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Leisure travel distribution patterns of Germans: Insights for climate policy

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ABSTRACT

Transport accounts for an estimated 23% of energy-related global CO_2 emissions, a large share of this for leisure and tourism purposes. Despite national and sector-specific pledges to reduce global emissions of greenhouse gases, there are no consistent policies for the transport sector, which is characterized by continued strong growth. Against this background, this paper investigates holiday travel patterns of one of the most important tourism markets worldwide, Germany, based on data from annual travel surveys ('Reiseanalyse', with n = ~7500). Data on trip numbers, transport modes and travel distances are evaluated, indicating that emissions of greenhouse gases related to holiday travel (including trips lasting 5 days and longer) are significant at an average 320 kg CO_2 per trip and person. Findings also show that the distribution of holiday travel emissions is highly skewed among the population and heavily depending on trip type. While about a quarter of the population does not participate in holiday travel at all, a small, highly mobile and wealthier share of travellers, 4% of the German population, engages in five or more holiday trips per year. These travellers are also more likely to participate in the most carbon-intense trips, long-haul flights and cruises, which generate 2 t CO_2 and more per trip. Findings are discussed in the context of national climate policy.

1. Introduction

Emissions of anthropogenic greenhouse gases (GHG) totalled 49 ± 4.5 $GtCO_2eq/yr$ in 2010. Transport is contributing 23% ($6.7GtCO_2$) of total energy-related CO_2 emissions (IPCC, 2014a). On global average, 72.1% of total direct emissions from transports are road-related, followed by aviation (10.6%), and international and coastal shipping (9.3%) (IPCC, 2014a). Aviation deserves special attention, however, because a considerable share of this transport subsector's emissions are short-lived, and hence not comparable in terms of their global warming impact (Lee et al., 2009). In the future, emissions from transport are expected to grow, with the IPCC (2014a: 637) noting that without policy interventions, transport related CO_2 emissions could double by 2050, and triple by 2100. Most of this will come from aviation, with Boeing (2015) and Airbus (2015) anticipating growth in revenue passenger kilometres in the order of 4.9% per year. The International Energy Agency suggests that this may lead to a tripling of energy use for aviation by 2050 compared to 2005, and that the sector will by then account for 19% of all transport energy (IEA, 2009, high baseline scenario).

Emission growth in the transport sector is consequently in conflict with IPCC (2014a) conclusions that drastic reductions in emissions will be necessary in the short-term future if humanity is to stay within the 'safe' guardrail of a 2 °C global average temperature increase, compared to pre-industrial levels. To limit global warming to this level is the declared policy goal of 196 countries that are parties to the United Nations Framework Convention on Climate Change , and has recently been strengthened to 'well below 2 °C' in the Paris Agreement of the 21st Convention of Parties (COP21) in December 2015. This translates into a global emissions budget from all anthropogenic sources of approximately 1000 GtC, of which some 65% have already been spent (IPCC, 2014a). Countries have made a range of unconditional and conditional pledges to limit GHG emissions (UNFCCC, 2016), but analysis indicates that current pledges will not be sufficient to meet the 2 °C objective (Reilly et al., 2015). Given current emission trajectories, it appears more likely that the CO_2 emission budget for staying within the 2 °C limit will be exhausted within 30 years (Friedlingstein et al., 2014). All economic sectors, including tourism and transport, will thus have to make contributions to emission reductions.

Within this broader context, there is evidence that contributions to

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transport emissions are highly skewed between countries and individuals (Brand and Boardman, 2008; Brand and Preston, 2010; Gössling et al., 2009a,b; Lassen et al., 2006; Schäfer et al., 2009). To better understand these interrelationships, and in particular the role of travel frequency (the number of trips per traveller per year) and trip energy intensity (as a measure for emissions associated with a single holiday), this paper analyses holiday travel patterns, which have received more limited attention in the literature. Focus is on Germany, one of the most important tourism markets worldwide, based on data from the national annual travel survey ("Reiseanalyse"). The purpose is to identify the most emission-intense leisure trips, as well as traveller segments making more significant contributions to climate change.

2. Climate policy and passenger transport emissions

The IPCC suggests that by 2050, reductions in transport CO_2 emissions in the order of 15–40% (against a 2010 baseline) could be achieved through a range of mitigation measures, including "fuel carbon and energy intensity improvements, infrastructure development, behavioural change and comprehensive policy implementation" (IPCC 2014b: 21). The design of "comprehensive" transport policies to significantly reduce emissions remains however unclear with regard to the focus of interventions (producer/consumer) as well as the type of policy (e.g. command-and-control, market-based, voluntary).

Transport behaviour is primarily influenced by cost and time (Schäfer et al., 2009), and effective transport policies could simply raise the cost of energy and/or GHG emissions, or remove fossil fuel subsidies and other sector-specific state aid (OECD, 2009,2012). As an example, the UK has maintained a long-standing duty on air travel, while national governments continue to extend a range of significant subsidies to aviation (Gössling et al., 2017). As emissions from shipping and car traffic remain equally unaddressed by legislation on both international and national levels (UNFCCC, 2016; OECD and UNEP 2011), there is broad academic consensus that current policy measures are insufficient to achieve emission reductions necessary for the transport and tourism sector to be consistent with international climate policy goals (e.g. Anable et al., 2012; Banister, 2008, 2011; Chapman, 2007; Creutzig et al., 2015; Marsden and Rye, 2010; Peeters and Eijgelaar, 2014).

Global policy approaches to reduce emissions are based on national per capita averages. This was the basis for the Kyoto Protocol in 1997, as well as the Paris Agreement in 2015 with its focus on 'common but differentiated' mitigation goals (UNFCCC, 2016). Table 1 shows distributions in CO_2 emissions in countries that are major contributors to global emissions. Transport emissions account for between 6% (China) and 35% (France) of national CO_2 emissions, and vary in absolute terms between less than 0.1 t CO_2 (India) and 4.5 t CO_2 (USA) per person and year. These relationships are of importance, as they illustrate that in countries such as the USA, averaged annual emissions from transport are higher than those emitted on global average in total.

Differences in individual contributions to global emissions of greenhouse gases, irrespective of country, are relevant for climate policy. With regard to international air travel, estimates of 3.5 billion passengers in 2015 (IATA, 2015a) suggest that a large share of humanity is traveling by air. However, as passengers are counted multiple times (arrival/departure, transfers) or engage in multiple trips per year, it has been estimated that only 2–3% of the world population participate in international air travel on an annual basis (Peeters et al., 2006). A distinction also needs to be made between business and leisure travel, as business travellers are generally more mobile than leisure travellers, perhaps with the exception of long-term backpackers (Cohen, 2011). There are both business and leisure travellers for whom frequent flying is a norm, sometimes involving hundreds of individual flights per year (ssling et al., 2009a,b; ssling et al., 2009a,b; Hall, 2005). Travel intensity consequently varies: Ummel (2014) highlights this for the USA, where the top 2% income takers have emission footprints four times larger than those in the bottom quintile. UNWTO (2015) suggests that with regard to international travel, 14% of all trips are made for business and professional reasons, 27% for visiting friends and relatives, health or religious reasons, and 53% for leisure & recreation. In the future, the relative share of leisure, recreation and holiday related travel is expected to increase (UNWTO, 2011), indicating the significance of leisure-related travel motives in a wealthier and growing world population.

Various studies have investigated business and leisure travel patterns. Lassen et al. (2006) found that the average employee of Hewlett-Packard participated in 3.8 business international trips per year, which virtually always involved air travel, covering 17,000 km on average. While 25% of Hewlett-Packard employees did not participate in any trips at all, the most frequent traveller had participated in 43 trips. A survey of travellers at Landvetter airport, Gothenburg, Sweden (Gössling et al., 2009b) found that the 12% of the most mobile travellers had participated in at least 30 and up to 300 return flights per year, 98% of these for business. The 3.8% of the most frequent flyers (> 50 return flights per year) accounted for 28% of all trips made. These studies indicate highly skewed distributions of 'traveller to trip' and 'traveller to transport distance' ratios.

Studies investigating leisure travel patterns have also found considerable differences between individuals. A study of international leisure tourists in Zanzibar, Tanzania (Gössling et al., 2006), found, for instance, that the average per capita distance flown for leisure in 2002 and 2003 (air travel only) was 34,000 passenger kilometres (pkm), excluding the trip to Zanzibar. The ten most frequent travellers had flown almost 180,000 pkm each over the 22 months covered by the study, visiting up to 24 countries. Together, these ten travellers (3.9% of the sample) accounted for 20% of the overall distances travelled. Similar ratios have been found elsewhere. A study of the French population revealed, for instance, that five per cent of the population accounted for 50% of the distances travelled (Gössling et al., 2009a).

Table 1
Emissions of CO_2 by subsector, 2005.[a]
Source: based on Schäfer et al. (2009), UNESA (2015).

Country	CO_2 emissions (Mt)	Energy-related (Mt CO_2)	Transportation related (Mt CO_2)	Transport as% of total	Passenger travel (Mt CO_2)	Passenger travel per capita (t CO_2)
Australia	393	384	91	23.2	60	2.9
United States	6140	6090	1920	31.3	1340	4.5
Russia	1780	1740	165	9.3	86	0.6
Germany	894	873	184	20.6	132	1.6
United Kingdom	596	558	171	28.7	106	1.8
Japan	1320	1290	281	21.3	170	1.3
France	434	417	154	35.5	85	1.4
China	5300	5170	335	6.3	135	0.1
India	1270	1250	110	8.7	47	< 0.1
World	28,200	27,900	6370	22.6	3890	0.6

[a] Including emissions from international air traffic.

The most frequent travellers in this study, mostly individuals with net incomes exceeding 7500 Euros per month, also chose more distant destinations, covering distances 17.3 times greater than the average traveller. This leads to skewed distributions in emissions, with for instance the top 10% of travellers in the UK causing 43% of personal travel emissions (Brand and Boardman, 2008).

Overall, these studies suggest that a small share of the most frequent travellers, including both business and leisure travellers, is responsible for a disproportionately large share of transport related emissions. More detailed, nationally representative studies of in particular holiday travel patterns are however missing. Against this background, this paper investigates transport distributions within the German-speaking population, i.e. interrelationships of travel frequencies (trip numbers), distances travelled, and transport modes used. The overall purpose is to identify the most emission-intense trips and traveller segments. Results are also compared to holiday types, length of stay and spending, to derive further insights of relevance for climate policy.

3. Method

To understand the distribution of emissions from holiday travel, data contained in the German 'Reiseanalyse' ("travel analysis") was evaluated with a focus on travel frequencies, distances covered, and transport modes. Germany is the third largest nation in terms of tourism spending, and an important outbound market (UNWTO, 2015). 'Reiseanalyse' (RA) is a representative survey of the holiday travel behaviour of the German-speaking population that has been carried out since 1970. The survey is focused on holiday travel with a trip length of five days or more. Data collection relies on random route samples involving face-to-face interviews (Bauer, 2016). Face-to-face data compiled in the RA 2015 is the basis for this article, including n = 7720 personal interviews in the home of the respondents. This is representative of the German-speaking population aged 14 and above living in private households, comprising 70.5 million individuals (Schmücker et al., 2015). Note that with regard to definitions, focus is on holiday trips, which involve two legs (going/returning), and both domestic as well as international holiday trips lasting at least 5 days.

The analysis has the purpose to shed light on the contribution made by frequent holiday travellers as well as specifically energy-intense holiday trips to emissions of greenhouse gases. Data is analysed with regard to travel frequencies, distances travelled, and transport modes. Travel frequencies are analysed on the basis of trip numbers. Existing studies have used classifications of 'non-mobile' (no international trips), 'slightly mobile' (1 international trip per year), 'fairly mobile' (2 trips), 'highly mobile' (3–5 trips) and 'hypermobile' (6 or more trips per year) travellers (Frändberg and Vilhelmson (2003)); as well as cluster-based classifications including 'immobiles', 'frequent travellers on short trips' (< 3 days), 'travellers using trains or cars with a focus on destinations within home country', 'travellers on aircraft, favouring European destinations', and 'frequent travellers in home country and abroad, using all transport modes' (Gössling et al., 2009a). In this study, the Frändberg and Vilhelmson (2003) classification is used, though three or more trips define the most frequent travellers. Analysis distinguishes 'nonmobiles' (no holiday trips), 'slightly mobiles' (one holiday trip per year), 'fairly mobiles' (two holiday trips per year) and 'highly mobiles' (three or more holiday trips).

Furthermore, given the importance of specific trips in generating emissions (Eijgelaar et al., 2010), highly energy and emission-intense holidays were also identified. Such 'carbon holidays' were defined to involve travel distances exceeding 2000 km (one way) and the use of aircraft as transport mode. Given the carbon-intensity of cruises, all cruise trips are also considered 'carbon holidays'. Trip distances for all journeys were calculated for city-to-city great circle (air) or terrestrial (road) distances. Note that city-to-city great circle calculations will underestimate true travel distances, as air travel often involves detours, for instance in the case of no-fly zones. Per traveller/trip emission calculations are based on (passenger kilometre) distances travelled with different transport modes and multiplied by emission factors specific for these transport modes and the German transport system. More specifically, this includes data for German railways at 0.011 kg CO_2/pkm for electric highspeed trains (note that the 2014 average throughout the German railway system is 0.056 kg CO_2/pkm; Bahn, 2015). For German cars, the average is 0.044 g CO_2/pkm in 2015, based on IFEU (2012). Distance-based air transport emission factors are derived from Gössling et al. (2015) (0.099–0.183 kg CO_2/pkm in 2015), while cruise emissions are calculated on the basis of estimates for per day emissions (at a global average of 169 kg CO_2/day; Eijgelaar et al., 2010). All calculations focus on CO_2, and do only consider energy throughput. This focus consequently omits the considerable additional warming effect of emissions from aviation released at flight altitude (Lee et al., 2009), as well as potentially significant lifecycle emissions (transport mode production) as well as emissions related to infrastructure construction and maintenance (e.g. Chester and Horvath, 2009; von Rozycki et al., 2003).

Two limitations of the RA survey need to be highlighted. First, a share of very highly mobile travellers is likely to be excluded in the data, as very wealthy travellers that use personal forms of transport (private or corporate aircraft or yachts) are not captured in random route sampling procedures and thus not adequately represented in the data. Second, for the highly mobile, business and leisure trip motives may often merge (Gössling et al., 2009a). As a result of these omissions, data presented in the following sections needs to be considered a conservative assessment.

4. Results

Table 2 shows the distribution of holiday travel intensities in the German-speaking population, expressed in the number of trips made by individuals in 2014. About a quarter of the population, the 'non-mobiles', did not participate in holiday travel at all. The largest group, 'slightly mobiles' (61%), participated in one holiday trip. 'Fairly mobile' travellers engaged in two holiday trips (13%). Finally, the 'highly mobiles' (4%, or 2.8 million people) engaged in 9.52 million trips, corresponding to 14% of all holiday trips (average: 3.4 trips per traveller). Across the share of the German-speaking population that participated in holiday travel, the average travel frequency is 1.3 trips per year.

Further analysis with regard to trip distances indicates the relevance of this parameter for emissions, as long distances virtually always involve energy-intense air travel. Table 3 shows that trips over distances between 500 and 999 km account for one quarter (24%) of all trips, and trips between 1000 and 1999 km for another quarter (26%). Trips between 2000 and 9999 km and those > 10,000 km accounted for 19% and 2% of trip numbers, respectively. In absolute numbers, the 1.44 million trips > 10,000 pkm generated a travel volume of 17.13 billion pkm (14.7%). Together with the 2000–9999 km distance class, the 21% of the most distant trips (14.89 million) thus accounted for 59.7% (69.35 billion pkm) of all distances travelled. These most energy-

Table 2
Distribution of holiday trips with a length of at least 5 days, 2014.
Source: FUR 2015 (RA 2015 face-to-face).

	% population	million travellers	% trips	million trips
Non-mobiles	23	15.94	0	0
Slightly mobiles	61	42.89	61	42.89
Fairly mobiles	13	8.89	25	17.78
Highly mobiles	4	2.80	14	9.52
Total	100	70.52	100	70.3

Database: German-speaking population aged 14 and older.
Definitions non-mobiles: no holiday trips; slightly mobiles: one holiday trip per year; fairly mobiles: two holiday trips per year; highly mobiles: three or more holiday trips per year.

Table 3
Holiday-trips (> 5 days) by one-way distance, 2014.
Source: FUR (RA 2015 *face*-to-face).

	%	million trips	total distance (one way, billion km)
< 500 km	29	20.42	6.46
500–999 km	24	17.06	11.89
1000–1999 km	26	17.91	25.20
2000–9999 km	19	13.45	55.58
10,000 km >	2	1.44	17.13
Total	100%	70.3	116.26

Database: German-speaking population aged 14 and older.

intense 'carbon holidays' mostly involve air travel (98%), while cruises account for 2%. Overall, German's total holiday travel was 232 billion pkm in 2014 (including return trips), 74% of this by air (172 billion pkm), 18% by car (42 billion pkm by car), 4% by bus (8 billion pkm) and 2% (4 billion pkm) by train. In addition, considerable distances are travelled by cruise ship, though there is no data on this.

A more refined understanding of the climate impact of holiday travel emerges if emission distribution ratios from these trips are calculated for transport modes. Table 4 shows this distribution by transport mode and per trip, indicating that total transport emissions from German holiday travel amounted to 22.7 Mt CO_2 in 2014. This estimate includes train (0.2% of total emissions); bus (1.1%); car (8.1%); air travel (77.4%); cruise (11%); travel to cruise port of departure/arrival (1.7%); ship (mostly ferries; 0.5%); and other transport (motorcycle; < 0.1%). As outlined, this estimate only considers energy throughput with a focus on CO_2. The data also reveals that long-haul flights (> 10,000 km one way) have a disproportionally large climate impact: Even though representing less than 2% of all trips, they account for 14% of CO_2. Cruise trips are equally energy intense, at 1.4% of holidays they contribute 12.7% of emissions (including travel to/from port). In comparison, train and bus are insignificant in terms of emissions (0.2% and 1.1%, respectively), yet representing 13% of trips. Cars cause 8.1% of emissions, even though they are the most often used transport mode (45% of all trips). Note that the estimate does not consider travel in the destination and higher energy requirements of camper vans and mobile homes. Findings underline the importance of long-haul flights and cruises in adding to national holiday emissions. This is also illustrated in Fig. 1, which shows the contribution of different transport modes to overall emissions, in relation to trip numbers. Air transport is divided into distance classes.

Comparative emissions per trip are illustrated in Fig. 2. Train-based holidays involve the smallest carbon footprints, at 12 kg CO_2, followed by bus (46 kg CO_2) and car (57 kg CO_2). Car-based holidays are comparably climate-friendly as a result of load factors, at 3.2 persons per car. All air travel is carbon-intense, though the figure illustrates that in particular trips with one-way distances exceeding 2000 km and cruises contribute disproportionally to overall emissions. Air travel exceeding one-way distances of 10,000 km results in about 2.4 t CO_2, and cruise trips 2 t CO_2. Any such transport mode thus 'depletes' a sustainable annual per capita carbon budget, at an estimated 4 t CO_2 per capita and year, by more than half. This estimate is based on the assumption that current globally averaged emissions of approximately 4.5 t CO_2 per person and year are not climatically sustainable (IPCC, 2014a).

Emissions can also be broken down to individual 'per traveller' contributions. An analysis of the 100 most mobile travellers of the sample (in trip numbers) suggests that these participated in five to 12 holiday trips (> 5 days) in 2014. Distances covered varied between 2704 km and 58,112 km (all holiday trips in 2014; return distance). Analysis of these trips suggests that travel frequency is not necessarily a predictor of emissions. For example, one traveller participating in 12 trips emitted less than 15 kg CO_2 in total, because all trips were by train and involved close destinations. In comparison, the five holiday trips of another traveller, four of these cruises, contributed to more than 8 t CO_2. A relationship was however found between the number of holiday trips taken by individual travellers and the share of 'carbon holidays' with a return distance exceeding 4000 km. In other words, more mobile travellers are more likely to engage in longer trips. Among the slightly mobiles, one fifth (21%) engaged in 'carbon holidays'; a share that increased to 27% among the fairly mobiles, and to 74% among the highly mobiles (Table 5).

Data on holiday transport distributions was also analysed in the context of sociodemographic traveller characteristics. Among the highly mobiles, 61% are female and 39% male, and a large share of them is older (average: 53 years; with 30% being 70 years and above). Highly mobile travellers are characterized by a higher formal education, and claim above average household incomes. Holiday motives differ, with highly mobiles valuing aspects of "get to know other countries, see the world" (+43 percentage points, compared to general traveller population), "do something cultural and educational" (+36), "get completely new impressions, discover something totally different" (+33), "new experiences, diversion from the ordinary" (+28), "travel around, be on the move" (+18), and "meet the locals" (+18). Holiday activities are also significantly different from other travellers, including "visiting natural attractions" (+37, compared to general population), "visiting sites of cultural or historical interest/museums" (+34), and

Table 4
CO_2-emissions by main transport mode, 2014.
Source: Bahn (2015); FUR (2015) (RA 2015 face-to-face); Eijgelaar et al. (2010); IFEU (2012).

	million trips	Return distance (km)	Emission factor (kg CO_2/pkm)	Emissions per trip (kg)***	CO_2 emissions	
					(Mt)	%
Train	3.61	1072	0,011	12	0.043	0.2
Bus	5.44	1528	0,030	46	0.249	1.1
Car	32.11	1298	0,044	57	1.834	8.1
Air < 500 km	0.2	690	0,183	126	0.025	0.1
500–999	1.46	1558	0,137	218	0.311	1.4
1000–1499	6.61	2582	0,116	300	1.979	8.7
1500–1999	5.04	3429	0,108	370	1.858	8.2
2000–9999	12.47	8289	0.099	821	10.238	45.0
10,000 km >	1.35	23,817	0.099	2358	3.183	14.0
Cruise Travel to cruise	0.97	–	169 kg/day mixed calc.	1910 mixed calc.	2.502 0.389	11.0 1.7
Ship*	0.34	1000	0.350	350	0.119	0.5
Other**	0.65	804	0.005	4	0.003	0.0
Total	70.3	–	–	323	22.733	100,0

German-speaking population aged 14 and older, holiday trips 5+ days; * without cruises, distance unknown, estimate; ** e.g. bicycle and motorcycle, estimate for average emissions; *** transport to/from destination only. Omits travel within destination. The opposite is true for cruise, which is based on 11.3 cruise days; travel to port of departure/arrival is calculated separately and included in 'travel to cruise'.

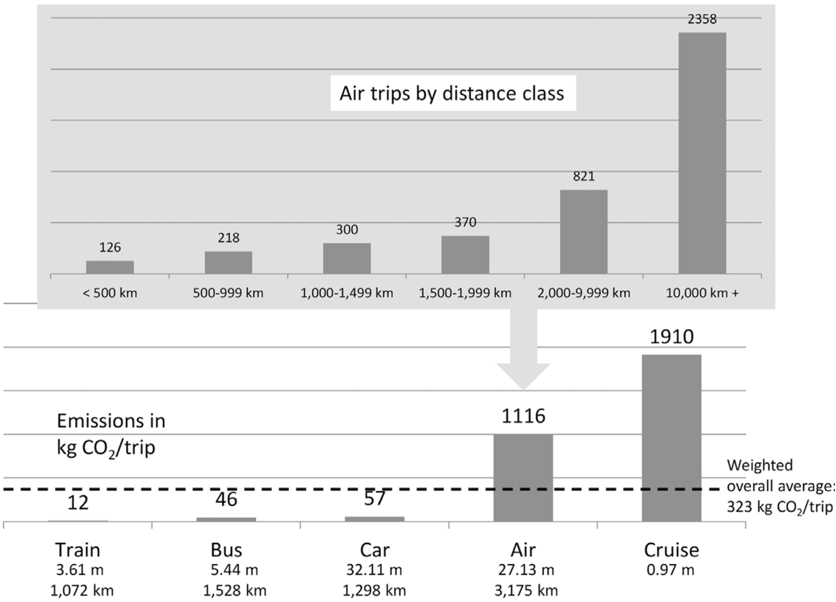

Fig. 1. Holiday transport modes as percentage of trips and emissions. Note: cruise trips are not directly comparable with other trips, because this type of holiday is based on constant movement, including accommodation. There is no data for average distances for cruises.
Source: Authors

"trips, excursions" (+26). In contrast, only a third of the highly mobiles (35%) have an interest in environmentally friendly holidays, compared to 42% in the general population.

With regard to the share of the most carbon-intense trips, analysis reveals that these are mostly made in summer (37%; average distribution 49%), as well as in autumn (28%; 23%). 'Carbon holidays' last longer than other holiday trips, on average 15.8 days, compared to 12.5 days for the average German holiday trip. Three quarters (75%) of carbon holidays involve hotels for accommodation, compared to 46% for the average holiday trip. Spending for 'carbon holidays' is 67% higher, at €1603 per trip and person, compared to €958 for the average traveller. Per person per day, spending for 'carbon holidays' is 34% higher, at €109 per person per day, compared to €81 per person per day for the average holiday. 'Carbon holidays' are particularly often sun-sand-sea holidays (34%, as compared to 21% on average). These insights create additional complexities for climate policy, and are discussed in the following.

Table 5
Participation in 'carbon holidays' by traveller classification.
Source: FUR 2015 (RA 2015 *face*-to-face)

	Slightly mobiles	Fairly mobiles	Highly mobiles
All holiday trips (million)	42.89	8.89	1.1
Carbon holidays as number/share of all holiday trips:			
million	9.17	2.41	0.8
as share of trips	21%	27%	74%

Definition 'carbon holidays': holiday trips with a length of five or more days, covering a one-way-distance of more than 2000 km and involving the use of aircraft or ship as the main transport mode.
Definition of segments: 'slightly mobiles': one holiday trip per year; 'fairly mobiles': 2 holiday trips per year; 'highly mobiles': three or more holiday trips.

5. Discussion

The main purpose of this paper was to analyse leisure travel patterns of the German population, and to derive insights for climate policy. A number of key insights emerge from the results. First of all, among the 7500 respondents, the greatest number of holiday trips was 12, and the maximum distance travelled 58,112 pkm. This is lower than the distances travelled by tourists in long-haul destinations such as Zanzibar (Gössling et al., 2006), where more mobile traveller populations may concentrate. In particular backpackers can be constantly on the move,

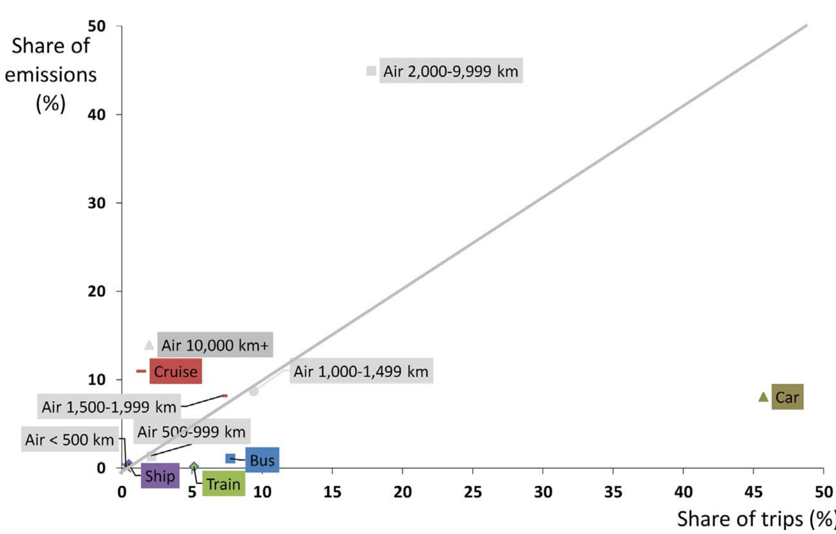

Fig. 2. Average emissions and one-way distances per holiday trip and main transport mode.
Source: Authors

described by Cohen (2011) as 'lifestyle travellers'. It is possible that these are underrepresented in this sample. Socio-demographics of the most highly mobile travellers in this study however reveal that these travellers often belong to the high to very high income segments of the population, with travel motives such as 'being on the move' or 'sun, sand, and sea'.

Findings reveal that holiday travel of the German-speaking population causes emissions in the order of 22.7 Mt CO_2, i.e. corresponding to the equivalent of about 16% of German CO_2 emissions from transport (about 163 Mt CO_2; UBA, 2016). This estimate does only include holiday trips of 5 days and more, and excludes accommodation or travel in the destination. It is based on the assessment of energy throughput, and ignores considerable lifecycle emissions. Averaged, a German holiday trip (transport) entails 320 kg CO_2, and the average German's contribution to leisure holiday travel is 415 kg CO_2 per year (at 1.3 trips, for the 77% of the population taking holidays).

Further insights were derived from the analysis of ratios, with 4% of travellers engaging in 14% of trips, and the 15% most distant trips accounting for 60% of the total distances travelled. These long-haul trips also generate a large share of overall emissions. The top quartile of the most energy-consuming trips results in 70% of all holiday CO_2. Considering even non-CO_2 emissions, the contribution of these trips to global warming is even higher. On a per trip basis, long-haul flights (> 10.000 km) and cruise ship holidays are thus more relevant for climate policy than other holidays. In Germany, average holiday distances grew from 1415 km to 1600 km between 2002 and 2011 (+13%; Frick and Grimm, 2014; Grimm and Schmücker, 2015), a trend mostly explained by growth in air travel (Lohmann et al., 2014). These insights confirm the need to regulate long-haul air travel and cruises in highly developed tourism economies.

Currently, emissions from aviation and shipping are not covered by national policies. Aviation emission reductions are to be pursued through the International Civil Aviation Organisation (ICAO), in recognition of the difficulty of assigning responsibility for international emissions to individual countries (Clarke and Chagas, 2009). Emissions from ships are the mandate of the International Maritime Organization (IMO) (Bows-Larkin et al., 2015). The European Parliament's Committee on Environment, Public Health and Food Safety (2015: 9) concludes that "Initiatives and actions taken by ICAO and IMO to address GHG emissions started late and have been insufficient from an environmental perspective to date: they do not take appropriate account of global decarbonisation requirements".

Currently two major international efforts aim to stabilize and eventually reduce emissions from air travel, including the European Union's Emission Trading Scheme (EU ETS) and ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) scheme. The EU Commission independently developed proposals for including aviation in its Emission Trading Scheme that imposes caps on large emitters. Aviation has been included since 2012. The scheme currently only applies to flights within the territory of the European Economic Area countries (i.e. the EU28, Iceland, Liechtenstein and Norway). In 2013, under pressure to allow airlines time to find international consensus at the ICAO level, international aviation was frozen from the ETS. The amended EU ETS Directive specifies that once the ICAO mitigation proposal (CORSIA) is available, the Commission should report to the European Parliament and to the Council on the matter and if appropriate prepare a proposal amending the directive (Europa, 2017). Even though it is unclear how the EU Parliament and Council will decide on the issue, CORSIA has already been challenged as an insufficient approach to mitigation, because the scheme:

- Only covers CO_2, ignoring non-CO_2 emissions that are estimated to have the same order of magnitude as the forcing caused by CO_2.
- Applies to only to 80% international air traffic, due to various exceptions, such as Small Island Developing States (EC 2017).
- Only covers emissions exceeding 2020 levels (i.e. it allows the sector to grow for another three years in emissions, before additional emissions will be 'covered' by the scheme).
- Is voluntary in its pilot (2021 through 2023) and first phase (2024–2026), involving only a share of airlines for at least another decade. Only after 2035 would most airlines be forced to join.
- Even though only a small share of emissions from aviation will be covered, the scheme would require offsetting at unprecedented scales. This will result in a situation where the scale of projects increases every year while available project opportunities decline. If expected breakthroughs in alternate low-carbon fuels do not materialize as early as projected, the requirements for offsetting credits would escalate rapidly after 2030.
- Plans to source offset credits through low-cost projects, including Reduced Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+). Forest projects have been criticized as highly unreliable offset projects, which in the case of REDD+ do not sequester carbon, rather than continue to maintain existing carbon pools. This will lead to a situation where atmospheric concentrations of CO_2 rise, even where projects work.

In the absence of credible international strategies to reduce emissions from aviation and shipping, national climate policy regains importance (OECD and UNEP, 2011). The Organization of Economic Cooperation and Development (OECD, 2003, 2005a,b, 2012) repeatedly outlined that removing subsidies and imposing a cost on fossil fuels is the most efficient approach to reduce emissions, consistent with the polluter pays principle. Given that the contribution made by air travel to overall emissions increases with distance, there is a need to specifically address long-haul flights in climate policies. Low cost air travel is also of relevance, as the sector delivers cheap mobility to mass markets, creating interest in aviation and turning air travel into a norm.

Research as presented in this paper also raises the question of travel motives. There has been a longstanding argument that a considerable share of air travel is 'induced' by low fares (Nilsson, 2009), while more recent research also raises the prospect of travel for social capital generation (Gössling and Stavrinidi, 2016). This is reflected in findings, where travel motivations include "being on the move". In a carbon-constrained future, there may have to be a debate as to what travel is desirable. This is also true for cruises, which are specifically problematic from a climate change point of view.

Complexities arise out of insights that a share of travel affected by national climate policies would involve trips desirable from destination viewpoints: this includes trips made during low-season, with greater trip-length, by travellers who are potentially flexible in their spending, or who spend more than "average" travellers. Many of the trips contributing most to emissions are made in spring and autumn, which is of relevance given many destinations' struggle to attract low-season visitors, and hence these destinations' economic viability. Climate policy may have to consider this, also because demand in high season influences the overall capacity considered economically viable by airlines and cruise operators (measured in airport or cruise port capacity, or seat numbers/berths). To reduce high season capacity is likely to also have repercussions for load factors: Currently, one in five air seats are flown empty (IATA, 2015b). Evening out demand would also affect air travel demand growth and price structures, but may require greater flexibility in European holiday periods. The implementation of national climate policies in the transport sector would also force destinations to reconsider their products and marketing strategies, and to invest greater efforts into the optimization of their systems.

Finally, results confirm considerable differences in travel activity. Climate policy will consequently have to consider principles of equity that underline the Paris Agreement. The transport sector provides ample evidence that it is a very small share of wealthy citizens contributing disproportionally to emissions (Brand and Boardman, 2008; Brand and Preston, 2010; Ummel, 2014). Even though a phenomenon more generally associated with the USA, where the wealthiest have their own travel networks (Frank, 2007), evidence grows that without tackling the travel patterns of the most mobile, mitigation in line with IPCC recommendations is unfeasible.

6. Conclusions

This paper evaluated German leisure travel data for holidays lasting five days or longer, with the overall goal to derive insights for the design of climate policies. Results show that there are significant differences in holiday participation and the emissions caused by individual trips or travellers. On one side of the spectrum, 23% of the population do not participate in leisure travel at all, while a small share of the population (4%) engages in three or more holiday trips per year. These travellers were also more likely to participate in the most carbon-intense trips, defined as air travel with return-distances exceeding 4000 km, as well as cruises. Long-haul flights with return distances exceeding 20,000 km were found to generate almost 2.4 t CO_2 per trip, while cruises, at an average length of 11.3 days, produced emissions of 2.0 t CO_2 per trip. As a result, the 3% of the most energy-intense trips contribute to 25% of all holiday transport emissions in Germany. Flights between 2000 and 10,000 km (12% of all trips) contribute another 45%. Taken together, 15% of the trips thus generate 70% of German's holiday transport emissions.

For climate policies to be efficient, it is crucial to focus on these travel segments. In the absence of credible international sectoral strategies to reduce emissions, aviation and cruises may have to be targeted at the national scale. An example of a feasible strategy is the UK's air passenger duty, which includes distance 'bands' and flight class considerations, and is thus somewhat proportional to emissions. A variety of countries in Europe have introduced or plan to introduce similar duties, though these could more accurately reflect the climate implications of different trips, as well as the fact that highly mobile travellers are disproportionally more wealthy. Precedents for the application of non-linear carbon costs to other consumer transport decision contexts exist, for example in the form of bonus/malus systems (D'Haultfœuille et al., 2011).

International tourism is a form of economic activity that is no more essential to economic development than electricity generation; steel, cement, or chemical production. All of these other economic sectors will have more stringent emission reduction expectations and requirements placed upon them through country pledges to the Paris Agreement and the tourism sector cannot expect special status exemptions if the goal of the international community to restrict global warming to 'well below 2 °C' is to be achieved. The overall cost of action for tourism in line with international climate objectives has been shown to be comparably low (Scott et al., 2015), and as insights from this paper suggest, tailored climate policy increasing the cost of in particular carbon intense holidays will represents an important step in meeting the sector's decarbonization challenge.

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