Brazil's Fair Share of global 1.5 °C-consistent mitigation through 2035

Ceecee Holz, Climate Equity Reference Project
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Introduction and Approach

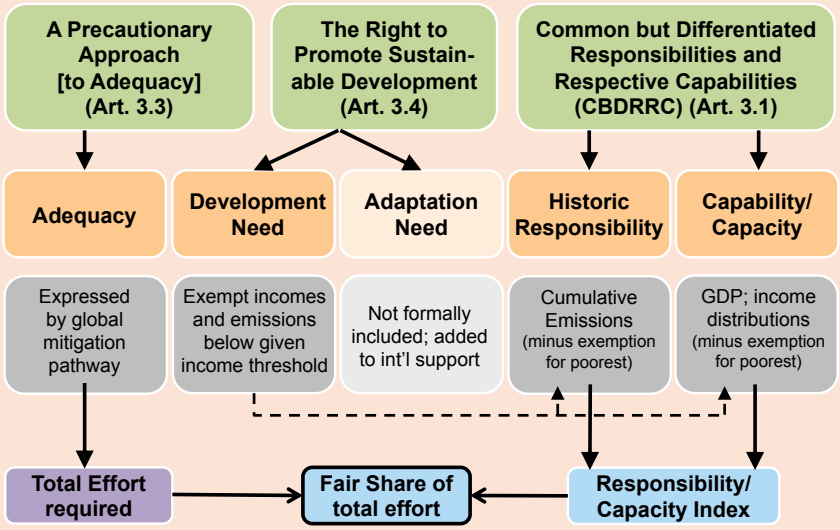
Using the Climate Equity Reference framework (CERf), a framework for international effort sharing that's widely utilized by civil society organizations and networks to calculate national fair shares of global climate action, this memo reports on calculations of Brazil's mitigation fair share – in sectors other than LULUCF – of a global 1.5 °C-consistent mitigation effort.

Importantly, CERf normally excludes LULUCF emissions from its fair shares calculation (see footnote 2 below for the justification of this exclusion). However, when calculating fair shares with the CERf, the notion of historical responsibility for greenhouse gas emissions is an important equity dimension and, in the case of countries with very high deforestation emissions, the exclusion of LULUCF substantially underestimates these countries' fair shares. For that reason, for the calculations reported here, historical LULUCF emissions – until 2022 – are included in the calculations of historical responsibility. Note though, that mitigation in the LULUCF sector remain excluded from the calculation of mitigation fair shares and fair shares results are only presented for non-LULUCF sectors.

The Paris Agreement and the United Nations Framework Convention on Climate Change (UNFCCC 1992, 2015) acknowledge the importance of equity in implementing a global response to the climate crisis. Specifically, both treaties highlight the equity principle of "Common But Differentiated Responsibilities and Respective Capabilities," which acknowledges that addressing climate change is a shared responsibility of all countries ("common responsibilities"), while they bear different degrees of responsibility for causing the problem and thus for contributing to the solution ("differentiated responsibilities"), while also acknowledging that countries' different levels of economic development and financial wherewithal constitute different levels of capacity to contribute to addressing the climate crisis ("respective capabilities"). Furthermore, the Paris Agreement explicitly acknowledges (in Article 4.1, UNFCCC 2015) that peaking of emissions will occur later in developing countries, which implies that developing countries' emissions would reduce at a relative rate slower than the global figures with developed countries having to achieve deeper reductions.
The Climate Equity Reference framework (CERf) is an equity modelling framework that allows to quantitatively reflect these equity principles to derive "national fair shares" of a specified global effort (e.g. the global mitigation effort implied by a given mitigation scenario pathway) under a variety of specific ethical-normative interpretations of the equity principles of the UNFCCC and the Paris Agreement. The CERf methodology is peer-reviewed (Holz et al. 2018a), is highlighted in the IPCC's Fifth Assessment Report (IPCC 2014) as one of the frameworks

implementing the "responsibility – capability – need" approach to equitable effort sharing, and by the IPCC's Sixth Assessment Report as one that introduced the ethical notion of "progressivity" to effort sharing (IPCC 2022). Since 2015, the CERf has also been utilized by the Civil Society Equity Review – a large, diverse and global coalition of organizations and movements – as a basis for a series of annual equity assessments of the climate pledges of countries (Civil Society Equity Review 2015, 2016, 2017, 2018, 2019, 2021, 2022, 2023).

Box: The Quantitative Model of the Climate Equity Reference Framework



The fair shares calculations used here are based on the Climate Equity Reference Framework (CERf), a generalized effort-sharing framework that evolved from the earlier Greenhouse Development Rights (GDRs) framework (Baer, Athanasiou, et al. 2008; Baer et al. 2009; Baer, Fieldman, et al. 2008). The figure shows the general structure and implementation of the CERf. Taking as a point of departure the equity principles of the United Nations Framework Convention on Climate Change (UNFCCC 1992) (green, indicating the relevant UNFCCC article in parenthesis) – (i) precautionary approach, (ii) right to promote sustainable development and (iii) common but differentiated responsibilities and respective capabilities (CBDRRC) – the CERf conceptualizes these principles via intermediate concepts (orange), namely, for (i) adequacy, for (ii) development and adaptation need and for (iii) historical responsibility for emissions and capability or capacity for implementing climate solutions. Those intermediary concepts, in turn, are represented by indicators (grey) quantified via authoritative data sources. Specifically, adequacy is quantified via mitigation pathways drawn from the IPCC's scenario database (Byers et al. 2022). Development need is quantified jointly with historical responsibility and capacity, via the different treatment of the incomes and emissions of individuals at different levels of income (and consumption) when calculating a country's national historical responsibility and national capacity. The overall philosophy behind this approach is that incomes below a certain, user-defined, threshold are most appropriately prioritized for development and poverty eradication and therefore not available to be mobilized for climate solutions. And that, likewise, the survival emissions associated with consumption at the same low level of income ought to be treated differently from other emissions (Shue 1993) and are therefore excluded from a nation's responsibility. For each of the world's countries, then, the total share of that entity of the total global responsibility and capacity is calculated (the Responsibility/Capacity Index), and used to calculate the entity's fair share of the total global mitigation effort as equal to its share of the global capacity and responsibility. More detail on the data sources used for the calculations is available (Holz et al. 2018c) and the formulas of the quantitative model are given and explained in Kemp-Benedict et al. (2018).

Specifically, the CERf considers the equity principle of responsibility by calculating the share of any country of the cumulative global emissions (of individuals above the "development threshold," see below) since a given start year. Capacity is taken into account by considering each country's total income of individuals above a certain "development threshold," below which incomes are not considered to be available to address climate change. This reflects the normative position that for the poorest individuals in every country the fulfilment of their immediate basic needs ought to take precedent over contributing to addressing the climate crisis. This is equivalent to "progressive" taxation which is universal in income tax regimes around the world.[1] Capacity calculations can also include a second threshold, making the

[1] There are some countries that use a "flat" income tax – the same tax rate applies to all incomes – , but since they also use tax exemptions for the lowest income (i.e. a tax rate of 0 %), those "flat taxes" are effectively progressive taxes as well.

calculations equivalent to "more progressive" taxation regime, with the rate at which incomes are considered available to address climate change gradually rising between the development threshold and this second threshold – this reflects income taxation regimes with multiple tax brackets with progressively higher marginal tax rates. The CERf calculates how much of the global capacity and global responsibility (each calculated as described above) can be attributed to each country and then apportions the global effort, here: the global effort to implement mitigation in line with the LED pathway, to each country.

Analysis and Results

For calculating Brazil's fair share of global 1.5 °C-consistent mitigation in its non-LULUCF sectors, first, this global mitigation effort needs to be defined. In the present analysis, the global mitigation effort is defined as the mitigation between baseline projections and the mitigation pathway (for non-LULUCF sectors), of the Low Energy Demand (LED) pathways – one of the illustrative pathways of the IPCC's Sixth Assessment Report (IPCC 2023) as well as the Climate Action Tracker's "Median 1.5 °C Pathway" (CAT 2023). Figure 1 below (panels a and c) show these global mitigation pathways in the context of the baseline projections – the CAT pathway requires global mitigation of 28 $GtCO_2eq$ below baseline by 2030 and 37 $GtCO_2eq$ by 2035, while the LED pathway requires 31 $GtCO_2eq$ and 39 $GtCO_2eq$, respectively.

Figure 1 also shows the results of the fair shares calculations for Brazil (panels b and d) for these pathways. In each set of blue and yellow lines, four different combinations of specific perspectives of how capacity and responsibility should be defined in the context of equitable effort sharing are shown (four "equity benchmarks"). The labels for the lines show the start date for calculating historical responsibility (1950 and 1850) as well as the version of "progressivity" (medium and high) that is used when calculating capacity (and responsibility). For "medium progressivity," a lower threshold of $ 7,500 USD PPP-2005 per person per year is used, which means that incomes below this threshold are not considered the capacity of any countries that it can mobilize toward climate action (and the emissions associated with life on incomes under the threshold are exempt from being considered the country's historical responsibility for causing climate change). For "high progressivity," a second threshold, set at $ 50,000 USD MER-2010 per person per year, is used to further differentiate the treatment of incomes at different levels in the context of capacity. Specifically, for "high progressivity," only the incomes (and emissions) above the $ 50,000 threshold are *fully* counted, whereas the degree to which incomes between the thresholds are counted as capacity gradually increases as incomes increase toward the upper threshold.

Importantly, Figure 1 (and Table 2) highlights the impact and importance of including responsibility for LULUCF emissions in the fair shares calculations: the set of blue lines in each of panel b and d show Brazil's fair share, under the four different benchmarks, when LULUCF emissions are excluded from the calculations of historical responsibility, whereas the yellow lines include it. It is a profound difference, with the results that exclude LULUCF responsibility suggest mitigation "fair" shares for the non-LULUCF sectors in Brazil equivalent to between 1.8 and 2.0 % of the global efforts, whereas under inclusion of LULUCF this figure increases to 3.1 to 3.3 %. The main results of this analysis, however, are the four equity benchmarks for

both mitigation pathways that include LULUCF emission in the calculations of historical responsibility – the yellow lines in Figure 1 and the results in Table 2 (a version of Figure 1 with the blue lines removed is provided as Figure 3).

	Responsibility Start Date	2030				2035			
		Progressivity (Capacity)				Progressivity (Capacity)			
		Medium		High		Medium		High	
		level $MtCo_2e$	below 2005	level $MtCo_2e$	below 2005	level $MtCo_2e$	below 2005	level $MtCo_2e$	below 2005
CAT 1.5°C	1850	300	66.6%	337	62.5%	82	90.8%	117	86.9%
	1950	245	72.6%	301	66.4%	15	98.4%	72	91.9%
LED	1850	215	76.0%	257	71.4%	22	97.5%	60	93.3%
	1950	156	82.7%	218	75.7%	-49	105.5%	13	98.6%

Table 1: Results of the Fair Shares Analysis for Brazil for 2030 and 2035. Table shows target levels for Greenhouse Gases (excluding LULUCF) in each target year and percentage reductions below 2005 levels (897 Mt CO_2e) for a set of combinations of pathways (CAT 1.5°C and LED), historical responsibility start dates (1850 and 1950) and definitions of capacity ("medium" and "high" progressivity)

Table 1 shows the main results of the analysis. It shows, each of the two mitigation pathways and for each of the four equity benchmarks the total emissions level in Brazil for 2030 and 2035 in sector other than LULUCF that is consistent with Brazil's fair share of the global mitigation effort implied by the perspective 1.5 °C pathway. For consistency with the manner in which the Brazilian government presents target emissions levels in its NDCs, this emissions level is expressed both as a quantity of emissions in the target year as well as the corresponding percentage reduction below 2005 levels (which are 897 $MtCO_2eq$ in the Climate Equity Reference Calculator database; slightly higher than the 882 $MtCO_2eq$ figure from Brazil's Fourth National Communication (Brazil 2020)). In 2035, for the CAT 1.5 °C pathway and depending on the equity benchmark chosen, Brazil's mitigation fair share implies a reduction in non-LULUCF sectors of between 87 % and 98 % below 2005 levels, while for the LED pathway fair shares reductions would be between 93 % and 106 % below 2005 levels.

Brazil communicates the emissions reductions targets in its NDCs as economy wide targets (i.e. inclusive of the LULUCF sector). The implications of these fair-shares results for the non-LULUCF sectors for economy-wide targets depends on the assumptions of what action would be taken in the LULUCF sector. For example, a Brazilian Government projection study (Rathmann et al. 2017) reports reference level emissions in the LULUCF (i.e. emissions that are expected in the absence of any additional efforts to reduce LULUCF emissions) of 298 $MtCO_2eq$ in 2030. The same source projects a credit of 268 $MtCO_2eq$ from sequestration by forests on indigenous lands and conservation lands, which means that reference level net emissions in 2030 in the LULUCF sector would be 30 $MtCO_2eq$. Assuming this same 30 $MtCO_2eq$ level for 2035 and combining it with, for example the "1850 High" equity benchmark level for the CAT 1.5 °C pathway for 2035 (117 $MtCO_2eq$) would yield an economy-

wide emissions level of 147 $MtCO_2eq$ of greenhouse gases, or a 94 % reduction below the 2005 levels as reported in the Fourth National Communication (2446 $MtCO_2eq$, Brazil 2020).

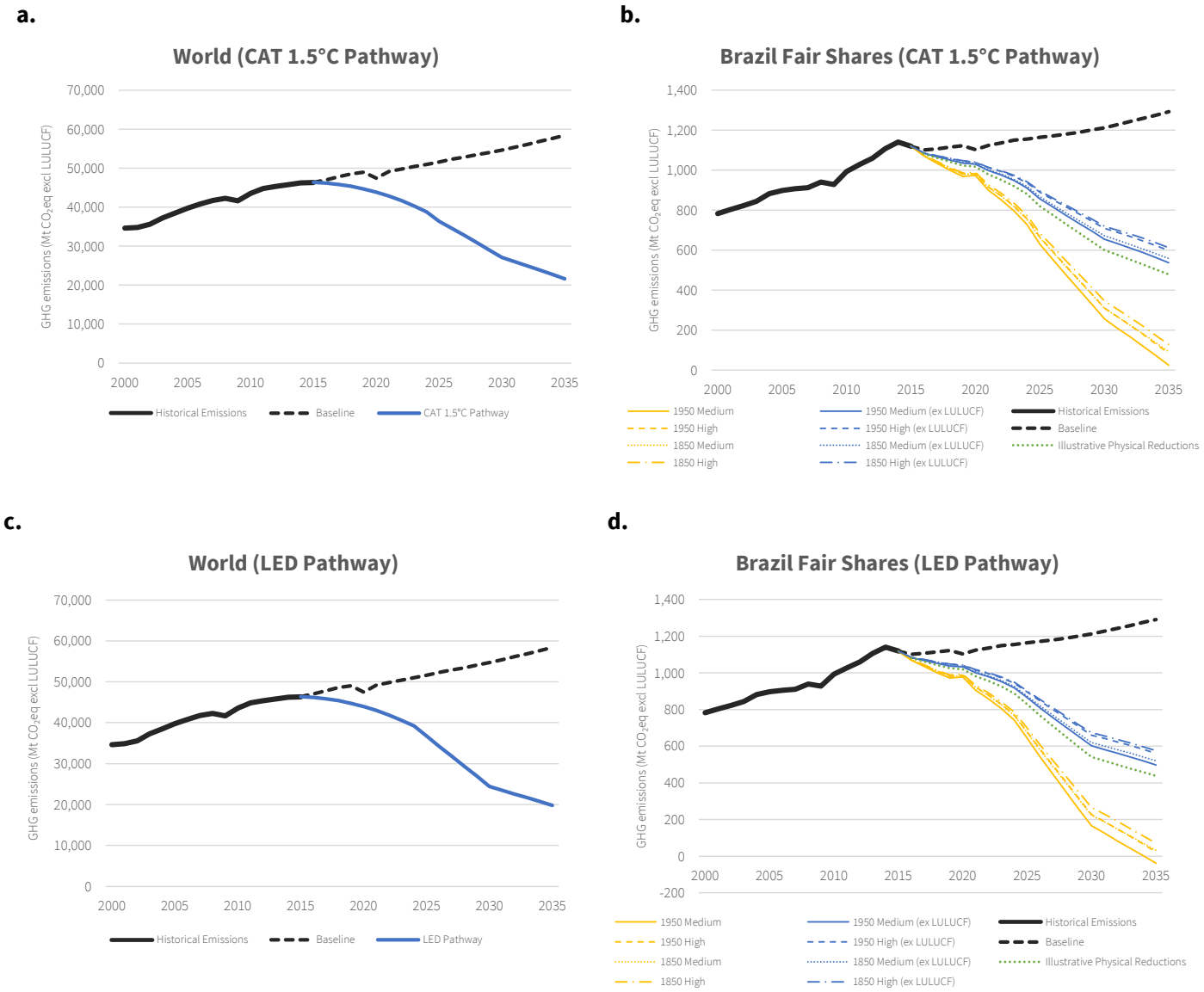


Figure 1: Overview of Fair Shares Results for the CAT 1.5°C (a & b) and LED (c & d)mitigation pathways. All figures for annual Greenhouse Gas emissions, excluding LULUCF. For each pathway, the global baseline and reductions are shown (a & c) as well as Brazil's fair share of the global mitigation (b & d). Fair shares are calculated using a definition of historical responsibility that disregards responsibility for LULUCF emissions (blue lines in panels b & d) as well as using a definition that includes historical responsibility for LULUCF emissions (yellow lines). For each the these cases, historical responsibility is measured since 1950 (solid and dashed lines) or 1850 (dotted or dot-dash lines) combined with capacity using "medium progressivity" (solid and dotted lines) or "high progressivity" (dashed and dot-dash lines) definitions of capacity.

	Responsibility Start Date	Responsibility without LULUCF				Responsibility includes LULUCF			
		2030		2035		2030		2035	
		Progressivity		Progressivity		Progressivity		Progressivity	
		Medium	High	Medium	High	Medium	High	Medium	High
		RCI	RCI	RCI	RCI	RCI	RCI	RCI	RCI
CAT 1.5°C	1850	2.0%	1.8%	2.0%	1.8%	3.3%	3.1%	3.3%	3.2%
	1950	2.0%	1.8%	2.0%	1.9%	3.5%	3.3%	3.4%	3.3%
LED	1850	2.0%	1.8%	2.0%	1.8%	3.3%	3.1%	3.3%	3.2%
	1950	2.0%	1.8%	2.0%	1.9%	3.5%	3.3%	3.4%	3.3%

Table 2: Comparing Responsibility-Capability-Indices (RCIs) with and without inclusion of LULUCF in responsibility calculations, for Brazil for 2030 and 2035, for a set of combinations of pathways (CAT 1.5°C and LED), historical responsibility start dates (1850 and 1950) and definitions of capacity ("medium" and "high" progressivity)

Background – Data Sources for LULUCF emissions data

For the present analysis, the Climate Equity Reference Calculator is run with a custom "core database" to support calculations of historical responsibility that includes responsibility for LULUCF emissions. By default, the Climate Equity Reference Calculator does not support including LULUCF emissions in its effort sharing calculations for a variety of reasons,[2] however, the inclusion of historical LULUCF emission in the calculations of historical responsibility only (as opposed to calculating "fair shares" of the effort of reducing and avoiding future LULUCF emissions) is less problematic.

To facilitate these calculations, the Calculator's core database was augmented by adding historical LULUCF emissions time series. The Global Carbon Budget (Friedlingstein et al. 2023) recently started to report national historical LULUCF emissions time series from a number of sources (Gasser et al. 2020; Hansis et al. 2015; Houghton and Castanho 2023). For Brazil specifically, a high-quality domestic data source for emissions time series, and LULUCF emissions in particular, is available from the Sistema de Estimativas de Emissões e Remoções

[2] "First, the available data for national land use emissions are partial, inconsistent, and contain well-known inaccuracies, a problem that is only compounded by the various well-known opportunities for accounting mischief. A second reason is that, even with accurate data and accounting, a strict fungibility between fossil carbon and land-based carbon is deeply problematic, in that it falsely equates the scope for labile, limited, and multi-purpose stock of carbon on the land to substitute for the permanent and secure stock of fossil carbon deep underground. Third, the extremely close link between land use and other sustainability and human rights concerns suggests that land must be managed within a substantively different type of regime than the UNFCCC, one that focuses on human rights, food security, indigenous rights, biodiversity, and watershed protection, lest it risk seriously undermining these other objectives. This is not to suggest that action on land-related emissions is unimportant or does not warrant science- and equity-based assessment, but rather to argue that such actions should be placed in their holistic context. We are exploring including LULUCF emissions again in the future, albeit only in the context of establishing responsibility for emissions, as opposed to calculating fair shares of future mitigation in the LULUCF sector." (Kemp-Benedict et al. 2023)

de Gases de Efeito Estufa (SEEG) (or System Study Greenhouse Gas Emissions Estimates) of the Observatório do Clima (Climate Observatory),[3] a long-term civil society initiative for the generation of high-quality and high-resolution emissions inventory data for Brazil. In the present analysis, the SEEG data is considered the highest-quality data source for historical LULUCF emissions data available for Brazil. However, its geographical scope is limited to Brazil and its temporal scope to the years 1990-2022.

For the present analysis, a nationally disaggregated global dataset with a deeper time horizon is required. Thus, while SEEG data is used for Brazil for the 1990-2022 period, data for other countries and years has been taken from the BLUE dataset (Hansis et al. 2015) as provided by the Global Carbon Budget (Friedlingstein et al. 2023). The BLUE dataset was selected over the other two data sources because it provides the closest match to the SEEG dataset for Brazil over the 1990-2022 period, based on a least square analysis.[4] A comparison of the Brazil LULUCF emissions data between the SEEG dataset and the three GCB data sources is also shown in Figure 2.

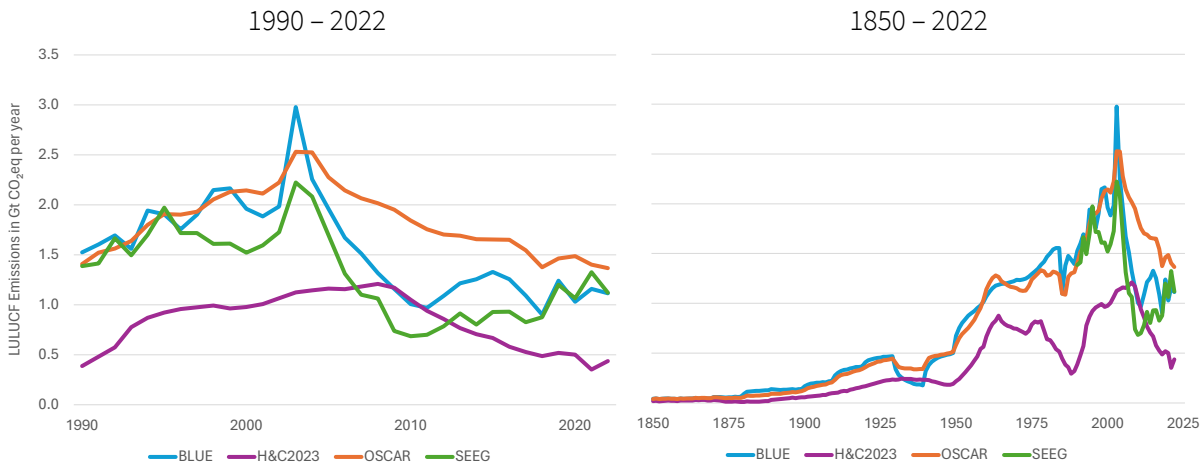


Figure 2: Comparison of LULUCF emissions time series for Brazil from SEEG, BLUE, H&C2023 and OSCAR (via Friedlingstein et al. 2023; SEEG Brazil 2024)

For calculations after 2022 of RCIs that include responsibility for LULUCF emissions, LULUCF emissions in all countries are assumed to get reduced to zero by 2030 and remain there through 2035 (the time horizon of the present analysis). While 1.5 °C-consistent emissions reductions pathways often include net-negative global LULUCF emissions in the second half of the 2020s, or in the 2030s the latest (as well as thereafter), allocating this net-negative global sum to individual countries is beyond the scope of the present analysis.

[3] For transparency, Observatório do Clima is one of the Brazilian civil society organizations that funded the work that is reported in this memo.

[4] The sum of the square of the difference between the SEEG data for Brazil for each of the years between 1990 and 2022 to the data for Brazil from each of the three data sets provided via the Global Carbon Budget was performed. The sum of the squared differences is 3.2 for BLUE, 12.9 for OSCAR and 13.8 for H&C. Thus, BLUE has the least square difference to the SEEG data for Brazil over 1990-2022.

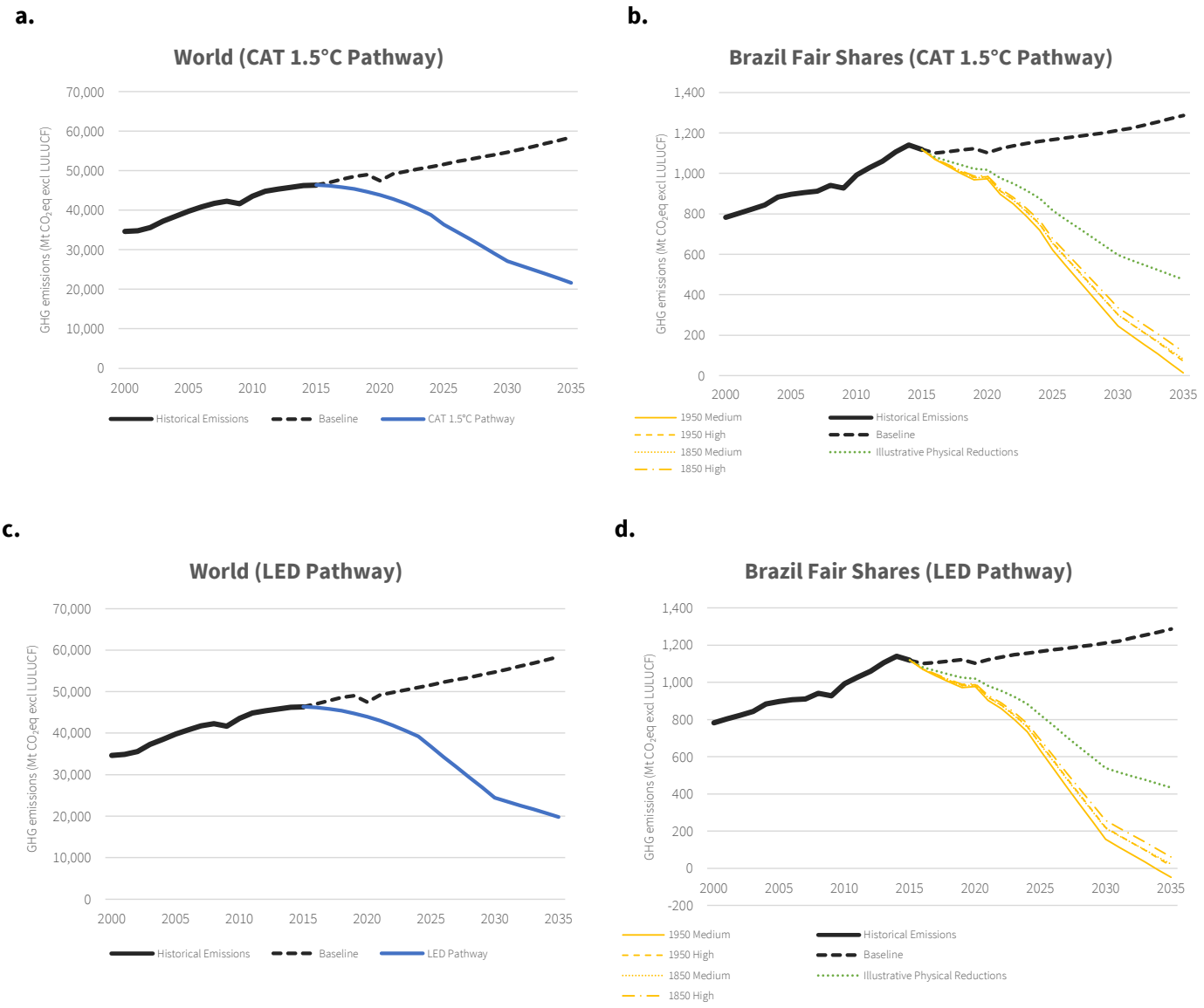


Figure 3: Overview of Fair Shares Results for the CAT 1.5°C (a & b) and LED (c & d)mitigation pathways. All figures for annual Greenhouse Gas emissions, excluding LULUCF. For each pathway, the global baseline and reductions are shown (a & c) as well as Brazil's fair share of the global mitigation (b & d). Fair shares are calculated using a definition of historical responsibility that includes historical responsibility for LULUCF emissions and historical responsibility is measured since 1950 (solid and dashed lines) or 1850 (dotted or dot-dash lines) combined with capacity using "medium progressivity" (solid and dotted lines) or "high progressivity" (dashed and dot-dash lines) definitions of capacity.

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