Continuous Descent Approach (CDA)

Benefits and Challenges

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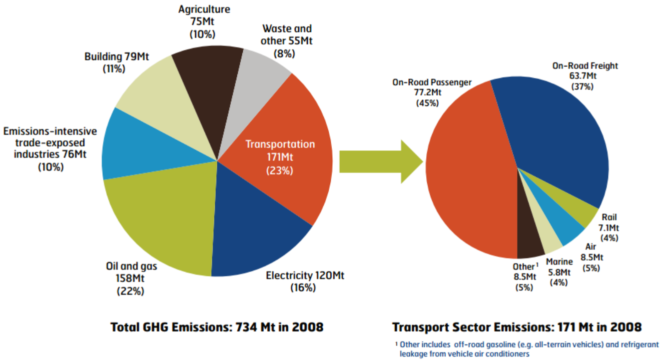
Background

1. Aircraft as a source of pollution.



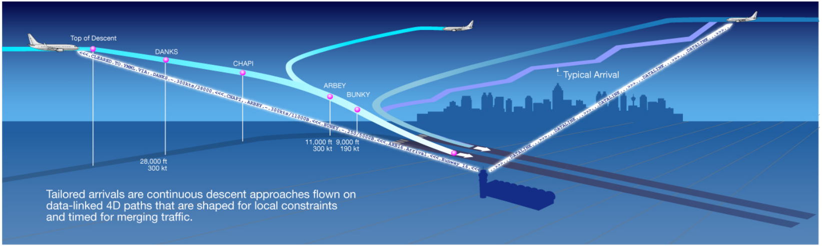
Aviation's contribution to greenhouse gas emissions [Transport Canada 2012]

Aviation emissions

2. Growing trend in pax numbers
3. Fuel emissions: long-term effects
    - Radiative Forcing (RF) = change in energy in the atmosphere due to GHG emissions.
    - NO_x $\rightarrow$ short duration life: 2 weeks life-cycle
    - CO_2, $\rightarrow$ life-cycle of $\approx$ 150-200 years. Can lead to acid rain.
    - AIC: differing opinions on scale of aviation induced cirrus (AIC) effects. The tiny ice crystals absorb thermal radiation in the upper atmosphere: overall warming effect (RF)
4. Will focus on direct fuel emissions, and not AIC.
5. Time to develop for radical situation-changing designs $>>$ time we have available

Continuous Descent Approach

1. Reducing fuel consumption will cut back emissions
2. CDA : aircraft descends smoothly from cruise alt to runway, no "steps" of intermittent level segments



Tailored arrivals into Melbourne Intl [Boeing 2009]

3. Started at Heathrow in the 70*s* to reduce noise. From 7000*ft*
4. Significant promise : (during landing phase) reducing fuel consumption, emission, noise impact and flight time.

Benchmark scenario

1. ANZ and QANTAS participated in the Aspire program. Goal was set ideal flight benchmark metric in maximum savings.
2. Framework:
   - ANZ-operated Boeing 777, Auckland - San Francisco. September 2008.
   - Most advanced air navigation available
   - Practically, all operational restraints removed: ATC: (congestion control vectoring, fixed route structure, procedures, flow restrictions) and airline restraints.
3. Achieved **3.5** tonnes fuel savings (**11.2** tonnes CO 2 reduction).
4. One month later Qantas. New A380 from KLAX -YMML. Saving **8.9** tonnes fuel (**28** tonnes CO_2).
5. CDA contributed to these savings

Literature review

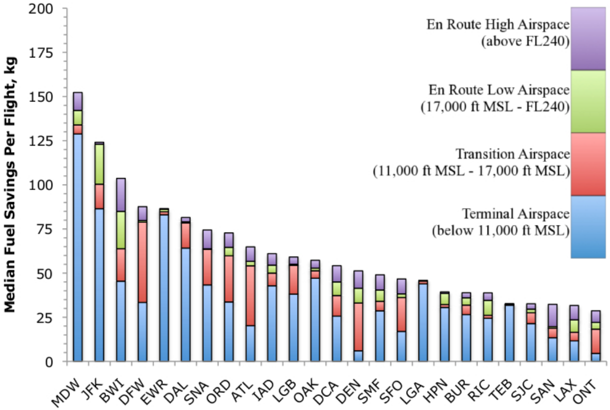
1. Some literature researching the effects of CDA was analyzed.
2. 50% was from an academic setting, the rest from institutions
3. Using radar databases from airports:
   - used for optimization model development;
   - algorithms for traffic decongestion: FMC and ground support systems
4. Data from flights:
   - ATC/Crew communication simulations
   - Model infrastructure to support decision making

Results: Benefits

Benefits of implementing CDA:

1. Fuel savings:
   - While descent/landing does not contribute to significant fuel usage, CDA has been proven to save fuel.
   - Actual figures vary for single-aisle and twin-aisles
   - Cao et al [2013] found on average, arrivals into KATL saved $\approx$ 160kg fuel/flight
   - Having a direct descend without level segments allows sustained near-idle engine runs with minimal throttle-ups
   - level segments have enforced speed restrictions $\rightarrow$ slowing the plane at constant altitude
   - Only valid for optimized CDA profiles (routing, weather)

Results: Benefits - cont'd



Effect of continuous descent scenario on median fuel savings by airport [Robinson and Kamgarpur 2010]

Results: Benefits - cont'd

2. Reduction in emissions:
   - Reduction in fuel corresponds to lower fuel-based emissions
   - Coppenbarger et al [2007] (Study on B777 trans-Pacific flights) found CDA could reduce CO_2 emissions by as much as 350 kg/flight depending on traffic conditions. 12% reduction in NO_x (Alam et al [2010])
   - Significant noise reduction (Alam and co-authors [2010]) in vicinity of airport along the descent flightpath due to virtual elimination of extended level segments
3. Time savings: approximately 2min (Turgut et al [2010]). A small figure, although when compounded could relate to significant savings in direct operating costs (DOCs) - salaries, maintanance, fees.

Results: Drawbacks

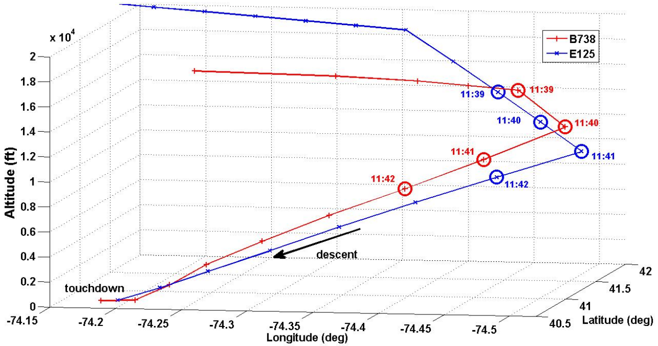
1. Level of automation: detailed support infrastructure required

Efficient Descent Advisor (EDA), a decision-support tool for air-traffic controllers managing arrival airspace in enroute facilities [Coppenbarger et al 2010]

2. Information flux. Crossflow between ATC and the pilot/FMS via datalink. Safety.
3. Plenty of benefits of CDA are curtailed by heavy traffic conditions
4. Complexity: CDA inadvertently provides aircraft with descent trajectory self-autonomy. The system is harder to control.
5. Poorly designed CDAs can lead to more traffic conflict, fuel usage
6. Heavy capital cost of support infrastructure
7. Additional training for crew and ATC. Long-established routines difficult to adjust.

Results: Observations

1. CDAs can be optimized for criteria: minimal fuel burn, flight time
2. CDA easiest to implement in low traffic conditions



Two aircraft in conflict get rescheduled [Cao et al 2011]

Results: Observations - cont'd

2. Although individual flights fail to achieve fuel savings, airport as a whole realizes fuel savings.
3. Fuel burn=f(altitude, speed) - sustain high alt as long as possible to realize max savings.
4. System automation has great promise to reduce information overload. (ATC/Crew)
5. Due to their long flights, wide-bodies are greatest beneficiaries of CDA - high priority. More could be done about single-aisle; they account for bulk traffic movement.
6. Time restrictions could reduce fuel savings.

Thank You For Your Attention!

Questions?