**Supplementary material S1. Glossary.**

**Allergenic power:** for the same quantity of ambient pollen, the intensity (power) of the allergic reaction could vary depending on several environmental factors (see Buters et al., 2010; 2012).

**Asthma symptoms**: tightness in the chest, difficulty to breathe, wheezing and coughing. Asthma is often triggered or exacerbated by aeroallergens and/or pollution. There is no cure for asthma but it can be controlled through appropriate medication and avoidance using forecast based on weather predictions. Avoidance of allergens and pollution is recommended to reduce symptoms.

**Background values**: in this study here, unless otherwise stated, it refers to upwind measurements of industrial plumes or in the urban background (i.e. measured by NAPS network in residential areas).

**Biological pollution**: generic term including invading species into aquatic and terrestrial ecosystems. The concept is extended here to take into account airborne allergenic pollen, spores and other bioaerosols transported from source regions and affecting urban polluted environment giving rise to a synergy between pollen and pollution (Légifrance, 2010).

**CAPMoN**: Canadian Air and Precipitation Monitoring Network is managed by the federal government of Canada. It provides information on regional patterns and trends of atmospheric pollutants in both rural and remote sites.

**Emission factor:** amount of pollutant emitted per unit of fuel burned.

**Environmental justice:** the obligation of non-discrimination in environmental protection, relates to addressing the unequal burden of exposure of certain groups of the population to environmental impacts. For example, some communities are more exposed to pollution (e.g. the poor and aboriginal communities) or more vulnerable (pregnant woman, older citizens or children) (Government of Canada, 2018).

**Euro-6 standard:** this European standard limits particulate number to 6E11 solid particles per test-cycle km for compression ignition (diesel) vehicles and direct injection gasoline vehicles (EC Directive, 2008).

**Eutrophication:** this phenomenon occurs whenever a body of water becomes overly enriched with nutrients and minerals that induces excessive nitrogen and growth of algae as well as oxygen depletion of the water. Fertilizers from agriculture is one of the cause along with phosphate or sewage water discharges (Calisto et al., 2014).

**GEM-MACH**: Environment and Climate Change Canada **M**odel of **A**ir quality and **Ch**emistry. GEM (Global Environmental Multiscale model) provides the meteorological driver. More details are given in Moran et al. (2012).

**MIR** (Maximum Incremental Reactivity): a useful definition of reactivity is that of incremental reactivity defined as the amount of ozone formed per unit of VOC (Carter and Atkinson, 1987), that is MIR= max(Δ[O3]/Δ[VOC]). In general, the faster a VOC reacts in the atmosphere, the higher the incremental reactivity (Seinfeld and Pandis, 2006). For more information, see [www.oal.ca.gov/CCR.htm](http://www.oal.ca.gov/CCR.htm).

**Nanometal:** metal deposited on nanoparticles (size < 100 nm).

**NAPS**: Canada’s National Air Pollution Surveillance program. It is a joint federal/provincial/territorial initiative established in 1969. Since then it has grown in scope tracking sulfur dioxide and particulate matter initially and now up to 340 compounds (website <https://www.canada.ca/en/environment-climate-change/services/air-pollution/monitoring-networks-data/national-air-pollution-program.html>).

**NPRI**: National Pollutant Release Inventory Reporting plays an important role in knowledge of toxics and pollutants. It is at the center of the Government’s efforts to track toxic substances and other substances of concern.

**Ozone-climate penalty**: increase of ozone due to increasing temperature caused by the climate change. It is mathematically defined as the slope of ozone change with increasing temperature (Jing et al. 2017).

**Precautionary principle:** The principle is used by policymakers to justify discretionary decisions in situations where there is the possibility of harm from making a certain decision (e.g. taking a particular course of action) when extensive scientific knowledge on the matter is lacking. The principle implies that there is an obligation to protect the public from exposure to harm, when scientific investigation has found a plausible risk. In accordance with this principle, the “worst case scenario” must be assessed regarding exposure to population. This principle is part of the Canadian Environmental Protection Act (see

https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/canadian-environmental-protection-act-1999.html).

**Prevalence**: percentage of the population affected by the disease.

**Reprotoxic:** having a toxic effect on the process of reproduction.

**Rotterdam Convention**: Multilateral convention concerning shared responsibilities for the importation of hazardous chemicals. In 2012, the Secretariats of the Basel and Stockholm conventions, as well as the UNEP-part of the Rotterdam Convention Secretariat, merged to a single Secretariat with a matrix structure serving the three conventions (see more information on www.brsmeas.org.).

**Sensitization**: first step in the allergy development. Sensitization is the primary contact with the allergen which induces a memory of the allergen by the immune system (although not causing allergic symptoms at this point). Later, the patient may develop allergic symptoms after the sensitization process is completed (Jelks, 1987).

**Stockholm Convention:** The convention entered into force on 17 May 2004 with ratification by an initial 128 parties and 151 signatories. Co-signatories agree to outlaw nine of the dirty dozen chemicals, limit the use of DDT to malaria control, and curtail inadvertent production of dioxins and furans. <http://chm.pops.int/TheConvention/ThePOPs/ListingofPOPs/tabid/2509>.

**Teratogenic**: substances causing developmental malformations.

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**Supplementary material S2.** List of WHO candidates for new/upgraded guidelines and considered in the algorithm of Figure 1 (substances already regulated through CAAQS and indicated in the table and consequently not part of emerging substances)

|  |  |  |
| --- | --- | --- |
| **CAS number** | **Compound** | **Comment** |
| - | Particles (PM2.5 and PM10) | Already part of CAAQS |
| 10028-15-6 | Ozone | Already part of CAAQS |
| 10102-44-0 | Nitrogen dioxide | Already part of CAAQS |
| 7446-09-5 | Sulfur dioxide | Already part of CAAQS |
| 630-08-0 | Carbon monoxide | Already part of CAAQS |
| 7440-43-9 | Cadmium | Emerging in Canada |
| 7440-47-3 | Chrome | Emerging in Canada |
| 7439-06-4 | Lead | Strict regulation in regular gasoline but not in aviation gasoline |
| 71-43-2 | Benzene | Excluded here since benzene is part of the Benzene Convention |
| - | Dioxins and Furans, PAH, PCB | Idem (Stockholm Convention) |
| 7439-97-6 | Mercury | Idem (Minamata Convention) |
| - | Asbestos | Production banned in Canada |
| 7440-38-2 | Arsenic | Emerging in Canada |
| 7439-96-5 | Manganese | Idem |
| 7440-06-4 | Platine | Idem |
| 7440-62-2 | Vanadium | Idem |
| 106-99-0 | Butadiene | Idem |
| 79-01-6 | Trichloroethylene | Idem |
| 107-13-1 | Acrylonitrile | Idem |
| 7783-06-4 | Hydrogen sulfur | Idem |
| 75-01-4 | Vinyl chloride | Idem |
| 108-88-3 | Toluene | Idem |
| 7440-02-0 | Nickel | Idem |
| 50-00 | Formaldehyde | Idem |
| 100-42-5 | Styrene | Idem |
| 127-18-4 | Tetracholorethylene | Idem |
| 75-15-0 | Carbon bisulfate | Idem |
| 16984-48-8 | Fluoride | Idem |
| 107-06-2 | 1,2-dichloroethane | Idem |
| 75-09-2 | Dichloromethane | Idem |

**Source**: WHO (2016) and ANSES (2018)

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**Supplementary material S3. Characteristics of selected emerging pollutants.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Emerging pollutant** | **Family** |  |  | **Lifetime** | **Air quality guideline**  **(µg/m3)** | **Anthropic source** | **Reference** |
| Acrolein | Aldehydes |  |  | 15-20 hourse | 0.4 (24HR) | Wood products, pulp and paper industry, pesticides, combustion, secondary formation from VOCs, fiber manufacture, traffic. | Galarneau et al. (2016) |
| Acrylonitrile | Amines |  |  | 5.6 daysf | 0.12 (A) | Textile industries, plastic, resins and rubber fabrication. | Galarneau et al. (2016) |
| 1,3-Butadiene | Alkanes |  |  | 4.2 hours (S)a  83 days (W)c | 0.06 (A) | Rubber, resins, plastic fabrication and burning, engine combustion, cigarette smoking, petroleum industry. | ANSES(2018) |
| Chloroform | Halocarbons |  |  | 6 monthsb | 1 (24HR)  0.2 (A) | Pulp and paper industry, solvent, chemical intermediate. | Galarneau et al. (2016) |
| Dichloromethane | Halocarbons |  |  | 3-5 monthsd | 25 ppm (8HR) | Solvent, industrial emissions. | Gribble (2009) |
| Ethylene oxide | Alcynes |  |  | 200 daysb | 0.0005 (A) | Sterilization agent, manufacture of surfactants, production of ethylene glycol. | Seinfeld and Pandis (1998),  Galarneau et al. (2016) |
| Formaldehyde | Aldehydes |  |  | 4-9 hoursb | 1.0 | Combustion, industrial processes, photochemical oxidation of organic compounds, tobacco smoking, also produced by secondary formation. | IARC(2015)  ANSES(2018) |
| Naphthalene | PAH |  |  | < 1 dayh | 1.8 | Jet combustion, plastic and resin fabrication, woodburning, traffic, surfactants, pesticides. | US/EPA (2011),  ANSES (2018) |
| Tetrachloroethylene | Halocarbons |  |  | 2-3 monthsa | 2 (A) | Plastic, chemical intermediate, solvent. | Galarneau et al. (2016) |
| Toluene | Aromatics |  |  | 2.1 daysa | 2000 | Fossil fuels combustion, solvent. | Galarneau et al. (2016) |
| Trichloroethylene | Halocarbons |  |  | 5 daysd | 0.4 (A) | Plastic and aerospace industries, solvent. | Galarneau et al. (2016) |
| Arsenic | Metals |  |  | Unknown | 0.003(A)g | Fuel and coal combustion, pesticides, smelting furnace, steel and iron industries. | Dai et al. (2015) |
| Cadmium | Metals |  |  | 7 daysb | 0.0036 (A) | Secondary smelters, fuel combustion, steel and iron industries, plastics production, tire wearing. | Dai et al. (2015),  Seinfeld and Pandis (1998) |
| Manganese | Metals |  |  | Unknown | 0.3(A)  0.15(A) WHO | Smelters, fossil fuels combustion, steel and iron industries, coal combustion. | ANSES(2018). |
| Nickel | Metals |  |  | Unknown | 0.02 (A)  0.025(A) WHO | Mining and metal industries, fossil fuel combustion (vehicles, aircraft), dyes, petroleum and coal combustion | Dai et al. (2015),  Rahim et al. (2019) |
| Vanadium | Metals |  |  | Unknown | 1 (A) WHO | Smelters, metal industries, mining, oil combustion | Dai et al. (2015) |
| UFPs | Particles |  |  | Unknown | 6X1011 particles/km | Combustion fossil fuels (including kerosene) | See main text |
| Black carbon/diesel | Particles |  |  | 4-12 days | - | Combustion fossil fuels (including kerosene) | Cape et al. (2012) |
| eNPs | Particles |  |  | variable | - | Produced by the nanotechnology industry |  |
| Bioaerosols | Particles |  |  | sec-days | - | - | Sofiev and Bergmann 2013 |

aAtkinson and Arey (2003), bSeinfeld and Pandis (1998), cWHO(2001), dSimpson et al. (2010), e ATSDR (1997), fWHO, ,g Ministere du Developpment Durable et des Changements Climatiques (P.Q.). hJia and Baterman (2010). Note. The most stringent guideline either in Canadian provinces or from by ANSES (2018) is indicated in the table. A: annual.

**Supplementary material S4.** Selected measurement of arsenic in the province of Québec (Canada): 2014-2018.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | Site | Observed annual mean (µg/m3) | Annual standard (P.Q.)  (µg/m3) | Ratio of exceedance  (measured/standard) |
| 2014 | Lac-Mégantic | 0.0065 | 0.003 | 2.17 |
| 2015 | Lac-Mégantic | 0.0104 | 0.003 | 3.47 |
| 2016 | Lac-Mégantic | 0.0065 | 0.003 | 2.17 |
| 2017 | Lac-Mégantic | 0.0051 | 0.003 | 1.70 |
| 2018 | Rouyn-Noranda | 0.0980 | 0.003 | 32.7 |

**Source.** Ministère du Développement Durable, de l’Environnement et de la Lutte contre les Changements Climatiques (MDDELCC), Government of province of Québec (P.Q), Canada.

http://www.environment.gouv.qc.ca/air/rouyn-noranda/arsenic.pdf

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