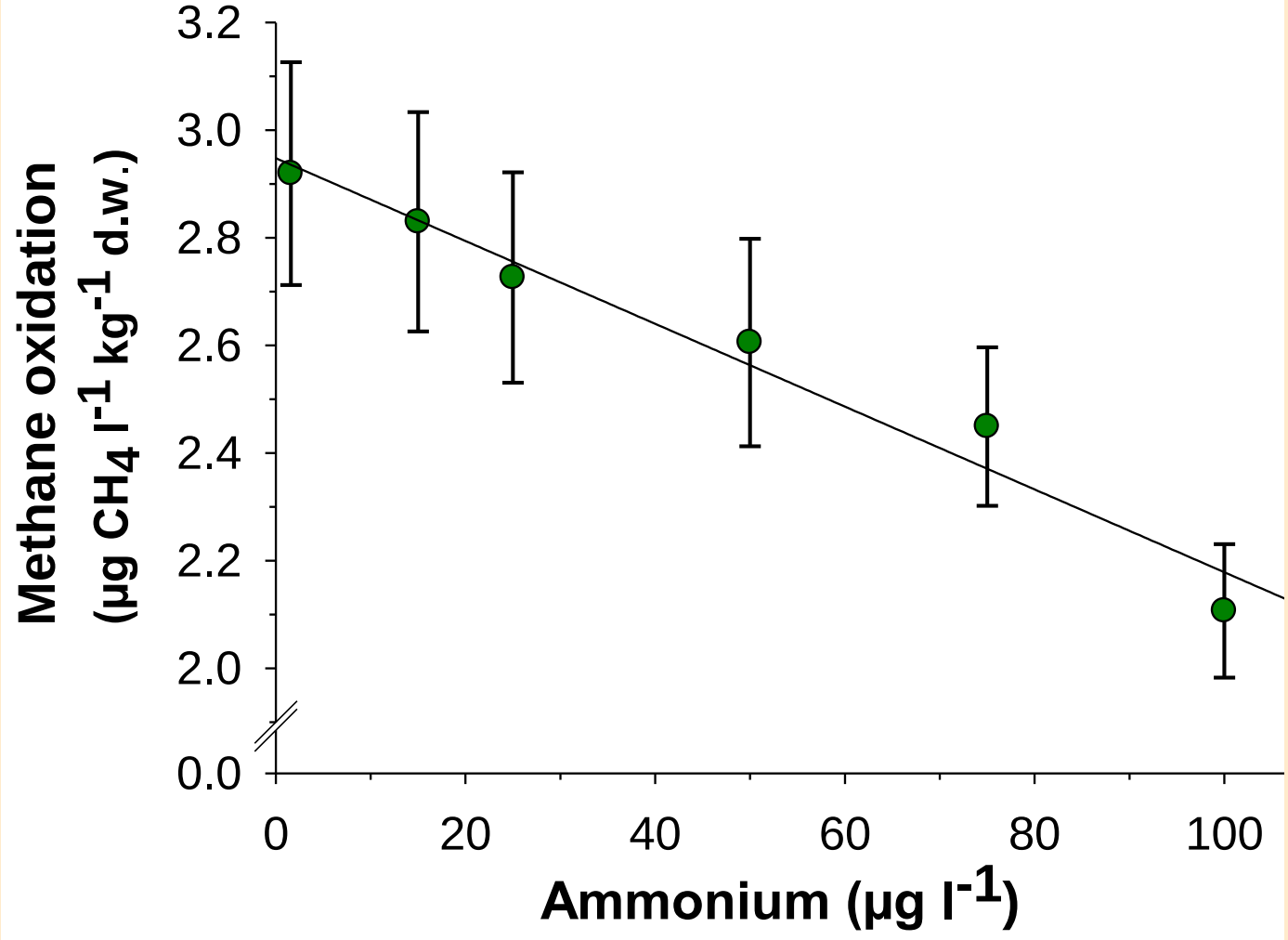
Part 2:
Laboratory Studies

Ammonium inhibits methane oxidation



Methane oxidation ↓ soil ammonium ↑

WHICH properties

MAGNITUDE of their effects ?

H_2O
Temp

Atmospheric
CH_4 conc.

SOIL properties

CH_4 Oxidation

Important controlling factors

Property	CH_4 Oxidation change
Soil H_20 - midrange	-
- high & low	↓
NH_4 conc ↑	↓
CH_4 conc ↑	↑

- Temperature and bulk density has little effect
- pH had a small although not significant effect except at the extreme pH values.

Laboratory studies

- ✓ Useful for determining the effect of an **individual** soil properties and **interactions** between soil properties
- ✗ May not replicated field conditions

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Field Studies

- ✗ Difficult to distinguish the effects of individual soil properties
- ✓ Required to **verify laboratory results** and **test models and assumptions**.
- ✓ Determine and compare CH_4 oxidation rates at different sites and locations (i.e., different vegetation, conditions, burn histories)

Does
fire and climate change affect CH_4 oxidation?

What controls CH_4 oxidation?

CH_4 ?

Fire and climate change WILL effect CH_4 oxidation

Fire and climate change WILL effect CH_4 oxidation

This is a **COMPLEX** system!!

The **direction, magnitude and duration** of this effect is dependent on:

- Fire properties
- Soil conditions and type
- Soil resilience and recovery
- Vegetation; type, diversity, & growth rate
- Bacterial diversity and population size

The Next Steps……..

Laboratory Studies

- More soil properties and more detail
- Interactions between soil properties

Field Studies

- Field manipulation of soil properties
- Long Term Ecological Studies
- Before After Control Impact studies

Method Development

- More accurate, less time consuming & laborious tasks
- Development and use of new technology

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Reason for changing atmospheric concentrations UNKNOWN

- Australian soils are important sink. How will this sink be effected by change?

Little research

Sink NOT accounted for in GHG inventory

Controlling factors UNKNOWN

.....How do soil properties effect this sink?

How can these results be used?

- Improved understanding of climate & fire effects
- Better estimate Australian and global methane flux budgets leading to better management strategies
- Predict the effect of fire and climate change on CH_4 oxidation so we can understand the importance and determine if action is required


Thankyou