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

Priority 2 Integrate Peace River Complex and Mercer Stations in the Network

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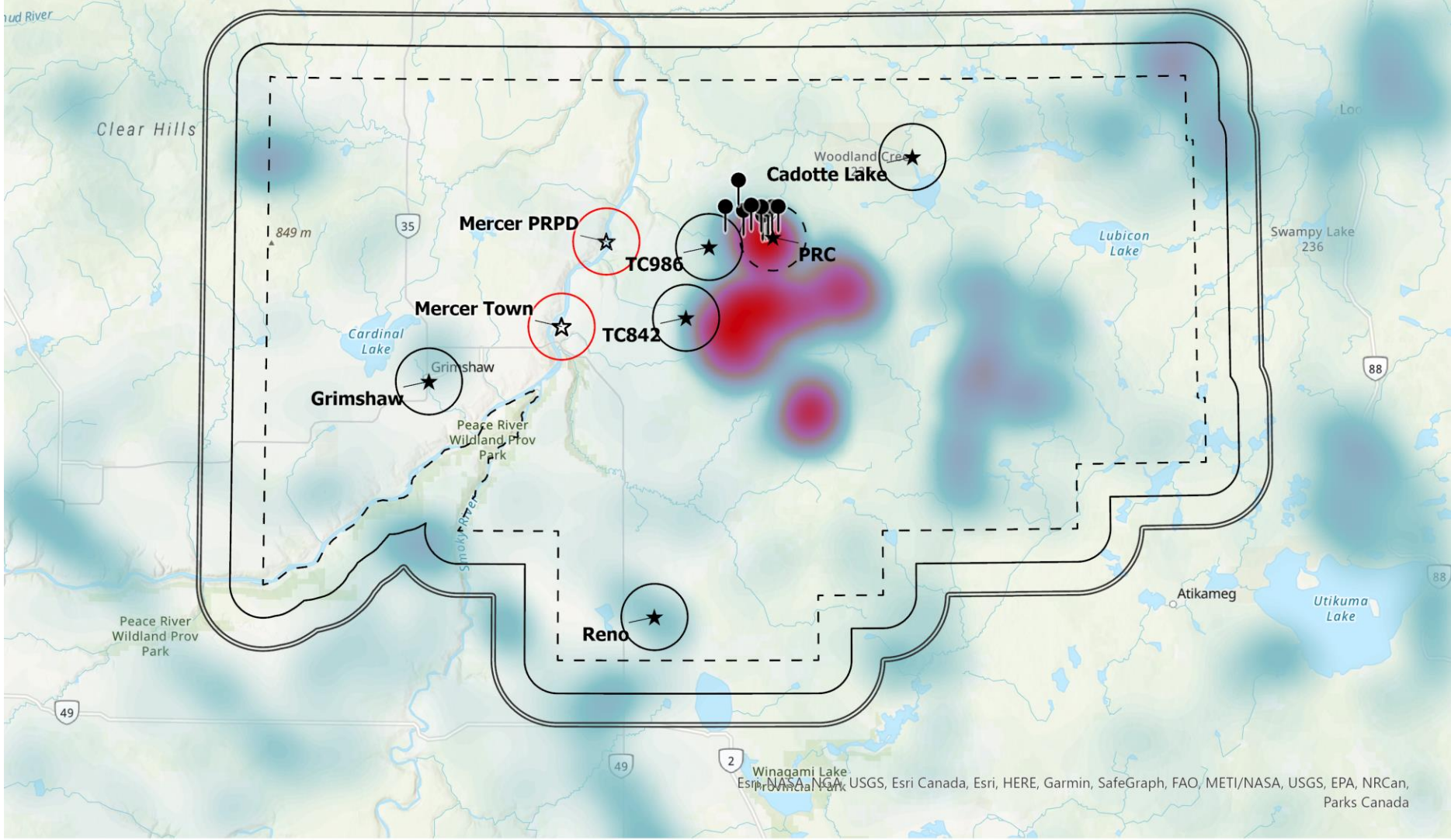
Peace River Area Monitoring Program (PRAMP)

- Current and potentially new continuous air monitoring stations (including a 5 km radius buffer)
  - Three Creeks (TC 986 & TC 842)
  - Reno
  - Cadotte Lake
  - Grimshaw
  - Peace River Complex (PRC) (recently added to the PRAMP network)
  - Mercer Peace River Pulp Division Plant (Mercer PRPD)
  - Mercer Town
- Other monitoring in the area:
  - 12 passive sampling sites (monthly SO_2 and H_2S measurements)
- Base map shows the area density of surface wells locations.



Air Quality Monitoring in the Peace River Ambient Monitoring Program (PRAMP) Region

- ★ PRAMP sites (SO_2, TRS, H_2S, THC, CH_4, NMHC, Met)
- ☆ Non-PRAMP sites (SO_2, TRS, PM and Met)
- Passive sampling sites (SO_2 and H_2S)

- 5 km buffer (@ non-PRAMP stations)
- 5 km buffer (@ PRAMP stations)
- 5 km buffer (@ recently added station to PRAMP network)
- PRAMP Boundary (10 km buffer)
- PRAMP Boundary (5 km buffer)
- PRAMP Boundary

Wells area density

Sparse

Dense

Reminder - Priority 1 Draft Recommendations – D84 Implications

- Remove stations? No
- Reduce parameters?
  - Can VOC/NMHC be eliminated given D84? 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
- Move stations?
  - No, unless we want to move into more dense emission areas
- Change technology?
  - Passive or low-cost SO_2? Possible
  - Passive or gas-sensitive semiconductor technology VOC? Possible

		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*	√	√	√	√				√	√	√

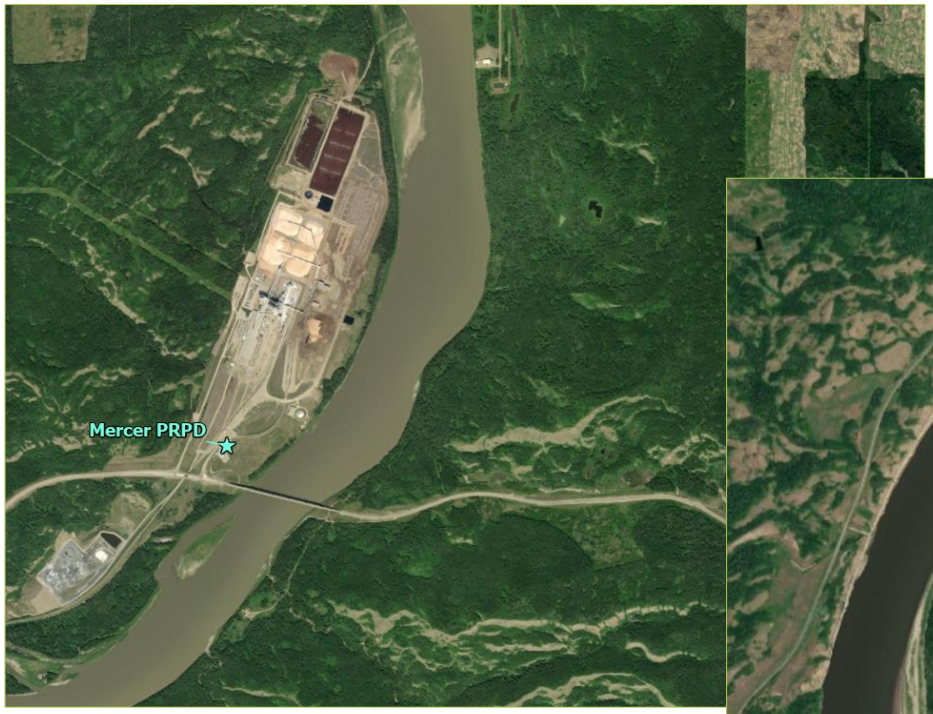
Basis for Network Evaluation

- **Priority One**
  - Hydrocarbon context: emissions reduction, regional air quality improvement, a regulatory framework for CHOP 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).

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

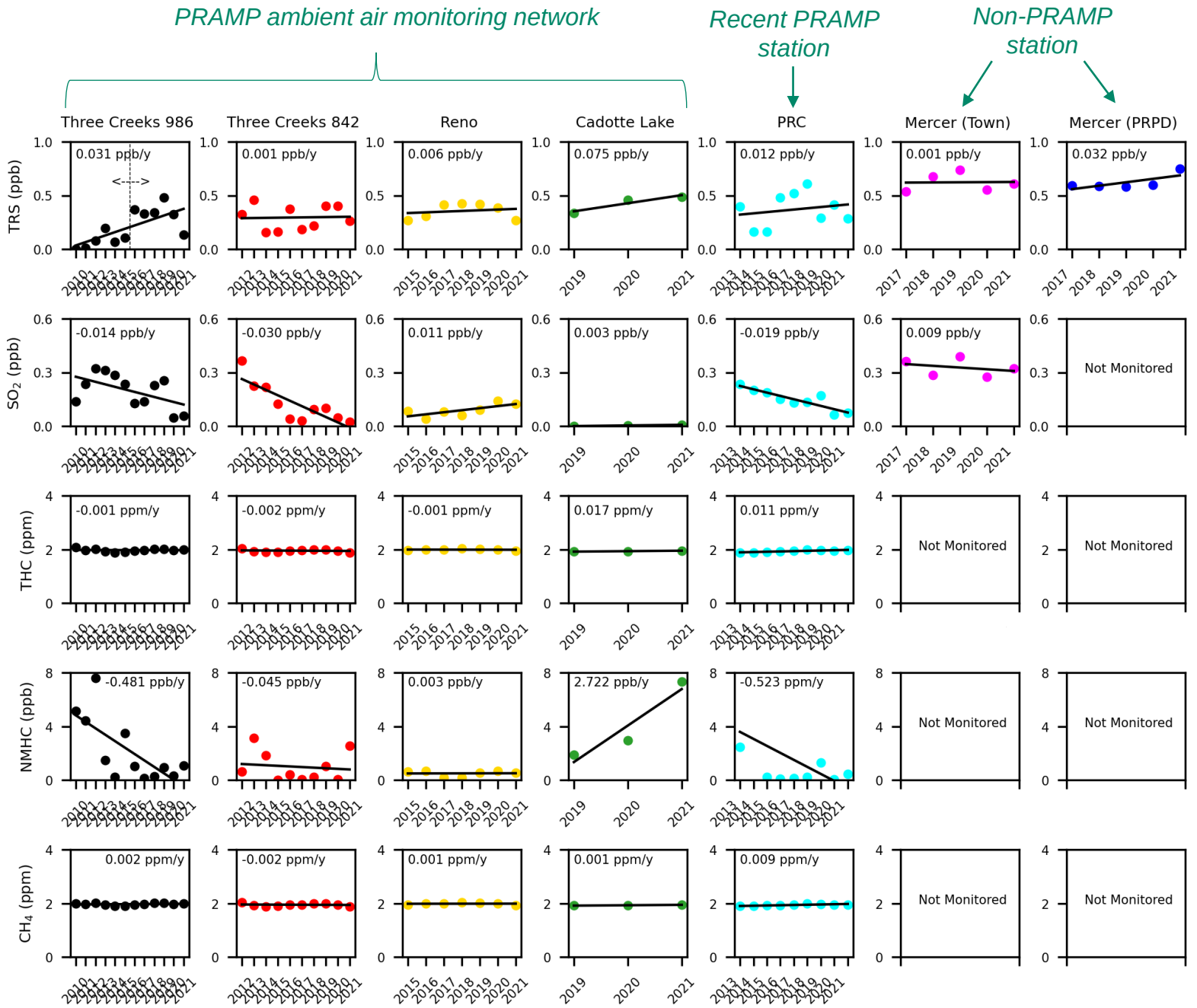


Priority 2 Approach

- **Potential Outcomes**
  - Reconsider number of continuous stations or passive monitors, and/or parameters
  - Reconsider location, duration, frequency, methodology, technology, etc.
- **PRC Assessment**
  - Calculate and tabulate inter-station correlations based on hourly data (the PRC station with others) for all common pollutants
  - Document the trend with time in annual concentrations at the PRC station, the concentration statistics, the diurnal trend, and the pollutant rose for all pollutants measured at PRC
  - Calculate and tabulate inter-site passive SO_2 data in the PRC network
- **Mercer Assessment**
  - Calculate and tabulated inter-station correlations (the two Mercer stations with others)
  - Document the trend with time in annual concentrations at the Mercer stations, the concentration statistics, the diurnal trend, and the pollutant rose for TRS, SO_2

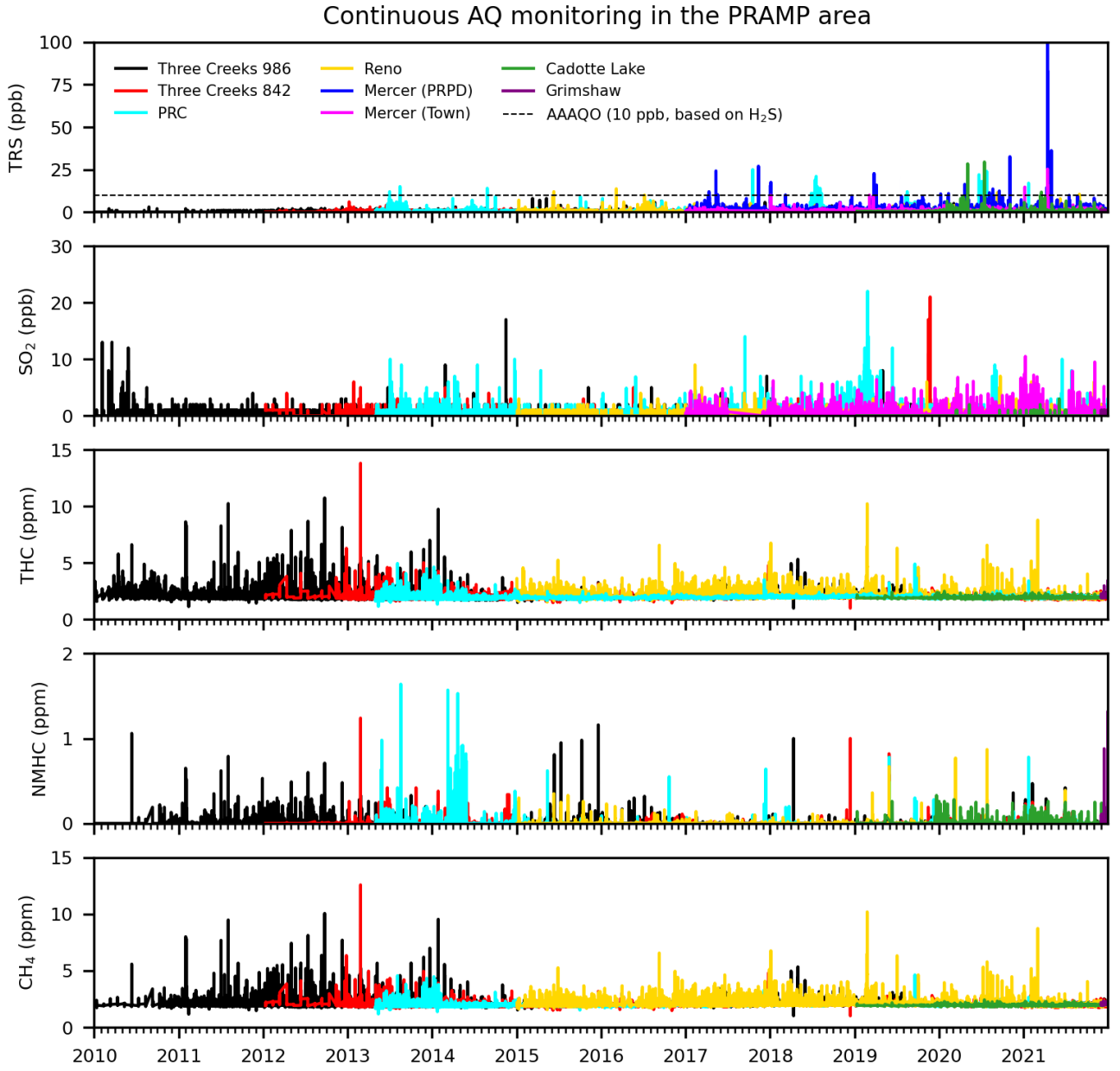
Concentration Trends at Continuous Monitoring Stations

- Trends of annual concentrations vary over the entire period of reporting
- PRC
  - Decreasing SO_2 over entire period and decreasing TRS since 2018
  - THC, NMHC, CH_4 constant
- Mercer
  - Increasing TRS
  - Decreasing SO_2
- Slightly higher TRS and SO_2 baselines at Mercer compared to PRAMP stations over the same period (2017-2021), reflecting local sources
- Mercer stations do not monitor THC, CH_4 and NMHC (not part of monitoring objectives)



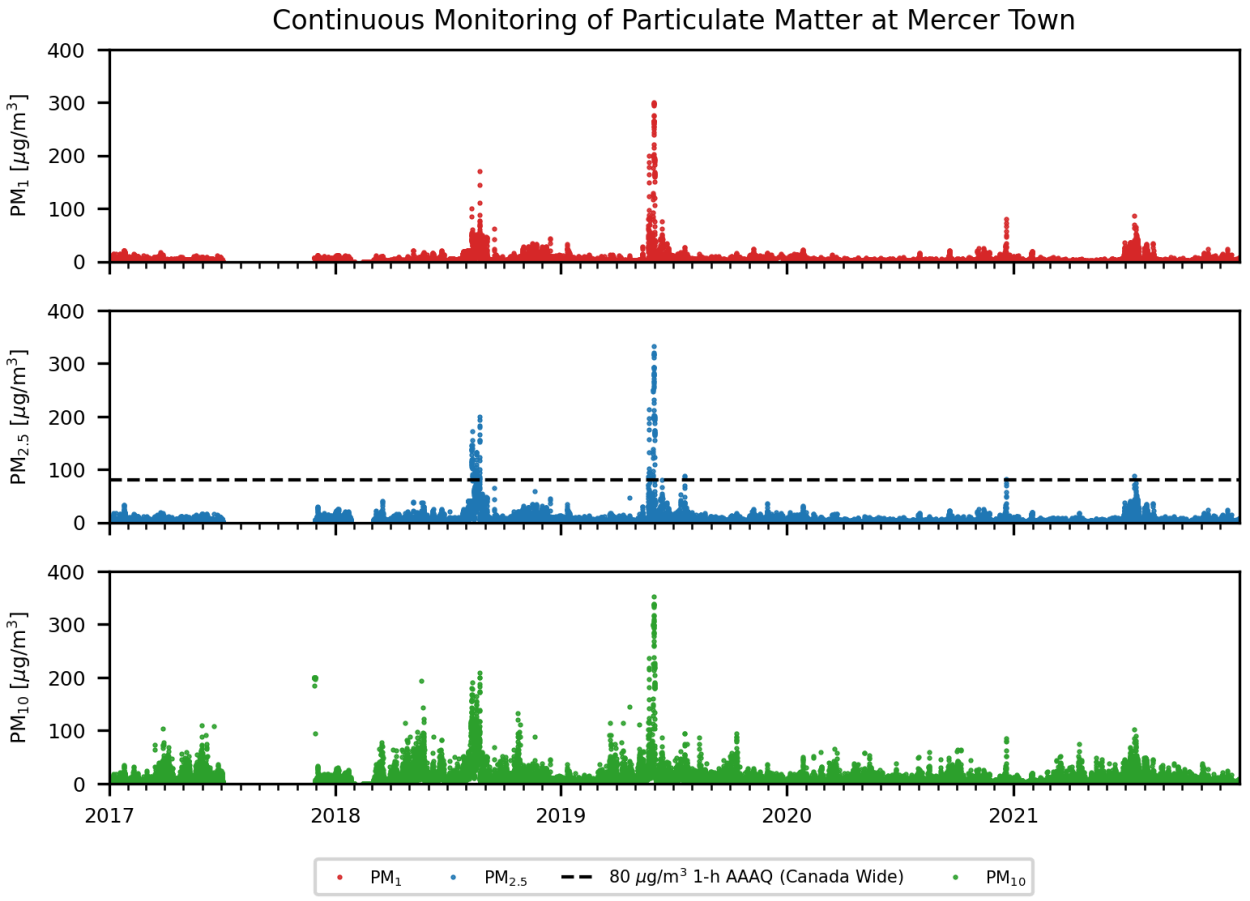
1-h Average Concentrations at Continuous Monitoring Stations

- Exceedances of 1-hour TRS threshold at PRC and Mercer (PRPD) stations, suggesting an ongoing potential for occasional odour detection (in addition to Cadotte Lake & Reno)
- No exceedances of 1-hour SO_2 (1-h AAAQO = 172 ppb) at PRC and Mercer Town – spikes to about 10 ppb, suggesting continuous monitoring may not be needed at these stations
- Methane
  - Global background at all stations - no indication of other source contributions



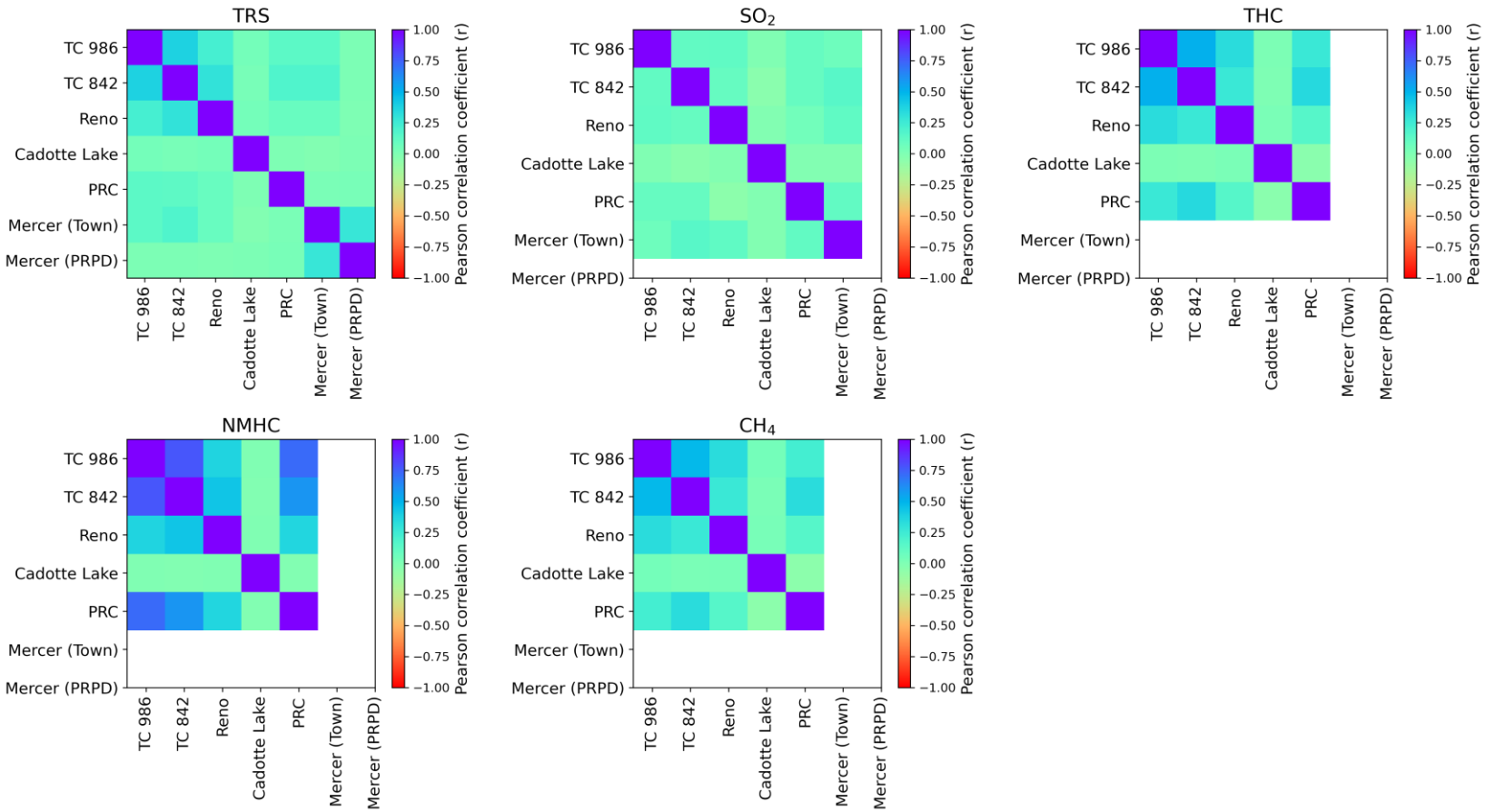
1-h Average Concentration of Particulate Mater (PM_1, $PM_{2.5}$ and PM_{10}) Monitored at the Mercer Town Station from 2017 to 2021

- $PM_{2.5}$ exceedances of the 1-hour Canada Wide Standard rarely occurred in 2018 (July), 2019 (May & June) and 2021 (June):
  - *May reflect emissions from wildfire smoke plumes, especially because of correlation with PM_1 (fresh PM) over the same times during the fire season*
- The occasional exceedances of the 1-h standard show that Mercer Town is a good location for detecting wildfire influences, which can help to understand better the contributing sources in the PRAMP region:
  - *Currently only Cadotte Lake monitors $PM_{2.5}$ in the network*
- PM_{10} contains both PM_1 and $PM_{2.5}$ fractions and additionally the coarse (e.g., sand) fraction and may be a good indicator for dust transport from the town to the monitoring site (see rose plots on slide 22)



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

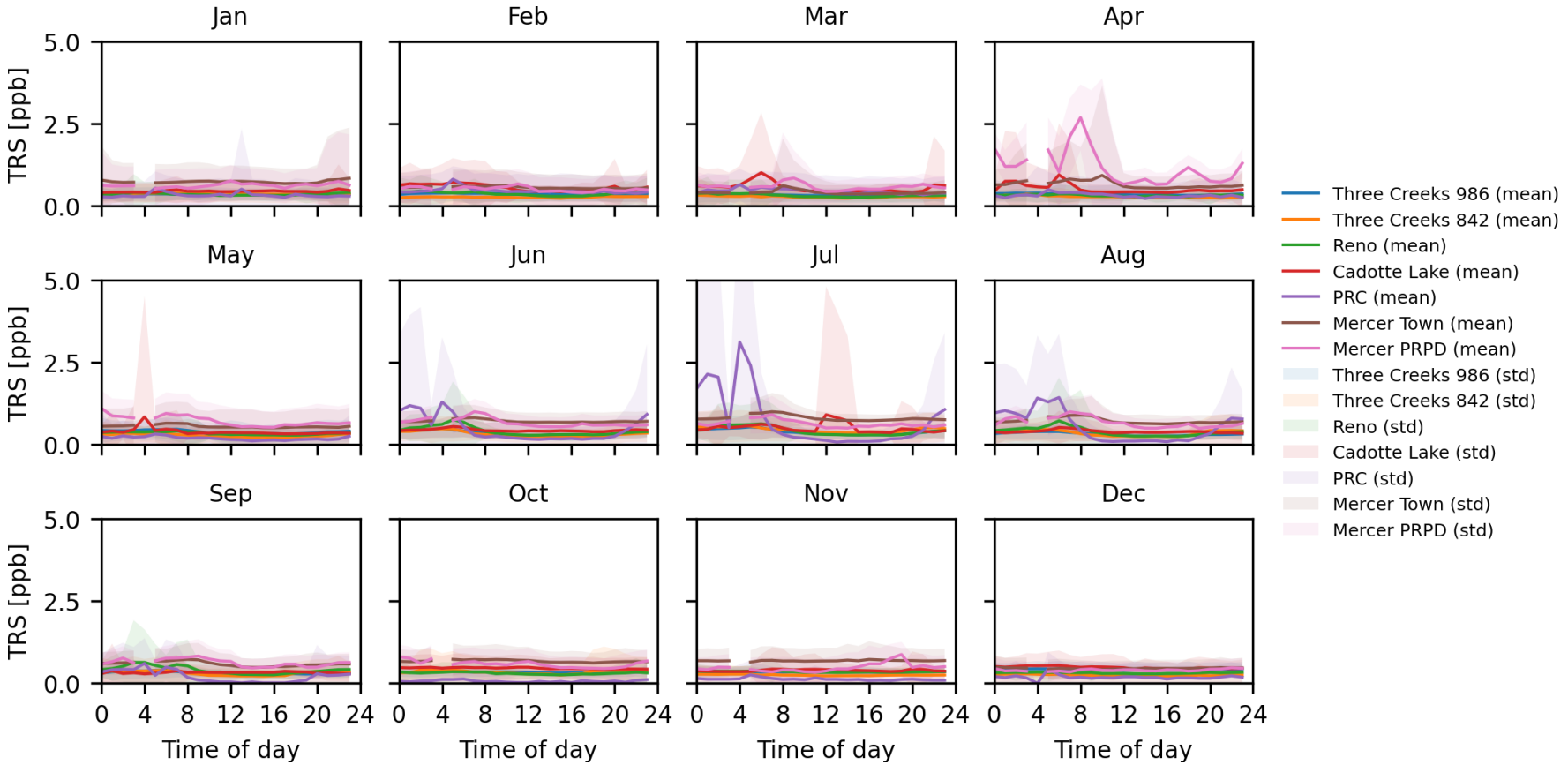
- Are the station concentrations highly correlated for? If yes, then optimization can be considered.
- NMHC: PRC is most strongly correlated with 986 (r = 0.72), 842 (r = 0.60) and Reno (r = 0.36)
- THC and CH_4: PRC is less strongly correlated with 986, 842 and Reno for (r = 0.16 - 0.35) → Include in 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 there are no correlation coefficients plotted for Mercer stations when specific measurements were not available (e.g., SO_2, THC, NMHC and CH_4).

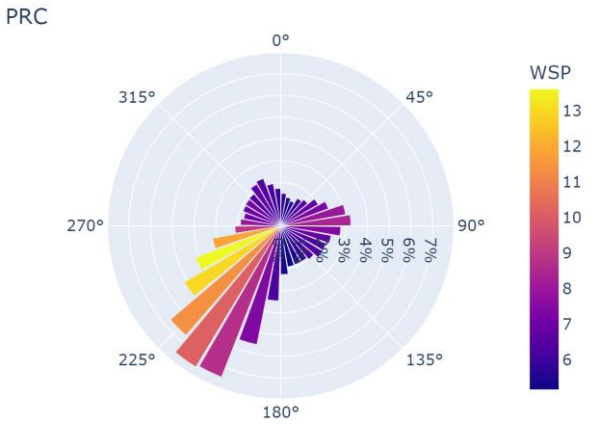
Diurnal Variations – TRS Example (2019-2021 Hourly Data From All Continuous Monitoring Stations)

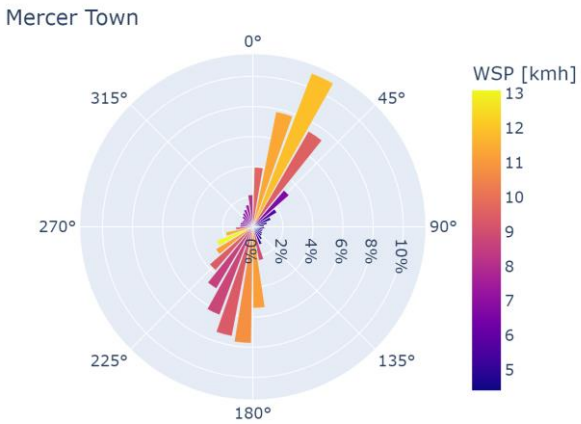
- Diurnal variations in mean concentration, and in the standard deviations of concentration can support network rationalization
- Diurnal variation is not the best differentiator, as deviations (in TRS) are often similar.
- TRS, PRC and Mercer PRPD stations show (larger) deviations from other diurnal profiles in spring and summer → Include in the network

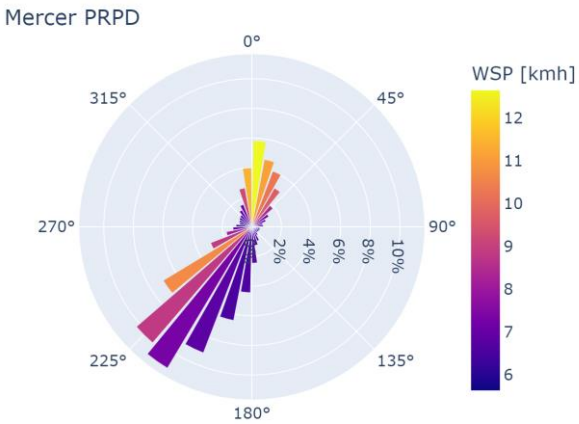


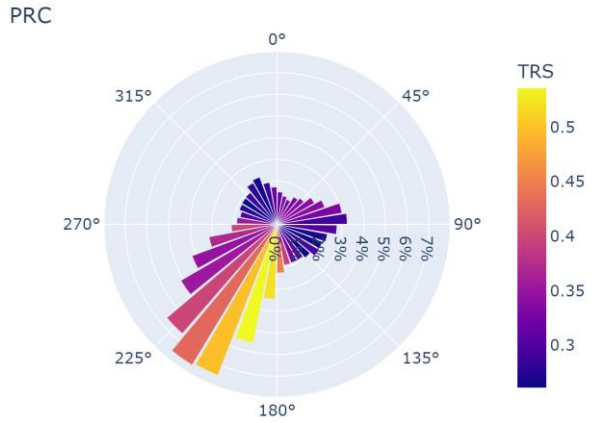
Meteorological Effects – Wind & Pollution (TRS) Roses (Data: 2019-2021)

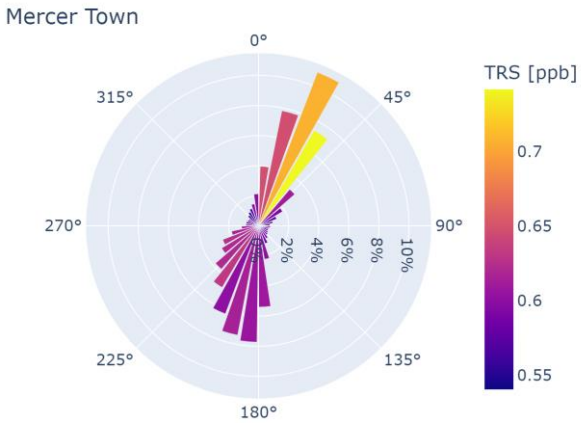
- Are any pollution roses different than the wind rose? If yes, the station might be uniquely situated
- At PRC, the plant may not be the source of TRS.
- At both Mercer stations, the PRDP appears to be the source of TRS
- At all three sites, meteorology is key to understanding the source and interpreting the information.
- Because of the uniqueness of the application, no reduction in monitoring is recommended.

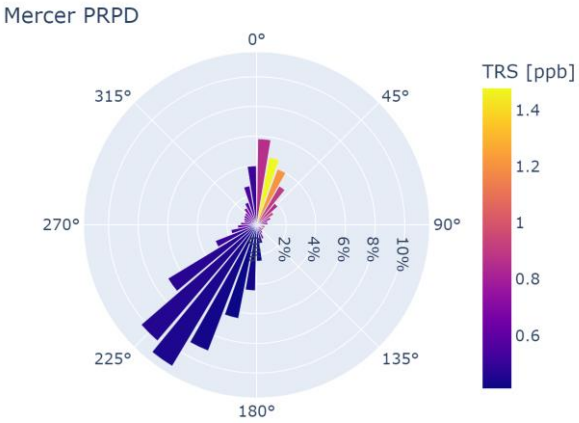






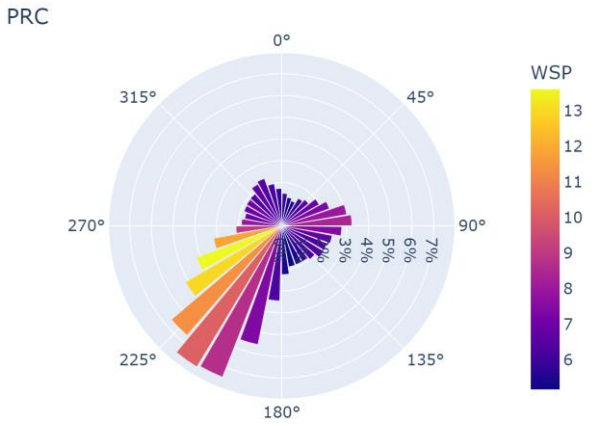


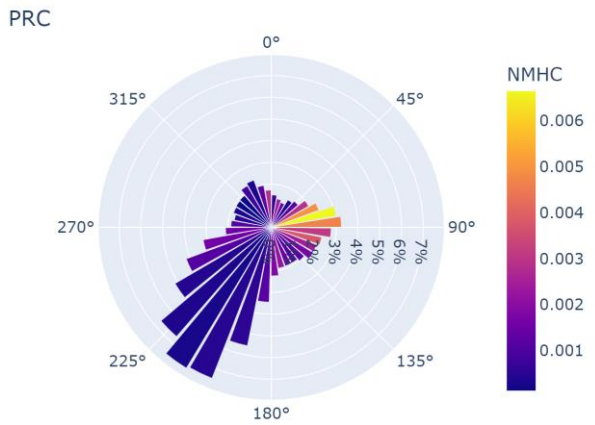




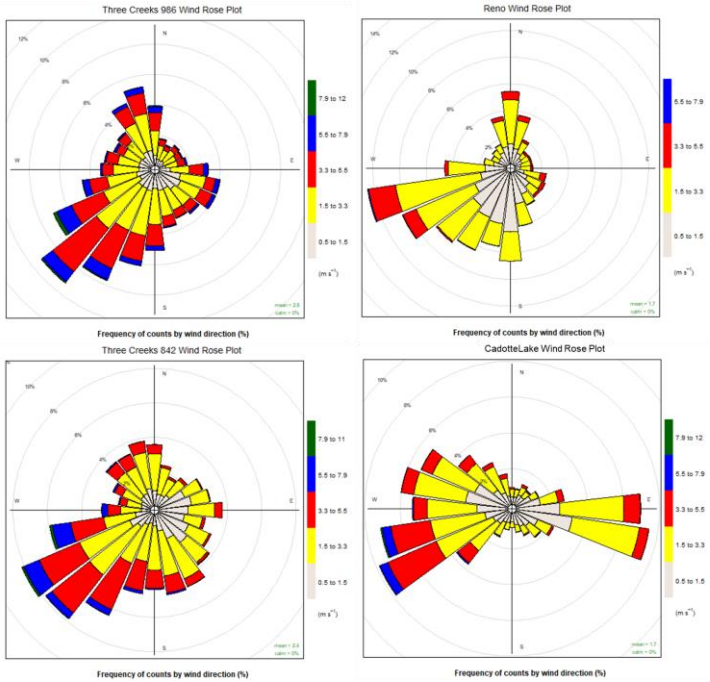
Meteorological Effects – Wind & Pollution (NMHC) Roses (Data: 2019-2021)

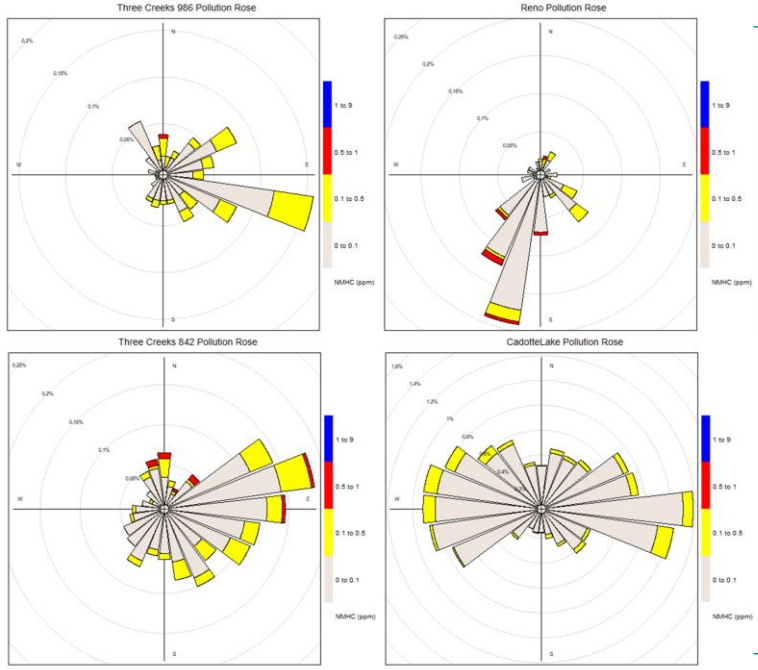
- For NMHC, the pollution and wind roses are similar and the plant is NOT the NMHC source – likely well pads to the east
- Because of the uniqueness of the application, no reduction in monitoring is recommended.



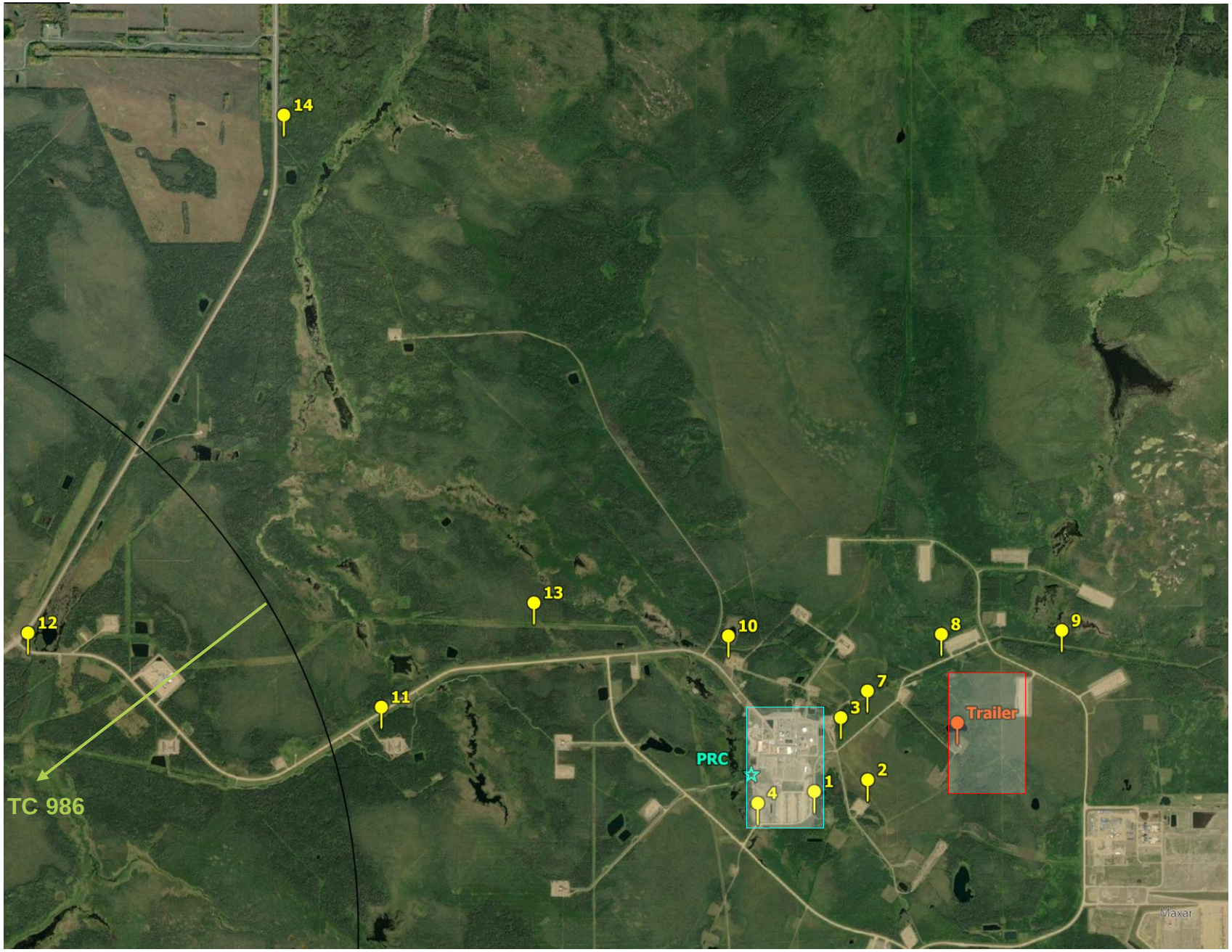


Rose plots at PRC station





Rose plots at other PRAMP stations

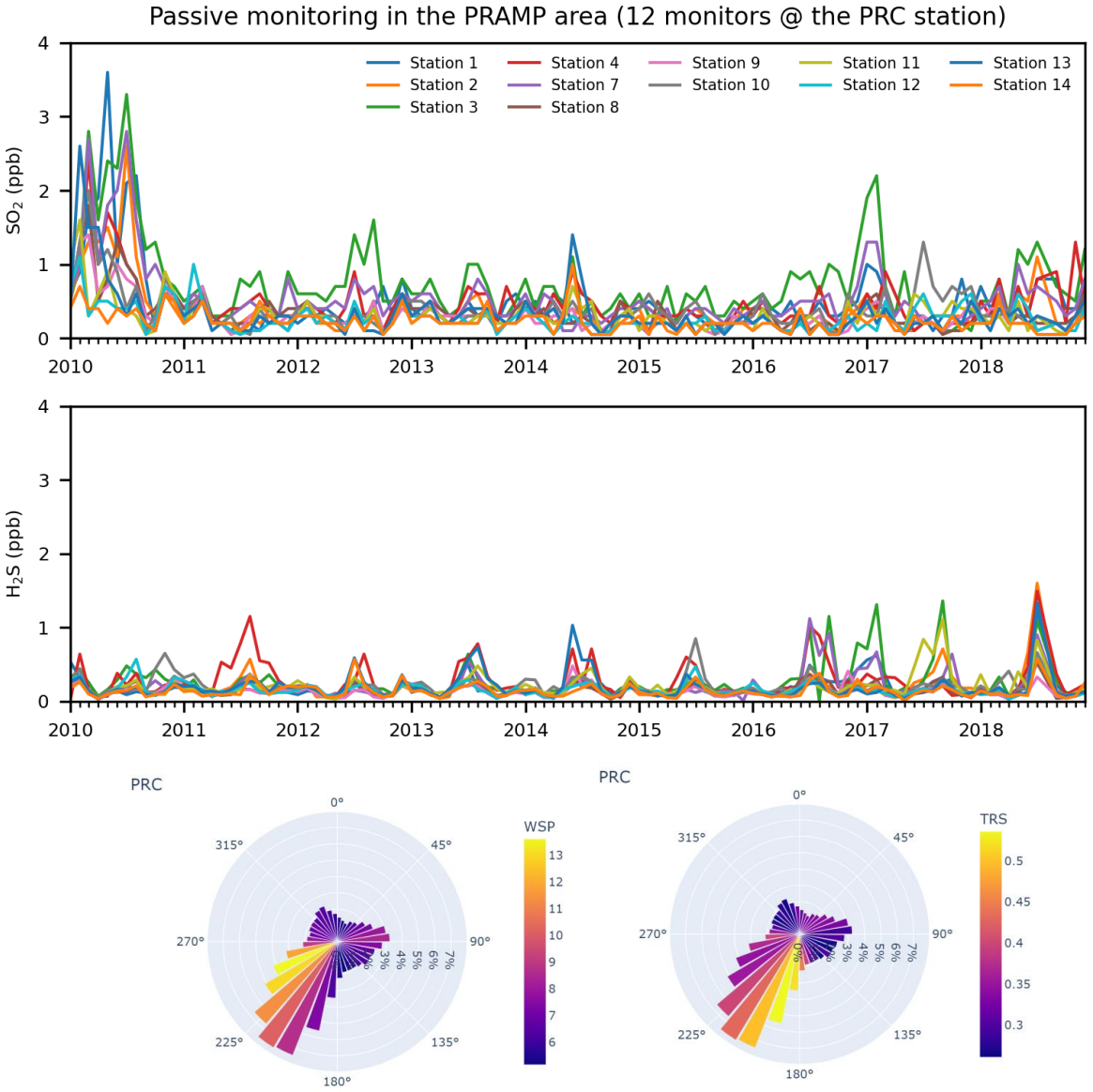


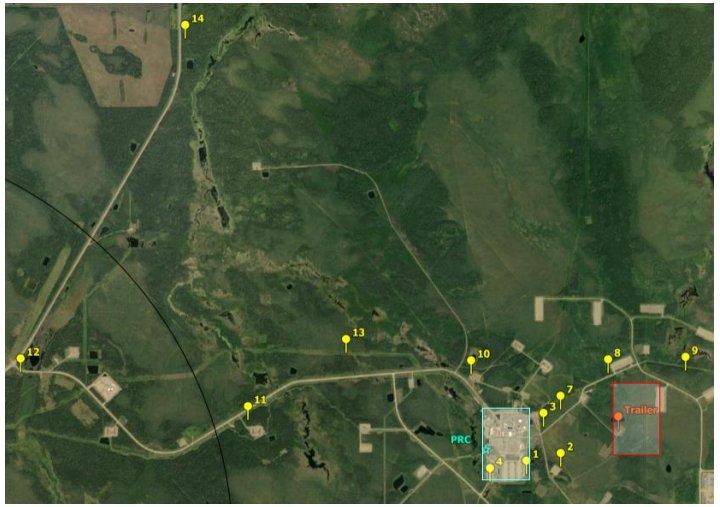
Passive Samplers around the Peace River Complex (PRC)

- 12 sites (yellow) for passive sampling of SO_2 and H_2S (monthly samples)
- The closest continuous air monitoring stations are the PRC (Trailer) and Three Creeks 986 (TC986)
  - → Assume similar meteorological conditions for the passive sites
- Two sites (11 & 12) are within ≤ 5 km northeast from TC986
- The furthest sites are ~ 11 km from TC986

Trends and Compliance of Monthly Average Concentrations (Passive Data)

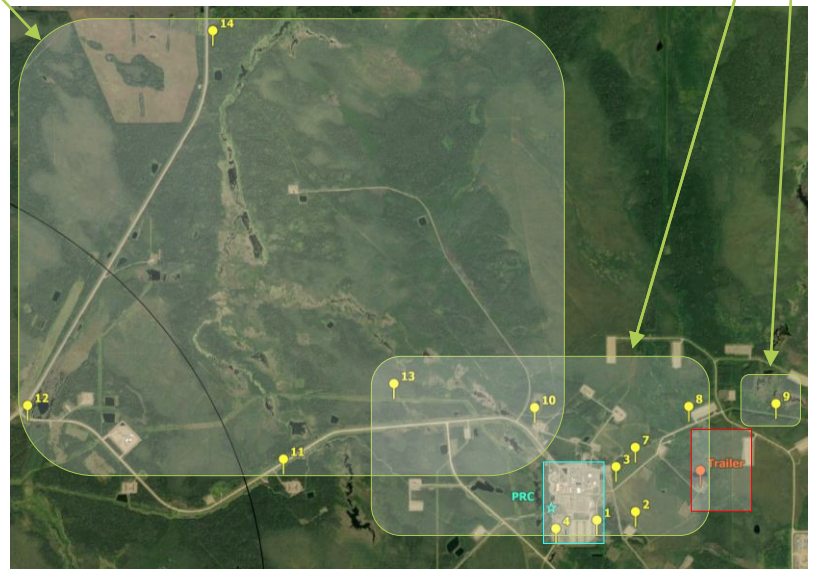
- SO_2 remains well below the 30-day average AAAQO (11 ppb)
- Stations closer to PRC (3, 4, 7) occasionally detect H_2S and SO_2 spikes
- Prevailing wind at the PRC station is from southwest and the continuously monitored 1-h TRS usually is the highest from this wind direction. What is the source – the plant?
- →H_2S "spikes" from passive monitoring appear to be seasonal driven by meteorology



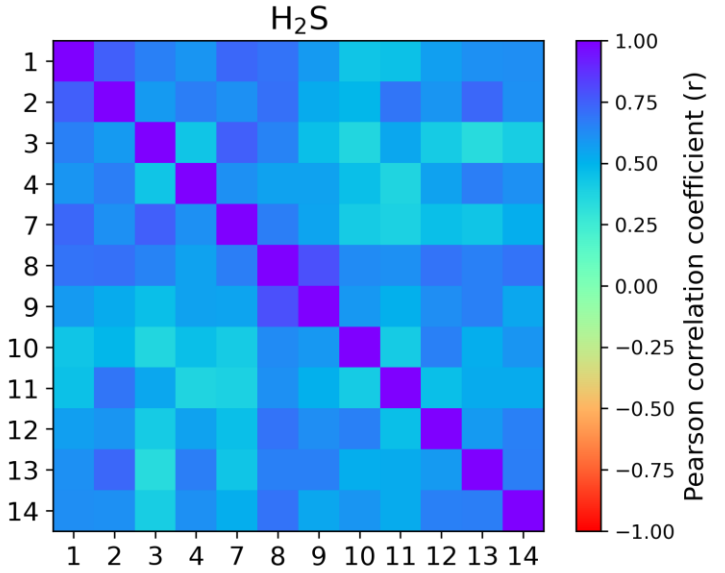


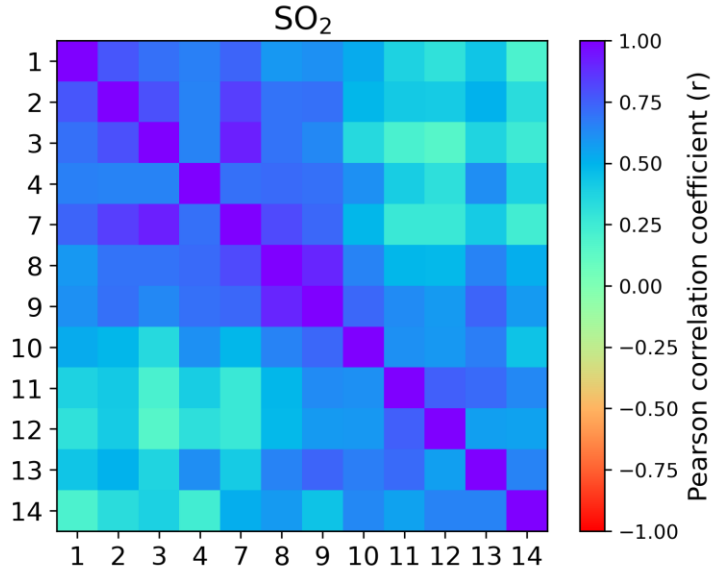
H_2S and SO_2 Passive Monitors Correlations (2010-2018)

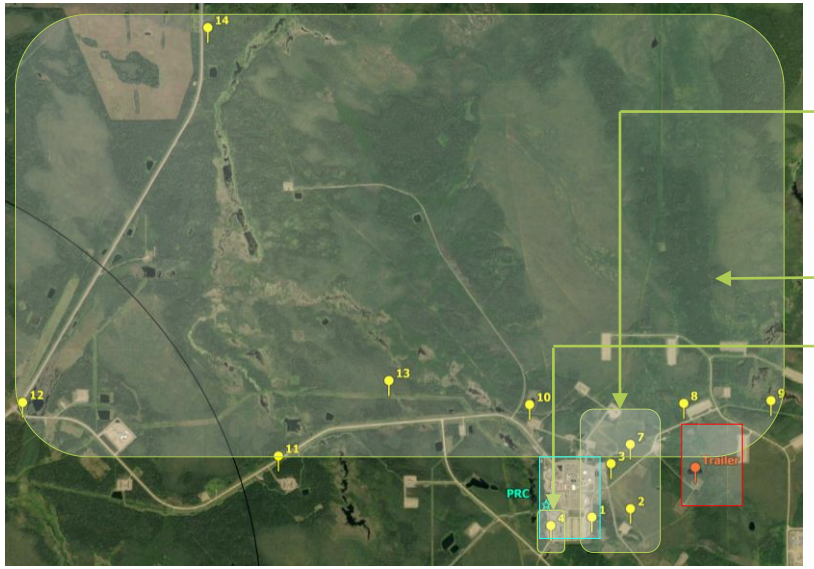
- H_2S:
  - Most correlated stations are stations 1, 2, 7, 8 & 13 (*r* = 0.70-0.75)
  - The least correlated stations are stations 9 & 10-14 (*r* = 0.41-0.66)



- Overall:
  - Two correlation clusters: stations near the plant are more corelated than stations further from the plant
  - Highly correlated area can be “thinned”?







- SO_2:
  - Most correlated stations are stations 1, 2, 3 & 7 (*r* = 0.71-0.78)
  - The least correlated stations are stations 4, & 8-14 (*r* = 0.20-0.66)

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Priority 2 Summary

❖ What the assessment says:

- PRC and Mercer (PRPD) stations are unlike the core PRAMP stations in that they are adjacent to facilities with specific monitoring needs, and act as compliance stations rather than measuring general airshed air quality
- Long-term trends at PRC and Mercer stations follow those of PRAMP stations over the same time period
  - Increasing TRS (but decreasing at PRC since 2018)
  - Decreasing SO_2
  - NMHC, THC, CH_4 variable but relatively constant
- Time series of extreme concentrations and AAAQ compliance.
  - Historical and recent exceedances of 1-hour TRS threshold at PRC and Mercer PRPD, suggesting an ongoing potential for occasional odour detection
  - 1-hour SO_2 concentrations are much less than AAAQs. Can the monitoring technology be changed to passive or lower-cost semiconductor?
  - 1-hour $PM_{2.5}$ exceedances of the 1-h Alberta planning guide and the $PM_{2.5}$-PM_1 correlation at Mercer Town suggest that further PM monitoring is needed in the region
- The correlation analysis for PRC and Mercer stations indicates that elimination of sites, parameters not supported:
  - PRC is correlated with some PRAMP stations for NMHC, is poorly correlated for THC, CH_4 and TRS
  - Mercer stations are poorly correlated with other PRAMP stations
  - PRC and Mercer TRS are uncorrelated with each other

Priority 2 Summary

❖ What the assessment says:

- Diurnal variations of pollutants (e.g., TRS)
  - Unique profiles for PRC and Mercer PRPD stations (deviation from other profiles) → no basis to eliminate measurements
- At all three sites, meteorology is key to understanding the source and interpreting the information. Because of the uniqueness of each site, no reduction in monitoring is recommended.
- PRC passive network
  - SO_2 measurements well below AAQO (supported by the continuous data), with highest values at the closest sites
  - Is there continued value in this network? Options:
    - No changes
    - "Thin" the high-density, near-plant sites 1-10
    - Redeploy network to include well sites
    - Eliminate passives altogether, as have continuous SO_2 and TRS
- Overall, and apart from the passive network, there appears to be no basis for optimizing the continuous stations.

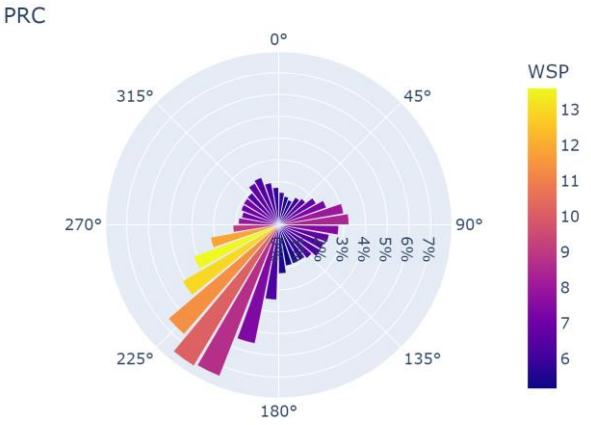
Priority 2 Draft Recommendations

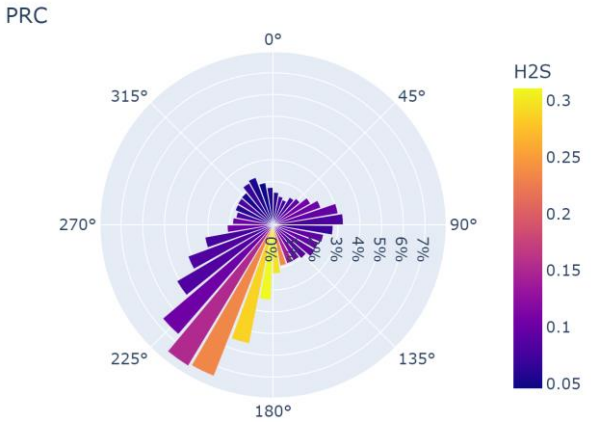
- Remove any of the new stations? No
- Reduce parameters?
  - Can SO_2 be eliminated given low values? Possibly or technology changes
  - TRS eliminated? No, TRS shows 1-h exceedances and odour potential.
  - What about meteorology? No, given differences in windroses at sites.
  - Eliminate either THC or CH_4 at PRC? Yes, possible
  - Eliminate PM monitoring at Mercer Town? No, given spikes in spring and summer
- Move stations?
  - No, as all are related to effects of specific plant sources
- PRC Passive network changes?
  - Eliminate (recommended?)

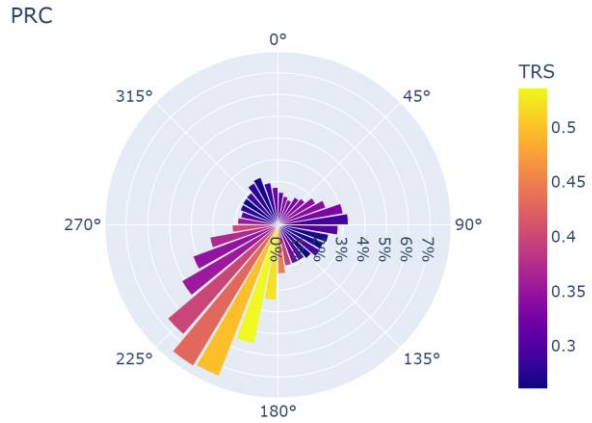
		Station Name									
Monitoring Method	Parameter	986c	842b	Reno	AQHI (Grimshaw)	CNRL (PRC)	Mercer (Townsite)	Mercer (Plantsite)	Peace River (above valley)	Peace River (in valley)	Nampa
Continuous	Sulphur Dioxide	√	√	√	√	√	√				
	Total Reduced Sulphurs	√	√	√	√	√	√	√			
	Hydrogen Sulphide					√					
	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*	√	√	√	√				√	√	√

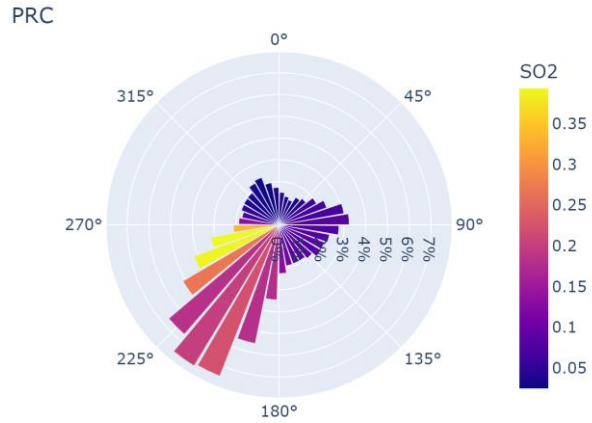
Thank you.

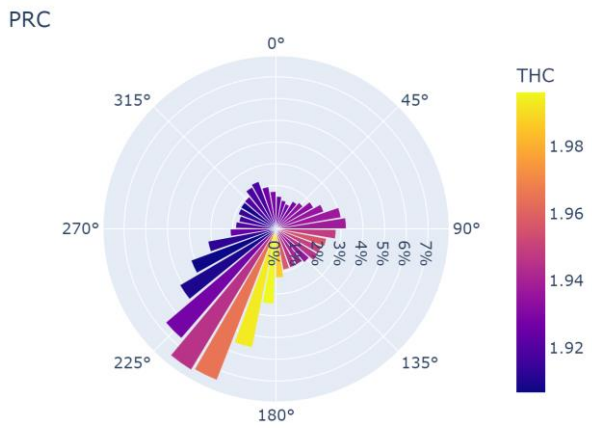
Wind and pollution roses at the Peace River Complex (PRC) station (1-h data from 2013 to 2021)

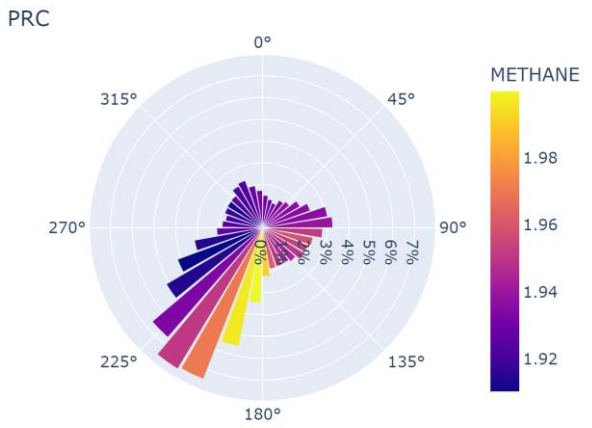


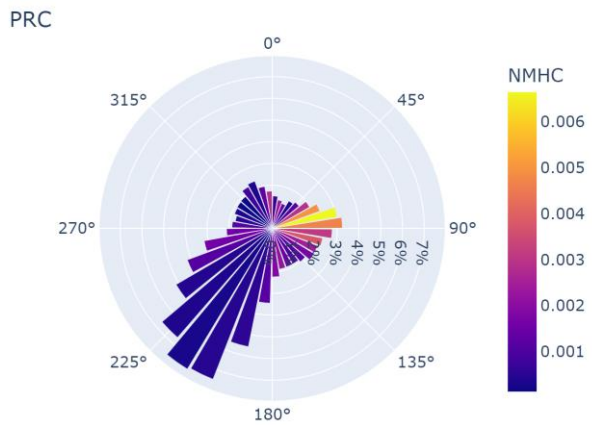




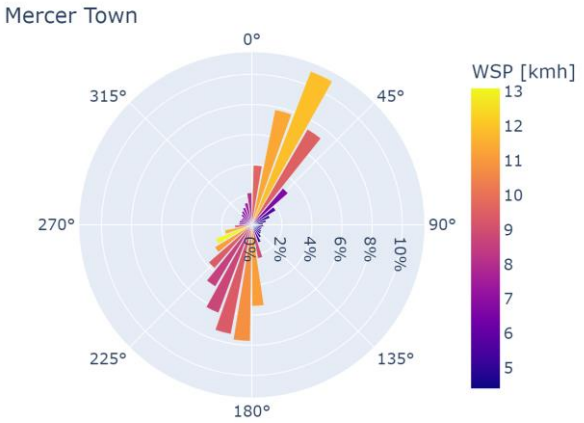


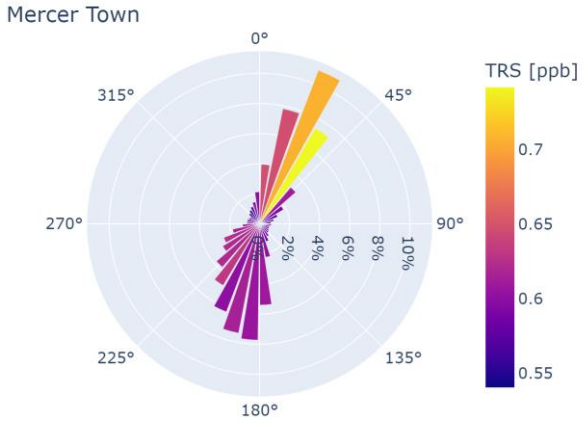


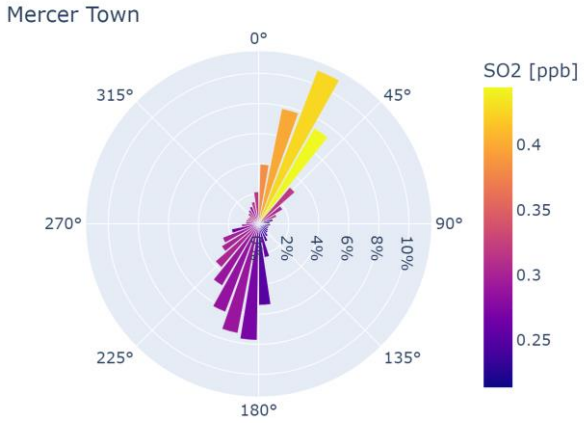


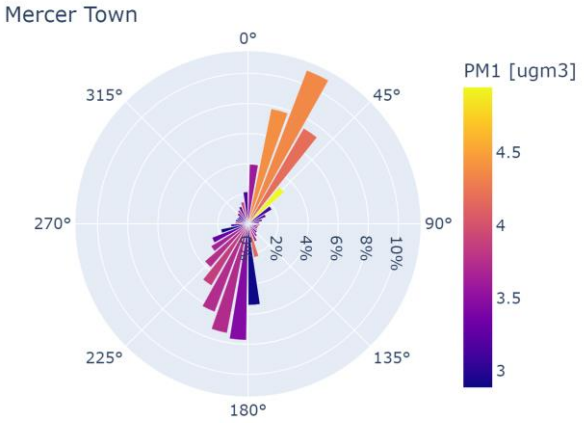


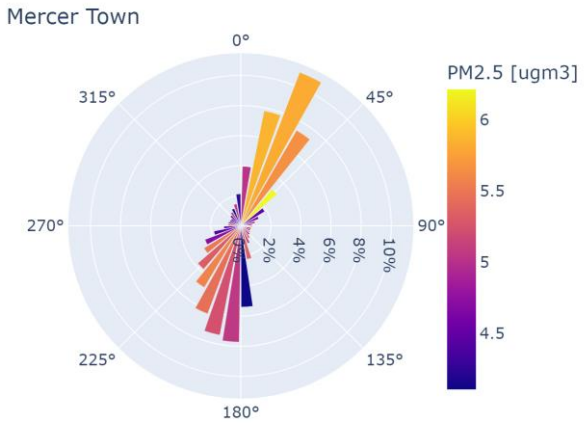
Wind and pollution roses at the Mercer Town station (1-h data from 2017 to 2021)

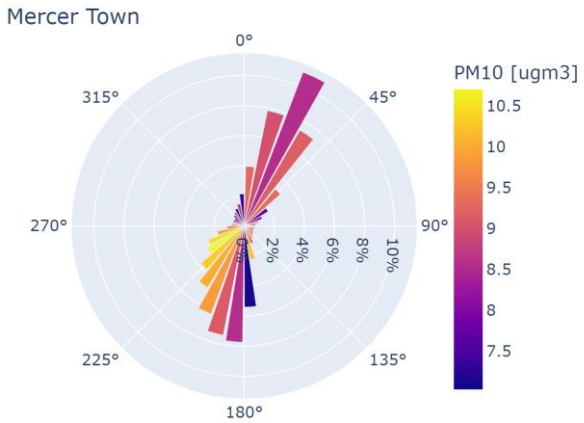




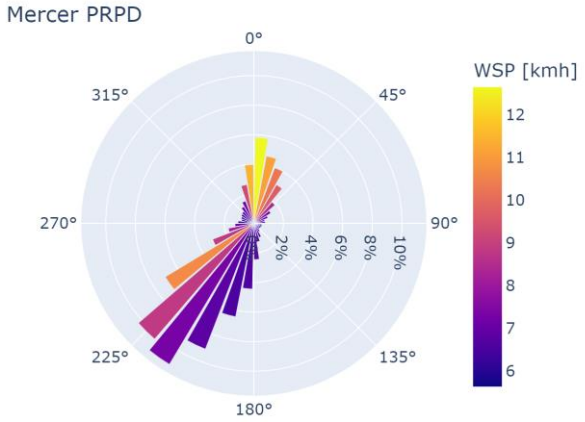


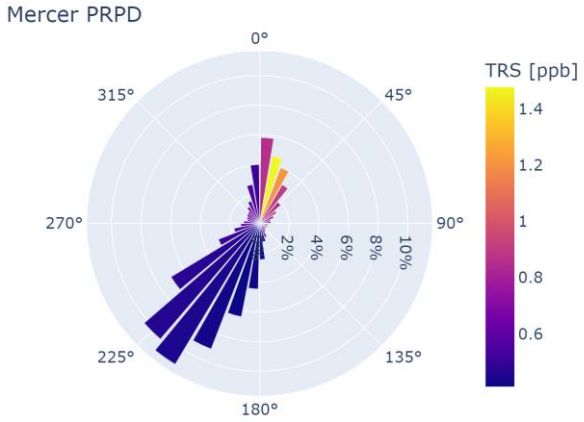






Wind and pollution roses at the Mercer PRPD station (1-h data from 2017 to 2021)





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