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Institute for Aviation and the Environment

Using the Aviation Integrated Model for Policy Assessment

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Institute for Aviation and the Environment, University of Cambridge

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Presentation Outline

1. Need for Policy Assessment Tools
2. Importance of System Interdependencies
3. Aviation Integrated Modelling (AIM) Tool
4. Using AIM for Policy Assessment
   - Emissions Trading Scheme (ETS)
   - Noise Regulation

Need for Policy Assessment Tools

- Air transport system is large, complex and multi-disciplinary involving numerous stakeholders with different agendas

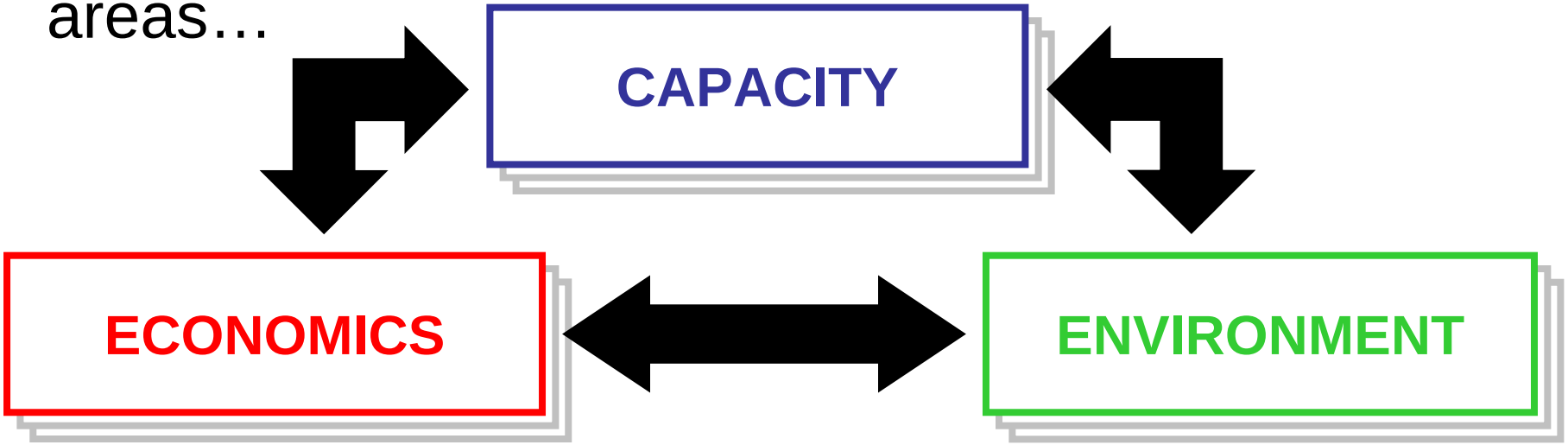
- Range of future trends
  - Developing regions (India, China,…)
  - Developing sectors (VLJ, SSBJ,…)
  - Developing technologies

- Increasing environmental pressures

- Need for tools to analyse interdependencies & trade-offs to assist policymakers

Importance of Interdependencies

- Environmental challenges must be set into context of multiple system interdependencies, e.g. between areas…



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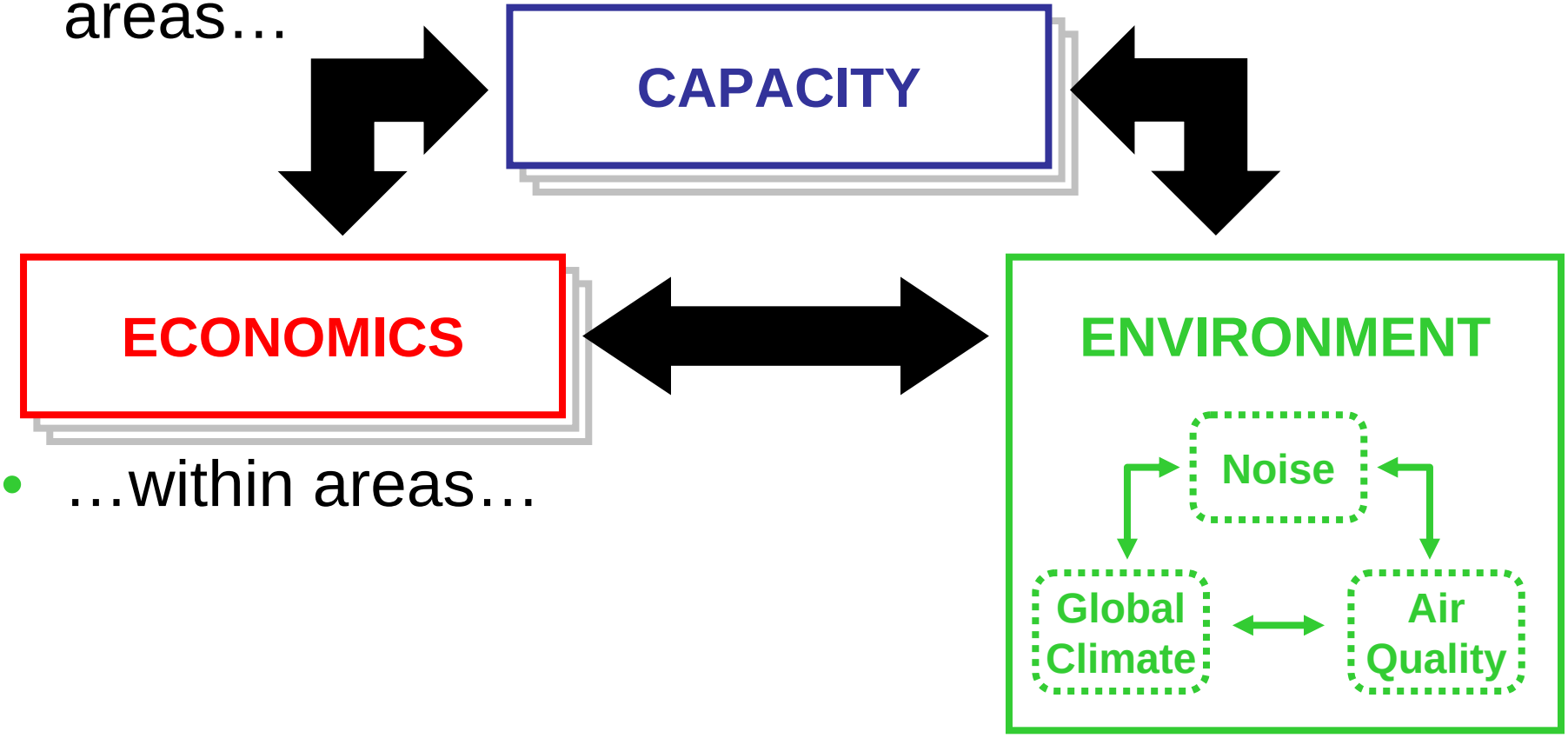

- …within areas…

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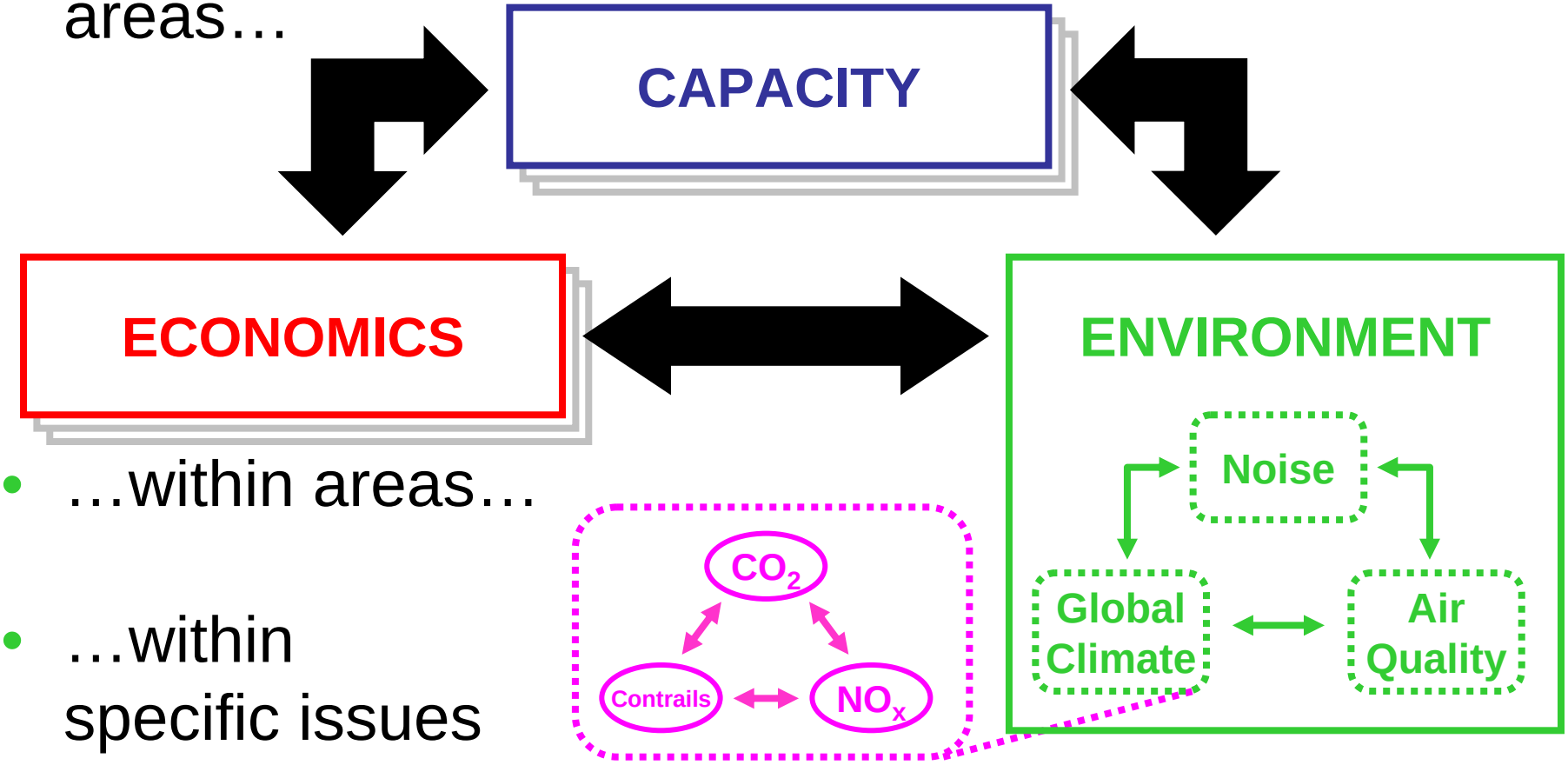
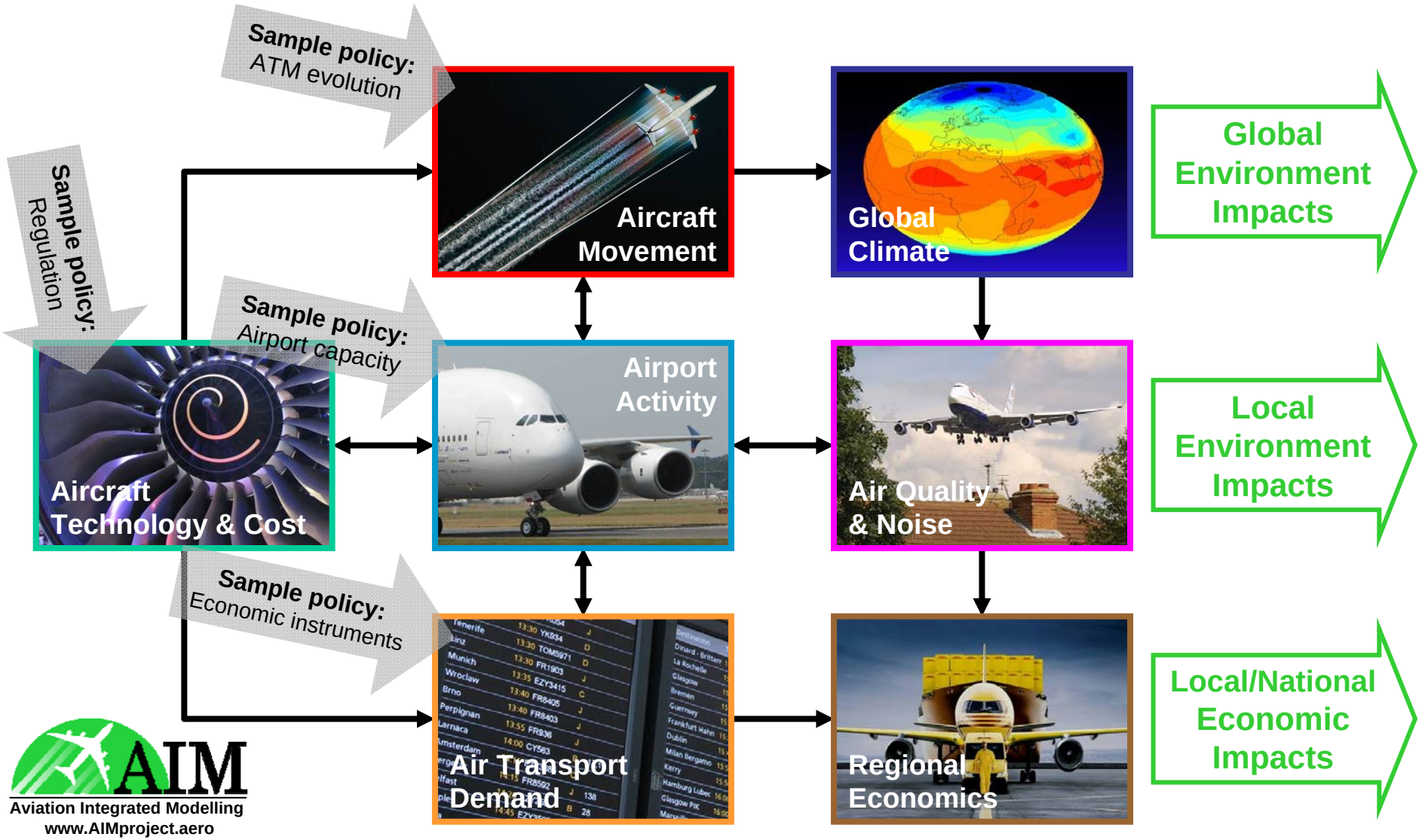


- …within areas…
- …within specific issues

Aviation Integrated Modelling Policy Assessment Tool



AIM
Aviation Integrated Modelling
www.AIMproject.aero

Looking for “Win-Wins”

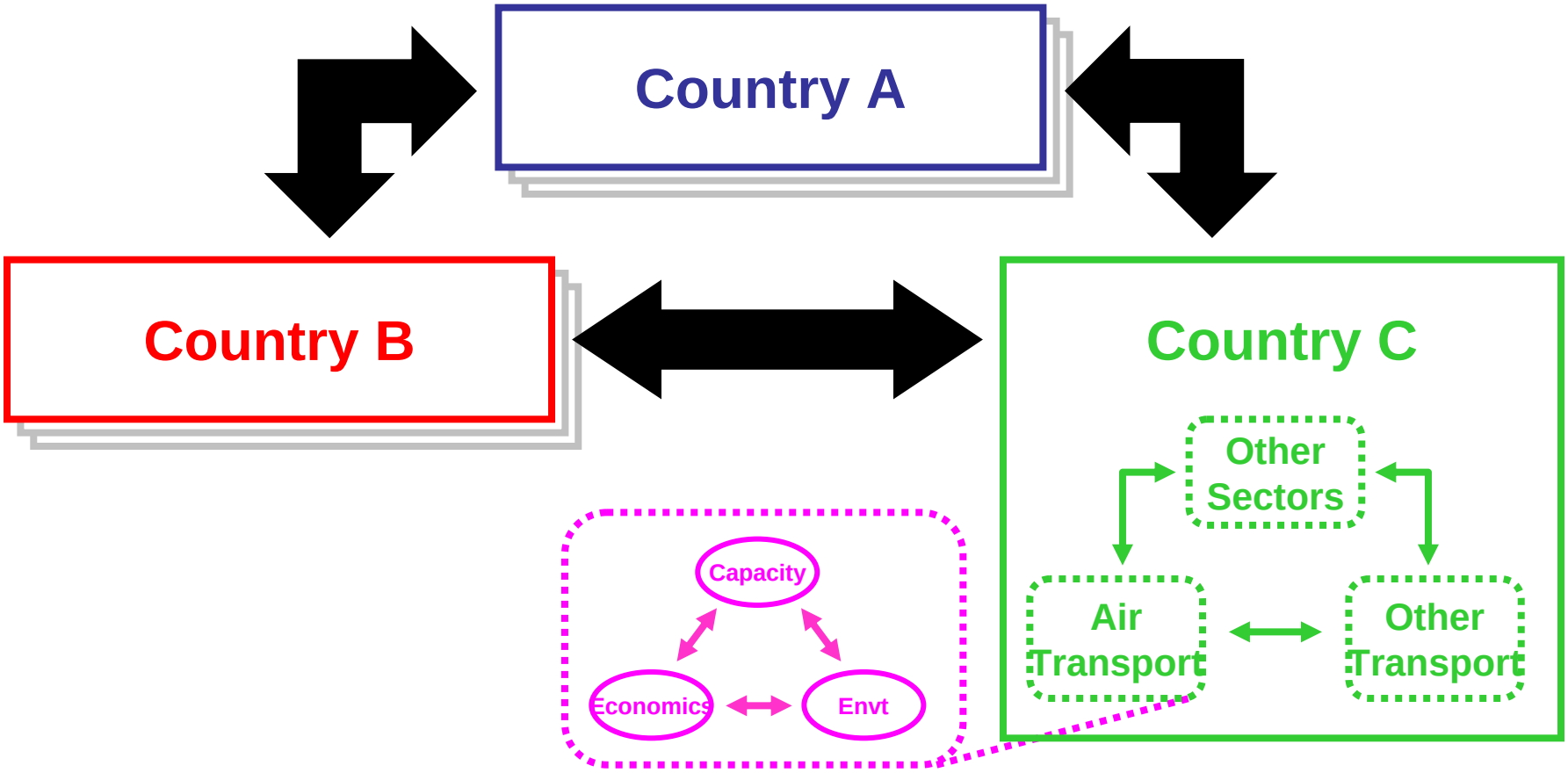
	Mitigation Strategy	Environmental Impact			Relative Economic Impact	Time-frame	Sphere of Influence
		Noise	Air Quality	Global Climate			
Technology	Source shielding	+	-	-	$ cost	Short	Existing a/c
	Retrofits e.g. winglets, shields	Neutral	Neutral	+	$ setup cost $$ fuel benefit	Short	Existing a/c
	Alternative fuels	Neutral	+	++	$$ cost	Med	System
	All-new designs	++	++	++	$$$ setup cost $$ fuel benefit	Long	New a/c
Operations	CDA	+	+	+	$ fuel benefit	Short	Airport
	De-rated thrust	+	+/-	Neutral	$ maint benefit $ fuel cost	Short	Aircraft
	Steep approach	+	+	Neutral	$ cost	Med	Airport
	ATM efficiency	+	+	+	$$ setup cost $ fuel benefit	Med	System

Promoting Non-Voluntary Change: Regulation & Market-Based Measures

	Noise	Air Quality	Global Climate
Regulation	• **Stricter certifications standards** • Local airport standards (e.g. quota counts)	• Stricter certifications standards • Local / regional / national / international standards	• Future fuel burn standards?
Market-Based Measures	• Noise charges	• Emissions charges	• **Emissions trading schemes**

Importance of Even Wider Interdependencies

- ETS forces assessment of aviation in context of even wider system interdependencies…



Emissions Trading Scheme (ETS) Basics

- Economic incentives for achieving reduction in pollutant emissions (aka “cap and trade”) by:
  - Setting a cap on total amount of a pollutant allowed in a given period
  - Sectors given permits allowing emissions to a certain level given cap
  - Sectors emitting more than allowed buy credits from those who emit less, i.e. trading of permits from sectors that can easily reduce emissions to sectors that cannot
- Aviation to be included in European Union ETS from 2012

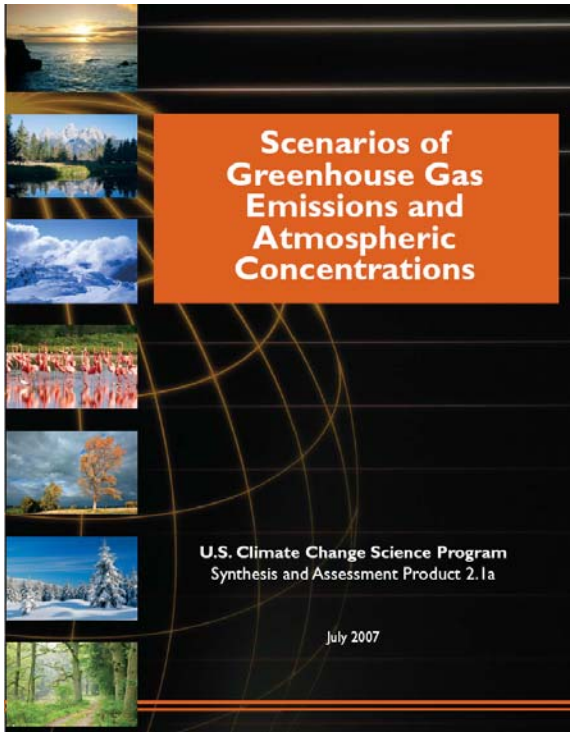
Using AIM to Assess ETS Impacts

- Reference scenario
  - No environmental policies affecting costs
  - Airport capacity increases to maintain 2005 delays

- ETS scenario
  - Exogenous carbon price from open (all sectors) global ETS to meet standard GHG stabilization targets
  - Carbon price affects airline operating costs, fares, and thus passenger demand, air traffic and emissions growth
  - With/without uplift factors for "non-CO_2" effects
    - Values of 1.9 and 2.7 have been proposed

Assumptions

- Population, GDP/cap, oil price and carbon price from US Climate Change Science Program study
  - MIT “Integrated Systems Model” (IGSM)
  - Stanford “Model for Evaluating Regional & Global Effects of GHG Reduction Policies” (MERGE)
  - Pacific Northwest Laboratory “Mini Climate Change Assessment Model” (MiniCAM)



	GDP growth	Oil Price	Carbon Price
IGSM	High	High	High
MERGE	Low	Medium	Medium
MiniCAM	Initially low, increasing	Low	Low

- Global carbon price for CO_2 atmospheric stabilization targets of 450 - 750 ppm

Assumptions

- Aircraft Technology and Cost Module
  - 3 size categories, Operating costs (excl. fuel) remain constant
  - New technology introduced using fleet turnover model, Fuel burn reduction by 1, 1.5 or 2%/year depending on fuel price

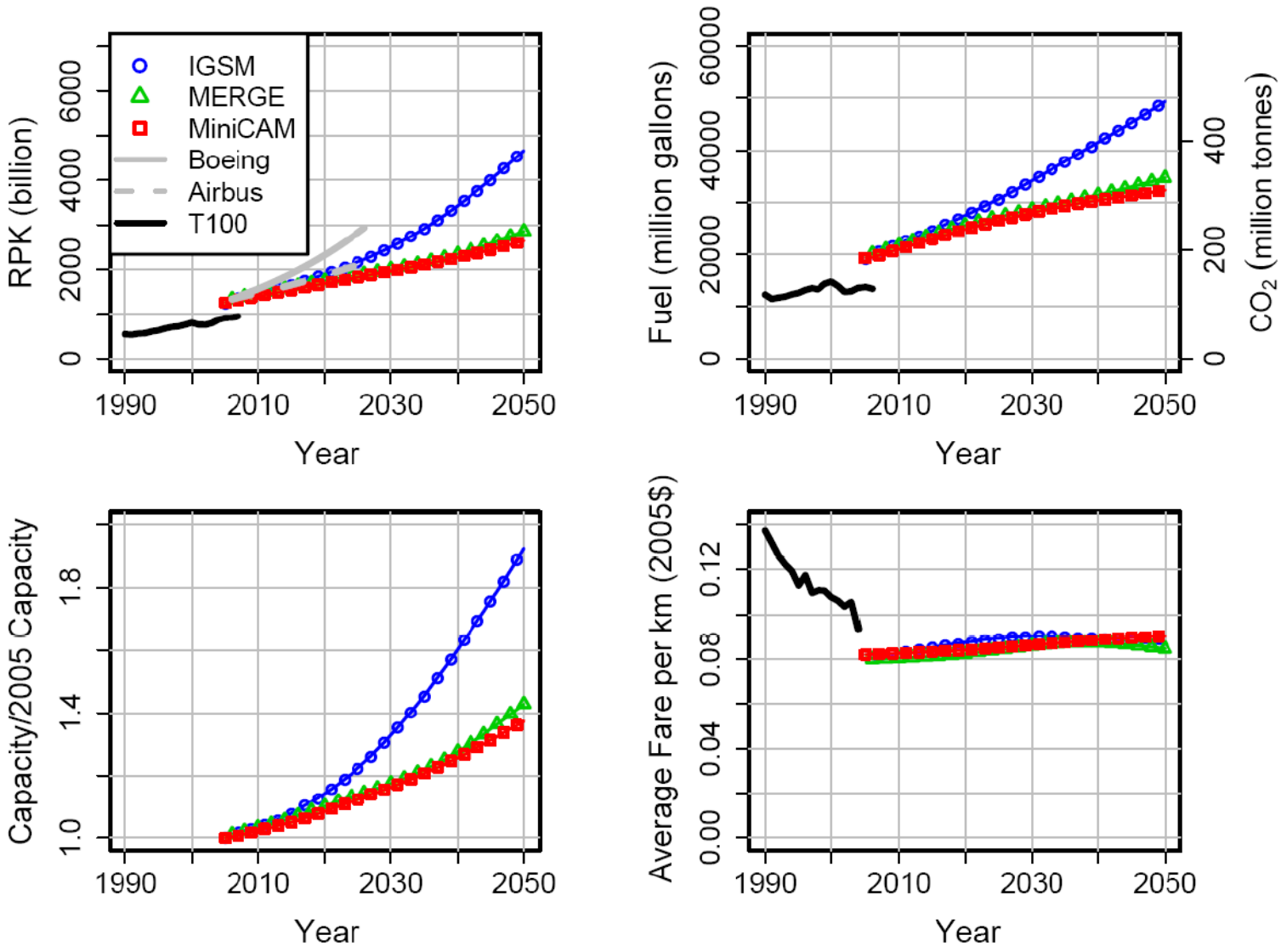
- Air Transport Demand Module
  - Gravity-type model

$$D_{ij} = (I_i I_j)^{\alpha} (P_i P_j)^{\gamma} e^{\delta A_{ij}} e^{\varepsilon B_{ij}} e^{\varphi S_{ij}} C_{ij}^{-\tau}$$

  - Elasticities calibrated from DOT database
  - Future fares modelled using airline competition model (marginal cost)

- Airport Activity Module
  - Current capacities from FAA database
  - Capacity growth to maintain 2005 arrival delay levels
  - Load factors & routing network remain constant

Reference Scenario Results



Reference Scenario Results

PK demand in 2050 2-4x current

- Differences arise mainly from GDP growth scenarios

uel use & CO_2 emissions increase at progressively lower
ate over time due to fuel burn improvement of new aircraft

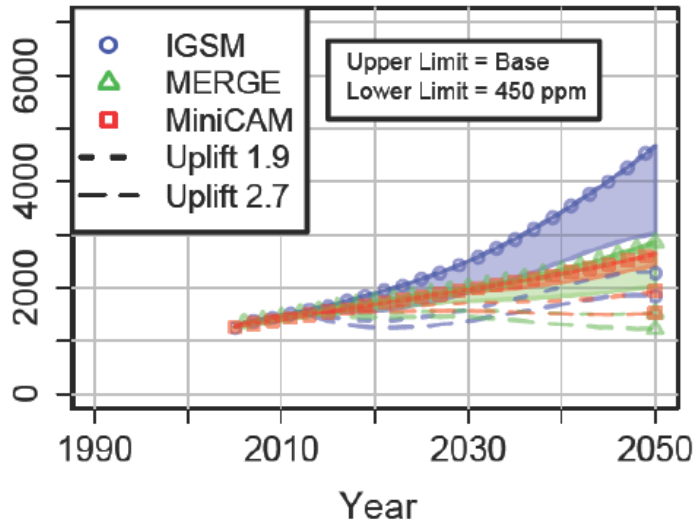
apacity requirements in 2050 up to 1.8x current on average

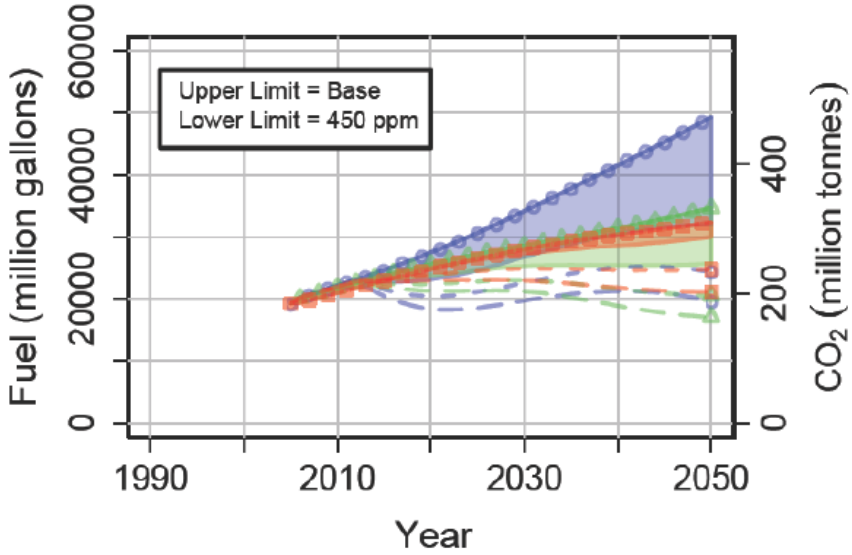
- Individual airports can need much higher (ORD: 2.7x current)
- Network evolution needs to be modelled

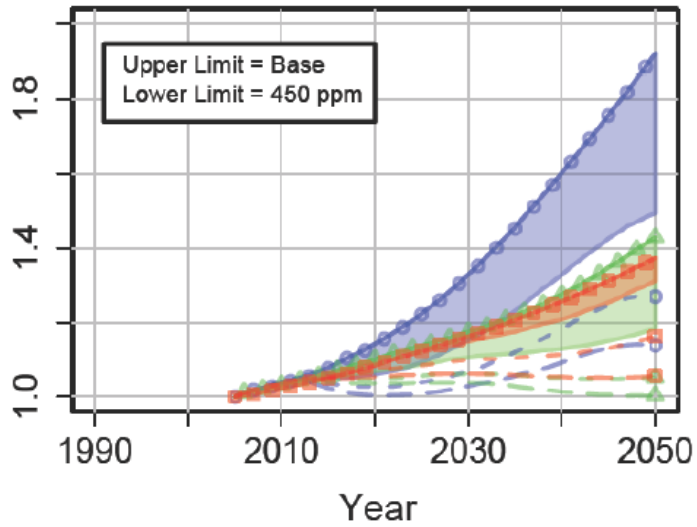
verage air fare roughly level trend due to balance between
creasing oil prices and decreasing fuel burn/RPK

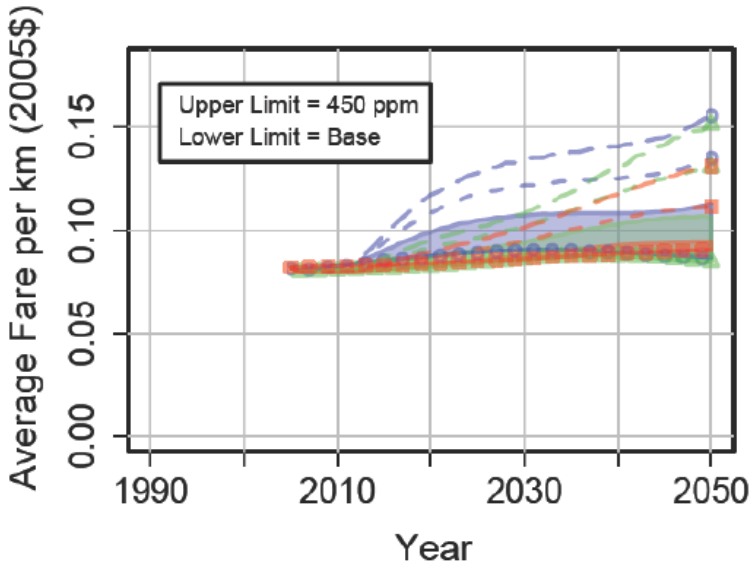
- Past decreases due to competition

ETS Scenario Results







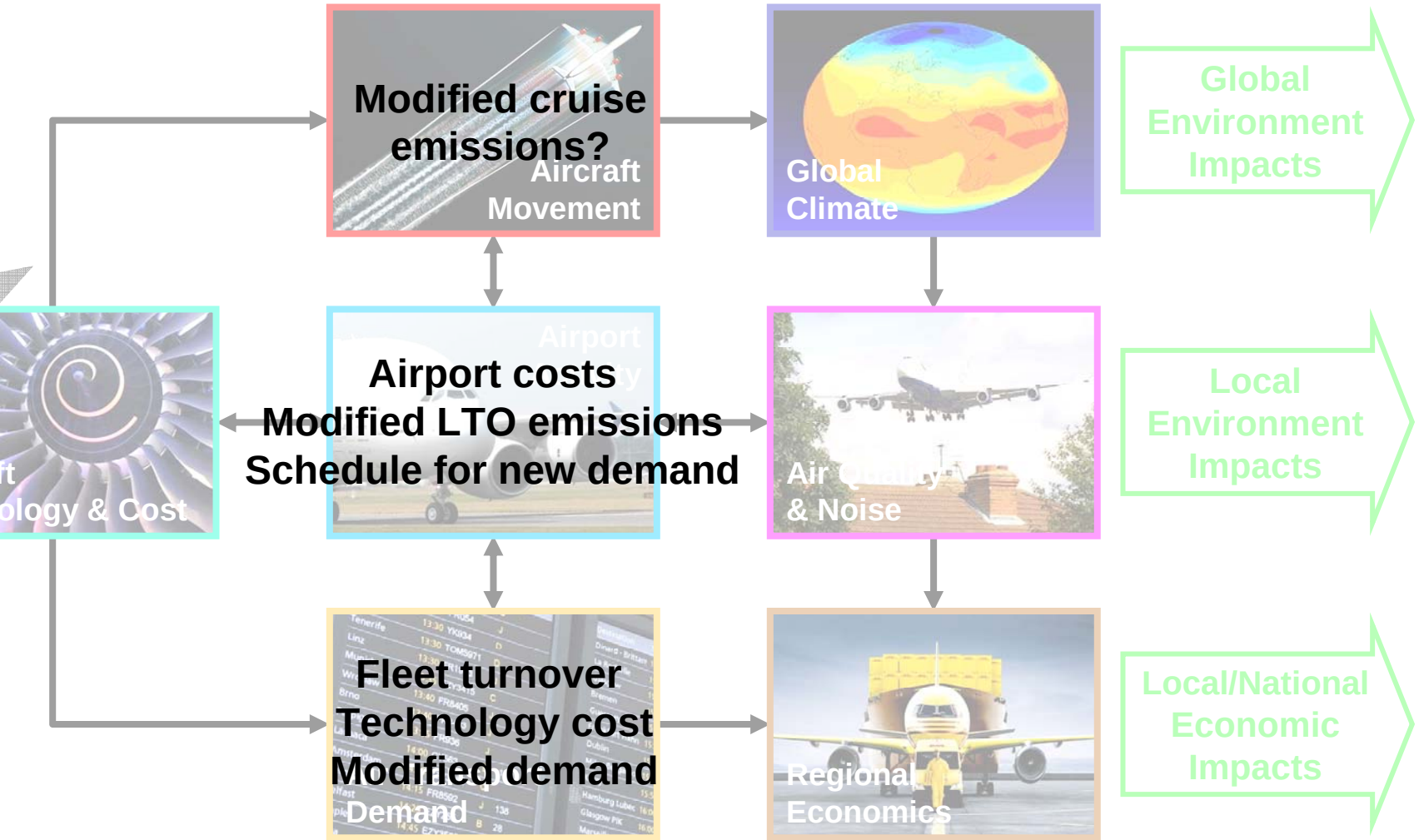


ETS Scenario Results

- TS significantly reduces growth in RPK, fuel use, CO_2 emissions & required extra airport capacity
  - 450 ppm target: reductions of up to 50% in 2050 levels
  - Additional 2.7 uplift factor for non-CO_2 effects reduces 2050 levels almost to base year levels

- aried model responses due to widely differing arbon and oil price assumptions
  - By 2050, IGSM oil plus carbon price is $250/bbl, 30% of the extra costs passed to ticket price
  - Equivalent MiniCAM model price is $140/bbl, and only 8% of costs are passed on
  - Price effects very different for long haul vs. short haul

Using AIM for Noise Regulation



Summary

Consideration of system interdependencies critical in modelling aviation environmental impacts

Integrated models are needed to support policy-making activities

Application of AIM model to policy options

More details on AIM and ETS analysis paper from: www.AIMproject.aero