COMPARISON OF MEASURED AND MODELLED NO_2 VALUES AT ZURICH AIRPORT, SENSITIVITY OF AIRCRAFT NOX EMISSIONS INVENTORY AND NO_2 DISPERSION PARAMETERS

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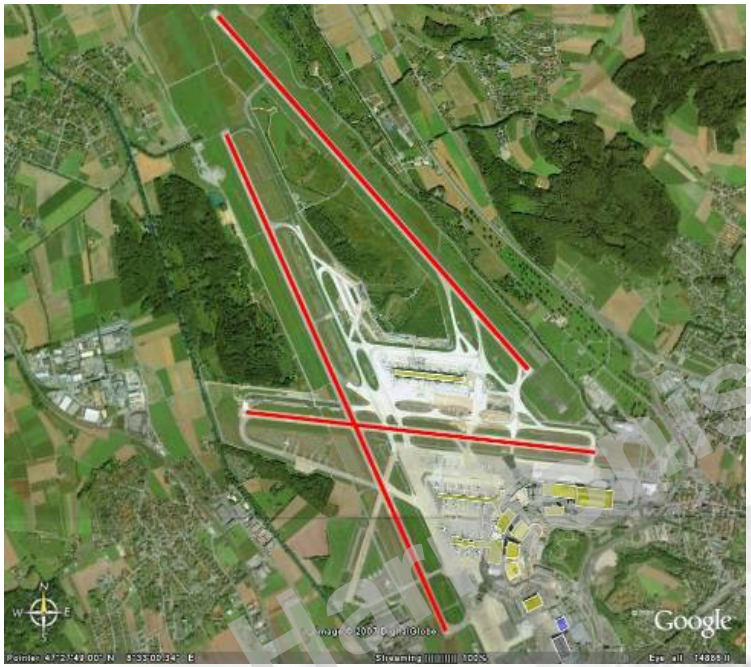
Zurich airport and LASPORT

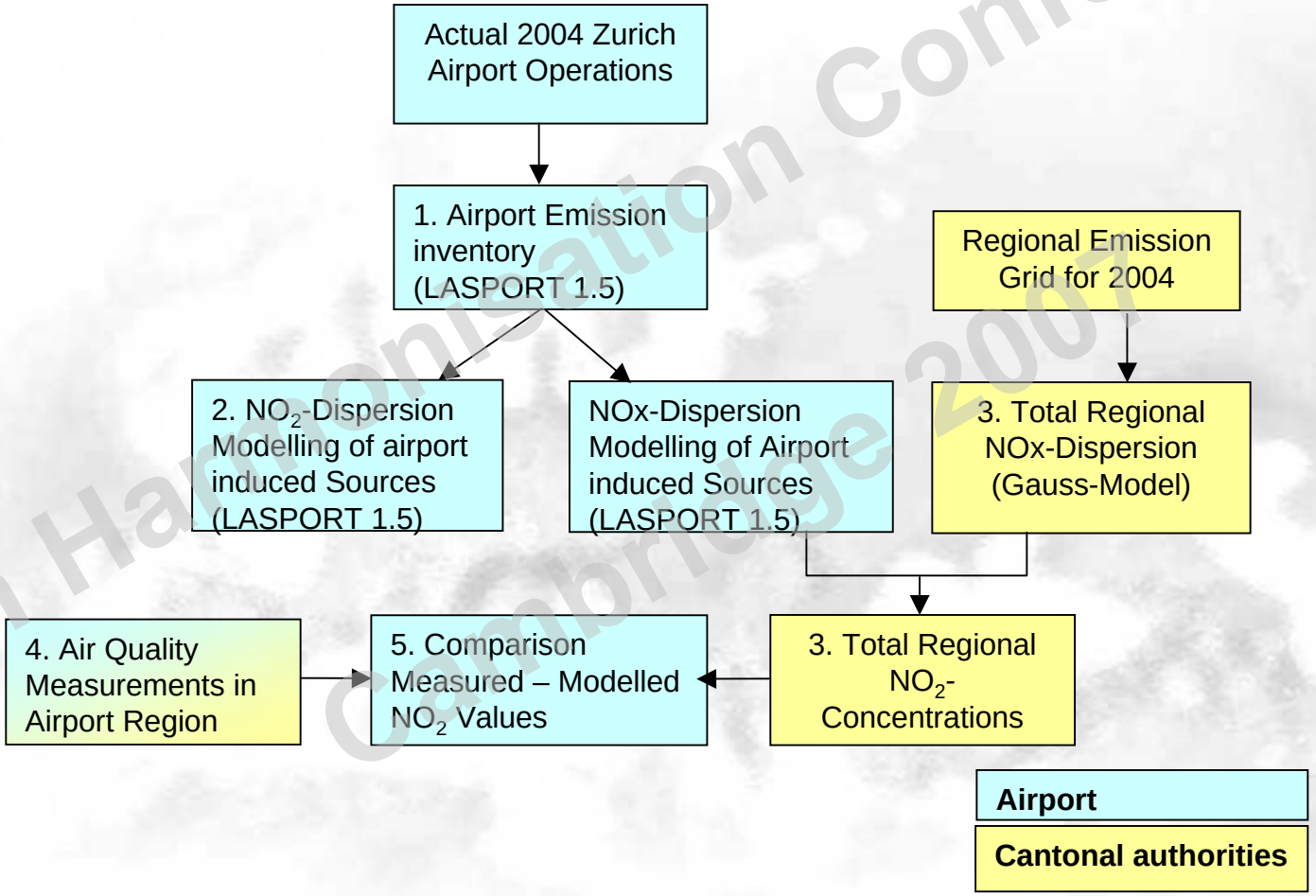


- LASPORT version 1.5, with lagrangian particle model and complex terrain
- Sources: aircraft main engines, Auxiliary Power Units, Ground Power Units, Ground Support Equipment, airside and landside road traffic and other stationary sources.
- 2004 annual means
- 263 000 movements
- NOx emissions in 2004 = 1053 t
- Aircraft contribution around 832 t
- Cut off height: 600m above ground
- NOx to NO_2 according to German Guideline VDI 3782 (15%)
- Aircraft profiles = LASPORT default
- Taxi times = specific for Zurich airport
- Aircraft emission indices from the ICAO database

Zurich airport model assumptions

- The study focused on comparing annual NO_2 concentrations for 2004. Short term effects were outside the scope of the project.
- Chemical processes = linear conversion NOx to NO_2 according to German Guideline VDI 3782
- Cut off altitude = 600m above ground
- Aircraft profiles = LASPORT default
- Taxi times = specific for Zurich airport
- Emission indices from the ICAO database

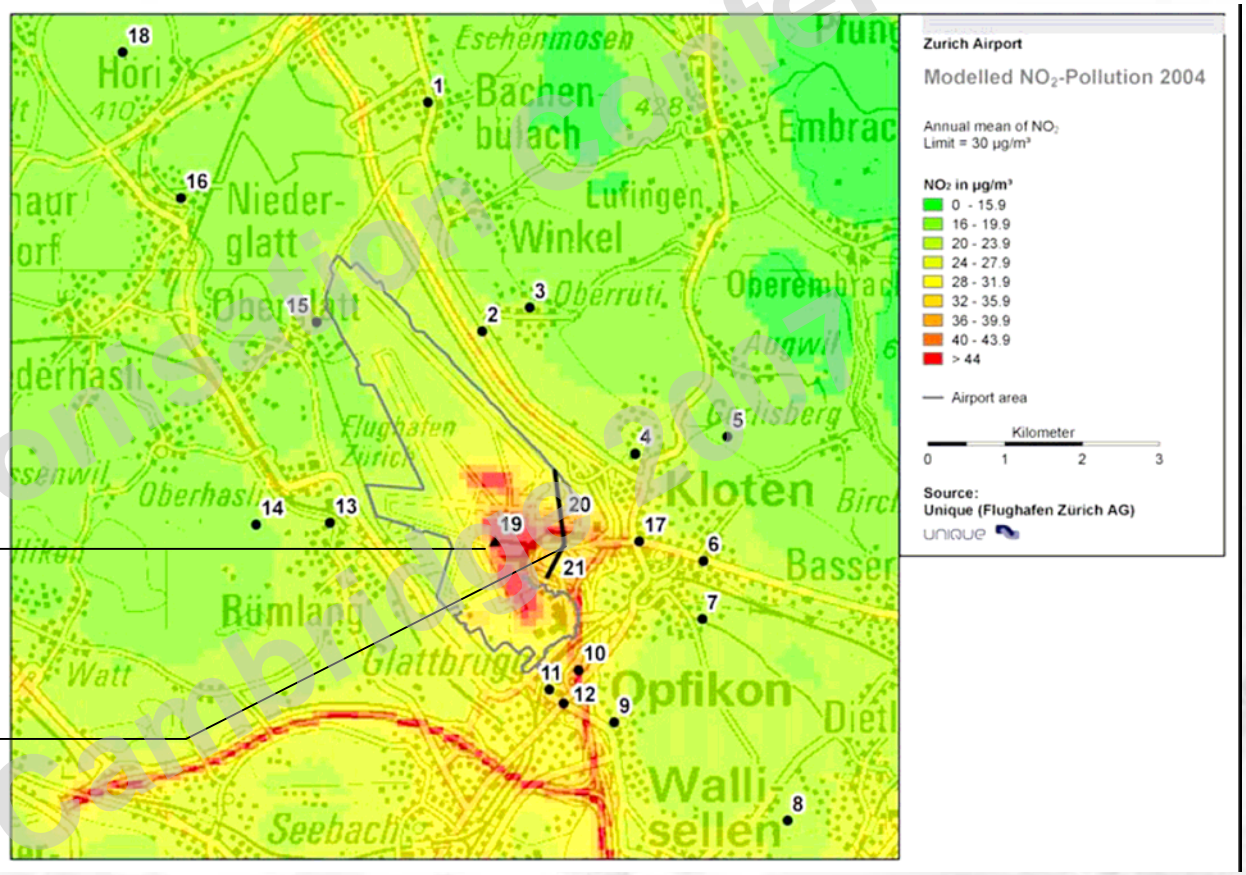
Measured vs Modelled



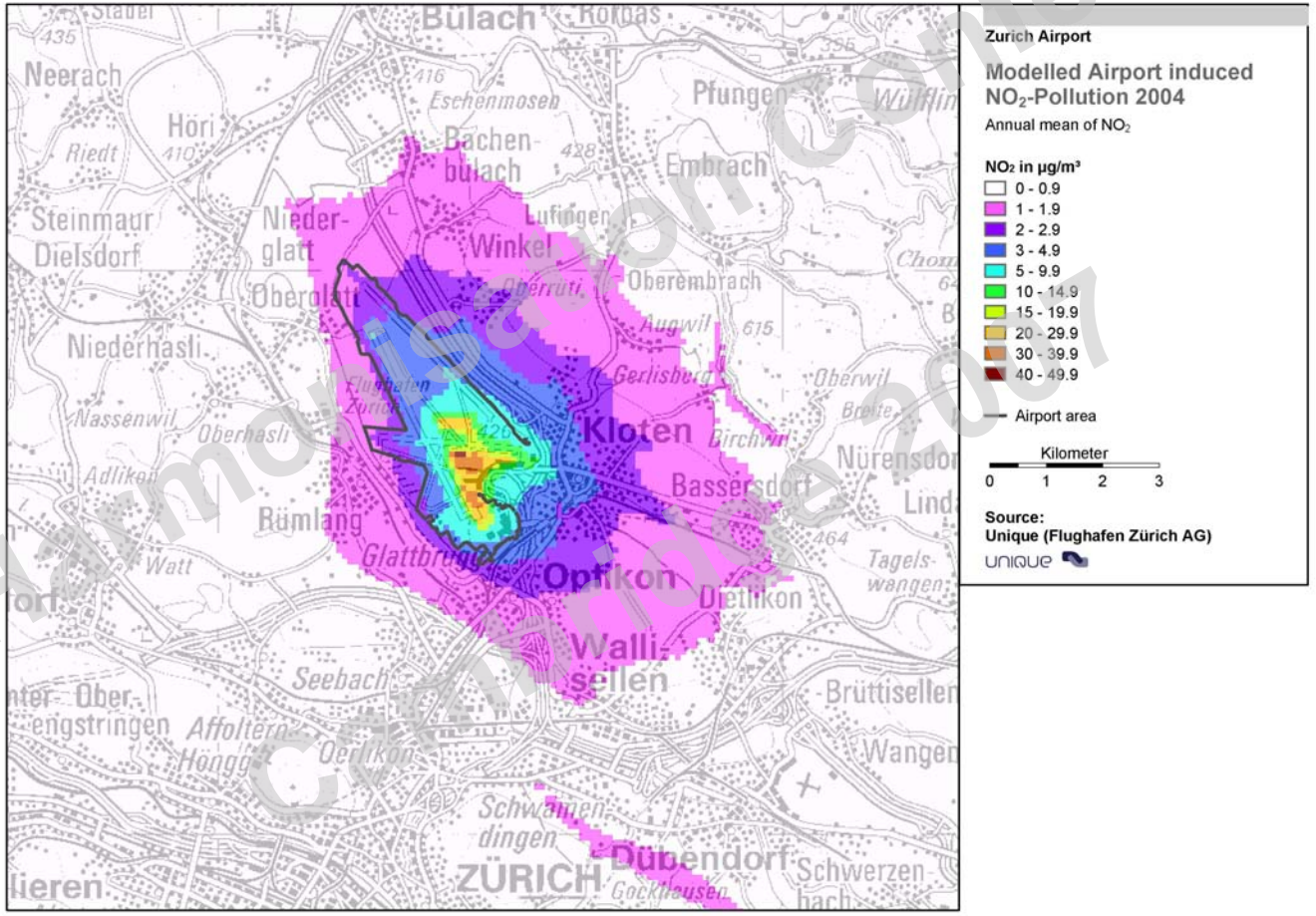
Modelled NO_2 and measurement points

NOx/NO/NO_2 analyser

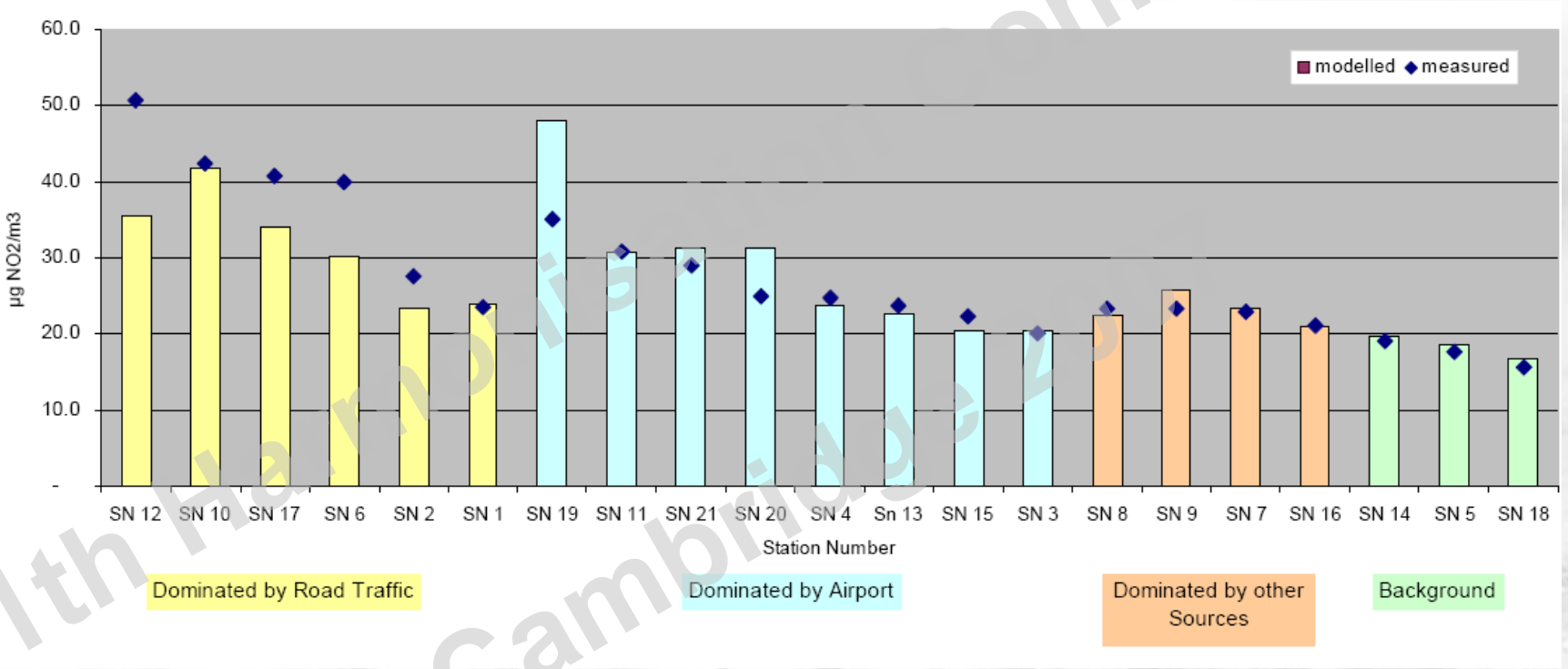
DOAS analyser



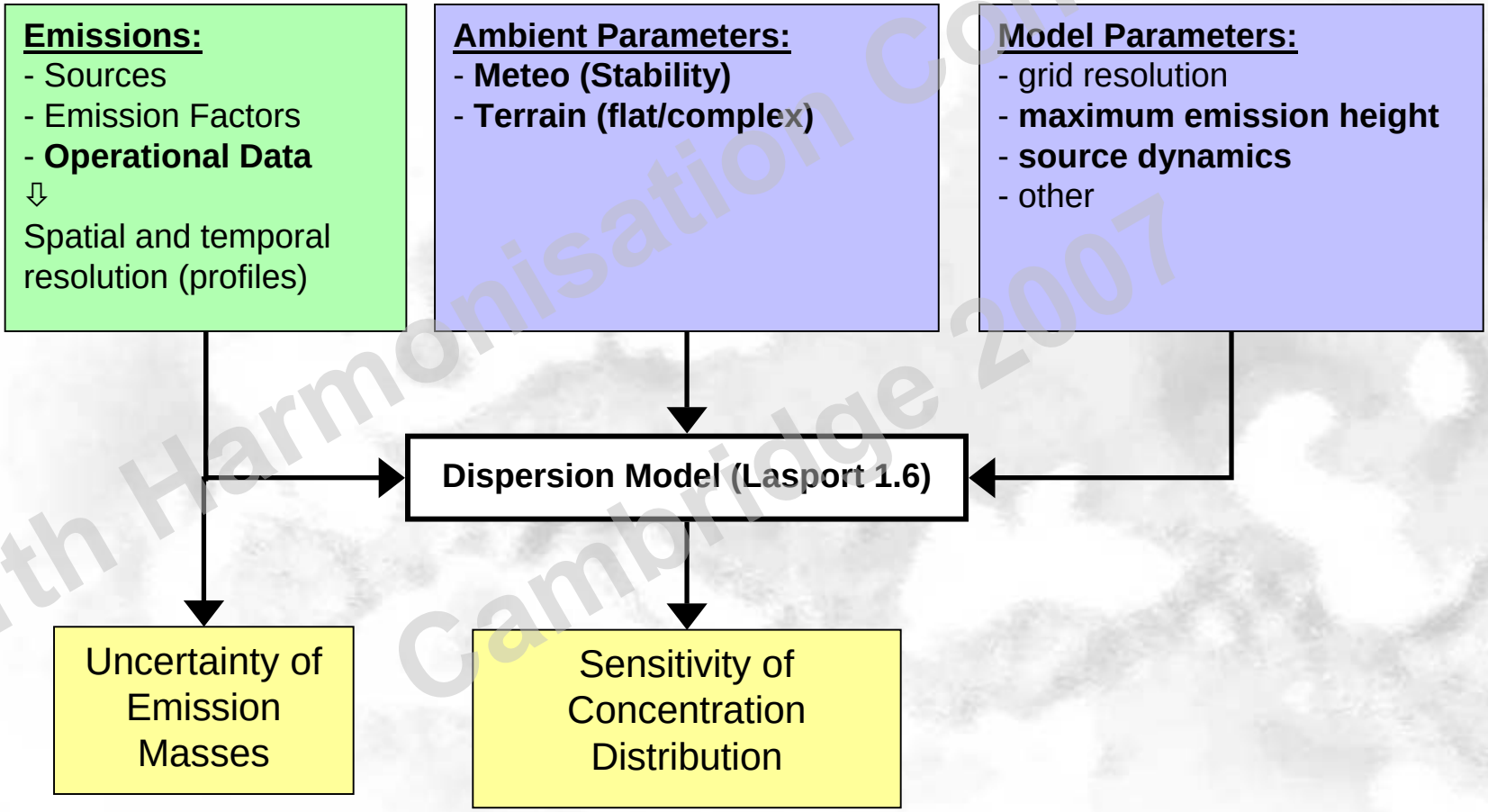
Modelled NOx



comparison



Emission Inventory Sensitivity



Airport emission inventory

Sources to consider:

- Aircraft main engines and Auxiliary Power Units
- Ground Support Equipment
- Stationary sources (power plants, fuel tanks,…)
- Roadways (airside and landside)

Aircraft main engines are the major contributors to NOx emissions at airports

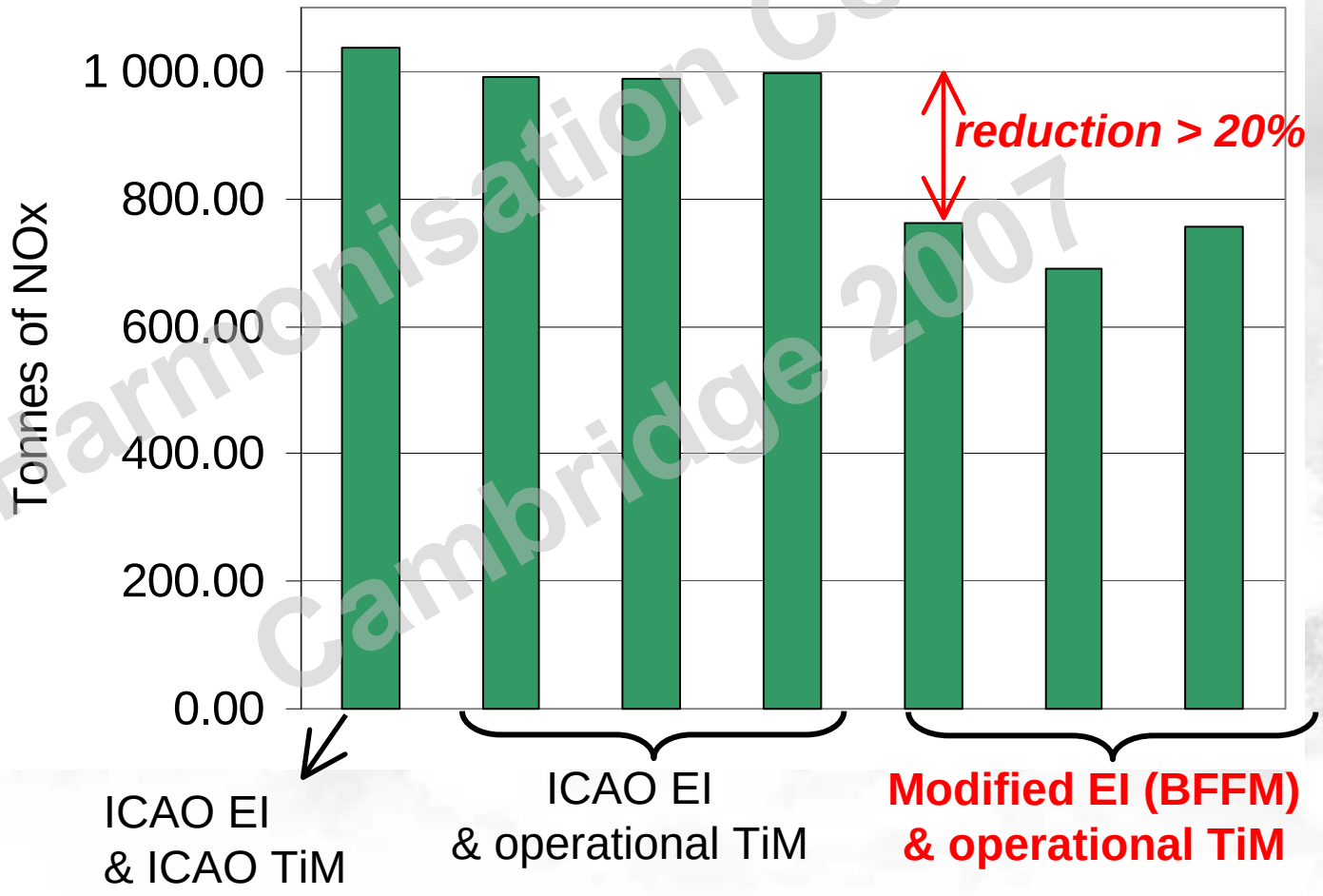
Aircraft emission calculations

$$\text{Emissions} = \text{Time}_{\text{mode}} \times \text{FF}_{\text{mode}} \times \text{EI}_{\text{mode}}$$

Where:

- Emissions = total mass emitted (g)
- Mode = corresponds to engine thrust
- Time = duration of the mode defined above
- FF = fuel flow (kg/s, engine specific)
- EI = emission index (g/kg fuel burnt, engine specific and varies for each pollutant)

Variations in aircraft emissions

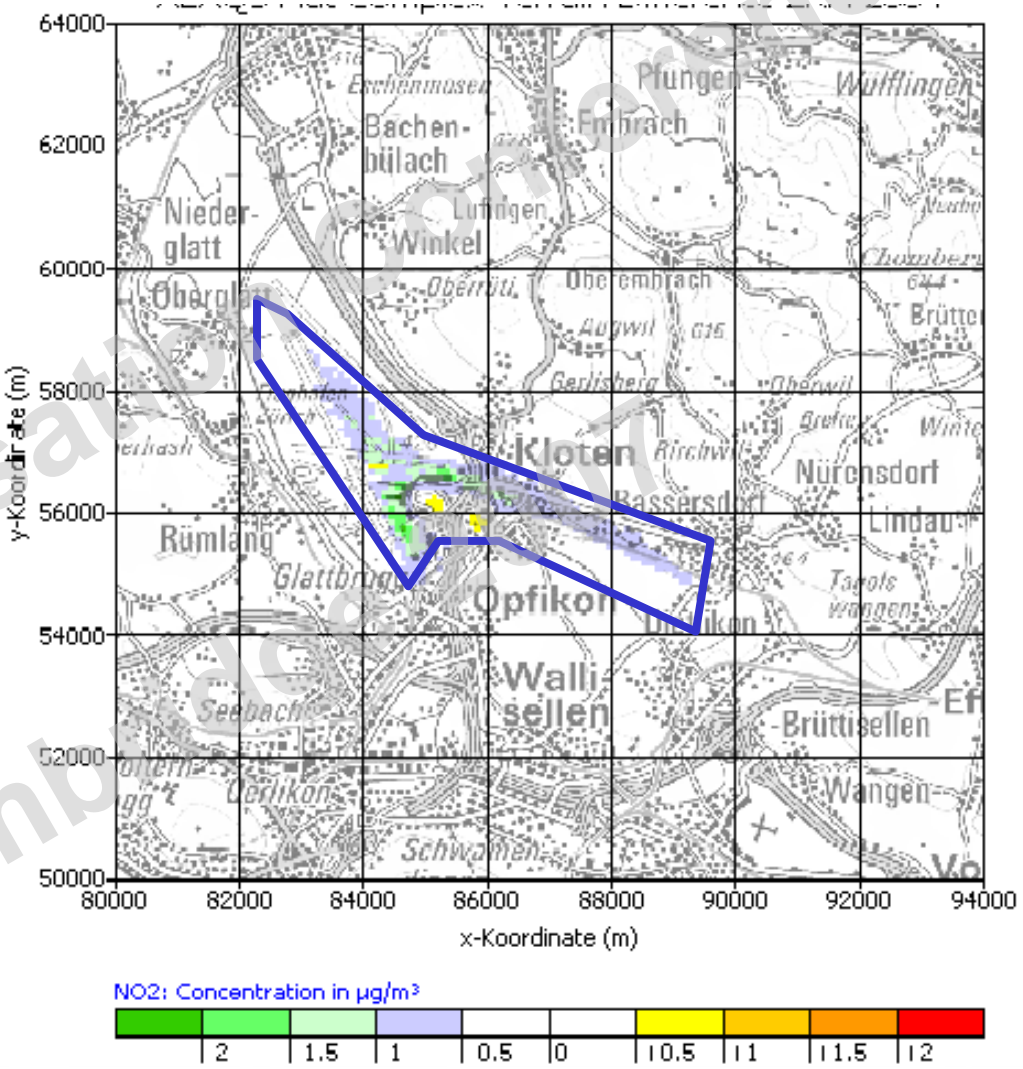


Emissions - Operational parameters

Scenario	Thrust in mode	Time in mode	tonnes NOx (2004)
0	ICAO default thrust in mode for all engine types and modes (7%-30%-85%-100%) with respective fuel flow and NOx indices.	ICAO default times in mode for all modes (including taxiing) and all engines types (table 2-3; line 1)	1038.0
1		ICAO default times in mode, same for all engine types; taxi times variable	992.5
2		ICAO default times in mode for jets >26.7 kN; EPA default times in mode for other engines; taxi times variable (table 2-3: lines 1/2)	987.6
3		Actual LTO times as calculated with LASPORT default profiles (German AzB); taxi times variable	995.5
4	Modified thrust, expressed as modified fuel flow and NOx indices for all jets according to aircraft size using original fuel flow and NOx data with Boeing Fuel flow Curve Fitting Method (cf. annexe).	ICAO default times in mode for jets >26.7 kN; EPA default times in mode for other engines; taxi times variable (table 2-3: lines 1/2)	761.9
5		Modified times in mode for all jets (table 2-3: line 3)	690.8
6		Actual LTO times as calculated with LASPORT default profiles (German AzB); taxi times variable	757.0

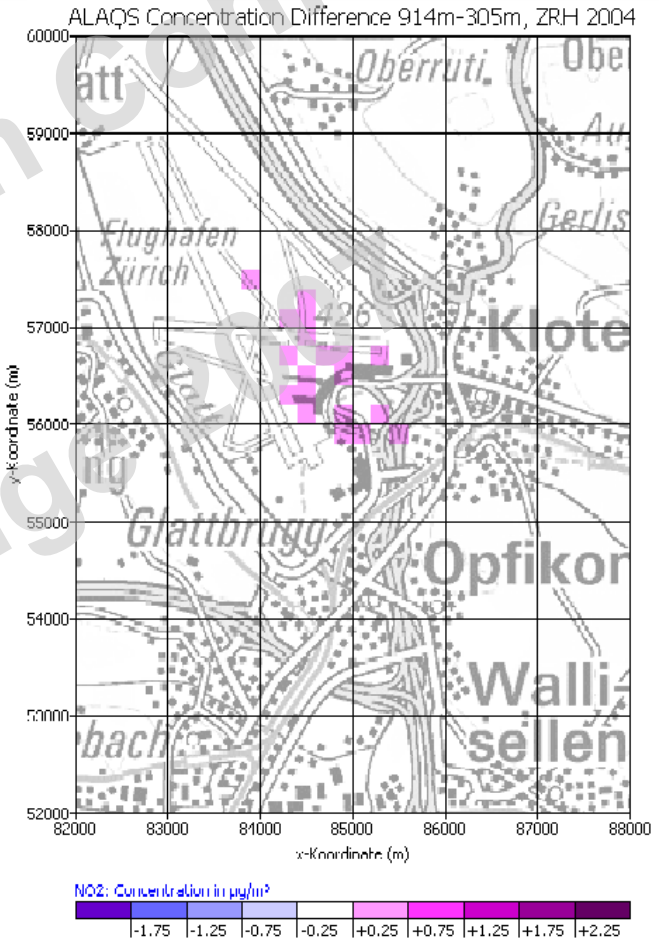
Complex terrain

- Complex terrain but without buildings.
- Terrain data from Swiss national altitude model with a vertical accuracy of 1m in a 25m grid.
- Impact: -2 to +1 µg/m3 NO_2 annual mean



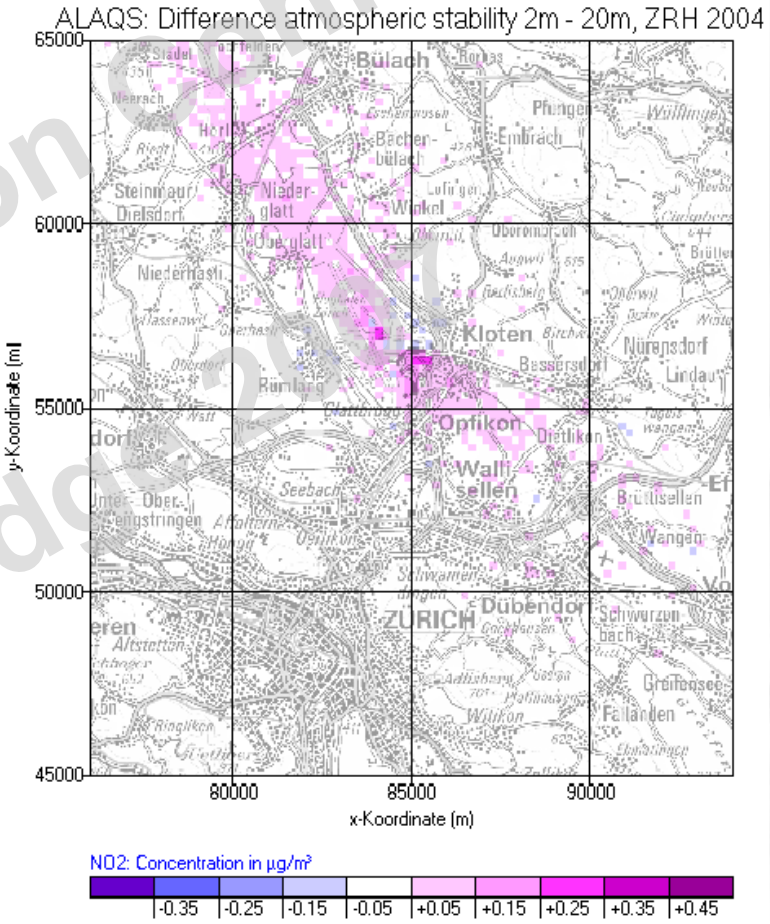
Cut off Height

- difference in NO_2 concentrations between the cut-off altitude of 305m and 914m.
- Impact: marginal increments of maximum +0.75 µg/m3
- limited to locations with already high concentrations values in the centre of the airport.



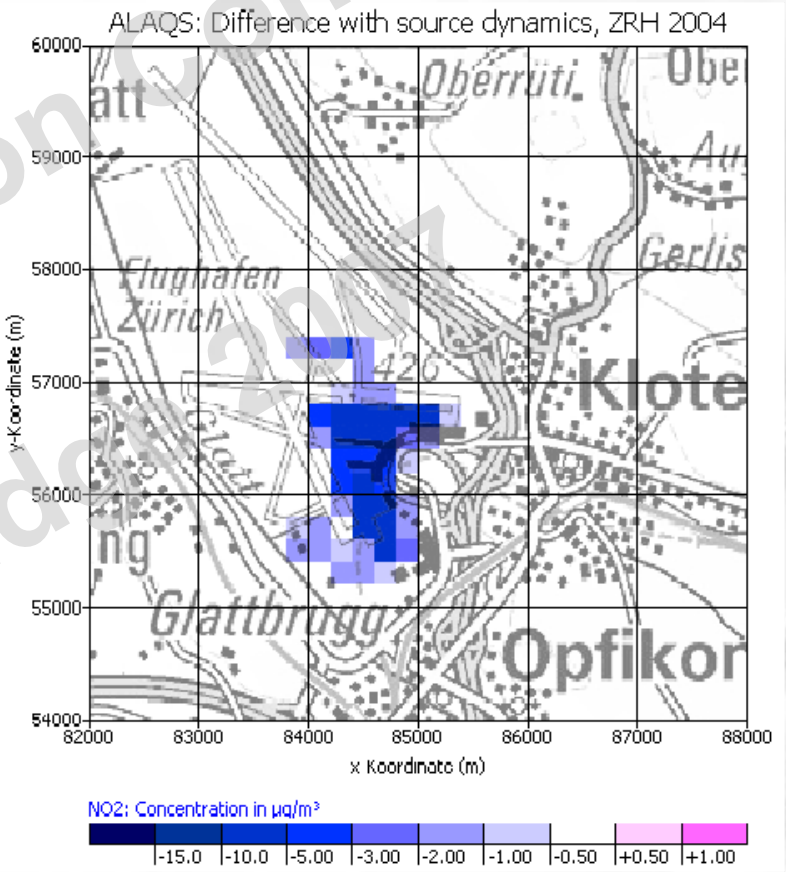
Atmospheric Stability

- Monin-Obukhov-Length changed from default value of 10m to 2m and 20m.
- While the Monin-Obukhov-Length continuously changes with the meteorology, it has been assumed constant in the modelling calculations.
- Impact: less than ±0.3 µg/m3 for the annual mean concentration for 2m and 20m.
- Need to study the impact for shorter time periods.



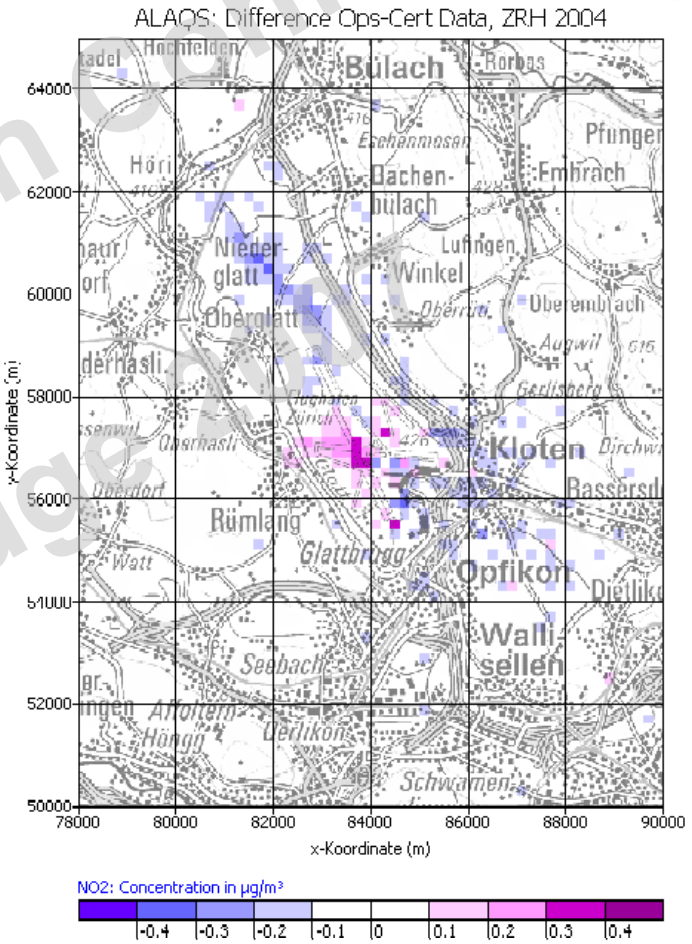
Source Dynamics

- Airside Vehicles vertical source extent increased from 2m to 8m
- APU heat flux included Frankfurt data
- Impact: up to 9.5 µg/m3 lower than with the default values



Aircraft Emissions

- Impact: -3 to -10% NO_2 concentration
- Statistical uncertainty:
  - 1% in the centre of the calculation area
  - about 7% at the edges
- NOx emissions:
  - aircraft = 561t up to 305m.
  - other sources = 215t



Conclusions

- Modelled NO_2 vs Measured
  - Underestimated for road vehicle dominated sites.
  - Overestimated for aircraft dominated sites
- Put sensitivity in context
  - Aircraft sources. Large impact from Time in Mode and Emissions indices
  - Terrain : case by case consideration
  - Source dynamics: more data needed for aircraft – initial plume
  - Chemistry not considered in this study (static 15% NOx/NO_2)

Thank you for your attention

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