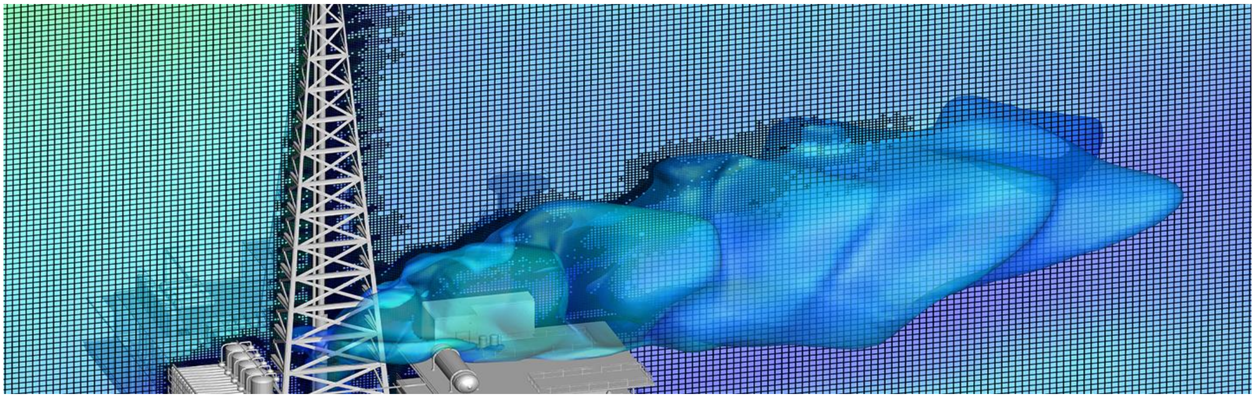
Abhinav Anand, PhD Mechanical Engineering

Current Project Overview



Recent studies estimate that Methane emissions from Oil and Gas facilities contribute 20-50 % of the total methane emissions in the US. With a Global Warming Potential of 28 over 100 years, reducing methane from O&G facilities is crucial for methane mitigation strategies for companies and governments across the globe. In order to curb methane emissions from the Oil and Gas facilities, we require reasonable emission estimates with smaller uncertainty bounds. More and more emission measurements are made, but the uncertainties remain in the Methane emission estimates and the emission inventories.

Measurement can be augmented with modelling approaches since measurements alone prove insufficient in remote locations, complex terrain and measuring at a high temporal resolution. The present modelling methods mostly use Gaussian-dispersion models, which are highly uncertain in estimating the emissions. Gaussian modelling uses a simplified approach, making unqualified assumptions, leading to greater differences from the actual values. In our work, we use Computational Fluid Dynamics (CFD) to solve for methane concentrations downwind of a controlled release at the Methane Emissions Technology Evaluation Center (METEC) facility at CSU. CFD modelling approach solves full Navier-Stokes equations without making simplified assumptions. It accounts for flow velocities and turbulence and their effects on mixing and can be applied in more complex three-dimensional environments. In this study, we are trying to model controlled methane emissions coming from the METEC facility. The current study will enable the prediction of methane emissions downwind with greater accuracy and will also inform where to place the monitoring instruments for better ground measurements. The model developed for the METEC facility can then be employed for more complex cases, which will help improve methane emissions estimates from Oil and Gas facilities.

Research Progress

The first step was to set up the CFD model (CONVERGE CFD) on the HPC. Multiple test cases have been run to ensure the model is working. The next step is to set up a test case with the METEC facility, which is ongoing.

The next phase involves collecting data, primarily the meteorological data, which must be fed into the model. Meteorological data, particularly wind data, U, V and W, will be needed at a high temporal resolution as input to model downwind concentrations of Methane. Meteorological data has been made available for a few months, and more will be available later (see the plots below).

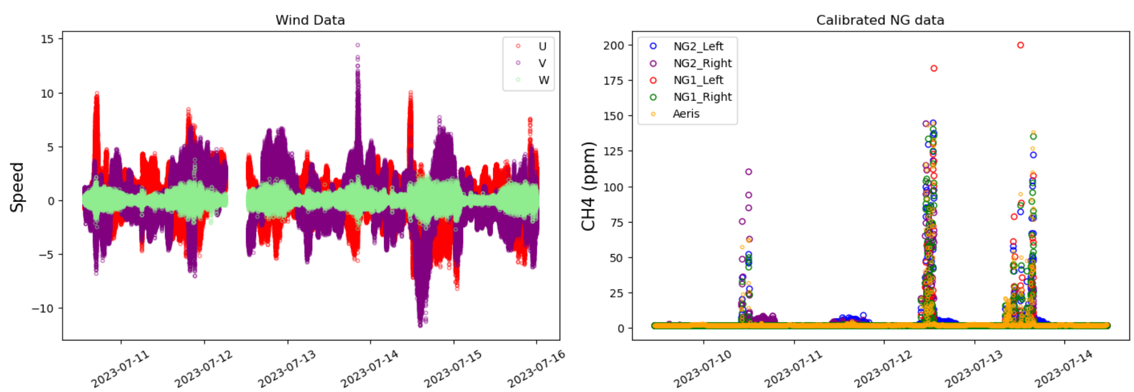


Fig: Wind data and ground observation data from the METEC facility from July 9 to July 14, 2023.

Later, when the model is run, downwind concentrations from the model will be evaluated against the measured downwind concentrations at the METEC facility (see the plot above).

Research Plans

1. Set up the CFD tool, CONVERGE, for the METEC facility with some simple assumptions and collect data from METEC for inputs to the model.
2. Analyze the model outputs and evaluate them against ground-based observations.
3. Inform the stakeholders using the results to improve facility sensor placements.
4. Increase the complexity by implementing the test case on complex cases.

Publications

n/a

Literature cited

Photo taken from CONVERGE-website.