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Methane Emissions from Abandoned and Suspended Oil and Gas Wells in Alberta and Saskatchewan

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Summary

Abandoned and suspended oil and gas wells have been shown to emit methane (CH_4), a greenhouse gas (GHG) with a global warming potential 80.8 to 82.5 times more potent than carbon dioxide on a 20-year timeframe and 27.2 to 29.8 times more potent on a 100-year time frame (Forster *et al*., 2021). Although there are over 400,000 suspended and abandoned wells across Canada, only 115 published measurements of CH_4 emissions from these wells have been made in the country (Williams *et al*., 2019; Williams *et al*., 2021; El Hachem and Kang, 2022). None of these published measurements are from Alberta and Saskatchewan despite containing over 92% of Canada's suspended and abandoned oil and gas wells (Kang *et al*., 2021). Measurements of CH_4 emission rates from suspended and abandoned oil and gas wells in Alberta and Saskatchewan are essential to obtain a representative dataset for Canada. A representative dataset is needed to improve GHG inventory estimates and develop cost-effective monitoring and mitigation strategies. Specifically, characterization and identification of high emitters can help inform provincial energy policy and regulations and provide useful data to operators. Therefore, we have conducted measurements of CH_4 emission rates and database analysis (ST37 from the Alberta Energy Regulator, and Saskatchewan Mining and Petroleum GeoAtlas) of abandoned and suspended wells in Alberta and Saskatchewan.

We measured CH_4 emissions from abandoned and suspended wells in Alberta and Saskatchewan over two field campaigns conducted in Summer and Fall 2021. In August 2021, we measured 20 "abandoned", 16 "suspended", one "drilled and cased", and one "observation" well from two regions of Alberta. In October and November 2021, we measured 47 "suspended" on "completed" and one "active" well in two regions of Saskatchewan. Our direct measurements can be used to develop CH_4 emission factors to estimate emissions from abandoned and suspended wells in Alberta and Saskatchewan and identify attributes of high emitters.

Method

We performed a geospatial analysis of well databases to determine areas of interest and wells to measure during the planning stages of the field campaigns. We obtained well information including operator, license, location, and status through the provincial oil and gas (O&G) databases. For Alberta and Saskatchewan, the databases used were the Alberta Energy Regulator (AER) ST37 and Government of Saskatchewan Mining and Petroleum GeoAtlas. We used Point Density (Spatial Analyst) tool in ArcGIS to determine areas of high abandoned and suspended well density within each province. We selected areas of relatively high density to limit the distance travelled between wells during the field campaigns and maximize the possible number of measurements. We selected regions with a variety of operators, well depths and well ages to achieve as representative of a sample set as possible. The resulting well density maps for Alberta and Saskatchewan are shown in Figures 1 and 2 respectively. The selected

measurement regions (A, B, C and D) and locations of measured well sites for Alberta and Saskatchewan are also shown in Figure 1 and 2.

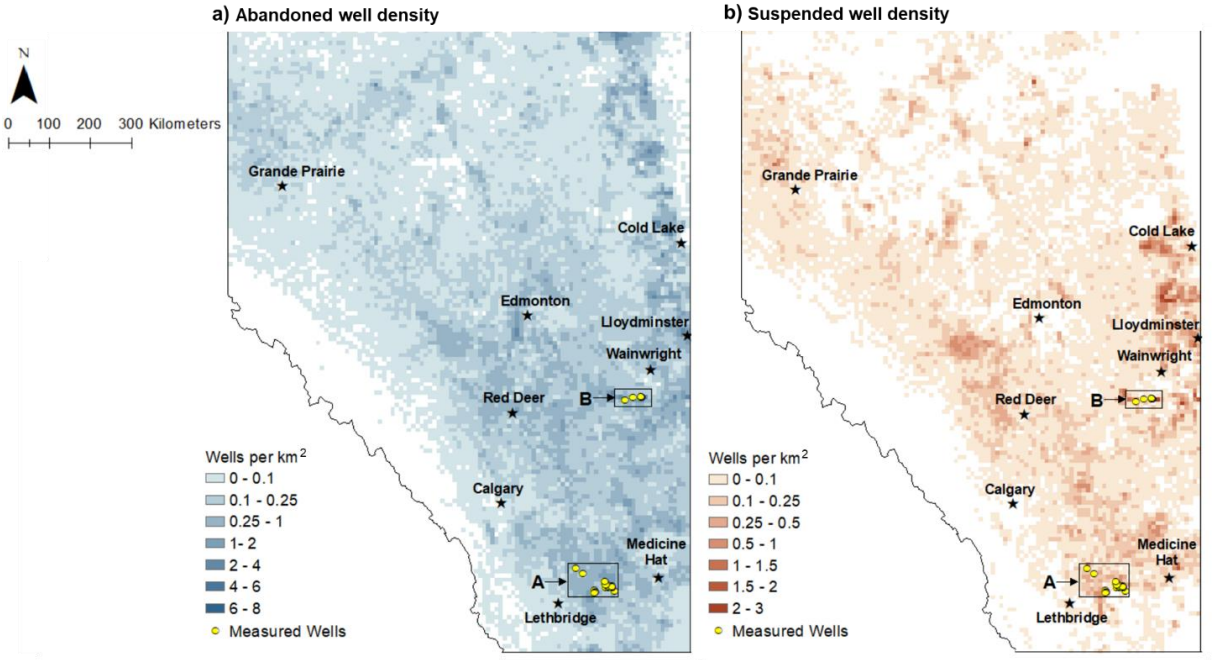

Figure 1: Maps showing abandoned and suspended well density compared to chosen measurement regions and measured sites/wells in Alberta.

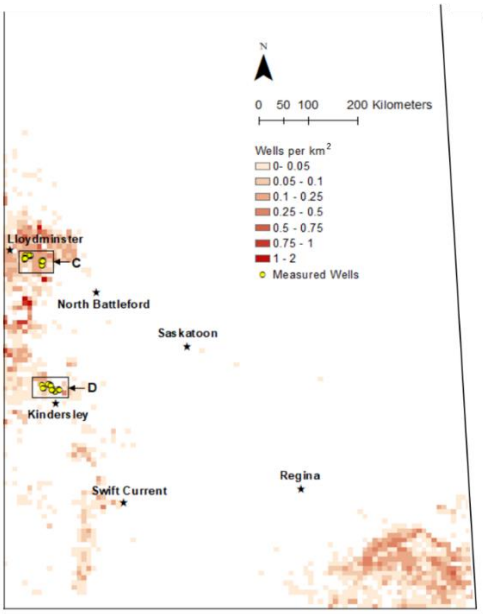

Figure 2: Map showing suspended well density compared to chosen measurement regions and measured sites/wells in Saskatchewan.

We used a static chamber methodology with two laser-based sensors for the emission rate measurements (Kang et al., 2014). During the Alberta measurements, we measured emissions from the surface casing vent (SCV) and well head infrastructure simultaneously using one chamber. In Saskatchewan, we used two chambers to measure surface casing vent flow (SCVF) and well head infrastructure separately to better understand how each component contributes to overall emissions from suspended wells.

Results

In Alberta, we found that suspended wells generally had higher CH_4 emissions than abandoned wells. Contrary to results from previous research which identified high emitters as primarily gas wells (Kang et al.,2016) we found that high emitting wells measured during fieldwork were not overrepresented by one fluid type (e.g., gas, oil, water injection). We found that CH_4 emissions from SCVFs were lower than emissions from well head infrastructure. To confirm these findings more measurements are needed as the number of wells measured in this study is small compared to the larger population of abandoned and suspended wells in Alberta and Saskatchewan.

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References

AER (2021) ST37: List of Wells in Alberta. From: https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st37

El Hachem, Khalil, and Mary Kang. (2022) . Methane and Hydrogen Sulfide Emissions from Abandoned, Active, and Marginally Producing Oil and Gas Wells in Ontario, Canada. Science of The Total Environment 823,153491. https://doi.org/10.1016/j.scitotenv.2022.153491.

Forster, P., Storelvmo, T., Armour, K., Collins, W., Dufresne, J.-L., Frame, D., Lunt, D.J., Mauritsen, T., Palmer, M.D., Watanabe, M., Wild, M., and Zhang, H.: 2021, The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press

Government of Saskatchewan (2021) Saskatchewan Mining and Petroleum GeoAtlas.From: https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/mineral-exploration-and-mining/saskatchewan-geological-survey

Kang, M., Brandt, A. R., Zheng, Z., Boutot, J., Yung, C., Peltz, A. S., & Jackson, R. B. (2021). Orphaned oil and gas well stimulus—Maximizing economic and environmental benefits. *Elementa: Science of the Anthropocene*, *9*(1). https://doi.org/10.1525/elementa.2020.20.00161

Kang, Mary, Shanna Christian, Michael A. Celia, Denise L. Mauzerall, Markus Bill, Alana R. Miller, Yuheng Chen, Mark E. Conrad, Thomas H. Darrah, and Robert B. Jackson. Identification and Characterization of High Methane-Emitting Abandoned Oil and Gas Wells. *Proceedings of the National Academy of Sciences of the United States of America* 113(48), 13636–41. https://doi.org/10.1073/pnas.1605913113.

Kang, M., Kanno, C. M., Reid, M. C., Zhang, X., Mauzerall, D. L., Celia, M. A., Chen, Y., & Onstott, T. C. (2014). Direct measurements of methane emissions from abandoned oil and gas wells in Pennsylvania. *Proceedings of the National Academy of Sciences*, *111*(51), 18173–18177. https://doi.org/10.1073/pnas.1408315111

Williams, J. P., Regehr, A., & Kang, M. (2021). Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States. *Environmental Science & Technology*, *55*(1), 563–570. https://doi.org/10.1021/acs.est.0c04265

Williams, James P., David Risk, Alexander Marshall, Nick Nickerson, Alexandra Martell, Chance Creelman, Mitchell Grace, and Grant Wach. (2019) Methane Emissions from Abandoned Coal and Oil and Gas Developments in New Brunswick and Nova Scotia. *Environmental Monitoring and Assessment* 191(8), 479. https://doi.org/10.1007/s10661-019-7602-1.