clsa élcv
Canadian Longitudinal Study on Aging
Étude longitudinale canadienne sur le vieillissement

# Data Support Materials
# Air Pollution and Meteorological Exposure Measurements

## 1. Background

The CLSA has partnered with Health Canada, Environment Canada and other researchers to link the CLSA dataset to nationwide air pollution and meteorological data.

The goal of linking air pollution and meteorological exposure measurements to the CLSA dataset is to be able to provide researchers an enriched dataset.

## 2. Implementation

### i. What data are collected?

Overall, data include satellite remote sensing of air pollution, estimates from the land-use regression (LUR) model, observations from fixed-site, ground-based monitoring from the National Air Pollution Surveillance (NAPS) program[1], measured proximity to roadways, and meteorological data. Exposure variables of interest are nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), fine particulate matter ($PM_{2.5}$), ozone ($O_3$), and distance from roadways (local and major) to the residential postal code.

### ii. How are the data prepared?

Data are assigned to each participant based on their six-digit postal code and interview date. This is done through a process 'linking' the CLSA individual level data to the various air pollution and meteorological exposure measurements. In order to protect the confidentiality of the CLSA participants, a list of 'dummy' Unique Identifiers (UIDs), corresponding to about 5% of the sample, were generated and attached to a list of randomly selected postal codes from the Postal Code Conversion File (PCCF) with random interview dates within the range of each province or data collection site. This generated dataset was mixed with real CLSA participant UIDs, associated to their actual postal codes and interview dates. These data were sent to the data custodians of the air pollution data, who extracted air pollution data for all the postal codes and dates and sent them back to the CLSA. These data were then linked to the CLSA dataset by replacing the generated UIDs with the real CLSA participant UIDs. Data associated to non-valid participant UID were removed from the final dataset. The PCCF from Statistics Canada updates each year, thus participants tested within the last year, who have a new postal code, would have missing data for air pollution and meteorological exposure measurements.

## 3. Use by researchers

### i. What data are available for use?

**Nitrogen Dioxide ($NO_2$)**

Estimated exposures to $NO_2$ are available from NAPS observations and from the national land-use regression (LUR) model.

[1] http://www.ec.gc.ca/rnspa-naps/Default.asp?lang=En&n=5C0D33CF-1

The goal of NAPS is to provide accurate and long-term regional air quality data of a uniform standard across Canada. NAPS was established in 1969 to monitor and assess the quality of ambient (outdoor) air in the populated regions of Canada. Unlike satellite data, which cover rural and urban areas, NAPS focuses only on urban areas. The NAPS network has approximately 300 monitoring stations in about 200 communities[1] (Note: not all NAPS stations collect data for all air pollutants). The data provided here are based on the weighted average of NAPS stations within 50 km of a six-digit postal code. The weight is inversely proportional to the distance from the monitoring site to the postal code of interest. It is recognized that NAPS data availability lags 1-2 years behind when it was collected, thus NAPS data have not been released for 2015. Participants with interview dates in 2015 have 2, 3, 4 and 5-year averaged data based on available data points. Participants with interview dates prior to 2015 also have 7 day, 1 month, 6 month and 1 year averaged data available. The NAPS $NO_2$ observations are quantified by chemiluminescence.

Additionally, residential exposures to 2006 annual mean concentrations of $NO_2$ were estimated using the national land-use regression (LUR) model developed with NAPS monitoring data, satellite $NO_2$ estimates, road length within 10 km, area of industrial land use within 2 km, and mean summer rainfall. For details, see Hystad et al. (2011).

### Sulfur Dioxide ($SO_2$)

Estimated exposures to $SO_2$ are available from NAPS observations only. $SO_2$ values are the 24 hr averages measured by NAPS stations[2], available on the Environment and Climate Change Canada website.[3]

### Ozone ($O_3$)

Estimated exposures to $O_3$ are available from NAPS observations and from a model developed by Environment Canada.

NAPS measurements of $O_3$ are carried out using gas analyzers that operate on the UV light absorption principle. All $O_3$ measurements in Canada are ultimately referenced to a National Institute of Standards and Technology (NIST) primary UV calibration device. As of 2008, there were 205 $O_3$ monitoring sites reporting data to the Canada-wide database, including 16 Canadian Air and Precipitation Monitoring Network (CAPMoN) regional-scale $O_3$ sites. Measurements are made year-round.[2]

An $O_3$ surface representing the average of the daily 8-hr maximum concentrations in the warm seasons (May 1–October 31) for the period 2002–2009 was generated across Canada with 21 km horizontal resolution through an optimal interpolation technique adapted to air pollutants (Robichaud & Ménard, 2014). This method combines the hourly modelled $O_3$ surface from Canadian air quality forecast models with observations available.

### Fine Particulate Matter ($PM_{2.5}$)

Estimated exposures to $PM_{2.5}$ are available from NAPS observations and from satellite-derived surfaces.

Estimates of exposures to fine particulate matter ($PM_{2.5}$) are available from NAPS observations.[2] Here, $PM_{2.5}$ is measured using a tapered element oscillating microbalance (TEOM) monitor.

[2] Please see $NO_2$ data above for more details on NAPS.

[3] http://maps-cartes.ec.gc.ca/rnspa-naps/data.aspx

Environment Canada re-evaluated how $PM_{2.5}$ data from TEOM instruments are handled. They have added an adjustment factor to correct for an apparent loss in $PM_{2.5}$ from volatile organic compound (VOC) volatilization during measurements. We are providing both the old and the new data. A short discussion on the topic can be found at:

https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=BA9D8D27-1&offset=4&toc=show

Satellite-derived estimates of exposure are available for two periods, namely median observations for 2001–2010 and median observations for 2008–2012. These estimates of $PM_{2.5}$ were derived from observations from three satellite instruments: (1) MISR (Multi-angle Imaging SpectroRadiometer; https://www-misr.jpl.nasa.gov), (2) MODIS (Moderate Resolution Imaging SpectroRadiometer; https://modis.gsfc.nasa.gov), and (3) SeaWiFS (Sea-viewing Wide Field-of-View Sensor; https://oceancolor.gsfc.nasa.gov/SeaWiFS/) to represent median annual concentrations during the periods noted above for each grid cell (van Donkelaar A et al., 2015). The methods of measuring gaseous and fine particulate air pollution via satellite technology and assigning exposure to study subjects have been previously described (Streets DG et al., 2013, Crouse DL et al., 2012, van Donkelaar A et al., 2010). Aerosol optical depth is measured by spectroradiography (van Donkelaar A et al., 2010, Martin RV, 2008). The spatial resolution is 10 km by 10 km and data are present for both rural and urban areas over the past several years.

**Measured Proximity to Roadways**

This method of estimating exposure to traffic has been previously reported (Gilbert NL et al., 2003, McConnell R et al., 2006). This is a measure of exposure to traffic-related air and noise pollution, in contrast to measures of individual pollutants. Estimates of proximity were made using data from 2008. The location of the participant's home is determined by the six-digit postal code, which can resolve the location to a group of homes on one side of a street (an average of 30) or an apartment building. The total length of roadways within a 200 metre radius around the home (based on postal code) is calculated using Geographic Information System (GIS) software[4] and information from CanMap® Major Roads & Highways, developed by DMTI Spatial.[5] It provides a standardized 'Cartographic Road Classification' of Canadian roadways; expressway, primary highway, secondary highway, major roadways and local roadways.

**Meteorological Data**

Meteorological data were supplied by the National Climate Data and Information Archive.[6] The data are based on the average of weather stations within 100 km to a six-digit postal code. Available climate data include twenty-four hour mean temperature, relative humidity and maximum twenty-four hour changes in barometric pressure. Weather data have not been released for 2015, thus participants with interview dates in 2015 have no weather data.

### ii. What are the conditions of use?

These data are available to approved researchers through a special request within the 'CLSA Data and Biospecimen Request Application'. When completing the 'Part 2: Data Checklist' portion of the application, researchers are asked to make their request in the 'Comments' box provided. Researchers must also explain in their application how these data will be used optimally to support research to benefit all Canadians and are required to follow the CLSA Data and Sample Access Policies and Guiding Principles.

[4] ArcMap 9.0,ESRI, Redlands, California
[5] DMTI Spatial Inc., Markham, Ontario, Canada
[6] http://www.climate.weatheroffice.gc.ca

**Conditions of use:**

**$NO_2$ LUR data**

a. $NO_2$ - Estimated using land use regression model by Hystad P et al., 2011. Reference article if data are used.

**$PM_{2.5}$ Satellite data**

a. $PM_{2.5}$ - Estimated using satellite models by van Donkelaar A et al., 2015. Reference article if data are used.

**$O_3$ Environment Canada modelled data**

a. Cite the following publication: Robichaud A & Ménard R, 2014.
b. Acknowledge the Air Quality Research Division (AQRD) of Environment Canada for providing the $O_3$ exposure data.
c. While not mandatory, we encourage potential users of the $O_3$ data to contact Jeff Brook, Alain Robichaud or Richard Ménard from the AQRD to obtain a better understanding of the $O_3$ data and for possible collaboration.

**References**

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