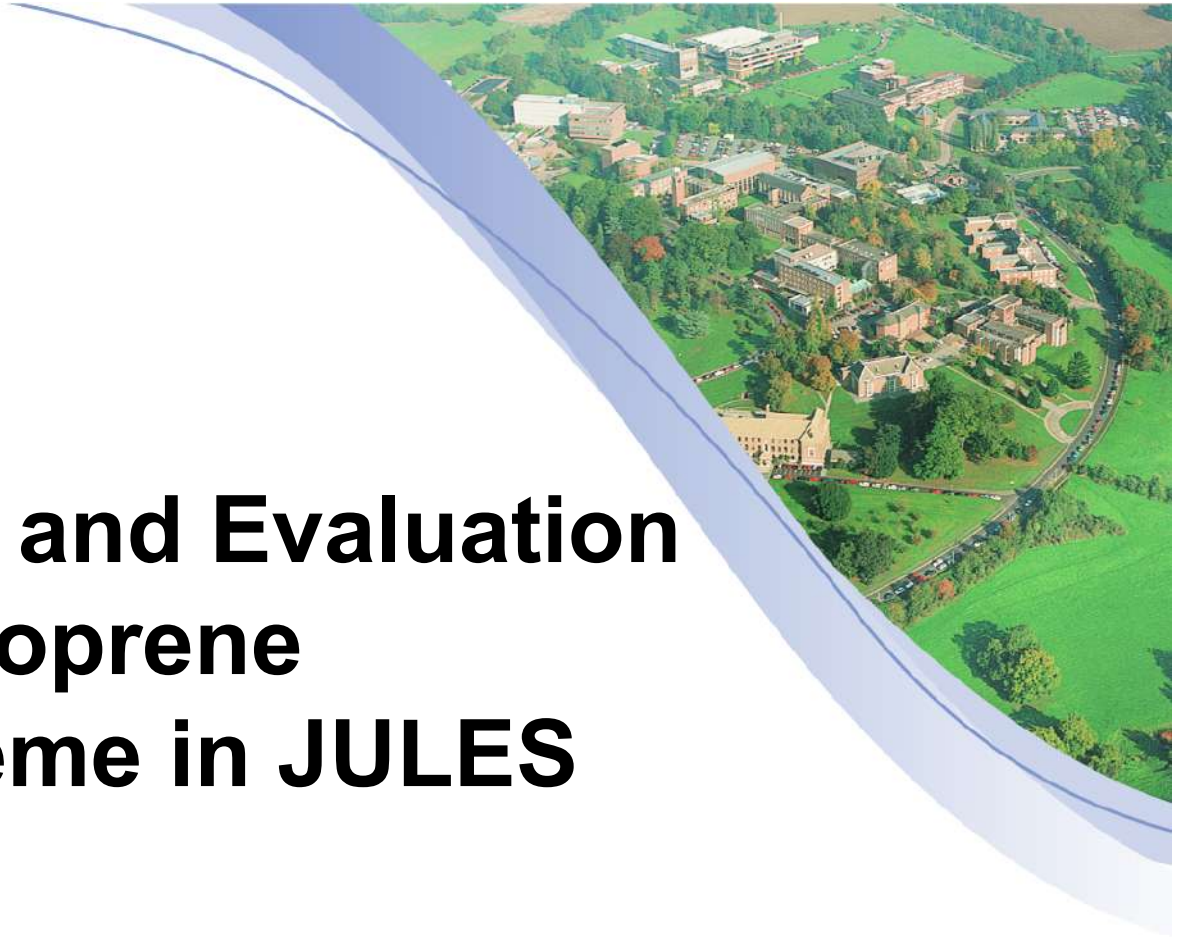

Implementation and Evaluation of a Biogenic Isoprene Emissions scheme in JULES

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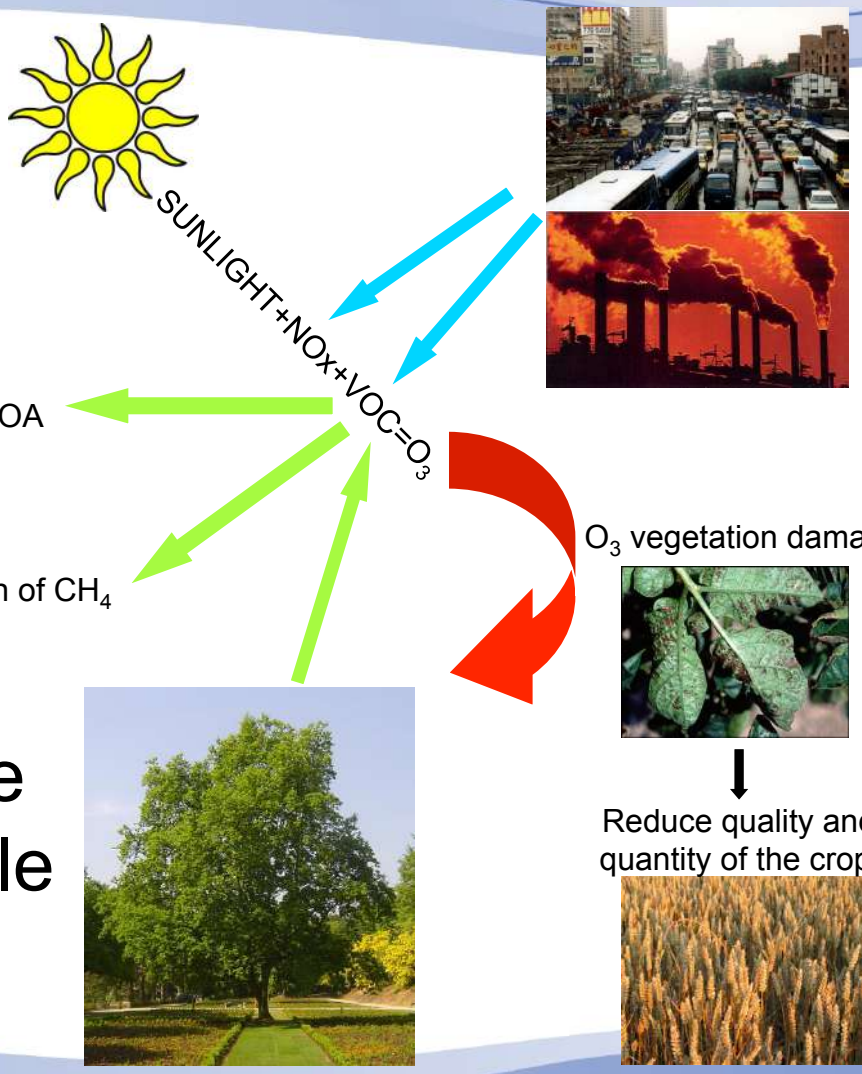
Subject of Study



BVOCs

Vegetation emits a wide range of Biogenic Volatile Organic Compounds

Model Description

Pacifico et al., 2011 ACP

This model is based on Arneth et al., 2007 and Niinemets et al., 1999

$$I = IEF \frac{A_{canopy} + R_{Dcanopy}}{A_{st} + R_{D_{st}}} f_T \cdot f_{CO_2}$$

I Above-canopy isoprene emission

IEF Isoprene Emission Factor, i.e. basal isoprene emission at the leaf level in standard conditions. This factor is Plant Functional Type-dependent in JULES.

A_{canopy} Net photosynthesis rate at the canopy level

$R_{Dcanopy}$ Respiration rate at the canopy level

f_T This empirical factor takes into account the fact that although isoprene is produced in the chloroplast from precursors formed during photosynthesis, there are differences in the short-term response of carbon assimilation and isoprene emission, such as the higher temperature optimum of isoprene synthase.

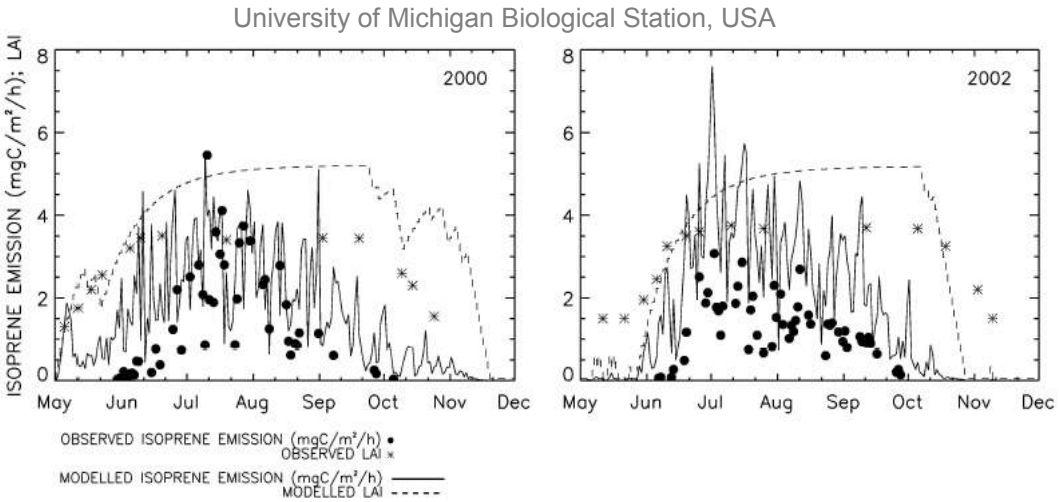
f_{CO2} This empirical factor models the inhibition of isoprene emission with increasing atmospheric CO_2 concentration, and vice versa the increase of isoprene emissions with decreasing atmospheric CO_2 concentration. It is relevant for past and future estimates of isoprene emissions.

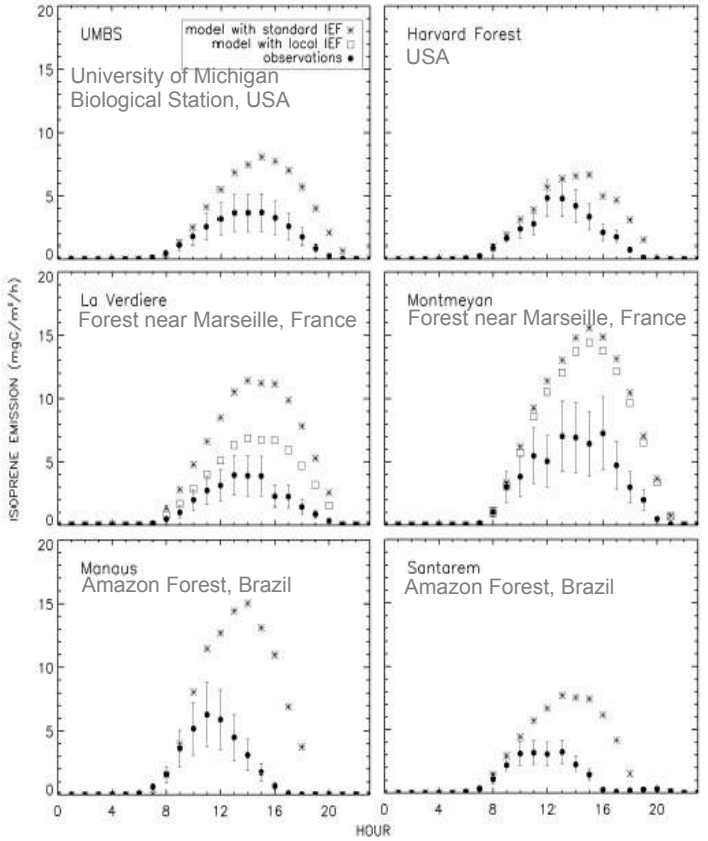
-st indicates standard conditions, i.e. temperature T_{st} of 30°C, photosynthetically active radiation of 1000µmol/m^2/s and CO_2 atmospheric concentration of 370 ppm.

Model Evaluation

Pacifico et al., 2011 ACP

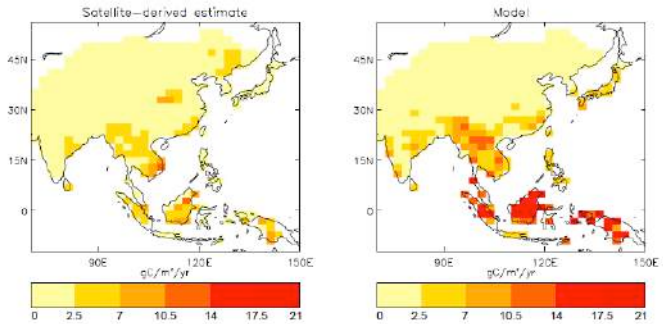
Diurnal and Seasonal Variability at the above-canopy isoprene flux measurement sites.



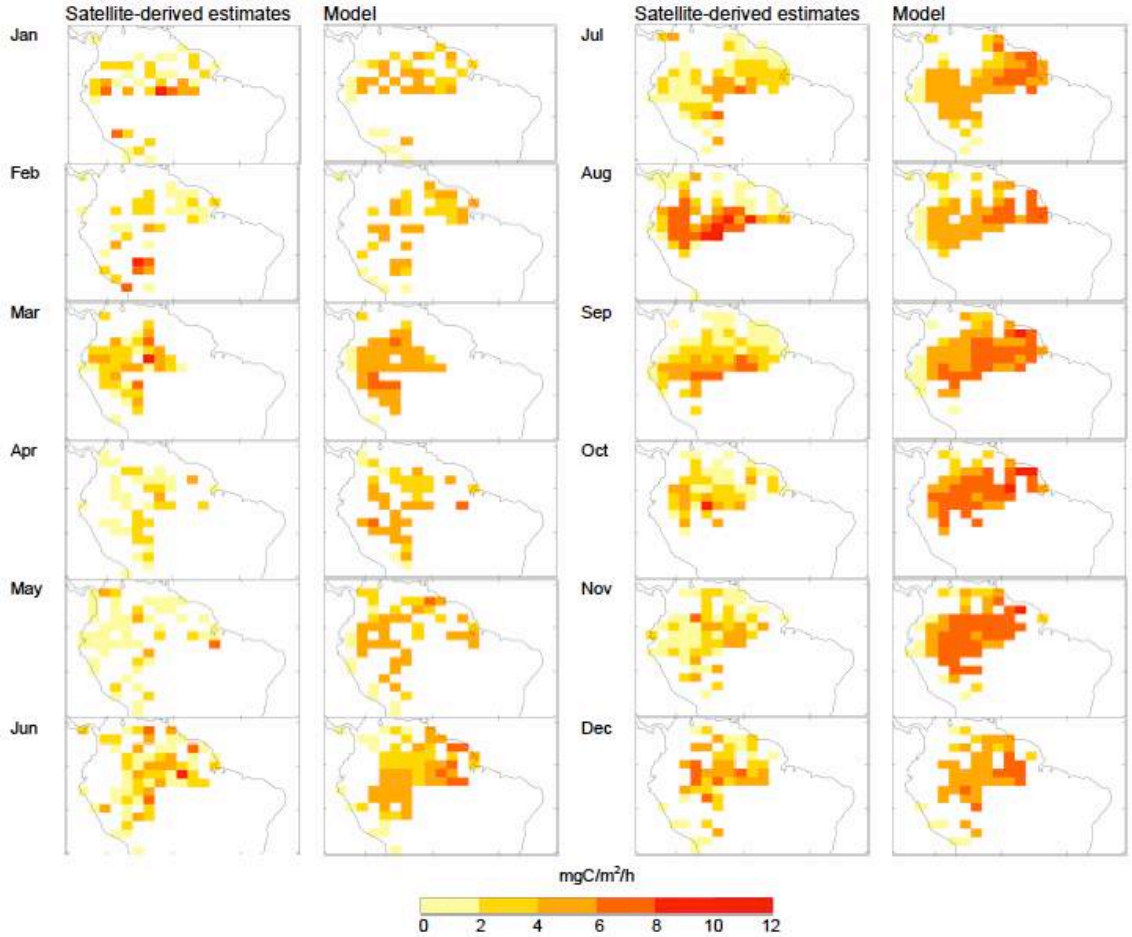


Model Evaluation

Pacifico et al., 2011 ACP



Comparison with satellite-derived isoprene estimates over south America and east and south Asia



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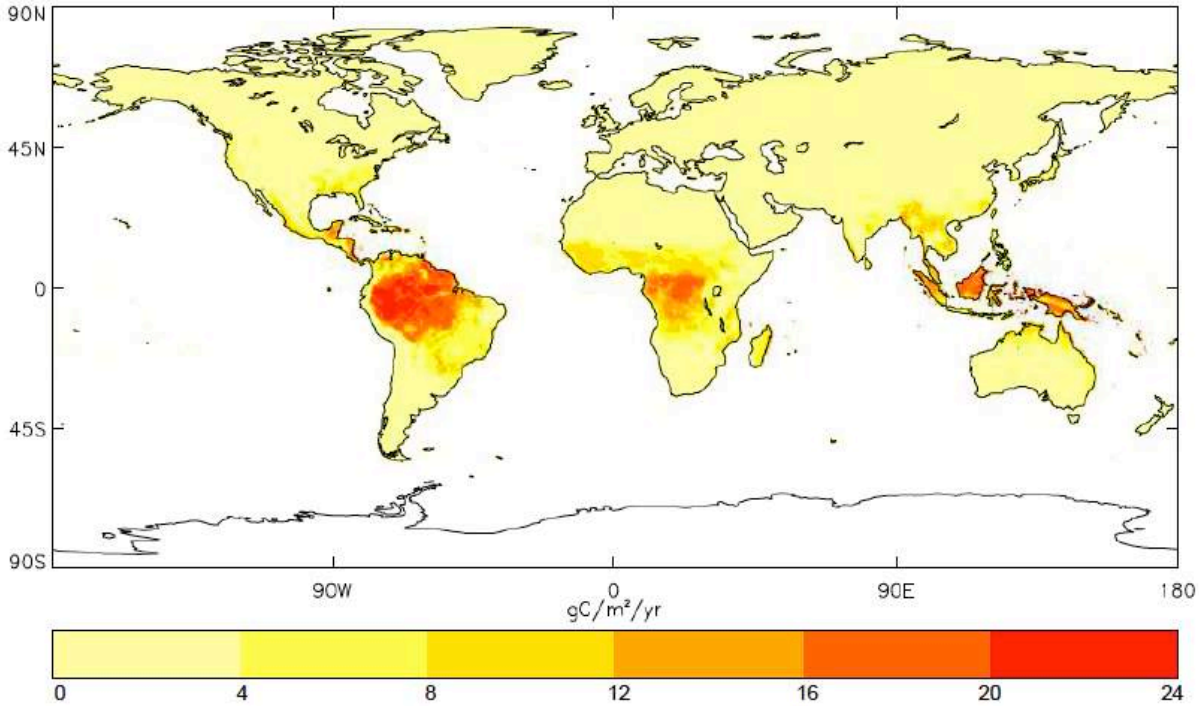
Model Applications

Pacifico et al., 2011 ACP

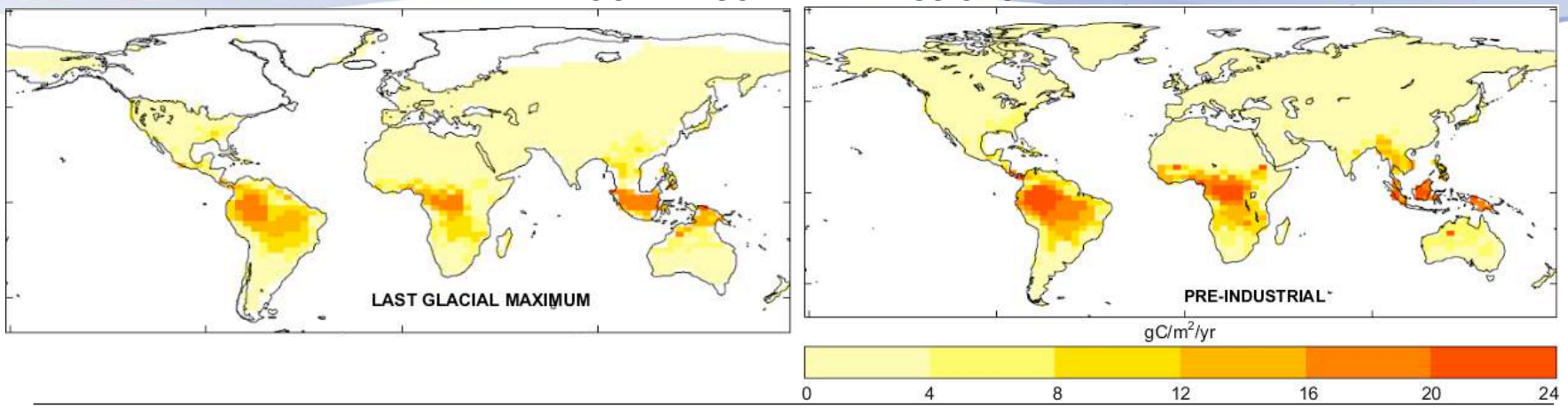
Present-day (1990s) global isoprene emissions with JULES: 535 TgC/yr.

Published estimates: 400-600 TgC/yr (Arneth et al., 2008 ACP).



Model Applications

BIOGENIC ISOPRENE EMISSIONS



Isoprene Emission at LGM (TgC/yr)	Isoprene Emission at PI (TgC/yr)	Decrease in Isoprene Emission at the LGM compared with PI (%)	Impact on CH_4 (ppb)	Isoprene Emission Model	References
343	502	-32%	n.a.	Guenther et al., 1995	Adams et al., 2001
331	702	-53%	n.a.	Guenther et al., 1995	Lathière et al., 2005
229	594	-61%	-238	Guenther et al., 1995	Valdes et al., 2005
335	541	-38%	-385	Guenther et al., 1995	Kaplan et al., 2006
357	447 (early 20th century)	-20%	n.a.	Arneth et al., 2007b	Arneth et al., 2007
428	567	-24%	-108	Pacifico et al., 2011	This study

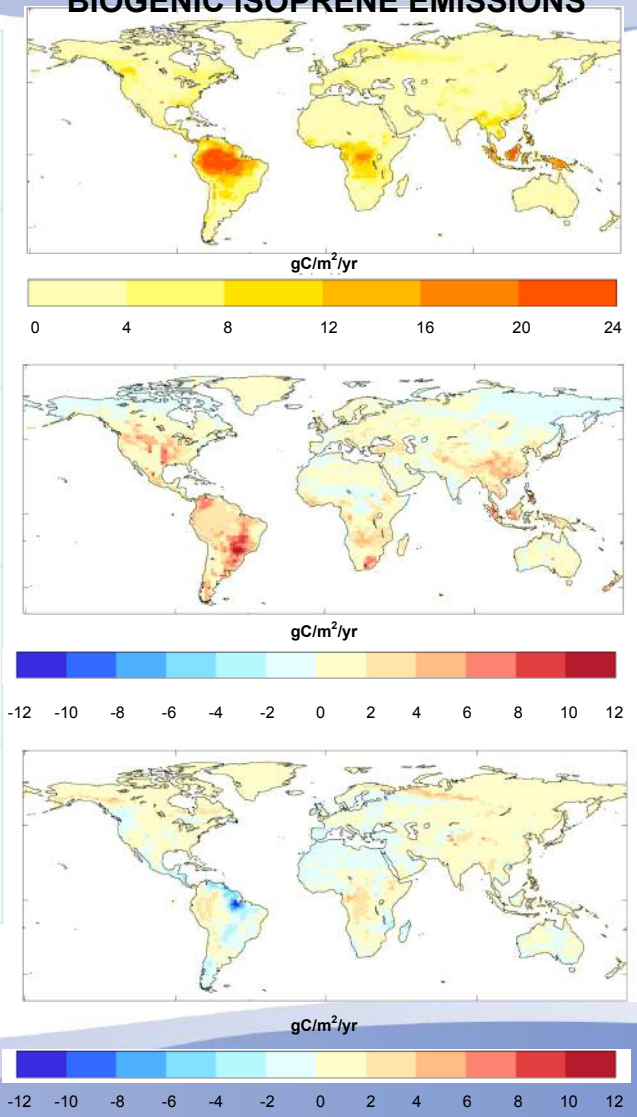
Federica Pacifico: Biogenic Isoprene Emissions in JULES

Model Applications

Pacifico et al., 2012 JGR

	Isoprene Emissions (TgC/yr)	GPP (PgC/yr)	CO_2 (ppm)	Air Temperature (°C)
Present-day 2000-2009	460	146	368	14.1
Pre-Industrial 1860-1869	579	119	286	13.4
Future (RCP 8.5) 2100-2109	456	239	936	18.8
Future (RCP 2.6) 2100-2109	461	162	421	15.4

BIOGENIC ISOPRENE EMISSIONS



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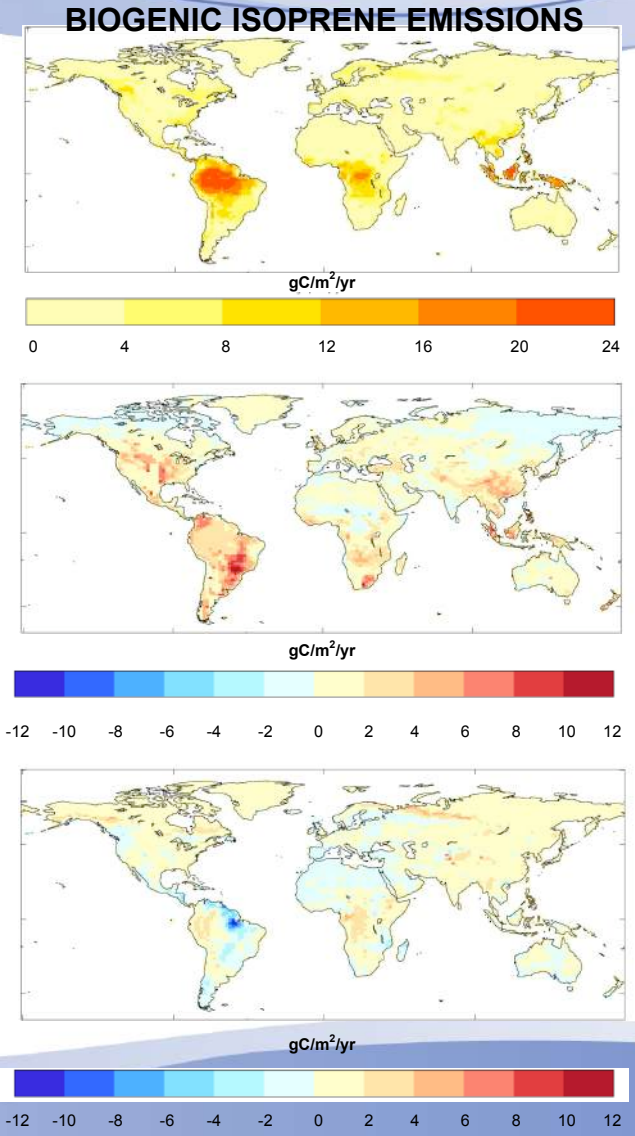
Model Applications

Pacifico et al., 2012 JGR

20% decrease in isoprene emissions	**Ozone burden**	**Methane Lifetime**
Under Pre-Industrial (1860-1869) conditions	+ 0.7 Tg + 0.2%	- 9 months - 80 ppb - 44 mW/m^2
Under Present-day (2000-2009) conditions	- 2 Tg - 2%	- 3 months - 59 ppb - 22 mW/m^2



Conclusions

- Scheme available to study Biogenic Isoprene Emissions at different locations/historical periods

- Modifying the Photosynthesis Scheme will affect the isoprene scheme, e.g. direct/diffuse radiation (can_rad_mod 5)

- Possible Improvements: phenology; make the isoprene scheme more process-based, less empirical; evaluation against newly available data

Thanks