Aviation and Climate Change: Policies & Challenges

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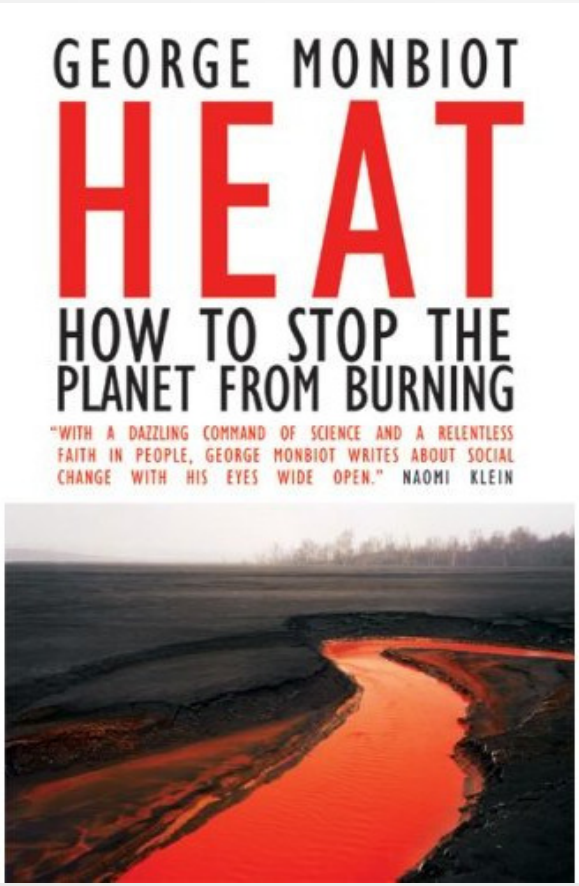
National Airspace System Performance Workshop

September 7, 2007



"We need to cut the number of flights by 87%...(this) cut in carbon emissions means the end (to the comforts we are used to)…These privations affect a tiny proportion of the world's people. The reason they seem so harsh is that this tiny proportion almost certainly includes you."

Public Perception of Aviation and Climate Change

Source: San Francisco Chronicle

Ripped from the Headlines!

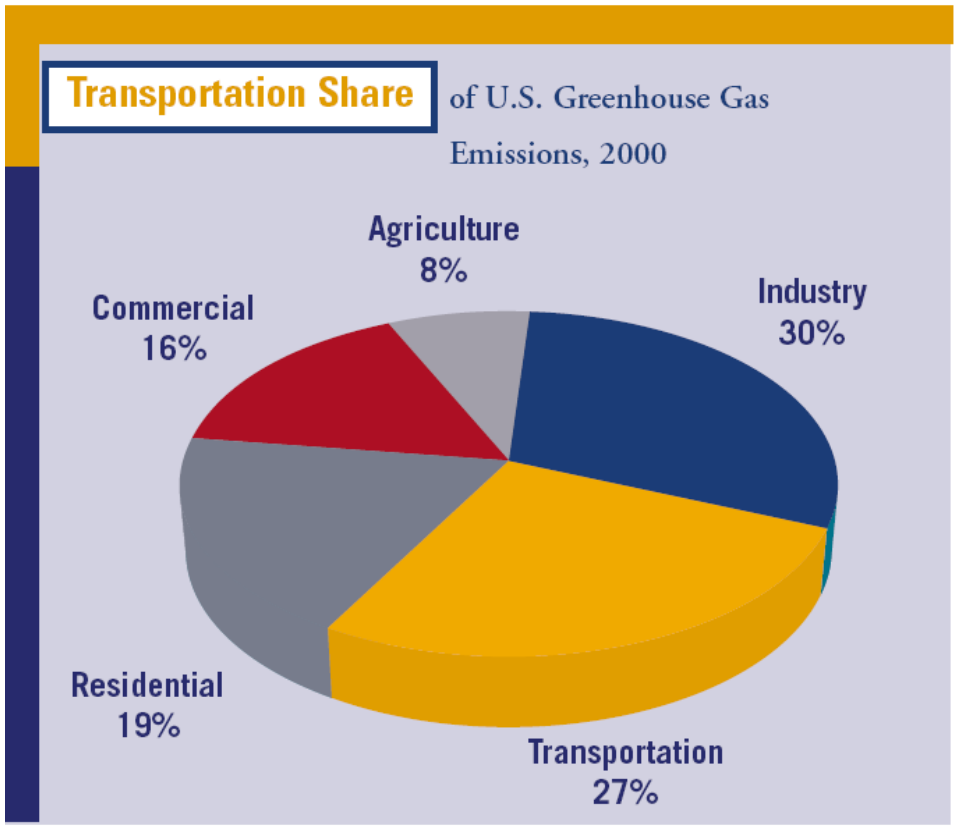
- *"Air travel latest target in climate change fight: Technology, taxation, and rationing are all being eyed as possible solutions."*
- *"Climate activists protest Heathrow expansion: Camp set up, 'direct action' vowed as way to highlight $C0_2$ emissions"*

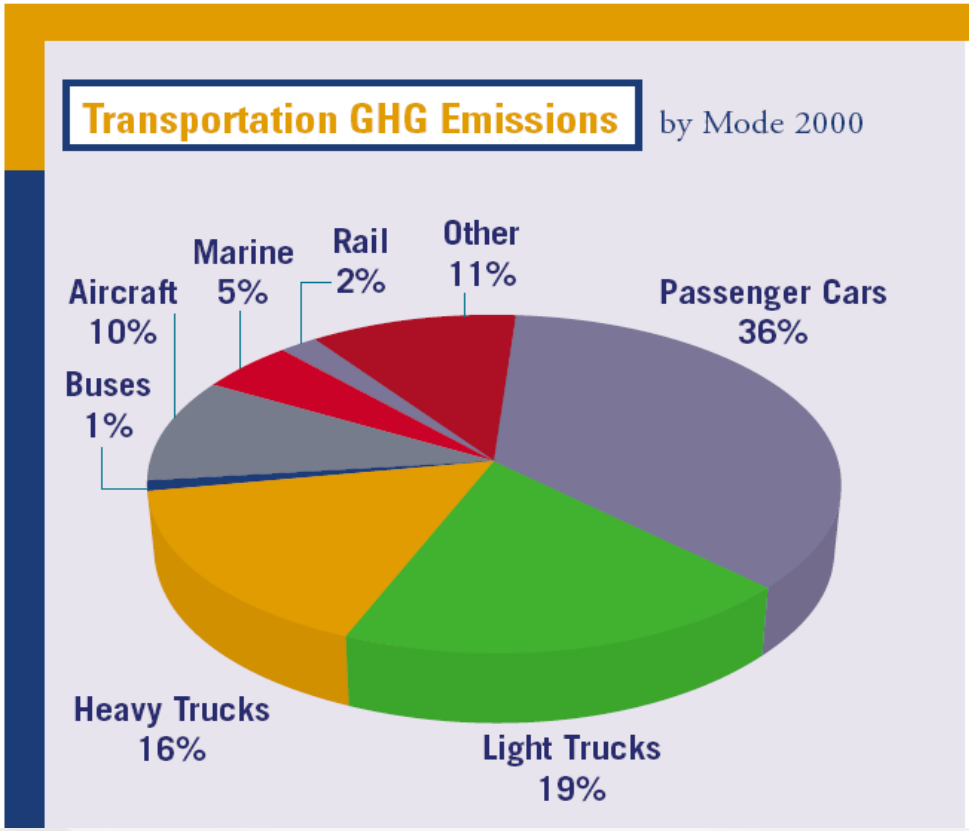
- *"Live Earth – the concerts for a climate in crisis" were termed "Private Jets for Climate Change"*

"I try to do my part."

Source: The New Yorker

- **Transport is a large portion of GHG emissions**
- **Aviation is not the highest!**





…but the growth of aviation and limited possibilities of alternative fuels make aviation's contribution more serious than it looks

Source: EPA,2002.

Aviation's Contribution

- Aviation emits CO_2 and other pollutants
- Aviation is responsible for 3.5-5.5% of global carbon emissions
- Aviation may be responsible for up to 10-15% of global carbon emission by 2050

Emissions Data Points

- CO_2 emissions (DFT & DLR)
  - Short haul: Estimated 240 grams per passenger-mile
    - Example: FRA-LHR on a A321-100: 10.41 tons
  - Long haul: 177 grams per passenger-mile
    - Example: International: FRA-EWR on a B777-200ER: 154.85 tons
- Carriers Yearly Data (2004)
  - Lufthansa: 11.95 million tons
  - Ryan Air: 2.01 million tons

Current US Initiatives

- NextGen
  - NextGen concepts claim they will lead to reduced emissions
- Emissions and Dispersion Modeling System (EDMS)
  - Assess the air quality impacts of airport emission sources
  - I could not determine if this will include GHGs
- State Climate Action Plans
  - In general, proposed plans do not include aviation but mention the contribution of aviation
  - States point to the difficulty and competitive distortions which arise with individual state aviation emissions regulation

Local Climate Action Plans

- UC Berkeley's Climate Action Plan
  - UC Berkeley Chancellor Robert Birgeneau committed the campus to reducing its greenhouse gas emissions to 1990 levels by year 2014
  - One strategy proposed is to limit air travel by increased utilization of videoconference rooms
- Cities of Berkeley & Oakland
  - City of Berkeley is aggressively reducing greenhouse gas emissions but excludes aviation
  - City of Oakland is going after a grant which may focus on aviation and ports because of the Port of Oakland

EU Initiatives

- Began limiting greenhouse gas emissions with the Kyoto protocol
  - Countries pledge to reduce emissions
  - Regulates CO_2, CH_4, N_2O, HFC, PFC, SF_6
- As of 2006, the European Commission published a directive to include aviation as a sector in the European Emission trading scheme (EU-ETS)
  - EC is concerned that the growth in aviation emissions will offset the savings in other sectors, and they will not meet their goal of CO_2 reduction
  - Effective 2011 (and 2012 for foreign airlines), air carriers in the EU must hold and surrender allowances for CO_2 emissions and participate in a cap and trade scheme for CO_2 credits.

EU-ETS Projected Scheme

- Air carriers (domestic and international) will receive allowances to emit CO_2
  - 1 Allowance is to emit 1 ton of CO_2 per year
  - In the EU-ETS, initially allocations will be free
    - Yearly emissions will be measured, and carriers required to "pay" with their allowances
    - If they emit fewer tons than they are allocated, they can sell their extra allocations
    - If they emit more tons than they are allocated, they can purchase allocations from other carriers or other sectors or they can purchase carbon credits (which is more costly)
  - The EU claims this method will allow aviation to grow while still decreasing CO_2 emissions

Scope Issues

- Scope of aviation activities included within the EU ETS remains undetermined
  - Intra-EU flights—this option covers emissions from flights from one locale to another within the EU.
  - Departing from EU—this option covers emissions from any flight that departs from the EU, regardless of its destination.
  - EU airspace—emissions from any flight, regardless of departure or destination point, that are release over EU airspace are covered by this option.
- Flights to be excluded
  - Flights with MTOW < 6.28 tons
  - VFR flights, training flights, state aircraft & rescue flights

Allocation Uncertainties

- Distribution of Allocations
  - 97% of allowances during the pilot phase allocated free of charge
  - Benchmarking
    - Allowances distributed free of charge on the basis of operators revenue ton-kilometer
    - Favors entities with new and low-emission aircraft
    - Benchmark provides strong incentives for investments in new technologies
  - Grandfathering
    - Initial allocation is based on historical emissions (2004-2006)
    - Contradicts the polluter-pays principle.
    - Favors legacy carriers and relatively polluting technologies
  - Auctioning used for the remaining allocations
- The generally favored method by researchers is benchmark for initial allocations and auction the rest

Impacts on LCCs and Network Carriers

- Network Carriers Wish List
  - Scope to be departures & arrivals
  - Allocations based on historical emissions
- Low Cost Carriers Wish List
  - Want scope to just be departing flights
  - Allocations to be based on a benchmark
    - Performance is better than benchmark
    - Would have excess allowances
- Study by DLR showed that these impacts are realized

Impact on the US

- **DLR study on competition between US and EU network carriers**

	Lufthansa	Continental
Free Allocation of Allowances (Mt CO_2)	11.2 - 12.0	2.7 - 2.9
Total Required Allocations in 2012 (no growth – moderate growth)	13.3 - 16.3	2.6 - 3.6
Cost to acquire extra allowances (million euro)	24.9 - 101.5	-6.3 - 16.2

- **A major US carrier could profit from EU-ETS or have to pay on the order of 10m Euro for extra allowances per year**
- **A major EU carrier will have to pay for extra allowances under all scenarios**

US History with Auctions

- Cap-and-trade mechanism is similar to slot controls
  - Slots are control in the EU but not auctioned
  - Slots are controlled at a few US airports, also have experience with slot auction at LGA
- Based on the US experience, one would suspect if they US makes looks to regulate aviation emissions, they will work with the experience

Why are these challenges exciting?

- Aviation is a field of proven and continual innovation!
  - Noise
    - The US has seen a 95% reduction in the number of people affected by aircraft noise in the in the last 35 years.
    - These reductions occurred during a period of six-fold growth through major technological advances
  - Fuel
    - Fuel use per passenger-mile has been reduced by 60% in the last 35 years
- An environmental mitigation strategy to solve one aspect of aviation's impact on the environment can produce unintended negative consequences
  - Climate change solutions, which are not well known, must also be evaluated for the implications of any policy presented

Interplay between Externalities

- Richard Branson advocates for tugs
  - Believes this system would reduce fuel consumption before aircraft take off by between 50-90 percent
- Aircraft tugging at LAX
  - ATAC study found tugs increased noise
  - Study found that tugged operations decrease runway capacity and productivity

Thank you for your attention!

Heathrow Protesters

Source: San Francisco Chronicle

Reference Slides

Sources

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Monitoring Uncertainties

- How will airlines report their emissions
  - Flights will be evaluated both ex-post vs. ex-ante for fuel burn
  - If emissions are based on the carbon content of measured trip fuel, aircraft operators run the risk of paying emission penalties for delays resulting from ATM problems. This could be avoided by using an *ex ante* emission figure as a basis, to reward airlines if they do better, but *not* punish them if they do worse
  - The major European air carriers expressed their preference for an ex post method
- Those who emit more than their allocation must purchase carbon credits or purchase allocations from another airline or sector
  - If they do not, countries are barred from emission trading
  - In Europe, a penalty payment of 40 Euros per ton of carbon dioxide for which allowances cannot be delivered

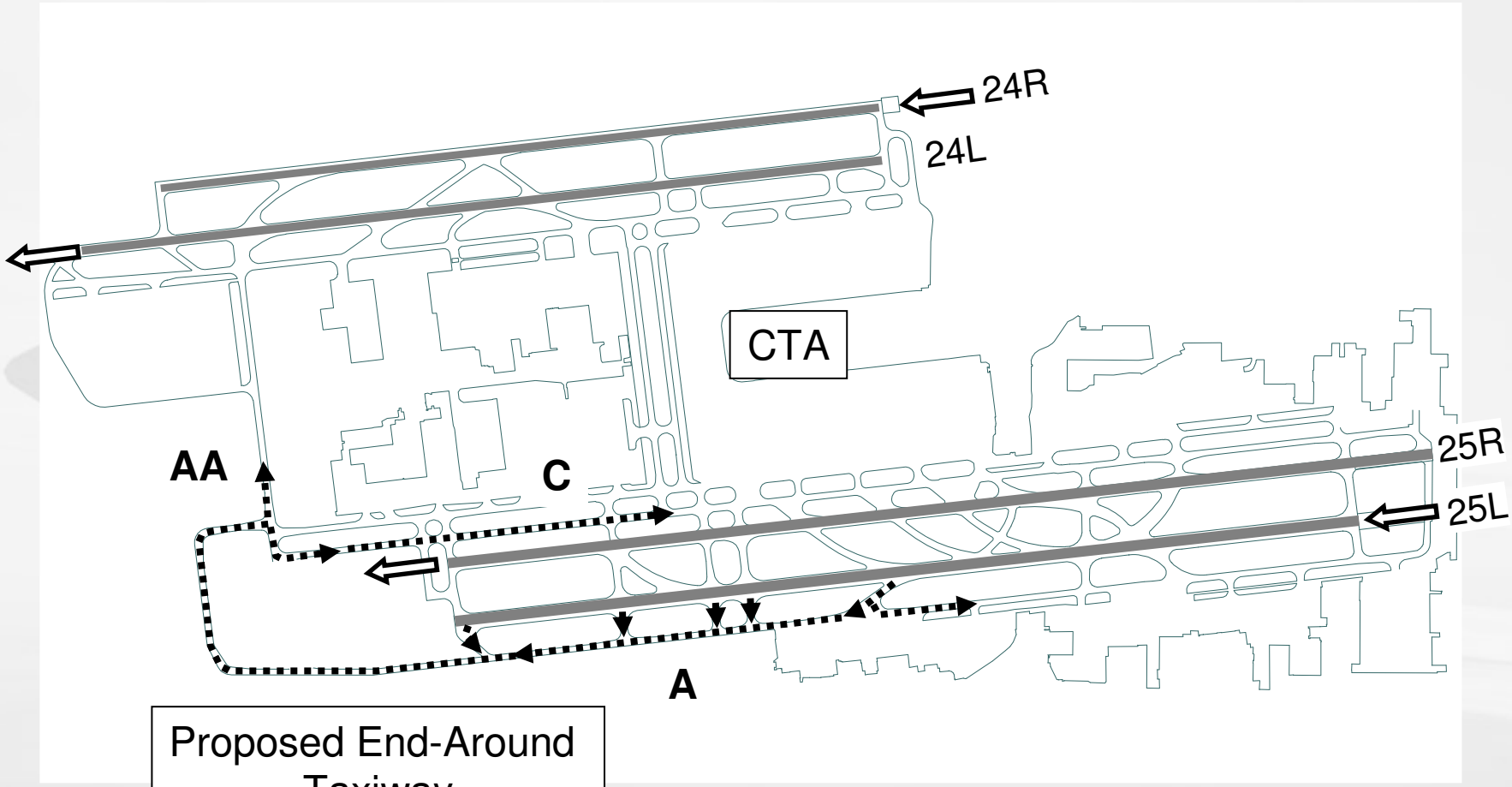
Example

- A study by ATAC corporation found that tugs at LAX increased the

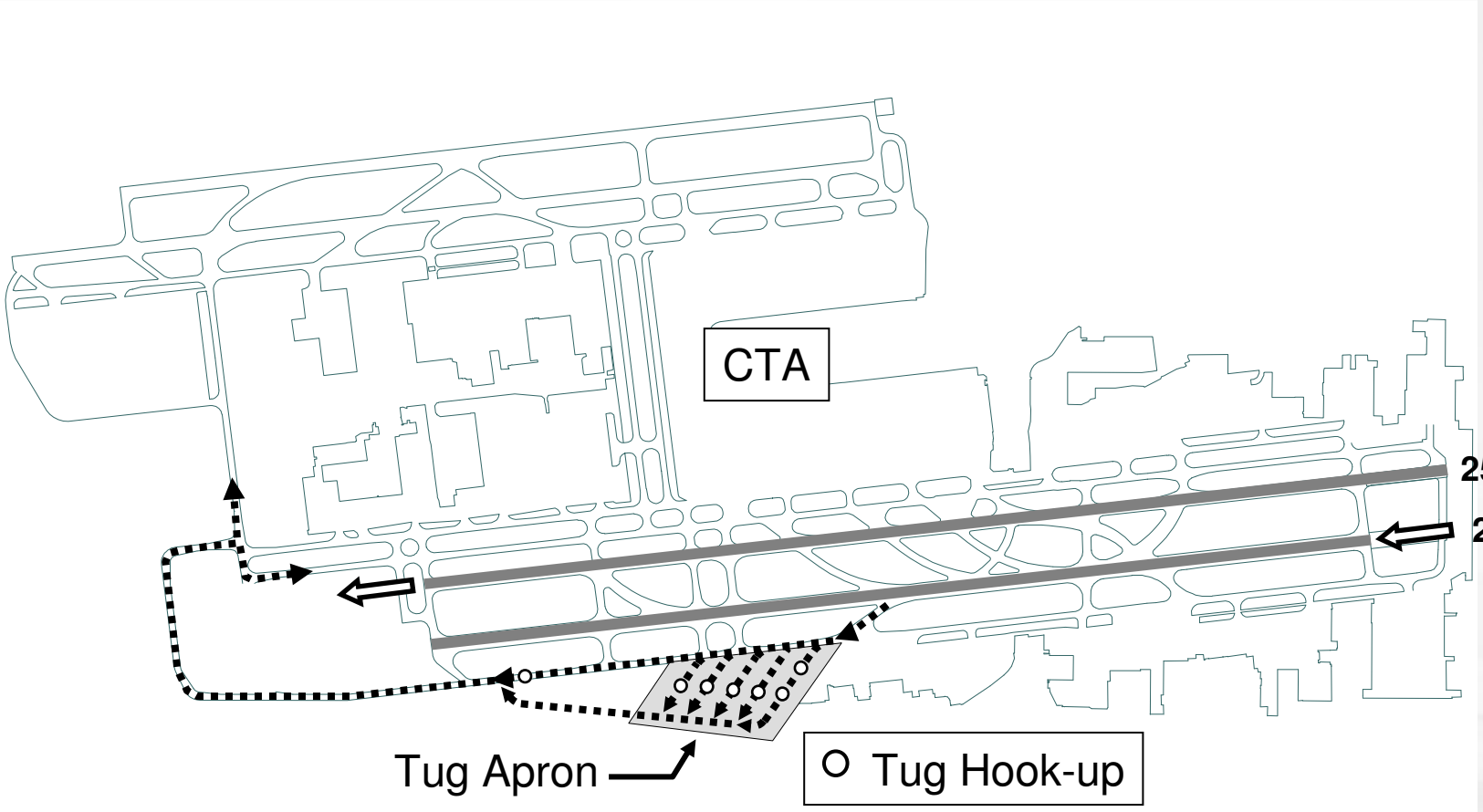
ATAC Study: The Impact of Towing Aircraft from Runway Exit to Gates at LAX

- Los Angeles World Airports studied a variety of ways to minimize or eliminate runway incursions at LAX
- Two alternatives that were studied for the South Airfield were A4 and B1B
  - Alternative A4 added an end-around taxiway
  - Alternative B1B moved Runway 7R-25L south ~55 ft and added a center taxiway between Runways 7R-25L & 7L-25R
- Environmental impact
  - Alternative A4 increased taxi noise in El Segundo
  - Alternative B1B shifted noise to the south, further into the City of El Segundo

Proposed A4 Alternative



A4 Airfield with tug apron

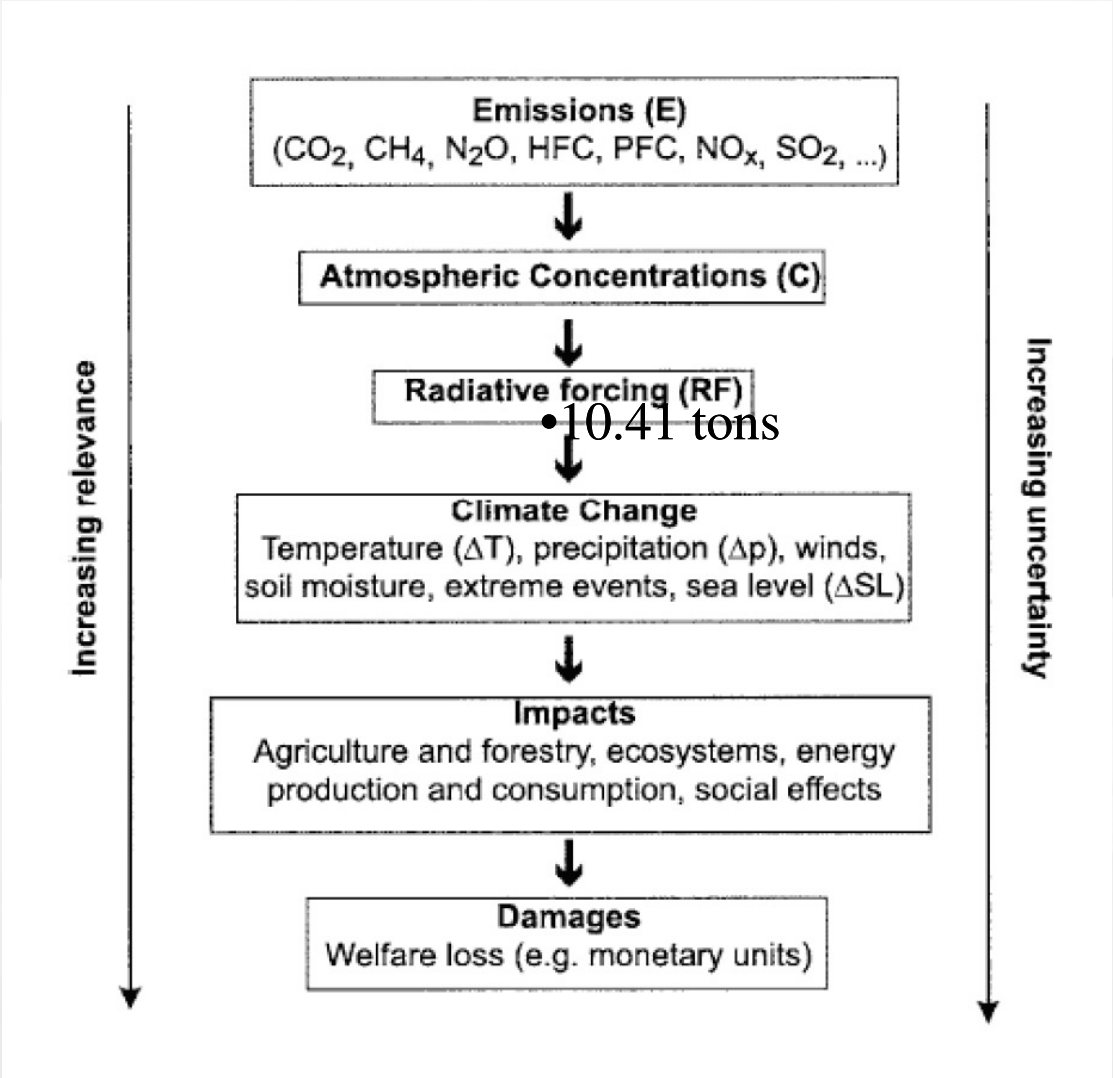


State Climate Action Plans

State	GHG Goals
AZ	2000 levels by 2020; 50% below 2000 levels by 2040
CA	2000 by 2010; 10% below by 2020; 75% by 2050
CT	1990 by 2010; 10% below by 2020; 75% by 2100
MA	1990 by 2010; 10% below by 2020; 75% by 2100
ME	1990 by 2010; 10% below by 2020; 75% by 2100
NC	TBD
NJ	5% -1990 by 2005
NM	2000 by 2012; 10% below by 2020; 75% by 2050
NY	5% below 1990 by 2010
OR	1990 by 2010; 10% below by 2020; 75% by 2100
PS/WA	1990 by 2010; 10% below by 2020; 75% by 2100
RI	1990 by 2010; 10% below by 2020; 75% by 2100

Source: Climate Science

Why are we concerned about Climate Change



- 10.41 tons