

# Climate and carbon cycle dynamics in a CESM simulation from 850-2100 CE

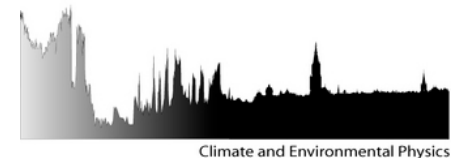
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Fortunat Joos, Christoph Raible, Juliette Mignot,  
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Climate and Environmental Physics, University of Bern, Switzerland

Oeschger Centre for Climate Change Research, University of Bern, Switzerland

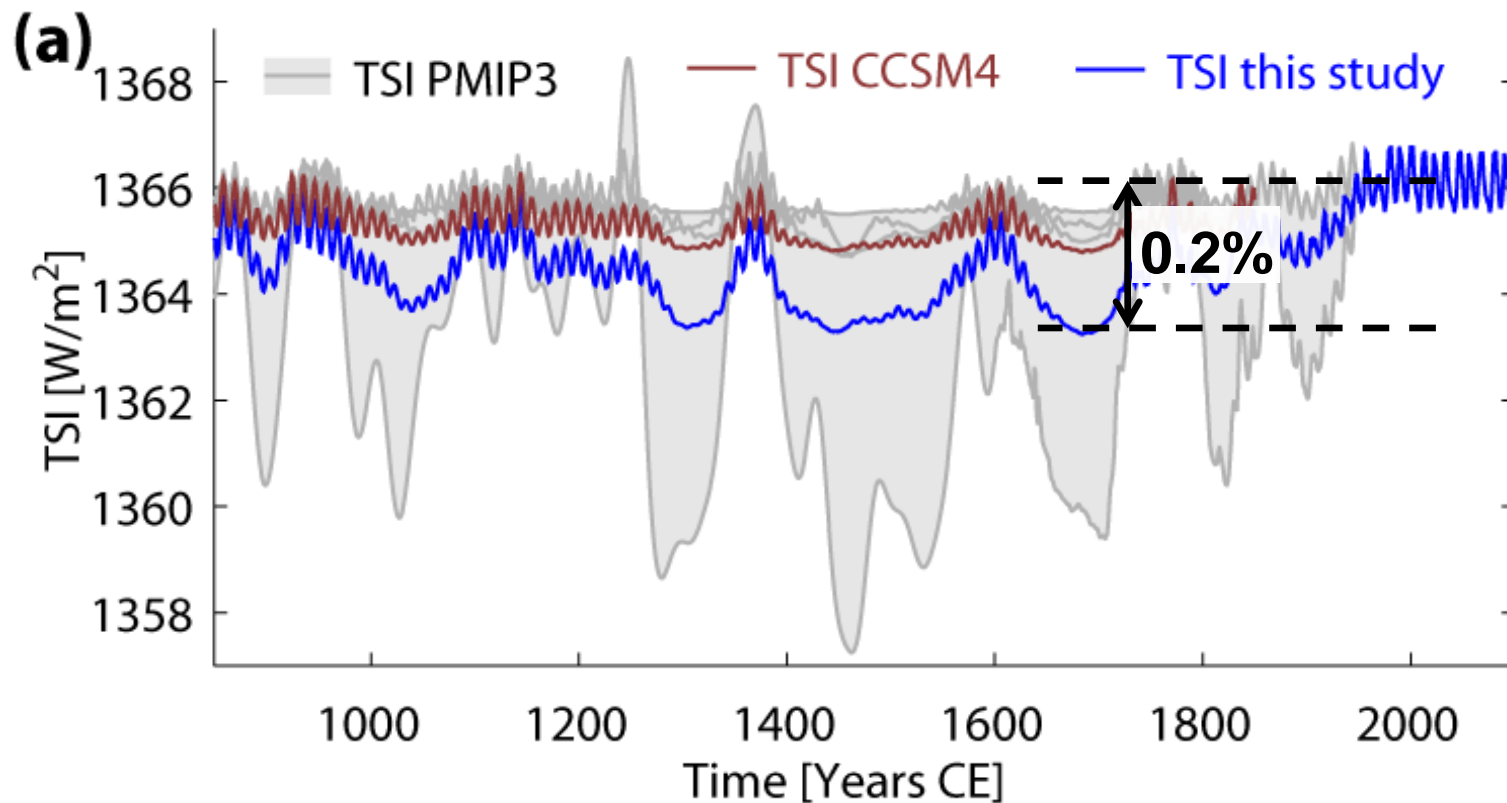


0. Experimental setup
1. Climate-carbon cycle sensitivity
2. Volcanic impact on carbon cycle

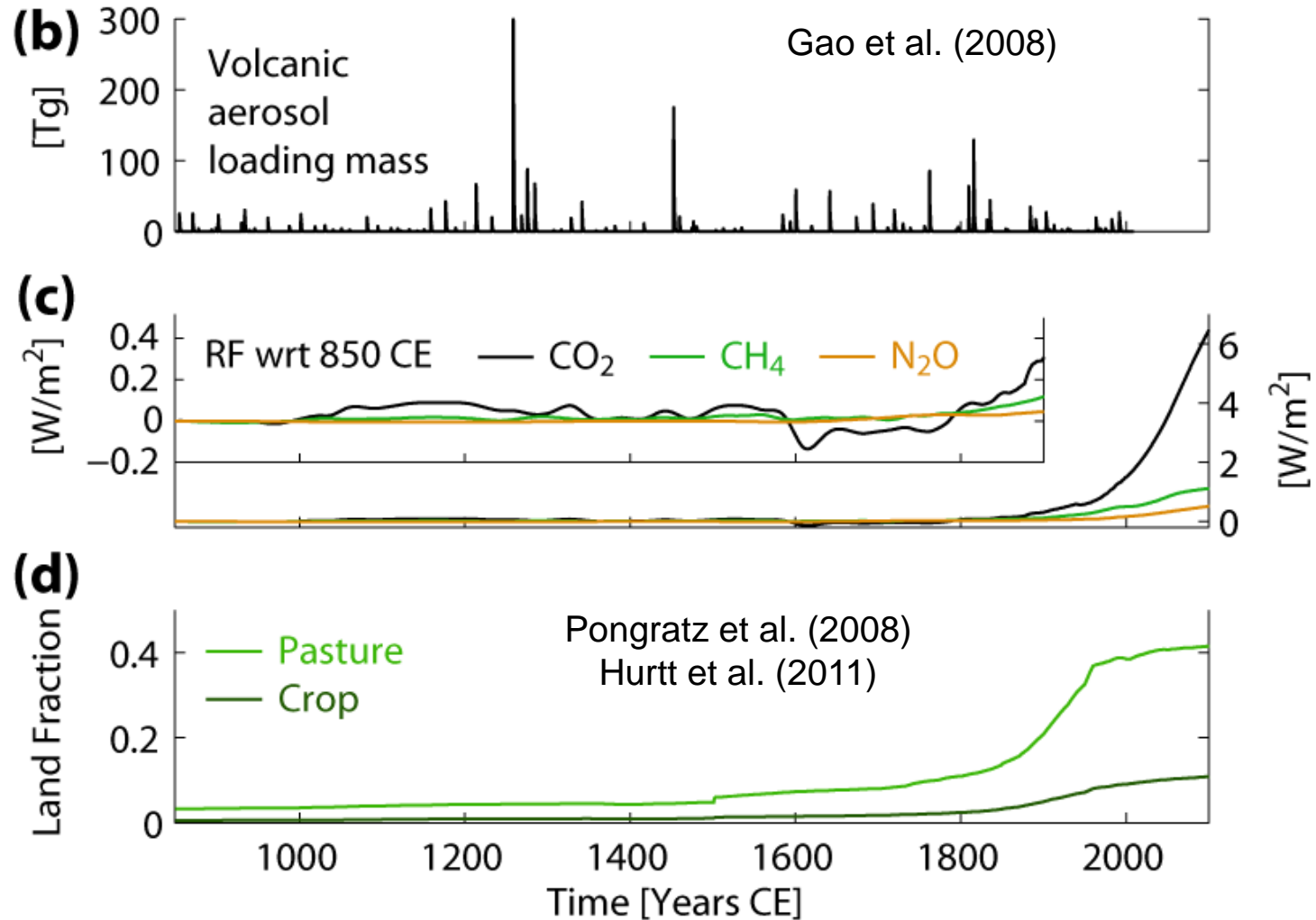
## CESM 1.0.1:

- CAM4, CLM4, CICE, POP2
- 0.9x1.25\_gx1v6 (~1°)
- BPRD: climate doesn't see progn. carbon cycle
- 500 year control 850, branched from piControl

# Experimental setup: solar forcing



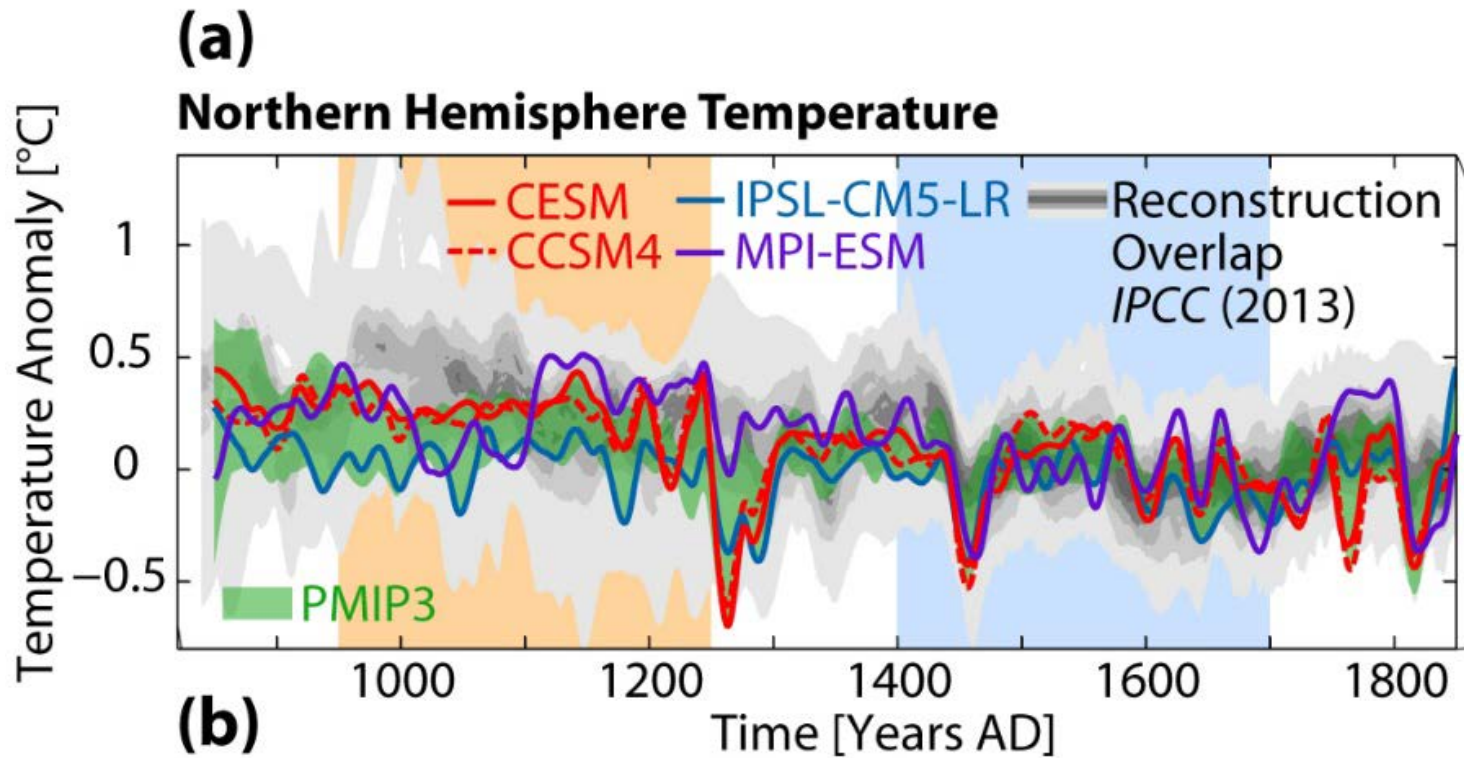
# Experimental setup: other forcing



- Lehner et al. (2015, ESD Disc.): Climate and carbon cycle dynamics in a CESM simulation from 850-2100 CE
- Keller et al. (2015, GRL): Detecting changes in marine responses to ENSO from 850 to 2100 C.E.: insights from the ocean carbon cycle
- Chikamoto et al. (in prep.): Delayed tropical Pacific biological productivity response to strong volcanic forcing
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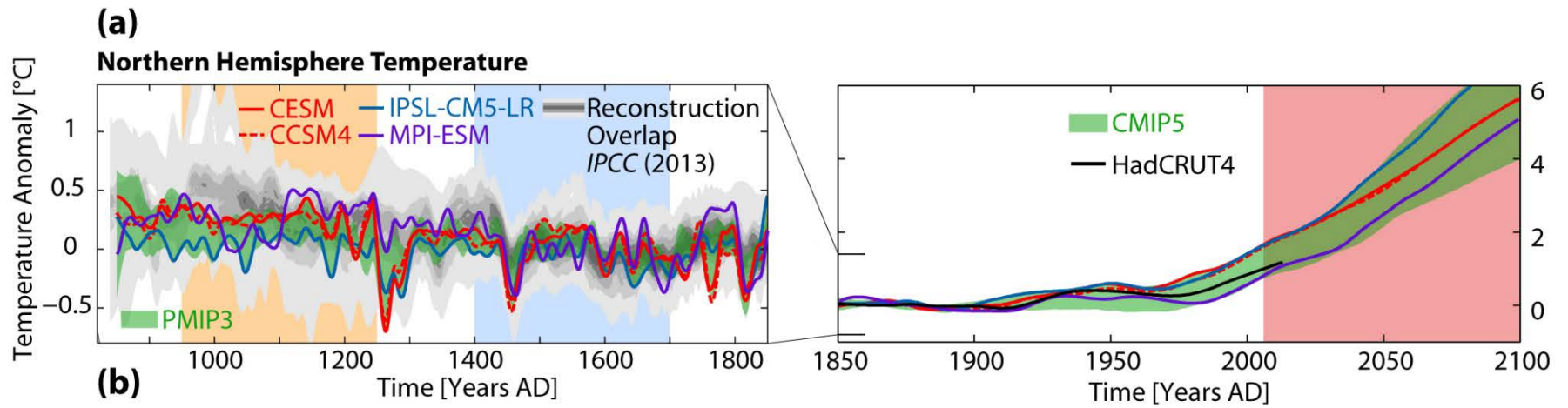
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# Temperature evolution

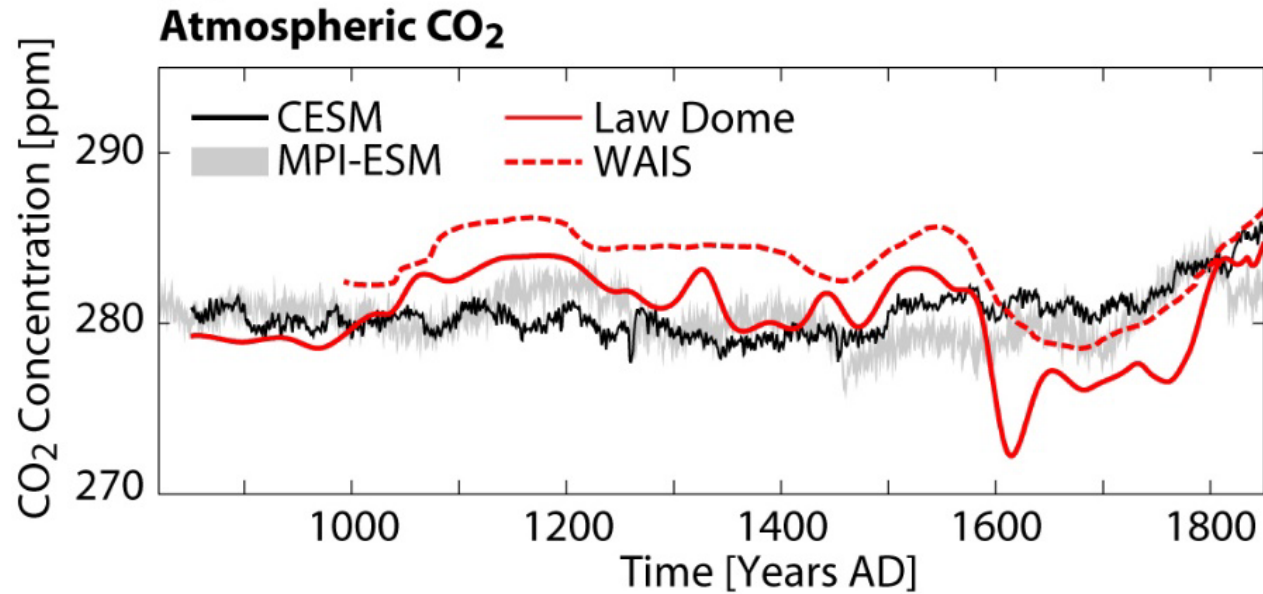




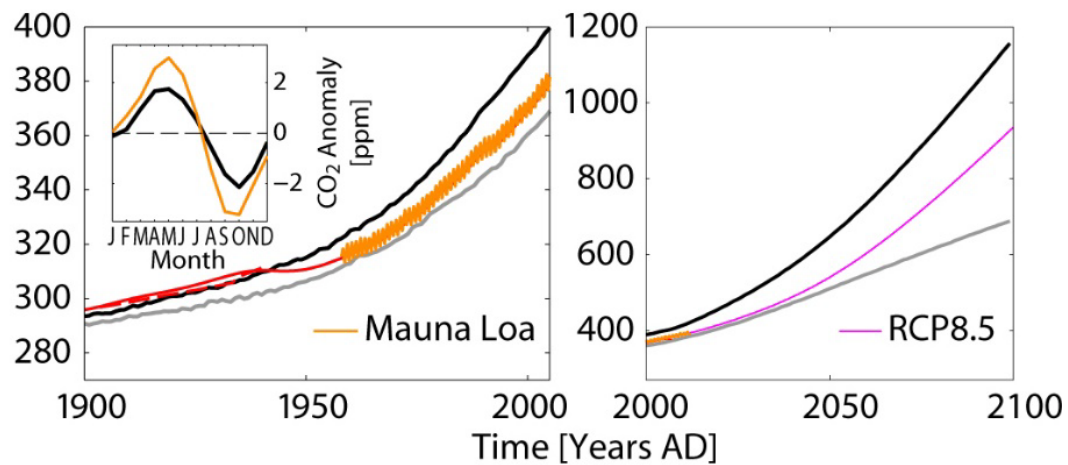
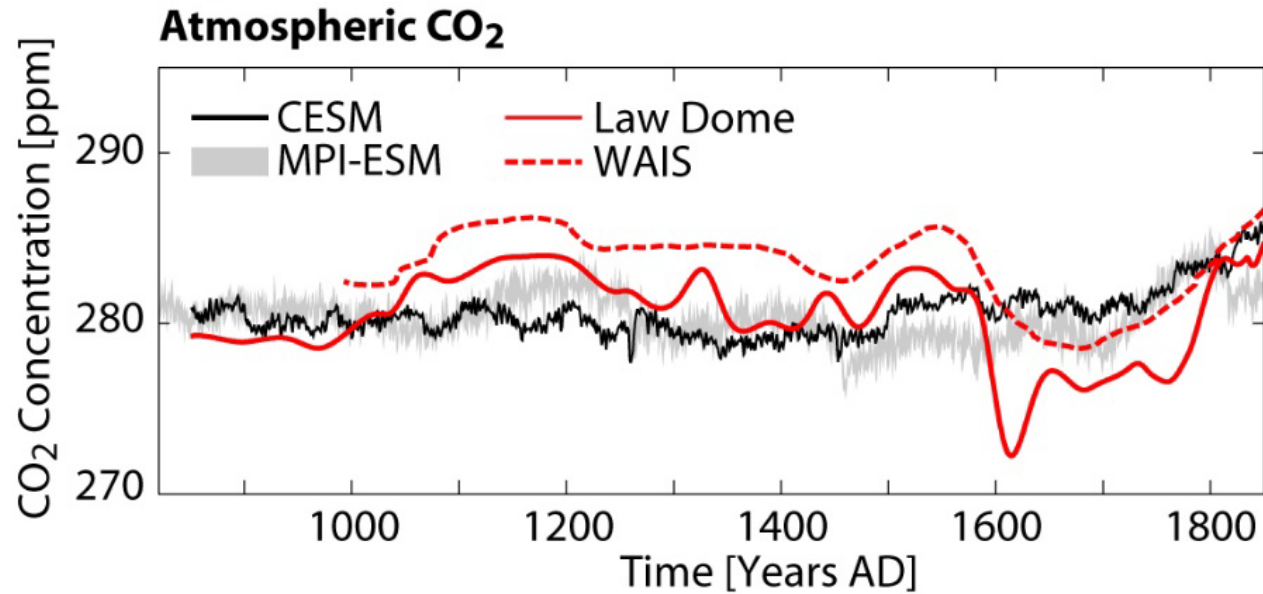
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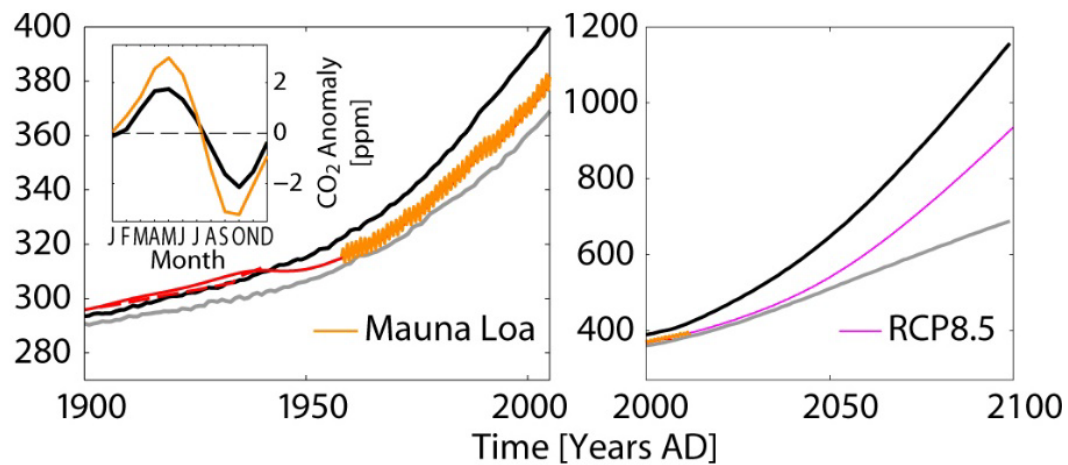
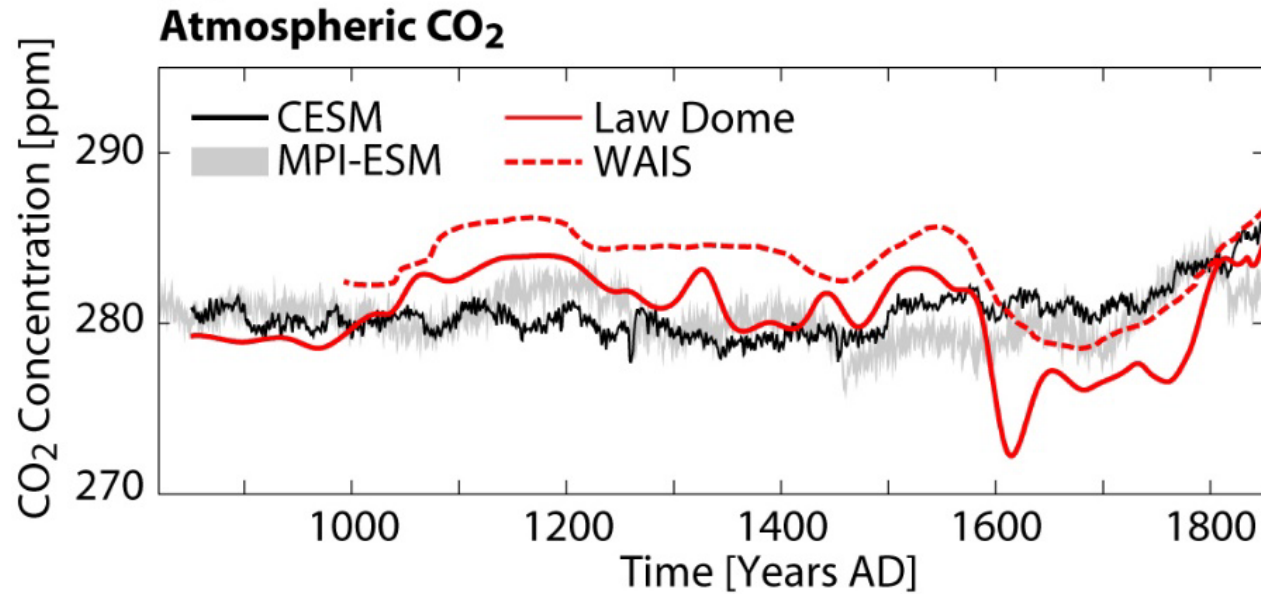
# Prognostic CO<sub>2</sub>



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Friedlingstein et al. (2014)

Long et al. (2013)

Lindsay et al. (2014)

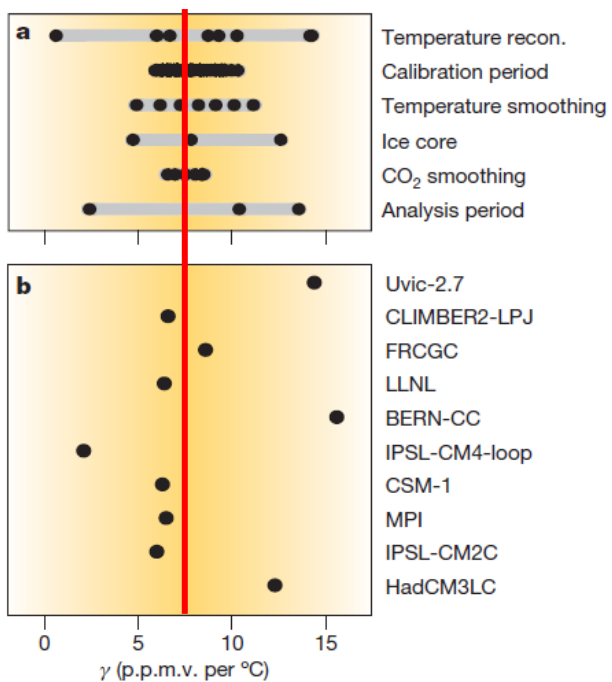
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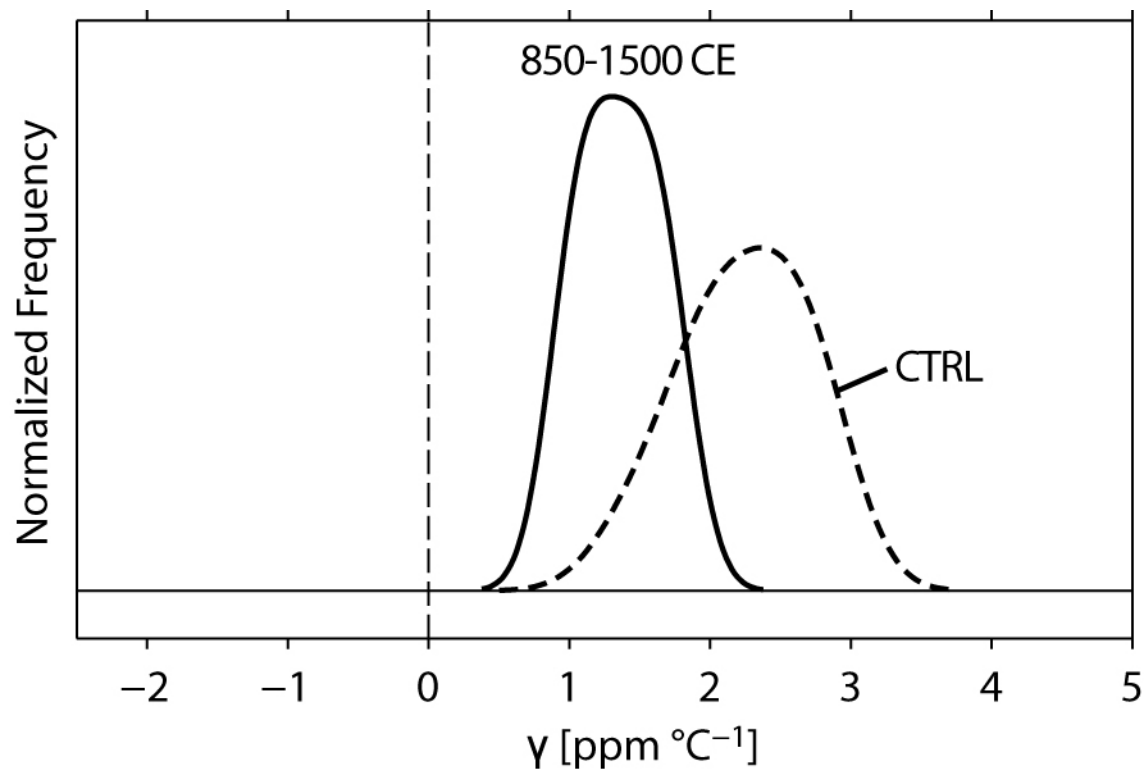
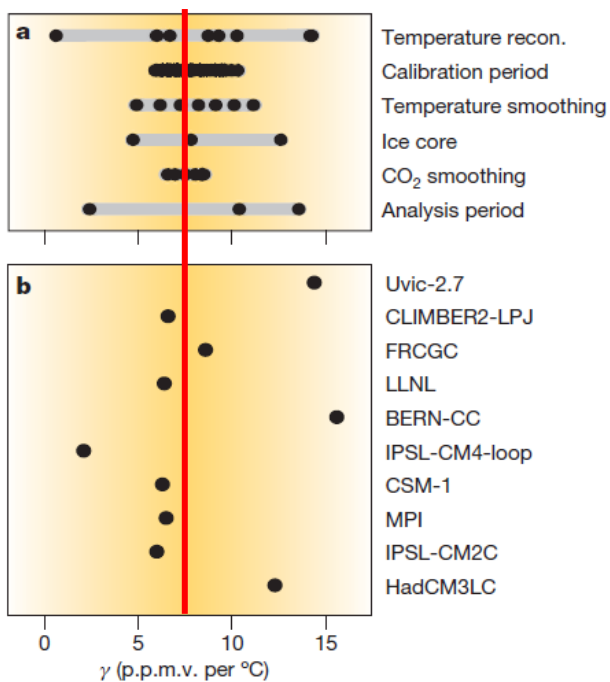
# Climate-carbon cycle sensitivity

Model	Carbon-climate feedback parameter $\gamma$ (Pg C °C <sup>-1</sup> )		
	$\gamma_A$ Atmosphere	$\gamma_L$ Land	$\gamma_O$ Ocean
MPI-ESM-LR	92.2	-83.2	-9.0
IPSL-CM5A-LR	64.8	-58.6	-6.2
BCC-CSM1	87.6	-77.8	-9.8
HadGEM2	40.1	-30.1	-10.0
UVic ESCM 2.9	85.8	-78.5	-7.3
CanESM2	79.7	-71.9	-7.8
NorESM-ME	21.4	-15.6	-5.7
CESM1-BGC	23.8	-21.3	-2.4
MIROC ES	100.7	-88.6	-12.1
Model mean (std dev)	66.2 (30.4)	-58.4 (28.5)	-7.8 (2.9)
C <sup>4</sup> MIP mean (std dev) (FEA)	109.6 (50.6)	-78.6 (45.8)	-30.9 (16.3)

# Climate-carbon cycle sensitivity

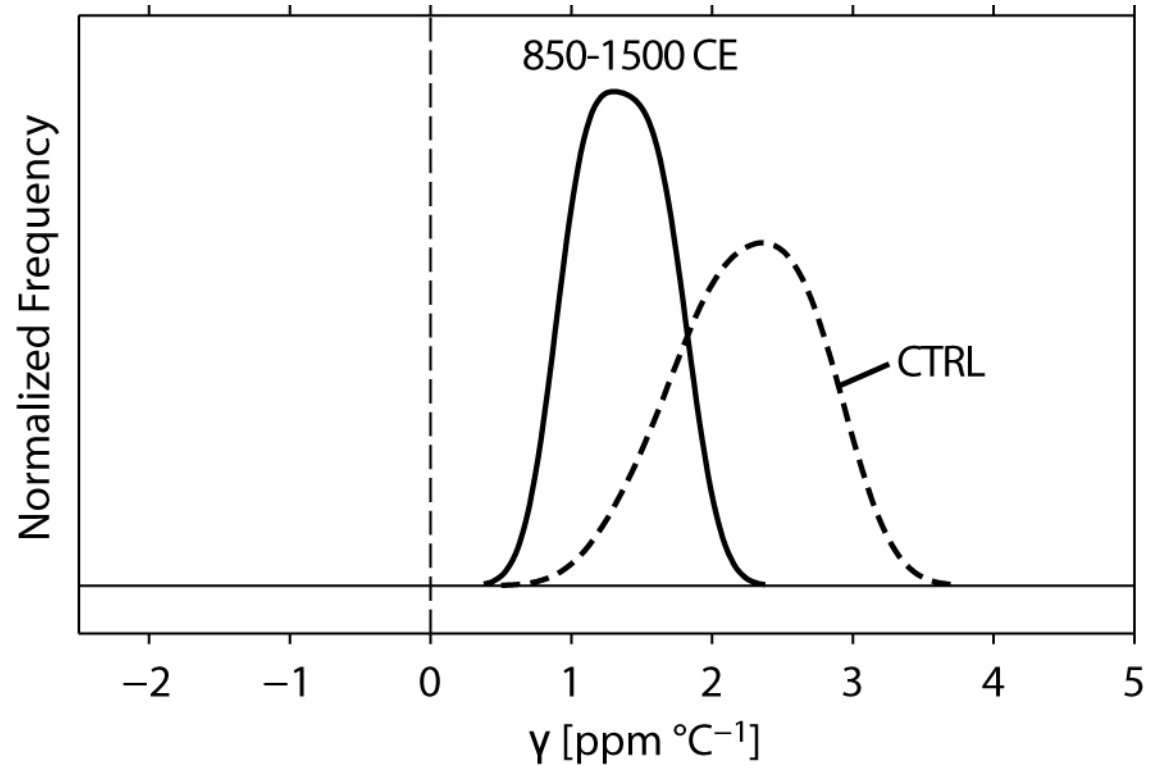
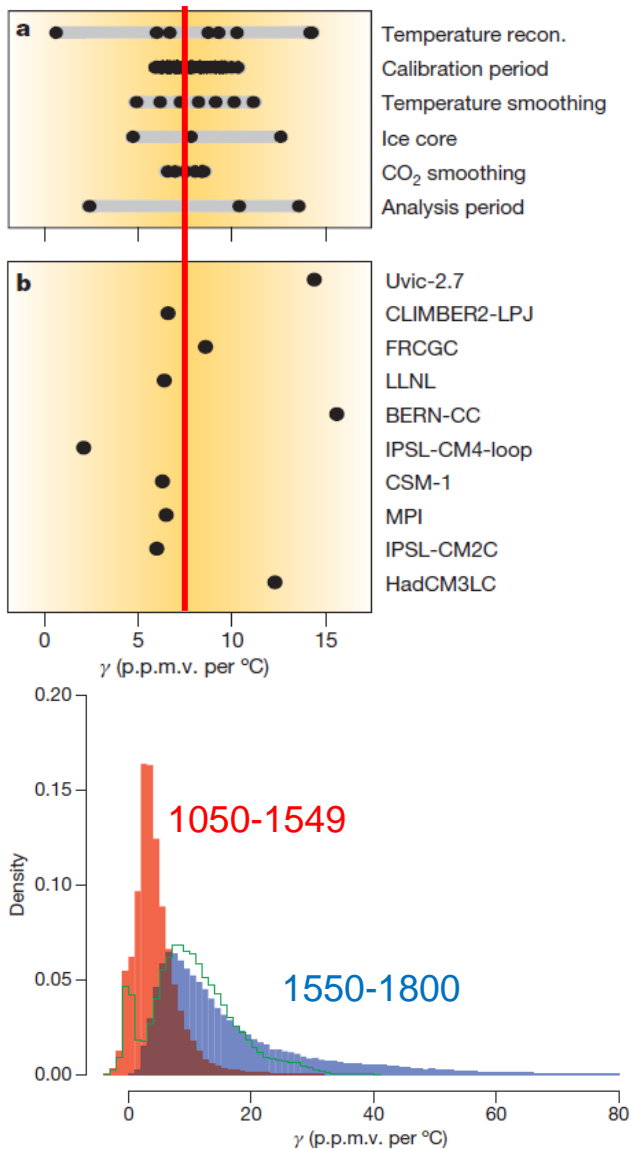


# Climate-carbon cycle sensitivity

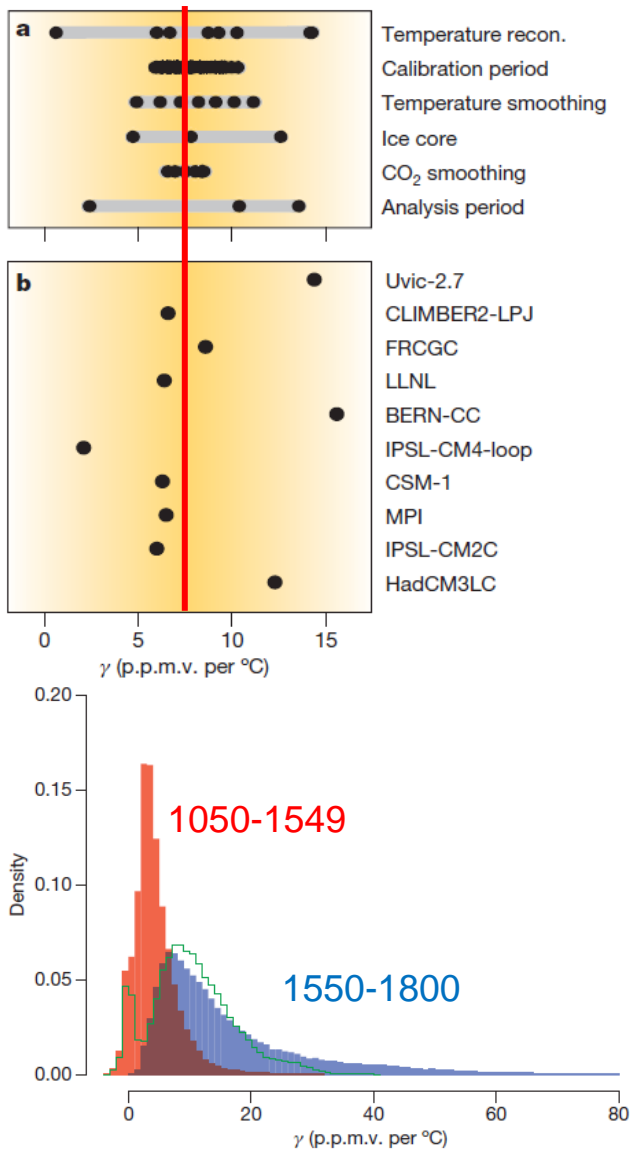




# Climate-carbon cycle sensitivity



# Climate-carbon cycle sensitivity



## 0. Experimental setup

## 1. Climate-carbon cycle sensitivity

- 1.3 ppm °C<sup>-1</sup>, but non-stationary
- Hard to constrain by paleo (data and simulations)

## 2. Volcanic impact on carbon cycle

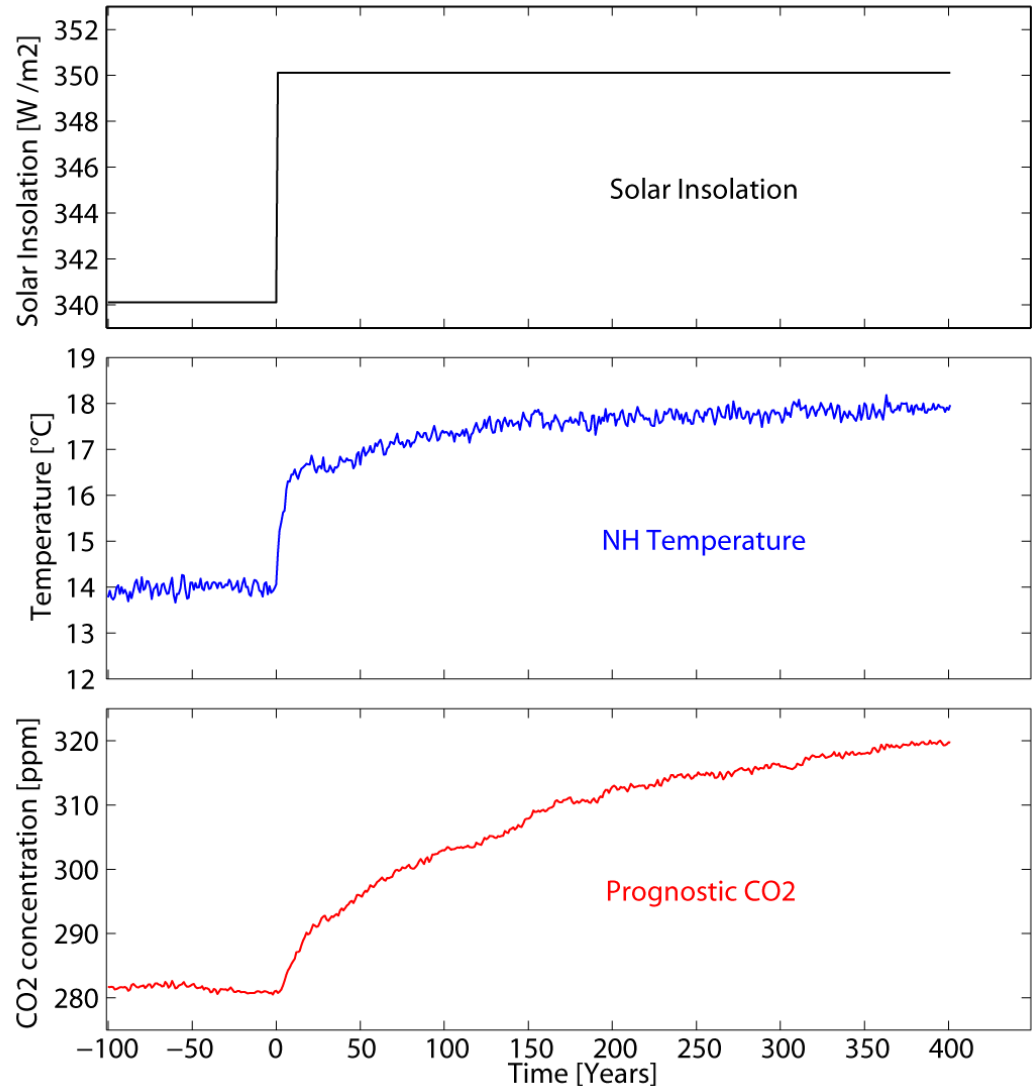
# Outline

0. Experimental set

1. Climate-carbon

- 1.3 ppm °C<sup>-1</sup>, but r
- Hard to constrain l

2. Volcanic impact



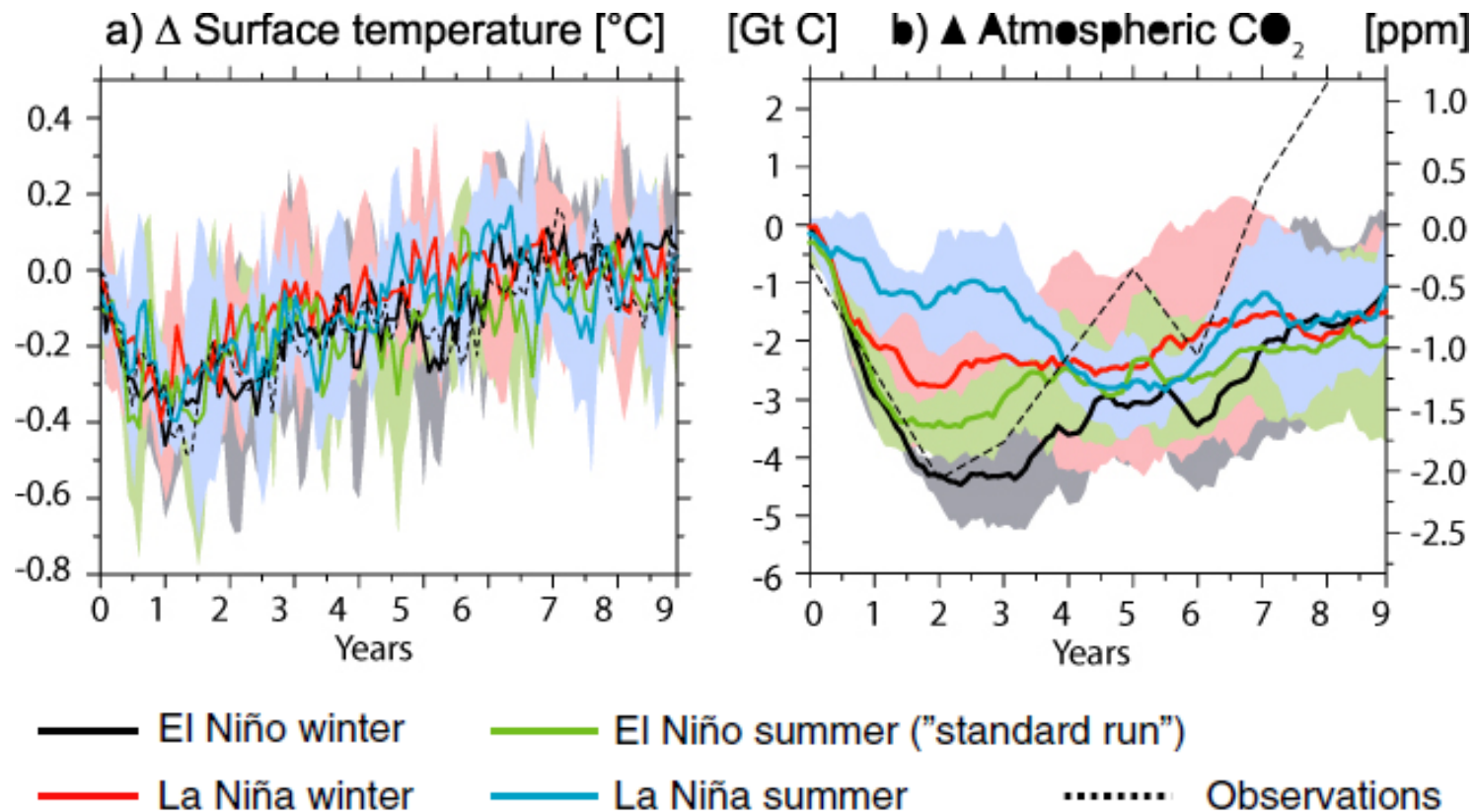
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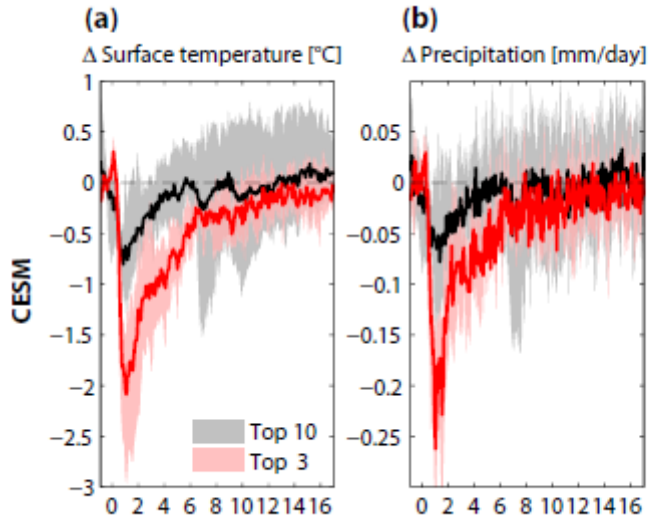
## 2. Volcanic impact on carbon cycle

# Volcanic impact on carbon cycle

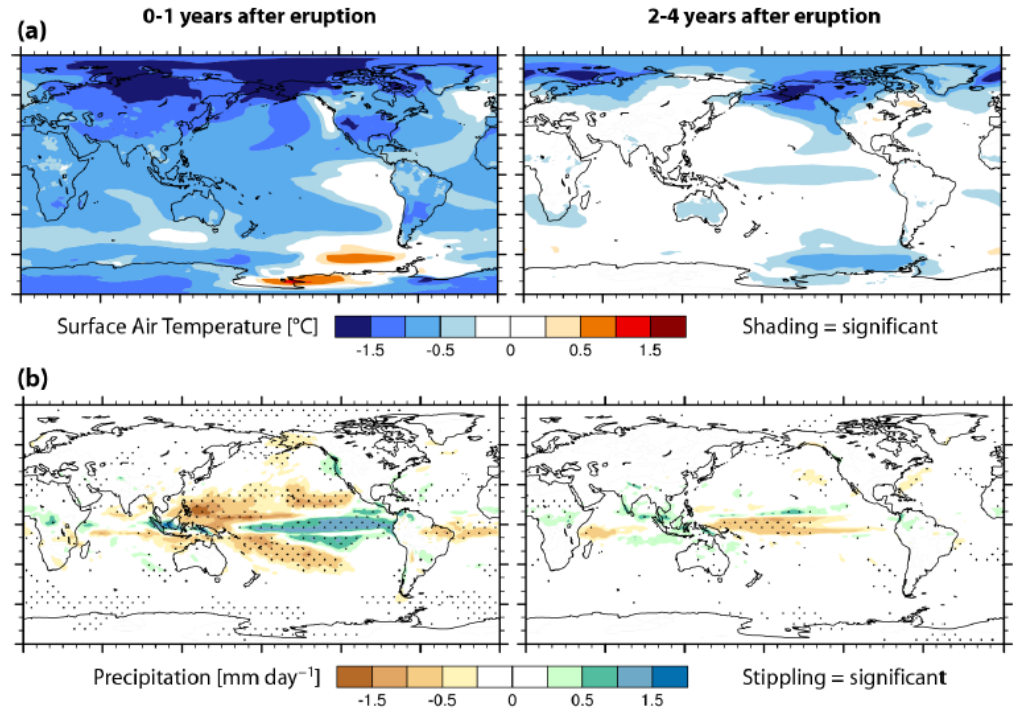
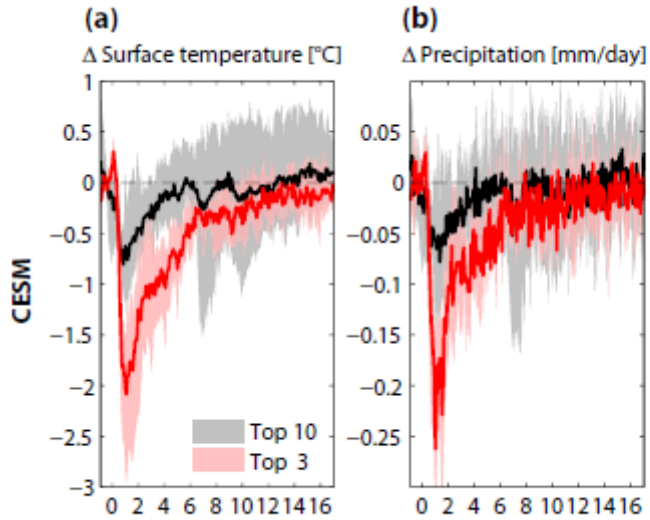


NCAR CSM1.4 carbon

# Volcanic impact on carbon cycle

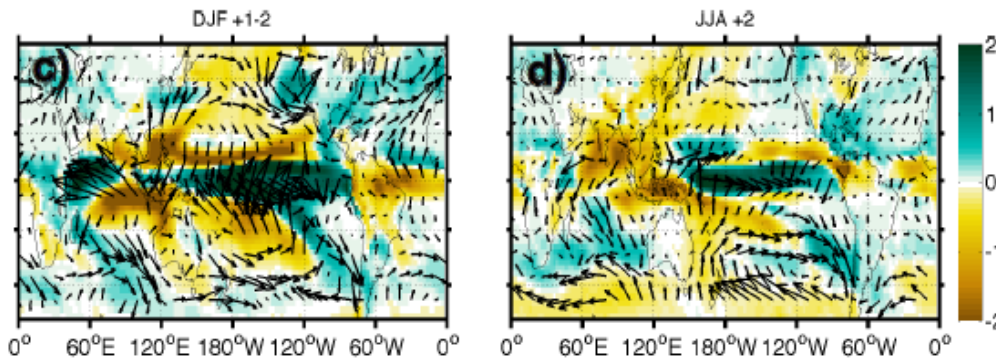
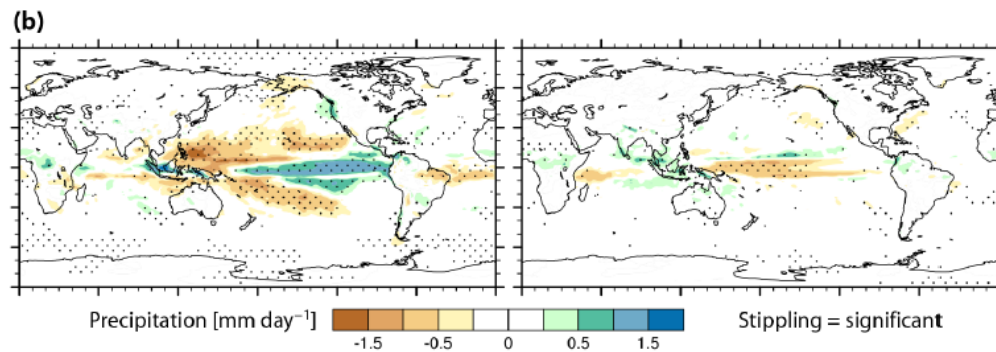
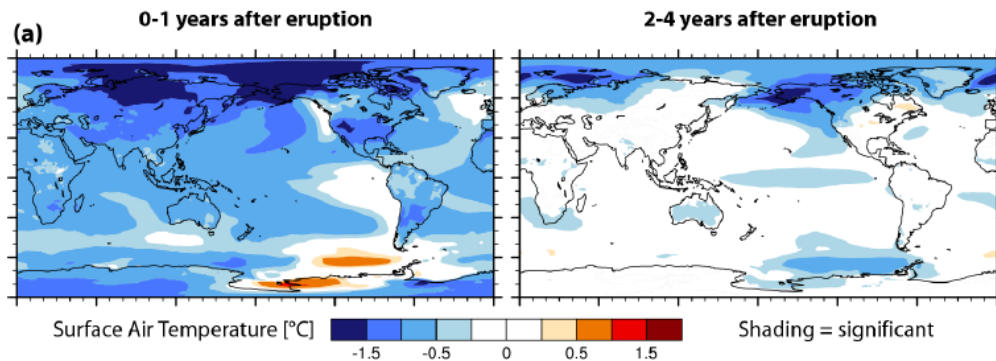
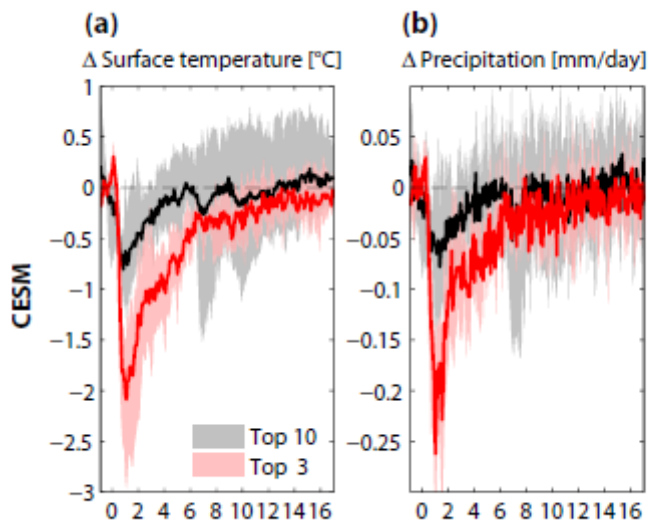


# Volcanic impact on carbon cycle

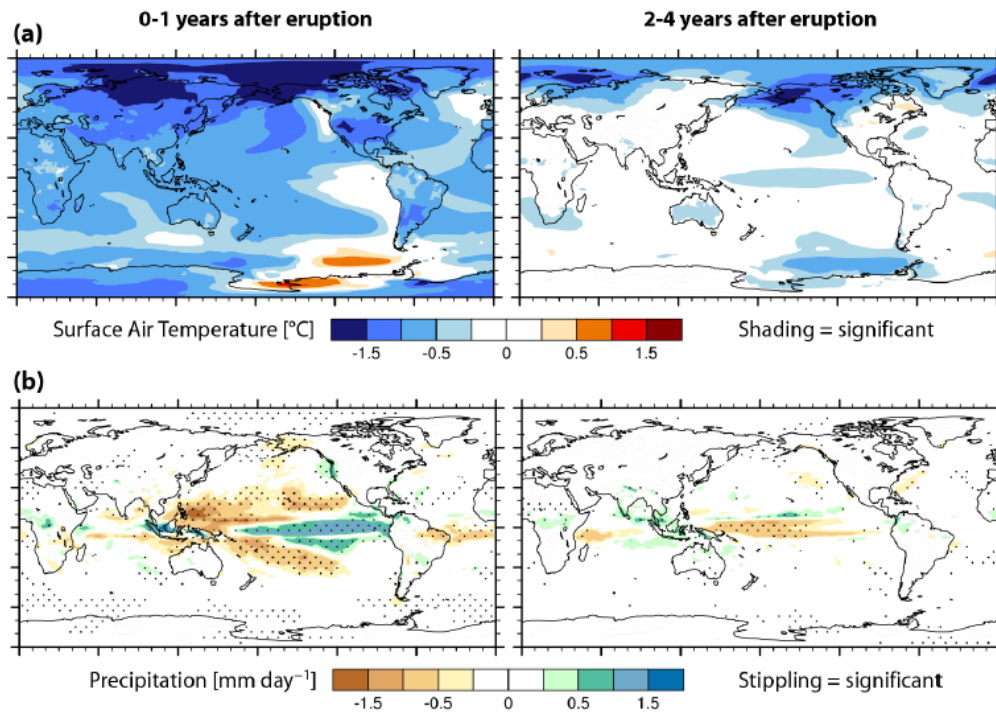
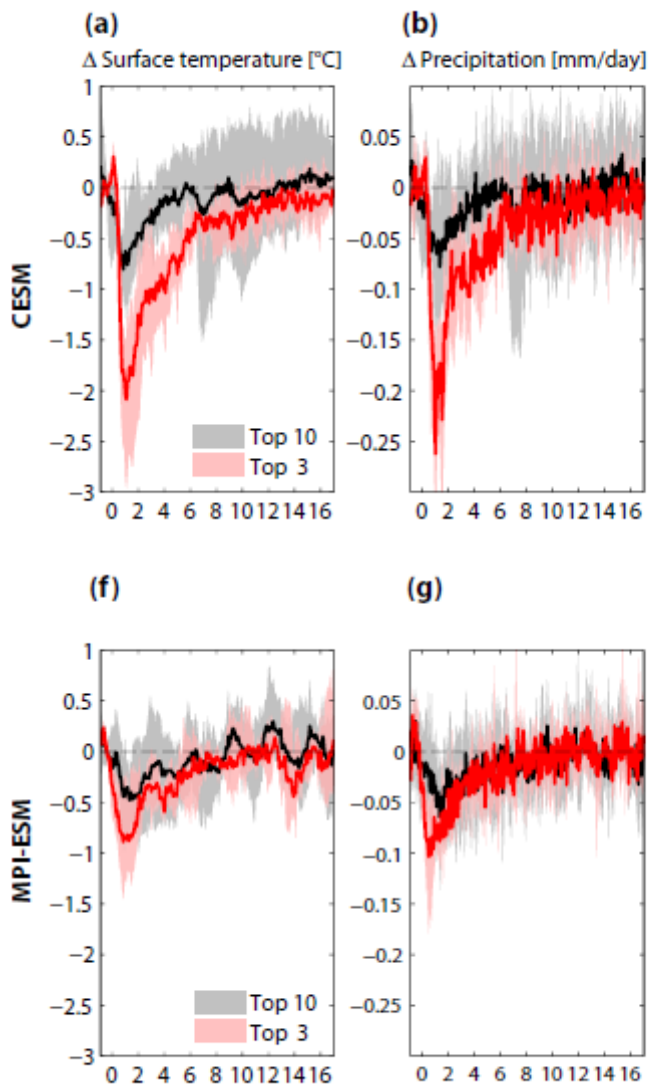




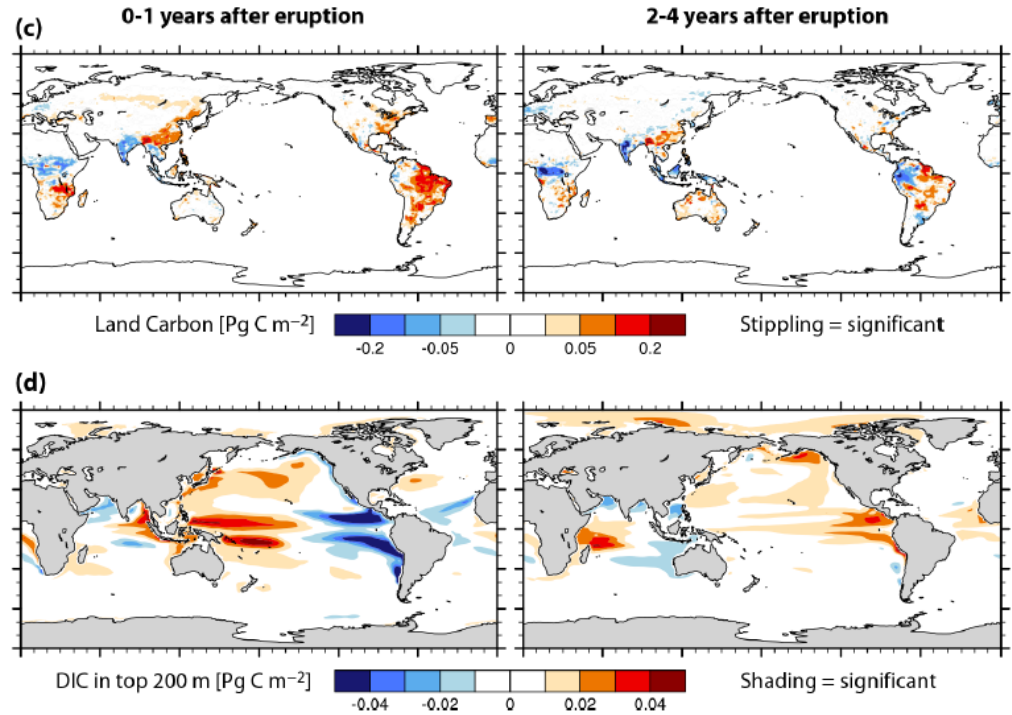
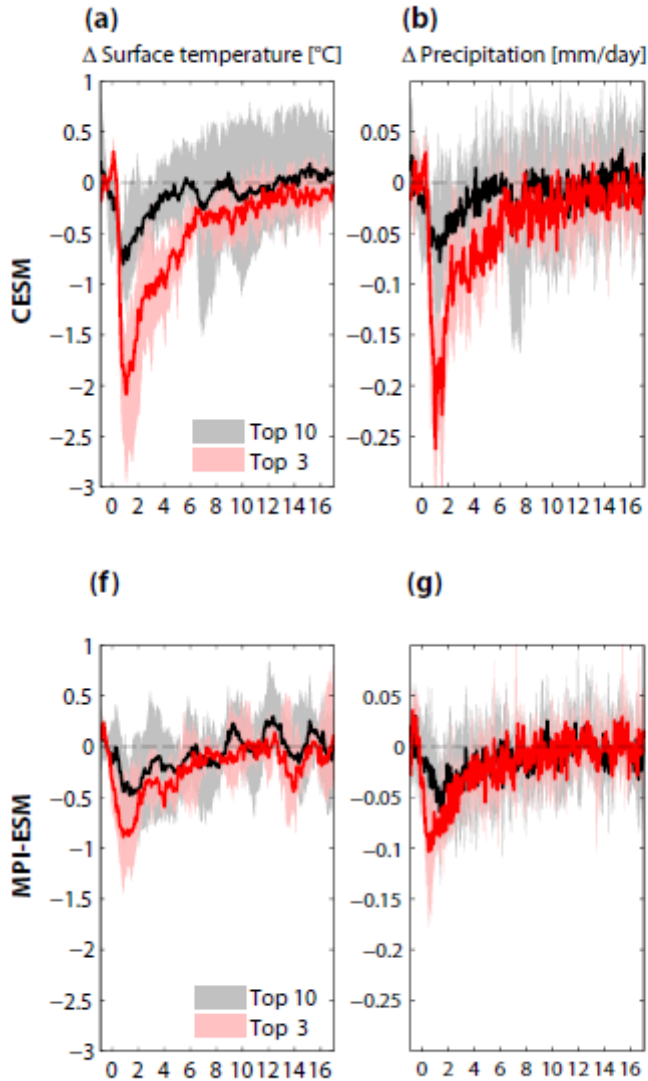
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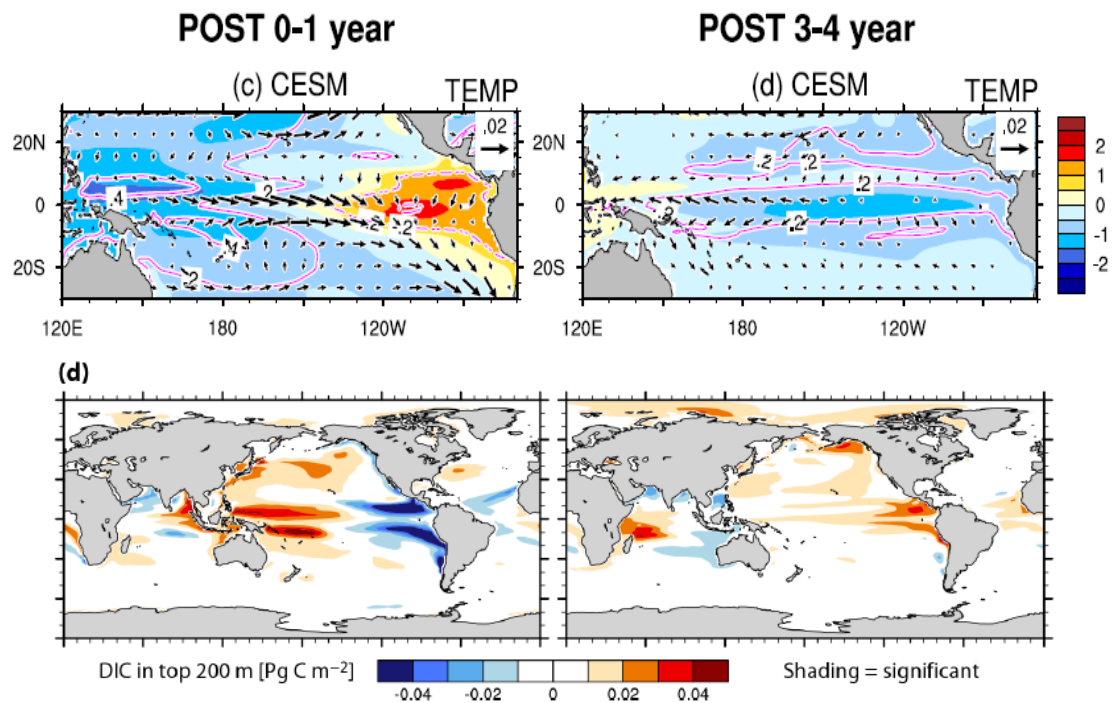
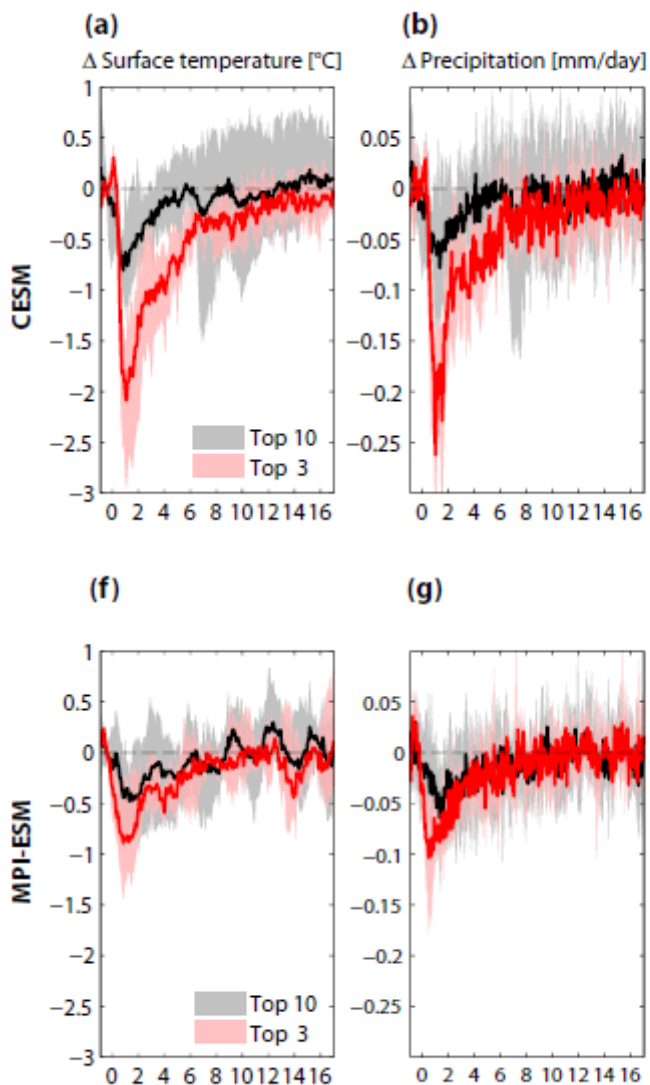
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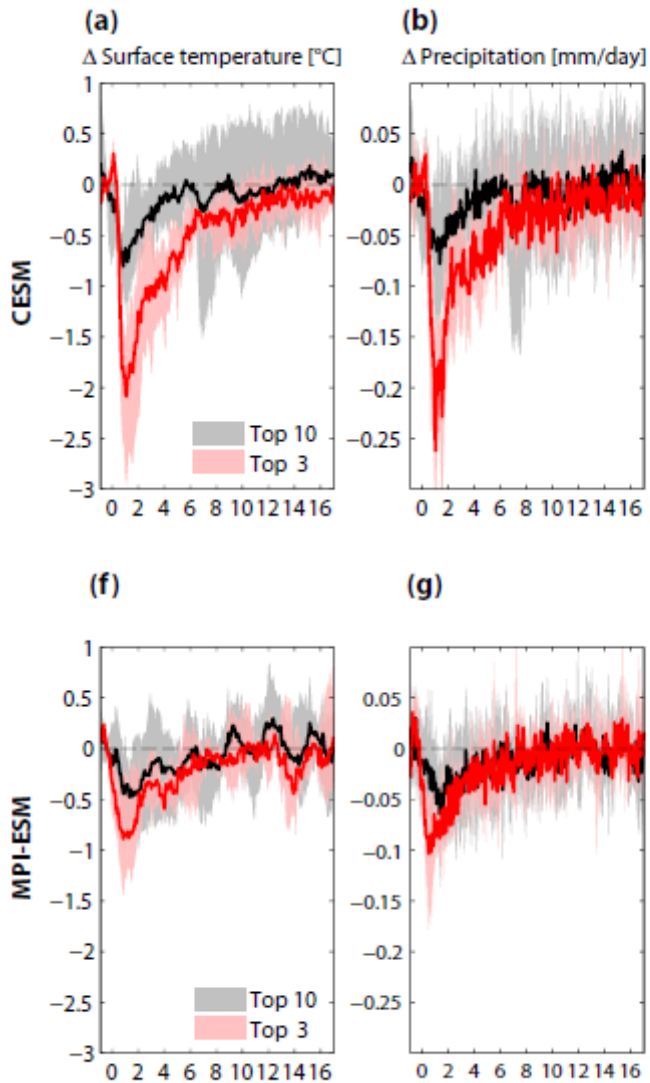
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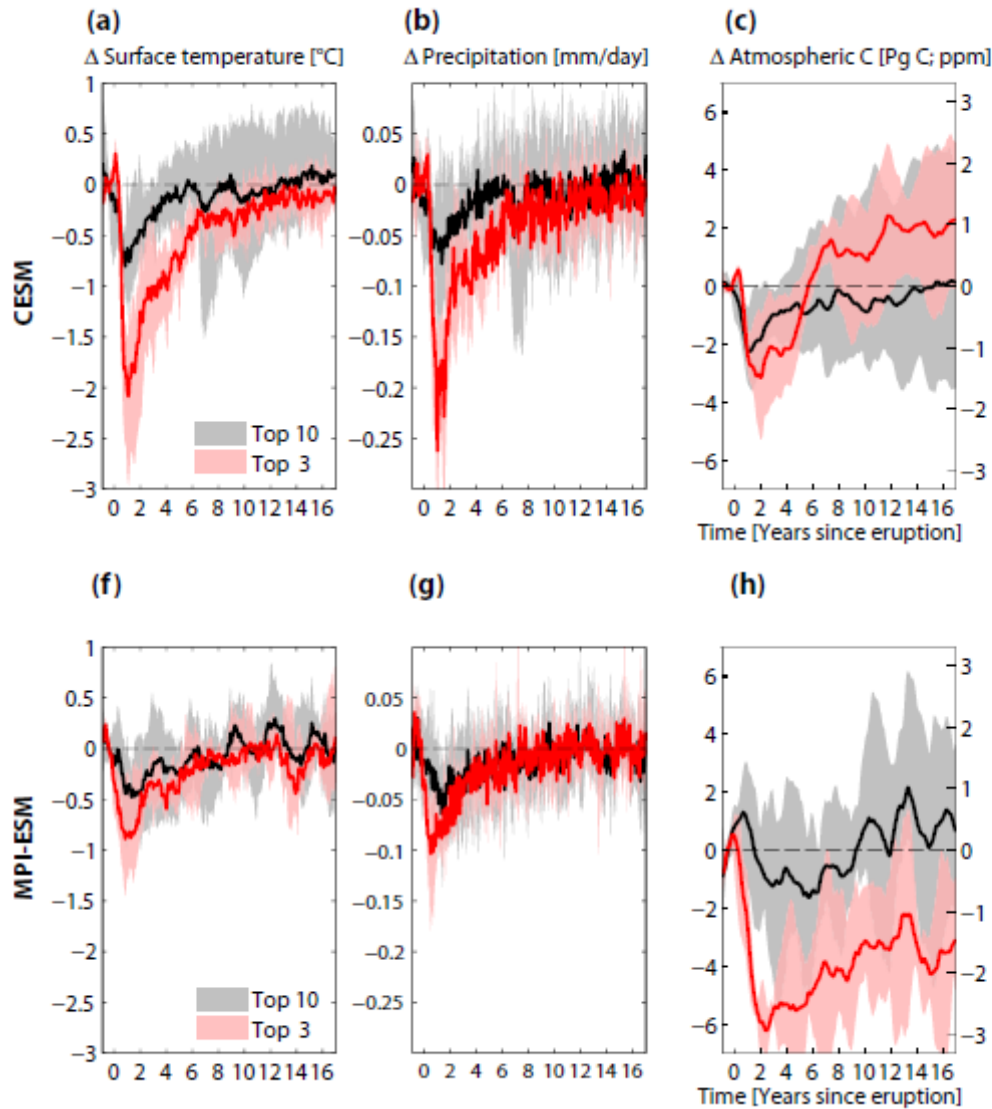


# Volcanic impact on carbon cycle

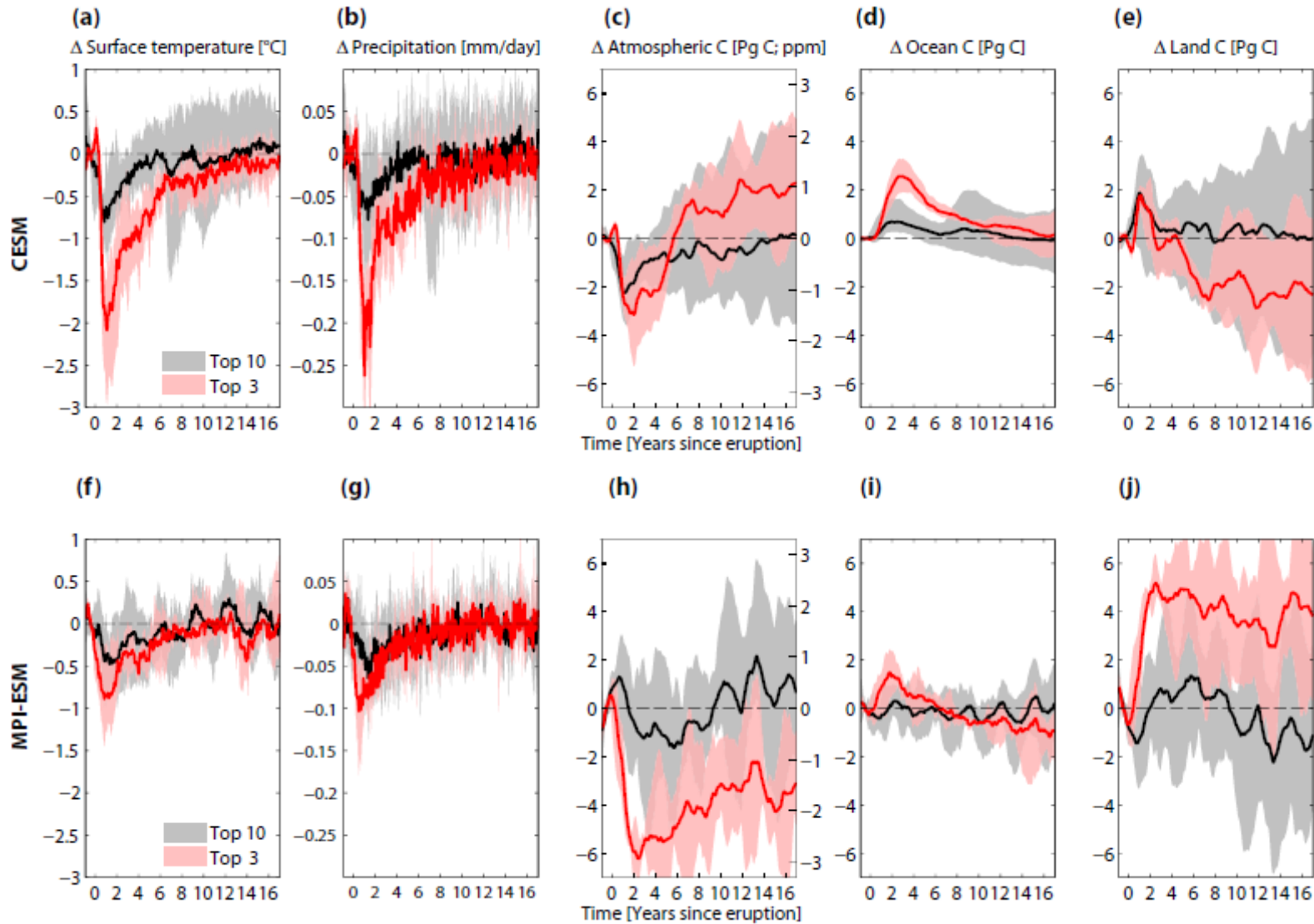




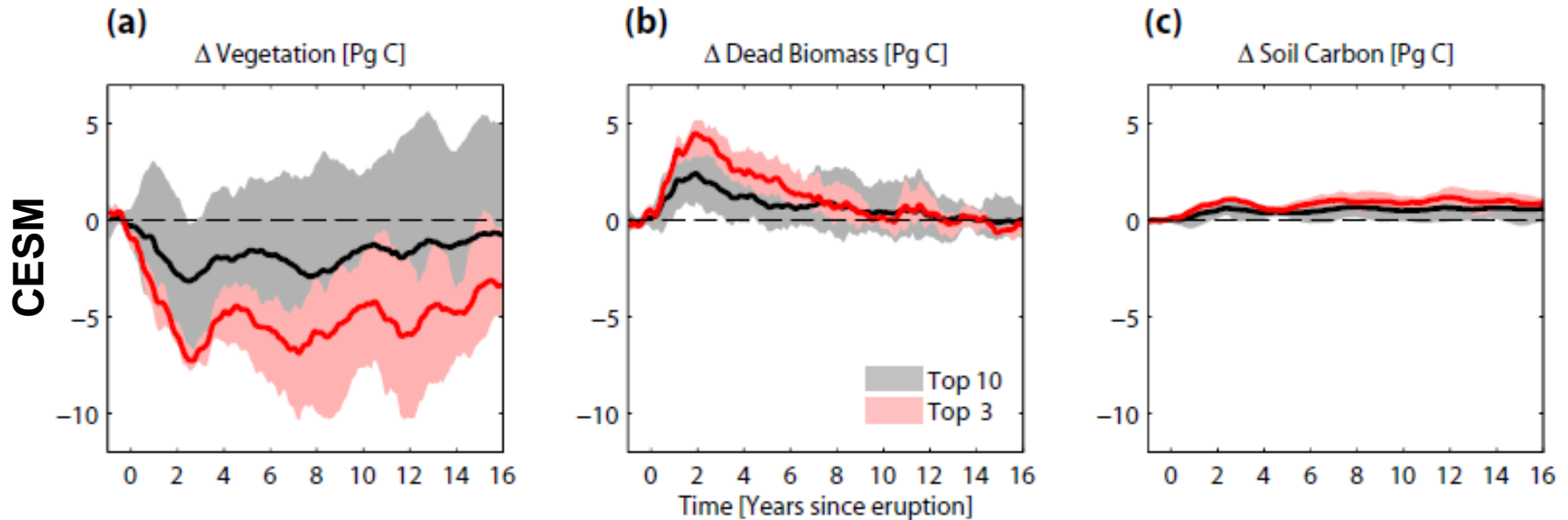
# Volcanic impact on carbon cycle



# Volcanic impact on carbon cycle



# Volcanic impact on carbon cycle (tropics)





## 0. Experimental setup

## 1. Climate-carbon cycle sensitivity

- 1.3 ppm °C<sup>-1</sup>, but non-stationary
- Hard to constrain by paleo (data and simulations)

## 2. Volcanic impact on carbon cycle

- Non-linear scaling with eruption strength
- Potentially poor model agreement, dynamical climate response matters

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BERN**

**OESCHGER CENTRE  
CLIMATE CHANGE RESEARCH**