Executive Summary

Airport Air Quality Workshop

Results of a Workshop

held at the Amsterdam Airport Schiphol, The Netherlands, on 5 - 6 April 2005

AERONET

It is definitely stated that the air quality issues at airports are relevant to the Environmental Council directives (most of the published Daughter directives) aiming at developing overall strategies for air quality control and mitigation. Air quality standards air settled up for a range of air pollutants through successive Daughter Directives (CD-1996, 1st DCD-1999, 2nd DCD-2000, 3rd DCD-2002, 4th DCD currently). The EC directives contains appropriate methodology to assess the air quality non attainment (or exceedance) and strategies for implementation of target values, drivers are mainly public health and ecosystems and vegetation protection.

Primary exhaust emissions at airports and secondary pollutants belong to the family of regulated gas and particulate pollutants classified as hazardous air toxics as having harmful effects on human health and considered as precursors of the important secondary pollutants such as ozone.
Limit values are applied to the concentration of pollutants observed or predicted in the air. For most of the pollutants, annual, daily, 8-hourly and hourly averaged values are considered. As a stringent example for airport air pollution, NO2 annual mean threshold will be regulated in 2010 to 40 µg m-3, benzene at 5 µg m-3 and PM 10 to 40 µg m-3. On the other hand, the NO2 hourly limit value is 200 µg m-3 not to be exceeded 18 times a year. For PM10, the daily limit value is 50 µg m-3 not to be exceeded 35 times a year. For ozone, the 8-hourly averaged for health protection is defined to be 120 µg m-3 whereas 180 µg m-3 is set up for public information and 240 µg m-3 for population alert. These different thresholds require adequate methodologies for implementation and for assessment as well as for monitoring than for modeling.

Mitigation measures applied on emissions have to consider the relationship between emissions levels and characteristics of different origins at airports and the pollutant concentration being regulated, which is very complex and non linear requiring:

- Clear and well defined drivers for airport air pollution: EC directives, ICAO recommendations, national regulations.

- Awareness of trade-offs between, for example, air quality and noise on local level, and air quality and climate change on global level - a complete and realistic description of information on airports operations, engine power settings, auxiliary power units specification, time-in mode, data from ground access vehicles and ground support equipment, local power plants, regional emissions, to complete and make the airport emission calculation the as precise as possible.

- A non-theoretical and high level of confidence of emission model for operational engines for emission species at landing and take off conditions and along taxiways.

- A full and detailed emission databases (time-dependent, spatial variations) appropriate to air pollution studies and modeling at local and regional scales.

- A category of numerical models appropriate to regulatory application, taking into account the most pertinent atmospheric processes representing the current state of scientific knowledge relevant to different air pollution scales and adapted to airport and vicinities.

- Consistent measurements strategies and adequate instrumentation for monitoring, air pollution control and observations to anticipate the potential application of EC directives and support numerical dispersion model validation.

Potential key issues

During the workshop, the following topics and main issues have been discussed, reviewed and identified where future works are required:

1. Airport emissions:

Emission databases at airports for future regulatory purposes (or mitigation option) and input for assessment modeling need to be completed and improved by using the best real world information at airports. The following topics require specific consideration:

- **Air traffic:** Actual information on flight procedures, on time-in mode, on fuel consumption or fuel flow along aircraft trajectories, on engine power settings, on APU's operations
  Requirement: Statistics of actual data

- **Emission factors:** Information on APU's: identification of exhaust emissions, determination of actual emission indices.
  Information on engines: actual emission indices and ageing issues, emission indices on speciated VOC (including carbonyls, e.g. formaldehyde, acetaldehyde) emission indices including relationship to odors, size distribution and mass of PM 1 and/or PM 2.5, ignition emission. Additional information on tire wear and brake wear emission of particles; on helicopter engines and piston engines for some airports.
  Requirements: APU specification

- **Ground support equipment and ground power units:** list of equipment (e.g. per haul if not per aircraft), information on emission factor per equipment and/or emission indices, fossil-fuel, list of activities
  Requirement: Improvement of databases.

- **Airside transportation:** all information related to ground access vehicles and vehicles for airport logistics and passenger transportation: flow rates, category of vehicles, fuel and power, emission indices of vehicles, flow rates, time-dependent line emission data.
  Requirement: Database improvement

2. Numerical tools or dispersion modelling

It has been stated that relevant to the ECD on air pollution, for airport application and assessment modeling, at least 2 approaches have to be considered: the microscale including plume, micro turbulent scales (i.e. impact of building on dispersion or accumulation); and the local-regional scales where pollutants are oxidized and mixed from the sources emissions to the ambient atmosphere, including the atmospheric boundary layer depth (i.e. up to 3 km) and airport vicinities (residential areas). Main issues requiring future works have been identified within these categories of models as follows:

- **Microscale dispersion models:** gaussian and lagrangian: Input parameters: atmospheric stability criteria, turbulence and mixing coefficients, type of vegetation, wind, Requirements: harmonization of parameters Chemistry including VOC's, particulate matter microphysics, aircraft plume physics, chemistry and mixing

- **Local-regional dispersion models:**

  Include Computational Fluid Dynamics applied to air pollution: dispersion of pollutants and Eulerian chemical dispersion models (multi-scales)

  - Plume mixing and chemistry of moving/flying aircraft

  - Impact of buildings and infrastructure on aerodynamics, dispersion or accumulation of pollutants

  - Non-linear photo-chemistry of VOC's coupled to aircraft exhaust species and NOx oxidation, ozone formation potential.

  - Physical-chemical transformation of particles to atmospheric aerosols including impact of heavy VOC's released by aircraft or other source emissions at airports

  - Turbulent mixing of pollutants within the atmospheric boundary layer, impact of mixing layer depth on pollutant concentration and emissions - Local and regional dispersion (atmospheric diffusion, long distance transport) of air pollutants including regional importation (exportation) of emissions and secondary pollutants

  - All other loss processes for pollutants (dry deposition, wet deposition, chemical-physical reaction on aerosol surface (e.g. O3 or NO).

3. Measurements and monitoring

An overview about airport monitoring activities was presented. It was stated that some European airports are not operating airport air quality monitoring. Both continuous monitoring and specific sophisticated measurement campaigns are still very useful as well as for air pollution regulation than for model validation. Furthermore, the following topics require additional consideration:

- **Gas phase measurements and monitoring:**

    - Insights: Some VOC's have been measured as much more important at airports than in some mega-cities: e.g. toluene, 1-3 butadiene, aldehydes (HCHO, CH3CHO, C2H5CHO)

    - NO and NO2 partition far from emissions, NOx actual emission indices and impact of "old engines"

    - VOC speciation, lighter for health issues (air toxics) and ozone formation, heavier for airborne particulate matters formation. Appropriate new measurement techniques required especially for heavier VOC

    - Emission measurements for ignition and APU's (at gates)

- **PM measurements and monitoring**

    - Insights: Airborne particulate matters at airports are ultra-fine in size, clear correlation between NOx and particle number are observed at any engine power settings. Total mass seems lower than in mega-cities.

    - Appropriate instrumentation to monitor PM2.5 mass (and PM1) which will be regulated is required

    - Systematic measurements of size distribution, composition and concentration during specific campaign are required.

    - Measurements of heavy VOC from aircraft for aerosol formation at airports

Future actions

1) Modelling assessment coupled to interpretation of measurements for a specific airport: A case study using existing models and improved emission database. Zurich airport could be the first choice followed by AdP or Heathrow.

2) Proposal for the 3rd call (6th framework) for specific co-ordinated scientific actions coupled to air transportation operations covering most of the topics and uncertainties identified during the workshop.

Edited by Richard Ramaroson, ONERA, France