Peace River Area Monitoring Program (PRAMP) - Air Quality Monitoring Network Evaluation

Evaluation Summary

September 27, 2022

Loredana Suciu[1] and Randy Rudolph[2]

1 Air Quality Scientist (AECOM, Houston, TX, U.S.A.), Loredana.Suciu@aecom.com

2 Associate Vice President, Oil & Gas Market Sector Lead (AECOM, Calgary, AB, Canada), Randy.Rudolph@aecom.com

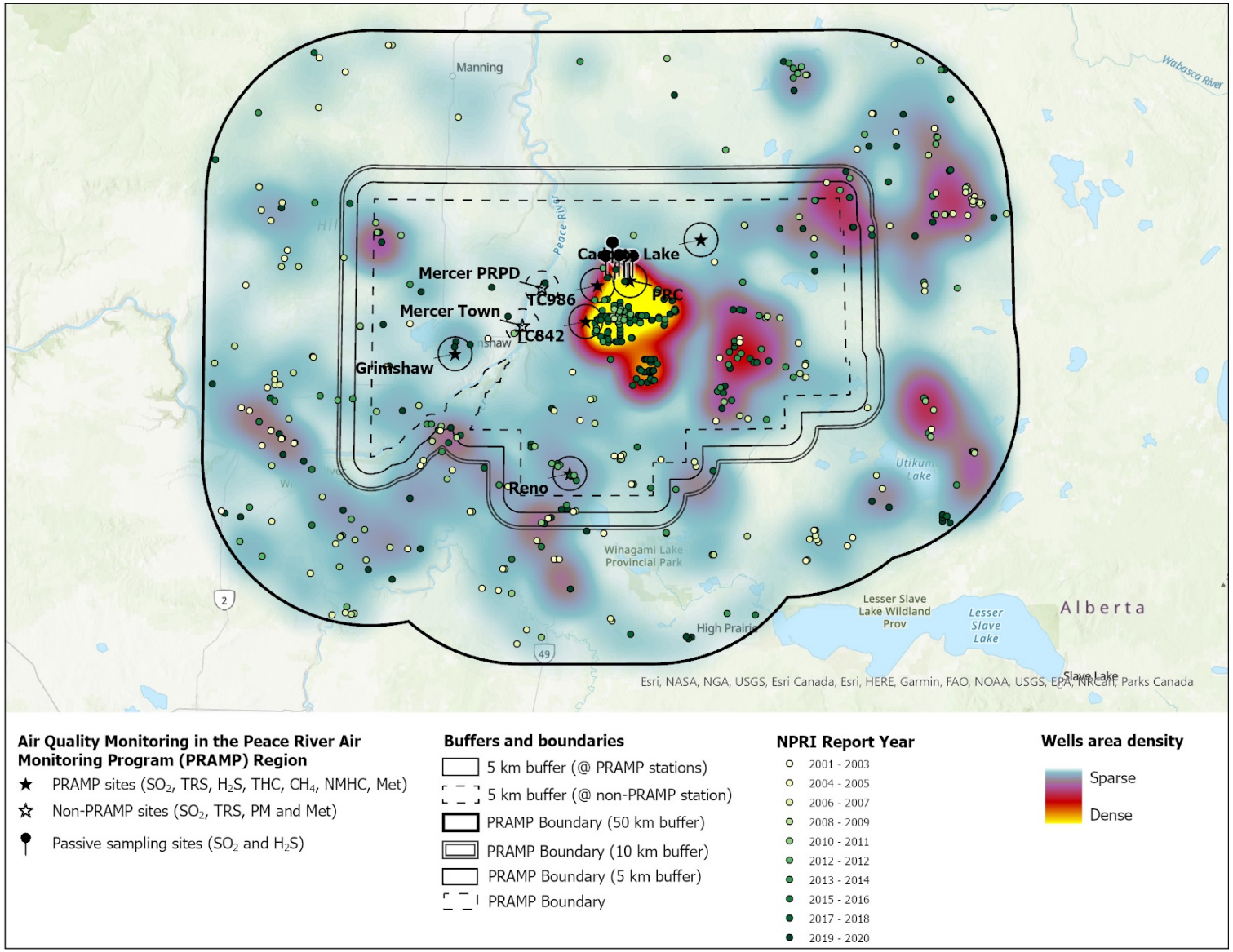
Basis for Network Evaluation

- **Priority One**
  - Hydrocarbon context: emissions reduction, regional air quality improvement, a regulatory framework for CHOPs is in place (Directive 84) and mitigation measures have been implemented. How do these changes inform the optimization of PRAMP's monitoring program?

- **Priority Two**
  - The air monitoring station and 12 passive monitors at the Peace River Complex are anticipated to be added to the PRAMP network soon (PRC has just been integrated in the network). If or how can the overall monitoring network be optimized?
  - PRAMP has been asked to consider incorporating the two Mercer air quality monitoring stations, Mercer Plant (PRPD) and Mercer Town. If or how can the network be optimized?

- **Priority Three**
  - There is a large monitoring-deficient area adjacent to PRAMP. Are there any emerging air quality issues in this area that PRAMP should consider in its monitoring program?
  - How can lower-cost technologies best be incorporated into the PRAMP program (e.g., Purple Air sensors).

Evaluation Data Sources



- AQ measurements
  - PRAMP continuous AQ and met
  - PRC passives
  - Canisters for VOCs
- Emissions
  - NPRI
  - AER wells/facilities - volumetric oil and gas production from Petrinex
- Other
  - Previous assessments
  - AEP model results

Priority 1 Evaluation – Directive 84

Impacts of D84 on Measured Air Quality

Evaluation Approach (Priority 1 Example)

❖ Potential Outcomes

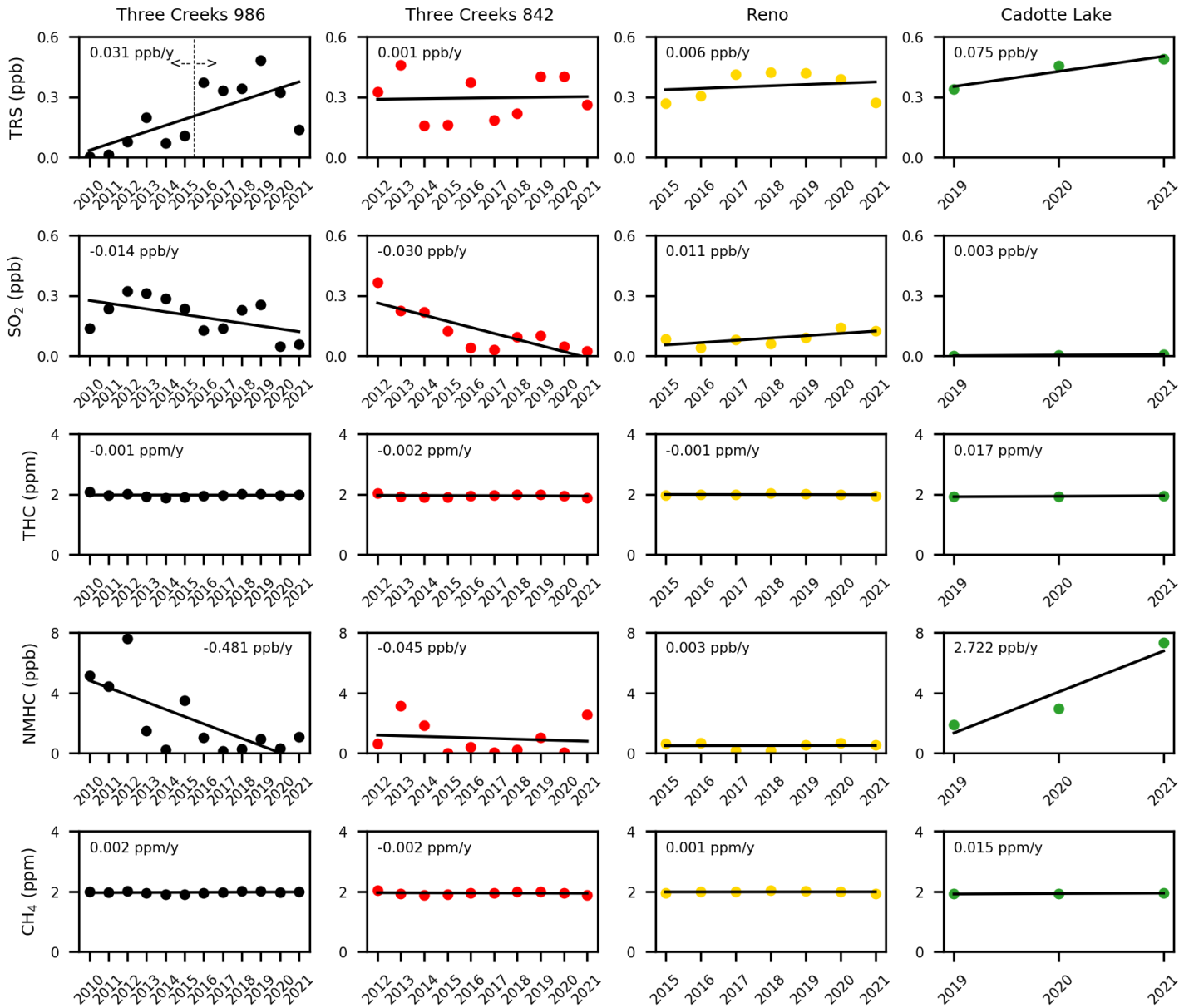
- Reconsider number of stations and/or parameters
- Reconsider location, duration, frequency, methodology, technology, etc.

❖ Assessment using continuous, intermittent and historical AQ/emissions data:

- Time series, temporal trends and compliance of pollutants levels measured by the PRAMP network
- Temporal trends of emissions as reported to NPRI from facilities within PRAMP
- Recent oil and gas production trends from wells within PRAMP, as reported to Petrinex
- Correlations of pollutants among PRAMP stations for optimization purposes
- Diurnal variations of pollutants at each PRAMP station and comparison between stations
- Meteorological controls on pollutants at each PRAMP station: wind and pollution roses
- Changes in canister-based VOCs concentrations over time and their compliance

PRAMP Concentration Trends

- Linear trends of annual concentrations increase/decrease over the entire period of reporting
- Results
  - Since 2011, all stations decrease TRS
  - TRS trend at 986 different before/after 2015 due to different analytical settings
  - SO_2 decreases at Three Creeks
  - No change in THC or CH_4 concentrations
  - Reductions in NMHC at 986 & 842
  - Constant but low NMHC at Reno

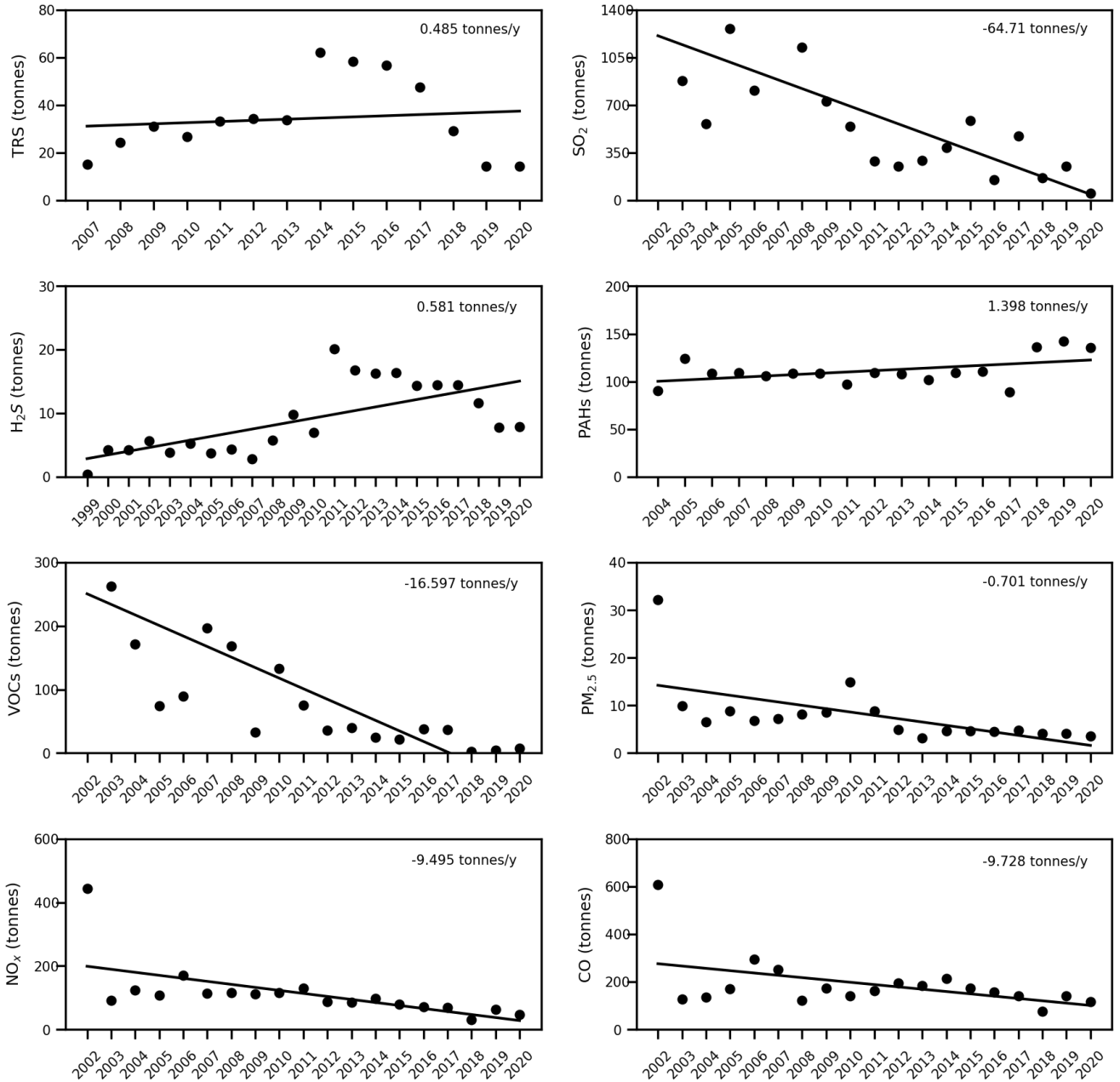


NPRI Emission Trends

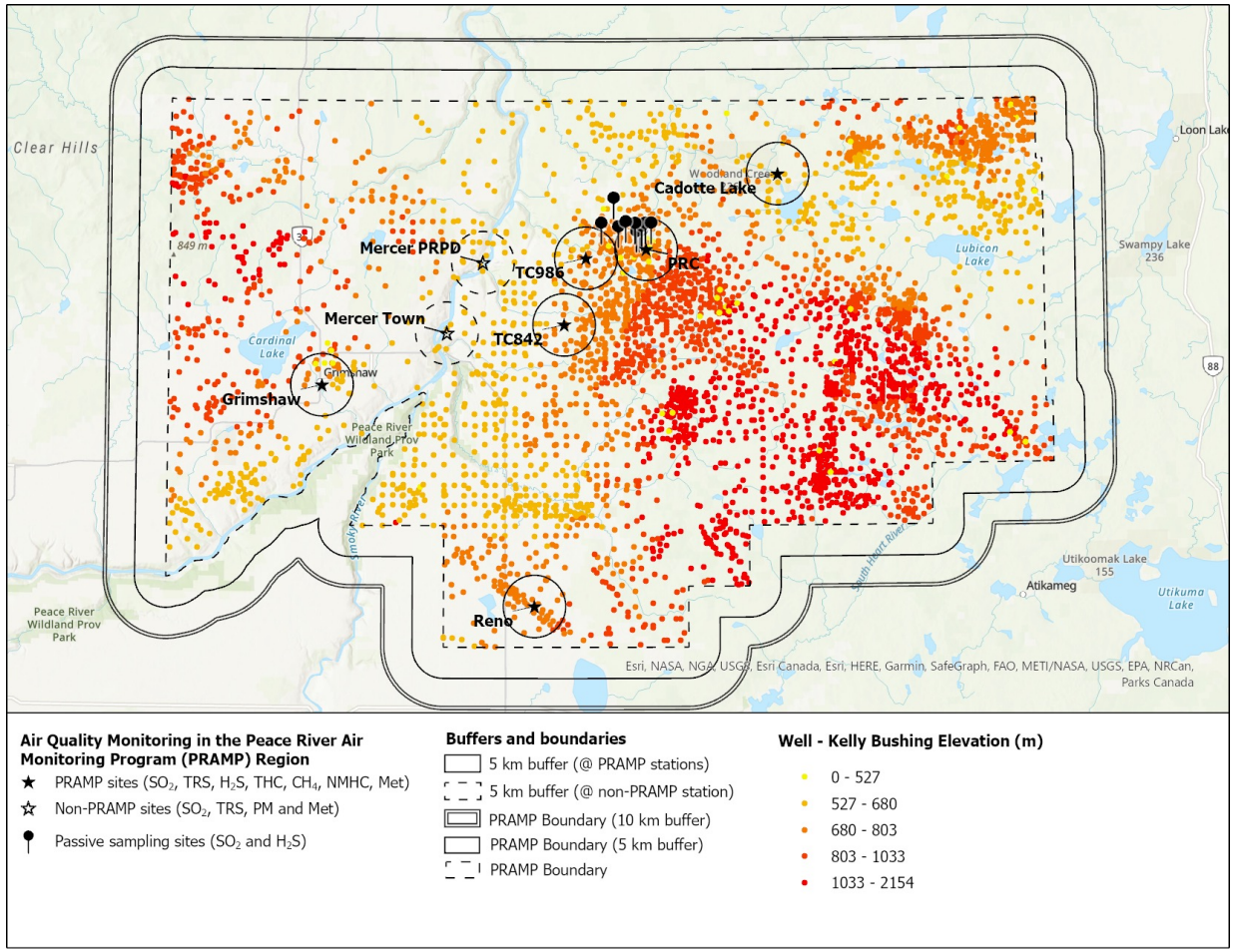
- Linear trends of annual emissions increase or decrease over the entire period of reporting:
  - However:
    - Since 2011, all decrease except PAHs
    - Near-zero VOC emissions since 2018

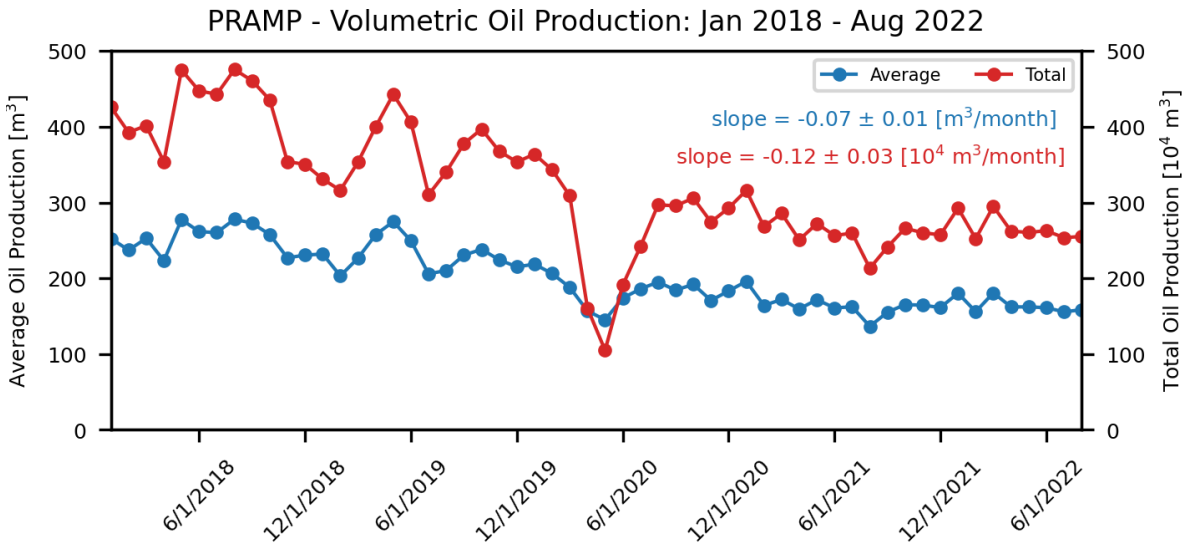
- Are decreased reported emissions the result of market trends, or improvements in emission control?

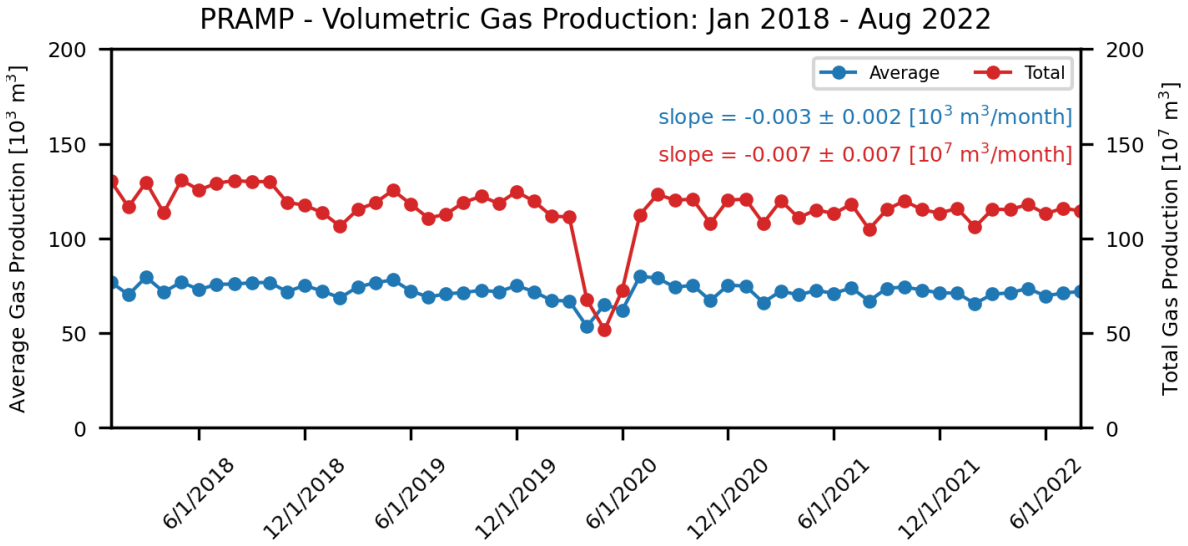
- If the latter, can VOC monitoring be eliminated, given the relatively large decrease?



Recent trends in oil and gas production volumes from wells within PRAMP





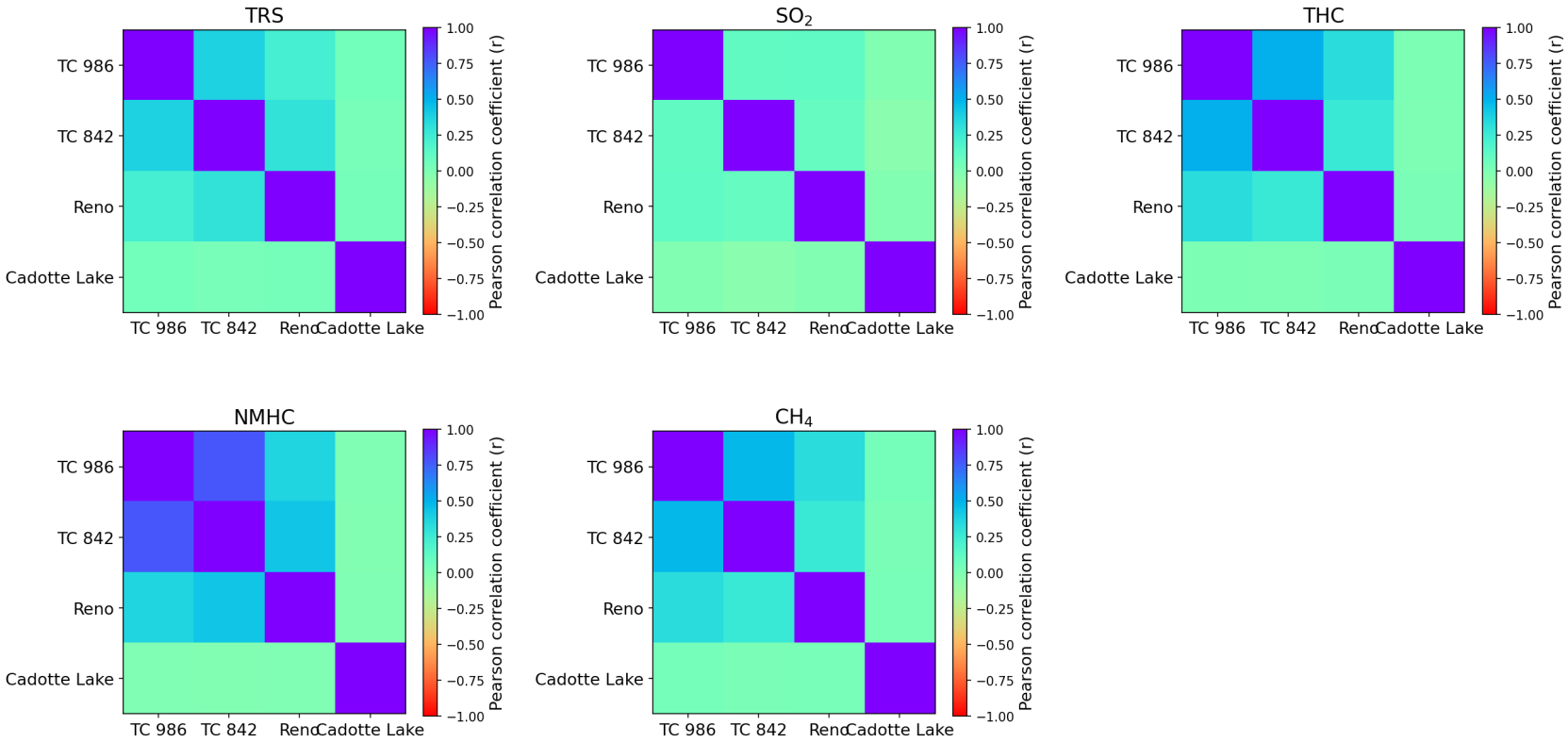


- Oil and gas production (average or total) decreased since 2018, but the decrease in oil production was more significant
- The drop in 2020 is the result of reduced activity in the oil and gas extraction sector due to the pandemic.

Data: https://www.petrinex.ca/PD/Pages/APD.aspx:

PRAMP Station Correlations: Three Creeks 986 & 842, Reno and Cadotte Lake (2019-2021 data)

- Are the stations highly correlated for all pollutants? If yes, then one of the stations can be removed from the network.
- Pearson *r* varied from -0.003 to +0.78→ stations are spatially and temporally related, especially in terms of NMHC (0.78) and THC (0.5)
  - However, the correlations for other pollutants are weak → different controls at each station (e.g., wind direction, emissions) may prevent stronger correlations → stations are not so similar.

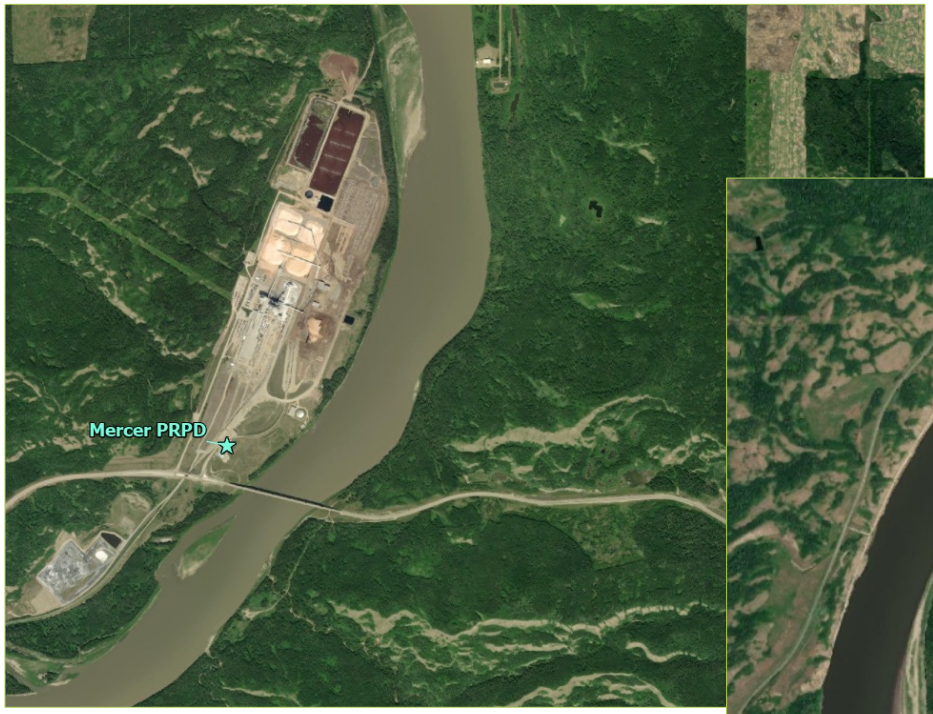


Note the strongest correlation between 986 and 842 for NMHC

Priority 2 – Additional Stations

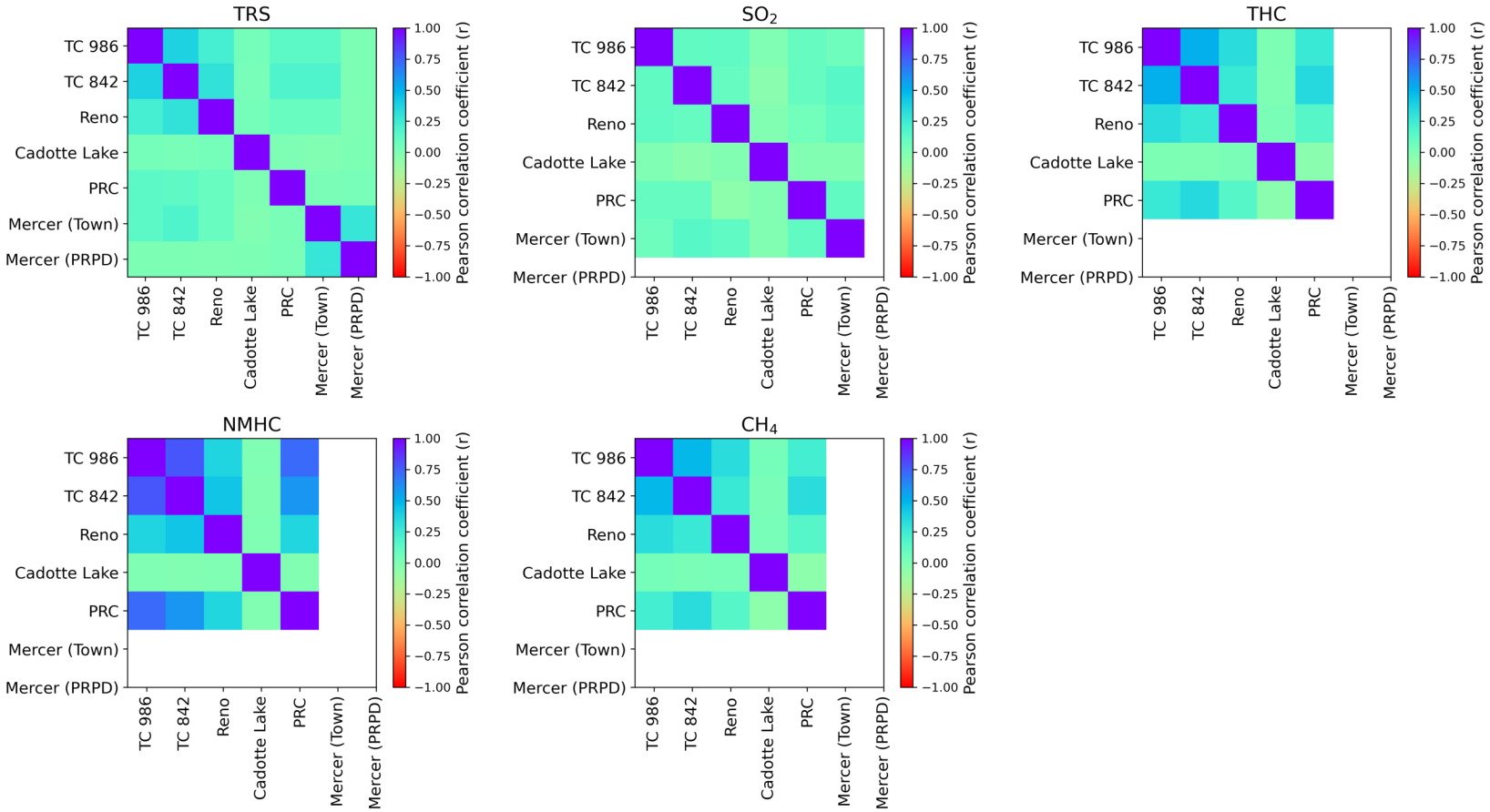
Impacts of Adding PRC and Mercer Stations to the Network

Detail views of Mercer PRPD (plant & monitoring site), Mercer Town (monitoring site) and PRC (plant & monitoring site)



Correlations of Pollutants at Continuous Monitoring Stations (2019-2021 data)

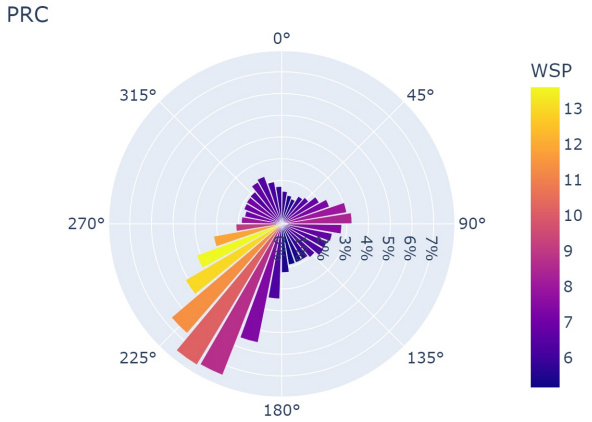
- Are the station concentrations highly correlated for? If yes, then optimization can be considered.
- NMHC: PRC is most strongly correlated with 986 (r = 0.72), 842 (r = 0.60) and Reno (r = 0.36)
- THC and CH_4: PRC is less strongly correlated with 986, 842 and Reno for (r = 0.16 - 0.35) → Include in the network
- TRS
  - PRC and Mercer stations are poorly correlated with other PRAMP stations: → Include in the network
  - PRC and Mercer uncorrelated (r = 0.02-0.03) → Include in the network
- Based on correlation analysis, no opportunity for optimization

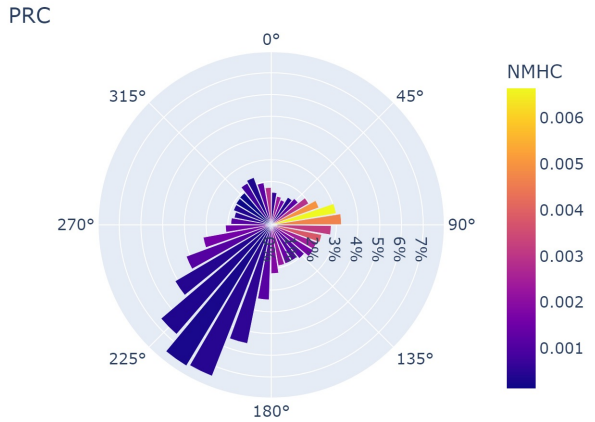


Note that SO_2, THC, NMHC and CH_4 are not monitored at Mercer stations; therefore, there are no correlation coefficients computed for these pollutants.

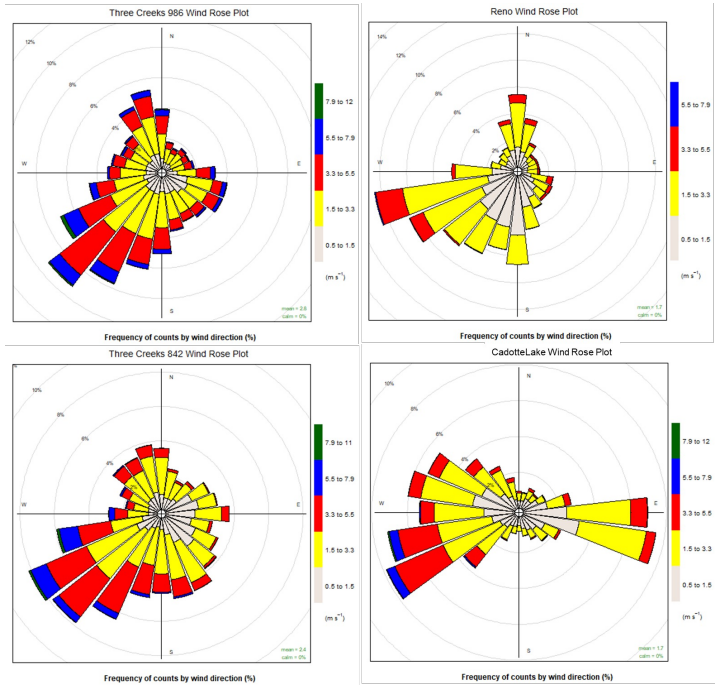
Meteorological Effects – Wind & Pollution (NMHC) Roses (Data: 2019-2021)

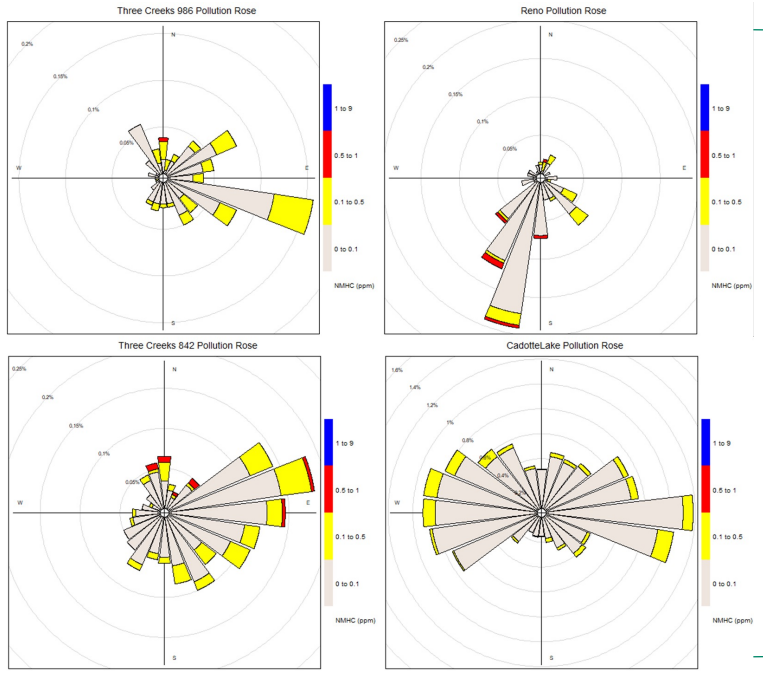
- For NMHC, the pollution and wind roses are similar, and the plant is NOT the NMHC source – likely well pads to the east
- Because of the uniqueness of the application, no reduction in monitoring is recommended.





Rose plots at PRC station



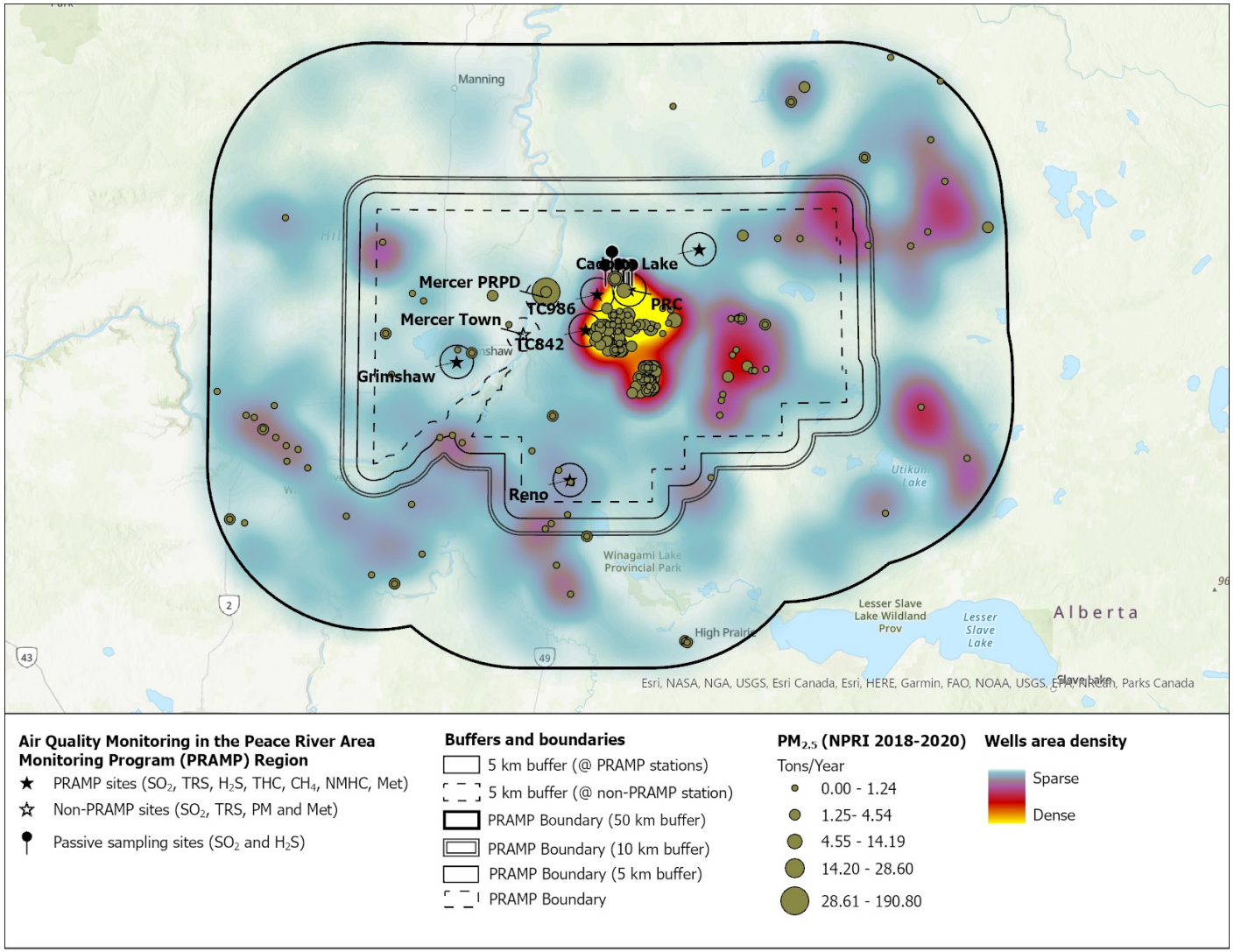


Rose plots at other PRAMP stations

Priority 3

Impact of Monitoring-Deficient Areas, New Technology

NPRI Emissions - $PM_{2.5}$



- Unmonitored source areas:
  - Wells/facilities near Walrus (SE of Three Creek / NE of Reno)
  - Existing wells on the NE corner of PRAMP and outside the ESE border
- Are these unmonitored “gaps” important?
  - reported emissions are low
  - well density may not correlate with emissions
- If gaps are important, how should they be filled?
  - New station
  - Moved station
  - New station with low-cost sensors

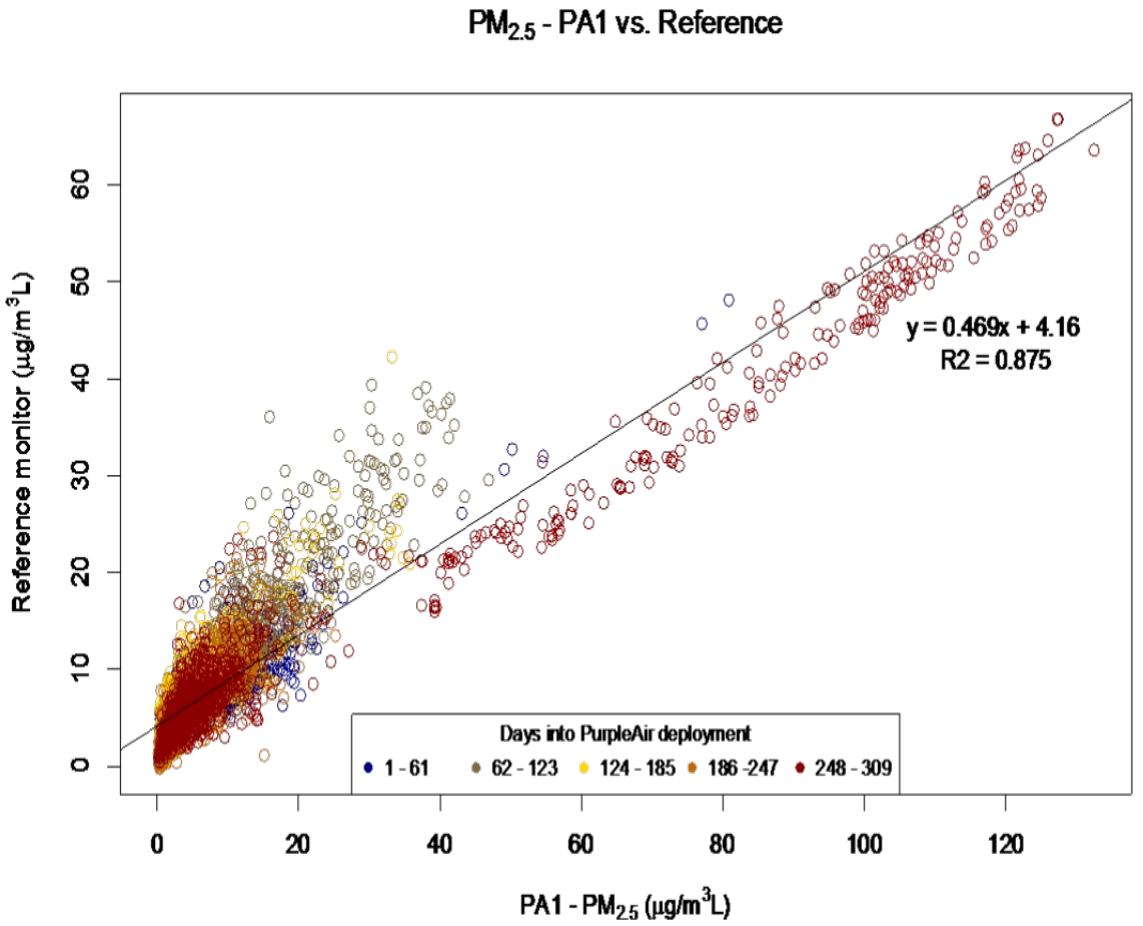
Emerging Technology

Application

- Offer opportunity for lower cost, high density networks most often in urban environments where large air quality gradients can exist, and populations can be large, to support AQHI determination
  - Low cost (~1/10 the cost of a regulatory grade sensor)
  - Run on solar/battery
  - No calibration; replace sensor after 2-3 years

$PM_{2.5}$ Example

- UBC included the Purple Air in an evaluation of low-cost sensors at two locations in Vancouver where they recorded an R^2 value of 0.88.
- ECCC reported preliminary results showed a 0.98 R^2 compared to reference values in Edmonton.



Closing

Considering all Evaluations

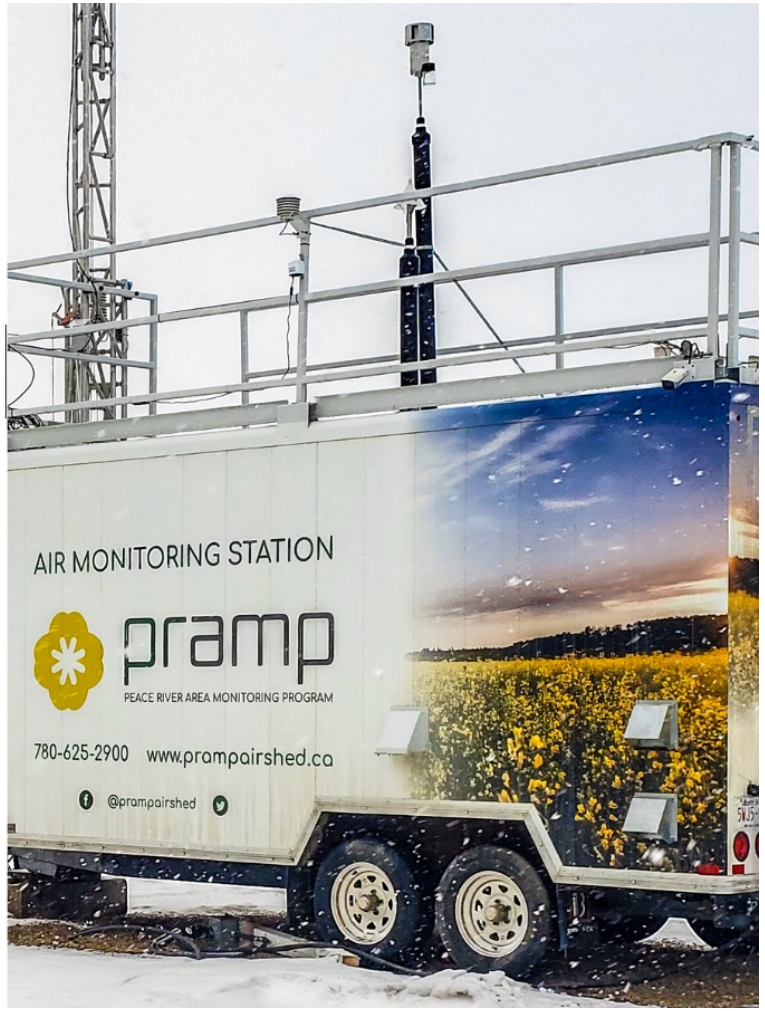
Overall Recommendations - Draft

- Remove stations? No
- New stations in monitoring-deficient areas?
  - Are they important enough to warrant monitoring? Not with current technology
  - Could redeploy passives
- Move stations?
  - No, unless we want to move into more dense emission areas
- Reduce parameters?
  - Can VOC/NMHC be eliminated? No
  - Can SO_2 or TRS be eliminated? No, because SO_2 is relevant and TRS still shows exceedances at two stations.
  - What about meteorology? No, given differences in windroses at sites.
  - Eliminate either THC or CH_4? Yes, possible
- Change technology?
  - Passive or low-cost SO_2? Possible
  - Passive or gas-sensitive semiconductor technology VOC? Possible
  - $PM_{2.5}$: Possible
  - To support AQHI in communities? Possible
- PRC Passive network changes?
  - Eliminate

		Station Name									
Monitoring Method	Parameter	986c	842b	Reno	AQHI (Grimshaw)	CNRL (PRC)	Mercer (Townsite)	Mercer (Plantsite)	Peace River (above valley)	Peace River (in valley)	Nampa
Continuous	Sulphur Dioxide	√	√	√	√	√	√				
	Total Reduced Sulphurs	√	√	√	√	√	√	√			
	Hydrogen Sulphide					√					
	Hydrocarbons *Total, Methane, & Non-Methane*	√	√	√	√	√					
	Oxides of Nitrogen *Total, Nitric Oxide, Nitrogen Dioxide*				√						
	Ozone				√						
	Fine Particulate Matter *Particles ≤ 2.5 Microns in Diameter*				√		√				
	Wind *Speed & Direction*	√	√	√	√	√	√	√			
	Precipitation	√	√	√							
	Climate Variables *Temperature, Relative Humidity, Barometric Pressure*	√	√	√	√	√	√	√			
	Air Quality Health Index (AQHI) *Third-Party Calculated Multi-Parameter Index*				√						
Intermittent	Non-Methane Hydrocarbon Canister	√	√	√							
	Methane Canister	√	√	√							
Passive	Polycyclic Aromatic Compounds	√									
Small Sensor	Fine Particulate Matter *Particles ≤ 2.5 Microns in Diameter*	√	√	√	√				√	√	√
	Climate Variables *Temperature, Relative Humidity*	√	√	√	√				√	√	√
	Air Quality Health Index Plus (AQHI+) *Third-Party Calculated Single-Parameter Index*	√	√	√	√				√	√	√

Closing

- Network evaluation focused on 3 priority areas
  - Impact of Directive 84
  - Impact of adding new stations
  - Monitoring gaps and new technology
- Considered multiple data sources
  - PRAMP continuous network
  - VOC canisters
  - PRC passives
  - NPRI emissions
  - Other reports, modelling
- Did not consider
  - Potential for new facilities
  - Community complaints per se
- Anything we missed?
- Any surprises?



Thank you.