University of Southampton Business Travel Emissions

Analysis of Clarity travel booking data from 2017/18 to present

Author:

Ben Anderson (b.anderson@soton.ac.uk, ECCD, @dataknut, on behalf of SIG)

History:

- *v1.0 - draft paper to SIG for comment*
- *v2.0 – final version following comments – for UoS internal publication*

Citation:

- Anderson, B (2022) *University of Southampton Business Travel Emissions: Analysis of trends to February 2022.* Report to the University of Southampton Sustainability Implementation Group.

This report is a contribution to Goal 3 M3.2: Consult on business travel points system and set 2025 reduction targets.

Executive summary

This report used business travel emissions data as captured by the Clarity travel management system to analyse University of Southampton Business Travel emissions from 2018/19 to present. Clarity estimates emissions for flights, rail and hotel bookings but does not currently estimate emissions for car hire, taxi or ferry bookings nor for externally or self-funded travel. In addition the CO_2e conversion factors used do not currently include Well-To-Tank emissions.

The analysis in this report uses 2018/19 as a 'baseline' year since it was the last pre-COVID academic year. 2019/20 was unaffected by COVID until March 2020 but the remaining months of the academic year to July 2020 were heavily affected as the data analysis shows.

Based on the Clarity data to date, the University's business travel emissions totals since the 2017/18 academic year were:

1. 2018/19: **8,361** T CO_2e (~ 6% of our estimated total of ~ 129,000 T CO_2e Scope 1, 2 and 3 emissions – see (Ben Anderson 2021a))
2. 2019/20: **5,339** T CO_2e
3. 2020/21: **58** T CO_2e (less than 1% of 2018/19)
4. 2021/22 (to February 2022): **747** T CO_2e

The overwhelming majority of these emissions derive from flights (97.5% of total in 2018/19) and especially long haul (65%) or international flights (18%). **Business class flights accounted for 15% of emissions in 2019/20 and 2021/20 but perhaps concerningly comprise 23% of emissions in 2021/22 to date**. Had these flights been Economy class, our emissions would have been ~10% lower in each year.

The majority of trips (and the greatest emissions) are coded to 'Conference' and 'Business Meeting' with 'Research' and 'Fieldwork' only featuring more strongly during 2020/21.

As we would expect, travel frequency and emissions per traveller are highly skewed. Some travellers make over 80 trips a year but the median is just 2. The mean emissions per traveller was 1.62 T CO_2e in 2018/19 but the median was 0.33 and the maximum **133** T for the highest emitting individual traveller. As a result, **some 5-6% of travellers in each year are responsible for ~50% of business travel emissions and around 20% are responsible for ~80%**.

This analysis confirms the current Goal 3 strategy of:

1. developing communications based on this work to engage colleagues in these patterns of travel and especially in the different emissions footprints of different modes (and classes) of travel as business travel re-starts;
2. developing separate communications focused on the smaller proportion of travellers who are responsible for the majority of emissions and who are likely to have been the first to re-start major business travel;
3. understanding the value placed on different forms of business travel and for different purposes as input to a 'value-based' emissions reduction strategy.

In addition, the results suggest the need to

1. strengthen the communication and application of the travel planning decision flow:
   a. **Avoid** (do you really need to travel? Can you achieve the aim without travel?)
   b. **Reduce** (do you need to go as often/far/can you combine trips?)
   c. **Take low emissions** options (if travel is unavoidable, take options which minimise emissions
2. prioritise the use of 'virtual' collaboration for 'Conferences' and 'Business Meetings' wherever possible given the positive experiences of this mode during COVID19;
3. understand the potential off-setting costs of unavoidable business travel emissions so that travellers and budget holders can understand the potential future costs of business travel should this approach be required;
4. model the potential emissions reduction to be gained from a range of scenarios such as a substitution of all Domestic Flights for Rail and/or some proportion of 'Conference' long haul and international flights for online attendance.

Contents

1 Background

The University of Southampton's Strategic Plan - Sustainability sets out six goals. These are:

1. **Goal 1: Reduce Scope 1 & 2 to net-zero by 2030**
2. **Goal 2: Measure our total emissions footprint and set targets for Scope 3 emissions reductions**
3. **Goal 3: Adopt a value-based approach to reduce emissions from business travel**
4. **Goal 4: Ensure that sustainability is a part of every University education programme by 2025**
5. **Goal 5: Make sustainability a cornerstone of UoS' research and societal impact**
6. **Goal 6: Implement a sustainable and ethical investment policy**

The purpose of this paper is to analyse the current level and trends in University Business Travel emissions as captured by the Clarity Travel Management system. This analysis will form the basis for a communication and awareness raising campaign to be implemented in April-May 2022 as business travel re-starts following COVID19 restrictions. It will also provide the evidence base for Goal 3's future business travel emissions reduction targets.

This report is a contribution to Goal 3 M3.2: Consult on business travel points system and set 2025 reduction targets.

2 Analytic code

All analysis reported here was run using R/RStudio and is available for inspection, feedback and/or re-use at https://git.soton.ac.uk/sig/goal_3/claritydata. This code constitutes part of SIG's effort to develop a set of transparent data analysis processes which are easily reproducible on an ongoing basis.

3 Data

This analysis uses an anonymised version of the Clarity system booking data sent to the University by Clarity Travel. Use of Clarity to book travel was introduced in 2017/18 and become mandatory later in 2018/19. The data received from Clarity comprises a 'Carbon report' and as such only includes bookings where emissions are currently estimated. These are bookings for flights, rail and hotels.

Pre 2018/19 data may not therefore capture all relevant business travel . Further, emissions from car hire, taxi or ferry bookings, as well as own car use or self-funded travel is **not** currently included. This will be addressed through future analysis of Agresso (travel expenses) data.

In addition, neither Clarity nor Agresso can capture emissions from travel arranged or paid for by third parties external to the University. The extent of these emissions is currently unclear but may be considerable (Ellie Harrison 2020, 11).

The data used in this report consists of a single file extracted on February 1st 2022 covering all periods up to December 2021 together with monthly 'academic year to date' snapshots since January 2022. The analysis reported here uses the data snapshots up to 1st March 2022. The data includes all trips that have been completed (or cancelled and refunded), trips in progress as well as those that have been booked for future travel. Reporting will therefore include emissions from trips that are yet to take place.

3.1 Accounting for refunds

'Refunds'may be due to a trip amendment or the complete cancellation of a trip, especially in 2019/20 and 2020/2021. Emissions on refunded bookings are included in the Clarity data as negative emissions and so will cancel out the original booking emissions when aggregated. However, due to the difficulty in matching original and refunded/cancelled bookings, neither the original booking nor its subsequent refund have been removed from the data. Whilst this does not affect the emissions estimates, the counts of bookings may be slight overestimates (see Table 1 below).

In addition, about 3% of booking records have 0 km and thus 0 emissions values even where the booking type is for travel (i.e. not hotels). In the absence of other evidence the analysis reported here excludes these records on the assumption that they are minor booking amendments, seat reservation or some other administrative adjustment[1]. Doing so will not affect the emissions analysis but may produce slight underestimates of travel item counts if this assumption is not valid.

3.2 Anonymisation

Each booking is associated with both the name of the Traveller and Travel Booker as well as the Staff ID of the Travel Booker (not the Traveller) and an Agresso code. To ensure anonymity in the analysis all names and Staff ids as well as project codes have been removed and the Traveller name converted to a unique cryptographic hash code using the openssl R package md5() algorithm. This anonymised Traveller code or ID is unique to a given Traveller name. However, analysis of the original data showed that some names have changed over time even though they refer to the same person, such as by the acquisition of a title. This means that while the hashed ID is unique to a specific Traveller name, one person may have more than one hashed ID. The consequence of this is that emissions derived from that person's travel may in fact be distributed across a number of hashed IDs. This is irrelevant for most purposes except for the analysis of per-Traveller (i.e. per-ID) emissions.

3.3 Data availability and re-use

Unfortunately, the original data cannot be made available due to disclosure risk but it may be possible to make the anonymised version of the data available for further analysis on request.

3.4 Data description

The following sections describe the main data categories (variables) that are used in this analysis.

3.4.1 Transaction types

There are three transaction types in the original data – invoice, referral and refund. Referrals are extremely rare (Table 1) but refunds, which may be trip amendments or complete cancellations, are more common especially in COVID-affected years.

[1] To be confirmed by Clarity.

Table 1: Frequency of transaction types (all data)

DEFRA category	2017/18	2018/19	2019/20	2020/21	2021/22 to date
Invoice	9,231	24,881	22,915	972	3,722
Referral		9	5		5
Refund	236	1,084	2,669	248	159

3.4.2 Accounts

The Clarity data codes bookings to one of a number of different accounts as shown in Table 2. This report does not distinguish between accounts so it will include emissions due to staff at UoS Malaysia (SOTONUSMC/ SOTONMC).

Table 2: Frequency of data observations by account (filtered data)

Account	2017/18	2018/19	2019/20	2020/21	2021/22 to date
MISSUOS	1	227	242	52	12
SOTON	5,232	11,500	11,312	628	1,910
SOTONE	4,222	13,435	12,999	378	1,680
SOTONMC					68
SOTONUSMC	11	23	11	4	

3.4.3 Faculties

Faculties are not currently coded in the Clarity data so per-Faculty analysis is not currently available. Coding to Faculty is on Clarity's development stack for delivery in May. Individual per-Faculty reports could then be generated.

3.4.4 Schools

Schools are currently coded in the Clarity and per-School analysis would be possible but has not been included here. Table 20 in the Appendix shows the coded Schools and their % of total business travel emissions by year. Note that there may be naming inconsistencies over time. It would be possible to produce per-School reports similar to this analysis if the naming inconsistencies can be easily resolved.

3.4.5 Booking types (DEFRA categories)

Clarity codes bookings and estimates emissions according to one of the booking types shown in Table 3. These are defined by the UK DEFRA/BEIS emissions factors and the SECRA reporting guidelines.

Note that according to BEIS 2021, "*Broadly speaking the definition of domestic flights, are those within the UK, short-haul are those within Europe, long-haul are outside of Europe and international flights are those between non-UK destinations*."

Table 3: Frequency of booking types

DEFRA category	2017/18	2018/19	2019/20	2020/21	2021/22 (to date)
Hotels - UK	1	1,167	2,194	248	491
Hotels - London		253	306	8	43
Hotels - International		1,153	1,962	27	182
Domestic Rail		5,845	7,247	188	1,371
International Rail	206	341	254	4	22
Domestic Flights	973	1,913	1,498	33	164
Short-Haul Flights	3,481	6,253	4,471	158	538
International Flights	2,417	4,231	3,222	224	471
Long-Haul Flights	2,388	4,029	3,410	172	388

As Table 3 shows, bookings fell markedly in 2020/21 and are now slowly recovering in the year 2021/22 to date lead by Domestic Rail. This is further illustrated by Figure 1 which shows the number of booked travellers by transport type (i.e. excluding hotels).

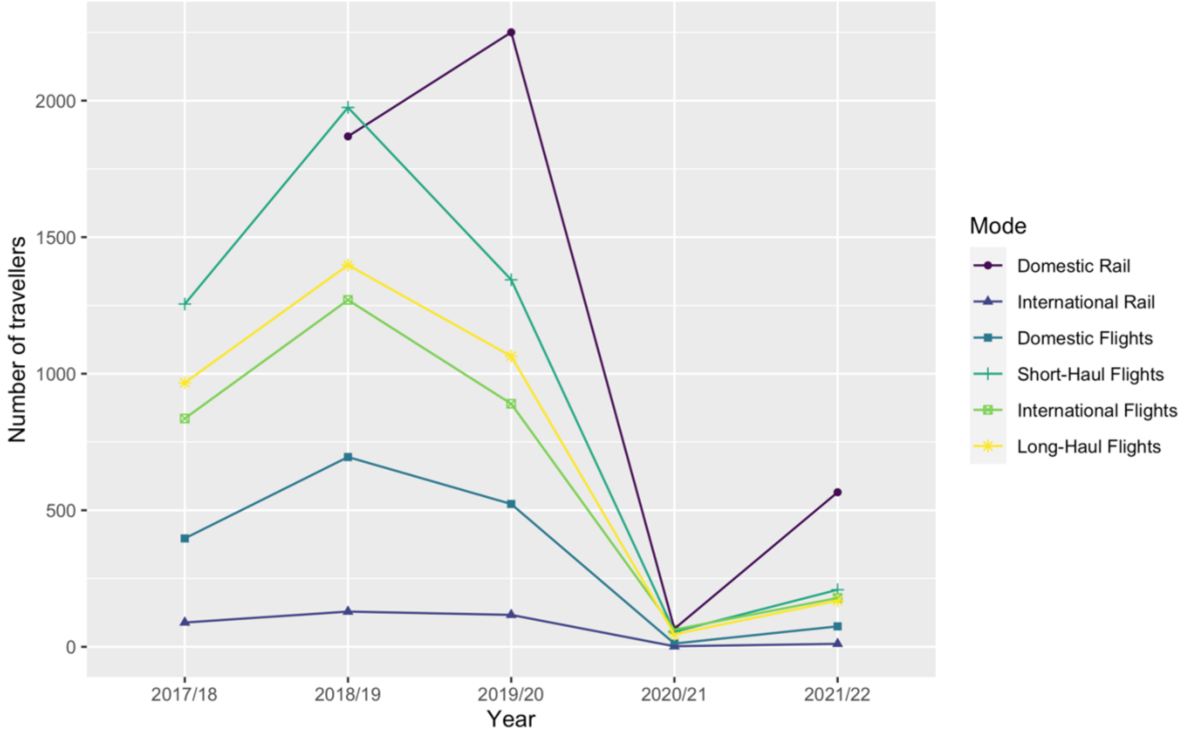

Figure 1: Number of travellers using a given transport mode

While the number of bookings was notably reduced in 2020/21, the proportion of bookings for each travel method remained roughly constant (Table 4).

In partial confirmation of Harrison's 2020 conclusions regarding 'journeys' (Ellie Harrison 2020) and also other analysis (Arsenault et al. 2019), Long Haul/International Flight bookings comprise around 35% of travel bookings in 'normal' years with Domestic/Short Haul flights comprising a similar proportion. Domestic Rail bookings are notably high as a proportion of transport bookings in 2021/22 to date, reflecting the international travel and COVID context.

Table 4: Percentage of 'transport' bookings

DEFRA category	2017/18	2018/19	2019/20	2020/21	2021/22 (to date)
Domestic Rail		25.8	36.1	24.1	46.4
International Rail	2.2	1.5	1.3	0.5	0.7
Domestic Flights	10.3	8.5	7.5	4.2	5.6
Short-Haul Flights	36.8	27.7	22.2	20.3	18.2
International Flights	25.5	18.7	16.0	28.8	15.9
Long-Haul Flights	25.2	17.8	17.0	22.1	13.1

3.4.6 Class of travel

Clarity captures class of travel as booked. When combined with booking type (Table 5) it is clear that Business Class sees ongoing use for most types of flights. The current Finance Policy 17 (Travel)[2] allows for the use of Business Class as follows:

> "Upgrades up to business class, premium economy class or equivalent may be permitted on any flight **in excess of 6 hours** in any of the following instances which must be made clear on relevant claims):
>
> - The timing of the flight in relation to business meetings, presentations, etc. merits the need for sleep and/or work on the flight. In these cases, consideration should be given to whether the upgrade is required for both legs of travel.
> - The case for upgrade is considered a reasonable adjustment on equality or medical grounds. Adjustments will be supported subject to satisfactory full completion of a travel/off-site risk assessment detailing the reason for adjustment(s) and adjustment(s) agreed. In such cases, a copy of the risk assessment should be provided with any claim.
>
> Upgrades to business class or equivalent may be permitted on in-country flights in certain destinations eg China where the upgrade is considered a reasonable comparison to economy flights in the UK" (**emphasis** added)

Despite the policy stating that First Class travel is not allowed under any circumstances, First Class appears to have seen a small amount of use historically for flights and also for Domestic Rail, especially in 2021/22 to date.

Table 5: Frequency of booking types by class

Travel class	DEFRA category	2017/18	2018/19	2019/20	2020/21	2021/22 (to date)
BUSINESS	Domestic Flights		2	4		
BUSINESS	Short-Haul Flights	62	80	86	6	21
BUSINESS	International Flights	109	142	159		25
BUSINESS	Long-Haul Flights	176	306	328	33	70
BUSINESSPREMIER	International Rail		2	10		
ECONOMY	Domestic Flights	973	1,911	1,494	33	164
ECONOMY	Short-Haul Flights	3,412	6,165	4,364	148	517
ECONOMY	International Flights	2,263	4,029	2,992	220	444
ECONOMY	Long-Haul Flights	1,982	3,248	2,655	120	302
FIRST	Domestic Rail		4	1		11
FIRST	Short-Haul Flights	2		5		
FIRST	International Flights	3	7	4		
FIRST	Long-Haul Flights	18	24	4		
PREMIUM ECONOMY	Short-Haul Flights	5	8	16	4	
PREMIUM ECONOMY	International Flights	42	53	67	4	2
PREMIUM ECONOMY	Long-Haul Flights	212	451	423	19	16
STANDARD	Hotels - UK	1	1,167	2,194	248	491
STANDARD	Hotels - London		253	306	8	43
STANDARD	Hotels - International		1,153	1,962	27	182
STANDARD	Domestic Rail		5,841	7,246	188	1,360
STANDARD	International Rail	151	271	199	2	22
STANDARD PREMIER	International Rail	55	68	45	2	

[2] See Finance Policy 17 – Travel at https://sotonac.sharepoint.com/teams/FinancePlanningandAnalytics/Finance%20regulations%20policies%20procedures/Policies/Finance%20Policy%2017%20-%20Travel.pdf

3.4.7 Purpose of travel

Clarity codes 'purpose of travel' according to a relatively small set of categories. Although only one purpose can be coded to each booking, multiple bookings within one trip can enable multiple purposes to be coded for one trip. However, analysis of the data shows that over 99% of all trips in each year are coded to just one purpose. Nevertheless, the manner of coding means that interpretation of any analysis of the purpose of travel should proceed with caution. For example, a single flight booking may involve a trip to a single location and thus only allows one 'purpose' to be coded even if multiple different business activities were carried out.

Table 6 shows the top 10 reasons for as booking in each year ordered by the 2018/19 values. The table shows that 'Conference' dominates in most years followed by 'Business Meeting'. As expected, the exception is 2020/21 when special approval measures were in place and 'Research'/'Fieldwork' significantly increased their share of the substantially reduced number of trips.

Table 6: % and total number of bookings by reason (top 10)

Reason	2017/18	2018/19	2019/20	2020/21	2021/22 (to date)
Unknown	99.9	35.0		1.9	
CONFERENCE	0.1	26.3	43.4	22.5	28.6
BUSINESS MEETING		17.9	23.5	12.3	16.4
RESEARCH		7.8	10.5	33.0	25.4
INTERNATIONAL PARTNERSHIP DEVELOPMENT		2.0	4.0		2.2
STAFF TRAINING		2.0	3.1		2.5
STUDENT RECRUITMENT	0.0	1.9	4.0	1.5	2.8
FIELDWORK		1.9	3.0	17.4	10.2
BUSINESS DEVELOPMENT		1.3	2.0	1.9	2.8
TEACHING		1.0	2.0	2.4	1.7
ENTERPRISE				3.1	2.1
INVITED TALK FUNDED LOCALLY			1.0		
PROFESSIONAL SERVICES				1.8	
Total number of bookings	9,466	25,185	24,564	1,062	3,670

3.4.8 Emissions factors

To estimate emissions, Clarity apply the relevant year's specific direct and indirect emissions factors sourced from BEIS[3] to the distance travelled according to the mode of transport and class of ticket, or to the class and country of hotel. Emissions are therefore reported as T CO_2e because they include all greenhouse gas emissions, not just CO_2. The emissions factors also include radiative forcing for flight emissions but do not currently include Well-To-Tank emissions.

[3] https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting

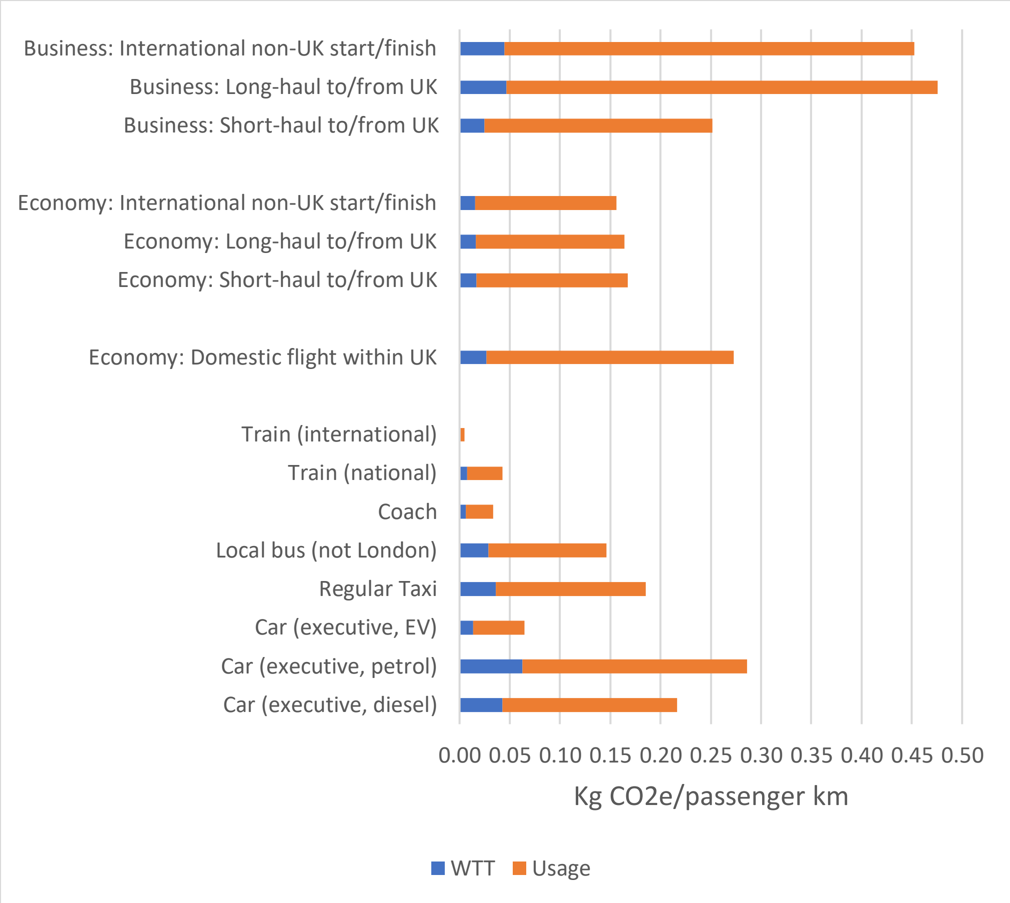

Figure 2: kg CO2e/passenger km for business travel by mode (Source: (BEIS, 2021)

For reference, Figure 2 shows the BEIS usage and WTT emissions for 2021 that were presented in our previous report on business travel scenarios (Ben Anderson 2021b) and which match the 2021 emissions in the Clarity data. Clarity have applied previous versions of these BEIS factors to the 2020, 2019 and 2018 data. As can be seen, including the WTT factors would make a small difference to overall emissions estimates and would be unlikely to substantially change travel mode priorities.

For comparison, Table 7 shows the Kg CO2e/hour of video and non-video based conferencing using recently published estimates (Obringer et al. 2021). This paper states that internet use has an emissions footprint "*ranging from 28 to 63 g CO2 equivalent per gigabyte (GB)*"[4].

	Kg CO2e/person/ hour	Application cited	Data rate
Videoconf (with video)	0.157	Zoom	2.5 GB/hour per person
Videoconf (no video)	0.006	Skype	0.1 GB/hour per person

Table 7: Internet data use emissions values (Source (Obringer et al. 2021))

Further discussion of the effect of these emissions intensity values on the ‘sustainability’ of different travel modes under a number of scenarios can be found in our previous report (Ben Anderson 2021b)[5] and in Section 6 (Low carbon options) below.

[4] Their values for the UK, based on mean UK grid carbon intensity, were even lower at 13 to 28 g CO2e/GB.

[5] See also internal UoS discussions on the Sustainability Strategy yammer group: https://web.yammer.com/main/threads/eyJfdHlwZSI6IlRocmVhZCIsImlkIjoiMTM0NjEzOTA3NzE4MTQ0MCJ9

4 Results

4.1 Overall emissions trends over time

Table 8 shows the total business travel emissions captured by this data over time (first row) and the percent of these emissions that derive from different travel modes. The total value for 2018/19 (8,362 T CO_2e) is slightly lower than the estimate included in the University's Strategic Plan - Sustainability for air travel alone (8,982 T CO_2). Since the new estimates include all direct and indirect emissions plus radiative forcing it seems likely that the Strategic Plan - Sustainability was a slight *over-estimate* unless the values also included WTT factors which are currently absent from the Clarity data.

The table also shows the fall-off in emissions in 2019/20 and close to zero business travel emissions in 2020/21. **The total of 58 T in 2020/21 was less than 1% of the 2018/19 emissions**. Nevertheless, we can see that flights dominate business travel emissions in all years with flights comprising between 80% (2020/21) and 97% (2018/19) of annual emissions as captured by this data.

Table 8: % and total T CO_2e due to Clarity-captured business travel (ordered by value in 2018/19)

Travel mode	2017/18	2018/19	2019/20	2020/21	2021/22 (to date)
Total emissions (T CO_2e)	5,101	8,362	5,339	58	747
Long-Haul Flights	67.5	65.2	63.3	21.6	61.3
International Flights	18.5	18.1	18.8	30.5	18.9
Short-Haul Flights	11.6	11.7	9.8	20.4	10.8
Domestic Flights	2.4	2.5	2.4	6.7	2.6
Hotels - International		1.4	3.2	5.4	3.0
Domestic Rail		0.6	1.1	2.1	1.3
Hotels - UK	0.0	0.4	1.2	12.9	1.9
Hotels - London		0.1	0.1	0.3	0.1
International Rail	0.0	0.0	0.0	0.0	0.0

Table 9 shows a similar analysis but focuses on distances travelled. This highlights the very low emissions factors (T CO2e per passenger km) for Domestic Rail at 0.6% of emissions but 3% of km in 2018/19, and especially International Rail (see also Figure 2). Domestic flights on the other hand, while lower than Domestic Rail at 1.7% of km travelled, were responsible for 2.5% of emissions in 2018/19 and 2019/20 (Table 8).

Table 9: % km travelled by Clarity-captured business travel mode

Travel mode	2017/18	2018/19	2019/20	2020/21	2021/22 to date
Total km travelled	27,022,206	46,198,505	30,085,658	337,545	4,163,869
Long-Haul Flights	63.5	61.0	60.9	23.3	55.1
International Flights	21.1	21.1	21.2	37.4	23.5
Short-Haul Flights	13.6	13.4	11.2	23.5	12.6
Domestic Rail		2.6	4.8	10.4	6.6
Domestic Flights	1.5	1.7	1.7	4.7	1.9
International Rail	0.3	0.3	0.3	0.6	0.2

4.1.1 Emissions by travel type

Figure 3 shows the total emissions per year split by booking type (as per Table 8). This makes clear the dominance of long-haul and international flights in our emissions profile despite their relatively lower frequency.

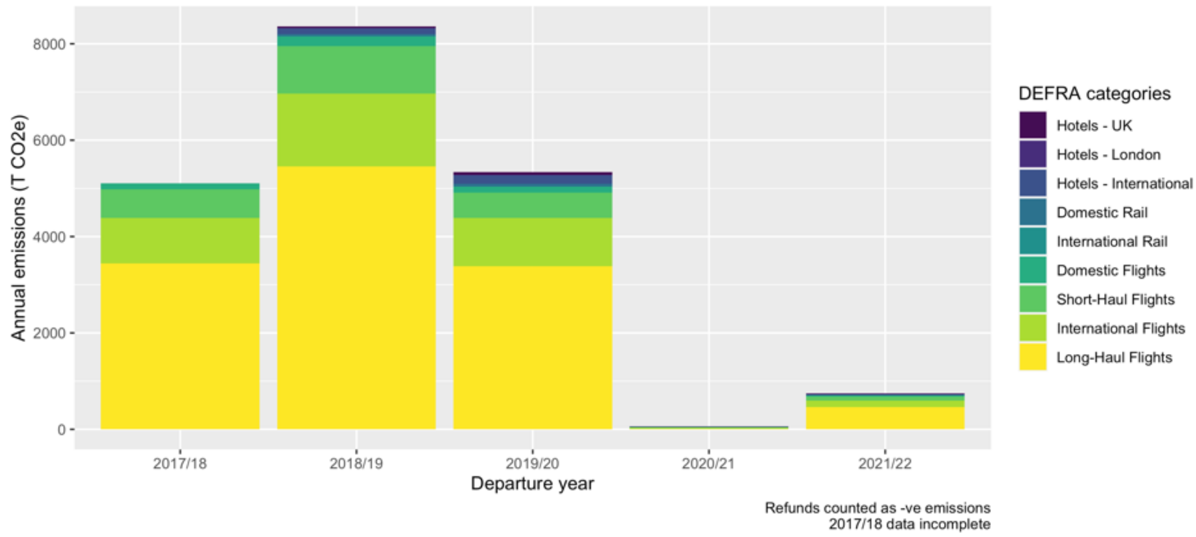

Figure 3: Total T CO_2e due to different travel modes by year

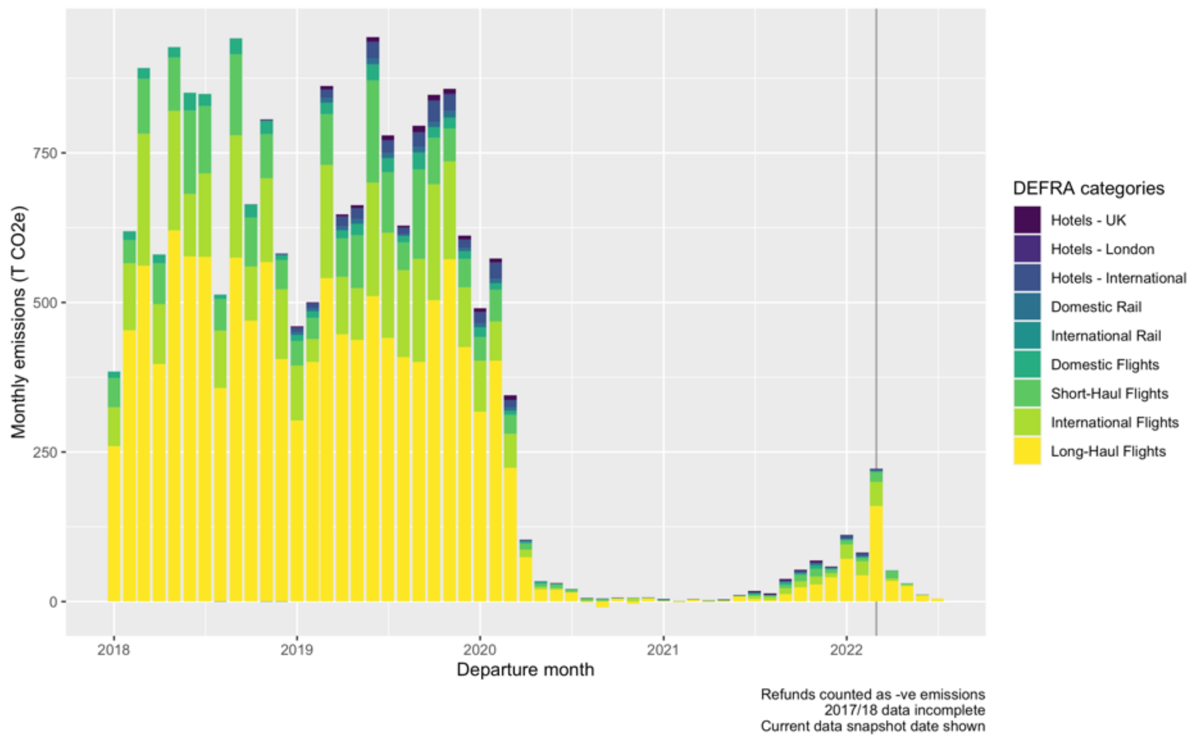

Figure 4: Total T CO_2e due to different travel modes by month

Figure 4 repeats this analysis but shows the emissions totals per month. This makes clear the impact of COVID19 travel restrictions on travel and thus the radical reduction in business travel emissions that ensued. It is also clear that emissions are re-bounding as business travel recommences.

4.1.2 Emissions by coded purpose

Figure 5 repeats the academic year analysis but shows emission by coded purpose. Notwithstanding the note of caution regarding the coding of purpose, this plot makes clear the dominance of ‘Conference’ trips in our emissions profile as might be expected from Table 6 above.

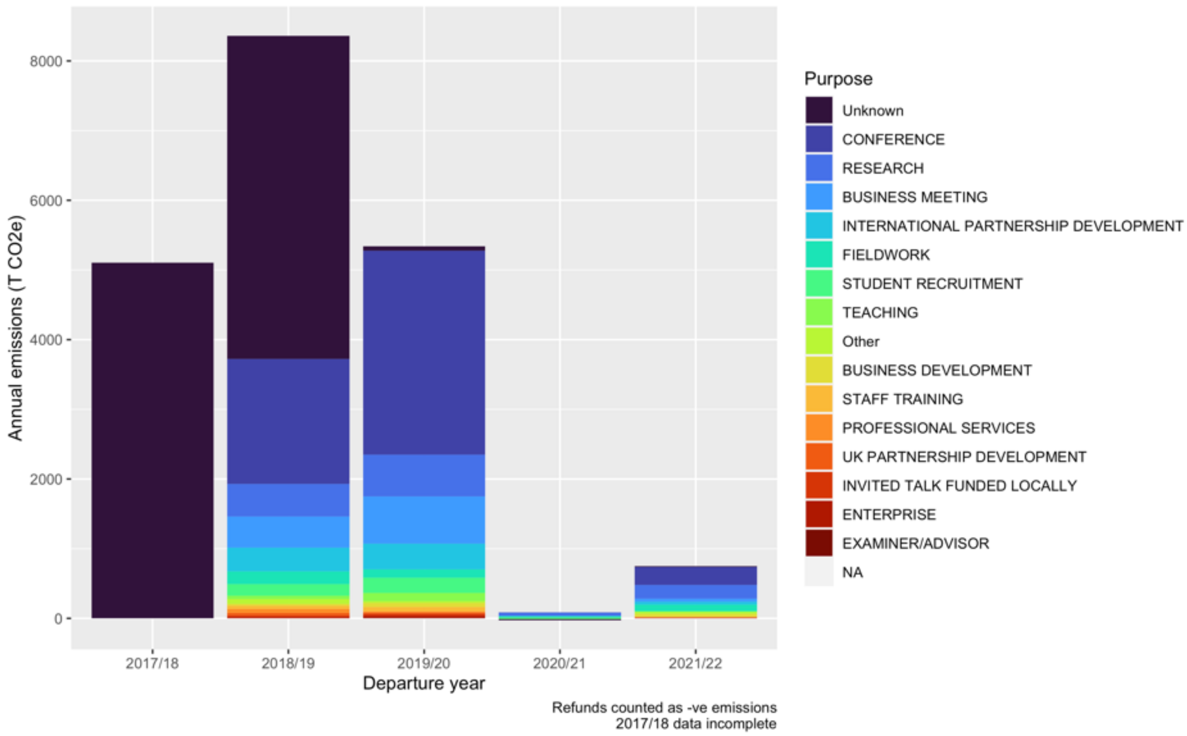

Figure 5: Total T CO2e due to different purposes by year

Table 10 shows the proportion of emissions attributed to each purpose. This also clearly shows the pre-COVD dominance of 'Conference', its disappearance in 2020/21 and its re-emergence in 2021/22 to date.

Table 10: Percent of emissions in each year by purpose (2020/21 will not sum to 100% due to -ve values due to cancellations)

Reason	2017/18	2018/19	2019/20	2020/21	2021/22 to date
Unknown	100.0	55.5	1.2	-29.4	0.9
CONFERENCE	0.0	21.5	54.8	7.1	35.0
RESEARCH		5.6	11.2	74.2	26.2
BUSINESS MEETING	0.0	5.3	12.7	8.9	6.1
INTERNATIONAL PARTNERSHIP DEVELOPMENT		4.1	6.9	5.0	5.1
FIELDWORK		2.2	2.2	34.8	12.6
STUDENT RECRUITMENT	0.0	2.0	4.1	-13.8	1.3
Other		0.8	0.5		3.4
PROFESSIONAL SERVICES		0.7	0.4	0.8	0.2
TEACHING		0.6	2.1	6.3	0.3
STAFF TRAINING		0.5	1.1	0.5	1.2
BUSINESS DEVELOPMENT		0.4	1.1	0.9	5.8
UK PARTNERSHIP DEVELOPMENT		0.4	0.3		0.3
INVITED TALK FUNDED LOCALLY		0.3	0.5	0.5	0.9
ENTERPRISE		0.2	0.6	4.1	0.6
		0.0			
EXAMINER/ADVISOR			0.1		0.1

4.1.3 Emissions by class of travel

Figure 6 shows the percent of total academic year emissions that derive from different modes of travel (or hotels) and travel class.

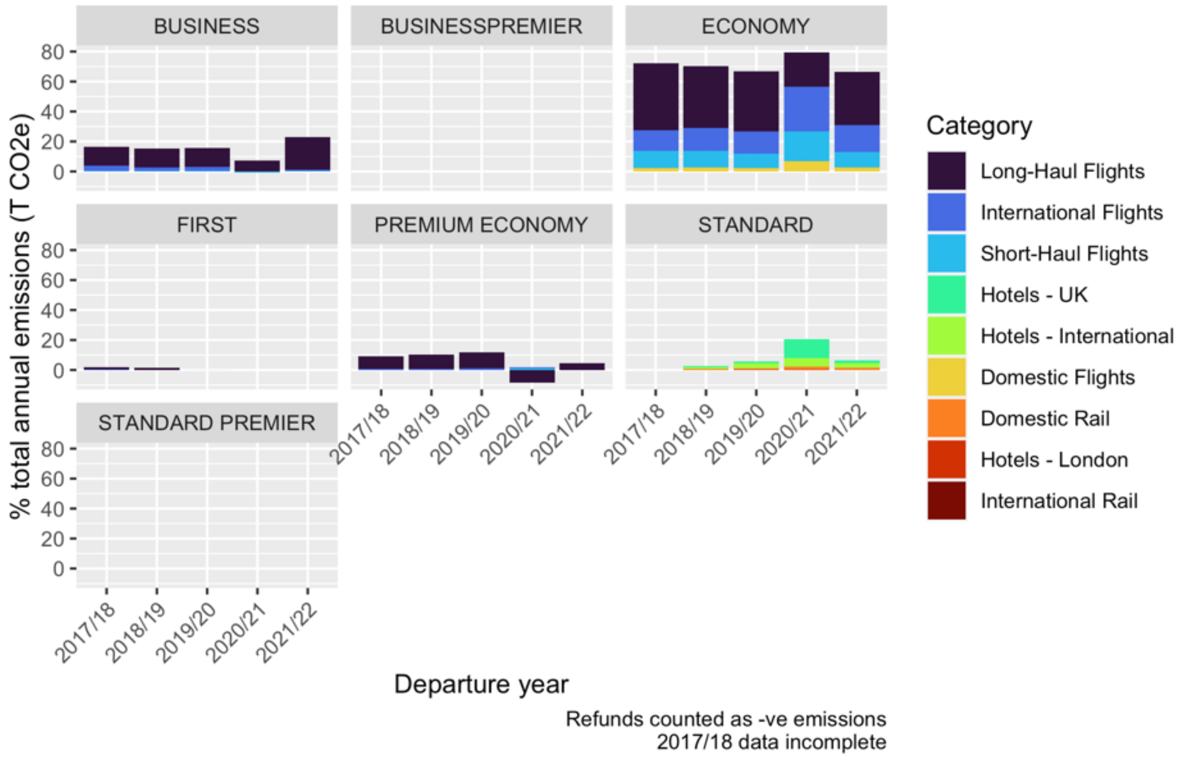

Figure 6: % of total annual T CO_2e by class and mode per year (negative values indicate cancellations that may have carried forward across academic years)

Table 11: Percent of emissions in each year due to Business Class travel

Year	% emissions due to Business Class Travel
2017/18	16.6
2018/19	15.4
2019/20	15.8
2020/21	6.5
2021/22 to date	22.9

The full results can be found in Table 19 in the Appendices but in summary, with the exception of 2020/21 around 15-18% of annual emissions were from Business Class flights (Table 14). This included some Business Class Short Haul flights (see Table 19). For 2021/2022 to date the figure is 23%.

Were all of these Business Class flights to have been Economy flights then the annual emissions totals would have been reduced by ~10% (see Table 12).

Table 12: Percent of emissions reduction in each year if Business Class flight had been Economy.

Year	Original emissions (T CO_2e)	Reduced emissions with all Business Class flights as Economy (TCO_2e)	% reduction
2017/18	5,101	4,551	-10.8
2018/19	8,362	7,523	-10.0
2019/20	5,340	4,789	-10.3
2020/21	58	56	-4.5
2021/22 to date	747	636	-14.9

4.2 Per traveller trends

This section disaggregates the analysis to the anonymised Traveller ID described in Section 2. As previously noted, this could result in one person's travel being split over one or more

IDs due to name changes over time. It would only be possible to correct this via extensive data checking.

It should also be noted that the following values apply to travellers and not all staff since not all staff travel.

4.2.1 Trips per traveller

As background to subsequent sections, Figure 7 shows the number of trips per traveller ID over the time period against the log of their annual rank in terms of number of trips. Log(Rank) is used to make the part of the distribution with higher number of trips per traveller clear[6].

The plot shows that in 'normal' years the distribution of frequency of travel is extremely skewed. Some travellers make over 80 trips a year but the median was just 1 in each year except 2019/20 (median = 2). Travel was clearly less frequent in 2020/21[7] but there is already evidence that travel is rebounding in 2021/22 with high frequency travellers re-emerging.

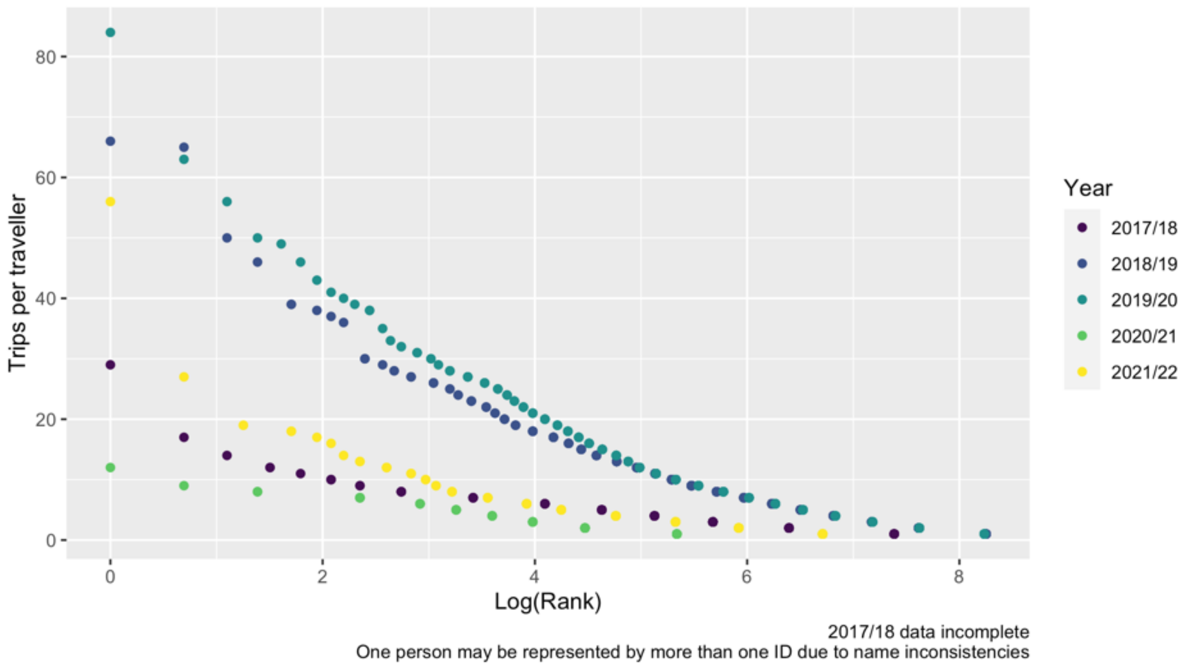

Figure 7: Number of trips per Traveller ID by academic year by log(annual rank).

4.2.2 Flights per traveller

Given the current dominance of flights as a source of business travel emissions, Figure 8 shows the distribution of the number of flights per traveller. This shows that some travellers make over 60 International Flights per year and over 40 Short-Haul Flights. Both Long-Haul (up to 30 flights per year) and Domestic Flights (up to 25 flights) are less frequent. In contrast, the median number of flights per traveller was 2 in all years reflecting the median of 1 trip (see above).

[6] A plot using Rank as a linear scale is shown in Section 9.1 Trips per traveller (linear scale) below for comparison.

[7] 2017/18 data is incomplete

Given that International Flights are broadly between non-UK international destinations they are likely to represent either a sequence of flights within a short/long-haul trip ('trip-chaining') or a long haul trip that happens to start/finish outside the UK, perhaps due to connections.

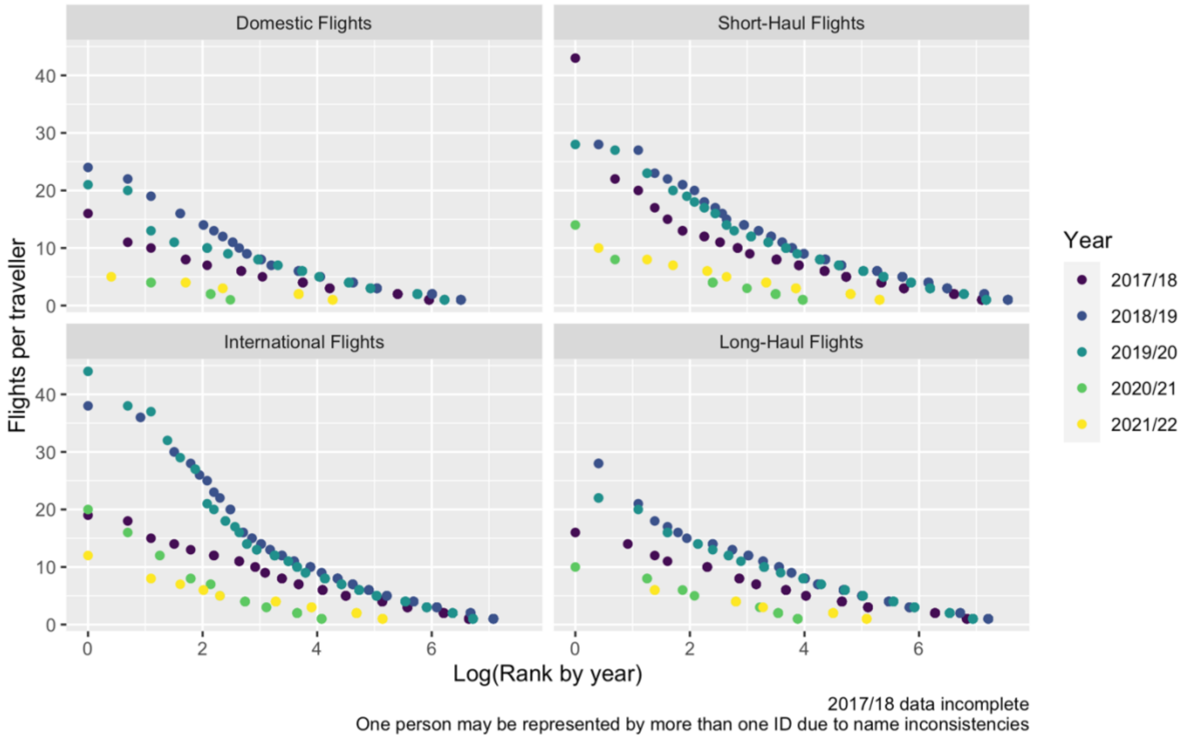

Figure 8: Number of flights per Traveller ID by type and academic year against log(rank).

The uneven distribution of flying is confirmed by Table 13 which shows the gini coefficient for the frequency of each flight type in each year calculated over all travellers[8]. This coefficient is generally used to assess the inequality of income distributions within countries or regions where 0 represents complete equality and 1 represents complete inequality (1 person receives all the income)[9]. The table shows that International Flights are generally more unevenly distributed (higher gini coefficient) than Long-Haul Flights which in turn are more unevenly distributed that Short-Haul or Domestic Flights. Given the relative costs and nature of Long-Haul and International flights (see above) this is not unexpected.

Table 13: Gini coefficient for count of flights by type (calculated over all travellers)

Flight type	2017/18	2018/19	2019/20	2020/21	2021/22
Domestic Flights	0.21	0.28	0.29	0.20	0.17
Short-Haul Flights	0.28	0.33	0.34	0.32	0.24
International Flights	0.33	0.39	0.40	0.43	0.26
Long-Haul Flights	0.23	0.30	0.33	0.34	0.19

4.2.3 Emissions per traveller

With the unequal distribution of flights in mind, this section focuses on emissions per traveller by aggregating emissions to the anonymised ID described in Section 2. As

[8] If calculated over all staff, including those who do not travel, the gini coefficient would be even larger due to the inclusion of zero-emissions non-travellers.

[9] See e.g. https://ourworldindata.org/income-inequality - the UK's income gini is currently ~ 0.37

previously noted, this could result in one person's emissions being split over one or more IDs due to name changes over time.

Figure 9 shows the emissions per traveller ID for each academic year against log(rankByYear). Thus the traveller with the highest emissions (over 100 T CO_2e in the case of 2018/19) will have an x value of zero on the plot. The plot clearly shows that the distribution of emissions per traveller are even more skewed than the distribution of trips or flights due to the scale of flight emissions and the uneven distributions of flight frequencies (see above). The plot shows that a relatively small number of traveller IDs are responsible for a large proportion of emissions and there is a long tail of travellers who contribute relatively little to these Business Travel emissions.

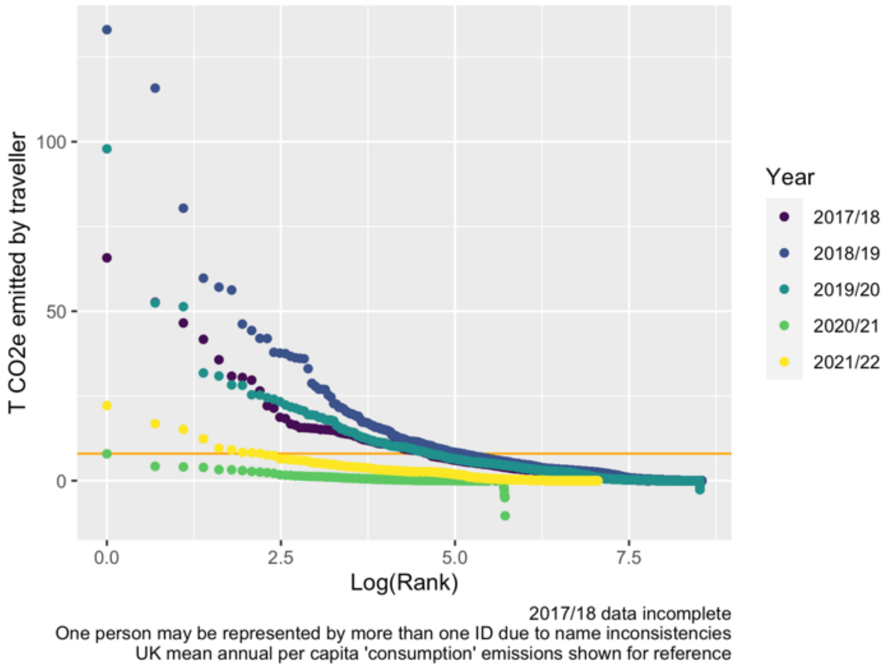

Figure 9: T CO_2e per Traveller ID by academic year by log(rank).Horizontal reference line is the mean per capita annual 'consumption' emissions (Source: ONS(ONS 2019))

Disaggregating the emissions to their constituent categories (Figure 10) confirms the dominance of Long Haul and International Flights in our Business Travel emissions profile largely irrespective of year. As above, a relatively small number of travellers (those with a rank close to 1 and so a log(rank) of close to 0) have much higher annual Business Travel emissions from International and Long-Haul Flights than the majority of travellers.

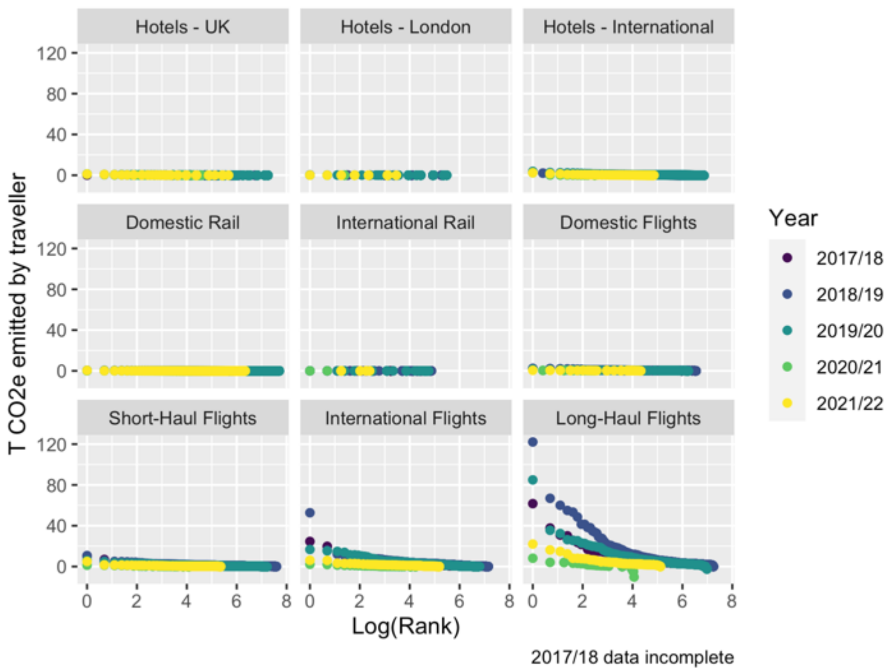

Figure 10: T CO_2e per travel model by Traveller ID by academic year by log(rank)

The uneven distribution of emissions across travellers is also reflected in the gini coefficient calculated for each academic year (Table 14). As can be seen in 'normal' years the coefficient is roughly 0.7 to 0.8 demonstrating extreme inequality. The 'impossible' > 1 value for 2020/21 is caused by negative emissions carried forward from cancellations/refunds.

Table 14: T CO_2e per traveller ID and gini coefficient by academic year (gini > 1 in 2020/21 indicates -ve emissions from cancellations that may have carried forward across academic years)

Year	Gini[10]	Number of unique traveller IDs ('Travellers')	Mean T CO2e per traveller	Median T CO2e per traveller	Max T CO2e per traveller
2017/18	0.61	2,400	2.13	0.98	65.74
2018/19	0.75	5,144	1.63	0.33	133.04
2019/20	0.81	4,999	1.07	0.10	97.90
2020/21	1.82	300	0.19	0.05	7.93
2021/22 (to date)	0.81	1,155	0.65	0.04	22.15

This inequality is further illustrated by Table 15 which shows the percent of annual Business Travel emissions which are due to different proportions of travellers. The results show that in most 'normal' years ~2% of travellers are responsible for 25% of business travel emissions and ~6% of travellers are responsible for 50% of emissions. This would suggest that targeting a communications campaign at those travellers would address 25% - 50% of emissions. However, this is still a relatively large number of travellers in a 'normal' year - as the row for 2018/19 shows (390 travellers). Interestingly the table also shows some support for the Pareto 80:20 principle[11] - roughly 80% of emissions are due to 20% of travellers in 'normal' years.

[10] As before, calculated over all travellers not all staff

[11] https://en.wikipedia.org/wiki/Pareto_principle

Table 15: % of total annual emissions due to a given % of travellers (2017/18 data is incomplete))

Year	Total travellers	N travellers responsible for 25%	% travellers responsible for 25%	N travellers responsible for 50%	% travellers responsible for 50%	N travellers responsible for 80%	% travellers responsible for 80%
2017/18	2,400	83	3.5	312	13.0	839	35.0
2018/19	5,144	86	1.7	390	7.6	1,164	22.6
2019/20	4,999	79	1.6	299	6.0	807	16.1
2020/21	300	2	0.7	6	2.0	15	5.0
2021/22 to date	1,155	21	1.8	74	6.4	174	15.1

Splitting the emissions gini by mode of travel (Figure 11) shows that in 'normal' years International Flights were the most unequally distributed followed by Domestic Rail and Short/Long Haul Flights. Domestic Flights were more equally distributed still (lower gini) and International Rail the most equally distributed. The Gini for Long Haul flights in 2020/21 is not plotted as it is greater than 1 for the reasons discussed above.

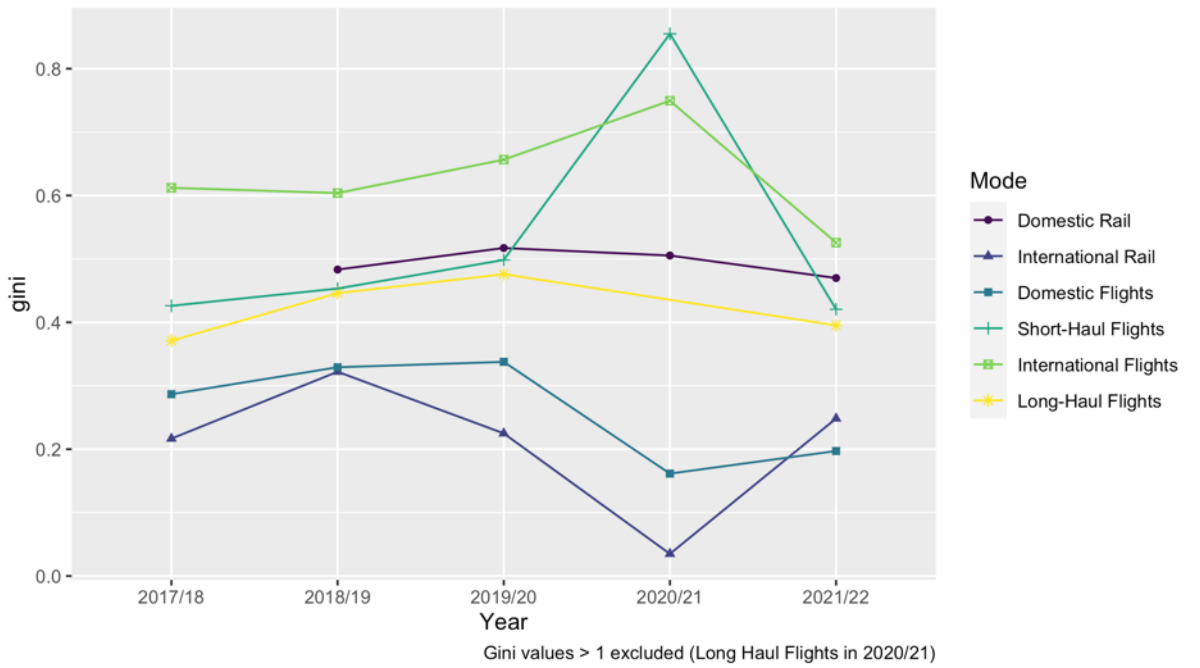

Figure 11: Emissions gini by mode of travel (gini > 1 excluded, calculated over all travellers not all staff).

Finally, Figure 12 shows the 70 travellers who comprised the top 20 travellers in each year ranked by emissions. Connecting lines join the same traveller over time. Although there is considerable churn in the travellers who rank in the top 20 each year (dots without lines), many feature in several years and a small number feature in the top 20 in all years. A number of these have also emerged amongst the top travellers to date in 2021/22.

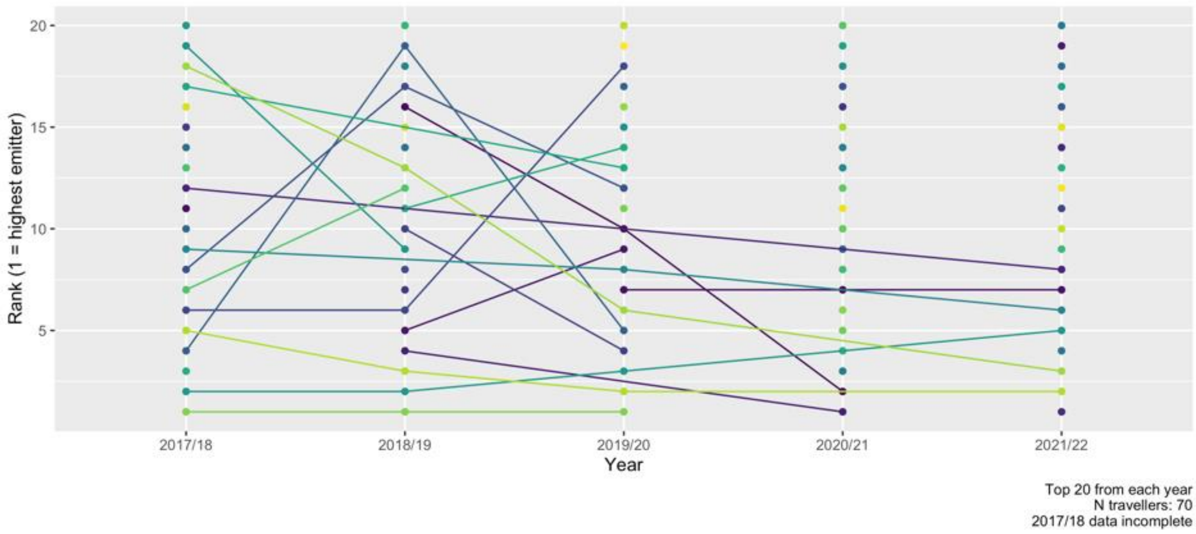

Figure 12: Parallel co-ordinate plot showing the top 20 travellers in each year ranked by emissions (connecting lines indicate the same traveller ID)

5 Discussion

Overall, the results of this analysis are relatively unsurprising. Given the substantial differences in per km emissions factors for different modes of travel (see Figure 3) and the scale of international travel for business purposes, it was always likely that flights, and especially international or long-haul flights would comprise the majority of emissions in this data.

The reduction in emissions due to pandemic-induced travel bans is also unsurprising although some, presumably essential, business travel continued as shown by the rise of 'research' and 'fieldwork' as coded purposes in 2020/21 (Table 6). Emissions in 2020/21 were less than 1% of those in 2018/19 but there are signs that business travel is rebounding (Figure 4) although not yet to pre-pandemic levels.

Bookings or Trips coded as 'Conference' were historically responsible for the largest share of emissions and show signs of returning to this share in the current year (Figure 5, Table 10).

Perhaps more surprising is that up to 20% of annual Business Travel emissions in this data are due to Business Class flights and this figure is 23% for 2020/21 to date (Figure 6). As Table 12 indicates, simply switching these to Economy class would have resulted in an overall reduction of ~10% in Business Travel emissions in each year

The persistent use of Domestic and Short Haul Flights (Figure 8) implies that some emissions reduction progress could potentially be made by substituting Domestic Rail for Domestic Flights and International Rail for Short-Haul Flights (Figure 3) where feasible. However, this would only address the ~12% of emissions which are due to these two forms of flights (in a 'normal' year) and it must be recognised that the majority of emissions are due to International and Long-Haul flights.

Turning to the per traveller results, the analysis shows that the number of trips and flights are very unequally distributed (Table 13) with a relatively small proportion of travellers, and thus an even smaller proportion of all staff, responsible for a large share of travel (Figure 7, Figure 8).

The extent to which emissions are therefore concentrated in a small proportion of travellers highlights the dominant contribution of 'frequent flyers' to business travel emissions. As

Table 15 shows, a mere 6% of travellers are generally responsible for about 50% of annual Business Travel emissions and around 20% are responsible for 80% with the single highest emitter responsible for over 95 T CO2e in 'normal' years (Table 14). Inequality in both counts of trips and emissions are clear and confirmed by gini coefficients (Table 14, Figure 11). If mobility and career opportunity/progression currently equate (Higham, Hopkins, and Orchiston 2019) then the inequality of long distance travel may need to be addressed.

Frequent flyers come to the fore when the top 20 emitters in each year are compared. These comprise 70 travellers over the 5 years of data with a number of travellers featuring in the top 10 in each year (Figure 12).

6 Low carbon options

With these patterns as background it is worth comparing emissions for low carbon and 'normal' options for Business Travel scenarios to understand how different choices could impact our Business Travel emissions. Table 16, Table 17 and Table 18 use the emissions factors described in Section 3.4.8 (Emissions factors) to show the potential emissions from various travel options for a business trip to Edinburgh, Berlin or Singapore. The Edinburgh and Berlin scenarios are taken from (Ben Anderson 2021b) but the Singapore example has been newly calculated to provide a scenario relevant to travel to the University's Malaysian Campus.

The scenario for a 4 hour meeting in Edinburgh includes a UK domestic return flight as an option and assumes that driving or using rail would require an overnight stay which has very low emissions compared to any mode of travel. As we can see emissions from fossil-fuelled driving and flying are roughly equivalent and an order of magnitude higher than either coach or train travel.

For this scenario, the air travel/petrol car options produce up to 640 times more CO_2e than the videoconference. The train option on the other hand is a 'mere' 100 times more emitting than a videoconference.

Table 16: Round trip to Edinburgh (Kg CO_2e) vs 'virtual' meeting

Round trip to Edinburgh for 4 hour meeting (kg CO_2e)			
1416 km	*Kg CO_2e*		
Car (executive, diesel)	306		
Car (executive, petrol)	405		
Car (executive, EV)	91		
Coach	47		
Train (national)	61		
Domestic flight	386		Economy
Hotel stay (1 person, 1 night)	14		UK outside London (14 Kg CO_2e/hotel night, BEIS 2021)
	1 person, 4 hours		
Videoconf (with video)	0.63		
Videoconf (no video)	0.03		

The 4-hour meeting in Berlin scenario also includes a 1-night stay in a hotel in Germany. As for Edinburgh, emissions from a hotel stay are insignificant compared to any mode of transport except for ‘Train (international)’ which has extremely low emissions factors (see Figure 2).

As a result, the emissions footprint of a round trip to Berlin by train is a fraction of the emissions of flying (3% of an economy flight) or driving while *using a video-conference and not travelling would produce 0.16% of the emissions of an economy flight*.

Table 17: Round trip to Berlin (Kg CO_2e) vs ‘virtual’ meeting

Round trip to Berlin for 4 hour meeting (kg CO_2e)			
2422 km	*Kg CO_2e*		
Car (executive, diesel)	524		(ignores ferry/Eurotunnel)
Car (executive, petrol)	693		(ignores ferry/Eurotunnel)
Car (executive, EV)	156		(ignores ferry/Eurotunnel)
Coach	81		(ignores ferry/Eurotunnel)
Train (international)	13		Split trip: Soton-> London (UK rate) + London-> Berlin (Eurostar rate)
Short haul flight	406		Economy
Short haul flight	609		Business
Hotel stay (1 person, 1 night)	17		Germany (17 Kg CO_2e/hotel night, BEIS 2021)
	1 person, 4 hours		
Videoconf (with video)	0.63		
Videoconf (no video)	0.03		

Finally, the Singapore scenario allows for a 5-day trip (3 nights hotel stay) and Long-Haul flights with 16 hours of meetings. For simplicity local transport to/from the airport is excluded. *In this case the use of online participation produces 0.07% of the emissions of an economy long haul flight*.

Table 18: Round trip to Singapore (Kg CO_2e) vs ‘virtual’ meeting

Round trip to Singapore for 16 hours of meetings over 3 days (kg CO_2e for flights and hotels only)			
21,746 km	*Kg CO_2e*		
Long-haul flight	3,567		Economy Class
Long-haul flight	10,346		Business Class
Hotel stay (1 person, 3 nights)	249		Malaysia (83 Kg CO_2e/hotel night, BEIS 2021)
	1 person, 16 hours		
Videoconf (with video)	2.5		
Videoconf (no video)	0.1		

7 Conclusions

The current Finance Policy 17 (Travel) states that “Travel activity should only be considered necessary when all other alternative means of conducting business have been assessed and discounted.” This aligns with the generally accepted decision flow:

1. **Avoid** (do you really need to travel?)

2. **Reduce** (do you need to go as often/far/can you combine trips?)
3. **Take low emissions** options (if travel is unavoidable, take options which minimise emissions – this will be particularly important if we choose to offset future unavoidable business travel emissions)

This report cannot determine whether this decision flow is currently being used as stringently as it could. Given successful experiences with alternative 'virtual' means of conducting business collaboration during COVID19 restrictions, there may well be scope to reduce the volume of travel that is considered 'necessary'.

From the perspective of the Strategic Plan – Sustainability, the analysis presented here leads to a number of insights and recommendations:

1. It confirms the current two-pronged Goal 3 strategy:
   a) communicating the nature and scale of our historical (and rebounding) business travel emissions, especially with respect to flights, to all current and potential travellers; providing information on the relative emissions footprints of different travel modes (see e.g. Section 6 (Low carbon options)) and providing information on credible options. While it seems unlikely that the simple provision of information can effect the scale of change required (Hoolohan et al. 2021), it is also possible that novel visualisations may start to engage travellers more meaningfully in reflecting on their need for travel (avoid/reduce) and the methods (low emissions options) of doing so (Biørn-Hansen et al. 2021).
   b) communicating specifically to the small number of 'frequent' and 'long distance' travellers who are responsible for up to 50% of Business Travel emissions as captured by this data.
2. It suggests that there would be value in modelling the potential emissions reduction to be gained from a range of policy options such as: a substitution of all Domestic Flights for Rail or a substitution of some proportion of 'Conference' trips' long haul and international flights for online attendance. This work is currently being taken forward by an ECCD MSc[12];
3. It suggests that estimates of potential off-setting costs of unavoidable business travel emissions should be developed so that travellers and projects can understand the potential future costs of business travel should this approach be required;
4. It suggests that a more detailed and robust understanding of the value staff place on business travel and the means of doing so should be developed, based on initial work carried out in 2020 (Ellie Harrison 2020). This work is currently being taken forward by a FEPS MSc[13].

As was noted in our previous Business Travel Scenarios report (Ben Anderson 2021b), if we set aside the other values/efficacies of business travel, from a purely emissions and time-value perspective the imperative to use videoconferencing as a functional alternative to domestic, short haul and especially long-distance travel is clear (c.f. Section 6 (Low carbon options)). There is therefore a strong argument for 'virtual' participation at 'Conferences' and 'Business Meetings' by default, especially for those for whom the value of in-person attendance is relatively low and for 'destinations' outside Europe where long-haul flights are largely the only practical solution[14]. This could start to address the ~60% of emissions that stemmed from these purposes in 2019/20 (Table 10).

This recommendation aligns with Harrison's pre-COVID pandemic staff interview results which identified long-haul flights and 'Conferences' as the priority for reduction target but

[12] Supervisor: Dr Ben Anderson

[13] Supervisor: Dr Ian Williams

[14] But see (Tyers 2019)

which also noted that “Even amongst environmentally conscious academics, participants believed that hosting conferences exclusively online could be problematic for career prospects” (Ellie Harrison 2020, 23). There is clearly a need for further research to establish the scale of this risk so that it can be aligned with the more equitable distribution of flight-based international travel (c.f. Section 4.2.3).

However, simply switching off long distance and international (air) travel is unlikely to be possible without radically reconfiguring an institutional culture where “aeromobility has become deeply embedded in the institutional culture of HE, with individual career progression and institutional standing linked to international mobility.” (Hoolohan et al. 2021). Lessons from research on academic mobilities undertaken in intrinsically ‘geographically remote’ locations such as New Zealand may offer insights of value in this respect (Hopkins et al. 2016; Higham, Hopkins, and Orchiston 2019).

For the travel that is considered unavoidable, more stringent travel policy settings to ensure low emissions options are taken could include:

1. Specifying coach/train for any within-UK travel as the default – although clearly this relies on easy access to the network at the location travelled to/from;
2. Specifying that travel to and around Europe should be by train only (whether the Eurostar emissions factors hold true across all European train networks or not) noting Harrison’s interviewee’s point that cost and time constraints were the largest barriers to low-carbon train transport (Ellie Harrison 2020). It is acknowledged that this may make attendance at some conferences or events initially difficult, but we would expect ‘rail connected’ venues to become the norm as expectations shift;
3. Setting more restrictive conditions under which Business Class flights can be used, if at all, based on relative emissions factors (Figure 2) and the analysis presented in this report (Table 12).

Finally, qualitative work carried out at the University in 2020 (Ellie Harrison 2020) provides a much longer and more comprehensive set of suggestions which would benefit from review. These are included in Appendix 9.4 (Summary of policy proposals (Ellie Harrison 2020)) below for reference.

8 References

Arsenault, Julien, Julie Talbot, Lama Boustani, Rodolphe Gonzalès, and Kevin Manaugh. 2019. ‘The Environmental Footprint of Academic and Student Mobility in a Large Research-Oriented University’. *Environmental Research Letters* 14 (9): 095001.

Ben Anderson. 2021a. ‘University of Southampton Sustainability Strategy: Overall Emissions Reporting: A Methodology and Initial Estimates (V2)’. SIG Discussion Paper Final v2.0. Southampton, UK: University of Southampton. https://web.yammer.com/main/threads/eyJfdHlwZSI6IlRocmVhZCIsImlkIjoiMTQwNTU5MjAwNTE1Njg2NCJ9.

———. 2021b. ‘University of Southampton (Virtual) Travel Scenarios: Emissions Implications’. SIG Discussion Paper v4. https://web.yammer.com/main/threads/eyJfdHlwZSI6IlRocmVhZCIsImlkIjoiMTM0NjEzOTA3NzE4MTQ0MCJ9.

Biørn-Hansen, Aksel, Daniel Pargman, Elina Eriksson, Mario Romero, Jarmo Laaksolahti, and Markus Robért. 2021. ‘Exploring the Problem Space of CO2 Emission Reductions from Academic Flying'. *Sustainability* 13 (21): 12206. https://doi.org/10.3390/su132112206.

Ellie Harrison. 2020. 'Business Travel in Higher Education: Opportunities for Carbon Reduction at the University of Southampton'. MSc Research Project, Southampton, UK: University of Southampton.

Higham, James E. S., Debbie Hopkins, and Caroline Orchiston. 2019. 'The Work-Sociology of Academic Aeromobility at Remote Institutions'. *Mobilities* 14 (5): 612–31. https://doi.org/10.1080/17450101.2019.1589727.

Hoolohan, Claire, Carly McLachlan, Christopher Jones, Alice Larkin, Christina Birch, Sarah Mander, and John Broderick. 2021. 'Responding to the Climate Emergency: How Are UK Universities Establishing Sustainable Workplace Routines for Flying and Food?' *Climate Policy* 0 (0): 1–15. https://doi.org/10.1080/14693062.2021.1881426.

Hopkins, Debbie, James Higham, Sarah Tapp, and Tara Duncan. 2016. 'Academic Mobility in the Anthropocene Era: A Comparative Study of University Policy at Three New Zealand Institutions'. *Journal of Sustainable Tourism* 24 (3): 376–97. https://doi.org/10.1080/09669582.2015.1071383.

Obringer, Renee, Benjamin Rachunok, Debora Maia-Silva, Maryam Arbabzadeh, Roshanak Nateghi, and Kaveh Madani. 2021. 'The Overlooked Environmental Footprint of Increasing Internet Use'. *Resources, Conservation and Recycling* 167 (April): 105389. https://doi.org/10.1016/j.resconrec.2020.105389.

ONS. 2019. 'Net Zero and the Different Official Measures of the UK's Greenhouse Gas Emissions - Office for National Statistics'. 2019. https://www.ons.gov.uk/economy/environmentalaccounts/articles/netzeroandthedifferentofficialmeasuresoftheuksgreenhousegasemissions/2019-07-24#the-uks-carbon-footprint.

Tyers, Roger. 2019. 'Southampton to Shanghai by Train – One Climate Change Researcher's Quest to Avoid Flying'. The Conversation. 2019. http://theconversation.com/southampton-to-shanghai-by-train-one-climate-change-researchers-quest-to-avoid-flying-120015.

9 Appendices

9.1 Trips per traveller (linear scale)

For comparison with Figure 7.

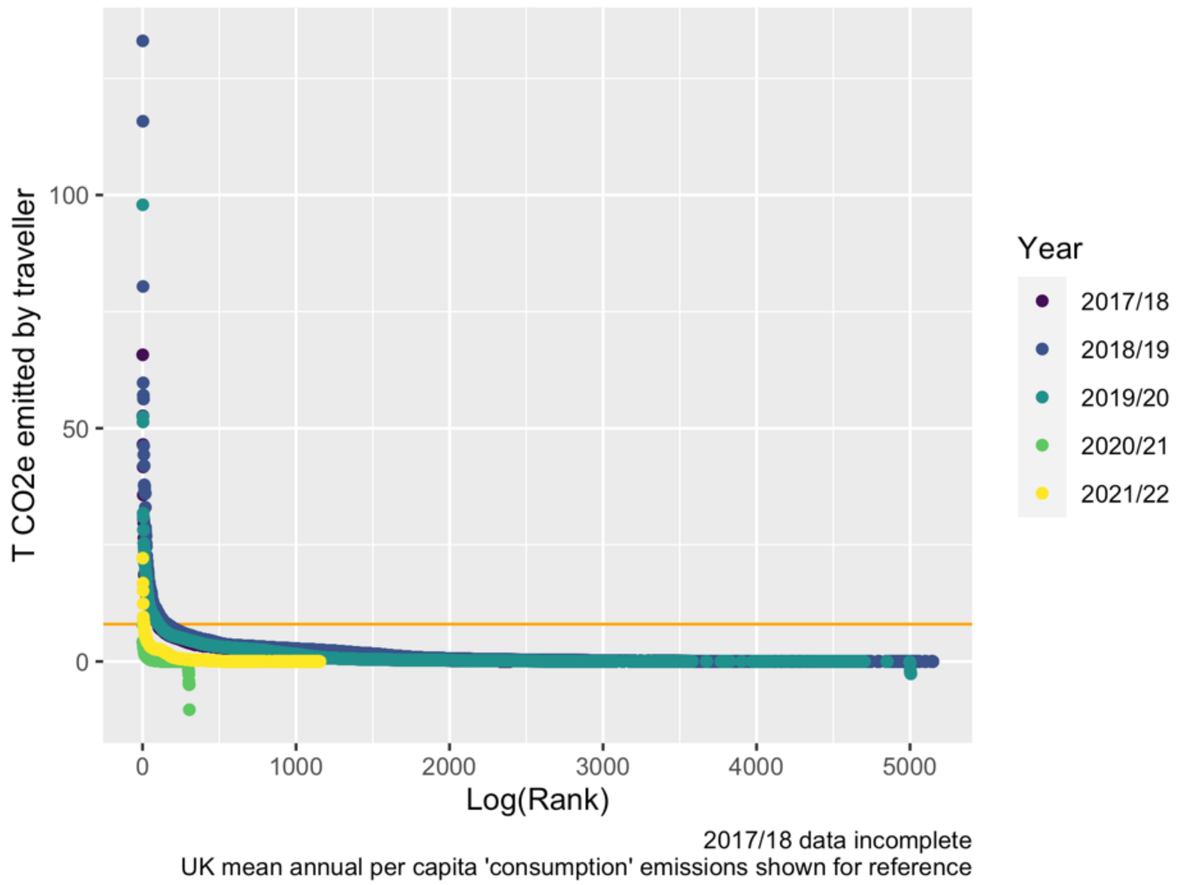

Figure 13: Number of trips per Traveller ID by academic year by annual rank

9.2 Emissions by mode and class

Table 19: % of total emissions by class, mode and academic year (negative values indicate cancellations that may have carried forward across academic years)

Travel Class	Travel mode	2017/18	2018/19	2019/20	2020/21	2021/22 to date
BUSINESS	Domestic Flights		0.0	0.0		
BUSINESS	Short-Haul Flights	0.3	0.3	0.2	-0.9	0.5
BUSINESS	International Flights	3.6	2.4	3.0		0.7
BUSINESS	Long-Haul Flights	12.7	12.7	12.6	7.4	21.7
BUSINESSPREMIER	International Rail		0.0	0.0		
ECONOMY	Domestic Flights	2.4	2.5	2.4	6.7	2.6
ECONOMY	Short-Haul Flights	11.2	11.4	9.6	20.0	10.3
ECONOMY	International Flights	13.9	15.0	15.0	29.9	18.1
ECONOMY	Long-Haul Flights	44.7	41.5	39.8	22.8	35.2
FIRST	Domestic Rail		0.0	0.0		0.0
FIRST	Short-Haul Flights	0.0		0.0		
FIRST	International Flights	0.2	0.0	0.0		
FIRST	Long-Haul Flights	1.8	1.4	0.0		
PREMIUM ECONOMY	Short-Haul Flights	0.0	0.0	0.1	1.3	
PREMIUM ECONOMY	International Flights	0.8	0.6	0.8	0.6	0.1

PREMIUM ECONOMY	Long-Haul Flights	8.4	9.7	10.9	-8.5	4.4
STANDARD	Hotels - UK	0.0	0.4	1.2	12.9	1.9
STANDARD	Hotels - London		0.1	0.1	0.3	0.1
STANDARD	Hotels - International		1.4	3.2	5.4	3.0
STANDARD	Domestic Rail		0.6	1.1	2.1	1.3
STANDARD	International Rail	0.0	0.0	0.0	0.0	0.0
STANDARD PREMIER	International Rail	0.0	0.0	0.0	0.0	

9.3 Schools

The following table shows the total business travel emissions per school over time.

Notes:

- School was not coded in a significant proportion of pre 2019/20 bookings;
- Coding/naming inconsistencies over time are apparent and no attempt has been made to clean these 'errors';
- Making comparisons between Schools (or Faculties) without accounting for FTE (staff numbers) and the nature of their core activities is not advisable

Table 20: Total emissions by school and academic year (alphabetically ordered, beware duplicate names)

School	2017/18	2018/19	2019/20	2020/21	2021/22 to date
Unknown	*100.0*	*55.5*	*1.2*	*-29.4*	*0.9*
ADVANCEMENT AND ENGAGEMENT		0.0	0.0	0.1	0.2
AERO ASTRO COMP ENG		0.4	1.6	0.0	2.9
AERONAUTICS ASTRONAUTICS COMPUTATIONAL ENGINEERING		0.0			
ARCHAEOLOGY		0.3	1.5	6.0	0.8
ART & HUMANITIES		0.0			
BIOLOGICAL SCIENCES	0.0	0.8	2.2	10.5	2.0
BIOMEDICAL RESEARCH FACILITY		0.0	0.0		1.2
BUSINES LAW AND ART CENTRAL		0.1	0.2		0.0
BUSINESS		0.0			
BUSINESS LAW AND ART CENTRAL		0.0	0.0		
BUSINESS MEETING		0.0			
BUSINESS SCHOOL		0.0			
CANCER SCIENCE		0.0			
CANCER SCIENCES		1.8	3.9	0.5	4.0
CENTRAL - CAPITAL			0.0		
CENTRAL - GENERAL		0.0	0.1		0.0
CENTRAL HEALTH SCIENCES		0.0			
CENTRE FOR INTL STUDENTS		0.0	0.0		0.1
CHEMISTRY		1.0	3.1	2.7	2.4
CIVIL MARITIME ENV ENG SCIENCE		0.4	1.8	2.4	1.4
CIVIL MARTITIME ENV ENG SCIENCE		0.1			
CIVIL, MARITIME AND ENVIRONMENTAL ENGINEERING					0.0
CLINICAL AND EXPERIMENTAL SCIENCES		0.1			
CLINICAL EXP SCIENCES		0.5	1.3	-7.0	4.8
CLINICAL EXPERIMENTAL SCIENCES		0.1			
CONFERENCE		0.0	0.0		
COO - CENTRAL		0.0	0.0		0.1
COPORATE SERVICES		0.0			
CORPORATE SERVICES		0.4	0.5		1.1
DEPARTMENT OF PHYSICS AND ASTRONOMY		0.0			

DEVELOP ALUMNI RELATIONS		0.0	0.1		0.0
ELCTR COMP SCIENCES		2.4	8.7	7.4	3.8
ELCTR/COMP SCIENCES		0.0			
ELEC COMP SCIENCES		0.0			
ELECTR COMP SCIENCE		0.1			
ELECTR COMP SCIENCES		0.4	0.0		
ELECTRONICS AND COMPUTER SCIENCE		-0.0			
ELECTRONICS AND COMPUTER*SCIENCE		0.0			
ENGAGEMENT AND ADVANCEMENT		0.0			
ENGINEERING		0.0			
ENGINEERING ENVIRONMENT		0.0	0.0		
ENGINEERING AND ENVIRONMENT		0.0			
ENGINEERING AND PHYSICAL SCIENCE		0.0			
ENGINEERING AND THE ENVIRONMENT		0.0			
ENGINEERING ENVIRONMENT		1.1	2.4	3.4	7.1
ENGINEERING SCIENCE			0.0		
ENGINEERING SCIENCES		4.4	5.0	2.2	3.1
ENGINEERING& ENVIRONMENT		0.0	0.0		
ENGINEERING? ENVIRONMENT		0.0			
ENGINEERINGÃ,Â ENVIRONMENT		0.0			
ENGINEERINGÃ,Â ENVIRONMENT			0.0		
ENGINERING ENVOINMENT		0.0			
ENGINERRING SCIENCES		0.0			
ENGLISH		0.0	0.0	0.4	0.0
ENINGEERING SCIENCES		0.0			
ESTATES AND FACILITIES		0.0	0.0	0.0	0.0
FACULTY CENTRAL - FELS		0.0			
FACULTY CENTRAL - FEPS		0.1			
FACULTY CENTRAL - FSS		0.1			
FACULTY OF BUSINESS LAW AND ART - CENTRAL		0.1			
FACULTY OF ENGINEERING AND THE ENVIRONMENT		0.2			
FACULTY OF HEALTH SCIENCES - CENTRAL		0.0			
FACULTY OF NATURAL/ENVIRONMENTAL SCIENCES		0.0			
FACULTY OF SOCIAL HUMAN/MATHEMATICAL SCIENCES	0.0				
FACULTY OF SOCIAL SCIENCES		0.0			
FEE EDUC ACOUSTICAL ENG		0.0	0.0		
FEE EDUC AEROSPACE ENG		0.0	0.0		0.3
FEE EDUC BIOMEDICAL ENG		0.0	0.0		0.0
FEE EDUC CIVIL/ENVIRO ENG		0.0	0.1		
FEE EDUC ENVIRO SCIENCE		0.0	0.0		0.0
FEE EDUC MARITIME ENG			0.3		
FEE EDUC MECHANICAL ENG		0.0	0.6		0.0
FEE EDUCATION - AUDIOLOGY					0.0
FEE EDUCATION - CENTRAL		0.0	0.0		
FEE EDUCATION - ENERGY		0.0	0.0		0.0
FEE ENTERPRISE		0.1	0.1	4.6	0.2
FILM		0.0	0.1		0.1
FINANCE PLANNING AND ANALYTICS		0.0	0.0	0.1	
GEOGRAPHY AND ENVIROMENT		0.0			
GEOGRAPHY AND ENVIRONMENT		3.8	5.5	44.0	7.8
GEOGRAPHY AND THE ENVIRONMENT		0.1			
HALLS OF RESIDENCE		0.0	0.0		0.0
HEALTH AND SAFETY		0.0	0.1		
HEALTH SCIENCES		0.0			
HEALTH SCIENCES CENTRAL		0.6	1.8	0.0	0.4
HISTORY		0.1	0.2	0.1	2.0
HUMAN DEV AND HEALTH		1.0	5.4	19.0	2.0
HUMAN DEVELOPMENT AND HEALTH		0.3	0.0		
HUMANITIES CENTRAL		0.6	1.8	-0.8	0.3
IN PROGRESS		0.0			

INNO/LEADERSHIP HEALTH SC		0.1	0.0		
INSTITUTE FOR LIFE SCIENCES		0.2	0.1	2.8	
INSTITUTE OF SOUND AND VIBRATION RESEARCH		0.0			
INTERNATIONAL OFFICE, UNIVERSITY OF SOUTHAMPTON			0.0		
ISOLUTION			0.0		
ISOLUTIONS		0.1	0.1		0.0
LEEDS BUSINESS SCHOOL		0.0			
LIBARY AND THE ARTS			0.0		
LIBRARY AND THE ARTS		0.1	0.1	1.1	0.2
MARINE AND MARITIME INSTITUTE		0.0			
MARITIME INSTITUTE		0.0	0.0		0.2
MATHEMATICAL SCIENCES	0.0	1.1	1.8		0.5
MECHANICAL ENGINEERING		0.7	1.7	-2.7	2.2
MEDICAL EDUCATION		0.1	0.3	6.7	
MEDICINE FACULTY OFFICE		0.2	0.9	0.2	1.1
MEDICINE: FACULTY OFFICE		-0.1			
MISSUOS			0.0		
MODERN LANGUAGES		0.0	0.6	0.0	1.1
MRC EPIDEMIOLOGY		0.1	2.2	-4.7	0.1
MRC LIFECOURSE EPIDEMIOLOGY UNIT		0.0			
MUSIC		0.1	0.1	0.5	0.5
NATIONAL OCEANOGRAPHY CENTRE		0.0			
NATL OCEANOGRAPHY CENTRE		0.0			
NATURAL/ENVIRO SCIENCES		0.1	0.1		1.5
NTL OCEANOGRAPHY CENTRE		0.1	0.3	0.0	0.7
OCEAN AND EARTH SCIENCE		1.3	5.8	10.0	10.0
OCEAN AND EARTH SCIENCES		0.0	0.0		
OFFICE OF DEVELOPMENT AND ALUMNI RELATIONS		-0.0			
OPTOELECTRONICS		0.7	3.2	0.3	1.8
OPTOELECTRONICS RESEARCH CENTRE		0.1			
PC AND POPULATION		0.1	0.6		1.3
PEOPLE AND STRATEGY		0.0	0.0		
PHILOSOPHY		0.1	0.2		0.2
PHYSICAL/APPLIED SCIENCES		0.2	0.2		0.1
PHYSICS AND ASTRONOMY		1.6	4.5	9.9	3.6
PRIMARY CARE AND POPULATION SCIENCES		0.1			
PRIMARY CARE POP SCIENCES AND MEDICAL EDU PPM			0.0		0.4
PROF PRACTISE IN HEALTH		0.0			
PROGRAMME MANAGEMENT UNIT			0.0		0.0
PSYCHOLOGY		0.1	0.7	0.1	0.5
PSYCOLOGY		0.0			
RESEACRH AND INNOVATION SERVICES		0.0			
RESEARCH		0.0			
RESEARCH AND INNOVATION SERVICES		-0.0			
RESEARCH/INNO SRVS		0.1	0.4	0.1	1.4
SCHOOL OF BIOLOGICAL SCIE*NCES			0.1		
SCHOOL OF BIOLOGICAL SCIENCES		0.1			
SCHOOL OF CHEMISTRY		0.3	0.1		
SCHOOL OF CLINICAL AND EXPERIMENTAL SCIENCES		0.0			
SCHOOL OF DEVELOPMENT AND HEALTH		0.1			
SCHOOL OF ECONOMIC SOCIAL AND POLITICAL S		0.1			
SCHOOL OF ECONOMIC SOCIAL AND POLITICAL SCIENCES		0.3			
SCHOOL OF ECONOMIC, SOCIAL AND POLITICAL		0.0			
SCHOOL OF ELECTRONICS AND COMPUTER SCIENCE		0.0			
SCHOOL OF ELECTRONICS AND COMPUTER SCIENCES		0.2	0.0		
SCHOOL OF ENGINEERING		0.6	0.3		
SCHOOL OF GEOGRAPHY AND ENVIRONMENTAL SCIENCES		0.0			

SCHOOL OF GEOGRAPHY AND ENVIRONMENTAL SCIENCES		0.3	0.2		
SCHOOL OF GEOGRAPHY AND THE ENVIRONMENT		0.1			
SCHOOL OF HEALTH SCIENCES		0.0			
SCHOOL OF HEALTH SCIENCES - CENTRAL		0.0			
SCHOOL OF HUMAN DEVELOPME*NT AND HEALTH		0.0			
SCHOOL OF HUMAN DEVELOPMENT AND HEALTH		0.4	0.4		
SCHOOL OF HUMANITIES		0.1	0.1		
SCHOOL OF MATHEMATICAL SCIENCES		0.3			
SCHOOL OF MATHEMATICS		0.0			
SCHOOL OF MEDICAL EDUCATION		0.0			
SCHOOL OF OCEAN AND EARTH SCIENCE		0.2			
SCHOOL OF PHYSICS AND ASTRONOMY		0.2			
SCHOOL OF PSYCHOLOGY		0.1	0.0		
SCIENCE		0.0			
SCOUTHAMPTON BUSINESS SCHOOL		0.0	0.0		
SOCIAL HUMAN/MATHS SCIENCES		0.1	0.1		0.0
SOCIAL SCIENCES		4.3	5.6	5.1	7.1
SOCIAL SERVICES			0.0		
SOES		0.0			
SOUND VIBRATION RESEARCH			0.0		
SOUND/VIBRATION RESEARCH		0.6	1.7	5.1	1.2
SOUTHAMPTON BUSINESS SCHOOL		0.8	2.1	0.0	0.9
SOUTHAMPTON EDUCATION SCHOOL		0.3	0.7		1.4
SOUTHAMPTON LAW SCHOOL		0.1	0.2	0.0	0.0
STATS SCIENCE RESEARCH		0.1	0.0		
STUD RECR ACADEM RELTNS			0.0		
STUD RECR/ACADEM RELTNS		0.7	3.3	9.3	2.1
STUD RECR/ADADEM RELTNS		0.0			
STUD RECR/INTL RELTNS		0.0			
STUDENT ACADEMIC ADMINISTRATION		0.0			
STUDENT AND ACADEMIC ADMINISTRATION		-0.0			
STUDENT RECR ACADEMIC RELTNS			0.0		
STUDENT RECR INTL RELTNS			0.1		
STUDENT RECR/ACADEM RELTNS			0.0		
STUDENT RECR/ACADEMIC RELTNS		0.1	0.1		
STUDENT RECR/INTL RELTNS		0.0			
STUDENT RECRUITMENT/ INTERNATIONAL RELATIONS		0.3	0.0		
STUDENT RECRUITMENT/INTER*NATIONAL RELATIONS		0.0			
STUDENT RECRUITMENT/INTERNATIONAL RELATIONS		0.1			
STUDENT RECT INTL RELTNS			0.0		
STUDENT SERVICES		0.0	0.6	0.0	0.1
STUDENT/ACADEM ADMIN		0.1	0.3	0.0	0.0
TEACHING		0.0			
UNIVERSITY EXECUTIVE		0.2	1.7	0.0	2.1
VICE CHANCELLORS OFFICE		0.2	0.2		
WESEX INSTITUTE		0.0			
WESSEX INSTITUTE		0.4	1.0	0.0	0.1
WINCHESTER SCHOOL OF ART		1.0	1.9	6.5	0.9
ZEPLER INST FOR PHOTO AND NANO		0.1			
ZEPLER INST FOR PHOTONICS AND NANOELECTRONICS		0.1			
ZEPLER INST PHOTONICS NANOELECTRONICS		0.1			
ZEPLER INSTITUTE		1.5	5.4	-16.5	7.4
ZEPLER INSTITUTE FOR PHOT*ONICS AND NANOELECTRONICS		0.1			
ZEPLER INSTITUTE FOR PHOTONICA AND NANOELECTRONICS		0.0	0.1		
ZEPLER INSTITUTE FOR PHOTONICS AND NANOELECTRONICS		0.2			

9.4 Summary of policy proposals (Ellie Harrison 2020)

The following as the policy suggestions proposed in (Ellie Harrison 2020).

Table iii: Policy suggestions for the University of Southampton.

Policy area:	Strategy:	Control/ influence:
Reducing the need for journeys	Provision of virtual conferencing and communications technology in replacement of travel (Fox *et al.*, 2009; Roby, 2014; Haynes, 2010; Achten *et al.*, 2013). Review of current virtual collaboration tools available; ensure future refurbishments of teaching/office spaces include a review and update of smart communications provision. Ensure that meeting rooms enabled for virtual communications and videoconferencing are indicated on the room booking system, and that access to facilities is consistent across all departments.	Control
	Work holistically with other core departments, e.g. HR to improve performance assessment criteria, reviews and recruitment practices to reduce expectation of presence at international conferences (Quéré *et al.*, 2015; Glover *et al.*, 2018; Nursey-Bray *et al.*, 2019). Personal carbon/travel budgets could be linked to performance reviews.	Control
	Engagement with the procurement and finance teams to improve the university travel expenses policy and claim forms, to ensure greater consistency across policy documents. Remove requirements to always book the cheapest travel option/flight (Burian 2018); encourage train travel.	
	Use of approval routines by senior management and expense application processes to deter travel (Gustafson 2013). International travel should be justified before approval through cost-benefit criteria, or with reference to policy benchmarks. Can provide more control compared to post-travel interventions, and may increase compliance with travel policy (Singh, 2007; Parry *et al.*, 2008).	Control
	Restructuring interview protocol to be routinely online for candidates who are abroad/a long distance from the university (Baer 2019; Kreil 2019).	Control
	Encouragement of more efficient trips, combining multiple activities/purposes into one. Support staff to plan their trips well in advance to ensure no overlaps in meetings and that maximum value is extracted (Burian, 2018; Kreil, 2019; Caset, Boussauw and Storme, 2018).	Control
	Allowing virtual attendance of external examiners and PhD examiners by default.	Control
	Rewarding staff who decline invitations that require flying (Burian 2018); e.g. by having funding bodies value travel rejections, or recognition by employers (Kreil 2019).	
	Encourage staff to use social media to disseminate and promote research, and facilitate discussion. Specific academic sites include Academia.edu, Researchgate.net, and Mendeley.com. Other social media sites include Twitter or LinkedIn (Lo *et al.*, 2013; Quéré *et al.*, 2015; Donelan, 2016).	Control
Active travel	Provision of mileage allowance for staff cyclists, to encourage cycling as business travel (most common amongst universities surveyed was 20p/mile, in line with HMRC guidelines).	Control
	Provision of bikes or electric vehicle pool cars for short journeys between campuses, or longer business trips where public transport is not available.	Control
Reducing the carbon intensity of journeys	Provision of flexible work schedules, incentive schemes or extra travel days to allow for longer land journeys, e.g. the Climate Perks Scheme (Quéré et al. 2015; Climate Perks 2020). Compensation could be provided in time or childcare for additional time travelled by train.	Control
	Provision of financial support for those who choose train travel over flights, by covering the extra costs for train travel or setting aside extra funding for low-carbon modes of transport.	Control
	Implementation of an employee carbon budget or internal emissions trading scheme (Lo et al. 2013; Zijlstra and Vanoutrive 2018), whereby staff members can either use the budget themselves or pass on surplus allowance to colleagues. This may address issues of early-career researchers being placed at a disproportionate disadvantage from limited travel. Low-carbon forms of travel could be incentivised by ensuring they are inexpensive or unlimited in the budget. Carbon budget could be applied either at the individual or departmental level.	Control
	An internal carbon tax is another suggestion (Nursey-Bray et al. 2019), which could target air travel exclusively (Kuang and Sternberger 2017), or be aimed at frequent fliers, with payments increasing with number of trips. A carbon tax could be combined with a carbon offsetting scheme to ensure funds are placed back into climate-related projects.	Control
	Adaptation of internal grant criteria, to encourage lower-carbon travel or online communications in replacement of travel, and remove the need for presentation of research at international conferences and meetings.	Control
	Encourage staff to minimise the size of groups travelling when travelling with colleagues to the same event. Could implement a policy limit on the size of groups travelling.	Control
	University-wide carbon offsetting scheme for tree planting, peatland or biodiversity restoration, or sustainability projects at the university. Could either be paid voluntarily by staff members when booking travel, or funded centrally by the university. If an external carbon offsetting company is chosen, they should be validated with the Gold Standard accreditation.	Control
	Prohibit or restrict domestic flights to UK destinations and/or destinations within 6 hours train journey of Southampton (to include some Western European destinations), unless a flight is completely necessary (Ciers et al. 2018). The WWF has adopted a policy of staff travelling for less than 10 hours must take the train at least one way, and if travelling for less than 6 hours must take the train both ways (Key Travel 2020).	Control

	Work with Clarity to collect data on distances travelled for ferry/taxi/hire car journeys.	Influence
Collaboration with other institutions	Ensure the University of Southampton is a member of the Roundtable of Sustainable Academic Travel, and participate in discussions and activities.	Control
	Discuss reporting tools and how they can be standardised across the HE sector, to enable comparison between universities. The University of Edinburgh, for example, has an open source reporting tool which they encourage other universities to use. It automates the carbon footprinting process, ensuring that the methodology is more consistent.	Control
	Collaborate with other universities to scale and improve virtual communications technologies for meetings and virtual conferences, and to share best practice and sector-wide targets (Caset et al. 2018; Glover et al. 2018).	Control
	Lobby UKRI (UK Research and Innovation) and the academic societies e.g. the Royal Society of Chemistry to adopt a sustainable travel policy or link funding to carbon emissions. Promote regional conferences and online attendance options wherever possible.	Control
	An ethical code of conduct for greenhouse gas emissions across the HE sector; committing signatories to replace travel with less carbon-intensive modes of transport wherever possible and remove all unnecessary travel (Favaro 2014).	Influence
	Sector-wide emissions trading scheme akin to international carbon cap schemes (such as the EU ETS), to avoid individual institutions being disadvantaged from carbon reduction efforts (Caset *et al.*, 2018).	Influence

	Create and promote a 'take action to reduce your business travel' section on the university website and/or intranet, with clear infographics.	Control
	Use of a decision tree or check list to aid staff with decision-making on whether to travel (Gustafson 2013; Quéré et al. 2015). The Tyndall Centre has provided a free template for decision trees for university business travel. Use of the 'Travel Better Package' provided by the EAUC Sustainability Exchange (Peres 2020).	Control
	Employment of a travel 'code of conduct' or a staff pledge to fly less, which is a social contract that staff can sign. A register could be created of signees. The Tyndall Centre has provided a free template for a code of conduct for academic business travel.	Control
	Promotion of business travel policy and communications by senior management. Whether employees comply with the travel policy is strongly related to the importance that senior management place on it (Parry et al. 2008). Hence, support is needed from highest levels of the organisation for travel plan to succeed. Senior/executive staff should be encouraged to lead by example, by removing the need for travel or using low-carbon alternatives to aviation.	Control
	Train administrative staff and travel management company booking staff on the business travel hierarchy and how to book and promote train travel to UK and EU destinations (Kreil 2019).	Control
	Host debates and/or talks on the environmental impact of travel, or business travel more specifically, amongst staff and students at the university.	Control
Reporting and monitoring	Mandate booking of public transport and air travel through Clarity to ensure travel data is captured.	Control
	Implementation of business travel reporting system for travellers who are booking through external funding.	Control
	Designate an individual to annually collate data and analyse progress on business travel emissions.	Control
	Establish emissions reductions targets against the 2018/19 baseline, for example: 5% CO_2e emissions reduction per year against the 2018/19 baseline.	Control
	Post business travel emissions data on UoS website, to enable public access and facilitate comparison with other universities.	Control
	Revision of the biennial UoS travel survey, to capture information about business travel habits.	Control
	Capture and monitor data on usage of smart communication/videoconferencing technologies at the university. Targets for 10% increase in utilisation against baseline year could be set.	Control

	Implementing a distance limit for student field trips, e.g. only permitting fieldtrips to Europe. Encourage domestic fieldtrips in replacement of site visits abroad where feasible (Kreil 2019).	Control
	Provide fuel efficient driving courses for university staff who conduct a large amount of business travel via personal or hire car.	Control
	Optimisation of online booking system to utilise 'visual guilt' to encourage lower carbon travel, such as displaying CO_2e emissions for different journeys and airlines at point of/ before booking. Travel selections that fall outside of travel plan requirements could be colour coded red to deter travellers, or a pop-up box could appear asking for a typed explanation for the journey (Gustafson 2013; Quéré et al. 2015).	Influence
	Optimisation of online booking system to make it easier for staff to book surface travel to European destinations. Travel management company could give rail as the default first choice for certain journeys, e.g. locations within 8-hour radius/ EU or UK.	Influence
	Decentralisation of conferences – regional sites with video-streaming of key presentations, to reduce the overall distance travelled by participants (Orsi, 2012; Klöwer *et al.*, 2020). Other ideas include reducing frequency of annual conferences to every 2-4 years, restricting visitor attendance, or allowing for virtual attendance (Hall 2007).	Influence
	Carbon calculators added to funding applications for research and funding bodies, or conditions for certain modes of travel to be included in grants or funding (Arsenault et al. 2019; Nursey-Bray et al. 2019). This would embed environmental consideration into the early, planning stages of research projects.	Influence
Education and awareness	Making carbon footprint data publicly available within the organisation to the departmental or individual level. To avoid penalising individuals, data should either be fully anonymised, made available only to the individual it concerns, or issued at the level of teams/departments.	Control
	Promoting use of communications technology in replacement of travel: advertise facilities on the website; training workshops to help staff use smart communications technologies effectively.	Control
	Establishment of a business travel working group or staff consultation, to involve staff in the decision-making process and increase awareness of the university's plans to tackle business travel carbon emissions.	Control
	Environmental education and communication campaigns. Communications need to be continual, to provide encouragement to break long-standing habits and views (Roby 2014). Communications should be targeted via several different media sources, such as emails, intranet homepage, staff training sessions etc. to ensure that all staff are reached.	Control
	Mandatory online training for staff on the environmental impact of business travel and reducing travel-related carbon emissions, including a video clip and/or quiz or test at the end. This could be developed into an induction pack for new university starters.	Control
	Separate the business travel policy from the Travel Plan. Make the business travel plan easy and quick to read and understand, and promote more widely. Incorporate visuals and graphs to make information easy to absorb.	Control