Design Project 2021

EPFL

EuroAirport
BASEL MULHOUSE FREIBURG

Analysis of the environmental impact of air traffic on the perimeter of Basel-Mulhouse Airport

Students:

Buchs Guillaume, Bugnard Alexandre

EuroAirport team:

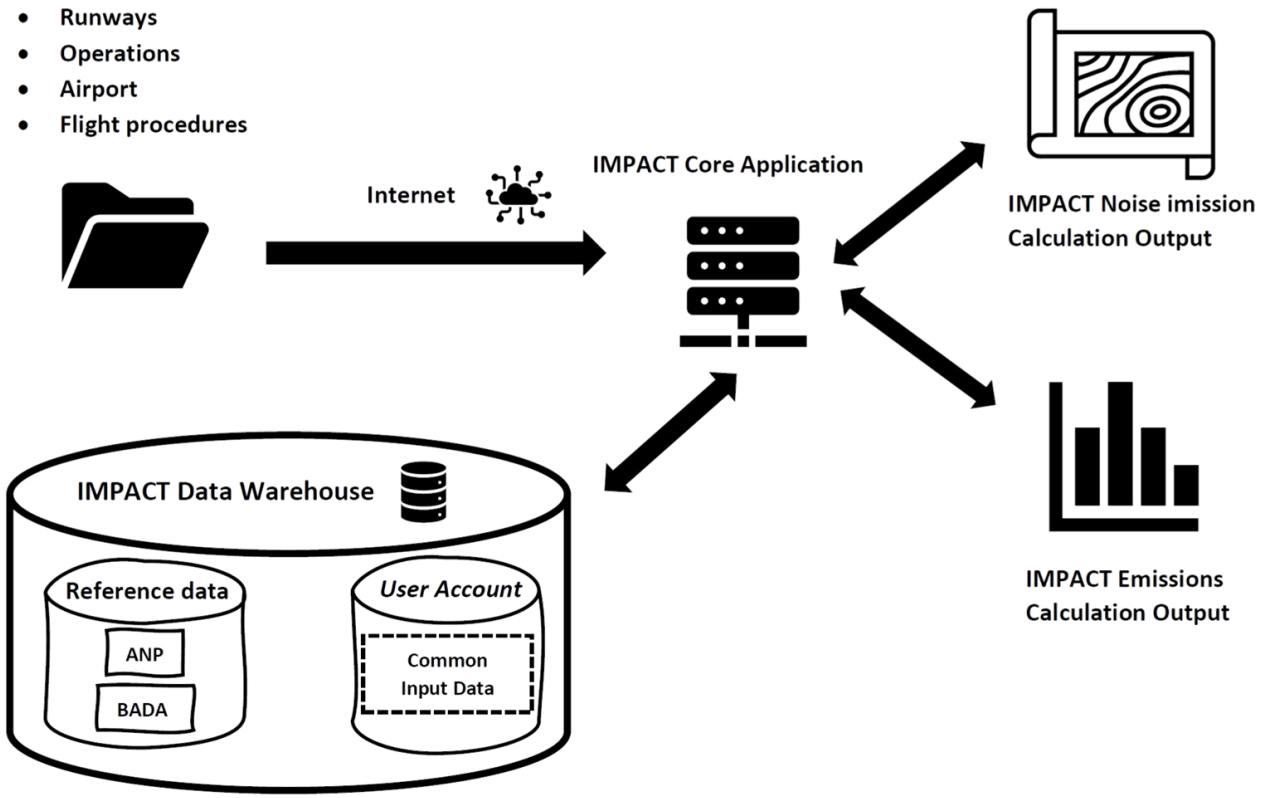
Bach Roland, Robra Jan Philipp, Unternährer Jérémy

EPFL supervisor:

Nenes Athanasios

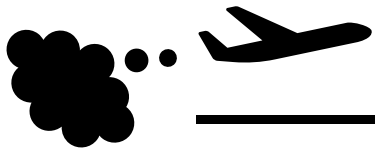
Introduction

- Simulation of noise and pollution impacts (using IMPACT web application)
- Analysis of sensitivity for noise and pollution reduction based on different scenarios



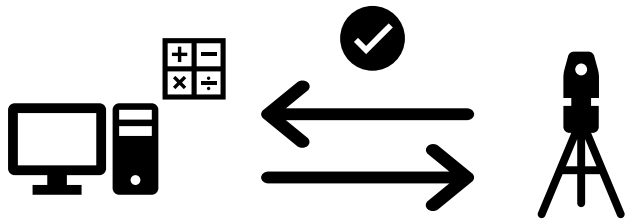
Definition of the study parameters

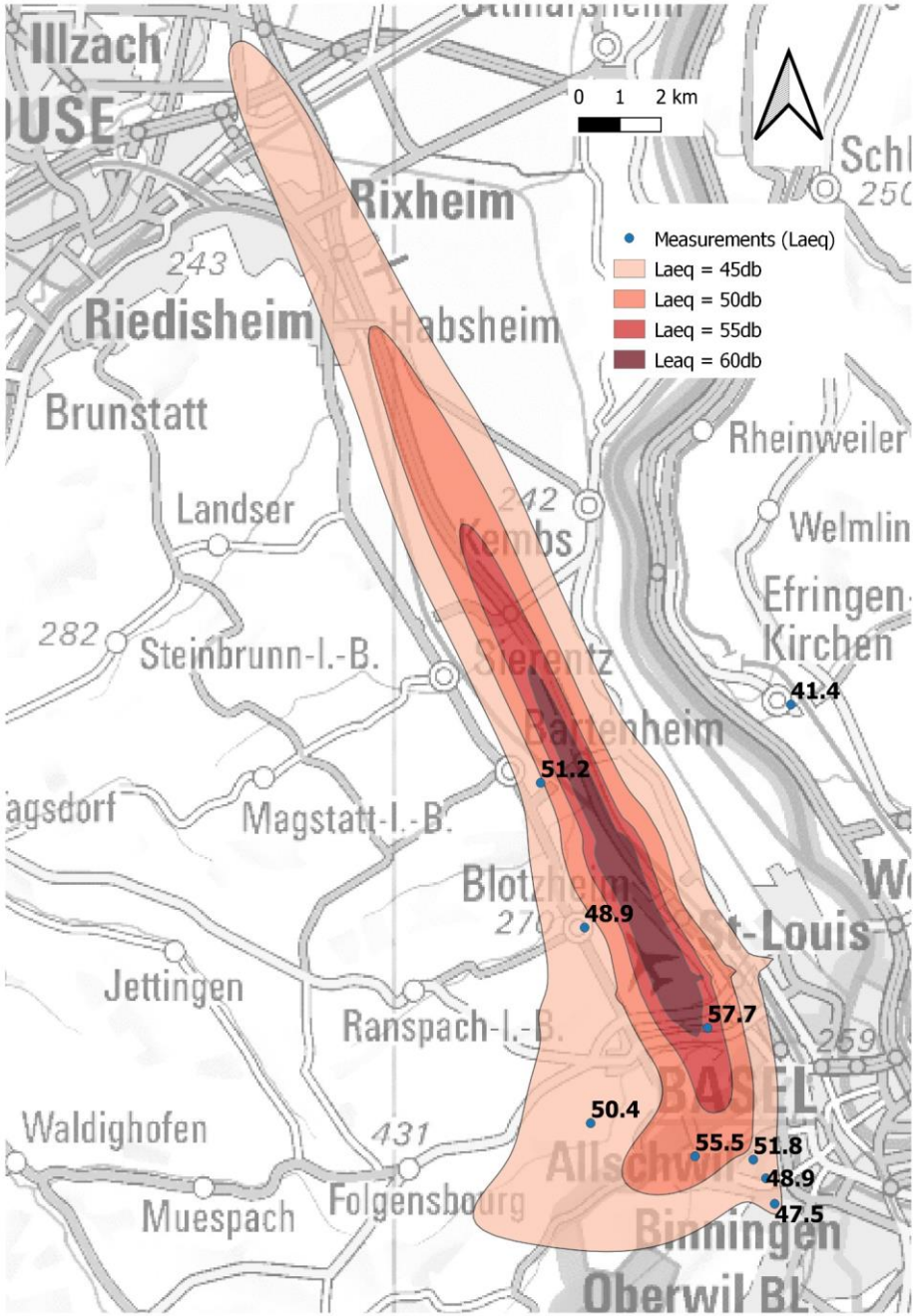
- Noise → immissions
  - Metrics
    - **LA_{eq}** the constant noise level that would have been produced with the same energy as the noise actually existing during a given period.
    - **Scenario noise population count (SNPC):** number of people exposed to a particular noise level. It is computed by performing the intersection between a noise contour layout and the reference density map, contained in a raster file
- Pollutants → emissions
  - Inventory of 25 different pollutants
    - Focus on: CO_2, NO_X, PM_{TOTAL} and CO
  - Emitted under 3000 [ft]



Validation of noise simulation

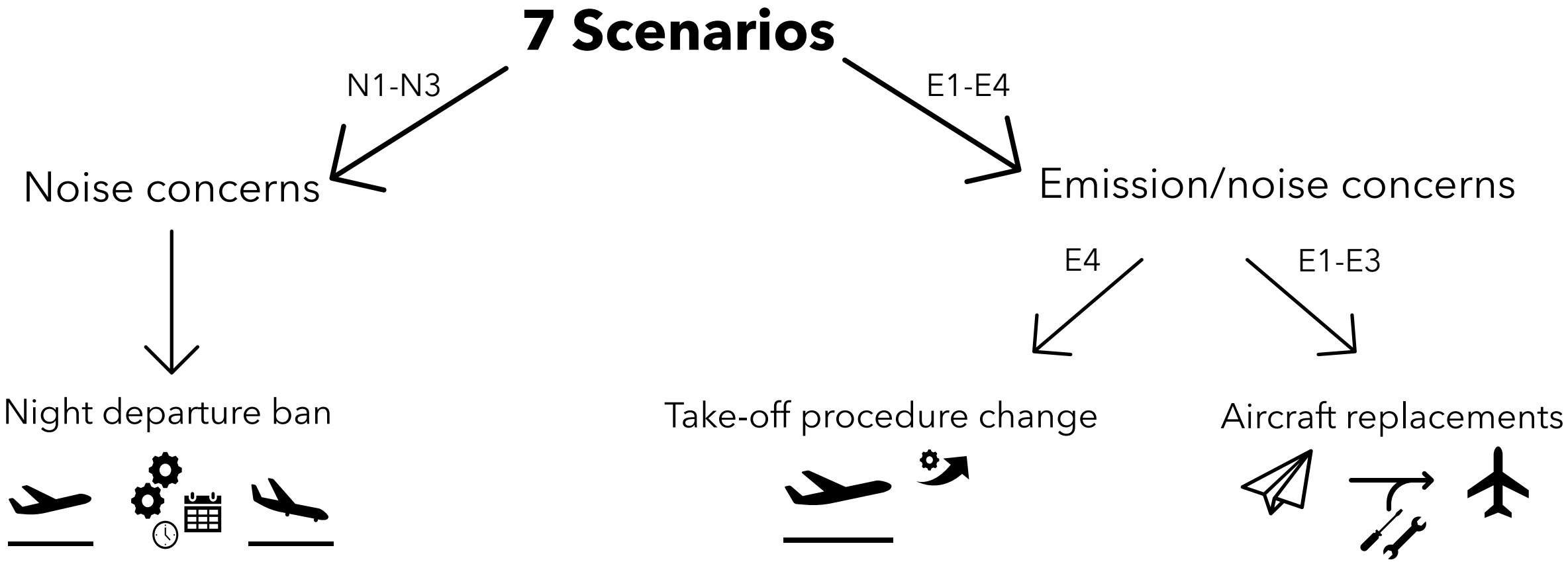
- Noise calculation for reference year 2018
- Comparison with in-situ measurements
  - 9 stations placed according to the main airplane's trajectories



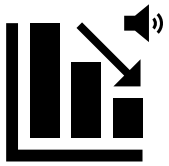


Comparison between IMPACT simulation and noise measurments 2018 for the first night hour(22h-23h)

Sensitivity analysis



Flights rescheduling

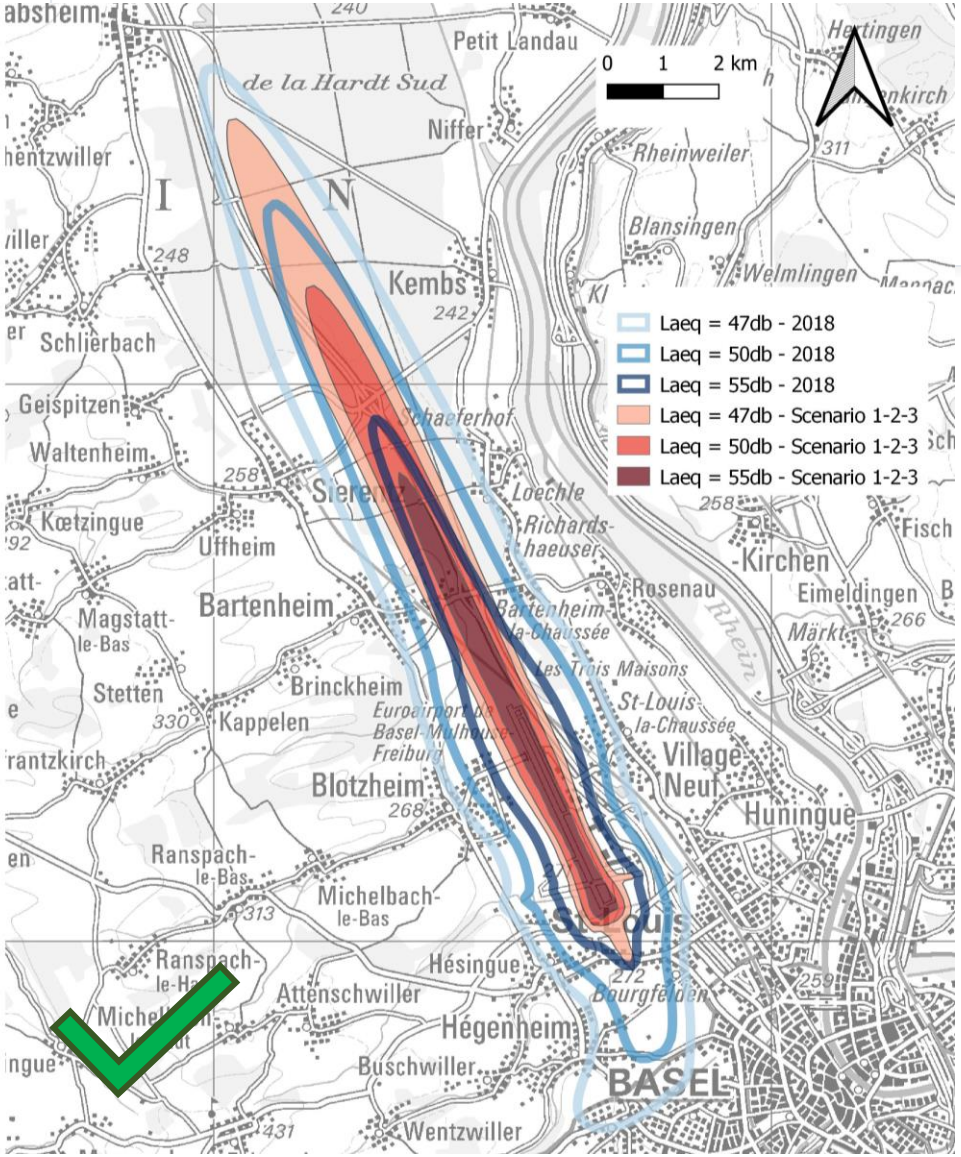


Departure ban between 23h-24h

- **Scenario N1**: (*extreme scenario*): 100% moved to the first night hour (22h-23h).
- **Scenario N2:** (*optimal scenario*): 100% moved to daytime hours (6h-22h).
- **Scenario N3:** (*half-half scenario*): 50% moved to first night hour and 50% to daytime hours

Time slot		Impact threshold (Laeq)	Population count
Daytime	06h-22h	60 db	131
First night hour	22h-23h	55 db	1504
Second night hour	23h-24h	50 db	4200

Effect of scenarios N1-N3



N1-N2-N3 second night hour noise

Effect on other time slots

- Negligible on daytime (less than 10% increase)
- More problematic during first night hour

Noise population count between 22h-23h (55dB)	
Scenario N1 (100% of D)	+93.3%
Scenario N3 (50% of D)	+28.9%

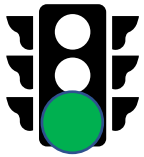
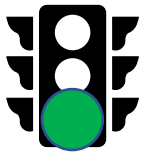
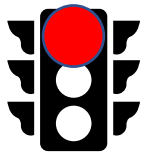
Is the ban a good solution ?

- Depends on exact rescheduling ratio day/night
- Depends on inhabitants feeling

Scenario E1

A319 → A321
(-30% movements)

*represents 20% of the total airport movements

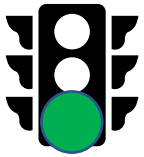
CO_2		(-4.3%)
PM_{tot}		(-4.3%)
CO		(-2.5%)
NO_X		(+6.8%)
Noise	06h-22h >57 [dB] (-15%) ✓ 22h-23h >50 [dB] (+2%) ✗ >55 [dB] (-10.9%) ✓ 23h-24h >47 [dB] (+1.3%) ✗	

- Bigger jet engines
- More fuel efficient
- Increased NO_x production
- Noise reduction during daytime

Scenario E2

A320 ⟹ A320neo

**represents 30% of the total airport movements*

CO_2		(-8.5%)
PM_{tot}		(-30.7%)
CO		(+0.7%)
NO_X		(-17.3%)
Noise	06h-22h >57 [dB] (-33%) ✓	
	22h-23h >55 [dB] (-20%) ✓	
	23h-24h >47 [dB] (-5%) ✓	

- Very beneficial in terms of pollutants emissions
- NO_X are also reduced unlike in scenario E1
- Net noise decrease for all the time-slots

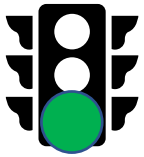
Scenario E3

Replacement of old freight (25-30 years) aircraft by more recent ones (10-15 years)

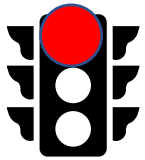
A300-600	B767-300
B757-200	A321-232
B737-400	B737-800

**represents 3.8% of the total airport movements*

CO_2  (-0.4%)

PM_{tot}  (-1.9%)

CO  (± 0%)

NO_X  (1.6%)

Noise

06h-22h	=
22h-23h	>57 [dB] (+20%) ✗
23h-24h	>47 [dB] (+50%) ✗

- Emissions reduction not very important
- NO_X increase as before due to higher combustion temperature
- Very negative effects on some pollutants such as acetaldehyde, acrolein, benzene
- Important increase in noise during night hours

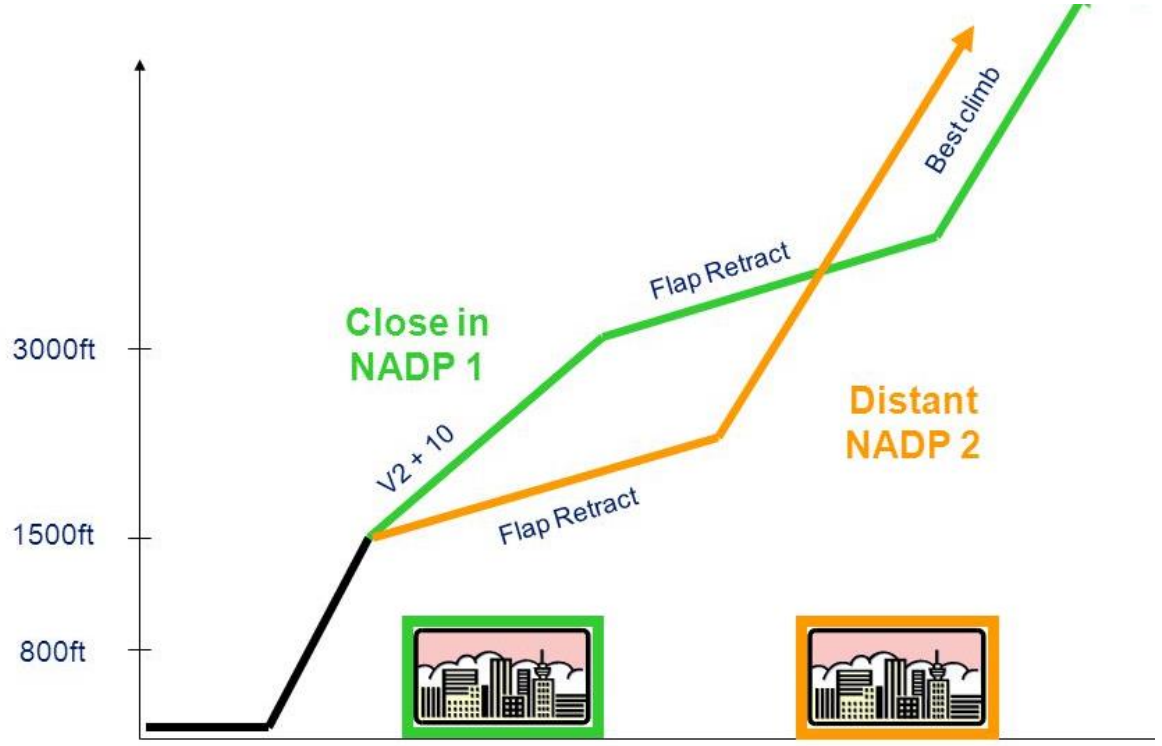
Scenario E4

Airbus + Boeing ⟹ NADP1
Airbus + Boeing ⟹ NADP2

*represents 60% of the total airport movements

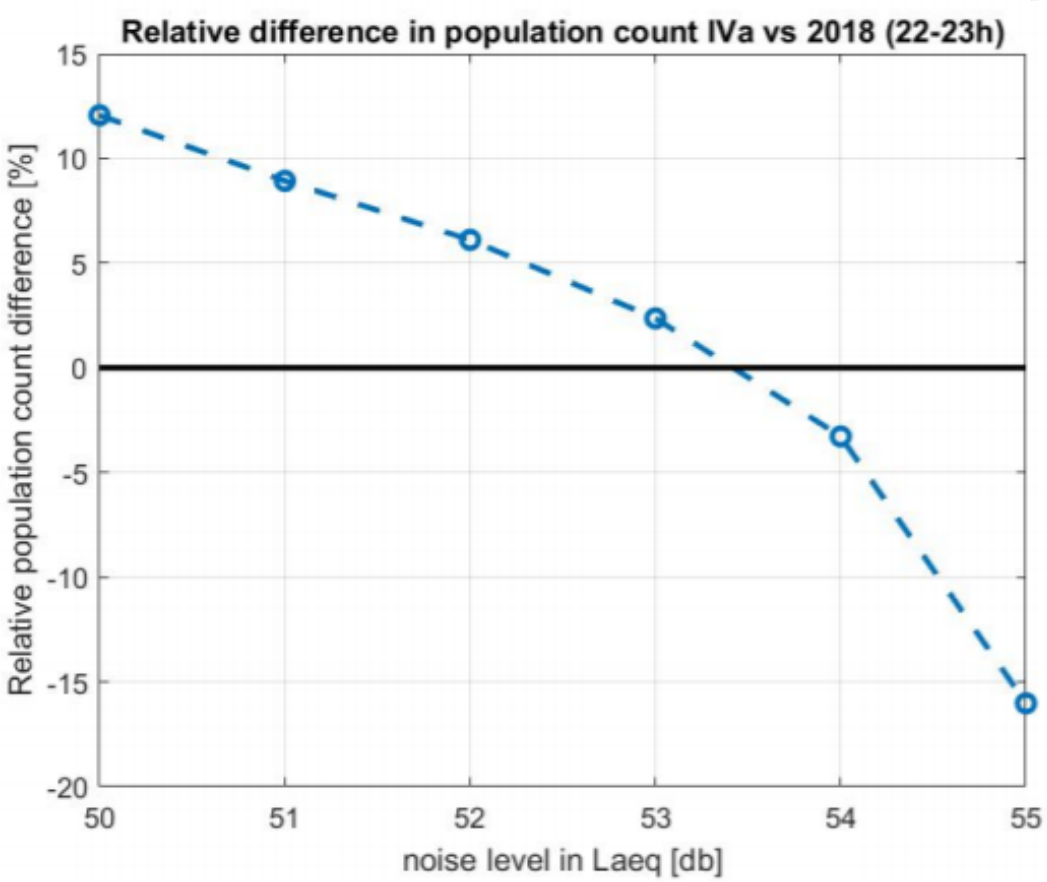
Take-off procedures for noise reduction

- NADP1 = noise reduction near airport
- NADP2 = noise reduction further down



Scenario E4: results

	NADP1	NADP2
CO_2	(+2.7%)	(-2.7%)
PM_{tot}	(+1.2%)	(-3.6%)
CO	(+0.1%)	(-0.1%)
NO_X	(+2.9%)	(-2.5%)
Noise	06h-22h ✓ 22h-23h ✓ 23h-24h ✓	06h-22h ✗ 22h-23h ✗ 23h-24h ✗



- NADP 1 increases the pollution whereas NADP2 decreases it
- Decreasing noise somewhere implies increase somewhere else
- NADP 1 tends to smooth the noise over the territory
- NADP 2 negative effect for all the time slots and limit values.

Conclusion

- Difficult to reduce both noise and emissions
- Difficult to reduce NO_x and CO_2 emissions

- Scenario Eˇ: decreasing noise without increasing too much air pollution

CO_2: -10 % ✓	NO_X: -12 % ✓	PM_{TOTAL}: -12% ✓	CO: -2% ✓

06h-22h	>57 [dB] (-56%)	✓
22h-23h	>55 [dB] (+20%)	✗
23h-24h	>47 [dB] (-96%)	✓

Thanks for listening !

- Feel free to ask questions !

Contact

guillaume.buchs@epfl.ch alexandre.bugnard@epfl.ch