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Kasshabog Lake – Dust Data

14 NOVEMBER 2012

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Acronyms:
TSP – total suspended particulates, PM10, PM2.5, PM1 – particulate matter less than 10, 2.5 and 1 microns in diameter, respectively.

Issue

This inquiry concerns air quality data collected by the Ministry of the Environment at Kasshabog Lake. This data has been gathered amid concerns regarding suspended particulates arising from tailings from the Unimin Mine.

Questions Posed

1) From May to October 2012, is there evidence that particulate levels are lower later in the season in comparison with earlier in the season?
2) What are the health implications of the observed dust levels?

Methods

Data Received

The data received provided minute readings of TSP, PM10, PM2.5, and PM1 as well as several meteorological variables (humidity, barometric pressure, wind speed and direction) for 24 May 2012 to 2 October 2012. The number of observations per month is:

- May – 10,548
- June – 26,705
- July – 13,771
- August – 29,595
- September – 43,187
- October – 2,245

Analysis Performed

The data was visualised as histograms by month for each suspended particulate reading (TSP, PM10, PM2.5, PM1) to test for the presence of peak readings. This confirmed the presence of peak readings through profoundly left-shifted data with a small number of very elevated readings (a narrow

distribution with the exception of a small number of outlier readings often 10-fold above the mean). The following summary quantilestatistics were then computed for all TSP, PM10, PM2.5 and PM1 values by month: mean, 90th percentile, 95th percentile, 98th percentile, and each permillile (‰ile) between 990 and 999. These permilliles permit assessment of peaks. The relative composition of TSP, PM10, and PM2.5 during peak episodes were computed by examining PM10:TSP and PM2.5:TSP ratios for all observations at or above the 99th percentile of TSP readings.

Analysis of meteorological data was not performed.

All Statistical analyses and graphs were generated using the R Statistical Package v.2.15.1 and Microsoft Excel 2010.

Results

Table 1 provides a summary of quantile statistics. The following trends are observed:

- Mean statistics show minimal variability by month. This is especially true for PM1 and PM2.5 observations. Maximal variability in mean observations is seen in the PM10 and TSP values when comparing May and September or October readings.
- At the 95th percentile, there is an approximately 2-fold variation in PM1, PM2.5 and PM10 readings between May and September and a 4-fold variation in TSP readings.
- Between the 990th and 999thpermillile, more substantial variability is observed. This is strong evidence of substantial but relatively brief peaks in the observed levels of TSP and PM10. Comparing May and September readings at the 999thmillile, there is an approximately 10-fold decrease in PM10 readings and a 4-fold decrease in TSP readings.

Figure 2 provides a summary of the trends observed in the 990th to 999thmilliles. Note that the y-axis is shown on a logarithmic scale. Again this provides substantial evidence of brief but intense changes suspended particulates, especially in PM10 and TSP values. These peaks values are most evident in May and August.

Analysis of the ratios of PM10:TSP and PM2.5:TSP revealed substantial variation in those ratios when observations below the 99th percentile of TSP readings were compared with observations above the 99th percentile. In brief, peak values of TSP (i.e.: those above the 99th percentile) were found to have a smaller PM10:TSP and PM2.5:TSP ratio than non-peak values. That is, peak TSP levels are composed of a larger proportion of suspended particulates larger than 10 microns than non-peak TSP levels. This is especially true during extreme peak episodes in August, where TSP values exceeded 1000 µg/m^{3}on 166 occasions and exceeded 10,000 µg/m^{3}on 2 occasions.

Discussion of Questions Posed

1) From May to October 2012, is there evidence that particulate levels are lower later in the season in comparison with earlier in the season?

The mean values for all suspended particulates suggest a decrease in particulate levels from May to October. However, these mean values are all within a narrow range, and this variability may be due to a variety of causes, ranging from an intentional intervention to meteorological variability.

Within the 990th to 999thmillile, used here to assess peak episodes, there is evidence that substantial TSP peaks occurred with particular severity in May and August. With the exception of August, all months after May showed substantially fewer peak episodes. The composition of suspended

particulates during peak episodes in May is different to the composition of peak episodes in August, possibly indicating a difference in the source of the particulate in August.

2) What are the health implications of the observed dust levels?

All computations performed on these data identify 24-hour levels below the Ontario standards (120 µg/m^3TSP measured as a 24-hour average over 3 years). However, use of these standards and the assessment of mean values (or even 98th percentile values) do not provide a meaningful assessment of health effects arising from peak dust events. Although these peak levels do not exceed any standard for ambient air, the standards do not attend to these kinds of peak readings well. Repeated brief episodes of TSP readings well above 1000 µg/m^3will likely be viewed as a nuisance and may have aggregate health effects. Whether mean 24-hour TSP, PM10 or PM2.5 readings are below existing standards is not relevant to these peak events.They will be perceivable and may be a nuisance and/or produce health effects such as eye, nose and throat irritation.

Conclusions

This analysis shows minimal variation in mean TSP, PM10, PM2.5 and PM1 levels between May and October 2012. The mean TSP readings meet existing air quality standards. However, there may be short-term peak events that may be missed if one looks only at mean concentrations. These kinds of peaks are observed in the data provided, especially in August and May 2012.

Table 1: Quantile Values for PM1, PM2.5, PM10 and TSP

Month	Quantile													
	50	90	95	98	99	99.1	99.2	99.3	99.4	99.5	99.6	99.7	99.8	99.9
PM1														
May	5.00	17.00	19.50	23.40	24.10	24.20	24.20	24.30	24.30	24.40	24.50	24.70	25.00	26.64
Jun	5.10	12.10	13.50	14.90	15.60	15.70	15.80	15.90	16.00	16.10	16.20	16.40	16.60	17.10
July	6.80	10.30	11.10	11.80	12.40	12.50	12.60	12.76	12.90	13.12	13.30	13.50	13.70	14.02
Aug	5.70	10.60	13.10	17.91	19.40	19.50	19.60	19.70	19.80	19.80	19.90	20.20	22.48	26.34
Sept	3.50	7.20	9.30	11.00	11.90	12.00	12.10	12.20	12.30	12.41	12.63	13.00	13.70	14.70
Oct	3.20	3.90	4.30	4.70	4.90	5.00	5.00	5.00	5.10	5.18	5.30	5.40	5.75	5.95
PM2.5														
May	8.50	21.10	23.90	27.6	28.40	28.50	28.56	28.70	28.90	29.80	32.79	37.44	45.46	66.99
Jun	8.30	15.80	17.20	18.7	19.70	19.80	19.90	20.00	20.10	20.20	20.32	20.60	20.90	21.60
July	10.10	13.80	14.60	15.4	15.90	16.00	16.10	16.30	16.60	16.70	16.99	17.10	17.25	17.85
Aug	9.00	14.40	17.10	21.9	23.30	23.40	23.52	23.70	24.79	27.70	32.79	40.40	47.70	61.66
Sept	6.70	10.80	12.90	14.63	15.60	15.74	15.90	16.00	16.10	16.20	16.60	17.00	18.00	18.60
Oct	6.40	7.40	8.00	8.7	9.10	9.10	9.20	9.23	9.30	9.40	9.40	9.50	9.70	9.78
PM10														
May	16.20	42.20	54.30	75.71	108.11	118.40	130.06	148.90	164.35	196.97	237.72	333.66	461.66	643.32
Jun	11.90	22.60	25.70	30.10	36.10	37.47	40.24	42.71	46.11	50.10	55.92	69.38	89.10	117.88
July	12.60	18.90	21.10	26.80	26.80	27.60	28.08	28.80	29.30	30.42	32.18	33.87	36.29	40.87
Aug	11.30	20.40	24.80	31.60	47.50	51.70	56.45	62.10	67.90	74.50	80.22	91.11	103.64	118.10
Sept	9.00	17.00	20.10	24.00	27.40	27.90	28.60	29.50	30.39	31.50	32.90	35.20	39.26	65.87
Oct	8.80	11.50	13.00	14.80	16.26	16.40	16.70	17.12	17.98	18.83	19.12	20.00	20.87	22.45
TSP														
May	26.65	97.50	144.47	245.99	352.55	363.85	376.95	399.97	446.72	480.20	555.21	714.16	1088.82	1356.75
Jun	16.20	38.80	47.40	72.29	105.49	112.70	123.61	132.52	143.58	158.75	175.11	211.65	258.76	352.25
July	17.70	28.30	32.30	41.46	49.13	50.10	51.35	52.00	53.74	54.90	57.00	59.07	64.75	72.07
Aug	15.40	32.60	46.10	81.72	272.77	340.04	422.20	534.44	835.68	1326.39	2344.44	3553.71	5398.87	6783.51
Sept	10.90	23.80	29.00	36.90	45.70	47.50	49.40	52.17	55.59	60.53	70.30	83.20	107.35	217.05
Oct	10.30	15.20	20.20	26.63	32.22	35.28	36.90	37.25	38.11	39.06	40.22	43.18	47.01	56.59

Figure 1: Graphs of 990th to 999thpermillile of PM1, PM2.5, PM10 and TSP readings