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for Oil Sands Monitoring

Atmospheric Mercury in the Oil Sands Region

Workshop at Earth Science - 2014
Analysis and Application of Speciated Mercury Data
July 30, 2014

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Alberta Government

aemera.org

Canada

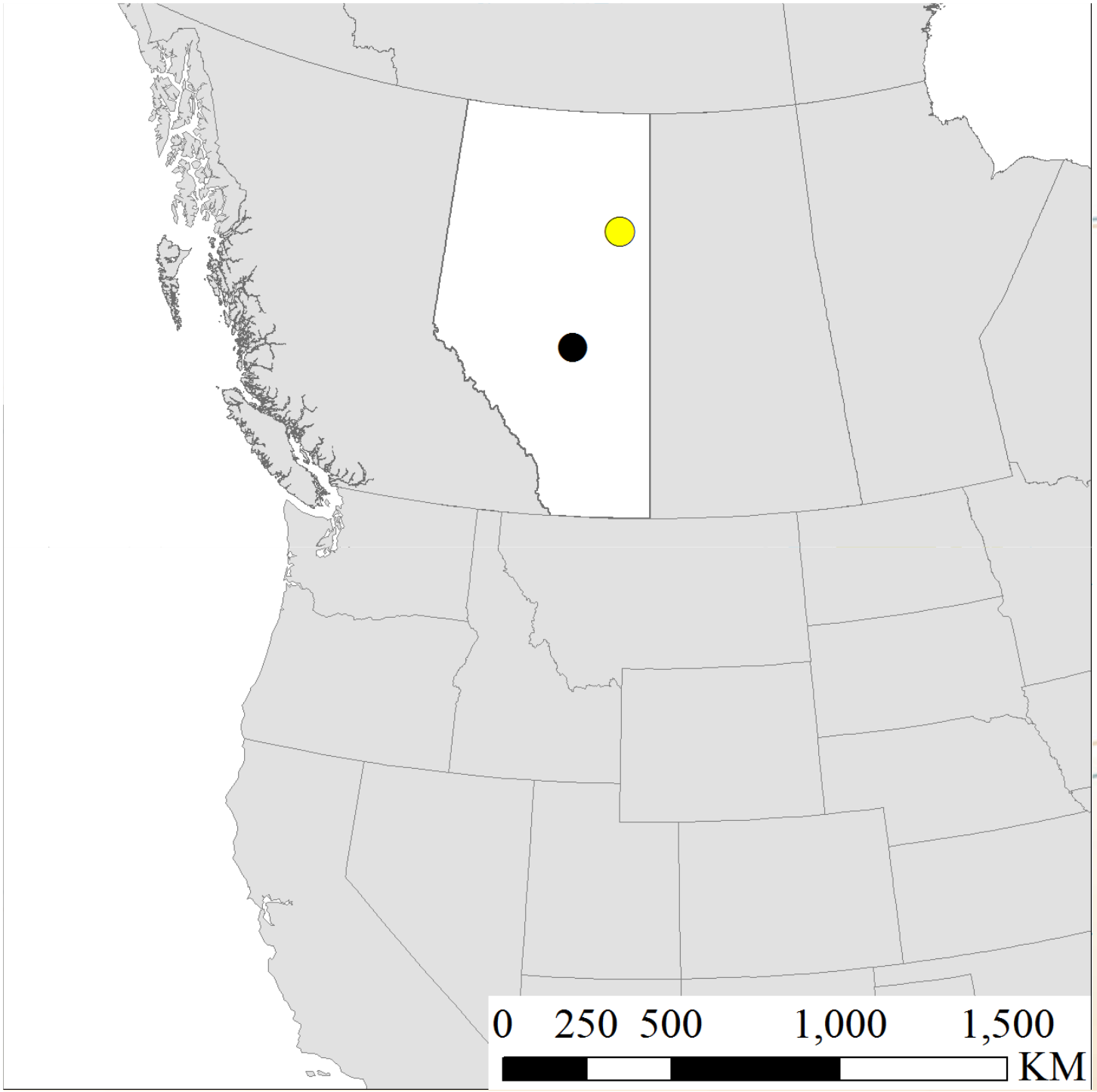
Outline

- Preliminary analysis of speciated mercury levels of the ambient air in the Alberta oil sands region

- Analysis of total gaseous mercury measurements of the ambient air in the Alberta oil sands region

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Speciated Sites



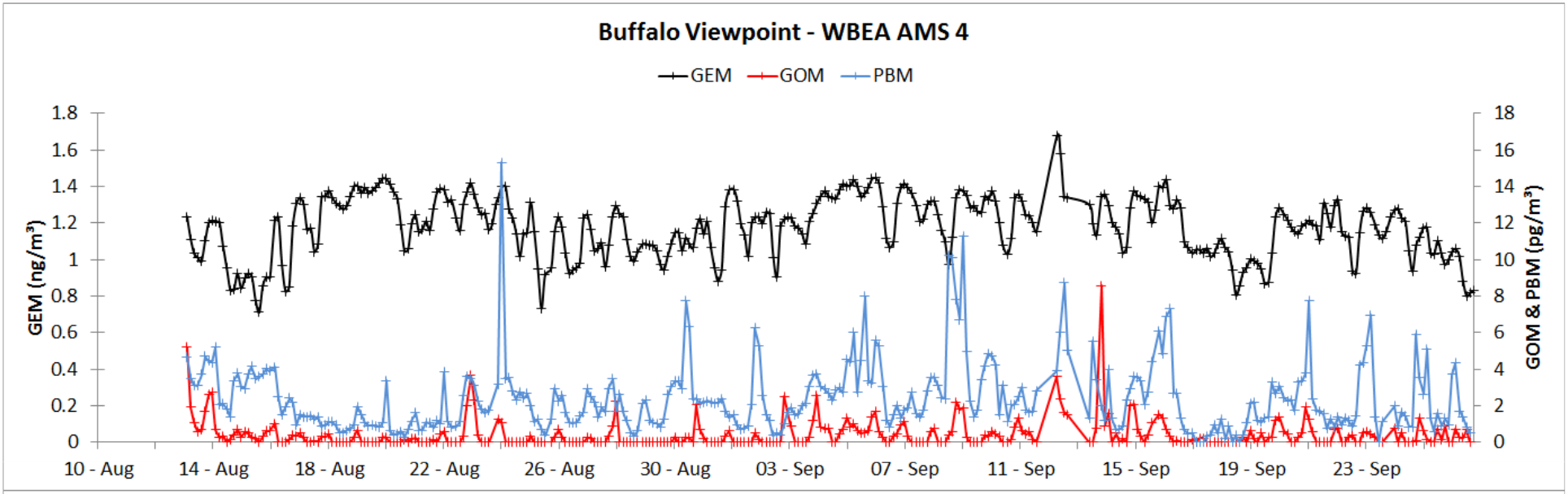
Canada

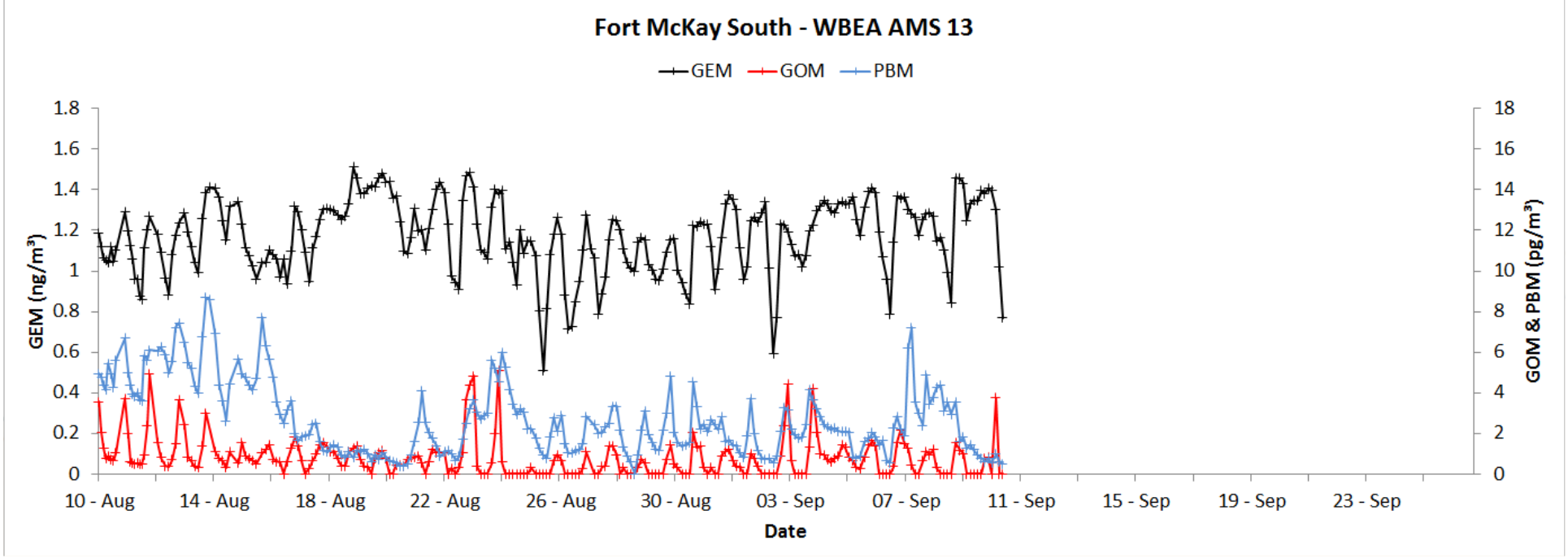
Comparison of Speciated Mercury Measurements in the Alberta Oil Sands Region

Species	Gaseous Elemental Mercury (GEM) ng/m³		Gaseous Oxidized Mercury (GOM) pg/m³		Particulate Bound Mercury (PBM) pg/m³	
Station	AMS 4	AMS 13	AMS 4	AMS 13	AMS 4	AMS 13
Average	1.18 ± 0.16	1.17 ± 0.18	0.43 ± 0.80	0.78 ± 0.95	2.42 ± 1.91	2.69 ± 1.79
Max	1.68	1.51	8.57	5.08	15.31	8.67
Min	0.71	0.51	0.00	0.00	0.00	0.00
N	344	249	338	247	338	248

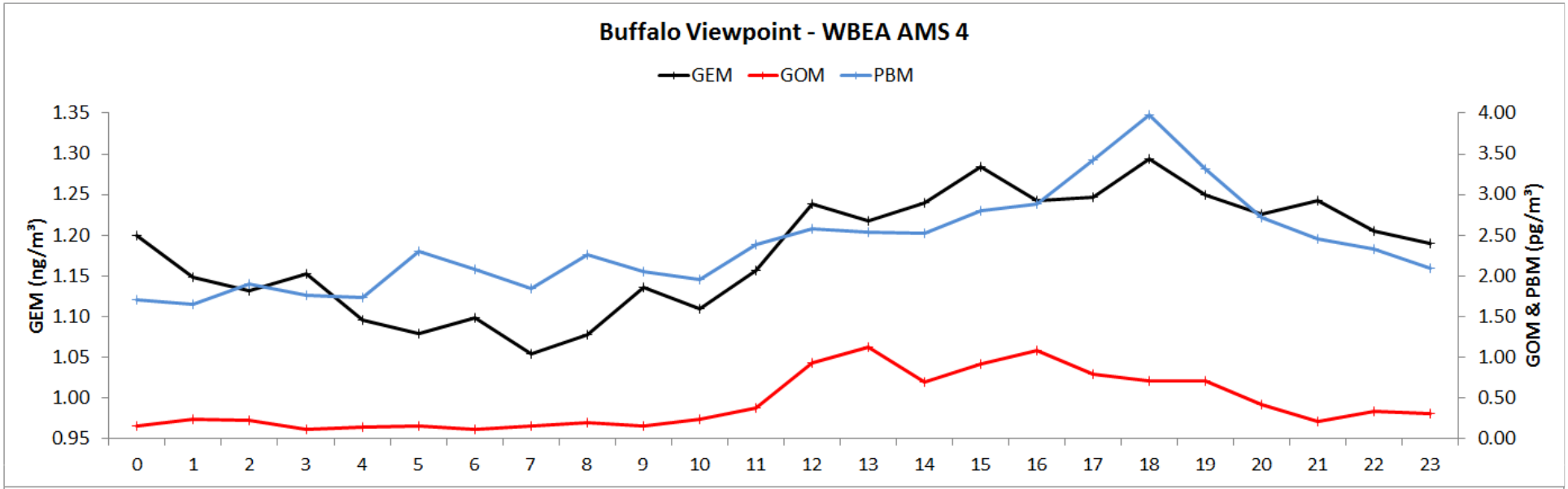
*AMS 4 from 13/08/2013 to 27/09/2013
*AMS 13 from 10/08/2013 to 11/09/2013

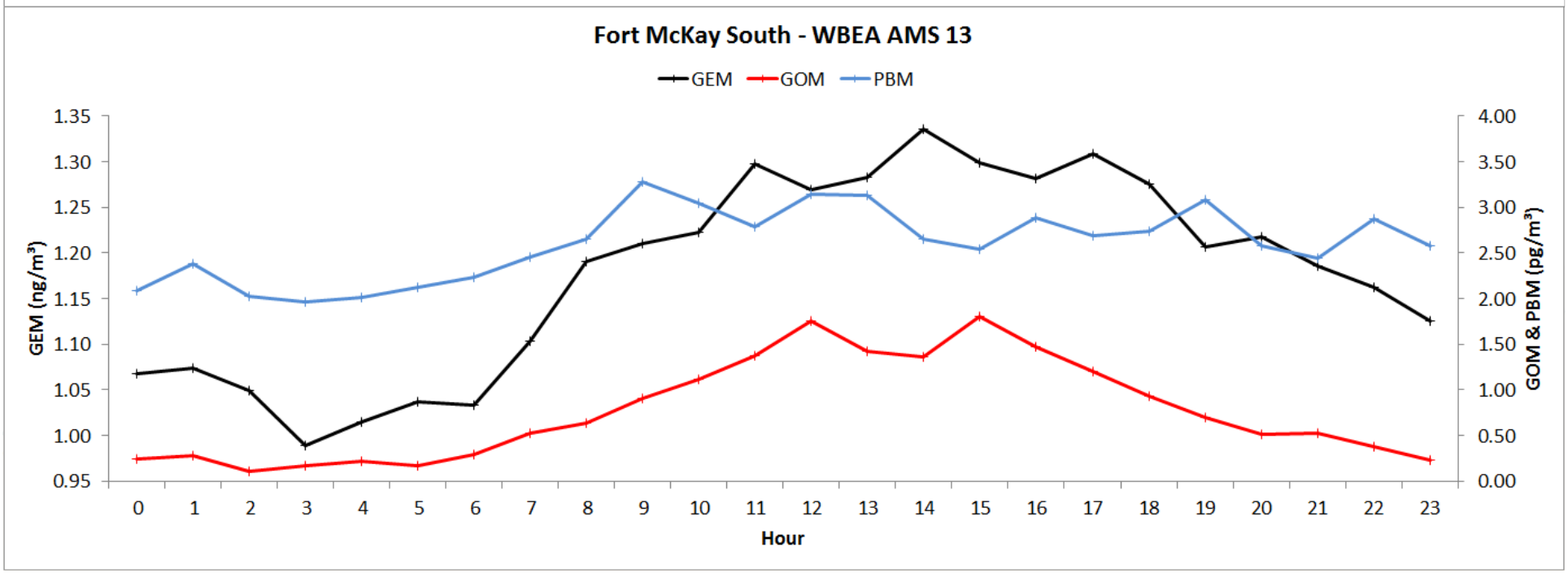
2013 Time Series



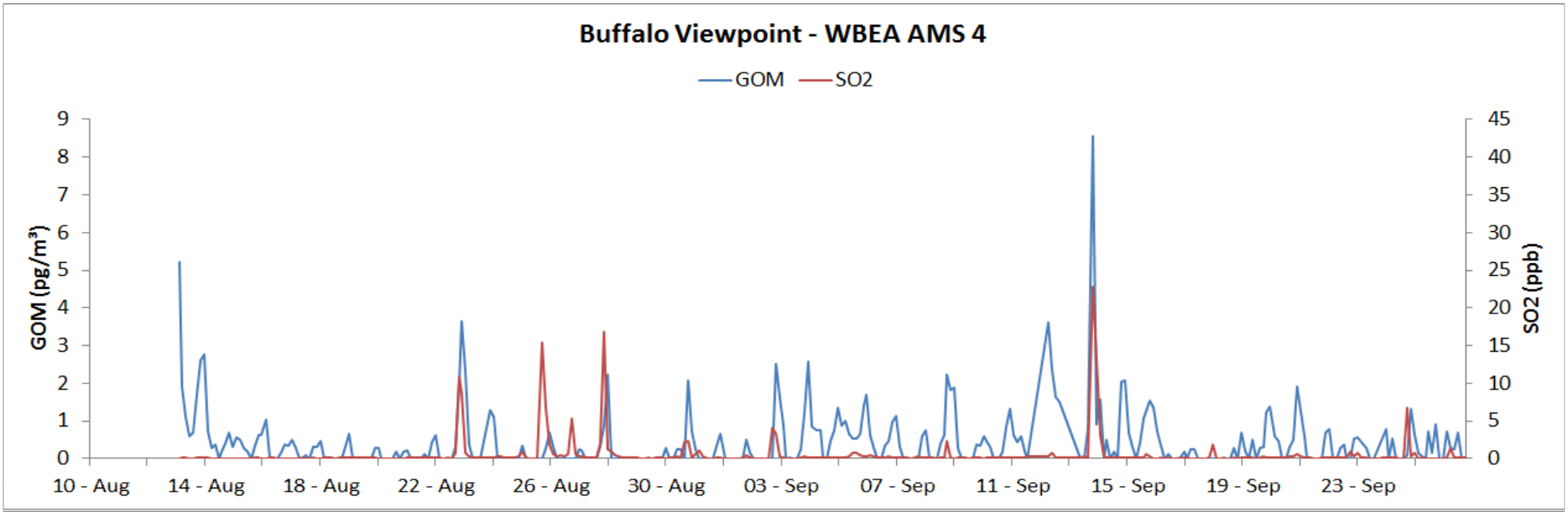


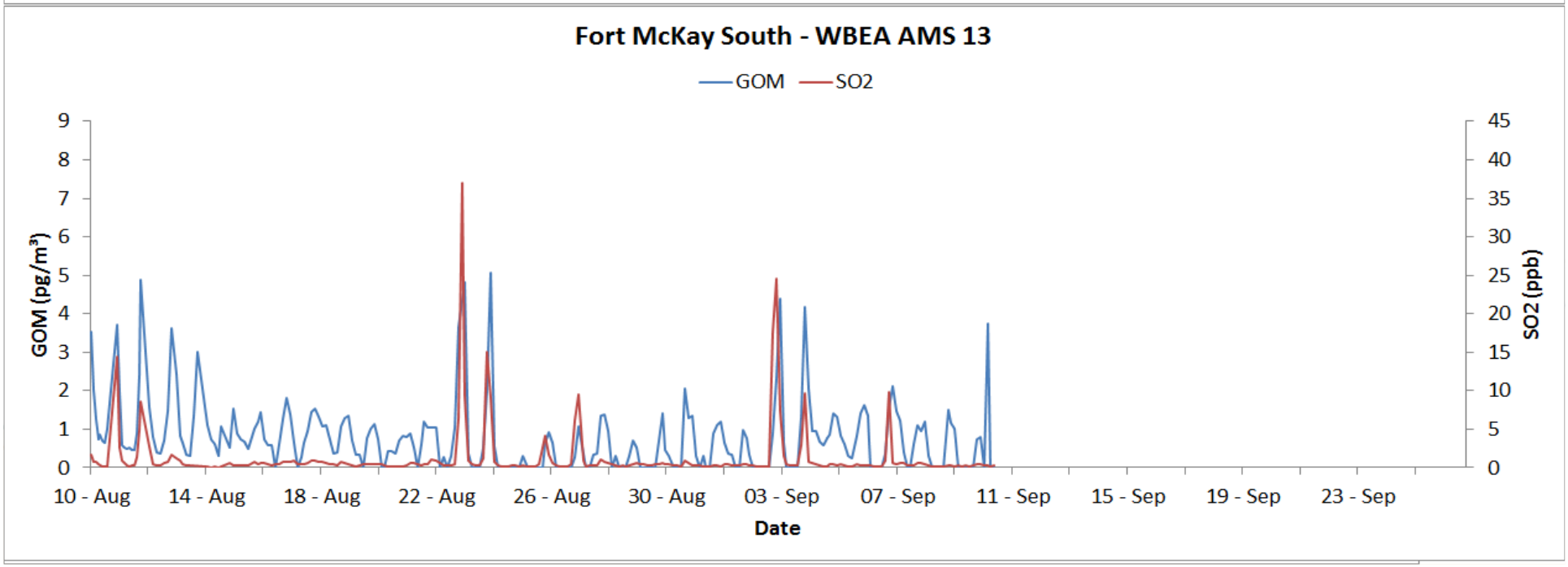
Diurnal Pattern

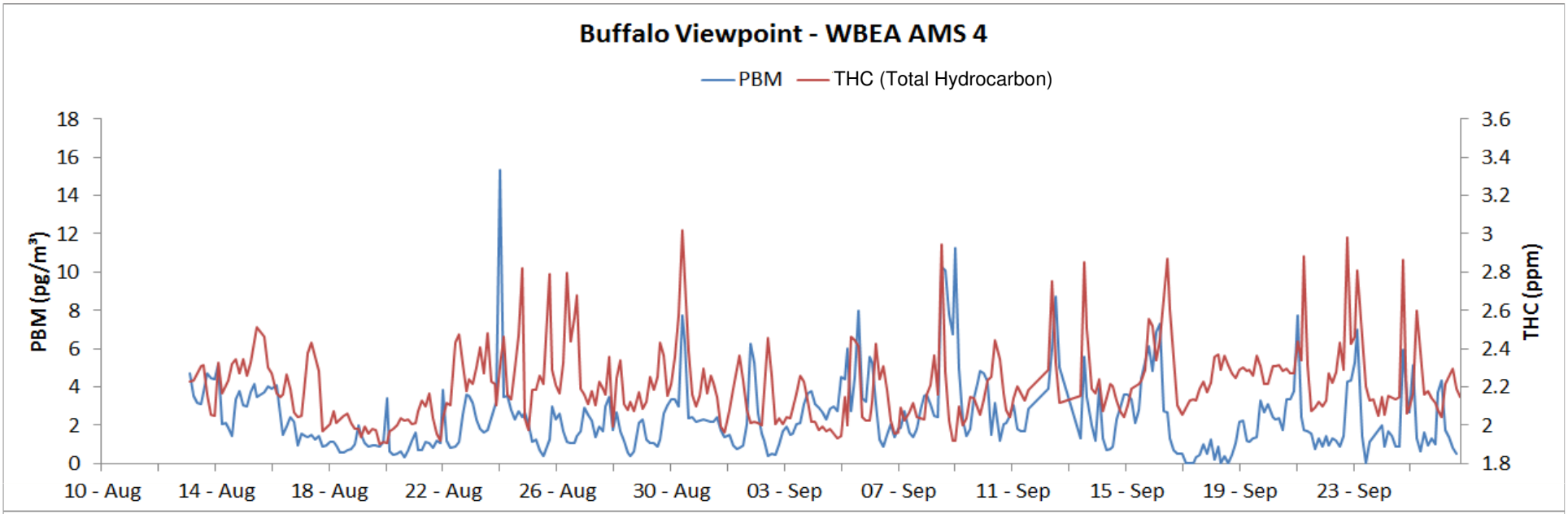


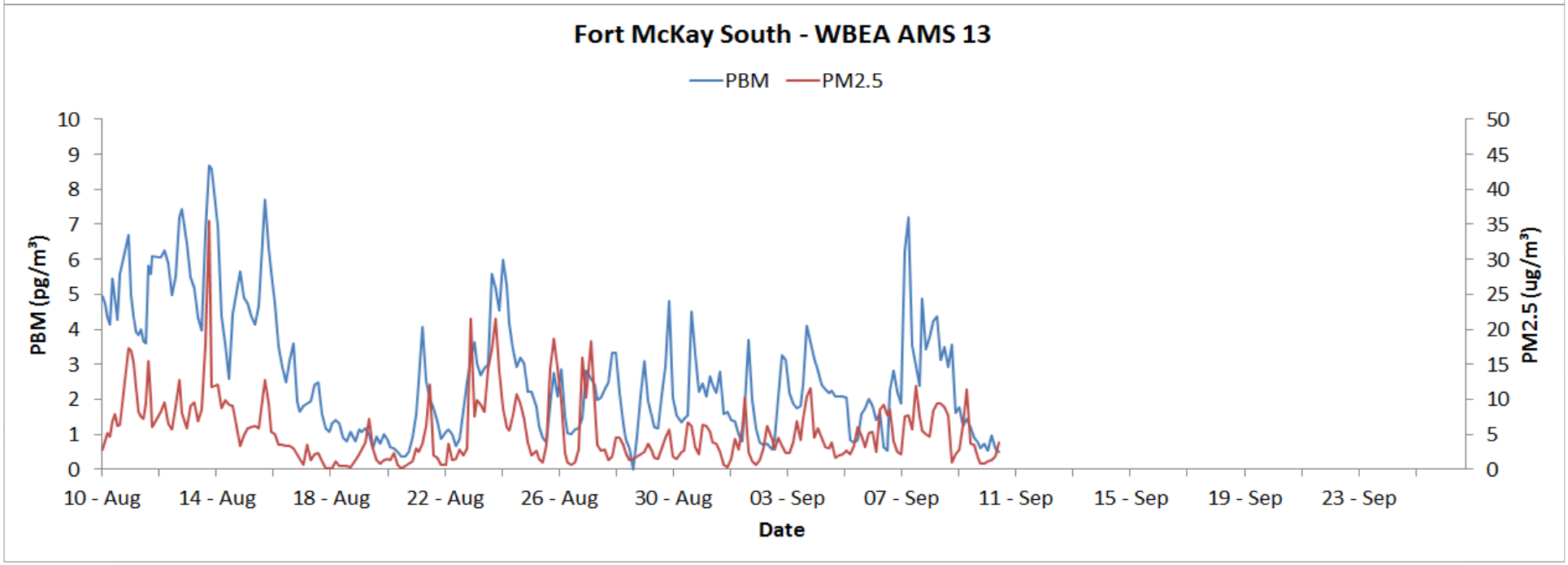


GOM and SO_2


Buffalo Viewpoint - WBEA AMS 4
GOM
SO2
GOM (pg/m³)
SO2 (ppb)
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25
30
35
40
45
10 - Aug
14 - Aug
18 - Aug
22 - Aug
26 - Aug
30 - Aug
03 - Sep
07 - Sep
11 - Sep
15 - Sep
19 - Sep
23 - Sep


Fort McKay South - WBEA AMS 13
GOM
SO2
GOM (pg/m³)
SO2 (ppb)
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25
30
35
40
45
10 - Aug
14 - Aug
18 - Aug
22 - Aug
26 - Aug
30 - Aug
03 - Sep
07 - Sep
11 - Sep
15 - Sep
19 - Sep
23 - Sep
Date


Buffalo Viewpoint - WBEA AMS 4
PBM
THC (Total Hydrocarbon)
PBM (pg/m³)
THC (ppm)
0
2
4
6
8
10
12
14
16
18
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
10 - Aug
14 - Aug
18 - Aug
22 - Aug
26 - Aug
30 - Aug
03 - Sep
07 - Sep
11 - Sep
15 - Sep
19 - Sep
23 - Sep


Fort McKay South - WBEA AMS 13
PBM
PM2.5
PBM (pg/m³)
PM2.5 (ug/m³)
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
40
45
50
10 - Aug
14 - Aug
18 - Aug
22 - Aug
26 - Aug
30 - Aug
03 - Sep
07 - Sep
11 - Sep
15 - Sep
19 - Sep
23 - Sep
Date

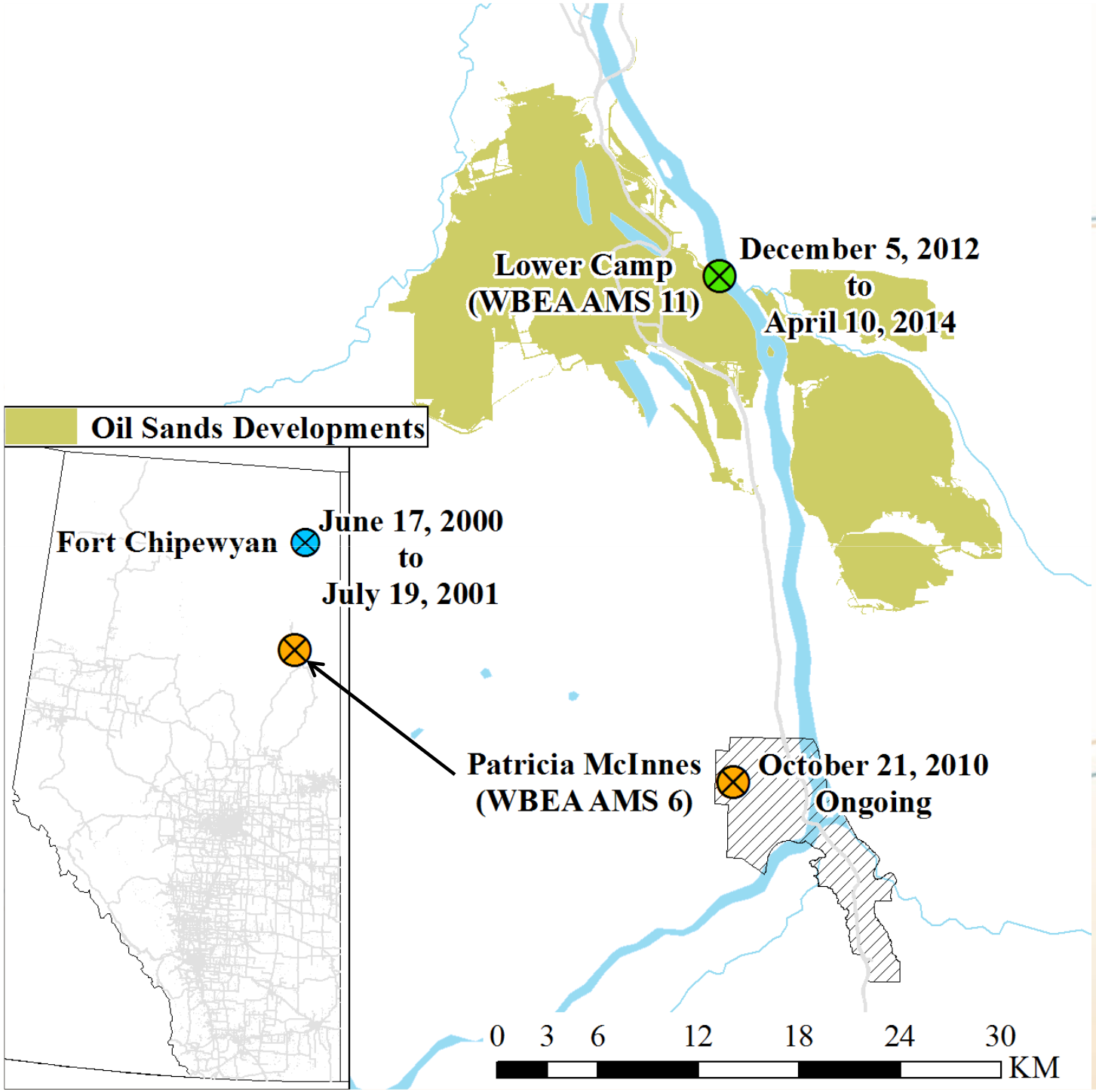
Next Steps

- More in-depth analysis of the speciated mercury datasets

- Collection of data from our new installation at Fort McKay South with co-located speciated mercury with $PM_{2.5}$ and PM_{10} inlets, along with TGM, and speciated particulate matter

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TGM Sites

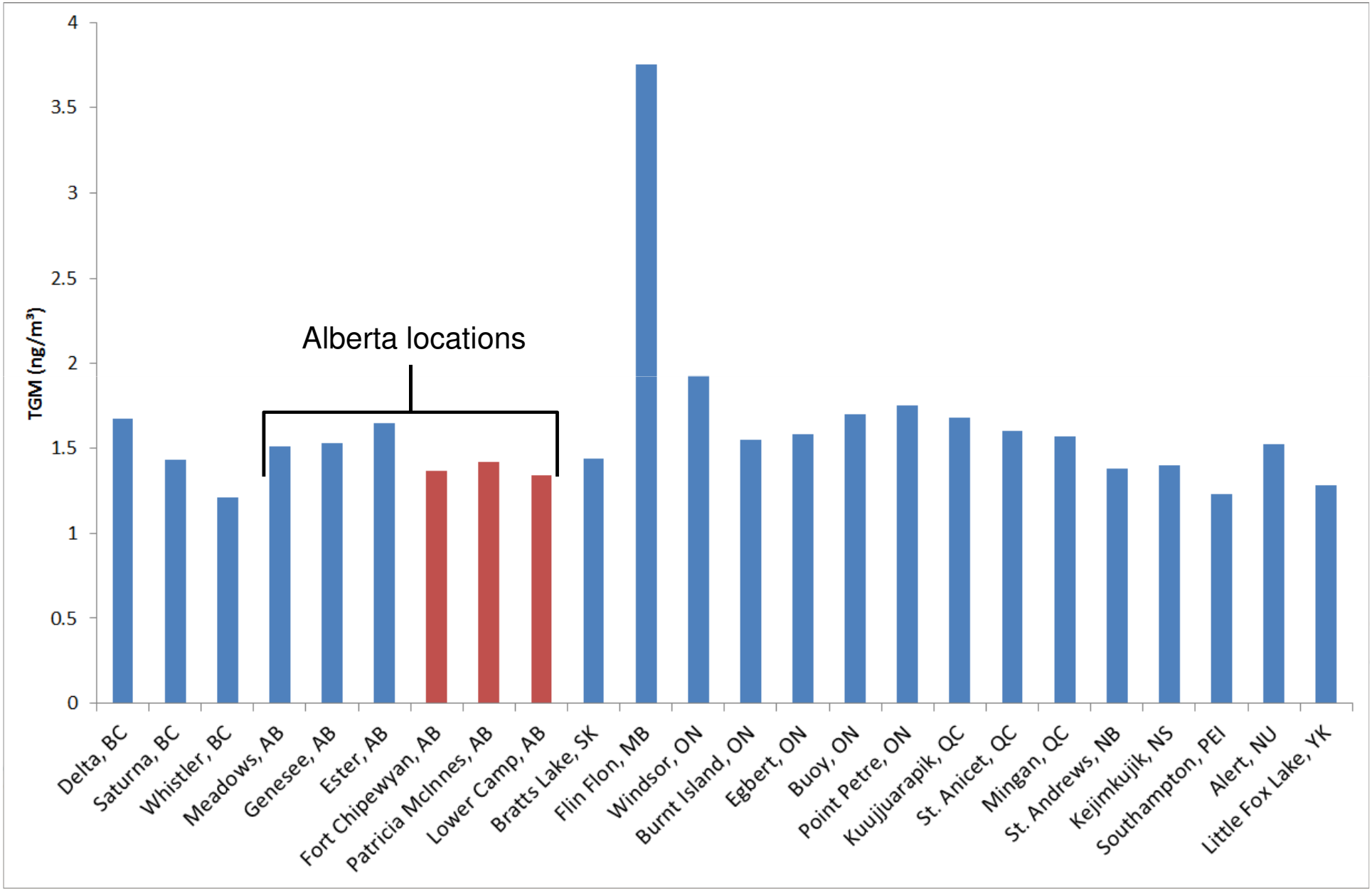


Canada

Comparison of TGM in Oil Sands Region

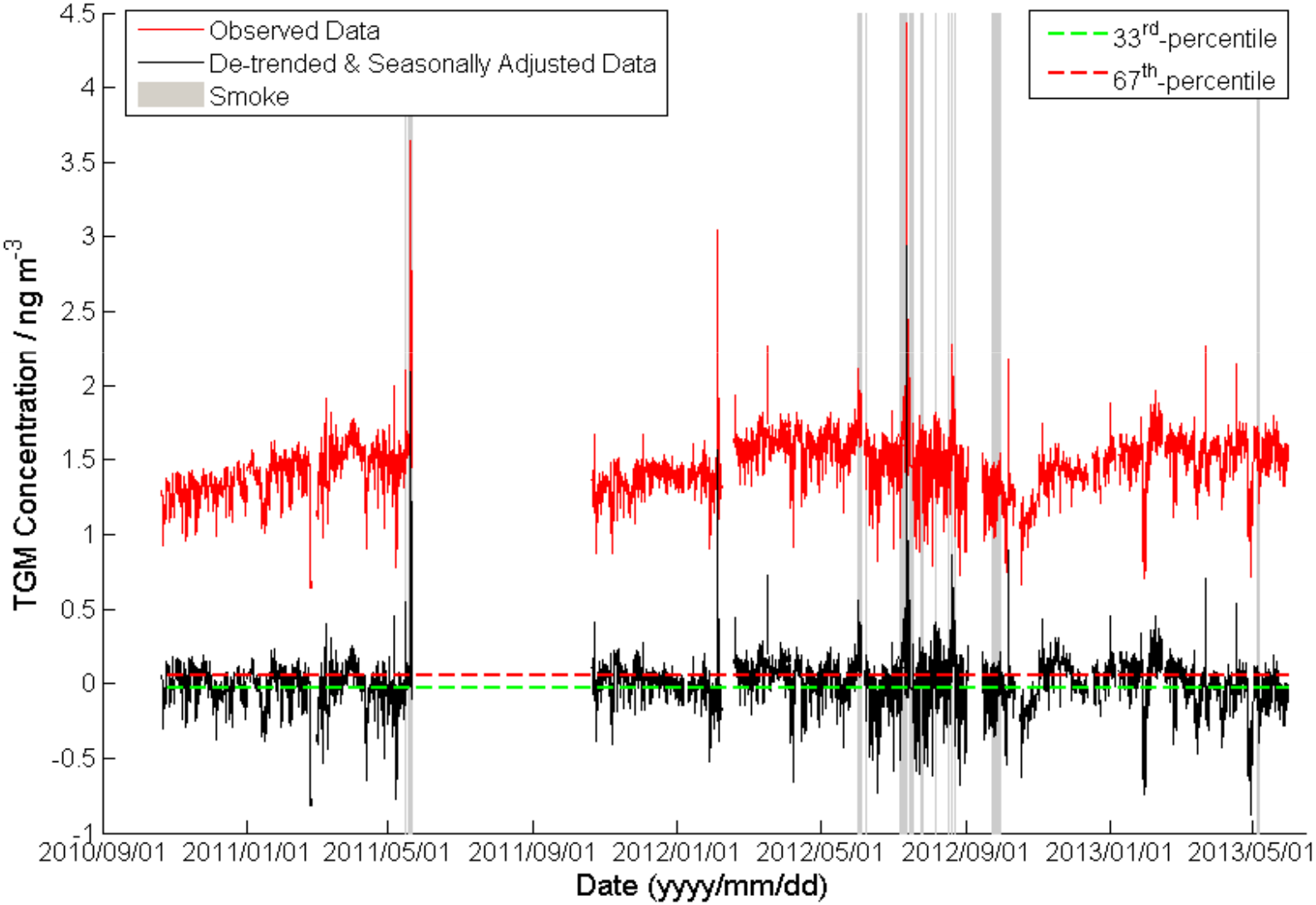
Station	Fort Chipewyan	Patricia McInnes	Lower Camp
	TGM – ng/m³	TGM – ng/m³	TGM – ng/m³
Average	1.37 ± 0.17	1.42 ± 0.20	1.34 ± 0.18
Max	2.18	4.43	2.89
Min	0.55	0.54	0.51
N	6908	21861+	8549+
Date	17/06/2000 – 19/07/2001	21/10/2010 – 31/12/2013	5/12/2012 – 31/12/2013

Mean TGM Concentrations over various years across Canada



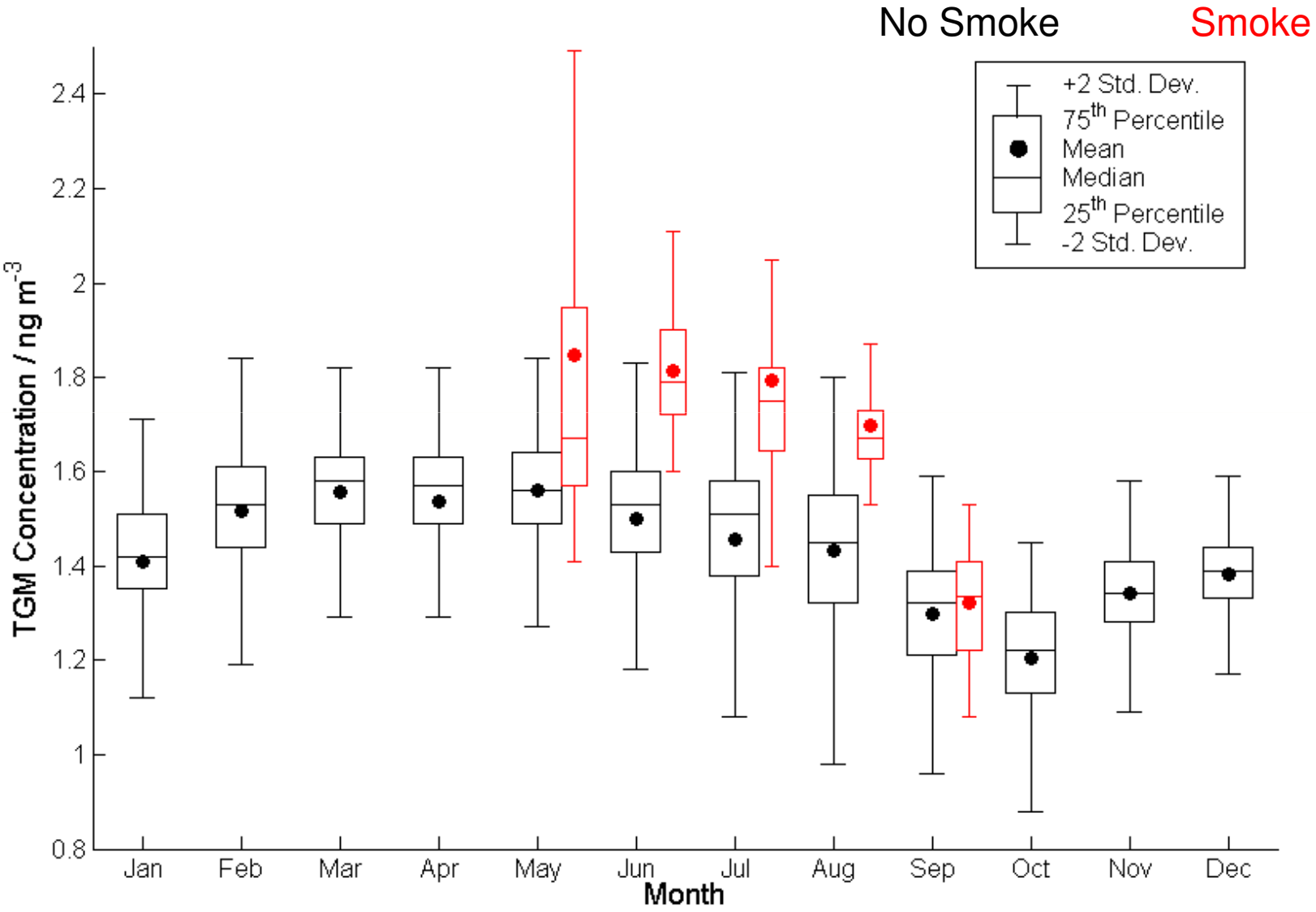
Time Series of Hourly TGM Deviations from Normal?

Patricia McInnes October 2010 – May 2013



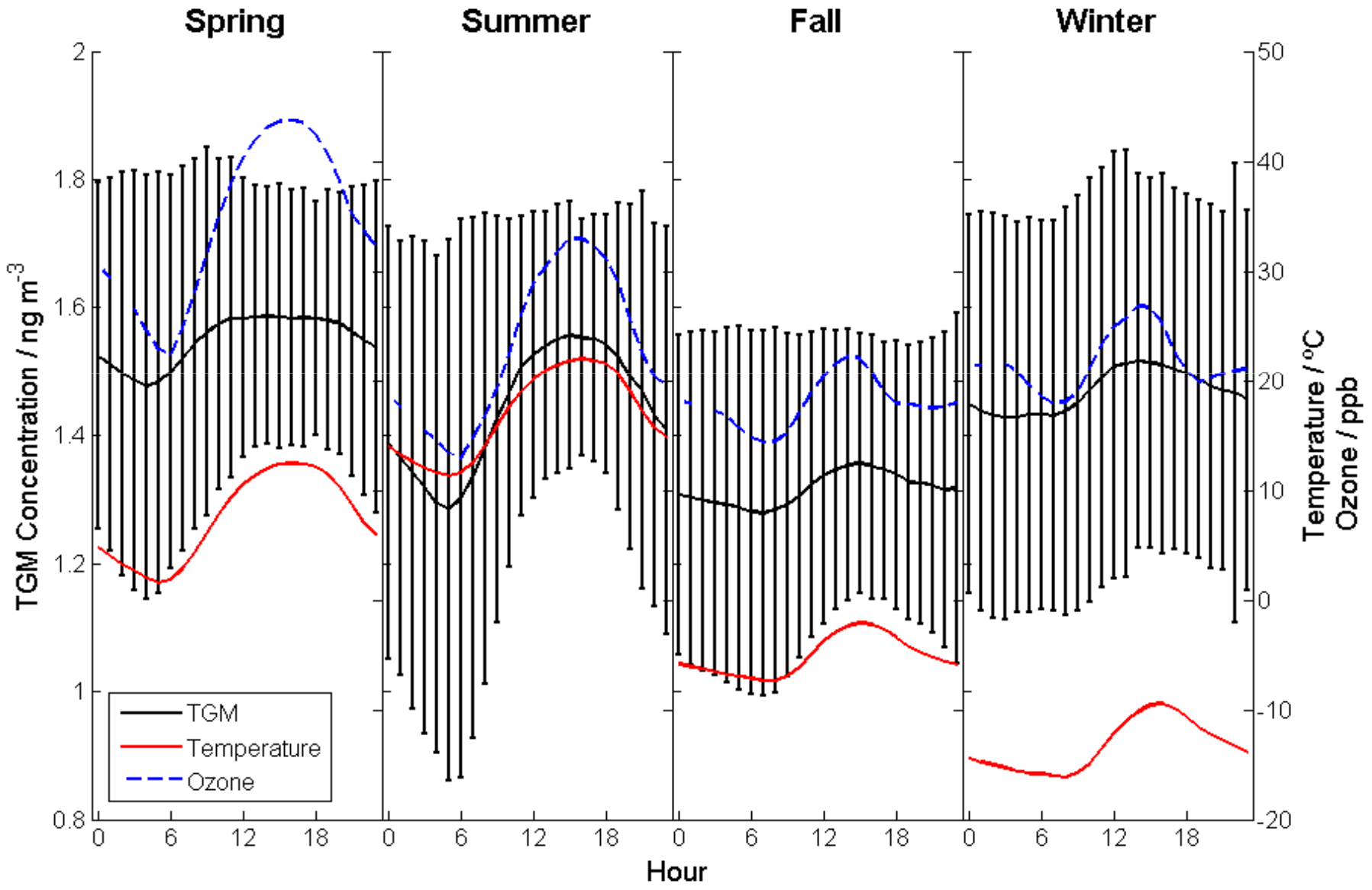
Seasonal Dependence?

Patricia McInnes October 2010 – May 2013



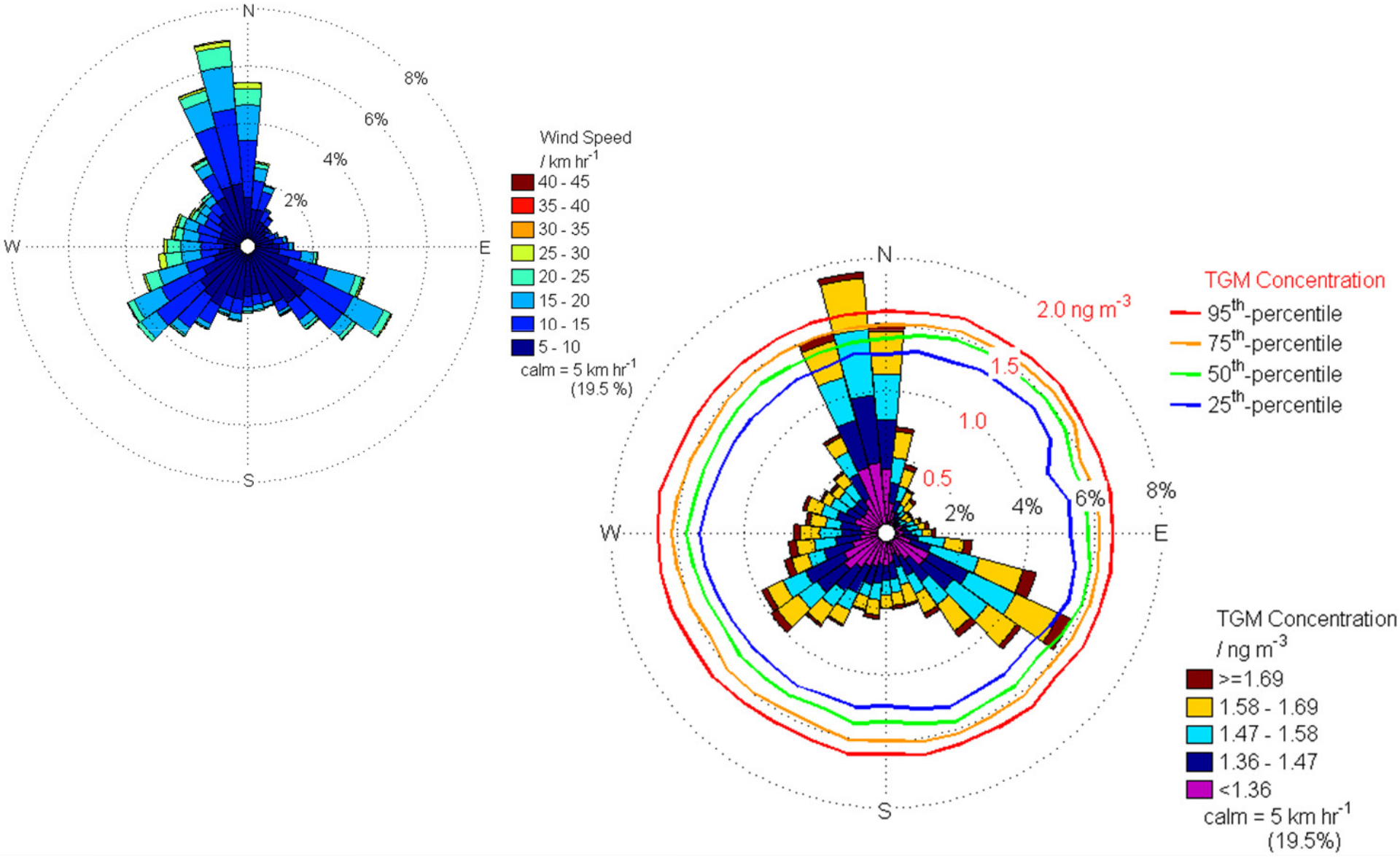
Seasonal Diurnal Profile of Mean TGM and Relationship to T and O_3

Patricia McInnes October 2010 – May 2013



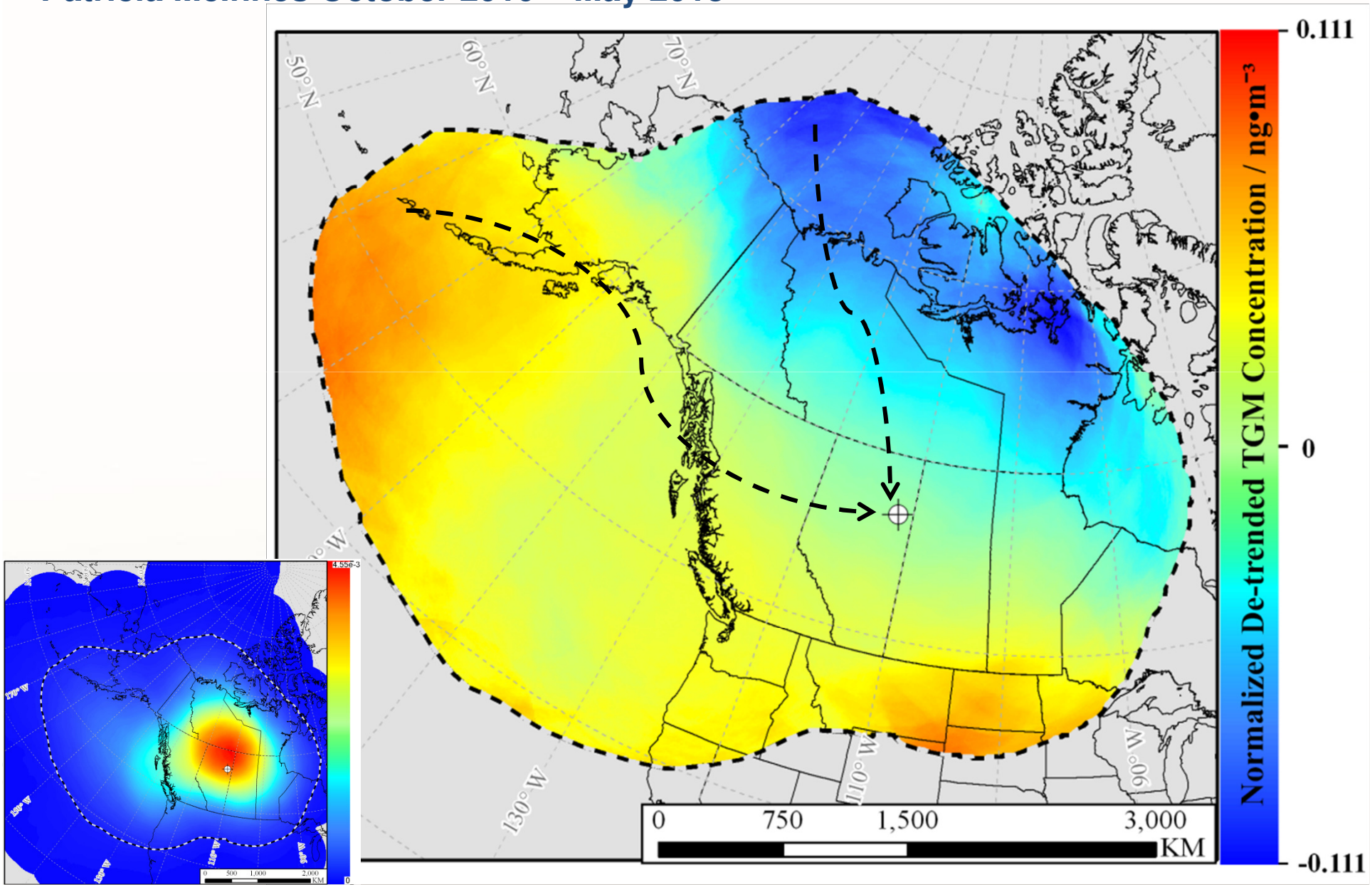
Local Sources of TGM?

Patricia McInnes October 2010 – May 2013



Long Range Transport?

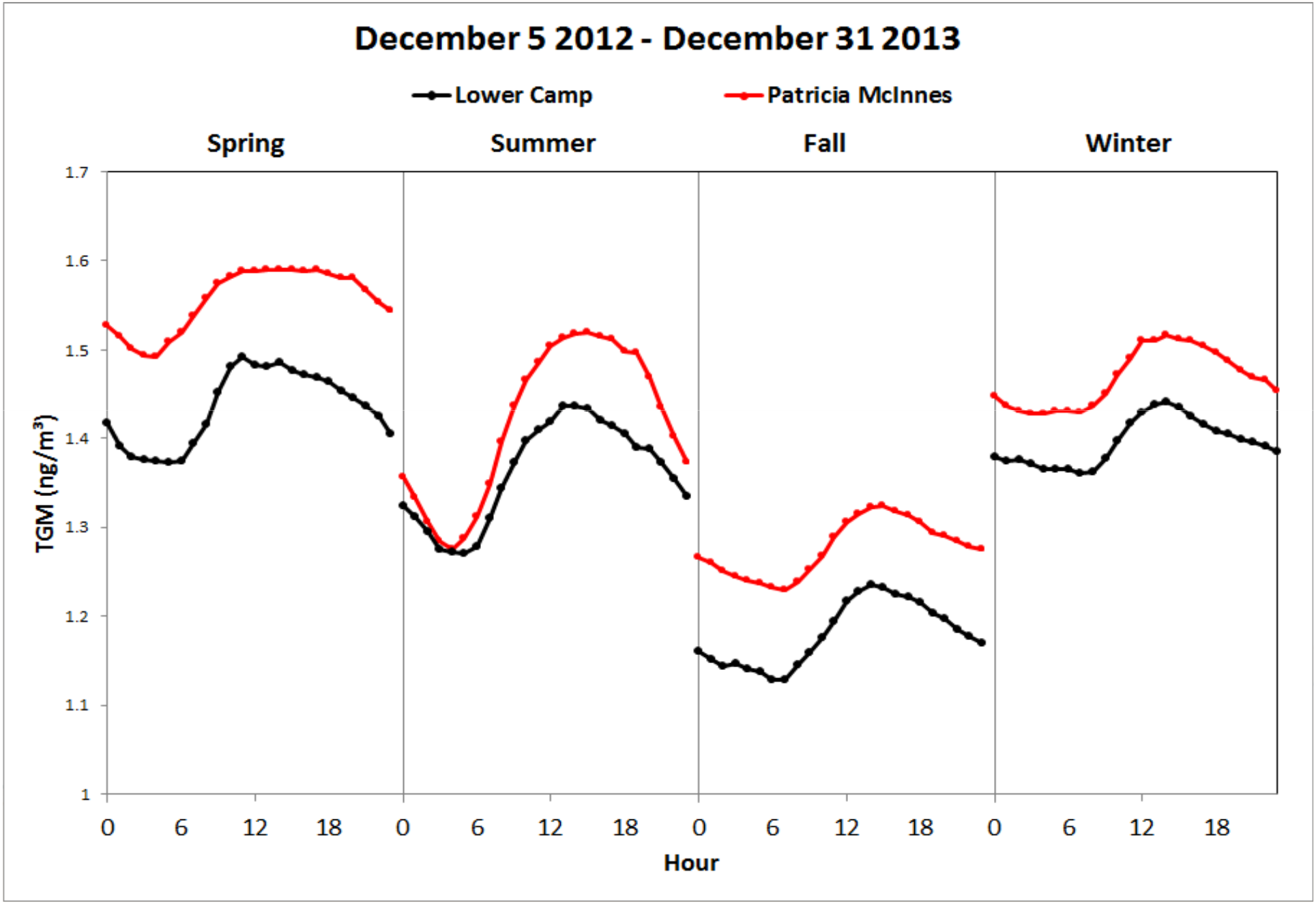
Patricia McInnes October 2010 – May 2013



Patricia McInnes – Key Findings

- TGM concentrations are similar to other sites in Alberta.
- PCA shows TGM is not significantly correlated with typical anthropogenic pollutants such as NO_x and SO_2.
- Unseasonably high TGM concentrations associated with forest fire smoke and air from regions to the southeast and west. Unseasonably low concentrations associated with air moving in from arctic regions.
- TGM concentrations undergo seasonal and diel trends, with high values in the spring and midday, and low values in the fall and early morning.

Seasonal Diurnal Profile of TGM



Lower Camp - Preliminary Findings

- Scatter plot of TGM at Patricia McInnes versus Lower Camp : slope = 0.97, R^2 = 0.74
- Concentrations at Lower Camp are generally lower than Patricia McInnes, and show similar diurnal and seasonal trends.
- Low concentration events at Lower Camp mirror low concentrations at Patricia McInnes, supporting the back trajectory analysis.

Conclusions

- TGM concentrations in the region are comparable to other rural areas in Alberta impacted by local industry.
- TGM concentrations at Lower Camp and Patricia McInnes show seasonal and diurnal similarities.
- Speciated mercury measurements are needed to provide additional information on mercury sources and chemistry.

Acknowledgments

- Thank the Wood Buffalo Environmental Association (WBEA www.wbea.org) staff responsible for local site maintenance, operations, and logistics.

Questions???

References

http://www.jointoilsandsmonitoring.ca/

http://www.mdpi.com/2073-4433/4/4/472

Parsons MT, McLennan D, Lapalme M, Mooney C, Watt C, Mintz R. Total Gaseous Mercury Concentration Measurements at Fort McMurray, Alberta, Canada. *Atmosphere*. 2013; 4(4):472-493.