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

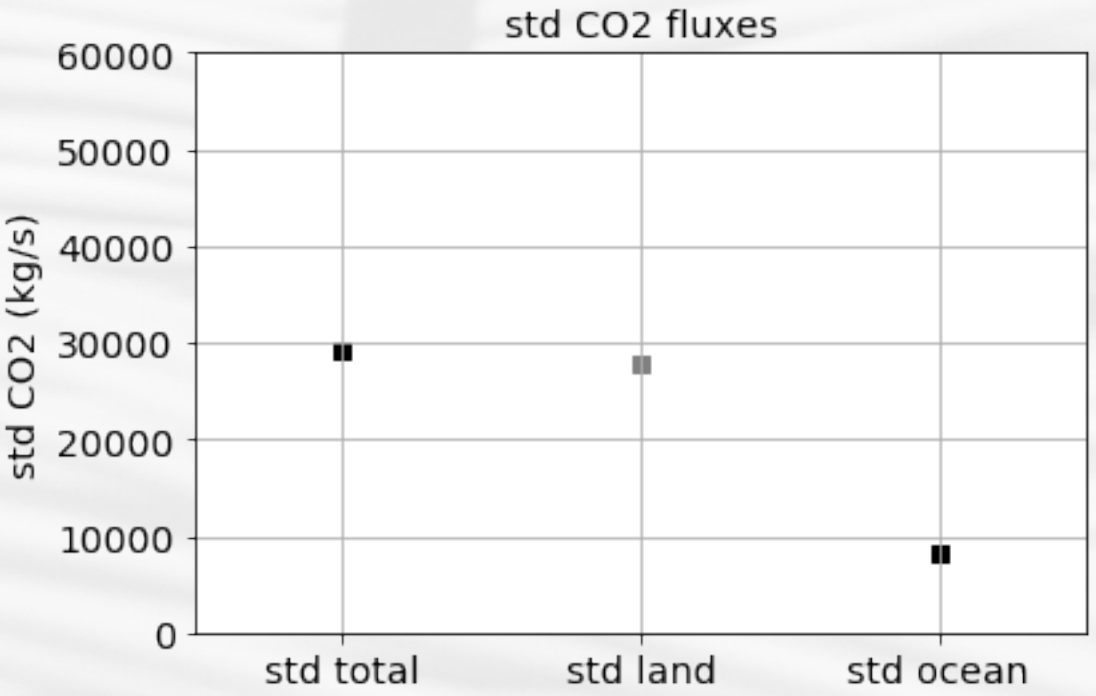
Verónica Martín-Gómez, Yohan Ruprich-Robert, Raffaele Bernardello, Etienne Tourigny, Markus Donat, Arndt Meier, Valentina Sicardi, Pablo Ortega and Margarida Samsó

4C Climate-Carbon Interactions in the Current Century

EGU, May 2022

Introduction and objective

- Internal variability of the atmospheric CO2 concentration is driven by the CO2 fluxes over the land and ocean
- Analyze the internal variability of the atmospheric CO2 concentration understanding:
  - the relative role of the CO2 fluxes over the land and ocean on the atmospheric CO2 concentration. Which one of these two is the most important triggering natural changes in the atmospheric CO2 concentration?
  - the main drivers for this natural variability
  - the origin of the uncertainties of the CO2 fluxes in CMIP6 models
- We consider the piControl CMIP6-ESMs for which all variables are available (22 models in total)



Black point: direct observed co2 flux
Grey point: estimated co2 flux

In observations, main contributor to the natural variations in the atmospheric CO2 concentration are the global land CO2 fluxes

Std total estimated from observed atmospheric CO2 growth rate from NOAA
Std ocean observed CO2 flux from Landschuetzer

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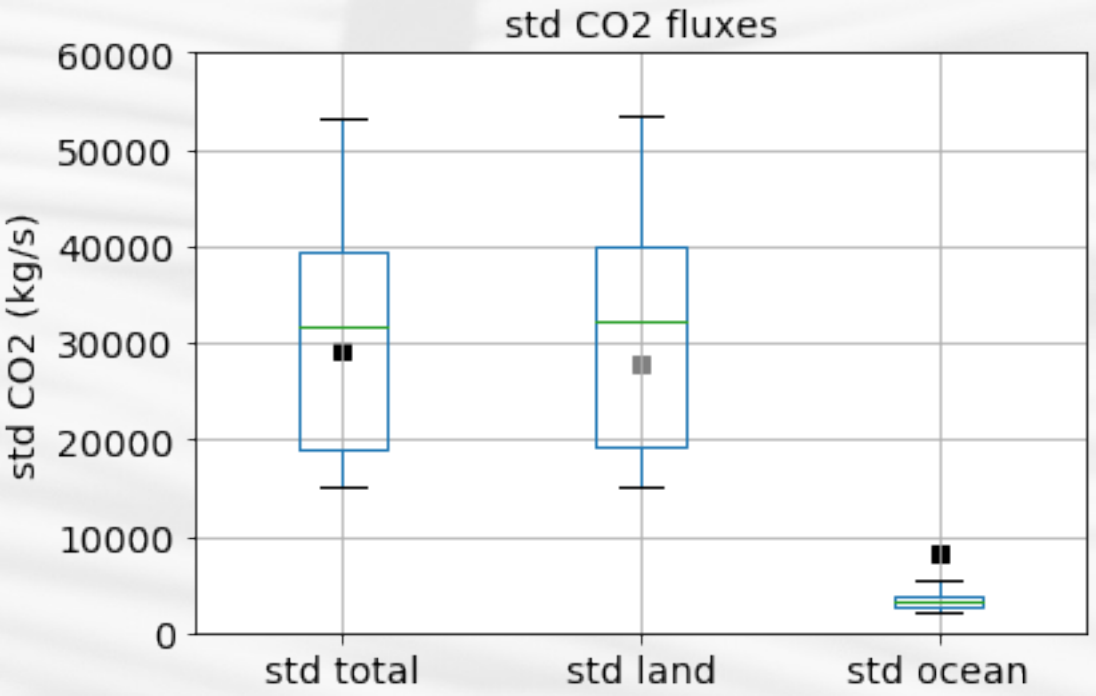

Black point: direct observed co2 flux
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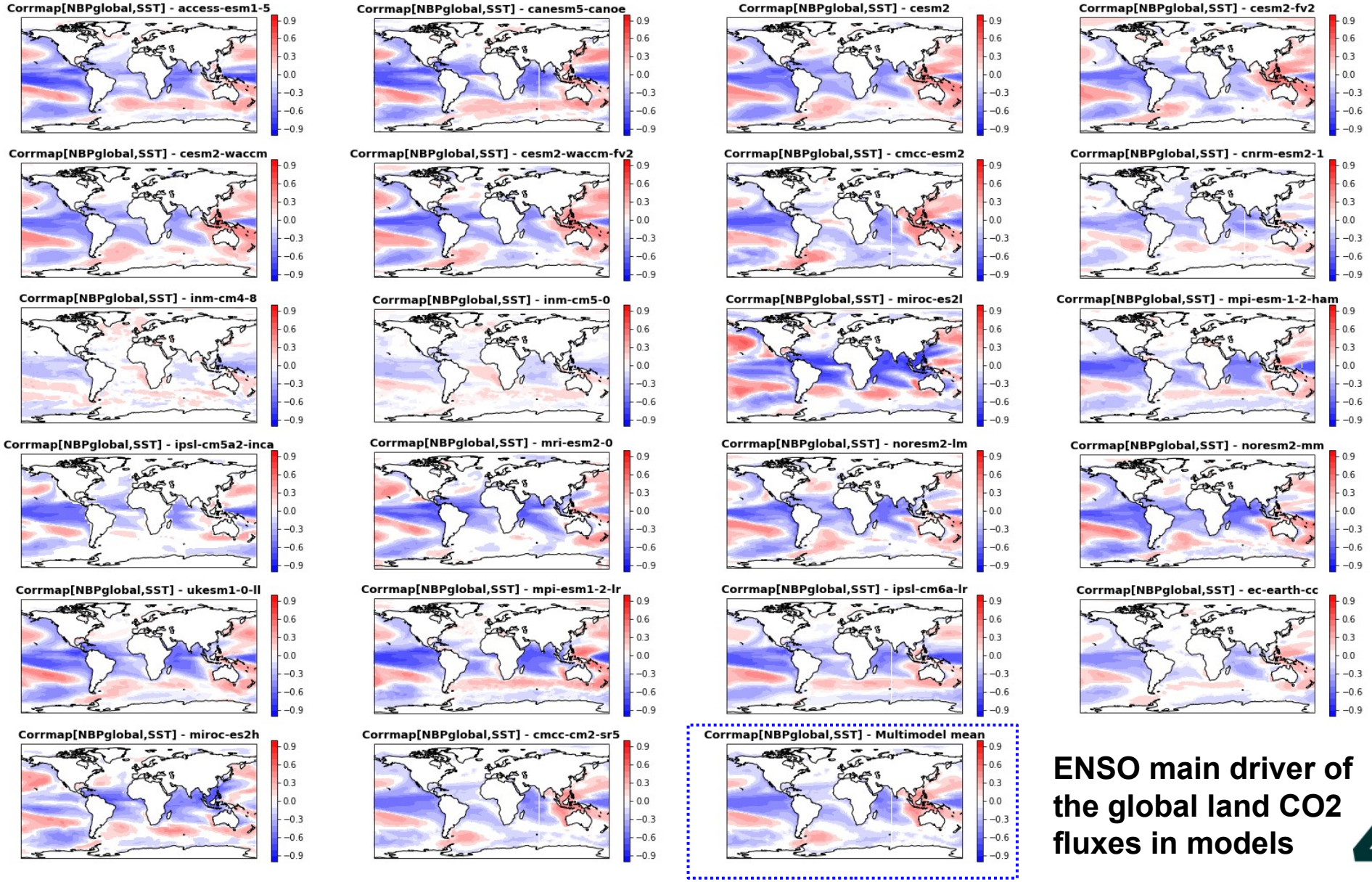
Boxplot: results from piControl CMIP6-ESMs

- CMIP6-ESMs reproduce this observed relative contribution of the ocean and land in the total CO2 fluxes, however there is a large spread in the variability of the total CO2 fluxes coming mainly from the land part fluxes.

- Models underestimate the variability of the global CO2 fluxes over ocean.

Correlation maps (global land CO2 fluxes index, SST)



ENSO main driver of the global land CO2 fluxes in models

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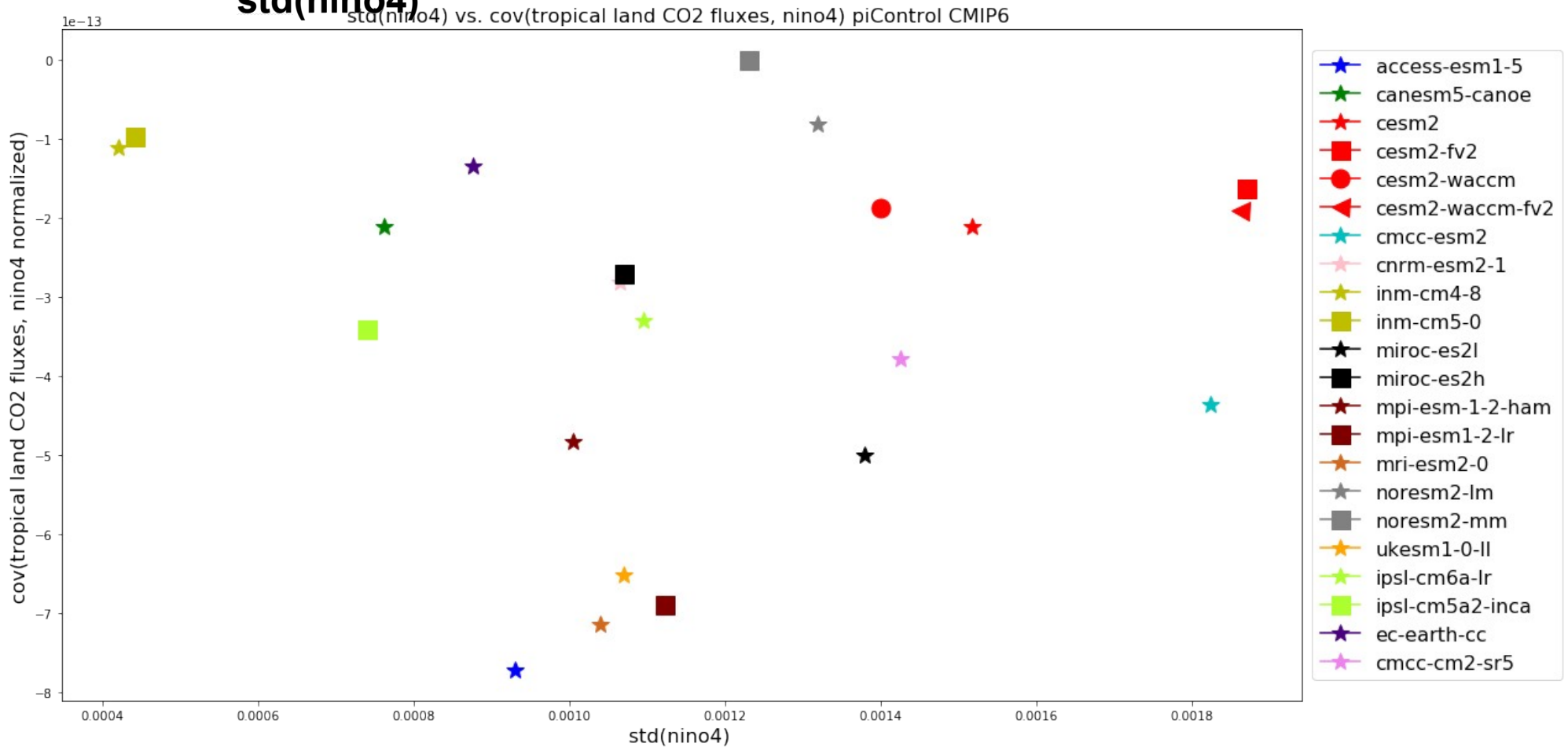
Uncertainty in the ENSO impacts on the land CO2 fluxes

Covariance(CO2 land fluxes, nino4) vs. std(nino4)



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Large intermodel uncertainty from:

- Different ENSO patterns in models
- Different ENSO teleconnections in models
- Different land vegetation models

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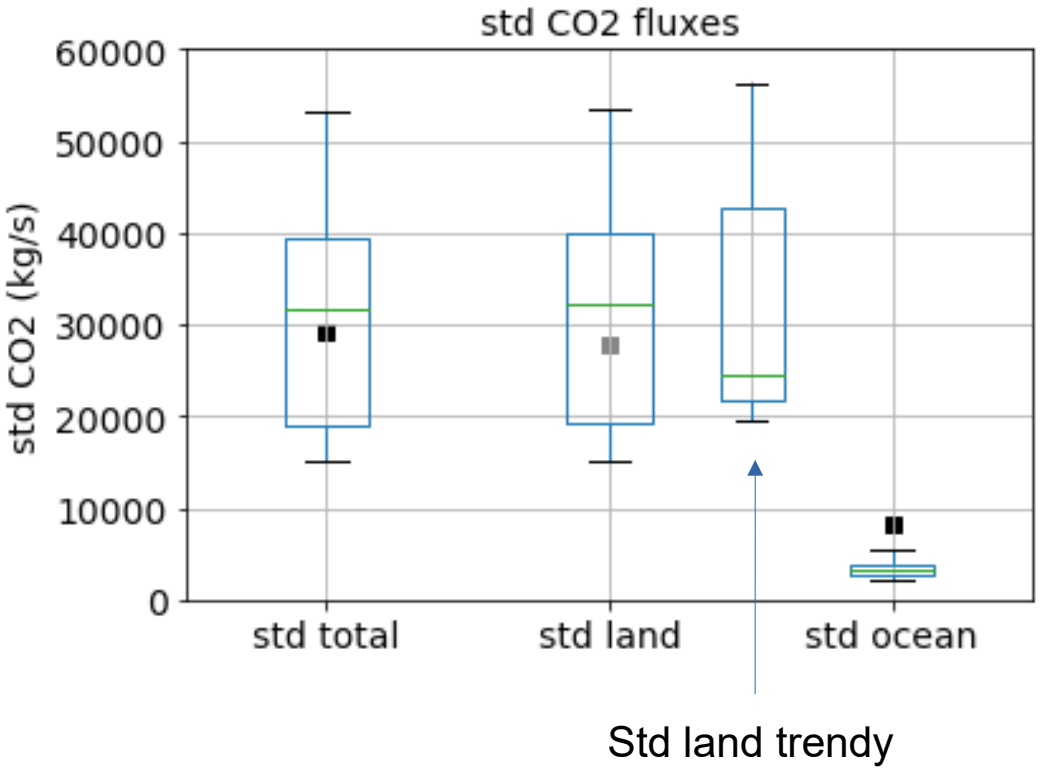
Origin of the uncertainty in cmip6 models



Main intermodel uncertainty is coming from land vegetation models

General conclusions

- The main source of internal variability of the atmospheric CO2 concentration comes from global land CO2 fluxes
- CMIP6 models reproduce this observed behavior
- For all models, ENSO is main driver of the interannual variability of the global land CO2 fluxes although there is a large uncertainty in the land CO2 fluxes response to ENSO
- Main intermodel uncertainty is coming from land vegetation models
- **We need to improve the land vegetation models to better constrain predictions and reconstructions of land CO2 fluxes**

Thank you!

veronica.martin@bsc.es

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