Article Title:

The Road to Baku: The Carbon Cost of Getting to COP29 in Azerbaijan

Author(s):

Harriet Brown[1], Simon Chin-Yee[2], Jonathan Barnsley[3], Lixuan Chai[4], Mark Maslin[5], Priti Parikh[6]

Affiliations:

Political Science, Department of Political Science, University College London [1] ; Department of Political Science, Department of Political Science, University College London [2] ; Geography, Department of Geography, University College London [3] ; Geography, Department of Geography, University College London [4] ; Department of Geography, University College London [5] ; Bartlett School of Sustainable Construction, Bartlett School of Sustainable Construction, University College London [6]

ORCID IDs:

0000-0002-4635-1944[2], 0000-0001-9957-3463[5], 0000-0002-1086-4190[6]

Corresponding Author:

Harriet Brown (harriet.brown.24@ucl.ac.uk)

DOI:

https://doi.org/10.14324/ucloepreprints.281.v1

Preprint Statement:

This article is a preprint and has not been peer-reviewed. The article has been submitted to UCL Open Environment (ISSN: 2632-0886) and is under consideration for publication following peer review.

Preprint Version:

This is version 1 of this article.

Data Availability Statement:

All data generated or analysed during this study are included in this published article (and its supplementary information files).

Preprint first published online:

2024-11-08

Keywords:
travel, offsetting, climate justice, transport, private jet, COP, climate change, Carbon footprint

The Road to Baku: The Carbon Cost of Getting to COP29 in Azerbaijan

Authors: Harriet Brown, Simon Chin-Yee, Jonathan Barnsley, Lixuan Chai, Mark Maslin, Priti Parikh
Corresponding authors: Harriet Brown, Priti Parikh

Abstract

2024 sees a return of the UNFCCC climate negotiations to Eastern Europe, as COP29 is hosted in Baku, Azerbaijan. Labelled the 'finance COP', this year will see the finalisation of the new collective quantified goal on climate finance, and thus questions of equity and climate justice are centre stage. In light of this, we present the COP29 carbon footprint calculator, providing data and analysis on the travel options from the United Kingdom to Baku, highlighting the carbon cost of such travel, and conferences as a whole. Ultimately, this calculator and research encourages transparency on travel choices and emissions and can inform sustainable travel policies. In addition, the usage and emissions of private jets from COP28 in Dubai are assessed, shedding light on the considerable carbon footprint of private aircraft and considering who uses these planes, why, and how they embody vast inequalities in consumption and carbon footprints across society. As the annual stage for climate action and climate justice, COPs drive both ambition and implementation. But they are not immune to carbon emissions and scrutiny, and have the opportunity to lead the way in sustainable practices, balanced against accessibility and impact on progress.

1. Introduction

The 29th United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP), COP29, is hosted by Azerbaijan in Baku, 11-22 November 2024. It is not unusual for the host of a climate conference to be announced at the last minute, but the Azerbaijani presidency was only confirmed in the final days of COP28 in Dubai (day 10 out of 14)[1,2]. Who the host would be had been hotly debated in the months running up to COP28 (not to mention during COP itself), as the rotation was turning to Eastern Europe, a region currently affected by the Russian invasion of Ukraine. In the past years, the Eastern European host tended to go to Poland - Poznań (2008), Warsaw (2013), and most recently Katowice (2018) have all hosted COPs[3]. However, as a result of the European Union's support to Ukraine, Russia blocked EU members from hosting COP29, leaving very few countries able, or willing, to take on the role. There were talks of an inescapable stalemate; resulting in Dubai taking a second turn, or it deferring to Bonn, as the headquarters of the UNFCCC Secretariat [4].

Hosting a COP is not only a significant responsibility due to the high stakes of the conference: securing international consensus across such issues as mitigation, adaptation, and loss and damage, but it is also a colossal logistical demand. Attendance of COP has increased dramatically in recent years, with 84,000 people physically attending COP28 in Dubai[5], which begs the question - who are all of these attendees? And how many of them need to have flown to a climate conference? In fact, it has become such a circus that the UNFCCC is looking at reducing the numbers of the next COPs - Azerbaijan is ‘only’ expecting 40,000. While this is half the number of attendees in Dubai, it will still be one of the biggest COPs ever, with COP26 and COP27 the only others to have had over 30,000 delegates[5,6].

With this year’s COP destined for Eastern Europe, the possibility of travelling from the United Kingdom of Great Britain without flying seemed to be on the table. Even positioned on the edge of Eastern Europe, crossing into Western Asia, there are hypothetical land routes from the UK to Azerbaijan. But this was not to be. Unfortunately, under current circumstances, Azerbaijan’s borders with Armenia and Georgia have been closed since the Covid pandemic. The reopening of the borders to travellers has been delayed several times, and even if they open before the start of COP29, the inability to effectively plan prevents participants from using this as a reliable option[7].

Following similar analysis by UCL on travel from the UK to COP26, 27 and 28[8,9], this research sought to find the least carbon-intensive options available to delegates travelling from the UK to Baku for COP29. Taking into account that a flight will be necessary for at least part of the journey to Baku, options range from a direct flight from London to travelling by bus, car or train all the way to Türkiye and then flying. This paper reveals that almost all alternatives to a direct flight from London, travelling part-way by bus, car or train, would reduce the carbon footprint of the journey. In addition, offsets can be purchased to further mitigate the climate impact of the journey.

A key distinction from previous years is that there are restricted flight options to Baku. London is the only city in the UK to fly direct, and there are relatively few cities across Europe that do. Specifically for London, the aircraft used to Baku is long-haul, compared to shorter-distance aircraft used in other European cities. This has resulted in disproportionately high emissions when flying direct from London and indirect flight routes are therefore also explored.

The climate conferences are not the only UN events that attract wide attendance. This year is a 'triple COP year', with the desertification and biodiversity conferences also occurring in Saudi Arabia and Colombia respectively. The climate COP may be the largest conference, but the others are not insignificant, and the cost to the climate stacks up. Approximately 7,000 delegates attended the last desertification COP in Côte d'Ivoire[10], while 16,000 are estimated to have been in Canada in 2022 for the biodiversity COP[11]. However, there is a reason the other two environmental COPs are only on number 16 while climate has reached 29 - there is significantly more attention being paid to the climate conferences, and the carbon emissions it creates. Hosts, organisers and attendees all play a role in ensuring the conferences are as productive and sustainable as they can be, and individuals and organisations can consider whether attendance is necessary.

This series of papers seeks to encourage and improve transparency on the carbon emissions of travel (flying in particular), identify optimal routes to COP, and ultimately aid decision making regarding travel to a climate conference. The use and emissions of private jets are also explored, considering why people use private jets - and the balance of the impact of attendance against the cost to the climate - comparing the emissions of private jets as a whole as well as per passenger, and relating this to societal inequalities in consumption and carbon footprints, thus raising issues of climate justice.

2. Methodology

This paper builds off two previous iterations, conducted on COP27[9] and COP28[8], utilising UCL's specifically designed carbon footprint toolkit. The latest version of the calculator is available online at the UCL Climate Hub, allowing users to calculate the footprint of their route from the UK to COP and see the data for themselves[12]. The first iteration of this series from Barnsley et al. (2022) explains the calculator in greater depth and the origins of this stream of research. Roberts et al. (2023) continues and expands on this by adding analysis of private jets.

2.1 Travelling to Baku

In determining the best options for travelling from London to Baku, direct flight routes across Europe were identified using FlightConnections[13], airline and aircraft information was taken from Google Flights[14]. Specific aircraft specifications were added to the UCL Carbon Footprint Calculator from a variety of sources, these are cited in the calculator. Google Maps API was used for determining distances for car, coach and rail.

Flight distances are calculated using great circle distance, the shortest distance between two locations across the surface of a sphere. Indirect flight times were calculated by adding the two flight times together, not considering connection times. Flight emissions are multiplied by 1.9 to account for the indirect emissions of air travel. This figure is based on the best available estimates[8,15–17]. The calculations used in this research judge coach times and distances to be equal to cars, however in reality coaches can often take longer routes, to include more stops and allow longer breaks for passengers and drivers. There is variation in the availability of data regarding train networks, in part due to the UK now reporting its data independently of the EU, but also due to the way some countries classify their transport data. The most recent year of available data was used in all cases, and references are included on the relevant toolkit tabs (*see Annex 1*).

The results and figures in this paper show a route by car, coach and train all the way from London to Baku, without flying. This is a hypothetical scenario that is not currently possible. Regardless of the border closures, there is no existing train route from Ankara to Baku, so the same time and distance for driving is used.

Azerbaijan is a transcontinental country, at the intersection of Eastern Europe and Western Asia, it borders Armenia, Georgia, Iran and Russia. All land borders were closed in 2020 in response to the Covid pandemic, and remain closed. In addition to the closure in 2020, Azerbaijan has had a contested border with Armenia for over 30 years and the UK Government advises against all travel within 5km of the Armenian border[18]. The media has recently reported terrorism and concerns regarding Russia as influencing the ongoing closure[19]. While a hypothetical route to Baku through Türkiye is considered in the results, there may have been additional routes possible if travel through Ukraine and Russia was possible, and potentially more flights without the restricted airspace over the region. This highlights the impact of geopolitics on transport, limiting the feasibility of sustainable travel options.

As shown in Figure 1, some flight paths following the great circle distance intrude on Russian and Ukrainian airspace, which is closed as a result of the Russian invasion of Ukraine. This research has still used great circle distances in its calculations of the emissions of flights, but does use real flight times.

Figure 1 - Direct flight routes to Baku across Europe. Authors own, using data from FlightConnections[13]

2.2 Private jets

Private jet inbound and outbound flights were recorded using the Flightradar24 database[20]. The time period used is 28th November - 15th December 2023, two days before COP28 began and 2 days after it concluded, as most COP-related traffic is assumed to be within this period. In addition, an average over the week before and after COP was determined to compare against. The data set for this research builds on that collected by Lixuan Chai[21] using the playback function of Flightradar24 over the Dubai area and flight history logs. The analysis then follows from Roberts et al.[8] and uses the UCL carbon footprint toolkit. Flights with unknown origins or destinations were not included. FlightRadar24 is not a complete database and does not capture all information or all jets, due to both inconsistencies in aircraft transmission as well as purposefully blocked information sharing. All flights found with the methods used were included in our database but this will not be all the flights that went into and out of Dubai during this period, and thus the results in this research will be lower than the actual emissions from all private jets.

This database includes many more options of aircraft and engine for private jets than commercial planes, as the only commercial route considered is London - Baku, while there are many variations of private jet flight route. Private plane specifications vary according to capacity, range, speed, and price. Information on the thrust specific fuel consumption (TSFC) was difficult to source, so for some private jet engines assumptions were made on the TSFC using the most similar engines data was known for.

Passenger load

A general passenger load was determined in Roberts et al.[8] of 0.381, using the following equation:

Private jet passenger load factor = (% of occupied flights x average occupancy) / average capacity

The assumptions of the 0.381 load factor are of 60% occupied flights, 4.7 average occupancy and 7.4 average capacity. This is based on research using European data on the average occupancy of flights and aircraft, as well as the most popular types of aircraft[8,15,22].

Keeping the average capacity of 7.4 and occupied flights at 60%, alternative load factors were tested to see how occupancy changes the carbon footprint per person. The different weight associated with varying occupancy is not taken into account in this calculator. The average landing weight across all aircraft recorded in the toolkit is 29 tonnes[12]. According to a report published by the European Union Aviation Safety Agency in 2022, average passenger weight with carry-on luggage is 84kg[23]. 84kg is 0.29% of 29 tonnes and thus passenger weight variations are deemed negligible. The alternative load factors used are in table 1:

Table 1: Private jet load factors, with varying occupancy

Load factor	Percentage occupancy	Average occupancy
0.15	25%	1.85
0.3	50%	3.7
0.381	64%	4.7
0.45	75%	5.55
0.6	100%	7.4

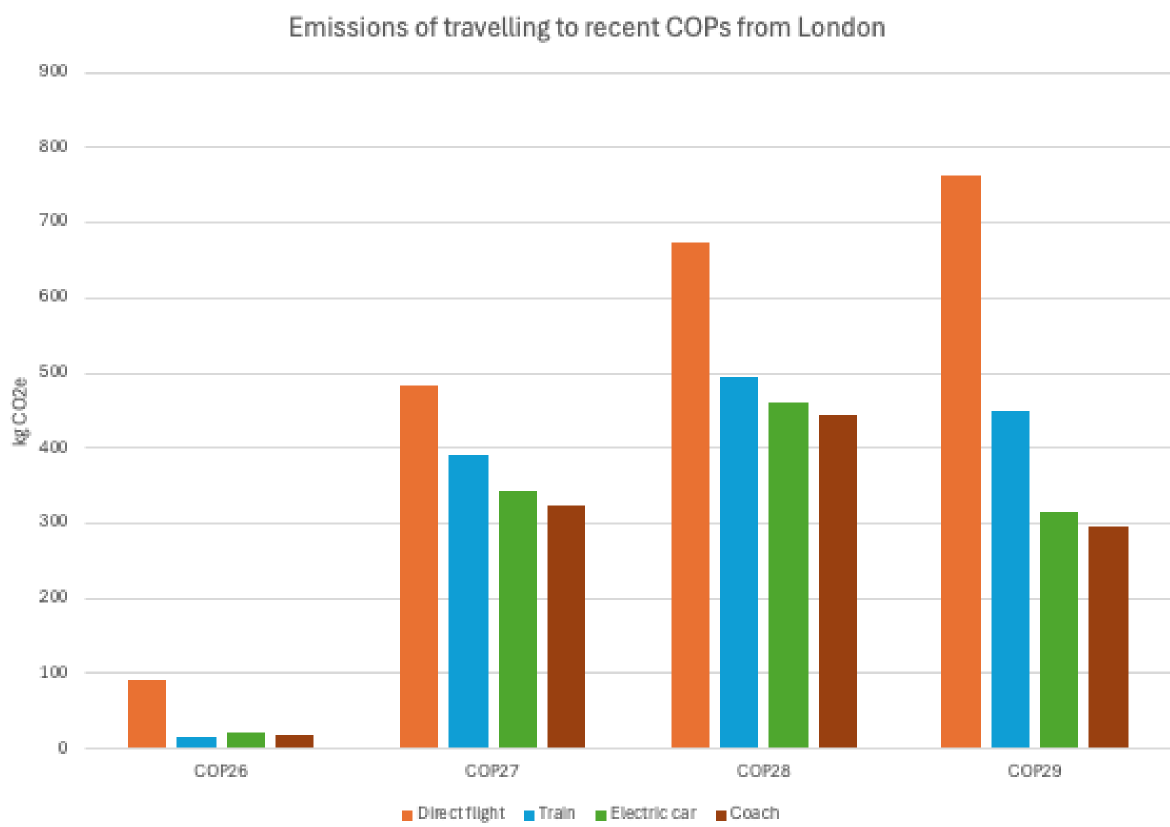
3. Results

3.1 The route to Baku

Following analysis by UCL on travel from the UK to COP26, 27 and 28[8,9], the emissions of direct flights this year see yet another increase in emissions on past years; and this is in spite of the fact that Dubai is approximately 1,500km further from London than Baku. The carbon footprint of travel to COP26 is starkly different due to it being hosted in Glasgow, Scotland. The increase in emissions this year is largely because Baku has fewer travel options. Previously, for Sharm el-Sheikh and Dubai, there were multiple flights a day, by a variety of airlines and departing from different cities across the UK[14].

Dubai is known as a global hub for international flights and Sharm el-Sheikh is a popular destination for British tourists. Whereas, London is the only city in the UK that has a direct flight to Baku, for which there is 1 flight per day (and none on Mondays), solely by Azerbaijan Airlines[14,24]. This is the same across Europe, there are not many cities or airlines with direct flights to Baku. In 2023, from London to Dubai, direct flight emissions ranged from 673 kg CO2e to 1174 kg C02e[8], and travellers could choose the more sustainable option, but for Baku there is no choice. Nevertheless, as elaborated below, there are alternative routes that delegates can elect to take to reduce the carbon footprint of their travel.

Figure 2 - Emissions of travelling to recent COPs from London (via point: Istanbul)

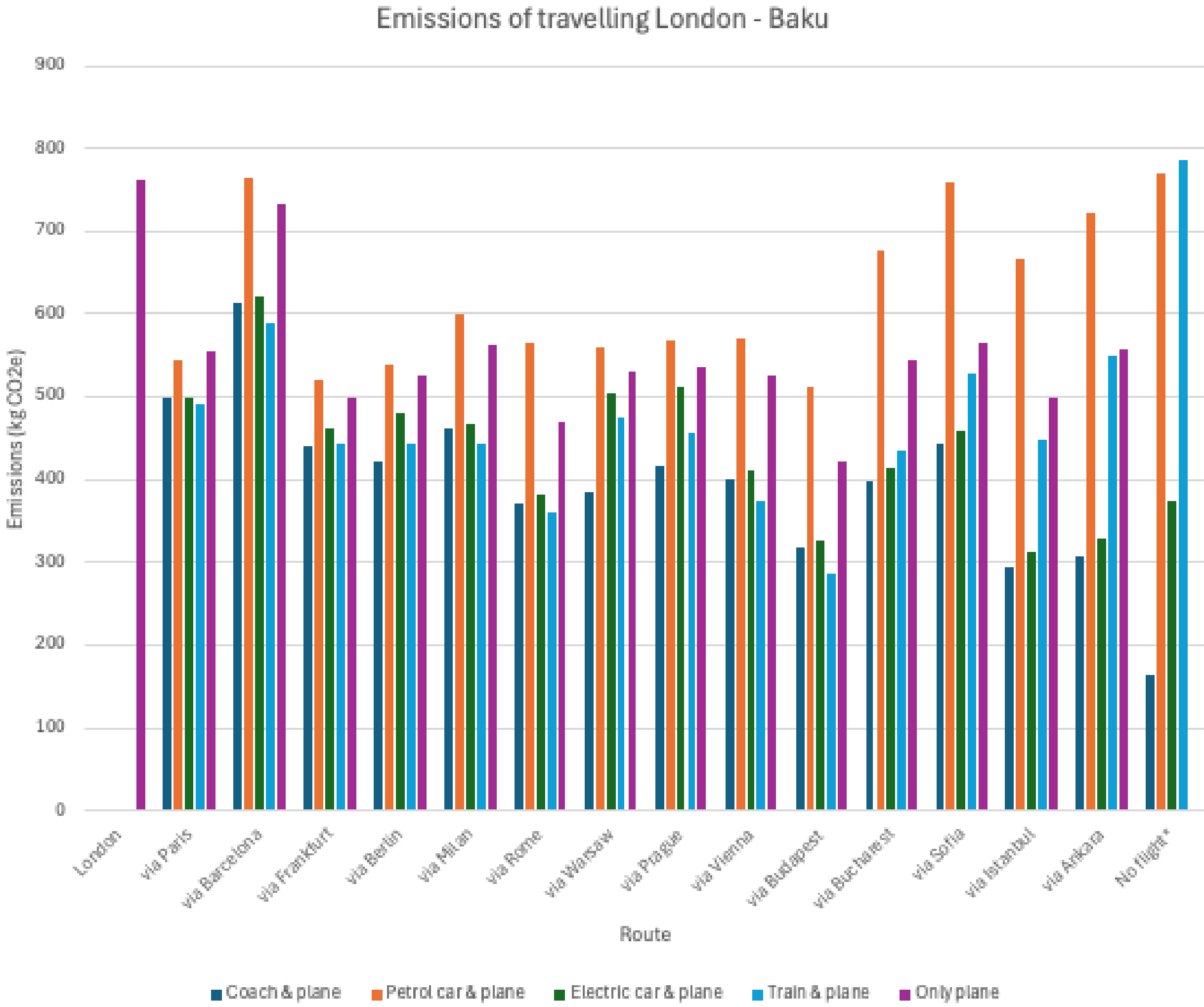


The emissions of a direct flight London - Baku is 763 kg CO_2e, and takes 5.5 hours. As a result of the limited options for travelling to Baku, the additional routes assessed in this research are via the following cities, in order of great circle distance from London: Paris, Frankfurt, Berlin, Milan, Prague, Barcelona, Vienna, Rome, Warsaw, Budapest, Sofia, Bucharest, Istanbul, Ankara (*see figure 3*).

Balancing carbon emissions with time and financial restraints, the most feasible alternative options are via Paris or Frankfurt. Vienna and Budapest also make significant emissions reductions, but considerable travel time is added so unlikely to be a popular choice. Getting the train to Paris, followed by a flight, is the quickest alternative, taking an additional 1.9 hours, and reducing emissions by more than a quarter. Getting the train to Frankfurt takes 11 hours total and is approximately 0.6x the emissions of a direct flight.

The lowest emission route is getting a train to Budapest then flying. This emits 287 kg CO_2e, 0.38x the emissions of a direct flight. However, the total travel journey is 18.2 hours. If a coach all the way to Baku was possible this would be the lowest emissions, only 164 kg CO_2e, 0.21x the emissions of a direct flight. This route would take 70.6 hours, almost 3 days, and is not currently possible due to the border closures in place and complex geopolitics, as discussed in the methodology section.

Figure 3 - Emissions from all possible routes to Baku



*The no flight route is a hypothetical scenario, travelling all the way by land to Baku is not currently possible.

Table 2 – Top routes to Baku, not including transfer times

via plane

Route	**Time (hours)**	**Emissions (kg CO2e)**
Direct from London	5.5	763
via Paris	6.5	555
via Frankfurt	6.4	498

via Budapest	6.2	422
via Istanbul	6.8	498

via train

Route	Time (hours)	Emissions (kg CO2e)
via Paris	7.4	490
via Frankfurt	11	443
via Budapest	18.2	287
via Istanbul	51.7	449

via coach

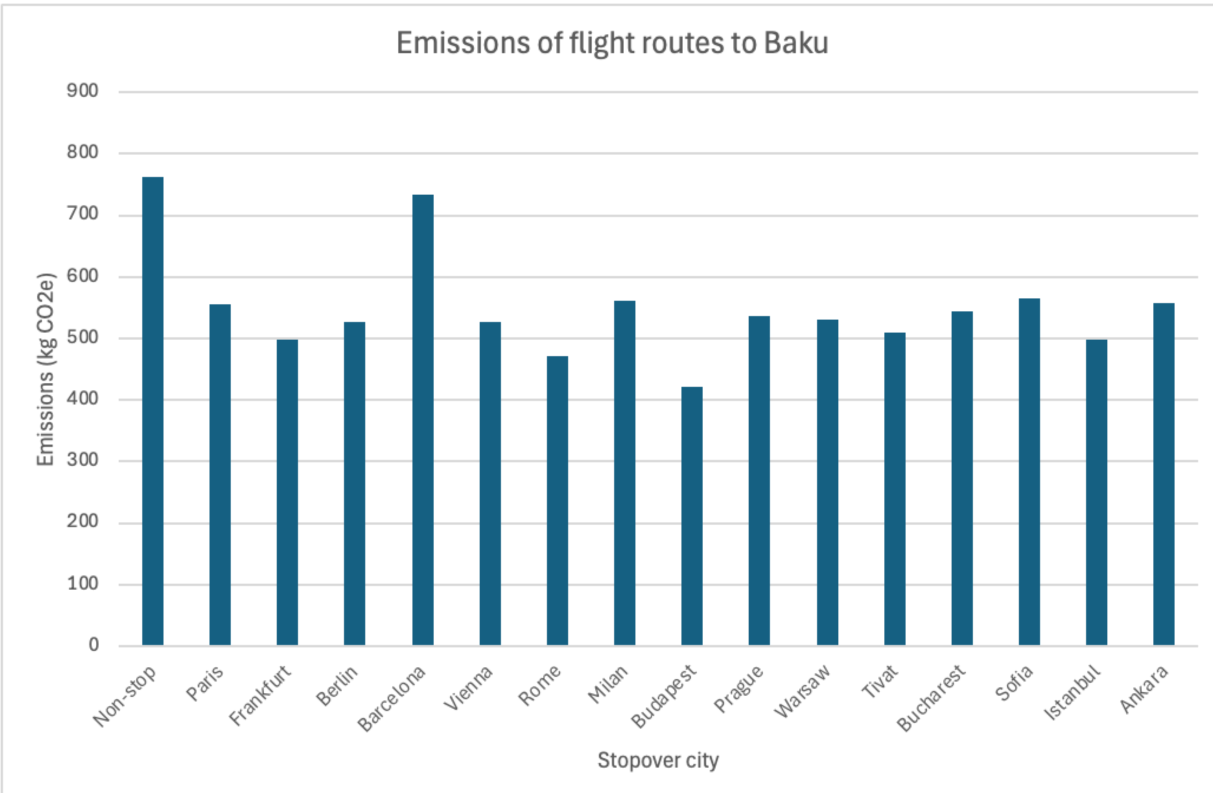
Route	Time (hours)	Emissions (kg CO2e)
via Paris	11	298
via Frankfurt	14.5	440
via Budapest	25	317
via Istanbul	44.7	295

via electric car

Route	Time (hours)	Emissions (kg CO2e)
via Paris	11	500
via Frankfurt	14.5	462
via Budapest	25	327
via Istanbul	44.7	314

In addition to exploring alternative routes via train, coach and car, indirect flights are compared below. This reveals that the direct flight from London, using a Boeing 787-8, is particularly carbon inefficient in comparison to the other flight routes across Europe, even with stopovers. This is likely because the Boeing 787-8 is a longer range aircraft than those used in other routes, and its additional specifications make it more carbon-intensive than the aircraft used in other locations. The flight times for indirect routes do not take into consideration the connection times within airports, therefore the real journey time could be considerably longer.

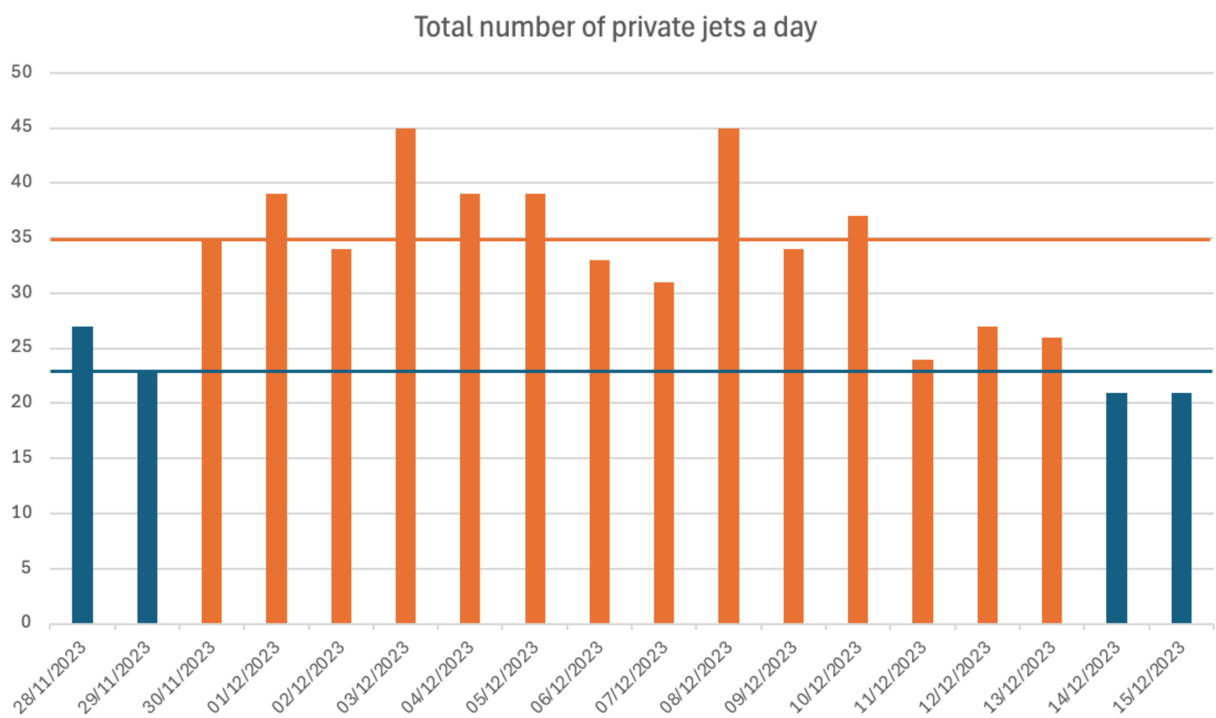
Figure 4 - comparing direct (non-stop) and indirect flights London - Baku



3.2 Private jets to COP28

The total number of private jets to and from Dubai in the period 28th November - 15th December was 580, for which we have the necessary data on 573, resulting in a total carbon footprint of 14 kt CO_2e. This is using the load factor 0.381, based on the assumption of 60% occupied flights, 7.4 average capacity, and 4.7 occupancy. Figure 5 shows the daily flights recorded.

Figure 5 - Total number of private jets a day to and from Dubai, 28th November - 15th December. Orange line is the daily average during COP28 (35), blue line is the average across the week before and week after (23).



Taking the global average per capita carbon footprint to be 4.8 t CO2e per year[25], 14 kt is the equivalent of approximately 3,000 people's yearly emissions. In just 573 flights, during a 17 day period. The global average is of course severely skewed by inequalities in carbon emissions. For comparison, table 3 shows the average per capita annual average carbon footprint in Malawi, the UK, US, and Vanuatu, and how the private jet emissions equate to annual emissions in these countries[25].

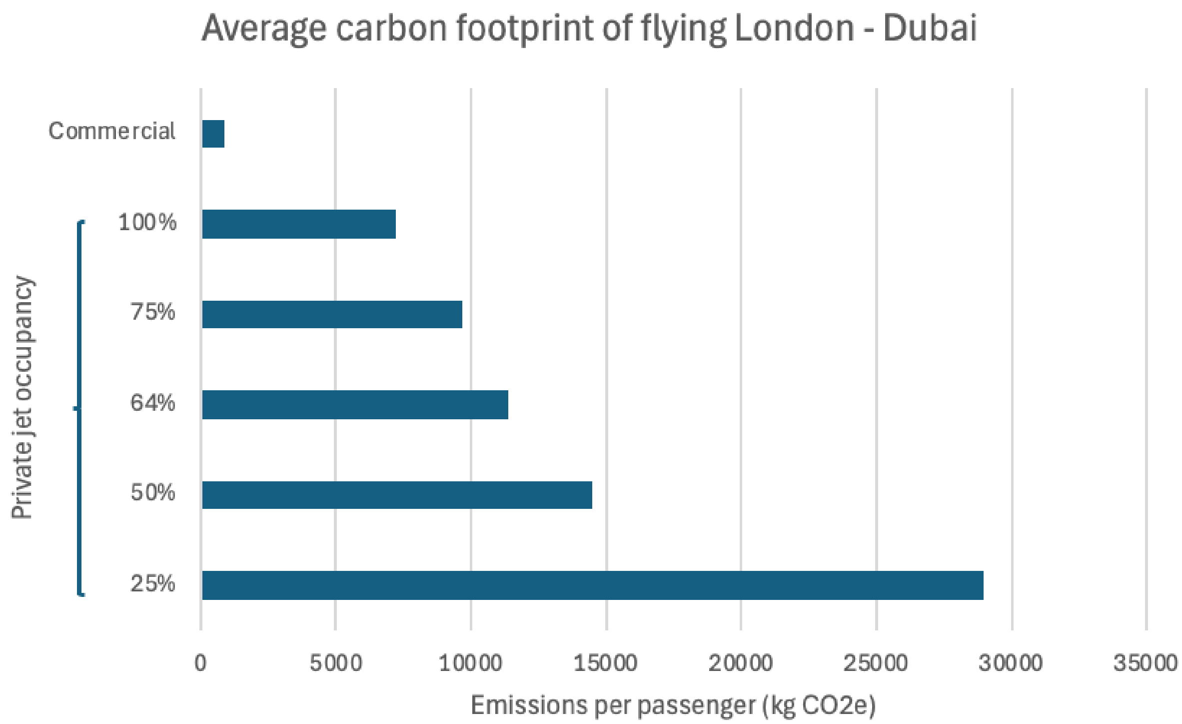
Table 3 - Comparing per capita emissions with private jet carbon footprint[25]

Country	Average annual per capita emissions (kg CO2e)	Number of per capita annual emissions equivalent to COP28 private jet emissions
Malawi	0.26	54,000
United Kingdom	5	2,800
United States	14.4	1,000
Vanuatu	0.71	20,000

Varying the occupancy of a private jet alters the per person carbon footprint, but the whole footprint of the jet remains at 14 kt of CO2e. However, if the occupancy is increased with people who would have flown commercial to COP anyway, the additional carbon footprint of the commercial flight is avoided. Table 4 below shows how occupancy changes the average carbon footprint of passengers.

There were 15 flights to London during this period, across which the average emissions per passenger was 11,398 kg CO2e. This is **13x** more emissions than the average passenger emissions on the commercial flights tracked last year from London to Dubai (851 kg CO2e)[26]. This corresponds to the widely cited Transport and Environment report that private jets are 5-14x more polluting than private jets[22]. Even at full occupancy (based on 7.4 person average capacity), private jets from London to Dubai, on average, would emit **8x** more carbon emissions than commercial flights on this route. Half full (or half empty, depending on your perspective) private jets are **17x** more polluting, and those using only a quarter of the capacity - averaging to approximately 1 passenger on a plane with capacity for 7.4 - emit **34x** more carbon than the commercial route.

Figure 6 - Comparing commercial and private flights London - Dubai



These statistics are an average of the jets tracked to and from Dubai within the COP period. In reality, the emissions of each jet varies greatly depending on the aircraft, influenced by capacity, weight, and engine model; a total of 67 different private aircraft types flew to and from Dubai during this period. From the data reported to Flightradar24 it is not possible to know the occupancy of the flights recorded. By far the most common capacities were 90% of these jets were between 10 and 20 seats (*see Annex*). However, it is worth noting that some of the jets included in this data are very large, with 24 aircraft having capacities of 98 - 189 passengers. If these larger aircraft are not utilising their high capacities, there will be significant per passenger emissions associated with the few who are using them.

Figure 7 shows a map of all the geographical dispersion of the private jets arriving to and departing from Dubai during this period, and table 4 species the most common routes taken. Europe is the most common region travelled to or from, representing 42% of the routes, however, the Middle East and Asia are also popular locations, representing half of the journeys (*see Figure 8*). There were 40 flights to or from Africa, and 1 to North America - Boston, US. In contrast to the private jets at COP27 in Sharm el-Sheikh[8], whereby the largest proportion of routes were short haul flights, almost half of flights to and from Dubai were long-distance, over 3000km.

Figure 7 - Private jet routes to/from Dubai (28th November - 15th December 2023)

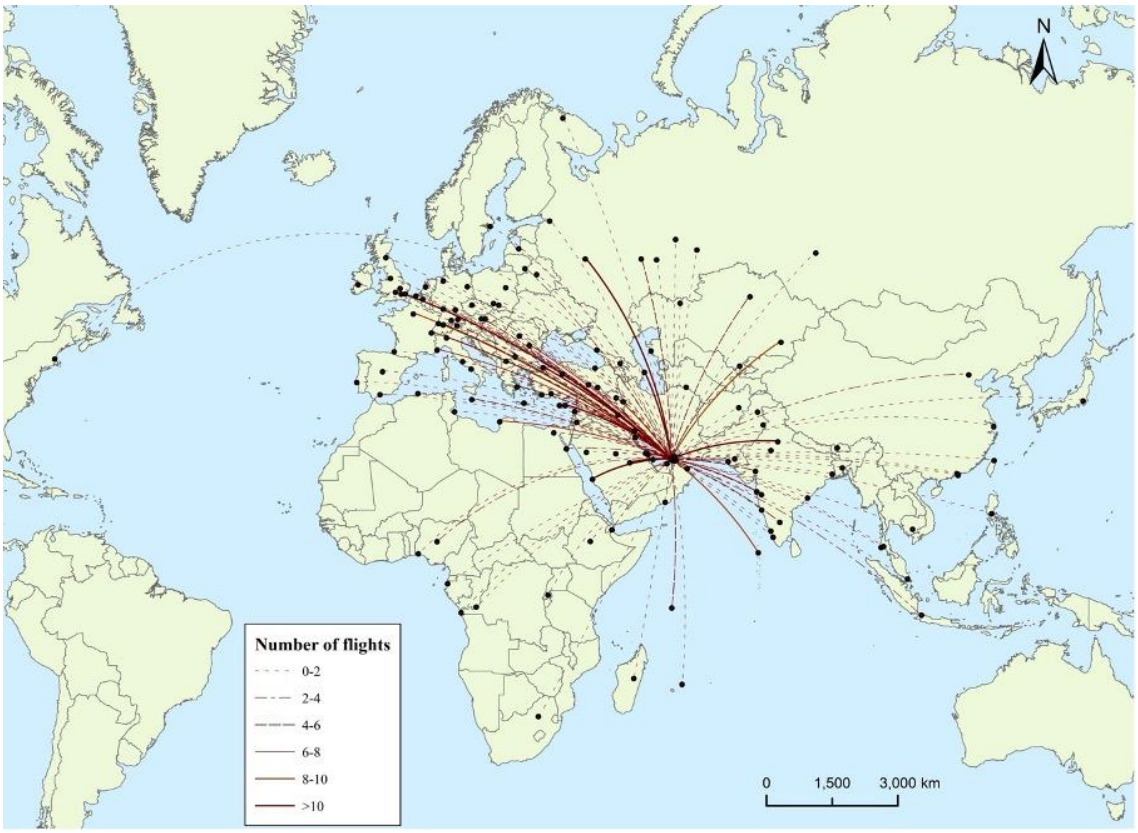
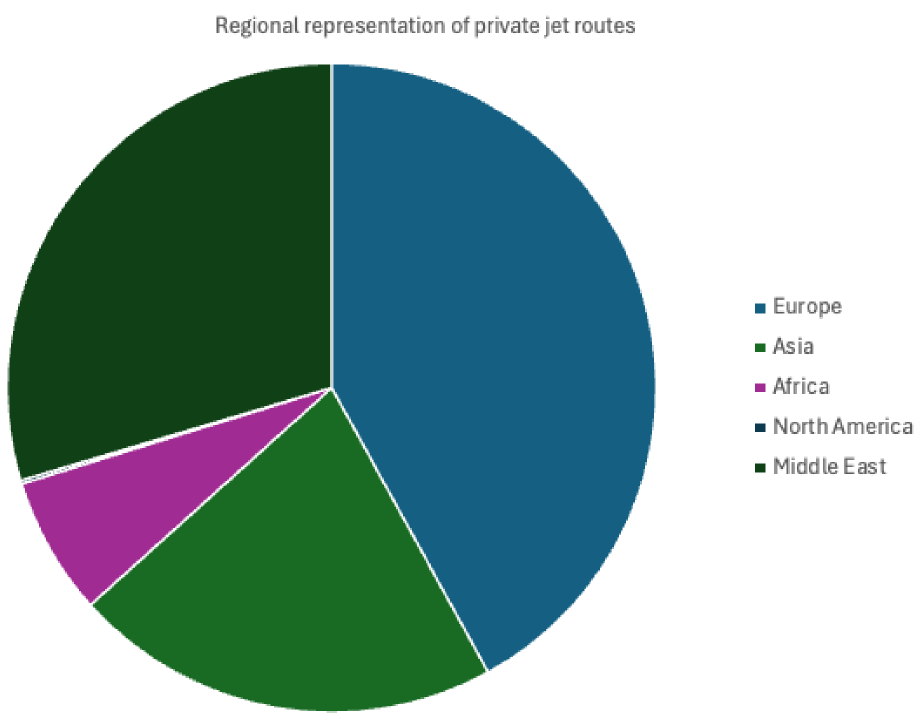


Table 4 - Top 10 private jet routes to/from Dubai (28th November - 15th December 2023)

Route	**Frequency**	**Distance (km)**
Riyadh	48	875
Moscow	48	3710
Doha	27	366
Jeddah	21	1701
Baku	16	1757
Larnaca	16	2345
Istanbul	15	3010
London	15	5483
Delhi	11	2187
Abu Dhabi	10	129

Figure 8 - Regional representation of private jet routes



4. Discussion

4.1 The carbon footprint of travelling to Baku and the role of offsetting

The climate negotiations and COP process is critical in setting and monitoring global climate targets, sharing knowledge and technical expertise, and establishing mechanisms to support countries who require further support to mitigate and/or adapt their current climate strategies. Saying that, the conference itself is a large source of emissions. As such, these emissions should be kept to a minimum, while the process keeps countries on track to decarbonise across a range of sectors in a just and equitable transition[26].

Carbon offsetting balances the impact of emissions by purchasing emissions reductions or removals elsewhere to counter that of the travel. Research over the past few years has thrown offsetting into controversy as many schemes have been found to exaggerate in their emission reductions claims, or even be completely illegitimate. Offsets based on reforestation or forest protection have come under particular scrutiny due to inflated claims[27–31]. Thus, it is paramount to conduct rigorous verification of offsets to ensure their additionality, leakage, durability and co-benefits. The recently updated (February 2024) Oxford Offsetting Principles[32] provide guidance on understanding and procuring offsets, and services such as the Gold Standard[33], enable the direct purchasing of carbon credits from accredited schemes.

Many carbon credit schemes come with co-benefits beyond their carbon sequestration, from biodiversity to education. For example, afforestation and forest protection schemes protect natural carbon sinks, but also conserve and enhance biodiversity and ecosystem services, while mangrove restoration increases carbon storage, protects coastal areas from extreme weather, and can support livelihoods through improved fishery stocks and sustainable tourism opportunities[34]. Offset projects can also bring new technologies to areas, supporting both education and livelihoods[35]. By selecting carbon offsets that benefit communities in less economically developed countries multiple targets are hit, including sustainable development, global injustices and climate change. Given the dual challenge that carbon footprints are often understated[36] while offsets are often overstated[27–31], purchasers should be mindful of the amount of emissions they are offsetting. Through raising awareness and encouraging transparency of the emissions of travel, as well as providing information on optimal routes, this research supports sustainable travel policies for organisations and individuals.

This project considers the individual carbon footprint of travel to COP. However, we acknowledge that responsibility for one's individual carbon footprint is dwarfed by the need for systemic action and responsibility of leaders and governments to deliver significant emissions reductions and achieve net zero by 2050[37]. There are criticisms of carbon footprints putting a disproportionate burden on individuals. British Petroleum, the UK oil and gas company, have been accused of purposefully popularising the term in the early 2000s as a means to deflect responsibility for rising emissions and climate change from fossil fuel corporations to individuals, encouraging a re-focusing on individual responsibility and choice[38,39]. Nonetheless, climate action is not a dichotomy between systemic change and evolving individual choices and behaviour, but requires both. Especially given the insufficient action taken to date on climate change; people need to be mindful of their emissions and reduce them wherever possible. This is particularly relevant regarding aviation. Globally, aviation contributes approximately 2.4% of greenhouse gas emissions[40], compared to approximately 23% for transportation more broadly[41] and 30% for food systems[43]. At the individual level, aviation has a much bigger impact and can make up a substantial proportion of a person's carbon footprint. Moreover, only 1% of the global population are responsible for 50% of emissions from flying[44]. Hence the importance of this project to highlight the carbon footprint of travel and raise awareness of the more sustainable options.

4.2 Private jets

The results show that for each passenger on the average private jet (assumed to be carrying 4.7 passengers) from London to Dubai, their emissions are the same as 13 people travelling on a commercial aircraft on the same route. Even operating a full occupancy (averaged at 7.4 passengers), the per passenger emissions of flying private is equivalent to 8 people flying the same route commercially. At the other end of the spectrum, the emissions of those travelling on a private jet operating at 25% occupancy - equating to approximately 1 passenger on the plane - is equivalent to 34 people travelling on a commercial aircraft.

While the focus of this paper is on individual carbon footprints, it is worth reiterating that changing the occupancy of a private jet does not alter the total emissions from the flight. In addition to the total emissions from private jets - 14 kt CO2e - there are emissions from the empty legs that are not taken into account, the assumption taken into account for the load factor is 40% of private jets flights are empty, and are arguably the attributable to those who commission the private jets.

The trends shown in the results on the frequency of private flights are consistent with those recorded by Roberts et al. for COP28 - more flights were recorded in the first half of COP[8]. This is unsurprising as the World Climate Action Summit, including the first part of the high-level segments for heads of state, was hosted on 1st and 2nd December. Heads of state are explicitly invited to the World Climate Action Summit by the COP President, emphasising the importance of world leaders and their central role in the need to "implement and transform key climate related decisions into concrete actions and credible plans, continue raising ambition, building up from previous Conference of the Parties, and keep the high-level commitment on climate change issues, with an aim to fight back climate emergency and promote coordinated action to tackle climate change"[47]. 165 heads of state and government attended the World Climate Action Summit. It was not only political leaders, but those from industry, philanthropy, civil society, youth and Indigenous Groups - the former two groups of which are most likely to include very wealthy individuals using private jets[48]. The most flights were recorded on Sunday 3rd and Friday 8th December, the 3rd follows the end of the World Climate Action Summit and the 8th being the start of the second week of negotiations.

Private jets commanded significant public attention last year at COP28, in part due to the revelation that UK Prime Minister Rishi Sunak, Foreign Secretary David Cameron, and King Charles would all be travelling on separate private jets to attend[49]. Moreover, Rishi Sunak was criticised for spending more time on the jet than at the conference[50]. It was also confirmed that junior ministers and officials would travel commercially, rather than with the Prime Minister. If the aircraft used was large enough to accomodate junior ministers and officials this contradicts a sustainable travel policy, as maximising the occupancy of the private jet would have produced a lower carbon footprint than the strategy taken by the previous Government.

There has been a growing academic literature on the climate impact of private jets in recent years[44,51–54]. This has been accompanied by negativity in the media, not only in relation to climate conferences but also in response to excessive use by celebrities[55]. There are genuine concerns about safety for world leaders, arguably legitimising the use of private jets, however the merit of attendance should still be evaluated[52]. For example, direct engagement from former-President Obama and President Xi was highly influential in the finalisation of the Paris Agreement[56]. In addition, Barack Obama's attendance to COP26 in Glasgow maintained the media attention in the US[57], showing that former leaders and others of influence also have significant power. As climate change increasingly becomes an issue of the present, rather than the future, it is important for leaders to participate in these events, driving ambition and securing progress. It is difficult to assess the impact of an individual on the negotiations, but this should be considered nonetheless, balancing the carbon footprint of the private jet with progress achieved at the conference. Government teams travelling together strikes a compromise, reducing the emissions per passenger and avoiding emissions from unnecessary additional commercial flights.

Aside from world leaders, private jets are only available to the very wealthy, and embody inequalities in wealth, consumption, and carbon footprints across society. The top 1% of global polluters emit 1000x more carbon dioxide than the bottom 1%[58]. This reflects part of the triple injustice of climate change: those who are most vulnerable to climate change did the least to cause it, are the least able to adapt, and are the most negatively affected by the policies implemented to combat it[59]. Such vulnerable populations, including women, youths and indigenous communities, are actively engaged in climate negotiations and are key themes of the discussions.

4.3 The future of COP

COP28, for the first time in COP history, called for the *transition away* from fossil fuels[60]. While many were disappointed that the language of the agreement did not go further and call for a *phase out* of fossil fuels, this was monumental nonetheless, and Simon Steill, head of the UNFCCC declared 2023 the ‘beginning of the end’ of the fossil fuel era[61]. This transition is also included in the draft pact for the Summit of the Future[62]. It is paramount that such a transition covers all sectors of society and is done in a just and equitable way, to avoid perpetuating the triple injustice of climate change[27]. There is still much to be done in order to achieve this goal, and COPs are central across the process of planning and implementation, as well as monitoring and evaluation. Going forward, COP30 will be hosted in Belem, Brazil and COP31 may be in Australia, as a partnership with Pacific island neighbours[63]. It is crucial to note that COPs in recent years have been criticised for being too euro-centric, even Baku is not a very difficult flight from the UK. It is very important that these conferences take place in different regions of the world. However, there will be no avoiding the fact that, at least for the next two COPs, flying will still be part of that travel process, and that a direct flight may not be possible.

COP attendance has risen dramatically in recent years, with COP21 in Paris being the beginning of the incline. Previous to Paris, almost all conferences were attended by under 10,000. COP 21 to 25 averages about 20,000; then, COP26 in Glasgow hosted almost 40,000, COP27 in Sharm el-Sheikh about 50,000, and COP28 last year in Dubai shot up to 84,000 people[5]. This growth is unsustainable, and arguably does not drive ambition or progress in the negotiations. The goal for COP29 and COP30 are 40,000-50,000 delegates, and COP29 has consequently seen dramatic cuts to accreditation awarded to organisations[64]. In addition to the reduction in badges overall, this year has seen a dramatic reallocation of badges from organisations in the Global North, going to the Global South; in order to achieve better representation. Proportionate representation shows the COP process moving closer to the principles of climate justice that it advocates for[64]. Yet even these numbers in Belem will be challenging, for a city located on the edge of the Amazon currently with 6,000 hotel rooms[6]. It is unclear whether cutting accreditation will actually reduce the number of people attending COP, and thus the emissions arising from travel, as many organisations are dividing their allocation so their delegates can still attend a couple of days of the conference, rather than a whole week or two.

Figure 9 - COP attendance[5]

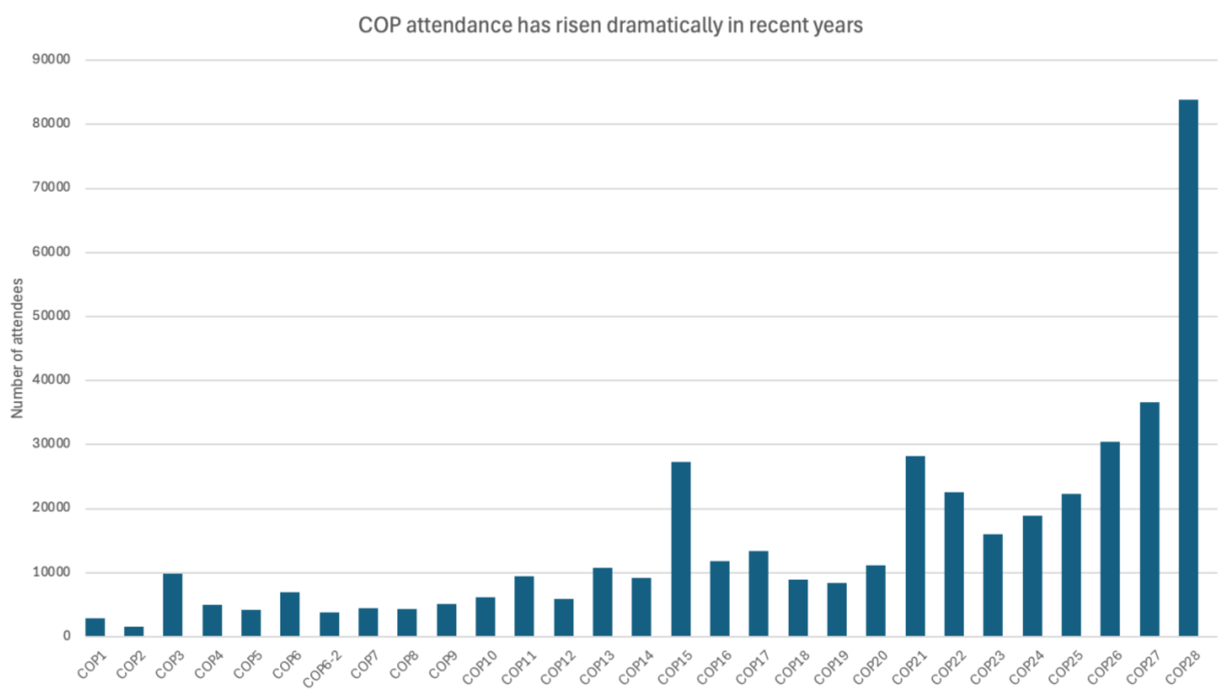
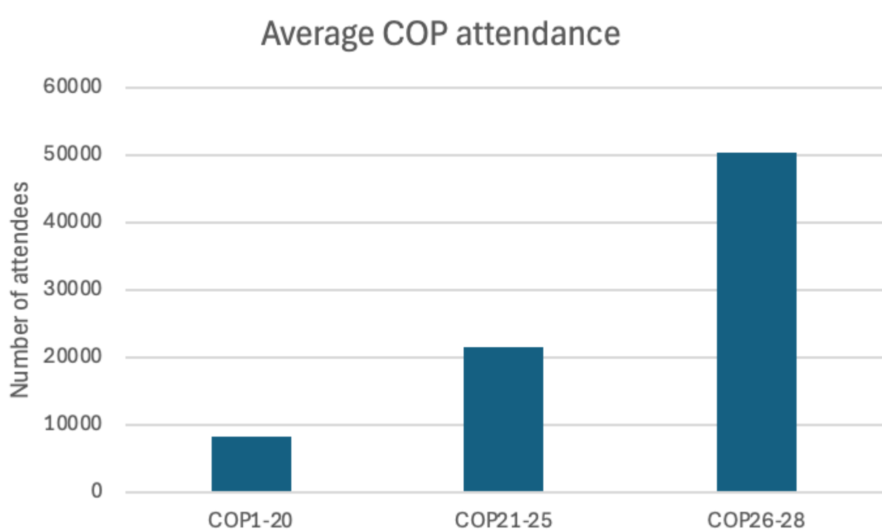


Figure 10 - Average COP attendance[5]



It is widely stated that the Paris Agreement transitioned the COP process from a prioritisation of negotiation to implementation[65,66] (though there are many caveats, as ambition is still required, and this arguably holds less true for loss and damage negotiations than for those centred on mitigation), thus calling into question whether a different approach to the process is required.

There are some who are calling for a much more extensive scaling down than is currently projected, alongside additional reforms of the system. The Club of Rome published an open letter in 2023 calling for COP reform. The signatories (which includes notable figures such as Ban Ki-moon, former Secretary General of the United Nations, Laurence Tubiana, France's special representative to COP21 and key architect of the Paris Agreement, Saleemul Huq, renowned adaptation and loss and damage expert and advocate, and Johan Rockstrom, climate scientist responsible for planetary boundaries concept, among others) call for a restructuring of COP sessions, from the current model of large annual meetings to smaller, more frequent meetings "focused on specific deliverables and accountability at the regional and national level with meaningful participation of both non-state, international organisations, and sub-national representation e.g., cities." They argue this will elevate the voices of other actors besides states, improve multi-stakeholder collaboration and strengthen the knowledge-policy interface. Their recommendations also include better defined roles of the UNFCCC Secretariat and COP Presidencies[67].

This is not the only call for reform. The efficacy of the current system has been called into question by many across the years. Research and proposals of reforms mainly focus on streamlining the negotiations and structure, and improving the voting system - no voting system was ever formally agreed in the development of the modalities of the UNFCCC, so consensus was adopted by default[68–71]. Structural reforms are particularly pertinent to questions of sustainable travel, as a different approach to the conference - perhaps smaller, more frequent, and focused, meetings - could attract a condensed audience, but require more travel for those who are participating. This research can inform any proposals or enactment of reform, encouraging transparency and a consideration of accessibility balanced against the carbon footprint of required travel for events. Nonetheless, reform to the UNFCCC process would require consensus from all Parties, and thus would be highly challenging to achieve.

5. Conclusion

United Nations climate conferences drive ambition, implementation, and monitoring of progress on climate goals across mitigation, adaptation, and loss and damage. They serve as yearly reminders of the impending climate crisis for governments, organisations and individuals across the world. However, they come at their own cost to the climate. Recent trends in attendance growth will have had a significant impact on the carbon footprint of the conferences, and, regardless of who the host is, people travel from all over the world to participate. However, location matters, for geopolitical, emissions, accessibility, and equity reasons.

This research shows that there are options available to participants that can minimise the carbon footprint of their travel to these events. The most convenient route is often at odds with the most sustainable, so delegates will have to decide for themselves what is feasible in their individual circumstances.

Private jet usage is available to only a small proportion of those who attend COPs, but this has a disproportionate effect on the climate. Given the significant emissions arising from private jets, the vast inequalities they represent in consumption and carbon footprints, there arises questions over the justifiability of their usage. As the global stage for climate action and climate justice, such an embodiment of inequality is even more scrutinised and criticised. COPs, and their attendees, have the opportunity to lead the way in setting and following an agenda of transparency, sustainability, and equity.

6. References

1. Harvey, F., Greenfield, P. & Carrington, D. Azerbaijan chosen to host Cop29 after fraught negotiations. *The Guardian* (2023).
2. Mammadov, R. Azerbaijan and COP29: An opportunity or a challenge? *Middle East Institute* (2024).
3. UNFCCC. Past conferences overview. https://unfccc.int/process-and-meetings/conferences/past-conferences/past-conferences-overview (2024).
4. Allan, J., Kosolapova, E., Templeton, J. & Wagner, L. *State of Global Environmental Governance 2023*. https://orca.cardiff.ac.uk/id/eprint/167251/1/state-global-environmental-governance-2023.pdf (2023).
5. UNFCCC. Statistics on Participation and in-session engagement. https://unfccc.int/process-and-meetings/parties-non-party-stakeholders/non-party-stakeholders/statistics-on-non-party-stakeholders/statistics-on-participation-and-in-session-engagement (2023).
6. Martins Morais, A., Civillini, M. & Lo, J. Peak COP? UN looks to shrink Baku and Belém climate summits. *Climate Home News* (2024).
7. Best of Caucasus. Covid-19 travel restrictions. https://www.best-of-caucasus.co.uk/en/travel-restrictions.html.
8. Roberts, C. *et al.* Navigating the Climate Conferences: Comparing the Carbon Footprint of Private Jet Travel and Other Modes of Transport to COP28. Preprint at https://doi.org/10.14324/111.444/000218.v1 (2023).
9. Barnsley, J. *et al.* Location location location: A carbon footprint calculator for transparent travel to COP27. Preprint at https://doi.org/10.14324/111.444/000179.v1 (2022).
10. IISD. *Summary Report 9-20 May 2022: 15th Session of the Conference of the Parties of the UNCCD (COP 15)*. https://enb.iisd.org/un-biodiversity-conference-oewg5-cbd-cop15-summary (2022).

11. IISD. *Summary Report 3-19 December 2022: United Nations Biodiversity Conference - OEWG 5/CBD COP 15/CP-MOP 10/NP-MOP 4*. https://enb.iisd.org/un-biodiversity-conference-oewg5-cbd-cop15-summary (2022).
12. UCL. The COP29 Carbon Footprint Calculator. https://www.ucl.ac.uk/climate-change/ucl-cop/ucl-and-cop29 (2024)
13. Flight Connections. Flight Connections webpage. https://www.flightconnections.com/ (2024).
14. Google. Google Flights webpage. https://www.google.com/travel/flights (2024).
15. EBAA. *Economic Impact of Business Aviation in Europe*. (2016).
16. Department for Business, Energy & Industrial Strategy. *2021 Government Greenhouse Gas Conversion Factors for Company Reporting*. (2021).
17. Climate Change Committee. *Meeting the UK Aviation Target - Options for Reducing Emissions to 2050*. https://www.theccc.org.uk/publication/meeting-the-uk-aviation-target-options-for-reducing-emissions-to-2050/ (2009).
18. FCDO. Foreign Travel Advice: Azerbaijan. https://www.gov.uk/foreign-travel-advice/azerbaijan/regional-risks (2024).
19. Eurasianet. Azerbaijan: Land borders remain sealed for individuals, but not trade. https://eurasianet.org/azerbaijan-land-borders-remain-sealed-for-individuals-but-not-trade (2024).
20. Flightradar24. Flightradar24 webpage. https://www.flightradar24.com (2024).
21. Chai, L. Assessing the carbon footprint of private jet travel at COP28: trends, data, and implications. (University College London, London, 2024).
22. Murphy, A. & Simon, V. *Private Jets: Can the Super Rich Supercharge Zero-Emission Aviation?* https://www.transportenvironment.org/uploads/files/202209_private_jets_FINAL_with_addendum_2024-05-07-140647_xczq.pdf (2021).
23. European Union Aviation Safety Agency. *Review of Standard Passenger Weights*.

https://www.easa.europa.eu/en/document-library/research-reports/easa2021c24 (2022).

24. Azerbaijan Airlines. Azerbaijan Airlines webpage. Azerbaijan Airlines (2024).
25. European Commission. GHG emissions of all world countries. https://edgar.jrc.ec.europa.eu/report_2023?vis=co2pop#emissions_table (2023).
26. UCL. The COP28 Carbon Footprint Calculator. https://www.ucl.ac.uk/climate-change/ucl-cop/cop28-carbon-footprint-calculator (2023).
27. Chin-Yee, S., De La Llama Kempeneers, L., Parikh, P. et al. A just and equitable transition: A sectoral approach to greener energy. *UCL Open: Environment* (2024).
28. Greenfield, P. Revealed: more than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis shows. *The Guardian* (2023).
29. West, T. A. P. *et al.* Action needed to make carbon offsets from forest conservation work for climate change mitigation. *Science* **381**, 873–877 (2023).
30. The Australia Institute. Here are 23 times carbon offsets were found to be dodgy. https://australiainstitute.org.au/post/here-are-23-times-carbon-offsets-were-found-to-be-dodgy-2/ (2024).
31. Song, L. An even more inconvenient truth: why carbon credits for forest preservation amy be worse than nothing. *ProPublica* (2019).
32. Dunne, D. & Quiroz, Y. Mapped: The impacts of carbon-offset projects around the world. *Carbon Brief* (2023).
33. Axelsson, K. *et al. Oxford Principles for Net Zero Aligned Carbon Offsetting (Revised 2024)*. https://www.smithschool.ox.ac.uk/sites/default/files/2024-02/Oxford-Principles-for-Net-Zero-Aligned-Carbon-Offsetting-revised-2024.pdf (2024).
34. Gold Standard. Gold Standard webpage. https://www.goldstandard.org/ (2024).
35. Smith, R. *et al.* Ensuring Co-benefits for Biodiversity, Climate Change and Sustainable Development. in *Handbook of Climate Change and Biodiversity* (eds. Leal Filho, W., Barbir, J. & Preziosi, R.) 151–166 (Springer International Publishing, Cham, 2019).

doi:10.1007/978-3-319-98681-4_9.

36. Second Nature. Co-Benefits of carbon offset project. (2020).

37. Nielsen, K. S. *et al.* Underestimation of personal carbon footprint inequality in four diverse countries. *Nat. Clim. Chang.* (2024) doi:10.1038/s41558-024-02130-y.

38. *Climate Change 2022 - Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. (Cambridge University Press, 2023). doi:10.1017/9781009157926.

39. Solnit, R. Big oil coined 'carbon footprints' to blame us for their greed. Keep them on the hook. *The Guardian* (2021).

40. Kaufman, M. The Carbon Footprint Sham. *Mashable* (2021).

41. Lee, D. S. *et al.* The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018. *Atmospheric Environment* **244**, 117834 (2021).

42. Transport. in *Climate Change 2022 - Mitigation of Climate Change* (ed. Intergovernmental Panel On Climate Change (Ipcc)) 1049–1160 (Cambridge University Press, 2023). doi:10.1017/9781009157926.012.

43. Crippa, M. *et al.* Food systems are responsible for a third of global anthropogenic GHG emissions. *Nat Food* **2**, 198–209 (2021).

44. Gössling, S. & Humpe, A. The global scale, distribution and growth of aviation: Implications for climate change. *Global Environmental Change* **65**, 102194 (2020).

45. Carrington, D. & Duncan, P. Revealed: 5,000 empty 'ghost flights' in UK since 2019, data shows. *The Guardian* (2022).

46. Office for National Statistics. Daily UK flights. (2024).

47. UNFCCC. Message to Parties and Observers. (2023).

48. COP28 Presidency. World Climate Action Summit webpage. https://www.cop28.com/en/world-climate-action-summit (2023).

49. Forrest, A. & Dalton, J. Sunak, Cameron and King Charles each take own private jets to

travel to Cop28. *The Independent* (2023).

50. Forrest, A. Sunak blasted for spending more time on jet than at Cop28 as PM accused of climate 'retreat'. *The Independent* (2023).
51. Sun, J., Olive, X. & Strohmeier, M. Environmental Footprint of Private and Business Jets. in *The 10th OpenSky Symposium* 13 (MDPI, 2022). doi:10.3390/engproc2022028013.
52. Gössling, S. & Lyle, C. Transition policies for climatically sustainable aviation. *Transport Reviews* **41**, 643–658 (2021).
53. Shone, J. AIR ASSISTANCE TO PILOTS, AN AID IN SITUATION OF EMERGENCY LANDING OF AIRPLANES. *IJRET* **05**, 287–289 (2016).
54. Schinas, O. & Bergmann, N. Emissions trading in the aviation and maritime sector: Findings from a revised taxonomy. *Cleaner Logistics and Supply Chain* **1**, 100003 (2021).
55. Graham, J. How do private jets fuel climate change? *Context* (2024).
56. Phillips, T., Harvey, F. & Yuhas, A. Breakthrough as US and China agree to ratify Paris climate deal. *The Guardian* (2016).
57. Euronews. COP26: Five takeaways as Obama arrives in Glasgow and ministers join negotiations. (2021).
58. Cozzi, L., Chen, O. & Kim, H. *The World's Top 1% of Emitters Produce over 1000 Times More CO2 than the Bottom 1%*. https://www.iea.org/commentaries/the-world-s-top-1-of-emitters-produce-over-1000-times-more-co2-than-the-bottom-1 (2023).
59. Deva, S. *Report of the Special Rapporteur on the Right to Development, Surya Deva. Climate Justice: Loss and Damage*. https://www.ohchr.org/en/calls-for-input/2024/call-input-2024-reports-special-rapporteur-right-development (2024).
60. UNFCCC. Outcome of the first global stocktake. (2023).
61. Stiell, S. COP28 Agreement Signals "Beginning of the End" of the Fossil Fuel Era. (2023).
62. United Nations. Pact for the Future. (2024).
63. Pill, M. Australia hopes to co-host COP31 but do we have what it takes? *Lowy Institute*

(2024).

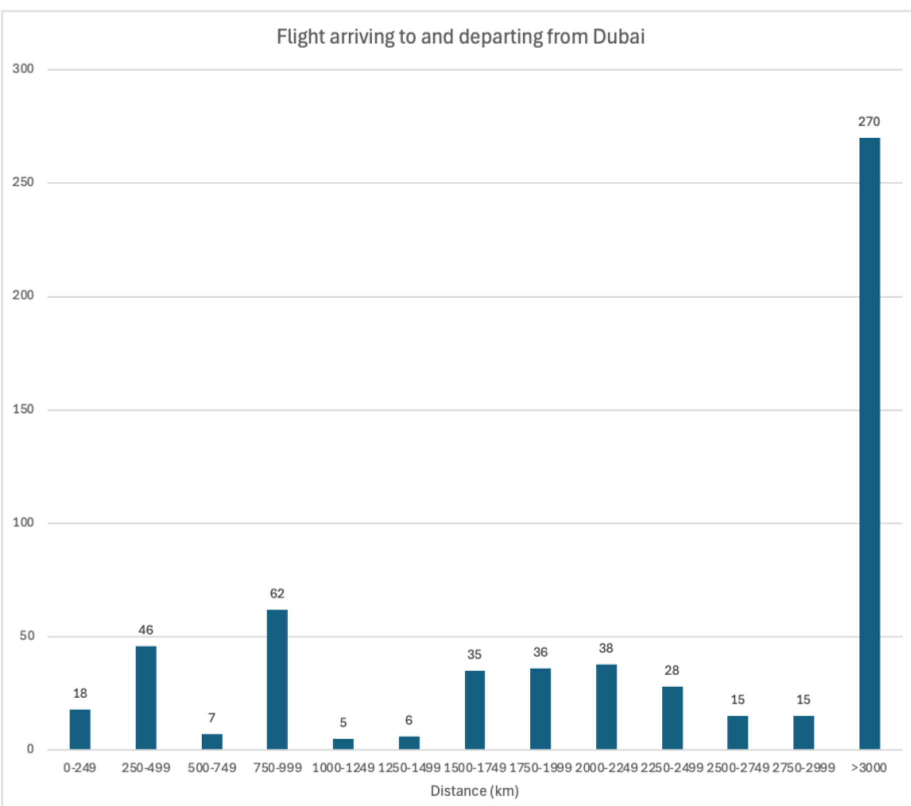
64. Civillini, M. & Lo, J. Bigger share of COP29 badges for Global South NGOs upsets rich countries. *Climate Home News* (2024).
65. Bodansky, D. & Day O'Connor, S. *Evolving Functions of the UNFCCC*. https://www.c2es.org/wp-content/uploads/2019/11/evolving-functions-of-the-unfccc.pdf (2019).
66. Müller, B., Allan, J., Roesti, M. & Gomez-Echeverri, L. *Quo Vadis COP? Future Arrangements for Intergovernmental Meetings under the UNFCCC - Settled and Fit for Purpose*. (2021).
67. Dixon-Decleve, S. *We Need an Urgent Reform of Our Climate COP's to Enable Real Climate Action*. https://www.clubofrome.org/blog-post/decleve-climatecop-reform/ (2023).
68. Allan, J. I. & Bhandary, R. R. What's on the agenda? UN climate change negotiation agendas since 1995. *Climate Policy* **24**, 153–163 (2024).
69. Berwyn, B. Policy Experts Say the UN Climate Talks Need Reform, but Change Would be Difficult in the Current Political Landscape. *Inside Climate News* (2024).
70. Vihma, A. *How to Reform the UN Climate Negotiations? Perspectives from the Past, Present and Neighbour Negotiations*. (Finnish Institute of International Affairs, Helsinki, 2014).
71. Buylova, A., Nasiritousi, N. & Linner, B.-O. *The Future of the UNFCCC*. https://www.mistra-geopolitics.se/wp-content/uploads/2018/06/The-Future-of-the-UNFCCC-Nov2023.pdf (2023).

Annex

1 - Most recent year of data regarding rail networks. Countries covered: France, Italy, UK, Germany, Austria, Belgium, Hungary, Poland, Romania, Bulgaria, Türkiye. See toolkit for resources [12]

Data	**Most recent year**
Total passengers	Belgium & Hungary: 2022 All others: 2023
Passengers by electric	EU + Türkiye: 2022 UK: 2023
Electricity consumption	EU + Türkiye: 2022 UK: 2023
Electricity emission factor	EU: 2022 UK: 2023 Türkiye: 2020

2 - Frequency of jets by distance to and from Dubai



3 - Capacity of private jets in database

Maximum private aircraft seats	Frequency
5	3
6	1
7	2
8	6
9	9
10	12
12	39
14	27
16	221
17	10
18	8
19	197
50	16
98	7
117	2
142	2
149	9
189	2

4 - Top 10 largest private jets to Dubai

Aircraft	Maximum capacity	Frequency
Airbus A318-112 (CJ) Elite	117	2
Airbus A319-115 (CJ)	142	2

Boeing 737-97Y (ER) (BBJ3)	189	2
Boeing 727-2X8	149	1
Boeing 737-7EG (BBJ)	149	1
Boeing 737-7JV (BBJ)	149	2
Boeing 737-7BQ (BBJ)	149	4
Boeing 737-7BC (BBJ)	149	1
Sukhoi SuperJet 100-95B	98	1
Sukhoi SuperJet 100-95LR	98	6