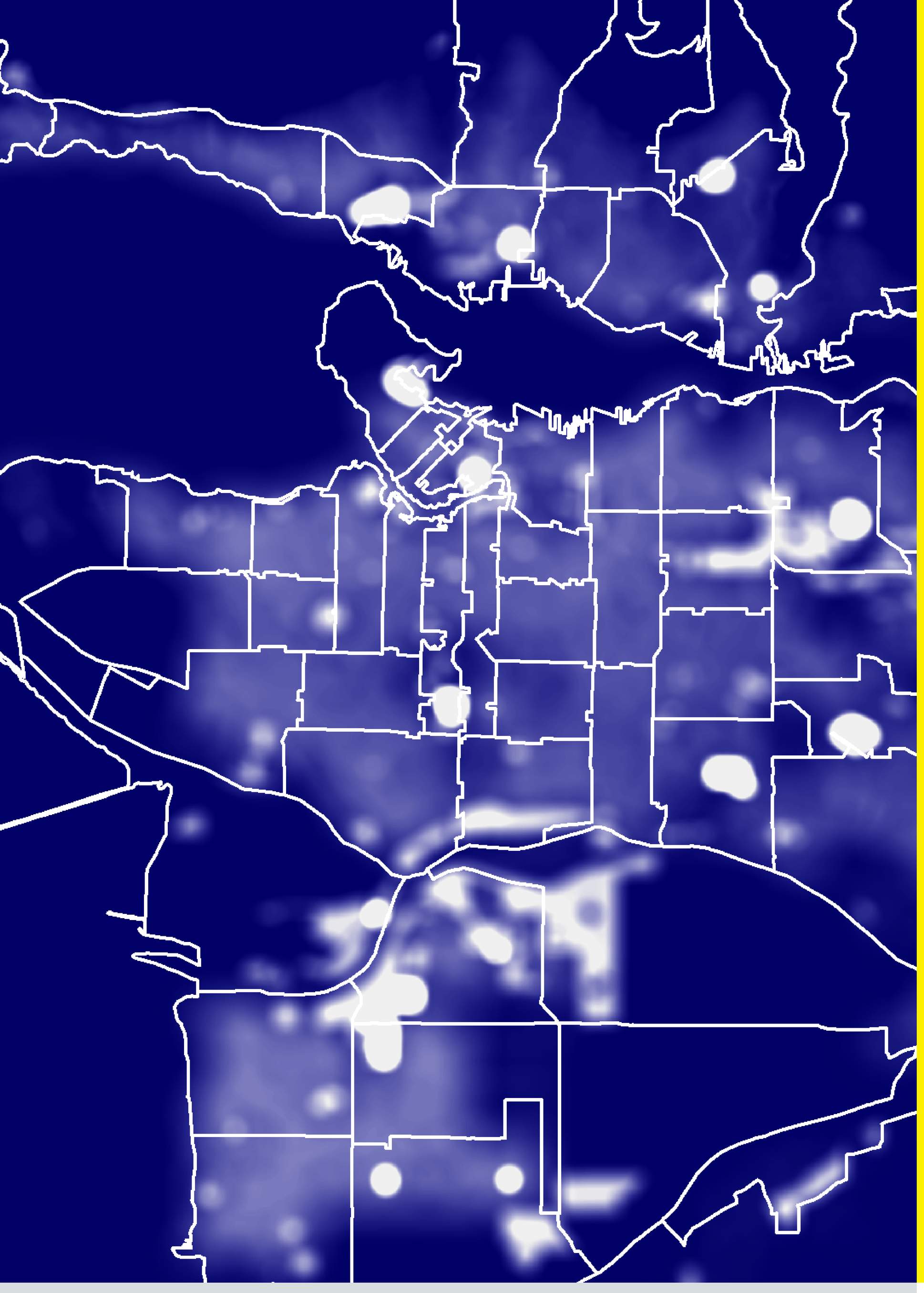

Developing Spatiotemporal Air Pollution Models

Minimizing Exposure Misclassification for an Air Pollution and Autism Retrospective Cohort Study in Metro Vancouver

Lief Pagalan[1], BSc • Meghan Winters[1], PhD • Bruce Lanphear[1, 2], MD • Michael Brauer[3], ScD
Gillian Hanley[2, 4], PhD • Tim F. Oberlander[2, 5], MD

1. Faculty of Health Sciences, Simon Fraser University
2. BC Children's Hospital Research Institute
3. School of Population and Public Health, University of British Columbia
4. Department of Obstetrics and Gynaecology, University of British Columbia
5. Department of Pediatrics, University of British Columbia

INTRODUCTION

The aims of this study are to develop and evaluate spatiotemporal estimates of particulate ($PM_{2.5}$) and gaseous (NO, NO_2) air pollutants and to apply these to investigate potential associations between prenatal exposure to air pollution and the development of autism spectrum disorder (ASD).

These estimates will combine land use regression models, which provide high spatial resolution of long-term average trends of airborne pollutants, with continuous air pollution monitoring data to temporally adjust these long-term average exposure models. This will result in air pollution estimates with a 10 m² spatial resolution and month-to-month temporal resolution.

These estimates will be applied at a 6-digit postal code and monthly resolutions for our retrospective cohort, composed of all children born in Metro Vancouver between 2004–2014, including all cases of ASD identified through the BC Autism Assessment Network.

We will develop two variations of spatiotemporal exposure estimates: one with a global temporal factor that will apply a uniform temporal trend across Metro Vancouver, and a second set of estimates with spatially heterogeneous temporal factors, derived by kriging air monitoring data, to reflect spatially heterogeneous temporal variation.

We will use these estimates to calculate exposure for every mother for each month, trimester, and the entire duration of pregnancy. We will then test the associations between prenatal air pollutant exposure with developing ASD, adjusting for various maternal (e.g. age, parity, folate supplement status, smoking, etc.), perinatal (e.g. sex, birth weight, etc.), and sociodemographic (e.g. education, income, etc.) factors.

OBJECTIVES

1. Develop spatiotemporal modelling methodologies
2. Characterize temporal and spatial air pollution trends
3. Link cohort and air pollution models through geocoding to develop exposure assessment estimates

CONCLUSION

Developing temporally-adjusted land use regression models of $PM_{2.5}$, NO, and NO_2 will reduce exposure misclassification and provide exposure estimates for assessing relevant prenatal windows of exposure that may increase the susceptibility of developing ASD. Additional error can be reduced by creating models that account for spatially heterogeneous temporal variation, particularly for NO, which exhibits the most heterogeneity in temporal variation across Metro Vancouver. Further work is required to evaluate both temporally adjusted models—one spatially homogeneous and the other spatially heterogeneous—to quantify model error and performance. Once air pollution estimates are refined, the next step will be to examine the developmental impacts of $PM_{2.5}$, NO, and NO_2 during prenatal development.

CONTACT

Lief Pagalan: lpagalan@sfu.ca

Blusson Hall, Rm 11522, Faculty of Health Sciences
Simon Fraser University, 8888 University Drive
Burnaby, BC, Canada V5A 1S6

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METHODS

Figure 1. Developing Spatiotemporal Exposure Estimates Using Temporally Adjusted Land Use Regression Models

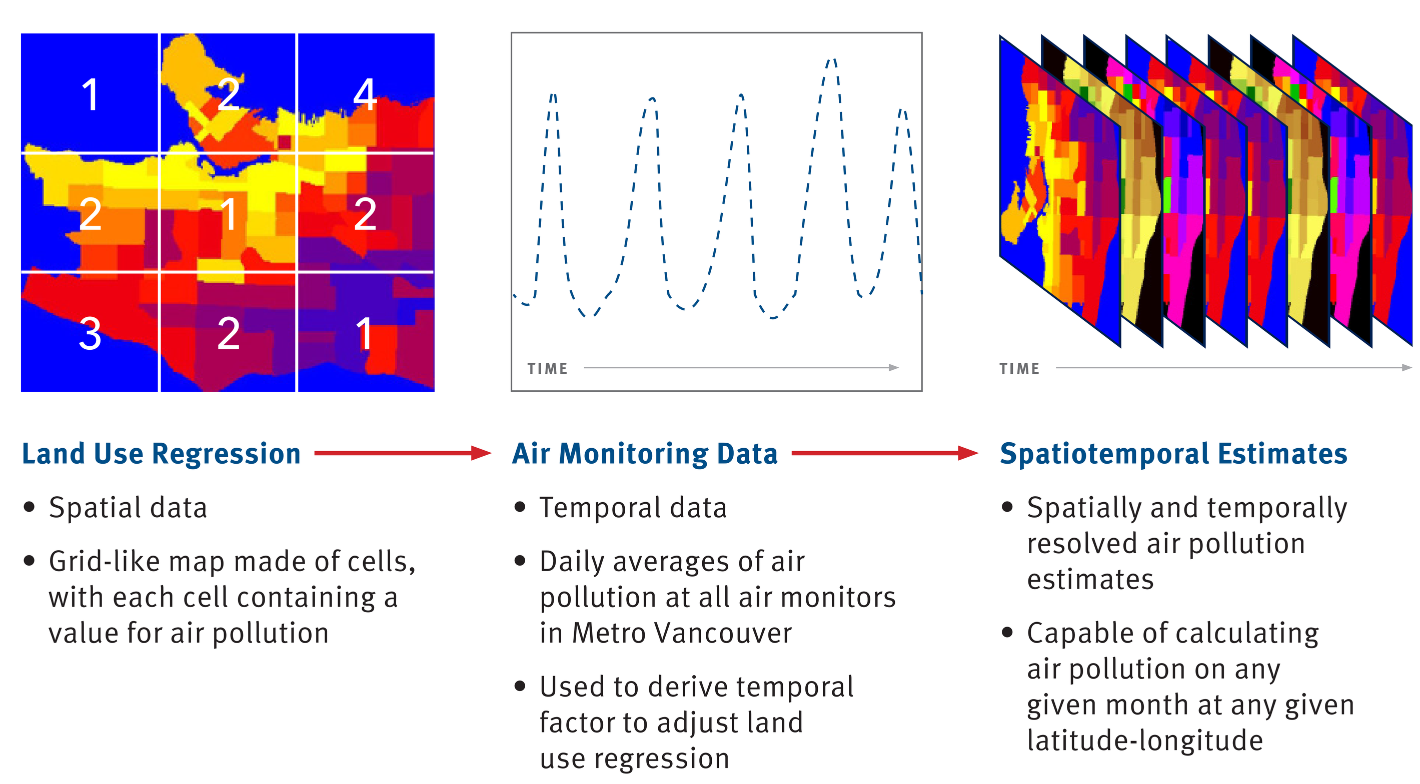


Figure 2. Temporally Adjusting Land Use Regression Models

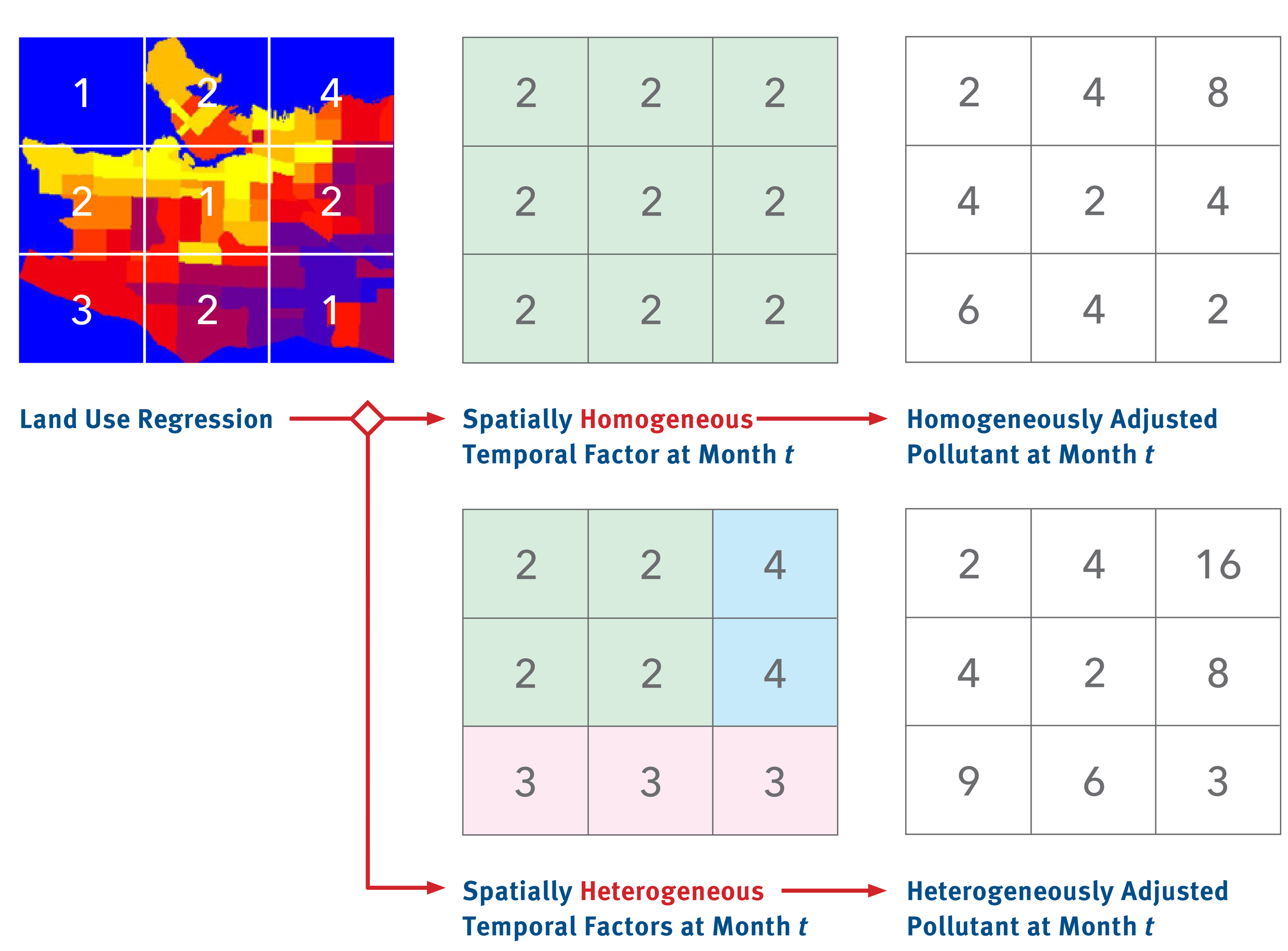
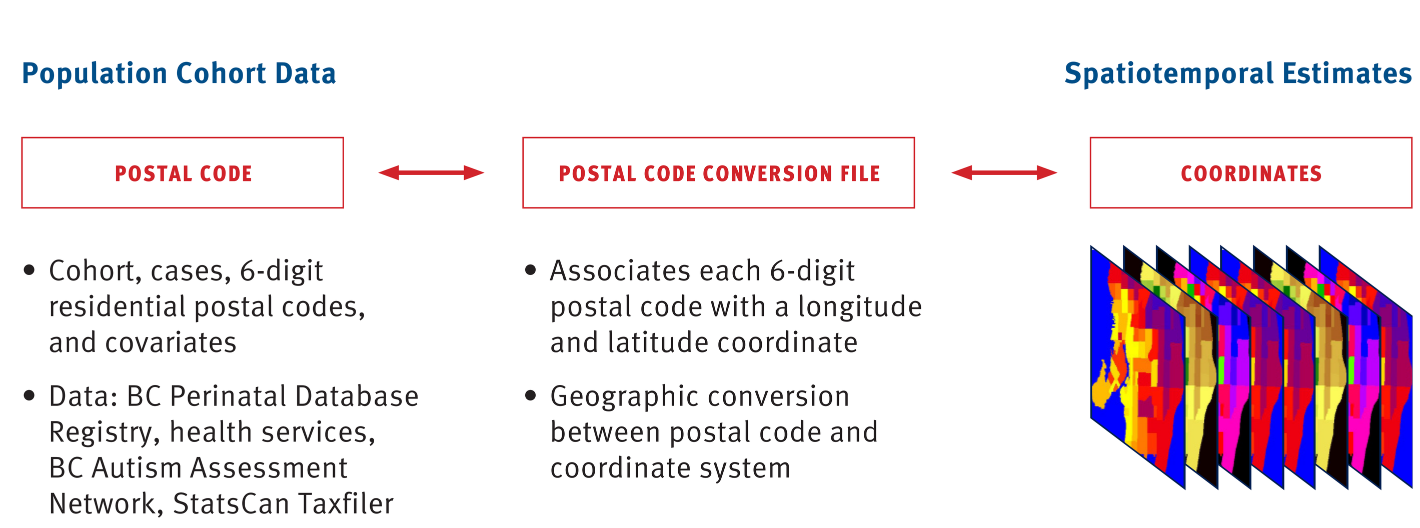


Figure 3. Deriving Temporal Factors

$$\textit{Adjusted Pollutant} = \textit{Pollutant}_{LUR} \bullet \textit{Temporal Factor}_t$$

$$\textit{Temporal Factor}_t = \frac{\textit{Avg. Pollutant Across All Monitors at Month } t}{\textit{Avg. Pollutant Across All Monitors for LUR Year}}$$

Figure 4. Linking Cohort Data and Air Pollution Estimates Through Geocoding to Derive Exposure Estimates



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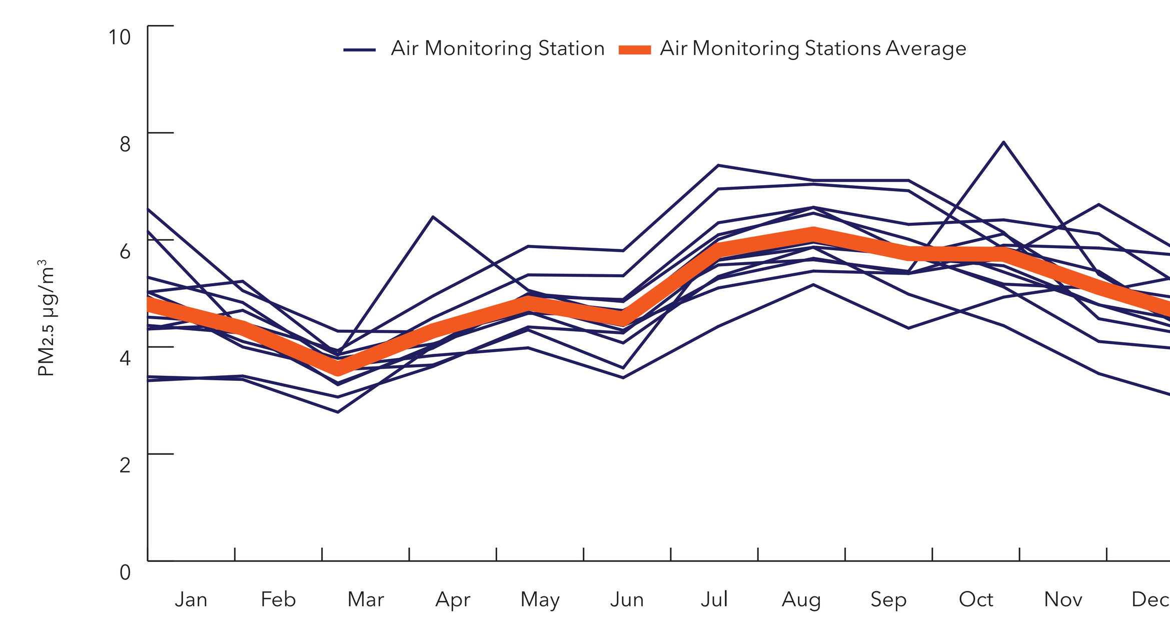
PRELIMINARY ANALYSIS

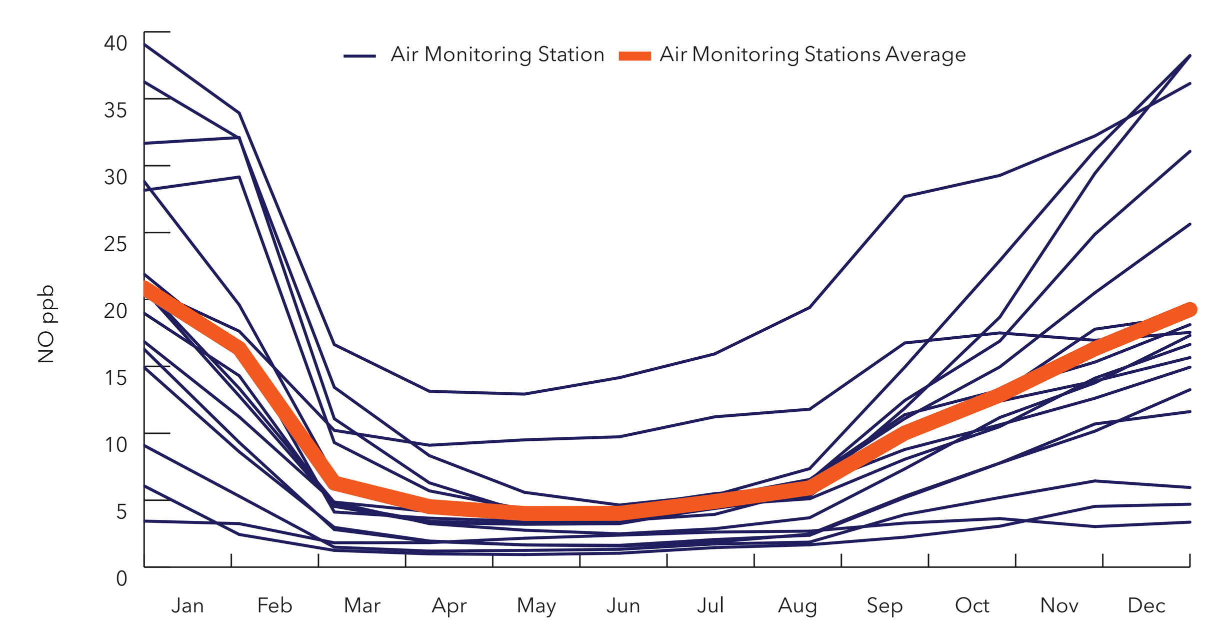
$PM_{2.5}$ decreased from an annual average of 5.5 to 4.0 μg/m³ from 2004–12, but appears to increase to 6.0 μg/m³ in 2013–14. $PM_{2.5}$ exhibits a seasonal trend that peaks in August and dips in March, and spatial homogeneity in average magnitude and seasonal variability.

Figure 5. Average Monthly PM2.5 from 2004–2014



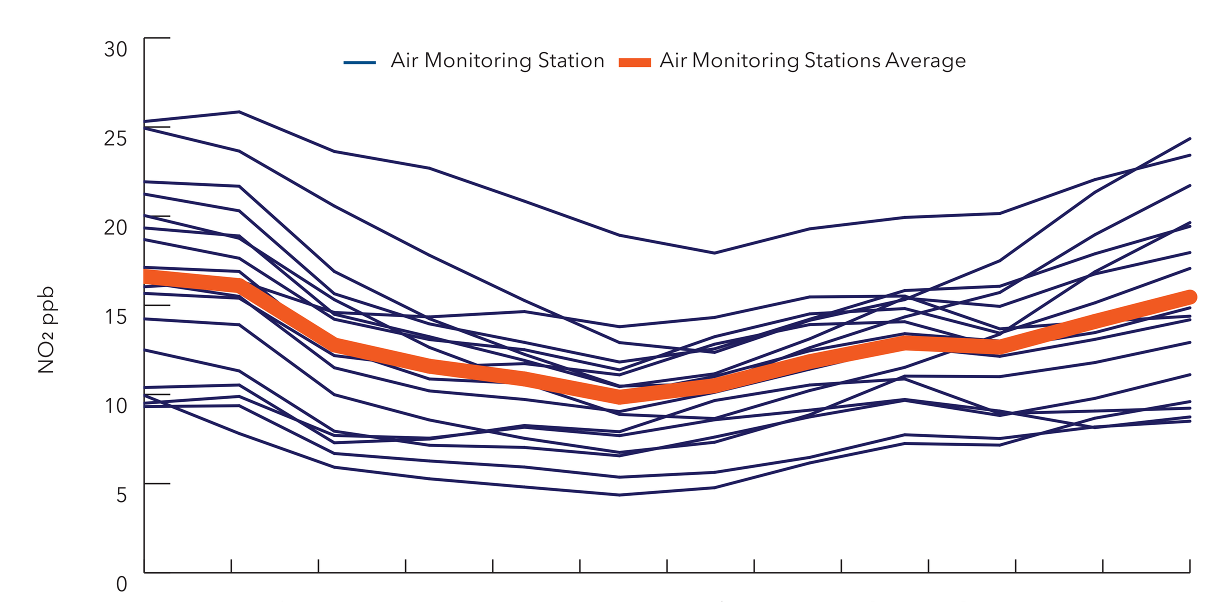
NO has steadily decreased over the years, from a yearly average of 14 to 8.5 ppb from 2004–2014, a 39% decrease. NO exhibits a seasonal trend that peaks in December–January and dips from March–July, and spatial heterogeneity in average magnitude and seasonal variability.

Figure 6. Average Monthly NO from 2004–2014



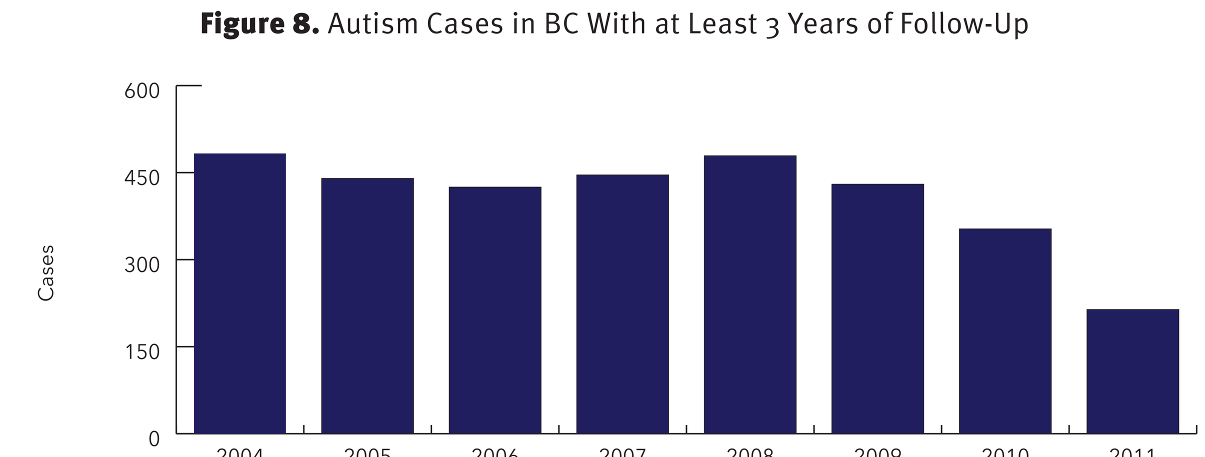
NO_2 has steadily decreased over the years, from a yearly average of 15 to 11 ppb from 2004–2014, a 26% decrease. NO_2 exhibits a seasonal trend that peaks in December and dips in June, and spatial heterogeneity in average magnitude but spatial homogeneity in seasonal variability.

Figure 7. Average Monthly NO2 from 2004–2014



The average number of autism cases per year from 2004–11 is 409, with an average annual point prevalence of 10 cases per 1,000 live births, and an average age of diagnoses of 5.7 years of age. The number of cases appears to decrease from 2010 onwards, but this does not necessarily indicate a decrease in prevalence—but rather that younger children haven't yet been diagnosed, since the onset of symptoms begins around 3 years of age, and diagnosis can also happen later in life.

Figure 8. Autism Cases in BC With at Least 3 Years of Follow-Up



	2004	2005	2006	2007	2008	2009	2010	2011
Cases	483	440	425	446	479	430	353	214
Live Births	39,547	39,996	41,036	42,975	43,757	44,495	43,390	43,646
Per 1,000	12	11	10	10	11	10	8	5