University of Washington Air Travel:

A Sustainable Path Forward

FINAL REPORT
March 18, 2016

Prepared for:
UW Sustainability Office

Submitted by:
Brian Mickelson (MPA Candidate, Evans School of Public Policy & Governance)
Gretchen Thuesen (MMA Candidate, School of Marine & Environmental Affairs)
Nicholas Waldo (Ph.D. program, Civil & Environmental Engineering)

Faculty Advisor:
Alison Cullen (Professor, Evans School of Public Policy & Governance)

Client Liaison:
Elise Glassman (Project Manager, UW Sustainability Office)

EXECUTIVE SUMMARY

The University of Washington's (UW) Climate Action Plan (CAP) set broad sustainability goals, including a commitment to achieving carbon neutrality by 2050. While the university has made great progress in both quantifying and reducing many of its greenhouse gas (GHG) emissions, it only has rough estimates of air travel emissions, and has taken few steps to reduce them. This project was commissioned by the UW Sustainability Office to better understand the university's footprint from air travel, which is estimated to account for 11 percent of emissions, making it is a key target for reductions. The goal of this report is to provide guidance to the Sustainability Office around tracking air travel more accurately, and to uncover faculty and staff attitudes around flying as a key step to creating and implementing emissions reduction strategies.

We received financial records of airplane ticket reimbursements from the UW Travel office and wrote custom software scripts to incorporate origin and destination airports. With this route data, we were able to calculate the actual mileage flown by specific departments, the most common routes flown, and other relevant statistics. We used this travel data to target surveys and interviews at the 30 departments shown to travel the most. The surveys were distributed online over departmental email lists, while in-person interviews were arranged by reaching out to directly representative faculty.

By adding more accurate mileage estimates to existing travel data, we determined that UW air travel emissions accounted for at least 23,800 metric tons of carbon dioxide equivalent (MTCDE) in 2014, 33 percent higher than UW's estimate. From the surveys and interviews, we learned that many respondents who fly frequently resent much of the time they feel they have to spend travelling, would like to travel less, and would be happy to switch to videoconferencing or ground transportation whenever possible. Many respondents also reported widespread skepticism of carbon offsets programs, which the CAP stipulates will eventually be necessary to reach carbon neutrality. We apply a change management framework to understand our results in the context of the current flying culture at UW.

We recommend UW adopt a robust change management strategy to encourage rapid adoption of and buy-in to five emissions reduction strategies:

- Implement a **universal booking system** to better track air travel and provide a baseline from which to measure the efficacy of future reduction strategies
- Work with other institutions to partner on ways for faculty to **fly less**
- Replace travel with **videoconferencing** wherever possible
- Utilize **ground transportation** for shorter distances
- Create consistent and open dialogue across campus prior to investing in **carbon offsets**

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LIST OF ABBREVIATIONS

AASHE -- Association for the Advancement of Sustainability in Higher Education
ACUPCC --American College and University Presidents' Climate Commitment
CAP -- Climate Action Plan
CTA -- Central Travel Account
EPA -- Environmental Protection Agency
eTrav -- eTravel
FLCF -- Finger Lakes Climate Fund
FY -- Fiscal Year
GHG -- Greenhouse gas
ICA -- Intercollegiate Athletics
ICAO -- International Civil Aviation Organization
ICCT -- International Council on Clean Transportation
IRB -- Institutional Review Board
LEED -- Leadership in Energy and Environmental Design
MBM -- Market Based Mechanism
MTCDE -- Metric Tons Carbon Dioxide Equivalent
NSF -- National Science Foundation
PGI -- Premiere Global Services
PI -- Principal Investigator
PM -- Per Passenger Mile
STARS -- Sustainability Tracking, Assessment, and Rating System
UC -- University of California
UW -- University of Washington

1.0 INTRODUCTION

1.1 BACKGROUND

The University of Washington (UW) was one of the first signatories to the American College and University Presidents' Climate Commitment (ACUPCC) in 2007. As part of this commitment, UW and other higher education institutions pledged to develop a Climate Action Plan (CAP) that set broad sustainability goals and strategies. The UW CAP, released in 2009, established an aspirational date for achieving carbon neutrality; created mechanisms and indicators for tracking progress; and made publicly available its reporting on annual greenhouse gas emissions (GHG) in the Sustainability Tracking, Assessment, and Rating System (STARS) through the Association for the Advancement of Sustainability in Higher Education (AASHE).[1]

The CAP set goals to reduce UW's GHG emissions 15 percent below 2005 levels by 2020 and 36 percent below 2005 levels by 2035, and achieve carbon neutrality by 2050.[2] It outlines several actions to reduce emissions, including energy efficiency upgrades in buildings, replacing electricity from fossil fuel sources with renewable energy, reducing and recycling waste, and investing in cleaner fuels to green the university vehicle fleet.[3] By most measures, UW has achieved significant progress on its sustainability goals--the university now has 29 LEED-certified buildings, has diverted 66 percent of waste from landfills through reuse, recycling and composting, and avoided $14.5 million in utility costs through energy conservation measures (2015).[4] But one area in which UW, and most ACUPCC universities, have not made as much progress is understanding the full extent of their carbon footprint from air travel.

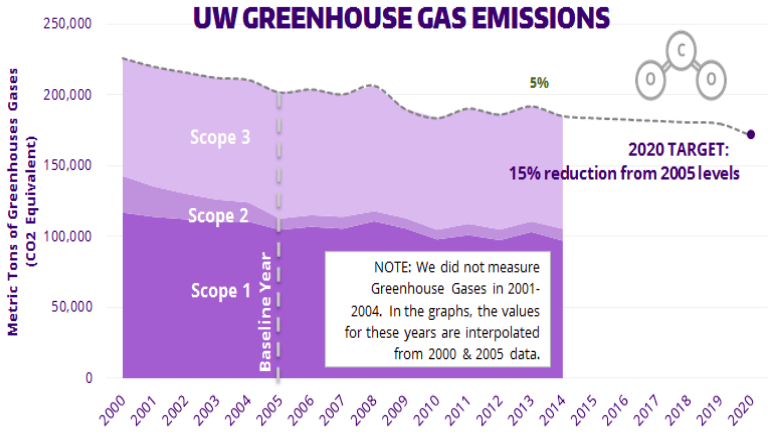

Figure 1, UW greenhouse gas emissions 2000-2014, plus targets to 2020 (Source: UW GHG Inventory)

Figure 1 estimates UW's carbon reduction progress through 2014. GHG emissions are broken down by "scope." Scope 1 emissions are generated directly by each of UW's three campuses (e.g. by buildings burning natural gas for heating). Scope 2 emissions are those produced

[1] University of Washington. "Climate Action Plan." 2009.
[2] Ibid.
[3] Ibid.
[4] Letter from President Ana Mari Cauce to the AASHE outlining the Oct. 2015 UW STARS submission.

indirectly by generating energy purchased by UW (most electricity is purchased from Seattle City Light, the city's carbon neutral electric utility). Scope 3 emissions consist of everything else, including commuting and air travel.[5] As we hope to demonstrate in the pages ahead, emissions from air travel, which make up a large percentage of UW's overall output, are likely much higher than previous estimates indicate.

1.2 PROJECT OUTLINE

Spearheaded by the UW Sustainability Office, this project seeks to better understand the extent of air travel undertaken by UW faculty, staff, students, and athletics teams. Our team includes graduate students from the Evans School of Public Policy & Governance, the School of Marine & Environmental Affairs, and the Department of Civil & Environmental Engineering.

The project is organized around three key goals:

> **Goal 1:** Provide a comprehensive accounting of UW air travel through aggregation and analysis of existing reimbursement data.
> **Goal 2:** Survey and interview faculty and staff in top-flying departments to uncover air travel attitudes and analyze how these may impact efforts to reduce emissions.
> **Goal 3:** Research and recommend actionable steps to achieve the long-term emissions reduction goals set forth in the CAP, including strategies to successfully implement these steps.

This report builds off the work of Jonny Stacey, an undergraduate student intern with the Sustainability Office during winter quarter 2015. He analyzed GHG emissions associated with professional air travel by UW faculty, staff, students, and athletics over the course of fiscal year (FY) 2013, and found that UW, like most institutions, is likely undercounting its impact from air travel due to a lack of available data. This project furthers Stacey's initial analysis of three different datasets:

1. **eTravel.** Reimbursements of trips booked with personal money (includes study abroad).
2. **Central Travel Account (CTA).** Trips booked with a UW-issued credit card.
3. **Intercollegiate Athletics (ICA).** Trips taken by UW's athletics teams.[6]

We begin by outlining the current state of air travel from an international, national, and higher education context. Next, we describe data collection and analysis techniques in the

[5] Henceforth, "scope 3" and "air travel" will be used interchangeably to refer to emissions from flying, unless otherwise indicated.
[6] Does not include football travel, which is tracked separately by the Athletics Department.

"Methodology" section, followed by a discussion of key findings from existing financial travel data from FY 2014, survey responses, and interview feedback, and associated limitations. We then recommend strategies, built around a change management framework that addresses employee experiences and beliefs around air travel, for the Sustainability Office to consider in reducing the impact of UW air travel. We conclude with suggestions for further research.

1.3 SURVEYING THE LANDSCAPE

1.3.1 Overview

The global aviation industry produces roughly 2 to 2.5 percent of total carbon dioxide (CO_2) emissions worldwide.[7] It is responsible for approximately 12 percent of CO_2 emissions from the transportation sector overall.[8] In the United States (US), the transportation sector is responsible for roughly 28 percent of total emissions, and aviation accounts for about 9 percent.[9] The International Civil Aviation Organization (ICAO), a specialized agency of the United Nations (UN), works with the UN's 191 member states to develop global Standards and Recommended Practices used in crafting state-level civil aviation regulations. In the last five years, ICAO has set an industry-wide fuel efficiency improvement target of 1.5 percent per year by 2020, and carbon-neutral growth thereafter, predominantly through implementation of a market-based mechanism (MBM) to offset carbon emissions growth.[10] ICAO's goal is to cut CO_2 emissions in half from 2005 levels by 2050, but these measures are in no way binding.

On the domestic front, the US Environmental Protection Agency (EPA) issued an endangerment finding in June 2015, declaring that GHG emissions from airplanes are a danger to human health because they contribute significantly to climate change.[11] The finding, coupled with litigation brought by environmental groups, means the EPA is working on new rules under the Clean Air Act to restrict airline emissions, and is scheduled to release its findings and make determinations in spring 2016.[12] In Washington State, Governor Inslee's Carbon Pollution Accountability Act, which would have created a statewide cap-and-trade system for reducing carbon emissions, failed during the 2015 legislative session. A separate initiative, I-732, from nonprofit group Carbon Washington, would institute a revenue-neutral tax on carbon, and will be placed on the

[7] Lee D.S. et al. (2009). "Aviation and Global Climate Change in the 21st Century." *Atmospheric Environment* 43, 3520-3527.
[8] Air Transport Action Group. "Facts and Figures." Web. 6 February 2016.
[9] US Department of Transportation. *Transportation's Role in Climate Change.* DOT and Climate Change Clearinghouse. Web. 6 February 2016.
[10] Carbon-neutral growth refers to a stabilization of carbon emissions at 2020 levels.
[11] Davenport, C, and Mouawad, J. "E.P.A. to Set New Limits on Airplane Emissions." *The New York Times*. 02 June 2015. Web. 7 February 2016.
[12] Environmental Protection Agency (EPA). "EPA takes first steps to address greenhouse gas emissions from aircraft." https://www3.epa.gov/otaq/aviation.htm#endangerment. Web. Accessed 8 March 2016.

November 2016 ballot.[13] The initiative is opposed by most major environmental groups and both state political parties.[14]

Widespread recognition that reductions in carbon emissions are a priority underscores the commitment by UW and other institutions to reduce their own emissions. While events beyond the control of higher education, such as the formation of a national, regional, or state cap-and-trade or tax system for CO_2, may eventually come to pass, the current political environment makes it difficult to predict when, and what authority legislation will have over aviation emissions. Therefore, universities must continue to focus efforts on understanding and curbing their carbon footprint from flying.

1.3.2 Air Travel in Higher Education

Air travel is central to the mission of higher education institutions. Faculty fly for a variety of reasons: to attend conferences and network with colleagues; to pursue professional development opportunities; to conduct research in far-reaching locations; to act as a guest speaker at other institutions; or to seek grant funding from large foundations. Students travel overseas to study abroad, immersing themselves in other cultures to broaden their perspective on the world and their place within it. Administrators fly around the country and the world to attend college fairs and recruit prospective students and faculty. Athletic teams traverse the state, the west coast, and the US to face off against conference and national competition.

Yet despite the integral role air travel plays in higher education, accounting for it is tricky. All signatories of ACUPCC commit to establishing a GHG inventory, and to updating it at least every other year. The inventory quantifies a school's carbon footprint in terms of metric tons of carbon dioxide equivalent (MTCDE).[15] Tracking emissions is the first and most important step for universities seeking to reduce their environmental impact, because it provides a baseline from which to measure the effectiveness of future reduction strategies, as well as a visual impetus to promote behavior change.[16]

1.3.3 Air Travel at UW Peer Institutions

For most universities, scope 3 emissions are inherently more difficult to quantify than scope 1 and 2 emissions. This is due in large part to a lack of available data to track air miles traveled and

[13] Revenue-neutral means the tax would not increase or decrease state revenue, but would offset the rise in fuel prices from the tax by decreasing other taxes, like the sales and business & occupation taxes.
[14] Brunner, J. "Carbon-tax initiative divides environmentalists." July 25, 2015. Web. Accessed 8 February 2016. http://www.seattletimes.com/seattle-news/politics/carbon-tax-initiative-divides-environmentalists/.
[15] Metric units are used due to the international nature of GHG emissions accounting. Association for the Advancement of Sustainability in Higher Education (AASHE). "Determining Your Carbon Footprint and Emissions Inventory." Web. Accessed 11 March 2016.
[16] Ibid.

the associated carbon emitted. We spoke to sustainability representatives at the University of California-Davis (UC-Davis) and Cornell University, both of whom remarked on the difficulty of accurately tracking air travel. Each school relies on reimbursement data from their travel, study abroad, and athletics offices to estimate emissions. UC-Davis calculates its carbon output using sample data extrapolated from its travel database and measured against the school's population.[17] Cornell's travel is equally decentralized, and to date has only been able to obtain reimbursement data for dollars spent instead of information on flight length and destinations.[18] Given each school's leadership in aggressively pursuing sustainability initiatives on their respective campuses (both consistently receive a "gold" ranking from the AASHE Sustainability Tracking, Assessment Rating System, or STARS), it is fair to assume that most schools have not determined a more accurate method to track air travel, and tend to undercount emissions.[19]

Appendix 1 shows data gleaned from the CAPs of five peer institutions, including UC-Davis and Cornell, as well as from information submitted to STARS. Peers were selected based on similarities with UW in terms of geography, population, and scope as research institutions. As the table shows, schools vary in terms of carbon neutrality goals and scope 3 emissions reported. For example, UC-Berkeley and Cornell aspire to reach carbon neutrality by 2025, which most others schools list carbon neutrality by 2050. The table also shows high variability in carbon emissions from air travel, which is consistent with the various ways schools count and report their emissions.

It should also be noted that emissions from most of these schools are likely higher not simply because of deficiencies in data collection, but also because most schools do not include radiative forcing in their calculations. Radiative forcing (RF) is a measurement of the capacity of a GHG to affect the balance between incoming solar radiation from the sun and outgoing infrared radiation, which together determine the planet's surface temperature.[20] Put more simply, RF measures a change in the atmosphere's energy caused by GHG emissions.[21] Planes don't just give off CO_2--they also emit sulphur oxides, nitrogen oxides, black carbon, and water vapor that can form heat-trapping clouds.[22] When RF is taken into account, it's estimated that emissions from

[17] Kirk, Camille (UC-Davis). Phone Interview. 2 December 2015.

[18] Turner, Aimee (Cornell University). Phone Interview. 26 February 2016.

[19] Sustainability Tracking, Assessment & Rating System. "STARS Participants & Reports." https://stars.aashe.org/institutions/participants-and-reports/. Web. Accessed 5 March 2016.

[20] Stockholm Environment Institute. "Radiative forcing." http://www.co2offsetresearch.org/aviation/RF.html. Web. Accessed 4 March 2016.

[21] Ibid.

[22] Aschwanden, C. "Every time you fly, you trash the planet — and there's no easy fix." FiveThirtyEight. http://fivethirtyeight.com/features/every-time-you-fly-you-trash-the-planet-and-theres-no-easy-fix/. Web. Accessed 8 March 2016.

aviation can produce roughly 2.7 times the warming effects of CO_2 alone.[23] Of the schools listed, only Cornell includes RF in its emissions calculations.[24]

1.3.4 Air Travel at UW

The latest official accounting of scope 3 emissions at UW puts emissions at 17,813 MTCDE (2014).[25] For 2014 and all years prior (except 2001-2004 when the school interpolated values from 2000 and 2005 measurements), UW's Utility Services office, which estimates the school's emissions, used a simple formula to calculate the carbon impact from air travel. Like similar institutions, UW does not have a central travel database from which to pull mileage figures and must rely on reimbursement data. Following ACUPCC's suggestion, UW uses a factor of $.25 per passenger mile (pm) to estimate the number of miles traveled, meaning that for every dollar spent on air travel, it is estimated that four miles are traveled.[26] Total miles are then multiplied by an emissions factor of 0.195 kg CO_2/pm to determine the total amount of CO_2 emitted.[27] This method does not account for other GHGs emitted by air travel.

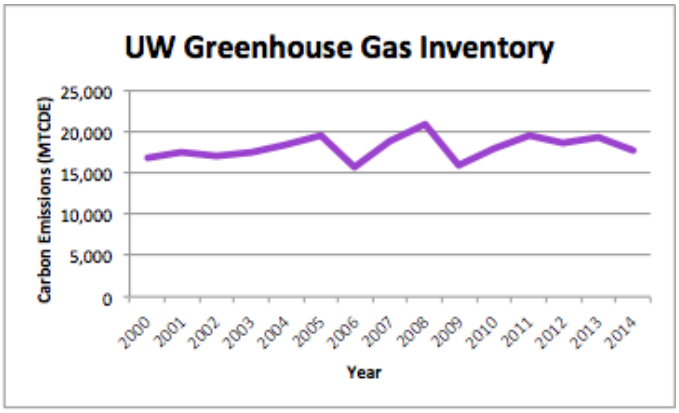

Figure 2, UW Greenhouse Gas Inventory, 2000-2014 (Source: UW GHG Inventory)

As Figure 2 shows, UW estimates of professional travel from 2000 to 2014 have fluctuated between roughly 15,000 and 21,000 MTCDE.[28] While it is encouraging that the trend does not indicate a steady increase in air travel emissions over time, the numbers reported in Figure 2 are likely much lower given the method of scope 3 accounting to date and the absence of RF warming effects.

The next section will detail the methodology used to aggregate data from the Travel Office to create a more accurate representation of UW's air travel footprint.

[23] Intergovernmental Panel on Climate Change (IPCC). "Aviation and Global Temperature." http://www.ipcc.ch/ipccreports/sres/aviation/index.php?idp=64. Web. Accessed 12 March 2016.
[24] Cornell University. "2013 Climate Action Plan Update & Roadmap 2014-2015." 2013.
[25] UW Sustainability. "Sustainability Metric: Greenhouse Gases." http://green.uw.edu/dashboard/greenhouse-gases. Web. Accessed 11 March 2016.
[26] Hammerschlag, Roel. Phone Interview. 2 March 2016.
[27] Ibid.
[28] UW Sustainability. "Sustainability Metric: Greenhouse Gases." http://green.uw.edu/dashboard/greenhouse-gases. Web. Accessed 11 March 2016.

2.0 METHODOLOGY

Stacey's report combined the eTravel and CTA data from FY 2013. He calculated the distance between cities to determine total miles traveled and ran the numbers through several carbon calculators to define a range of possible emissions outputs. ACUPCC recommends using the Clean Air Cool Planet method, which is included with several others in a table in Appendix 2**.**

2.1 DATA COLLECTION

2.1.1 Travel Data

All air travel data was provided to the project team by the UW Travel Office. We received electronic reports generated by the CTA and eTravel systems that listed each flight booked or reimbursed during FY 2014. The eTravel report on non-UW affiliates (those not employed by UW whose tickets were paid for by the university) also included data going back to 2011, but these were excluded from our analyses to maintain consistency. Both CTA and eTravel data listed the date and origin and destination airports of each flight reported under the system. The CTA data also included the department, while eTravel only revealed whether or not the flyer was a student or an employee of UW. See the "Limitations" section (Section 3.3) for a discussion on how individual flyers sometimes reported their data in unhelpful ways. The raw data files we were provided are also available on the project website.[29]

2.1.2 Surveys and Interviews

We surveyed UW faculty and staff to obtain a representative sample of flying habits at UW, with a particular focus on top-flying departments (by most total miles traveled). We then interviewed a handful of faculty to gather contextual information from individual flyers within these departments. In general, both our survey and interview sampling designs were targeted at representative samples, but the responses we actually collected were dependent on respondents' availability. Given limited availability and time, we elected not to include study abroad and athletics in our surveys and interview process. More detail about this can be referenced in the Limitations section.

Surveys

In developing questions for faculty and staff surveys, we used a stratified sampling design containing a few specific demographic categories of interest (age, department) as identifiers. We did this to strike a balance between collecting sufficient information to facilitate comparison of financial travel data and survey responses while protecting respondent anonymity. The

[29] https://sites.google.com/site/uwairtravel under "Project Documents"

Institutional Review Board (IRB) determined this project to be exempt from requiring IRB approval.

We then piloted our survey by testing questions on representative faculty to ensure we included relevant topics in an easy-to-understand format. Separate surveys were generated for faculty and staff using Qualtrics software and sent them to department coordinators of UW's 30 top-flying departments, who in turn distributed to faculty and staff. Given the departments we targeted, our results may not be representative of an average UW faculty or staff member. Appendices 4 and 5 contain faculty and staff survey questions.

Interviews

We used a semi-structured interview design in order to formulate questions that were "sufficiently structured to address specific topics related to the phenomenon of study, while leaving space for participants to offer new meanings to the study focus."[30] More specifically, the semi-structured approach aims to capture data that can then be codified in order to explain behavior according to predetermined categories (structured) while employing a less rigid framework to establish rapport and focus on understanding (unstructured). Because it is a hybrid method, semi-structured interviews can contain open-ended questions combined with targeted, theoretically-driven questions. Appendix 6 contains faculty interview questions.

We interviewed one staff and five faculty members from the following departments (rankings according to total air miles traveled are in parentheses): Global Health (#1), Information School (#21), School of Aquatic and Fishery Sciences (#24), Civil and Environmental Engineering (#29), Atmospheric Sciences (not ranked in the top 30), and one staff member from the Applied Physics Lab (#13).

2.2 DATA ANALYSIS

2.2.1 Travel Data

The CTA and eTravel Data was provided in a variety of Excel spreadsheets, which were compiled into a single database using MATLAB.[31] In MATLAB, the first step was to check for "problem" entries. An entry was deemed problematic if it took the same person on the same route on the same day, had the same origin and destination airport, or one of the airports could not be found on a database of every airport in the world. Duplicate trips were deleted, while the other two types of problems were stored in a spreadsheet for future reference. The data compilation also

[30] Galletta, A. and W.E. Cross. 2013. *Mastering the Semi-Structured Interview and Beyond: From Research Design to Analysis and Publication*. New York: NYU Press.

[31] See Appendix 2 for a full description of all MATLAB scripts referenced in this section, as well as a guide to the output files they produced.

included pinpointing airport locations. The airport database we used included the latitude and longitude of each airport, which we added to our dataset and calculated the shortest distance between the airports using the Haversine Formula.[32]

Once we had an accurate and unified dataset, we were able to perform a number of analyses. To determine top individual flyers, we wrote scripts to count the number of flights attributed to each individual and to each department. As noted in Section 2.1.1, the eTravel data did not include department, so we simply recorded the type of UW affiliation. For routes, we decided that direction of flight did not matter and counted the number of flights between two airports as the total trips for that route, regardless of direction. We further organized each route by the departments that flew it most. We also sorted trips into lists by month, distance (using EPA definitions of <300, 300-2300, and >2300 miles for short-, medium-, and long-haul flights, respectively),[33] domestic vs international, and method of booking. For each of these categories, we calculated number of trips, distance flown, and GHG emissions.[34]

2.2.2 Surveys and Interviews

Surveys

We generated descriptive statistics for responses to each survey question, including mean, median, mode, and standard deviation. To demonstrate the most common answers, faculty and staff responses are presented according to percent of respondents that provided specific answers to each survey question. We also ran a number of t-tests using SPSS to explore possible correlation between variables and identify trends using alpha=0.05 as our level of significance.

Interviews

We organized responses according to predetermined categories to draw out common themes in attitudes and opinions regarding professional air travel.

[32] A standard mathematical method for calculating distances along the surface of a sphere.

[33] EPA Center for Corporate Climate Leadership. “Emission Factors for Greenhouse Gas Inventories.” 19 Nov. 2015.

[34] EPA Center for Corporate Climate Leadership, 2015.

3.0 RESULTS AND DISCUSSION

3.1 TRAVEL DATA

Our analysis of the travel office data showed that in FY 2014, UW was responsible for 84,075 flights totaling 136 million miles and emissions of 23,811 MTCDE.

3.1.1 Frequent Routes

We ranked frequent routes by both mileage and number of trips. By both measures, the top 10 routes included Seattle as one endpoint, with the exception of the ninth highest mileage route, which fell between Johannesburg and Atlanta (2,202,930 miles). The top five routes by each measure are presented in Tables 1a and 1b. An overview of domestic flights to and from Seattle (including any routes flown six or more times), as well as all international flights (routes flown five or more times), are presented as maps in Figures 3 and 4, respectively.

Rank	City	Distance flown (Miles)
1	Amsterdam	5,661,097
2	Washington, D.C.	5,651,692
3	Chicago	4,837,943
4	Boston	3,890,424
5	Atlanta	3,515,358

Rank	City	Number of Trips
1	San Francisco	3,135
2	Chicago	2,819
3	Washington, D.C.	2,433
4	Los Angeles	2,043
5	Denver	1,971

Table 1a and Table 1b, Cities flown to from Seattle ranked by a) distance and b) number of trips

Figure 3, map of all domestic flights to or from Seattle in 2014 paid for by UW, on routes flown 6 or more times

We Identified two cities from our top routes that represent areas where our air travel emissions could be reduced: Washington, D.C., and Chicago. Both cities are among the five top routes by both mileage and number of trips, but they appear for very different reasons.

Washington, D.C., is a unique destination because it is a center not for major conferences or research, but for federal funding and regulatory agencies. One finding from our interviews is that informal interactions at conferences are hugely valuable for forming collaborative relationships with other researchers. This is a major reason why scientists continue to attend conferences in-person despite advances in videoconferencing. However, those faculty we spoke to believed that these sorts of opportunities were less available at meetings with funding agencies. This points towards opportunities to replace trips to DC with videoconferences, or with smaller meetings at regional offices of the federal agencies.

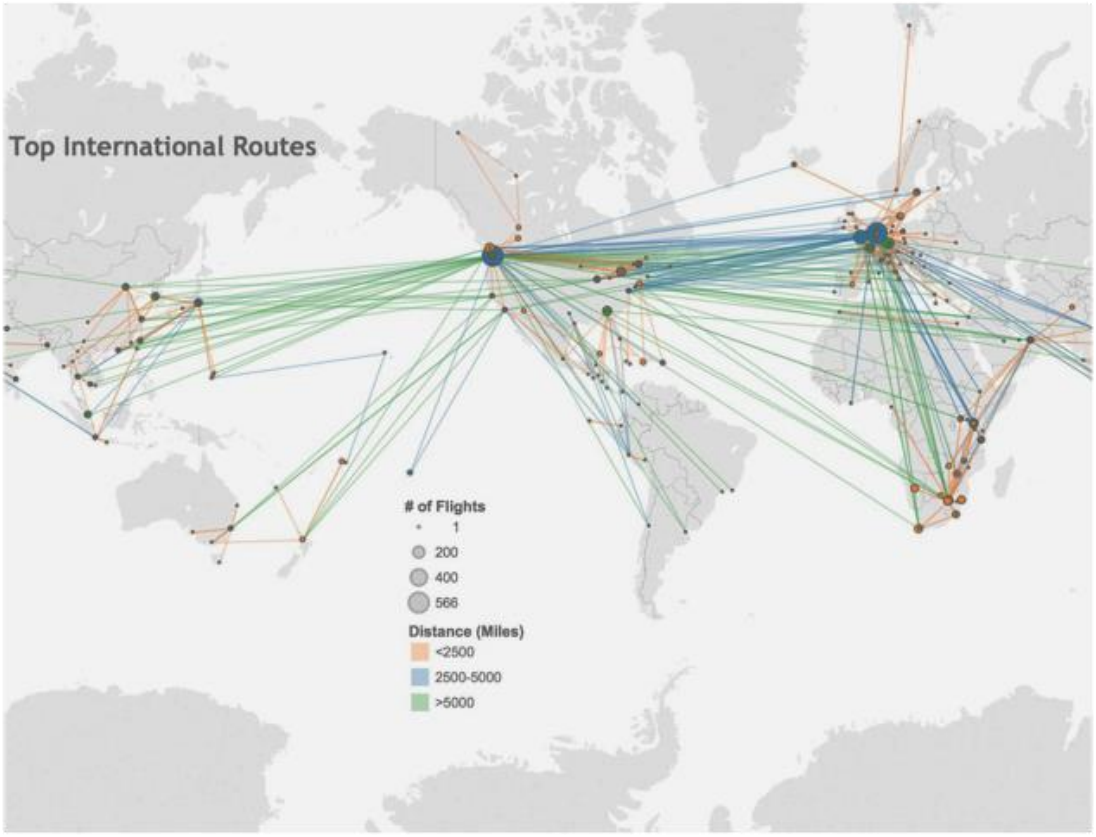

Figure 4, map of all international flights paid for by UW in 2014, on routes flown five or more times

Chicago is representative of the more general problem of taking indirect flights. Both analyses of the raw travel data and the survey data indicate Chicago is more often a hub for connecting flights than it is a destination. Direct flights emit far less carbon than an indirect flight with the same endpoints, so encouraging direct flights could be a way to significantly reduce emissions.

When categorized by distance, we found that short-haul flights accounted for 9,924 flights, totaling 1,868,173 miles and 474 MTCDE. There were 56,203 medium-haul flights totaling 63,151,859 miles and 9,119 MTCDE and 23,958 long-haul flights totaling 84,285,994 miles and 14,218 MTCDE. This data is presented in Figure 5.

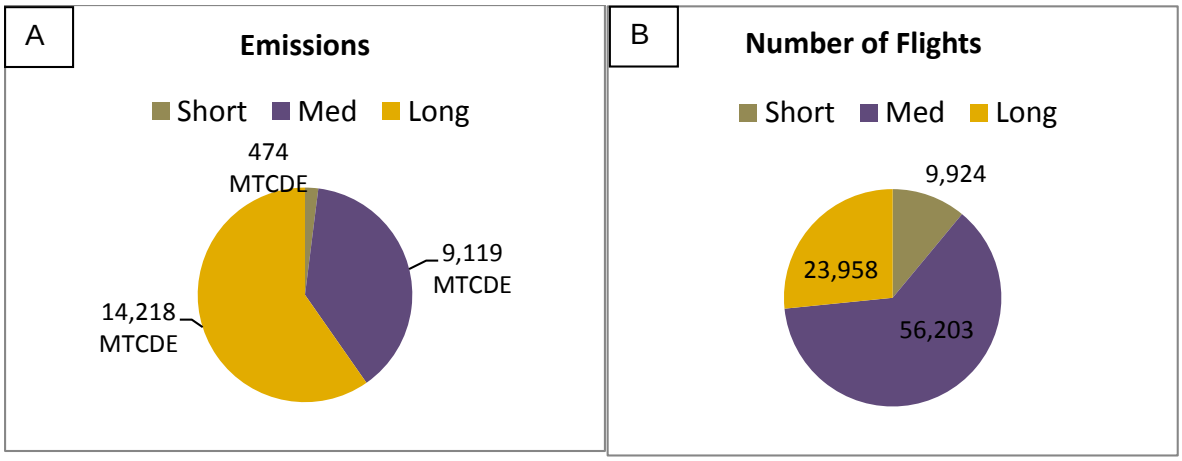

Figure 5, Categorization of a) emissions and b) flights by EPA distance category: short (<300 miles), medium (300-2300 miles) and long (>2300 miles)

Short-haul

The top three short-haul routes by a wide margin were from Seattle to Spokane (1,998 flights, 445,670 miles), Portland (697 flights, 90,100 miles), and Pullman (458 flights, 114,200 miles). No other short haul route had over 270 flights or over 50,000 miles. Seattle was the most significant hub for short-haul flights, and all routes flown from it are shown in Figure 6, but short-haul flights do happen elsewhere. Examples of other common short-haul flights include Johannesburg, South Africa to Maputo, Mozambique (159 flights, 42,778 miles) and Minneapolis, Minnesota to Madison, Wisconsin (143 flights, 32,525 miles).

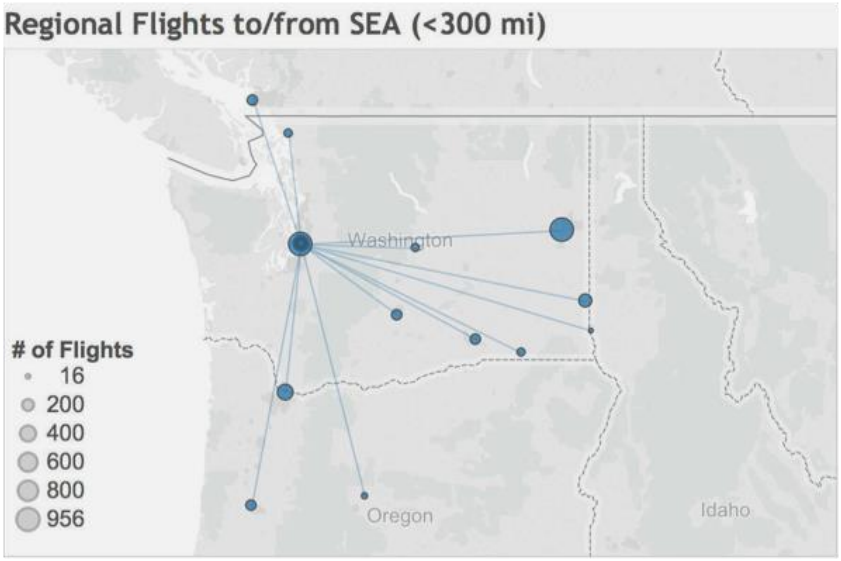

Figure 6, flights under 300 miles to or from Seattle in 2014 paid for by UW

3.1.2 Frequent Flyers

Categories

We ranked categories by the distance flown, and each category was labeled with either the department or type of UW affiliation, depending on which dataset from which we the trip was pulled. Five of the top ten were all departments or programs that operate in close collaboration.

These categories include International Training & Education Center for Health, the HIV Vaccine Trials Network, Health Metrics and Evaluation, The Department of Global Health, and the HIV Prevention Unit. We categorized them together as "Global Health and Related Departments," and they collectively accounted for 7,823 trips and 19,111,675 miles of air travel. The next largest CTA category was the Center for Educational Leadership, which was interesting because they travelled shorter than average distances, with an average flight of only 891 miles. However, they did fly 2,611 trips in 2014, giving them the 2,325,713 miles and putting them in the second highest CTA category. The top ten CTA categories were rounded out by the Jackson School for International Studies (585 trips, 1,597,754 miles), The Bothell Campus (921 trips, 1,402,842 miles), The Biochemistry Department (894 trips, 1,401457 miles), and International Programs and Exchange (404 trips, 1,189,103 miles), which manages study abroad programs for students.

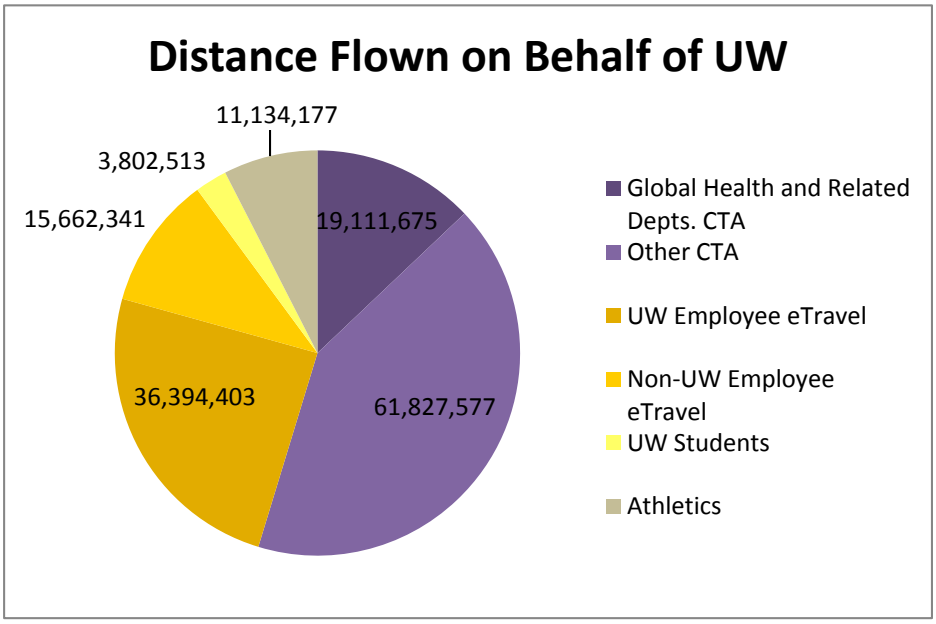

Figure 7, Distance flown in 2014 paid for by UW, by category of flyer

While Global Health and related departments are responsible for more emissions than other departments, our survey and interview responses indicate that they fly so much because they are doing a huge amount of work in regions of sub-Saharan Africa that are in dire need of public health improvements. We had originally tried to identify top flying departments and individuals to see if they had a culture of excessive flying, but instead found that those who fly the most dislike it the most and attempt to fly only when it is necessary.

The amount of non-UW affiliates paid by UW to fly to campus was initially surprisingly large. However, once our survey revealed that 44 percent of the flying our faculty respondents do is reimbursed through non-UW channels, it became clear that universities fly other institution's researchers around quite often, for example to interview for positions or give guest lectures.

Individuals

Because we used financial data, the individuals we identified may not be those who actually flew, but instead those who booked or paid for the trips. From the eTravel data, we had many department travel coordinators who were associated with hundreds of flights a year, up to 522 flights and 1,417,374 miles for our "top flyer." The CTA data gives slightly more realistic numbers, showing a top flyer by distance as a Professor of Genome Sciences with 109 flights for 202,316 miles. In addition, 35 individuals showed over 50 CTA trips, and nine individuals reported over 100 (one individual from the Center for Educational Leadership reported 171 trips). We were unable to verify if these trips were all actually taken by the person named, or if some of them were instead taken by graduate students or others operating under the budget of the person named on the CTA account.

3.1.3 Frequent Months of Travel

Travel at UW in 2014 did not have a strong seasonal pattern, except for a lull during January and December. These months had less than 4,750,000 miles each, while the other ten months all had between 9,000,000 and 16,000,000 miles.

3.2 SURVEYS AND INTERVIEWS

Results and discussion of surveys and interviews are discussed below. Each subsection begins with a brief reasoning for asking each question, key findings from survey results, and, where appropriate, the implication of these results using anecdotal evidence from interviews for context.

Faculty and Staff Surveys

We received responses from 97 faculty and 156 staff. "Faculty" refers to those who teach (e.g. professors, lecturers) while staff "refers" to salaried employees (e.g. administrative, field and lab technicians). Faculty respondents tended to be older (31% were over 60), while staff respondents were younger on average (40% were 30-39 years old). Some respondents did not answer all survey questions, or only answered certain questions without completing the survey, so the results show different sample sizes for each question. We received responses from 29 total departments for the faculty survey and 24 total departments for the staff survey, 10 of which ranked as one of our 30 top-flying departments. Faculty responses came mostly from Humanities (15%), Global Health (13%), and Oceanography (12%). Among staff, most responses came from Global Health (31%), JISAO (15%), and Genome Sciences (11%).

Number of flights taken in 2015

Sixty-five percent of staff reported taking one to four flights in 2015, with one flight being the most common response (26%) (See Figure 8). The staff survey data contained three outliers: one respondent reported 12 trips, another reported 13, and a third reported 60. Fifty-five percent of faculty reported taking three to seven flights in 2015, with four flights the most common response (13%). The faculty survey data contained four outliers: two respondents reported 16 trips, another reported 20, and a fourth reported 30. These outliers were removed from data represented in Figure 8.

On average, UW faculty reportedly flew more than staff in 2015. Further, the majority of both faculty and staff respondents reported this number of trips as representative of a typical year, implying that in a given year faculty take more flights than staff.

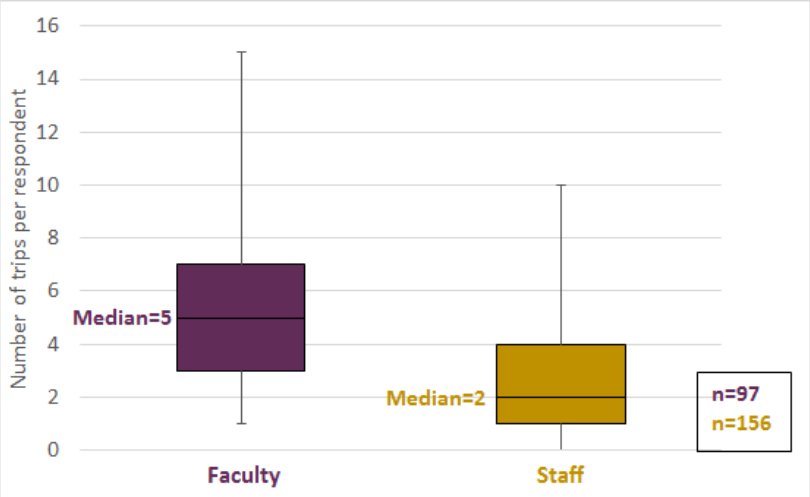

Figure 8, Number of flights taken in 2015. The error bars contain 95% of data points

Common destinations and layover hubs

Common destinations reported by both faculty and staff respondents were highly varied among respondents. Many respondents named "Varies" as their common destination (21% of faculty, 31% of staff), followed by D.C. (31% of faculty, 12% of staff). Similarly, common layover hubs were highly varied, with "Varies" the most common response (27% of faculty, 39% of staff), followed by Amsterdam (9% of faculty, 17% of staff) and Chicago (18% of faculty, 12% of staff).

Despite high variability in destinations (which may be due to factors such as alternating locations of annual conferences and variability in field work sites), survey responses supported and verified observations made with the financial travel data. Namely, there is high variability in where people are going, D.C. is a common destination, and Chicago, San Francisco, and Amsterdam are popular layover hubs.

Direct versus connecting flights

On average, faculty reportedly took a higher percentage of direct flights (61%) than staff (44%) (see Figure 9). This may be related to differences in how flights are funded--faculty often pay for flights using grant money and thus have more direct control over how much they'll pay for tickets, while staff often use university funds and thus may be encouraged to book the cheapest flight, which are typically connecting flights. It is worth noting that both respondent groups exhibited high standard deviations, indicating wide variance in responses.

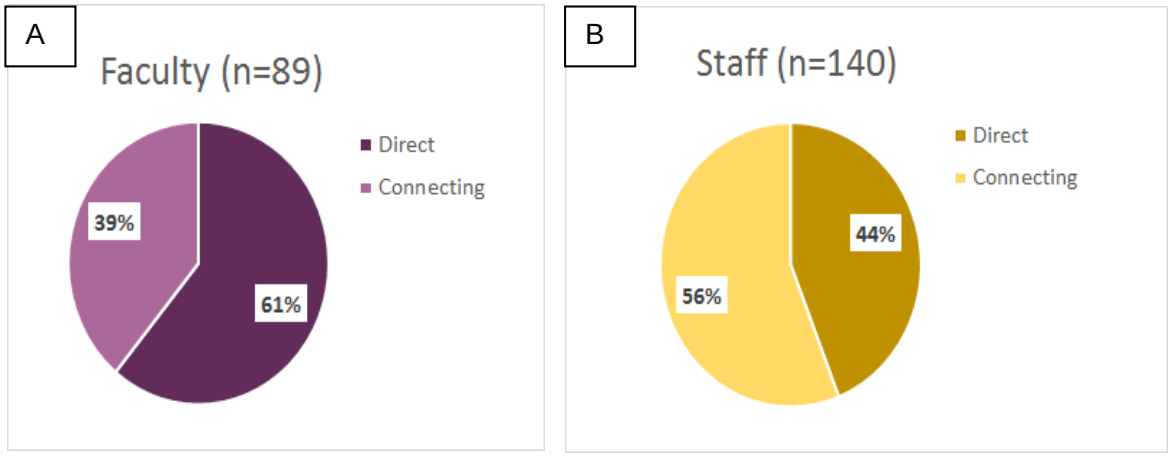

Figure 9, Percent of a) faculty and b) staff reporting average percentage of direct v. connecting flights.

Reimbursed by UW versus non-UW

On average, respondents reported most of their flights being reimbursed by UW (56% for faculty, 73% for staff) (See Figure 10). Both groups demonstrated large standard deviations, implying that reimbursement varies widely among respondents. The relatively higher percentage of staff being reimbursed by UW likely relates to the differences in paying for flights mentioned above. Despite most faculty and staff reportedly being reimbursed mostly through UW, a noticeable percentage report being reimbursed by outside sources (for example, another university flying a professor out to give a talk). This is particularly apparent for faculty; just under half reported being reimbursed by outside entities. This is notable because it implies that UW employees may be doing a significant amount of "professional travel" that is not paid for through UW channels. Under current definitions, this falls outside our definition of scope 3 emissions, but it is worth considering whether the university wants to take responsibility for these emissions in the future.

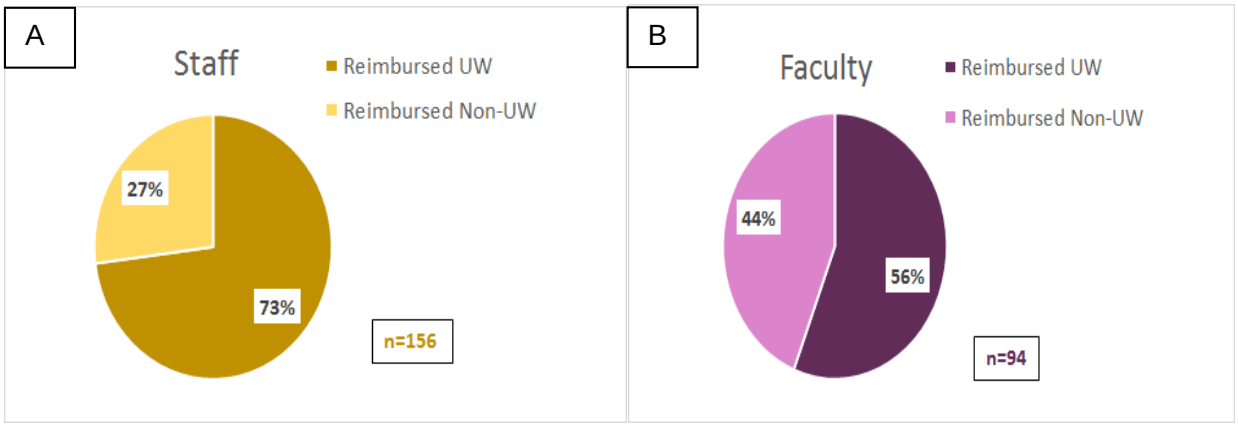

Figure 10, Percent of a) faculty and b) staff reporting average percentage of flights reimbursed by UW v. non-UW.

Percent of flying stated as necessary for work

Most respondents stated 76-100% of the flying they do for professional reasons to be necessary for work (52% of faculty, 60% of staff) (See Figure 11). There was a noticeable difference between faculty and staff in the stated necessity of flying for work, with a 21% of staff reporting only 0-25% of the flights they take to be necessary for work. This could reflect different reasons for travel and the perceived necessity of travel associated with those tasks. For instance, field technicians are likely to rank their travel as very necessary – they have to physically be at a specific location to carry out tasks such as deploying oceanic instruments and administering vaccines. However, the director of a department may view flying across the world to attend a conference as less necessary. On the other hand, 87% of faculty stated more than 50% of flying as necessary for work. According to one faculty interviewee, "You cannot do your job effectively if you want to interact with the international scientific community by sitting in your office. That's where the action is. You just have to be there."

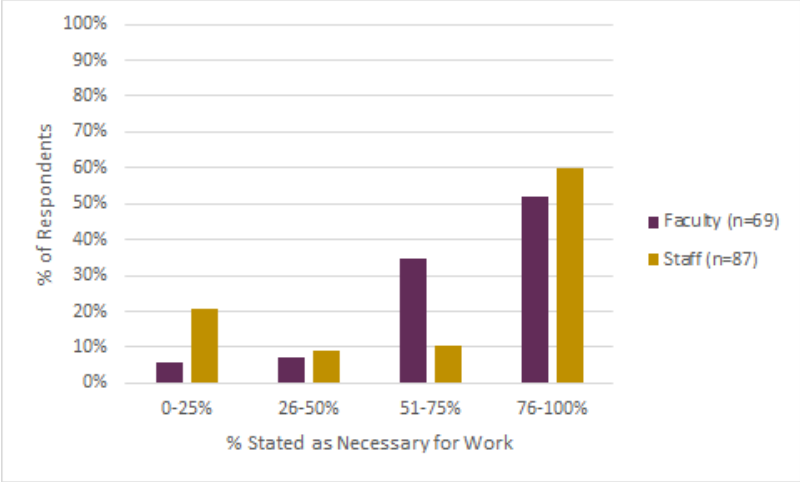

Figure 11, Percentage of flying stated as necessary for work by faculty and staff

These varying levels in perceived necessity highlight the importance of understanding different reasons for faculty and staff flights and their associated perceptions of importance, as this will impact their attitudes and opinions toward whether or not they can change their flying habits.

Factors when booking air travel

Most faculty ranked saving time as being of the utmost importance when booking air travel, while saving money is of medium importance (see Figure 12). Very few respondents reported their carbon footprint as an important factor when booking a flight. Staff appeared to place slightly more importance on saving money than did faculty. This is unexpected considering many faculty pay for flights using their own grants, which they could use for research purposes, while staff often have a less personal stake in their budgets. This may imply pressure from the university to book the cheapest flight, but our staff interviewee indicated that is not the case.

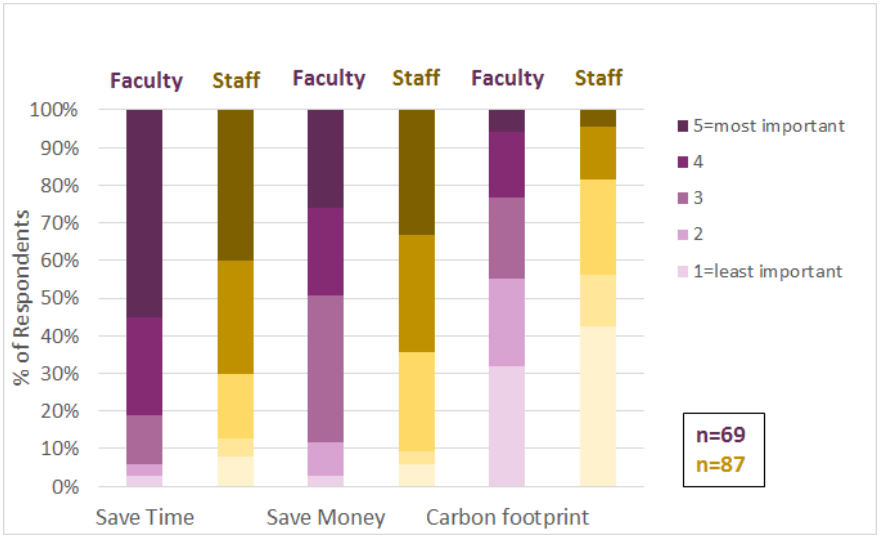

Figure 12, stated importance of various factors in booking air travel

Expressed likelihood of using alternatives to flying

Because videoconferencing and taking ground transportation for shorter trips (under 300 miles) are two key alternatives to flying, we asked respondents about their likelihood of using these modes in lieu of flying.

Most faculty (49%) and staff (53%) reported being 'very likely' to use videoconferencing as an alternative to flying (See Figure 13). However, during our interviews several respondents noted person-to-person interactions that cannot be replaced by videoconferencing, such as interacting with colleagues and small

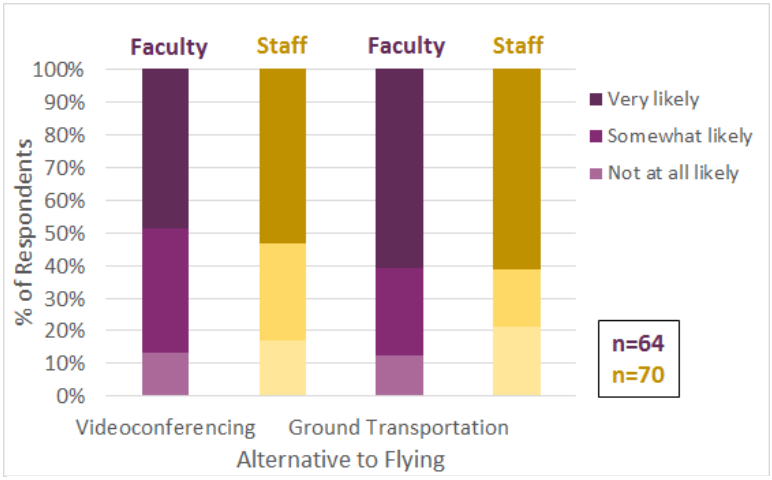

Figure 13, stated likelihood of using alternatives to air travel

talk while grabbing a cup of coffee between sessions. According to one interviewee, “You would lose all the schmooze time.”

Sixty-one percent of both faculty and staff reported being ‘very likely’ to use ground transportation for shorter trips (<300 miles) as an alternative to flying.

Stated reasonable distance

Most faculty (80%) and staff (74%) reported 100-300 miles as a reasonable distance to travel via ground transportation as an alternative to flying (median=200 miles) (See Figure 14). Recall that 61% of both respondent groups stated they would be ‘very likely’ to use ground transportation in lieu of air travel. Given that taking ground transportation is suggested as a way to reduce emissions from flying, these findings suggest UW employees would be willing to drive for trips averaging 200 miles instead of flying, replacing short-haul flights with ground transportation.

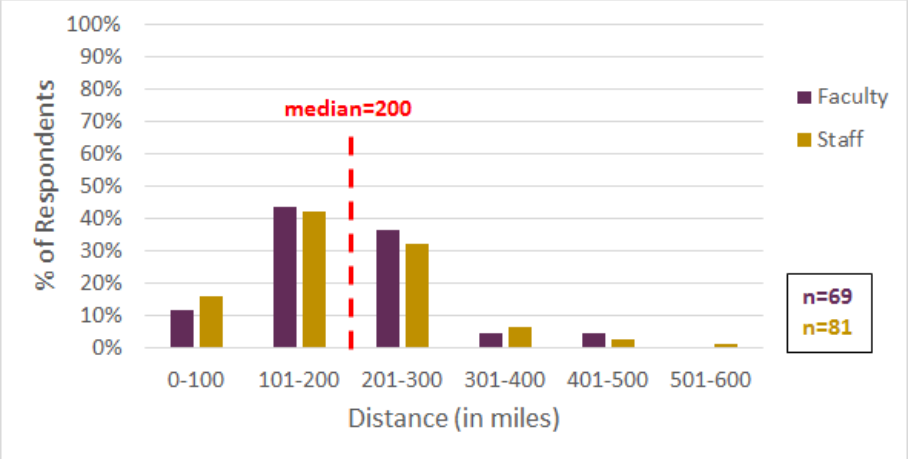

Figure 14, stated reasonable distance to travel by ground transportation instead of flying

Faculty Only Survey

We asked three additional questions of faculty (see Appendix 4 for faculty survey questions).

Reasons for flying

Figure 15 lists the key reasons faculty fly and the perceived importance faculty ascribe to each. Attending conferences was stated as ‘essential’ by

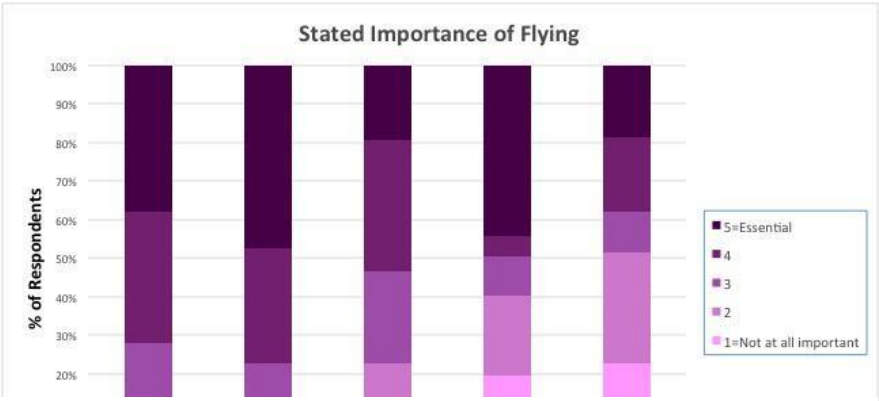

Figure 15, stated importance of flying for each of the following reasons: meeting with colleagues, attending conferences, giving a guest lecture, conducting research (e.g. field work), and attending a funder meeting such as an NSF panel in D.C.

most respondents (47%), followed by conducting research/field work (44%), and meeting and collaborating with colleagues (38%). Stated importance of the other two listed reasons (giving a guest lecture and attending a funder meeting) were roughly considered by faculty to be of medium importance. Other reasons listed by respondents included participation in working groups, sitting on another institution's advisory board, site visits for study abroad, and attending executive committee meetings of professional organizations.

Videoconferencing ease of use

Fifty-three percent of faculty have never used campus videoconferencing facilities, which may indicate a lack of interest or unawareness of the availability of such facilities (See Figure 16). Of those faculty that have used videoconferencing outside their office, 42% found it easy or moderately easy to use, and only 5% found it difficult to use. This suggests that the issue is less difficulty of use and more one of convenience, comfort, or apathy. Our interviews provided more insight on this point. One professor in the Atmospheric Sciences department claimed that, while he has tried to make more use of videoconferencing facilities, it has not coincided with less flying. Other interviewees cited cost as a top concern, and reported that some departments make video conferencing facilities available for free, while others charge a significant fee.

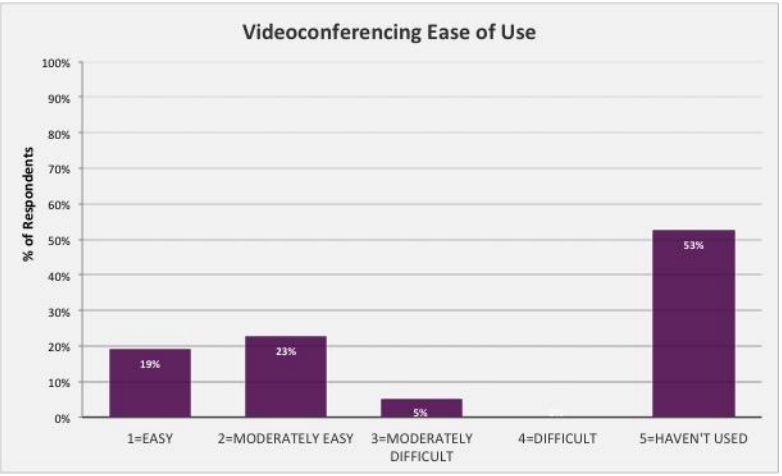

Figure 16, stated ease of locating and using on-campus videoconferencing facilities by faculty.

Carbon offsets

To achieve carbon neutrality, UW will inevitably have to invest in some kind of offset program. With this in mind, we wanted to get a sense of faculty awareness around carbon offsets, whether they've been offered them, and how much they'd be willing to pay if they had flexibility in spending grant money.

Seventy-four percent of faculty reported having never been offered carbon offsets when booking a flight (See Figure 17). Of those who reported being offered offsets, only 22% purchased them, mostly out of a sense of guilt. The open-ended response question in our survey yielded a great deal of rich feedback from faculty, most of it questioning the validity of offsets. Some respondents raised concerns about offsets as a "feel good" solution, or that they merely benefit those running the trading program rather than local populations working to safeguard a carbon sequestering forest, for example. The CAP expressly mentions utilizing a carbon offset program to offset most of its scope 1, 2, and 3 emissions that cannot be reduced through other means, so strong faculty opinions against the use of offsets is an obstacle UW must eventually overcome. One caveat is that the relatively small size of this sample, and the anti-carbon offset responses mostly from high respondent departments that work in the environmental field (e.g. Civil & Environmental Engineering and Oceanography) may skew the results negative.

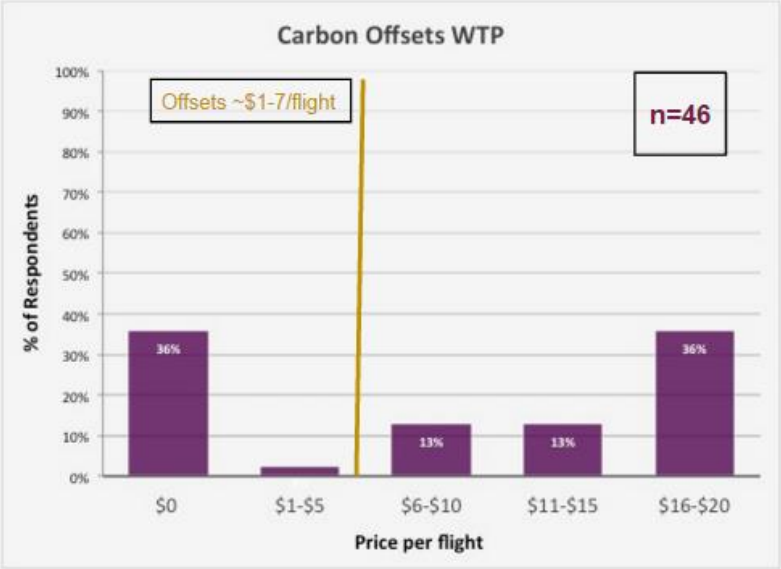

Figure 17, stated willingness to pay for carbon offsets when booking a flight by faculty

Offsets typically cost $1-7 per person, and price per person varies depending on whether he/she is taking a short-, medium-, or long-haul flight.[35] Interestingly, 72% of faculty reported a willingness to pay either top dollar ($16-20) or nothing at all per flight for carbon offsets (See Figure 17). Many faculty mentioned that federal grants do not reimburse the purchase of offsets, a major impediment for those who want to offset their carbon but have no financial incentive to do so. Still others were unaware that carbon offsets existed. Perhaps most importantly, a number of faculty respondents recognized that the best way to reduce one's carbon footprint is not to fly at all. This idea was borne out time and again in our interviews.

[35] Based on offset price per MTCDE from TerraPass (http://www.terrapass.com) as of March 2016 and our calculation of emissions per person per flight, calculated from EPA guidelines for emissions per person per mile (Environmental Protection Agency Center for Corporate Climate Leadership. "Emission Factors for Greenhouse Gas Inventories." 19 Nov. 2015.)

T-Test Results

Many of our sample sizes were too small and thus lacked statistical power. Despite this, we did identify a few significant relationships, which are discussed below. Tables including all research questions and associated t-tests can be found in Appendix 7.

Younger staff (< 50 years of age) reported being reimbursed by UW significantly more (78% of flights purchased, on average) than did older staff (>/=50 years of age) (63% of flights purchased, on average) (p=0.05). Older faculty reported significantly longer distances (249 miles, on average) as reasonable to travel via ground transportation than did younger faculty (202 miles, on average). Specifically, older faculty reported a willingness to take ground transportation an average of 47 miles further than younger faculty (p=0.05). We asked if tenured faculty reported being more willing to pay more for carbon offsets and, despite the average carbon offset price being higher for tenured faculty ($10.64) than non-tenured faculty ($6.00), the results were not significant. This may have been due to a very small sample size for non-tenured faculty (n=6).

Faculty and staff in environmental departments reported taking significantly more direct than connecting flights. On average, staff respondents in environmental departments take direct flights 59% of the time (compared to 42% of the time in other departments) (p=0.02) and faculty in environmental departments take direct flights an average of 71% of the time (compared to 56% of the time in other departments) (p=0.04). Staff in environmental departments reportedly were willing to travel significantly longer distances (260 miles, on average) via ground transportation than were staff in other departments (206 miles, on average) (p=0.02). Significantly more staff from environmental departments reported having been offered carbon offsets than those from other departments (p=0.02). Still, the overall percentages of respondents having been offered carbon offsets was very low.

3.3 STUDY LIMITATIONS

Travel Data

The primary limitations we encountered with the travel data stemmed from the fact that the data reported to the travel office was of variable quality and content. While CTA provided only the department paying for the trip and not whether the individual was an employee or student, eTravel reported only what class of traveler it was and did not provide departmental data. Within each of these datasets, there were issues with how individuals reported their data to the travel department. Some errors rendered data unusable, some simply made it less reliable.

Our unusable data came in three forms. Many flights included destination airport codes that do not correspond to any airport on the international airport directory we used. Some of these appear to be typos, others appear to be small regional airports that are not listed in the registry.

Still other small regional airports (generally in developing nations) do not have an airport code at all, and are listed as "XXX". The final issue was flights that listed the origin and destination as the same airport, or as two airports serving the same metropolitan area (we highly doubt that 166 people actually flew 11 miles from the San Francisco Airport to the Oakland airport). We believe these cases to be people listing the origin and destination of a round trip ticket, instead of each one-way portion.

Related to the problem of people listing only the round-trip origin and destination was the problem that some people listed each flight of their trip separately, and others listed only their origin and final destination. While this interfered with our ability to analyze direct vs. indirect flights and may have impacted our overall calculations, we believe that enough people reported each leg separately that our results are still an improvement over prior methods of estimating air travel.

A final limitation of this project was our lack of access to ICA data. We attempted to contact the Athletics Department, with assistance the Sustainability Office, but we were unsuccessful in securing additional data. We did have records for ICA bookings done through CTA, but this does not encompass all ICA travel and we do not have a good sense of what portion we may be missing. However, due to the constraints of this project and the different natures and professional and athletic travel, we decided that assessing ICA travel was outside the scope of this project. Looking into athletic travel could be a good avenue for further reductions work in the future, especially since teams travel as large groups, making highly efficient ground transit a viable option.

Surveys and Interviews

We reached out to all top-flying departments in the hopes of receiving survey responses from and scheduling interviews with top flyers. Not surprisingly, many faculty and staff either did not respond or stated they were too busy.

Unfortunately, we were unable to calculate individual response rate because we could not determine our total sample size (N), which would include all faculty and staff our surveys reached. For those department coordinators that never responded to our initial email regarding distributing our surveys to departmental faculty and staff, we had no way of knowing if the surveys were either never distributed or if we simply received no responses from members of that particular department. Additionally, locating total numbers of faculty and staff per department is difficult, as they are not readily displayed on departmental web sites. Calculating total response rate as well as response rate per department would have allowed us to get a better idea of what fraction of departments are represented in our surveys. This is important because departments and/or types of departments likely display similar cultures due to commonalities in their members' attitudes and values. For example, those in environmental departments may

place high importance on environmental value given their fields of study, while those in other departments may assign less importance.

In order to highlight potential bias associated with this limitation, we draw attention to two noticeable trends in departmental representation in our surveys. First, environmental departments were well represented among respondents, which may have skewed results. Secondly, we received very few survey responses from the hard sciences (e.g. Biochemistry and Chemistry, which ranked as the 7th and 9th top flying departments according to the travel data) and were unable to schedule interviews with these faculty and staff, meaning they are not represented in our data. Because time was a limiting factor, we were unable to pursue these departments further. However, it would be worthwhile to reach out to all top 30 flying departments to obtain a more thorough understanding of the breadth of air travel attitudes among these top flyers, which could then be used to examine differences in attitudes toward flying (e.g. reasons for flying and perceived importance) by department or types of department.

It is important to keep in mind that our surveys revealed stated preferences, not real actions. This must be taken into account when interpreting results from these surveys. Faculty and staff stated preferences may differ from real actions when booking flights for a number of reasons, two of which are habits and ambivalence. Changing habits can be very difficult, and can be made even more cumbersome by ambivalence, which occurs when we experience conflicting values. For example, while UW faculty and staff may value the environment and wish to reduce their carbon footprint, they may value convenience and saving time more. This implies that a tradeoff between values exists when it comes to air travel, and stated preferences cannot be directly translated to real actions as people are likely to say one thing and do another.

Lastly, we would have surveyed and interviewed more faculty and staff to get a more representative sample of flying habits and attitudes, but could not fit additional outreach into the project timeline.

4.0 RECOMMENDATIONS

4.1 BEHAVIOR CHANGE

4.1.1 Framework

The results we have presented show a snapshot of UW air travel over 2014 (existing travel data) and 2015 (surveys and interviews). They indicate that it is possible to paint a more accurate picture of air travel at UW, and therefore to establish a baseline from which to measure the success of future reduction strategies. But beyond achieving a better understanding of the impact flying has on UW's overall emissions output, we have also sought to uncover some of the perceptions faculty and staff have around the professional travel they do on the university's behalf.

To help provide a relevant context for the air travel culture at UW and for the recommendations we present below, our team adopted the "Results Pyramid" framework from *Change the Culture, Change the Game*, a book by leading change management practitioners Roger Connors and Tom Smith.[36] The central tenets of the book include the following:

- Leaders must create the desired culture
- Culture produces results
- The most effective culture is a culture of accountability

Any change in the flying habits of UW employees must come from the top. As Connors and Smith's research shows, no change effort will succeed unless the leaders of the organization buy in. This means that the ultimate success of UW's drive to reduce air travel emissions depends on its leaders promoting the effort consistently and visibly, and removing any barriers that might prevent faculty and staff from participating. As V'Ella Warren, Senior Vice President of Facilities and Finance at UW and Treasurer of the Board of Regents, noted in a HuffPost blog in 2013, "Support must come from the President, Provost, [and] Board of Regents. If they're not totally behind sustainability efforts, higher education simply can't help drive a robust environmental agenda on or off campus."

The Connors and Smith book uses a four-tiered framework to describe how organizations can shift to a new culture that will produce the desired results (shown in Figure 18). The culture of accountability around UW air travel can only be achieved when it creates experiences that cause employees to think and act (beliefs and actions) in a manner necessary to achieve the needed result (carbon reductions outlined by the CAP).[37] We use this framework as a way to understand

[36] One of the people we interviewed, Nancy Richards, is a change management professional helping Seattle Public Utilities implement its strategic business plan. She recommended the book as a basis for understanding culture change.

[37] Connors, Roger and Smith, Tom. *Change the Culture, Change the Game: The Breakthrough Strategy for Energizing Your Organization and Creating Accountability for Results.* New York: Portfolio Penguin, 2011.

and describe our results in the context of the current flying culture at UW, and as support for our recommendations.

Figure 18, a conceptual framework for how user experience can be considered when implementing behavior change (Source: Connors & Smith, 2011)

4.1.2 Application to Air Travel

Most organizations seeking to implement a change make the mistake of focusing on the top two rungs at the expense of the bottom two.[38] In the case of air travel, it is crucial to recognize that UW employees are used to a particular experience, whether it's booking travel a certain way or attending the same conference every year, and this experience drives their beliefs and values around the travel they undertake. Without first recognizing and addressing employee experiences and beliefs (i.e. focusing on the bottom of the pyramid), they will not take appropriate actions, such as reducing travel or using alternatives, and UW will not achieve its desired result--carbon neutrality.

To be clear, UW is already among the most environmentally-conscious of any university in the world. The collective efforts of administration, faculty, staff, and students to reduce scope 1 and 2 emissions have made UW into a leader in sustainability. Great strides have been made in other areas of UW travel to adjust habits and promote behavior change. For example, UW Transportation Services is working on changing the commuting habits of staff, faculty, and students, by identifying barriers and benefits to using different modes of travel. The

[38] Connors, Roger and Smith, Tom. *Change the Culture, Change the Game: The Breakthrough Strategy for Energizing Your Organization and Creating Accountability for Results.* New York: Portfolio Penguin, 2011.

Transportation Climate Action Strategy report, based largely on proven social marketing approaches, can be applied to developing strategies aimed at reducing UW air travel emissions.[39]

4.2 UNIVERSAL BOOKING SYSTEM

Recommendations

- Provide greater support and awareness for the Travel Office's efforts in piloting Christopherson's Airportal system.
- Simultaneously market the system as one way UW plans to achieve its goals of more accurately accounting for and reducing its emissions from air travel.

Supporting Detail

Currently, UW has no unified system for booking air travel. The faculty and staff we heard from have become accustomed to using whatever booking experience works for them. This variety of experience will necessary effect a variety of responses to any policy change, most of them negative. Many faculty we spoke to said that they personally booked travel in whatever way is most convenient way to them. This presents the dual challenge of creating policies that are easy to follow while convincing users of that ease of use. Low buy-in from faculty and staff and a general lack of policy enforcement across the university is not likely to result in needed behavior change. Still, faculty and staff following unified procedures to enhance tracking is necessary for the new tracking methods to accurately capture the GHG emissions associated with UW air travel.

The UW CAP is clear on the necessity of improving the monitoring of air travel emissions in order to accurately measure the efficacy of reduction strategies. One of the strategies it lists for improving the process is "to obtain a more accurate, time-sensitive, cost-to-mileage conversion factor." As this report has shown, that is no longer necessary since our method produces a more accurate estimate that is 33 percent higher than the most recent UW estimate of 17,813.[40] Even our measurement is not perfectly precise, for the reasons laid out in section 3.3.

A second step recommended by the CAP to improve accuracy is to record all air travel destinations in a central database with a coded system that allows automated calculations of trip length. This would likely require additional administrative staffing, which UW may not have resources to provide. Moreover, the Travel Office is already taking steps to remedy data collection issues. For the past year, the office has been in conversations with Christopherson Business Travel, a leading travel management and planning firm, and piloting its Airportal system

[39] UW Transportation Services. 2014. Climate Action Strategy for Transportation. http://www.washington.edu/facilities/transportation/files/reports/cast-020415.pdf.
[40] University of Washington. "2015 Greenhouse Gas Report." http://rs.acupcc.org/ghg/3336.

with select UW employees. The roll-out of this new system provides many opportunities to encourage widespread adoption. For example, if Airportal can be made to interface with Ariba, which UW currently uses, and allow a single transaction to both purchase the ticket and request reimbursement, this would save the traveler from having to fill out a separate set of paperwork after buying the ticket. This is the type of added convenience that would cause faculty and staff to want to use the new system, aligning their incentives with the university's goal of better emissions tracking.

4.3 ALTERNATIVES TO FLYING

4.3.1 Flying Less

Recommendations

- Pursue a more robust travel policy tied to a universal booking system. If UW employees can see the emissions associated with each flight they take, they will be more likely to consider their impact.
- Encourage faculty to sign the petition being circulated by the Tyndall Centre for Climate Change Research.[41] This will provide formal recognition of faculty's role in perpetuating frequent air travel, and pledge cosigners to reduce their travel whenever possible.
- Partner with other universities on a joint request to large funding agencies asking them to formally recognize the high emissions costs associated with flying to Washington, D.C.
- Advocate for and promote regional conferences that carry a lower carbon footprint.

Supporting Detail

As our survey results indicate, over half of faculty and staff state that the majority of flying they do (75-100 percent) is necessary for their job. In other words, their experience on the job reinforces a belief that foregoing flying is not an option. Further, over 70 percent of faculty respondents suggested that flying to conferences or to meet and collaborate with colleagues was either essential or very important to their work. For most, academic travel has become so ingrained in their experience that they have little choice but to rationalize the impact their actions have on the planet (fewer than 25 percent of both faculty and staff respondents rate their carbon footprint as important in determining whether or not to fly). One interview respondent noted that big conferences are a waste of time where little actual knowledge is exchanged. He and others freely admit that most academic research is better read than recited.[42] But for many faculty seeking promotion in the traditional tenure system, presenting at relevant conferences

[41] https://www.change.org/p/universities-and-professional-associations-call-on-universities-and-professional-associations-to-greatly-reduce-flying?recruiter=294645973&utm_source=share_petition&utm_medium=copylink.
[42] Pedelty, M. "Academic travel causes global warming." *The Chronicle of Higher Education.* January 2008. http://chronicle.com/article/Academic-Travel-Causes-Global/45937. Web. Accessed 8 Feb 2016.

can feel like an obligation.[43] While reforming the tenure system is beyond the scope of this report, it is worth noting that many feel pressure to fly due to the very nature of academia.

And so, faculty continue traveling to conferences and meetings, despite the fact that many survey and interview respondents claimed that flying is a hassle and they try to avoid it whenever possible. As one faculty member aptly stated: "By flying at all you are worsening your carbon footprint. Details of the trip are unimportant. Planning to go (or not go) is the critical issue."

UW has been a leader in sustainability for years, and other institutions look to the university for leadership on tough issues. The school has an opportunity to lead when it comes to finding ways to reduce employee air travel. One initial strategy other schools have tried is to tweak travel policies to encourage faculty and staff to fly less, as the example below from Cornell's travel website purports to do:

"Low-Carbon Travel Travel relating to educational, research, and university operations is essential to the university. In order to achieve the climate neutrality goals for Cornell, the university asks you to take into consideration the environmental impact of your trip. Telecommunication has the lowest carbon impact (and the lowest cost) for meetings. Travel by bus, train, or carpool emits less carbon than travel by plane."

While adding a disclaimer like this to UW's travel website can't hurt, it is unlikely to produce substantial behavior change. It is better to pursue a more robust travel policy tied to a universal booking system as described in the previous section. The Tyndall Centre for Climate Change Research in East Anglia, England, has such a travel strategy aimed at academic research travel that UW can use a model. Importantly, the Tyndall Centre recognizes the critical role research plays in academia, and its policy is driven by an overarching goal of working to establish targets for the global research community and developing alternatives to travelling with substantial buy-in from all of its employees.

UW has an opportunity to engage with Tyndall directly by signing on to a petition the Centre began circulating in October 2015. The petition calls on universities and academic professional associations to recognize the impact from their air travel and begin taking steps to reduce it. Thus far, the petition has 56 individual signatories from over a dozen countries. That alone is evidence that there is willingness to change if the UW administration agree to pursue it.

Alternatively, UW leaders can partner with other west coast universities on a joint request to large funding agencies like NSF, asking them to recognize the high emissions costs of obligating

[43] Ibid.

faculty to fly to Washington, D.C., and advocate instead for regional conferences that carry a lower carbon footprint. As our survey and interview results demonstrate, most faculty travel long distances to conferences every year that take them away from their families and students. UW can create opportunities for informal interactions with colleagues that faculty value, but in a more regional setting that yields far fewer emissions than cross-country and international travel.

4.3.2 Videoconferencing

Recommendations

- Acknowledge legitimate faculty and staff concerns around using videoconferencing in lieu of flying, including costs associated with paying for the technology as well as with missing certain events that may have an adverse impact professionally.
- Support the videoconferencing experience for faculty and staff by hosting a videoconferencing event on campus and promoting it widely.
- Reduce the number of guest speakers flown to campus by replacing with interactive videoconferencing talks.

Supporting Detail

UW's CAP lists videoconferencing as the most viable alternative to air travel. According to the CAP, "as the technology improves and cultural practices evolve to make use of them, it is reasonable to expect that videoconferencing will become a strong substitute for travel." But what is the culture around videoconferencing at UW?

According to our surveys, at least half of faculty and staff responded that they would be very likely to use group videoconferencing facilities on campus in lieu of flying, and overwhelming majorities reported being somewhat likely to do so. Yet, over half of faculty respondents claimed never to have used these facilities. The results indicate that everyone views the experience differently. For some who have used it and have found it relatively easy to operate (42 percent of faculty respondents that have used videoconferencing outside their office), videoconferencing has been a positive experience. Others have had nightmare experiences with inaudible sound, choppy video, or unreliable reception, that have led them to believe that videoconferencing is a hassle and a waste of time. These faculty certainly do not believe it is a viable substitute for traveling to conferences, panels, or funder meetings.

Any meaningful progress towards changing the flying-centric culture to one that embraces videoconferencing requires changing employee experiences and beliefs. Doing so involves shifting the perception of what it will cost to change one's behavior. In a working paper that discusses alternatives to travel with modern modes of communication, the Tyndall Centre identifies the top factors among its own researchers that encourage use of non-aviation alternatives. Not surprisingly, three of the top four factors relate to costs, either of the costs of

using alternatives to flying, or recognition by funders of the added costs of not flying.[44] Our survey results support the conclusion that costs often take precedence over carbon footprint considerations. But what is the nature of those costs?

Large videoconferencing facilities at UW, also known as Premiere Global Services (PGI), are not free. On a per meeting basis, the cost ranges anywhere from $.06 to $.29 per minute per participant, depending on the level of service provided, and is typically charged to the department, which also pays a monthly fee for traditional IT services provided.[45] For the purposes of illustration, let's say 50 people around the country want to use the facilities for a 4-hour session. This would cost anywhere from $720 to $3,480. If one imagines an entire UW department using videoconferencing in lieu of attending a weekend conference, those costs escalate substantially. Granted, using videoconferencing would offset the costs associated with plane tickets and reduce the department's carbon footprint, but the question is whether enough incentive exists for faculty to skip the conference and the collaborative opportunities it promises. The same holds true for skipping a meeting in D.C. and risk losing out on a grant. Additionally, the department may not be willing to foot the bill for videoconferencing facilities, preferring instead to rely on faculty to receive reimbursement for air travel through grants.

To overcome these and other barriers to wider adoption of videoconferencing in lieu of flying, UW must do more than focus on merely offering videoconferencing facilities and expecting employees to use them. The university must make a sincere attempt to create a videoconferencing experience that faculty and staff can reasonably expect will not adversely affect their professional standing at the university, their ability to collaborate with colleagues, or their access to funding for research, should they choose to forego air travel. One way to do so is to promote a regional videoconference in partnership with a national scholarly organization.[46] The keynote address can be broadcast to small regional gatherings at UW and other schools, where participants can discuss the talk and call in questions or comments to the speakers. Small sessions can also be arranged for more intimate engagement. For many of the faculty we heard from, the best conferences are those that are smaller in attendance and have a more focused agenda, such as one aimed at working collaboratively on an edited collection. By showing a willingness to host more events geared to those located within the same region, UW would be making a sincere attempt to provide an experience that signals real change from a university

[44] Quere et al. "Towards a culture of low-carbon research for the 21st century." Tyndall Centre for Climate Change Research. Working Paper (March 2015). http://tyndall.ac.uk/sites/default/files/twp161.pdf. Web. Accessed 8 March 2016.
[45] UW IT Connect. "Audio and Video Conferencing." https://itconnect.uw.edu/service/audio-and-video-conferencing/. Web. Accessed 10 March 2016.
[46] Smythe, K. "Air Travel and Climate Change: Should Faculty and Students Be Grounded?" *Sustainability: The Journal of Record.* October 2010, 3(5): 257-258.

perspective. If successful, it can create an entirely new experience for employees and change their beliefs about the possibilities of videoconferencing.

Finally, our analysis indicates that over 15 million miles were flown in 2014 by non-UW affiliates, which includes those UW invites to speak on campus. Rather than fly many of these individuals to campus, especially in the case of small talks or panels, UW might consider using videoconferencing instead. Obviously, we don't suggest this as an option for every person UW reimburses to fly to the west coast, but reducing even half of the miles flown by these individuals would put a serious dent in emissions.

4.3.3 Ground Transportation

Recommendations

Recognizing that there are some times of year that taking ground transportation is not advised (driving over the pass during winter, for example), there are steps UW can take to promote greater adoption of ground transportation to reduce emissions from short-haul flights:

- Lobby the state legislature to grant UW employees a waiver for using ground transportation in lieu of flying, regardless of whether it is more expensive.
- Expand carpool and vanpool services to include longer-distance trips.
- Institute a travel policy that requires employees to take ground transportation under certain circumstances. This should not be done in a vacuum. Frequent short-haul travelers should be consulted and any concerns taken into account before implementation, otherwise the policy will end up as just another burdensome, top-down regulation.[47]

Supporting Detail

Our survey results show that many respondents are willing to take ground transportation up to 250-300 miles, distances that account for many of the short-haul flights UW employees take. UW has an opportunity to reduce emissions from such flights, which our estimates show accounted for almost 500 MTCDE in 2014. While that may seem like a small amount, it represents reductions that won't have to be accounted for through carbon offsets.

Ground transportation includes driving, taking the bus, or taking the train. Research from the International Council on Clean Transportation (ICCT) indicates that, under almost all circumstances, any mode of ground transportation is more sustainable than flying even short distances.[48] This means that for UW employees traveling to Spokane, Pullman, Vancouver, or

[47] Connors, Roger and Smith, Tom. *Change the Culture, Change the Game: The Breakthrough Strategy for Energizing Your Organization and Creating Accountability for Results.* New York: Portfolio Penguin, 2011.
[48] Rutherford, D and Kwan, I. "Choose Your Own Adventure: By Plane, Car, Train, or Bus?" ICCT. 30 April 2015. Web. 6 June 2015.

Portland (as shown in Figure 19), any mode of ground transportation (aside from driving alone) will be emit far fewer emissions than flying.

Figure 19, flights under 300 miles taken to/from Seattle in 2014, paid for by UW

Again, it's useful to view ground transportation in terms of employees' experiences and beliefs. While the majority of survey respondents indicated they would be willing to take ground transportation, the majority also indicated that time is by far the biggest factor they consider when deciding their means of travel. When one considers the time it takes to get to the airport, go through security, wait for takeoff, retrieve luggage from baggage claim, and travel to a final destination, it may be equivalent to the time it takes to use an alternate mode of transportation. On the other hand, many likely experience dread at the thought of sitting on a bus or train for five hours. Employees' perception of how they spend their time traveling will necessarily be in conflict with their stated willingness to take ground transportation.

From a policy perspective, employees do not experience any pushback regarding the type of travel they take; there is no university-wide policy in place to encourage ground transportation instead of flying. Thus, employees believe that there are no negative consequences for choosing to fly to Portland, for example, rather than taking the train. Further, Washington State policy dictates that state employees must travel in the most "economically efficient" way, which can create a perverse incentive to fly instead of taking ground transportation that happens to be more expensive. Their experience has shown that flying is the path of least resistance, despite being much more warming intensive than all other modes of transportation.

4.4 CARBON OFFSETS

Recommendations

- Before purchasing offsets, conduct a transparent, campus-wide outreach initiative to ensure all faculty, staff, students, and administrators have a voice in the decision. Only with strong campus buy-in will any future offset policy be successful.
- Focus greatest attention on offsets programs that provide a benefit to local populations in need, rather than an international program that potentially marginalizes indigenous populations. Cornell's partnership with the Finger Lakes Climate Fund offers a possible model to emulate.

Supporting Detail

ACUPCC notes that investing in offsets can be a short-term tool for reducing an institution's carbon footprint after efforts to avoid and reduce internal emissions have been initiated, but it should be of secondary focus. In other words, offsets should be a last resort. Nevertheless, it warrants a brief discussion here given the feedback we received from our survey and interview respondents.

A carbon offset is "a reduction or removal of carbon dioxide equivalent (CO_2e) emissions that is used to counterbalance or compensate for ('offset') emissions from other activities."[49] Programs offset carbon in several different ways, including by planting trees that sequester CO_2, developing renewable energy sources, or capturing emissions from landfills. As we mentioned at the beginning of our report, it is possible that larger forces--such as a state- or nation-wide cap-and-trade program--will influence the price of carbon, and thus the actions UW takes to pay for using it. For example, as part of the University of California system, UC-Davis was both granted free allowances and opted to purchase allowances under the first round of the state's cap-and-trade program.[50] Should UW choose to purchase offsets, it can simultaneously support emissions reductions elsewhere while urging legislators to support a price on carbon.[51]

Our survey and interview results uncovered healthy skepticism amongst faculty around carbon offsets. Their experience of offsets is grounded in conversations with colleagues, or in their own research into international offsets programs, which has led them to believe that offsets are merely a way to make one feel better about their carbon footprint, rather than a viable solution to reduce emissions. Many faculty have strongly-held beliefs that will not be easily abandoned, and very real concerns about the moral and ethical implications of offsets.[52] On the other hand, our surveys indicate that at least some respondents would be willing to purchase offsets if they

[49] ACUPCC. "Voluntary Carbon Offset Protocol." http://vps.secondnature.org/resources/guidance-documents/offset-protocol. Web. Accessed 5 February 2016.
[50] Kirk, Camille (UC-Davis). Phone Interview. 2 December 2015.
[51] Revkin, Andrew. "Carbon-neutral is hip, but is it green?" *New York Times*. 29 April 2007. Web. Accessed 21 Feb. 2016.
[52] Connors, Roger and Smith, Tom. *Change the Culture, Change the Game: The Breakthrough Strategy for Energizing Your Organization and Creating Accountability for Results.* New York: Portfolio Penguin, 2011.

had the funds to do so, but many do not given federal restrictions on how grant money may be spent.

We offer the following example from Cornell as one possible path UW might consider when purchasing offsets. Cornell is currently engaged with the Finger Lakes Climate Fund (FLCF), a community-based carbon offset initiative in the Finger Lakes region of New York. The program provides funding to low- to moderate-income homeowners for residential energy efficiency renovations like insulation, weatherization, and high-efficiency heating systems.[53] Cornell promotes the program, which is voluntary, for employees to offset their daily commuting and other university-funded travel (links to purchase offsets have been added to existing travel procurement and employee commuting websites).

Our team spoke to Aimee Turner, Associate Vice President and Controller at Cornell. She noted that faculty responded well to using the FLCF because it benefits the local community, so the offset projects have a more certain outcome, and avoid potentially exploiting developing countries. While FLCF is not necessarily considered a rigorous carbon offsets program, its focus on local, visible solutions had made it a welcome addition to Cornell's energy reduction portfolio.[54] UW can use Cornell's approach as a model once the purchase of offsets is deemed necessary to achieve the emissions reductions goals established by the CAP.

Based on our conversations with the Sustainability Office, UW has already held several meetings and information sessions about carbon offsets. The school's leaders are aware that they will need to engage in a thorough, campus-wide conversation about the best way to approach offsets purchases when the time comes. Getting all parties aligned around a common goal won't be easy, and will require dialogue, debate, and, above all, leadership.[55]

5.0 CONCLUSION AND NEXT STEPS

In closing, we recommend that this report be read not as a definitive plan for carbon neutrality, but rather as an iterative step in UW's ongoing progress towards that goal. We identified how a

[53] Finger Lakes Climate Fund (FLCF). http://fingerlakesclimatefund.org/faqs#FAQ6. Web. Accessed 11 March 2016.
[54] The GAO has identified five general criteria for assessing rigorous offset quality—an offset must be additional, real, verifiable, permanent, and enforceable.
[55] Ibid.

lack of tools has led the university to historically underestimate its carbon emissions, but even this new estimate is imperfect and can be improved as the university takes additional steps to account for its air travel. In addition to providing a more accurate assessment of air travel, we also demonstrated that the time is right for UW to begin taking concrete steps to reduce emissions from air travel. The most direct way to do this is to reduce the number of trips taken by air, a fact that has not escaped the attention of many of our survey and interview respondents. While increased promotion of videoconferencing and encouraging ground transportation are strategies worth pursuing, UW will eventually hit the limit of its carbon reduction capacity. Some air travel is simply essential to support the mission of a global research institution like UW, and carbon offsets will be needed to neutralize those unavoidable emissions. This report has identified some of the barriers and potential paths forward with regard to carbon offsets. We sincerely hope that the administration takes this report as a starting point to begin a serious, campus-wide conversation around potential carbon offsets programs that may work for UW.

All of our work was done with a narrow focus and within a relatively short timeframe. In the next round of air travel review, the scope should be expanded beyond professional travel to the air travel being done by study abroad programs and intercollegiate athletic teams. While some solutions can apply to all three categories, these additional emitters present their own set challenges. For example, one cannot play football over Skype. We also suggest integrating air travel into longer, more robust methods of data collection. One possible next step is to begin integrating questions about air travel into the Transportation office's annual commuting survey and working with Transportation Services staff to analyze the results, which can then be applied to further behavior change strategies.[56]

UW has come a long way since it published the CAP in 2009. There is no reason to believe it won't again rise to the challenge of pursuing and implementing effective strategies to offset emissions from air travel.

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[56] We recommend the Sustainability Office connect with Zachary Howard, who runs the commuting survey, Casey Gifford, an expert in social marketing behavior change strategies that UW has already been applying to campus commuting.

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7.0 APPENDICES

7.1 APPENDIX 1 – PEER INSTITUTION COMPARISON

(Table on next page)

School	Pop.	Emissions Reductions Goals	GHG Emissions Data	Methods	Proposed Solutions (CAP)
UW	44,786	- Reduce emissions 15% below 2005 levels by 2020 - Carbon neutral by 2050	- Reported 17,813 MTCDE from air travel (2014) - Air travel 11% of total emissions	- Fiscal data based on reimbursements - Formula using $. 25/mile and 0.195 kg CO_2/mile emissions factor	- Improved videoconferencing - Develop and implement professional travel policies - Verifiable carbon offsets
UC-Davis	35,415	- Reduce emissions to 2000 levels by 2014 (met) - Reduce emissions to 1990 levels by 2020 - Carbon neutral as soon as feasible	- Reported 16,516 MTCDE from air travel (2008)	- Use TerraPass (different emissions factors for short-, med-, long-haul) - Air miles traveled calculated from sampling queries from MyTravel database	- Improved videoconferencing - Verifiable carbon offsets (purchases allowances under California AB 32)
UC-Berkeley	37,581	- Reduce emissions to 1990 levels by 2014 (met) - Carbon neutral by 2025	- Reported 20,998 MTCDE from air travel (2007) - Air travel 10% of total emissions	- Use Cool Climate calculator - Available campus data approved by third party through inventory verification	- Decrease air miles traveled - Increase videoconferencing - Climate Action Fund
Arizona State	83,301	- Carbon neutral by 2025 (except transportation, which will be carbon neutral by 2035) - Reduce air travel emissions minimum of 2 percent	- Reported 32,187 MTCDE from air travel (2013) - Transportation 20% of total emissions	- Use Clean Air Cool Planet calculator (ACUPCC recommended) - Environmental Indicator Data Management System (EIDMS)	- Improve access to videoconferencing - Environmental Impact Fee to support carbon reduction projects - Verifiable carbon offsets in 2035
Oregon	24,181	- Reduce emissions to 10% below 1990 levels by 2020 - Carbon neutral by 2050	- Reported 21,544 MTCDE from air travel (2008) - Scope 3 (not including study abroad) 31% of total emissions	- Use Carbon Fund calculator (formula converts dollars spent to miles to emissions) - Data gathered via interview with travel coordinator	- Develop robust emissions monitoring and reporting - Reduce business travel budgets, change staff travel priorities - Develop offset programs
Cornell	21,850	- Carbon neutral by 2035 - Reduced emissions 32% since 2008 and nearly 50% since 1990 - Broad-based, mission-linked carbon management strategies	- Reported 29,841 MTCDE from air travel (2014)	- General emission factor of .24 kg CO_2/mile - Connecting trip factor - LTO factor - Multi-passenger factor - RFI of 2.7	- Community-based carbon offset initiative intended to promote GHG reductions in the Finger Lakes region - Implement university-wide carbon neutral travel policy (offsets) - Videoconferencing and WebEx

7.2 APPENDIX 2 – CARBON CALCULATOR RESULTS

Terra Pass					
Haul	**Miles**	**EMF (lb CO2/mile)**	**Total Miles**	**Total CO2 (lbs)**	**Year Estimate (mt)**
Short	**0-280**	**0.64**	**811556**	**519395.84**	
Medium	**281-993**	**0.45**	**2002686**	**901208.7**	
Long	**994+**	**0.39**	**3080665.5**	**1201459.545**	
			Total	**2622064.085**	
			Total Tons	**1189.347292**	**14,272.17**
World Resources Institute					
	Total Miles	**Emission Factor (kg)**	**Total CO2 (kg)**	**Total CO2 (mt)**	**Year Estimate (mt)**
	5894907.5	**0.24**	**1414777.8**	**1414.7778**	**16,977.33**
$0.20 per mile					
Total Cost	**Total Miles**	**WRI Emission Factor**	**Total CO2 (kg)**	**Total (mt)**	**Year Estimate (mt)**
2223607.2	**11118036**	**0.24**	**2668328.64**	**2668.32864**	**32,019.94**
Clean Air Cool Planet	**Total Miles**	**Emission Factor (kgCO2/mile)**	**Total CO2 (kg)**	**Total (mt)**	**Year Estimate (mt)**
	5894907.5	**0.776**	**4574448.22**	**4574.44822**	**54,893.38**
UW 2013 GHG report					
Current method				**Total (metric tons)**	
				19,292 metric tons	

7.3 APPENDIX 3 – MATLAB CODEBOOK

The following Matlab scripts were used to parse the raw data given to us. With only minor modifications they can be used on any future data. They are available online through https://sites.google.com/site/uwairtravel/documents

Categorizer
inputs: MasterTable.mat
prerequisites: Locator
Outputs: CatTable.mat, CatTable.xlsx
Reads in the MasterTable and counts how many flights each category and subcategory is responsible for. The categories are ICA, CTA, and non-uw while the subcategory can be an academic department, a sports team, or a designation such as “candidate” for faculty recruitment.

Combinator
inputs: CTAtable.mat, etravTable.mat
prerequisites: CTA2014Parse, ETravParse
outputs: MasterTable.mat
Combines the Corporate Travel Account (CTA) and e-travel data into a single MasterTable that is then used for all future analysis. Each row of MasterTable is one flight. NOTE: this version of MasterTable.mat does not contain the locations of airports, which is needed by any script that calculates distances. Be sure to run Locator before attempting to analyse any distances.

CTA2014Parse
inputs: CTAdata2014.xlsx
prerequisites: none
outputs: CTATable.mat, Processed CTA.xlsx
Reads in the raw CTA data from the 2014 summary and organizes it into a useful table. Checks for duplicate entries and deletes them.

CTAMonthlyParse
inputs: a folder named “CTAMonthly” full of excel files with names of the form “CTALevelIIIAirlineData” followed by the three letter abbreviation for the month, and the last two digits of the year.
prerequisites: none
outputs: CTATable.mat, Processed CTA.xlsx
Reads in monthly CTA data from multiple excel sheets and organizes it into a useful table. Checks for duplicate entries and deletes them.

DestVLay
inputs:MasterTable.mat, RouteTable.mat
prerequisites: Locator, Router_Round

outputs: LayTable.mat, LayTable.xlsx
Uses the assumption that all round-trips start and end in Seattle to estimate what percentage of stops in each city are layovers versus destination stops.

ETravParse
inputs: etravel-raw-data-2013-2014.xlsx, Airfare UW employee 2014.xlsx, Airfare UW Students 2014.xlsx, Airfare UW Student Employees 2014.xlsx
prerequisites: none
outputs: etravTable.mat, Processed etrav.xlsx
Reads in the raw e-travel data from 4 files summarizing different classes of flyers and organizes them into a single useful table. Checks for duplicate entries and deletes them.

Individualizer
inputs: MasterTable.mat
prerequisites: Locator
outputs: IndiTable.mat, IndiTable.xlsx
Names the individuals who appear most frequently in the data and records the number of flights and total distance flown. Note that many trips are recorded under the purchaser's name instead of the flyer’s name, so departmental travel coordinators and similar individuals are over-represented.

Locator
inputs: MasterTable.mat, Airports.csv
prerequisites: Combinator
outputs: MasterTable.mat, MasterTable.xlsx, FrequentAirports.xlsx, Problems.xlsx
Fills in the name, latitude, and longitude of each airport based on the airport code from MasterTable. Then calculates the distance between the origin and destination. Counts the most common origin/destination airports and stores them in a seperate table. Finally, identifies any flight that appears to be improperly recorded. Example problems include having no airport code or having the origin and destination being the same airport.

NestRouter
inputs:MasterTable.mat
prerequisites:Locator
outputs: NestedRoutes.mat, NestedRoutes.xlsx
Creates a nested table where the top level is each unique route found in MasterTable, and for each entry there is a table of the departments or teams that fly it most often.

RoutCater
inputs:NestedRoutes.mat
prerequisites:NestRouter
outputs: RouteCats.mat, RouteCats.xlsx
Sorts the nested table of routes and categories and displays only the top flyers for the top routes.

Router_OneWay
inputs:MasterTable.mat
prerequisites:Locator
outputs: RouteTable.mat, RouteTable.xlsx
Iterates through MasterTable and creates list of most-flown routes (origin to destination). Note that Seattle to Chicago and Chicago to Seattle would show up as different routes in this table. In most cases Router_Round will be preferable, unless you are examining multi-destination trips.

Router_Round
inputs:MasterTable.mat
prerequisites:Locator
outputs: RouteTable.mat, RouteTable.xlsx
Iterates through MasterTable and creates list of most-flown routes, ignoring direction. So Seattle to Chicago and Chicago to Seattle would both be recorded as the same route. This is usually preferable to Router_OneWay, under the assumption that most trips are round-trips.

ShortCater
inputs:NestedRoutes.mat, Shorties.mat
prerequisites:NestRouter, Shorter
outputs: ShortRouteCats.mat, ShortRouteCats.xlsx
Takes the most-flown short-haul flights and find them in the nested route table to identify the departments and teams that fly short distances most frequently.

Shorter
inputs:RouteTable.mat
prerequisites:Router_Round (or Router_OneWay)
outputs: Shorties.mat, ShortRoutes.xlsx
Finds those routes from the RouteTable that are under 280 miles and pulls them into a seperate document.

Statisticizer
inputs:MasterTable.mat, RouteTable.mat, CatTable.mat
prerequisites:Locator, Categorizer, Router_Round (or Router_OneWay)
outputs: RouteTable.mat, RouteTable.xlsx
Calculates a variety of descriptive statistics: the most common months that UW flies, what percentage of flights are short-hault, medium-haul or long-haul, and domestic vs. international.

7.4 APPENDIX 4 – FACULTY AIR TRAVEL SURVEY QUESTIONS

This is a survey to find out about your professional air travel (any air travel paid with funds that come through UW and/or that you undertake as a representative of UW). The survey should take about 15-20 minutes.

(1) General information

1. What is your age?

   20-29 30-39 40-49 50-59 Over 60
2. What is your department?
   a. 'Open box'
3. Are you in a tenure-track position?
   a. No
   b. Yes, but I don't have tenure yet
   c. Yes, and I already have tenure

(2) Current air travel

1. Roughly how many trips did you take by plane in the past year (Jan - Dec 2015) for professional reasons (e.g. in the context of your work for or as a representative of UW)?
   a. 'Open box'
2. Is the amount of flying you did for professional reasons in the past year:
   a. More than an average year
   b. About equal to an average year
   c. Less than an average year
3. To what city do you most often travel by plane for professional reasons?
   a. 'Open box'
4. What percentage of your flights are direct versus those that include one or more layover?
   a. Slider
5. When you fly connecting flights, what is the most common layover city?
   a. 'Open box'
6. How important is professional air travel for each of the following reasons?

	Not at all important	Slightly important	Important	Very important	Essential
Meeting with colleagues / Nurturing collaborations	○	○	○	○	○

Attending conferences	○	○	○	○	○
Serving as an invited speaker at another institution	○	○	○	○	○
Conducting research trips (field work, etc.)	○	○	○	○	○
Meeting funding sources (e.g. attending panel reviews of large foundations such as NSF)	○	○	○	○	○
Other	○	○	○	○	○

   a. If there are other important reasons for air travel, please list below:
      i. 'Open box'
7. Of the flights you took this past year, approximately what percentage were reimbursed through UW versus through non-UW sources (outside sources might include other universities, foundations, or private entities)?
   a. Slider

(3) Air Travel Attitudes

1. Approximately what percentage of your professional air travel is **necessary** for your job? In other words, if you chose not to take a trip, would it potentially have adverse effects on your professional standing with the university? (e.g. not getting tenure, threatening funding sources, sacrificing important research)

   0-25% 26-50% 51-75% 76-100%
2. How important are the following factors when booking air travel for work? 1 = least important and 5 = most important.

	Least important				Most important
Save time/convenience (e.g. book a one-way flight instead of one with layovers regardless of cost)	1	2	3	4	5

Save money (e.g. book the cheapest fare)	1	2	3	4	5
Your carbon footprint	1	2	3	4	5

   a. If there are other important factors to consider, please list below:
      i. 'Open box'

3. How likely are you to use the following alternatives to flying?

	Not at all likely	Somewhat likely	Very likely	N/A
Video/teleconferencing (in lieu of in-person meetings/conferences)	○	○	○	○
Telemedicine (for medical community)	○	○	○	○
Other modes of transportation for trips under 300 miles (e.g. train, bus, car)	○	○	○	○

   a. If there is another alternative you would consider, please list below.
      i. 'Open box'

4. In your opinion, what is a reasonable distance for one to travel by ground transportation (drive, bus, or train) in lieu of air travel?
   a. 'Open box'
5. If you've used campus teleconferencing facilities outside of your office, how easy were they to find/book/use?
   a. Difficult
   b. Moderately difficult
   c. Moderately easy
   d. Easy
6. Have you personally been offered the option to purchase carbon offsets when booking your professional air travel?
   a. Yes
   b. No
7. If yes, have you purchased them?
   a. Yes
   b. No

    c. N/A
8. If yes, why or why not?
    a. ‘Open box’
9. When booking a flight with money that is "fungible" (e.g. research or grant funds that can be spent how you see fit), how much would you be willing to pay to purchase carbon offsets **per flight?**
    a. $0 - $5
    b. $6 - $10
    c. $11 - $15
    d. $16 - $20
    e. N/A
10. Do you have anything more to add that this survey hasn’t covered regarding your professional air travel?
    a. ‘Open box’
11. If you would like to be entered into the raffle for a $50 Amazon gift card, please include a valid email address below. **Your information will be kept strictly confidential and will not be used for any purpose other than to notify you should you win.**

7.5 APPENDIX 5 – STAFF AIR TRAVEL SURVEY QUESTIONS

This is a survey to find out about your professional air travel (any air travel paid with funds that come through UW and/or that you undertake as a representative of UW). The survey should take about 15-20 minutes.

(1) General information

1. What is your age?

   20-29 30-39 40-49 50-59 Over 60
2. What is your department?
   a. 'Open box'

(2) Current air travel

1. Roughly how many trips did you take by plane in the past year (Jan - Dec 2015) for professional reasons (e.g. in the context of your work for or as a representative of UW)?
   a. 'Open box'
2. Is the amount of flying you did for professional reasons in the past year:
   a. More than an average year
   b. About equal to an average year
   c. Less than an average year
3. To what city do you most often travel by plane for professional reasons?
   a. 'Open box'
4. What percentage of your flights are direct versus those that include one or more layover?
   a. Slider
5. When you fly connecting flights, what is the most common layover city?
   a. 'Open box'
6. Of the flights you took this past year, approximately what percentage were reimbursed through UW versus through non-UW sources (outside sources might include other universities, foundations, or private entities)?
   a. Slider

(3) Air Travel Attitudes

1. Approximately what percentage of your professional air travel is **necessary** for your job? In other words, if you chose not to take a trip, could it potentially have adverse effects on your professional standing with the university?

   0-25% 26-50% 51-75% 76-100%
2. How important are the following factors when booking air travel for work? 1 = least important and 5 = most important.

	Least important				Most important
Save time/convenience (e.g. book a one-way flight instead of one with layovers regardless of cost)	1	2	3	4	5
Save money (e.g. book the cheapest fare)	1	2	3	4	5
Your carbon footprint	1	2	3	4	5

a. If there is another important factor, please describe below:
    i. 'Open box'

3. How likely are you to use the following alternatives to flying?

	Not at all likely	Somewhat likely	Very likely	N/A
Video/teleconferencing (in place of in-person meetings/conferences)	○	○	○	○
Telemedicine (for medical community)	○	○	○	○
Other modes of transportation for trips under 300 miles (e.g. train, bus, car)	○	○	○	○

a. If there is another alternative you would consider, please list below.
    i. 'Open box'

4. In your opinion, what is a reasonable distance for one to travel by ground transportation (drive, bus, or train) in lieu of air travel?
    a. 'Open box'
5. If you've used campus teleconferencing facilities outside of your office, how easy were they to find/book/use?
    a. Difficult
    b. Moderately difficult

    c. Moderately easy
    d. Easy
6. Have you personally been offered the option to purchase carbon offsets when booking your professional air travel?
    a. Yes
    b. No
7. If yes, have you purchased them?
    a. Y
    b. N
8. If yes, why or why not?
    a. 'Open box'
9. Do you have anything more to add that this survey hasn't covered regarding your professional air travel?
    a. 'Open box'
10. If you would like to be entered into the raffle for a $50 Amazon gift card, please include a valid email address below. **Your information will be kept strictly confidential and will not be used for any purpose other than to notify you should you win.**

7.6 APPENDIX 6 – FACULTY AND STAFF AIR TRAVEL INTERVIEW QUESTIONS

Introduction

"This interview is part of our research on faculty air travel habits and their attitudes towards flying as part of the work they do for or as a representative of UW. We are interested in how you think about these issues. Don't worry about whether your ideas are right or wrong. We encourage you to speak honestly and say whatever comes to mind."

With your permission, we would like to make an audio recording of this interview. All recordings will be destroyed following the completion of this study.

General questions - *to warm up and create relaxed environment*

"We'd like to start with you sharing a bit of detail about yourself."

1. How long have you been with the UW?
2. How would you describe the work you do at UW?
3. How did you come into this line of work?

Current Air Travel

1. How frequently do you fly for professional reasons?
2. To what destination(s) do you most often travel for professional reasons?
3. For what reason(s) do you tend to fly? Where, when and how often?
4. How important is air travel to your work/research/career? Could you identify specific reasons why air travel is important to your work/research/career?
5. Who typically arranges your business travel? Would you be willing to use a university-wide travel agency/booking system if it helped UW better account for its emissions?
6. Have you ever been pressured/encouraged to book the cheapest flights (regardless of travel time or carbon output) in order to save money for grants and departments?

Air Travel Attitudes

1. In the past, have you changed a trip or itinerary to reduce your carbon footprint?
2. Have you been offered the opportunity to buy carbon offsets when booking your travel? If so, have you purchased them? Why or why not?
3. Assuming you have a flexible budget that you can use to purchase carbon offsets, what is the most you would be willing to pay per flight to offset your emissions?
4. How often do you use other modes of transportation (e.g. car, bus, train). How far do you travel when taking alternative modes of transportation? In your opinion, what is a reasonable distance for one to drive/bus/train in lieu of air travel?

5. If you've used teleconferencing facilities on campus (outside of your office), how easy were they to find/book/use? Do you get pushback from government agencies, funders, peers or others when using these alternatives? If so, how?
6. Do you have anything more to add that we haven't covered regarding your professional air travel?

7.7 APPENDIX 7 – T-TEST RESULTS FROM FACULTY AND STAFF SURVEY DATA

The tables below include research questions asked and the results from running a series of t-tests using a significance level of alpha=0.05. In the first table, 50+ refers to faculty and staff 50 years of age or older and <50 refers to faculty and staff under 50 years of age. In the second table, T refers to tenured and NT refers to non-tenured faculty. In the third table, Env refers to the following Environmental Departments: Applied Physics Lab, Atmospheric Sciences, Civil and Environmental Engineering, Climate Impacts Group, College of the Environment, Earth and Space Science, Joint Institute for the Study of the Atmosphere and Ocean, Oceanography, School of Aquatic and Fishery Sciences, School of Environmental and Forest Sciences, and School of Marine and Environmental Affairs. Other refers to all other departments.
In general, sample sizes were small and thus lacked statistical power.

FACULTY & STAFF	**STAFF**				**FACULTY**			
Research Question	**Answer**	**p-val**	**n**	**means**	**Answer**	**p-val**	**n**	**means**
Is there a noticeable age difference in direct v. indirect flights?	No	0.27	50+=41 <50=99	50+=54% <50=46%	No	-	50+=47 <50=42	50+=65%direct <50=56%direct
Do younger faculty/staff report being reimbursed by UW more than older faculty/staff?	**Yes**	**0.05**	**50+=47 <50=109**	**50+=63%UW <50=78%UW**	No	0.06	50+=49 <50=45	50+=49%UW <50=62%UW
Do older faculty/staff report willingness to travel longer distances via ground transportation?	No	-	-	-	**Yes**	**0.05**	**50+=43 <50=26**	**50+=249 <50=202**
Do older faculty/staff fly more than younger faculty/staff?	No	0.93	50+=47 <50=109	50+=2.8 <50=2.8	No	0.12	50+=52 <50=45	50+=6 <50=5
Are younger faculty/staff more likely to consider flying a necessity for work?	No	0.41	50+=21 <50=66	50+=3.3 <50=3.0	No	0.45	50+=43 <50=26	50+=3.4 <50=3.2

FACULTY ONLY				
Research Question	**Answer**	**p-val**	**n**	**means**
Do tenured faculty fly more than untenured faculty?	No	0.92	T=49 NT=10	T=6.2 NT=6.3
Are untenured faculty more likely to consider flying a necessity for work?	No	0.07	T=38 NT=7	-
Are tenured faculty willing to pay more for offsets?	No	0.29	T=33 NT=6	T=$10.64 NT=$6.00
Do younger faculty (under 50) have an easier time using videoconferencing facilities on campus?	No	0.19	50+=29 <50=10	-

ENVIRONMENTAL V. OTHER DEPARTMENTS	STAFF				FACULTY			
Research Question	**Answer**	**p-val**	**n**	**means**	**Answer**	**p-val**	**n**	**means**
Did respondents in environmental departments travel more than those in other departments?	No	0.46	Env=57 Other=99	Env=2 Other=3	No	0.10	Env=33 Other=64	Env=7 Other=5
Are environmental departments taking more direct flights?	**Yes**	**0.02**	**Env=51 Other=89**	**Env=59% Other=42%**	**Yes**	**0.04**	**Env=28 Other=61**	**Env=71% Other=56%**
Are environmental departments getting reimbursed more from UW?	No	0.73	Env=57 Other=99	Env=72% Other=74%	No	0.49	Env=33 Other=61	Env=53% Other=58%
Are staff from environmental departments willing to drive longer distances?	**Yes**	**0.02**	**Env=30 Other=51**	**Env=260 Other=206**	No	0.51	Env=25 Other=44	Env=222 Other=237
Have faculty/staff from environmental departments been offered carbon offsets more than others?	**Yes**	**0.02**	**Env=30 Other=57**	**Env=0.23 Other=0.04**	No	0.07	Env=25 Other=44	Env=0.40 Other=0.18