Keeping British Columbia "the best place on Earth": Reducing the carbon footprint of air traffic in British Columbia

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Abstract

Anthropogenic climate change is projected to have significant negative impacts on the global environment. One human activity driving climate change is transportation, which accounts for about 20% of worldwide greenhouse gas (GHG) emissions (Nijkamp 2003, 2).Civil aviation accounts for 2% of this total, of which 62% results from international flights and 38% from domestic flights (ICAO 2010, 31). Aviation is not only intricately integrated into the global economy but also one of the most carbon-intensive modes of transportation. Moreover, it is projected to be one of the fastest-growing sources of carbon emissions in the transportation sector. The Intergovernmental Panel on Climate Change (IPCC) estimates that emissions from aircrafts could be responsible for up to 15% of total anthropogenic global warming by the year 2050 (IPCC) . It is therefore critical to mitigate aviation-related emissions. However, there is little social scientific research on what the aviation industry has done, is doing, and could do to mitigate GHG emissions. In order to gain a better understanding of their mitigation efforts, I analyze the aviation industry in British Columbia. Specifically, I calculate the carbon footprint of civil aviation in British Columbia, analyze and assess current efforts by airline companies to reduce or offset this footprint, and formulate policy recommendations for further emissions reductions.

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Introduction

Aviation is an integral part of life for many people worldwide, especially for business and leisure travel in developed countries. This was vividly demonstrated during the eruption of the Icelandic volcano, Eyjafjallajokull, in April 2010; planes were grounded resulted in hundreds of cancelled business meetings and thousands of stranded travellers. However, while aviation is an integral element of modern life, it is also an important contributor to anthropogenic climate change. Emissions resulting from aviation differ from emissions from other modes of transportation; they have a dual impact on climate, first when planes are on the ground and second when they are in the air (ICAO Air Transport Bureau). Most aircraft emissions are produced in the air at cruising altitudes because this phase is commonly the longest part of a flight. Notably, greenhouse gases (GHGs) released at high altitudes have a more harmful climate impact than emissions at ground-level. The radiative forcing[1] of high altitude emissions is several times that of ground level emissions.

In 1900, at the dawn of the age of aviation, global emissions of CO_2 from fossil fuels were 2.5 billion tons (World Resources Institute). In the early years of the 20th century, after the first flight of the Wright Brothers in 1903, carbon emissions due to aviation were miniscule. Between 1900 and 2004, however, CO_2 emissions from fossil fuels grew from 2.5 billion tons to 27 billion tons (World Resources Institute), and emissions from air traffic grew immensely as aviation spread around the world. In 2010, civil aviation globally accounted for 2% of total GHG

[1] Radiative forcing is a common measure of the potential of a constituent in the Earth's lower atmosphere (the tropopause) to alter the energy balance of the Earth. It is defined as the difference between incoming radiation and outgoing for a given climate system. Radiative forcing can have a positive or a negative value. A positive value implies that the radiation trapped in the troposphere increases; a negative value implies that increased radiation is lost to outer space. Radiative forcing due to aviation activity occurs due to the release of GHGs and soot (fine particles), creation of contrails, and other factors.

emissions (ICAO 2010, 31), and it is estimated that aviation could account for up to 15% of global emissions by 2050 (IPCC), potentially a dramatic 650% increase in only 40 years.

Considering the aviation industry as a whole, there are numerous activities that contribute to GHG emissions. While most are generated by airplanes, significant emissions also are contributed by supporting structures such as airport operations (e.g. airport vehicles) and auxiliary services (e.g. catering companies). The way in which passengers use aviation services can also contribute to overall emissions (e.g. through airport congestion). Mitigation of GHG emissions by the aviation industry thus requires a multi-layered approach.

There are numerous efforts by the industry to reduce its carbon footprint (CF)[2]. For example, many airlines offer passengers the opportunity to offset[3] their carbon footprint, or offer advice on how passengers can prevent emissions in the first place (e.g. through packing less luggage). In cooperation with airport authorities, some airlines have begun to reduce superfluous emissions generated by inefficient ground practices such as virtual departure queues that reduce the time planes spend idling on taxiways; others have experimented with new operational procedures such as advanced navigation techniques using GPS.

Despite the impact of the aviation industry on anthropogenic climate change and despite the efforts the industry is making to reduce its emissions, there is surprisingly little social scientific research on what the aviation industry has done, is doing, and could do to mitigate its GHG emissions. The purpose of my research is to add to this modest body of knowledge. I do not tackle the global aviation industry as a whole, rather I focus on one corner of the world,

[2] The term 'carbon footprint' is defined as: a measure of the amount of carbon dioxide released into the atmosphere by a single endeavour or by a company, household, or individual through day-to-day activities over a given period. (Dictionary.com 2010).

[3] Offset programs allow consumers to calculate the CF of a specific activity, such as a flight, and purchase credits in the form of CO_2 emissions from projects that result in a net savings of CO_2 emissions, thus nullifying their impact.

British Columbia (BC) and examine the relationship between air traffic and climate change in this province of Canada.

In Canada, total CO_2 emissions have increased from 435.1 Mt CO_2e[4] in 1980 to 549.7 Mt CO_2e in 2006, an increase of 26.3% over roughly a 25-year time span (World Resources Institute). The percentage for emissions from transportation relative to total emissions in Canada has remained stable at around 28%, but total emissions have increased 24.8% from 127.9 Mt CO_2e in 1980 to 159.6 Mt CO_2e in 2006 (World Resources Institute), or roughly 1% per year. If the focus is solely on aviation, the increase is even more significant. GHG emissions from domestic Canadian aviation increased by 43% from 5.22 Mt CO_2e in 1990 to 7.48 Mt CO_2e in 2008, or just over 2% per year (Environment Canada 2010).

Within Canada, BC has by far the highest percentage of emissions resulting from transportation and is the only Canadian province in which over 50% of GHG emissions are due to transportation (Natural Resources Canada 2003). The province, however, does not have the highest total GHG emissions of Canadian provinces; this dubious honour belongs to Alberta with 201 Mt CO_2e, followed closely by Ontario with 198 Mt CO_2e (Natural Resources Canada 2003). Total GHG emissions in BC grew 23.4% between 1990 and 2008, from 55.7 Mt CO_2e to 68.7 Mt CO_2e. During the same period, emissions from the transportation sector grew 38.9% and emissions from BC domestic aviation grew 41.0% from 1.07 Mt CO_2e in 1990 to 1.50 Mt CO_2e in 2008, based on data provided in the British Columbia Greenhouse Gas Inventory (British Columbia Ministry of Environment September 2010). Thus, BC domestic aviation emissions

[4] Mt CO_2e refers to Megatons of CO_2 equivalent. The unit CO_2e is commonly used to account for the different warming effect of different GHGs to represent the amount of CO2 that would have the same relative warming effect as the basket of greenhouse gases actually emitted (CO2 Australia Limited 2010).

grew at almost twice the rate as overall GHG emissions in BC[5]. This argues for the need to conduct research into aviation industry emission reduction activities in BC.

In addition, BC has set highly ambitious GHG reduction goals, which further strengthen the argument for detailed analysis of the CF of aviation in BC. The province has spearheaded several strategies, such as implementing a carbon tax in 2008 that encourages individuals and companies to reduce their consumption of fossil fuels (Ministry of Finance) and mandating emission reductions or offsets, such as requiring public-sector organizations to be carbon-neutral by 2010 (Government of British Columbia).

Despite the BC government's proactive approach to addressing GHG reductions and despite the importance of the CF of aviation in BC, very little is known either quantitatively about the CF or qualitatively about what airlines are doing to address it. The purpose of my research is to fill this gap in our knowledge. This thesis is seemingly the first analysis of the CF of aviation in BC or in Canada. The following questions guided my research.

Thesis questions

Three main questions are answered in this thesis.

(1) What is the CF of civil aviation in BC?

It is relatively easy to calculate the total CF of civil aviation in BC; however, I sought to conduct a micro-level analysis. My calculations of the present (year 2010) CF provide a benchmark from which to compare past or future emissions as they have been or will be affected by policy changes.

[5] The data provided by the Ministry of Environment is not limited to British Columbia. It includes all Canadian domestic flights which originate in BC, and provides an aggregate value for all branches of aviation, including commercial, military, charter, and agricultural

(2) What actions have BC-connected airlines taken in the past or are they taking now to mitigate their CF in BC, and why have they taken these actions?

There is a complete lack of codified information on what airline companies in BC have done or are doing to reduce their GHG emissions. I am seeking to find out what kinds of changes companies have made and why they made them. In general, I will be investigating corporate behaviour change relative to the environment, specifically relative to GHG reductions. For example, I will identify current activities and programs and analyze whether they are effective, both in terms of actual emissions reductions and in terms of financial effectiveness.

(3) What are airlines planning to do and what options are available that they might pursue in the future that would further reduce their CF, and at what financial and social cost?

Even less is known about airline companies' future thinking and the potential for change in BC. In answering this third set of questions, I will bring together the two main components of my research—quantitative calculation of the CF and qualitative analysis of corporate behaviour change—to try to assess what future potential emission reduction strategies can be pursued and what their impact will be in terms of reducing emissions. I will try to quantify reduction options in terms of how many tons the CF could be reduced. On the basis of this analysis, I seek to make policy recommendations for how aviation-related actors (provincial government, airline companies, etc.) can further reduce GHG emissions.

Methods

The above questions will be answered in the order given above. Thus, the first step—answering the first question—is to quantitatively calculate the CF of BC civil aviation. I will gather data on routes, type of aircraft used on a flight and number of seats per flight, distance per flight, number of yearly flights per route, and yearly kilometres flown per route. Calculations

will be performed using two different publicly available CF calculator tools to enhance their credibility. The end result of this step is a detailed portrait of the CF of aviation in BC for the year 2010.

The second step—answering the second question—is to determine what airline companies have done and are doing to reduce their GHG emissions. I will gather information on current emissions reductions activities and offset programs. This will be done through a combination of document analysis and interviews with airline representatives, scholars, offset agents and representatives of environmental agencies. Besides identifying what actions are (or are not) being taken to reduce GHG emissions, I will also try to determine why these actions were taken, and whether they are effective. In this second step, my main objective is to evaluate corporate change. Corporate change can stem from within a company or be driven from the outside (e.g., its customers). I seek to understand what causes corporations, specifically airlines, to proactively adjust corporate behaviour relative to the climate change problem.

The third step—answering the third question—is to analyze and assess the potential for future change. There are two prongs to this process. First, information will be gathered on airline companies' future plans. This will be drawn from document analysis and interviews, similar to step 2. Second, this information will be used to re-calculate the CF. I will attempt to rank possible emissions reduction strategies so that the most promising strategies can be highlighted, which will be the basis for making policy recommendations.

Literature reviews

Two distinct literatures are relevant to this thesis. The first literature pertains to the CF of aviation, which is a subset of a much larger literature on climate change-related impacts of aviation-driven emissions. The purpose of reviewing this literature is to situate my BC-based CF

calculations into a larger context of work in this field. The second literature pertains to environmentally-driven corporate change. The purpose of this review is to present what is known about corporate change related to the environment, which will provide the theoretical basis for explaining the data I gather on corporate change within the BC airline industry.

Literature on the CF of aviation

There is a large body of scholarship on the relationship between aviation and climate change. Much research into the climate change impacts of aviation, and ways to address the impact, has been conducted in the past 15 years or so.[6]

The most comprehensive study to date of the impact of aviation on climate change is the *Special Report on Aviation and the Global Atmosphere* published by the Intergovernmental Panel on Climate Change (IPCC) (IPCC 1999). It is a formally agreed to statement about the current state of knowledge about aviation and the atmosphere. It contains sections on CO_2, ozone, methane, and contrails, and concluded, *inter alia*, that total aviation emissions have increased because increased demand for air transport has outpaced the reductions in specific emissions from the continuing improvements in technology and operational procedures (IPCC 1999).

There are numerous other less comprehensive studies on a variety of topics. While these represent a number of institutional backgrounds and thus, at times, differing assessments, there is a general consensus about the negative climate and environmental impacts of aviation and the need to make aviation more environmentally-friendly.

[6] As early as 1915, the U.S. National Advisory Committee for Aeronautics (NASA's predecessor,) accepted a role in addressing the environmental consequences of aviation, leading to what is the earliest or one of the earliest publications on the topic (National Academic Press 2002).

Aviation-related technological change is extensively discussed in the literature, addressing, for example, issues such as new plane designs (Nederveen, Konings et al. 2003; Akerman 2005, 111). Revolutionary improvements to airplane designs are so far off that alternative emission reduction strategies have to be pursued in the near-term.

Research on the CF of aviation has been conducted by the International Civil Aviation Organization (ICAO). The ICAO was formed in 1944 as a means to secure international cooperation and the highest possible degree of uniformity in regulations and standards, procedures and organization regarding civil aviation matters (ICAO, Foundation of the International Civil Aviation Organization), which today include safety, security, environmental protection, and efficiency (ICAO, Strategic Objectives of ICAO). The ICAO is the leading non-governmental body dealing with all facets of aviation. ICAO is therefore a valuable starting point to understanding the environmental and climate impacts of aviation.

The David Suzuki Foundation has investigated the physical and chemical effects of airplane emissions, and provides information about the CO_2 intensity of aviation compared to other modes of transportation, the GHGs produced by airplanes, contrails, aviation emission mitigation measures, and the potential impact of new technologies (David Suzuki Foundation)

Despite the availability of information about the climate impacts of aviation, there is a lack of clarity in the literature regarding how certain emissions values or projections are obtained. While indices can be used to calculate GHG emissions, these indices vary widely. Scholars such as Joumard (1999, 95-96) have thus suggested a more harmonized approach to general emissions indices. Relevant to my thesis research, very little work specifically addresses the CF of aviation. Instead most work has been done on the CF of transportation in general (Greene and Wegener 1997; Koopman 1997; Akerman and Hojer 2006; Yang, McCollum et al.

2009). To the best of my knowledge, only Akerman (2005) has quantitatively investigated the CF of aviation, using the year 2000 as a base year. Because of these diverging emissions values and the lack of existing scholarship in the field, I decided to calculate the CF of civil aviation in BC.

Literature on Environmental Corporate change

The second important body of literature relevant to my thesis is the literature on environmental corporate change because in my thesis I am trying to explain how and why airline companies change their behaviour to reduce GHG emissions.

An extensive body of work exists that analyzes factors influencing or driving corporate change. Based on the literature and for the purposes of this thesis, I grouped these factors into the following five categories: (1) the effect of regulatory agencies, (2) financial pressure from investors, (3) financial benefits of corporate change, (4) proactive environmental management, and (5) social change. Each category will be explained below.

Regulatory agencies can influence corporate environmental behaviour. For example, Post and Mahon (1980) argued that regulatory agencies can function either as a buffer against change or as an agent of change, and that to be an agent of change, the regulatory agency must contain some form of enforcement mechanism. Levy and Egan (1998), however, caution that in an ever-globalizing world there is growing concern that multinational capital is turning to international fora to circumvent constraints from governments and social movements at the national state level, which would make it much more difficult for national regulatory agencies to have significant impacts. Levy and Egan also argue (2003) that the conventional demarcation between market and non-market strategies is untenable because of the highly intertwined nature of

markets and contested social and political structures. This calls into question the very core focus of regulatory agencies and whether their focus is too narrow and thereby unfeasible.

Pressure from investors can influence corporate environmental behaviour. For example, Heinkel, Kraus and Zechner (2001) argue that if enough investors avoid a company because of its environmental policies that company's stocks will be less desirable and vulnerable. Aslaksen and Synnestvedt (2003, 212) concur, arguing that screened portfolios do not systematically underperform conventional portfolios.

Financial benefits can influence corporate environmental behaviour. Russo and Fouts (1997), as well as Porter and Van der Linde (1995), for example, argue that companies benefit financially from greening their operations. Ruf et al. (2001) concur that companies generally financially benefit when management meets the demand of multiple stakeholders, but caution that such incentives require expenditures that reduce profits unless revenues increase at a faster rate. Other scholars, such as Hussain (1999), caution that win–win situations are progressively becoming less apparent for many firms. Scepticism about by financial benefits is also voiced by Doane (2005), who argues that because measures of Corporate Social Responsibility lie within the framework of markets and require market-based incentives for companies to invest in them, they ultimately fall prey to the vagaries of the market, while King and Lenox (2001) assess that existing research cannot answer clearly whether it pays for a company to be green. What is found in the literature is thus a diverging opinion on whether a company benefits from going green, a question that depends in part on the kind of industry.

Proactive environmental management can influence corporate environmental behaviour. Berry and Rondinelli (1998) argue that environmental liability has grown immensely in the past 30 years and that pollution prevention is often less costly than regulatory compliance. The

question that remains is whether this argument holds true for carbon-intensive industries such as aviation. Sharma and Vredenburg (1998, 738-741) state that apart from financial or legal benefits that companies may obtain by changing their corporate environmental behaviour, they also gain additional benefits that make these changes even more attractive.

Social change can influence corporate environmental behaviour. Button and Nijkamp (1997), for example, address ways in which social change affects transportation. While social change can advance corporate change, lack of social change can also prevent corporate change, as discussed by Stewart and Pringle (1997).

With this overview of drivers of corporate change in mind, it is possible to situate policy options within this context and evaluate them in reference to the drivers above., An extensive body of literature discusses policy options for reducing transportation emissions, such as behavioural change (Nederveen, Konings et al. 2003; Chapman 2007), portfolio approaches utilizing multiple approaches (Yang, McCollum et al. 2009), mobility management strategies (Meyer 1999; Litman 2005), modal shift (Chapman 2007), and spill-over effects of policies (Koopman 1997). This literature is very important to my thesis because it provides impetus on potential strategies to reduce emissions. However, most of the research deals with land transportation, such as cars. What is not widely available is an analysis of such policies in respect to civil aviation.

In summary, while the literature on factors influencing and driving corporate change is extensive, to my knowledge there are no studies examining corporate change in the aviation industry relative to climate change and GHG reduction actions. The information gathered from the corporate change literature is nonetheless valuable as it will be used to ascertain the factors influence GHG reduction strategies undertaken by the BC aviation industry.

Work plan

November 2010	Collecting material for Question 1: Gathering data and information to calculate the CF of civil aviation in BC
November and December 2010	Working concurrently on Questions 2 and 3: Gathering information from documents both to assess and evaluate current offset and reduction programs, and to assess future potential emission reduction strategies. Interviews with various experts in the field of aviation will be conducted in the same time frame to supplement and expand the information gathered from documents.
January through March 2011	Writing of the thesis after data collection is completed.

Benefits of research

There are several important benefits resulting from this research. First, I will conduct what seems to be the first detailed analysis of the CF of the aviation industry in BC. Second, I will determine what the BC aviation has done, is doing, and plans to do to address GHG emissions. Third, I will evaluate the effectiveness of aviation-related carbon offset or reduction policies. Finally, I will seek to determine how current policies can be improved, and on the basis of this will make policy recommendations for how the industry can further reduce its CF. Scholars, policymakers, and practitioners in the aviation field should find the results of this research useful.

Based on research conducted so far, I can offer a few preliminary insights. First, the percentage of people who offset their air travel emissions is minute. Vast differences between offset programs cause confusion and hesitancy for consumers (leading to decreased pressure for corporate change), not least because most offset programs do not reveal their calculation methods. Second, meaningful technological improvements seem to lie in the distant future because, as long as planes are required to use fossil fuels, the major improvements that can be made have been made. From this follows the deduction that the biggest immediate reductions

can be made through operational improvements that reduce fuel burn such as improved air traffic guidance and continuous approaches, which incidentally present win-win scenarios for airlines as they reduce fuel costs and environmental impacts, and policy alternatives such as Transportation Demand Management.

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