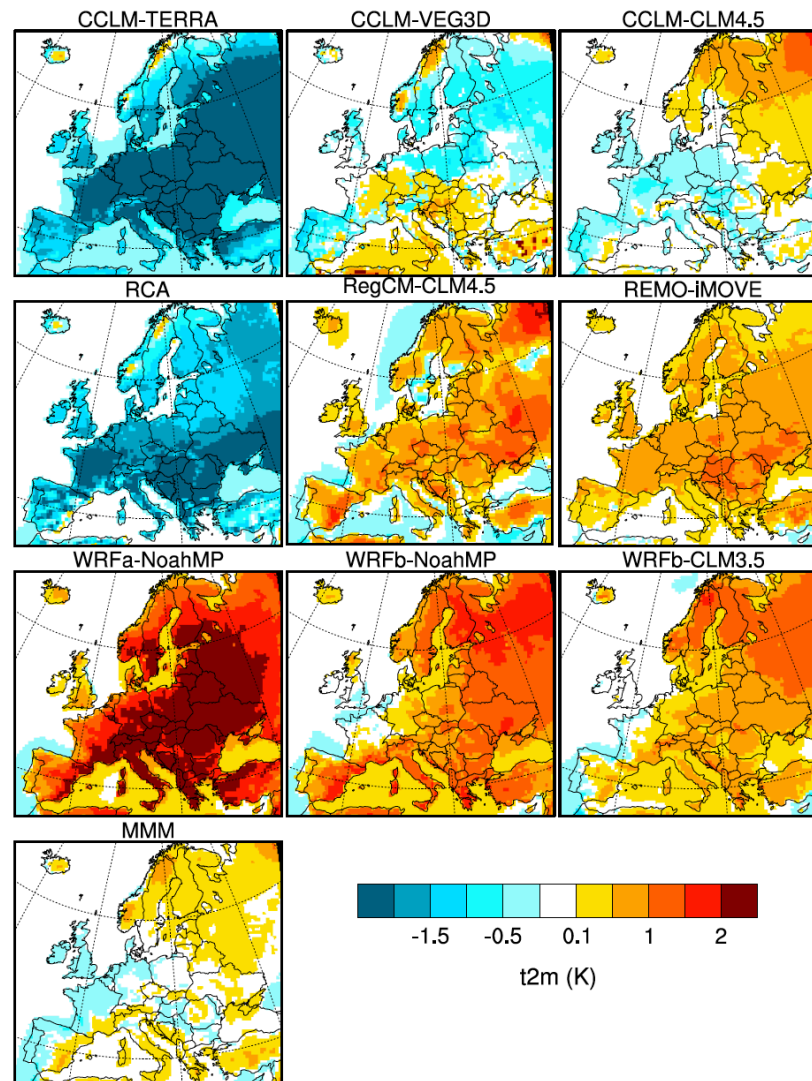


An historical data-driven reconstruction of land use change-induced impacts on temperature

E.L. Davin, J. Schwaab, R. Bright, G. Duveiller, D. Lawrence,
P. Lawrence, A. Bastos, J. Nabel, J. Pongratz et al.

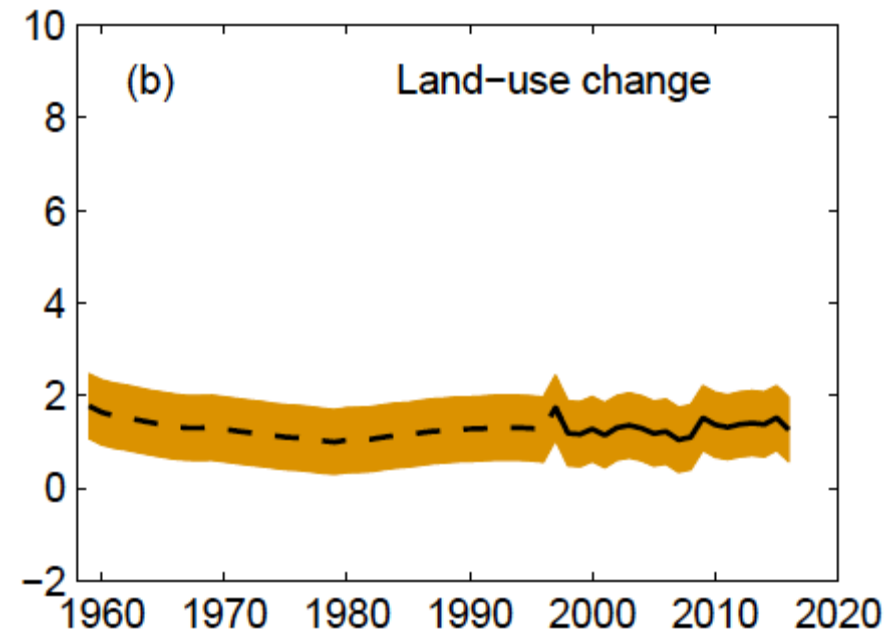
Why is benchmarking of biogeophysical effects critical?



FOREST – GRASS
(effect of re/afforestation in
9 RCMs)

Davin et al., ESD, 2019

- Historical reconstructions of carbon flux from land use change already exist based on bookkeeping methods
- Equivalent reconstructions of biogeophysical effects, independent from models, are still to be developed



Le Quéré et al., ESSD, 2018

LUC transition matrix:
BLUE (LUH2-based)



$$\begin{bmatrix} \text{ENF2GRA} \\ \text{DNF2GRA} \\ \text{EBF2GRA} \\ \text{DBF2GRA} \\ \text{ENF2CRO} \\ \text{DNF2CRO} \\ \text{EBF2CRO} \\ \text{DBF2CRO} \\ \text{CROr2CROi} \\ \text{DBF2ENF} \end{bmatrix}$$

X

Temperature sensitivity:
Bright et al., 2017 (B17)
and Duveiller et al., 2018 (D18)



$$\begin{bmatrix} \text{DTs_ENF2GRA} \\ \text{DTs_DNF2GRA} \\ \text{DTs_EBF2GRA} \\ \text{DTs_DBF2GRA} \\ \text{DTs_ENF2CRO} \\ \text{DTs_DNF2CRO} \\ \text{DTs_EBF2CRO} \\ \text{DTs_DBF2CRO} \\ \text{DTs_CROr2CROi} \\ \text{DTs_DBF2ENF} \end{bmatrix}$$

Uncertainty analysis:

- Uncertainty in temperature data: “B17” and “D18”
- Uncertainty in LUC reconstruction: low and high estimate of LUH2

LUC transition matrix:
BLUE (LUH2-based)



$$\begin{bmatrix} \text{ENF2GRA} \\ \text{DNF2GRA} \\ \text{EBF2GRA} \\ \text{DBF2GRA} \\ \text{ENF2CRO} \\ \text{DNF2CRO} \\ \text{EBF2CRO} \\ \text{DBF2CRO} \\ \text{CROr2CROi} \\ \text{DBF2ENF} \end{bmatrix}$$

X

Temperature sensitivity:
Bright et al., 2017 (B17)
and Duveiller et al., 2018 (D18)



$$\begin{bmatrix} \text{DTs_ENF2GRA} \\ \text{DTs_DNF2GRA} \\ \text{DTs_EBF2GRA} \\ \text{DTs_DBF2GRA} \\ \text{DTs_ENF2CRO} \\ \text{DTs_DNF2CRO} \\ \text{DTs_EBF2CRO} \\ \text{DTs_DBF2CRO} \\ \text{DTs_CROr2CROi} \\ \text{DTs_DBF2ENF} \end{bmatrix}$$

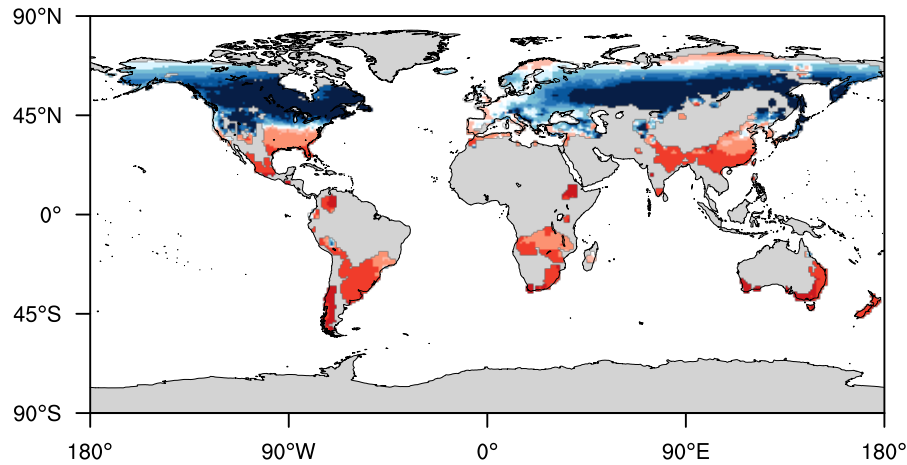
Caveats:

- Assume present-day temperature sensitivity is climate-independent
- Only local LUC effect without considering remote large scale feedbacks
- Temperature is a radiative temperature
- “Conservative” estimate due to limited spatial coverage of data

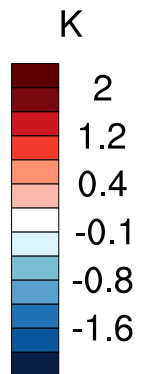
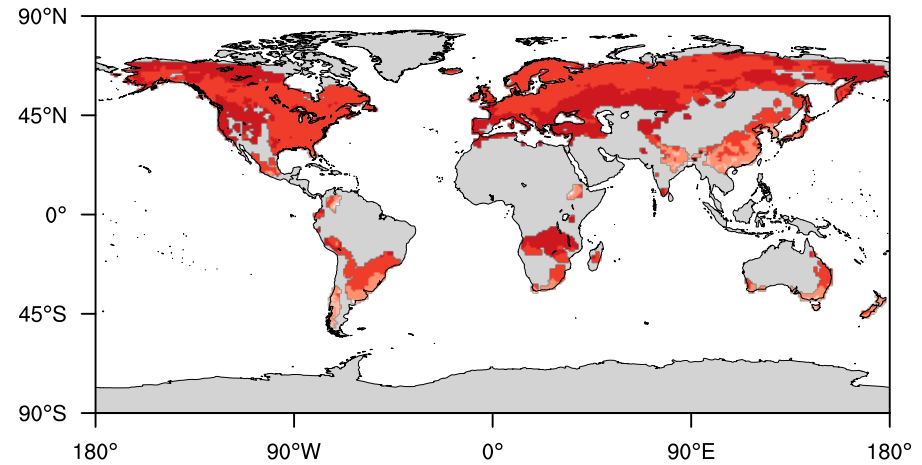
DJF

JJA

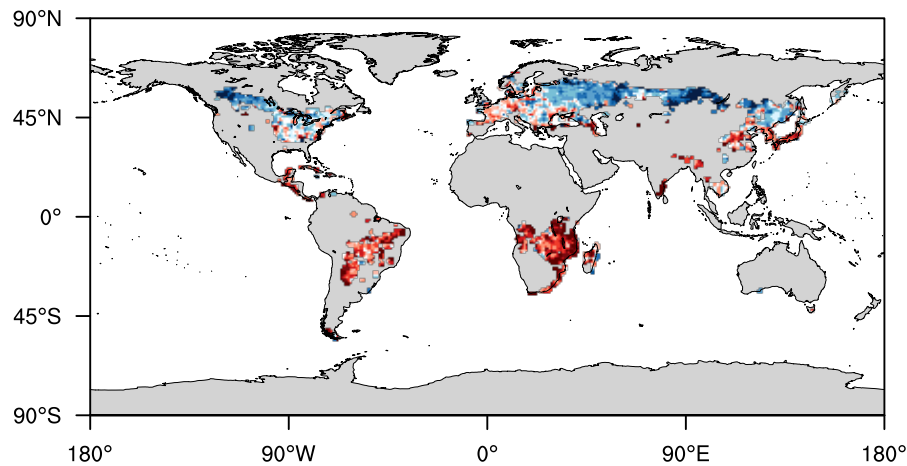
DBF2GRA B17



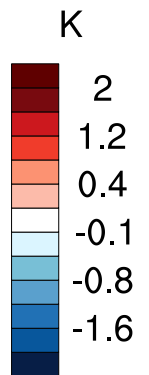
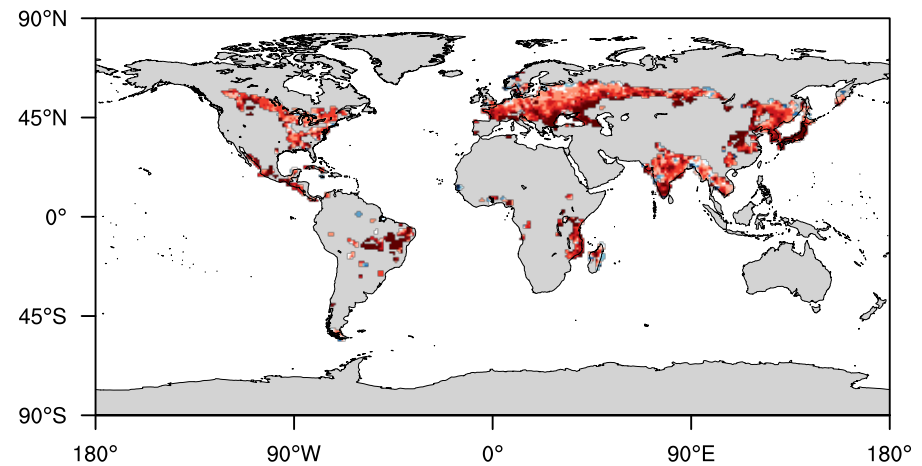
DBF2GRA B17



DBF2GRA D18



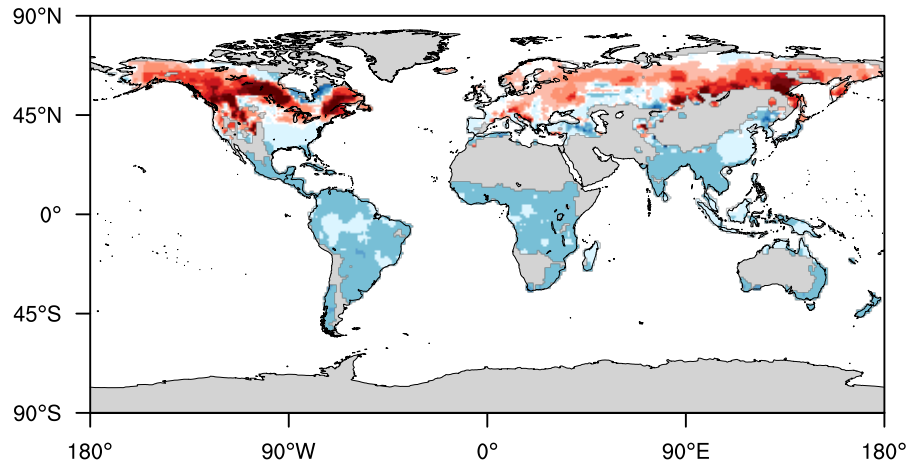
DBF2GRA D18



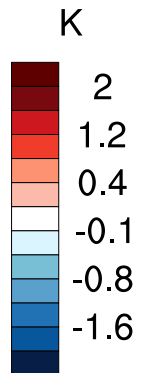
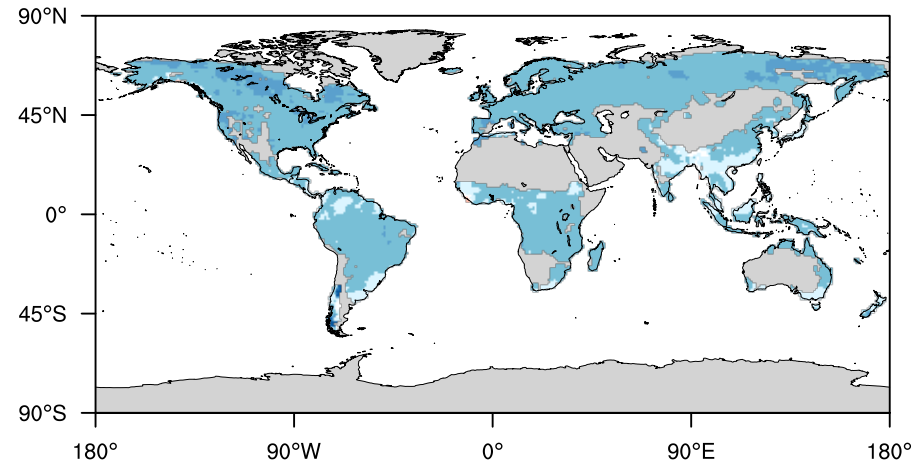
DJF

JJA

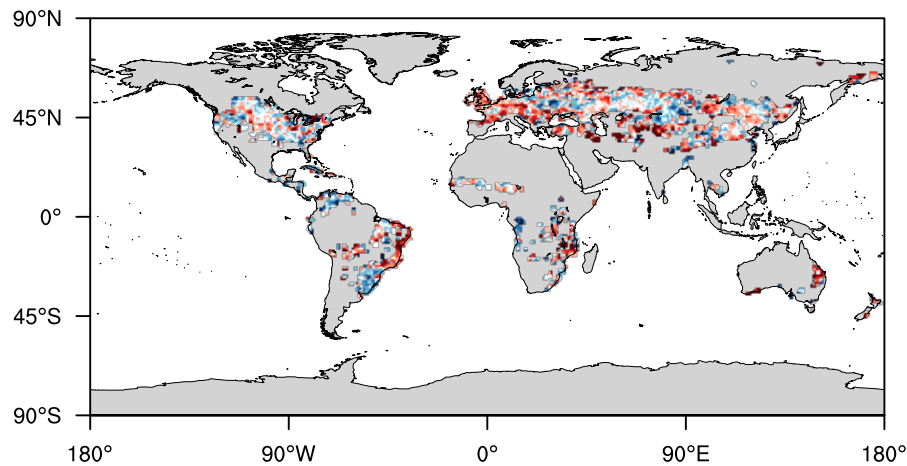
GRA2CRO B17



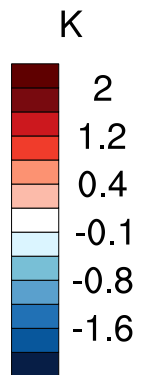
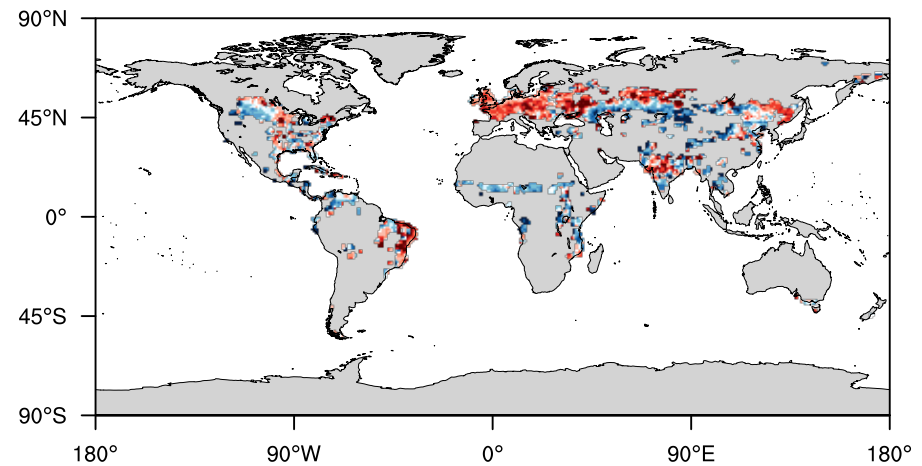
GRA2CRO B17



GRA2CRO D18

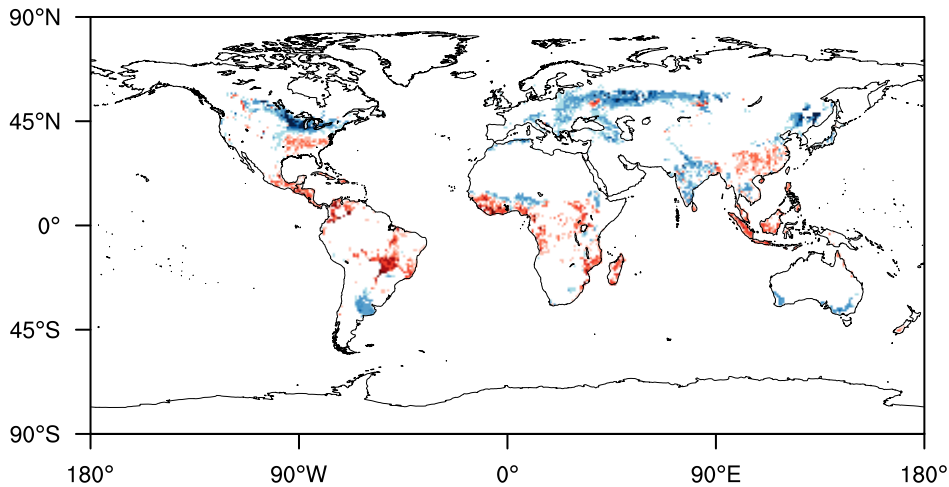


GRA2CRO D18

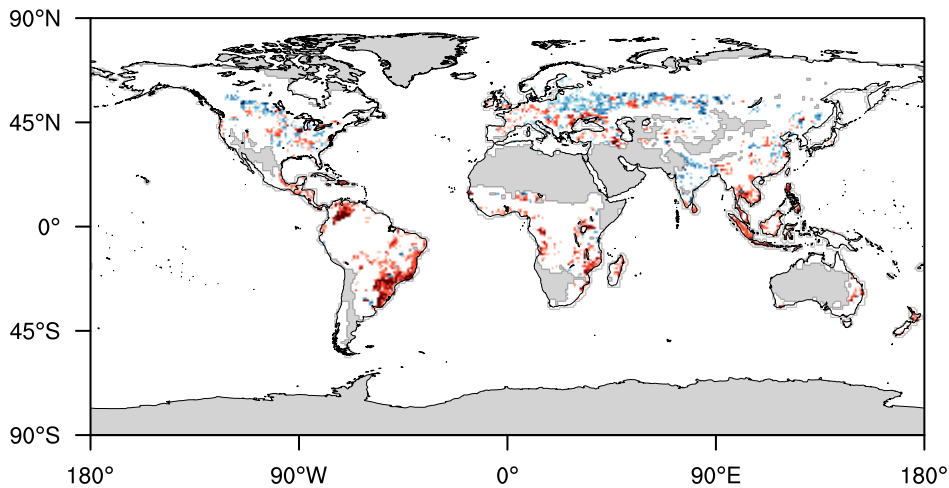


DJF

LUH2 B17

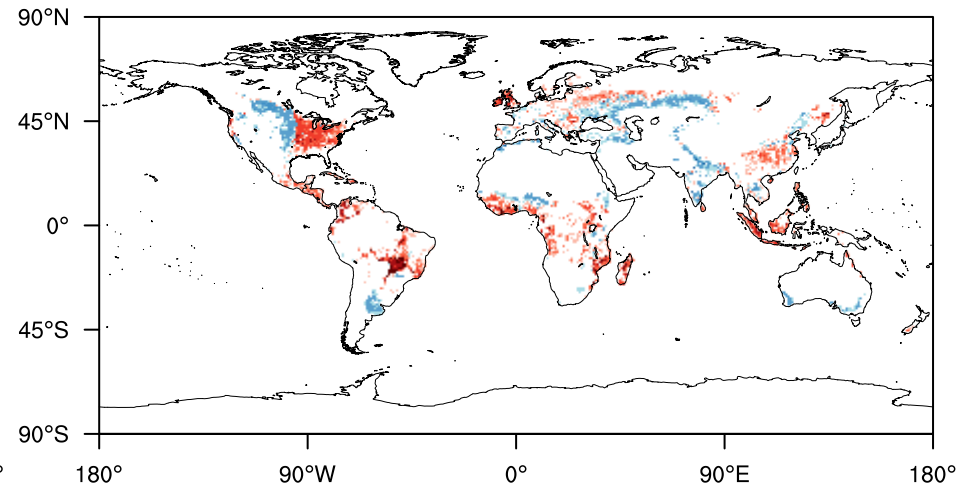


LUH2 D18

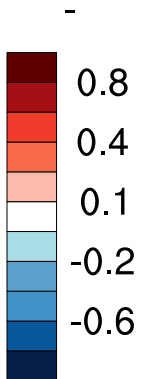
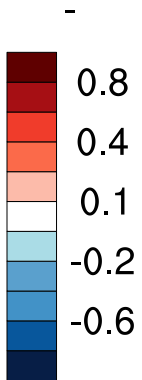
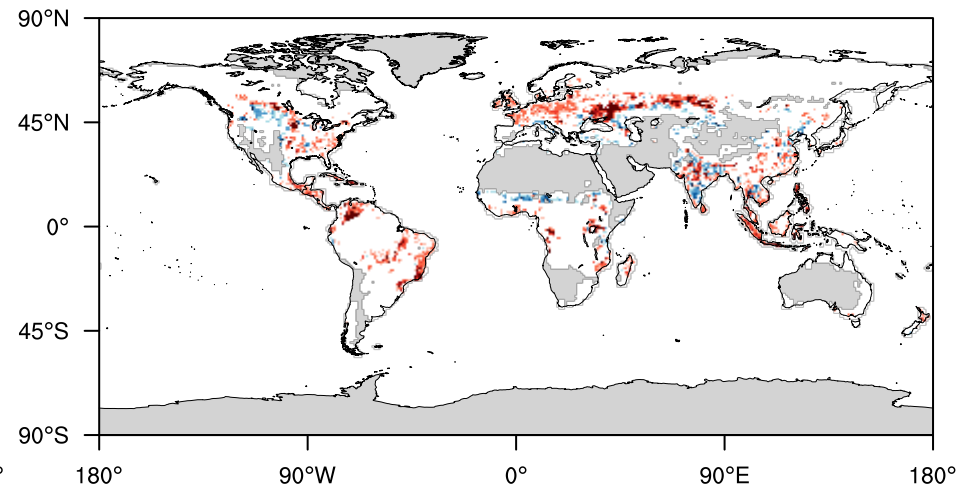


JJA

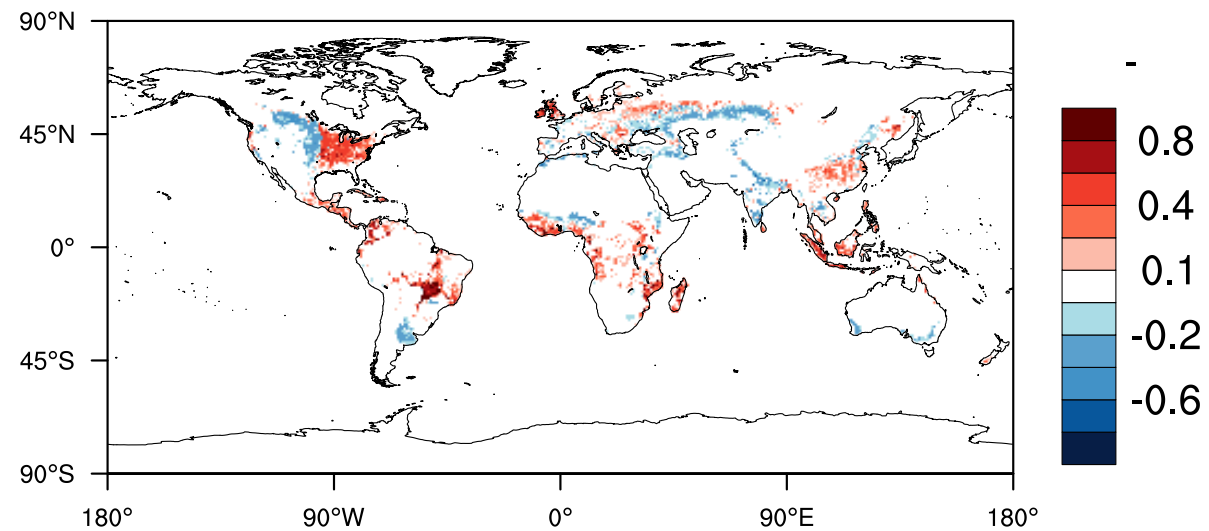
LUH2 B17



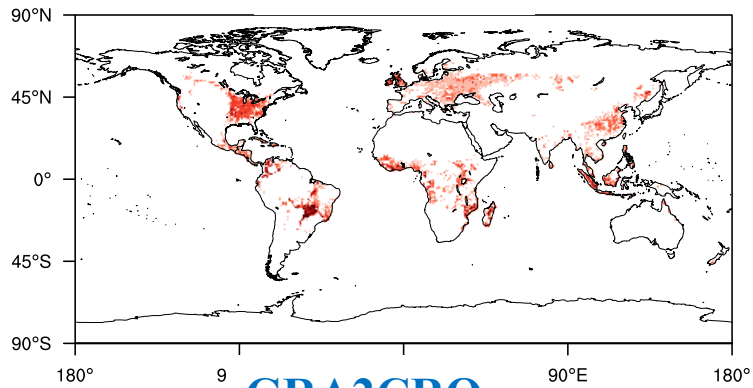
LUH2 D18



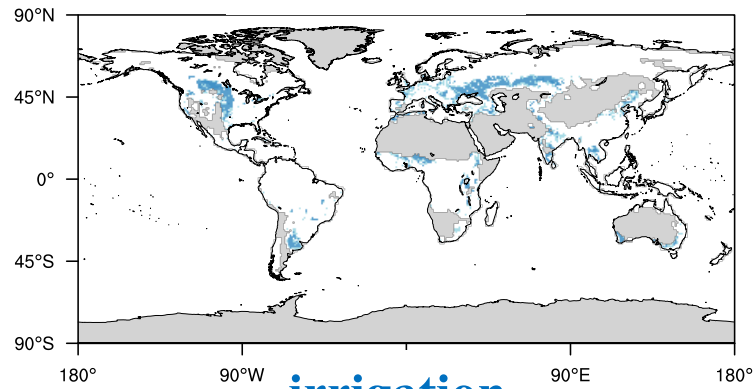
Total Land Use change effect on Ts



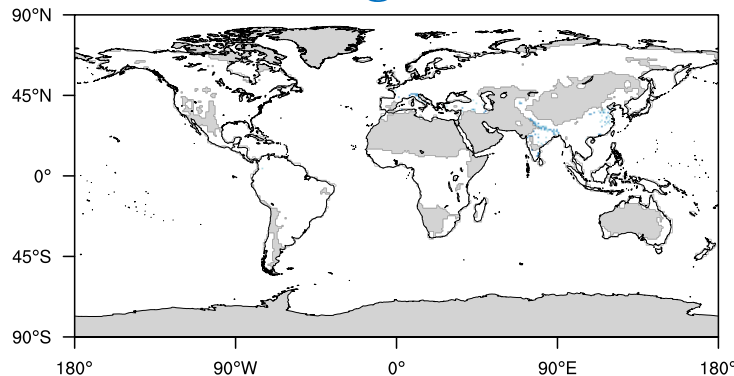
Forest loss



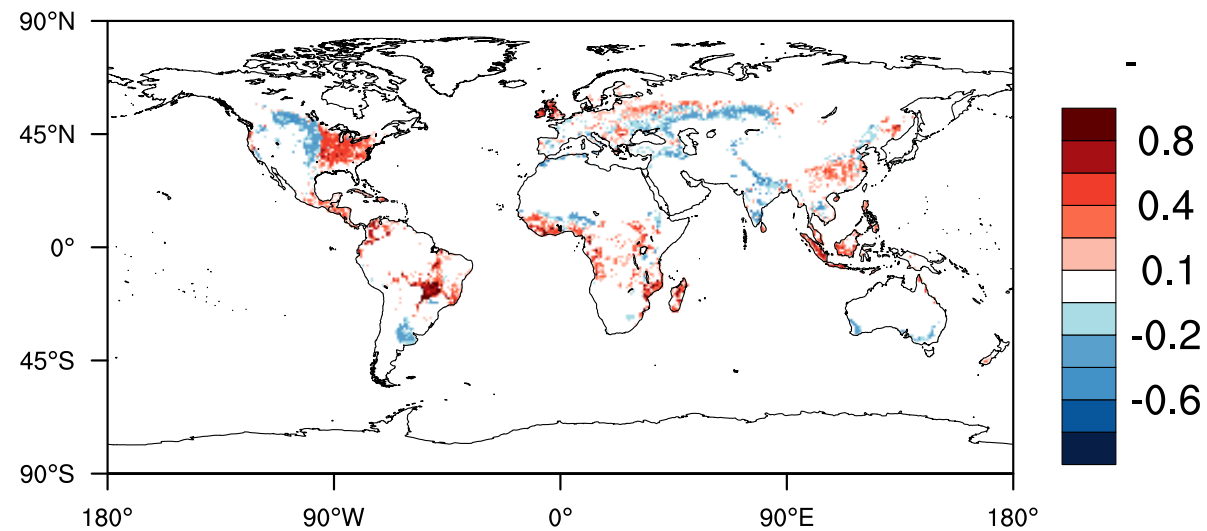
GRA2CROr



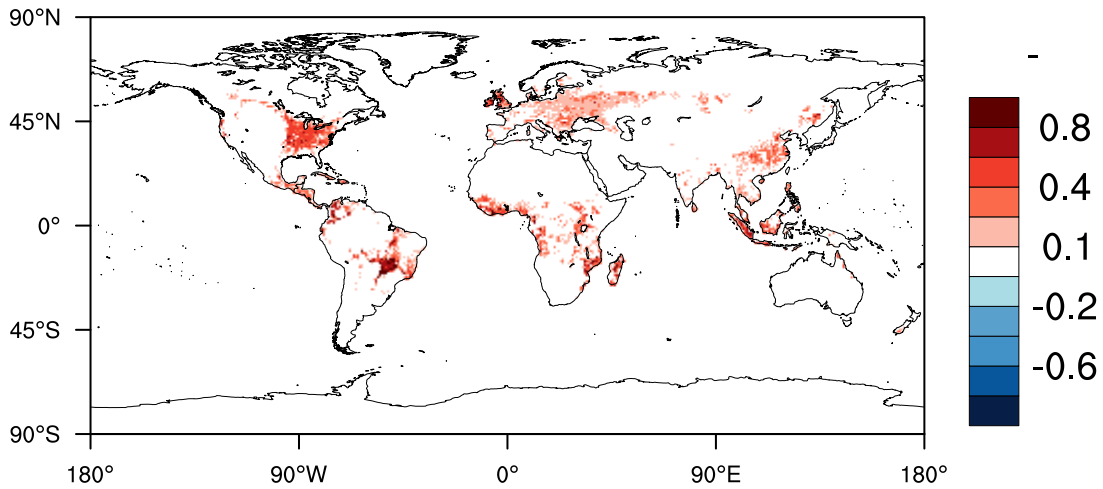
irrigation



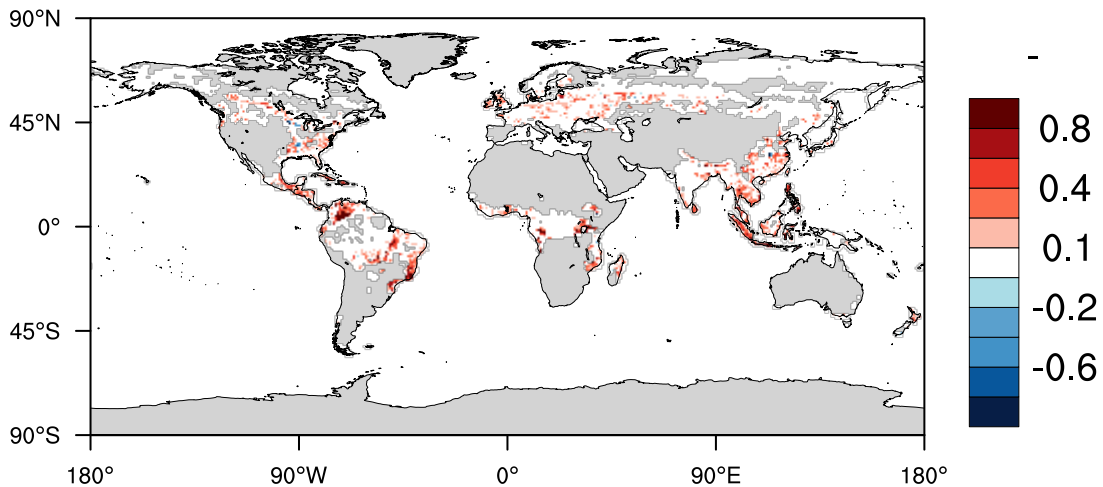
Total Land Use change effect on Ts



LUH2 B17

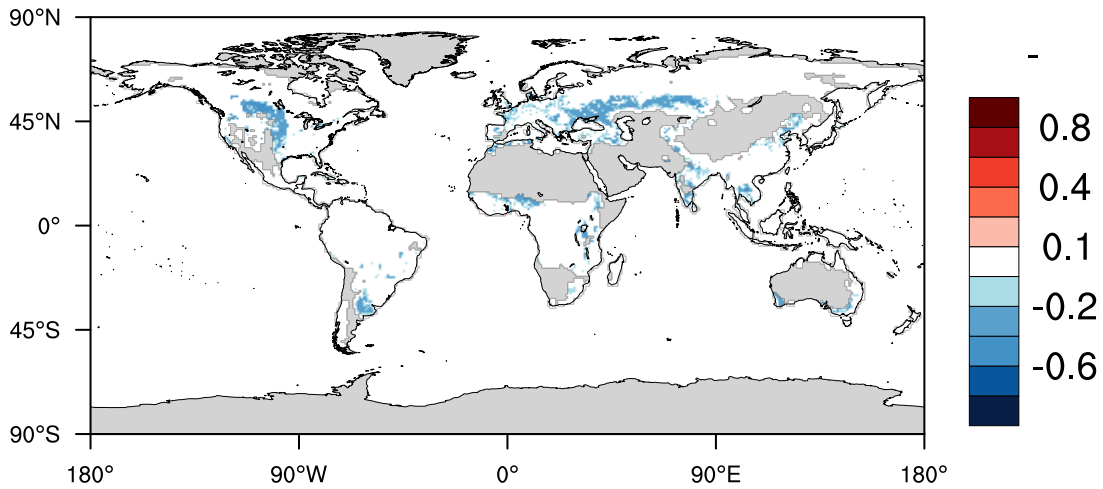


LUH2 D18

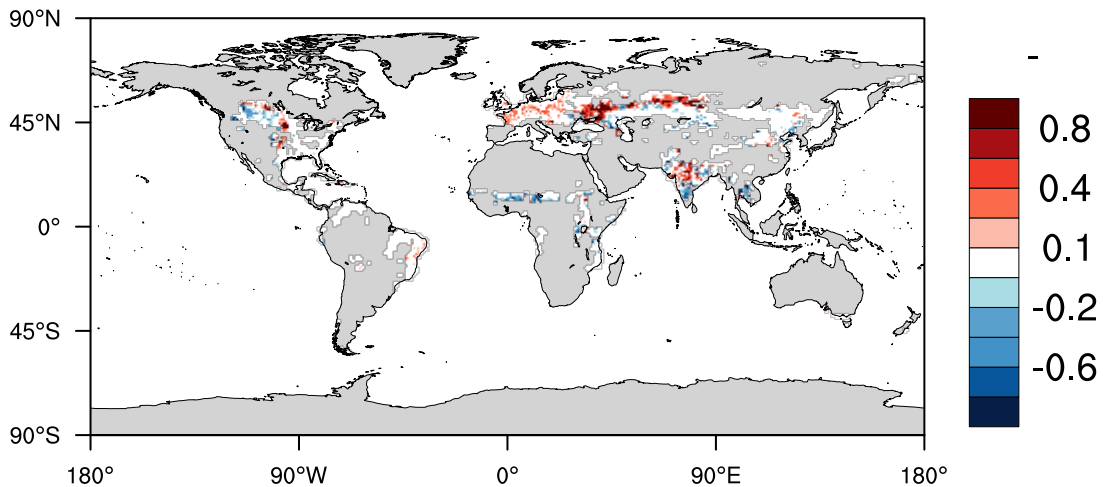


GRA2CRO

LUH2 B17



LUH2 D18

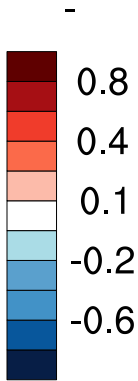
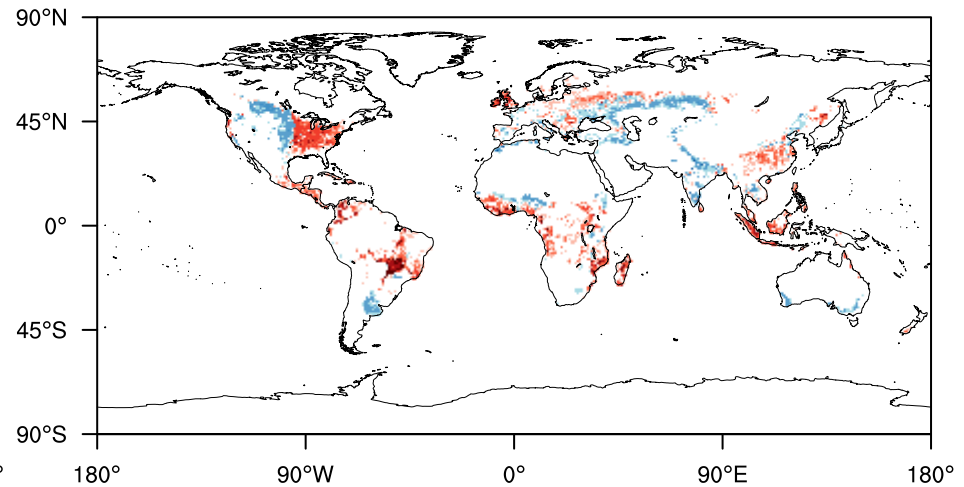
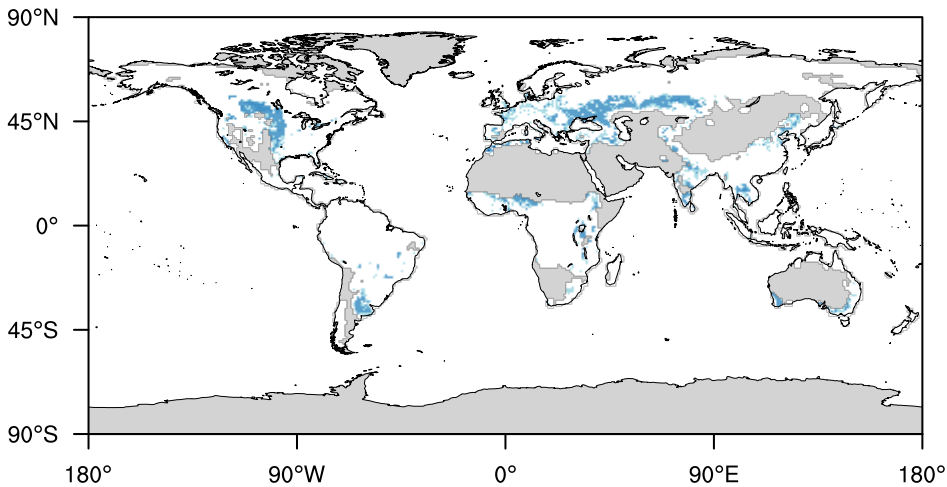


GRA2CRO

Total LUC effect

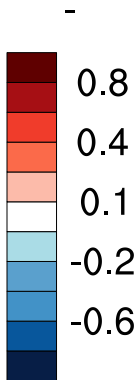
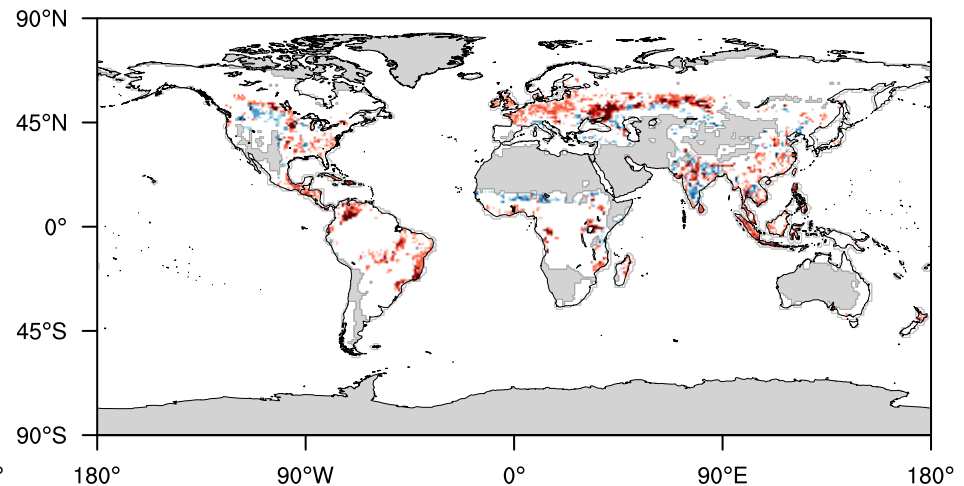
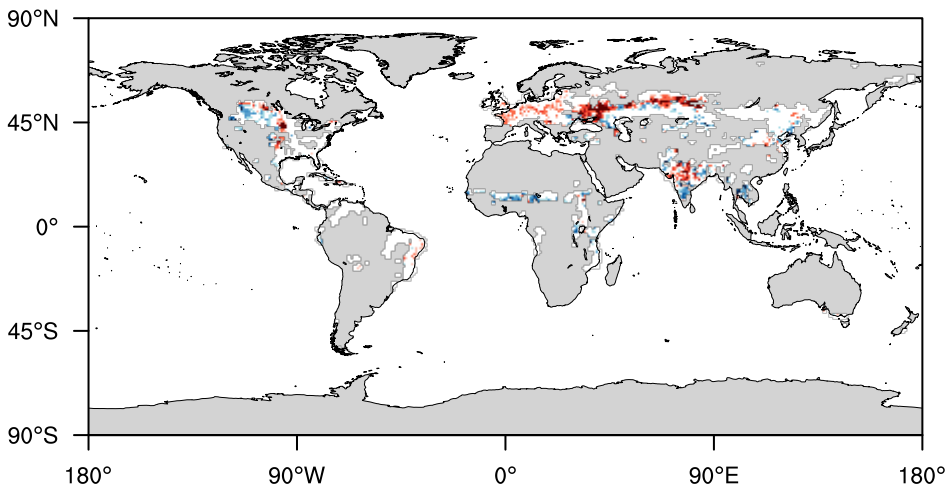
LUH2 B17

LUH2 B17

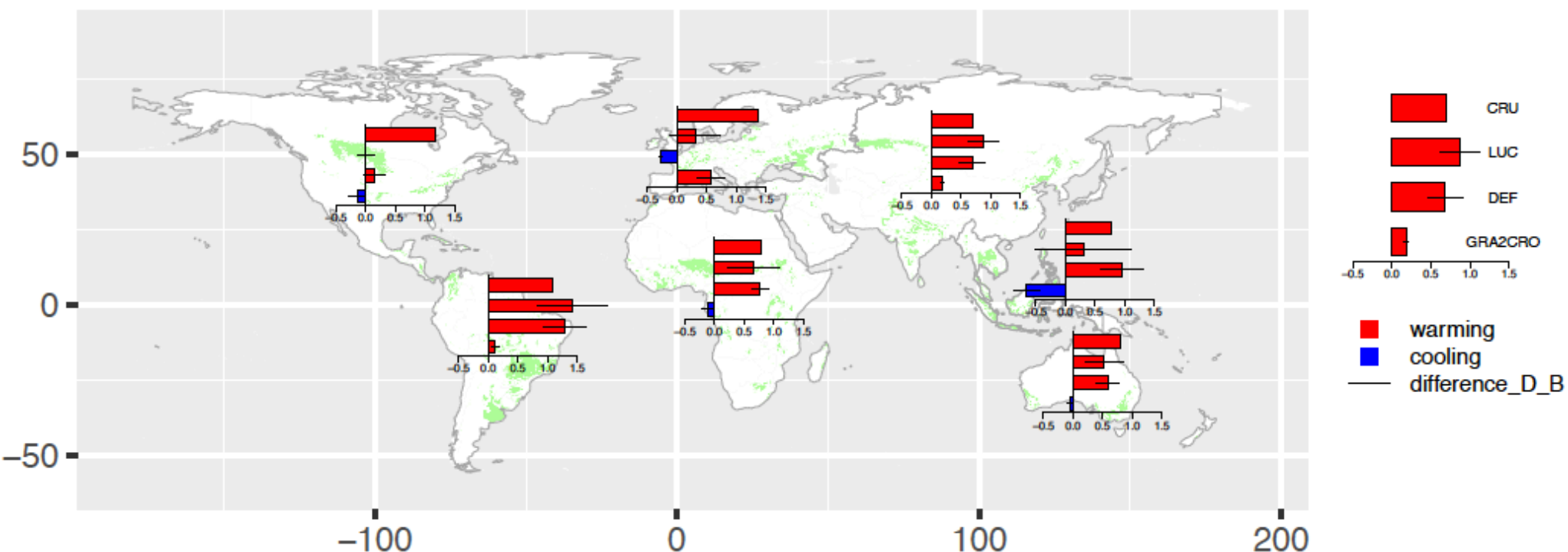


LUH2 D18

LUH2 D18



LUC effect versus climate change (CRUTS) for grid cells with at least 20% LUC



- LUC impact on surface temperature seasonally and locally of similar magnitude as observed climate change (even larger impacts expected for extremes, see previous presentation)
- Grassland to crop conversion is the most poorly constrained conversion
→ largest source of uncertainty in reconstruction
- Primarily for benchmarking Land-only simulations