Ambient Hydrocarbon Concentrations near Cold Heavy Oil Production in Northern Alberta

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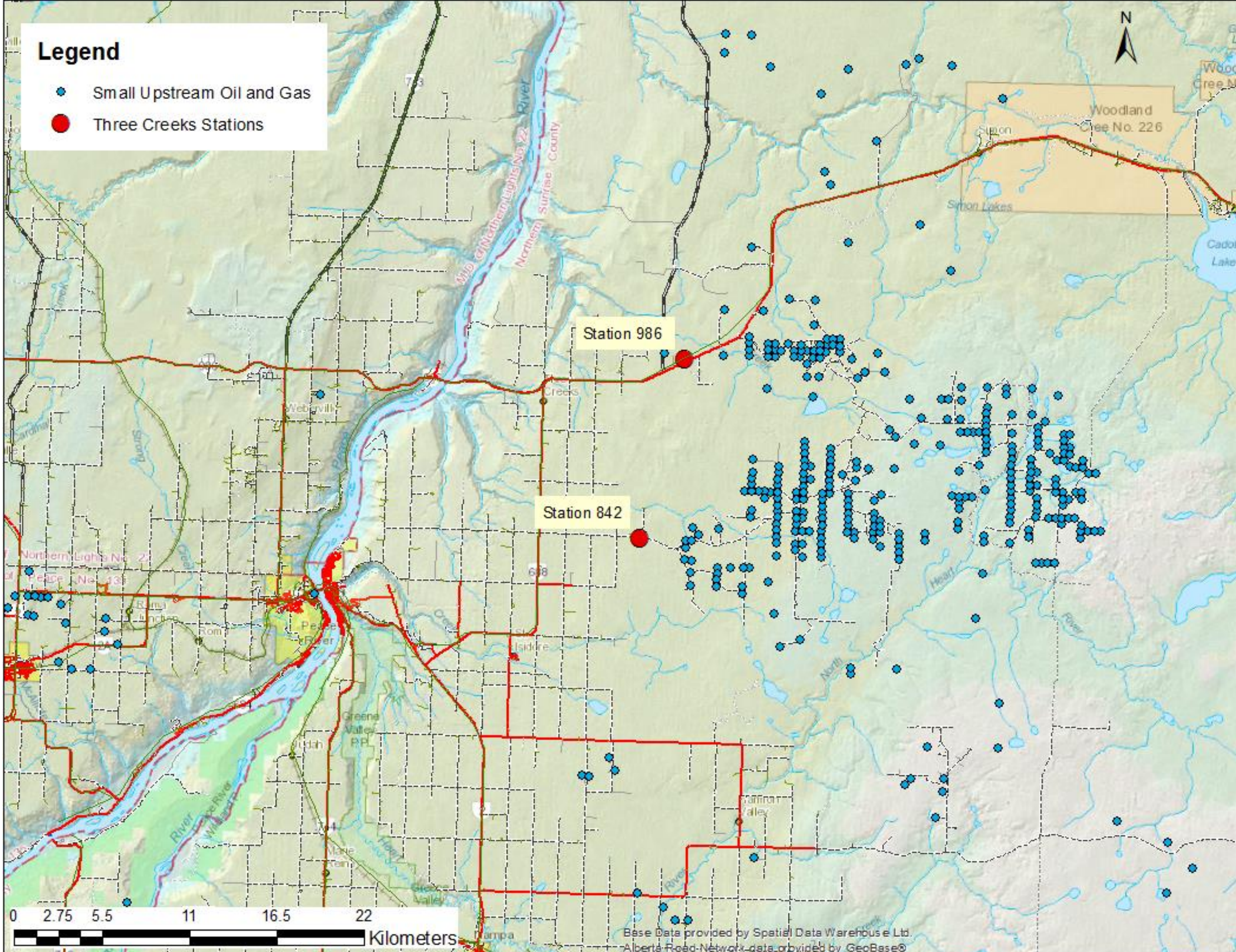
CPANs Annual Conference

May 26th 2015

Government of Alberta

Overview

- The monitoring and monitored area
- Elevated hydrocarbons and probably reasons
- Temporal changes in elevated hydrocarbon concentrations
- Volatile Organic Compound, receptor analysis and findings

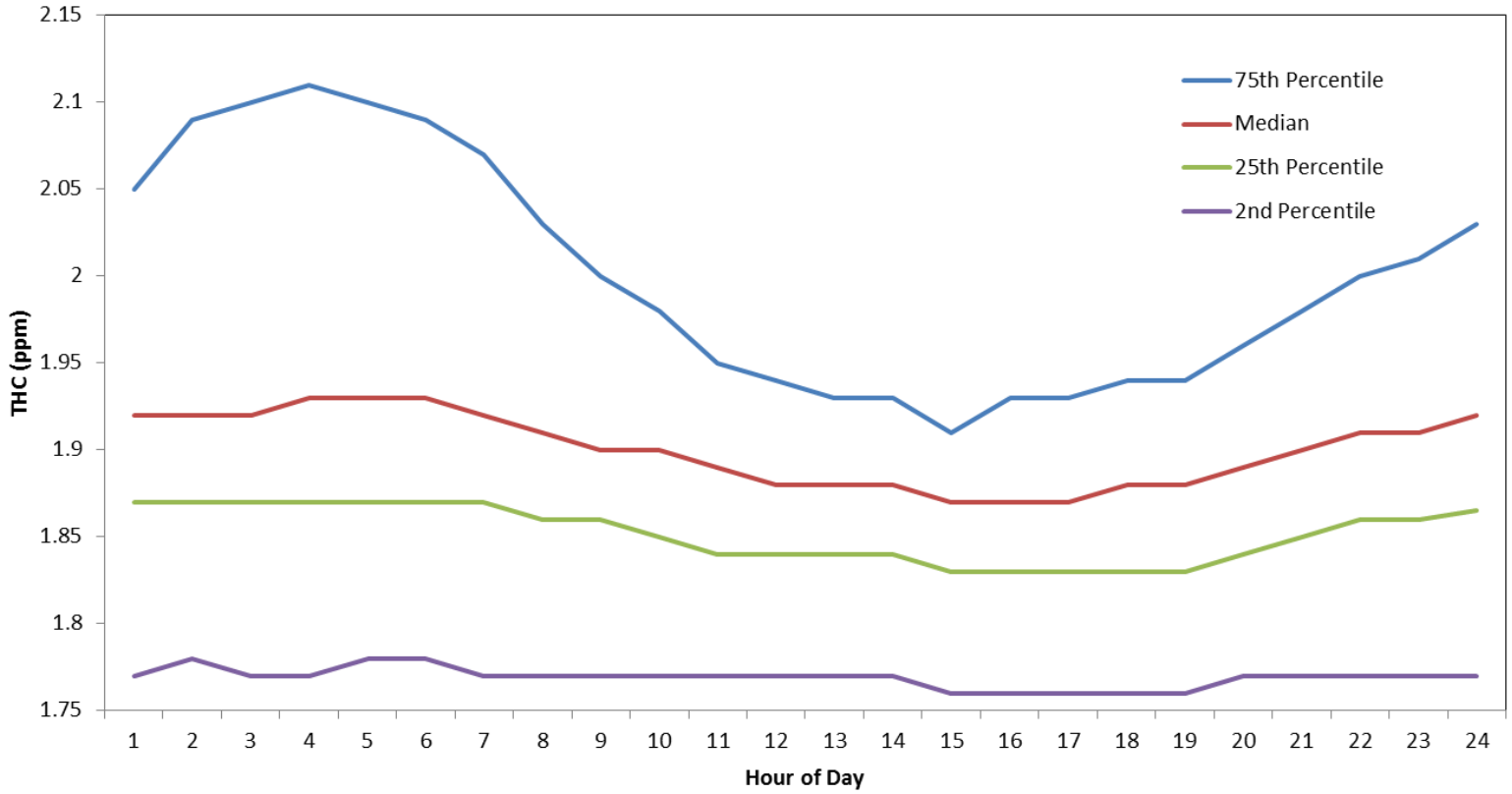

Legend
Small Upstream Oil and Gas
Three Creeks Stations
Station 986
Station 842
Woodland Cree No. 226
Cadotte Lake
0 2.75 5.5 11 16.5 22
Kilometers
Base Data provided by Spatial Data Warehouse Ltd.
Alberta Road Network data provided by GeoBase®

Data used in the Study

Station	Parameter	Interval	Period
986*	Total Hydrocarbons	1 hr	Mar 2010-Aug 2014
	Methane	1 hr	Mar 2010-Aug 2014
	Non-methane Hydrocarbons (NMHC)	1 hr	Mar 2010-Aug 2014
	Meteorological Info	1 hr	Mar 2010-Aug 2014
	Volatile Organic Compounds (VOCs)	15-60 min	triggered
842	Total Hydrocarbons	1 hr	Nov 2012-Aug 2014
	Methane	1 hr	Nov 2012-Aug 2014
	Non-methane Hydrocarbons (NMHC)	1 hr	Nov 2012-Aug 2014
	Meteorological Info	1 hr	Mar 2010-Aug 2014
	Volatile Organic Compounds (VOCs)	15-60 min	triggered

Data used provided by Peace River Area Monitoring Program (PRAMP)

Diurnal Variation of Total Hydrocarbon Concentrations



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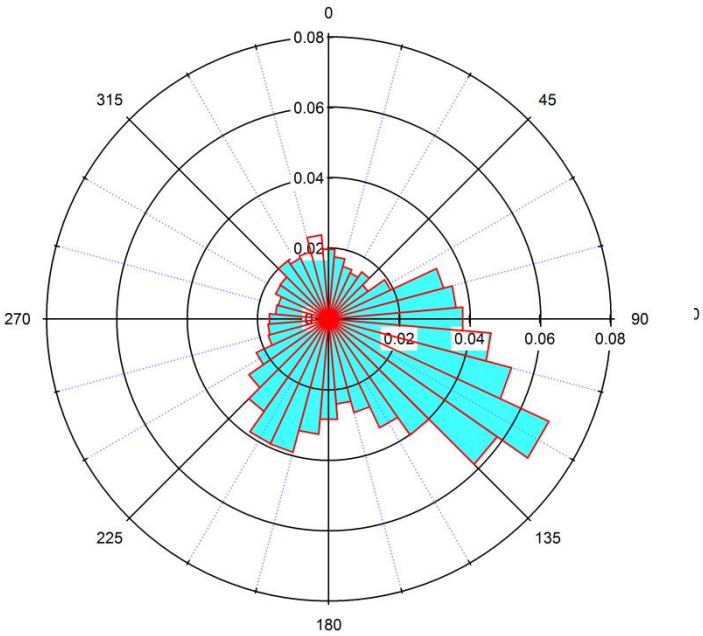

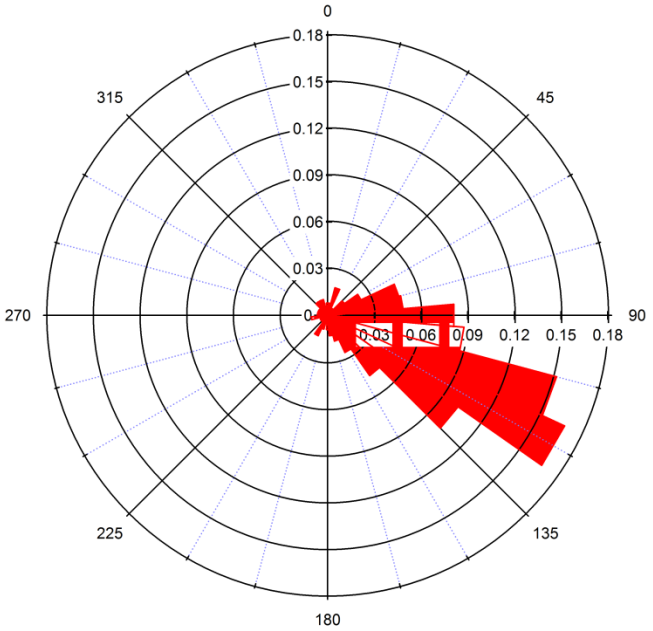

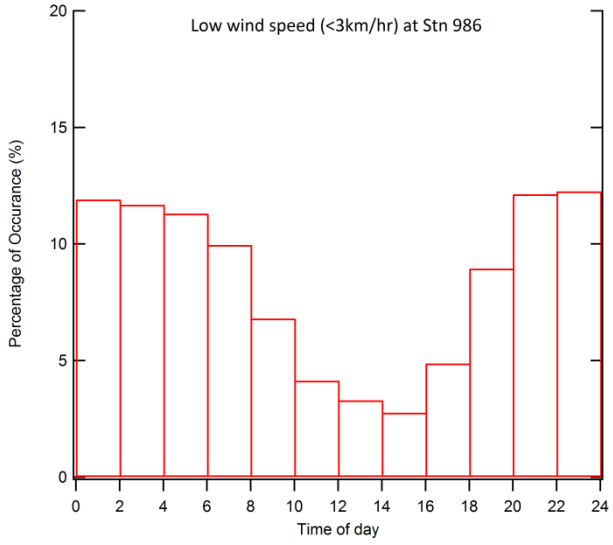

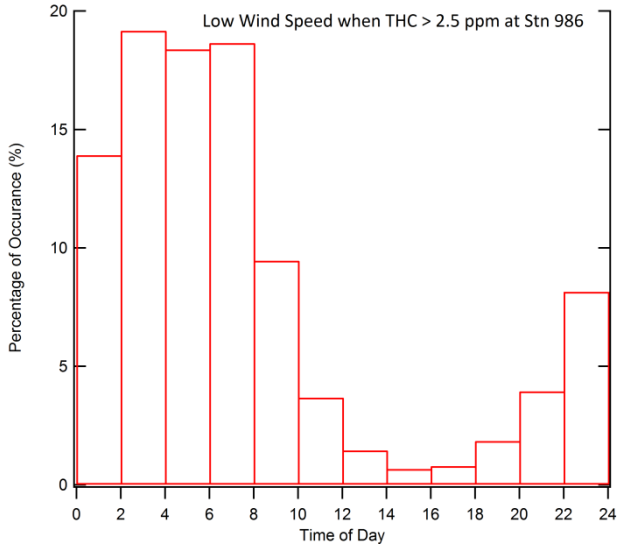

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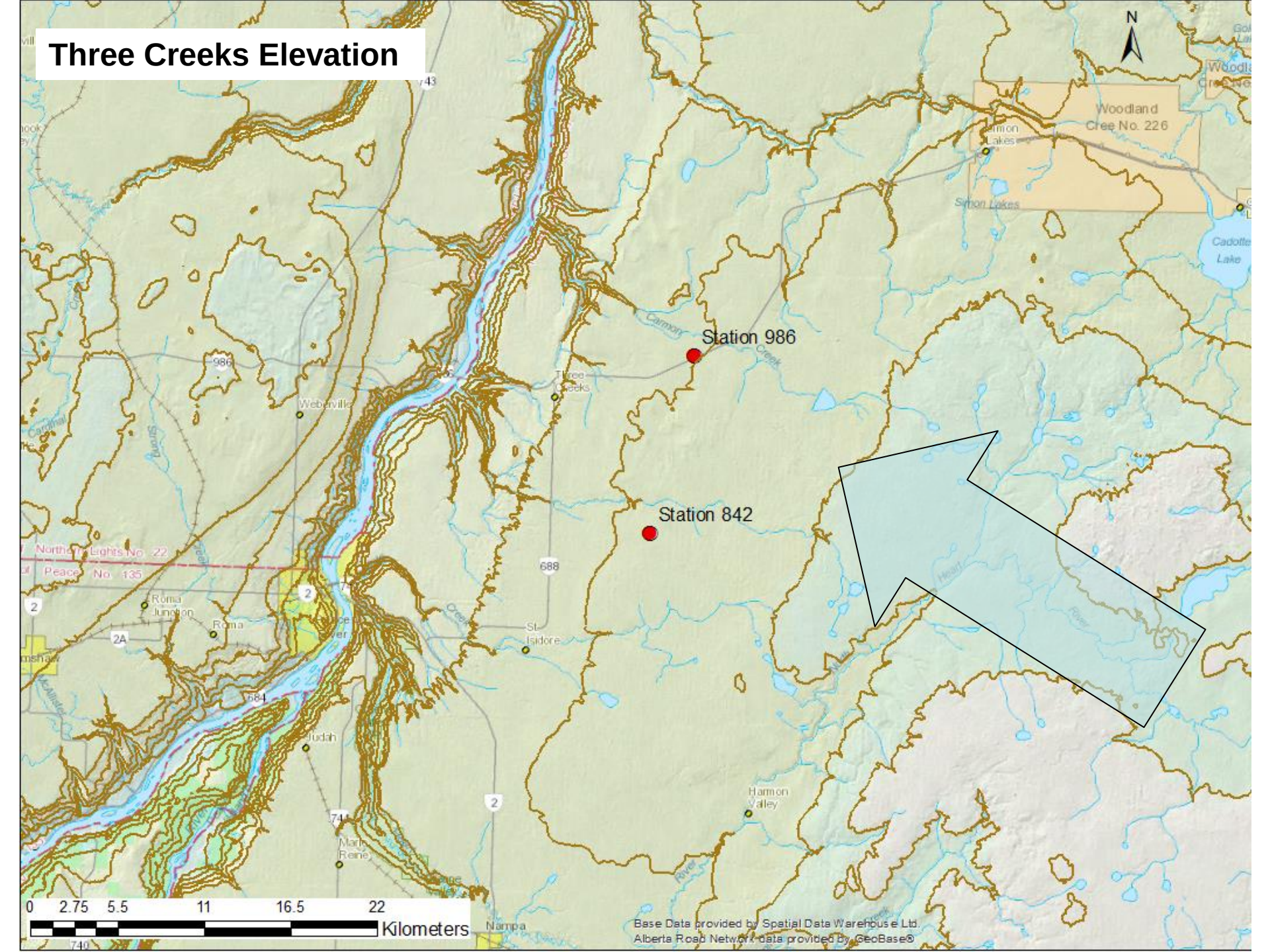
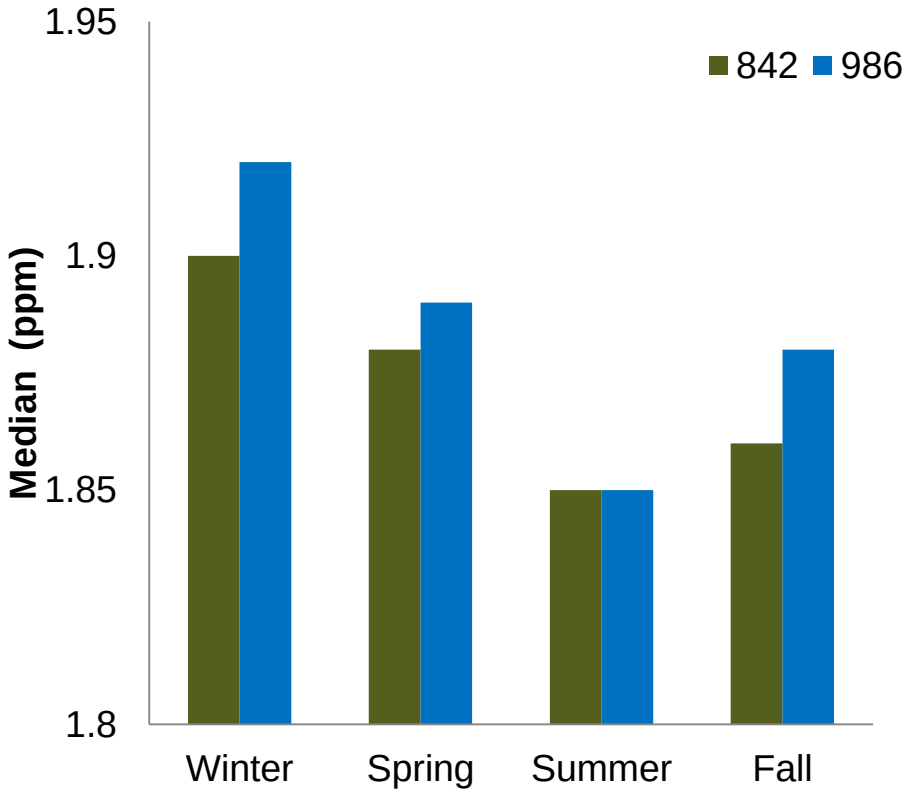
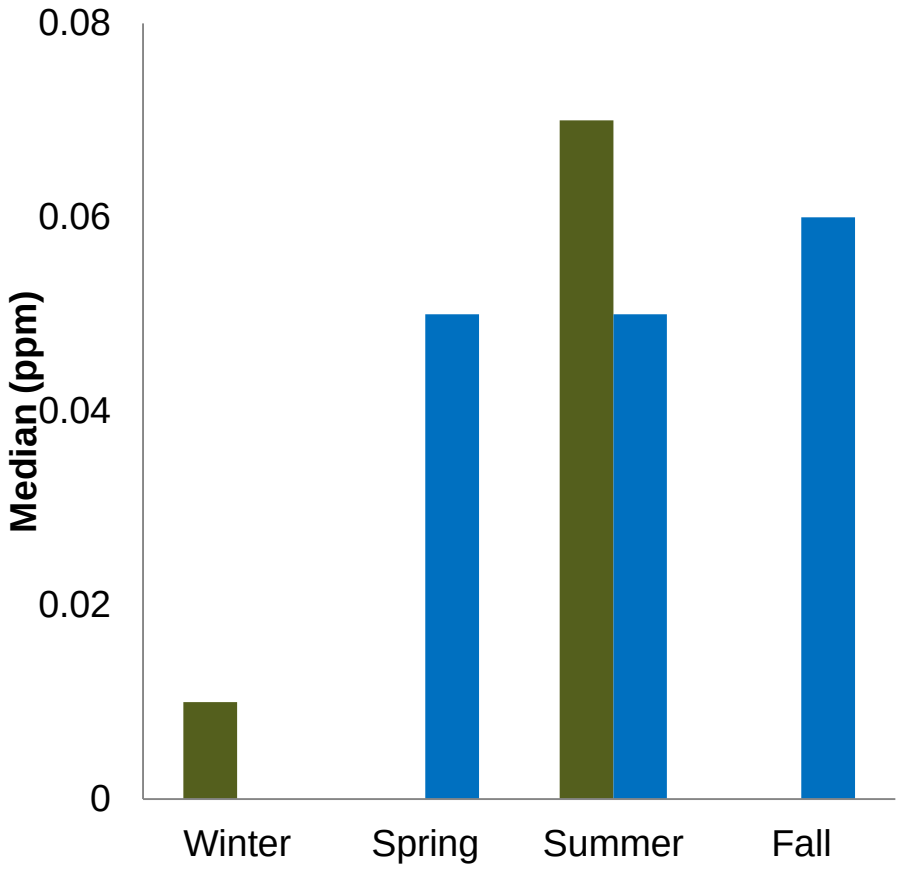

Three Creeks Elevation
N
Station 986
Station 842
Woodland Cree No. 226
Simon Lakes
Cadotte Lake
Carmony Creek
Three Creeks
Weberville
Roma Junction
Roma
St. Isidore
Judah
Marie Reine
Harmon Valley
Nampa
0 2.75 5.5 11 16.5 22
Kilometers
Base Data provided by Spatial Data Warehouse Ltd.
Alberta Road Network data provided by GeoBase®

Seasonal Median

THC



NMHC



Fugitive emission mitigation

- January 2014, hearing on odour and emissions from heavy oil operation in the Peace River area
- Alberta Energy Regulator revised Directive 60
  - Requirement for flaring, incinerating, capturing or conserving all casing and tank top gas in the Peace River area.
- Fugitive emissions mitigation
  - Started prior to hearing and Directive revision and continued until it became requirement in 2014.
- Was any change observed in the occurrence of elevated THC?

Measure of Change

- We know the meteorological conditions that result in elevated THC

$$\%\ sample = \frac{\#[THC]_H}{\#WDR([THC]_T)} \times 100\%$$

Number of elevated THC observed $\#[THC]_H$

Number of sample hours with meteorological conditions associated with elevated THC $\#WDR([THC]_T)$

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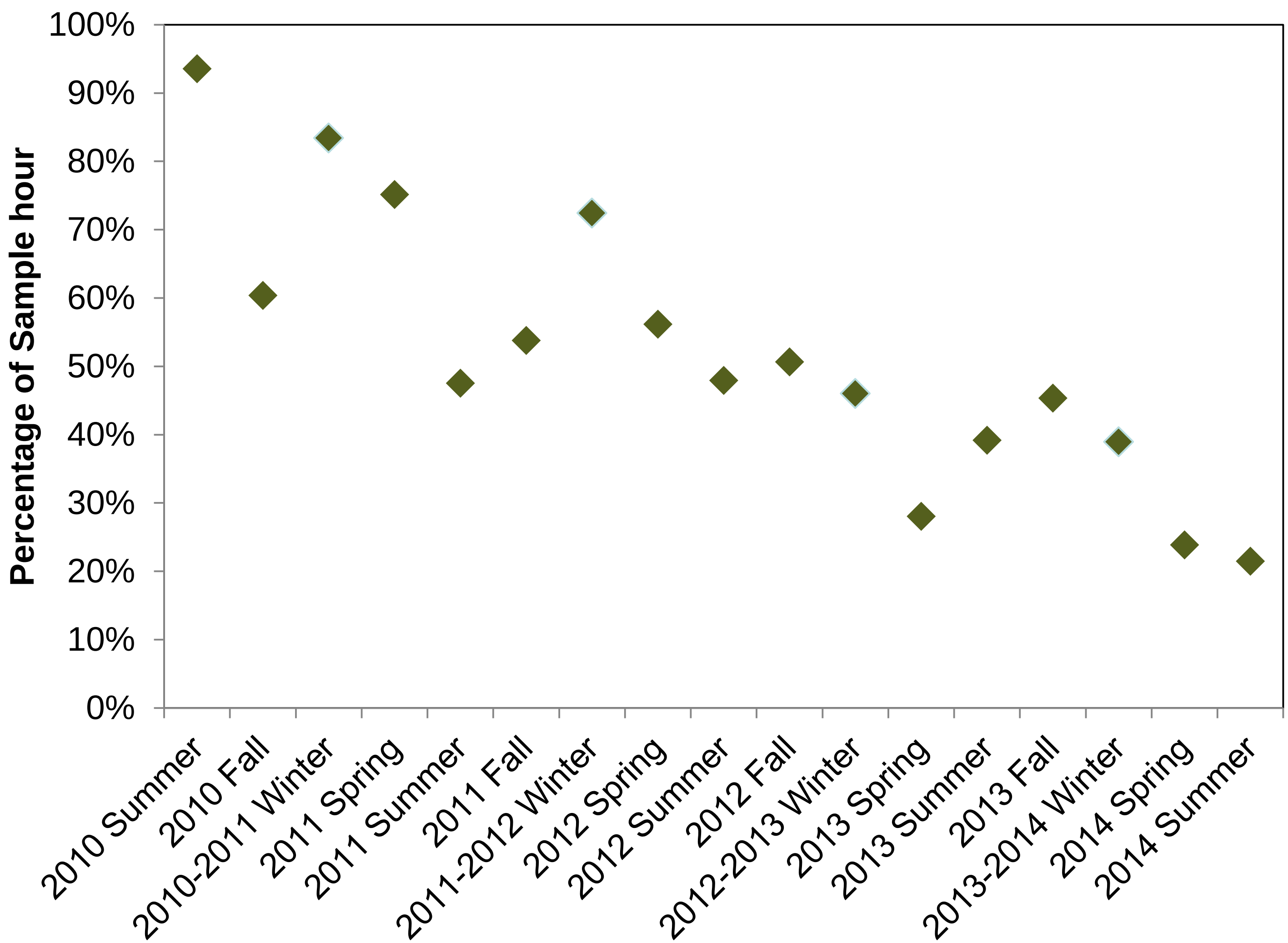
Incidents of Elevated THC (986)



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Observations from

Volatile Organic Compounds

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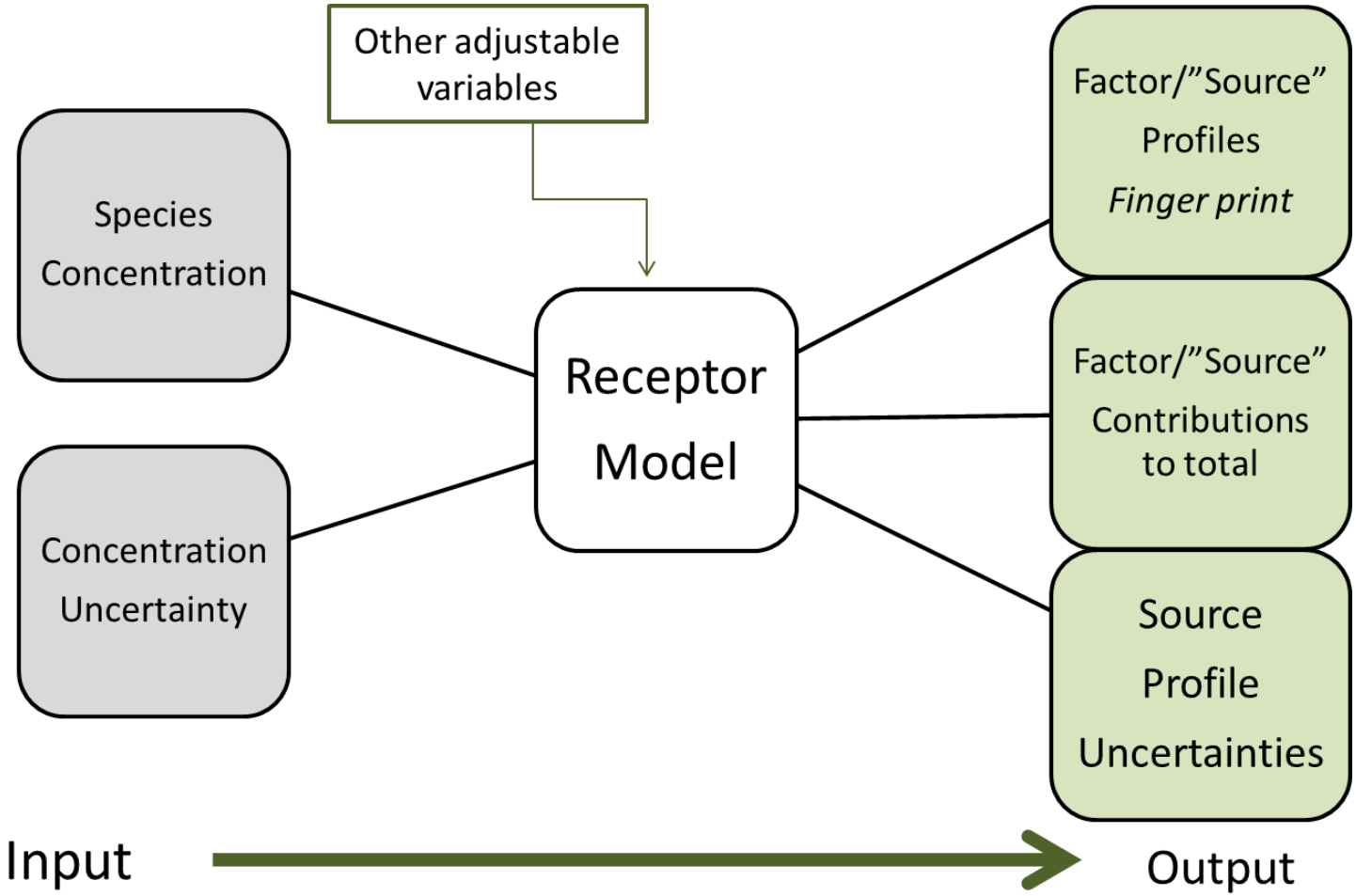
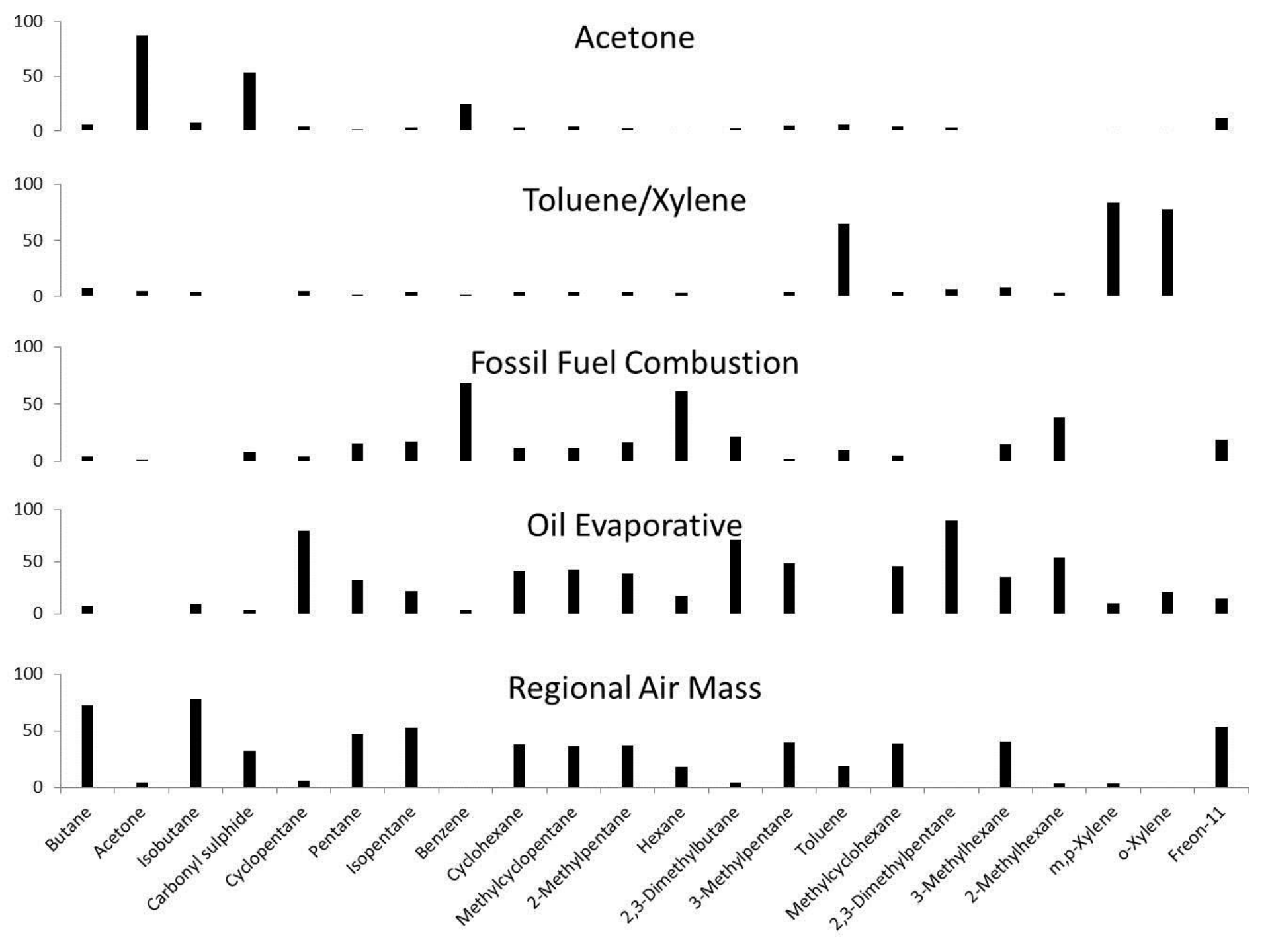
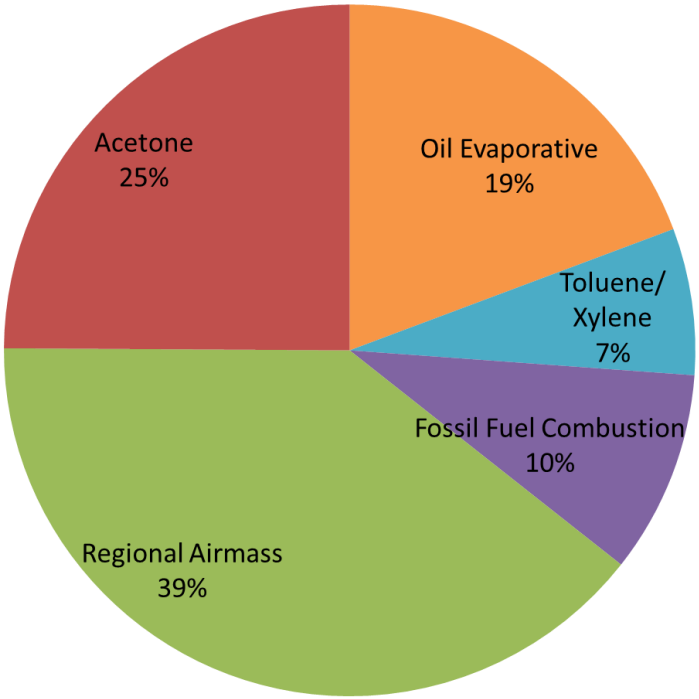
Simplified Schematics of Receptor Source Apportionment



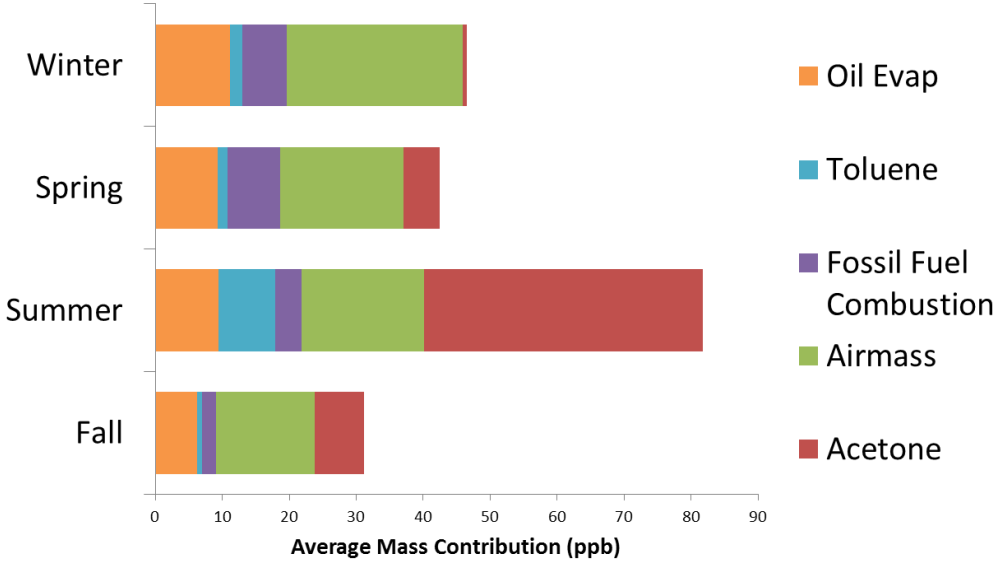

Acetone
Toluene/Xylene
Fossil Fuel Combustion
Oil Evaporative
Regional Air Mass
100
50
0
Butane
Acetone
Isobutane
Carbonyl sulphide
Cyclopentane
Pentane
Isopentane
Benzene
Cyclohexane
Methylcyclopentane
2-Methylpentane
Hexane
2,3-Dimethylbutane
3-Methylpentane
Toluene
Methylcyclohexane
2,3-Dimethylpentane
3-Methylhexane
2-Methylhexane
m,p-Xylene
o-Xylene
Freon-11

Receptor Analysis: 5 factors

Average Mass Contribution



Seasonal Variation



Summary

- Elevated hydrocarbon concentrations occurred largely in the early morning with low wind speeds from the east to southeast; this is likely promoted by gravitational drainage flow.

- The incidents of elevated hydrocarbons are decreasing over time, most likely associated with efforts to reduce fugitive emissions associated with heavy oil production.

Summary

- The measured VOCs are likely emitted and secondary
- On average higher VOC mass concentrations were measured in the summer (e.g. Acetone and Toluene factors). Warmer seasons and more sunlight promote evaporation and photochemistry.
- THC concentration (largely CH_4) were higher in the colder months, likely promoted by the lower mixing heights.