A trend analysis approach to air quality network data

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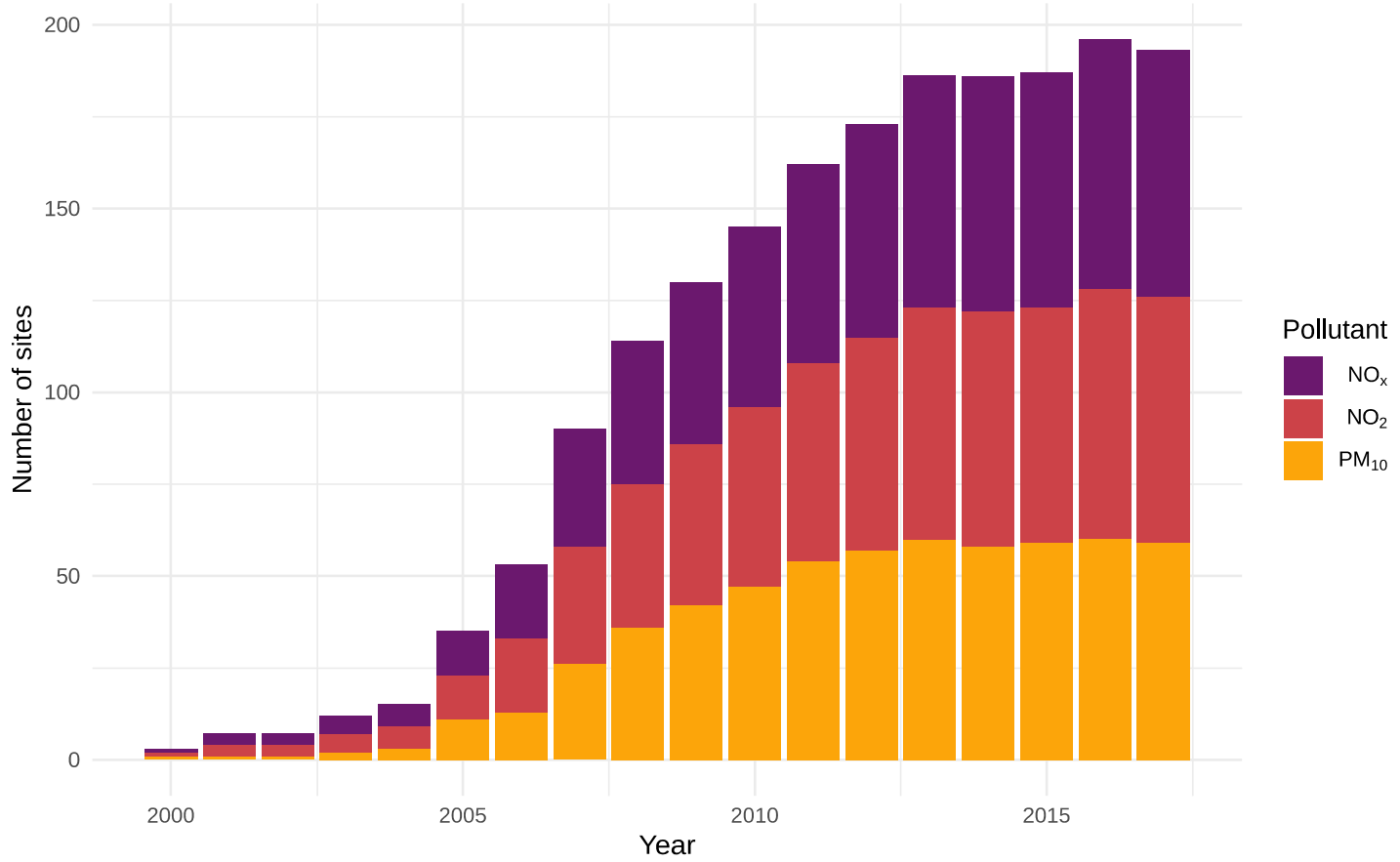
Why is long term trend analysis important?

- Measure the change in air pollutant concentration over time
- Evaluate the effects of long term changes, e.g. policy interventions on air quality
- Identify unexpected ‘signals’
  - Lack of expected response in pollutant concentrations
  - Unexpected changes enabling exploration of drivers

Methods for long term trend analysis

- Analysis of time series of a single monitoring site
  - Not representative of a large area
  - Local variation
- Compare long term trends from multiple sites individually
  - Not practical for large monitoring networks
- Average concentration from multiple sites
  - Trend may be leveraged by sites opening and closing
- Filter data to only use data from sites measuring over entire period of analysis
  - Prohibitive for long time periods/sparse monitoring networks
  - Limits the length of the time period

Monitoring site counts in the Scottish network over time



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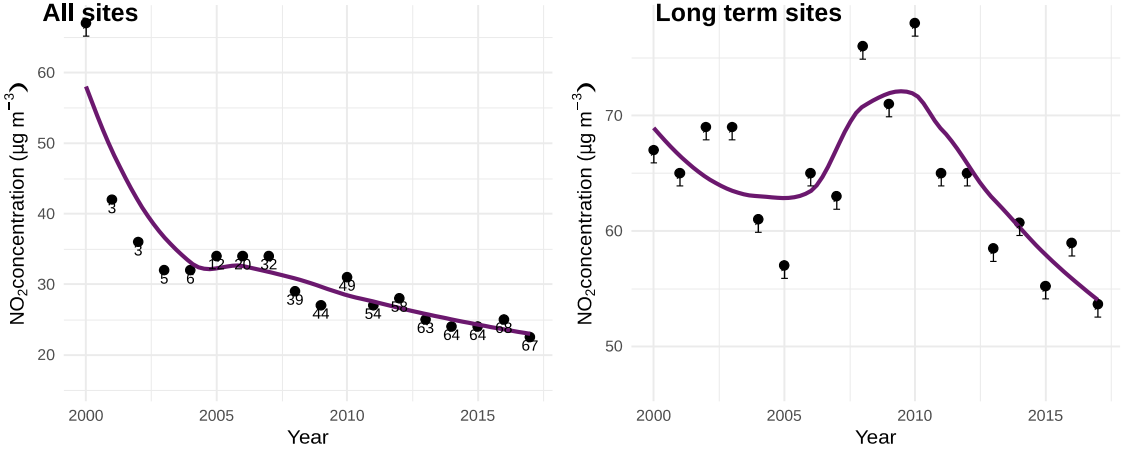
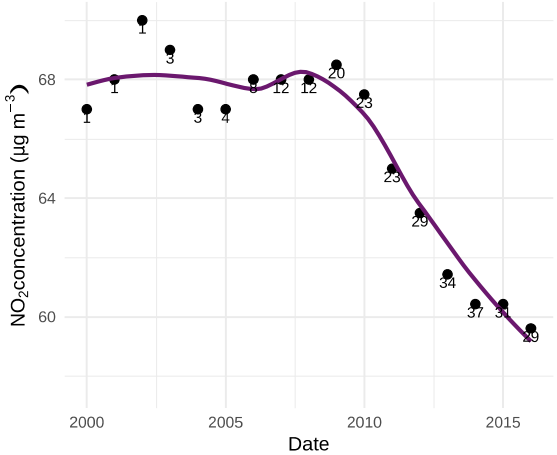
All monitoring sites measuring NO_2 between 2000-2017

Long term monitoring sites measuring NO_2 for the entire period 2000-2017

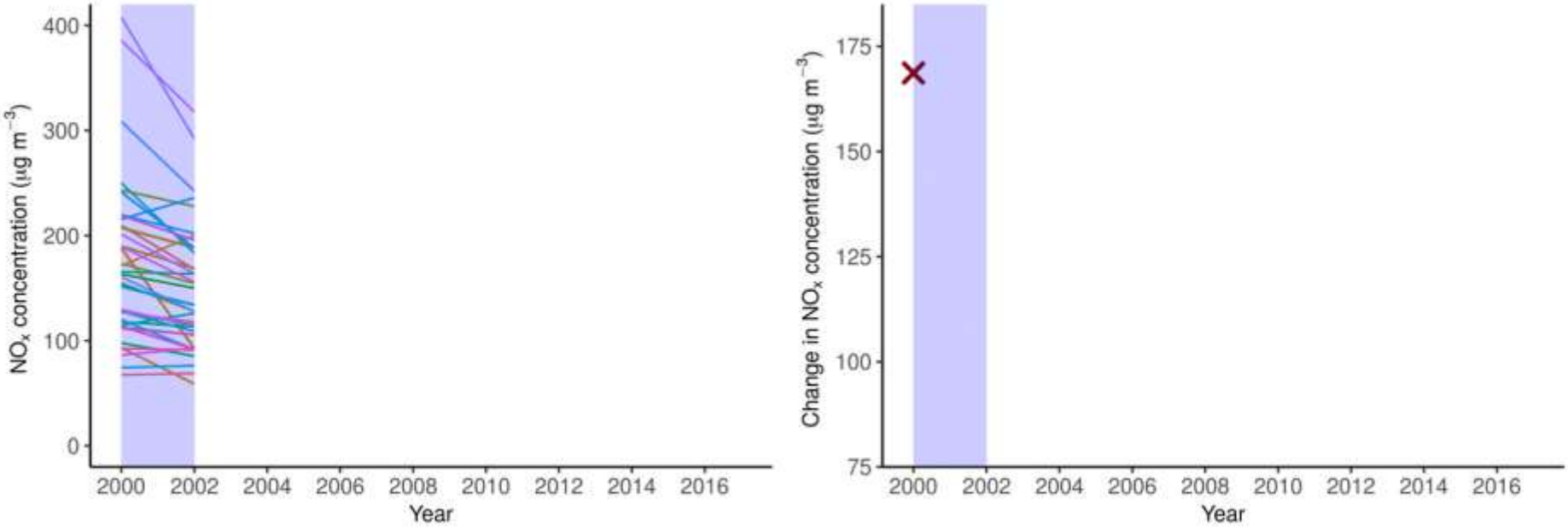
Annual average trends in NO_2 for all sites and long term sites



Rolling change trend in NO_2 concentration 2000-2017

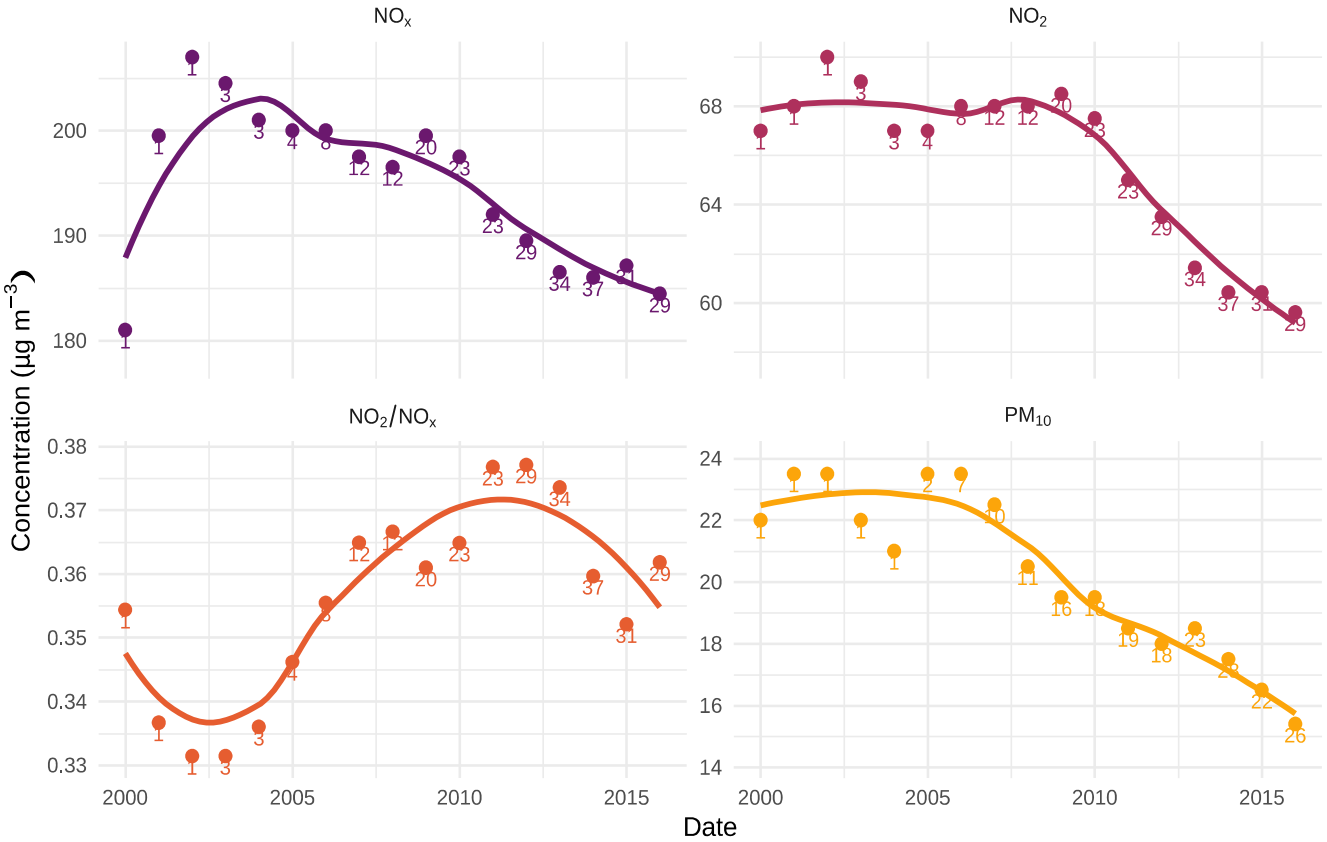


The rolling change method

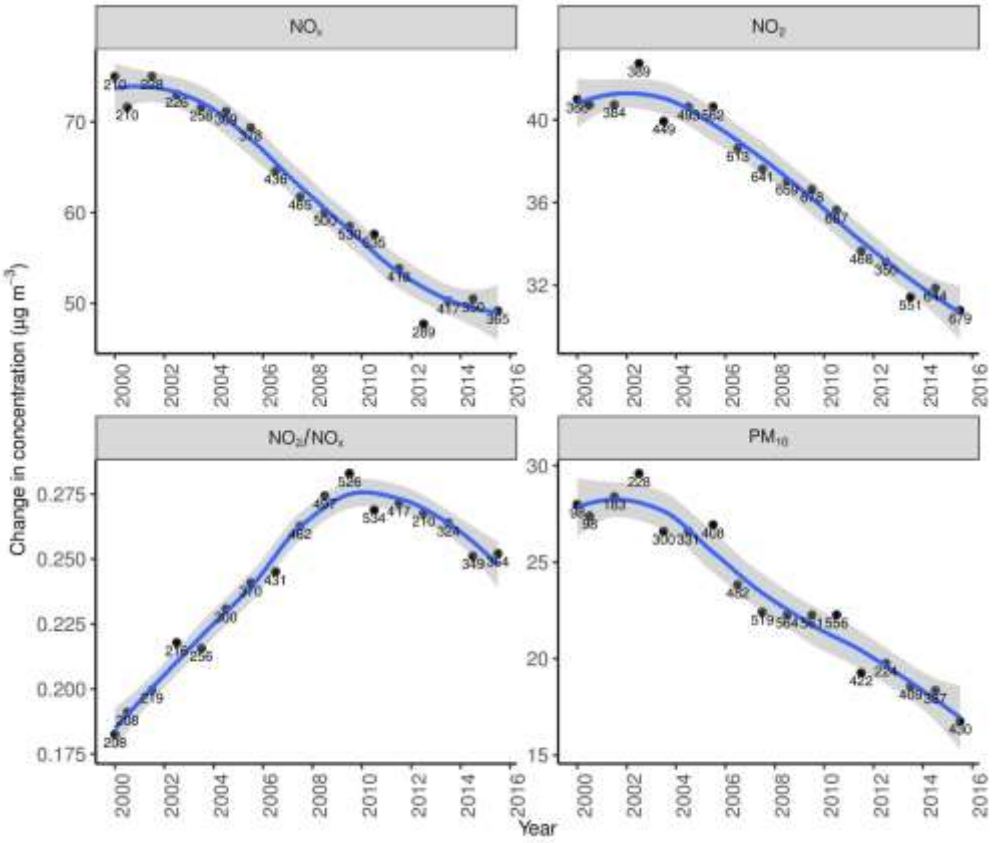


Step (1): Filter monitoring sites to only those measuring constantly during window.
Initialise concentration change as average concentration in year 1.

Rolling change trends in roadside NO_x, NO_2, NO_2/NO_x and PM_{10} concentration in Scotland 2000-2017



Rolling change trends in roadside NO_x, NO_2, NO_2/NO_x and PM_{10} concentration in Europe 2000-2017



Concluding Remarks

- Long term trend analysis is important for measuring changes in air quality over time and evaluating the effects of policy interventions
- Aggregating data from multiple monitoring sites ‘averages out’ local variability
- This is complicated by site flux in monitoring networks introducing bias to the average trend
- The rolling change method is a technique for long term trend analysis using data from sparse and/or biased monitoring networks

Rolling change method can be implemented using the ‘aqtrends’ R package available here: https://github.com/pollylang/aqtrends

Further Information

More detail on the rolling change method can be found in the following unpublished paper:

Lang, P. E., Carslaw, D. C., & Moller, S. J. (2019). A trend analysis approach for air quality network data. Atmospheric Environment.

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