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Environmental Assessment of Airplanes

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Capacity Area B2 SCCER Mobility

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Introduction

- Air travel can provide transportation services at relatively low impacts per passenger kilometer (pkm), with very short trip times.
- Air travel makes up nearly 40% of total passenger kilometers (pkm) in Switzerland*, totalling almost 80 billion pkm per year.
- Both domestic and international air travel must be included in any transport scenarios considered for the future mobility system.

*Includes international air travel: Bundesamt für Statistik (2013). Mobilität und Verkehr 2013.

Aim

- Examine the life cycle environmental impacts of different aircraft size classes. Compare current (2015) technology to estimated future (2050) technology.
- Develop models that allow parametric analysis of important variables such as flight length, aircraft weight, and technology improvments.

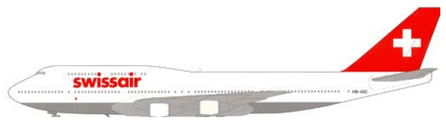
Airplanes Assessed


Regional


Small Narrow Body

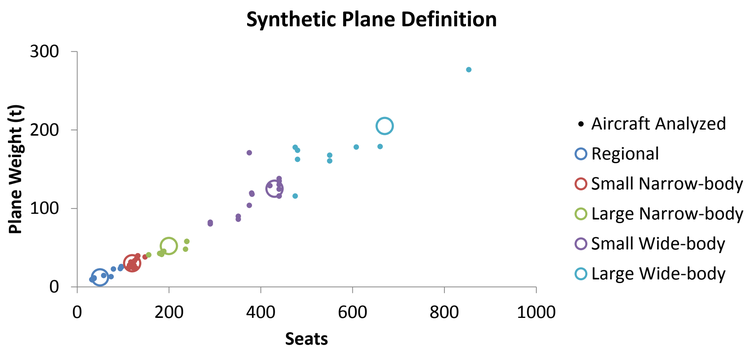

Large Narrow Body


Small Wide Body

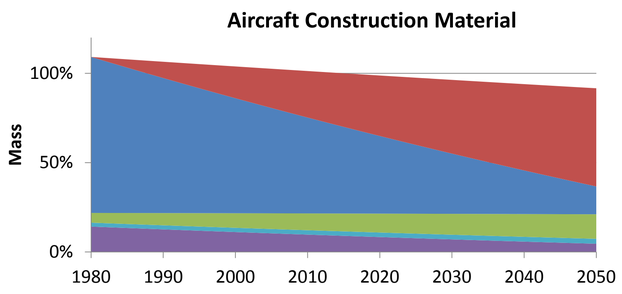

Large Wide Body

Aircraft Modelling

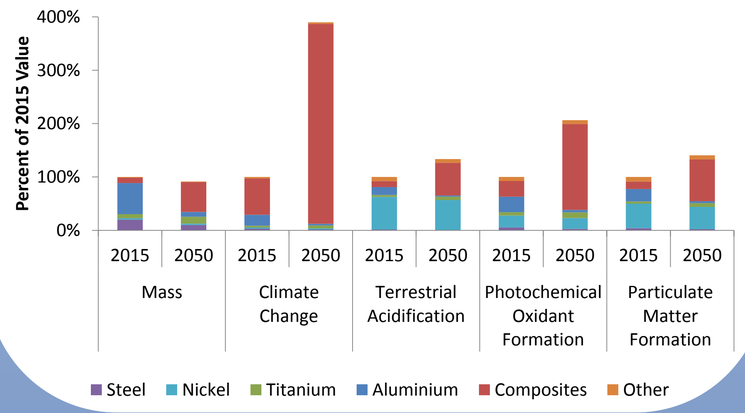
- 5 synthetic airplanes defined to represent the Swiss fleet.



- Aircraft are constructed mostly from aluminium and carbon fiber – with compostition changing strongly over time, resulting in overall weight reduction.

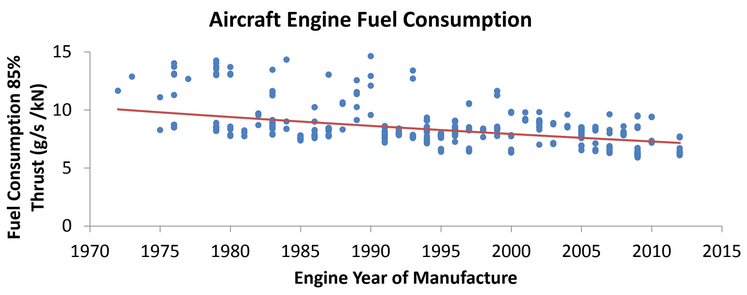


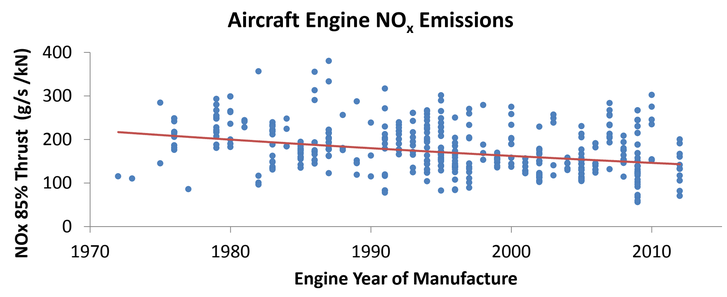
- Increased use of composites significantly increases environmental impacts of future aircraft production.



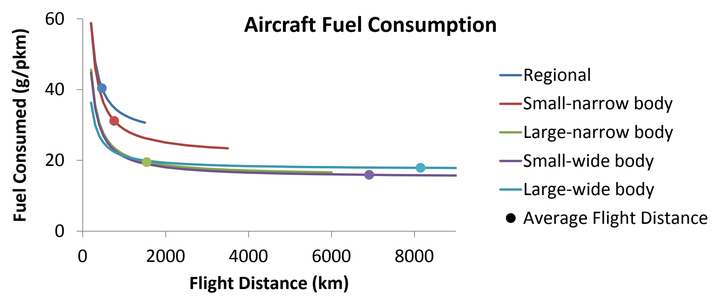
Aircraft Fuel Consumption and Emissions

- Database of engine testing results shows fuel consumption and emission reductions over time.



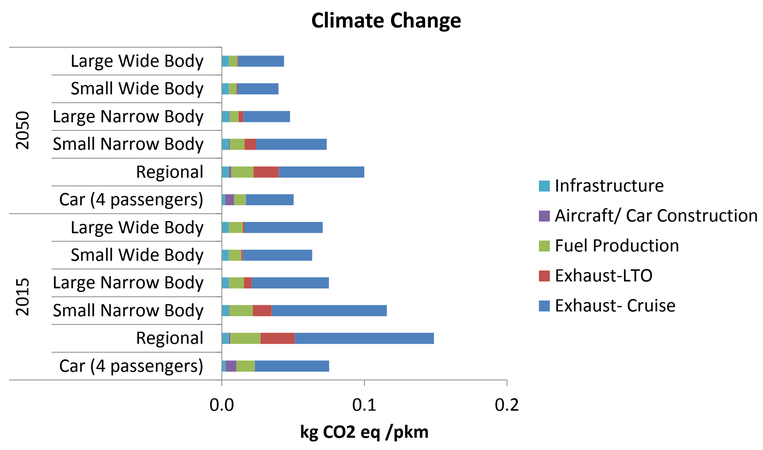


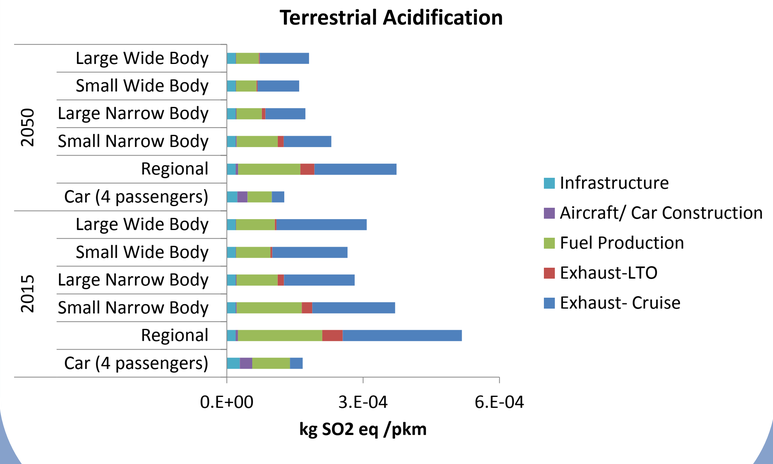
- Emissions and fuel consumption due to Landing and Take-Off Cycle (LTO) and climb-out are important for shorter flights. The flight distance is important to consider when quantifying impacts per passenger kilometer (pkm).



Environmental Results

- Impacts shown for average flight lengths in Europe.
- Environmental impacts are mostly due to operating emissions and fuel production.
- Aircraft manufacture contributes very little to overall result, even for future lightweighted aircraft.
- LTO and climb-out are important for short flights.
- Results look very similar for most impact categories.
- Cars (VW Jetta, 4 passengers) outperform aircraft for short flights, however, seat loading is important.
- Single passenger cars have larger impacts than flying for all distances analysed





Conclusions

- Lightweighting of aircraft strongly beneficial due to increased freight carrying capacity.
- Flight distance very important for analysis.
- Different aircraft sizes do have different environmental impacts.

Assumptions and Remarks

- Aircraft are assumed to be filled with freight when all seats are not full – reflects commercial best practice.
- Allocation between passengers and freight is done by mass, assuming average passenger weight of 100 kg with luggage.

Category	Seats	Weight (t)	Thrust (kN)	Lifetime Distance (million km)	Payload (t)
Regional	50	12	66	11.4	5.6
Small Narrow-body	120	30	171	27.9	12.8
Large Narrow-body	200	52	274	41.7	26.1
Small Wide-body	430	125	644	89.8	40.9
Large Wide-body	670	205	1028	87.3	72.9

Outlook

PSI is developing consistent, high quality data for the environmental burdens and costs of transportation for current and 2050 technology levels.

Future work will include:

- extending existing data coverage to all transportation modes including road, rail, water and air for both personal and freight transportation for current and future technology levels.
- implementing more advanced models using state of the art LCA techniques such as consequential, dynamic and regionalized LCA.
- extending analysis to include other sustainability indicators such as noise, accident risk, etc..

Acknowledgements

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About the authors

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