Flares and their contribution to methane emissions

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Introduction/Background

- Background and area of expertise
  - Associate Professor,

  Department of Climate & Space at University of Michigan
  - For the curious: http://clasp-research.engin.umich.edu/faculty/kort/
  - My group studies the atmosphere, with a focus on greenhouse gases and air pollutants
  - We use ground, airborne, and space-based measurements
  - Of relevance today, my group has worked extensively to improve our understanding of anthropogenic methane emissions, including in-field observations of flaring

Identifying/quantifying emissions

- What are flares?
  - In circumstances where ‘excess’ hydrocarbons are present, flaring is preferable to venting
  - Occurs predominantly in oil and gas production and processing.
  - Types of flares: Emergency, Process, Production
    - Different durations/quantities.
    - Production flaring makes up majority of gas presently flared.

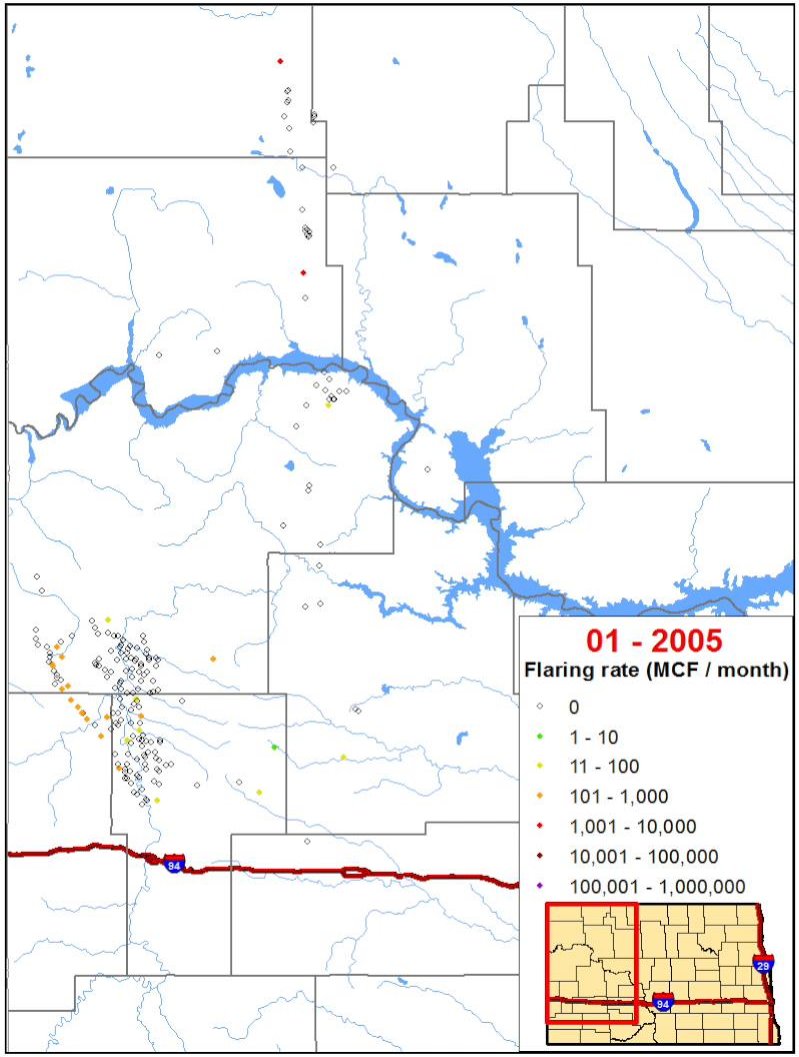
- What causes methane emissions?
  - Incomplete combustion
  - Unlit flare (vent)

Identifying/quantifying emissions

- How much flaring occurs?
  - In the US (pre-Covid), ~9-10 billion cubic meters of natural gas are flared each year, (>20,000 flares)
  - ~1% of total natural gas withdrawals
  - ~ 5% of associated gas production at oil wells.
  - US has seen large increases in flaring in the past ~15 years (Bakken, Eagle Ford, Permian basins)

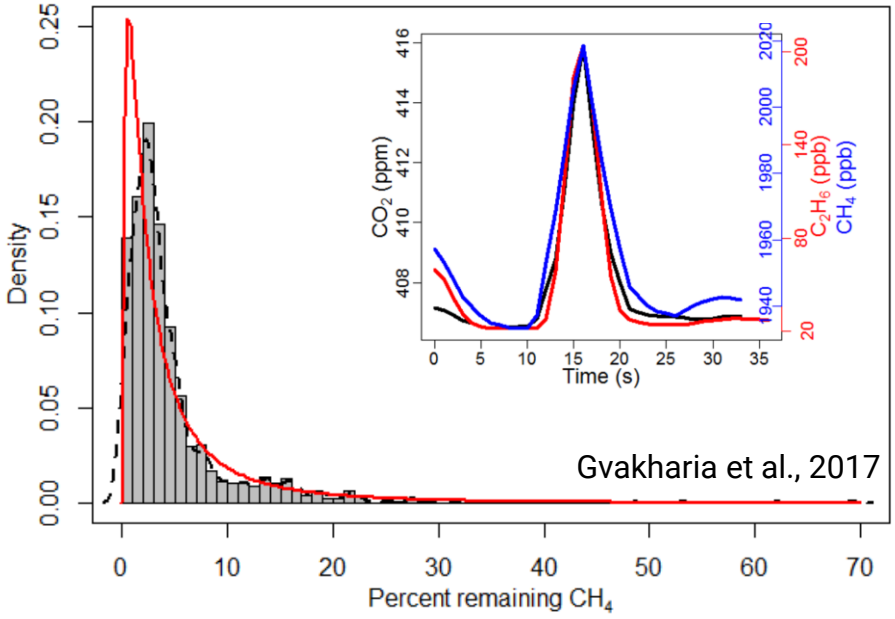
- How are methane emissions characterized?
  - Typically assume flare functions at 98% efficiency with few checks of combustion efficiency or if flare goes unlit.

How flaring has increased, Bakken example



What do we know about combustion efficiency?

- Industry & US EPA assumes flares 98% combustion efficiency
- Real-world airborne sampling of **37** unique flares in the Bakken showed heavy-tail distribution, with median ~97.5%
- Heavy tail leads to >2 times total methane emissions



- To our knowledge, total real-world flares sampled for combustion efficiency to date is only **48** (11 from Caulton et al. study).
- Skewed distribution suggests much greater impact from incomplete combustion.
- We presently are expanding this sampling as part of a project funded by the Alfred P. Sloan foundation (http://graham.umich.edu/f3uel).

What do we know about unlit flares?

- Terminology challenge: is an unlit flare just a vent?
  - Sometime vent and flare terminology is used interchangeably
- Limited real-world observations
- EDF Permian Methane Project – helicopter surveys
  - https://www.permianmap.org/flaring-emissions
- ~5% of sampled flare stacks unlit and venting methane
  - This would more than double estimated methane contribution

We can't currently clearly answer whether incomplete combustion or unlit flares are a larger CH_4 challenge (or whether they both are comparable problems)

Challenges

- We don't presently know relative importance of efficiency vs. unlit flares (and thus importance compared to other anthropogenic methane challenges)
- We don't have good monitoring of either condition
- My opinion: this problem exists more because it has not received much attention, rather than because technology to improve the circumstance doesn't exist.
- This suggests that with proper characterization of the problem and incentivization emissions from this source could be reduced