



Evolution of Environmental Monitoring

Kevin McCullum, Ph.D., P.Eng.
University of Regina & Matrix Solutions Inc.



Presentation Pathway

- Traditional Monitoring
- What drives our environmental monitoring
- Monitoring and data
- Evolution of monitoring
 - What can new monitoring platforms do for us
- What about the data



Traditional Monitoring

- Environmental monitoring has often been driven by:
 - Permit / Operational conditions
 - Collection of credible data
 - Data for decisions
- As we collect environmental samples
 - we learn more and then we ask more questions
- Questions often require more monitoring

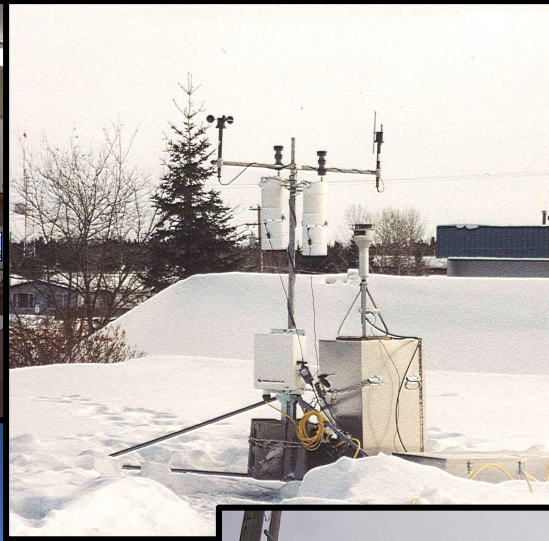


Traditional Monitoring

- Environmental monitoring = data
- Where is our current data?
 - Soils monitoring
 - Water monitoring
 - Groundwater monitoring
 - Company emission monitoring
 - Air monitoring



Traditional Monitoring



As we monitor more...

- As we sample more we often want the data faster
- With more sophisticated samplers – we now collect vast quantities of data
- We will dig further into air monitoring
 - Facility emissions (fence line)
 - Government monitoring (NAPS)

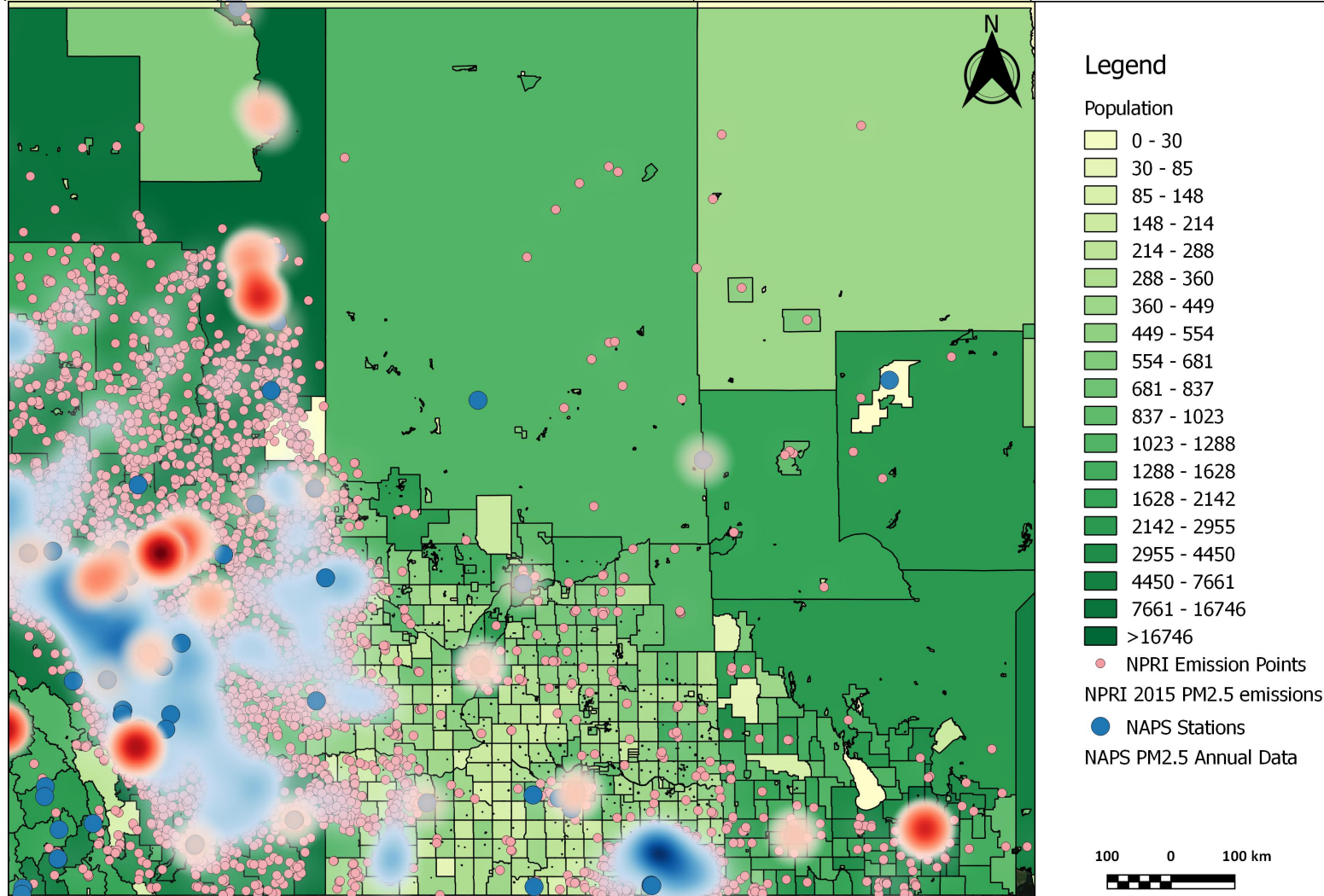


NAPS

NPRI

NAPS

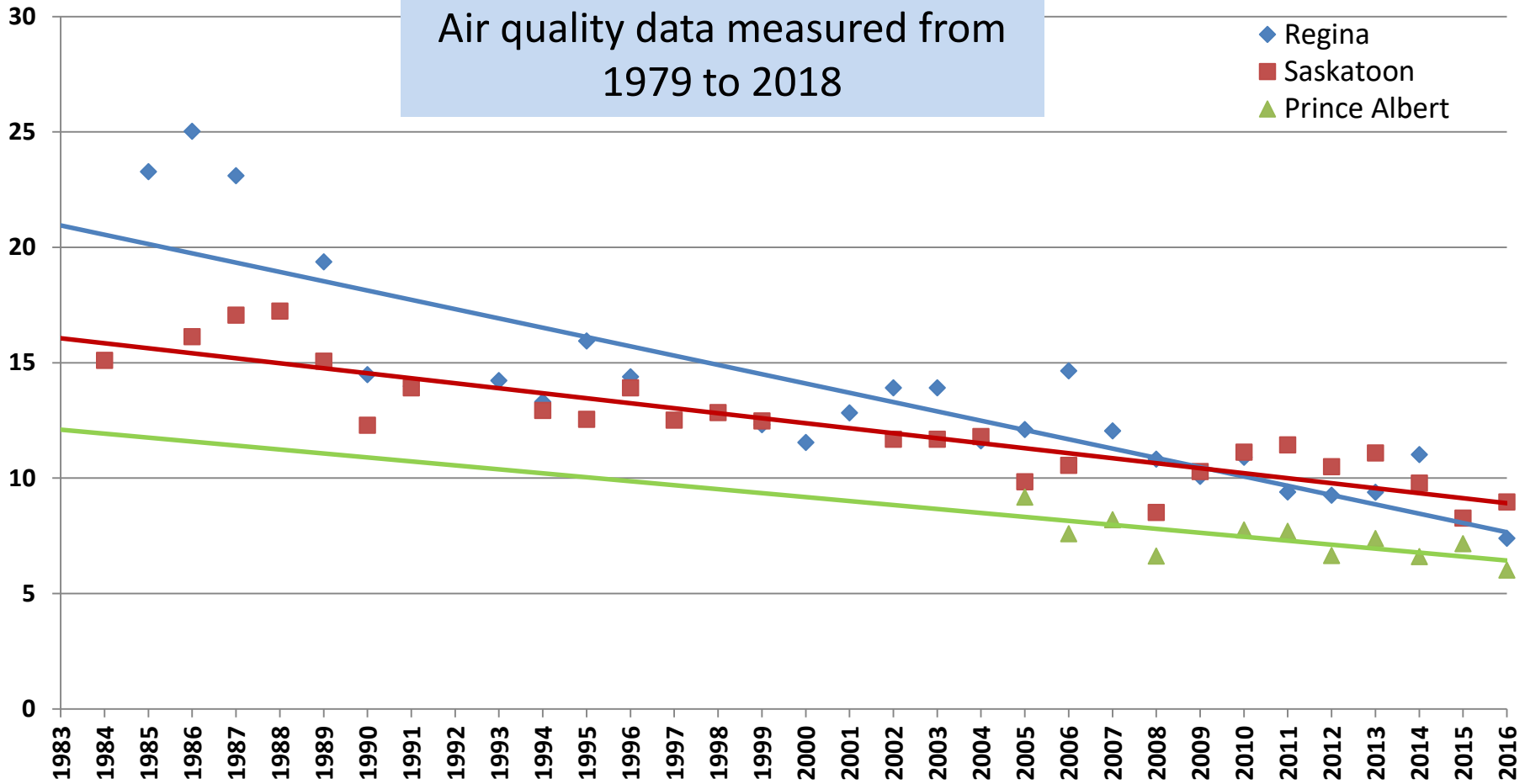
Data



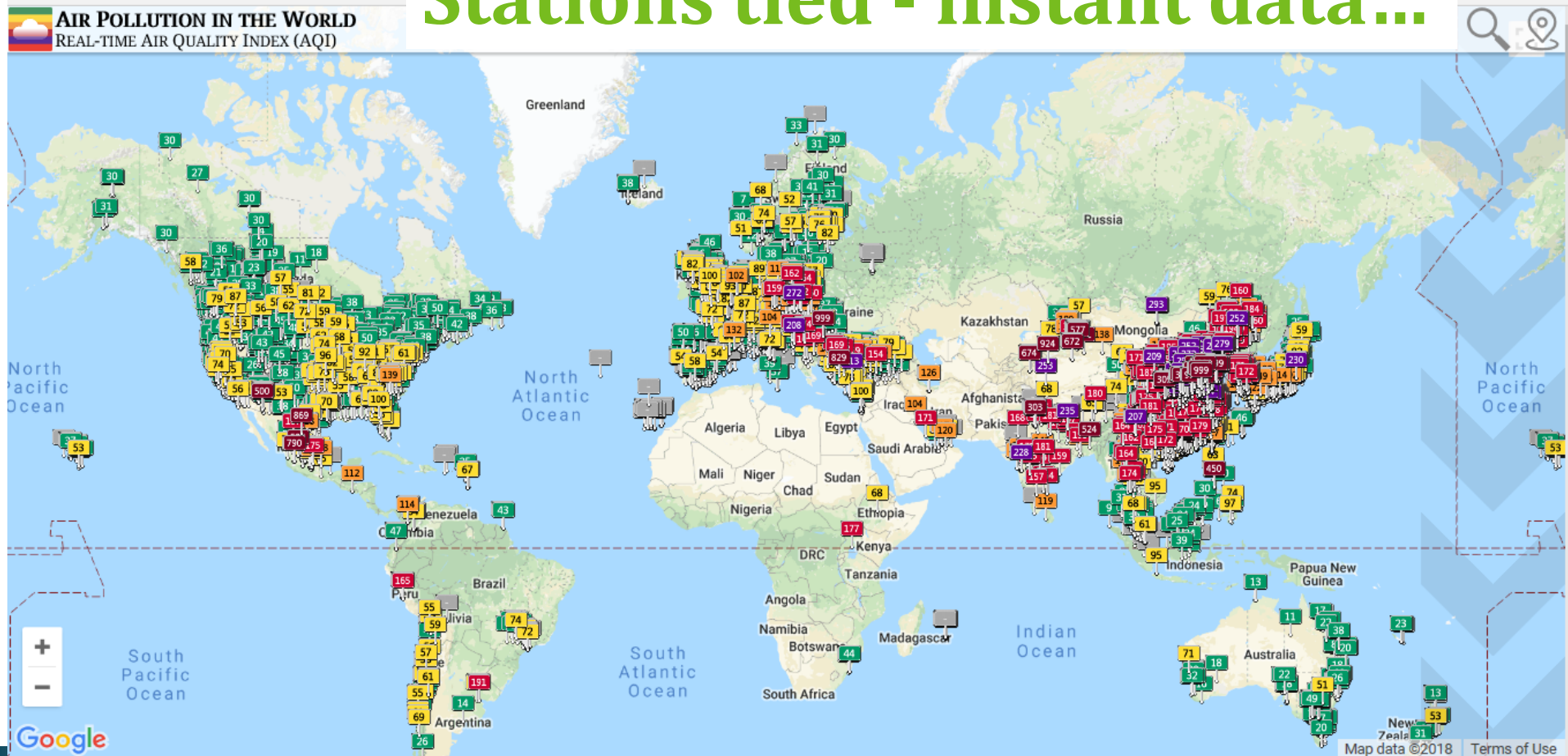
Air quality data measured from 1979 to 2018

- ◆ Regina
- Saskatoon
- ▲ Prince Albert

Nitrogen Dioxide (NO₂) in ppb



Stations tied - instant data...



Monitoring and Data Availability

- Many of our choices involve risk – the more data we have the better our risk decision becomes
- Concerns can come from
 - long delays in data before public facing
 - monitoring datasets that are well hidden
 - rapid monitoring data



Evolution of Monitoring

- Rapid data needs for both industry and public
 - some data is needed just for industry
 - public now has increased their involvement and become more engaged
 - public has the pulse on social media
 - citizen science is becoming more important
- We cannot manage what we do not measure
 - open information can lessen public fears



High air pollution levels prompt special weather statement for Calgary

Air Quality Health Index rated Calgary's air as high risk

CBC News · Posted: Mar 08, 2018 6:35 PM MT | Last Updated: March 8



Genetic study of Quebec residents finds air pollution trumps ancestry

IVAN SEMENIUK >
SCIENCE REPORTER
PUBLISHED MARCH 6, 2018

Air pollution leaves its mark on the human body, not just in the throats and lungs of those who breathe it in, but in their very DNA, a newly published Canadian study has found. The work provides a unique window into how

Environment

This is how much air pollution we breathe every day in Britain's cities

'Imagine how differently we might think of the issue of air pollution if it were visible all around us'

Beijing's air quality 'best' among China's northern cities despite frequent smog woes

Capital tops air quality rankings in 28 cities in northern China, according to environment ministry

PUBLISHED : Thursday, 06 April, 2017, 3:20pm

CTV NEWS

Video Shows Canada World Politics Entertainment Sci-Tech Health Autos Business

Air pollution during pregnancy could change structure of children's brains

Relaxnews

Published Friday, March 9, 2018 11:21AM EST

New European research has found that exposure to air pollution while pregnant could affect the cognitive function of children, by changing the structure of the brain.

EU urges Germany to introduce air pollution toll for drivers

AFP
news@thelocal.de
@thelocalgermany

7 March 2018
11:32 CET+01:00

eu

diesel

ban



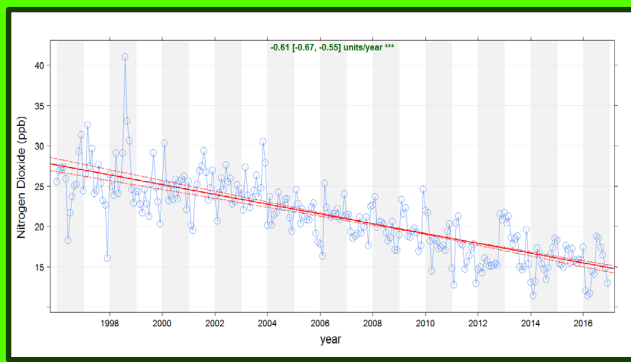
Despite gains, Toronto's air pollution still causing serious health problems

Toronto Public Health says that levels of major pollutants in the air have become stagnant after years of decline, with traffic emissions being the greatest source.

Evolution of Monitoring

- Sampling can be conducted with the most sophisticated technology or a sample bag
- What data do you need?
- Do we need ppm or ppt levels?
 - As we miniaturize our samplers we may sacrifice detection
- Do we want to see a trend?
 - Do we want something that can be rapid deployed and collect decent quality data





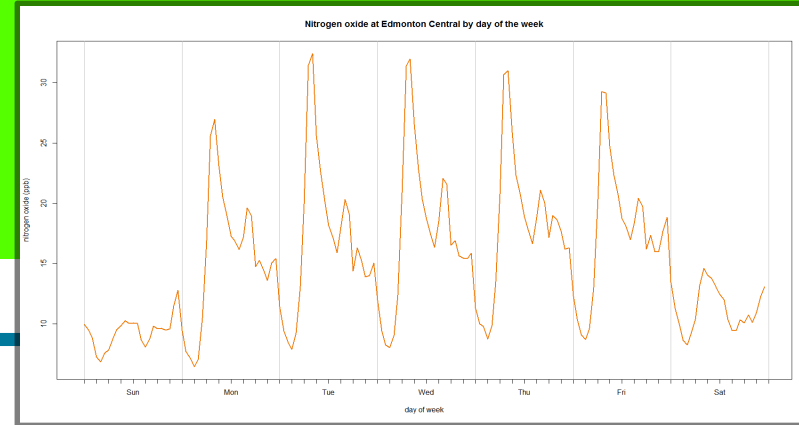
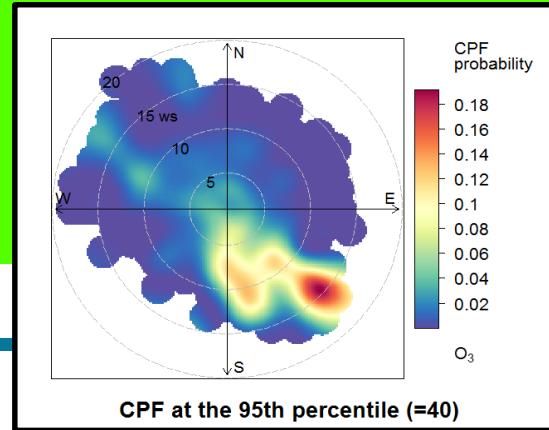
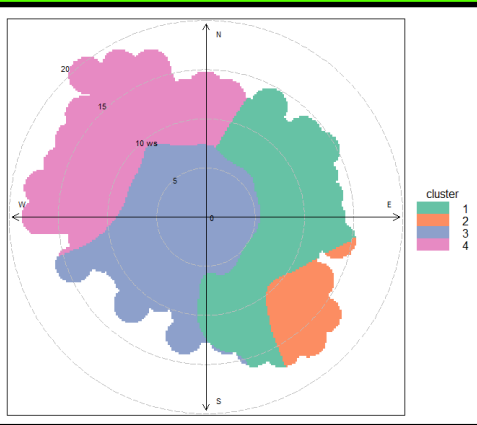
THC

NO₂

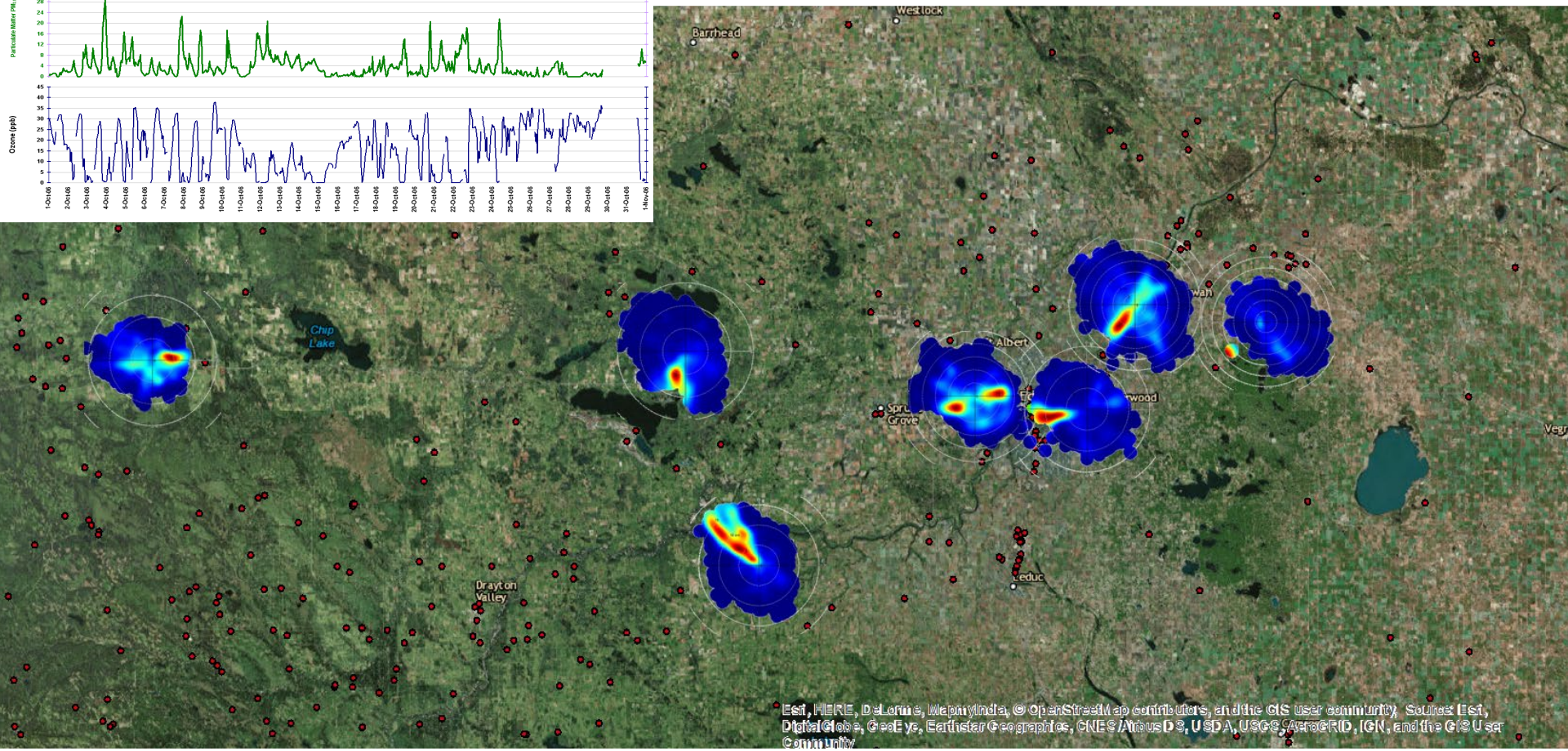
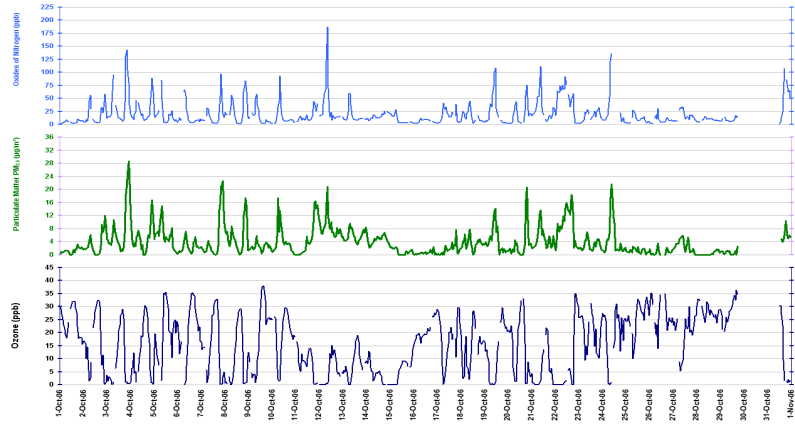
PM_{2.5}

O₃

PM_{2.5}



Explaining Trends / Profiles



Focus on Air Monitoring

- Monitoring stations measure the outdoor ambient air quality
- Data from a number of stations, collected over time are used to determine air quality in a region
- Most common data collection is from large and expensive continuous monitoring stations
- New monitors utilizing nanotechnology and algorithms are becoming smaller and inexpensive



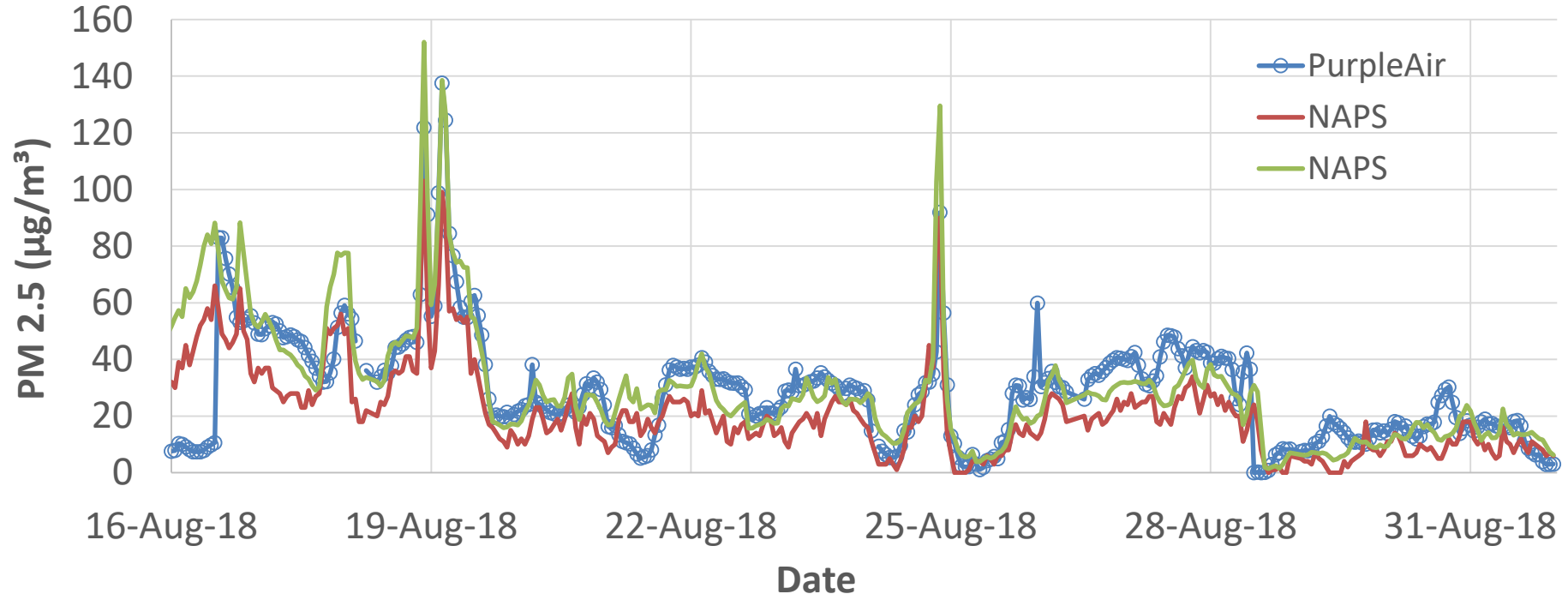
New Monitors – Small Portable Monitoring

- Airmetrics MiniVols ($\text{PM}_{2.5}$ / PM_{10})
- GRIMM aerosol analyzer ($\text{PM}_{2.5}$ / PM_{10} / TSP)
- Met One 9012 & E-Sampler ($\text{PM}_{2.5}$)
- AirBase (TSP, VOC, NO_2 , O_3)
- Dylos ($\text{PM}_{2.5}$ / PM_{10})
- Atmotube (VOCs)
- PurpleAir ($\text{PM}_{2.5}$ / PM_{10})
- Plume Labs Flow (TSP, NO_2 and O_3)
- Aeroqual AQS1 ($\text{PM}_{2.5}$ and O_3), AQY1 ($\text{PM}_{2.5}$ / PM_{10} , NO_2 and O_3)
- Vaisala AQT410 ($\text{PM}_{2.5}$ / PM_{10} , NO_2 , SO_2 and O_3)

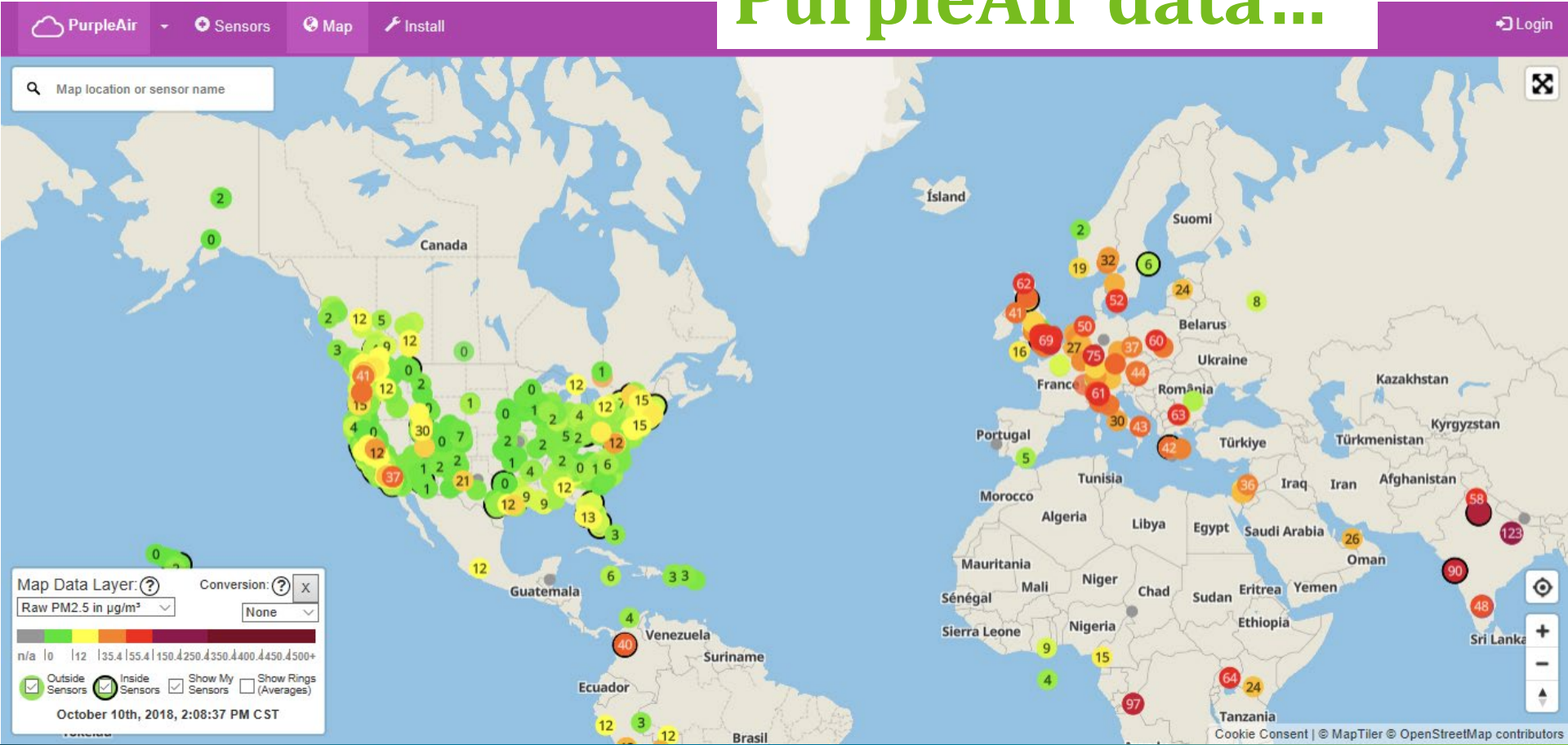


PurpleAir (~\$200) located east Regina

- Study conducted in August 2018



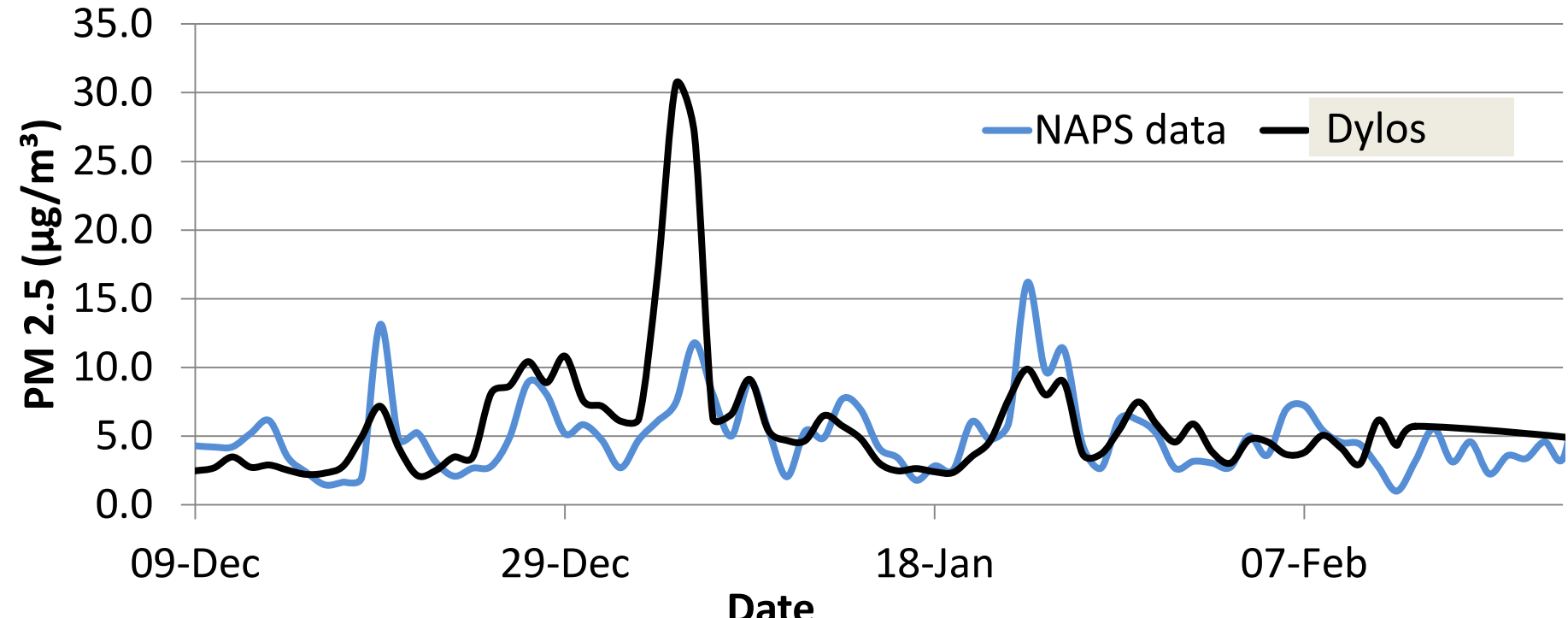
PurpleAir data...



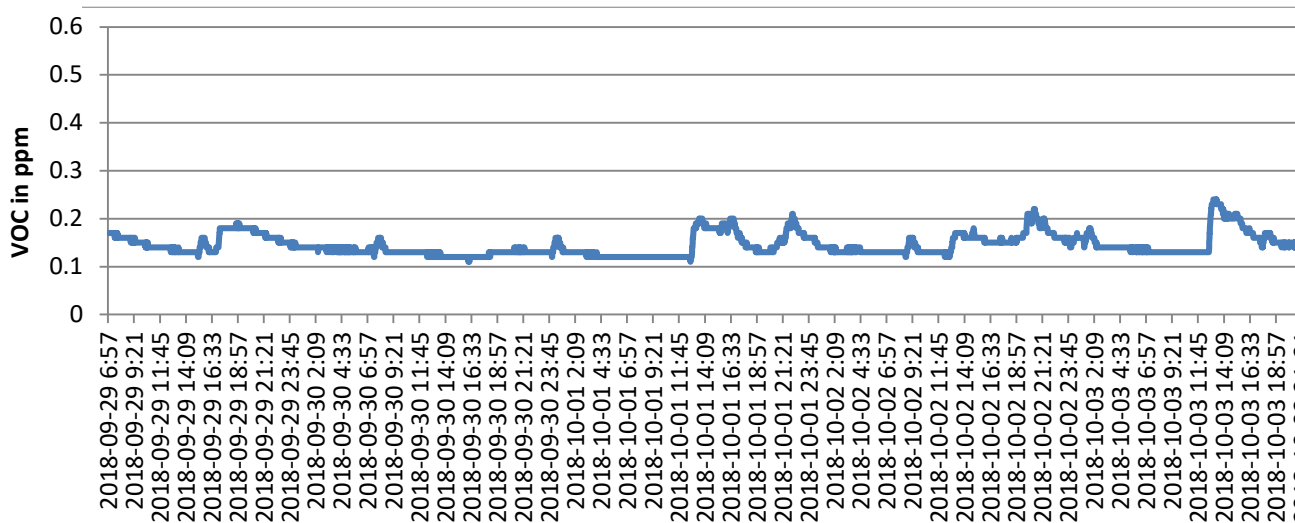


Dylos (~\$250) co-located at NAPS

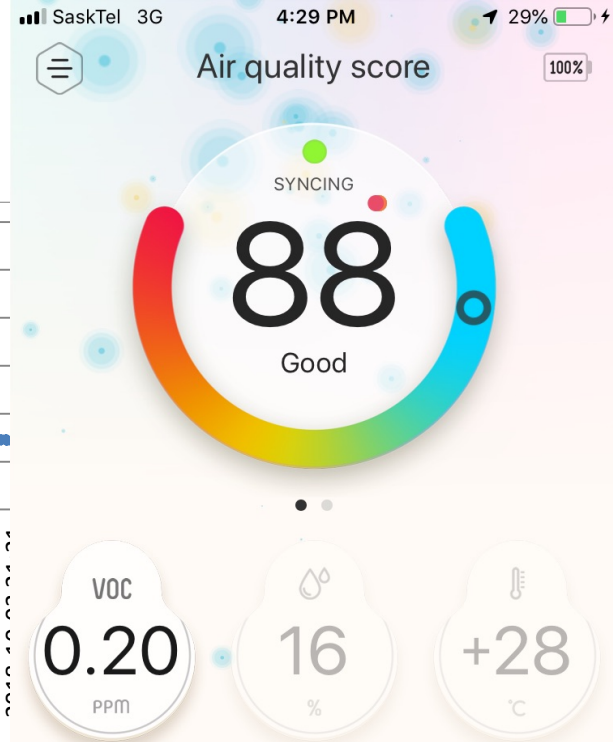
- Study conducted from Dec 2017 – March 2018



Atmotube (~\$250)

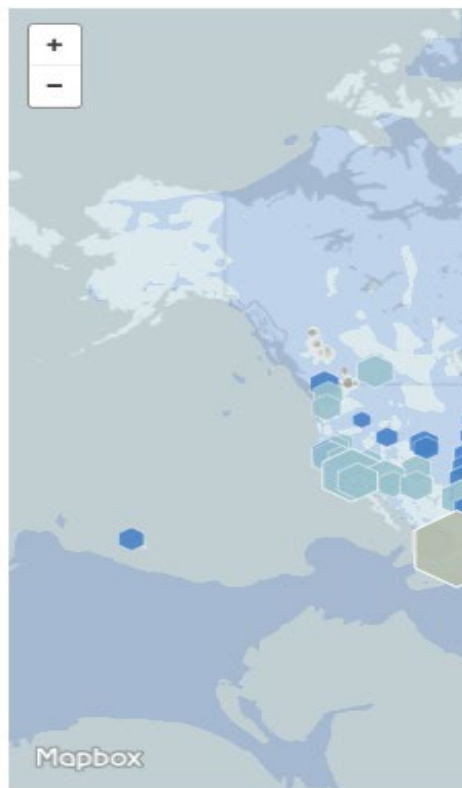


VOC monitoring study conducted between Sept 2017 and January 2018 – test above was in an office joining a vehicle shop



Air is Good

Air quality is considered satisfactory, and air pollution poses little or no risk.



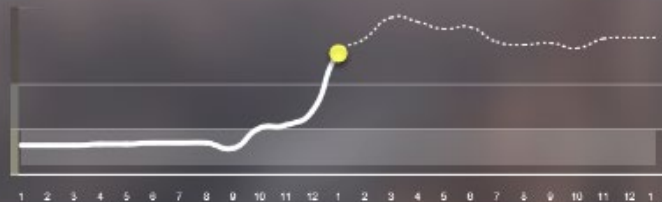
EXTREME pollution



Fri, October 12, 2018 1:00 AM

☁ 29°C UV 0

LIVE WEEK MONTH YEAR



- OUTDOOR SPORTS
TAKE CARE
- CYCLING
TAKE CARE
- BRING BABY OUT
TAKE CARE
- EATING OUTSIDE
TAKE CARE

ABOVE AVERAGE



Plume Air
Quality Index
annual average



MAIN POLLUTANTS



PARTICULATE
MATTER



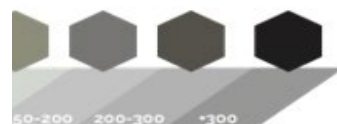
NITROGEN
DIOXIDE



OZONE



nStreetMap Improve this map



HOW TO READ THIS MAP
see our sources

Popul
of the

IMMEDIATE EFFECTS FOR
EVERYBODY

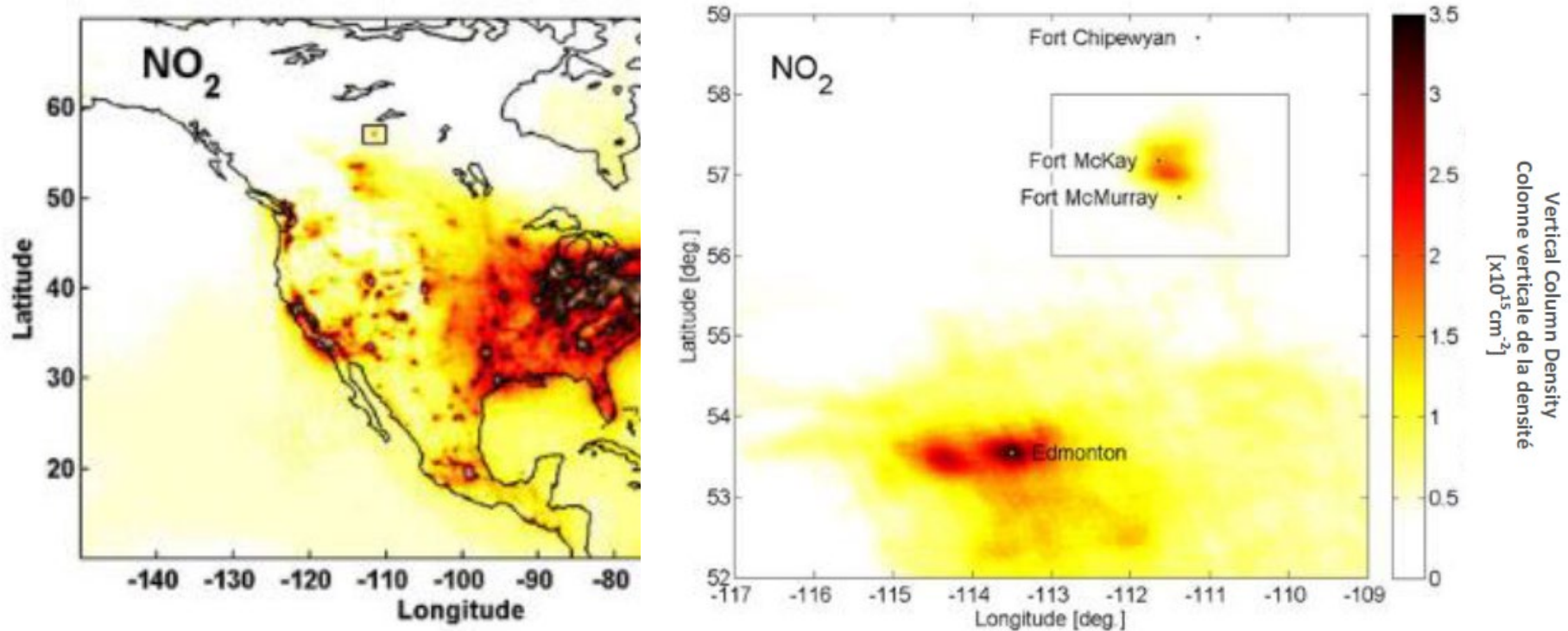
The pollution has reached extreme levels. Immediate effects on health.

Monitoring Evolution - Continued

- Remote Sensing
 - Extensive studies have been conducted in the Oil Sands Region for SO_2 , NO_2
 - $\text{PM}_{2.5}$ models based on MODIS retrievals have been used to extend ground monitoring networks
 - Copernicus Sentinel-5P mission (European Space Agency), which is dedicated to atmospheric monitoring



Remote Sensing – from OMI



Monitoring Evolution - Continued

- Coupling UAVs & monitoring
- Research is being conducted at several universities to use UAVs for environmental monitoring
 - small monitors
 - micro mass specs
 - multi spectral cameras
- Current research is mounting small monitors with UAVs



Summary

- Monitoring techniques will continue to get faster and more accessible
- Data will be our next hurdle – how much data do we need and what do we do with it
- Our new monitors are focusing on community and rural monitoring as well as citizen science for environmental information



Summary

- As we tie the environmental monitoring together from air - water - soil – we will use this information to aid our future decisions with clearer pictures of the environment





Questions

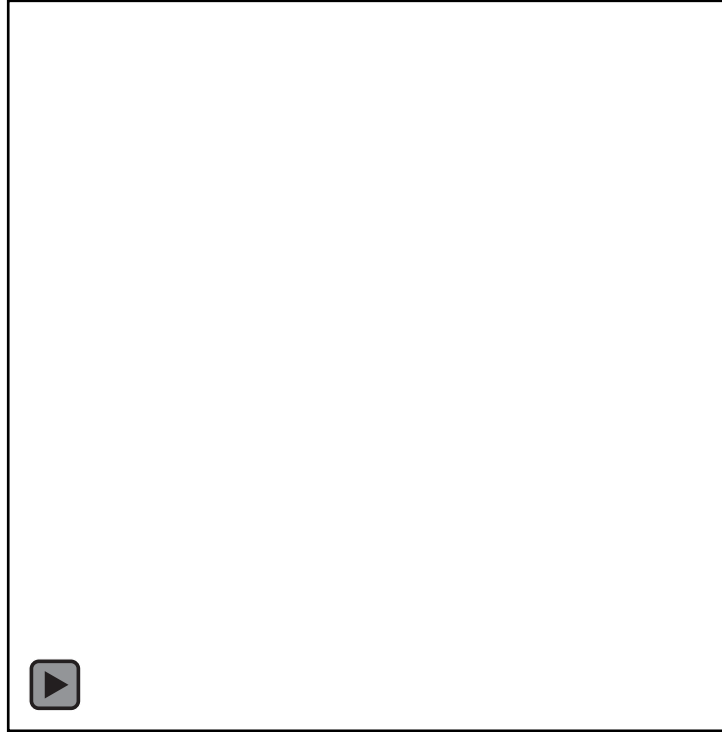
Kevin McCullum, Ph.D., P.Eng.

Kevin.mccullum@uregina.ca

kmccullum@matrix-solutions.com



Advantage of small equipment...



Office Locations

SASKATCHEWAN

Weyburn

Box 279, 1780 Railway Ave.
Weyburn, SK S4H 2K1
Phone: 306.842.3088
Fax: 306.842.3356

Swift Current

#2 505 N Service Rd. W
Swift Current, SK S9H 4X5
Phone: 306.773.3009
Fax: 306.773.3109

Regina

34A Great Plains Rd.
Emerald Park, SK S4L 1B7
Phone: 306.781.7750
Fax: 306.781.7751

Oxbow

874 Prospect Ave.
Oxbow, SK S0C 2B0
Phone: 306.483.2179
Fax: 306.483.2197

Lloydminster

102A 1625 – 50th Ave.
Lloydminster, SK S9V 1T3
Phone: 306.825.6900
Fax: 306.825.6907

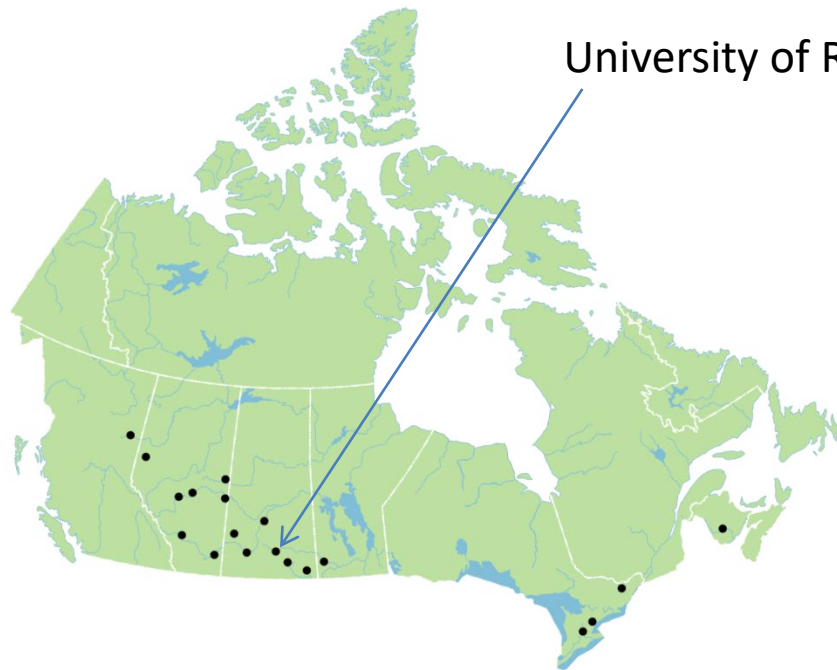
Kindersley

3A, 1319 – 11th Ave. W
Kindersley, SK S0L 1S0
Phone: 306.460.9635
Fax: 306.463.2190

Saskatoon

102 – 116 Research Dr.
Saskatoon, SK S7N 3R3
Phone: 306.649.3320
Fax: 306.649.3321

24-Hour Spill Response
1.877.774.5525 or
1.877.SPILL25



University of Regina

