Fire-O_3 Interactions: Terrestrial carbon response

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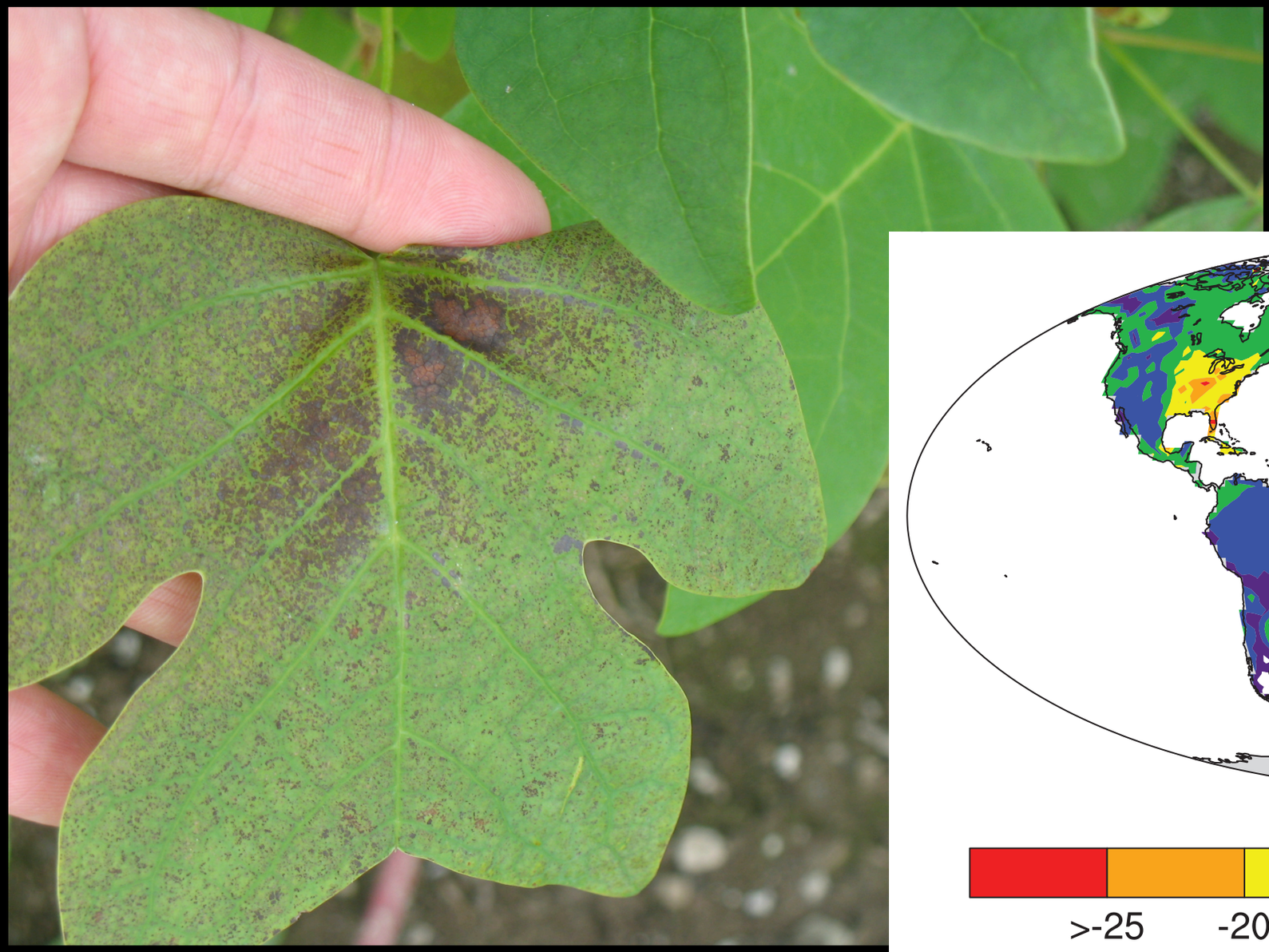
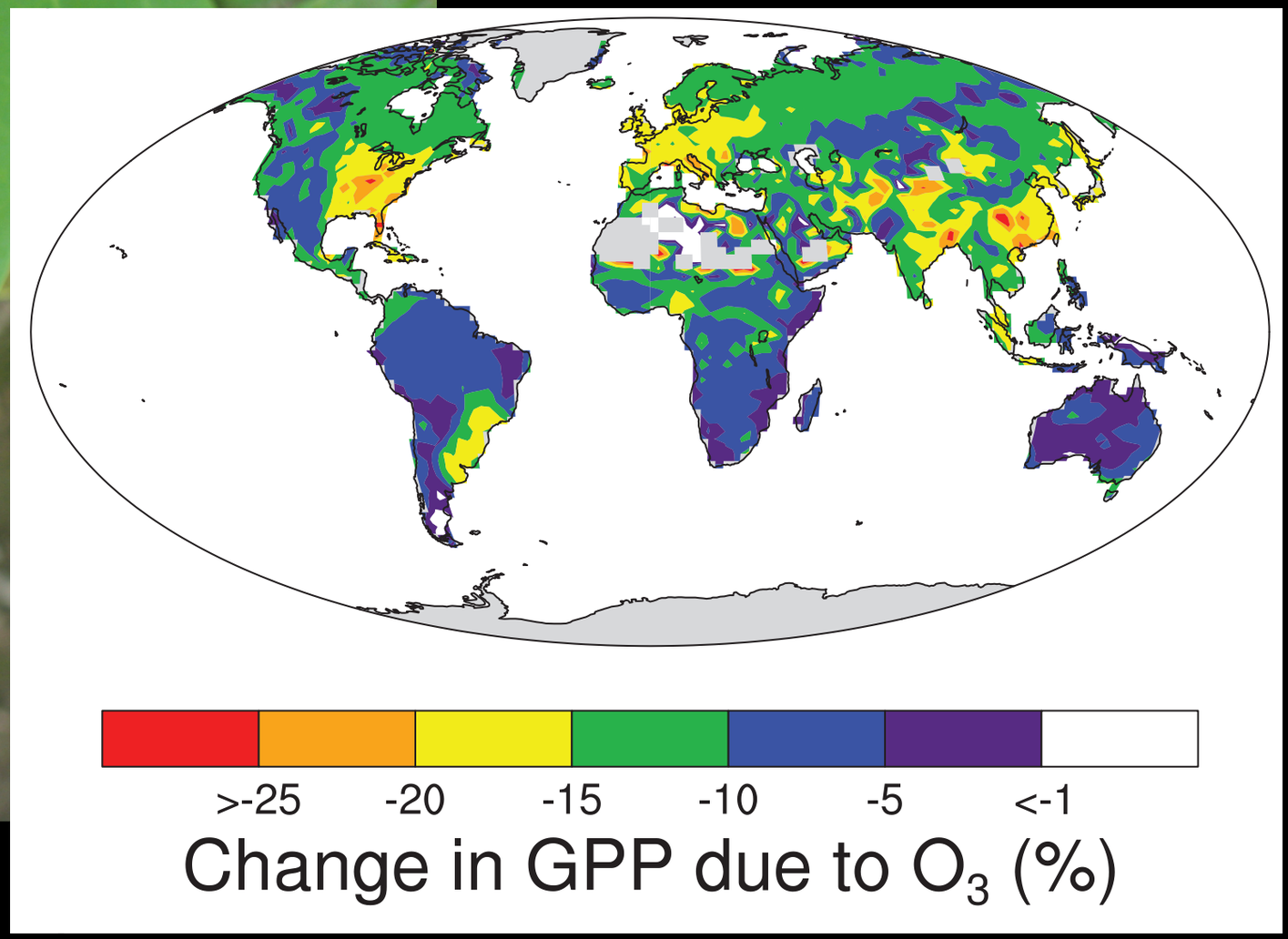
Foliar O_3 damage

Ecosystem recovery post-fire

O_3 decreases GPP





Lombardozzi et al. 2015

Simulations: CLM4.5-BGC

Fire (default CLM4.5-BGC)

Fire + O_3

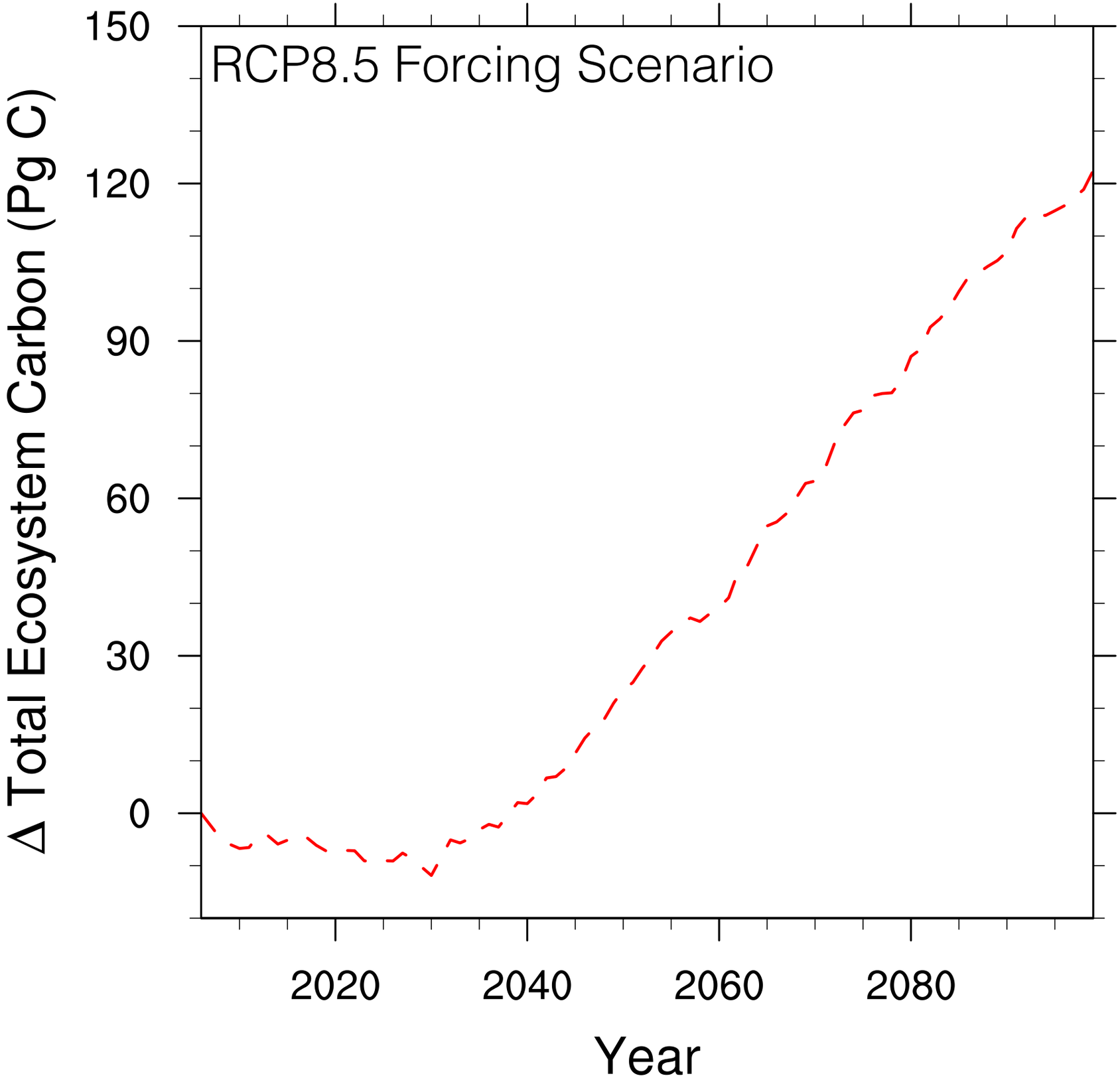
No Fire

No Fire + O_3

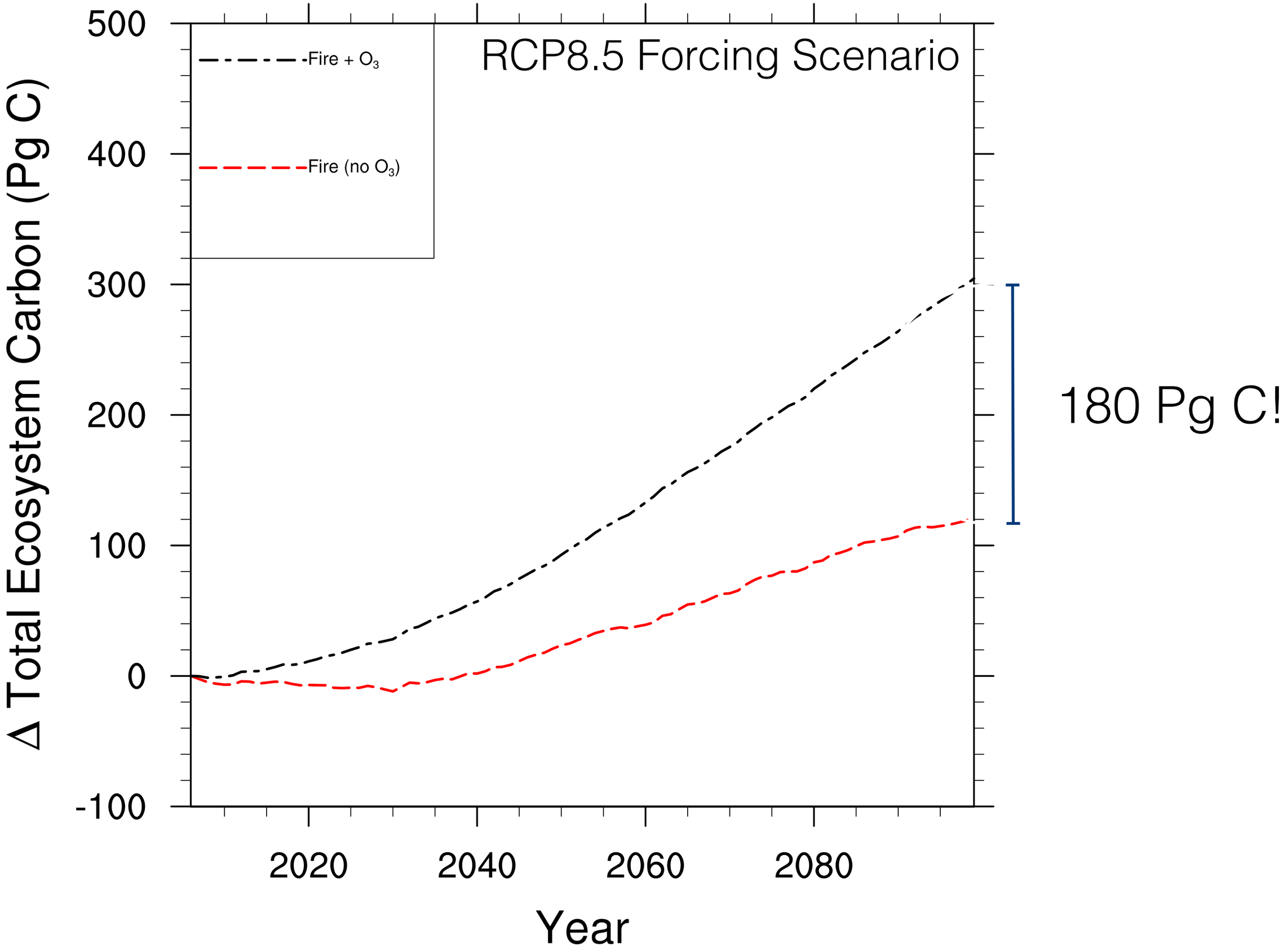
2006-2100 using RCP 8.5
(Anomaly forcing, developed by Sean Swenson)

Fire model: Li et al. 2012 *Biogeosciences*

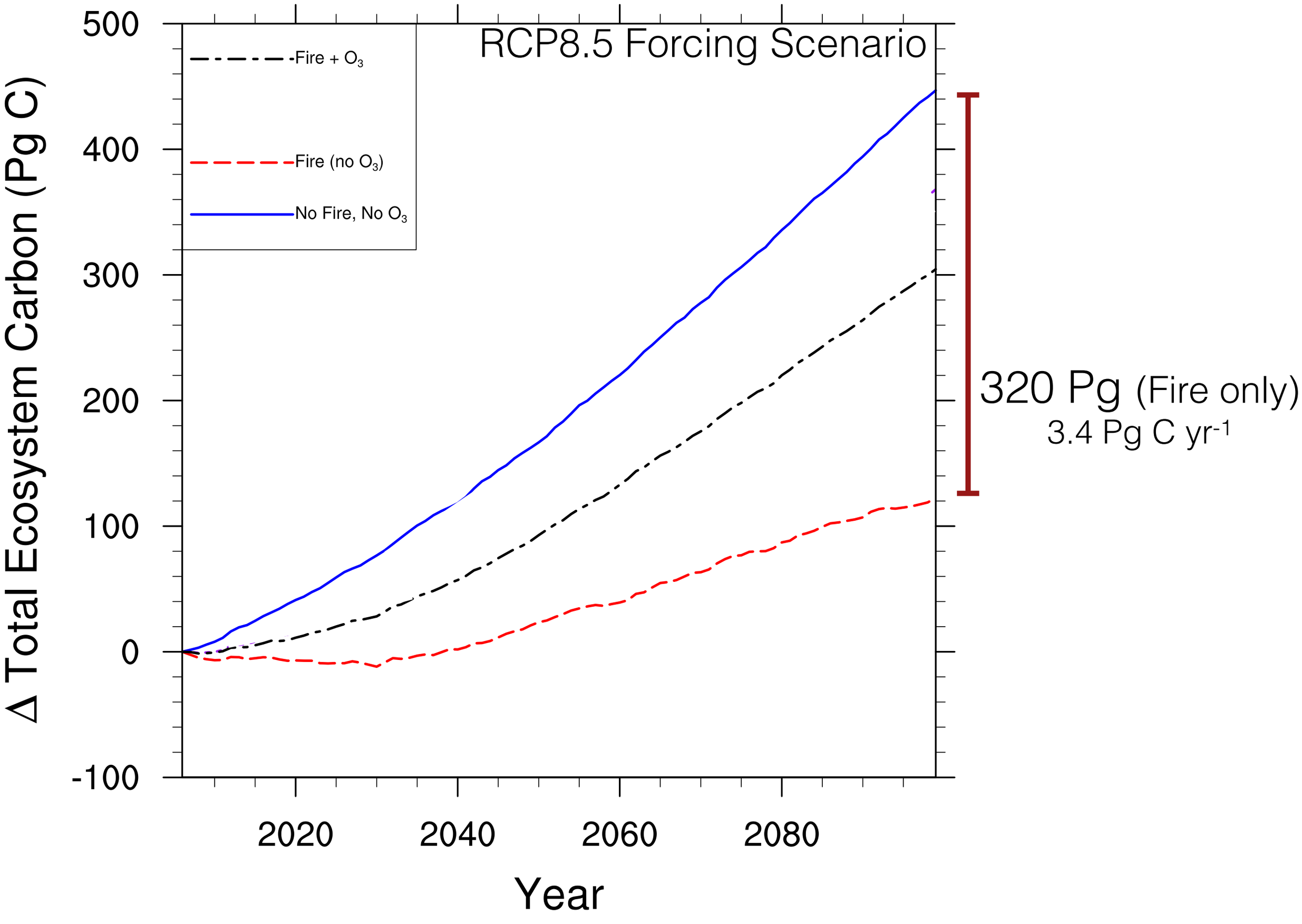
CLM4.5-BGC Ecosystem C (unmodified: Fire on, no O_3)



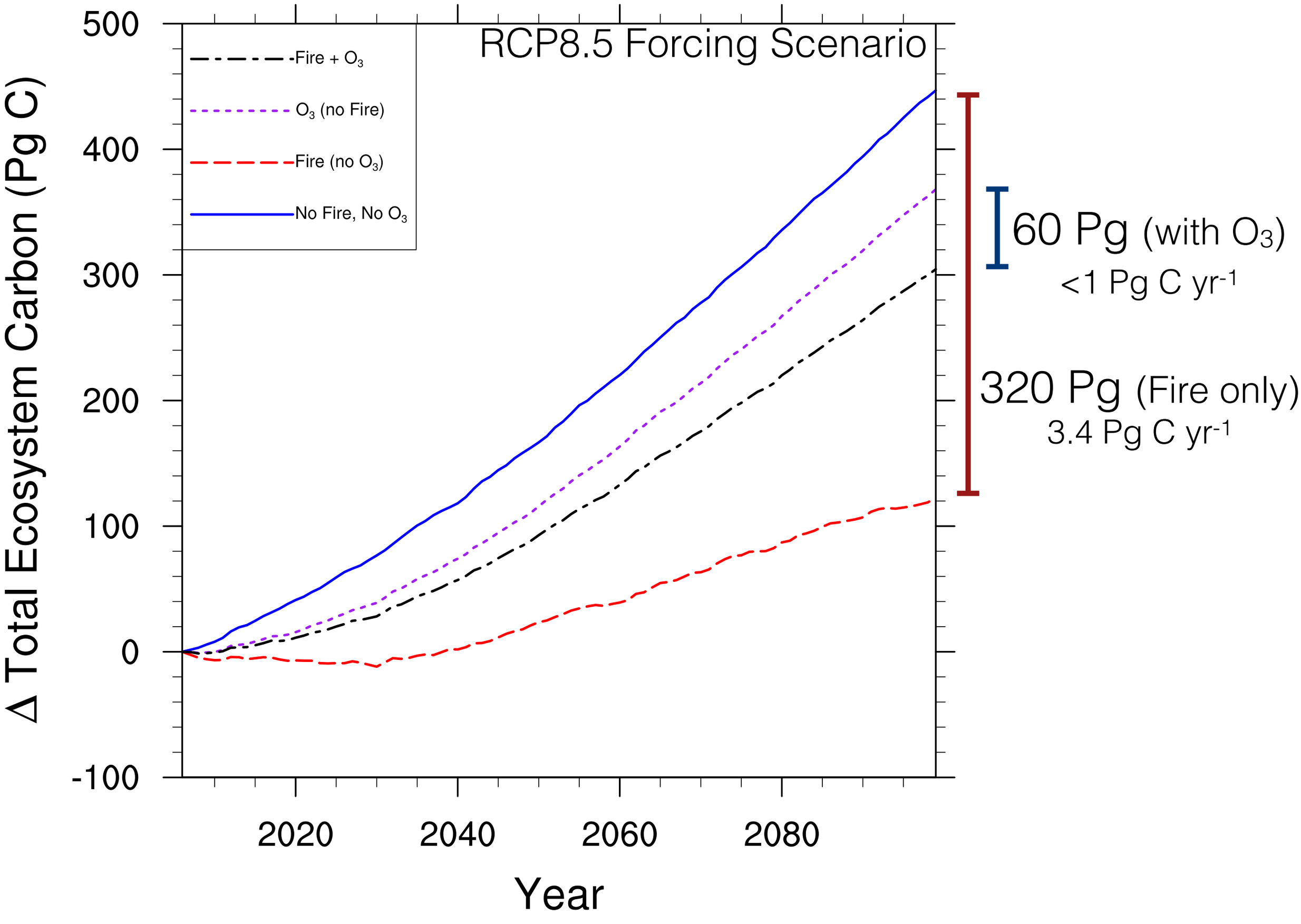
O_3 ***Increases*** Ecosystem C



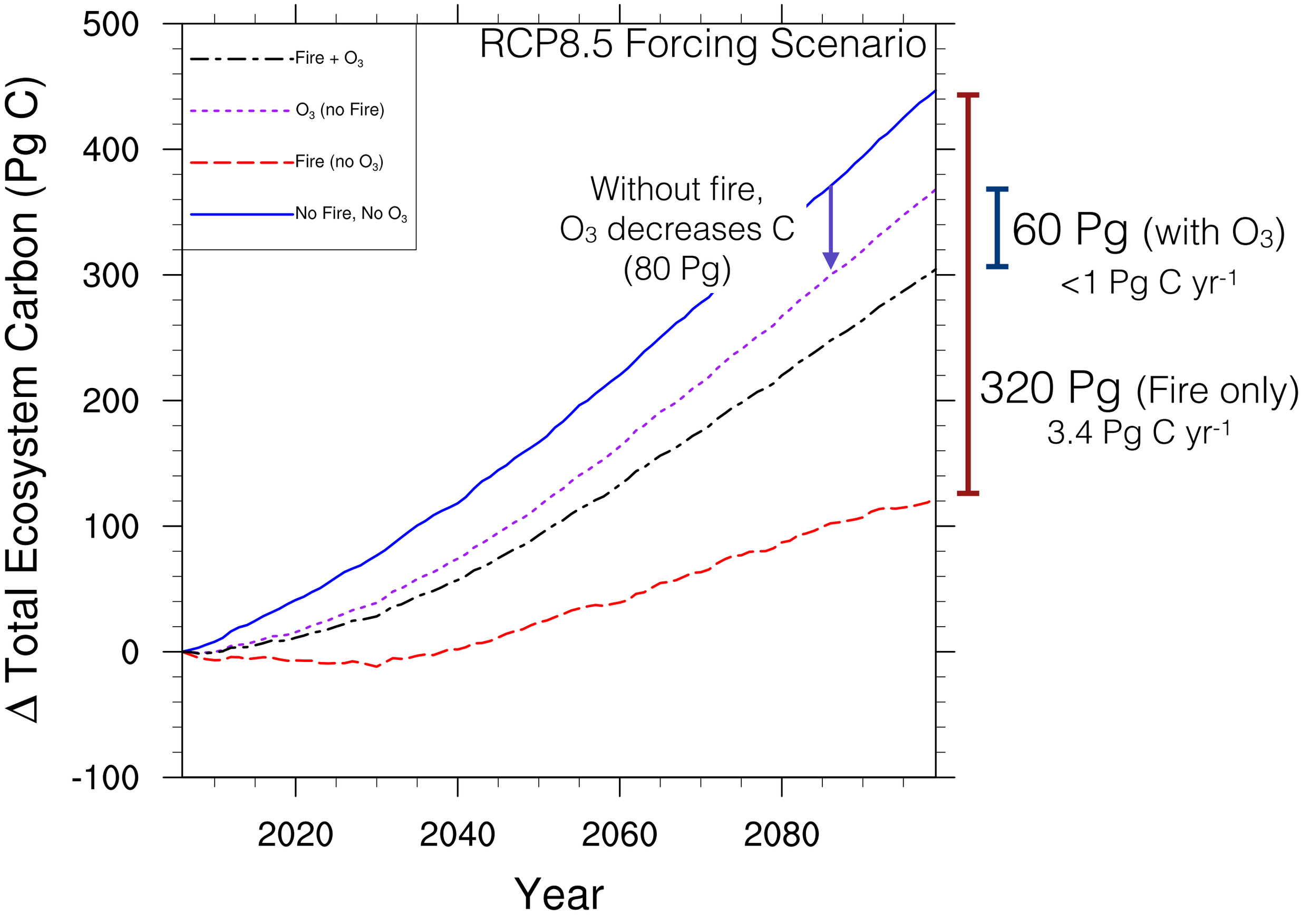
Fire impact


RCP8.5 Forcing Scenario
Fire + O3
Fire (no O3)
No Fire, No O3
Δ Total Ecosystem Carbon (Pg C)
500
400
300
200
100
0
-100
2020
2040
2060
2080
Year
320 Pg (Fire only)
3.4 Pg C yr-1

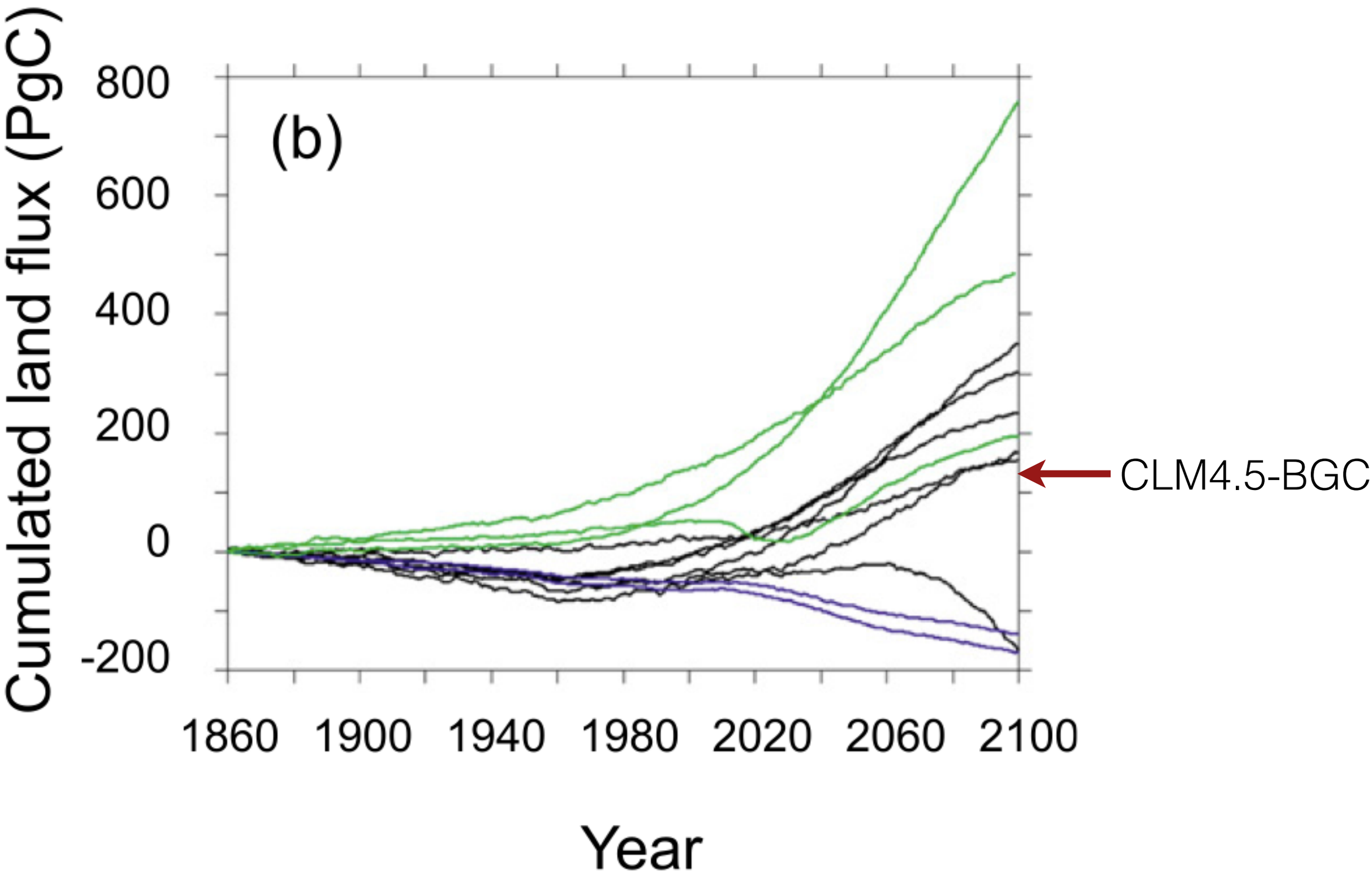
Fire impact: smaller with O_3



Fire impact: smaller with O_3

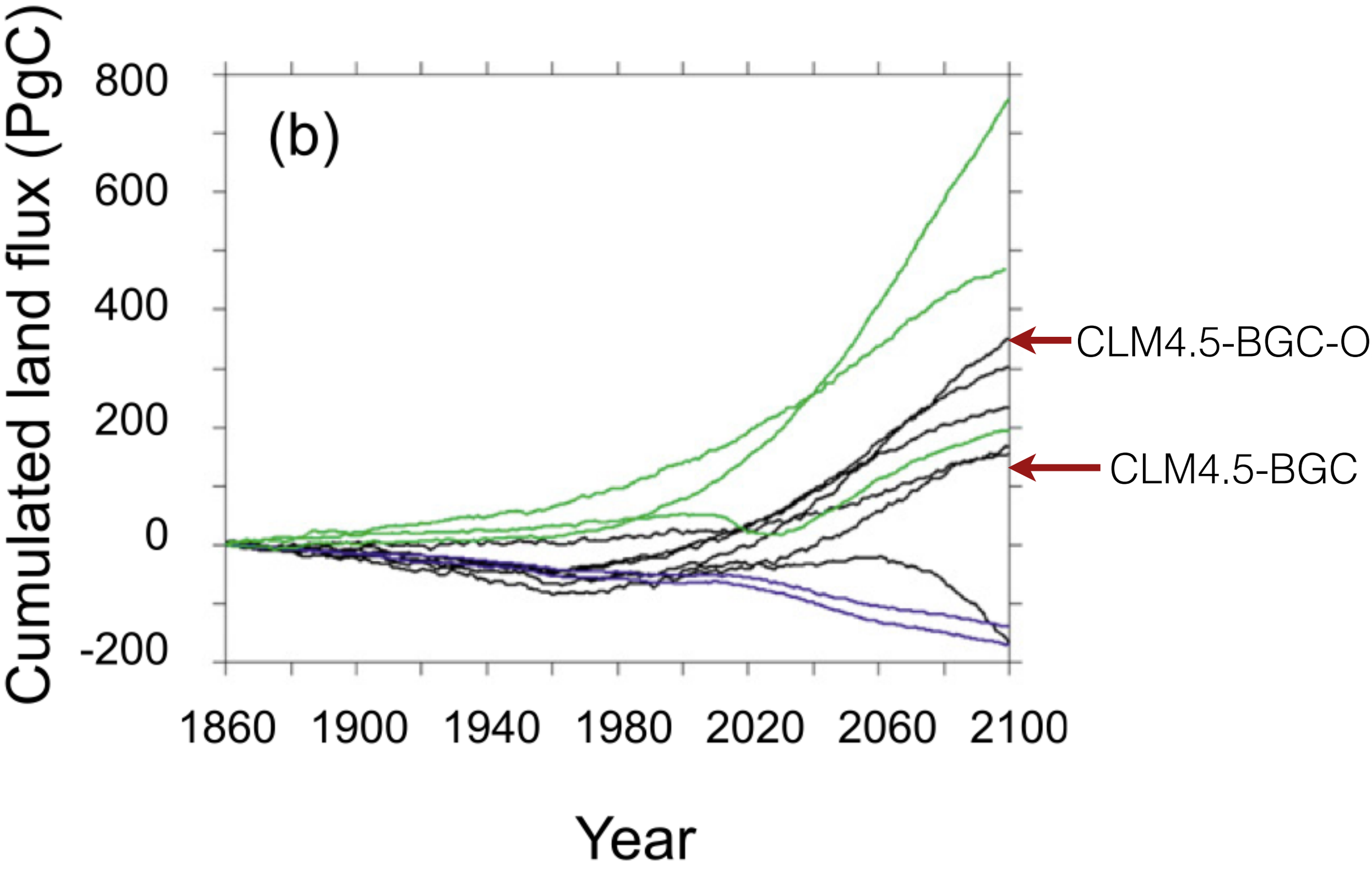


Multi-model Ecosystem Carbon



Friedlingstein et al. 2014

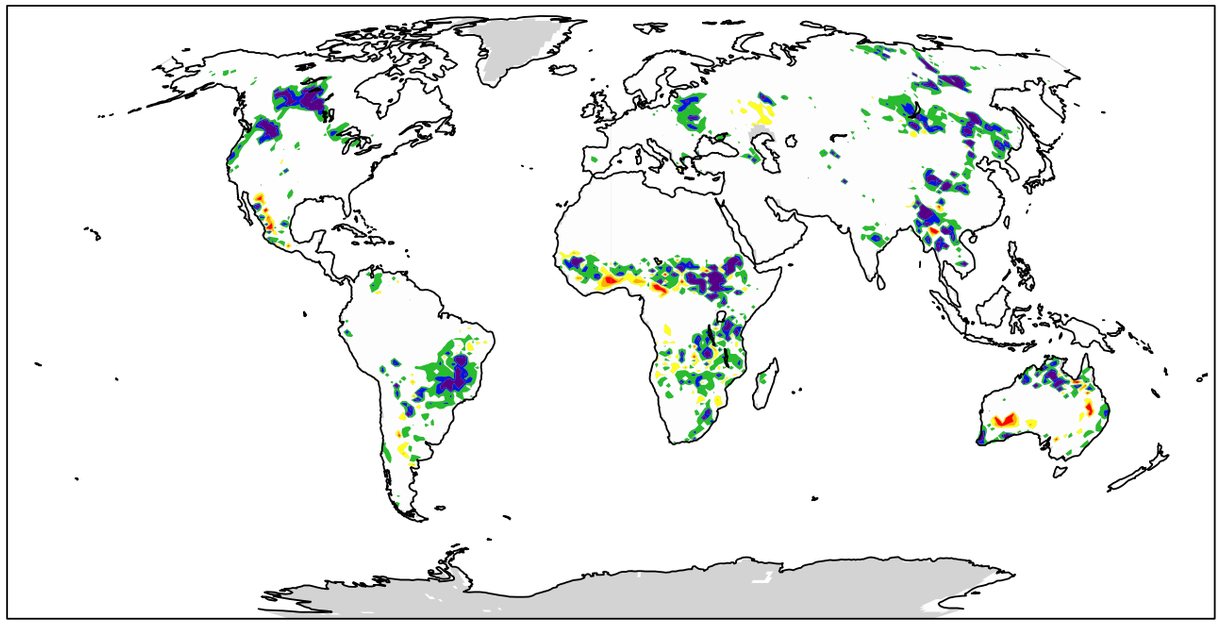
Multi-model Ecosystem Carbon

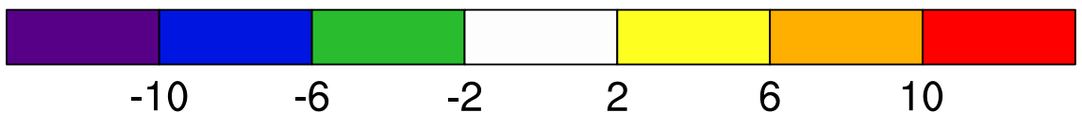


Friedlingstein et al. 2014

O_3 decreases burned area

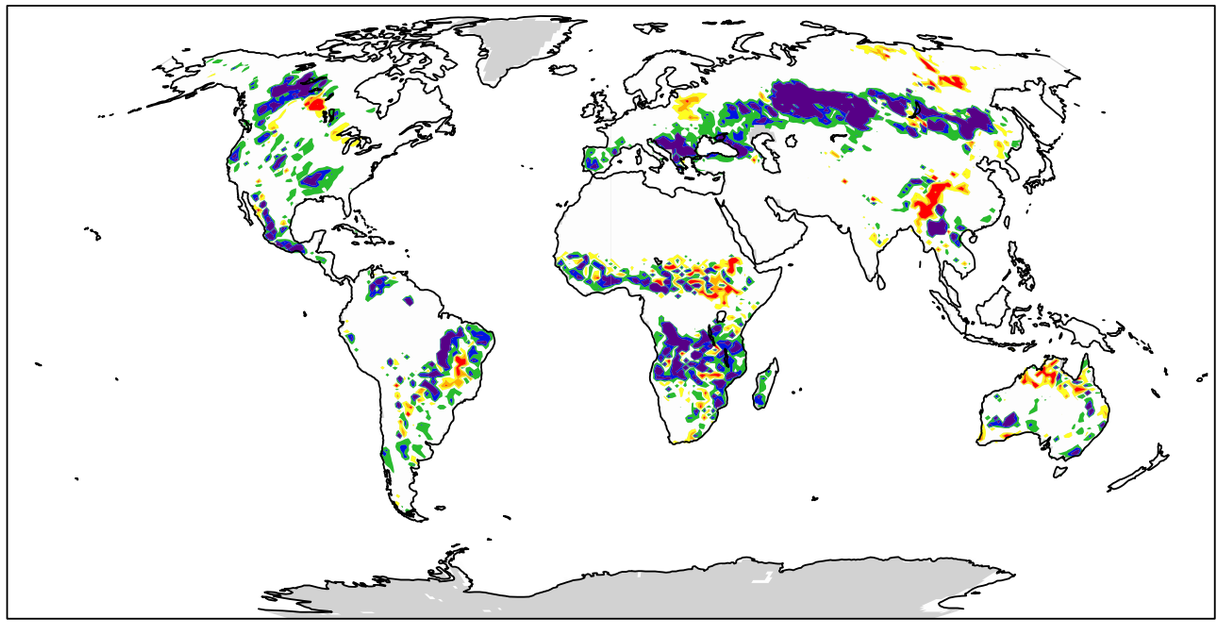
2006 Difference due to O_3

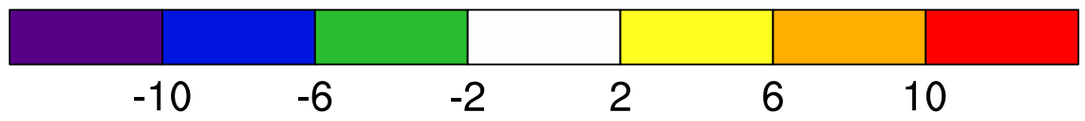




Δ Area Burned (% yr^{-1})

2100 Difference due to O_3*





Δ Area Burned (% yr^{-1})

Fire Occurrence in CLM

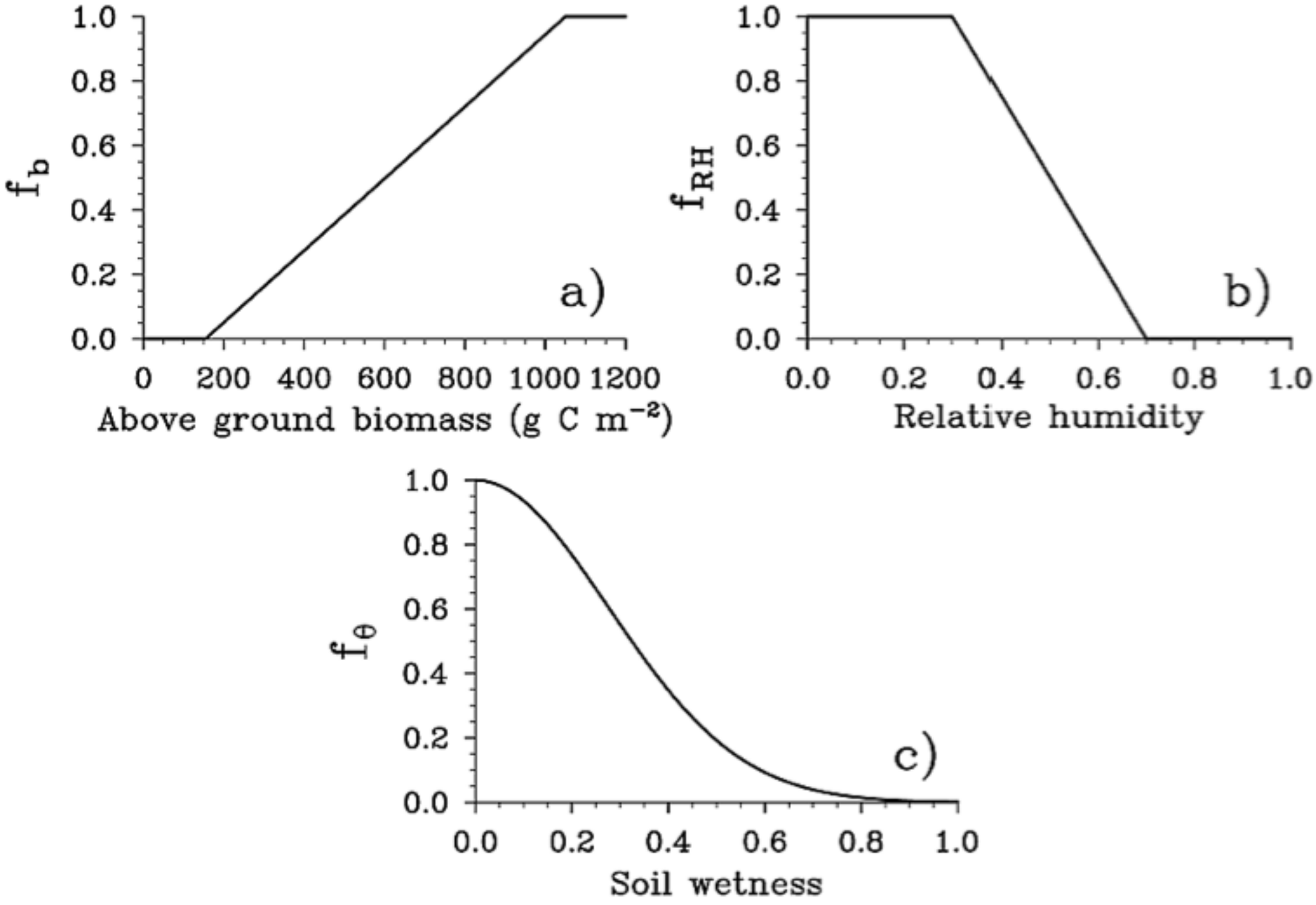


Fig. 3. Dependence of fire occurrence on **(a)** fuel availability f_b, **(b)** relative humidity f_{RH}, and **(c)** soil wetness f_θ.

Li et al. 2012

Fire Occurrence in CLM

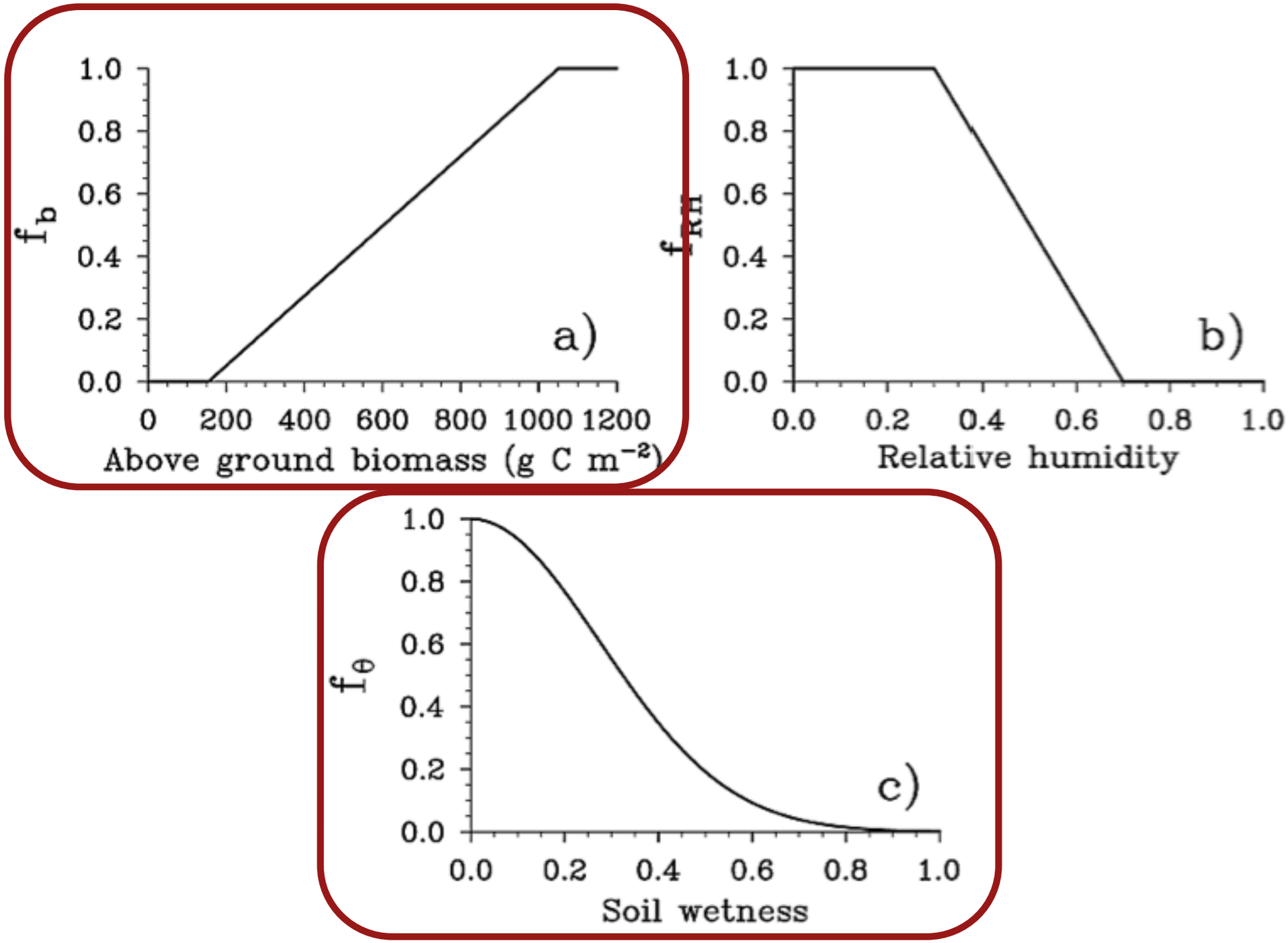
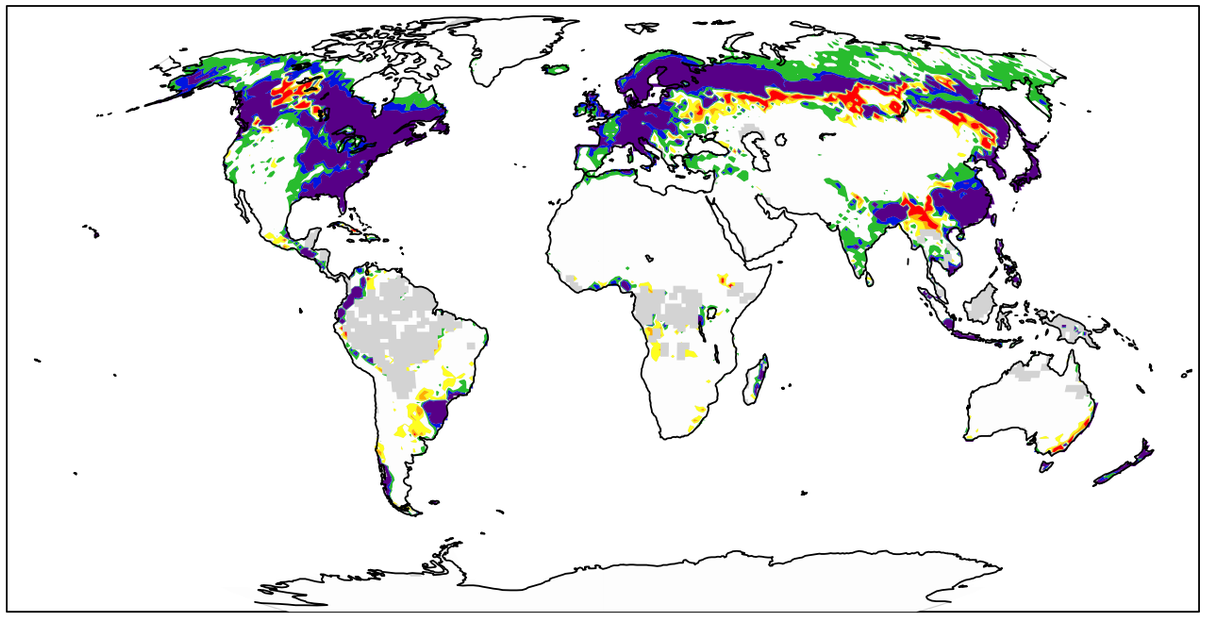


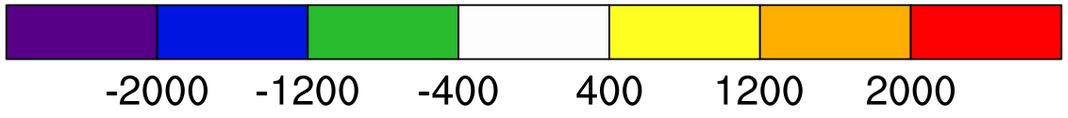
Fig. 3. Dependence of fire occurrence on **(a)** fuel availability f_b, **(b)** relative humidity f_{RH}, and **(c)** soil wetness f_θ.

Li et al. 2012

Available Fuel

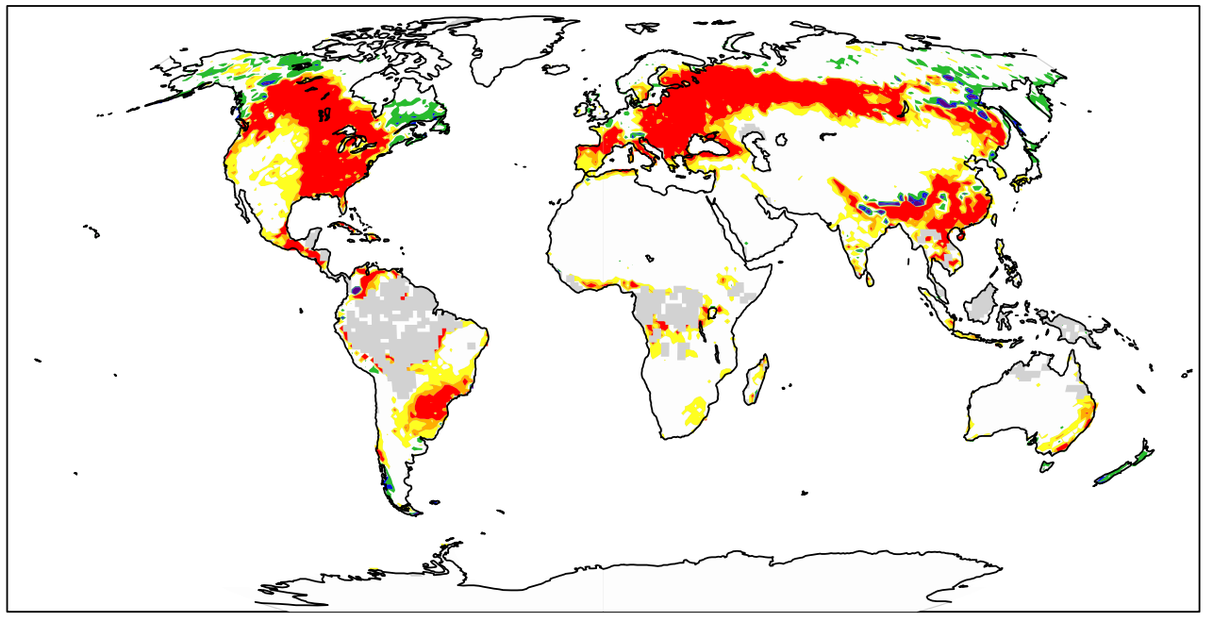
2006 Difference due to O_3

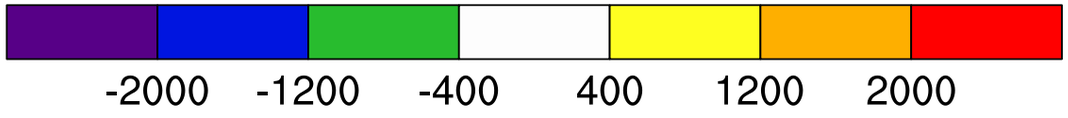




Δ Fuel Carbon (g m^{-2})

2100 Difference due to O_3*

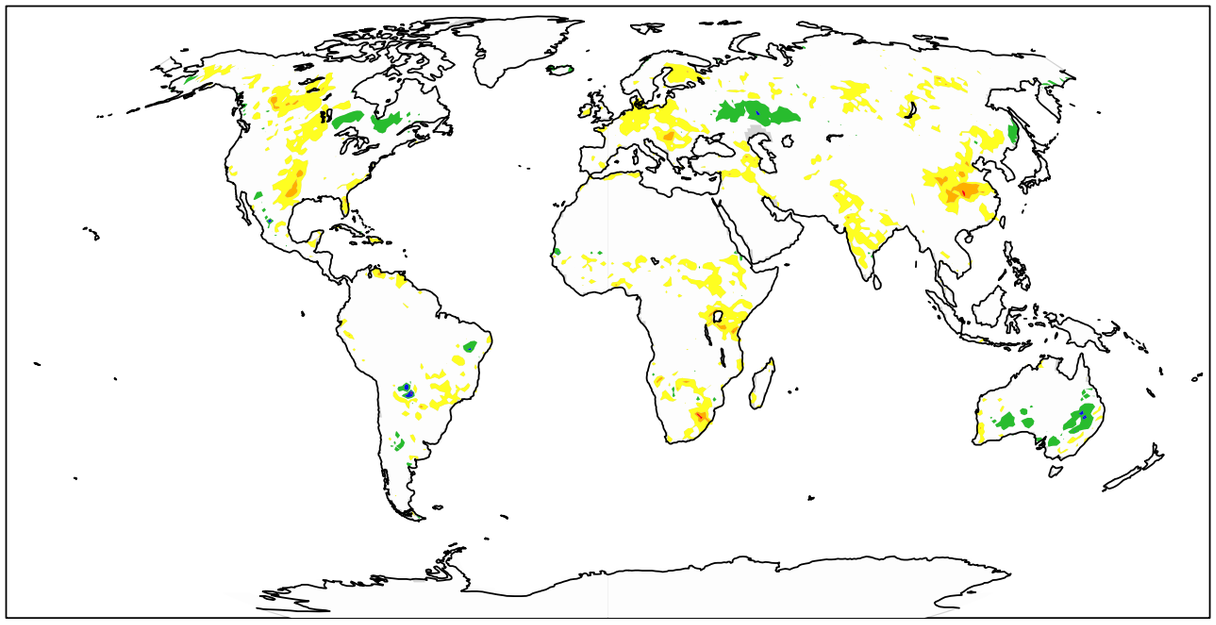


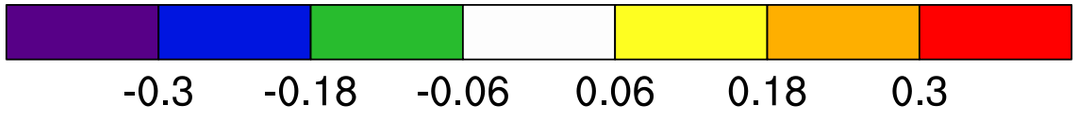


Δ Fuel Carbon (g m^{-2})

Soil Wetness

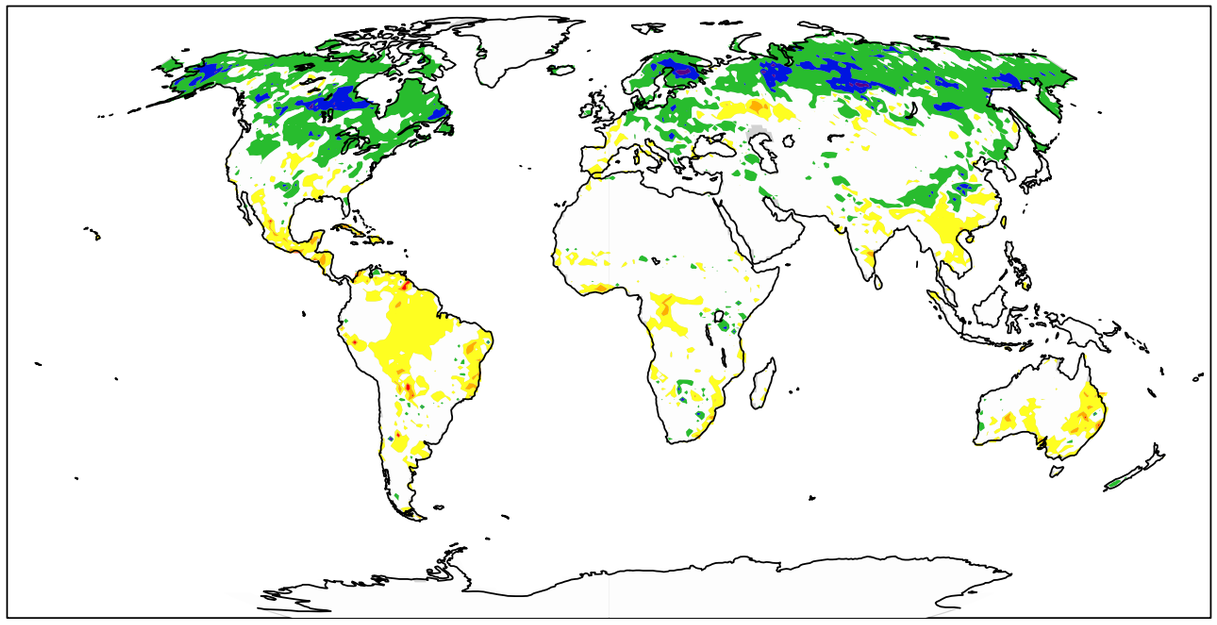
2006 Difference due to O_3

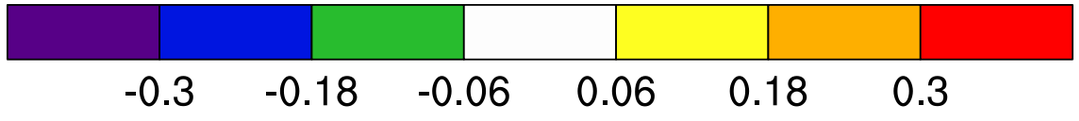




Δ Soil Moisture Scalar

2100 Difference due to O_3*



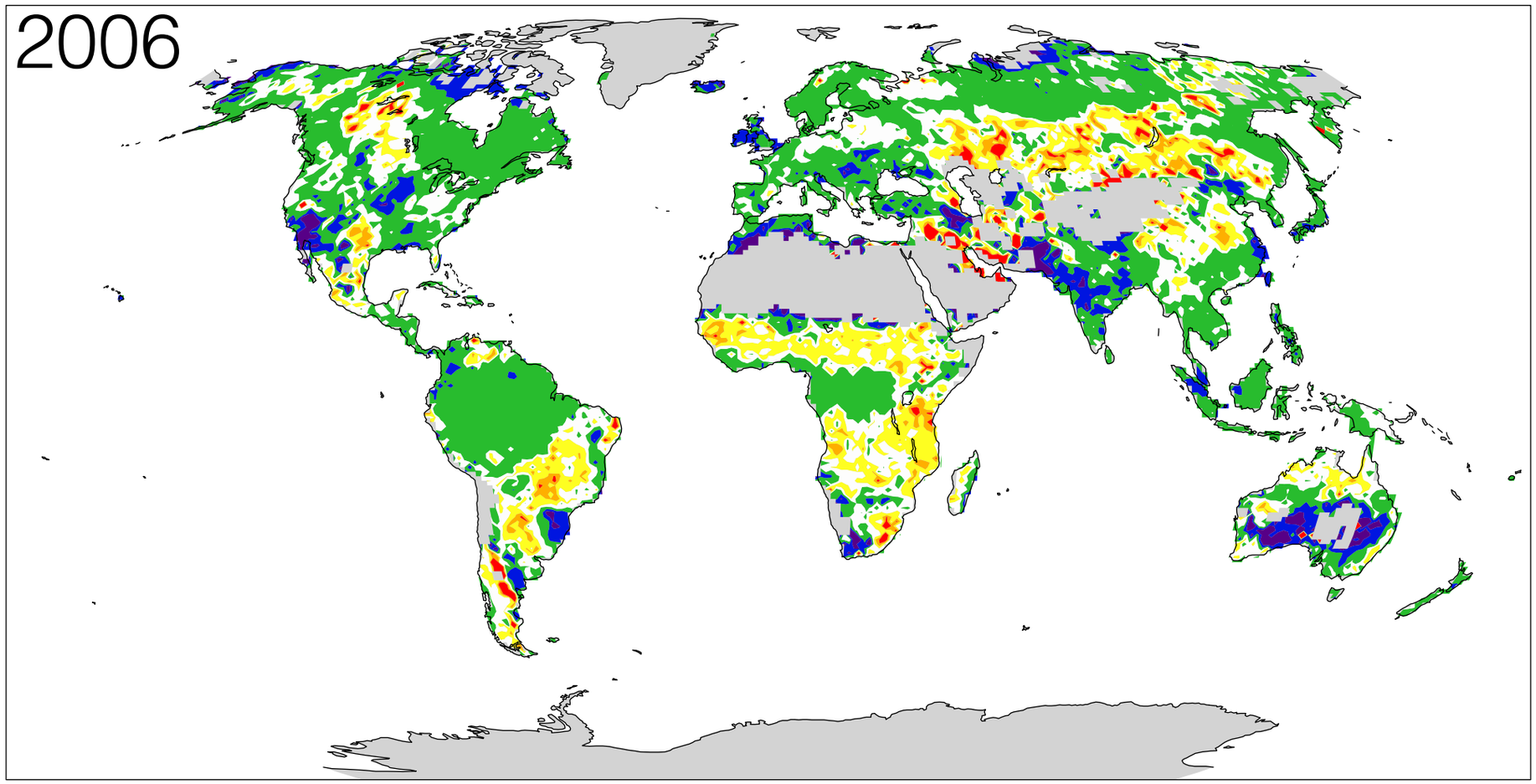


Δ Soil Moisture Scalar

Summary

- O_3 decreases fire occurrence, increasing ecosystem C
- Interactions driven by fuel availability
- Magnitude of change is likely unrealistic
- Need for evaluation & tuning of fire & O_3 models

Models are necessary to determine large-scale interactions, which are otherwise difficult to observe or measure.

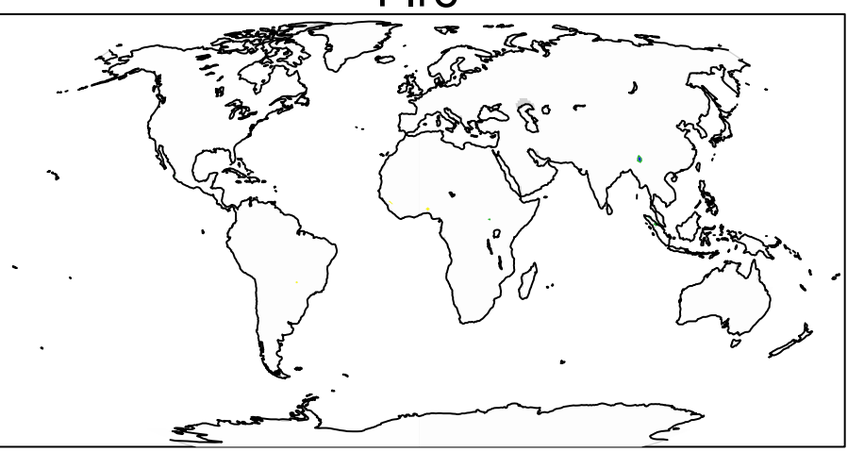


-50 -30 -10 10 30 50

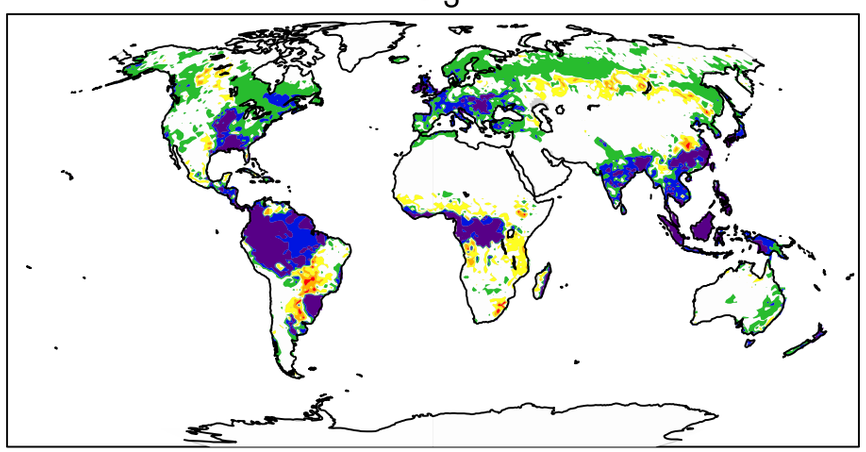
Change in GPP due to O_3 (%)

Note: Fire does not directly alter GPP

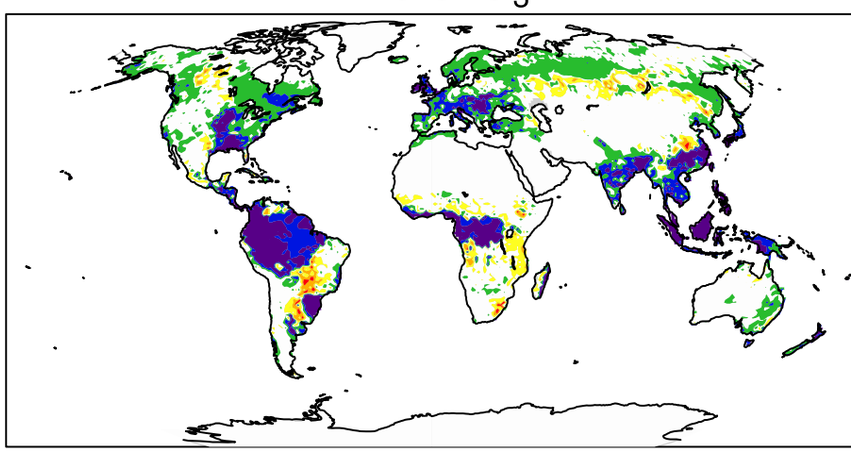
Fire

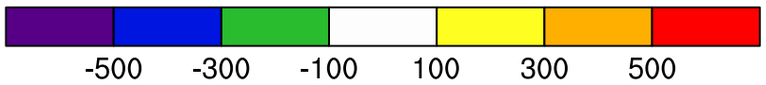


O_3

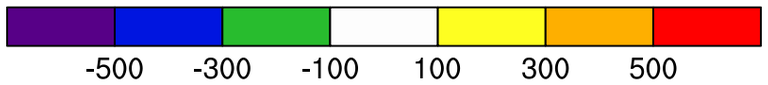


Fire & O_3

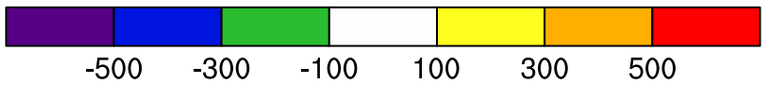




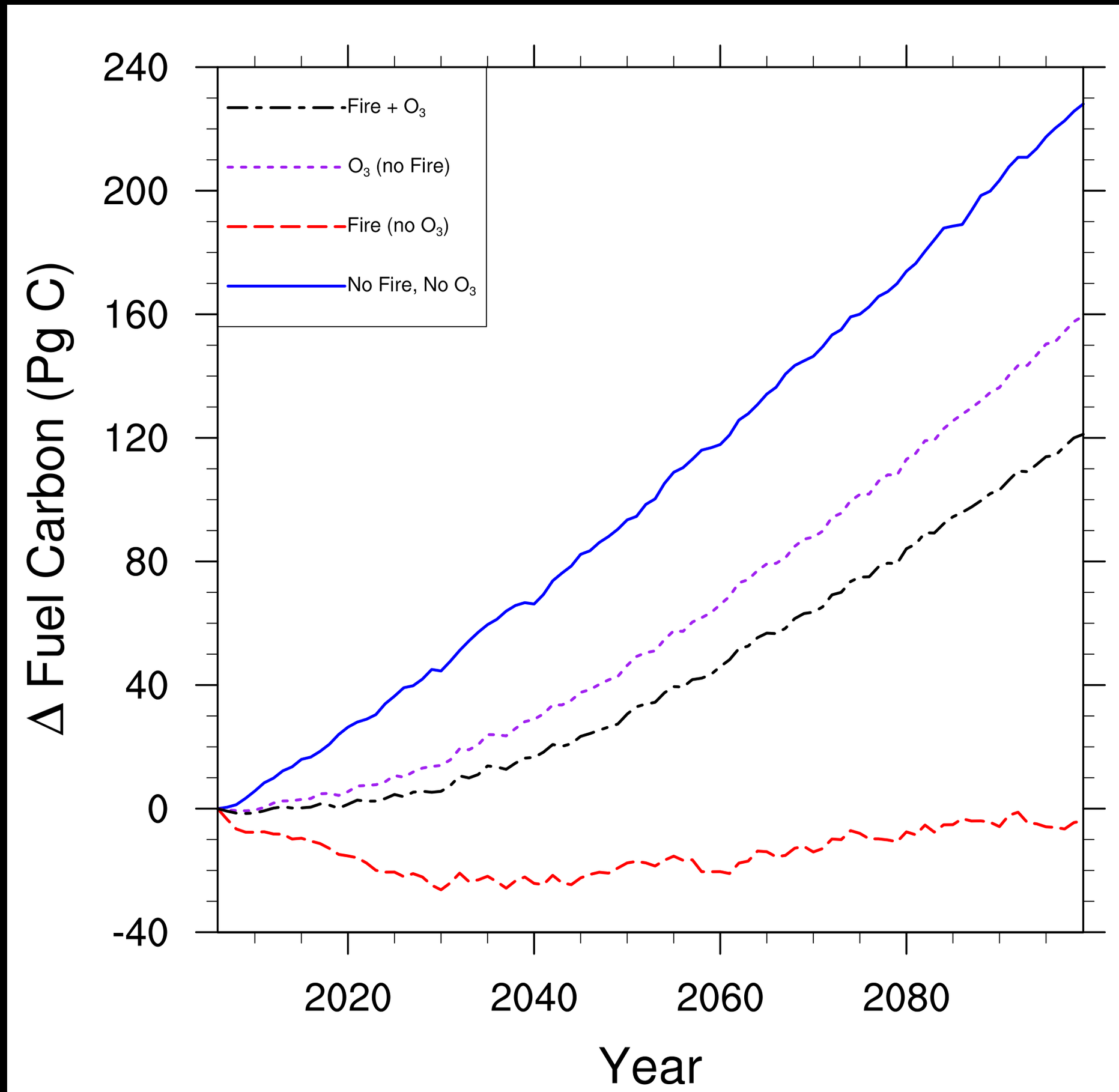
2006 Δ GPP (g C m^{-2} yr^{-1})

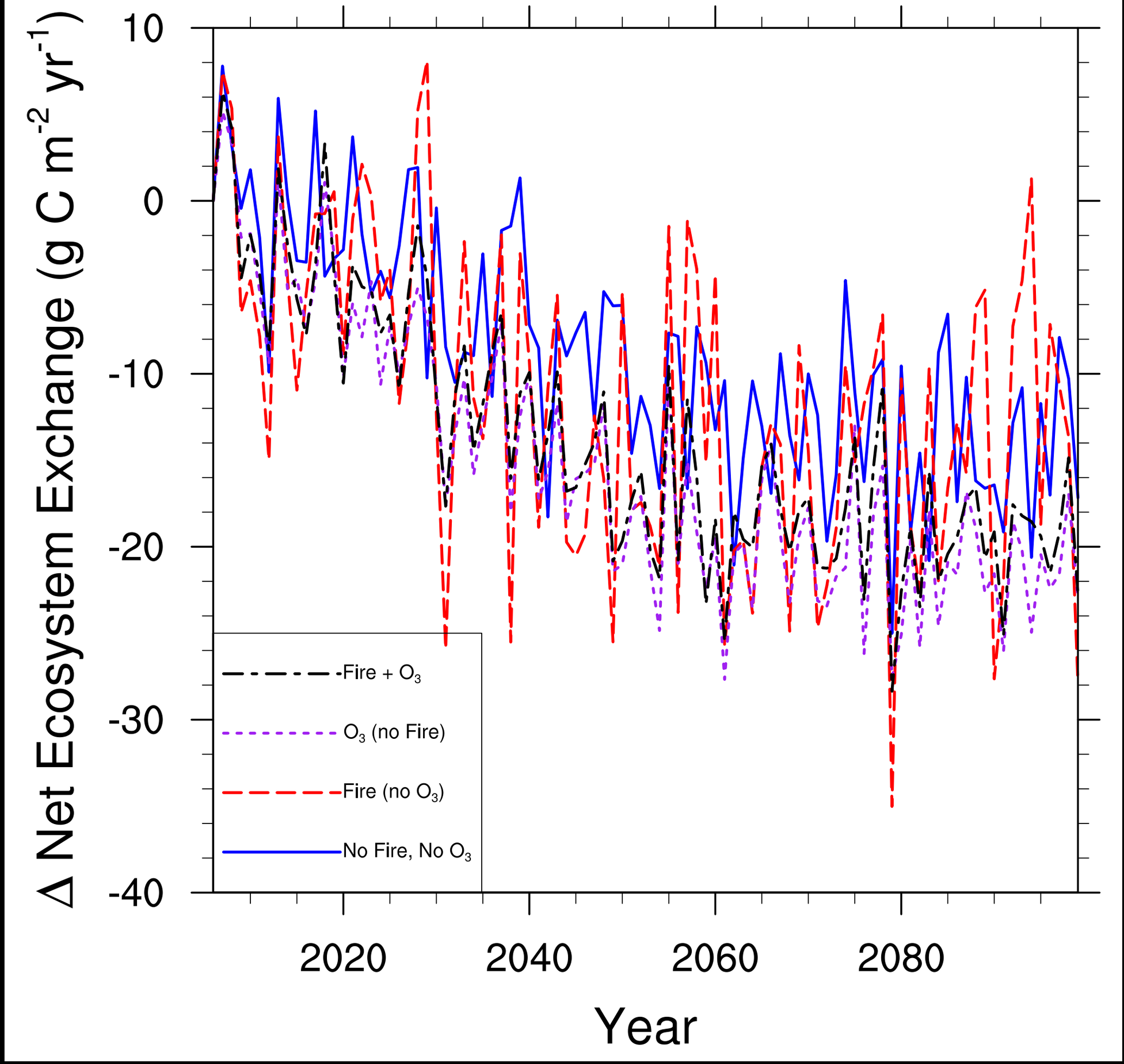


2006 Δ GPP (g C m^{-2} yr^{-1})

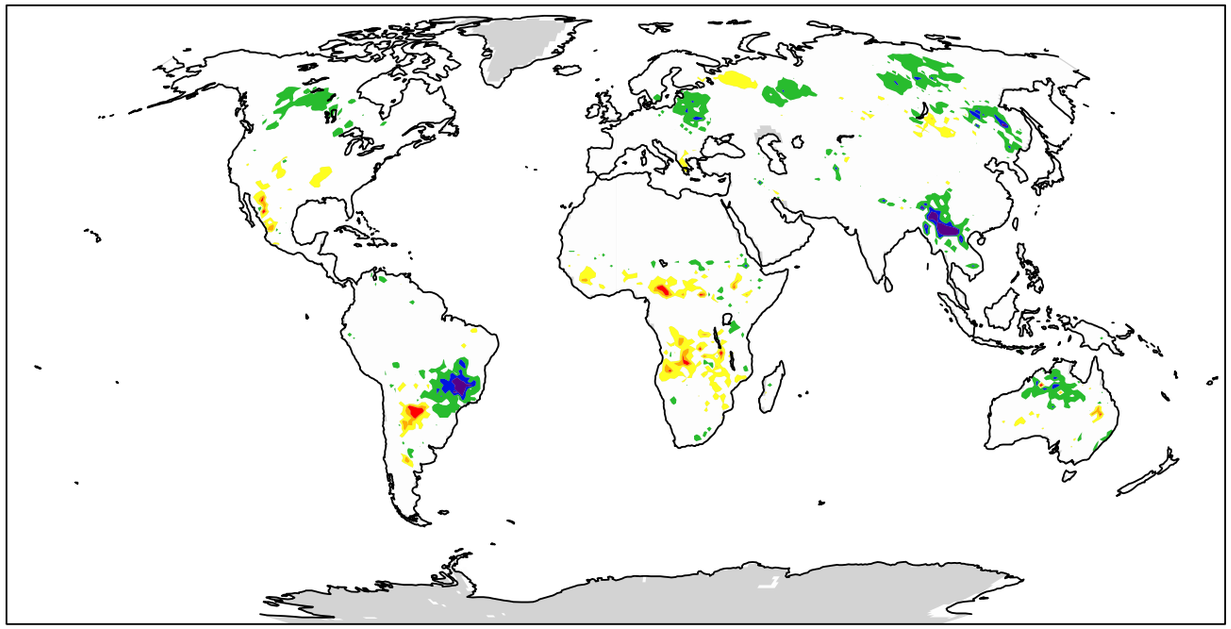


2006 Δ GPP (g C m^{-2} yr^{-1})


240
200
160
120
80
40
0
-40
Δ Fuel Carbon (Pg C)
Fire + O3
O3 (no Fire)
Fire (no O3)
No Fire, No O3
2020
2040
2060
2080
Year


Δ Net Ecosystem Exchange (g C m-2 yr-1)
10
0
-10
-20
-30
-40
2020
2040
2060
2080
Year
Fire + O3
O3 (no Fire)
Fire (no O3)
No Fire, No O3

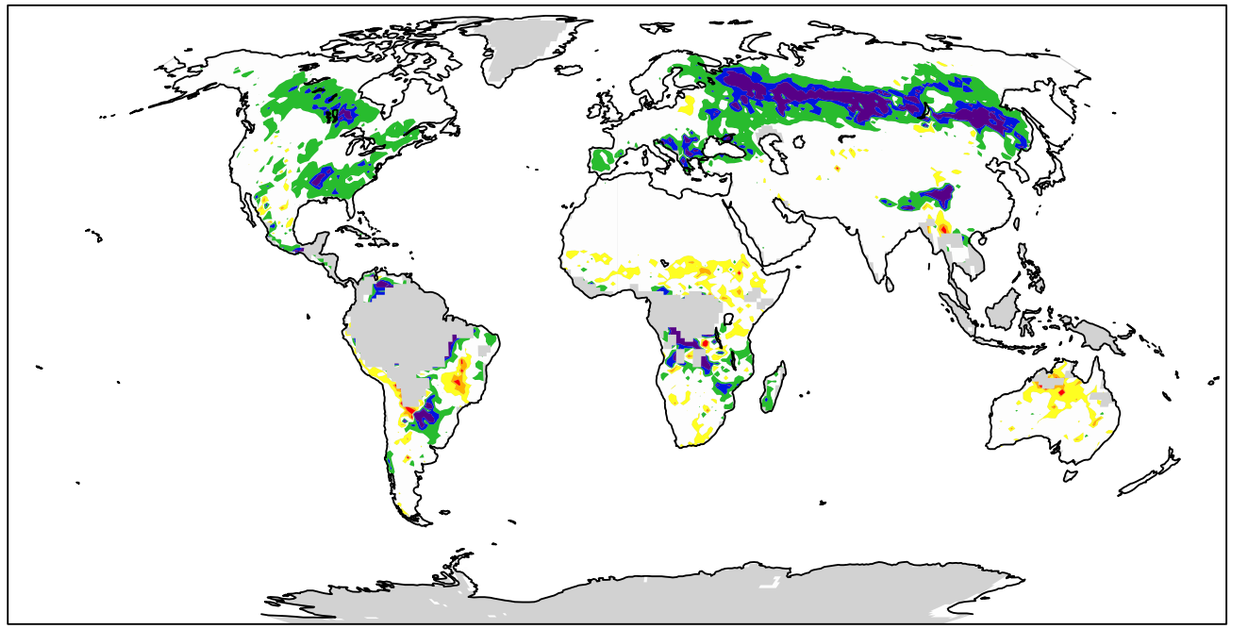
2006 Difference due to O_3



-0.05 -0.03 -0.01 0.01 0.03 0.05

Δ Fire Occurrance (counts km^{-2} yr^{-1})

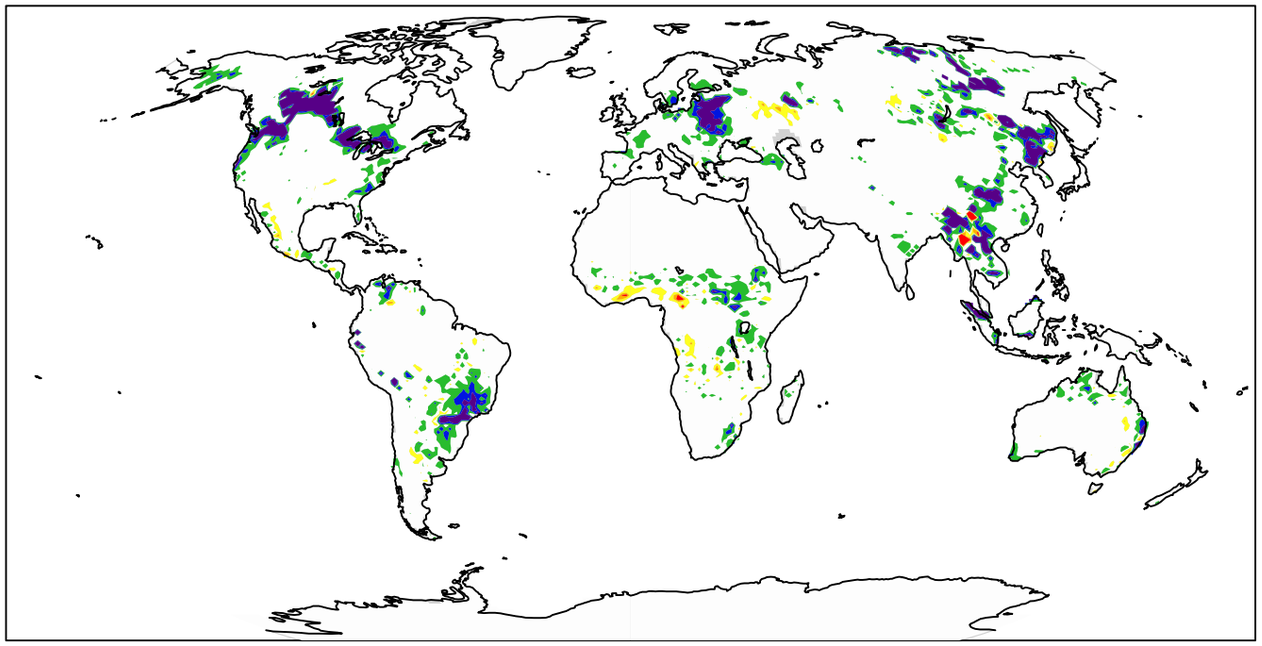
2100 Difference due to O_3*



-0.05 -0.03 -0.01 0.01 0.03 0.05

Δ Fire Occurrance (counts km^{-2} yr^{-1})

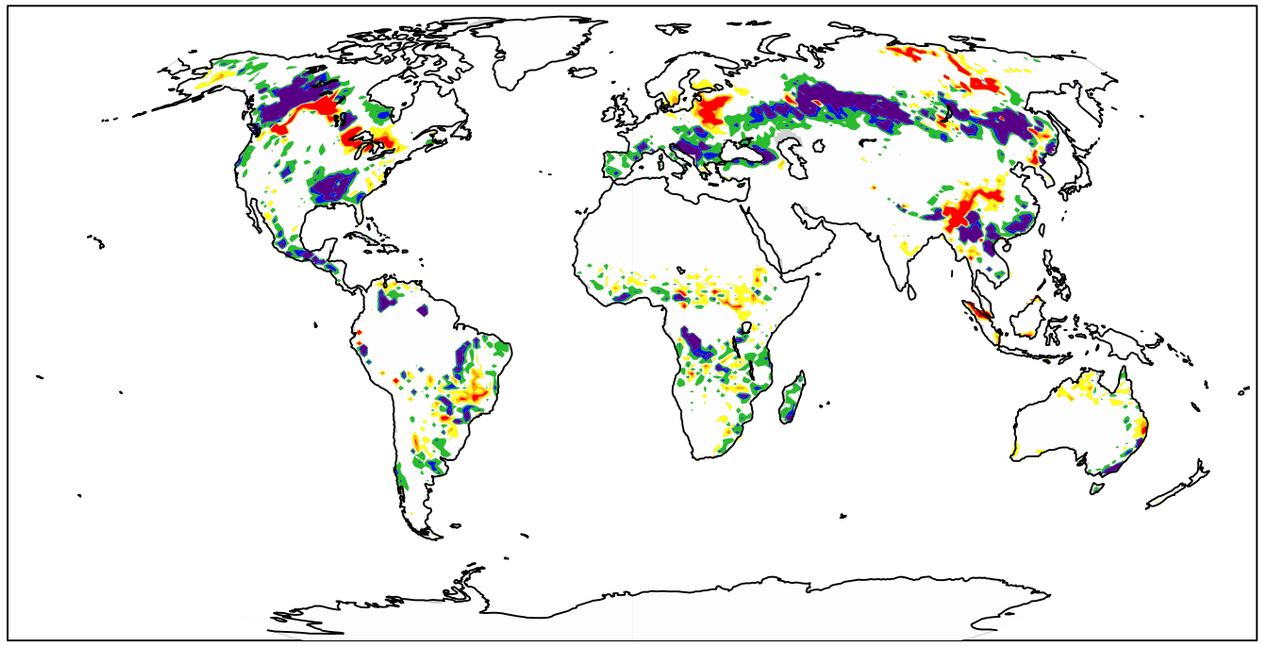
2006 Difference due to O_3



-100 -60 -20 20 60 100

Δ Fire C Emissions (g C m^{-2} yr^{-1})

2100 Difference due to O_3*



-100 -60 -20 20 60 100

Δ Fire C Emissions (g C m^{-2} yr^{-1})