Validating land carbon fluxes in the Community Land Model based on TransCom land regions

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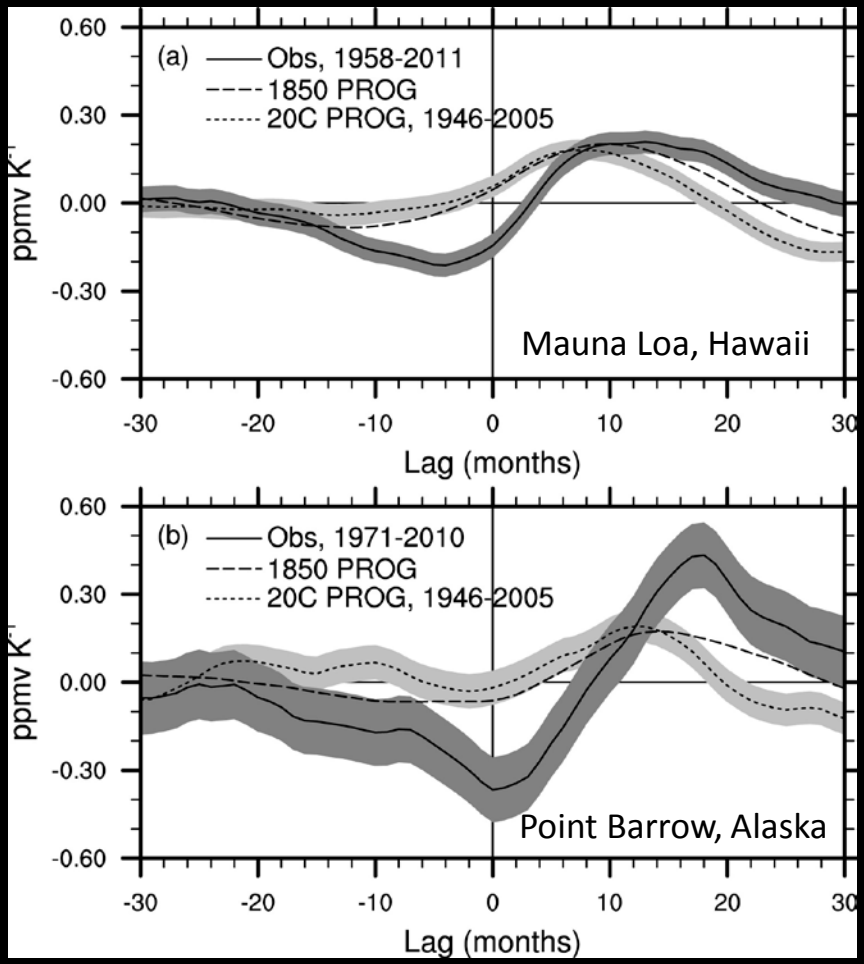
NCAR

Motivation

- Lindsay et al 2014 attributed the weak atmospheric CO_2 response to a weak response in the land-to-air CO_2 fluxes.
- Lindsay et al 2014 found that the model carbon system is undersensitive to variations in physical forcing.
- This is relevant in the context of interannual prediction of the carbon system.

Motivation



Lindsay et al 2014

- Lagged regression between Nino3.4 SSTs and atmospheric CO_2 at Mauna Loa (top) and Point Barrow (bottom).
- Model (light gray) shows undersensitivity to ENSO signal.

Science Questions

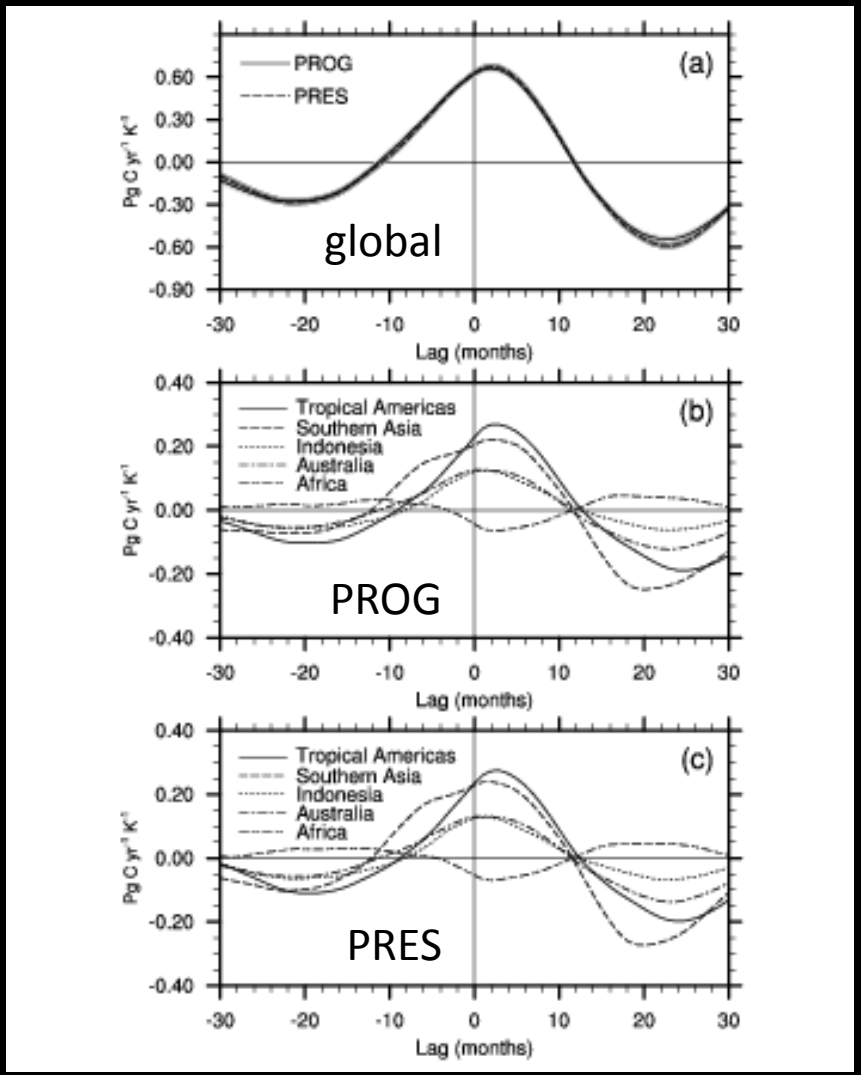
- Is interannual CO_2 response in CLM4.5 improved when compared to CLM4 from forced runs?
- How does the relationship with ENSO differ between coupled and forced runs?

Simulations being analyzed:

- Coupled simulations:
  - b40.prescribed_carb.001
    - CLM4
  - Large-ensemble control
    - CLM4
- Land forced simulations:
  - clm40cn
  - clm45bgc

land-to-air CO_2 flux response to ENSO

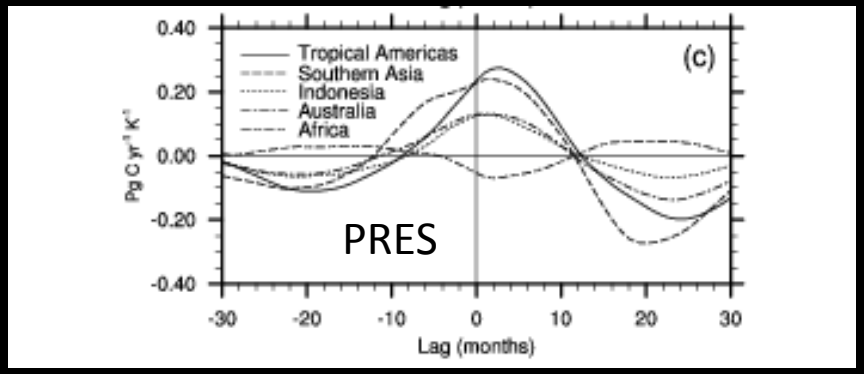
Coupled simulations



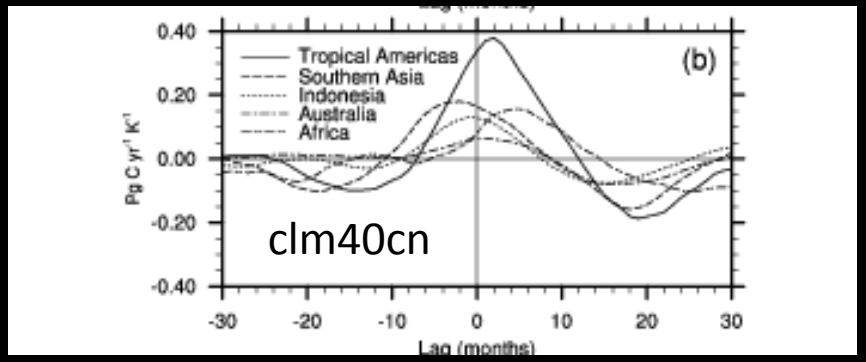
- Lagged regression between Nino3.4 SSTs and land-to-air CO_2 flux
- Simulations are the same as in Lindsay et al 2014. Regions are slightly different.

land-to-air CO_2 flux response to ENSO

Coupled simulation



Land forced simulation

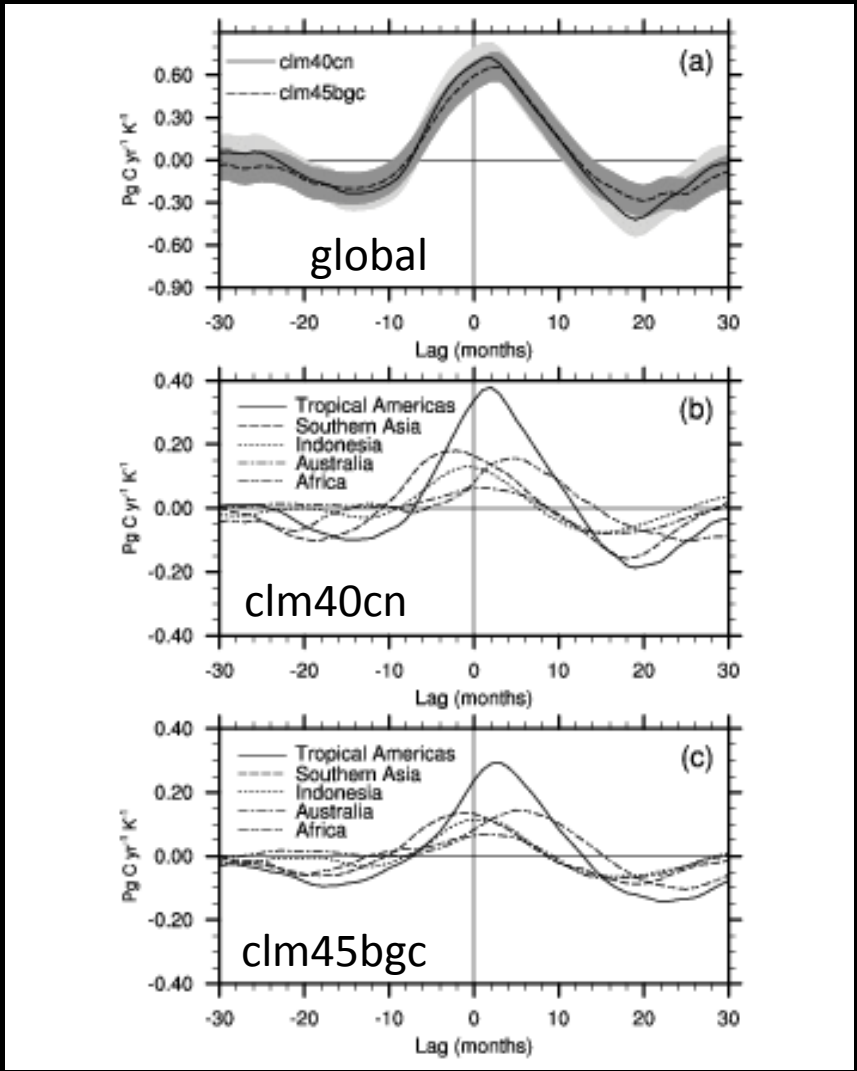


- In tropical America, the land forced simulation has stronger response to observed ENSO than the coupled simulation

land-to-air CO_2 flux response to ENSO

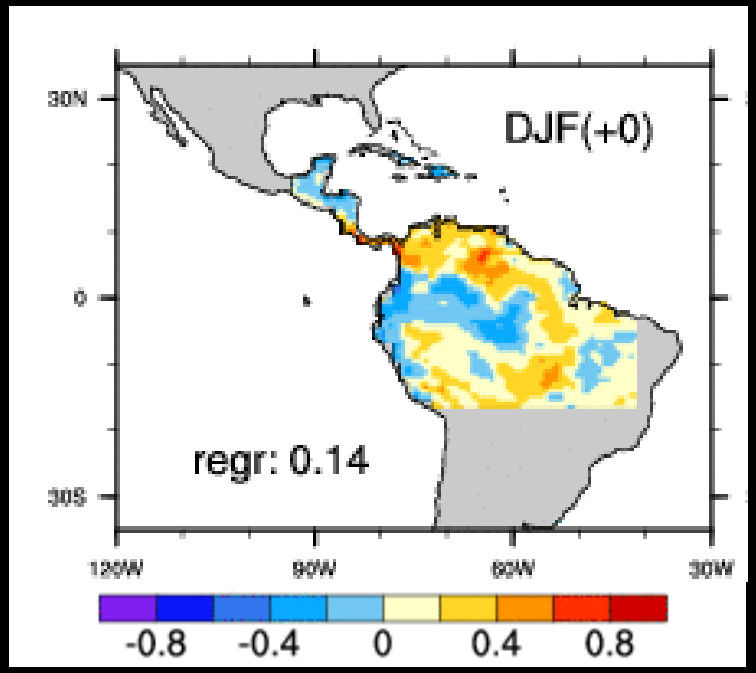
- Lagged regression between Nino3.4 SSTs and land-to-air CO_2 flux in land forced simulations

Land forced simulations

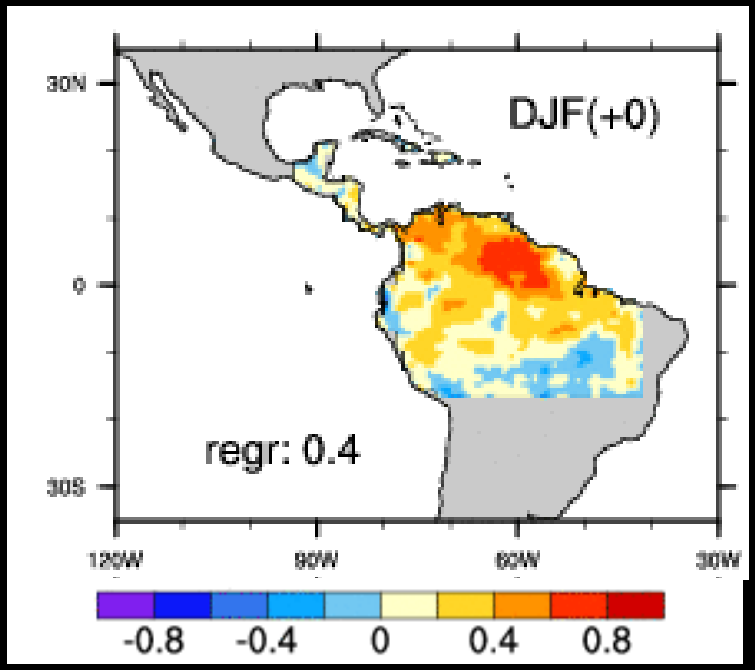


Correlation with ENSO is higher in land forced than in coupled simulation

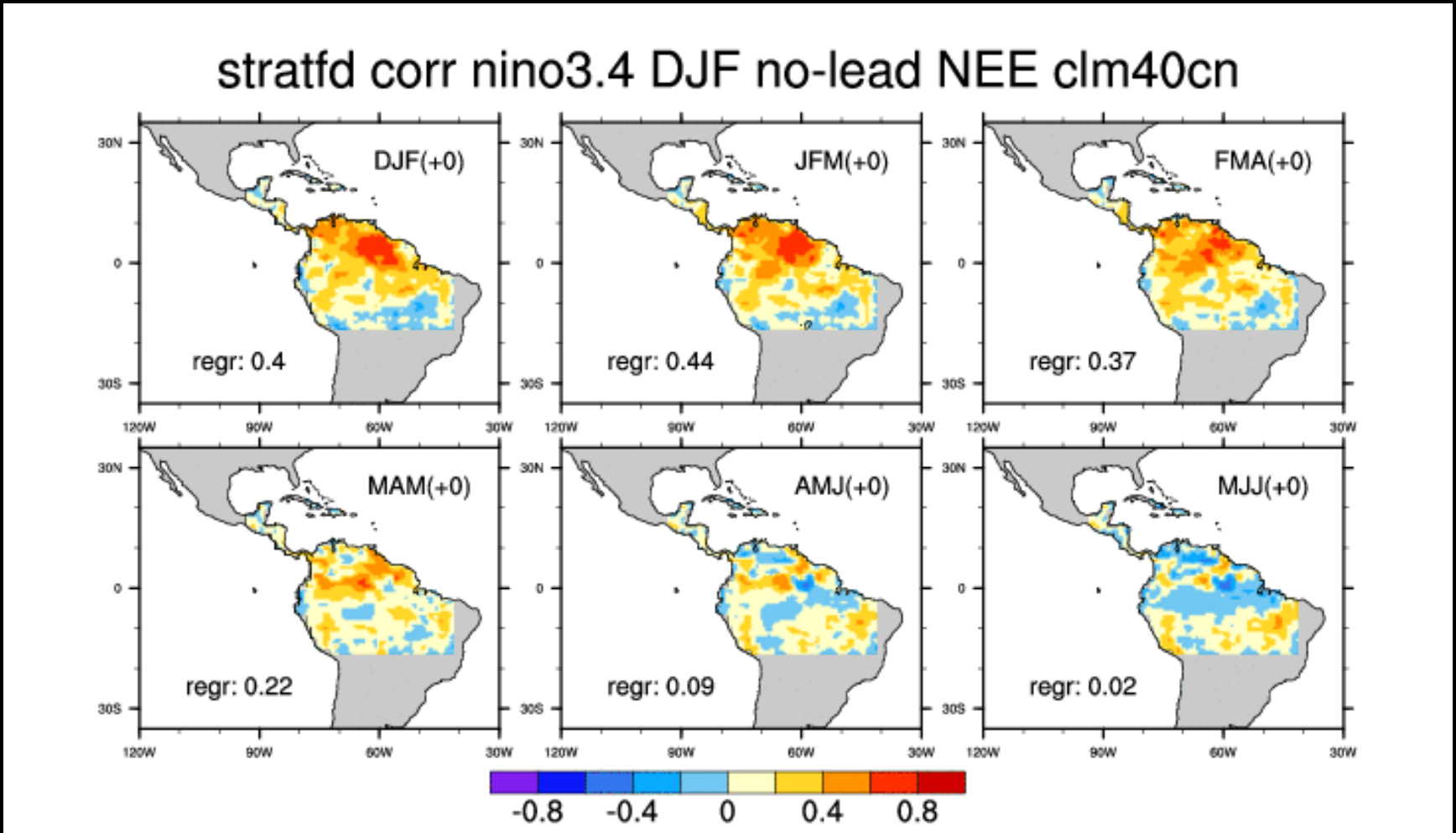
Coupled (Large ensemble)



Land forced



There is phase difference in response to ENSO



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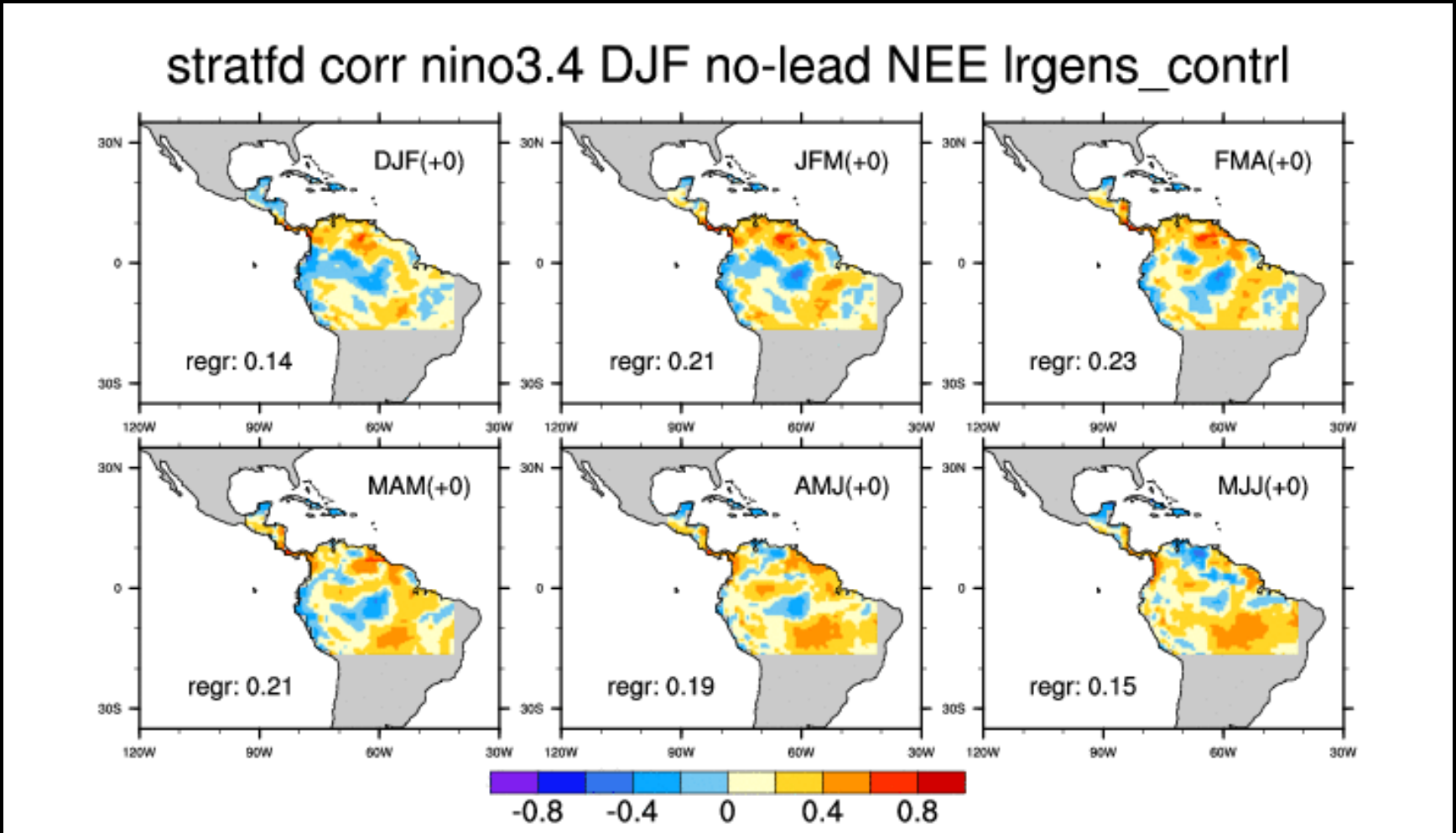
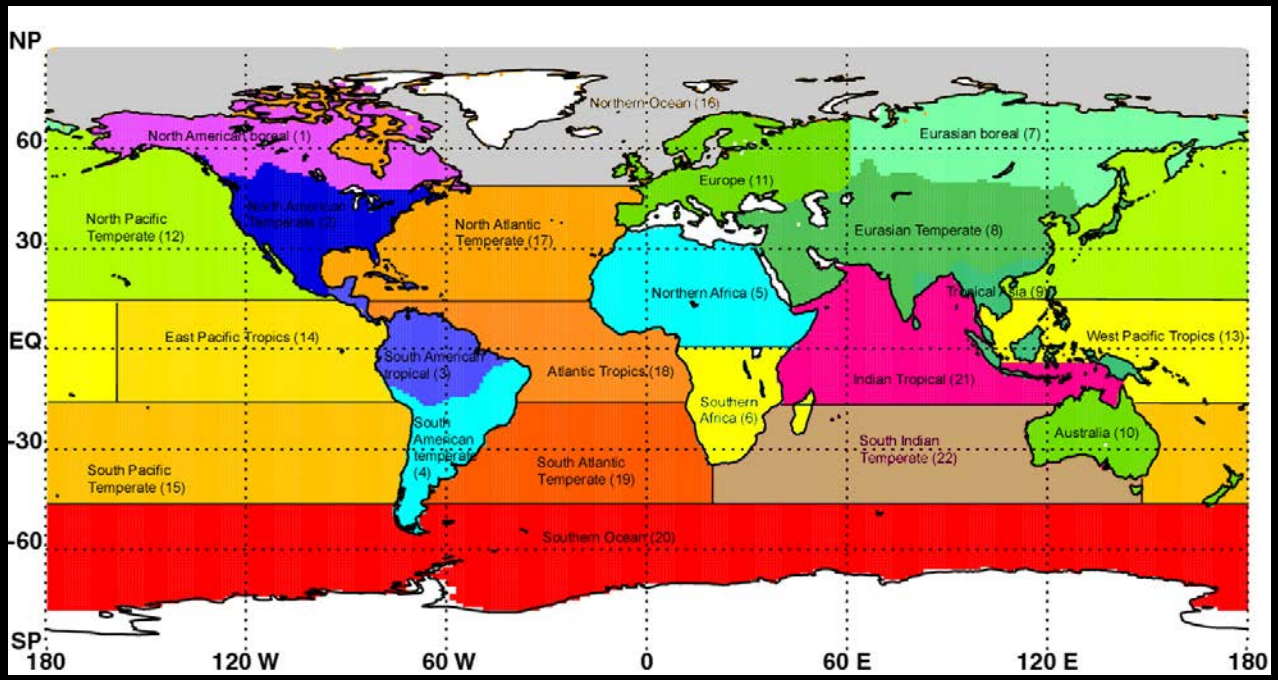
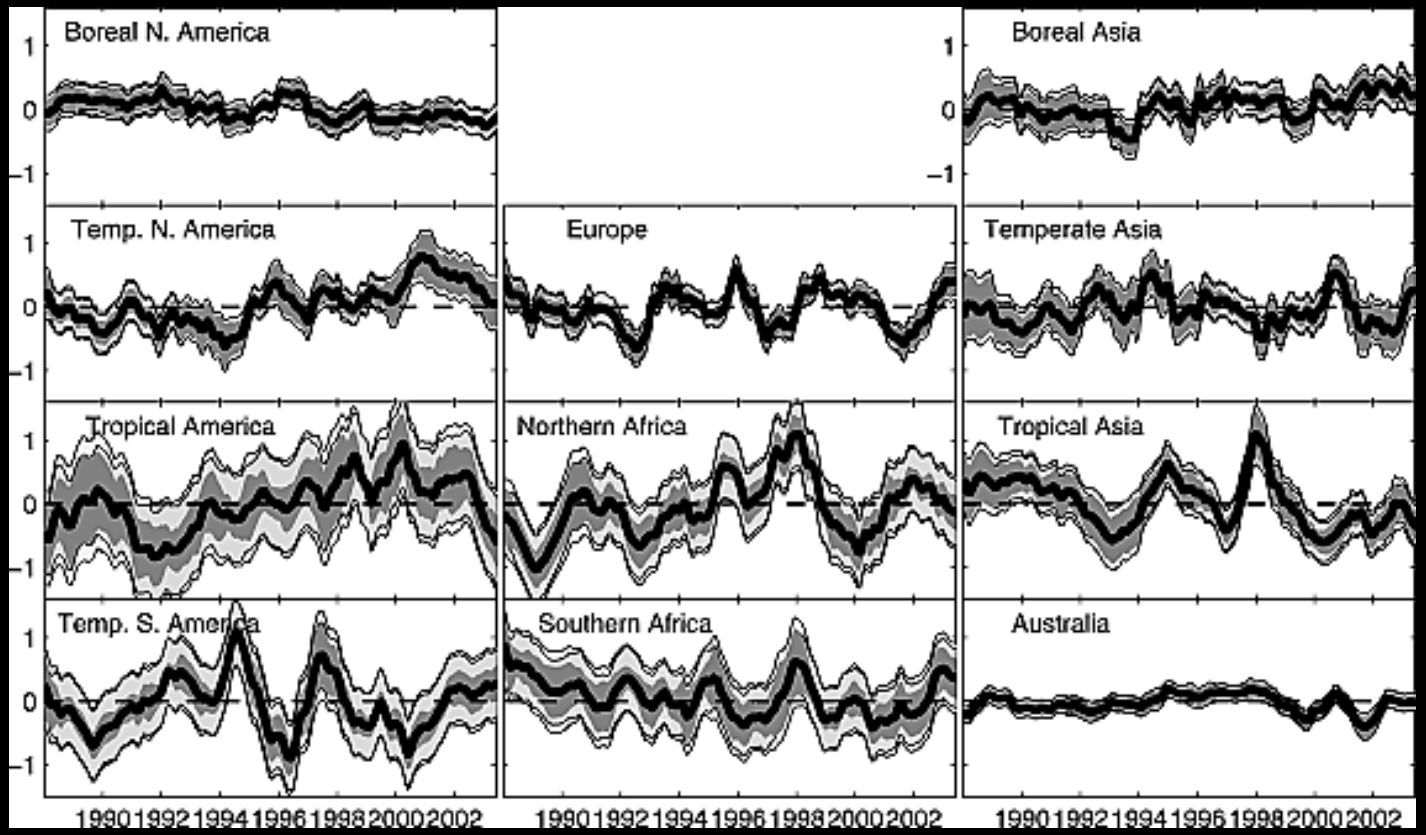


TransCom 3

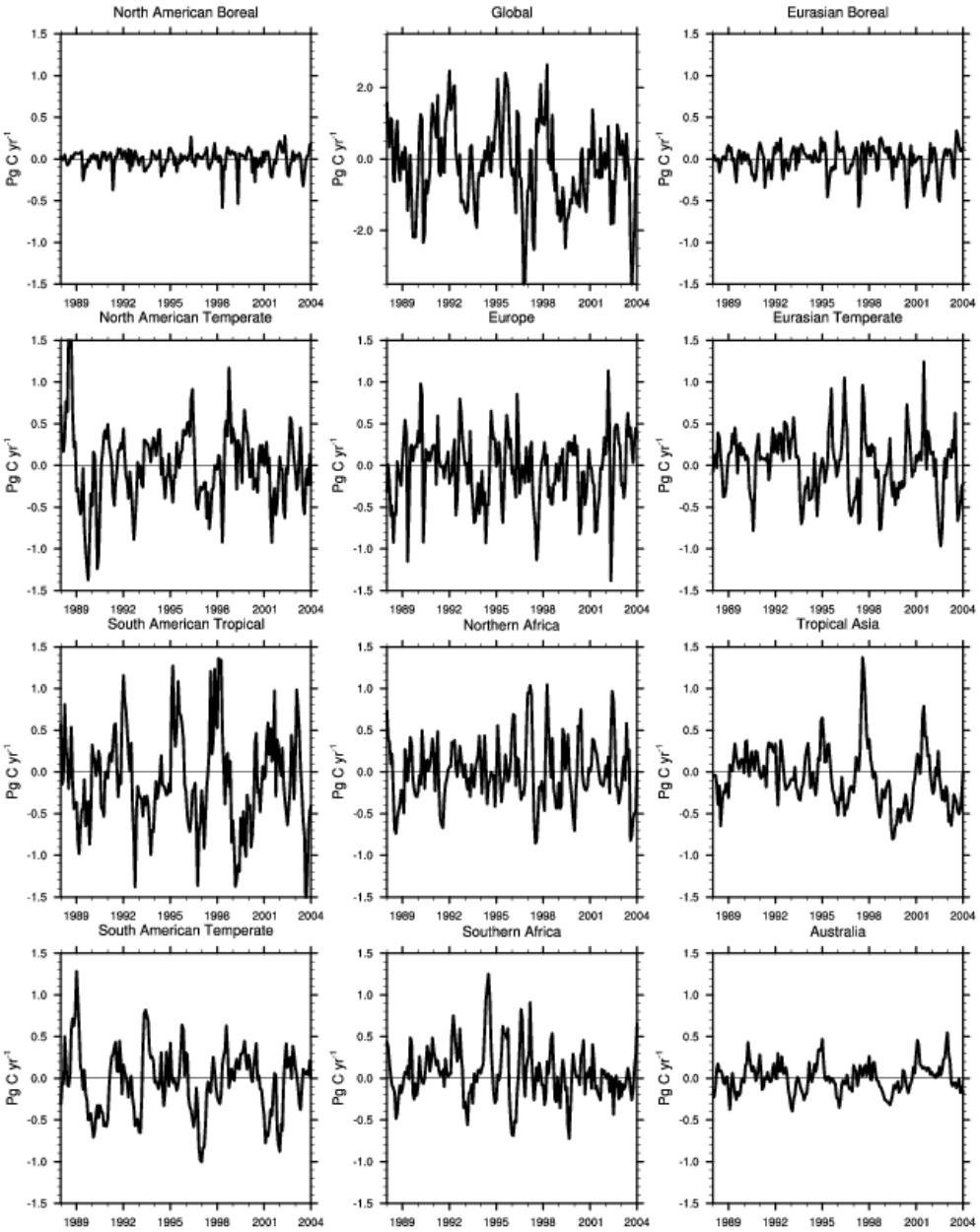
- Third phase of TransCom focused on interannual variability of CO_2 sources and sinks.
- Solved for CO_2 sources for 1988-2003 for 22 regions using 13 different transport models.



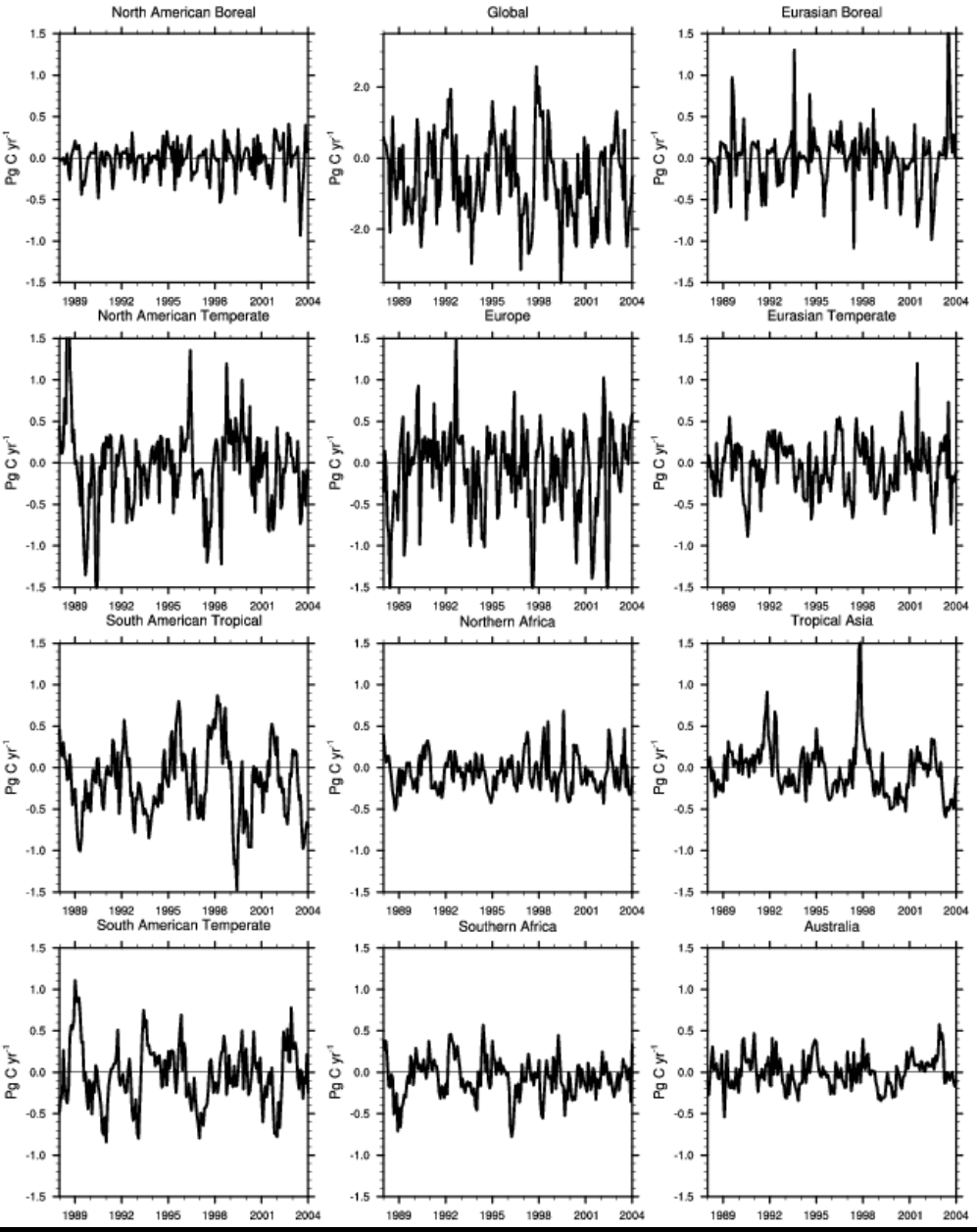
TransCom 3 land-to-air CO2 flux, 1988–2003 by region



Baker et al. 2006
Global Biogeochemical Cycles
Volume 20, Issue 1, GB1002, 7 JAN 2006 DOI: 10.1029/2004GB002439
http://onlinelibrary.wiley.com/doi/10.1029/2004GB002439/full#gbc1241-fig-0007


NEE in transcom regions
North American Boreal
Global
Eurasian Boreal
North American Temperate
Europe
Eurasian Temperate
South American Tropical
Northern Africa
Tropical Asia
South American Temperate
Southern Africa
Australia
Pg C yr-1
1989
1992
1995
1998
2001
2004

clm40cn


NEE in transcom regions
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Pg C yr-1
1989
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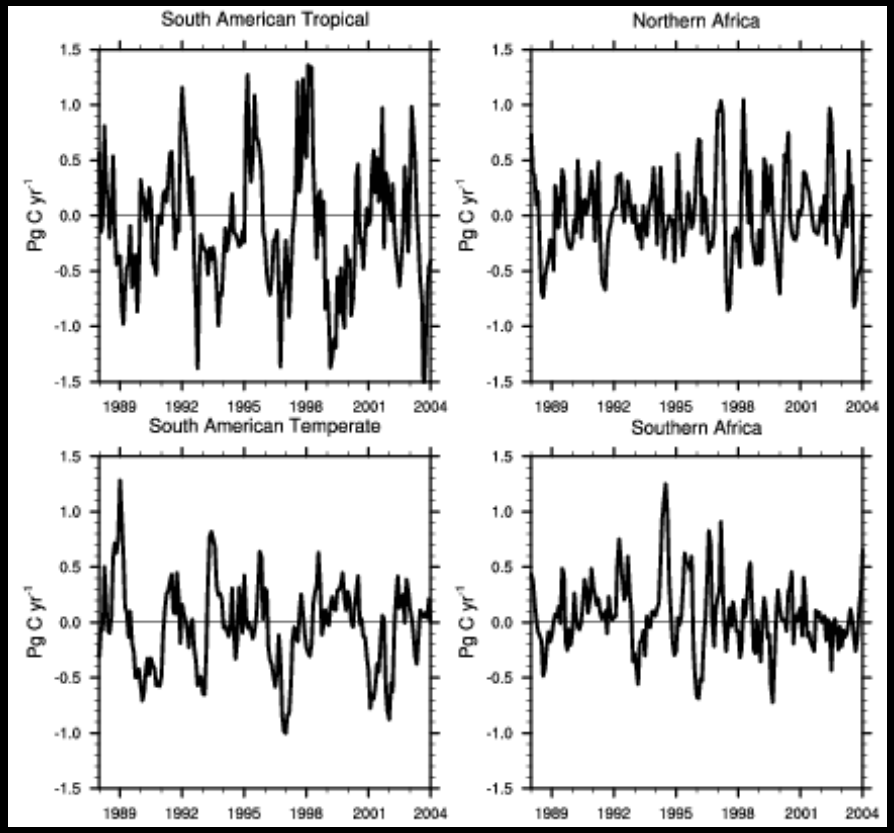
2001
2004

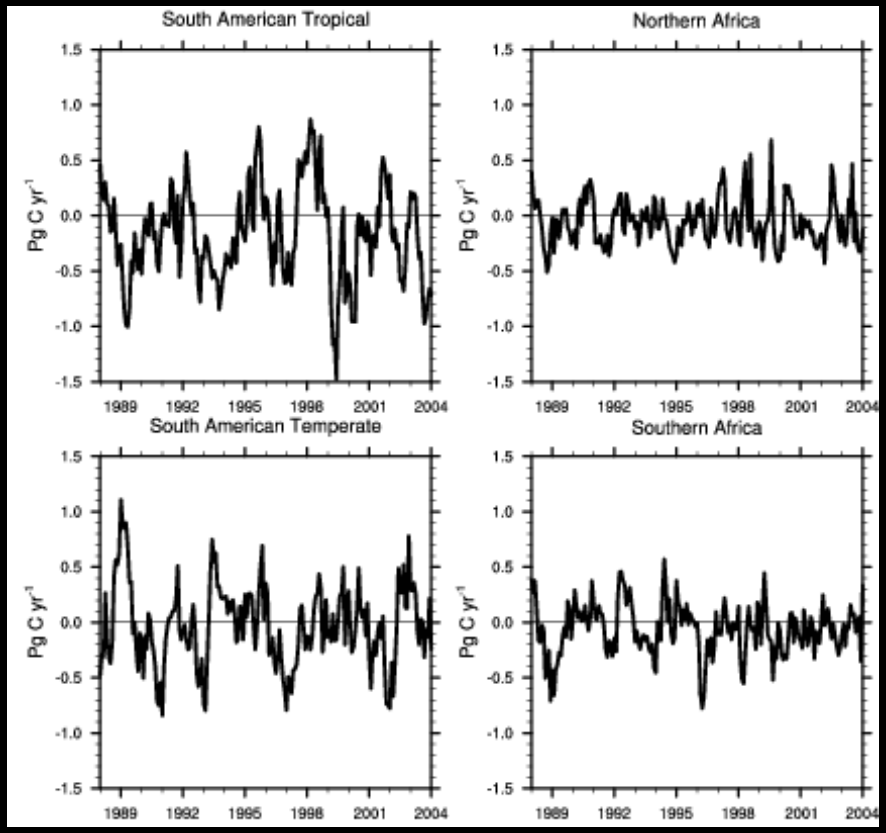
clm45bgc

Land-to-air CO_2 flux differs between clm40cn and clm45bgc

clm40cn



clm45bgc



Do these differences point to improvements in CLM4.5?

Summary

- Ongoing work in diagnosing the “undersensitivity” of the model carbon system to variations in physical forcing
- Phase difference in response to ENSO between coupled and land forced simulations
- TransCom inversion data is useful as benchmark for land-to-air CO_2 fluxes
- clm40cn and clm45bgc differ in the amplitude of the anomalies of land-to-air CO_2 flux