Quantifying Emissions from a Small Oil Sands Demonstration Pit Lake

using OP-FTIR Measurements coupled with Vertical Radial Plume Mapping

Youssef Taha, Ignacio Gallardo, Ahmad Kia, and Randy Rudolph

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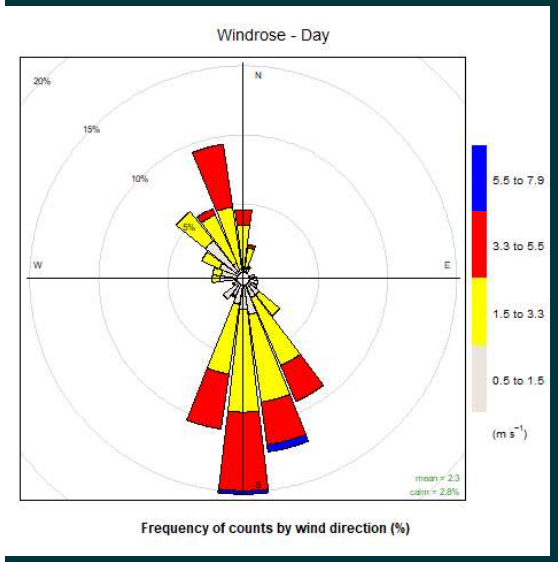
Suncor Demonstration Pit Lake Project

- Lake Miwasin facility constructed in 2017 as a scaled down demonstration and test facility to evaluate PASS technology.
- Air emissions component:

  Are any gases or constituents (e.g., bitumen) released from the DPL that would be harmful to waterfowl, wildlife and people within 1 week after deposition, over time, and at closure?
- Specific air objectives, to monitor and assess:
  - air emissions from the DPL
  - the impacts of aerial deposition on the lake and upland ecosystems

2022 Layout



Emissions based on water column characterization

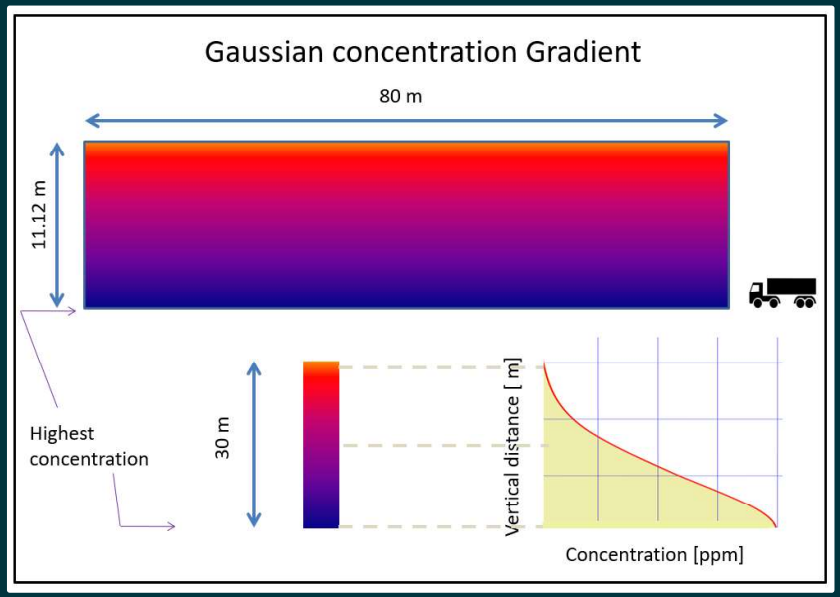
OP-FTIR MDLs typically 1-7 ppb

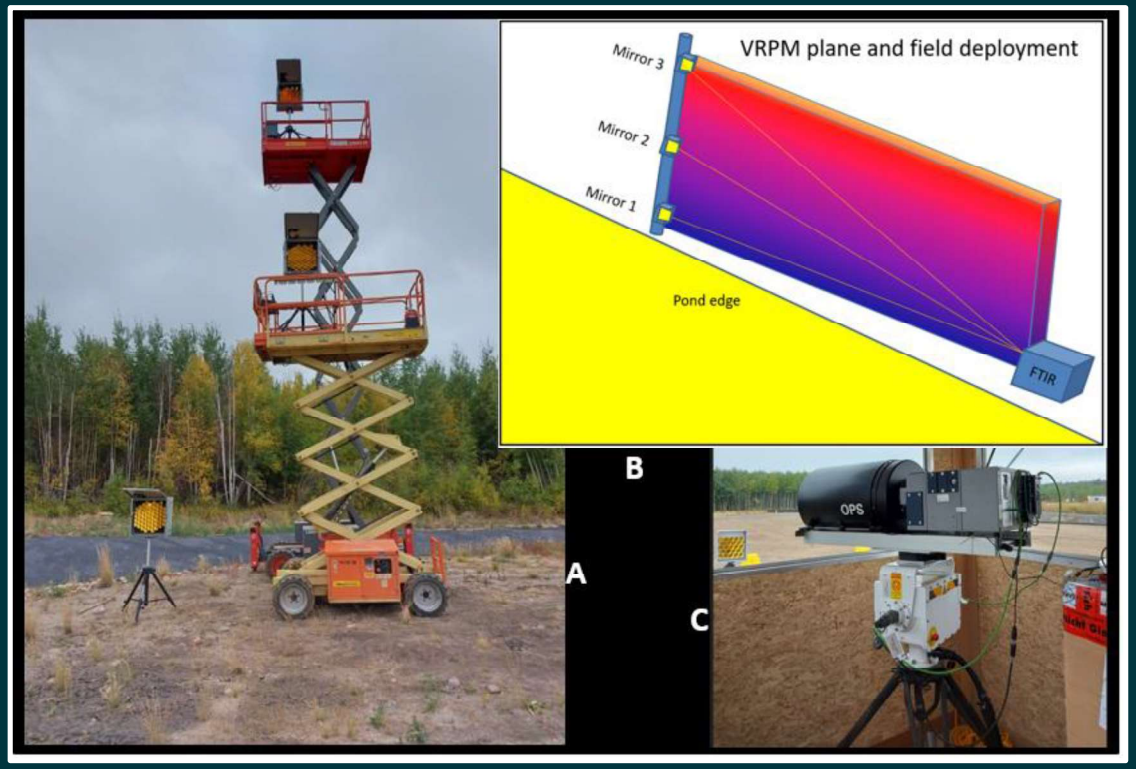
OP-FTIR at N end of Lake to take advantage of S winds

Three retros at NW edge of lake at Ground, 5.9 m and 11.1 m.

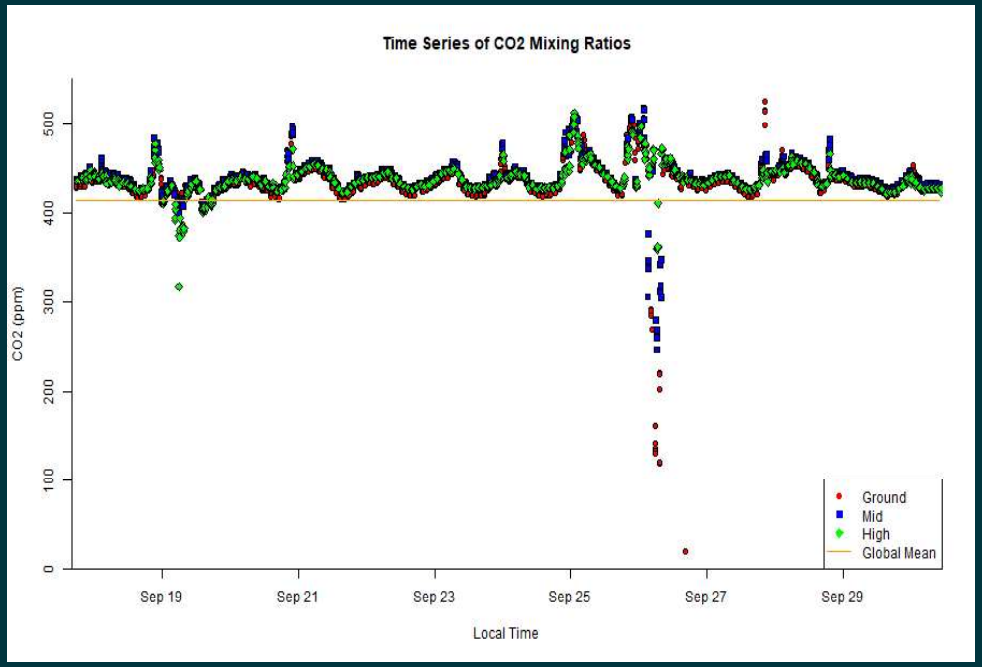
Lake is 80 m wide which is smaller than optimal to minimize MDLs

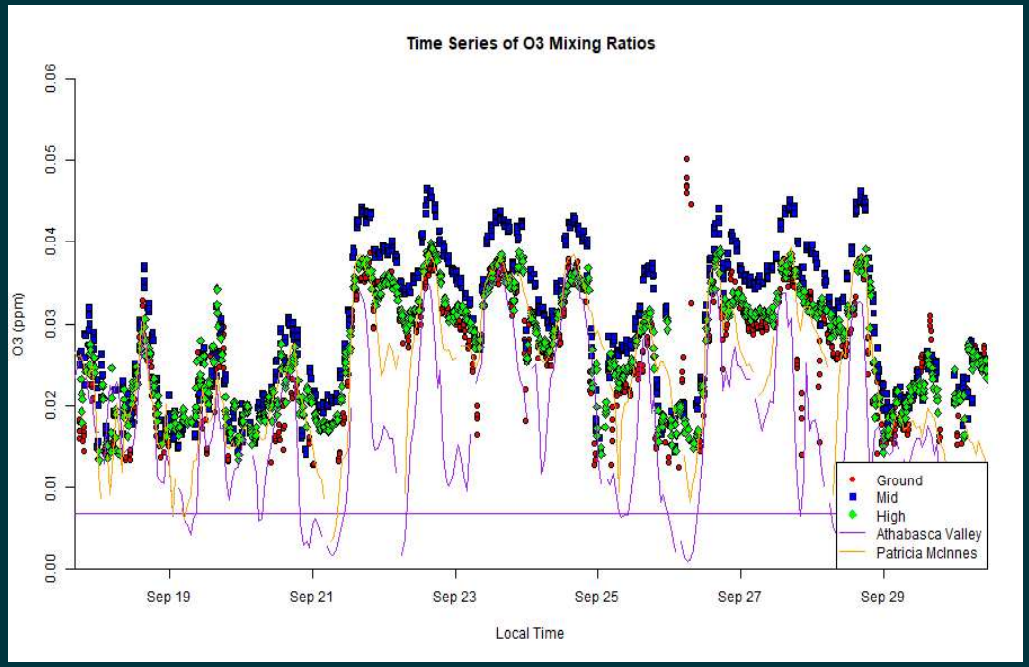
2022 Approach



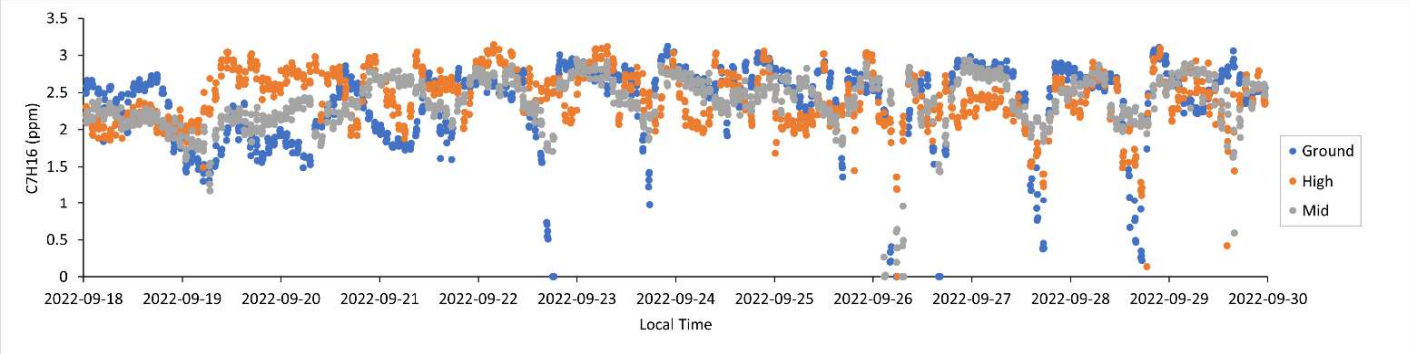


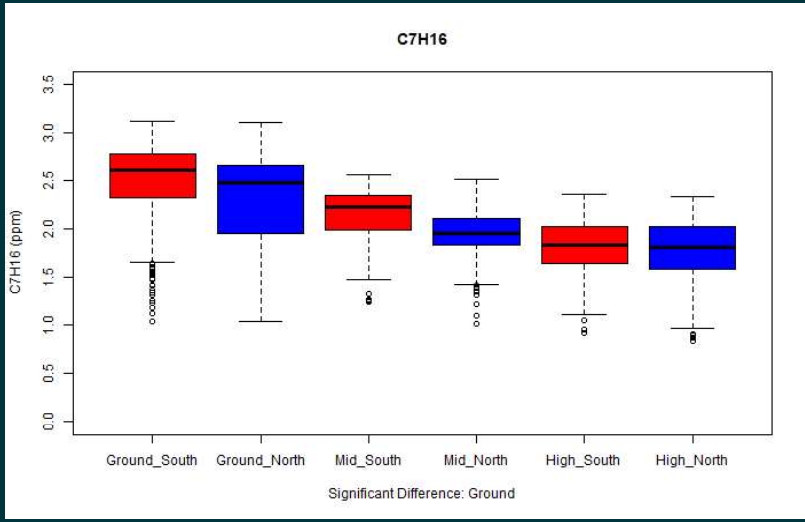
Comparison to Reference Data – CO2, O3





Example Data – n-heptane





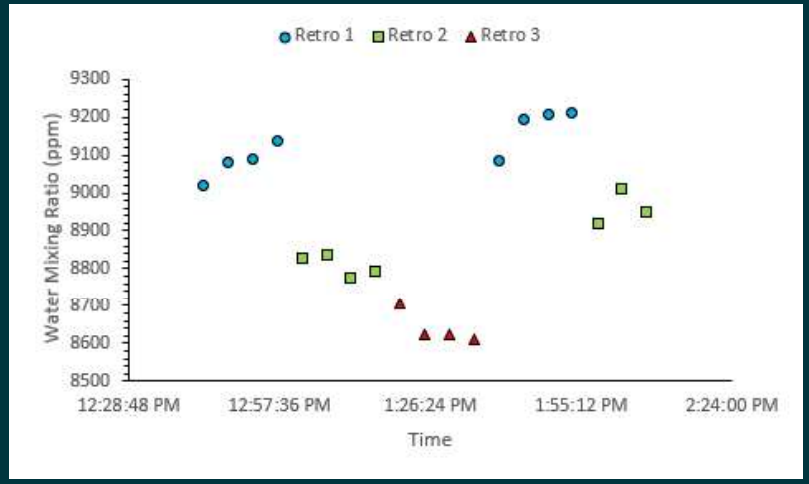
Quality Control 1

Several additional quality control procedures were introduced into the program driven in part by the very low concentrations measured in the area:

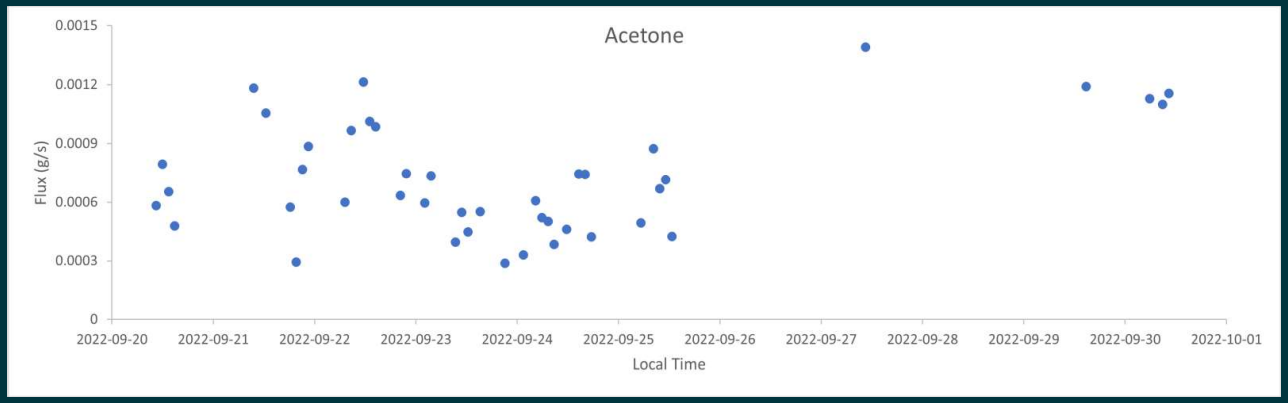
- Reviewed the frequency ranges and fit parameters yielding the optimum returns
- Choice of spectral fitting ranges and fitting method must account for potential non-Beer Lambert law behaviour (non-linear response) at sub 300 m path lengths – path length constraints and DPL make this an issue – increases measurement uncertainty
- Minimum correlation factors were established for each substance measured, rather than using the 2021 standard thresholds
- Determined the cause of unexpected periodicity in 2021 measurements.

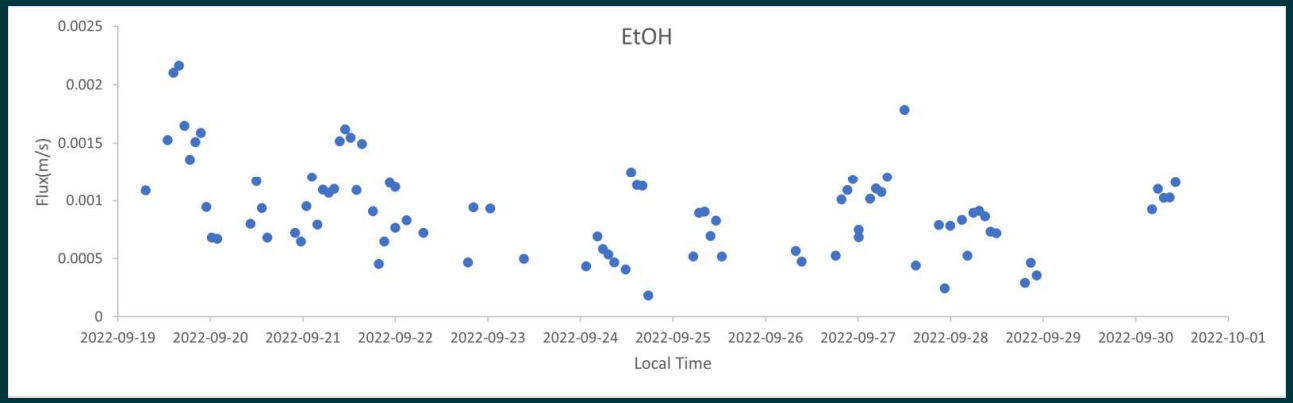
Quality Control 2

- Established reflectivity differences among the three retroreflectors in a controlled test, to investigate any systematic differences among measured concentration – apply retro to retro scaling factor prior to comparison
- concentrations scaling with signal strength - issue doesn't appear to be reported in literature



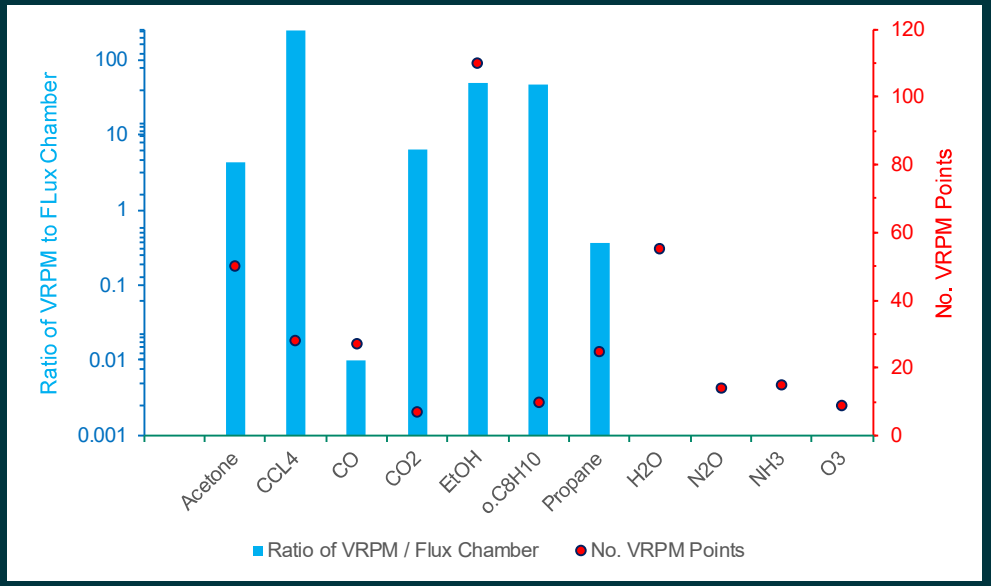
VRPM


Acetone
Flux (g/s)
0.0015
0.0012
0.0009
0.0006
0.0003
0
2022-09-20
2022-09-21
2022-09-22
2022-09-23
2022-09-24
2022-09-25
2022-09-26
2022-09-27
2022-09-28
2022-09-29
2022-09-30
2022-10-01
Local Time


EtOH
Flux(m/s)
0.0025
0.002
0.0015
0.001
0.0005
0
2022-09-19
2022-09-20
2022-09-21
2022-09-22
2022-09-23
2022-09-24
2022-09-25
2022-09-26
2022-09-27
2022-09-28
2022-09-29
2022-09-30
2022-10-01
Local Time

VRPM Results

Compound	No. VRPM Points	VRPM Flux from South (g/s)	VRPM Flux from South Std dev (g/s)
Acetone	50	7.61e-04	3.78e-04
CCL_4	28	1.69e-04	8.32e-05
CO	27	5.45e-04	3.07e-04
CO_2	7	1.30e+00	4.36e-01
Ethanol (EtOH)	110	8.82e-04	3.72e-04
o-xylene (o.C8H10)	10	2.17e-03	1.35e-03
Propane	25	2.70e-04	1.97e-04
H_2O	55	9.57e+00	4.44e+00
N_2O	14	8.44e-04	3.39e-04
NH_3	15	1.06e-06	1.28e-06
O_3	9	1.37e-04	6.70e-05



Key VRPM Results

- For most substances, too few data points survived the acceptance criteria based on
  - vertical structure (i.e., not a Gaussian shape)
  - wind speed (winds above 1 m/s) and
  - wind direction range (i.e., directions were too variable or differed among the three measurement heights)
    - Variable wind direction range product of measurement time at each retro per cycle – ~25 mins per retro as focus thus far has been on maximizing detection limits – can be greatly reduced in future
- OP-FTIR flux estimates were generally higher than flux chamber estimates.
  - different years
  - "cover" or represent much different surface areas of the Lake

The evidence to date is that the Lake itself and any nearby sources, are relatively small emitters and only marginally impact observed concentrations.

Thank you.

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