Drivers of the natural CO2 fluxes at global scale as simulated by CMIP6 piControl simulations

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4C Annual Meeting, May 2021, virtual

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Climate-Carbon Interactions in the Current Century

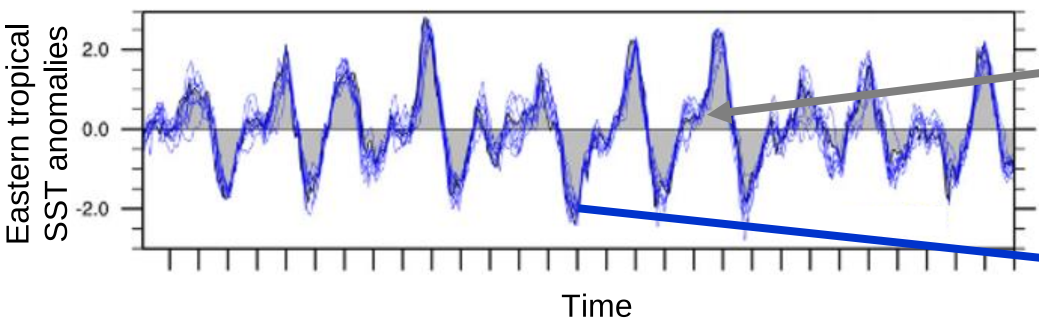
Main processes and drivers of internal atmospheric CO2 variability?

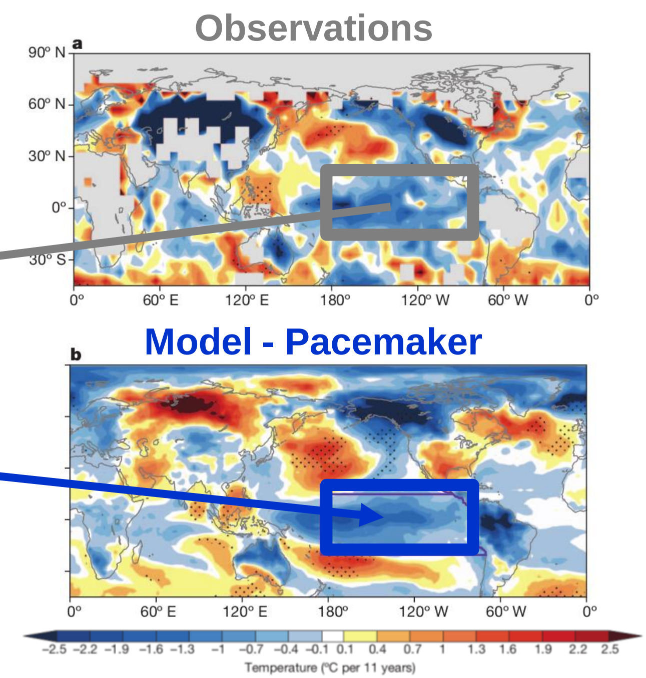
Task 2.1.2 – Potential predictability: processes, drivers and key regions

- Hot spot regions driving global CO2 variability
- Pacemaker experiments

Ensemble members simulations in which a sub-region of the ocean surface is restored to the chronology of the observed variability.

- Global variability driven by this region
- upper bound of predictability skill if this region is fully predicted





(from Kosaka and Xie 2013)

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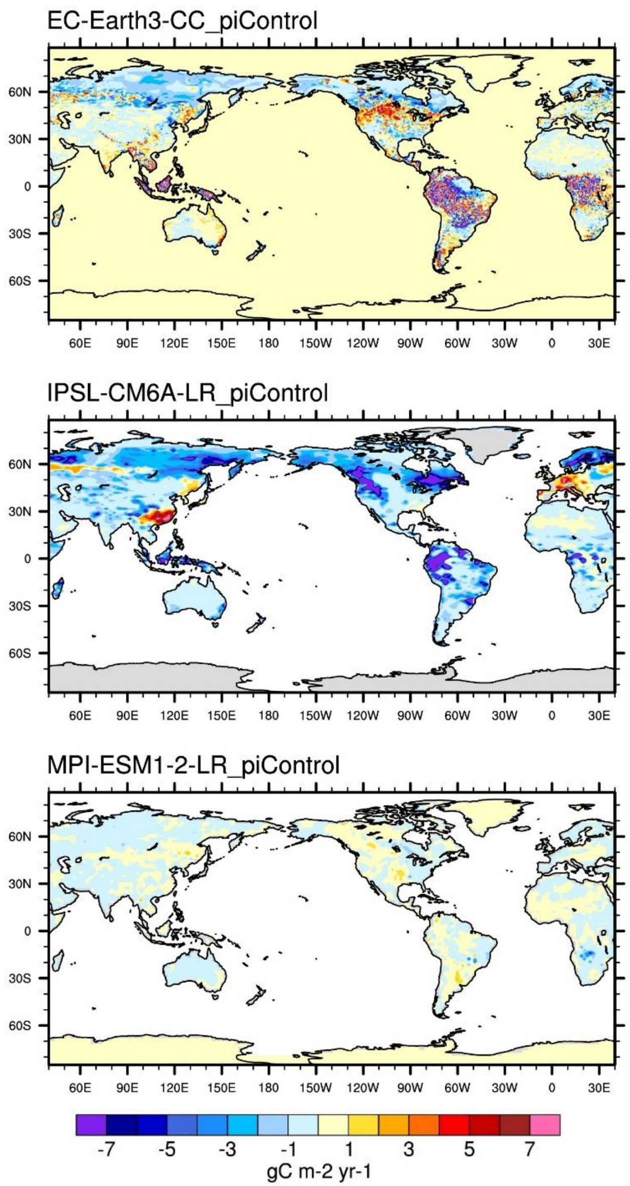
What are the hot spot regions for the global atmospheric CO2 variability?

- Explore surface CO2 fluxes in piControl of CMIP6
- EC-Earth3-CC, IPSL-CM6A-LR, MPI-ESM1-2-LR

Model mean states

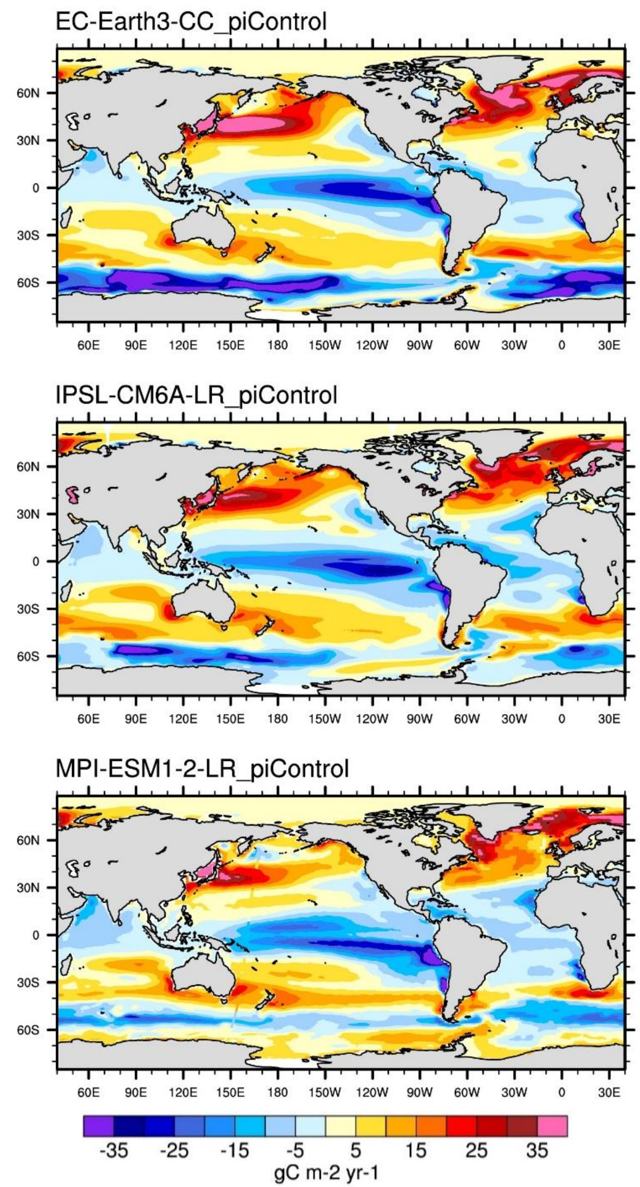
Climatology land CO_2 fluxes

(positive into land)



Climatology ocean CO_2 fluxes

(positive into ocean)



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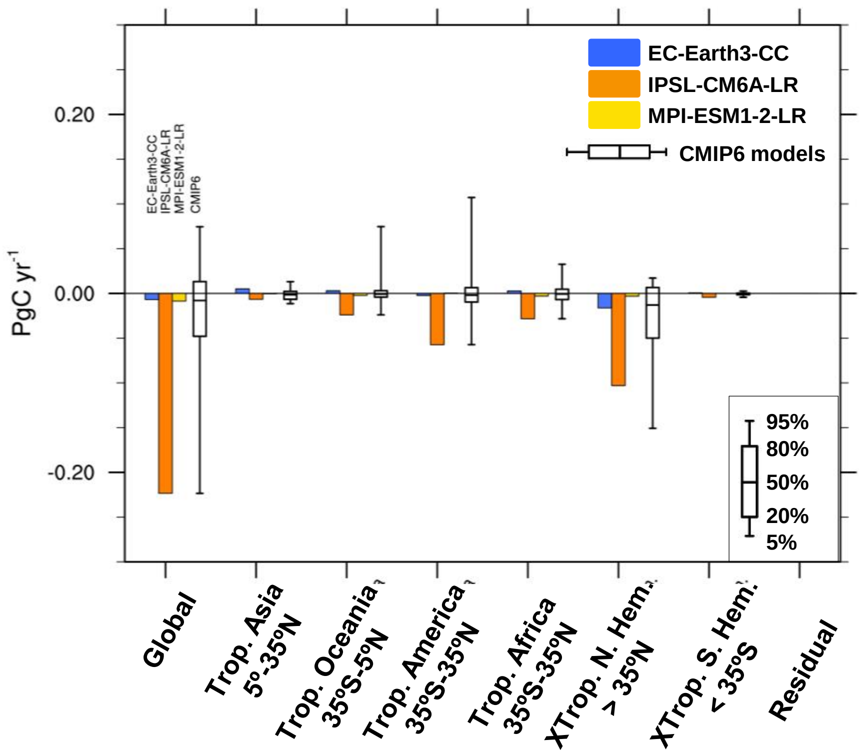

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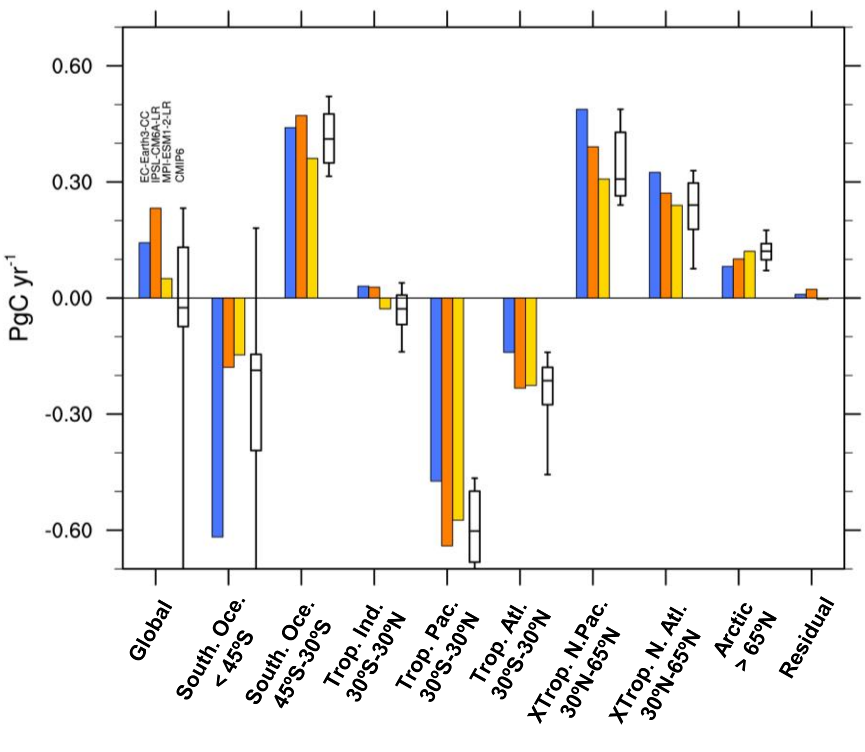
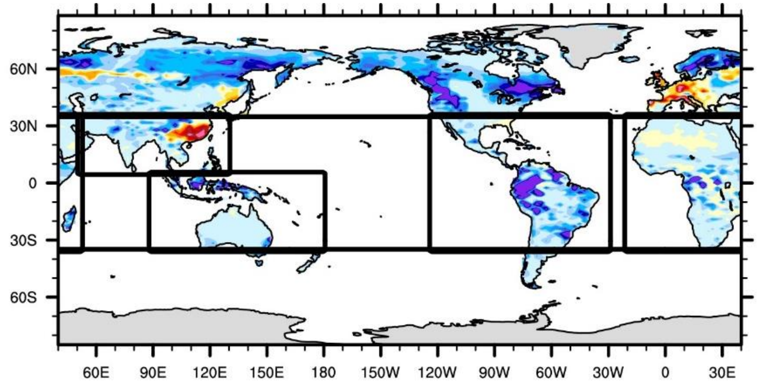
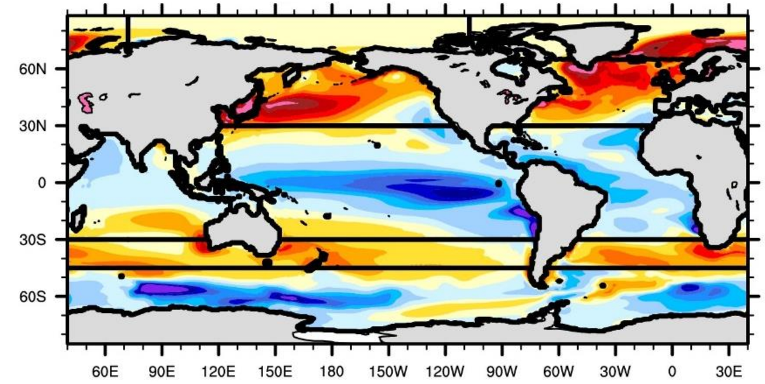


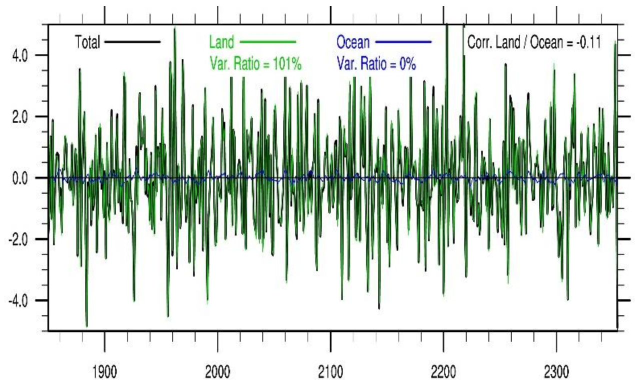




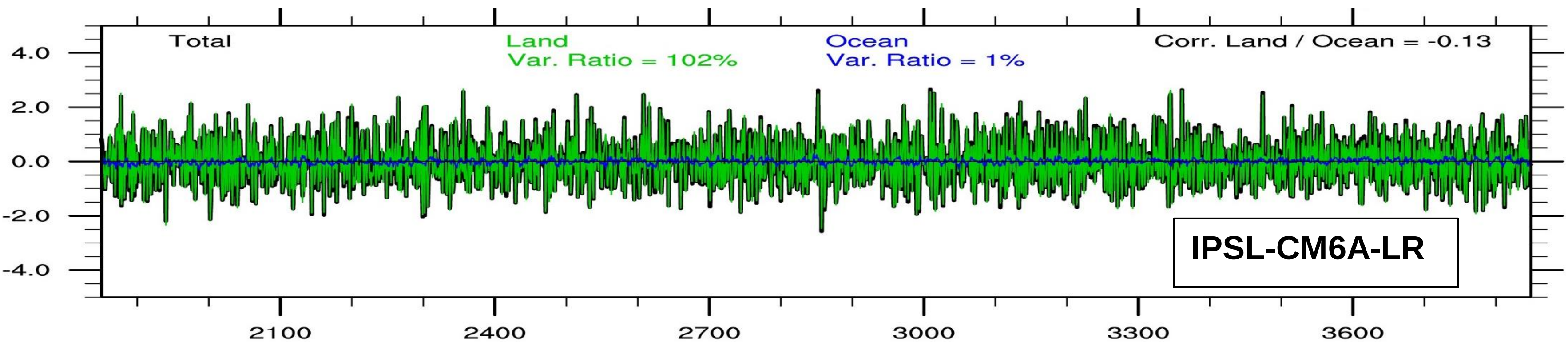
Globally integrated surface CO2 fluxes

Anomalous Global surface Carbon Mass Flux to the atmosphere (PgC/yr)

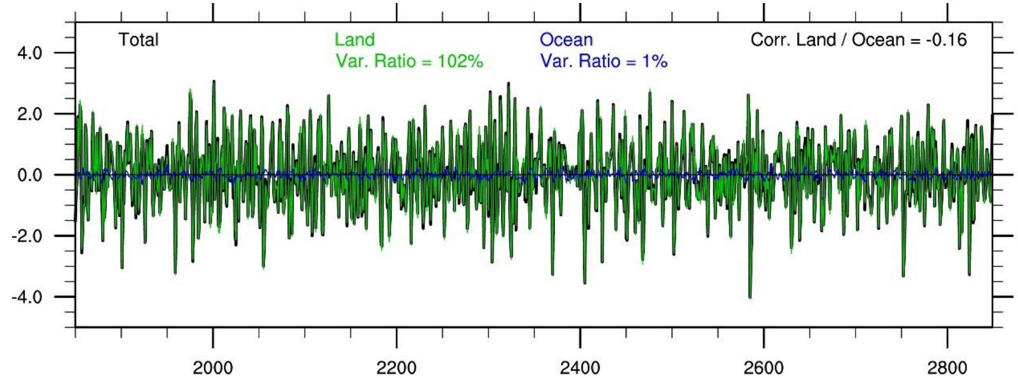
(land + ocean)



EC-Earth3-CC



IPSL-CM6A-LR



MPI-ESM1-2-LR

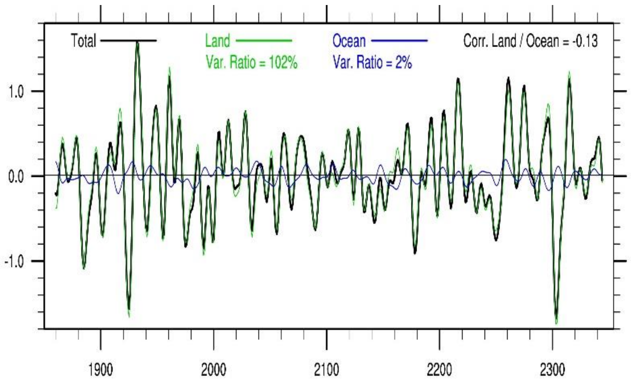
Warning: not same simulation length!!

Globally integrated surface CO2 fluxes – 10yr low pass filtered

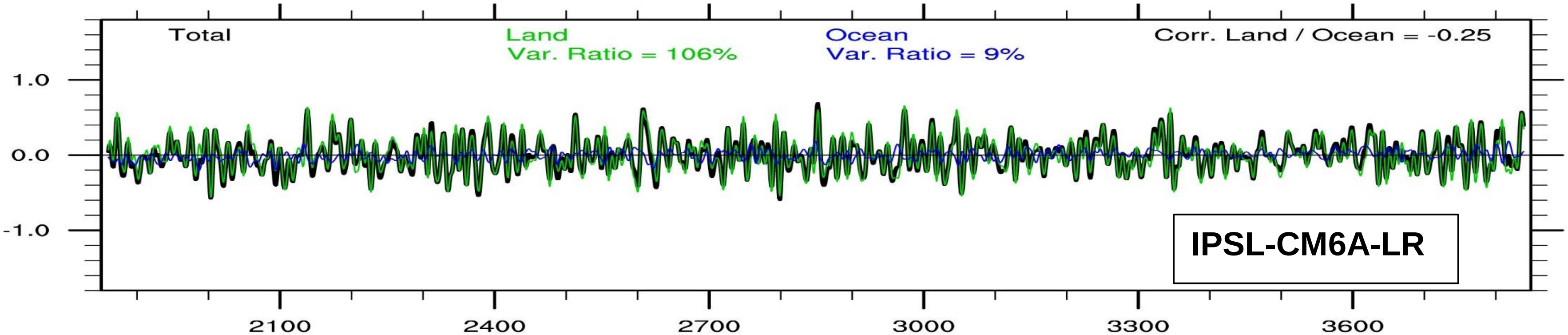
Anomalous Global surface Carbon Mass Flux to the atmosphere (PgC/yr)

(land + ocean)

<u>10yr low pass filtered</u>



EC-Earth3-CC



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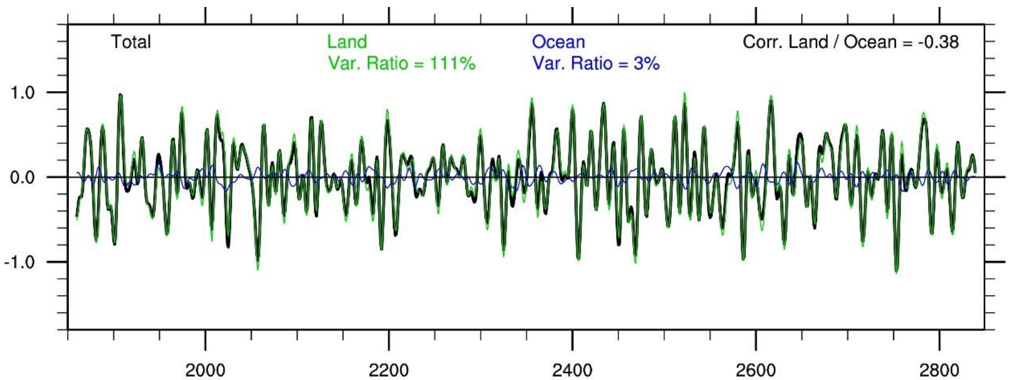

MPI-ESM1-2-LR

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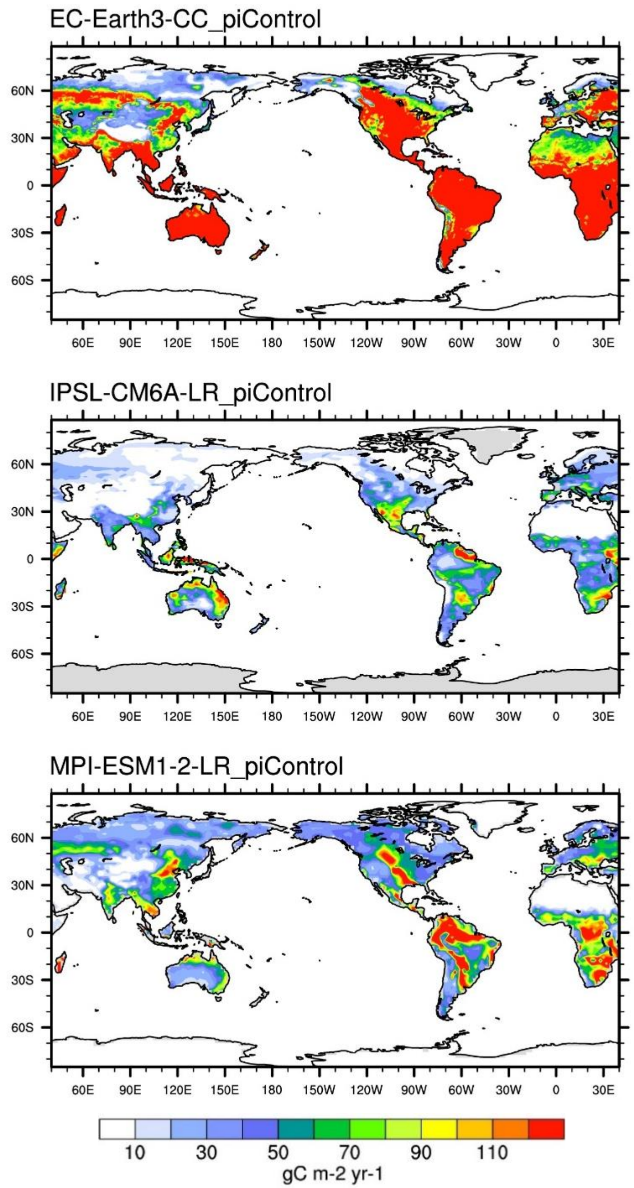
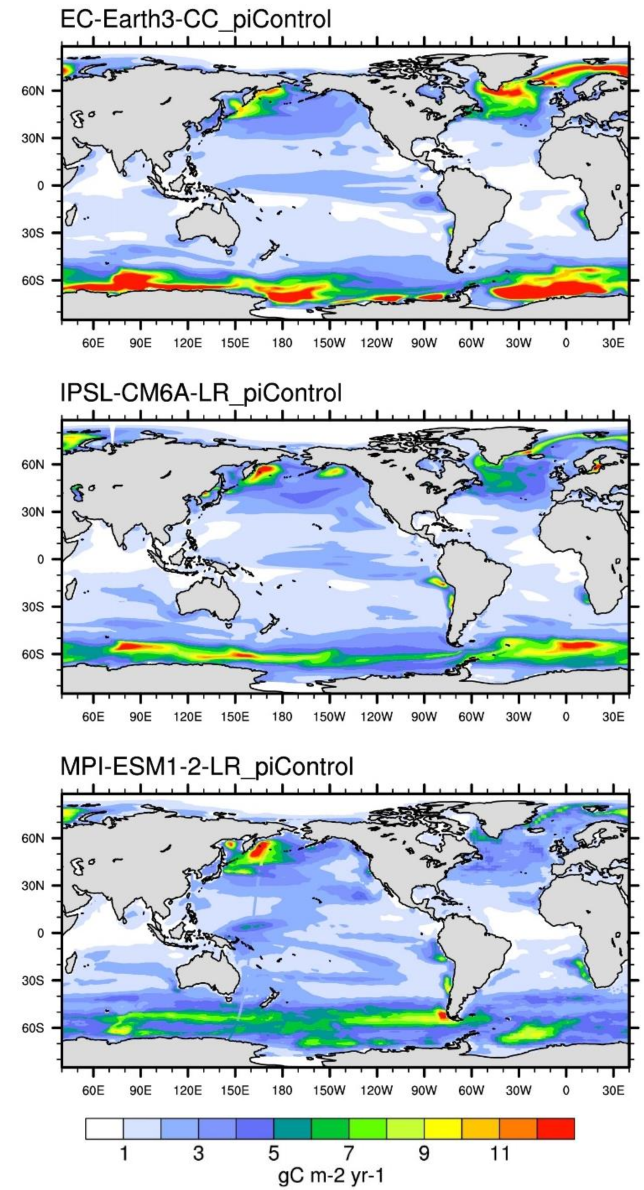
Which regions control the global variations?

Standard deviation land CO2 fluxes



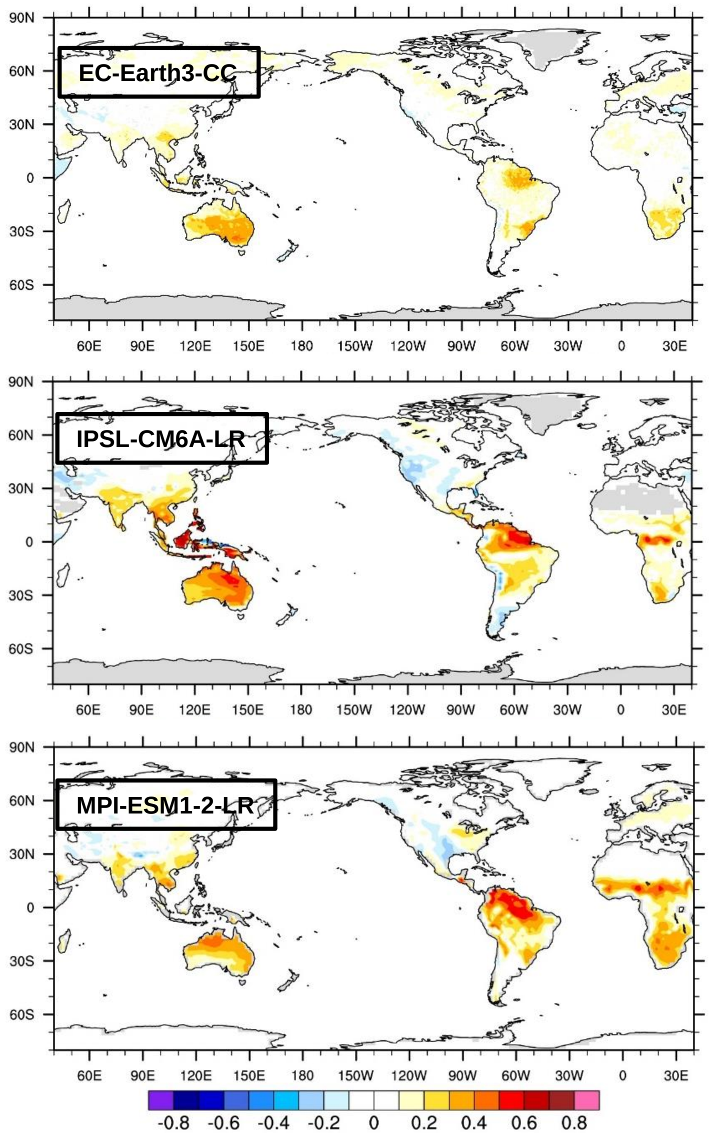
Standard deviation ocean CO2 fluxes



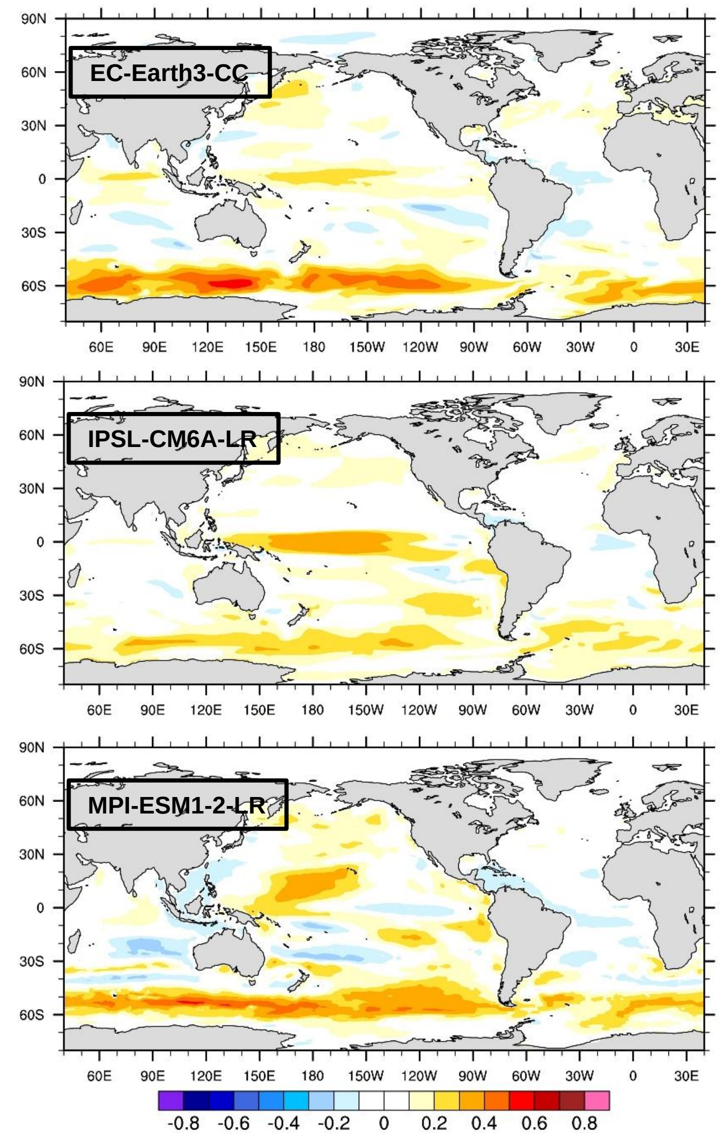
Which regions control the global variations?

Local correlation of CO2 fluxes on Globally averaged CO2 fluxes

Land fluxes vs Global land fluxes



Ocean fluxes vs Global ocean fluxes



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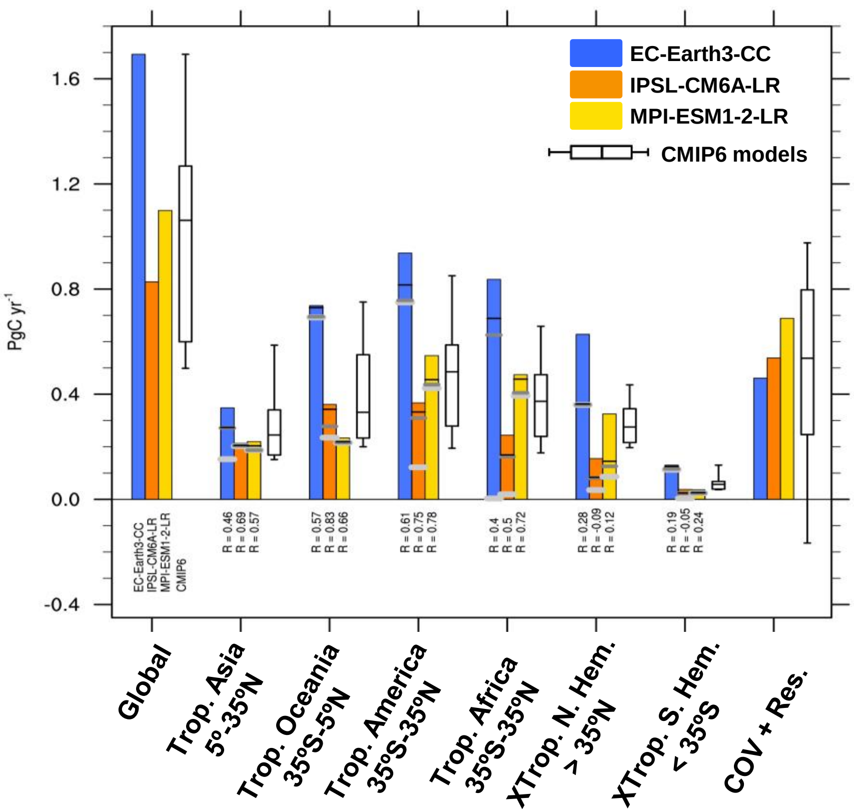

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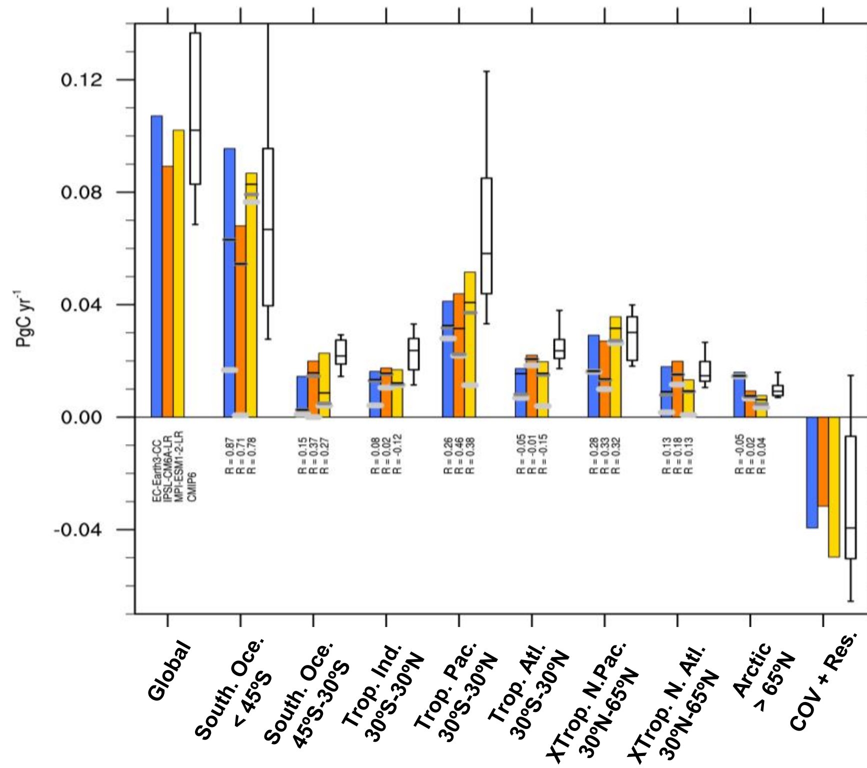
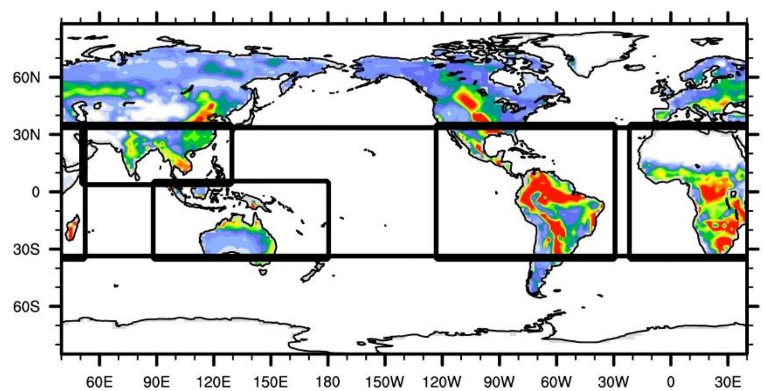
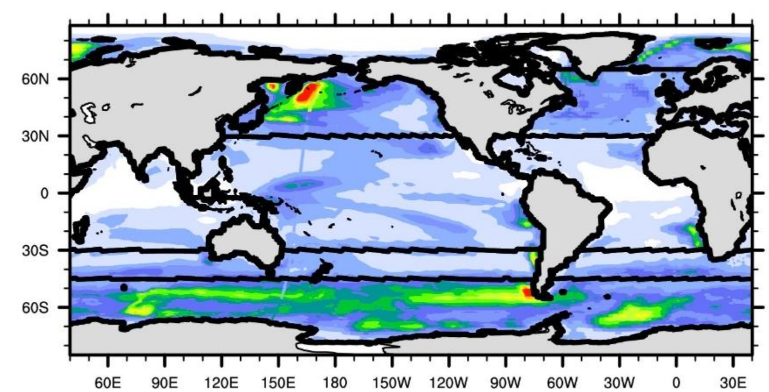
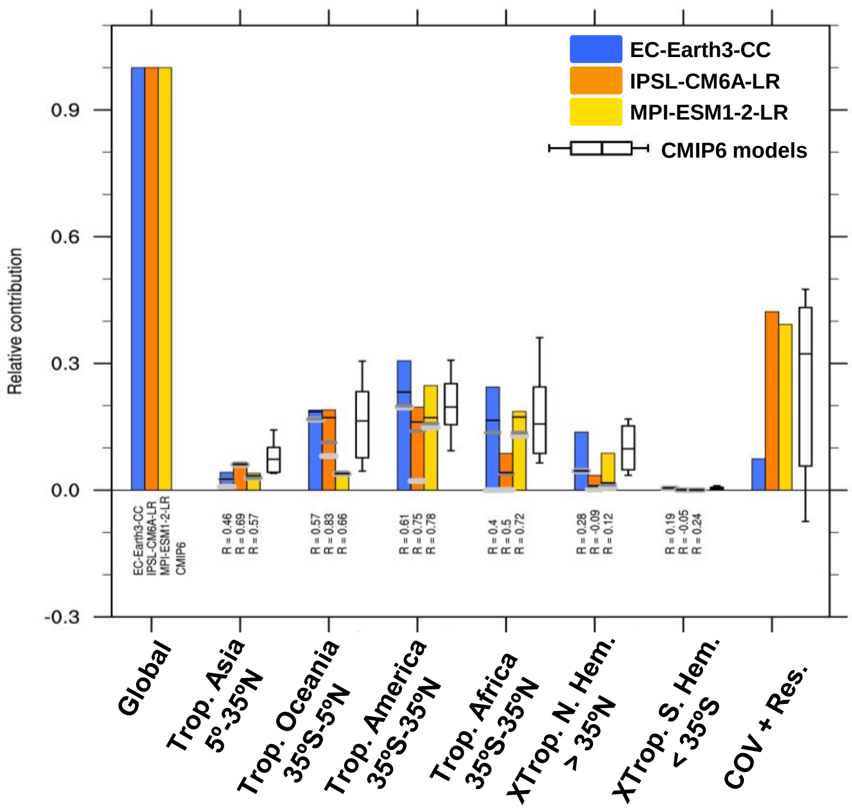


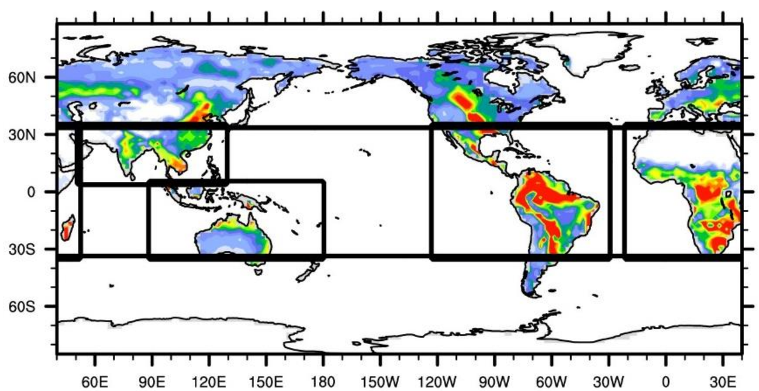




Which regions control the global variations?

Regional contribution to global land CO2 fluxes





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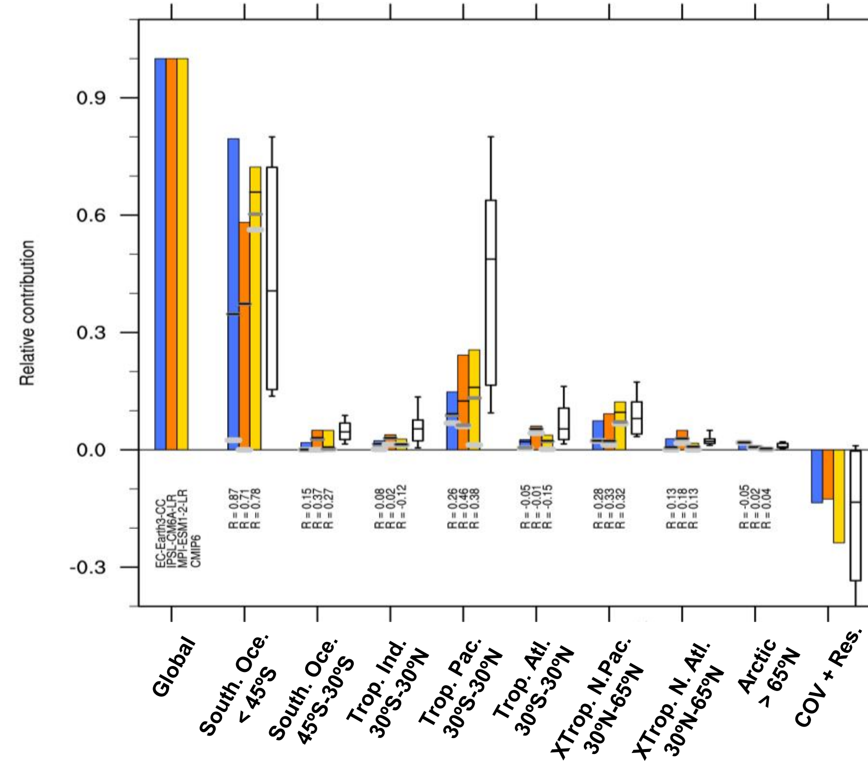
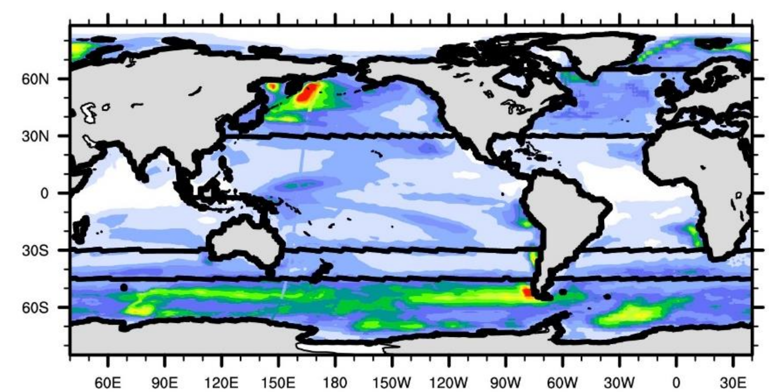
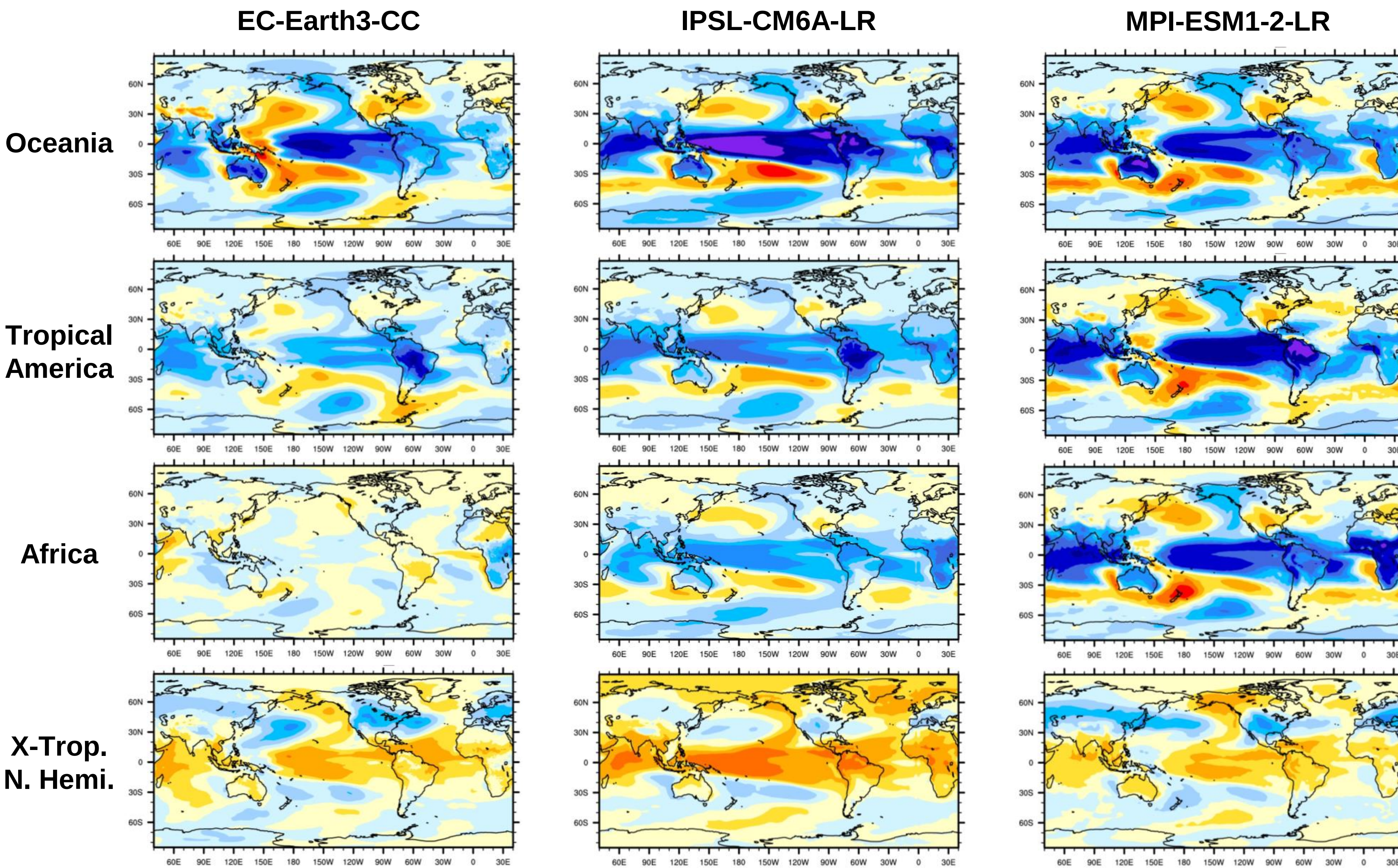




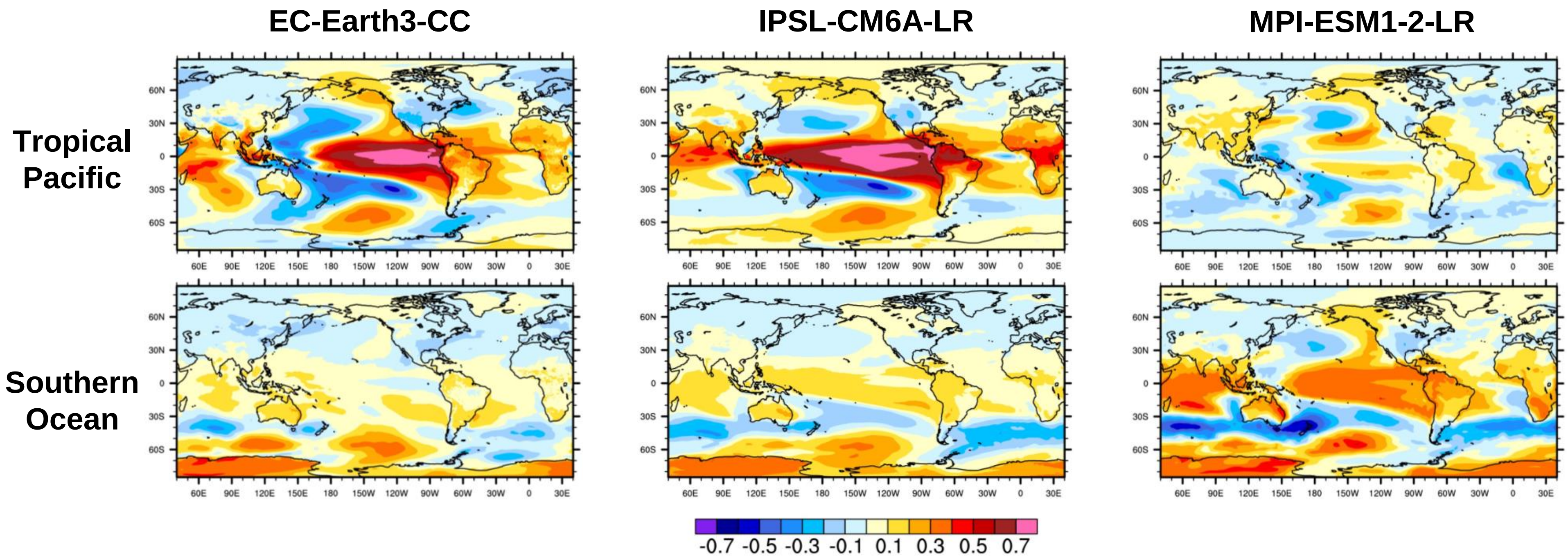
What are the drivers of those variations?



Correlation map of local surface temperature with global land CO2 fluxes

What are the drivers of those variations?

Correlation map of local surface temperature with global ocean CO2 fluxes



Summary

Analyse of CMIP6 piControl simulations show that:

1) Land CO2 fluxes variability 10x higher than ocean CO2 fluxes variability
   - ➢ implication for prediction of atmospheric CO2 variability

2) Regions contributing the most to global variations are:
   - Australia
   - South America
   - sub-Saharan Africa

   ➢ all linked to tropical SST variations (ENSO?)

3) Over the ocean the regions contributing the most are
   - Southern Ocean
   - tropical Pacific

   ➢ Different SST signature among models

Conclusion: Tropical Pacific appears as the main driver of global CO2 variability

In WP2 we will first perform tropical Pacific pacemaker experiments

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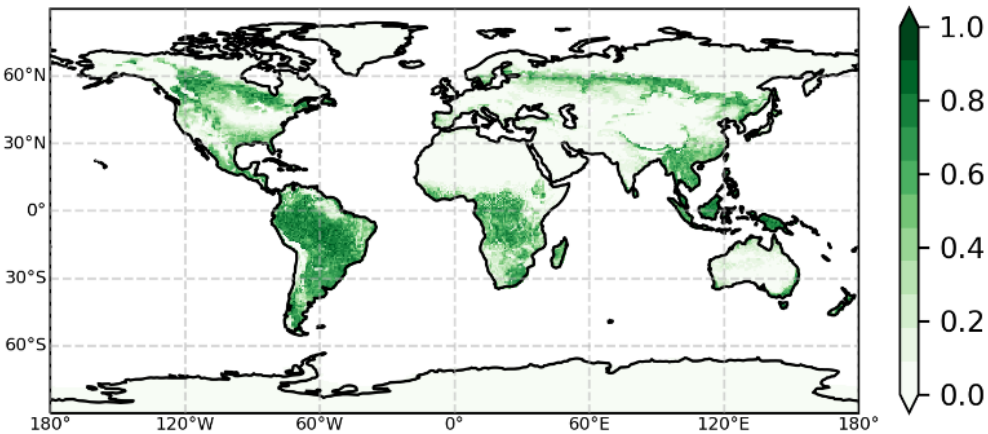
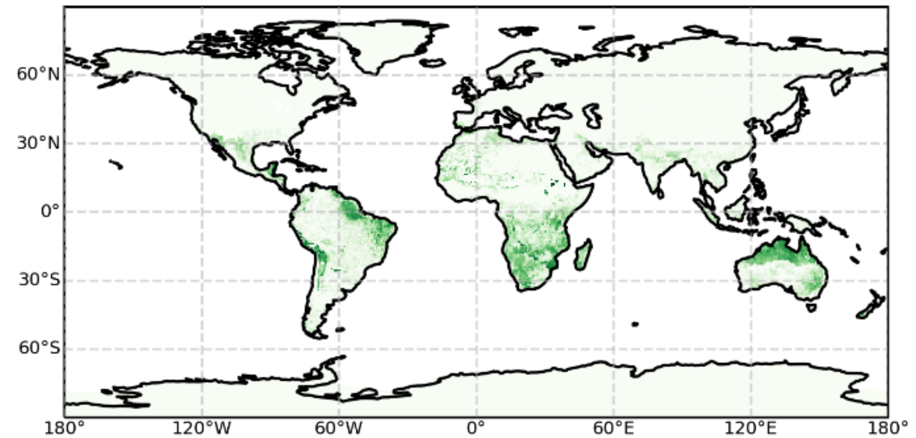
Thank you!

Model mean states

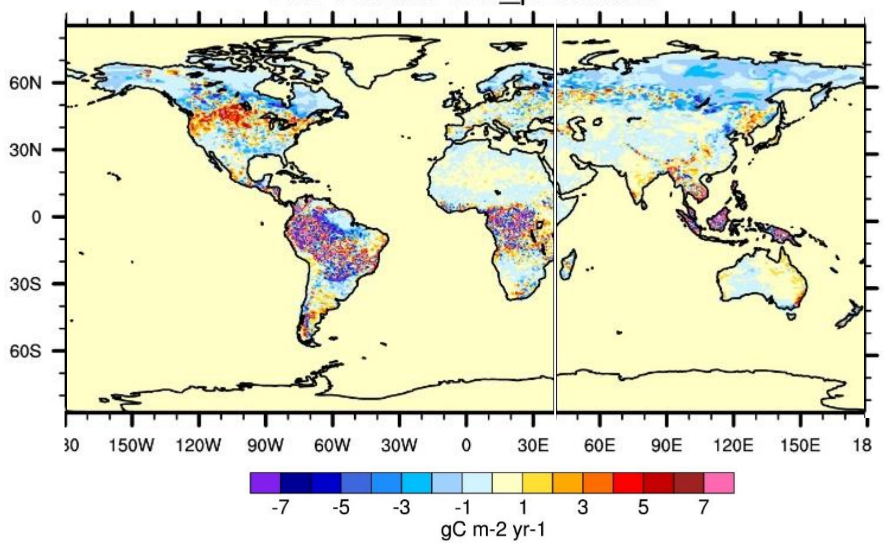
High Vegetation Cover



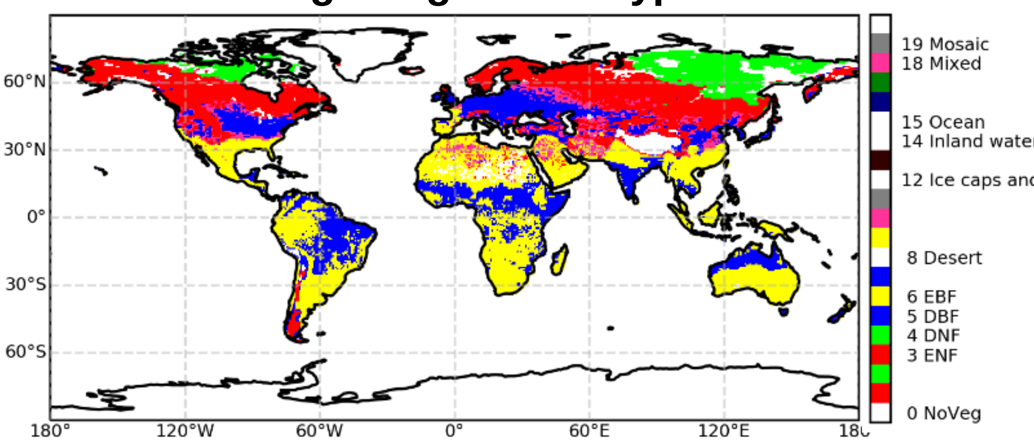
Low Vegetation Cover



EC-Earth3-CC_piControl



High Vegetation Type



EBF = Evergreen BroadLeaf

DBF = Deciduous BroadLeaf

ENF = Evergreen NeedleLeaf