Impacts on air quality due to aviation emissions

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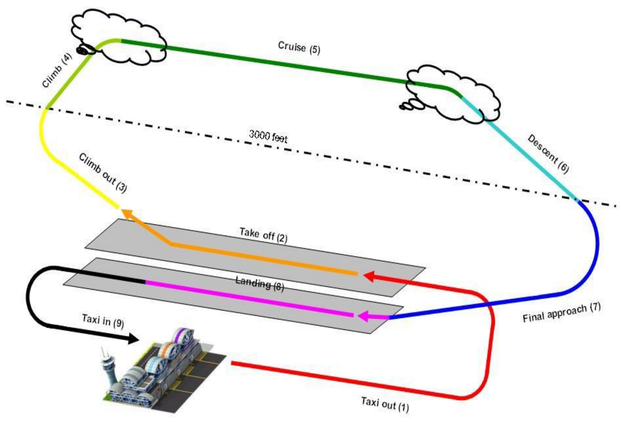
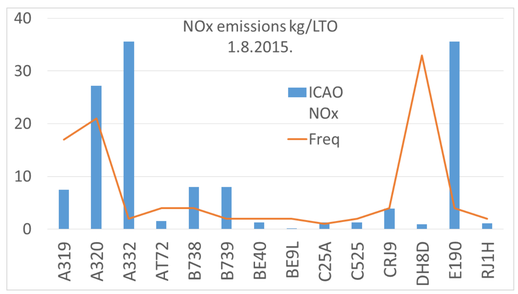
Aviation emissions

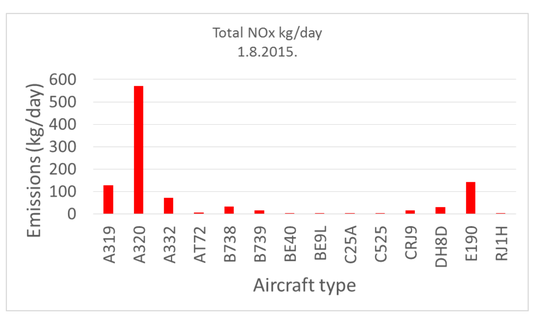
ICAO LTO cycle
Below 3000 ft



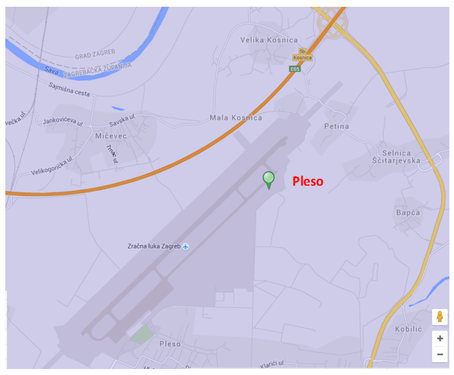
$$E_{pollutant} = AR_{fuel\ consumption} \times EF_{pollutant}$$

In TIER 1 the emission factors have been averaged over all flying phases assuming 10 % of the fuel is used in the LTO.
The emissions produced by aviation come from the use of jet fuel (jet kerosene and jet gasoline) and aviation gasoline (small piston engine aircraft only) the principal pollutants (common to other combustion activities)
CO_2, CO, HC and NO, SO_2 (dependent of the level of sulphur in the fuel.). Other important species, emitted at relatively low concentrations include PM , N_2O and CH_4.

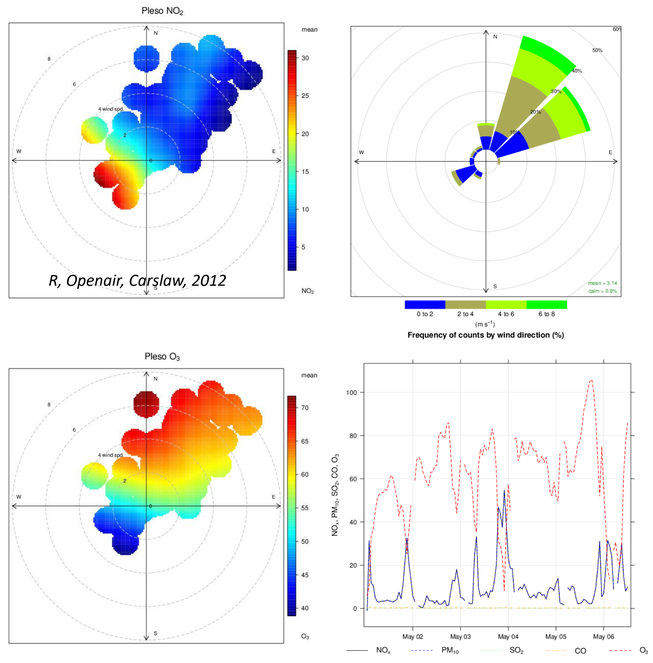




Air quality measurements



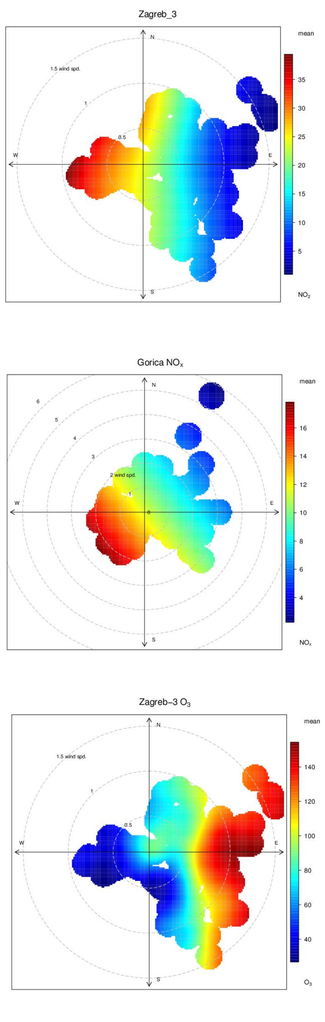
Zagreb Airport (Pleso) is situated at approximately 10 km south of the centre of Zagreb situated in the territory of the City of Velika Gorica and Zagreb County.
Air monitoring program is developed for for carbon monoxide (CO), ground level ozone (O_3), nitrogen dioxide (NO_2)



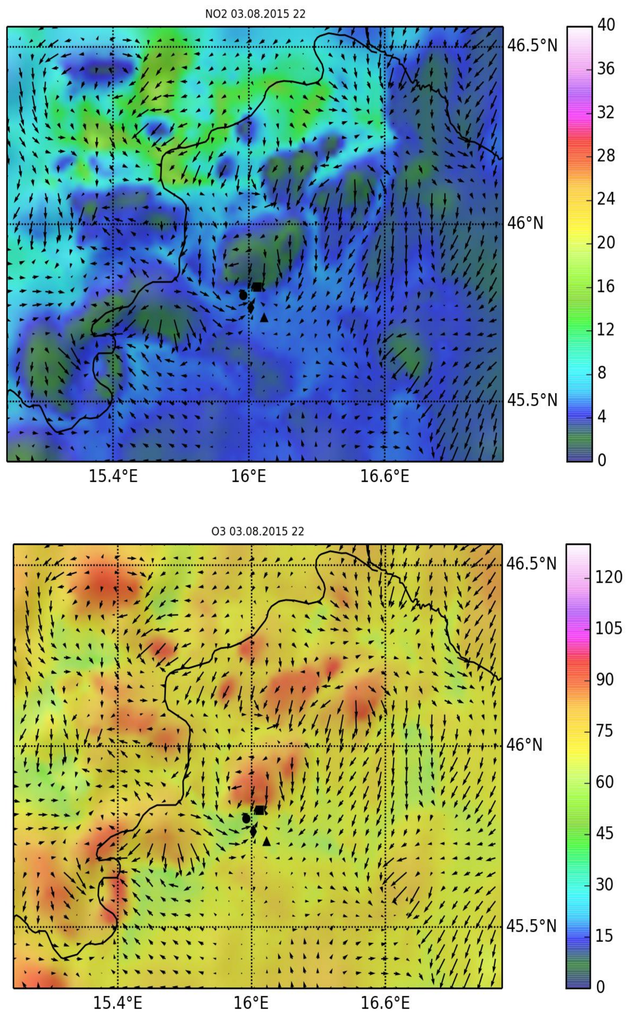
At Figures bivariate polar plots for NO_2 and O_3 (left) are shown for May, 2016. The highest hourly NO_2 concentrations are observed from SW for winds between 2-4 m/s (from runway). The highest ozone concentrations are transported from N and NE directions with higher wind speeds. Frequency of counts by wind direction (top right) indicates the most frequent winds from NE.

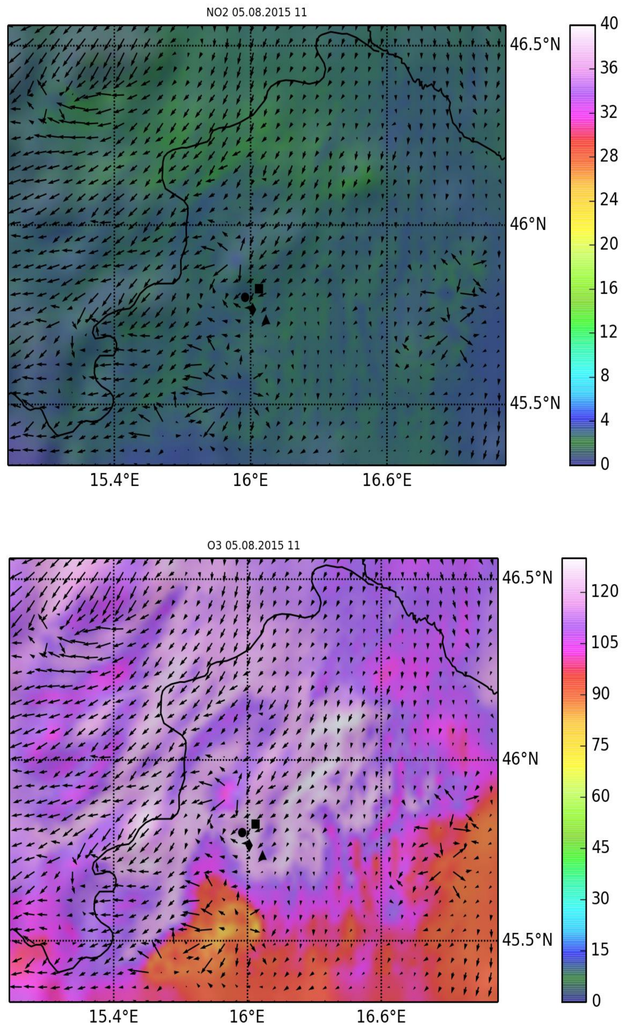
Model simulations with WRF-Chem and CAMx

Measurements



WRF-Chem

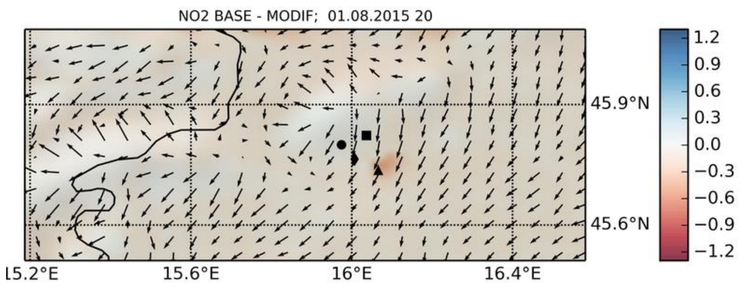




Simulations with WRF-Chem are conducted for August 2015 and surface NO_2 (top) and O_3 (bottom) concentrations are provided.
During nighttime NO_2 (top left) concentrations are transported from E and SE to measuring locations.
During the day NO_2 (top left) concentrations are transported from NE.

Measurements (bivariate polar plots) show that the highest concentrations ~ 35 $\mu g/m^3$ are transported from the W while minimum concentrations ~ 5 $\mu g/m^3$ are transported from E directions.
High ozone concentrations are transported from E and NE while minimum concentrations are from W.
WRF-Chem model simulates very well the wind direction but underestimates the measurements of NO_2 and O_3.

CAMx



Aviation emissions estimated for LTO cycles were incorporated in the CAMx and differences in the simulation of surface NO_2 concentrations are shown (above).

Conclusions

- Bivariate polar plots of NO_2 measurements show high airport contributions.
- WRF-Chem simulates well the transport of NO_2 and O_3 concentrations, but underestimates the magnitude of concentrations.
- Contribution to NOx concentrations from aviation is ~ 30 % according to CAMx.