

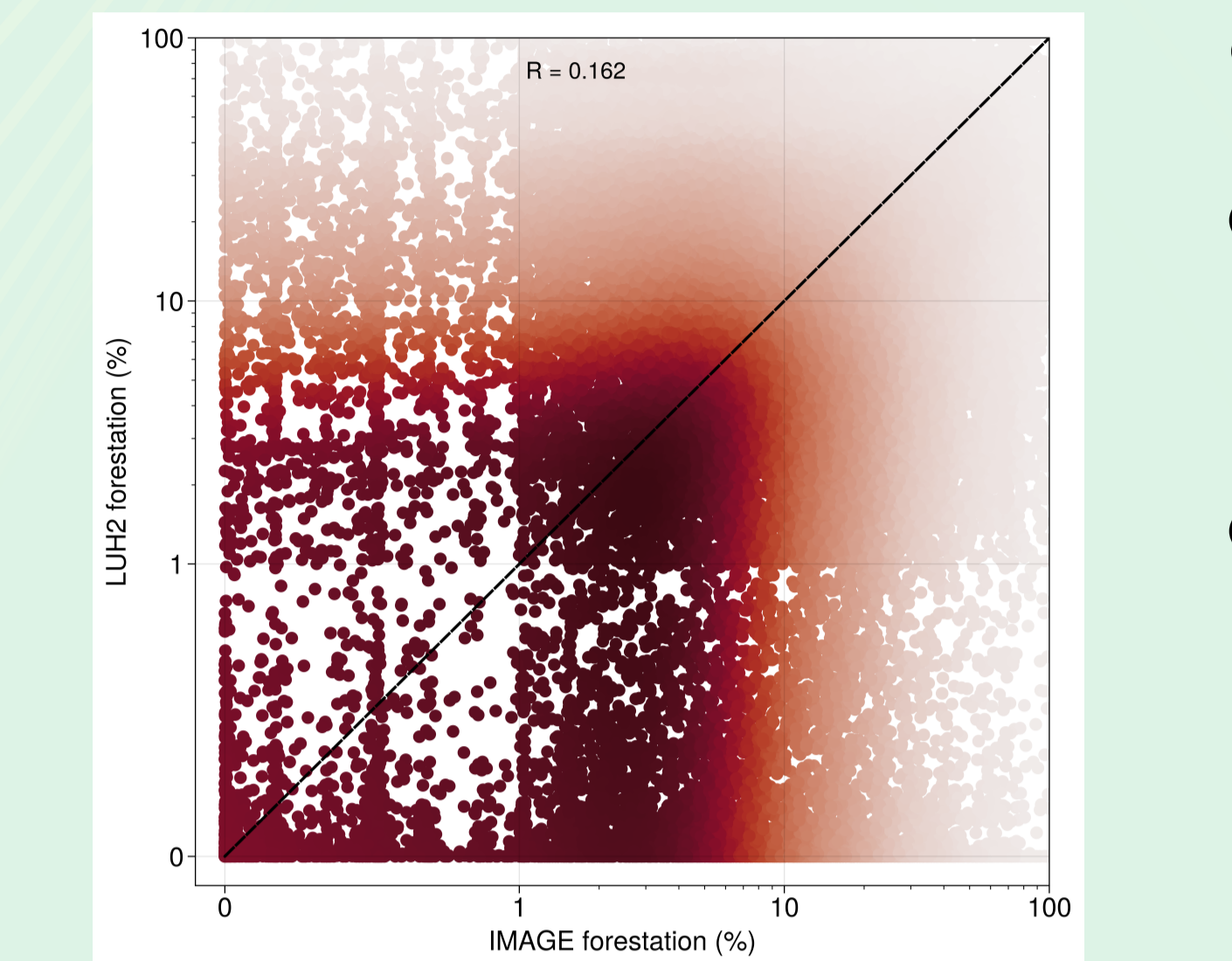
Forest cover changes from observation and projection to Earth System Model forcing

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1: LUH2 omits to harmonize forest cover

- Land use harmonization (LUH) fits a multilinear model to approximate land use change in its harmonized classification system to differently classified input land use change.



- Forest cover is not harmonized.
- Only by grid cell-level closure, global forest cover changes are maintained as residual of other land use changes.
- This does not preserve regional or local features in input data sets.

Fig 1a: Grid-cell scale forestation from 2015 to 2100 in the original IMAGE projection of SSP1-2.6 vs. the harmonized data set.

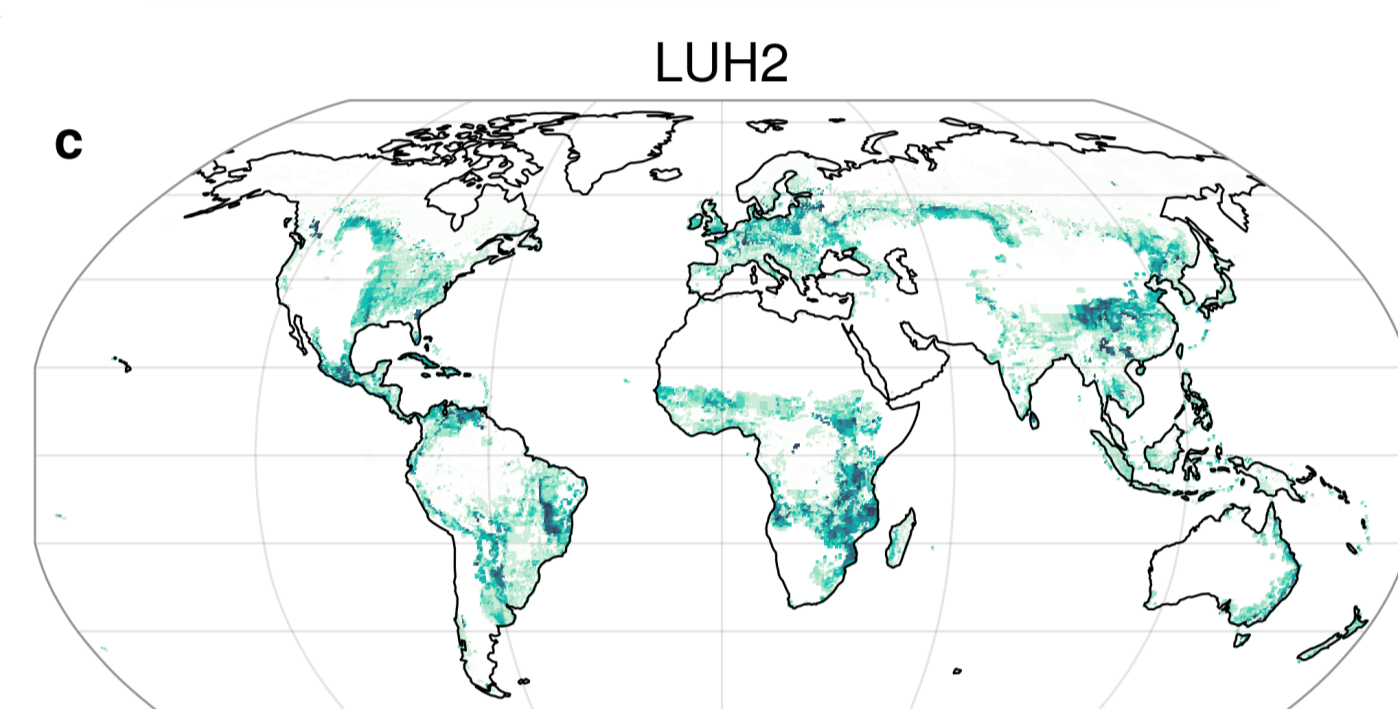
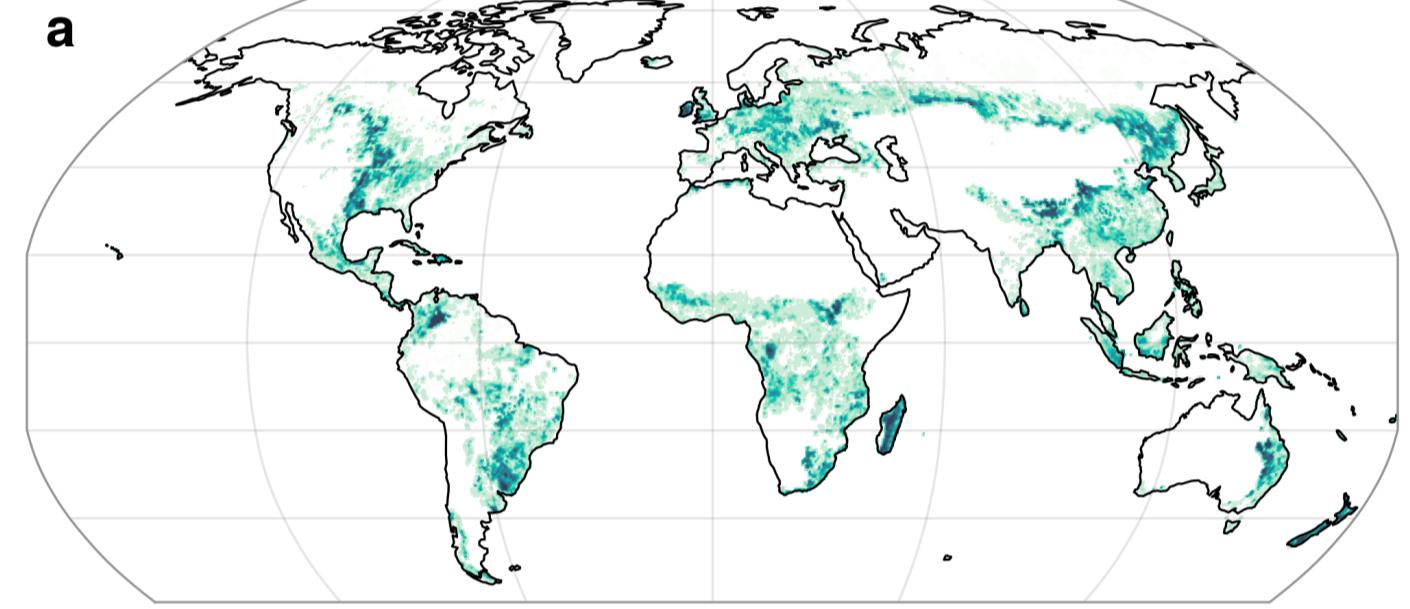
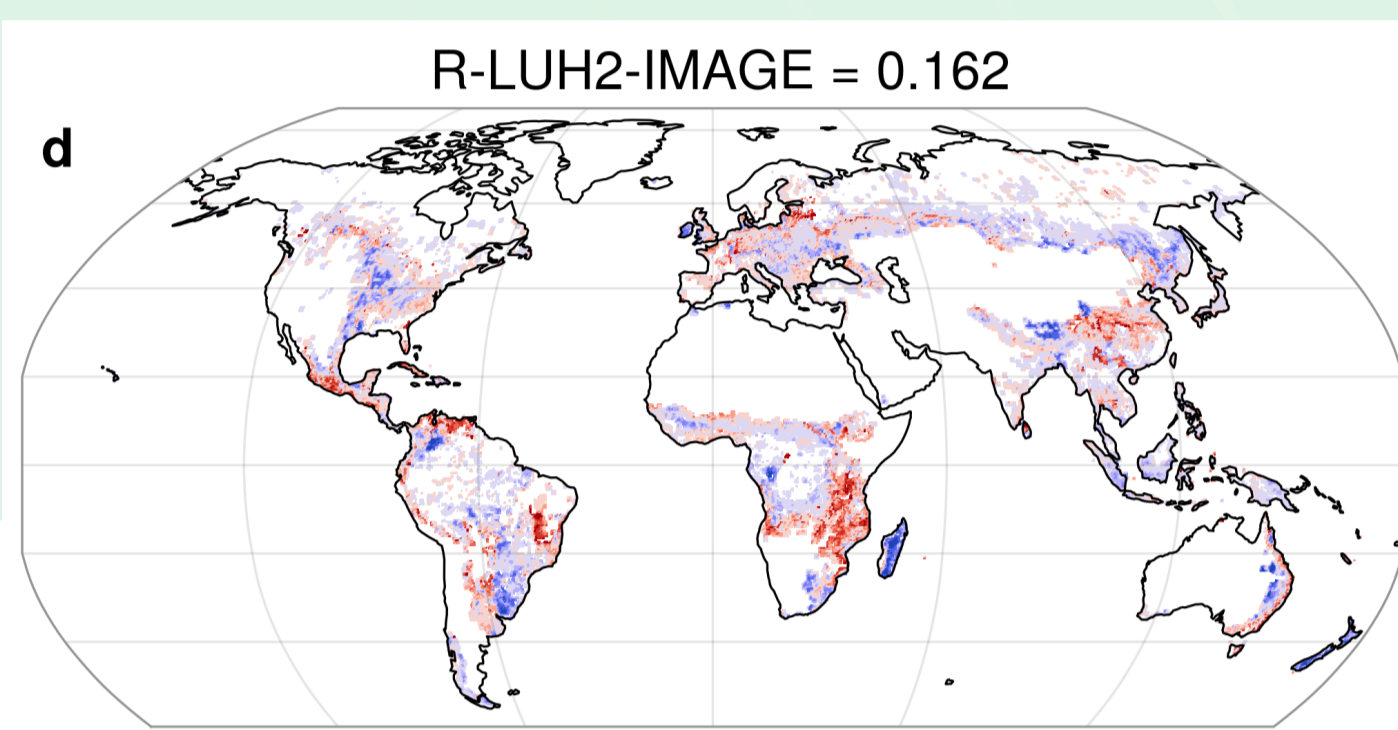
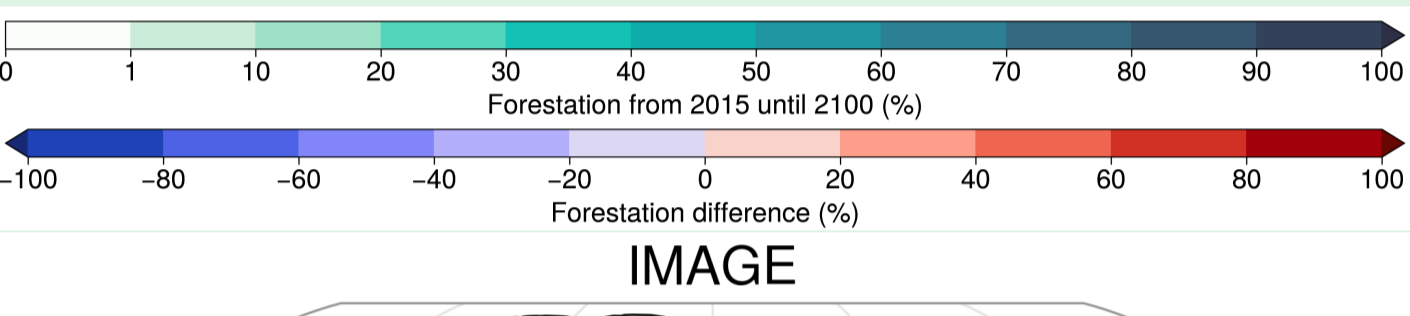


Fig 1b: Afforestation and Reforestation from 2015 to 2100 under SSP1-2.6 (take grid cells where forest cover change is positive) in LUH2 and its difference to the input dataset generated by the Integrated Assessment Model IMAGE.

2: ESMs convert LUH2 info differently into forcing

- To exemplify this implementation diversity, we show forest cover change from CESM2 and IPSL-ESM. ESMs including CLM or Orchidee match historical trends well.

- ESMs including CLM or Orchidee match historical trends well.

- Forestation under SSP1-2.6 as given by LUH2 is under-assimilated by all ESMs.

- Reasons (see box 3) are different surface data inputs apart from LUH2, prescribed vs. dynamic vegetation and classification system differences.

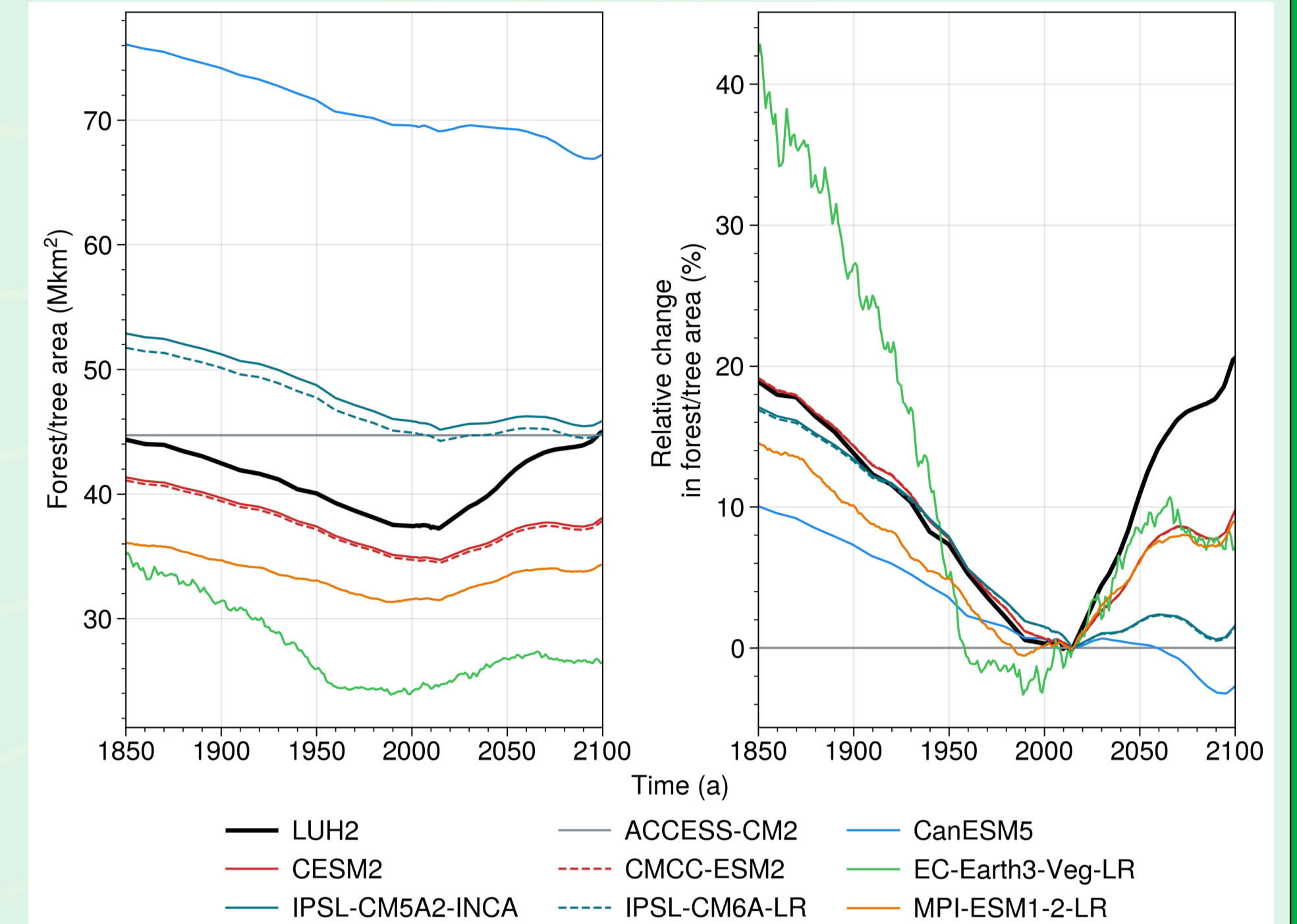


Fig 2a: Absolute value evolution (left) and relative change wrt 2015 (right) of global forest (LUH2) or tree area (ESMs) over the historical and 21st century (SSP1-2.6) period.

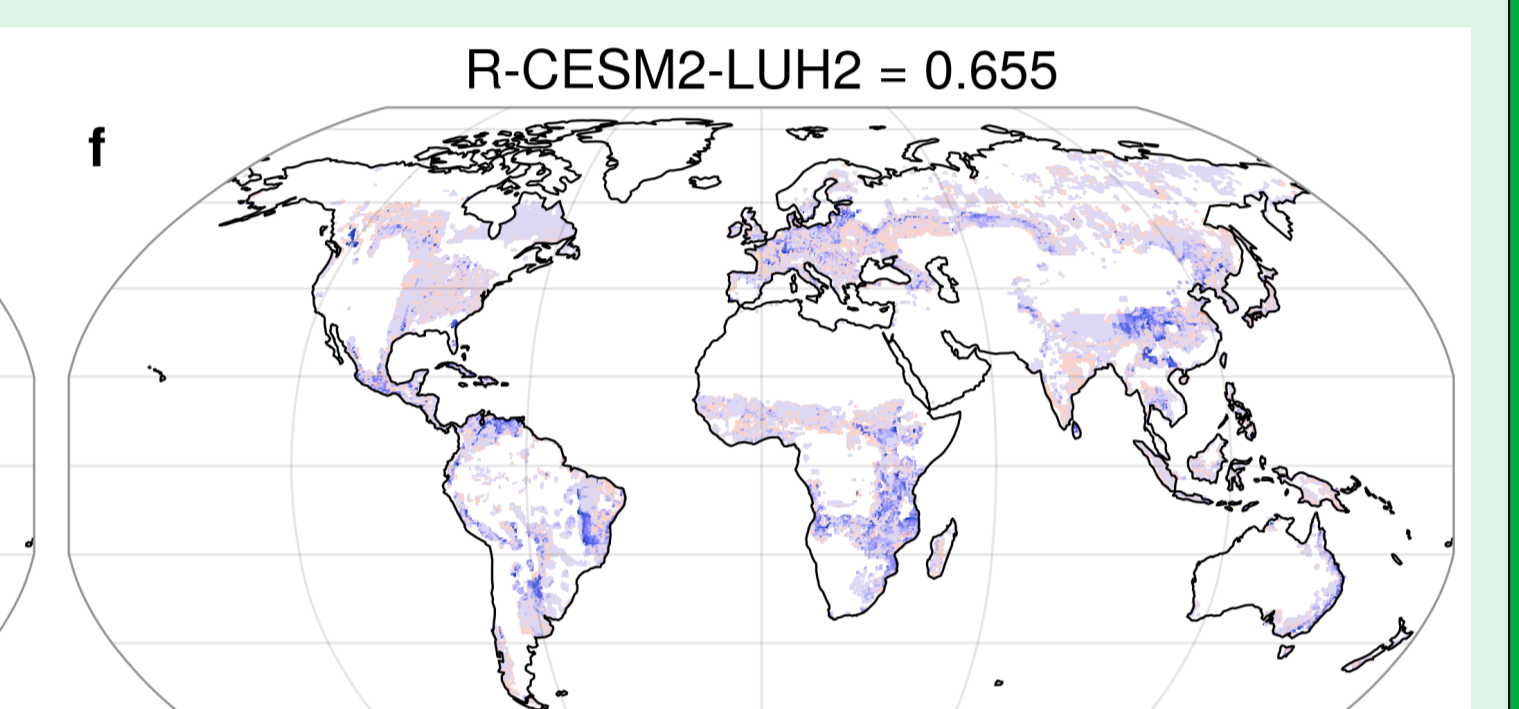
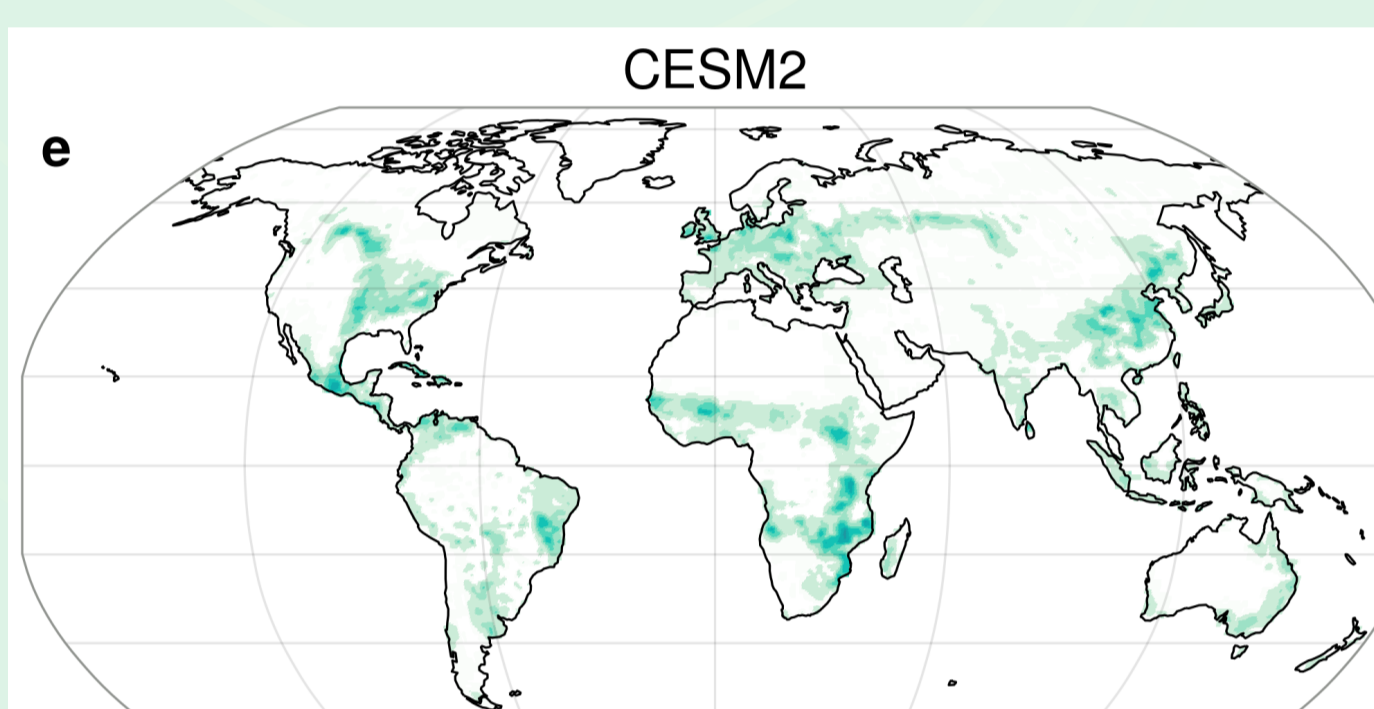


Fig 2b: Afforestation and Reforestation from 2015 to 2100 under SSP1-2.6 (take grid cells where forest cover change is positive) in CESM2 and its difference to the input dataset LUH2.

3: The imperfect data river in CMIP6 from projection to future ESM forcing

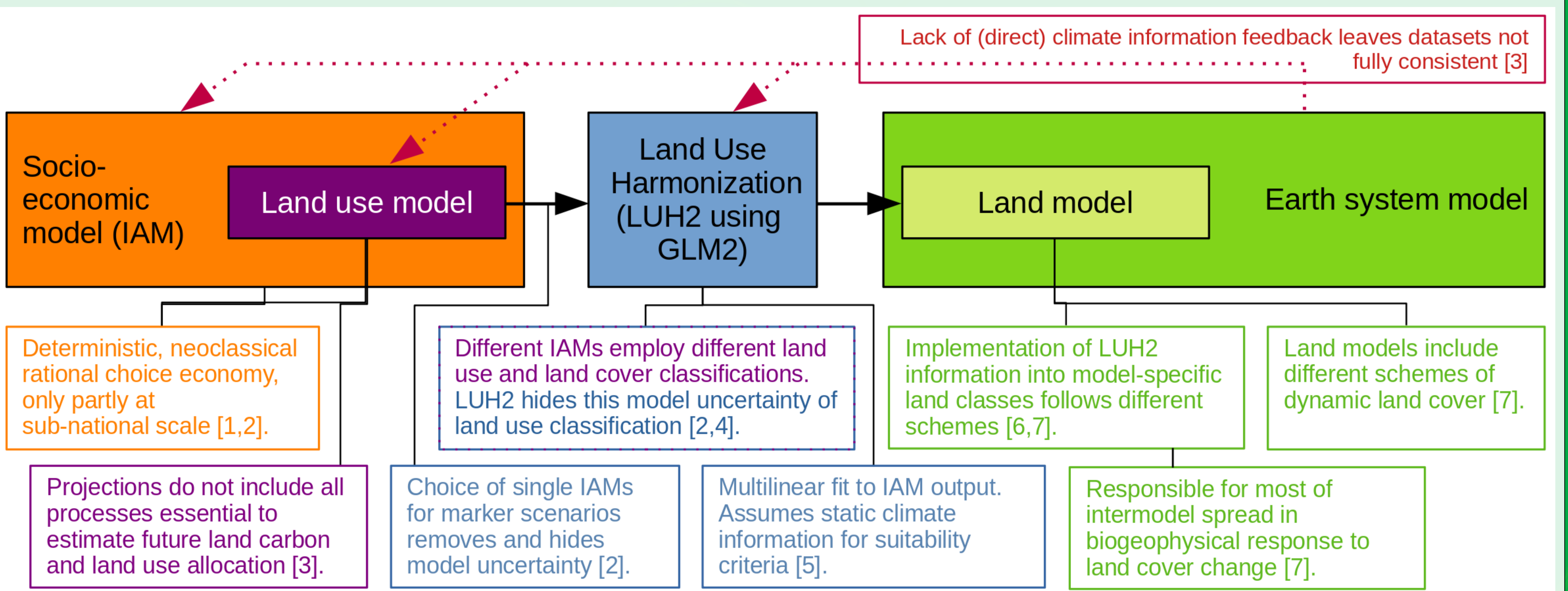


Fig 3a: Schematic of information flow concerning land use and land cover change in CMIP for ScenarioMIP (full boxes). Limitations and criticism to this methodology (transparent boxes) for science questions both in the socio-economic and the physical realm. For sources, see references.

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Outlook

- The data flow from observations and projections to ESM forcing has several limitations and hidden uncertainties, which matter for the assessment of climate response uncertainties..
- For idealized MIPs, artificial reduction of forcing uncertainty can be necessary to isolate across-model physical response diversity.
- We propose to embrace deep methodological uncertainties concerning socio-economically driven land use change by widening the spectrum of land use projections in policy-relevant model intercomparison studies.