C3: The Colorado Coordinated Campaign

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1 Background

There is a persistent disagreement between 'top-down' (TD) emission estimates from oil and gas (O&G) operations made via satellite, aircraft, or regional observations, and 'bottom-up' (BU) estimates based on inventory methods. The disagreement is likely due to a number of causes, including large abnormal emissions not adequately captured in inventory methods or emission factors, differences in the timing of top-down estimates versus inventory estimates, or other systematic causes. While TD methods are advancing rapidly, BU generated inventories remain attractive because they are readily updated and provide actionable information for operators and regulators.

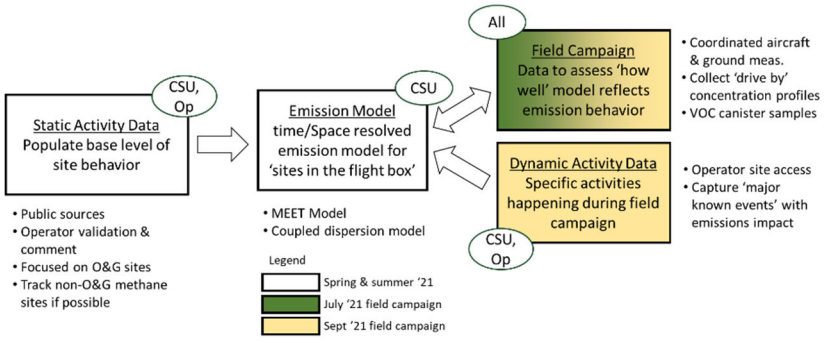
The *Colorado Coordinated Campaign* (C3) will study the TD/BU disagreement and also produce a more robust inventory model, validated through measurement, for the DJ basin in northeastern Colorado. The project includes both measurement and modeling, including: (1) coordinated aerial and ground measurements, (2) next-generation emissions modeling tools, and (3) advanced activity data contributed by operators and public sources.

The C3 Team is soliciting participation from DJ stakeholders including O&G operators, operators of other major methane sources, and leak detection solution developers.

Colorado State University (PI: Zimmerle) will coordinate the study. The team previously coordinated the Fayetteville Study, which included ground and basin-scale aircraft measurements.[1–4] Aircraft measurements will be provided by the University of Arizona (Duren) and Scientific Aviation (Conley). CSU (Vaughn, Riddick) and the University of Wyoming (Murphy) will perform the ground measurements. VOC samples will be collected by the ground teams and analyzed by CSU (Collett). Additional measurement teams may be added. The project is funded by *The Mark Martinez and Joey Irwin Memorial Public Projects Fund* in cooperation with the Colorado Department of Public Health and Environment (CDPHE).

2 Concept

The project concept is outlined in the figure. Prior to field campaign, the team will assemble available 'static' activity data for emissions modeling. "Static" data refers to common descriptions of facilities – well locations and production, well pad locations extracted from satellite data (see figure, below), and prior study results. Much of this is available from public sources, but review, additions, and comments from O&G operators will be requested.



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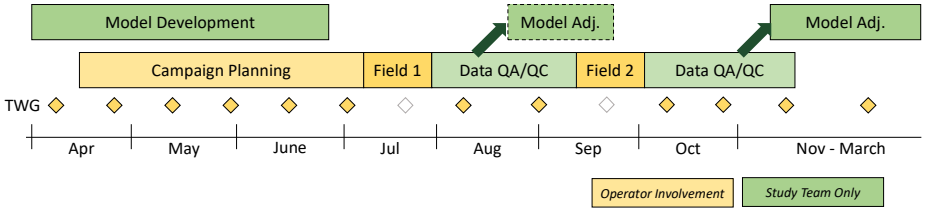
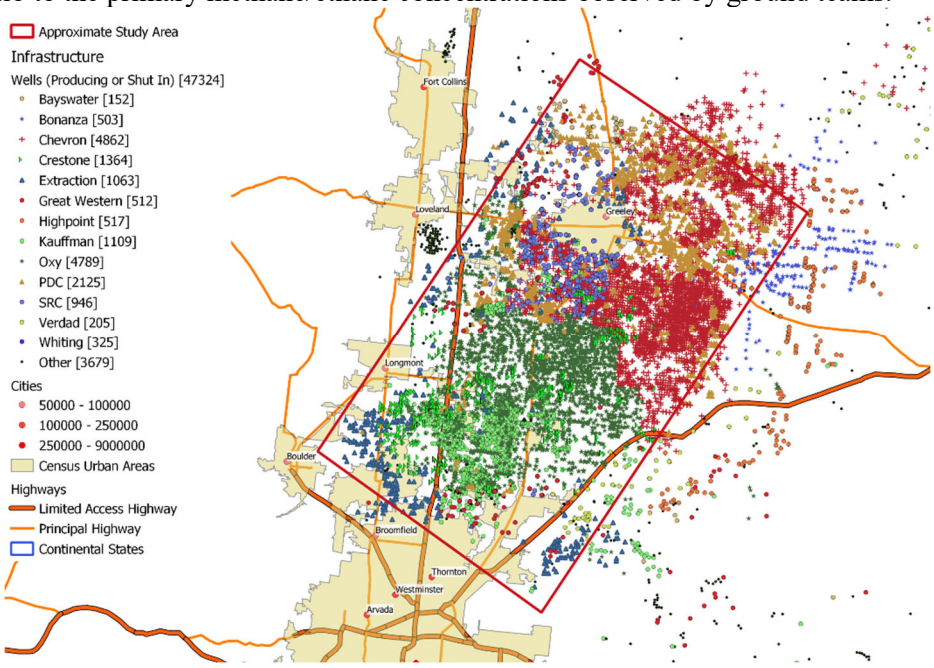
The field campaign will be conducted in two field campaigns – July and September 2021 (see timeline below) in the subset of the DJ basin with the most ongoing O&G activity (see map, below). More measurement teams may be available during the September field campaign. Ongoing technical working group (TWG) meetings will be used to both plan the campaign and also to provide previews of the results.



Aircraft and ground teams will be dispatched in a coordinated fashion during both campaign periods. Aircraft measurements by U. Arizona will make multiple measurements covering the study area shown below (2 flight days for full coverage) with a detection limit of 5-10 kg/h CH_4 to inventory large emission sources. Ground and auxiliary aircraft/drone teams will perform simultaneous measurements with two foci: (1) tracking the duration of large emitters detected by aircraft, and (2) measuring other facilities at random. All ground measurements will use downwind methods to capture full-facility measurements. However, **onsite, component-level measurements made by operators can be coordinated with the study.**

VOC measurements will be made by collecting canister samples during other ground measurements, and estimating VOC flux by ratio to the primary methane/ethane concentrations observed by ground teams.



Additional leak detection and measurement: Several leak detection solution developers have expressed an interest in providing data during the campaign period. Where possible, these data will also be collected and integrated into the study data set. Interested solution developers, or operators who are deploying next-generation leak detection solutions, should contact CSU to be included in the program.

Satellites: There have been preliminary discussions of including satellite data in the coordinated study. These data may include regional emission flux estimates or facility-scale detections. Interested parties should contact CSU to be included in the program.

Dynamic activity data: During the campaign period, participating operators will be requested to collect augmented activity data – the 'dynamic' activity data shown in the first figure. The primary focus of these data is to identify O&G emissions events which *may* have a significant emissions signature, such as liquid unloading, maintenance blowdowns, truck load outs, compressor loading, and similar activities. The hypothesis is that some fraction of 'large emission detections' from aircraft and ground teams will be explained by these activity data – what fraction is a key question of the study. This comparison, by itself, will

provide the first coordinated look at what fraction of large emission detections are due to known O&G events, and which are unknown/unexpected large abnormal emissions.

The exchange of information between operators and CSU (see confidentiality section, below), will be designed in conjunction with participating companies.

Non-O&G data: While the focus of the project is on O&G emissions, CDPHE is consolidating an inventory of non-O&G emission sources which could be used for comparison with regional mass balance data, such as those from satellites. The study team welcomes data and measurement inputs from other major methane sources (methane is the primary gas used in the regional balance), including landfills, wastewater treatment, confined animal feeding operations (CAFOs), animal operations, and reservoirs.

Modeling: The study team will use all activity data to populate a DJ-basin emissions model in the *Methane Emissions Estimation Tool* (MEET), a next-generation inventory model developed by UT Austin and CSU. MEET intrinsically models the temporal and spatial variability in emissions. The team will 'tune' the model with field measurement data, providing insights into the causes and locations of emissions. After the field campaign, CSU will finalize & validate the model, which will be transferred to CDPHE and any other interested parties for long term use, augmenting or replacing existing inventory tool(s).

3 Confidentiality

During the project, partners will likely provide confidential data to CSU to improve the model. *This data will be confidential between CSU and each individual operator, and will be published only in anonymized form.* Data will not be shared with CDPHE or other operators.

4 Contacts & Engagement

The study team is seeking participation by:

- O&G operators
- Operators of other major methane sources (landfills, wastewater treatment, CAFOs, etc.)
- Leak detection solution developers
- Industry associations

To provide:

1) Additional activity data
2) Insight into the accuracy and completeness of available activity and emissions data.
3) Participation in the field campaign by collecting 'dynamic' activity data.
4) Permission for ground crews to measure randomly chosen facilities on, or near, the facility.
5) Coordinated measurement activities.

Participants will be members of a technical advisory board and regularly briefed on the content and progress of the project. No financial commitment is required, and no financial support can be offered.

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