# Impacts of COVID-19 Containment Policies on Air Pollution and Exposure Disparities in Canada

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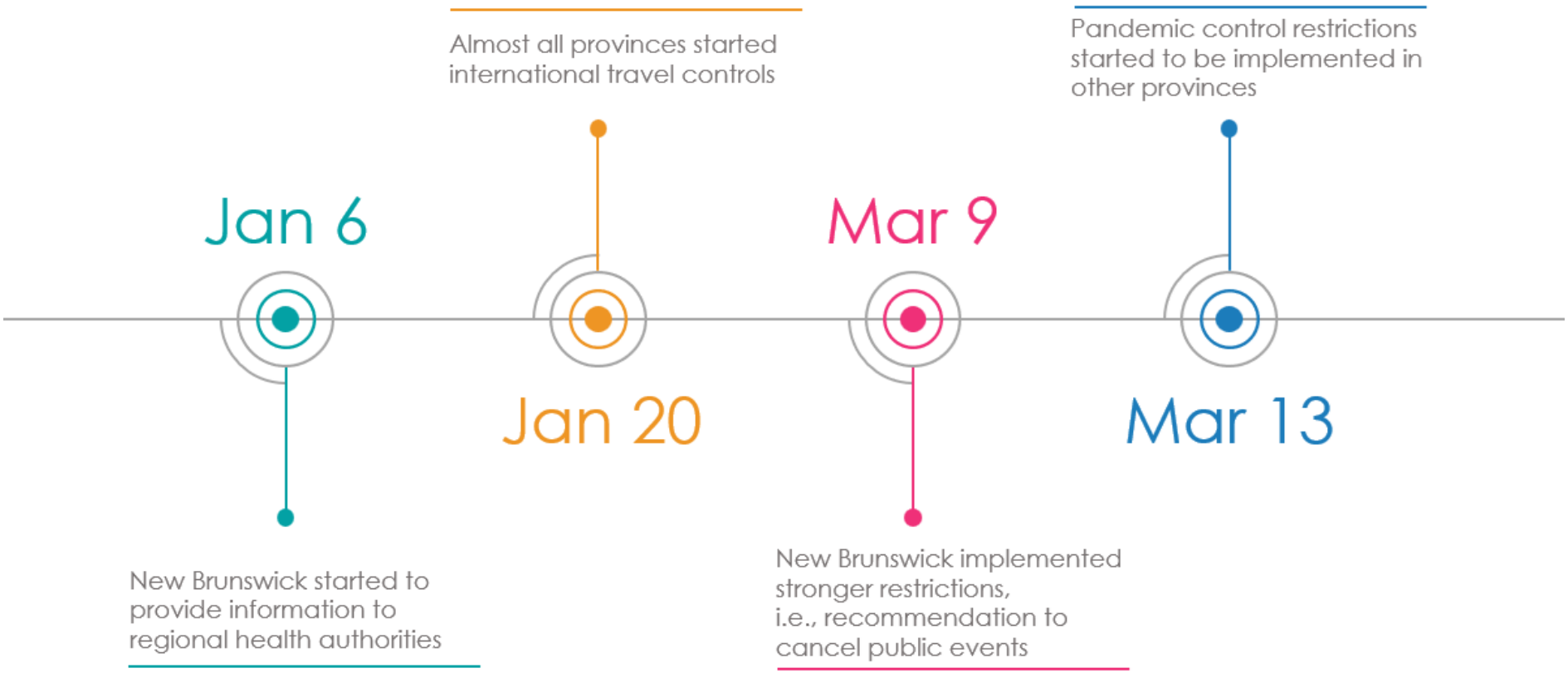
Source: John Ulan, The Quad

# COVID Policy in Canada in 2020



# COVID Policy around the World

- A combination of restrictions with different intensities or stringencies to reduce the spread of COVID-19 diseases, such as:
  - school and workplace closures
  - restrictions on gathering
  - stay-at-home orders
- Both positive and negative unintended consequences were found on society and the environment

Source: Sophie-Claire Hoeller, Business Insider

# Motivations

- "Natural experiment" of policy impacts on air quality
- Co-benefits of air quality improvements associated with the policies
- The environmental impacts of changes in behaviours

# Overview

- Estimate the effect of the stringency of Canadian COVID-19 policies on the concentration level of 8 major air pollutants in 2020
  - $PM_{2.5}$, $PM_{10}$, $O_3$, $SO_2$, CO, $NO_X$, NO and $NO_2$
- Find negative, significant and robust impact on most pollutants
- Detect disproportionate reduction in air pollution exposure among different socio-economic groups

# Air Pollution Data

- Data obtained from the National Air Pollution Surveillance (NAPS) program of Environment and Climate Change Canada (ECCC)
- Daily averages from hourly data of the 8 pollutants during 2015-2020
- The data is winsorized using 1% and 99% as thresholds

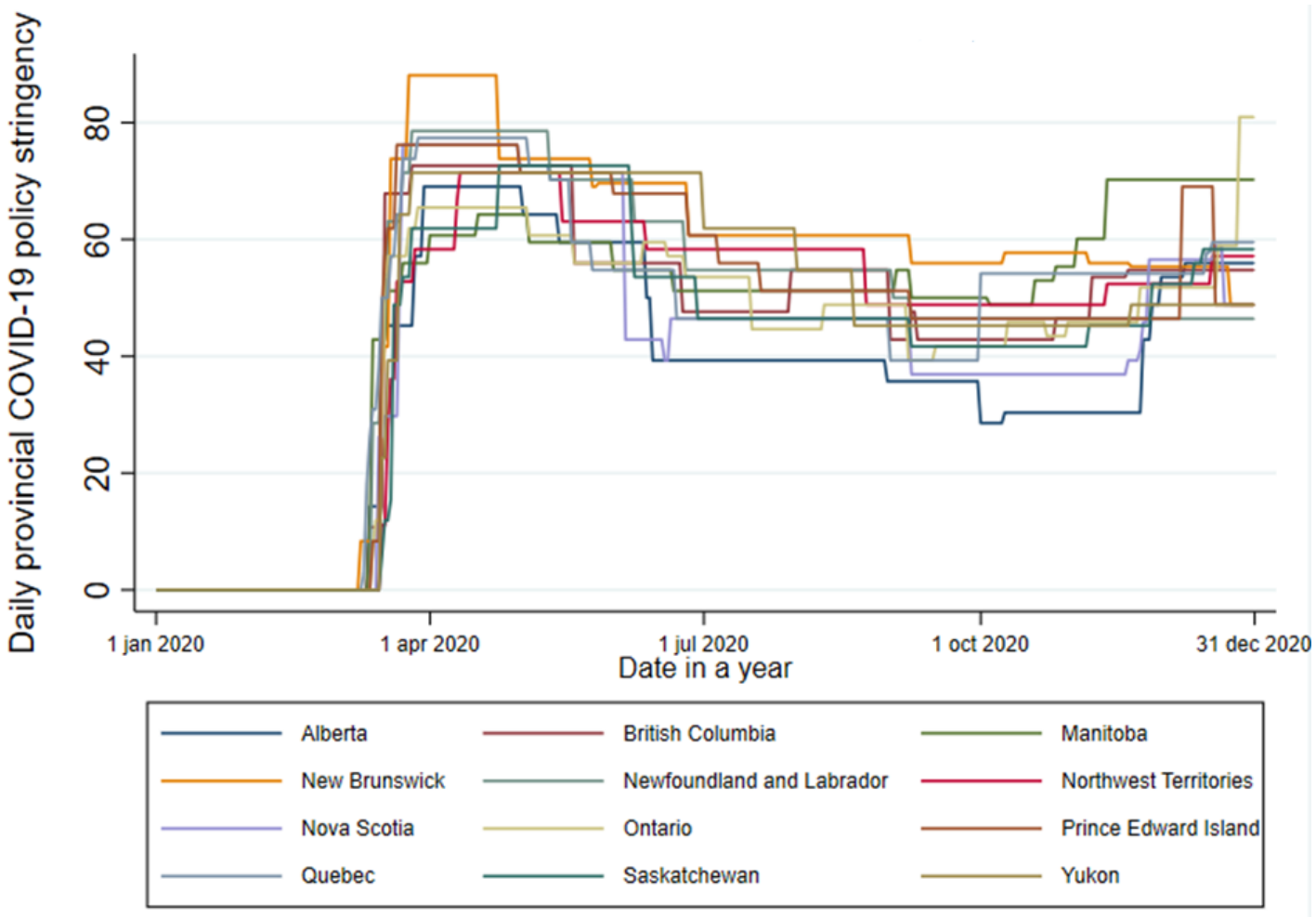
# COVID-19 Policy Stringency Index

- Oxford University's COVID-19 Government Response Tracker (OxCGRT)
  - 4 policy indices calculated based on the value of 24 policy indicators
  - each indicator is assigned an ordinal value between 0 to 5
  - indices aggregated into a value between 0 to 100

# COVID-19 Policy Stringency Index (cont'd)

- Follow OxCGRT procedures to construct the Stringency Index for **stricter** policies based on 7 indicators:
  - school closure, workplace closure, cancellation of public events, gathering restrictions, public transportation closure, stay-at-home order, and internal movement restrictions
  - daily and provincial index between March 16 and December 31, 2020

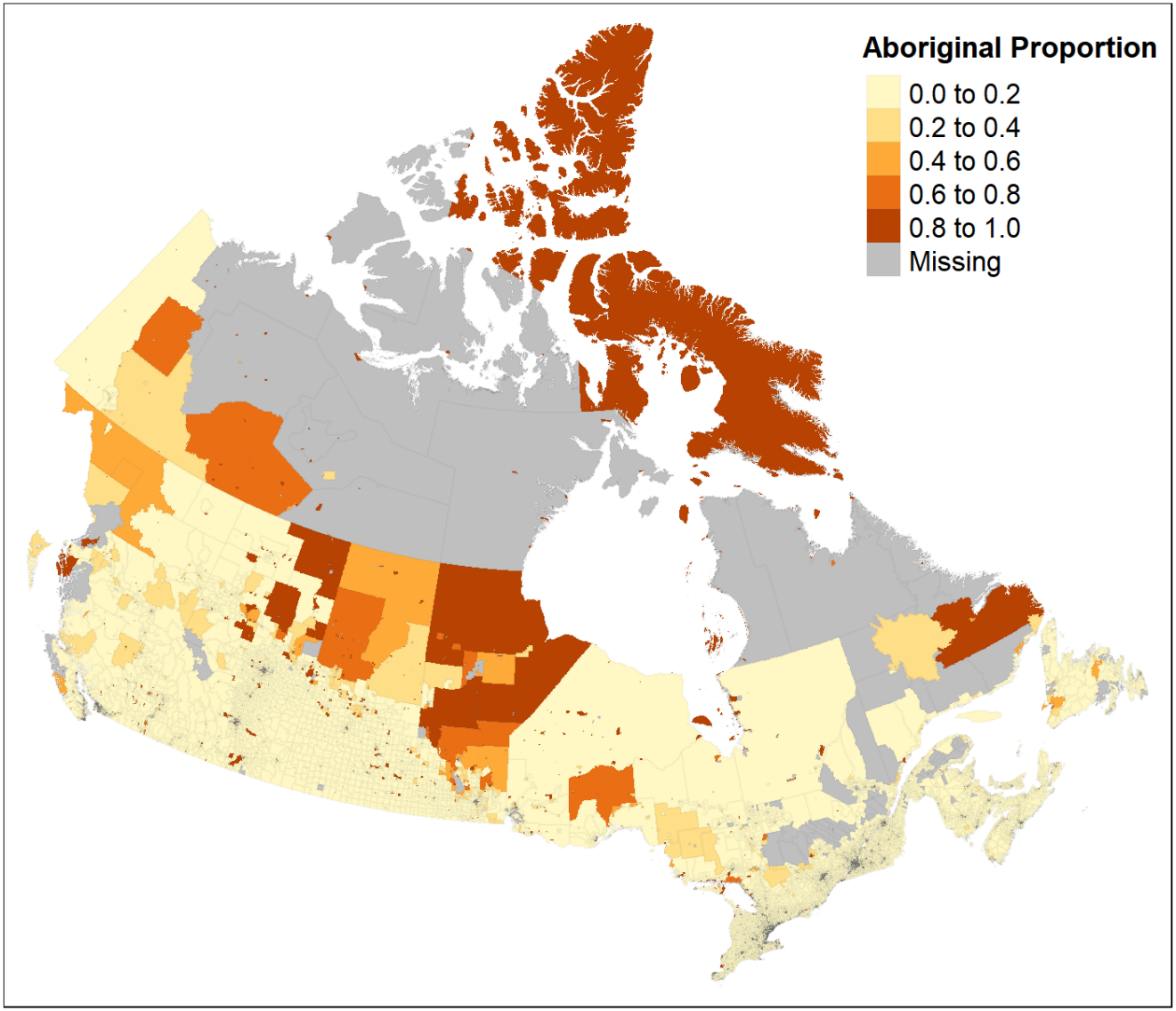
# COVID-19 Policy Stringency Index (cont'd)



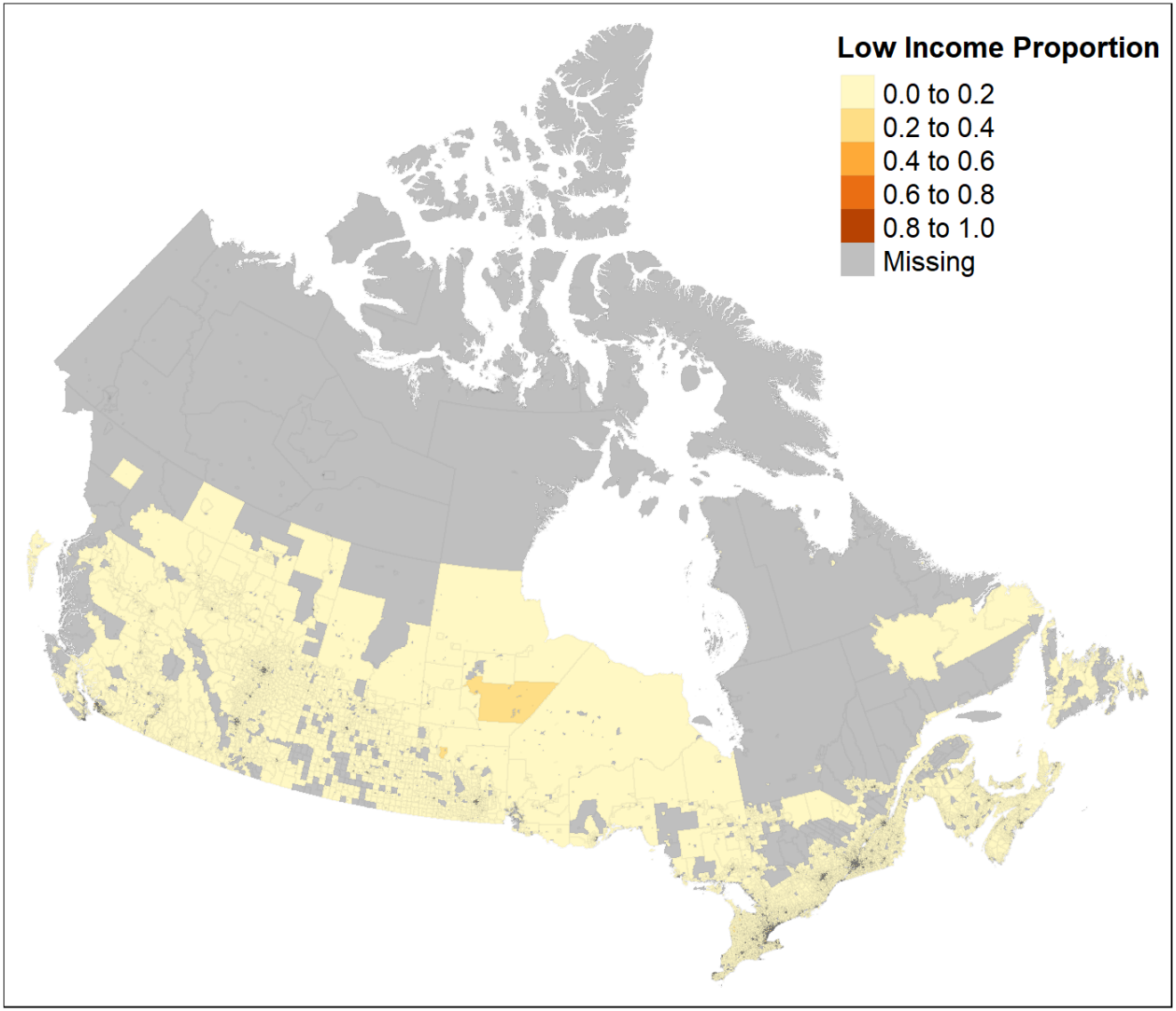
# Meteorological and Socioeconomic Data

- Daily meteorological data during 2015-2020 from the Environment and Climate Change Canada (ECCC):
  - temperature and total precipitation
- 2016 Canadian Census data on socioeconomic backgrounds at the Dissemination Area (DA) level:
  - proportion of Indigenous population, senior age groups, low-income population, visible minorities population

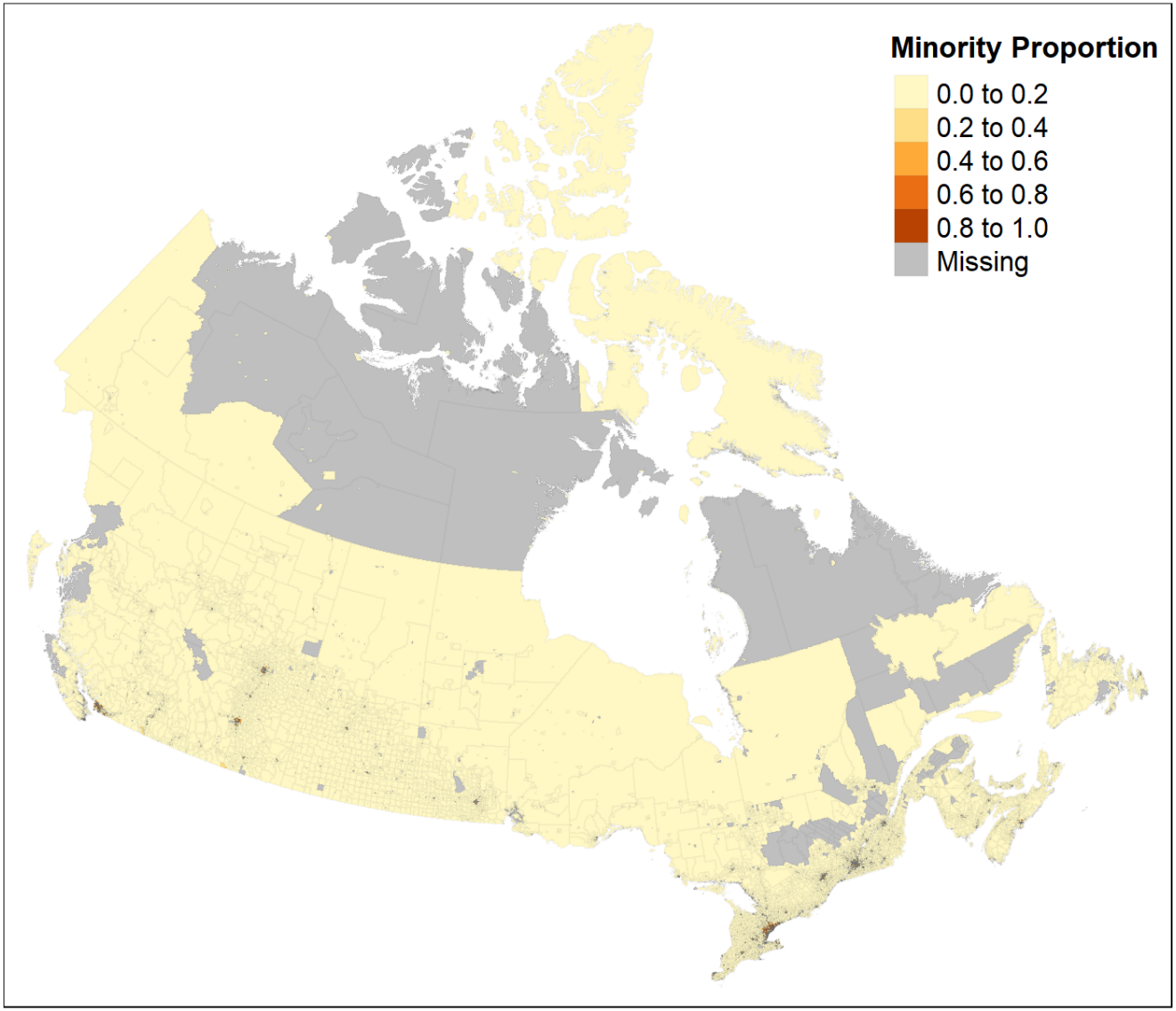
# Socioeconomic Data - Indigenous



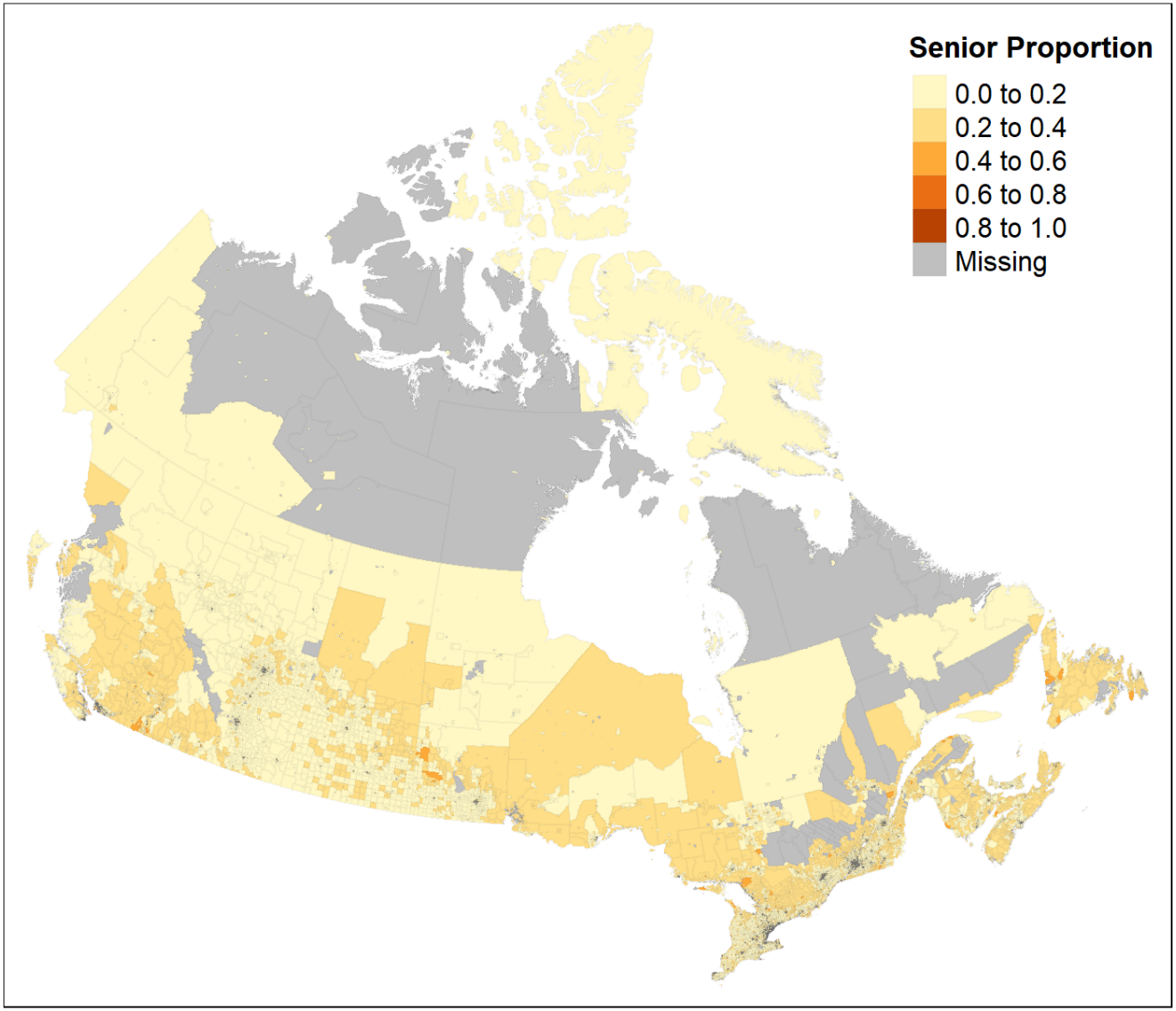
# Socioeconomic Data - Low-Income



# Socioeconomic Data - Visible Minorities



# Socioeconomic Data - Senior Age



# Primary Results

- Significant negative impacts of policy stringency on 7 pollutants (except $O_3$) during March 16 - December 31, 2020
  - 1% increase in the stringency of COVID-19 policies reduces $PM_{2.5}$ by 0.74% in Canada
  - 3.83% for $PM_{10}$, 0.31% for $SO_2$, 0.05% for CO, 2.96% for $NO_X$, 3.12% for NO, 2.50% for $NO_2$
- $O_3$ is formed from interactions between $NO_X$ and VOCs
  - the level is highly dependent on the ratio between $NO_X$ and VOCs, so small decreases in $NO_X$ can even lead to increases in $O_3$
  - "Ozone weekend effect"

# Primary Results - SAH Orders

- Between March and May 2020, provinces in Canada implemented Stay-at-home (SAH) recommendations/requirements
- Estimate the same model, but for the SAH period
- The coefficients are generally larger in magnitude

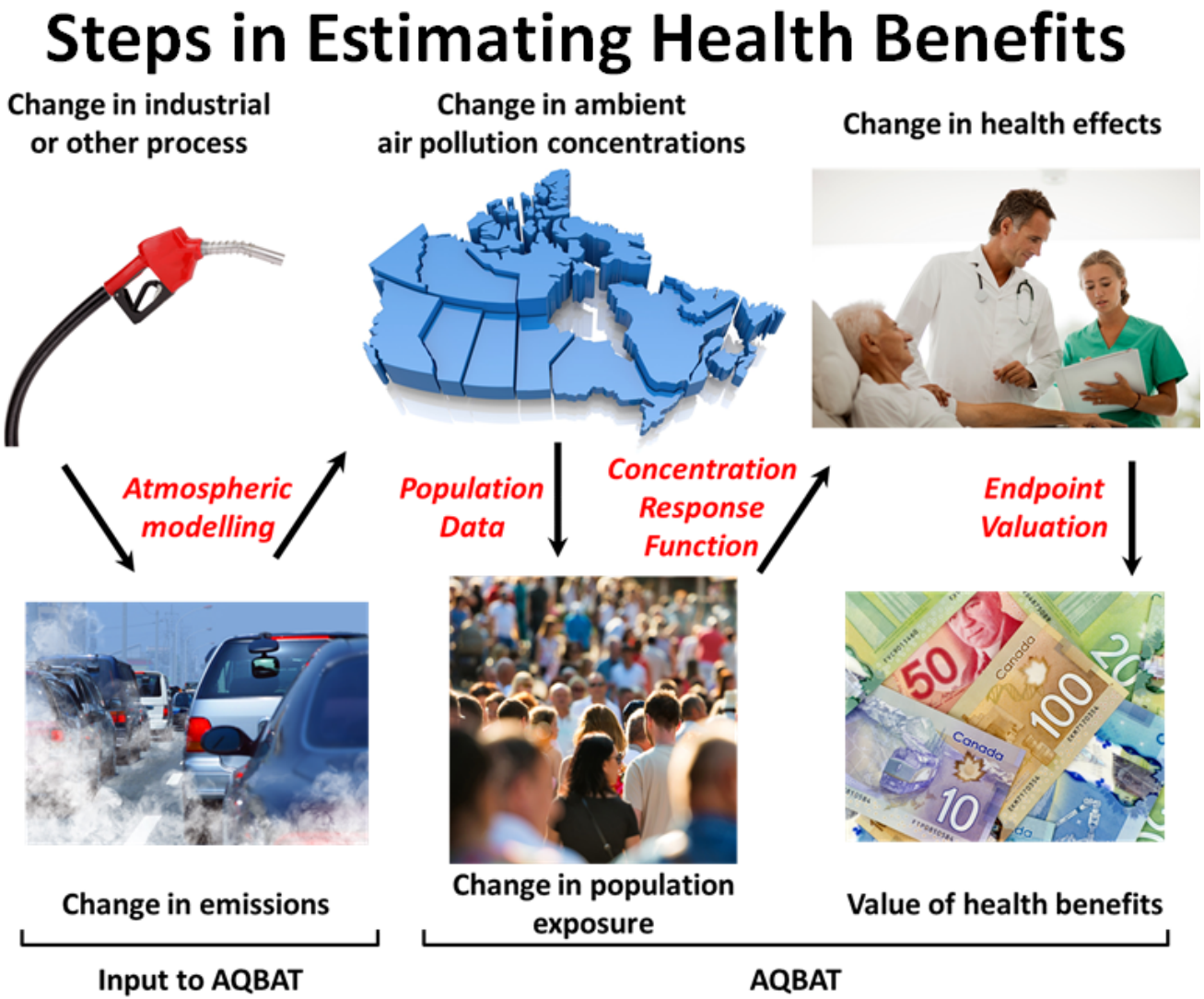
# Disparities in Air Pollution Exposure

- Heterogeneous effect across different socioeconomic groups:
  - Indigenous, seniors aged over 64, low-income, and visible minority
- Disproportionate (mixed) reduction in air pollution, except for the senior group
  - Indigenous: higher exposure to CO
  - low-income: higher exposure to $PM_{2.5}$, $NO_X$, NO and $NO_2$
  - visible minority: lower exposure to $SO_2$, CO, and $PM_{10}$
- Similar results during the SAH period, but include the senior group

# Air Quality Benefits Assessment Tool

- Air Quality Benefits Assessment Tool (AQBAT): an application developed by Health Canada, to estimate the human health impacts due to changes in the ambient air quality in Canada
- Occurrences of mortality/morbidity and symptoms potential, associated economic benefits/damages of changes in air quality

# Air Quality Benefits Assessment Tool (cont'd)



# Monetary Valuation

- 1% (10%) increase in the COVID-19 policy stringency in 2020 across Canada would lead to
  - 68 (815) fewer occurrences of mortality
  - \$597 million (\$7 billion) economic benefits
  - 18 days of SAH requirement (instead of no requirement) = 1% increase
- The valuation estimates the potential welfare impacts associated with reduced treatment costs and productivity losses, avoided pain and suffering, and the impacts of decreased mortality risk

# Monetary Valuation (cont'd)

- Provincial comparison of Saskatchewan and Manitoba
- Similar GDP, population, weather and terrain conditions
- Policy stringency is 63 for Saskatchewan and 67 for Manitoba
- If Saskatchewan had adopted the same policy stringency as Manitoba
  - 12 fewer occurrences of mortality
  - \$104 million total economic benefits, or \$115 per adult in Saskatchewan

# Robustness Check

- Using multi-pollutant air quality health indices (AQHIs)
  - similar negative impact of the COVID-19 policy stringency
- Using overall OxCGRT index
  - significant and the same signs as the coefficients in the primary results
- Tests and regressions to prove validity and reliability

# Conclusion

- Estimate the effect of the stringency of Canadian COVID-19 policies on air pollution
- Find significant and negative impact on 7 pollutants (except $O_3$)
  - robust across various specifications and during SAH policy period
- Detect mixed results regarding the disproportionate reduction in air pollution exposure among socio-economic groups
- Use AQBAT to simulate potential economic benefits caused by the changes in the COVID-19 policy stringency

# Policy Implications

- Design of the policies requires careful evaluation of trade-offs associated with intended/unintended benefits and cost
- The consequences of such policy interventions can vary depending on various contexts (e.g. different socio-economics groups)
- To support environmental justice, underlying mechanisms that are driving the disparities in air pollution exposures need to be identified

# Thank You!

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