Air Transport in Northern Canada:

Modeling the impacts of infrastructure and weather on operational performance

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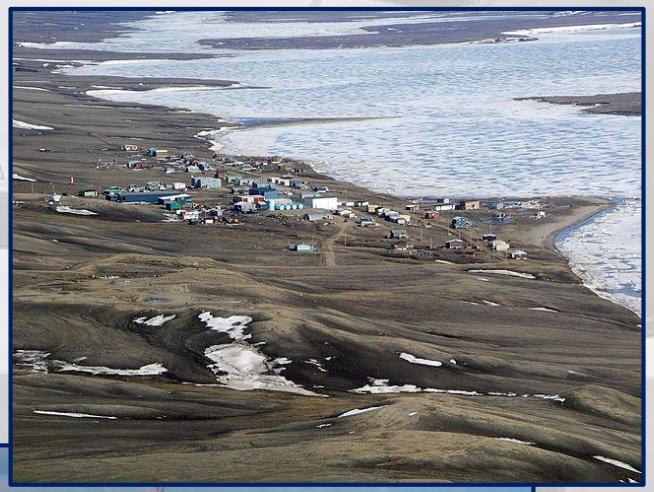
Air transportation services are critical to Northern Canada – connecting and serving important communities, natural resource extraction sites, research stations, and others



There are many Canadian researchers studying Northern issues

ualbertanorth

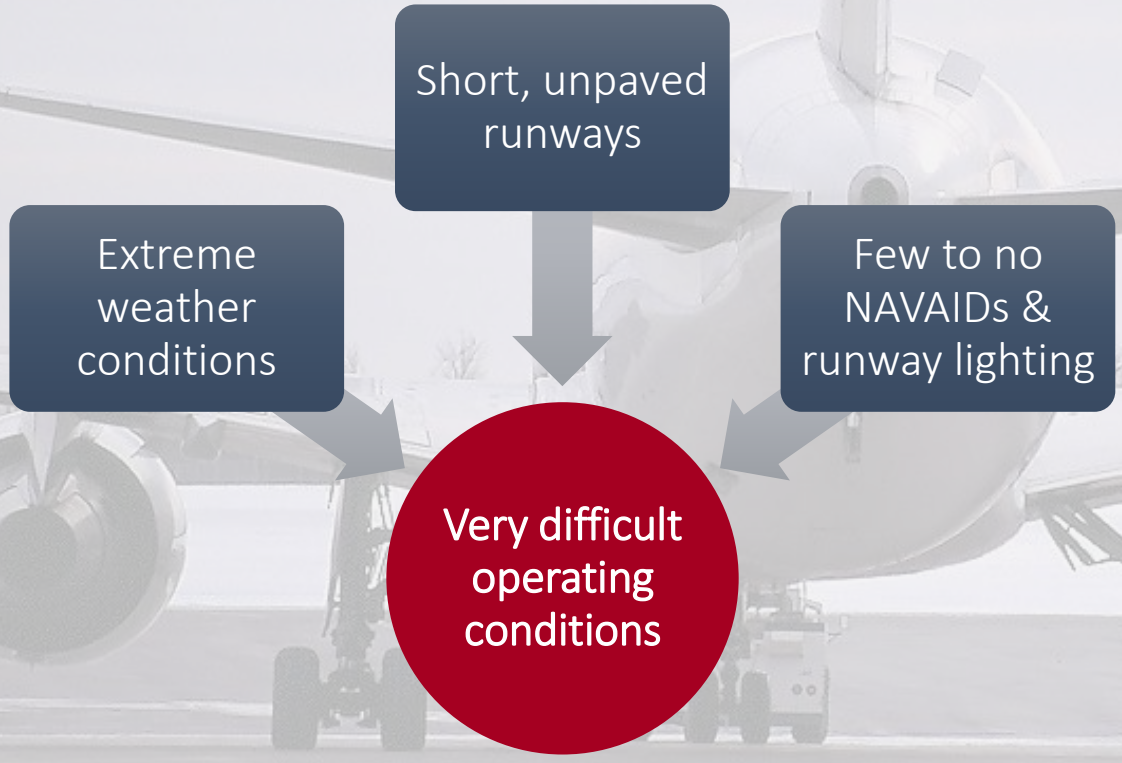
Table 4
Propensity to travel by airplane, 2006

Selected cities	Enplaned and deplaned passengers	Population 2006[1]	Aviation passenger trips per capita
Territories			
Iqaluit	110,512	6,184	17.9
Yellowknife	281,532	18,700	15.1
Whitehorse	151,765	22,898	6.6
Provinces			
Calgary	11,158,243	1,079,310	10.3
Halifax	3,290,441	372,858	8.8
Kelowna	1,264,943	162,276	7.8
Vancouver	16,200,257	2,116,581	7.7
St. John's	1,156,999	181,113	6.4
Toronto	29,467,559	5,113,149	5.8
Winnipeg	3,590,164	694,668	5.2
Edmonton	5,287,848	1,034,945	5.1
Regina	914,286	194,971	4.7
Saskatoon	1,009,462	233,923	4.3
Moncton	534,002	126,424	4.2
Charlottetown	227,352	58,625	3.9
Ottawa	3,540,530	1,130,761	3.1
Fredericton	228,050	85,688	2.7
Québec City	805,095	715,515	1.1

1. For city populations, Census Agglomerations or Census Metropolitan Area geographies were used.

Source(s): Statistics Canada, 2008, Table 1.1, *Air Carrier Traffic at Canadian Airports 2006*, Catalogue no.51-203-X.
Statistics Canada, 2008, *2006 Census Community Profiles*, Catalogue no.92-591-X.

Providing air services in the north require an entirely other set of skills and expertise



Northern airports see a disproportionately high number of very small aircraft movements

	2011	2012	2013	2014	2015
PROVINCES					
Maximum take-off weight, <=9,000 kilograms **(A)**	5458	5546	5385	4415	4480
Power plant, jet engines **(B)**	264	269	278	265	277
PROVINCES: small versus jet (A/B)	**20.7**	**20.6**	**19.4**	**16.7**	**16.2**
TERRITORIES					
Maximum take-off weight, <=9,000 kilograms **(A)**	1366	1190	1095	927	1131
Power plant, jet engines **(B)**	38	43	33	32	46
TERRITORIES: small versus jet (A/B)	**35.6**	**27.5**	**33.6**	**28.6**	**24.7**

Annual itinerant movements, by weight group and type of power plant, airports without air traffic control towers
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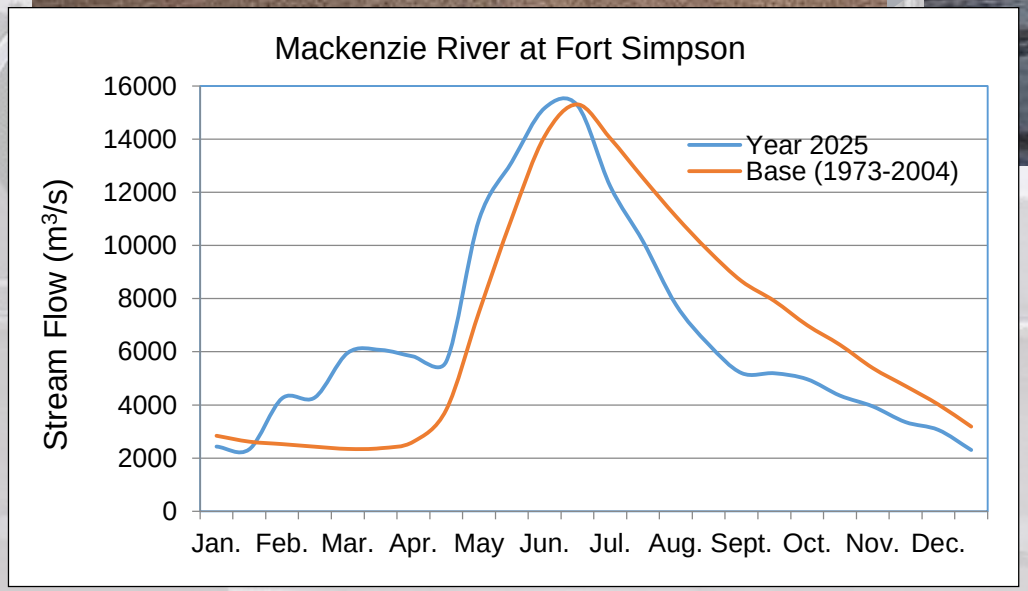


In addition… disproportionately impacted by a rapidly changing climate

Experience informs us about major causes of delay & operational challenges

Many operating statistics are reported by operators continuously

?

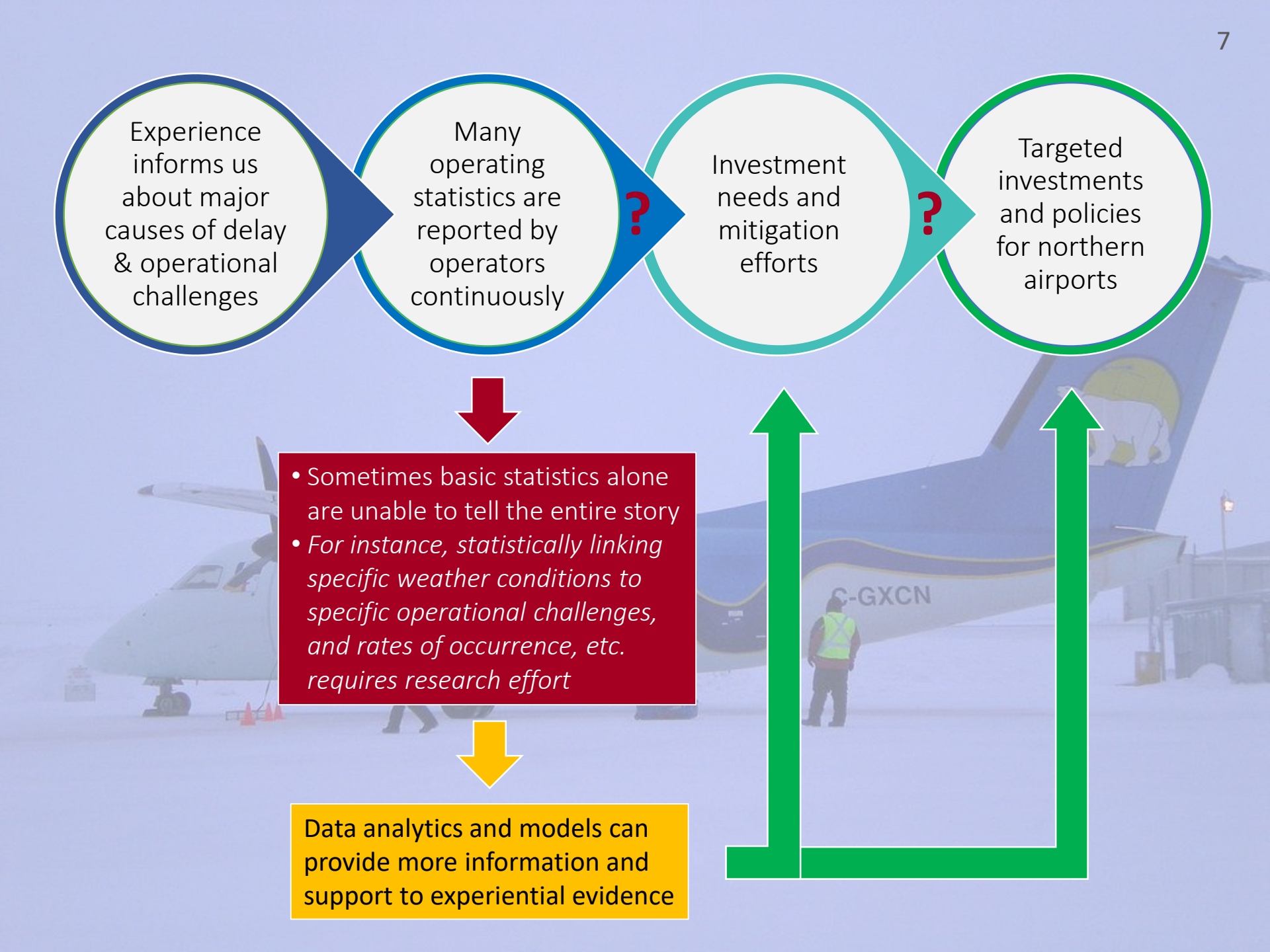
Investment needs and mitigation efforts

?

Targeted investments and policies for northern airports

- Sometimes basic statistics alone are unable to tell the entire story
- *For instance, statistically linking specific weather conditions to specific operational challenges, and rates of occurrence, etc. requires research effort*

Data analytics and models can provide more information and support to experiential evidence



Much of my previous research experience is in the realm of airport and aviation operations

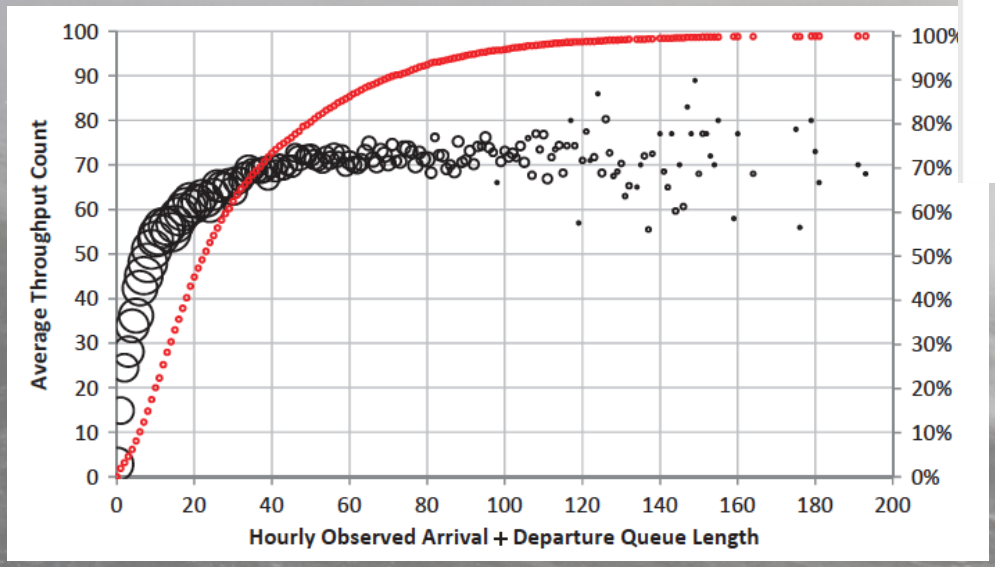
Airport operations analysis, air traffic flow management program design since 2007

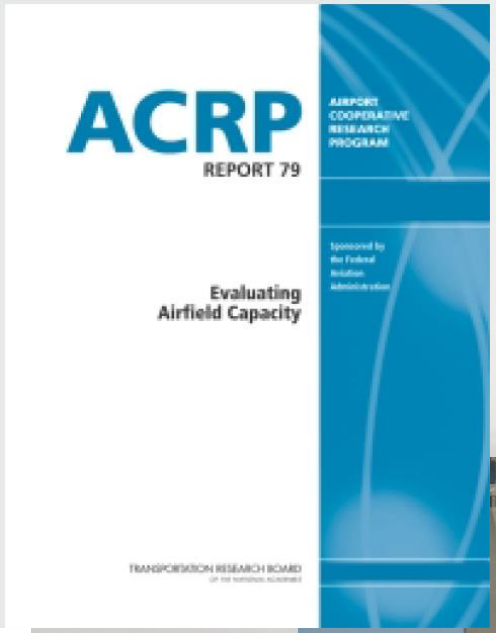
Worked with the FAA, NASA, Edmonton Airports, Port Authority of New York and New Jersey, and GNWT DOT

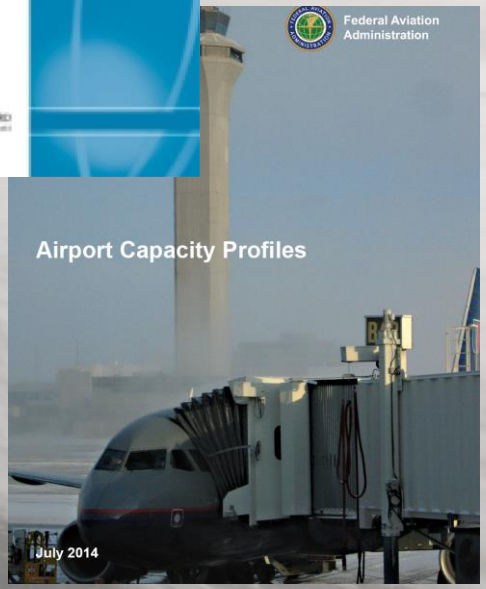
I build data-driven models that can support aviation infrastructure investment decisions

Airport operations have been a core focus of my research – including **runway capacity estimation models** and delay analysis models

- Directly relate impacts of weather (ceiling, precipitation, wind, etc.), runway configuration, demands to operational performance







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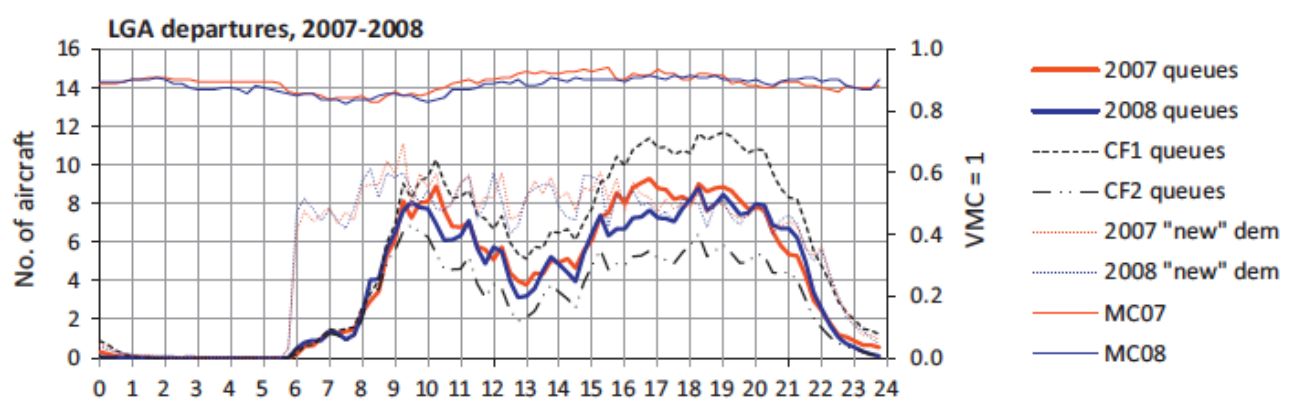
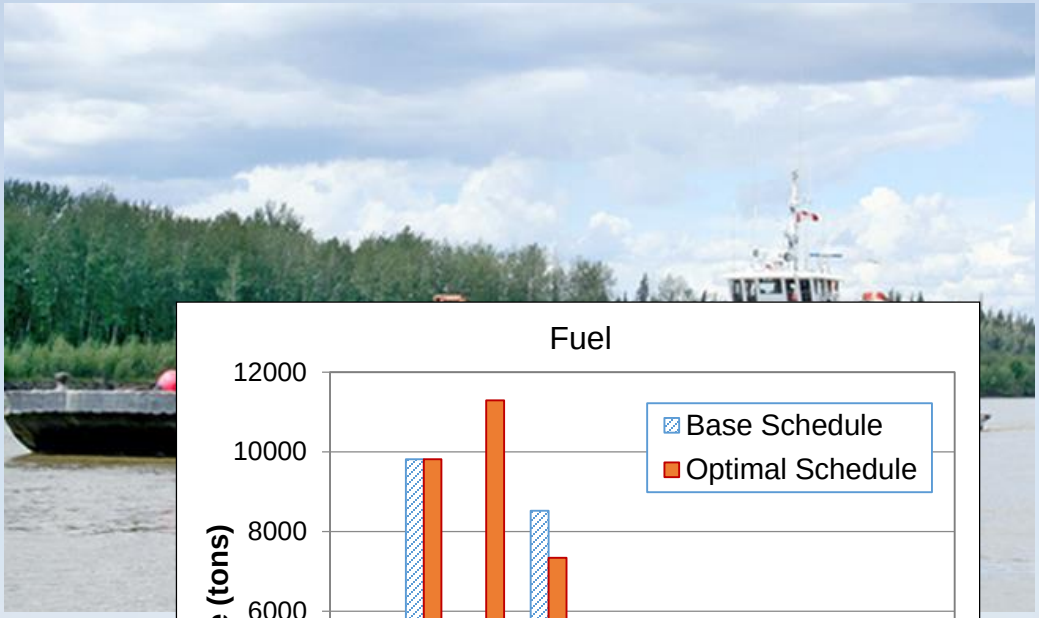


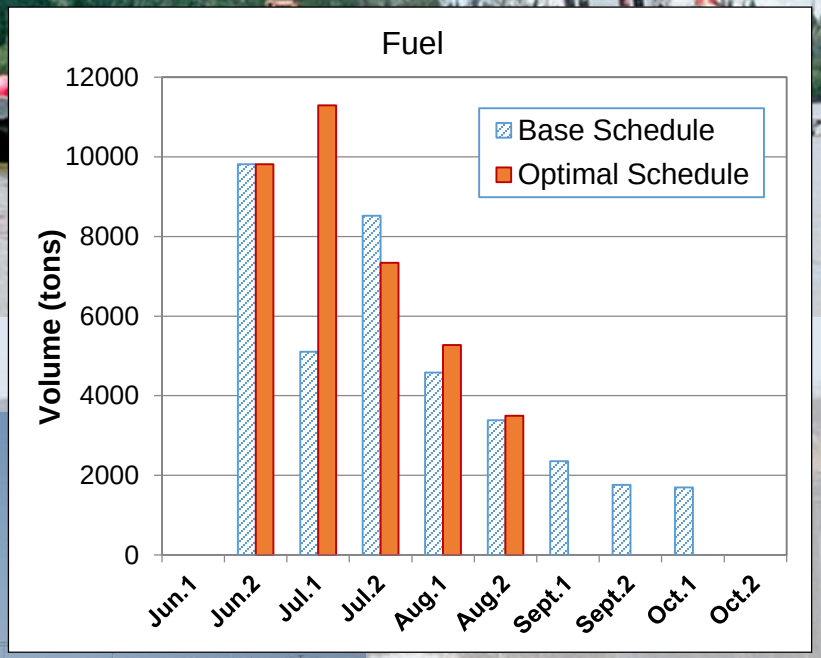
Table 4
2007–2008, and 2008–2009 counterfactual delay simulation results (minutes per flight).

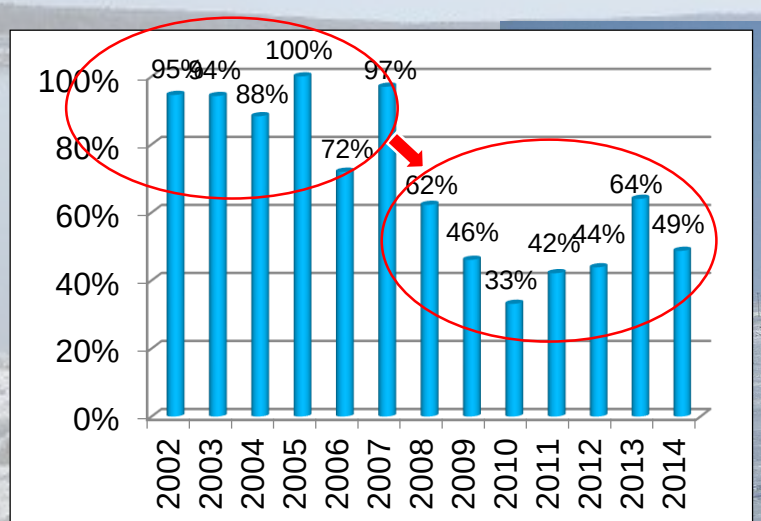
	Average delay (min per flight) in			Counterfactual 1 (delay, in min per flight), $\widehat{w}_0^1$							
				2007–2008				2008–2009			
				07 dem	Δ delay due to		σ^a	08 dem	Δ delay due to		σ^a
	2007	2008	2009	08 thpt	Δ thpt	Δ dem		09 thpt	Δ thpt	Δ dem	
LGA											
Departure	10.7	10.3	7.4	14.0	3.3	−3.7	0.14	16.2	5.9	−8.9	0.26
Arrival	10.7	11.8	10.8	19.0	8.3	−7.2	0.42	30.1	18.3	−19.3	0.41
EWR											
Departure	10	11.3	8.1	11.3	1.3	0	0.08	9.8	−1.5	−1.7	0.07
Arrival	12.1	12.5	11.1	11.6	−0.4	0.8	0.26	23.8	11.3	−12.7	0.21
JFK											
Departure	14.4	11.8	8.5	18.4	4.0	−6.6	0.13	6.9	−4.9	1.6	0.15
Arrival	8.1	8.7	6.8	20.0	11.8	−11.3	0.25	5.7	−3.0	1.1	0.26

[a] Standard deviation of 1000 counterfactual delay simulation runs results.

With ***Transport Canada*** and the ***GNWT DOT***, I studied the impacts of climate change on freight transportation in the Mackenzie River corridor







NTCL total freight volumes (as proportion of max annual total volumes)

$$C = \sum_q \sum_i C_{H_i}^q + C_{T_i}^q + C_{R_i}^q + C_{D_i}^q$$

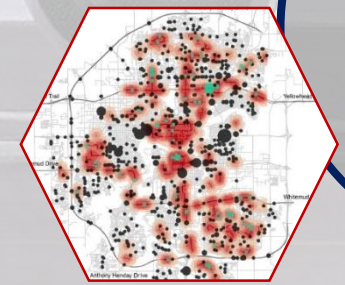
Applied Transportation Systems Analysis @UofA

Interurban transportation networks

System uncertainty & resilience

Northern transportation

Major Themes



Network analysis

Multimodal transportation

Airports & air transport systems

My aim is to bring together these 3 areas of research, by working with northern aviation operators and government

- Operational impacts of infrastructure & weather conditions
  - Permafrost degradation
  - Changing winds
  - Weather, NAVAIDs, airstrip lengths/surfaces
  - Safety and efficiency
- Changing performance under climate change: current vs. historical performance
- Societal impacts of aviation performance (i.e. food security)

Advanced Modeling and Analysis

Benefits for Policy and Practice

- Analysis results can provide:
  - Additional empirically-based evidence to support investment decisions
  - Greater insights and analysis toolkit for practitioners
  - Quantification of benefits of investments to Northern Canada

But this isn't possible without your participation!

Benefits for Policy and Practice

1. Your expertise and domain knowledge
2. Understand your operational needs
3. Flight operations data

Advanced Modeling and Analysis

Thank you!

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