Assessing Long-Term Exposure

Micah Sherman
Gavin Fisher

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Why long-term exposure?

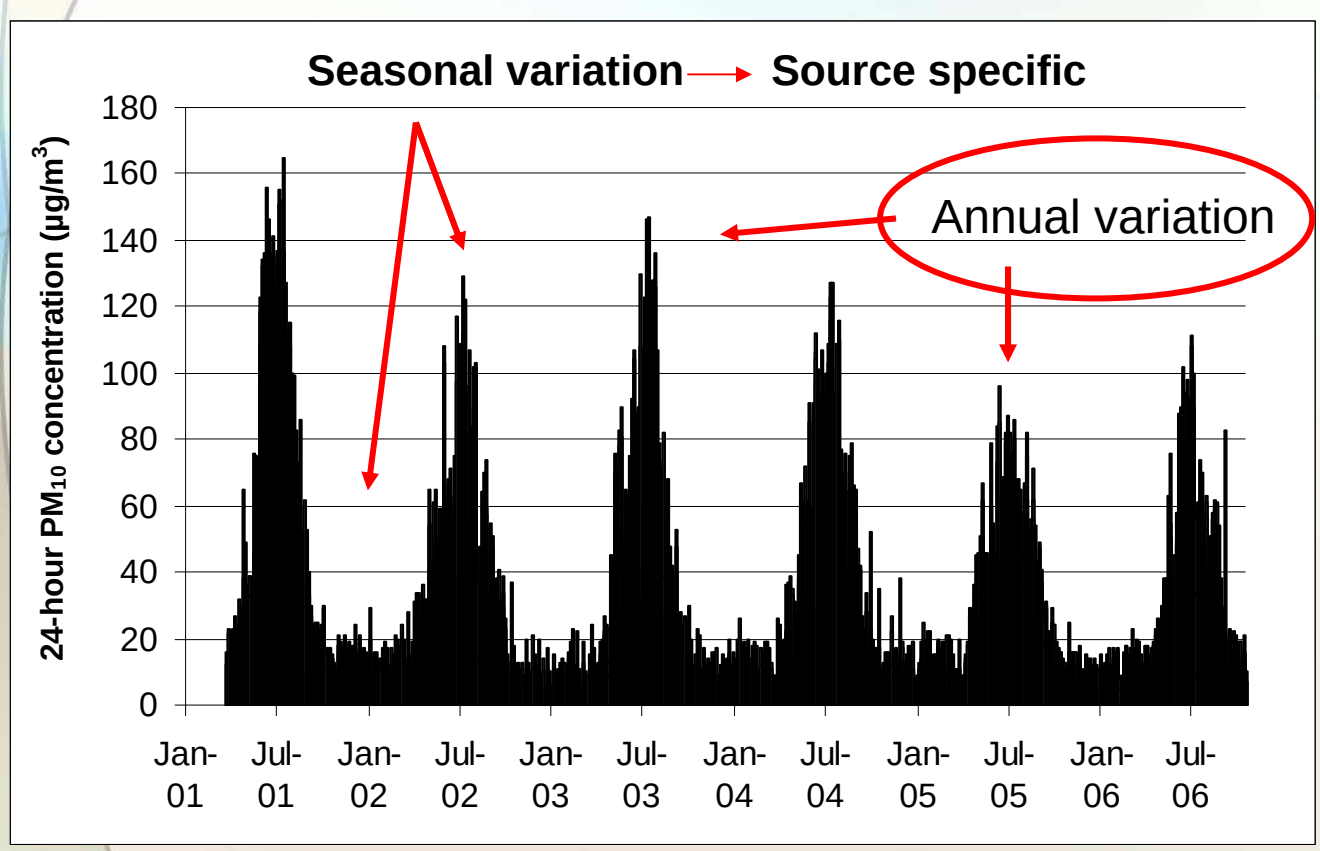
- In terms of the public health impact the long-term exposure relationships are of greatest interest (and least understood).

- Time-series methodologies
  - typically underestimate effects
  - variations in the exposure-response relationships
    - Pollutant source
    - Population – confounding factors
    - Climate/weather
    - **Exposure – contaminant concentration**

Exposure-response relationships

Duration of effect measurement	Dose response relationships % increase in daily mortality for 10 μg m^{-3} increase in PM_{10}	Reference
Short term	1.0	Several
Medium term	1.6	APHEA2 study
Long term	8.4	Harvard 6 cities study
	4.2	American Cancer Society study, first stage
	4.3	Kunzli (Hapinz)
	6.0	American Cancer Society study, second stage

Nelson PM_{10} summary (and variations in exposure)



	Averages ($\mu g/m^3$)
Annual	**33.3**
Winter	**56.3**
Non-winter	**15.1**

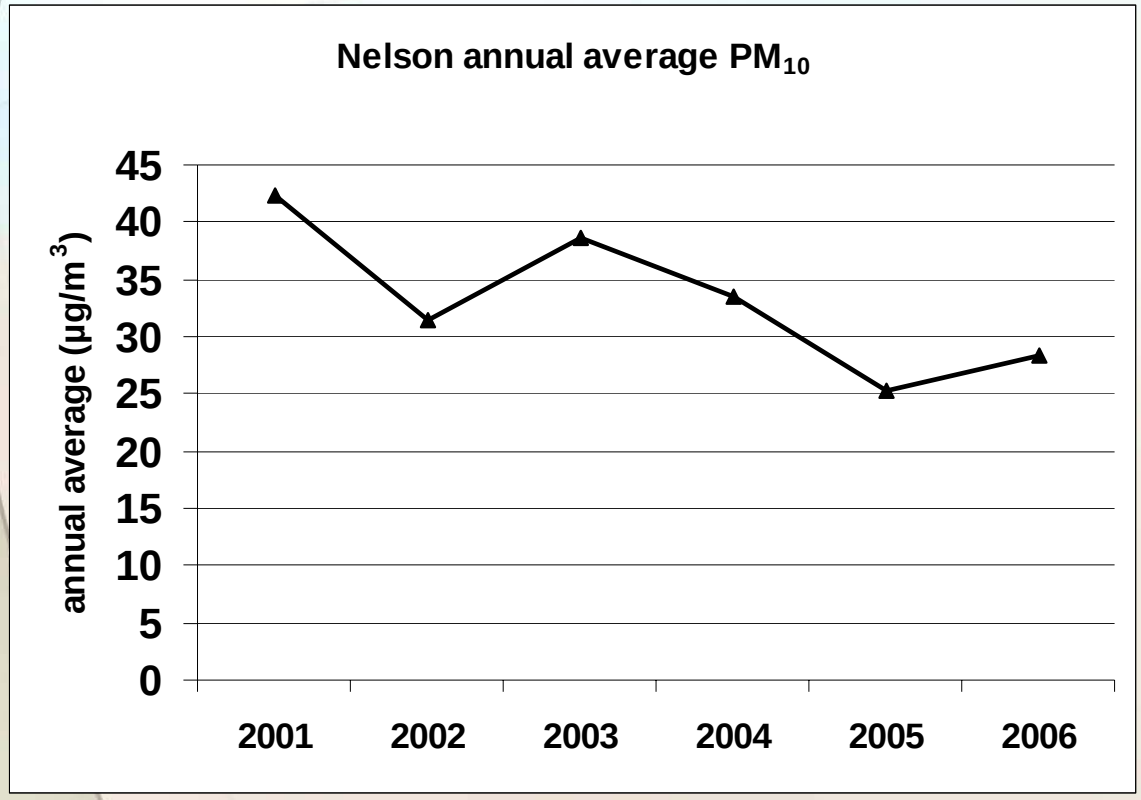
additional uncertainty in exposure conc.

- **Diurnal**
- **Indoor/outdoor**

Data made available courtesy of Nelson City Council

Nelson PM_{10} summary

- Large annual variations complicate exposure estimates



	annual peak (µg/m³)	annual average (µg/m³)
2001	165	42.4
2002	129	31.5
2003	147	38.7
2004	127	33.4
2005	96	25.2
2006	111	28.3
Average		33.3

Data made available courtesy of Nelson City Council

Weather and PM_{10}

PM_{10} concentrations are heavily dependent on climate factors, as well as emissions, actual trends cannot be determined without examining the weather and climate conditions.

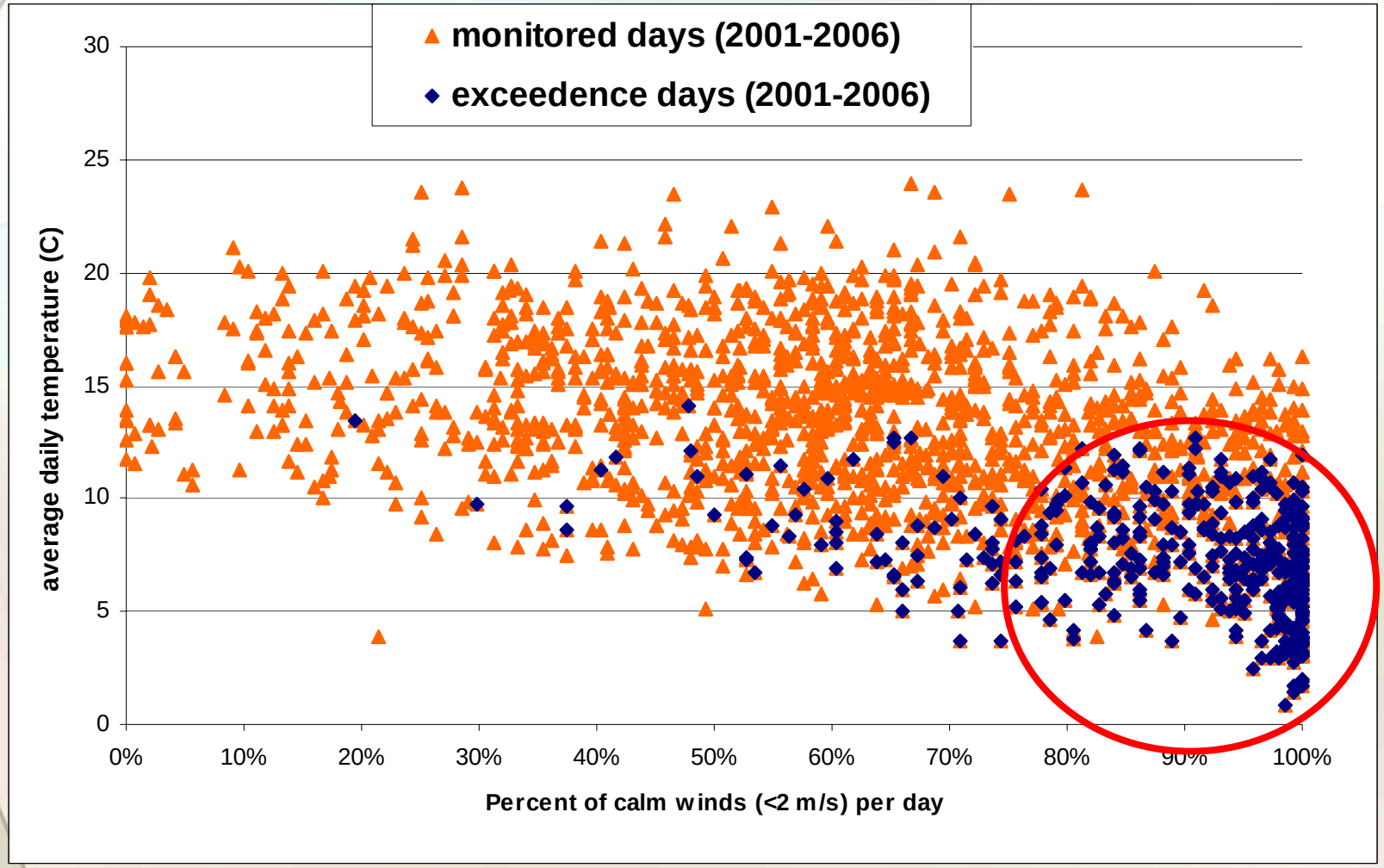
- Temperature (i.e. *"..is it cold enough to fire up the burner…?*")
- Dispersion (i.e. "*…is it windy enough to blow the smoke away..?")*
- Atmospheric stability, rain, humidity
- Climatic drivers (i.e. SOI, Zonal, etc.)

Nelson PM_{10} and weather

	average winter 24-hour PM_{10} ($\mu g/m^{3)}$	average wind speed (m/s)	Percent Calms (<2 m/s)	min temp (ºC)	Ave temp (ºC)	humidity (RH%)
Winter 2001	76.6	1.4	78.8%	-2.8	8.4	75.3
Winter 2002	51.2	1.8	67.9%	-0.1	10.0	71.0
Winter 2003	59.1	1.5	73.3%	-1.3	8.8	75.4
Winter 2004	57.8	1.3	79.9%	-1.0	8.7	79.2
Winter 2005	46.0	1.4	75.6%	-0.2	9.9	78.5
Winter 2006	47.2	1.5	77.2%	-1.9	8.6	75.8
Correlation (2001-2005)		-0.30	0.49	-0.97	-0.85	-0.07
Correlation (2001-2006)		-0.26	0.36	-0.70	-0.62	-0.05

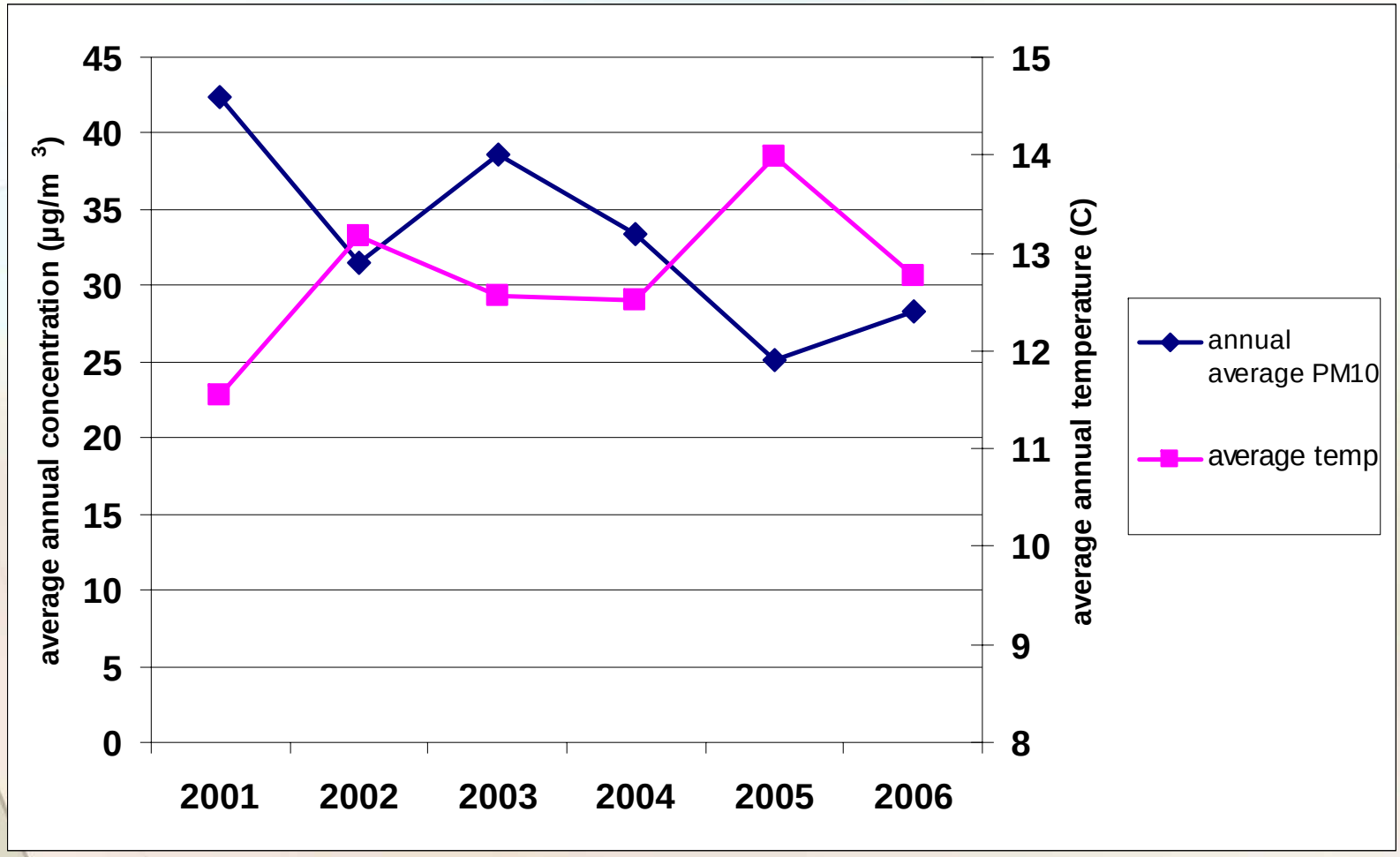
Data made available courtesy of Nelson City Council

Weather and PM_{10} in Nelson



Data made available courtesy of Nelson City Council

Climate variability and PM_{10} in Nelson



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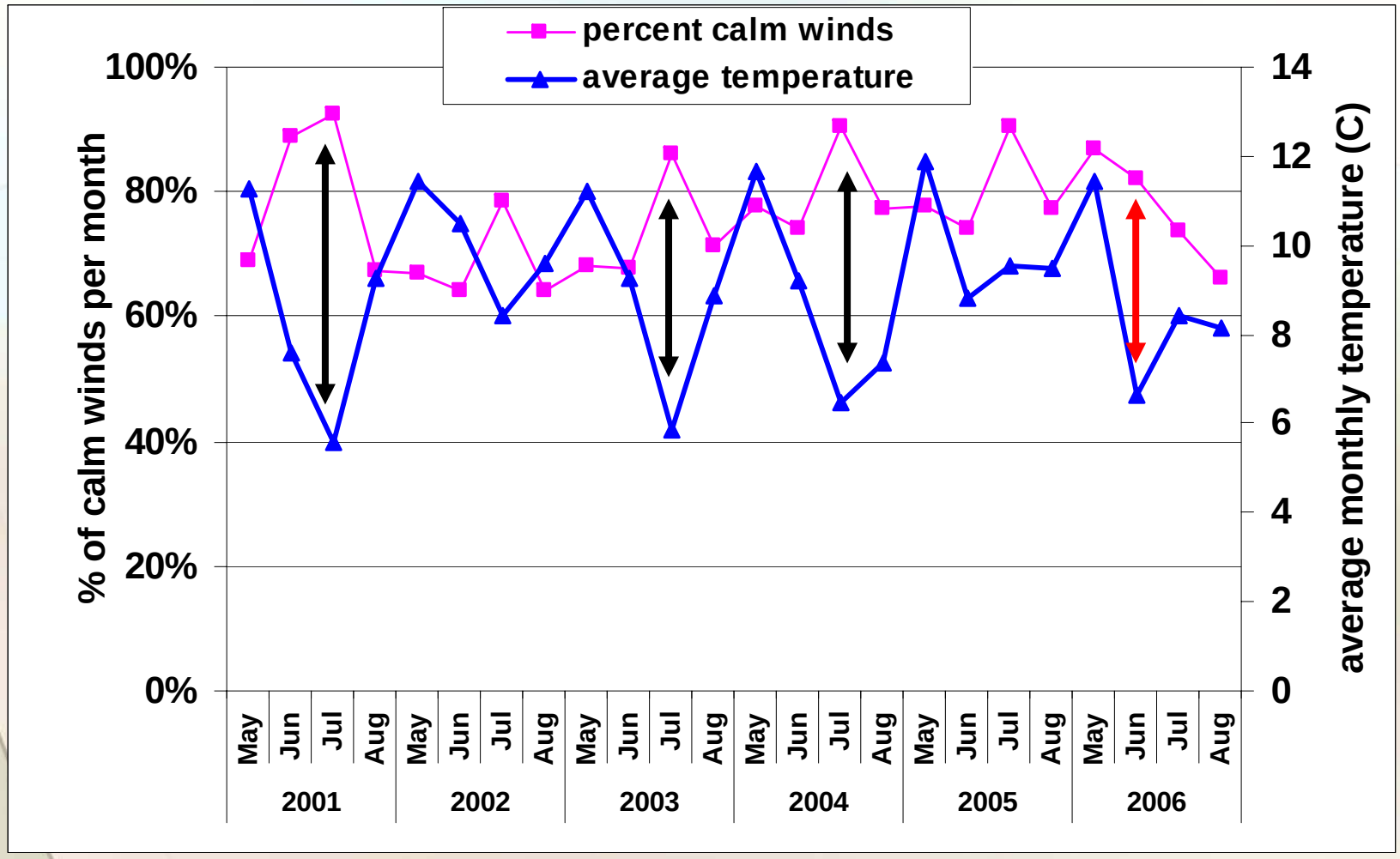
Nelson weather conditions



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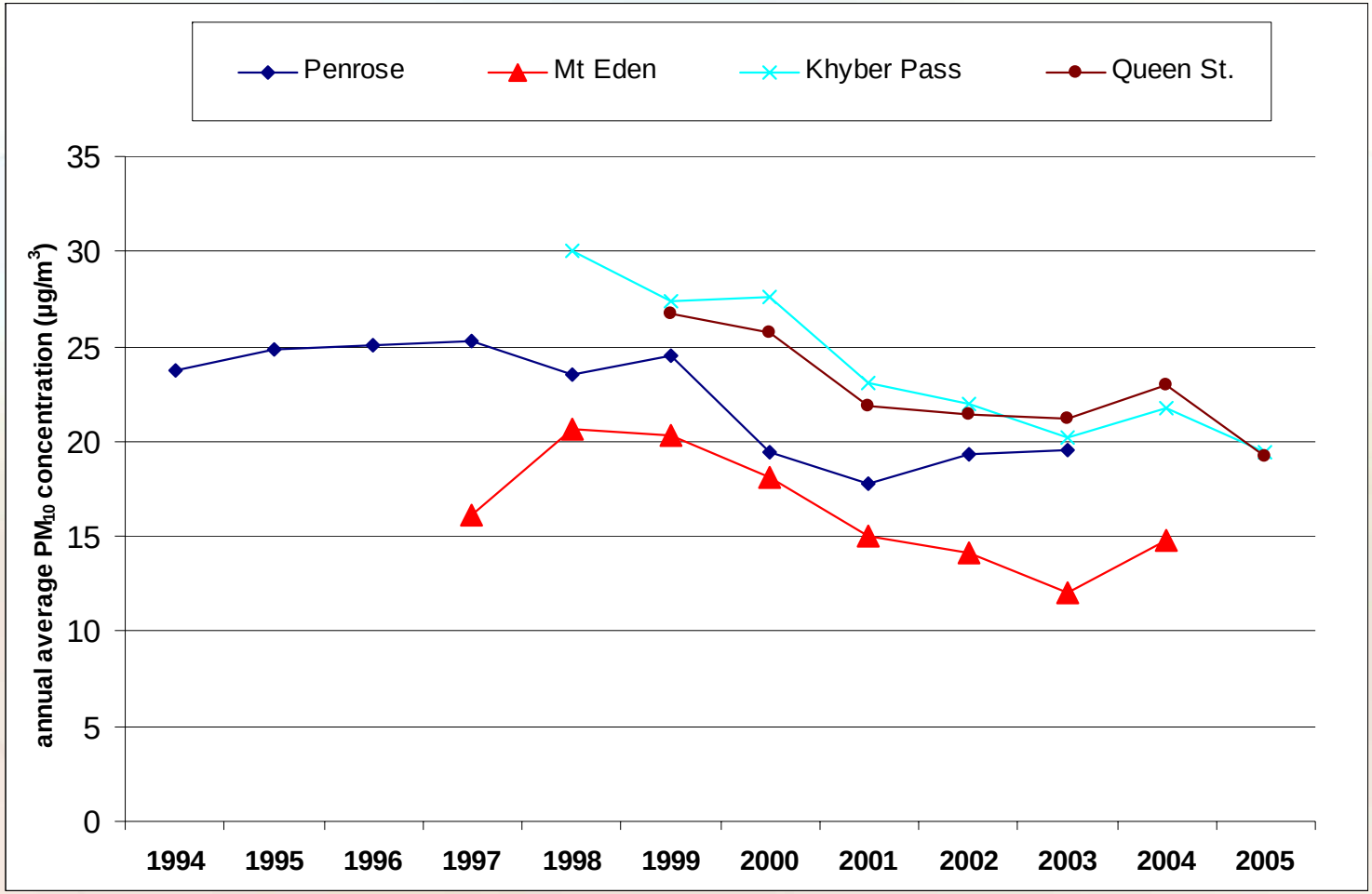
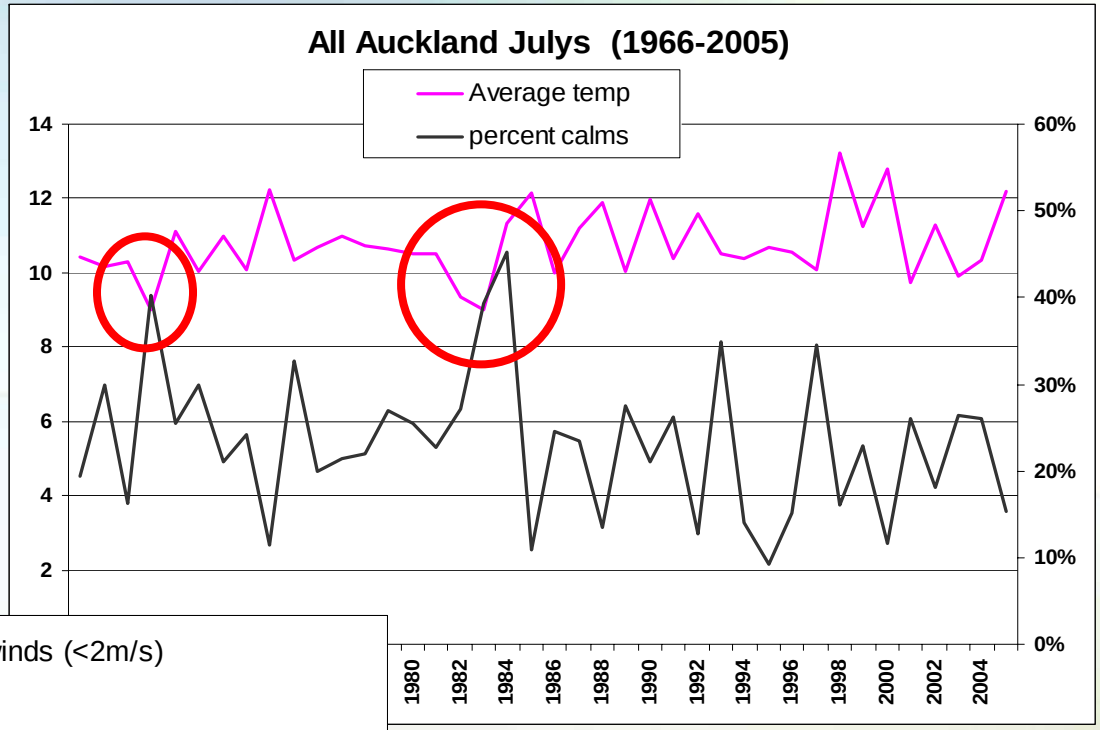
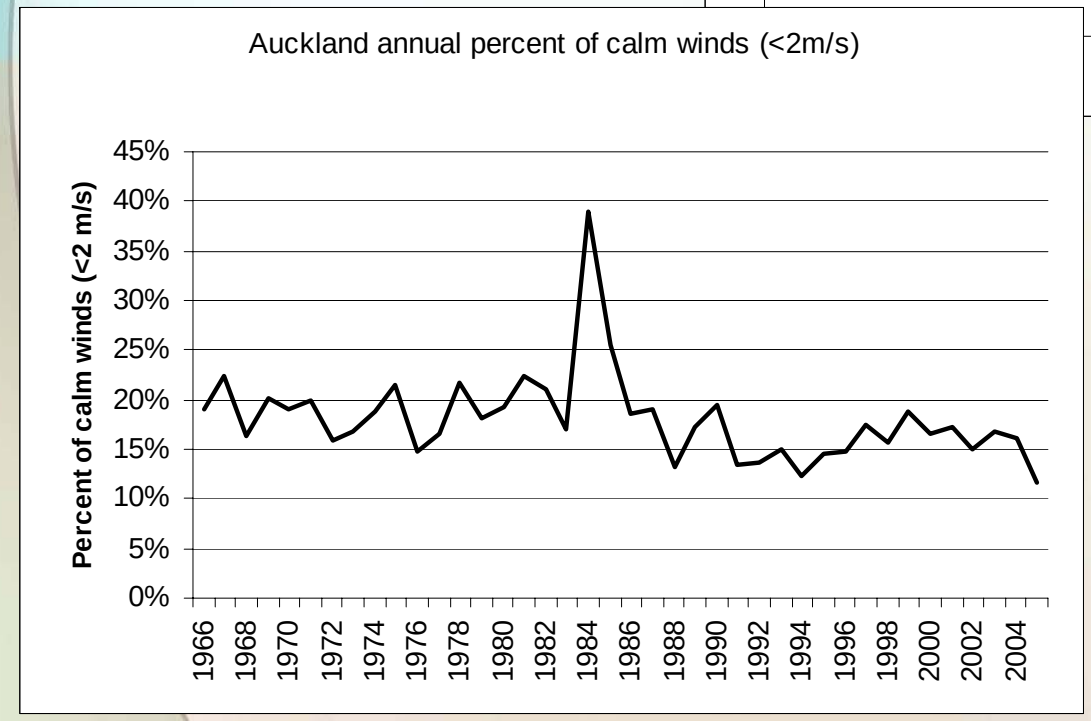
Auckland annual PM_{10}



Data made available courtesy of Auckland Regional Council

Historical weather in Auckland





Data made available courtesy of Auckland Regional Council

Variations in Mortality

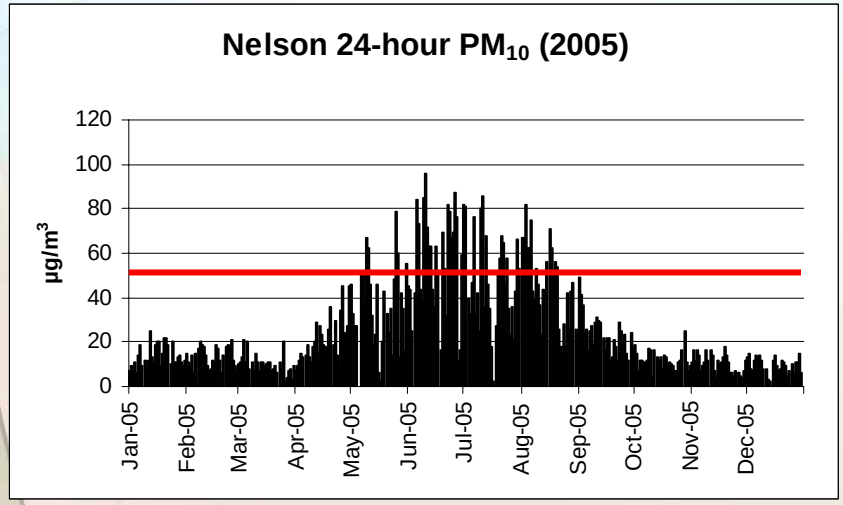
Examination of mortality using Kunzli

Comparison of Mortality calculations*		
	Auckland	**Nelson**
Max annual PM10	**24.7 (1999)**	**42.4 (2001)**
Min annual PM10	**18.2 (2003)**	**25.2 (2005)**
Max mortality	**244**	**24**
Min mortality	**184**	**15**
% difference	**25%**	**38%**

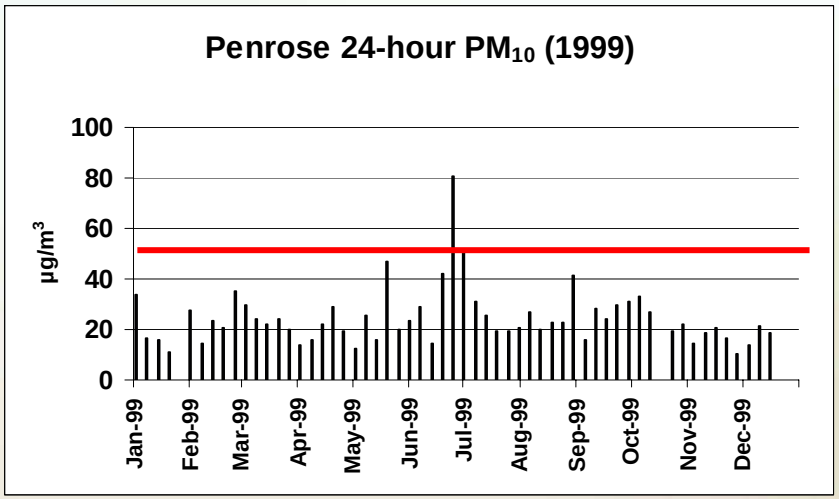
**Based on 2001 population statistics*

Similar annual averages but similar health effects?

Annual average: 25.2 µg/m3



Annual average: 24.7 µg/m3



Data made available courtesy of Auckland Regional and Nelson City Councils

Research gaps

- More consistent monitoring to help understand the long-term pollution trends and the interaction with climatic conditions.
- Vehicle smoke and wood smoke – different effects?
- Season variation – exposure to peaks.
- More emphasis on multi-year, or even whole lifetime, exposures. By studying pollution-climate linkages it is possible to gain information on longer term trends, including possible future exposures in the face of climate change and varying emissions.