Characterizing ENSO Teleconnections Impacts on Gross Primary Productivity across CMIP6 Earth System Models

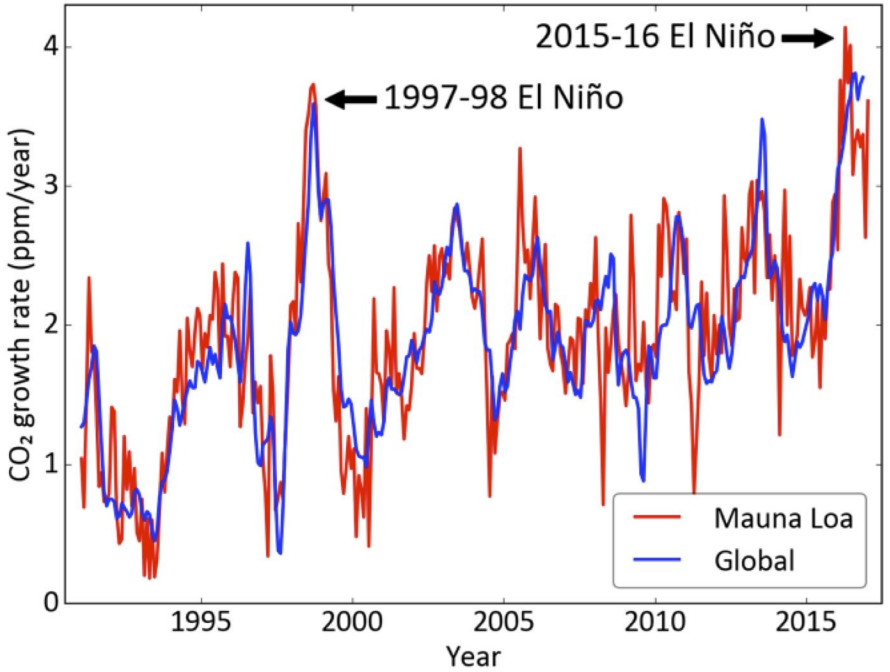
Maria Salazar
Drs. Gretchen Keppel-Aleks & Allison Steiner

University of Michigan

RUBISCO
REDUCING UNCERTAINTIES IN BIOGEOCHEMICAL INTERACTIONS THROUGH SYNTHESIS AND COMPUTATION

ENSO impacts Atmospheric CO_2 Fluctuations

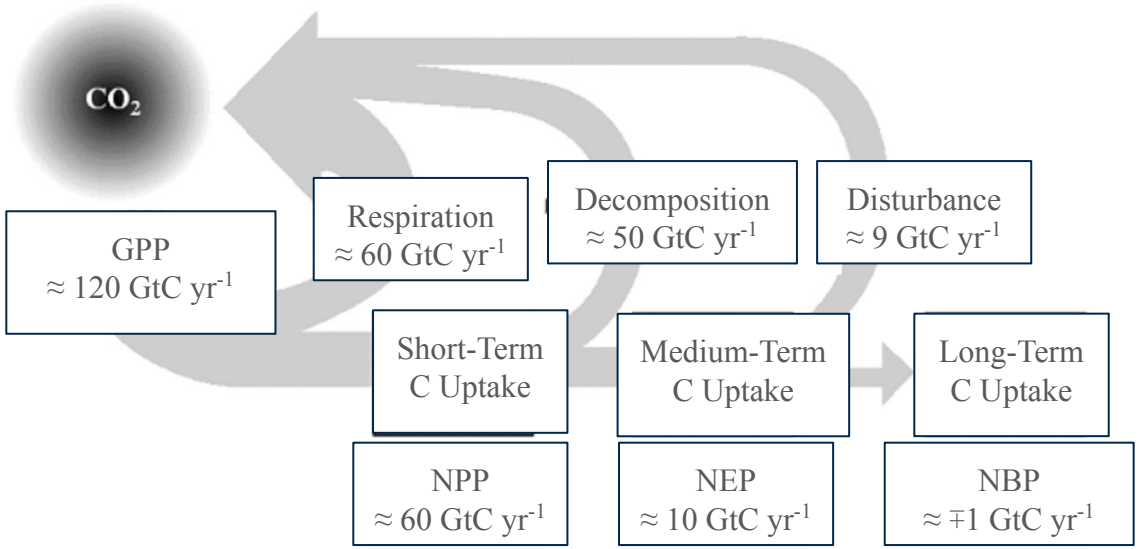
- Variations in atmospheric CO_2 growth rate are related to ENSO
- If El Niño is causing these large CO_2 growth rates, what is the driving mechanisms?
- ENSO drives changes in global climate



The Climate Tango of ENSO and CO_2 - EGU Blogs

ENSO impacts Carbon Cycle Interannual Variability

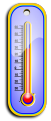
- Terrestrial photosynthesis is the single largest exchange of carbon between the atmosphere and another reservoir
- ENSO is important for understanding interannual variability in the carbon cycle which has implications for atmospheric CO_2 growth rate



Steffen et al., 1998

Solar Radiation

Precipitation



Temperature

(1) How do CMIP6 Earth System Models represent interannual variability in terrestrial productivity associated with ENSO teleconnections?

(2) What climate variables drive changes in terrestrial productivity associated with ENSO teleconnections?

(3) Are differences between models attributable to the dynamics or the land model response?

- Historical 1950-2014 Monthly Output
- 10 CMIP6 ESMs:

ACCESS-ESM1-5
BCC-CSM2-MR
CanESM5
CESM2
CMCC-ESM2
IPSL-CM6A-LR
MIROC-ES2L
MPI-ESM1-2-LR
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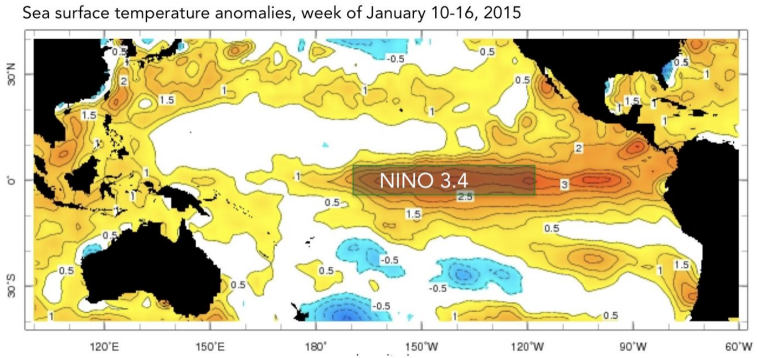
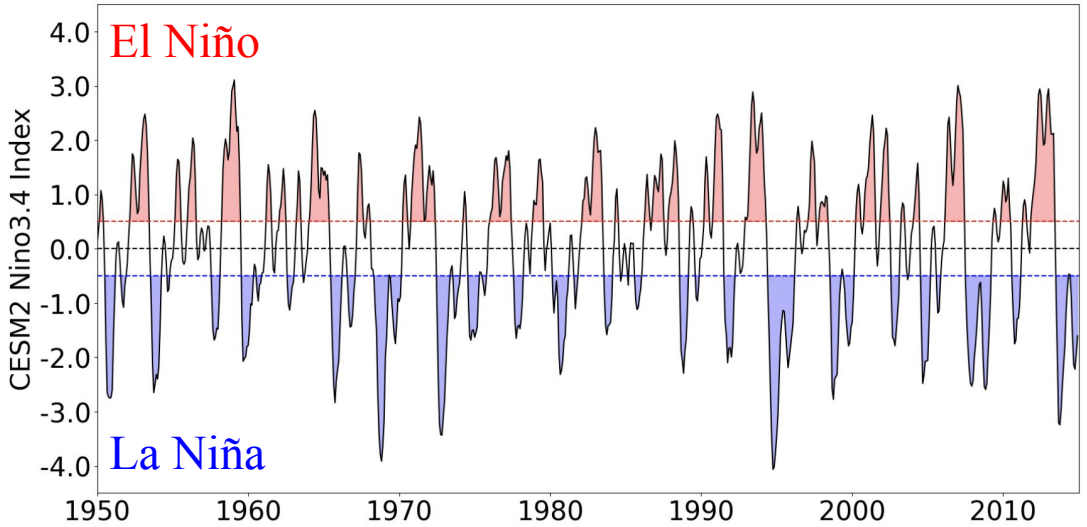
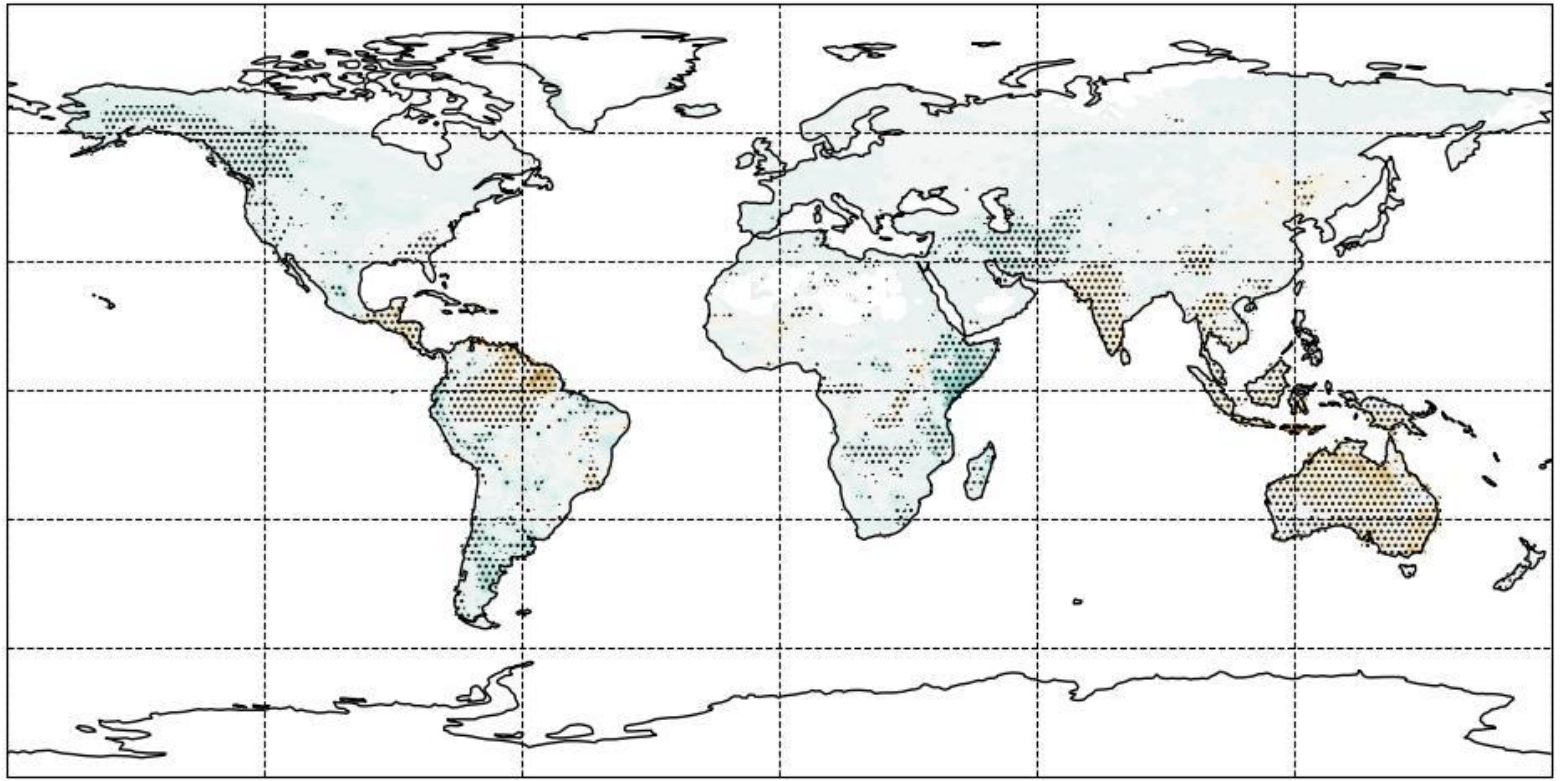


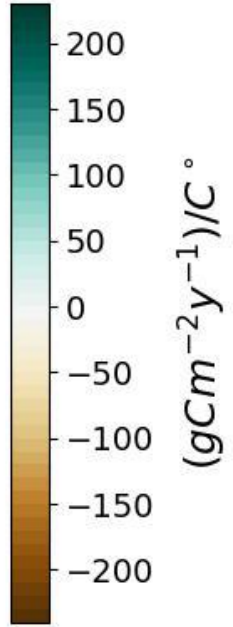
Columbia Climate News



Regression Nino3.4 Index with GPP Anomalies, CESM2, 1950-2014

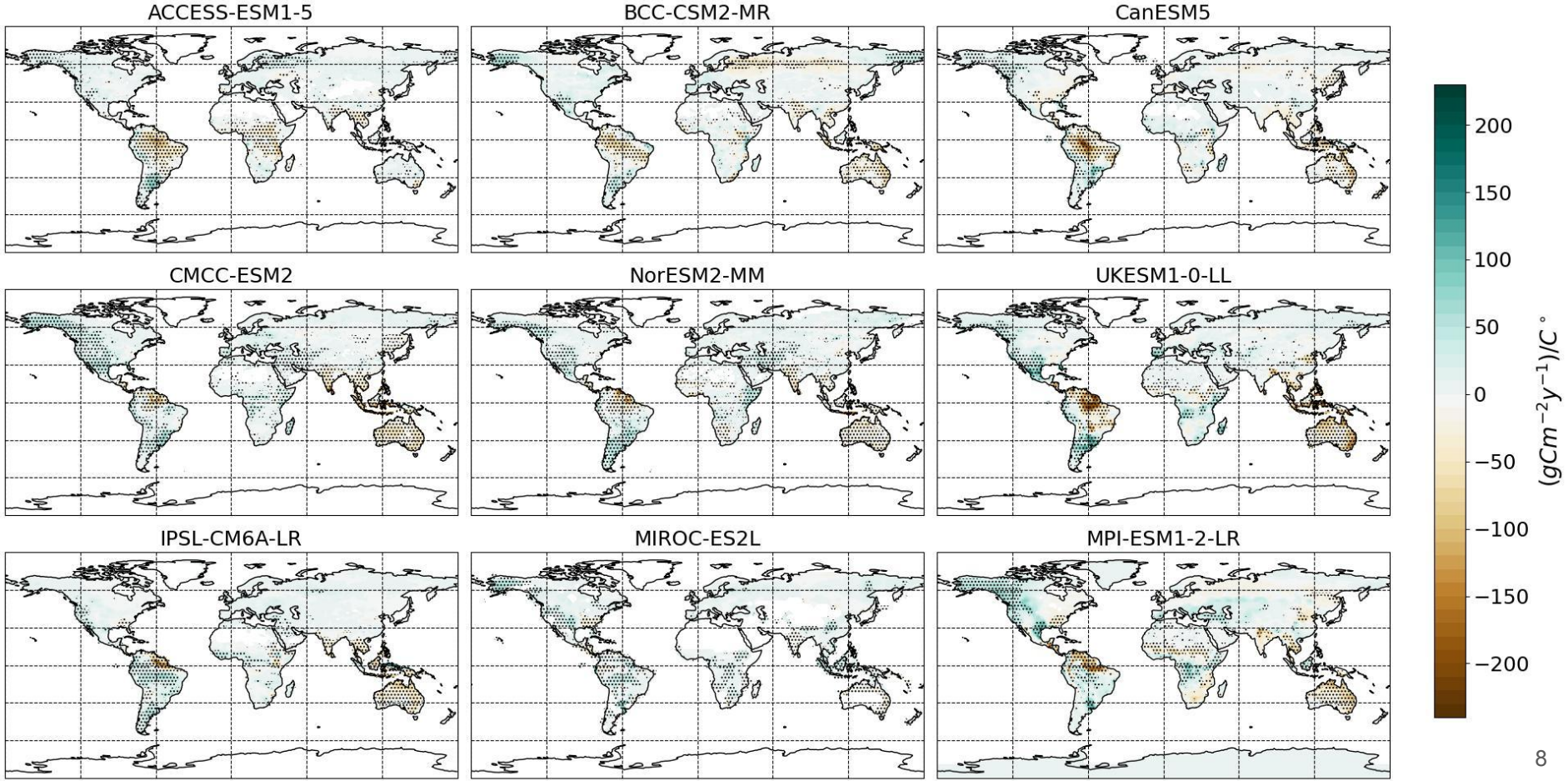


Enhanced GPP during El Niño

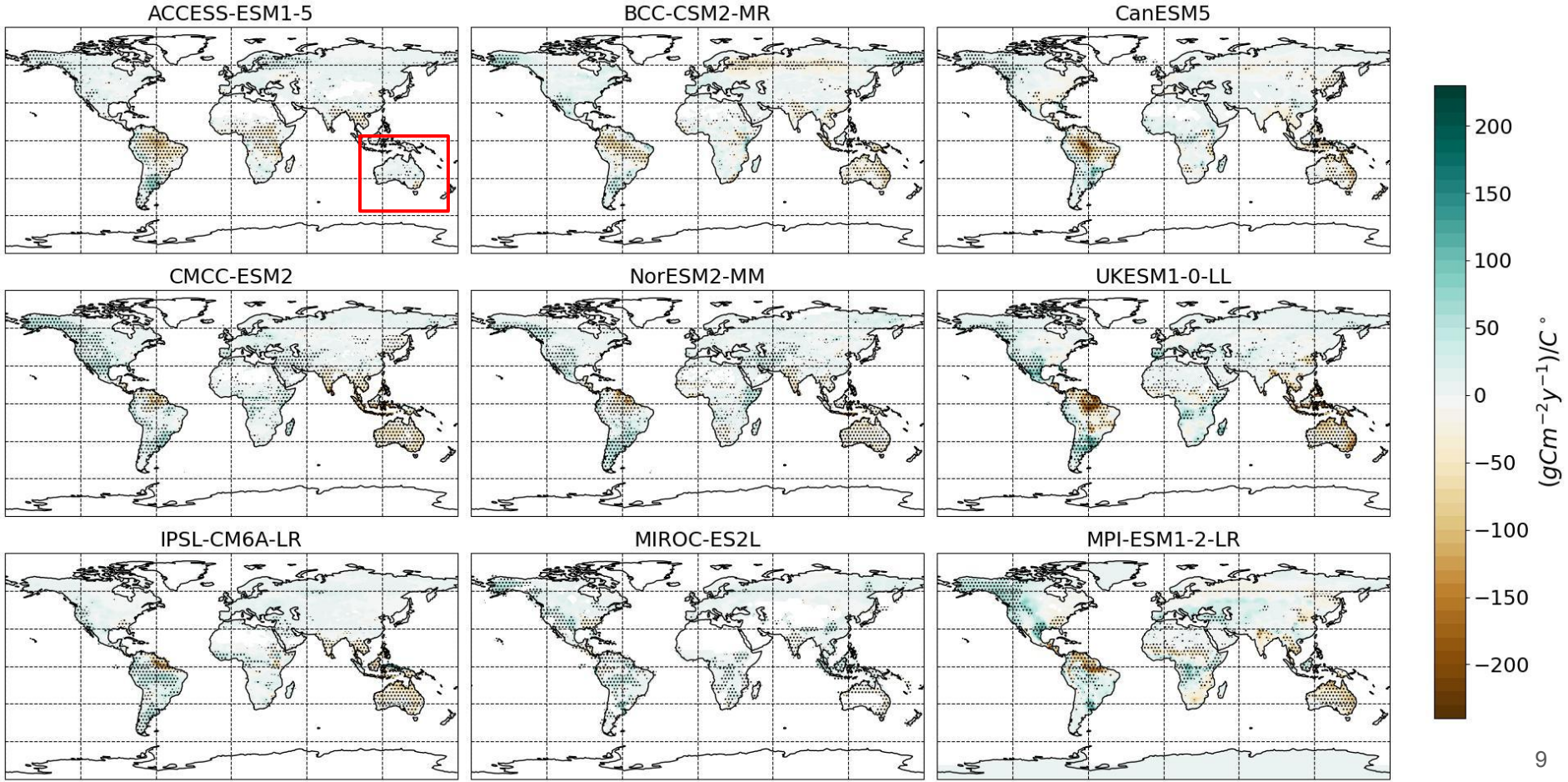


Suppressed GPP during El Niño

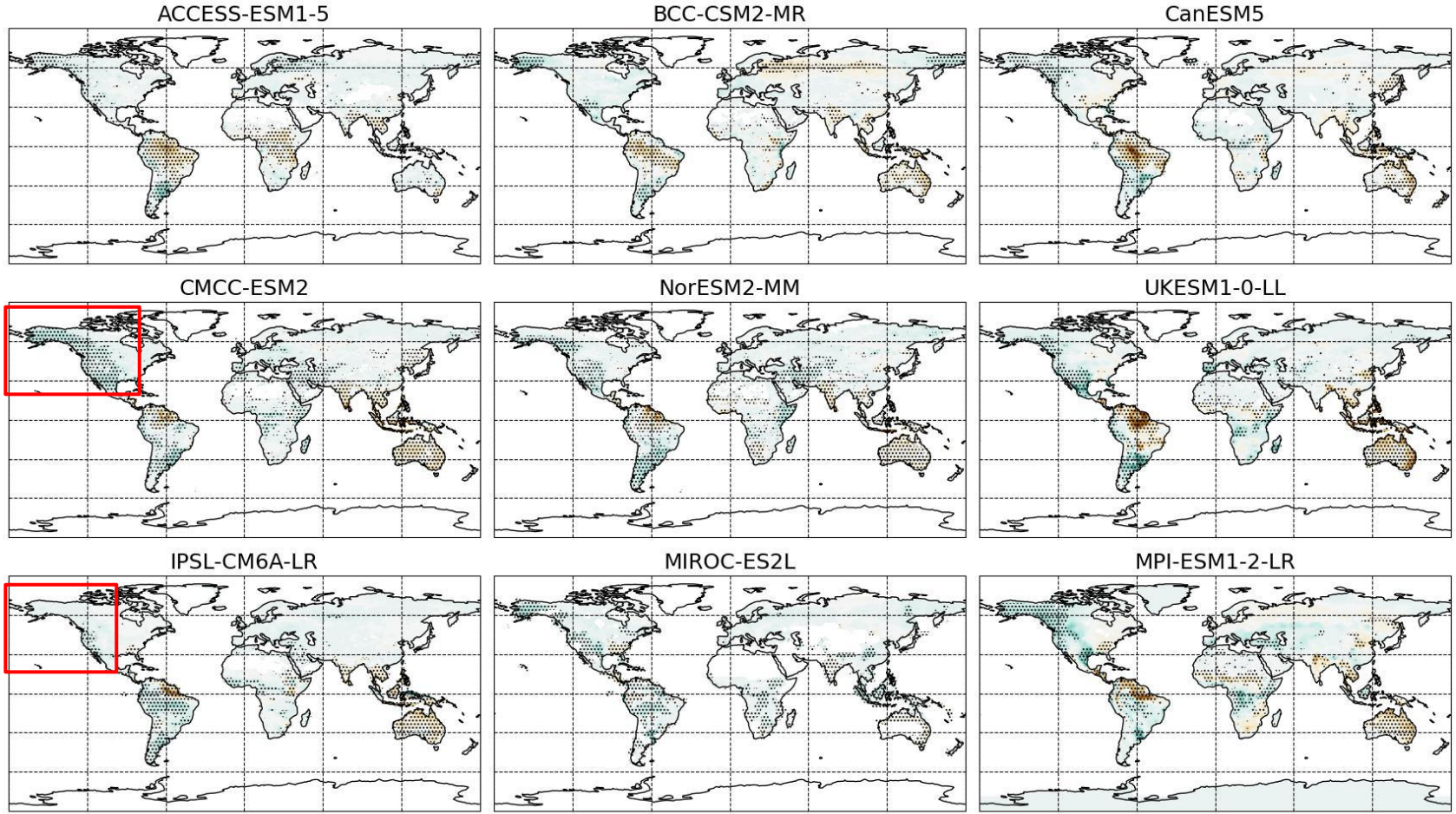
Regression Nino3.4 Index with GPP Anomalies, CMIP6 Ensemble



Regression Nino3.4 Index with GPP Anomalies, CMIP6 Ensemble



Regression Nino3.4 Index with GPP Anomalies, CMIP6 Ensemble



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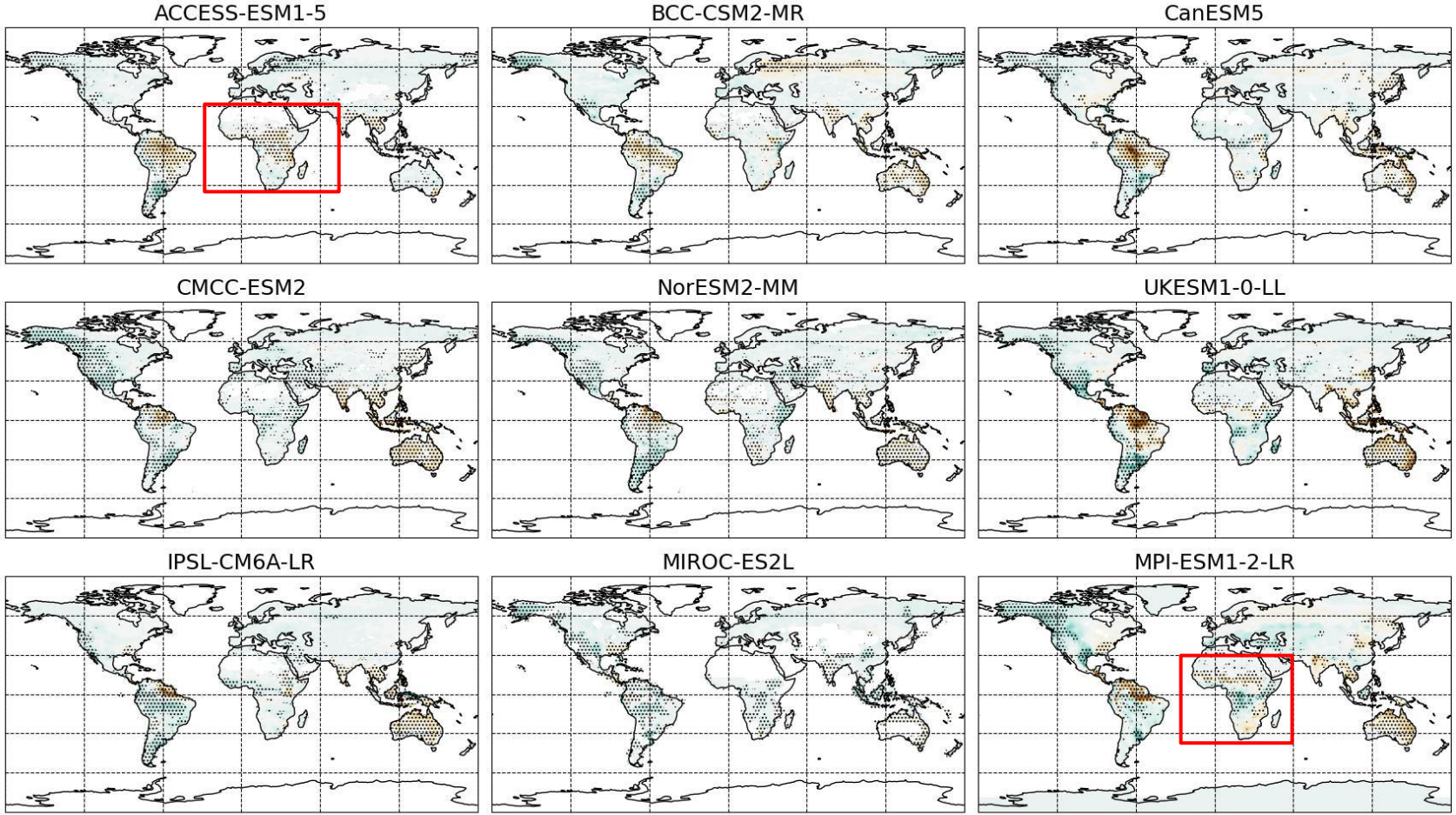

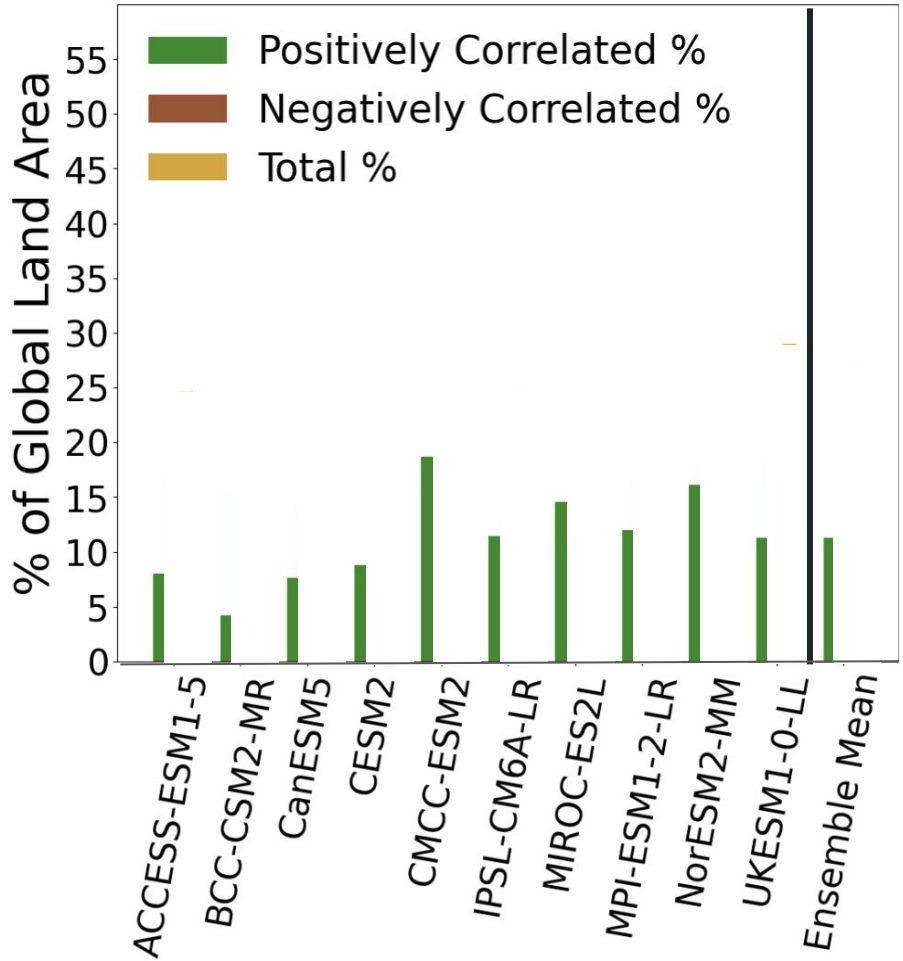
Positively Correlated %
Negatively Correlated %
Total %
% of Global Land Area
0
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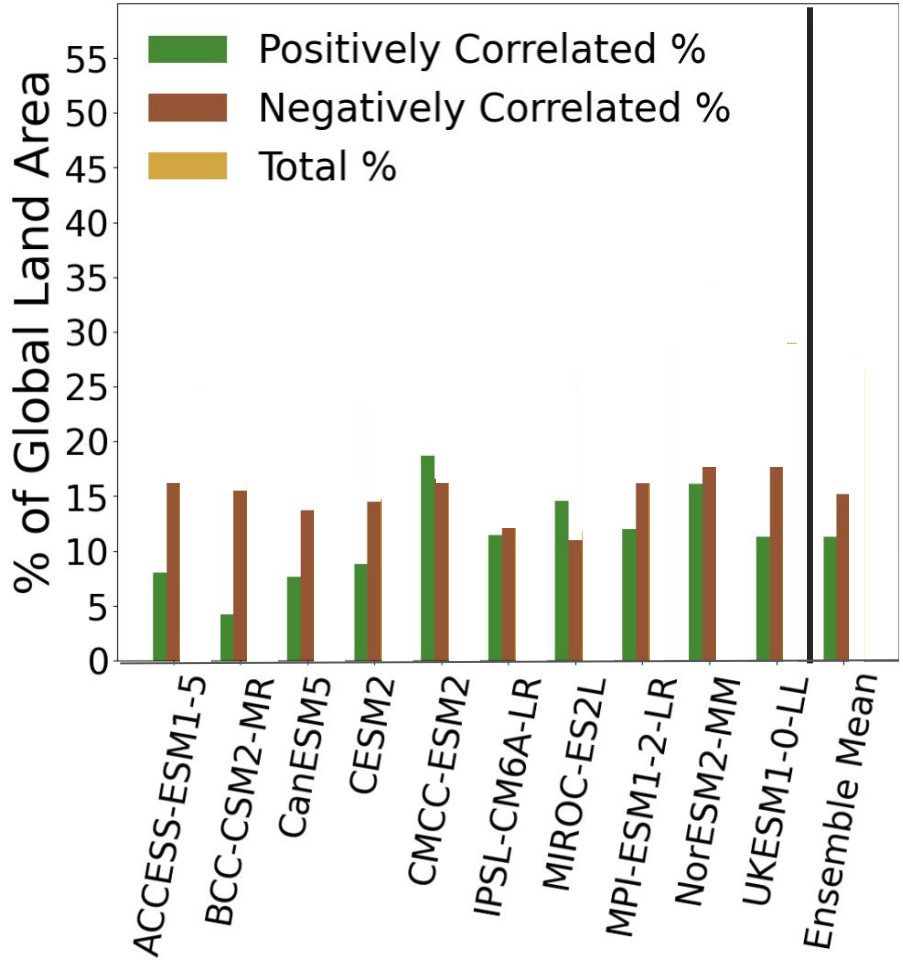
55
ACCESS-ESM1-5
BCC-CSM2-MR
CanESM5
CESM2
CMCC-ESM2
IPSL-CM6A-LR
MIROC-ES2L
MPI-ESM1-2-LR
NorESM2-MM
UKESM1-0-LL
Ensemble Mean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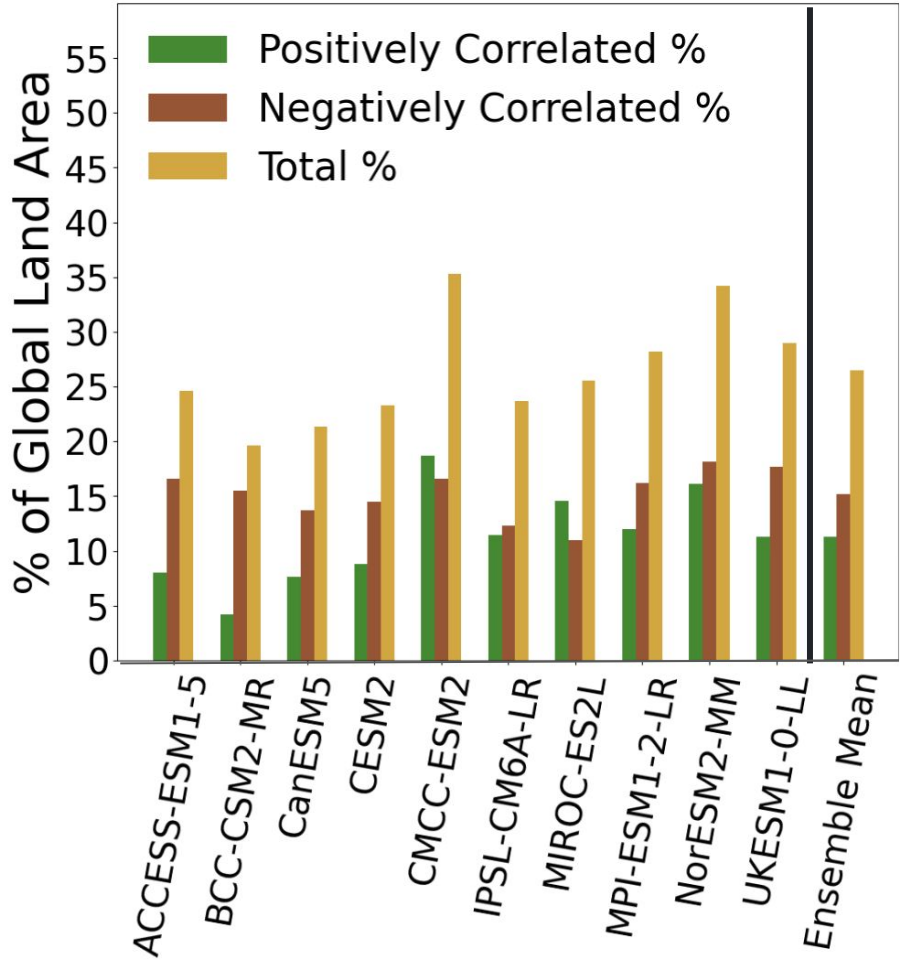
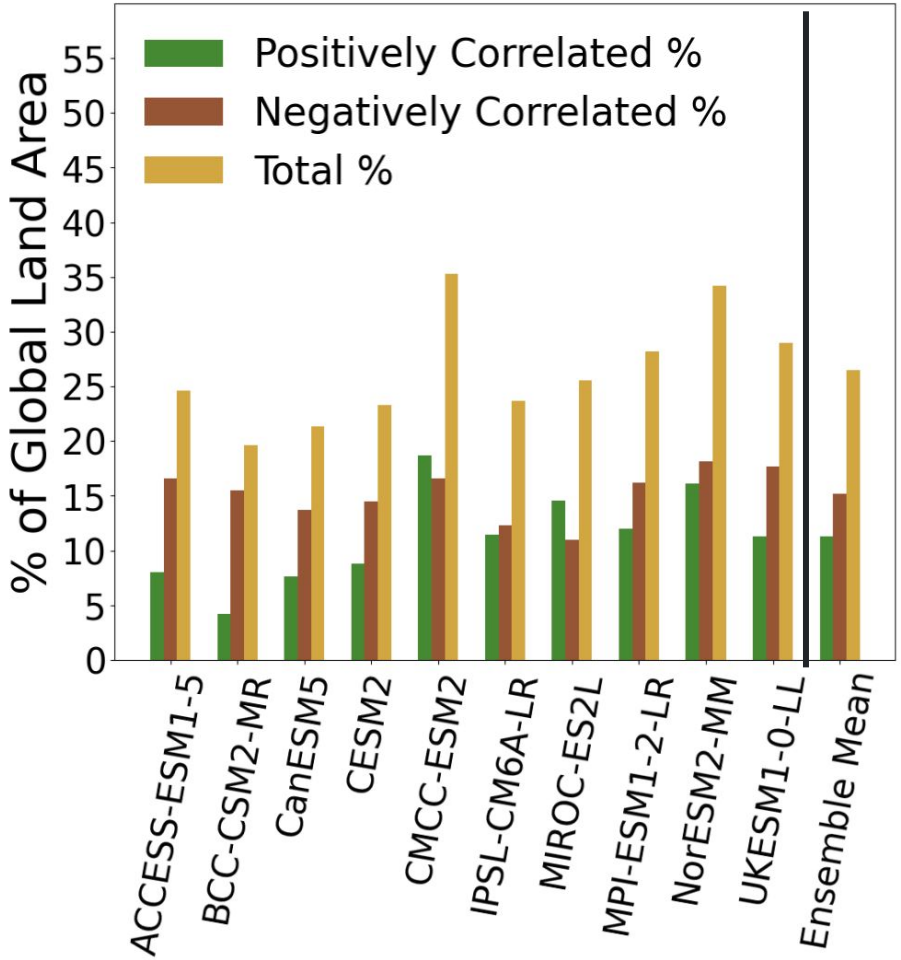
Ensemble Mean Total Land Area Impact: 26.5%

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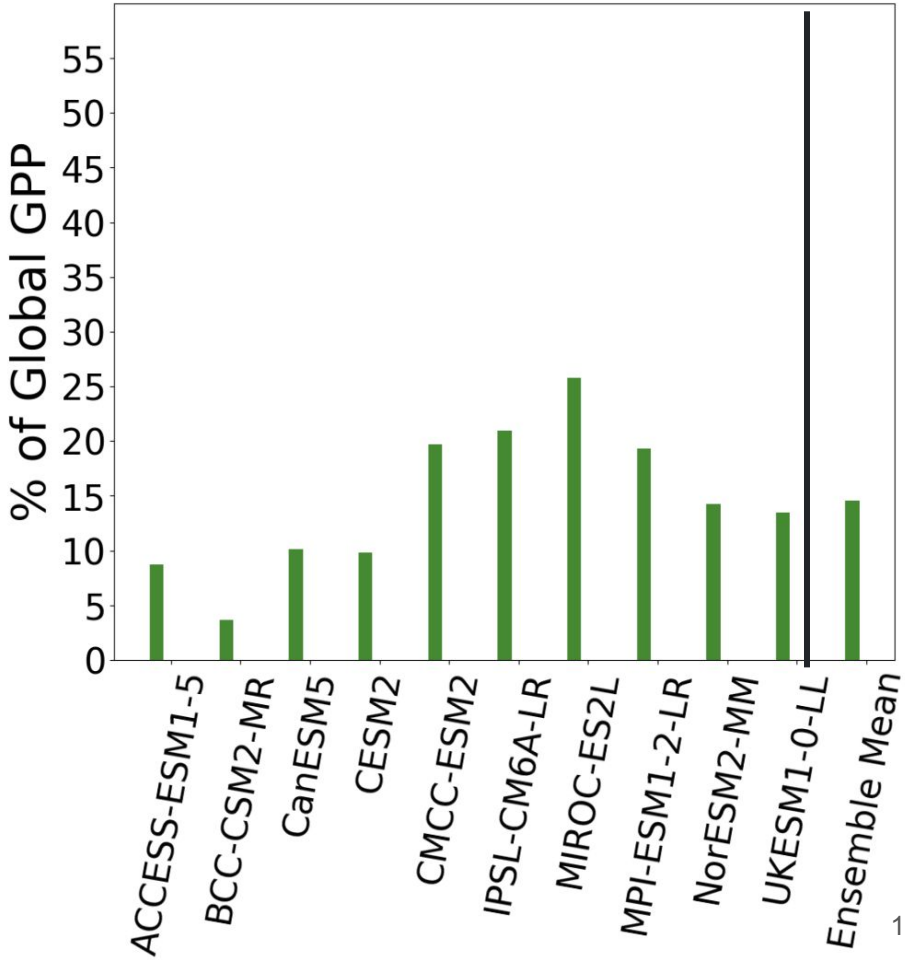
% of Global GPP
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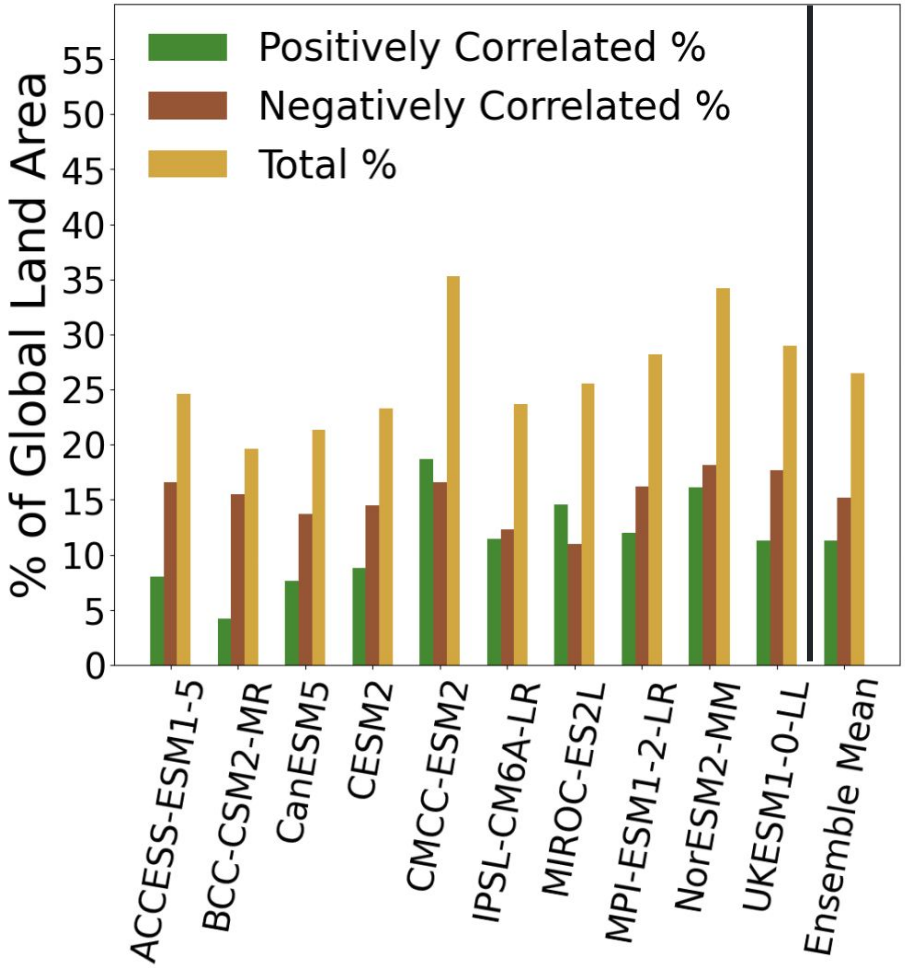
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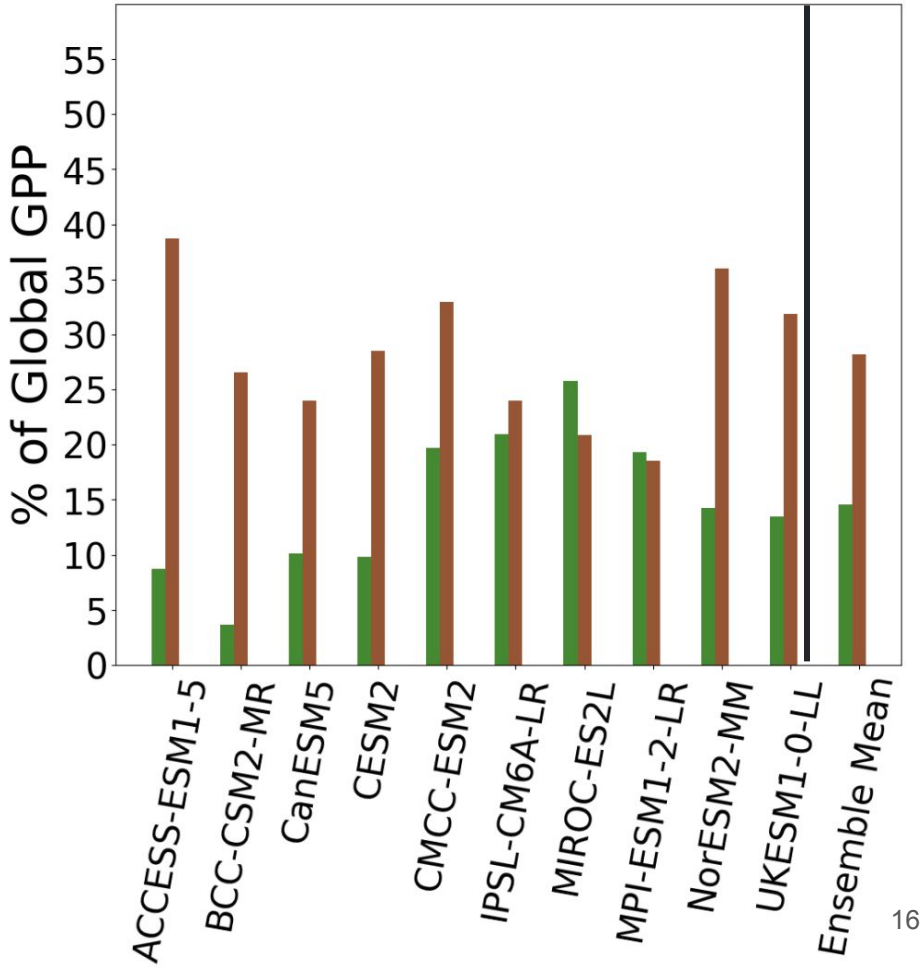
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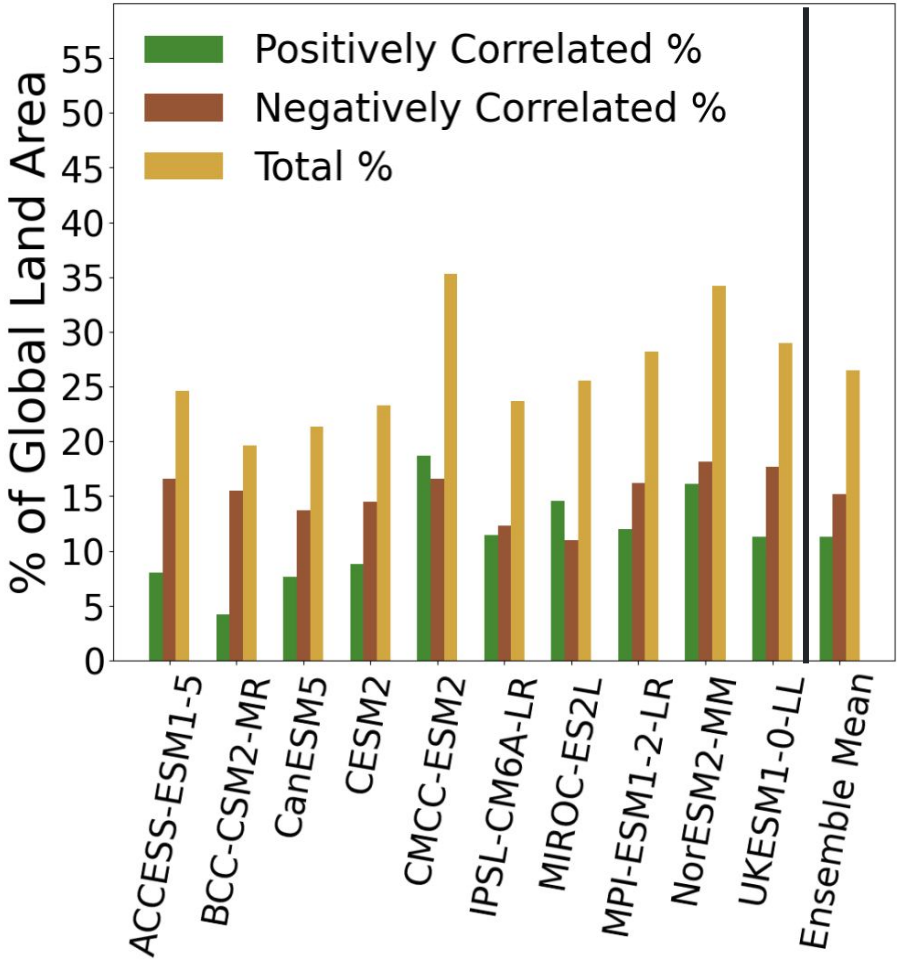
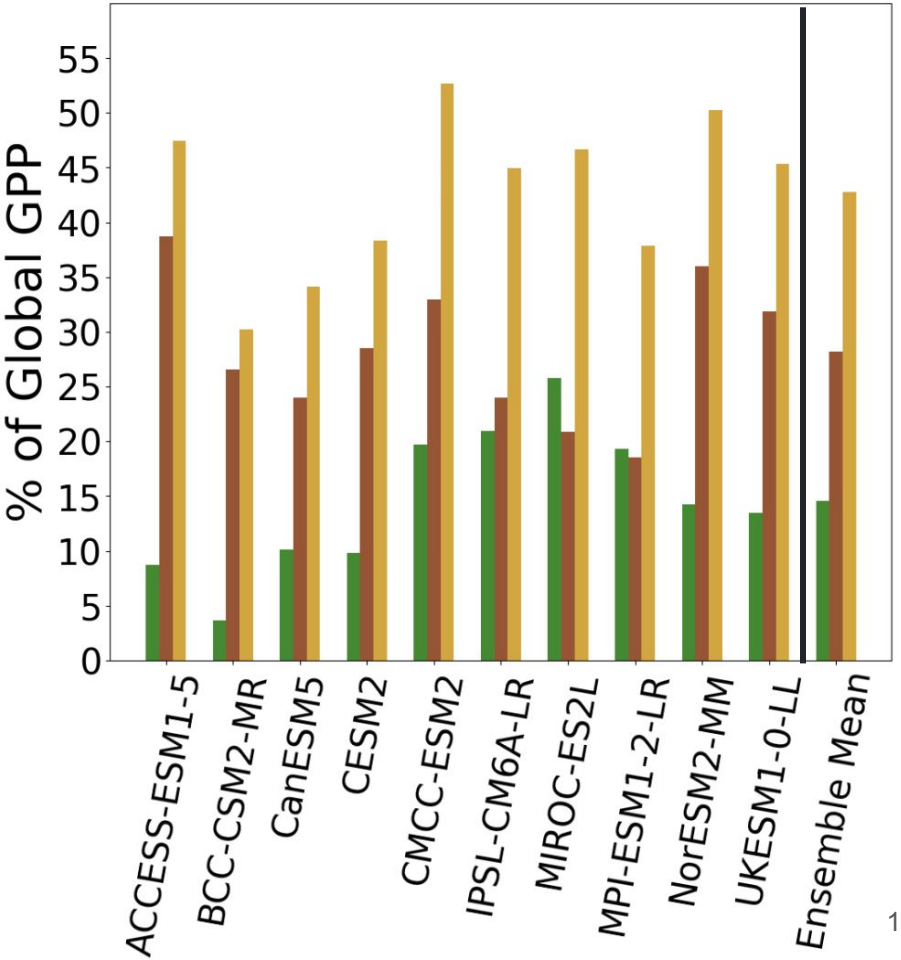
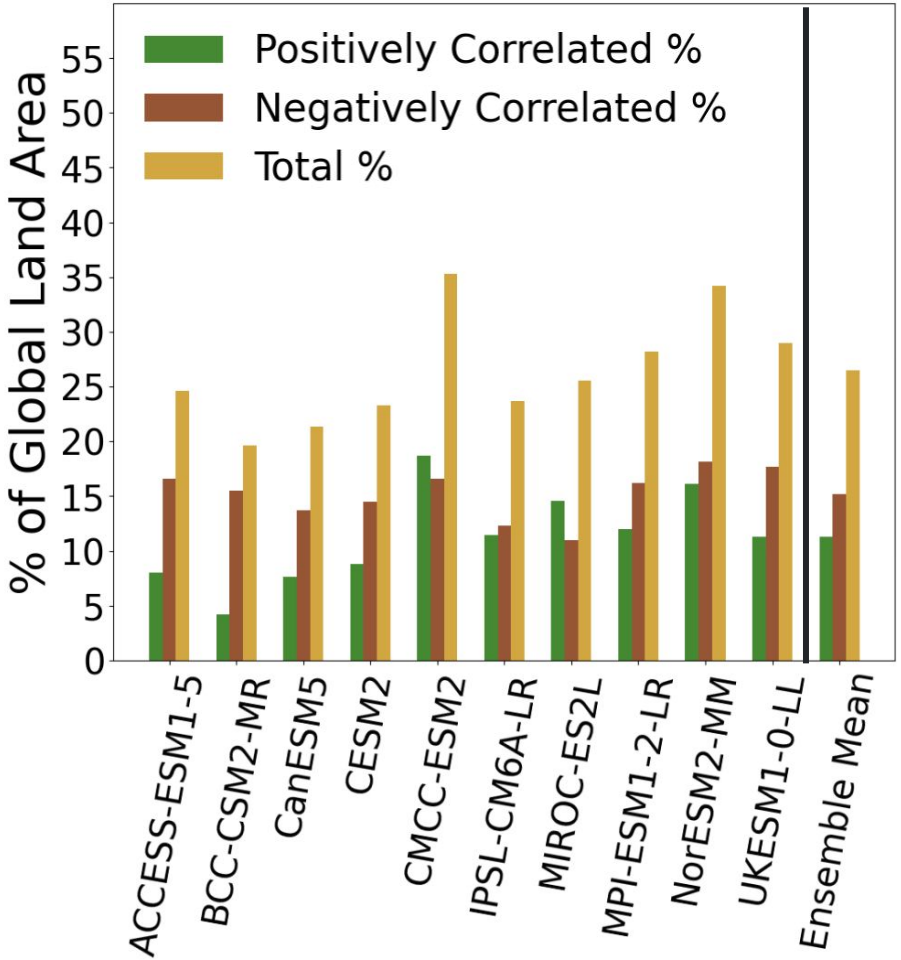
Ensemble Mean

Ensemble Mean Total GPP Impact: 42.8%



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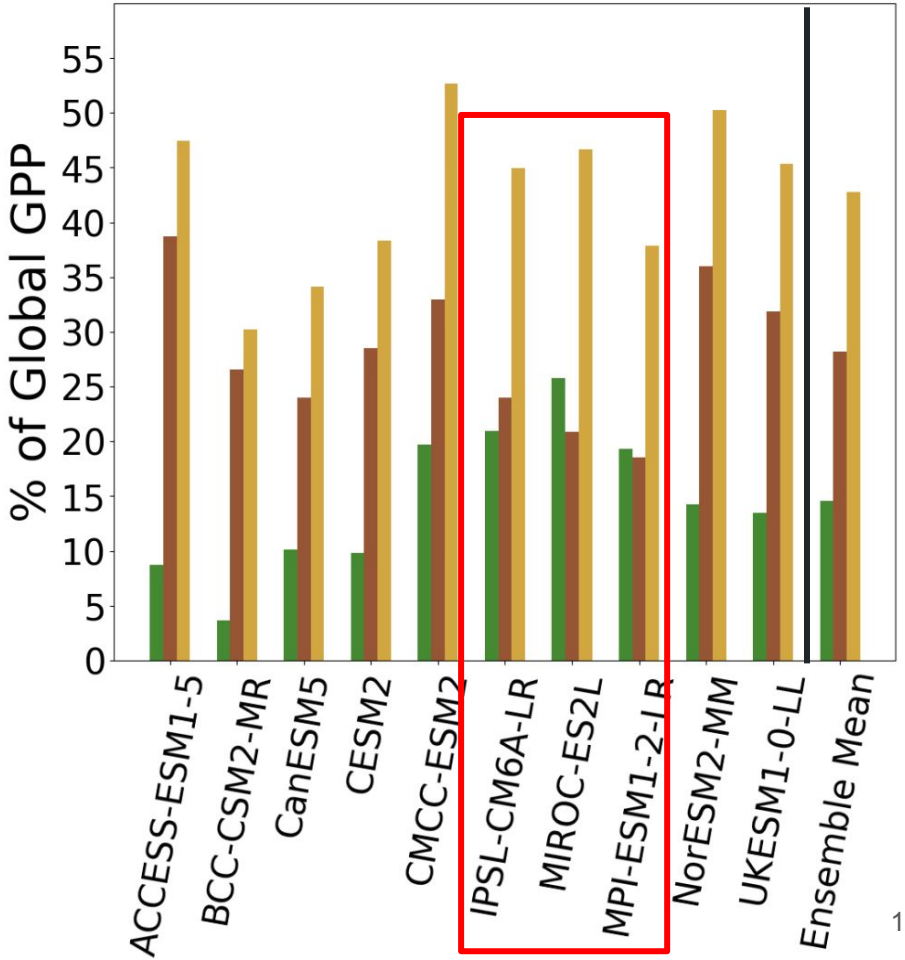
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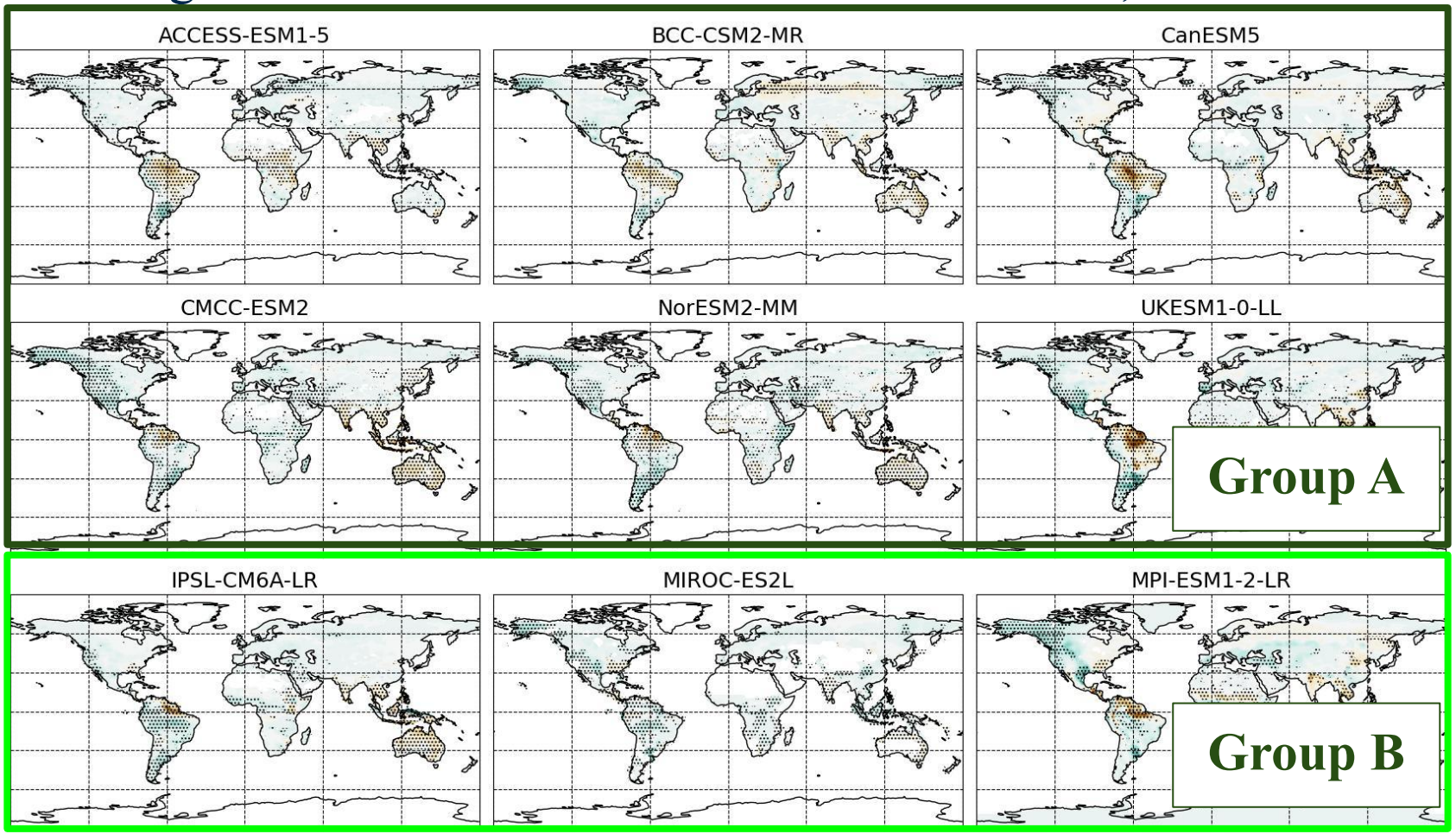
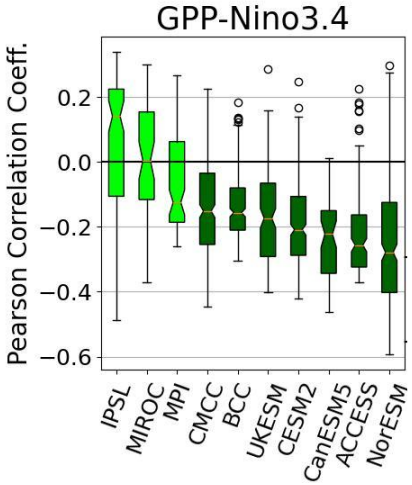
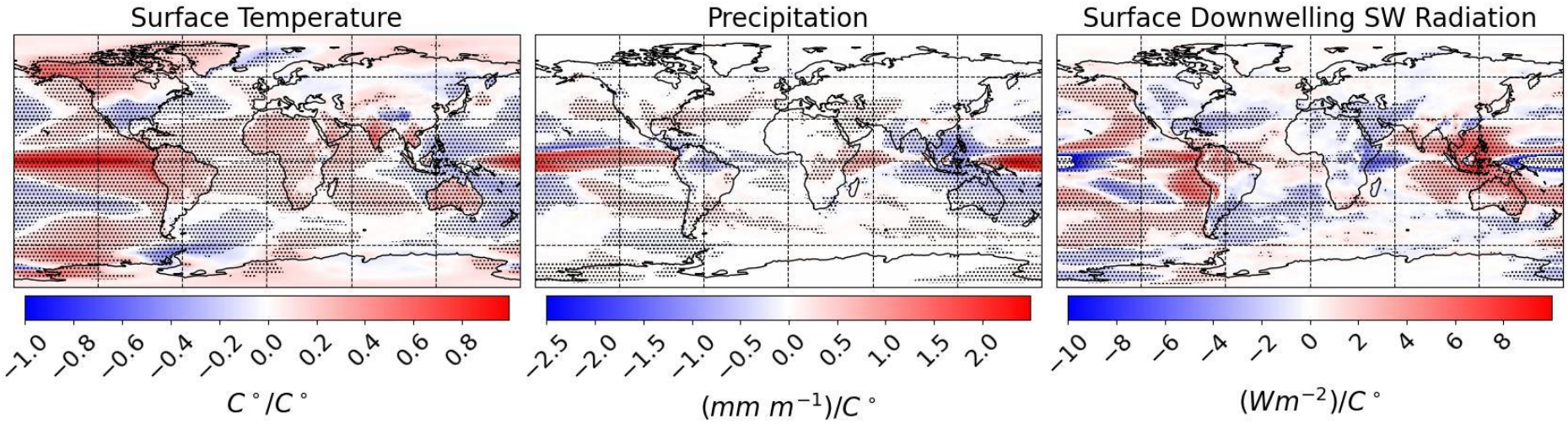


Amazon Basin Region (5.8N-8.8S, 54W-74W) Regressions



ENSO Effects on Temperature, Precipitation, Radiation in CESM2



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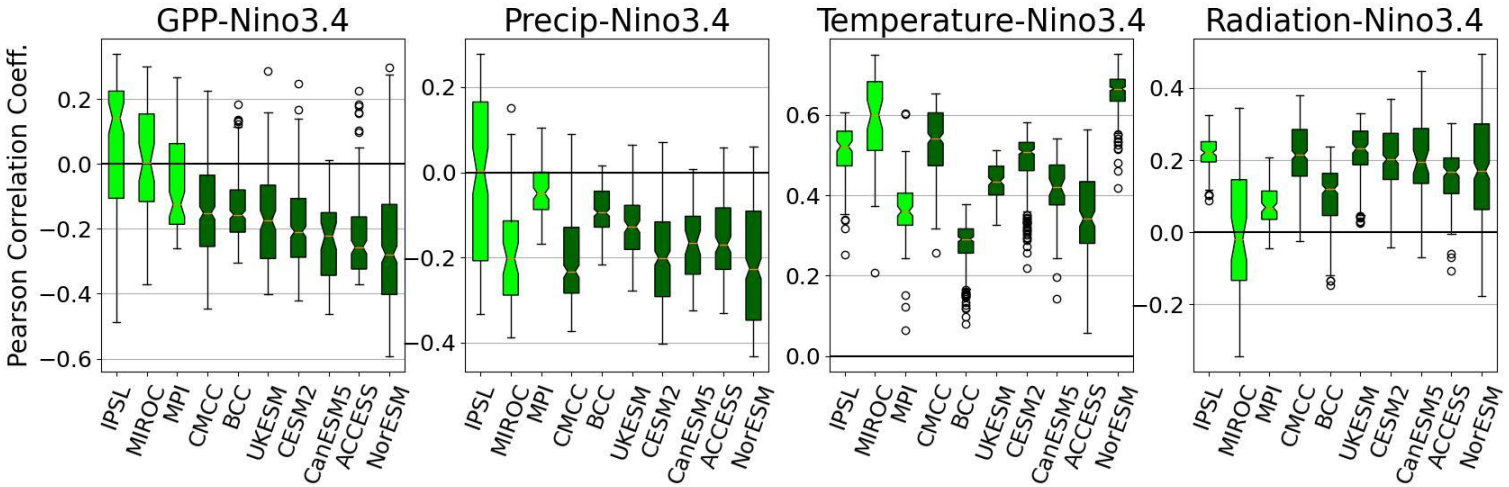
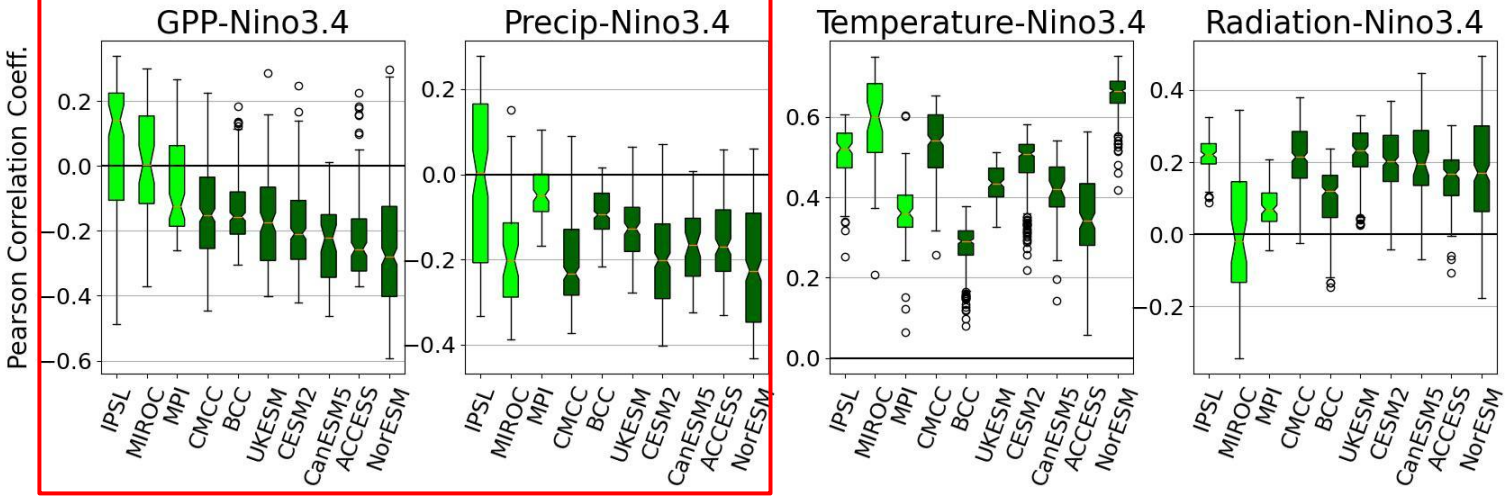


Nino3.4-Variable

Amazon Basin Region (5.8N-8.8S, 54W-74W) Regressions



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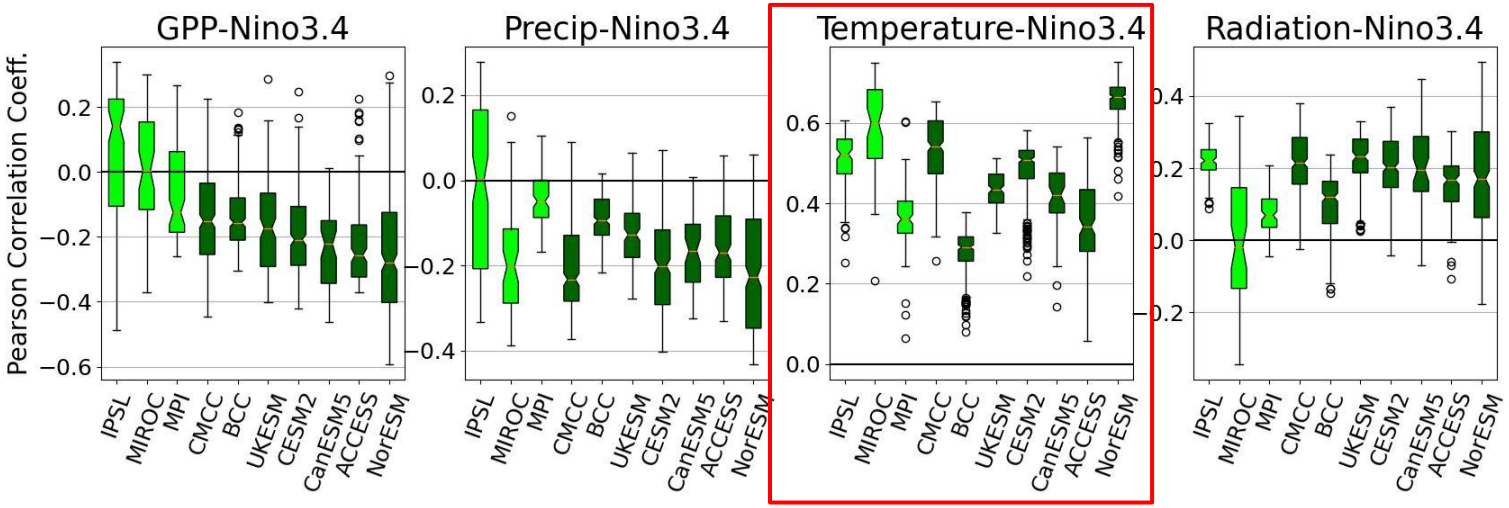


Nino3.4-Variable

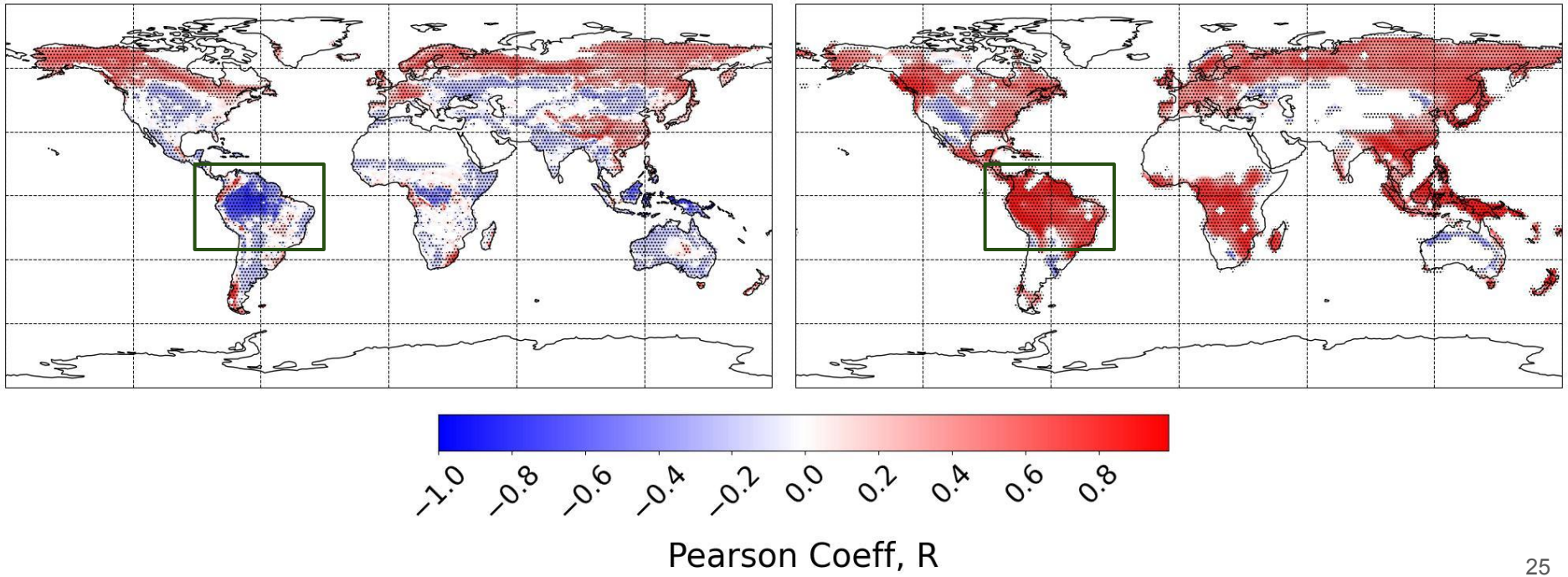
Group A & B Exhibit Different GPP-Radiation Responses in the Amazon

Group A

CESM2

Group B

MIROC-ES2L



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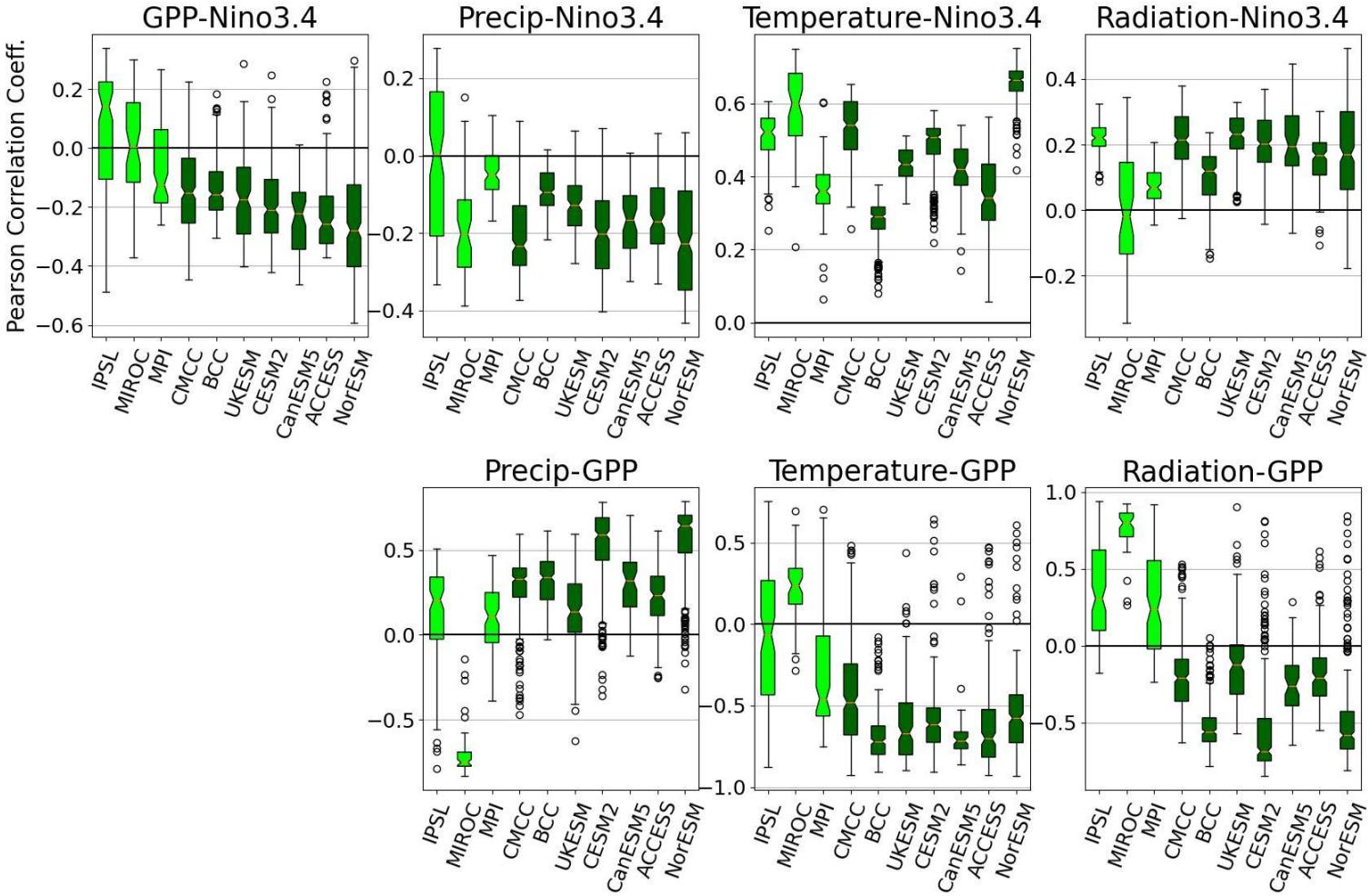
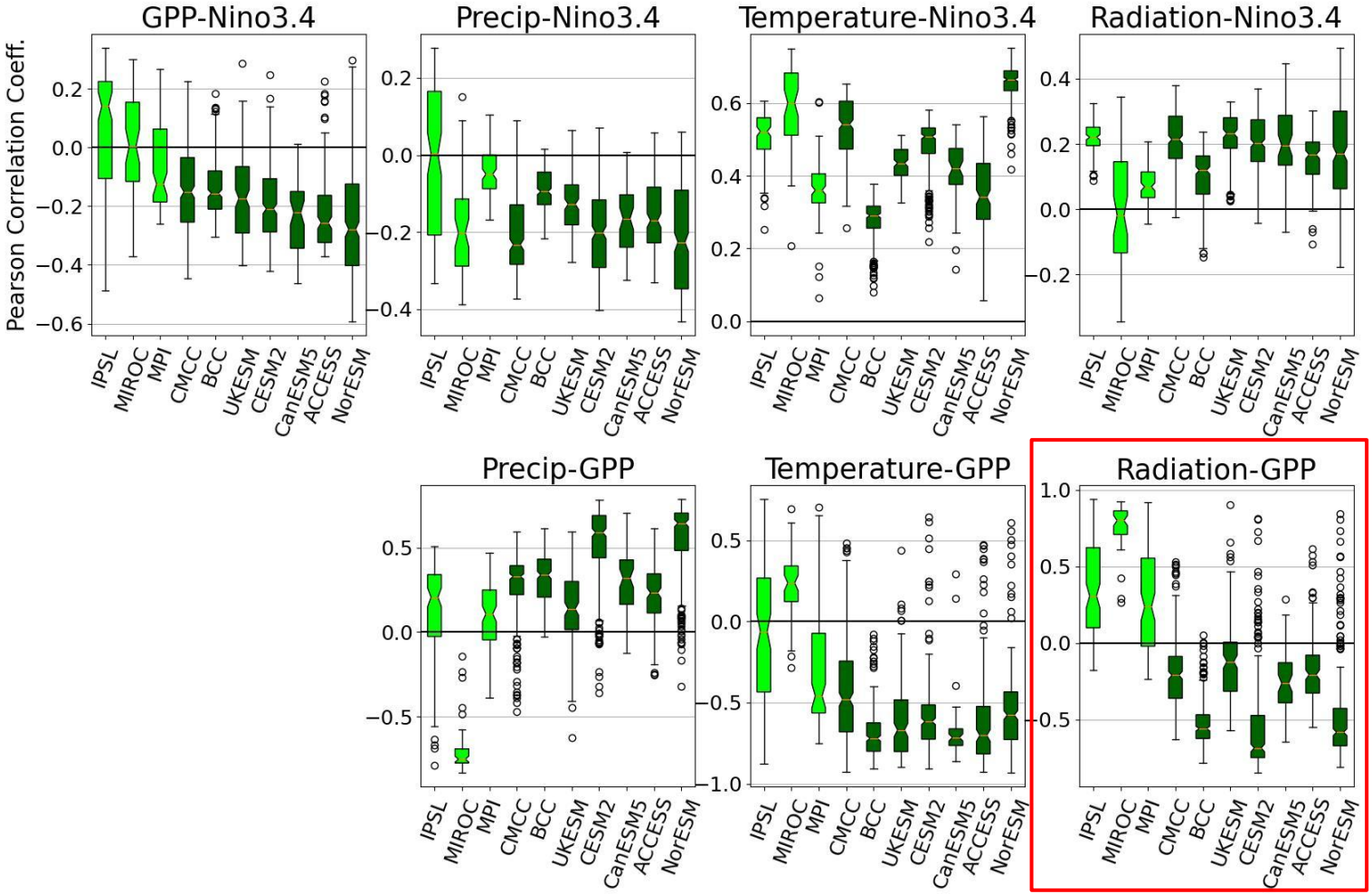


Nino3.4-Variable

GPP-Variable

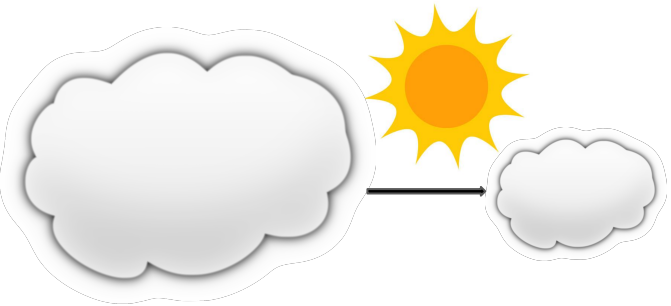
Amazon Basin Region (5.8N-8.8S, 54W-74W) Regressions



Nino3.4-Variable

GPP-Variable

Group A Models

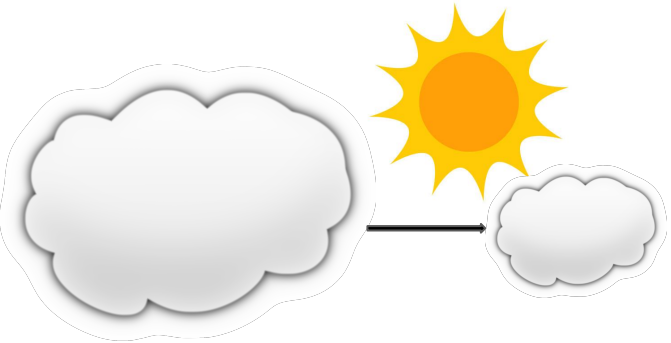


Solar Radiation

GPP

Precipitation

Temperature



Solar Radiation

Group B Models

Precipitation

Temperature

Conclusions:

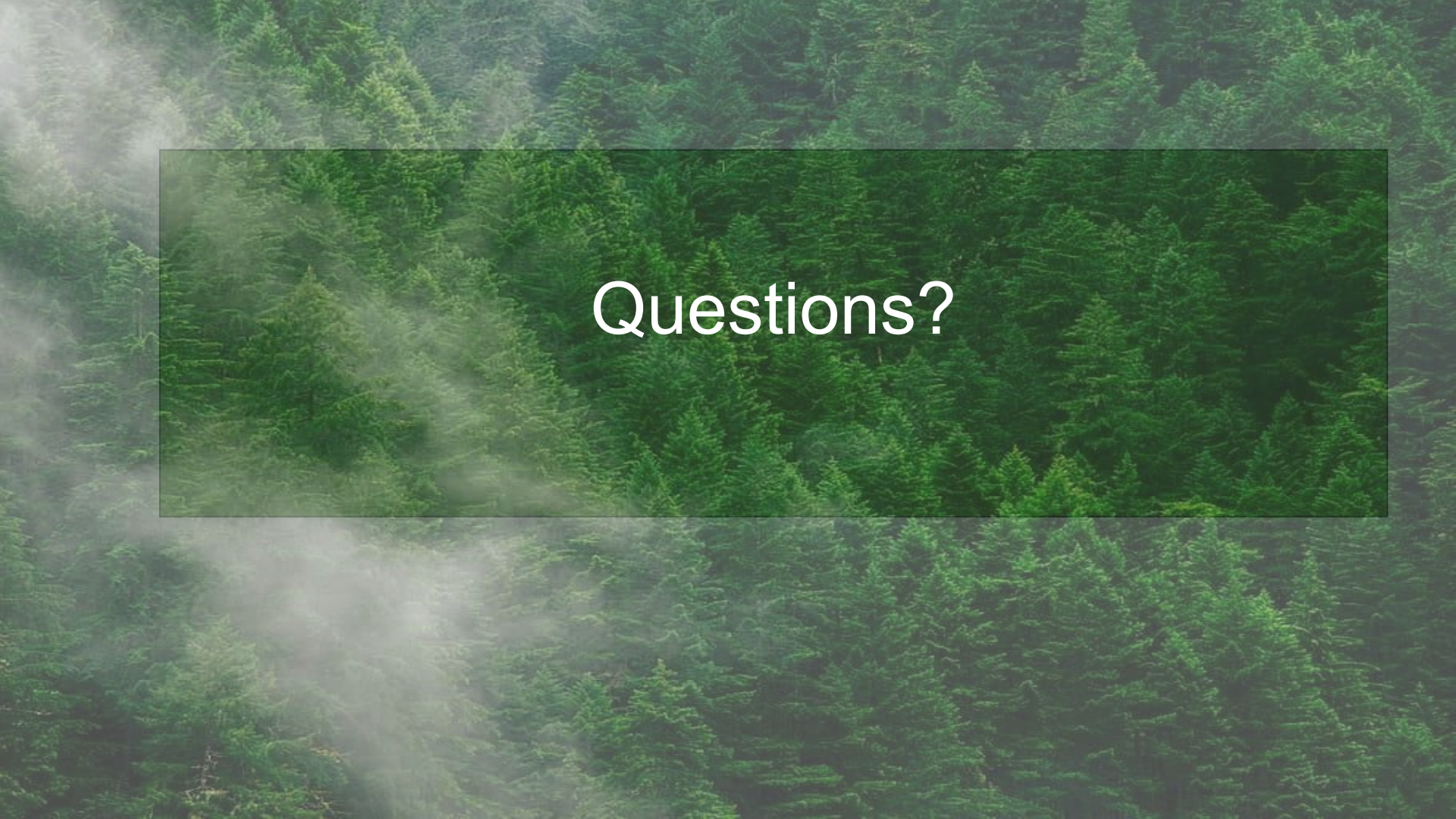
1) **All models exhibit similar spatial patterns of ENSO-impact on GPP, characterized by a reduction in carbon uptake during El Niño events**

Conclusions:

1) All models exhibit similar spatial patterns of ENSO-impact on GPP, characterized by a reduction in carbon uptake during El Niño events
2) This reduction in global carbon uptake is driven by reduced GPP in the Amazon Basin due to reduced precipitation

Conclusions:

1) All models exhibit similar spatial patterns of ENSO-impact on GPP, characterized by a reduction in carbon uptake during El Niño events
2) This reduction in global carbon uptake is driven by reduced GPP in the Amazon Basin due to reduced precipitation
3) MIROC, MPI, and IPSL exhibit a weaker reduction in GPP in the Amazon Basin due to these models' dependence on radiation


Questions?

References

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