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Evaluation of methane emission from three representative deciduous tree species dominated in cool temperate Japan grown under elevated CO_2 concentration

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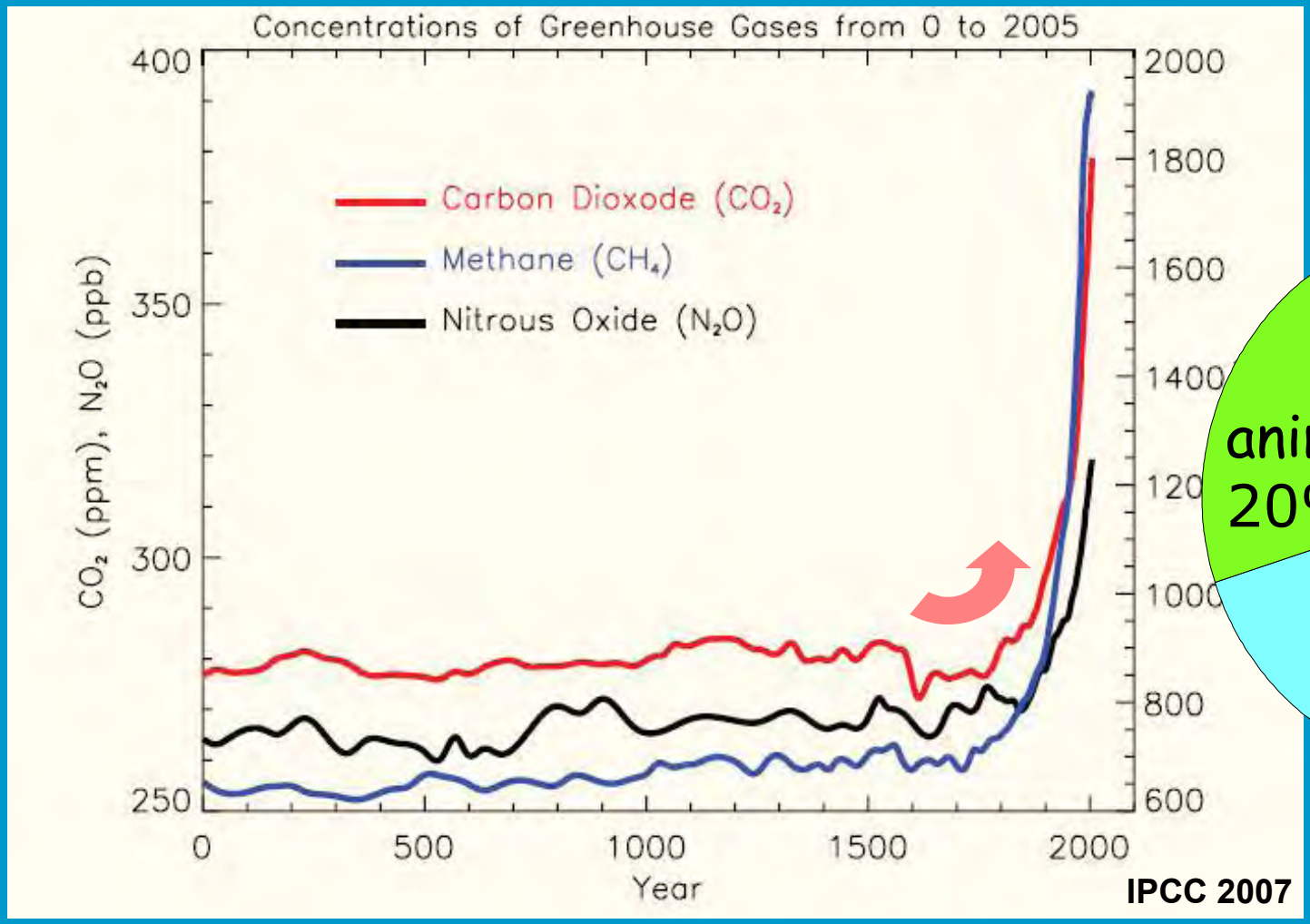
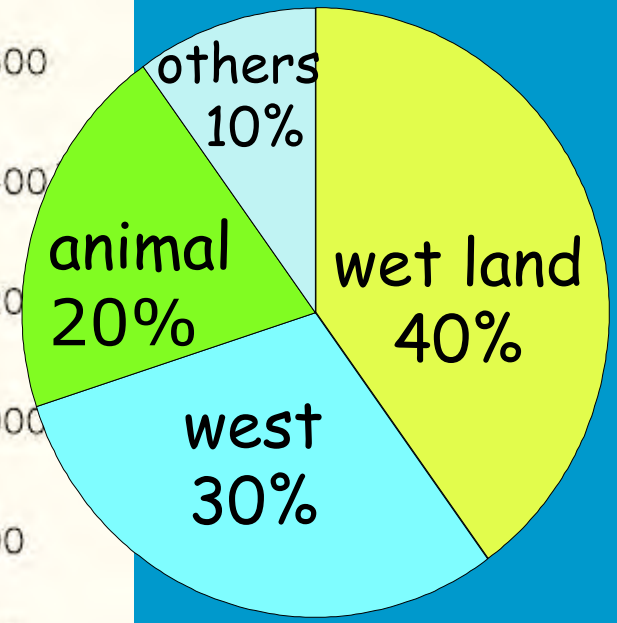
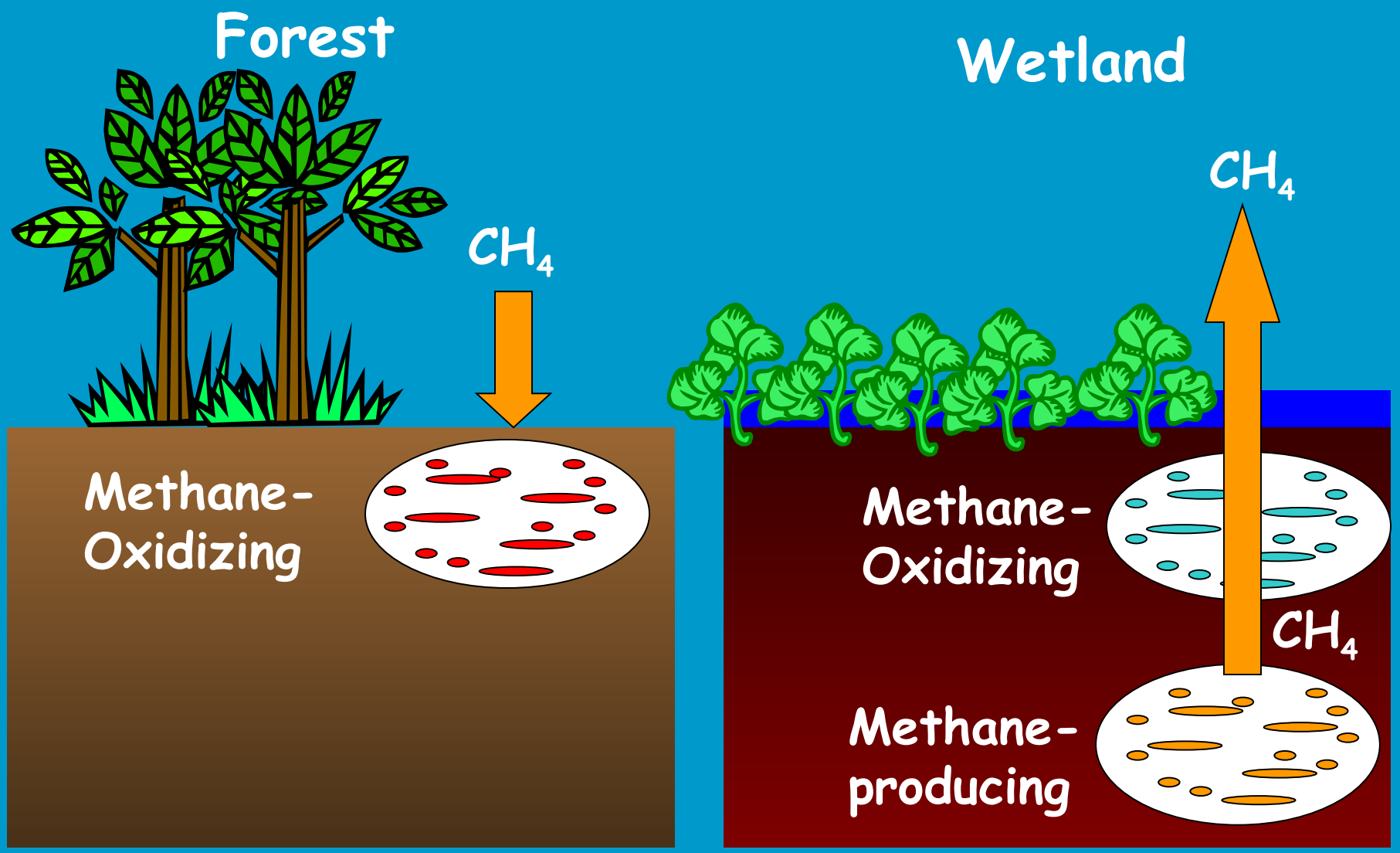
Characteristics of Methane





- 250% increased after Industrial Revolution.
- Each molecule has 8x greater warming than CO_2.
- Anaerobic Production.

Methane producing procedure



Methane is produced under anaerobic condition. However,

Keppler et al. 2006 Nature

Vol 439|12 January 2006|doi:10.1038/nature04420 nature

LETTERS

Methane emissions from terrestrial plants under aerobic conditions

Frank Keppler[1], John T. G. Hamilton[2], Marc Braß[1,3] & Thomas Röckmann[1,3]

Methane is an important greenhouse gas and its atmospheric concentration has almost tripled since pre-industrial times[1,2]. It plays a central role in atmospheric oxidation chemistry and affects stratospheric ozone and water vapour levels. Most of the methane from natural sources in Earth's atmosphere is thought to originate from biological processes in anoxic environments[3]. Here we

(dry weight) h^{-1} at 30 °C (see Supplementary Table S1). Release of CH_4 was very temperature sensitive—concentrations approximately doubled with every 10 °C increase over the range 30–70 °C (Fig. 1a), suggesting a non-enzymic rather than an enzyme-mediated process. $\delta^{13}C$ of the emitted CH_4 ranged from −51.8‰ to −68.4‰ (mean = −58.2‰, n = 61) and −46.9‰ to −53.1

Plants emit methane under aerobic condition !

- Methane emission strongly depends on light and temperature.

"new forestation might create methane source."
-Lowe 2006 nature-

Questions

- Does methane really emit from the dominant deciduous trees in cool temperate forest?

  If so, how much methane do emit ?

- Do methane emission rates increase under elevated CO_2 ?

Material & Method

Material

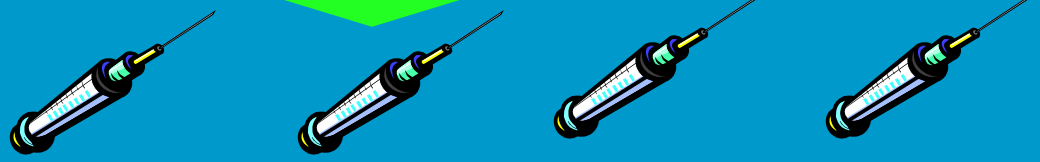
· Japanese larch (*L. Kaempferi*), monarch birch (*B. maximowicziana*), oak (*Q. mongolica*).

· Grown under 370 and 500 ppm CO_2. 3 replications in each species.

· Incubation experiment as followed *Ishizuka and Takahashi (2006)*,

PPFD: 350 μmol $\cdot m^{-2}s^{-1}$

Temperature: 35 °C

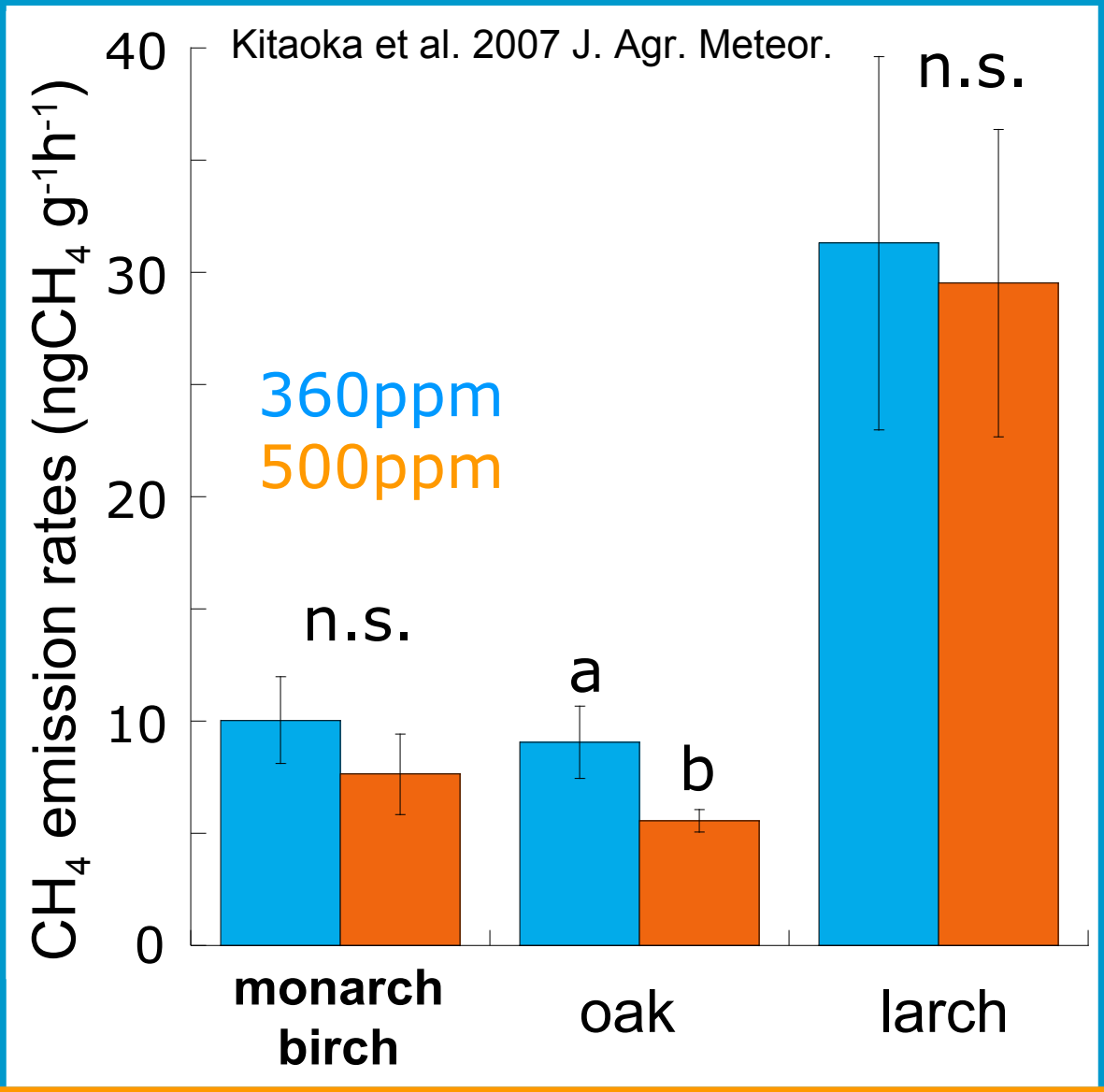


0h 24h 48h 72h

24h sampling interval

Analyzed by gas chromatic graph (Shimadzu GC-14C)

Mean methane emission rates after 72 hour incubations



- Larch showed 2 to 3 times higher methane emission rates.
- Oak showed lower methane emission rates at 500 ppm.

Comparison of methane emission rates of tree species from warm and cool temperate forests

Kitaoka et al. 2007 J. Agr. Meteor.

	Methane emission rates ($ngCH_4\ g^{-1}h^{-1}$)
Japanese larch	31.3
Japanese ceder[2)]	39.1
Japanese oak	9.1
Japanese white oak[2)]	22.6
European beech[1)]	21.6
monarch birch	10.0
European ash[1)]	9.1

1) Keppler et al. 2006
2) Ishizuka & Takahashi 2006

Comparison of total methane emission estimates from the terrestrial plant community

Kitaoka et al. 2007 J. Agr. Meteor.

	Total methane emission ($TgCh_4y^{-1}$)
Keppler et al. (2006)	62-150
Megonigal (2006)	27-43
Kirschbaum et al. (2006)	10-62
Guenther (2006)	34-56
	Methane absorption of soil ($TgCh_4y^{-1}$)
IPCC (2007)	30

We need further methane flux study about terrestrial plant community.

Conclusion

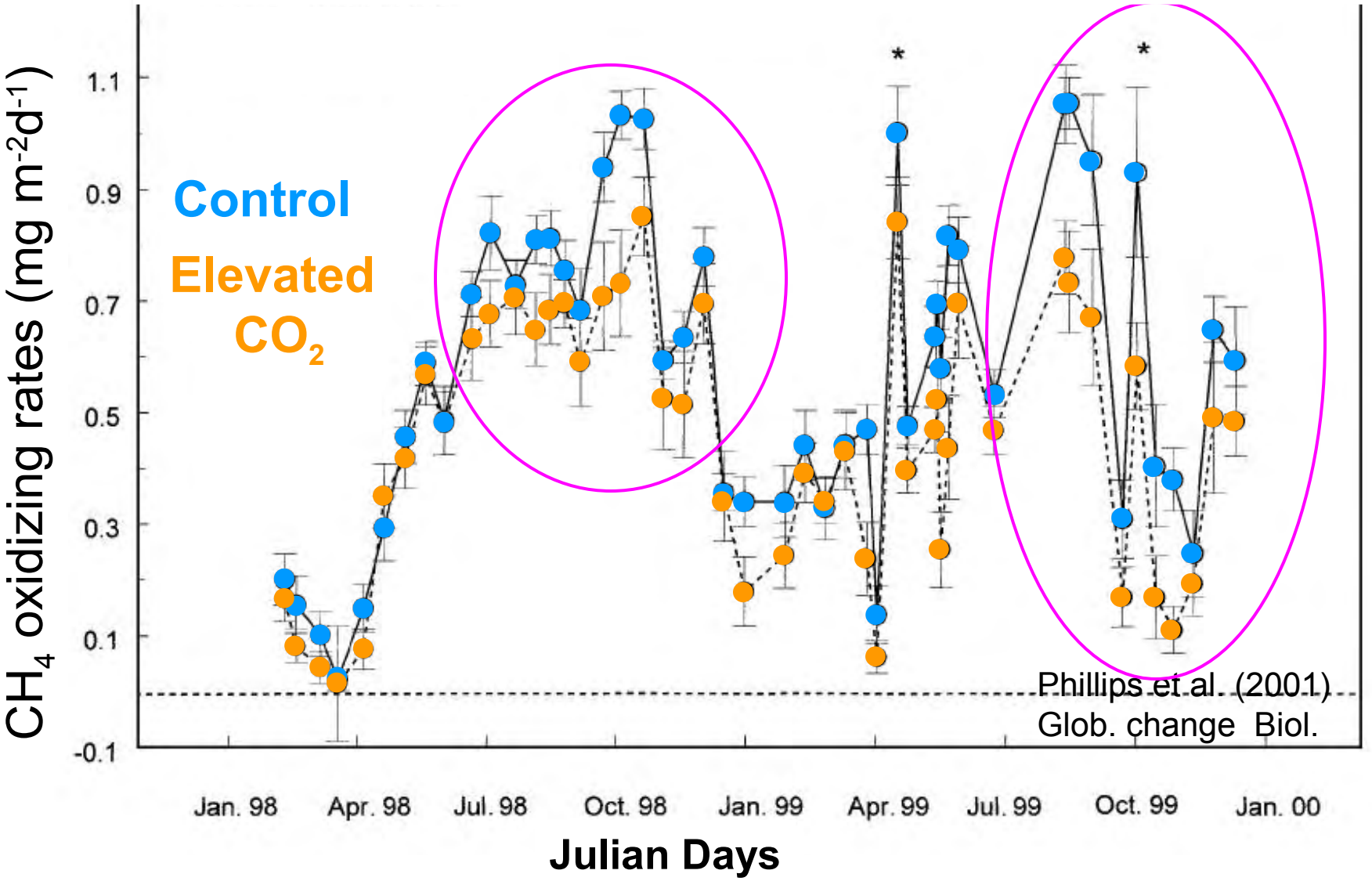
- Methane were emitted leaves of three dominant deciduous trees at cool temperate forest in Japan.
  - Specific variation of methane emission was observed;

    Larch produced highest methane, while oak and monarch birch showed similar value.

    No significant increment at elevated CO_2 was observed.

We need further methane flux study about terrestrial plant community.

Seasonal changes of CH_4 oxidizing rates under elevated CO_2



CH_4 oxidizing rates decreased under elevated CO_2 !

Methane flux studies in FACE are necessary for evaluation of accurate methane flux under changing environment.