DTC Low Carbon Technologies
Faculty of Engineering

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Aircraft Cost Index and Carbon Emissions Reductions

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Introduction

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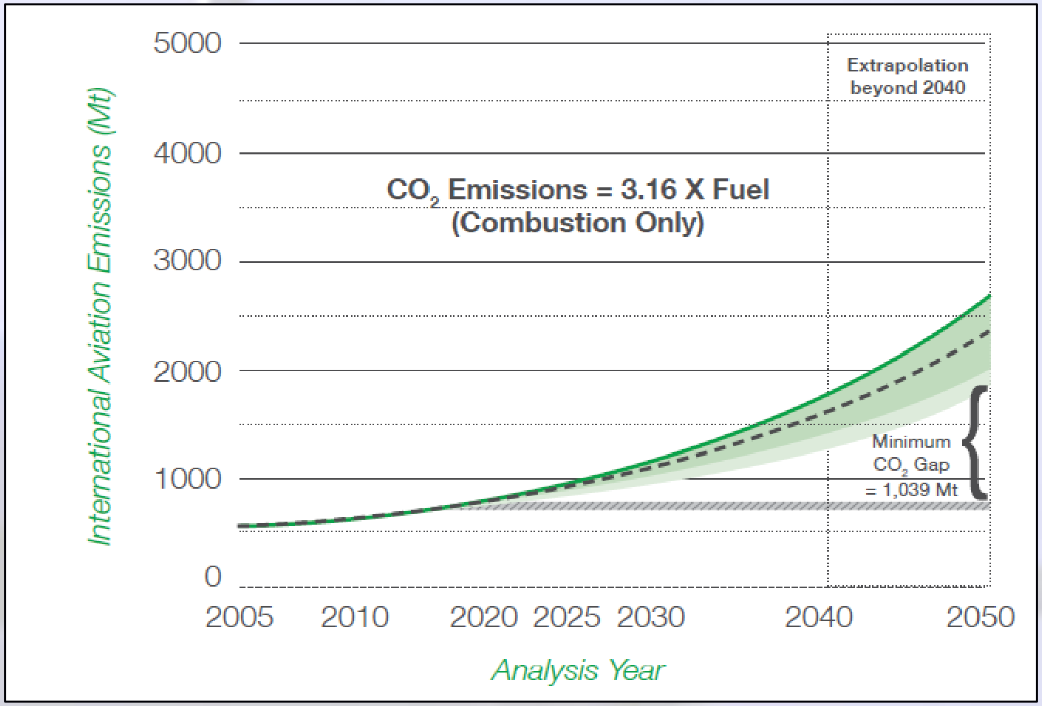
Aviation responsible for around **2-3%** of global greenhouse gas emissions

This proportion set to rise as carbon reduction solutions cannot keep up with demand growth

Likely scenario annual average growth rate:

- average growth rate 2010 to 2030 – 4.9% per annum
- 2030 to 2050 - 4% per annum

56,000 new aircraft required by 2040 (65% for growth)



Cost Index

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CI = Time Cost ($/min) / Fuel Cost ($/kg)

- CI value determines the speed of the aircraft
- The higher the CI the higher the speed. This leads to higher fuel use and carbon emissions.
- Time costs are the most complicated to calculate and include
    - Flight and cabin crew costs
    - Maintenance costs
    - Depreciation costs
    - Delay costs

Cost Index

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Emissions Savings:

B767-300ER – 3.4%

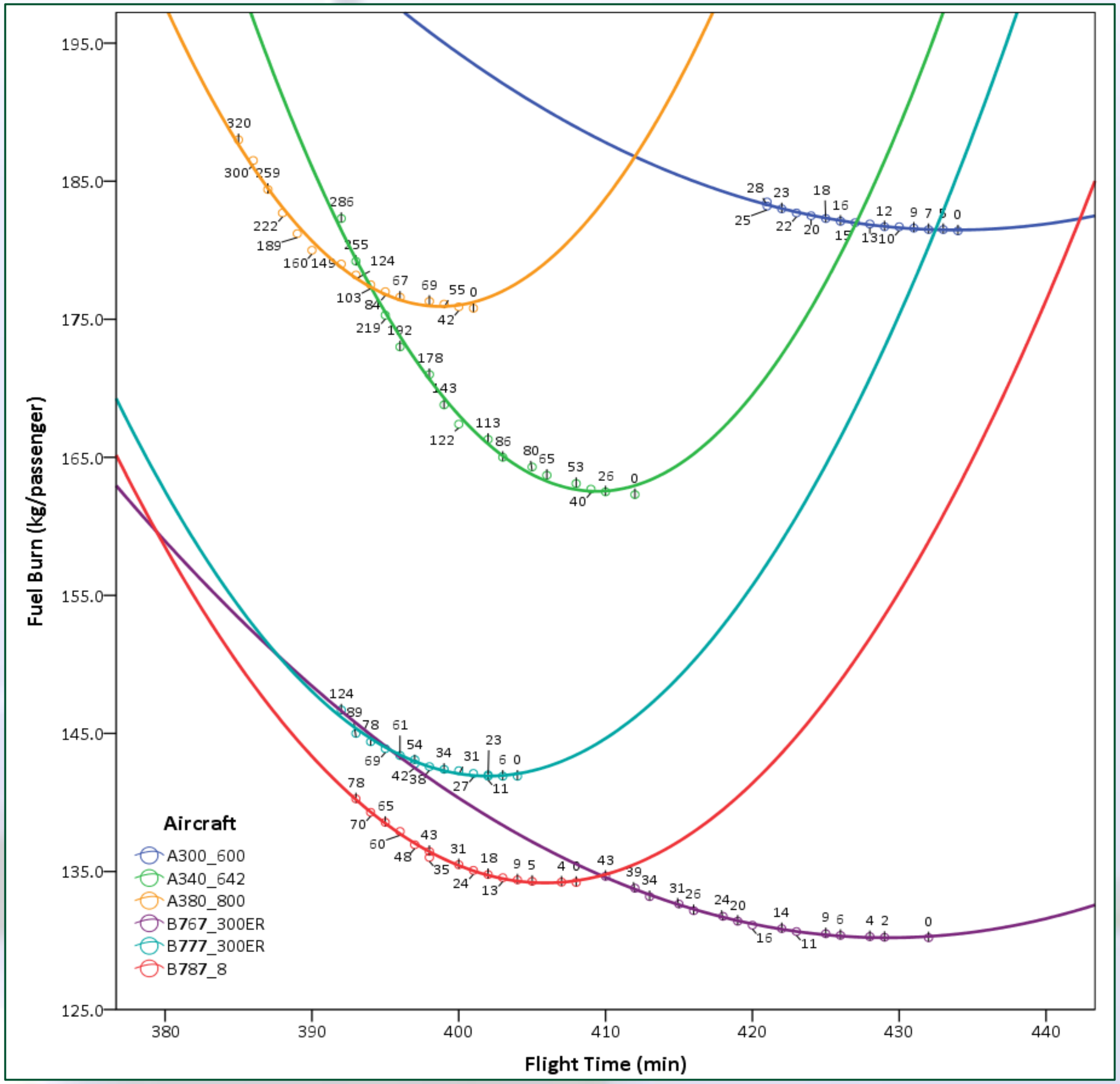
B777-300ER – 3.4%

B787-8 – 4.5%

A300-600R – 1.1%

A340-600 – 12.3%

A380-800 – 6.9%



Future Impacts

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Impacts can be divided into three main areas:

- Technology
- Policy
- Environment

Technology

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Aircraft and Airframe

- Thermodynamic propulsion efficiency
- Propulsion efficiency
- Drag
- Structural weight
- Radical designs

Operational Technology

- ADS-B
- Datalink
- Other ground systems

Maintenance – design of aircraft

Technology

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Expected Improvements in fuel efficiency: aircraft technology

Scenario	Single Aisle		Twin Aisle	
	2020	2030	2020	2030
TS1: Continuation	23%	29%	19%	26%
TS2: Increased Pressure	29%	34%	25%	35%
TS3: Further Increased Pressure		41%		41%
TS3 with open rotor		48%		

Relative to year 2000 technology baseline

Technology

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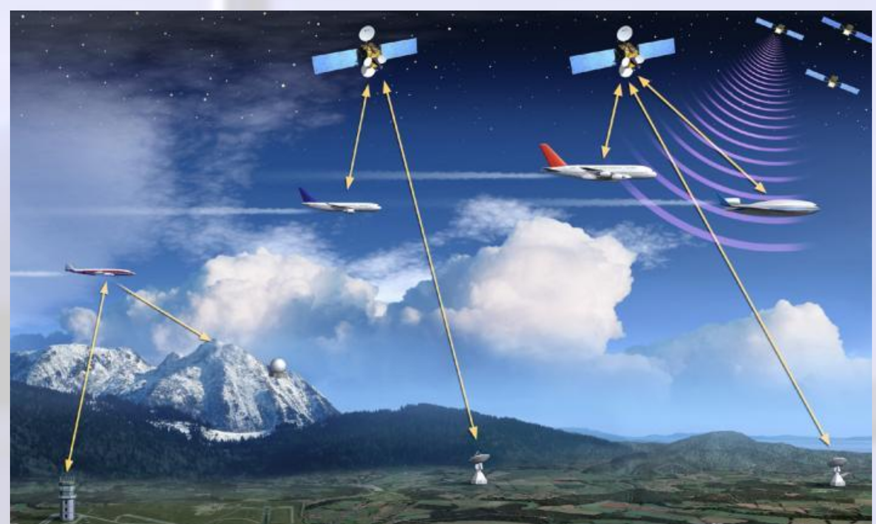
Expected Improvements in fuel efficiency: Operations

	2020	2030	2040
Goal	3.25%	6.75%	9.00%
Lower Confidence Interval	2.25%	4.50%	5.75%

Relative to 2010 levels



Technology

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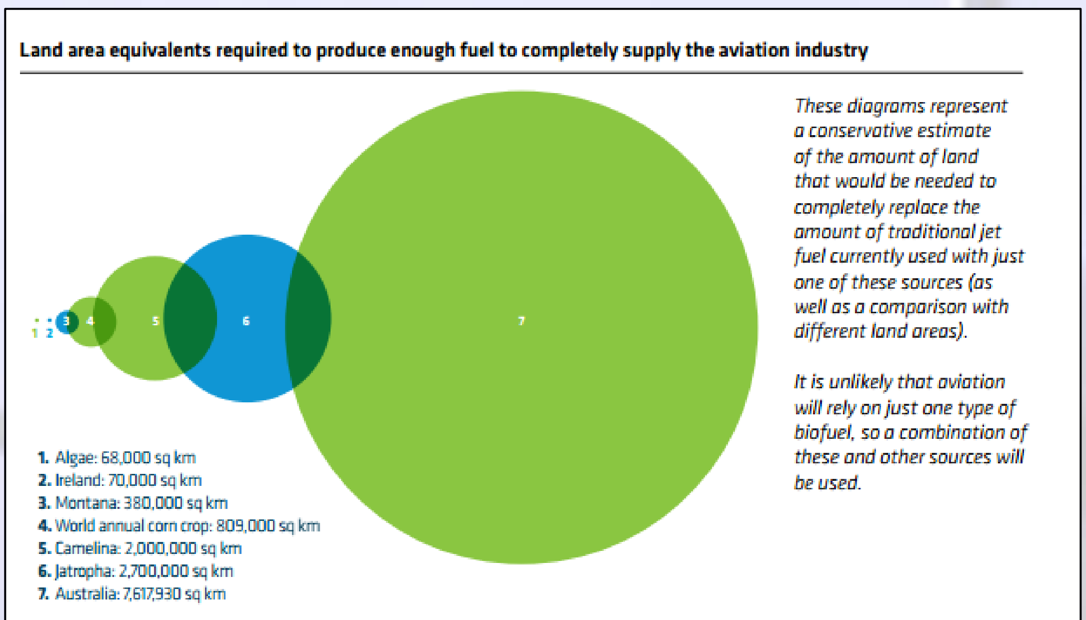
Biofuels

- Started to gain attention in late 2000s with high profile test flights
- Need to be at least second generation biofuels
- Still environmental and social issues attached to production of biofuels



Possible drop in fuel proportions:

- 2020 – 15%
- 2030 – 30%
- 2050 – 50%

Policy

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- Operations
  - Airspace charging and restricted airspace

- Emissions Trading
  - Global agreement – carbon pricing

- Regulation on crew work times

- Airport Construction

Zone	Unit Rate (EUR)
Portugal	10.60
Belg.- Luxembourg	72.19
Germany	77.47
Finland	52.21
Netherlands	66.62
Ireland	30.77
Denmark	71.53
Norway	52.66
Poland	35.36
Malta	27.76
United Kingdom	89.26
Switzerland	100.72
Austria	73.54

Environment

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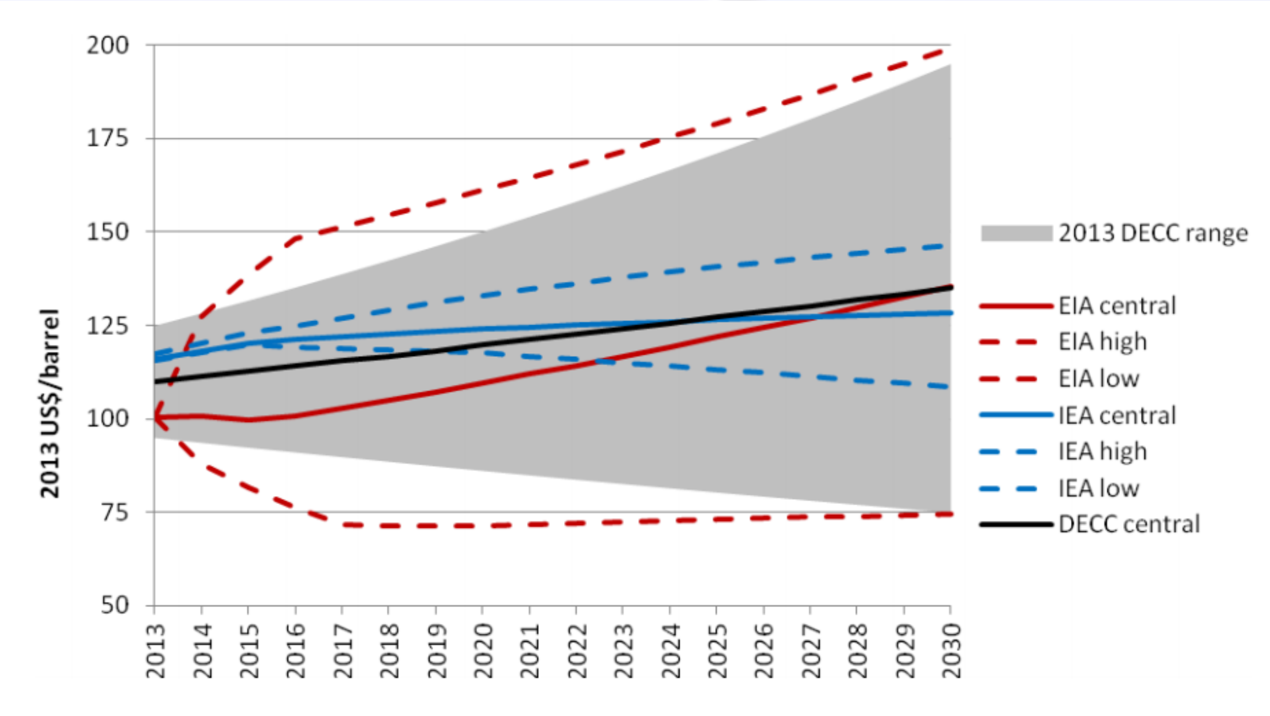
Climate Change Impacts on Aviation

Climate Impact	Aviation Impact
Temperature Increase	Changes in demand; changes in climb performance; redistribution on noise impact; heat damage to tarmac surfaces.
Changes in Precipitation	Operational impacts: loss of capacity and efficiency; increased delay; increased de-icing requirements; structural issues due to changes in ground frost depth and duration.
Increase in intensity and frequency of convective weather	Operational impacts: loss of capacity and efficiency, increased delay.
Changes in wind patterns	Increased crosswinds and loss of runway capacity; redistribution of noise impact due to procedural change
Sea Level Rise	Loss of network capacity; increased delays, network disruption; temporary or permanent airport closure

Environment

Jet Fuel

- In general there is an expectation that oil prices will rise
- Have to be careful that CI represents the price at origin airport
- To convert crude oil price to jet fuel price a 25% crack spread is used



Calculating CI and Costs

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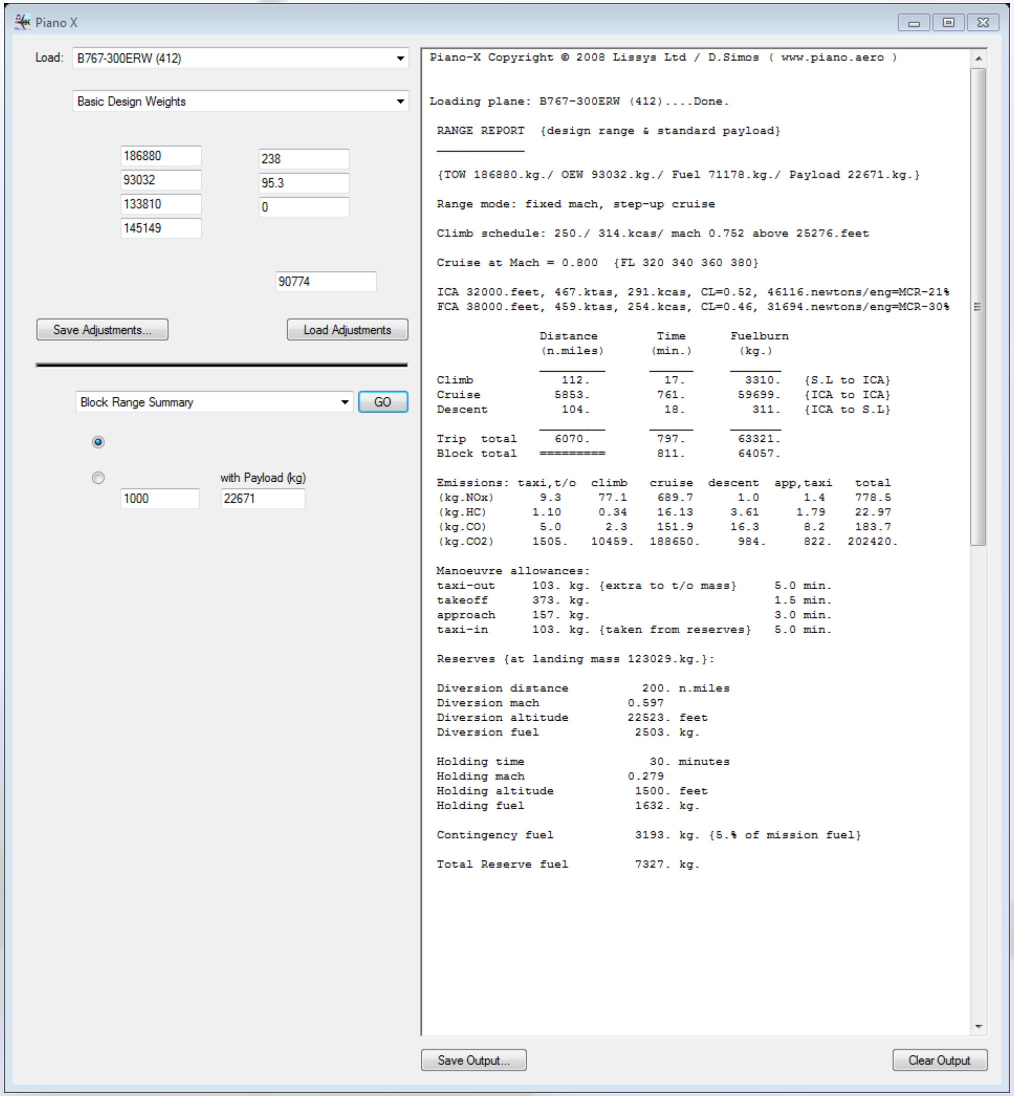
- Piano-X used to model flights for B767-300ER
- Mach numbers from MRC (CI=0) and the maximum
- Fuel burn and flight time used to calculate CI for each Mach number
- Costs allocated for each CI – time costs from University of Westminster, fuel and carbon costs from DECC.



Overall Effect on Cost Index

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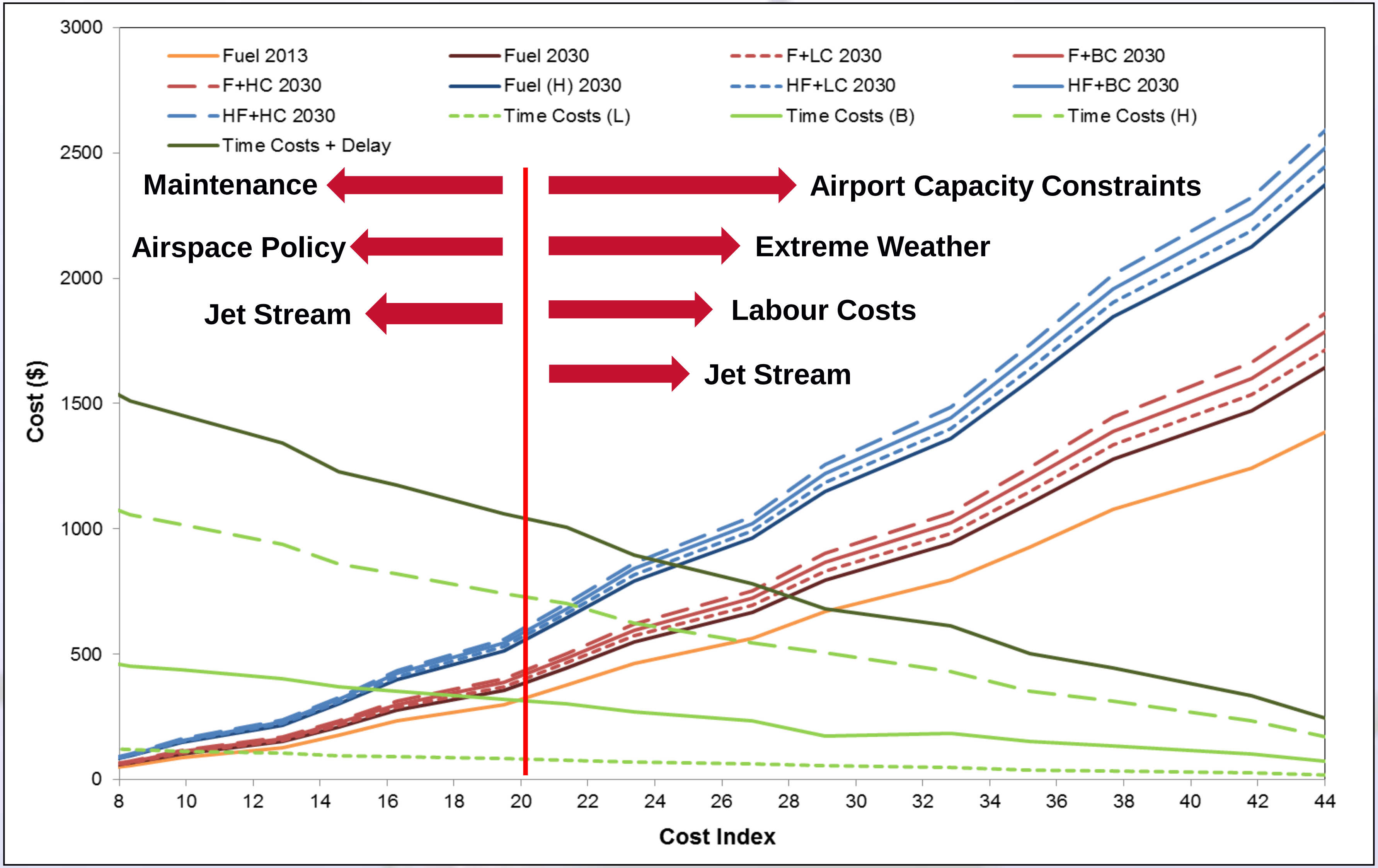

Impact on CO_2 Emissions

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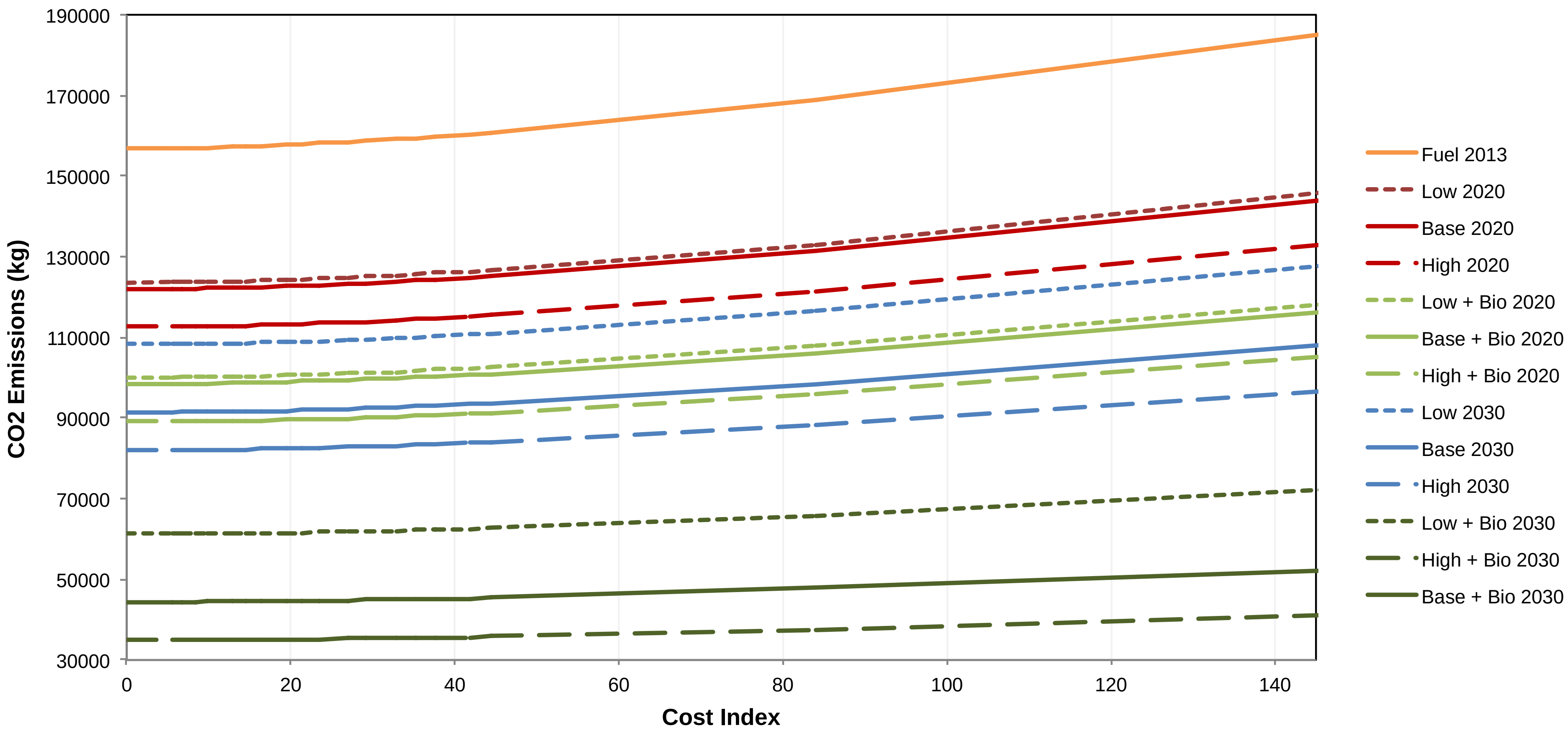

Global Impact

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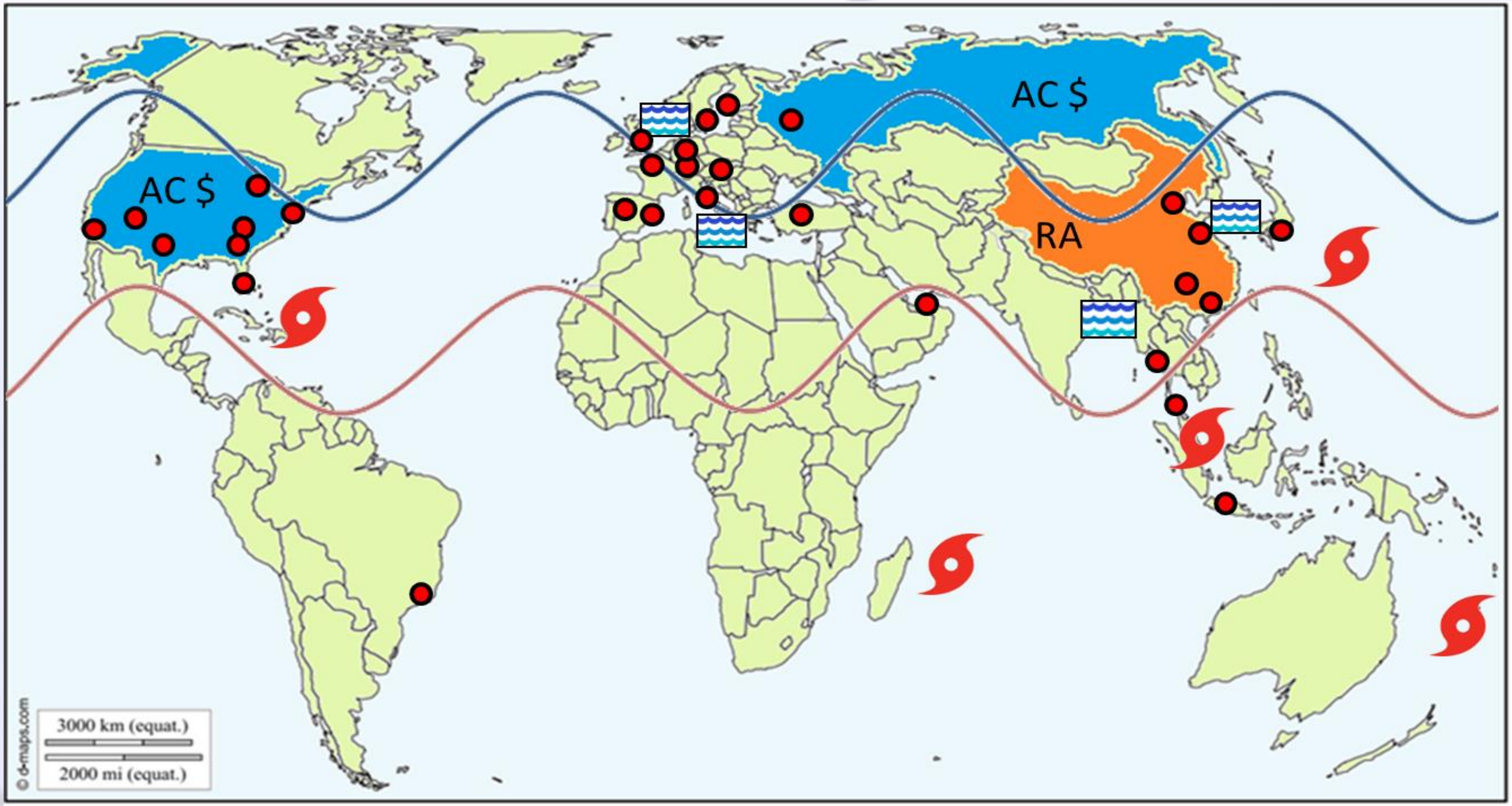

AC $/RA: Airspace charging/restricted airspace

Severe Extreme Weather

Sea Level Rise

Polar Jet Stream

Subtropical Jet Stream

Busy/Congested/ Airports

Conclusions

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- Cost Index can provide a tool for assessing future impacts on aviation on a flight by flight basis

- Cost Index is also a tool for reducing emissions in itself

- Three main areas which will have an effect – policy and environment are still very uncertain.

- Questions over the impact of implementing a carbon price.

- Need policy that:
  A. Addresses both direct and indirect impacts on Cost Index
  B. Provides real incentives and solutions to reducing emissions

- Whole aviation system needs to be considered.