Effect of land-atmosphere coupling strength on impacts from Amazonian deforestation

A study with ACCESS1.3b AMIP runs

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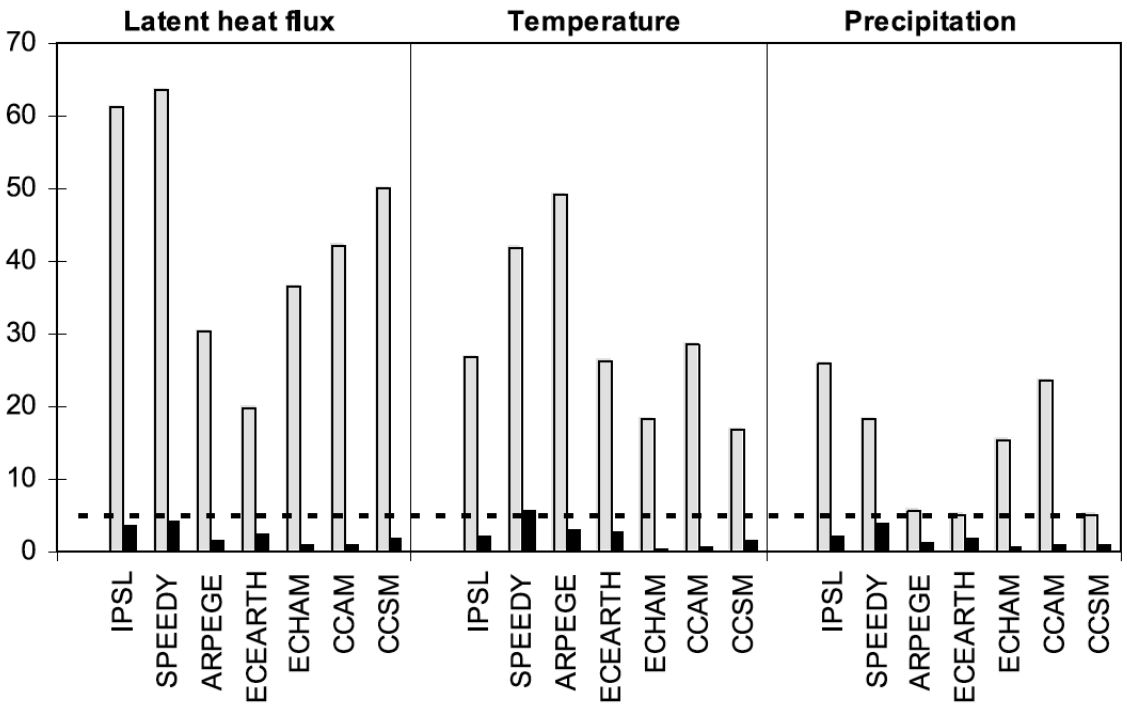
CABLE Videoconference

08/10/2014

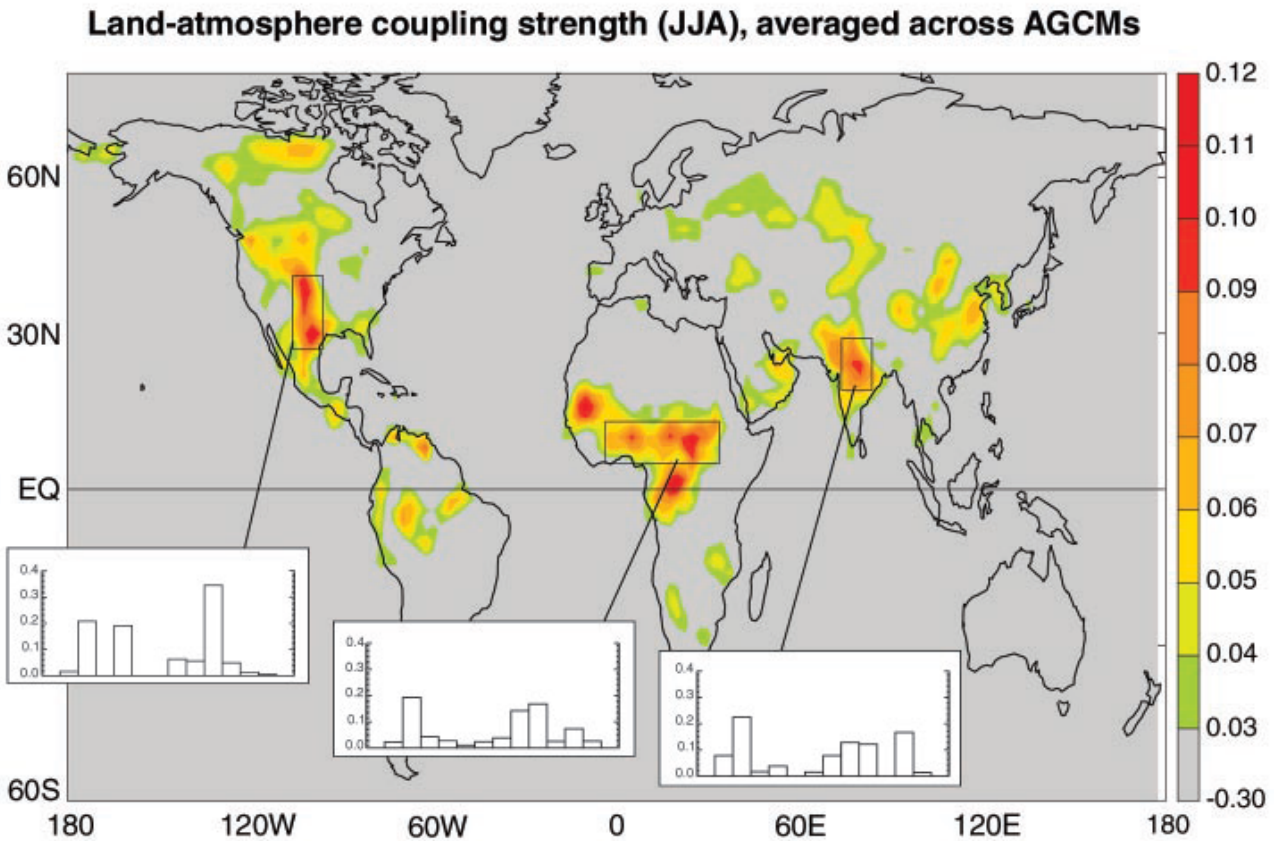
Inter-model differences in effects from Land Use Change



Percent of land area that exhibits statistically significant changes in JJA

Pitman et al. 2009, GRL

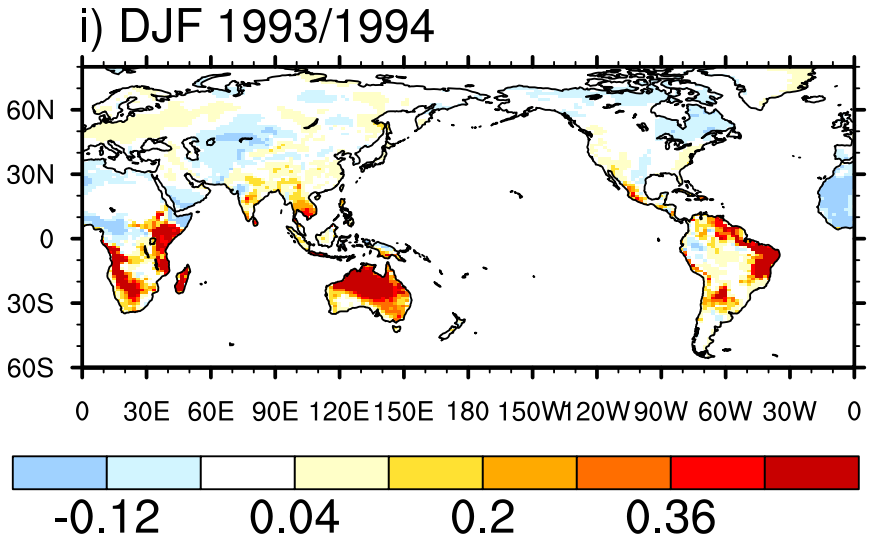
Land-atmosphere coupling hot spots



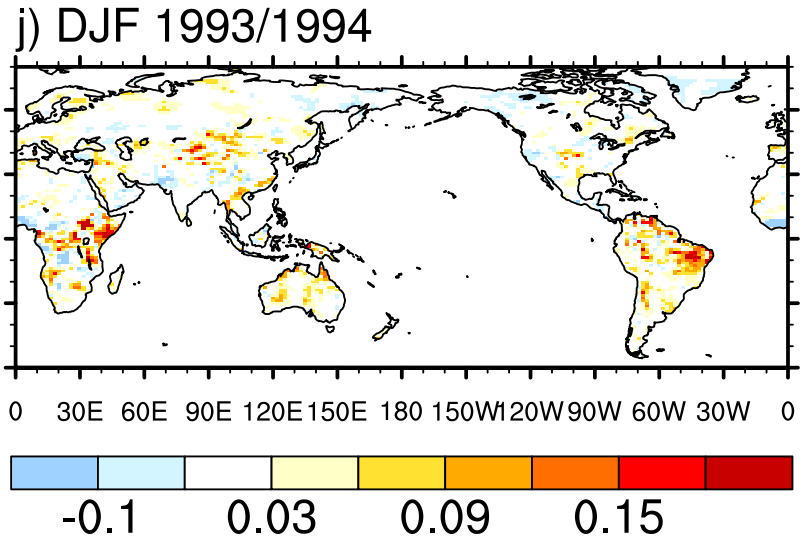
Koster et al. 2004, Science

Land-atmosphere coupling in ACCESS (GLACE-1)

$\Delta\Omega_T$



$\Delta\Omega_P$



Research Question

- What is the influence of land-atmosphere coupling strength on deforestation experiments in Amazonia?

ACCESS1.3b, AMIP

- Atmosphere: UM7.3
- Land surface: CABLE2.0
- AMIP: Prescribed Sea Surface Temperatures and Sea Ice
  $\rightarrow$ only Land surface and Atmosphere
- Resolution: N96 (1.25 $^\circ$ lat x 1.875 $^\circ$ lon)

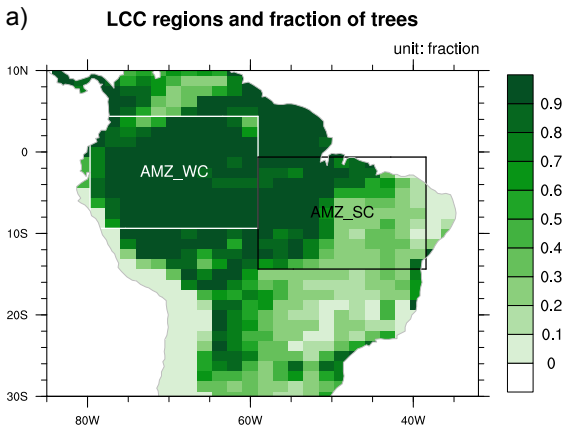
GLACE methodology

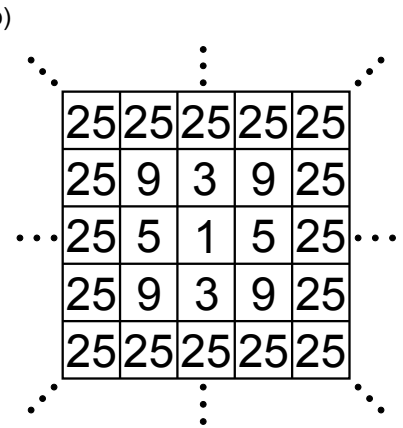
- 2 sets of experiments:
  - CTL or COUPLED: interactive calculation of soil moisture
  - UNCOUPLED: prescribed soil moisture based on CTL
- GLACE-CMIP5: long runs, 150 years 1950–2100, 6 GCMs so far, (*Seneviratne et al. 2013*)
  - ExpA: uses prescribed soil moisture from 1971–2000 climatology from CTL

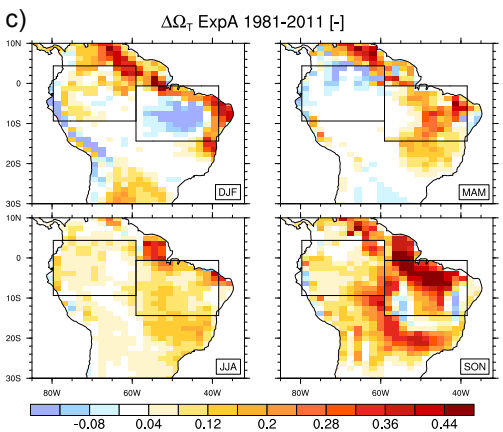
Land-atmosphere coupling strength $\Delta\Omega$

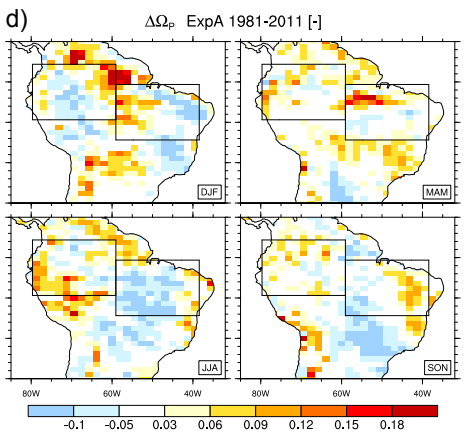
- Similarity of ensemble members: $\Omega_X = \frac{N\sigma^2_{<X>} - \sigma^2_X}{(N-1)\sigma^2_X}$
- X: variable, e.g. Precipitation, Temperature, T_{MAX}
- σ^2_X: temporal standard deviation of X
- $\sigma^2_{<X>}$: standard deviation of ensemble mean timeseries
- N: number of ensemble members, 16 in GLACE-1, number of years in GLACE-CMIP5
- Land-atmosphere coupling strength:
  $\Delta\Omega_X = \Omega_X(UNCOUPLED) - \Omega_X(CTL)$
  $\rightarrow$ higher values show stronger coupling
- Koster et al. 2006 (GLACE-1), Seneviratne et al. 2006 (GLACE-CMIP5)

Experiment set-up

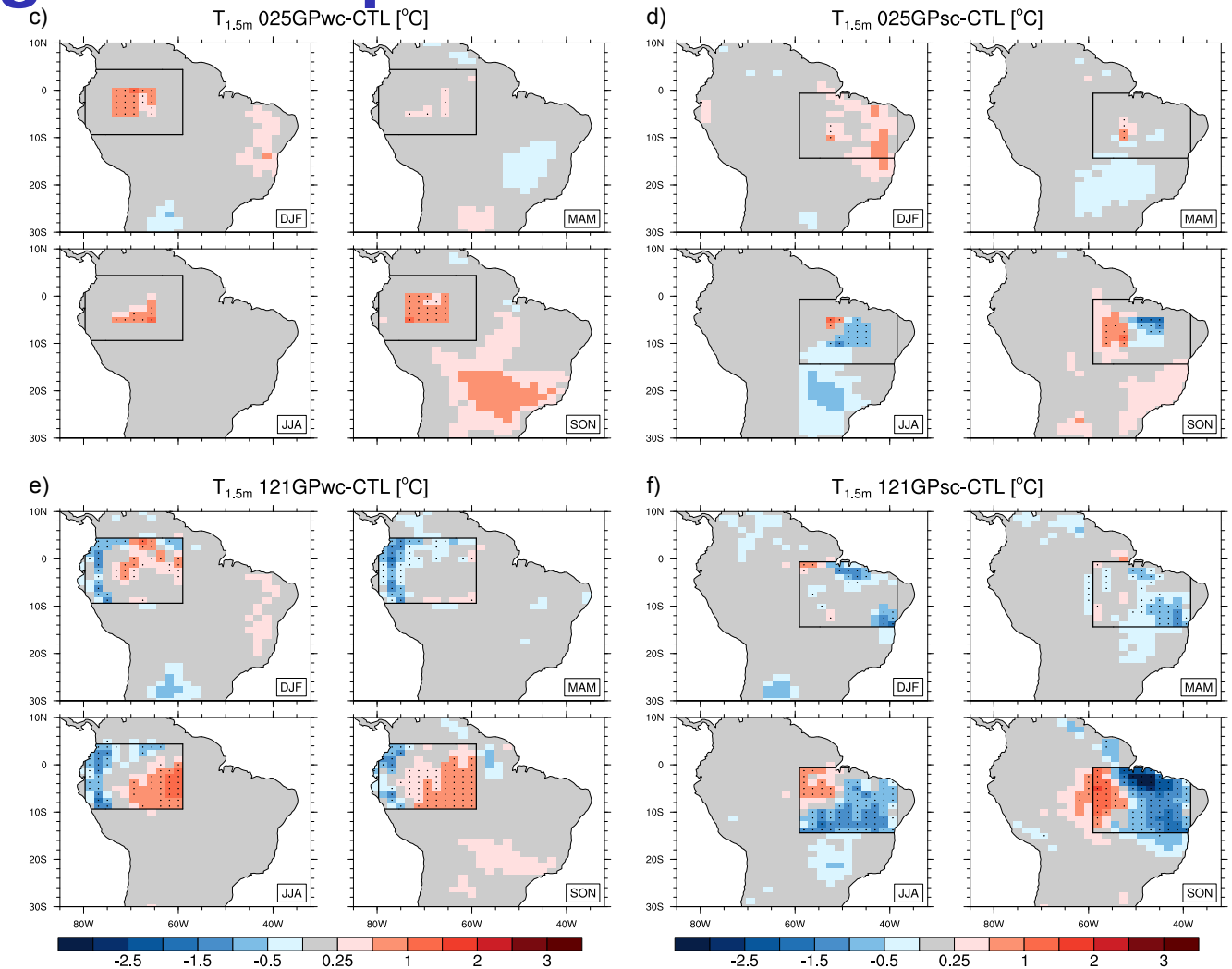




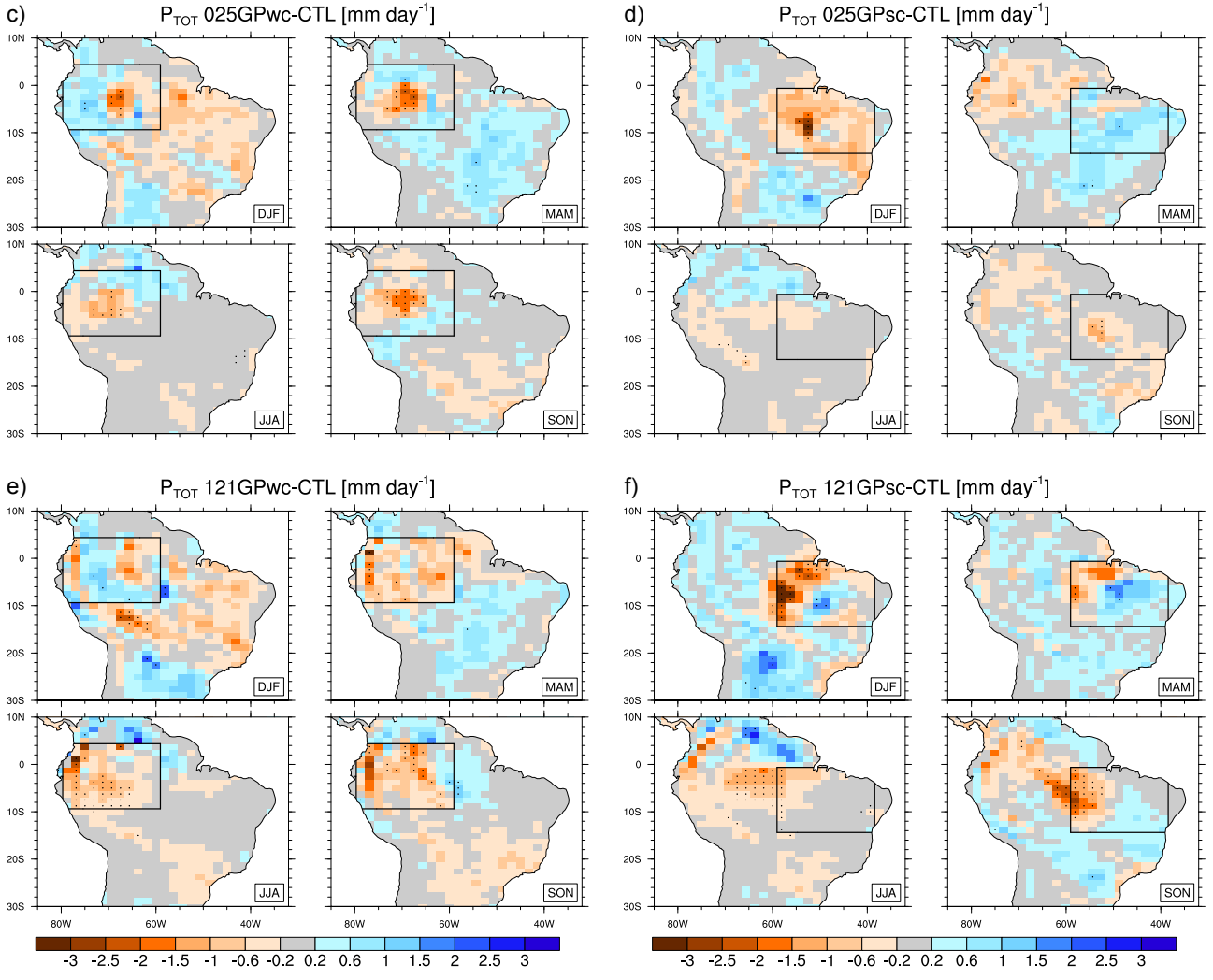




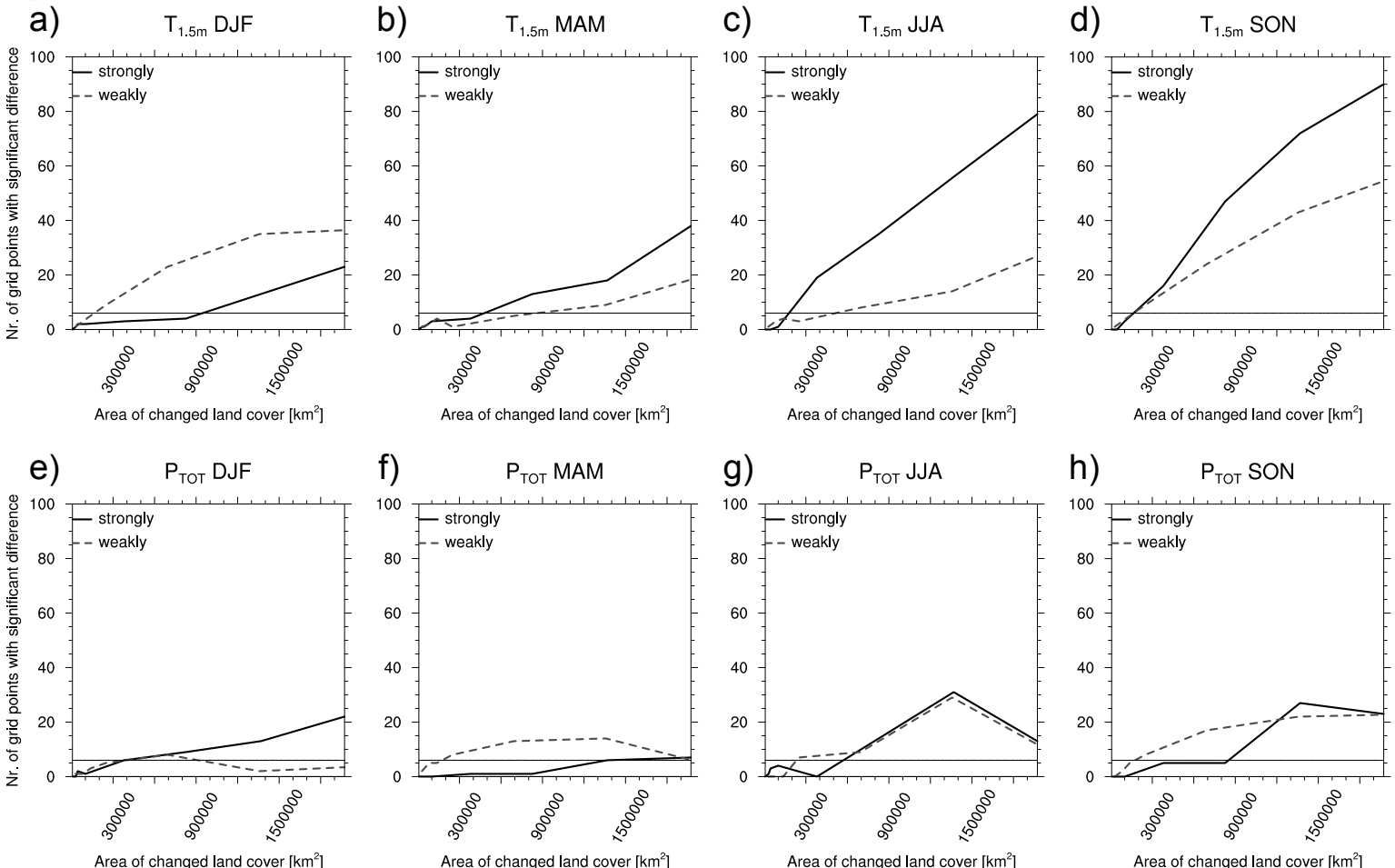
Changes in temperature



Changes in precipitation



Scaling of deforestation and influence of coupling



Conclusions

- Regional impacts of deforestation on temperature are linked with coupling strength
- Stronger coupling leads to larger effects on temperature in dry season
- Because land-atmosphere coupling model dependent, multi-model ensemble simulation are needed to reduce uncertainty

Thank you for your attention!

References:
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Seneviratne, S. I. et al. 2006. Land-atmosphere coupling and climate change in Europe. Nature 443.
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