Country-level land carbon sink and its causing components by the middle of the 21st century

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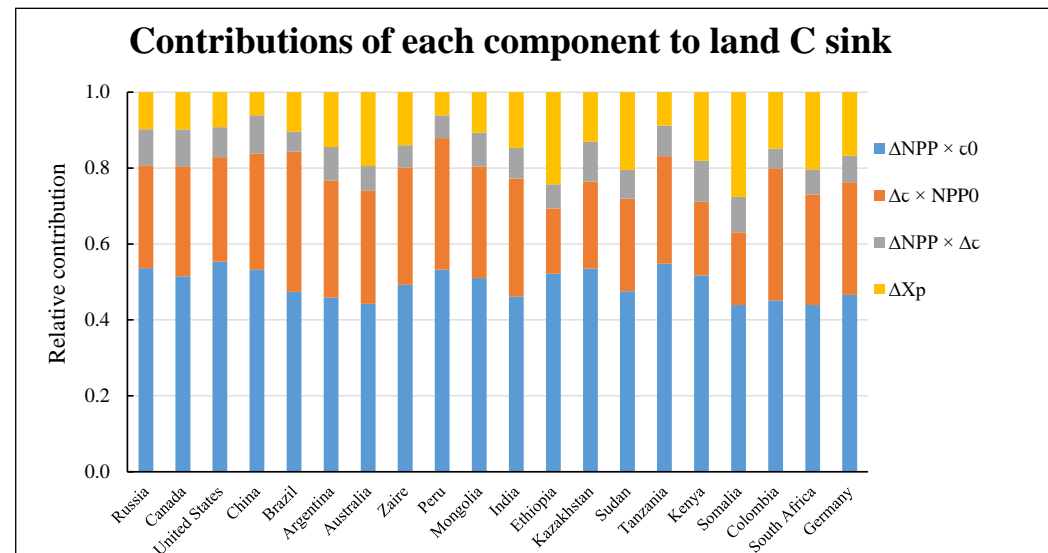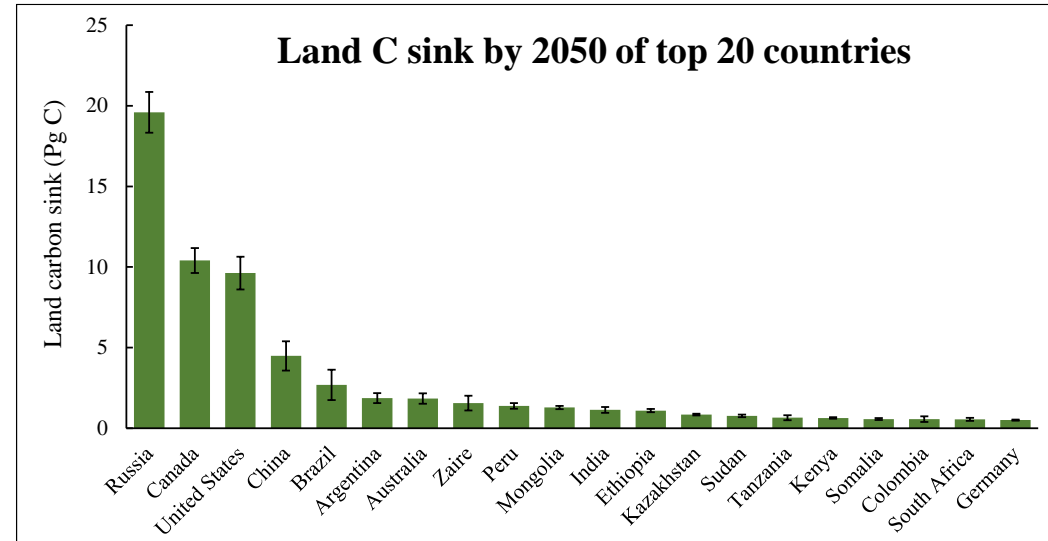
Science motivation and summary

Why:

Carbon (C) sink by natural terrestrial ecosystems remains difficult to quantify.

United Nations Framework Convention on Climate Change

What has been done:

Country-level C sink by terrestrial ecosystems and its causing components by 2050 simulated by 12 CMIP5 models under RCP8.5 were estimated by using a **transient traceability framework**

What has been found:

❖ The top 20 countries that have highest C sink has the potential to sequester 62 Pg C in total; Russia, Canada, United States, China, and Brazil sequester the most.

❖ C sink can be traced to four components:
   1) Production-driven change (49.5%)
   2) Turnover-driven change (28.1%)
   3) Interaction between 1) and 2) (7.9%)
   4) Change in C storage potential (14.5%)

Land C sink by 2050 of top 20 countries

Land carbon sink (Pg C)

Russia, Canada, United States, China, Brazil, Argentina, Australia, Zaire, Peru, Mongolia, India, Ethiopia, Kazakhstan, Sudan, Tanzania, Kenya, Somalia, Colombia, South Africa, Germany

Contributions of each component to land C sink

Relative contribution

Russia, Canada, United States, China, Brazil, Argentina, Australia, Zaire, Peru, Mongolia, India, Ethiopia, Kazakhstan, Sudan, Tanzania, Kenya, Somalia, Colombia, South Africa, Germany

Legend: $\Delta NPP \times c0$; $\Delta c \times NPP0$; $\Delta NPP \times \Delta c$; ΔX_p

NPP_0: net primary production in 2005; ΔNPP = NPP in 2050 - NPP in 2005
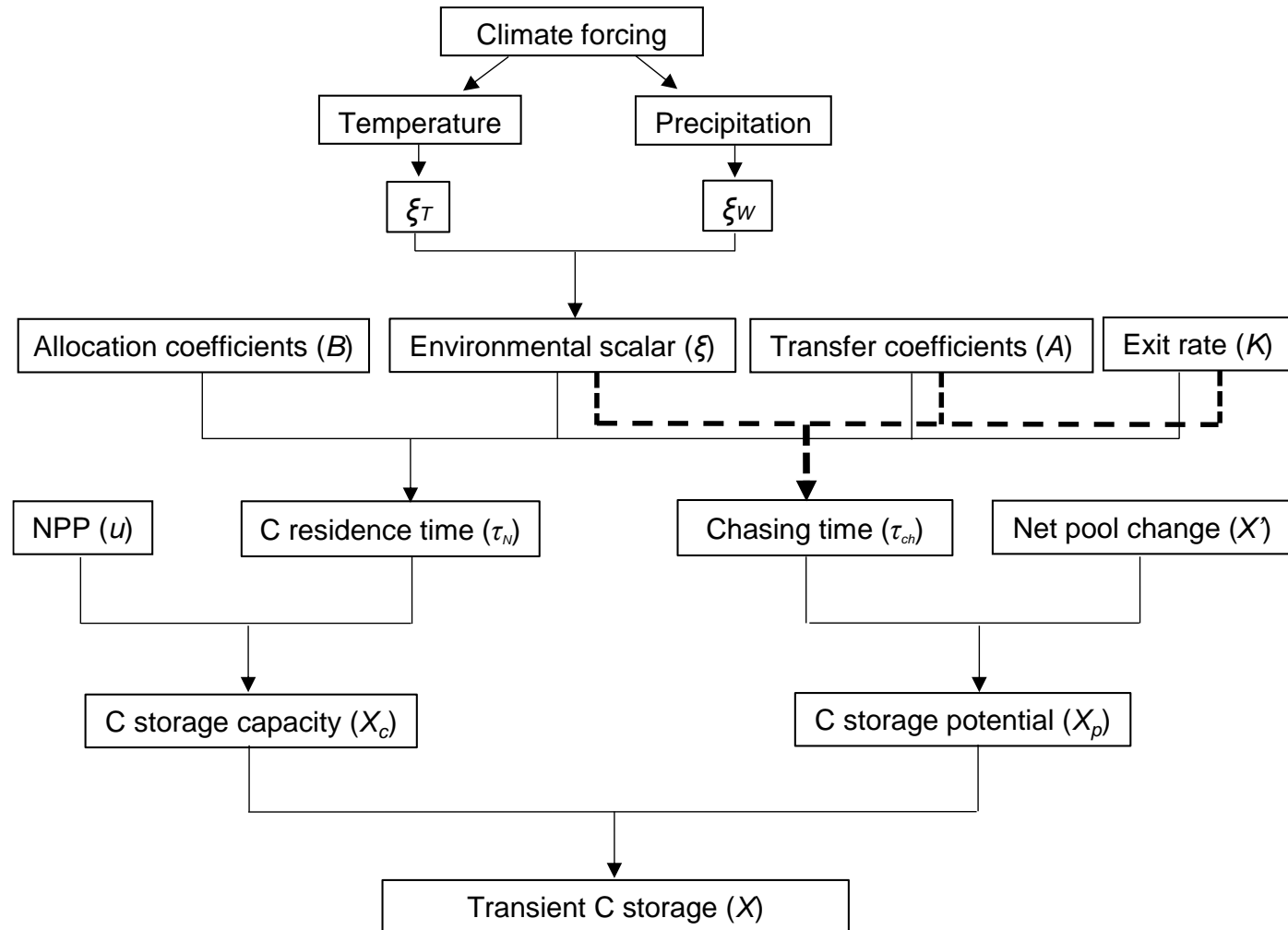
τ_0: C residence time in 2005; $\Delta\tau$ = C residence time in 2050 - C residence time in 2005

ΔX_p = C storage potential in 2050 - C storage potential in 2005

Transient Traceability Framework

Climate forcing

Temperature

Precipitation

ξ_T

ξ_W

Allocation coefficients (B)

Environmental scalar (ξ)

Transfer coefficients (A)

Exit rate (K)

NPP (u)

C residence time (τ_N)

Chasing time (τ_{ch})

Net pool change (X')

C storage capacity (X_c)

C storage potential (X_p)

Transient C storage (X)

Jiang et al. 2017, *JAMES*

❖ **CMIP6**

❖ **Other MIPs**

Relationship to white paper

The transient traceability framework can contribute to improve model performance:

❖ Facilitate model intercomparison to help reduce model uncertainty by decomposing modeled land C storage into traceable components

❖ Explore the responses of land C storage to changes in climate, CO_2, N, land use change, etc. and the mechanisms

❖ Identify the differences in land C storage dynamics among ecosystems, biomes, regions, etc. and the mechanisms

❖ Help benchmark analysis

Jones et al. 2013, *J. Clim*

Arora et al 2019, *Biogeosciences*