An Institutional Carbon Footprint: The Assessment of Transportation-Related eCO2 Emissions and Applied Study of Mitigation Policies for Macalester College

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Abstract: Macalester-funded air travel represents the majority of Macalester's travel-related greenhouse gas (GHG) emissions. As a whole, transportation emissions from study abroad, institution-funded air travel, and faculty staff and off-campus student commuting constitutes roughly 29% of total institutional eCO2. Though vehicle-miles-travelled (VMT) and resultant automobile emissions are often emphasized when assessing institutional GHG emissions, commuting trips currently make up only 3% of Macalester's total eCO2 emissions due to transportation. The most effective way for Macalester to both limit its carbon footprint and honor its commitment to sustainability as outlined by the President's Climate Commitment is to enact institutional policies that address the short and long-term costs of its current transportation systems. Chief among this study's policy recommendations are: 1) monitor, stabilize and reduce institutionally funded air travel 2) emphasize continental study abroad programs and reallocate student tuition to address externalities of long-distance flights 3) discourage single-occupant vehicle (SOV) use by shifting parking costs to users 4) unify and augment commuting and air travel data collection systems.

I. Introduction

As scientific evidence of human impact on global climate change gains greater cultural recognition in the United States, individuals, institutions, and governments are beginning to assess and mitigate their carbon footprints. Macalester has adopted the American College and University Presidents Climate Commitment (PCC) as a catalyst for addressing global climate change at an institutional level. This commitment entails qualitative and quantitative analysis of current Greenhouse Gas (GHG) emissions and a plan of action to achieve climate neutrality. In 2008 the Macalester Environmental Studies senior seminar conducted a baseline study, assessing Macalester's current emissions related to heating/cooling, electricity, solid waste, agriculture, refrigerants, and transportation. Their study, *Macalester College Greenhouse Gas Emissions Inventory: 1990-2006*, found that roughly 20% of total institutional Effective Carbon Emissions (eCO2) are from the transportation sector. The current 2009 Environmental Studies Senior Seminar will publish a report, *The Macalester College Institutional Action Plan For Climate Neutrality* in May 2009; Macalester will officially submit this report to the ACUPCC before September 15th, 2009. The Action Plan will detail the steps Macalester will take to reach climate neutrality by a pre-determined date. The Institutional Action Plan can be thought of as a continuous working document for the college that guides planning and implementation of projects that directly reduce or indirectly mitigate institutional emissions.

Working in conjunction with the Institutional Action Plan research, this study details Macalester's transportation-related greenhouse gas emissions and recommends policies towards

reducing the school's carbon footprint as it pertains to the transportation sector. This sector includes institutionally-funded air travel, study abroad air travel, and personal ground transportation: faculty, staff and off-campus student commuting. This report, however, excludes greenhouse gas emissions from the transportation of goods and services at Macalester. This study's findings and recommendations are based on original research that builds upon last year's report. The central finding is that although Macalester has enacted a number of ground transportation programs that aim to lower travel-related GHG emissions, the school lacks a comprehensive transportation plan to guide current and future transportation investments; strategies and priorities to manage trip generation are not well defined. Additionally, data collection systems are currently incapable of producing the necessary figures required for a complete quantitative analysis of carbon emissions. This study's chief recommendations to the institution are to: 1) Monitor, stabilize and reduce institutionally-funded air travel, 2) Emphasize continental study abroad programs and reallocate student tuition to address externalities of long-distance flights, 3) Discourage single-occupant vehicle (SOV) use by shifting parking costs to users, 4) Unify and augment travel data collection systems.

II. Background

With the goal of providing state and national context for this case study, this section will give an overview of The American College & University Presidents Climate Commitment (ACUPCC); briefly discuss transportation projects being implemented by other ACUPCC

institutions; and provide a summary of the current state of the economy, within which Macalester's transportation initiatives are being recommended.

The American College & University Presidents Climate Commitment

> *"The American College & University Presidents Climate Commitment is "a high-visibility effort to address global warming by garnering institutional commitments to neutralize greenhouse gas emissions, and to accelerate the research and educational efforts of higher education to equip society to re-stabilize the earth's climate."*

The Presidents Climate Commitment (PCC) was released on December 12, 2006. President Brian Rosenberg became one of its charter signatories and Leadership Circle members by signing Macalester College onto this commitment before September 15, 2007 (American College & University Presidents Climate Commitment, 2009). As stated on the President's Climate Commitment website, this signature makes Macalester accountable as an institution for:

- Setting up a mechanism/an advisor (committee, task force, office, etc.) within 2 months to guide the process
- Completing an inventory of greenhouse gas emissions within 1 year of the start date
- Creating and implementing a climate neutral plan (that includes a target date and interim milestones for achieving campus climate neutrality) within 2 years.
- Taking 2 of 7 immediate steps specified in the commitment to reduce greenhouse gas emissions while the more comprehensive plan is being developed.
- Integrating sustainability into the curriculum and making it part of the educational experience.
- Making related reports (Action Plan, Greenhouse Gas Inventory and Progress Reports) publicly available.

The timeline for implementation of the Commitment is based on three potential start dates, (September 15, December 15, and May 15). Macalester, as a charter signatory, is based on the September schedule. As a means of setting up a mechanism to guide the process, Macalester has thus far created a Sustainability Office, hired Suzanne Hansen as the Sustainability Manager

and combined the former Campus Environmental Issues Committee with the Presidents Climate Commitment Committee to form a Sustainability Advisory Committee. In light of the work completed by the 2008 GHG Inventory, the two immediate steps Macalester has taken to reduce greenhouse gases are 1) purchasing only Energy Star appliances where available and 2) subsidizing bus passes (50% of retail price) for students, faculty and staff.

Air Travel at PCC Schools

Thus far, air travel at PCC schools is not widely recognized as an important source of emissions, nor have air travel emissions been widely addressed at PCC institutions. Among the Presidents Climate Commitment's seven options for immediate action is: "establish a policy of offsetting all greenhouse gas emissions generated by air travel paid for by our institution." Of the 470 institutions that signed by December 31, 2007 only twenty chose travel offsetting as one of their commitments (American College and University Presidents Climate Commitment, 2007). However, as schools complete their greenhouse gas inventories, schools such as Macalester have learned that air travel contributes significantly to an institution's total GHG emissions. Of Macalester's total GHG emissions, 26% are attributed to air travel for the 2007-2008 school year (Environmental Studies Senior Seminar, 2009).

Within the air travel emissions sector, institutions often distinguish between air mileage generated by departmental air travel (speakers, conferences, etc.) and student study abroad air travel. Current recommendations to reduce the impact of department air travel emissions include the University of California Santa Cruz's proposed policy to place a $30-$50 tax on each

individual trip (Winslade, 2009). To combat emissions associated with study abroad, Middlebury College provides an optional $36 offset for students that funds either Native American-owned wind power generation, or family farm methane digester projects that create electricity from cow manure. At institutions such as Middlebury College, Ithaca College, and Yale University where studying abroad is highly recommended, yet responsible for a large portion of the air travel emissions, the values of studying abroad are being reconciled with the values of sustainability. Rather than requesting quantitative reductions in study abroad air miles, most sustainability projects focus on education and incentives for reducing one's individual impact while abroad. This includes Middlebury's $500 grant program for students conducting sustainability research abroad and website links to the Green Passport Program which suggests sustainable travel habits (Middlebury College, n.d.).

Commuting at PCC Schools

The impact of commuting on a campus varies greatly depending on the location of the school, urban or rural, and the percentage of residential students. As an urban, residential campus, Macalester's commuting accounts for significantly less of total GHG emissions than a rural commuting campus. Regardless of total impact, solutions for reducing GHG emissions have been similar across the board and include: introducing or increasing parking fees, redrawing parking systems to favor carpooling, integrating school transit systems with city transit systems, subsidizing public transit, creating rideshare boards, and expanding bike programs. These programs can have beneficial quantitative reductions. For example, through reorganizing their

transportation system, Cornell University has been able to save 417,000 gallons of fuel and 10,000,000 vehicle miles traveled annually. They have cut costs by more than $36 million and reduced greenhouse gas emissions by 51,100 tons over 12 years American College and University Presidents Climate Commitment, 2009). An example of a qualitatively-effective measure, which various institutions have taken, is to consolidate all transportation web links onto a single page. Carleton College provides the link "Maps and Transportation"* from within their Student web portal while still making it accessible to non-students. This page provides connections to all forms of public transit in the Northfield area and links to other Carleton transportation programs such as "Carleton Rideshare" (Carleton College, n.d.).

The Economy

Since other PCC schools as well as Macalester are not operating in institutional bubbles, it is important to understand the economic and infrastructural mechanisms in place that guide their project recommendations. Beginning with the current economic recession this section will provide a background of the larger economic and political situation in which this research is being performed.

At the federal level, the economic downturn and change in executive administration, coupled with an earlier local incident—the collapse of Interstate-35 in Minneapolis—has provided an opportunity for transportation funding to re-enter the national conversation. Infrastructure development and maintenance, especially in Minnesota, has risen to become a top political issue. As part of the American Recovery and Reinvestment Act (ARRA), colloquially referred to as

"the stimulus package," the government is providing $8.4 billion toward public transit. The entire transportation budget for this act equates to $27 billion; Minnesota's portion is about $600 million with $94 million designated for public transit (Recovery.gov, 2009).

Although this economic recession has provided a stimulus for funding transportation infrastructure, it is still a recession, meaning that in general people and institutions have tighter budgets. A series of articles has been published in The Chronicle of Higher Education this spring discussing how institutions of higher education and particularly the signatories of the Presidents Climate Commitment are being affected in their ability to pursue environmental sustainability and reduce eCO2 emissions. The concern brought forth in these articles is that sustainability initiatives and even the act of measuring emissions can be expensive and may resort in schools being unable to fulfill their commitments (Carlson, 2009). In response to these articles members of the sustainability community have articulated that the PCC Climate Action Plans are meant to be adaptive to situations like economic shifts. The best methods for maintaining the implementation schedule in this tight economy have been: involving students in the data collection process rather than hiring professionals, and networking with other PCC institutions, through tools such as the green schools listserv* to discuss strategies (Dryer, 2009). Macalester is utilizing both of these strategies.

As a pledged leader in sustainability for institutions of higher education, Macalester College is dedicated to providing quality examples of GHG reduction strategies, especially during a long-term economic downturn. Concerns of institutional financial self-interest and long-term economic sustainability have catalyzed this initiative, not solely institutional

commitments to community service and global citizenship. The economic welfare of Macalester College is among the greatest considerations when reducing institutional GHG emissions. Within this context, the current step of Macalester's institutional commitment seeks to more clearly understand its own institutional carbon footprint and implement strategies and goals to reduce that impact by achieving climate neutrality. The following research addresses this mission in the transportation sector.

III. Internal Research: Air Travel

Though tailpipe emissions may be first and foremost in one's mind when considering transportation-related GHG emissions, this study's internal research found that Macalester's air travel footprint is much larger than its commuting footprint. Macalester-funded air travel represents a clear majority of institutional travel-related greenhouse gas (GHG) emissions. As a whole, transportation emissions from study abroad and institution-funded air travel constitutes roughly 26% of total institutional eCO2 in 2007-2008. This is a very high percentage; overall, it is the 3rd highest sector of GHG emitters after Purchased Electricity and Campus Heat (see Figure 1). Air travel represents an important sector for reducing emissions and introducing campus-wide policies to help mitigate Macalester's carbon footprint.

In order to conceptualize Macalester's air travel related carbon footprint it is important to understand the difference between short flights and long flights, flights with layovers and direct flights. In total Macalester funded 10,473,703 air miles for its students, staff and faculty during the academic year 2007-2008, but flight during some miles released more eCO2 emissions than

others. Numerous factors impact this measure including: the distance traveled in a single flight, aircraft type, seating, seating occupancy, altitude, latitude, taxi, and layovers. The most accessible data for calculating GHG emission is the distance covered in each individual flight. Flight mileage helps determine fuel consumption as well as serves as an indicator for altitude allowing for the measurement of nitrogen oxide (ozone) release. Most often, the absolute fuel consumption is higher in long haul flights than short, but the relative consumption per 100 kilometers is higher in short flights than long haul. Medium distance flights provide the optimum in both categories. Ozone's impact on climate change is relative to the flight altitude (9 km or more above sea level), state of the atmosphere, and pollutants emitted; however, it is measured in climate change calculators in relation to the flight distance because flights traveling over 500 km usually exceed the altitude requirements while shorter flights do not (The Atmosfair Emissions Calculator, 2009)

Air Travel Data and Methodology

Macalester funded air travel encompasses many categories including: speakers, conferences, prospective students/recruiters, sports, faculty research, and study abroad. This study excludes trips to/from campus before/after vacations because these trips do not qualify as part of Macalester's carbon footprint as an institution. The breadth of this category involves disparate information sources with data ranging from well-documented multi-stop flight paths, to unspecified purchases recorded only by price rather than by mileage. To accurately calculate Macalester's greenhouse gas emissions produced yearly by college-funded air travel, the total

number of miles traveled is necessary. Last year's transportation-related greenhouse gas emissions study calculated the total miles traveled by acquiring the percent of the total travel budget spent on airfare. They then estimated total miles traveled from a yielded dollar value through a conversion calculator from the Air Transport Association of America.

This year, more specific data were gathered through Macalester's P-Card purchases, which has a highly detailed and well-maintained record of all flights purchased through the college credit cards. For the 2007-2008 school year, 2,200 records were received pertaining to air travel, from which 727 separate round-trip flights were extracted. In order to calculate the mileage associated with these flights, an online mile calculator Mile Marker was utilized to measure these trips, including their recorded layovers. In all, Macalester's funded air travel through P-Cards totaled 1,884,174.7 miles from June 2007 to May 2008. Through these P-Card records, it was determined that 7.7% of Macalester-funded air travel involved international flights while 92.3% of flights were domestic. The high level of detail in these P-Card purchases gives a much clearer picture of Macalester's overall air travel in comparison to last year's figures because it also recorded layovers, and identified purchasers of tickets so data could be collected on trends within Macalester's departments and offices.

The data from P-Card purchases ultimately represented only a portion of non-study abroad related air travel. Because not all faculty and staff have access to a P-Card, many flight records are simply recorded through check-requisition and refunded by the school. To calculate the miles traveled from non P-Card purchased flights first the total airline expenditure for P-Cards was calculated. Only $342,964 was spent on airline tickets (77.8%) while the other

charges consisted of agent fees, airline bag check fees etc. Knowing the total miles traveled (1,884,175), a cost per mile traveled was calculated by dividing the total miles by the total dollar amount spent on air travel ($441,059), which amounted to 4.2719 miles/dollar spent. It was assumed that this conversion could be utilized on the total amount spent on non P-Card air travel, which was $461,467. By multiplying this dollar amount by our 4.2719 conversion, it was determined that non P-Card air travel totaled 1,971,357 miles. All college-funded, non-study abroad travel totaled 3,855,532 miles for the 2007-2008 school year. This category of Directly Financed Air Travel, air travel paid for by Macalester for all students, faculty and staff accounts for 2,993 MT eCO2 and represents 15% of overall emissions.

Study Abroad Air Travel Data and Methodology

As demonstrated by the Fall and Spring Study Abroad Maps (Figures 3 and 4), Macalester Study Abroad programs are located all over the world, with little attention paid to continental programs. Over the past ten years students have participated in upwards of 110 international programs and eight domestic programs. The International Center has published a recommended list, which includes sixty-five international programs and ten domestic studies programs that have been selected by Macalester departments. There are a number of quality criteria for a program to make the recommended list, but these criteria do not include sustainability of the program nor its geographical relationship to Macalester.

To calculate GHG emissions related to study abroad, the International Center provided lists from Fall 2007 and Spring 2008 that detailed the city and country in which the study abroad

occurred, and the program running the trip. The only data collection system currently in place to track air miles accrued through study abroad is this register. Since the International Center has not previously recorded study abroad air miles, there is no data regarding student departures, layovers, or destinations to aid this research. To calculate air travel miles, a few assumptions had to be made. First, because there were no records detailing each student's travel data, it was assumed that all study abroad students left for their trips from the Minneapolis/St. Paul airport. The destination airport was also assumed because the data only included the cities in which students studied abroad. For many, this was a reasonable assumption by using the closest international airport, but the actual flight patterns are largely unknown. The total miles were then calculated by using Mile Marker for consistency and recorded: Fall 2007 students traveled 1,069,872 miles round trip, whereas Spring 2008 students traveled 1,692,768 miles round trip. Study Abroad Air Travel accounts for 2,144 MT eCO2, which represents 11% of overall emissions.

These three data sources, P-Card air travel purchases, check reimbursement charges, and study abroad mileage total 6,618,171 miles for the 2007-2008 school year. The GHG emissions associated with this mileage equates to 5,138 MT eCO2 or 26% of overall emissions. Last year's senior seminar figure was also close to 7,000,000 miles and 22% of total emissions. Though the total mileages may seem similar, there are significant differences between this years' study as compared to the previous study: specifically, the accuracy provided by detailed P-Card purchases and the addition of study abroad mileage, which previously had not been calculated. It is also important to note that proportionally, Macalester-funded air travel is a significant

emissions source, representing over a quarter of the total 2007-2008 GHG emissions. To reduce the impacts of Macalester-funded air travel emissions, this study recommends the following:

Strategy: Monitor, Stabilize and Reduce Institutionally-funded Air Travel

Departmental Air Travel

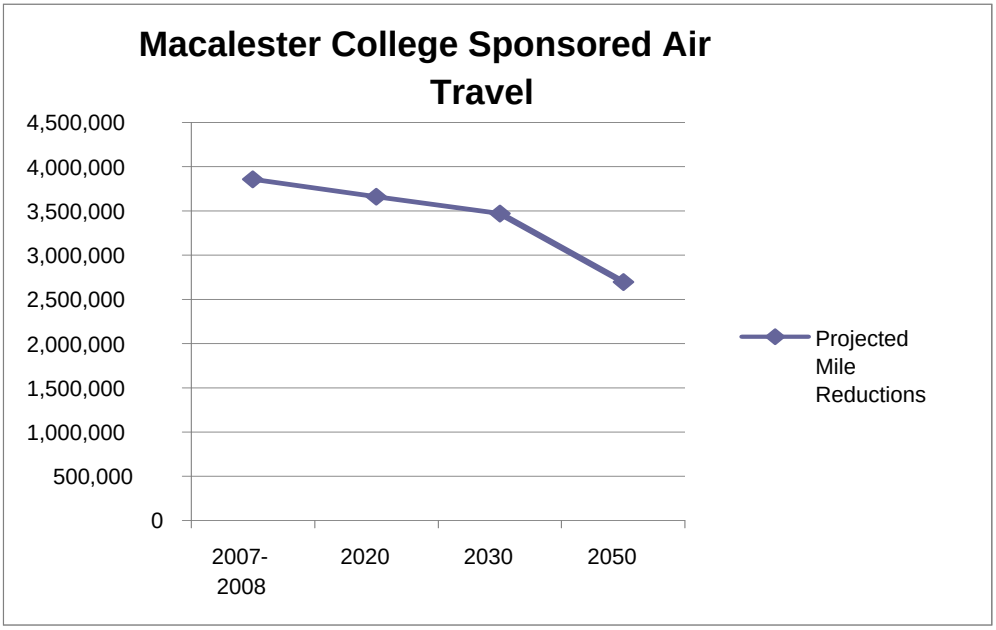
In the 2007 to 2008 fiscal year Macalester spent a total of $902,526 on airfare, excluding student study abroad. College-funded air travel occurs for a wide variety of reasons and many of the trips cannot be legitimately avoided. For certain purposes such as fundraising for a capital campaign, a phone call or email does not elicit the same response as a personal visit. For others, such as a national collegiate sports event, there is no hope of telecommuting. Despite the legitimacy of most air travel funded by Macalester's budget, it would be both financially and environmentally wise to closely track institutionally-funded air travel. Furthermore, it would be in the school's best interest to reverse any increases in institutionally-funded air travel through 2010-2011. Ultimately, it should be the goal of the college to reduce institutionally-funded air travel from current levels, especially as it strives to achieve carbon neutrality.

Performing the task of monitoring, stabilizing and ultimately reducing institutionally-funded air travel may appear to run counter to the current ideological direction of Macalester College. Macalester is a leader in international education and champion of the concept of global citizenship within higher education. Global citizenship, however, does not necessitate increasing personal nor institutional carbon emissions. In fact, good arguments have been made that

reducing, not enlarging, one's carbon footprint, is the act of a caring global citizen.

There are many creative ways in which Macalester's institutional carbon footprint from air travel can be directly reduced at no cost to the college and without reducing the number of trips. In fact, this can be achieved while conservatively increasing Macalester's air travel; we may fly more often to places that are not as distant and still reduce our institutional carbon emissions. While certain trips across the world cannot be avoided, policies should incentivize national and continental travel for trips that have a degree of flexibility (speakers, guests, field trips, conferences, research, etc.). Another key way to reduce emissions without radically reducing the number of trips taken is to favor direct flights in which the carbon-intensive actions of take-off and landing are minimized (The Atmosfair Emissions Calculator, 2009). Throughout the data utilized in this study are instances of flights that have multiple stops such as traveling from Minneapolis, to Chicago, to New Orleans, with a return flight from New Orleans, to Charlotte, and back to Minneapolis rather than a direct Minneapolis-New Orleans flight. These multi-stop trips overall contribute much more to Macalester's institutional carbon footprint due to the increased emissions from multiple take offs and landings.

Below is a long-term scenario for management of college-sponsored air travel. For the immediate future—from now until 2010-2011—Macalester should stabilize its miles flown at current levels. By the 2020-2021 school year, Macalester will achieve a 5% decrease in mileage, bringing total miles flown to 3,662,755. By 2030, a 10 percent decrease from current levels will be achieved. By 2050, Macalester will achieve a 30% reduction in miles flown from the current figure, overall reducing the miles traveled to 2,698,872.



The challenges to successfully implementing a program that reduces college-funded air travel are great; political and cultural hurdles within the Macalester community will be particularly daunting. Some may disagree that it is necessary to emit fewer greenhouse gases at all. Cultural hurdles are among the greatest barriers to implementing global warming solutions; voluntary behavior change to address global warming is not yet a widespread cultural value at Macalester. Grassroots initiatives based on inter- and intra-collegiate competition have begun to make cultural change at Macalester in other sectors, such as the electricity sector. Grassroots efforts for individual behavior change in the transportation sector, however, have addressed ground transportation only. This excludes our largest source of emissions from the transportation sector, air travel.

Though facilitating personal commitment is a good place to begin air-travel emissions reductions, this strategy may not be effective given current campus culture. Mandatory department-based strategies, such as office travel caps, may be more effective. Departmental

travel is determined by individual budget discretion, which accounts for much of the college's overall mileage. There is no statistically significant difference between total miles flown between Administrative Offices, Academic Departments and Academic Offices (this includes co-curricular civic engagement programs' offices) in 2007-2008 (Stonehill, 2009). However, Figure 2 shows significant discrepancies between singular departments and offices. Under a department-cap strategy, travel planners must be aware of their own department's emissions. Departments and offices may also "compete," as dormitories and colleges compete in electricity-use competitions, for accruing the fewest emissions from travel.

The concept of a limit (be it in dollars, miles, or carbon emissions) for department and office travel budgets brings up the question of how to create a fair system. A very close look must be taken at the overarching mission and logistical needs of every office and department, as well as data analysis of their air travel emissions over time. Some offices fly more because their programs absolutely necessitate it. For other departments, most flights are voluntary, avoidable, or can be replaced with alternate modes of transportation. In the case of department-caps, the most politically feasible method of implementation may involve departments and offices, rather than institutional administrators, setting their own goals for emissions reductions. The first years of any program that is implemented should serve as a trial period to see which combination of strategies achieve institutional goals.

Alternative types of travel can take the form of physical transportation as well as electronic communication. Physical transportation alternatives, such as bus, rail, and the campus van fleet, should be the primary choice for regional trips and also considered for other

continental travel. Stimulus money is being put towards a high-speed rail for the Midwest that could open its first lengths from Chicago to Madison Wisconsin, Detroit, and St. Louis by 2014. The Twin Cities will be considered for stage two of construction (Staff and wire reporters, 2009). This high-speed rail system can serve as a primary mechanism for transferring Macalester's continental travel needs to a more sustainable for of transit in future years.

Another alternative to air travel that is being investigated by a number of institutions, especially in the face of the current economic recession, is electronic communication. As discussed above, flights for athletic competitions or even bringing in potential job candidates cannot be replaced with a simple phone call or even internet conferencing; however, a percentage of Macalester's air travel GHG emissions can potentially be reduced through the proper implementation of teleconferencing technology.

Before purchasing an airline ticket departments should seriously consider whether the goals of the trip could be met through digital communication. Barron Koralesky, Associate Director of Macalester's Information Technology Services, recognizes that teleconferencing technology such as Google's video chat does not provide the same level of intimacy or ability to network as physically traveling to talk face-to-face. He outlines scenarios in which teleconferencing could serve as a possible alternative to air travel including meetings where all participants are already familiar with each other, or as a means of "bringing in" guest speakers. It is important to consider how necessary a speaker's physical presence is to expressing their message, and if there are other mediums for communicating that message. Teleconferencing allows for "question and answer style" interaction, but more intimate follow up conversations

must take place through electronic means rather than face to face. (Koralesky, B. Personal Communication, April 1, 2009). The potential for teleconferencing to reduce Macalester's green house gas emissions as well as eliminate the high cost of airfare and accommodations may be very high.

Strategy: Emphasize continental study abroad programs and reallocate student tuition to address externalities of long-distance flights

Study abroad-related air travel does not represent a simple or easy opportunity for institutional GHG reductions, but should not be ignored as the sector represents 11% of the institution's total emissions. Learning within other cultures is clearly found within the core mission of Macalester College. Thus, our recommendations to address the externalized costs associated with study abroad travel are not meant to interfere with the success of Macalester's international education programs. Participation in study abroad programs can be maintained or even increased without increasing emissions in much the same way as institutionally-funded air travel: by flying to closer destinations on direct flights.

Macalester can offer students high quality study abroad opportunities within the continent that minimize the externalized costs of flying. The idea of "staying local" when going abroad may seem counter-intuitive, but is logical from an economical perspective. The Study Abroad maps (Figures 3 and 4) show relatively few students studying in the Caribbean, Mexico and Central America. Broadening opportunities for cross-cultural learning in these destinations

should be among the priorities of a more cost-conscious and carbon-conscious International Center. This culture shift begins with the International Center, but like all culture shifts, it ultimately involves every member of our institution. Promoting the importance of "staying local" even when going abroad and being conscious of the environmental impact of long-distance travel should be a collective responsibility at Macalester.

Although studying closer to home is ideal for reducing Macalester's GHG emissions, at times it is necessary for students to travel to more distant countries to broaden their cultural and academic knowledge. For example, Macalester's Japanese Studies majors are required to study one semester in Japan where in addition to honing their language skills they are able to form friendships and experience the culture first hand. Also, as a currently popular study abroad choice, the International Honors Program offers very valuable world knowledge and experience through its programs: *Cities of the 21st Century, Health and Community,* and *Rethinking Globalization* (International Honors Program, n.d.). These programs contribute significantly to Macalester's air miles, as each spans three continents throughout the semester. Consequently, as not to penalize these programs, the recommendation is that students fly the most direct routes available and additionally that every student abroad reduce their individual footprint by practicing sustainability in their day to day lives.

Promoting sustainable living for students studying abroad is not a measure that can be computed in a calculator, but it is a valuable qualitative measure that falls under the PCC category "integrating sustainability into the curriculum and making it part of the educational experience" (American College and University Presidents Climate Commitment, 2009).

Following the example of other campuses such as Middlebury College, Macalester's International Center should create a list of study abroad programs with sustainable values such as *SIT Australia: Sustainability and the Environment* and *LivingRoutes Study Abroad in EcoVillages.* Another method for publicizing Macalester's vision of sustainability during study abroad is by incorporating this message into the orientation process. Since not all students are looking to study sustainability abroad, they should also be provided with a list of changes they can make on the personal level to reduce their carbon footprint on any program. One manor of accomplishing this is to create a link from the study abroad website to the external site Green Passport, which emphasizes the need to be aware of the social, environmental, and economic consequences that living abroad has on the local community (Green Passport, 2009).

To quantitatively reduce the environmental impacts of study abroad, several schools now use student fees to fund sustainability efforts. However, charging additional fees to address the externalized environmental costs of study abroad flights provides a disincentive for students to study abroad. Thus, this study recommends a small amount of the normal tuition paid by Macalester students who study abroad for a semester should be re-allocated to fund sustainability projects on the Macalester Campus through the Clean Energy Revolving Fund (CERF) or locally by purchasing offsets. Assuming a constant rate of 282 students studying abroad every semester and a $20 per student allocation, the fundraising potential of this project is $45,120 by 2020, $101,520 by 2030 and $214,320 by 2050. Student tuition and fees are already in place at Macalester to address various costs of study. They should be allocated to internalize the cost of emitting carbon when studying abroad.

Strategy: Unify and augment travel data collection systems

Air Travel: Data Accuracy

To accurately assess and reduce Macalester's transportation-related emissions, clean and reliable data is integral. As stated previously in the data section, there were vast improvements in data collection methods due to the useful air travel data that could be extracted from Macalester's P-Cards. There still are, however, limitations due to the vagueness of check requisition data. As mentioned before, only half of the overall miles flown by Macalester were recorded by the P-Card, and the rest was calculated in the same manner as last year's report. Check requisition data is not as accurate as P-Card data because it simply provides a dollar-amount spent on air travel, and does not include actual flights taken. Consequently, domestic and international flights cannot be separated, and all flights are equalized with one conversion factor. Another drawback to check requisition data, as observed in the P-Card data is that many short flights from Minneapolis to Chicago O'Hare can cost as little as $118 or as much as $534. By using our conversion tool of 4.27 miles/dollar these trips would have mileages of 504 miles and 2281 miles respectively; this broad range could severely impact the reflection of actual roundtrip miles traveled, which is 666.

The data collection improvements from P-Card data were invaluable to our analysis, however, the amount of time spent manipulating the data into a format suitable for a carbon calculator (roughly 25 hours) reveals serious inefficiencies in current data collection systems.

Part of the required data manipulation can be avoided in the future by separating domestic flights from international flights. These types of recommendations require communication between people such as Suzanne Hansen of the Sustainability Office, and Kathy Johnson, Purchasing and Accounts Payable Manager, as well as an official request process.

Along with changes in the data collection system, it would facilitate the process and more accurately reflect emissions from air travel if a different mile-calculator was used. Mile-marker is the website that was chosen by Purchasing and Accounts Payable to serve as an optional mileage calculator for people who would like to calculate the mileage associated with their flight. In addition to creating more formal language indicating that use of this mileage calculator is not optional but "officially requested by the Sustainability Office for emissions tracking," a more user-friendly website is also recommended.

An ideal mileage calculator program would provide accurate mileage while still taking into account multiple stop-overs in non-destination cities (layovers) and show relevant and thought-provoking carbon-emission equivalents. For example, a program that calculated resultant ecological harm if all people were to emit similar levels of carbon, such as global sea level rise, might enhance transparency of the impacts air travel has on the environment. This program could be directly linked to an institutionally-sanctioned carbon offsetting program or other clean energy financing mechanism (such as CERF). At the time of this study, no such calculator exists. As an institutional leader among colleges and universities seeking to mitigate GHG emissions related to air-travel, the Sustainability Office should take it upon itself to share with other institutions any such programs it finds or develops. In addition, it should share its

approach to successfully implementing its use.

It is worth restating that institutional carbon emissions from air travel are not uniform by office or department. It is within reason to request that those offices that contribute the greatest number of miles towards Macalester's total carbon emissions calculate their distances personally, or relegate the task to a student employee. The concept of responsibility for carbon emissions on an individual level is an important step towards realizing collective responsibility for institutional emissions. Dedicating a few minutes to record this information for institutional data tracking is a request that is well within reason when juxtaposing this small task with the potential magnitude of GHG emissions' short and long-term effects.

Promotion of purchasing options in which complete data collection systems are built into an existing program is optimal for the continued assessment of Macalester's carbon footprint. For Macalester, these purchasing options include the P-Card (Purchasing Card) and use of Vanguard Travel Unlimited, the ACTC travel agent. The current P-Card system was instituted at Macalester roughly five years ago and every Department and Office at Macalester is given at least one P-Card for purchasing. Technically speaking, everyone at Macalester has access to a Purchasing Card. It would be useful to complete a series of interviews or surveys to better understand the current barriers and disincentives to using P-Cards. In all likelihood, a sustained publicity effort will be needed to significantly increase Purchasing Card user rates.

The Vanguard Travel agent is an equally if not more efficient resource with clean organized and detailed flight paths and costs. Not only would promotion of these two options be a sound decision because they result in complete or near-complete data sets for performing

carbon calculations, but also because it is logistically and financially inefficient for Macalester to maintain multiple purchasing systems. Macalester should officially promote the use of P-Cards and Vanguard for purchasing airfare for reasons of data collection efficiency as well as the efficiency of our purchasing system. It is important to note that significant time commitments are necessary for publicity efforts to be successful over long periods of time. Additional human resources in the Sustainability Office and/or the Purchasing Office will likely be necessary to put together a publicity campaign that has a significant impact on people's flight-booking habits, especially in today's ingrained culture of "do-it-yourself" online flight booking services such as Expedia or Orbitz.

If a sustained publicity effort is not effective in creating higher usage-rates of Vanguard Travel and the P-Card, the Sustainability Office and Purchasing Office should facilitate a complete re-assessment of data collection systems. Eventually, if data collection reform cannot be accomplished through voluntary measures, Macalester should establish requirements that ensure that air travel-related data is collected efficiently and completely. It is important that a well-functioning system for data collection be put in place for the following reasons: 1) Air travel is among Macalester's most carbon intensive activities (26% of Macalester's overall GHG emissions), 2) Air-travel is among the most difficult sources of GHGs to mitigate, and 3) The need for monitoring emissions due to air-travel will be permanent and likely will increase as Macalester enters a new age of globalization and global warming.

IV. Internal Research: Commuting and Ground Transportation

Faculty, staff, and student commuting patterns make up a relatively small percentage of GHG emissions for Macalester College, emitting 412.9 MT eCO2 per year – around 3% of total emissions. This emission was determined by the Clean Air Cool Planet calculator, which requires three levels of commuting data--from faculty, staff, and students as well as divisions between mode of transportation—private car, public transportation, walking, biking etc. For this study it was decided to only survey off-campus students since it is assumed on-campus students do not have to commute to classes at Macalester due to its compact campus.

According to American Community Survey (ACS) data released by the U.S. Census Bureau, in 2007, the nation as a whole had an average daily commute of 25.3 minutes, up from 24.3 in 2003. This is higher than the average commute time for Minnesotans, which was 22.3 minutes. Macalester faculty averages 16.1-minute commute time, whereas staff is slightly higher at 18.1 minutes, and off campus students averaged 8.7 minutes. It's important to examine these numbers in conjunction with the most common mode of transportation for each group: faculty/staff it is commuting by car, while the majority of off-campus students walk or bike to Macalester.

While commuting emissions from faculty, staff, and off campus students are relatively small, on the individual level, it can be the largest part of a person's carbon footprint. Although, proportional to the total institutional emissions, Macalester's commuting emissions are low, this is also the most tangible portion of Macalester's emissions. Community trends provide an

opportunity for individuals to change their personal behaviors and participate in Macalester's move towards carbon neutrality.

Commuting Data and Methodology

The data for calculating greenhouse gas emissions from Macalester's faculty, staff, and off-campus student commuting patterns is divided into five categories by the Clean Air Cool Planet calculator: percent commuting alone, percent carpooling, passenger trips/week, passenger weeks per year, and passenger miles/trip. The first three inputs were collected using a multiple-choice survey sent out to all Macalester Faculty and Staff (259 Faculty, 432 Staff) and Off-Campus Students (510). The survey included questions about commuting habits to collect necessary data for the calculator, but also incorporated supplementary questions to gauge the campus' interest in carpooling and desired incentives or to examine reasons that prevent the Macalester community from carpooling, using public transportation, walking or biking.

The surveys were distributed through GoogleForm, which proved to be an effective surveying tool as both the faculty/staff and off-campus student surveys had high rates of response. The off-campus student survey yielded 165 respondents or 32.35%, faculty 93 respondents or 35.91%, and staff yielded 197 respondents or 45.60% of the total surveyed population. The survey directly yielded results for the 'percent driving alone' portion of the calculator (19.63% for off-campus students, 64.21% for faculty, and 72.22% for staff) 'percent carpooling' (12.27% for off-campus students, 7.37% for faculty, 8.59% for staff), and 'percent commuting by bus' (4.29 for off-campus students, 9.47% for faculty, 5.56% for staff). In order to

calculate the number of one-way trips per day category, averages were taken from the question "Approximately how many round trips per day do you travel between Macalester and home?" Since this question had multiple-choice answers with ranges such as 2-3 the mean of the range was used, with the assumption that an equal number of people came to campus two or three times a day. The final results depended on the main mode of transportation, faculty and staff averaged about 2 one-way trips per day and off-campus students averaged around 3.5 one-way trips per day, which were then multiplied by 5 to determine the average number of trips/week. The weeks/year category followed the Environmental Studies trend of using 52 weeks for faculty and students, though this may not accurately reflect real workweeks.

Geographic Information Systems (GIS) was utilized to compute an average distance traveled by faculty, staff, and students for the passenger miles/trip category. Records of home addresses of faculty, staff, and off-campus students had to be obtained in order to calculate an average commuting distance, which was achieved through communications with specific offices at Macalester including Human Resources and the Registrar. To maintain confidentiality, these spreadsheets were delivered anonymously with only the street address, city, state, and zip code for each record in two sheets: one of faculty and staff updated in March 2009, and one of off-campus students from the 2008-2009 school year. To find an average distance traveled for the three categories, the addresses of faculty, staff, and off-campus students were first geocoded within ArcMap. In some instances, the software was unable to find the exact address provided by Human Resources or the Registrar, and in these cases, the nearest recommended address was used. Some records were immediately discarded, including seven faculty/staff members that

lived in states outside of a feasible commuting distance from Macalester. Three more faculty/staff members could not be geocoded because of unrecognized addresses or PO boxes but ultimately 98.7% of faculty and staff addresses were successfully geocoded and 100% of off-campus student addresses were geocoded.

To calculate the "miles traveled" category of the calculator, the shortest distance from these geocoded addresses to Macalester was calculated through an origin-destination cost matrix created through the Network Analyst extension of ArcMap. This component of Network Analyst creates a matrix that computes the distance from multiple origins to a destination (Macalester College) by following the least distance path along a road network. The geocoded address layer was used for origins, and a point layer for Macalester, geocoded at its 1600 Grand Avenue address, was used as the destination. Matrices were run for each map and ArcMap calculated the distances, which were represented in the map by a straight lines shapefile, even though the matrix calculated the distance on a street network to represent realistic commuting pathways. Each line contained a field with the distance from origin to destination recorded in miles. This table was then exported into an Excel spreadsheet where both the mean and the median distances were found.

The mean was significantly higher than the median both for Faculty/Staff commutes (mean: 8.24 miles, median 5.60 miles) and Off-Campus student commutes (mean: 1.14 miles, median 0.53 miles), which signifies that more people are commuting shorter distances than longer distances, but that a few people are traveling very far. This is consistent with the maps, which show a high proportion commuting from neighborhoods surrounding Macalester, and

others mostly from within the Twin Cities Metro Area, with a few outliers in places such as Northfield, Paynesville, and Hutchinson MN. Because the mean for each year heavily weighted those few commuters who lived farther away, and the median did not fully account for them, an average of the mean and median was taken for each year. The final average distances utilized for the 'miles per trip' portion of the calculator was 0.841 miles for off-campus students, and 6.92 miles for faculty and staff.

Faculty / Staff commuting, that is the estimated calculation of the fuel used by faculty and staff commuting to and from work, and on work related errands, throughout the year as determined by the distributed surveys and through GIS analyses totaled 302.9 MT eCO2. This represents around 3% of Macalester's overall emissions. While this is usually a large percentage of the average employee's personal emissions, it is a very small percentage of Macalester's. Student commuting, which includes all off-campus Macalester student transportation from their off-campus residences to campus during the academic year amounted to 110 MT eCO2. The emissions associated with off-campus student emissions represents <1% of Macalester's emissions. This number is so small partly because few Macalester students own vehicles and commute by car, and because students tend to live very close to campus. As mentioned previously, although commuting does not represent a large proportion of total emissions, it is the sector where personal changes have positive impacts.

Strategy: Discourage single-occupant vehicles by shifting parking costs to users.

Single-Occupant Vehicle Reduction through Transportation Demand Management

Background

Single-Occupant Vehicles (SOVs) represent the largest proportion of transportation to work both in the United States and at Macalester. A SOV is a privately operated vehicle whose only occupant is the driver; hence all emissions are associated with one person. In the United States, the percent of people driving alone to work has increased from 66.4% in 1980 to 73.2% in 1990 (Kemp, M.A., 1998). This has only increased in recent years, in 2007 76.1% of workers over the age of 16 drove to work alone as their primary means of transportation (American Community Survey, 2007). This increase in SOVs in commutes to work not only represents a decrease in carpooling, which has been steady since the 1980s, but also an increase of millions of extra vehicles on the road. It has been estimated that the 6.8% increase in SOV commuting added 22 million cards to the road (Kemp, M.A., 1998). This has incredible environmental impacts due to emissions from burning fuels and is perpetuated by eroding public transportation shares (in 2007 only 4.9% of US workers use public transportation as their primary means of transportation) (American Community Survey, 2007). The rise in SOVs reflects America's car culture as well as our changing geography; for example, the rise in suburban population increases commuting distance and time and the general lack of public transit connectivity in American suburbs creates a reliance on private-vehicle use. SOVs are the most convenient mode

but the least-environmentally friendly means of commuting. In order to move towards carbon neutrality and to mitigate greenhouse gas emissions other options must be explored and incentivized at Macalester.

The body of transportation planning research that deals with utilizing existing transportation infrastructure efficiently rather than building new infrastructure is known as Transportation Demand Management (TDM) (Victoria Transport Institute, 2009). Developed in response to insufficient funds to build additional highways to address congestion, this strategy seeks to move the greatest number of people to their destination at the least cost, using existing systems to their full capacity (Wachs, 1990). Furthermore, TDM seeks to address travel demand at its root, designing transportation systems that limit demand for inefficient trips and inefficient modes. Single-occupant Vehicles are essentially what the field of TDM seeks to avoid at all costs. Transportation Demand Management is already established at Macalester. Walking, cycling, transit and carpooling are all modes of transport that utilize Macalester's existing transportation infrastructure to the highest efficiency. Programs such as the Walk to Work program help control demand for inefficient trips by helping faculty and staff live locally.

Current Single-Occupant Vehicle Reduction Programs at Macalester

Several institutional programs and policies that strengthen the sustainability of Macalester's transportation system are already underway:

Zipride is the newest addition to Macalester’s transportation options. It is an online rideshare board, which assists in the organization of carpooling groups and trip-sharing,

originally released to the public in September 2008. Along with Zipride's general promotion of carpooling, the program also collaborates with college and university campuses across the nation to provide the security of a campus-based rideshare board that can only be accessed by those with the institution's email address. Macalester joined this initiative before February 29th, 2009 by making a one-time payment of $1,500 through the collaboration of the Sustainability Office and the Macalester College Student Government (MCSG). The ability to purchase this service through a one-time fee means that as long as Zipride exists, Macalester will have access to the ride share board. As years pass and the network of students and alumni increases, the program will become increasingly viable. Although currently 91% of Macalester faculty and staff do not carpool, 23.8% of all survey participants noted that they would be more likely to try carpooling if they had assistance with finding partners. Zipride is the optimal program to facilitate trip-sharing and will hopefully aid in the future in reducing carbon emissions from SOVs at Macalester College.

Subsidized Bus Passes, one of two immediate actions taken by Macalester in 2009 towards fulfilling the PCC, includes both pay-per-ride SuperSaver cards and the unlimited "Go To (College)" cards. Although Macalester began implementing the 50% off retail Subsidized Bus Passes in Spring of 2008, original 2009 funding for this project was insufficient; subsidies ran out in February 2009. In early April 2009 subsidies resumed. According to the survey 4% of off-campus students and only 7% of faculty and staff commute to Macalester by bus. When asked "If you currently commute by driving alone, what keeps you from walking, biking, or using public transportation?" 44% of faculty and staff and 82% of off-campus students said

subsidized bus passes. A sustainable system for funding Macalester's subsidized bus passes has not yet been solidified and institutionalized; however, the campus' interest is certainly strong.

The HOURCAR car-sharing program currently serves Macalester College as well as the Mac-Groveland community with two gas-electric Toyota Priuses. The Priuses are located in the parking lot on Grand Avenue across from Patagonia and near the George Draper Dayton dorm. Using the car is simple: drivers reserve a time online, use the HOURCAR, and then return it to the reserved parking space. Drivers pay for time and mileage, but operational costs such as the cost of gas, insurance ($1 million with a $500 deductible), and parking are all included (Holmes, 2008).

Macalester's Bike Share program can be considered a "first generation" bicycle program, as opposed to more technologically advanced "smart bike" programs with electronic/digital features and tracking capabilities, implemented in cities such as Paris, Barcelona, and Washington D.C. (Demaio & Gifford, 2004) Operated in conjunction with the Campus Center Information Desk and coordinated by a work-study employee, the program offers 5-15 bicycles (with fewer available in winter) to students, faculty and staff for year-round use, each with a helmet and lock. Begun in the Fall of 2005, the Bike Share Program is a popular service; turnover rates for rented bicycles are consistently high (Judge, 2008)

Existing programs that have great potential to strengthen the sustainability of Macalester's transportation system include: Macalester's Van Fleet, which is relatively fuel-inefficient but represents an opportunity for highly-efficient ground transport of students, faculty and staff. It also has the potential, along with HOURCAR, to significantly lower auto ownership

at Macalester. The fleet is now composed of one half ton Chevy Vans with fuel ratings under 20 miles per gallon (Ungier, State of College Report, 2004). As plug-in-electric vehicles enter the marketplace and become financially viable, Facilities Services should conduct periodic research on the feasibility of converting their vehicle fleet. An Environmental Studies Senior Seminar or a student group within a Senior Seminar in Transportation Geography could perform this research. Until then, institutional policies should promote the HOURCAR program as well as encourage higher per-capita fuel efficiency by utilizing Zipride, Macalester's ride-share board.

High Winds Fund's Pedestrian-Oriented Development Projects such as the Grand Avenue planted median and pedestrian refuge, as well as the planned Snelling Avenue median not only enhance the beauty of our neighborhood but also make walking safer in areas with high road-traffic volumes. Low-cost traffic calming options, including landscaping, street furniture, pedestrian-scale lighting and leading pedestrian intervals should be considered around the intersection of Grand and Snelling Avenues. Macalester should maintain and strengthen its close relationship with the Department of Public Works to better facilitate pedestrian-oriented development.

The High Winds Fund's "Walk to Work" Program is currently small but deserves greater resources because it represents the most direct and efficient Transportation Demand Management strategy available to Macalester. The High Winds fund provides financial assistance for faculty and staff members purchasing homes within one mile of campus by offering "fix up" matching grants for up to $3,000 for home improvement projects (Hansen, Sustainability at Mac) The High Winds Fund also invests in local housing stock and real estate as

well as matches staff and faculty to local housing options. The Walk to Work program has limited funding and can handle only about a dozen participants every year (Welna, 2009). As the housing market evolves in the coming years, the Walk to Work program should be augmented to include the most pertinent incentives for faculty and staff, particularly job-secure staff members, to settle within walking distance of campus. Both financial and social incentives should be considered.

Parking

Single-occupant Vehicles (SOVs) is a commuting trend that Macalester should recognize and address at an institutional level through parking management. SOVs increase the need for parking, increase institutional carbon emissions, and congest the regional transportation systems upon which Macalester depends. Driving alone is now the mode choice for over three-fourths of all U.S. commuters (Schwager, 1998). Furthermore, studies show that parking prices are a strong deterrent to commuting alone (Schwager, 1998). By granting free parking to all students, faculty and staff, Macalester may be missing its greatest opportunity to provide revenue for under-funded walking, biking and transit projects as well as reduce SOVs and free up campus space for meaningful academic and co-curricular programs.

When considering the value of free parking we rarely assess its true costs, which fall upon the institution that provides it. University of California professor and transportation planner, Donald Shoup, sees the urban planning problem of our century in the parking lot. Looking at parking from the perspective of financial incentives and disincentives, Shoup raises

an analog worth considering: "How much more pizza would you eat if it were free?" The answer is "A lot more than pizza than if you were charged by the slice" (Shoup, 2005). By seeing free parking as an incentive to drive wherever we go, it is easier to understand why close to 87 percent of all trips made in the United States are made by automobile while roughly 1.5 percent are made by public transit. Instead of letting prices regulate demand, as they do in the free market, most institutions bypass the market and directly regulate parking supply by keeping prices artificially low. (Shoup, 2005)

Macalester's parking policies mirror the national trends Shoup exposes-- true costs of free parking are absorbed by the institution that locks its land in parking lots. Macalester's land value is high, on-campus real estate is severely restricted and parking demand is relatively high. From these premises, it would be logical that the cost of parking would be high. Indeed, the cost of parking is high, estimated at $15,000 per space (Welna, 2009). This estimate includes real estate acquisition, paving & striping and the cost of tying up the funds in parking rather than some other investment. In total, Macalester provides 641 free off-street parking spaces to faculty, staff and students (Welna, 2009), at an approximate cost of 9.6 million dollars.

Given the high institutional cost of offering free parking, Macalester should eliminate current incentives to drive alone by shifting the true costs of parking to automobile drivers who necessitate this expense. Freeing space on campus by reducing demand for parking spaces represents Macalester’s most viable and profitable land development strategy. Additionally, collecting revenue from those who choose to drive to campus could fund much-needed incentives for the same faculty, staff and students to walk, bike and take transit. By eliminating

free parking, Macalester will incentivize positive commuting behaviors that reduce both carbon and cost. At the same time, the institution disincentivizes negative commuting behaviors that involve significant maintenance costs and opportunity costs.

The precedent for charging market-rate prices for parking and ending the culture of free parking as a fundamental entitlement has already been set within cities and college campuses alike. MIT's 2007 collaboration between students and staff is one of several examples of this publicized by AASCHE, the Association for the Advancement of Sustainability in Higher Education. The group of urban studies students and parking staff created a final group report, "A Sustainable Transportation Plan for MIT" in May 2007. This report calculates true costs and actual subsidies for parking and compared with costs and subsidies offered for transit passes. Their findings were that parking subsidies were significantly higher than transit subsidies (CEE at MIT, 2007). If an institution seeks to effectively promote specific modes of transportation, it is crucial to perform quantitative analysis that analyzes the subsidies inherent in existing transportation policies or lack-thereof.

Macalester's existing parking policies are well-defined but are not fiscally responsible or well executed. None address issues of cost to provide parking nor do they include sufficiently strict enforcement of permits. In addition, adherence to school transportation policies is generally low. Facilities Services makes it clear through their website that parking is free at Macalester and because parking regulations are generally not enforced, there is no incentive to comply with Facilities Services' parking permit regulations. First year students are discouraged from bringing a vehicle to campus. This policy represents Macalester's most effective and least intrusive form

of transportation demand management at the student level. Policy language may play a key role in the effectiveness of this policy. Discouraging, rather than mandating, that incoming students not bring cars to campus allows the opportunity for Macalester to suggest, rather than impose, a car-free life for a year.

To encourage positive behavior than discourage negative behavior around ground transport, the admissions office should consider including car culture as a talking point when speaking to prospective students. Prospective students should be able to gauge institutional transportation priorities during their first contacts with Macalester: admissions recruiters, a brochure, or a college guide. Promoting Macalester as a walking, bicycling, and public transit campus, rather than a car-owning campus featuring free parking will recruit students who seek car-free lifestyles. This will diminish demand for parking spaces and result in a culture on campus that favors walking, biking, and transit over automobile-use.

Because achieving significant change in SOVs by promoting positive behavior has its limits, Macalester should also consider strengthening mandatory measures such as on-campus parking permit enforcement. Student, Staff, and Faculty Parking Permits are currently free, although, according to Facilities Services policy, vehicles should still be registered and have a permit sticker visible when parked in campus lots. (Macalester College, 2008) This policy creates a system in which those who wish to comply with Facilities Services policy may, but lacks a legitimate incentive for drivers to register vehicles. Permit stickers are not regularly checked to ensure compliance, so compliance with this policy is generally low, resulting in a total count of registered vehicles that does not reflect the actual number of vehicles owned by

students, faculty and staff. More strictly enforcing existing parking regulations will show that Macalester transportation systems are actively planned and managed as well as help reduce SOVs on campus.

Reducing the number of people driving alone to Macalester is, as mentioned before, the most viable strategy for expanding opportunities for development on campus. Considering the highest and best use of land should help guide planning strategies in any urban context. In shaping a comprehensive transportation plan, Macalester should closely consider the potential land uses of properties currently serving as parking lots. There is considerable pressure placed upon campus administrators for more designated spaces for student and campus programs. Thus, as parking lots do not further any institutional goals or pillars of the Macalester College, some areas that are currently designated for vehicles should be re-designated in future campus master plans for more meaningful programming. This, of course, is contingent upon the success of SOV reduction programs and reduction in parking demand.

Jumping scale and analyzing municipal strategies for SOV reduction may prove helpful for Macalester College. The City of St. Paul has adopted land and transportation development strategies that favor smart growth and complete streets—dense, multi-modal, transit-oriented development that is built to the scale of people rather than automobiles. With these strategies in place, minimum parking requirements with which Macalester currently struggles to comply may be revised in the near future to allow more flexibility. In some communities, requirements have not only been relaxed but opposite measures have been instated to limit rather than require parking. These are known as “maximum parking allowances” (MAPC, 2007). Thus, the

constraints within which Macalester currently manages its parking may change significantly in the near future and radically in the distant future as municipal requirements reflect new transportation paradigms.

One small but important land use planning change is currently being instated at Macalester. A preferential parking program required for the LEED certification of Markim Hall--the Institute for Global Citizenship-- is currently underway. This program will give preference to Low Emitting Vehicles (LEVs) as well as Car Pool Vehicles, and proposes criteria by which LEVs and Carpool Vehicles will be judged for preferential parking. Criteria for LEV standards have not yet been finalized, but will be unchangeable once they are set. It is recommendable to update preferential parking requirements periodically as LEV owner rates increase so that only the most efficient vehicles receive preferential parking. A reasonably efficient car today will likely be considered highly inefficient in ten years. Furthermore, as hybrid-electric and electric plug-in car ownership rates increase, the number of cars vying for preferential LEV parking will increase. Standards should be updated so as to give preference to a select group of vehicles. No more than 10% of total vehicles should qualify so as to provide an incentive to the majority of drivers to purchase a qualifying LEV vehicle.

Carpool preferential parking will be offered to permit-holders that transport two or more Macalester faculty, staff or students to campus a minimum of three days per week and travel a minimum of three miles from campus. In addition, permit holders may be required to register with macalester.zipride.com, the online rideshare board, and Metro Transit's Guaranteed Ride Home free voucher program in which walking, cycling, carpooling and Metrotransit riders

to receive free cab or bus fare in the case of an emergency. Carpool preferential parking regulations, like LEV Parking, should be updated with diligence to maintain a reasonable and effective incentive to shift to the most sustainable commuting behaviors. For example, within the near future it is conceivable that the carpooling minimums of two passengers riding in their vehicle three days per week will have to be raised to reduce heavy competition for the number of officially designated LEV parking spaces.

While parking lot signage may increase the visibility of carpooling vehicles and LEVs, a convenient parking spot alone may not be a sufficient incentive for behavior change—a financial advantage will be required to maintain this incentive. Especially when considering a major financial decision such as purchasing a LEV, the difference between a one-minute and two-minute walk from one's car to one's destination is negligible. It is possible that in the long-term future average distance from drivers' cars to their destinations will increase, especially if Macalester achieves significant SOV reduction and some lots are opened up for development. However, financial incentives for LEVs and carpools will be necessary if Macalester wishes to meet even moderately high goals for the success of this program. While there are many creative ways to provide financial incentives, the most logical is to charge SOVs for the use of Macalester's parking and discounting or exempting LEVs and carpools from parking payment.

One reason why parking has remained free at Macalester as neighboring institutions raise parking rates is to avoid "overflow" of Macalester vehicles into on-street parking spaces within the community, preserving a positive relationship between the institution and community-members. However, it is possible to both charge for parking and maintain a positive relationship

with the community. Though implementing a Residential Parking Permit program in Mac-Groveland to ensure that residents in the community have designated on-street parking spots is not a popular idea, it should be duly considered in future transportation plans. With sufficient reductions in SO's on campus, enough parking spaces may be available on campus to implement a parking charge without significant overflow-- without having to resort to municipally-allocated residential parking permits in Mac-Groveland. Accurate car registration data is essential for informing Macalester's predictions of overflow. In managing parking availability and overflow as well as devising a successful system that discourages SOVs effectively and maintains sufficient parking to handle demand, close communication with the community is a key tool. Education, especially around community resilience to global warming and peak oil production, should go hand in hand with actions to reduce SOVs and parking pressures in Mac-Groveland.

Understanding carbon emissions from ground transportation through the perspective of Single-Occupant Vehicles is one way to approach Transportation Demand Management and its system-efficiency principles. A car that transports one person alone represents the least efficient use of the vehicle, gasoline, road, parking, etc. SOV reduction goals are relatively easy to quantify and are "image-able"-- it is easy to imagine a car filled with 5 people instead of one. Other methods, such as looking at Vehicle-Miles Travelled are also applicable to the study of carbon emissions. Ultimately, however, emissions reductions must be quantified in terms of eCO2 emissions-- a much less "image-able" form. Whichever approach is most appropriate or effective in reducing carbon emissions should be used. SOVs are simply one of many ways in which to measure and conceptualize the efficient use of our existing transportation infrastructure.

Commuting: Data Accuracy

Although the commuting trends surveys were invaluable to this study, there were some issues. The survey was voluntary, the answers to some of the survey questions were based on summary or human memory, and the there was the possibility of social pressures to appear greener (i.e. an overestimation of biking or walking versus car use). Furthermore, commuting patterns are not necessarily static. Though the survey asked for a division in the frequency a commuter travels by disparate modes of transportation, there was no real way to account for those who travel by multiple modes in the Clean Air Cool Planet calculator. Commuting to Macalester is also highly dependent on weather, 23% of faculty and staff and 39% of off campus students reported weather as the primary reason they do not commute by walking, biking, or public transit. Because of the compactness of Macalester's campus and the proximity of many faculty, staff, and off-campus student homes, many walk or bike in the spring and fall, but drive in the winter. There is no way to account for these differences, therefore the overall commuting footprint might be affected by these weather-dependent activities and the human errors outlined above.

The "passenger miles/trip" category also contained some data accuracy issues because of Network Analyst and because faculty and staff could not be separated into two categories. The address file for faculty and staff arrived combined and the two groups could not be extracted. It is well known that many of Macalester's professors live close to campus whereas staff members

as a whole may be commuting from a farther distance. The combination of the two into one category could have lengthened the average miles commuted for faculty and underestimated the miles traveled by staff. Furthermore, Network Analyst calculates route distance based on lowest-cost or shortest road distances from the origin to the destination. These routes may not be representative of the actual paths that faculty, staff, and students take to Macalester. There is also no way to account for stops along the way to work, such as dropping off/picking up children at school or childcare.

Data Collection: Commuting

Improved data will be required to quantify achievements in SOV reduction at Macalester. Our main recommendation to improve data collection regarding commuting is for Macalester to implement new data collection systems for monitoring of the number of vehicles brought to campus by students, faculty and staff. Finding a reliable and valid method to accurately track the number of vehicles that regularly park on campus is especially crucial. Though the infrastructure to collect these data already exists, there is currently no legitimate incentive for students, faculty, and staff to register their car with Facilities Services. The fact that Macalester parking permits are offered for free is as much an incentive to drive to Macalester as it is an incentive to not bother applying for a permit. Lack of enforcement of parking regulations is also a strong disincentive to register vehicles as free parking. Though many of the recommendations that follow will greatly ease improvements in data collection systems, the most direct solution to increase Macalester's participation in Facilities Services' parking permit program is to encourage

its use by properly publicizing it or making it truly mandatory for students, faculty and staff to obtain permits. Without proper data collection systems, the potential is lost for addressing Macalester's true parking costs by charging drivers for parking.

V. Report Conclusions and Summary

Macalester College lacks a comprehensive, multi-modal transportation plan that outlines institutional strategies, policies and goals. While a number of programs have been enacted to reduce Macalester's carbon footprint from ground transportation, there are currently no systems that address Macalester's carbon emissions from air transport. Figure 1 shows that institutional air travel is more significant than total faculty, staff and student commuting emissions: 26% of total emissions, versus 3% of total emissions, respectively.

Thus, Macalester should monitor, stabilize and reduce institutional air travel as a long-term strategy to uphold Macalester's climate neutrality commitment. Additionally, incorporating new strategies to reduce the impact of student study abroad should be considered as a long-term strategy for achieving emissions reductions. This study emphasizes the effectiveness of shorter, direct flights that can be partially offset using student tuition. Additionally, the International Center should seek more high quality educational programs in the Americas. As Macalester's culture and educational pillars support internationalism and multiculturalism, the institution should assess how long-distance air travel is related to globally-informed education in both quantitative and qualitative terms.

Percent driving alone and number of single-occupant vehicles are just one way in which

Macalester may conceptualize and quantify goals to reduce emissions from the commuting sector. One key long-term strategy is shifting parking costs away from the institution and towards users. This strategy must be coupled with significant decreases in single-occupant vehicles parking on campus and possibly a neighborhood parking permit program to ensure that parking "spillover" onto neighborhood streets does not occur.

Finally, travel data collection systems must be significantly improved in order to perform quantitative analyses of the success of its programs and strategies. The original research performed in this study—faculty and staff and off-campus surveys as well as P-Card air travel data analysis—should be streamlined and institutionalized.

Further Research

Though this study aims to be a comprehensive analysis of all carbon emissions from Macalester's transportation sector, it excludes a potentially significant subsector: Goods and Services Transport. Quantitative or qualitative analysis of goods and services transport to and from campus is a challenging area of study but will ultimately be necessary if Macalester is to take full responsibility for its carbon emissions. This research would likely involve an independent study with Kathy Johnson of the Purchasing and Accounts Payable Office.

One shortcoming of this study is the lack of specific recommendations to address the complex issue of parking management on an urban campus. Parking availability and price is often underestimated as a potential factor in encouraging or discouraging single-occupant vehicles. As maintaining sufficient parking on campus is of utmost importance to Macalester, this area of

study is widely applicable to the institution. Research regarding preferential parking, parking costs, supply, demand, availability, etc. would likely involve close coordination and/or independent studies with Tom Welna of the High Winds Fund and Terry Gorman of Facilities Services.

Relatively little is known about the potential for telecommunication technology to reduce institutional carbon footprints. While digital communication may seem to have the potential to limit trip demand and reduce Macalester's institutional carbon footprint, closer analysis may reveal the opposite. One notable study argues that the substitution of communication for transportation is a widely-held transportation myth (Black, 2001). More research on this strategy's effectiveness is necessary before Macalester considers it as an institutional strategy for reducing carbon emissions.

Finally, any future research on the topic of institutional sustainability, including transportation, should be conducted in close collaboration with the Macalester Sustainability Office as well as students, staff and faculty members whose positions and interests align with the research. Upon completion, all reports should be made public through various sources, including the Sustainability Office, to foster further study as well as better-informed implementation plans. With that said, there are countless avenues for further research in the transportation sector as it pertains to climate neutrality and climate change mitigation at Macalester. Those suggested above are merely a few of the most obvious gaps in this specific study's research.

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FIGURES

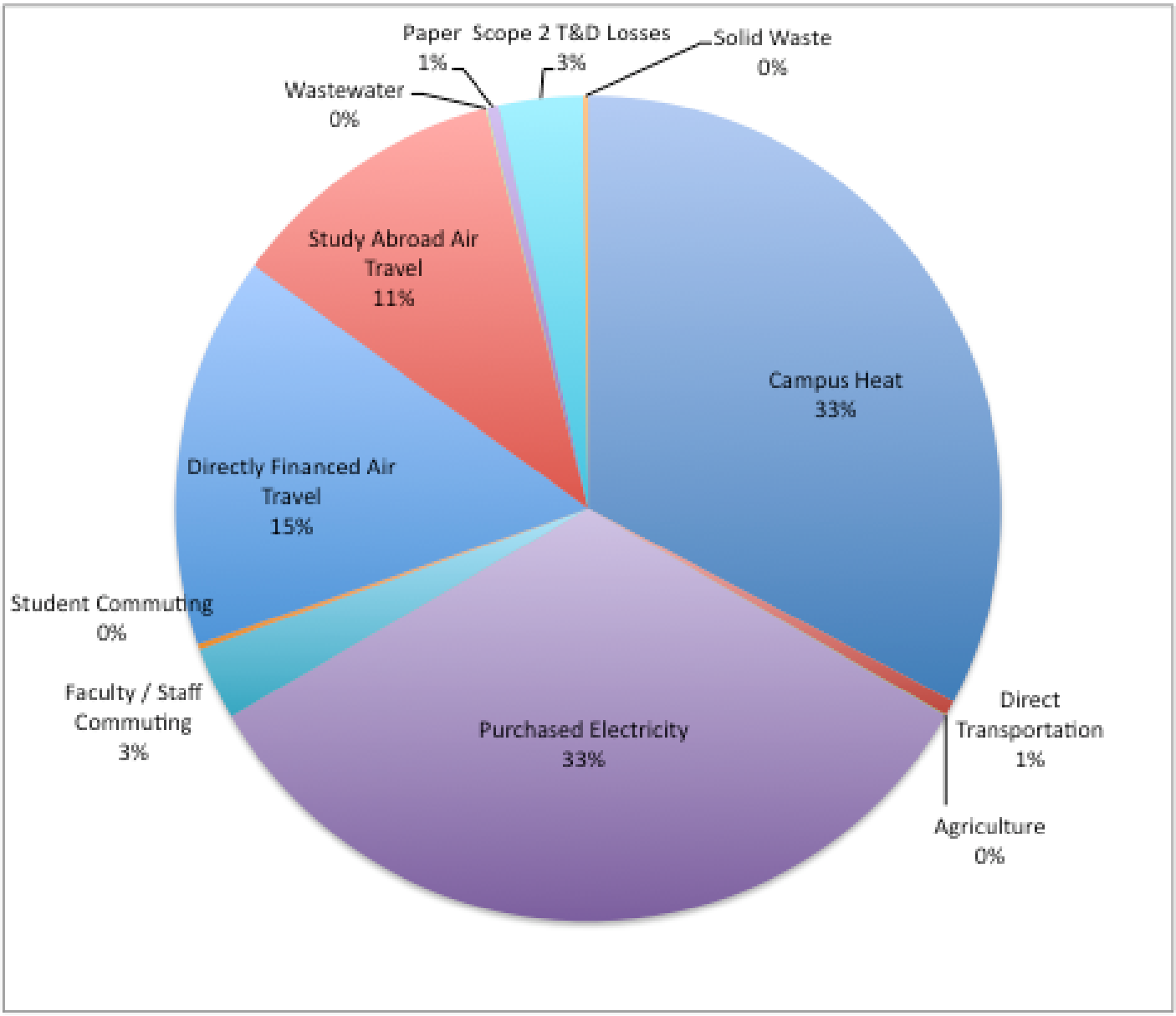

Figure 1: Macalester College GHG Emissions per Sector for 2007-2008 (Commuting 2008-2009)

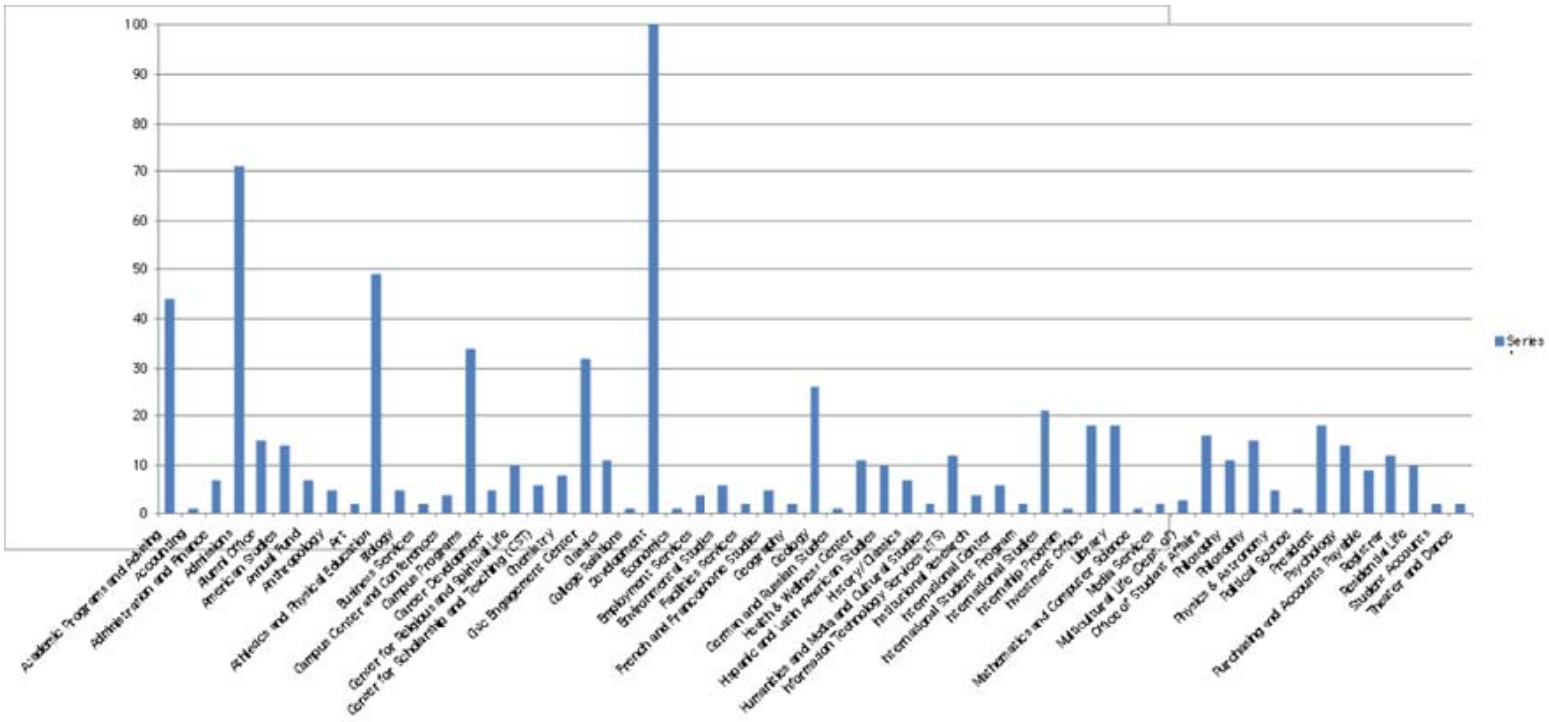

Figure 2: Number of Trips by Office/Department, 2007-2008

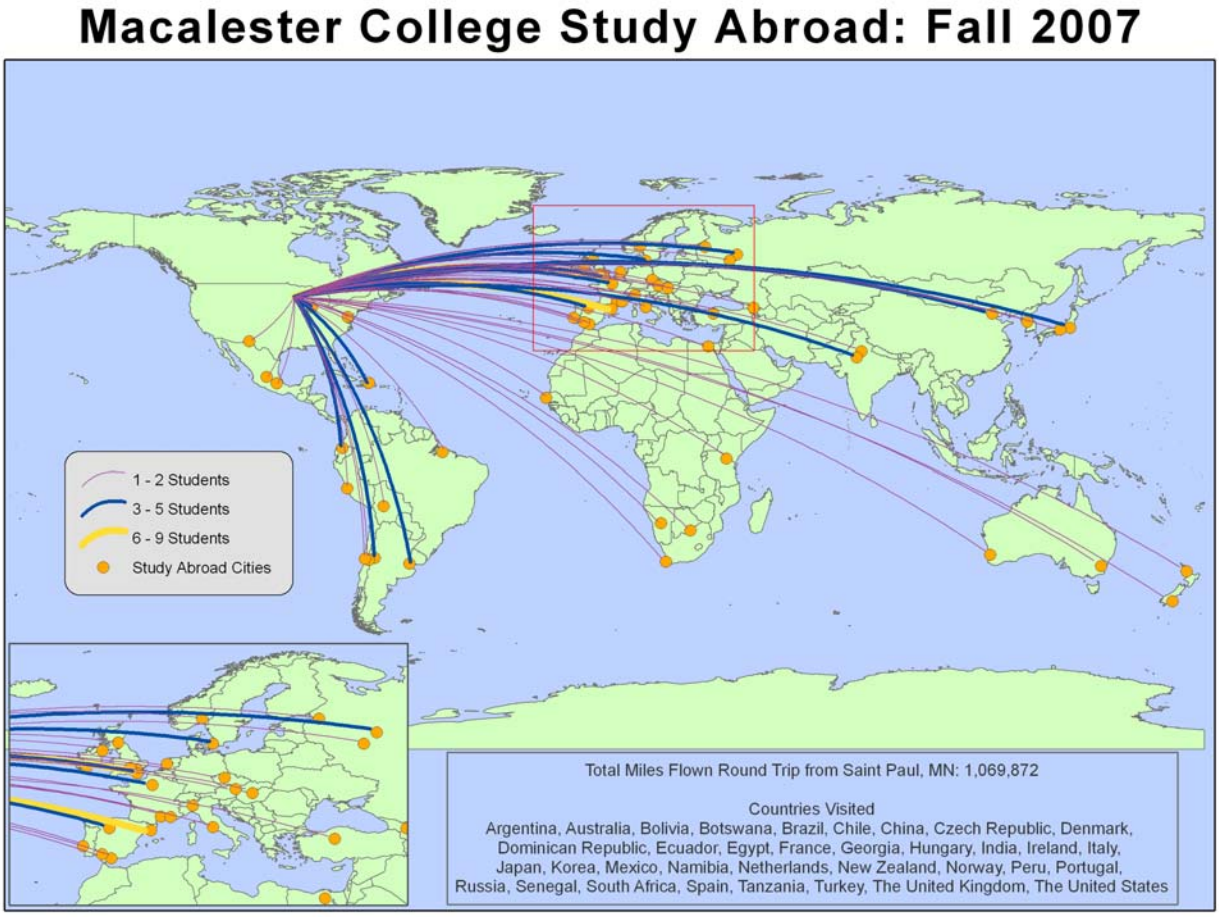

Figure 3: Macalester College Study Abroad, Fall 2007

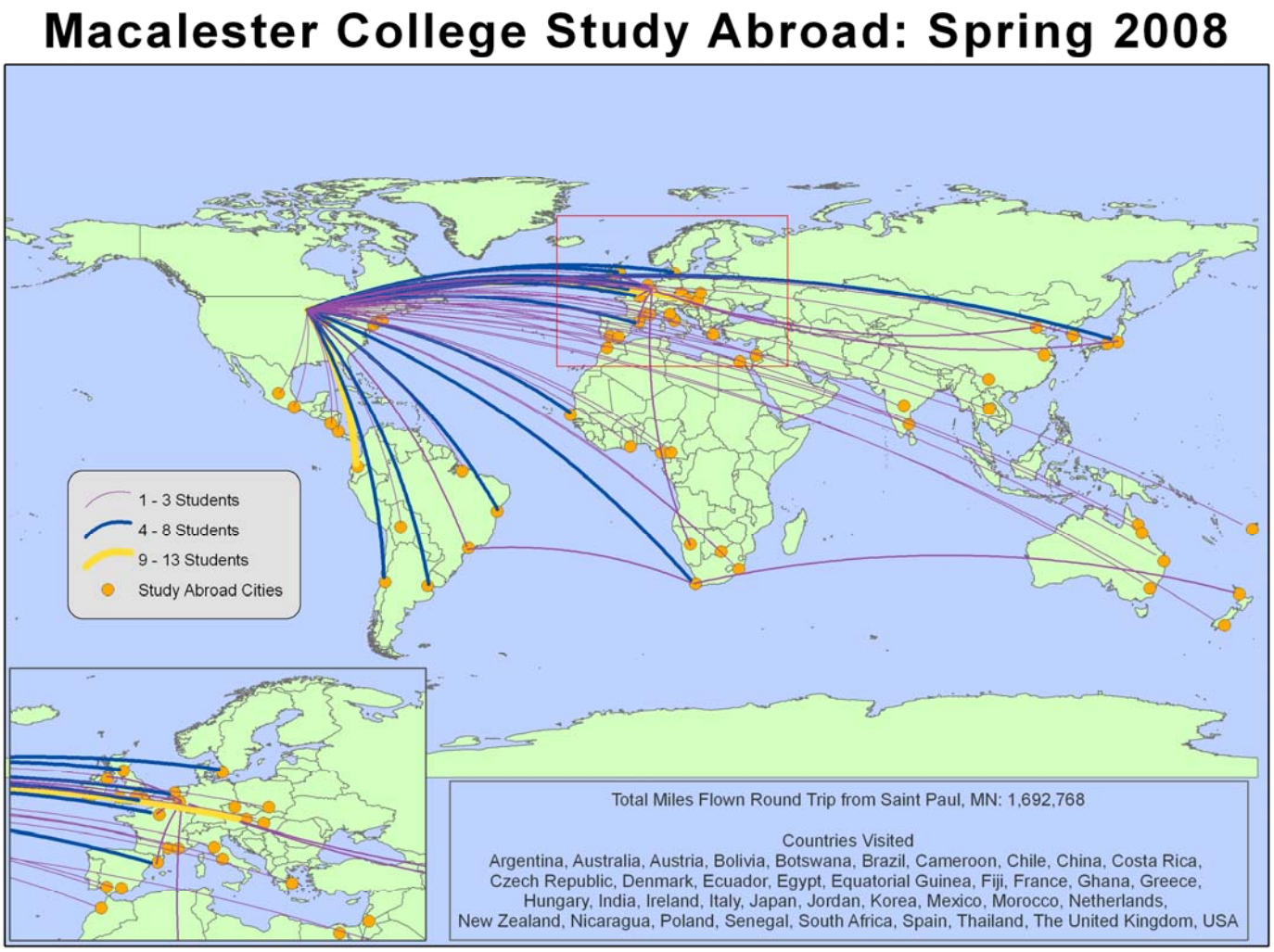

Figure 4: Macalester College Study Abroad, Spring 2008