



# JULES-INFERNO in the Fire Model Intercomparison Project

Model performance and process evaluation

**Douglas Kelley, Stijn Hantson, Stephane Mangeon**

FireMIP contributors: Almut Arneith, Sandy P. Harrison, Sam S. Rabin, Dominique M. Bachelet, Matthew Forrest, Silvia Kloster, Gitta Lasslop, Fang Li, Joe R. Melton, Tim Sheehan, Chao Yue

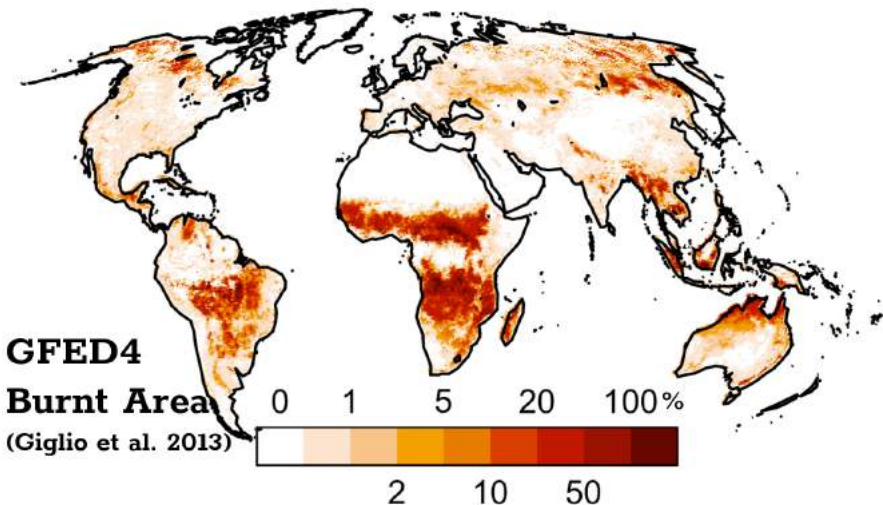
Fire Limitation Framework: Ioannis Bistinas, Rhys Whitley, Chantelle Burton, Toby Marthews

27th June 2017



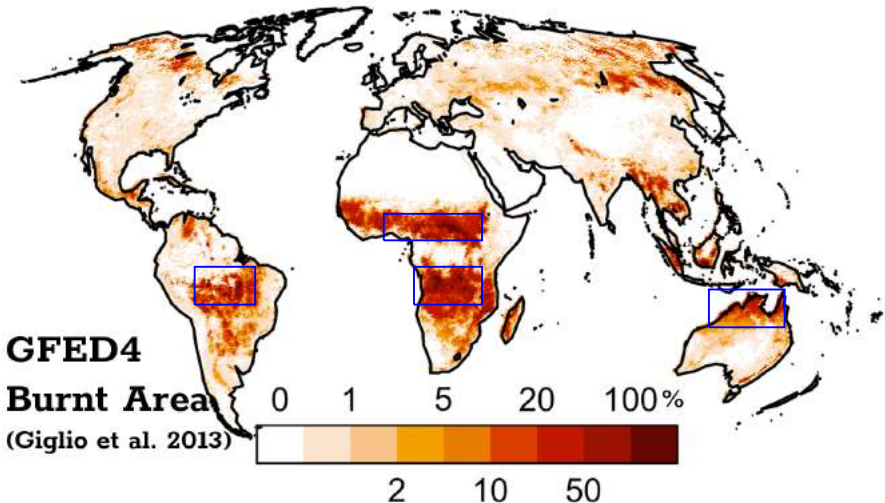
# Fire In the Earth System

Areas affected



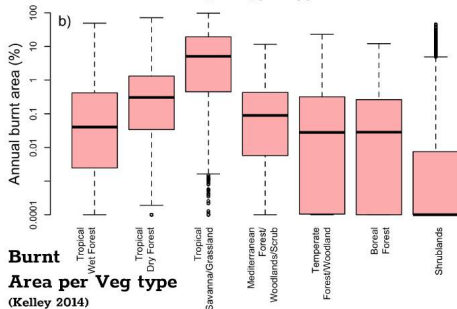
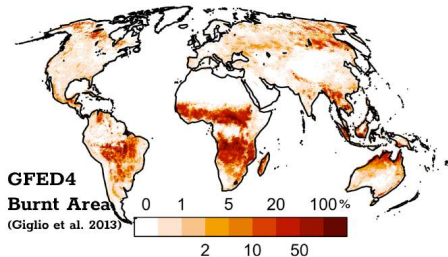
# Fire In the Earth System

Areas affected



# Fire In the Earth System

Areas affected



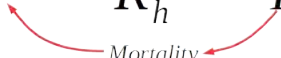
# Fire and carbon

$$NEP = NPP - R_h - Fire$$

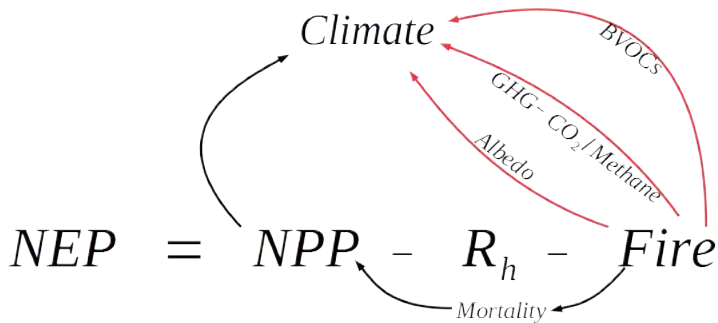
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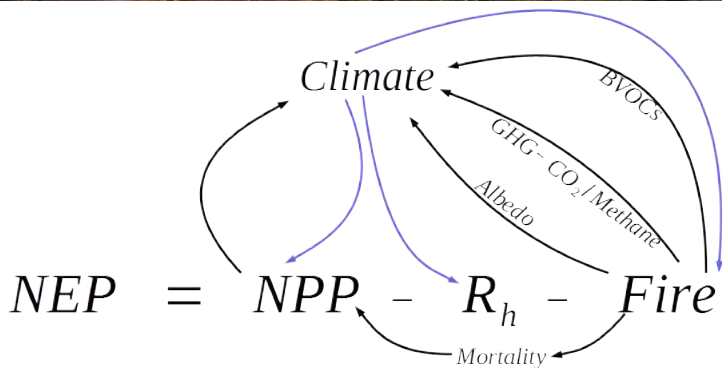
*Mortality*



# Fire and carbon

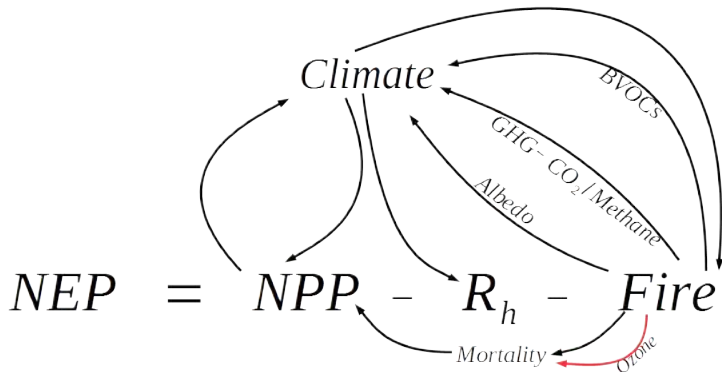


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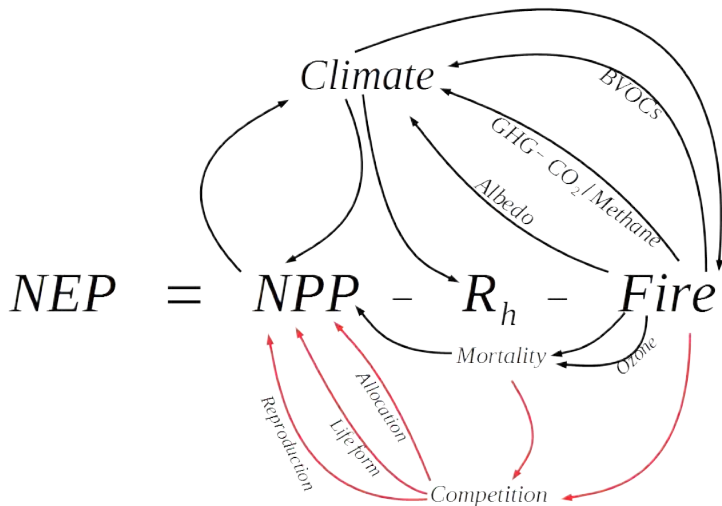




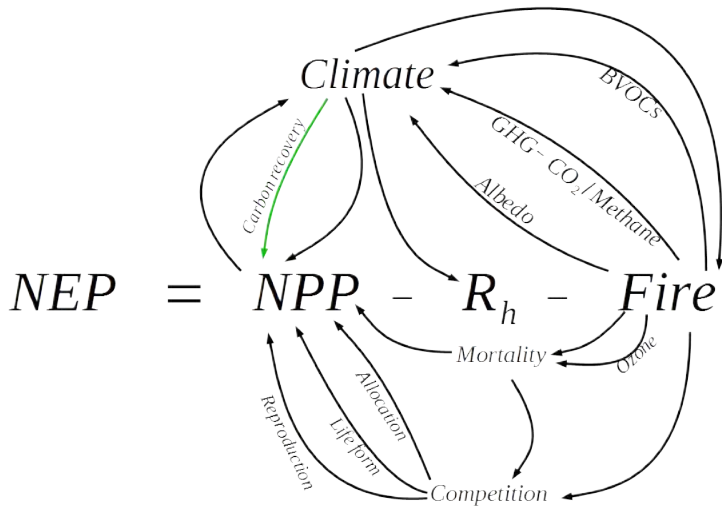
# Fire and carbon



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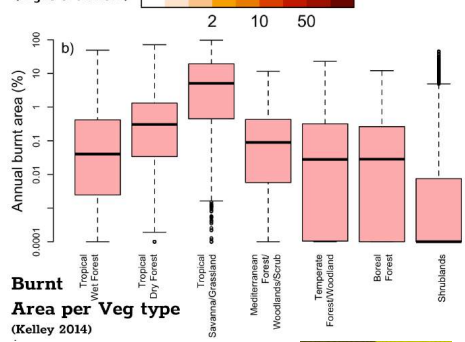
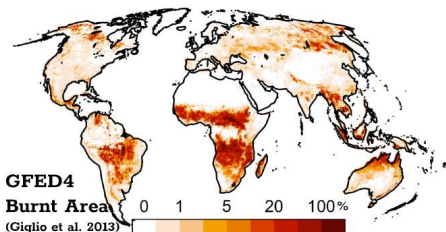
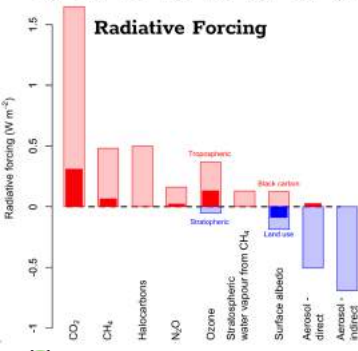
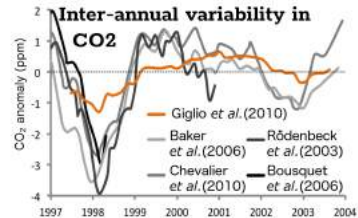


# Fire and carbon



# Fire In the Earth System

## Carbon Cycle and Radiative Forcing



### fireMIP Models

CLM

CTEM

JSBACH

JULES-INFERNO

LPJ-GUESS-BLAZE

LPJ-GUESS-GLOBFIREM

LPJ-GUESS-SPITFIRE

MC2

ORCHIDEE-SPITFIRE



### ■ Benchmark overview

#### **Benchmarking** Historic Evaluation

**CLM**

**CTEM** Fire Seasonality

**JSBACH** Human Impacts

**JULES-INFERNO**

**LPJ-GUESS-BLAZE** Process Evaluation

**LPJ-GUESS-GLOBFIREM** Paleo Fires

**LPJ-GUESS-SPITFIRE** Future fires

**MC2**

**ORCHIDEE-SPITFIRE** ESM evaluation



### Benchmarking

Historic Evaluation

CLM

CTEM

JSBACH

**JULES-INFERNO**

LPJ-GUESS-BLAZE

LPJ-GUESS-GLOBFIREM

LPJ-GUESS-SPITFIRE

MC2

ORCHIDEE-SPITFIRE

Fire Seasonality

Human Impacts

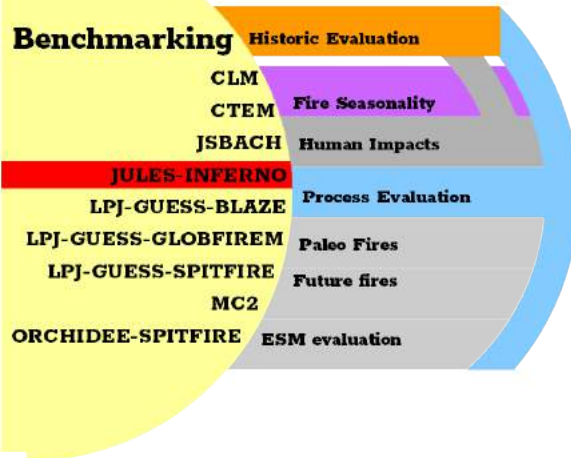
Process Evaluation

Paleo Fires

Future fires

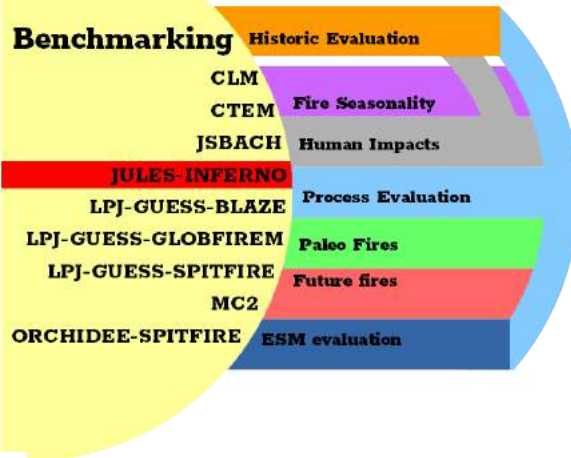
ESM evaluation

- Benchmark overview
- Focus on JULES performance & fire controls



- Benchmark overview
- Focus on JULES performance & fire controls
- Diagnose seasonality performance
- Explore missing anthropogenic processes

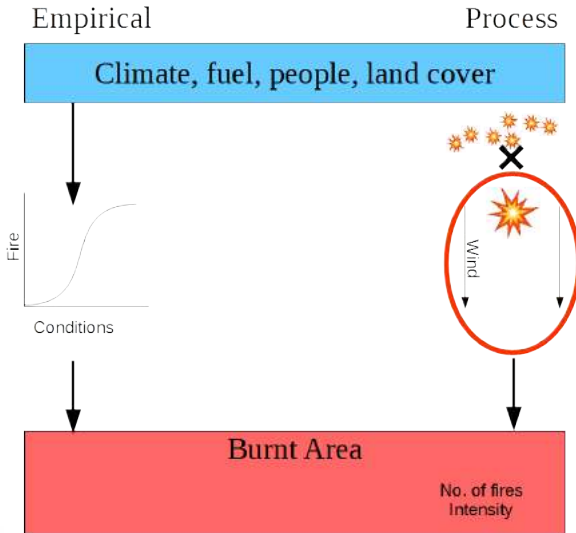




- Benchmark overview
- Focus on JULES performance & fire controls
- Diagnose seasonality performance
- Explore missing anthropogenic processes
- Future fireMIP evaluations

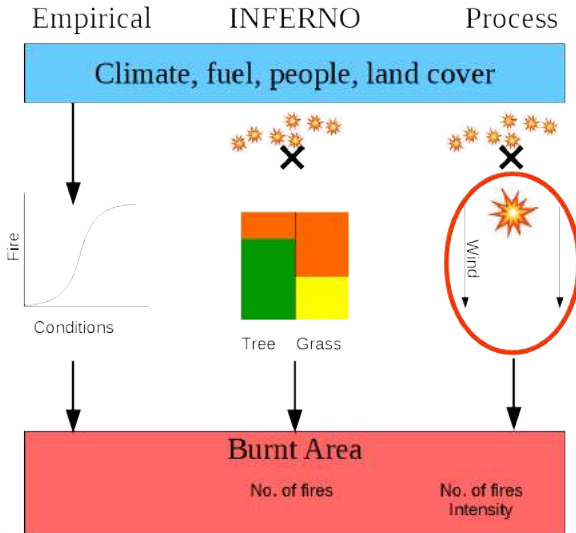
# fire Models

## Types



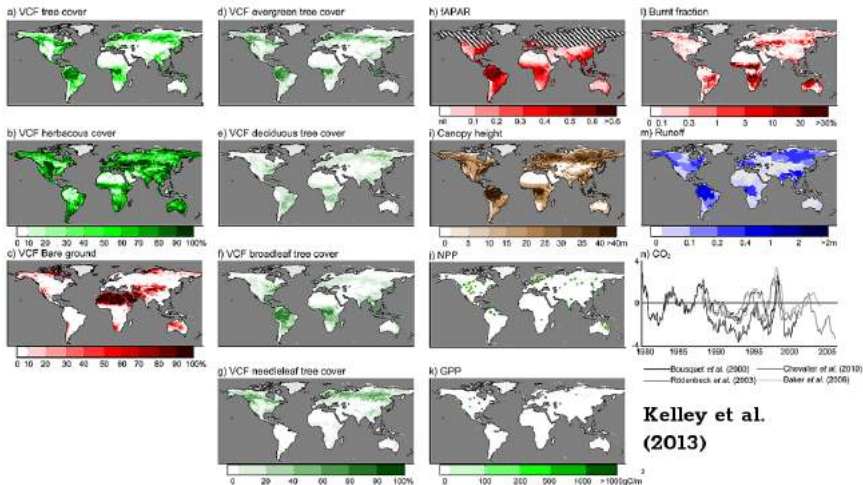
# fire Models

## Types



# FireMIP benchmarking

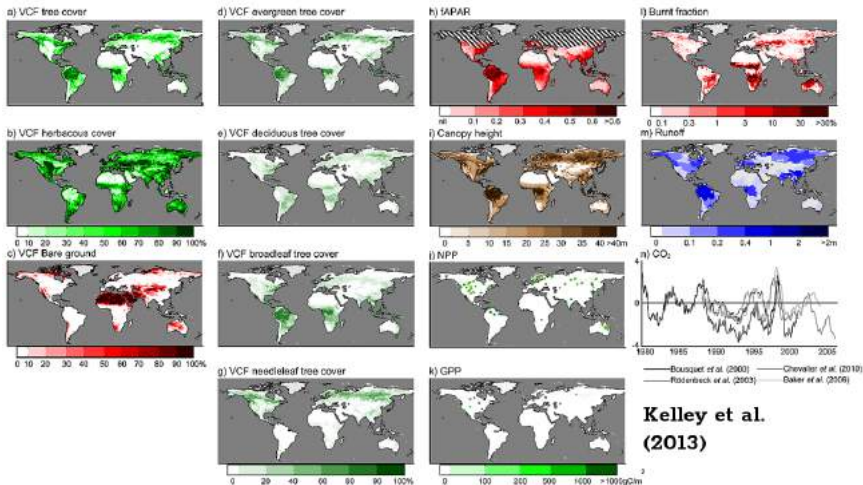
## Benchmark Datasets



Plus some new ones

# FireMIP benchmarking

## Benchmark Datasets

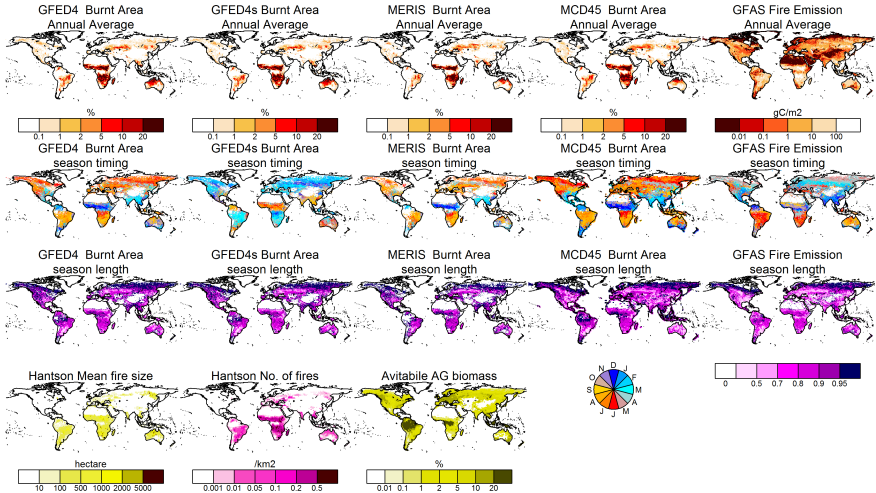


**Kelley et al.  
(2013)**

Plus some new ones

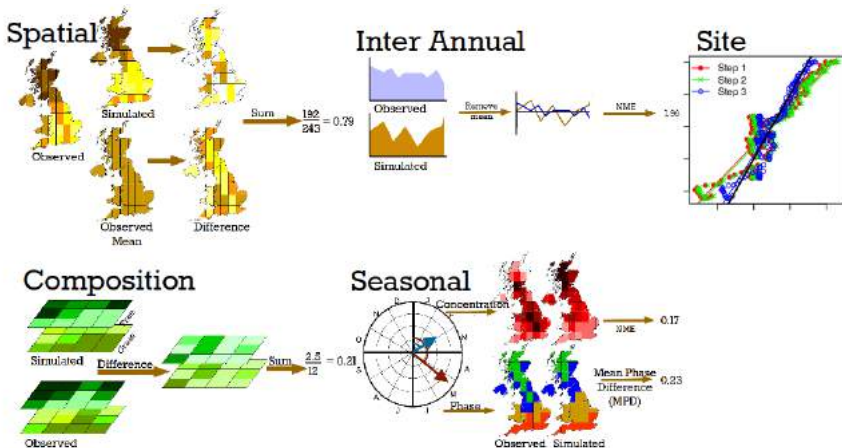
# FireMIP benchmarking

## Fire Benchmark Datasets



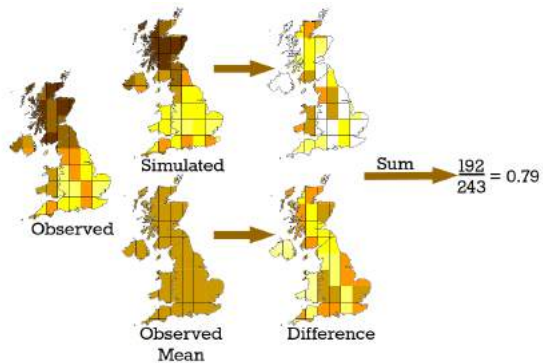
# FireMIP Metrics

## All Metrics



# FireMIP Metrics

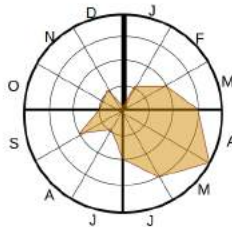
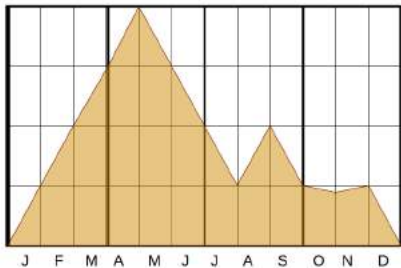
## Normalised Mean Error





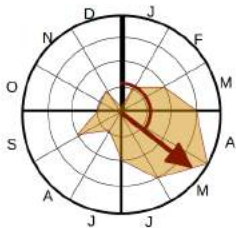
# FireMIP Metrics

## Seasonal Comparisons



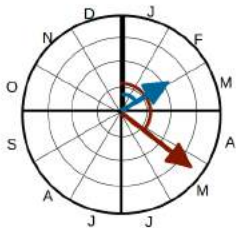
# FireMIP Metrics

## Seasonal Comparisons



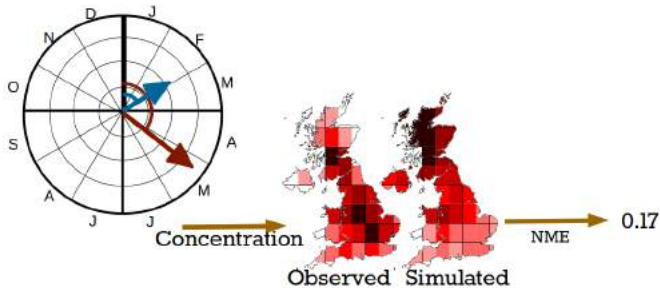
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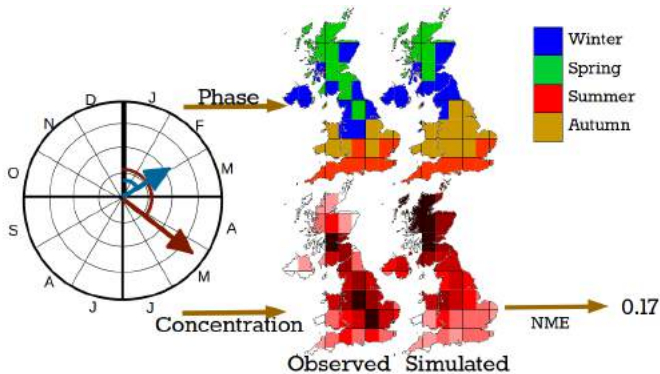
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## Seasonal Comparisons



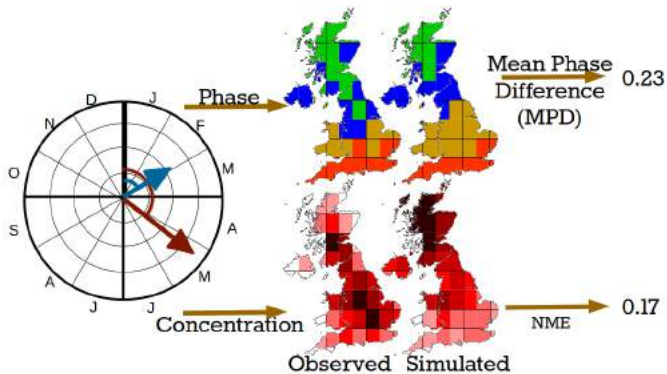
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## Seasonal Comparisons

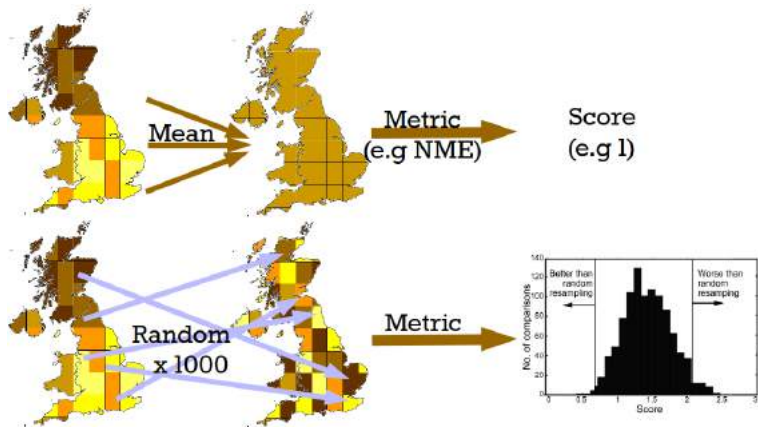


# FireMIP Metrics

## Seasonal Comparisons



# FireMIP Null Models

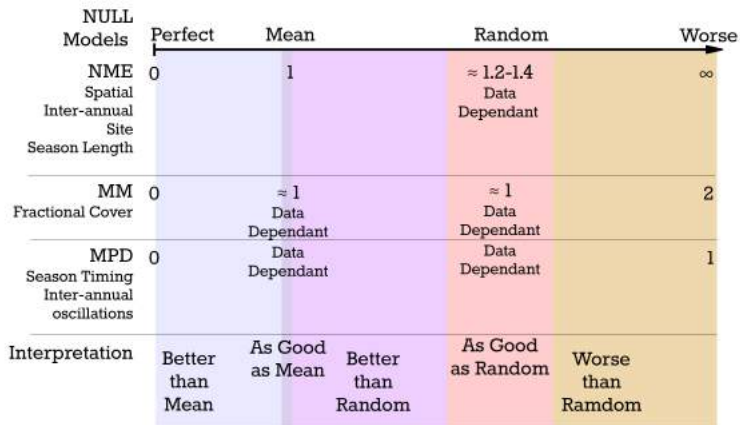


# FireMIP Null Models





# FireMIP Null Models



# Model Scores

			mean	RR	CLM	CTEM	JULES	JSBACH	LPJ	LPJ	LPJ	MC2	OSCHMIDT
							INFERNO	SPITFIRE	GLOBURM	SPITFIRE	BLAZE		SPITFIRE
	Burnt Area	GFED4 (s)	1	1.18	0.67	0.77	0.68	0.76	0.74	0.83	0.84	0.79	0.7
		GFED4	1	1.14	0.81	0.83	0.76	0.87	0.71	0.97	0.98	0.78	0.82
	Veg C		1	1.32	0.73	0.89	0.89	1.35	1.3	1.27	1.3	1.27	0.73
	Fire C	GFAS	1	1.2	0.82	0.93	0.77	0.96	0.75	0.94	0.95	0.77	1.07
Phase	Burnt Area	GFED4 (s)	0.49	0.5	0.30	0.34	0.37	0.38		0.31			0.32
			1	1.36	1.08	1.20	1.73	1.35		1.05			1.12
Phase	Fire C	GFAS	0.57	0.47	0.42	0.50	0.49	0.47		0.37			0.37
			1	1.36	1.15	1.78	1.81	1.45		1.21			1.15

# Model Scores

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							INFERNO	SPITFIRE	GLOBURM	SPITFIRE	BLAZE		SPITFIRE
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# Model Scores

			mean	RR	Model Ensemble	JULES INFERNO
	Burnt Area	GFED4(s)	1	1.18	0.67-0.84 (0.68-0.84)	0.68
		GFED4	1	1.14	0.71-0.98 (0.71-0.98)	0.76
	Vegetation Carbon		1	1.32	0.73-1.35 (0.89-1.35)	0.89
	Fire Carbon	GFAS	1	1.2	0.77-1.07 (0.77-0.95)	0.77
Phase	Burnt Area	GFED4(s)	0.49	0.5	0.30-0.38 (0.31-0.37)	0.37
Conc.			1	1.62	1.05-1.73 (1.05-1.73)	1.73
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# JULES-INFERNO v obs

## Overall fire performance

Burnt Area	
Veg C	☹️
Fire C	☹️
Burnt Area	☹️
Fire C	☹️
Burnt Area	☹️
Fire C	☹️

# JULES-INFERNO v obs

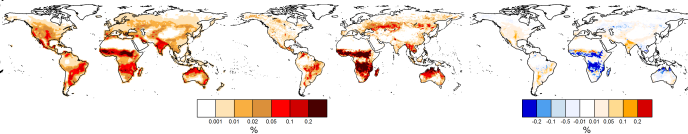
## Overall fire performance

Burnt Area  
(GFED4s)

JULES-INFERNO

Observations

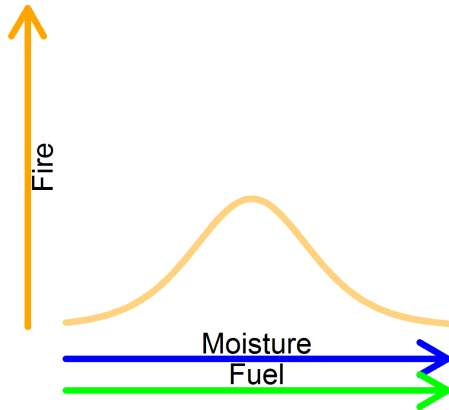
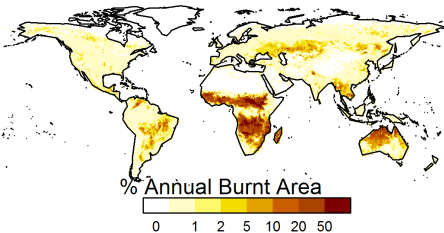
Difference



Burnt Area	
Veg C	😊
Fire C	😊
Forest Area	😊
Seasonal	😊
Fire C2	😊
Seasonal	😊

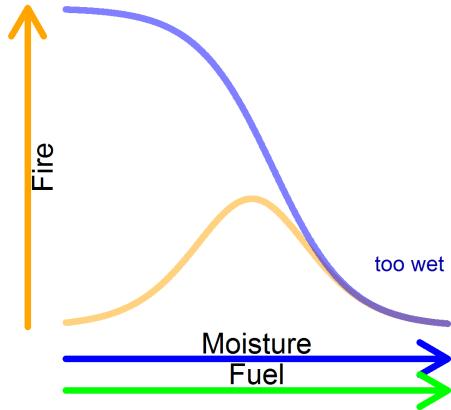
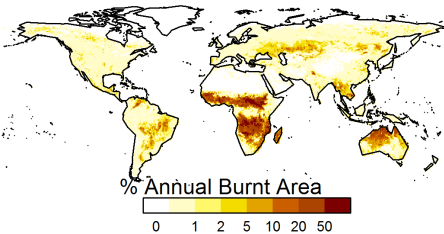
# It burns where it rains (a bit)

## Uni-modal relationship with moisture



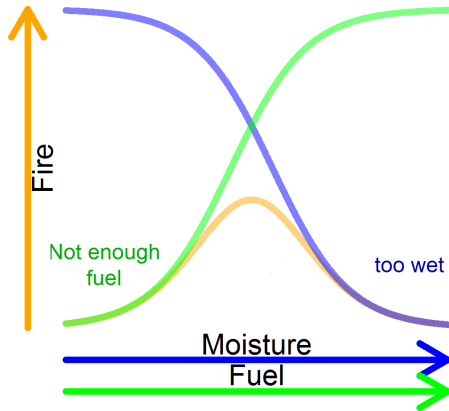
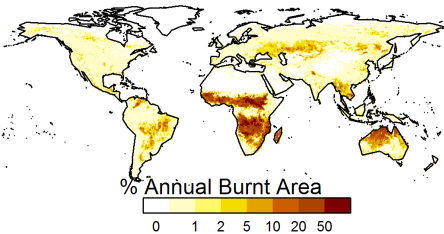
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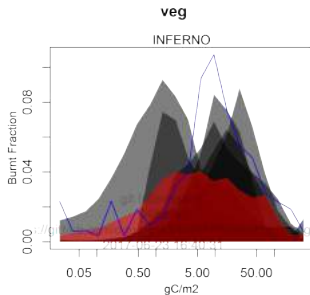
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## Uni-modal relationship with moisture



# INFERNO Fire Controls

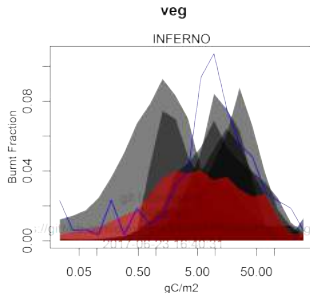
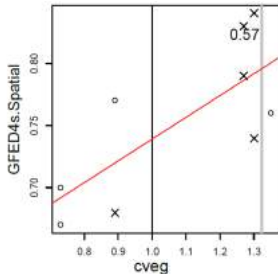
## Vegetation



Burnt Area	😬
Veg C	😊
Fire C	😬
Burnt Area	😬
Burnt Area	😬
Fire C	😬
Fire C	😬

# INFERNO Fire Controls

## Vegetation

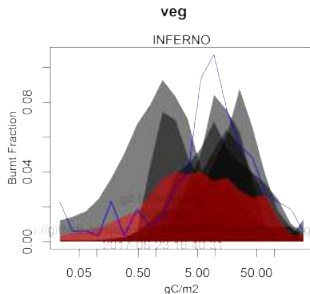
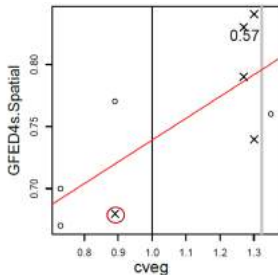


Burnt Area	☹️
Veg C	😊
Fire C	☹️
Burnt Area	😬
Fire C	😬
Green	😊



# INFERNO Fire Controls

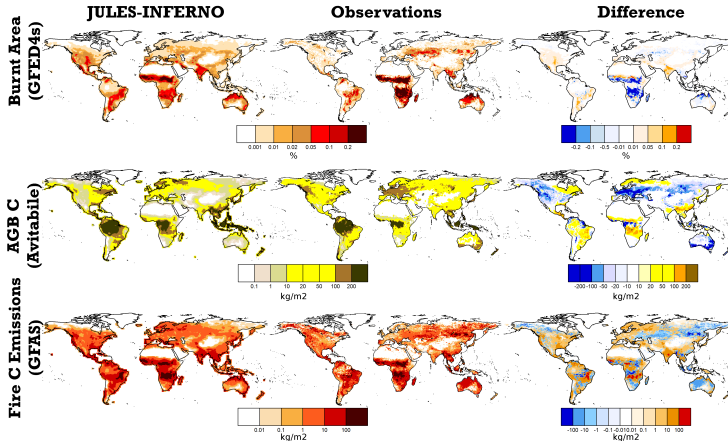
## Vegetation



Burnt Area	☹️
Veg C	😊
Fire C	☹️
Burnt Area	😬
Fire C	😬
Soiling	😬

# JULES-INFERNO v obs

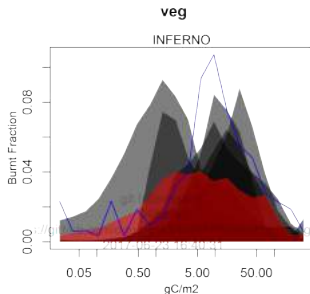
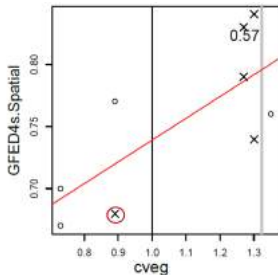
## Fire Emissions



Burnt Area	☹️
Veg C	😊
Fire C	☹️
Burnt Area	😊
Burnt Area	😊
Fire C	😊

# INFERNO Fire Controls

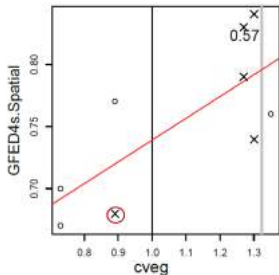
## Vegetation



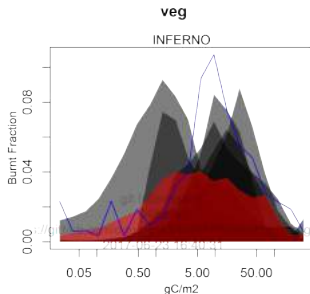
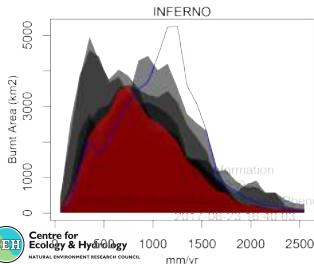
Burnt Area	☹️
Veg C	😊
Fire C	☹️
Burnt Area	😞
Fire C	😞
Green	😊

# INFERNO Fire Controls

## Moisture



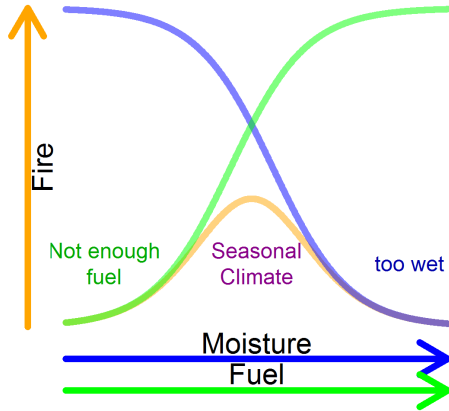
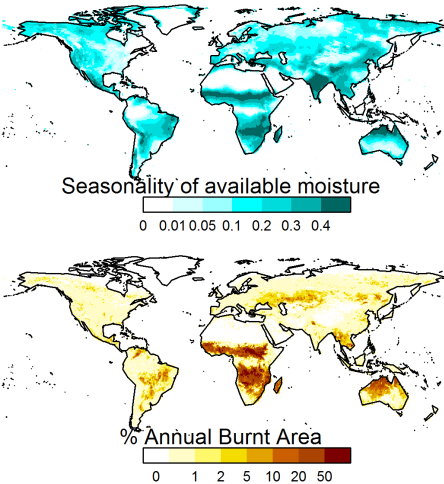
MAP



Burnt Area	😊
Veg C	😊😊
Flow C	😊😊
Burnt Area	😊😊
Scenario	😊😊
Flow C	😊😊
Scenario	😊😊

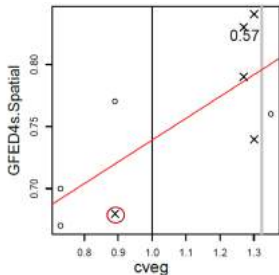
# It burns where it rains (a bit)

## Uni-modal relationship with moisture

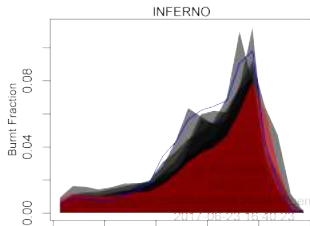
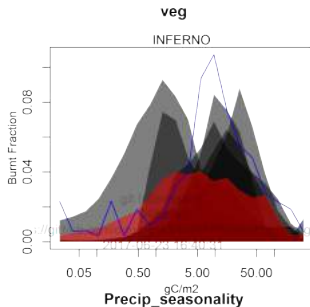
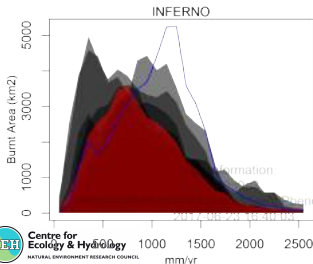


# INFERNO Fire Controls

## Moisture



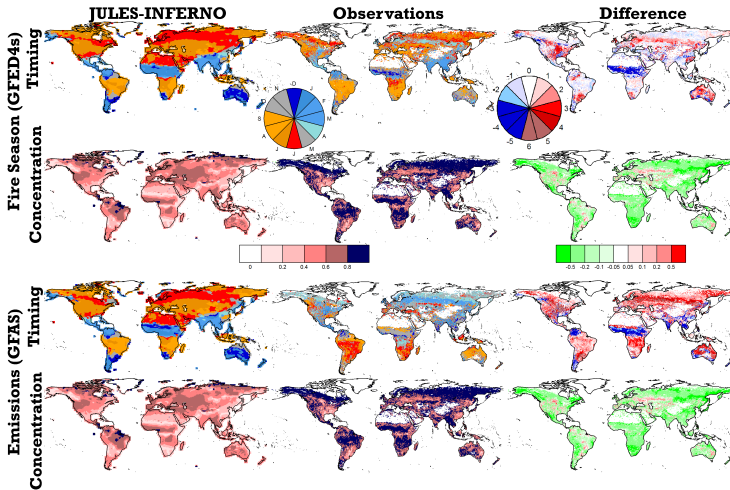
MAP



Burnt Area	😊
Veg C	😊😊
Flow C	😊😊
Burnt Area	😊😊
Season	😊😊
Flow C	😊😊
Season	😊😊

# JULES-INFERNO v obs

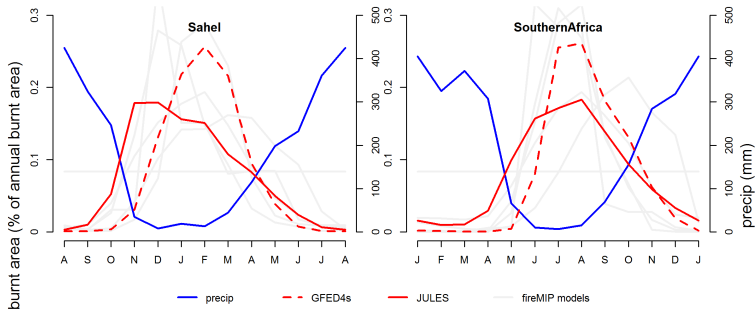
## Seasonality



Burnt Area	☹️
Vegetation C.	🌳
Fire C.	🔥
Burnt Area Season	☹️
Fire C. Season	☹️

# JULES-INFERNO v obs

## Seasonality



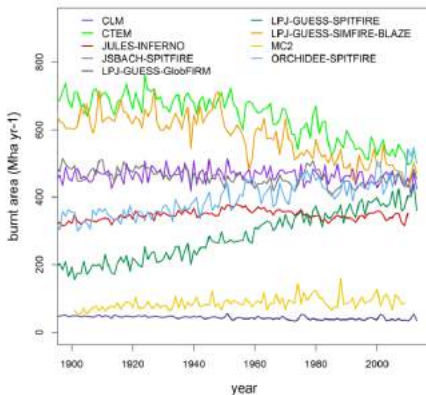
Burnt Area	☹️
Veg C	😊😊
Fire C	😊😊
Burnt Area Season	☹️
Fire C	😊😊
Season	😊😊



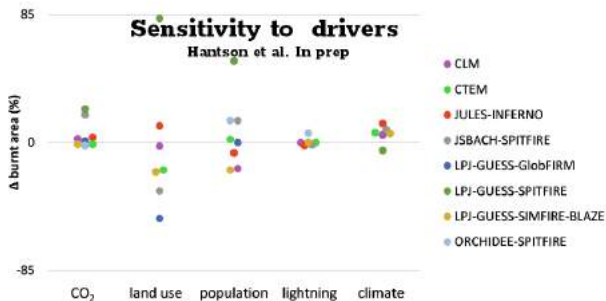
# Human Impact

## Simulated historic fire

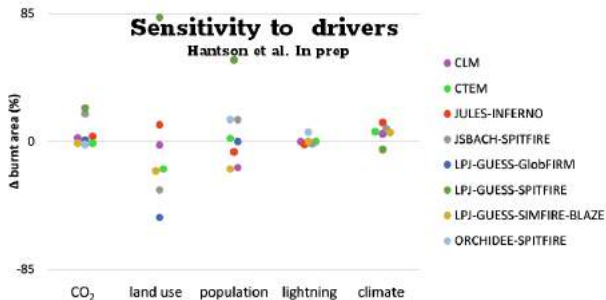
Hantson et al. In prep



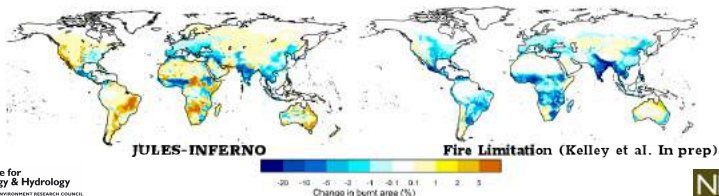
# Human Impact



# Human Impact



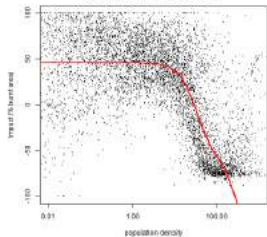
## Impact of Humans



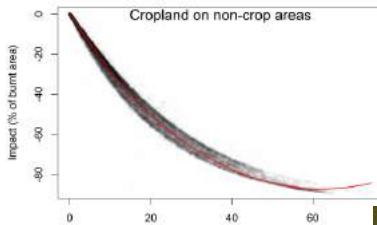
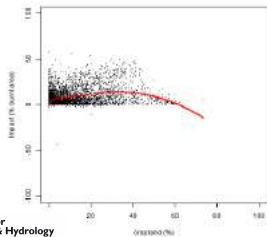
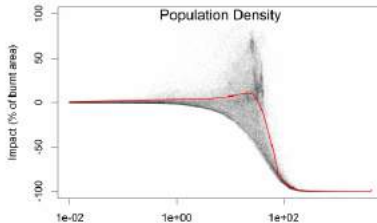
# Human Impact



**JULES-INFERNO**



**Fire Limitation (Kelley et al. In prep)**



# Some things to work on...

Areas for JULES-INFERNO to improve on

- Burnt area in seasonal humid areas.
- Delay fire season onset
- Include land use fragmentation

Burnt Area	
Veg C	
Fire C	
Burnt Area Season	
Fire C Season	

# fireMIP

## Fire Modelling Inter-comparison Project



- World without fire.
- Pre-industrial fire regime.
- Pre-industrial atmospheric CO<sub>2</sub>.
- Fixed 1700 human population density.
- Fixed 1901-1920 lightning.
- Fixed 1901-1920 climate.
- Fixed 1700 land use.

# fireMIP

## Fire Modelling Inter-comparison Project



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