A geospatial method to assess site suitability for static vehicle-based measurements of methane plumes

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Abstract

Vehicle-based methane-sensing systems are gaining popularity as tools for monitoring site-level methane emissions from oil and gas (O&G) sites. To measure emissions, vehicles equipped with methane sensors intersect plumes along roads downwind of target sites and acquire measurements in static (parked) or mobile modes. The downwind distance between the emissions source and the measurement location is one of several factors that must be considered in planning these types of surveys. Here we present a method to estimate the suitability of O&G facilities for vehicle-based measurements using downwind distances recommended in OTM 33A and the tracer technique. We present two types of analyses: (1) a historical analysis using weather reanalysis data and (2) an operational analysis using forecast data. The method uses modeled wind direction and geospatial data to identify O&G facilities that have roads between 20 and 200 m downwind for OTM 33A and between 500 m and 3000 m downwind for the tracer technique. We apply the method to O&G facilities in Alberta that will soon require annual or triannual LDAR surveys. For the historical analysis we use ERA-Interim wind data and calculate the vectorial average (resultant) of modeled winds for the period 2009-2018. Of the 35047 O&G facilities examined, we find that 7% are, on average, suitable for OTM 33A and 69% are, on average, suitable for the tracer technique, based solely on downwind distance. We surmise that other factors like landcover, weather conditions (e.g., stability), and topography would likely reduce the candidate pool from these estimates. We demonstrate the operational utility of the method by examining a subset of 100 O&G facilities in southern Alberta and using forecast wind direction from the Canadian High Resolution Deterministic Prediction System (HRDPS), which has a 2.5 km grid spacing. We propose that the method can be used as a screening tool to estimate site suitability for static vehicle-based surveys and that it will likely translate to mobile surveys once the effect of downwind distance is clarified. Other factors can be incorporated in the method once test results are available.

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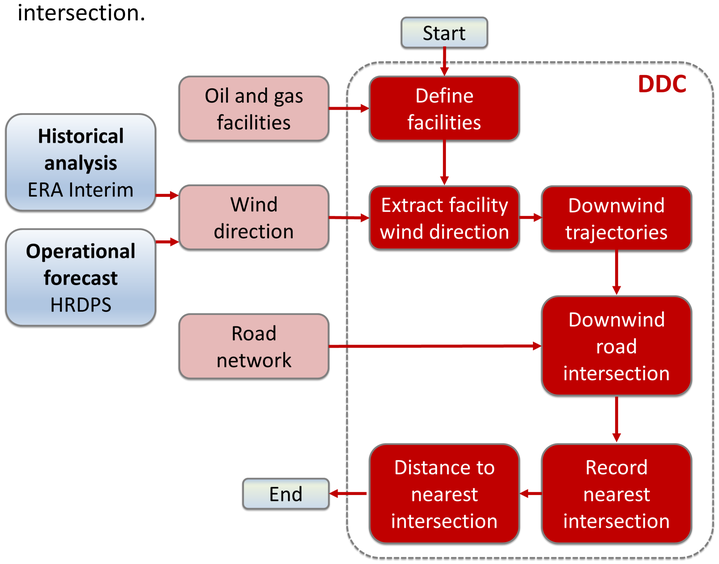
1. Introduction

We developed a methodology to evaluate the suitability of oil and gas facilities for vehicle-based measurements using downwind distances recommended in OTM 33A and the tracer technique. We present two types of analyses: (1) a historical analysis using weather reanalysis data and (2) an operational analysis using high-resolution forecast data. The methodology uses modeled wind direction and geospatial data to identify oil and gas facilities that have roads between 20 and 200 m downwind for OTM 33A and between 500 m and 3000 m downwind for the tracer technique. We apply the method to O&G facilities in Alberta that will soon require annual or triannual LDAR surveys.

University of Calgary vehicle system: ***PoMELO***

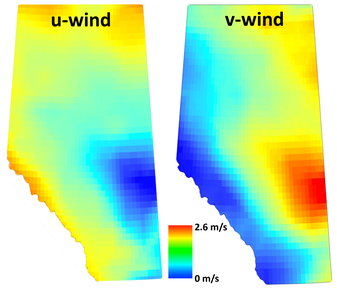
2. Methodology

Downwind Distance Calculator (DDC): A method to find the distance from an oil and gas facility to the nearest downwind road intersection.

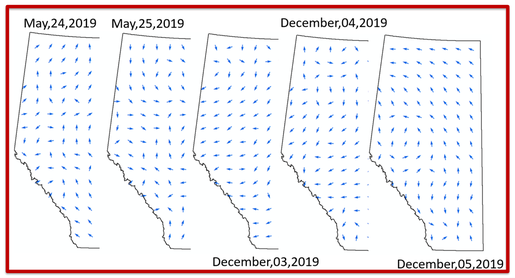


3. Data

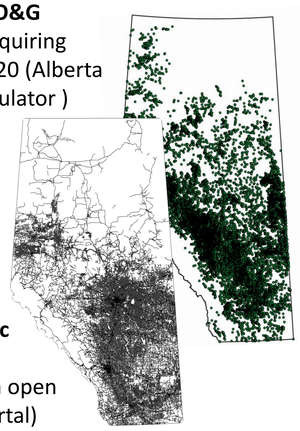
a) ERA-Interim: historical u & v wind components (10 m agl) @ 0.125° × 0.125°



b) High-resolution deterministic prediction system (HRDPS): Forecast wind data (10 m agl).



c) Alberta O&G facilities requiring LDAR in 2020 (Alberta Energy Regulator)

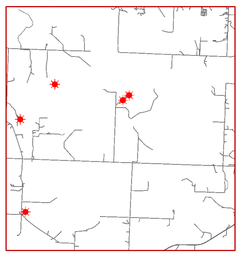


d) Public Roads (Alberta open data portal)

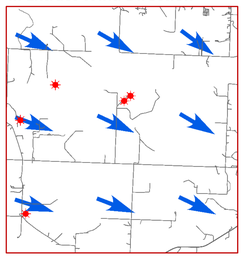
4. Operational mode

High-resolution forecast data (e.g., Canada's HRDPS) can be used to estimate the suitability of facilities for future downwind surveys. The predicted wind-road intersections represent potential locations for both static and mobile survey modes.

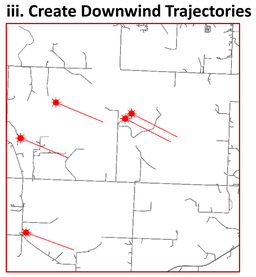
i. O&G Facilities



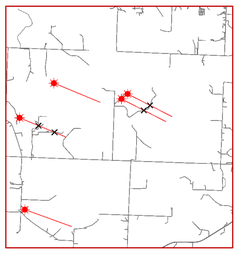
ii. Extract Wind Direction



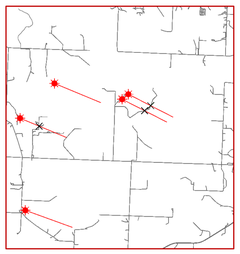
iii. Create Downwind Trajectories



iv. Find the Intersections



v. Nearest Intersections

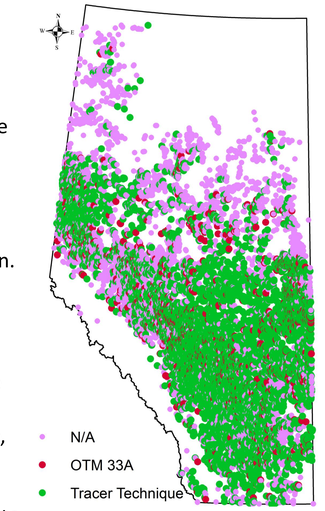


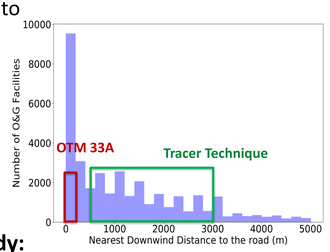
5. Results

A) Historical Analysis:

We examined 35,047 oil and gas facilities in Alberta to determine the suitability of OTM 33A and tracer techniques based on the long-term resultant wind direction and the corresponding distance to the nearest downwind road intersection. We found that:

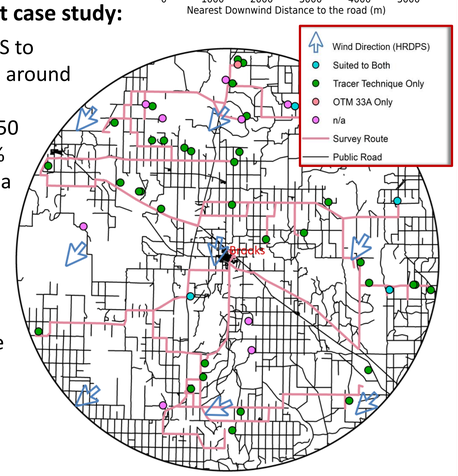
- 7% (2,332) of the facilities are suitable for OTM 33A.
- 51% (17,863) of the facilities are suitable for tracer techniques.
- 42% (14,852) of the facilities are, on average, unsuitable to both methods.
- The median downwind distance to the nearest road intersection is 1.2 km using historical wind vectors.
- There are more oil and gas facilities in the southern half of Alberta suited to OTM 33A and tracer techniques.





B) Operational forecast case study:

We used Canada's HRDPS to forecast wind conditions around Brooks, Alberta, on 04 December 2019. Of the 50 facilities in the area, 12% meet the distance criteria for OTM33A, 80% meet the distance criteria for tracer techniques, and 18% are unsuitable to both methods. We also show an optimized route for intersecting plumes during mobile screening surveys.



6. Summary

The proposed methodology only considers downwind distance. Other factors like landcover also impact the suitability of sites for OTM 33A and tracer methods but are not considered here.

Based on downwind distance we find that up to 51% and 58% of oil and gas facilities in Alberta may be suitable, on average, to static vehicle-based emissions quantification per OTM 33A and tracer techniques, respectively. Use of weather forecast data may help identify facilities where these methods can be applied on an operational basis.