Student Projects Related to TROPOMI Methane Data

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Introduction

- Five student teams investigated TROPOMI data between May 2018 and February 2020 as part of a semester long statistical practicum.
- Here, we present a selection of interesting results.

Anomaly Detection

- Applied unsupervised machine learning methods such as local outlier factor and isolation forest to identify anomalous atmospheric CH_4 concentrations.
- Employed the non-parametric bootstrap to estimate CH_4 distributions and subsequently detect anomalies.

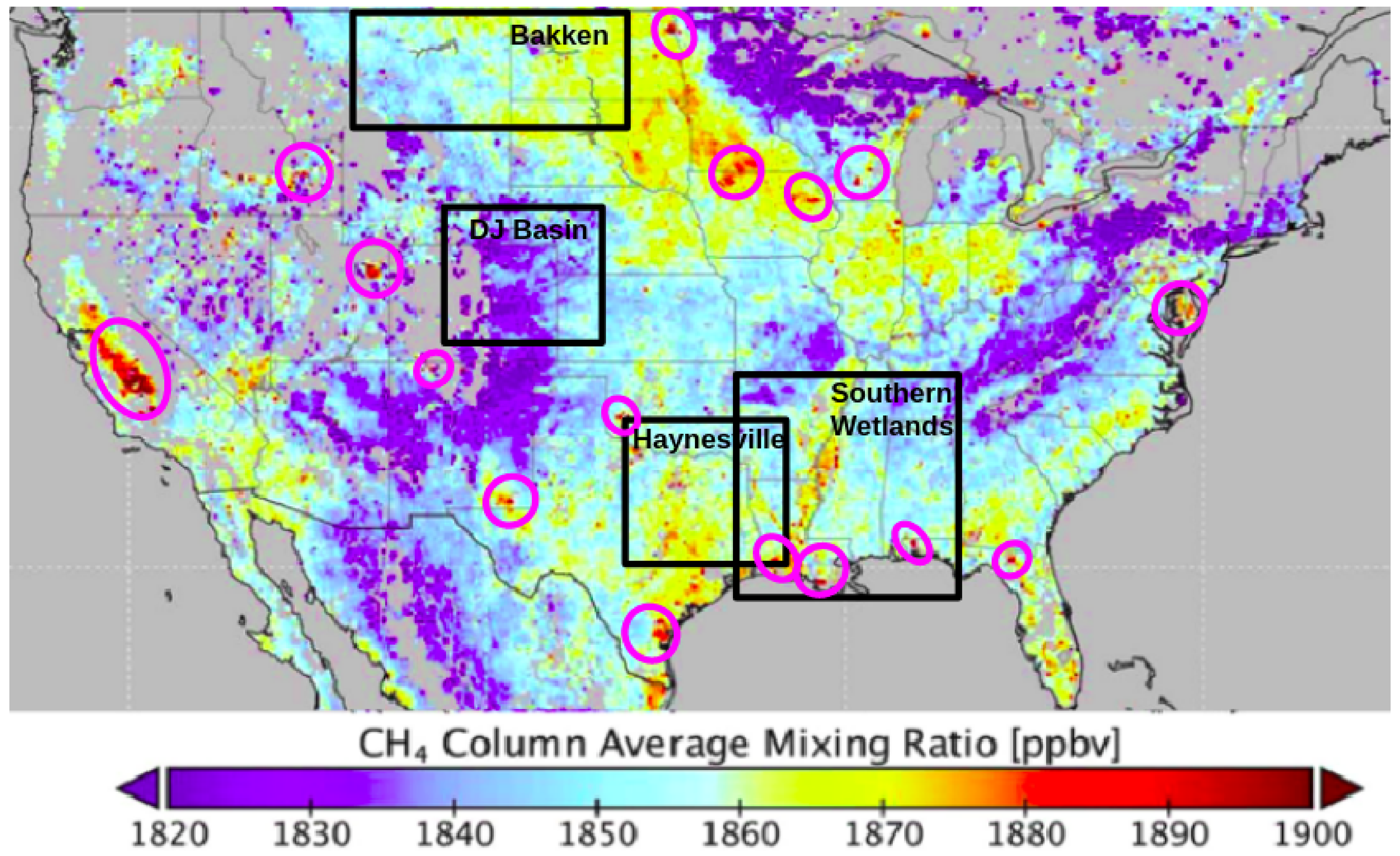

Figure 1: Average CH_4 Mixing Ratio over the Mainland USA (Winter 2018/2019). Regions Studied are Boxed in Black and Anomalies are Circled in Magenta.

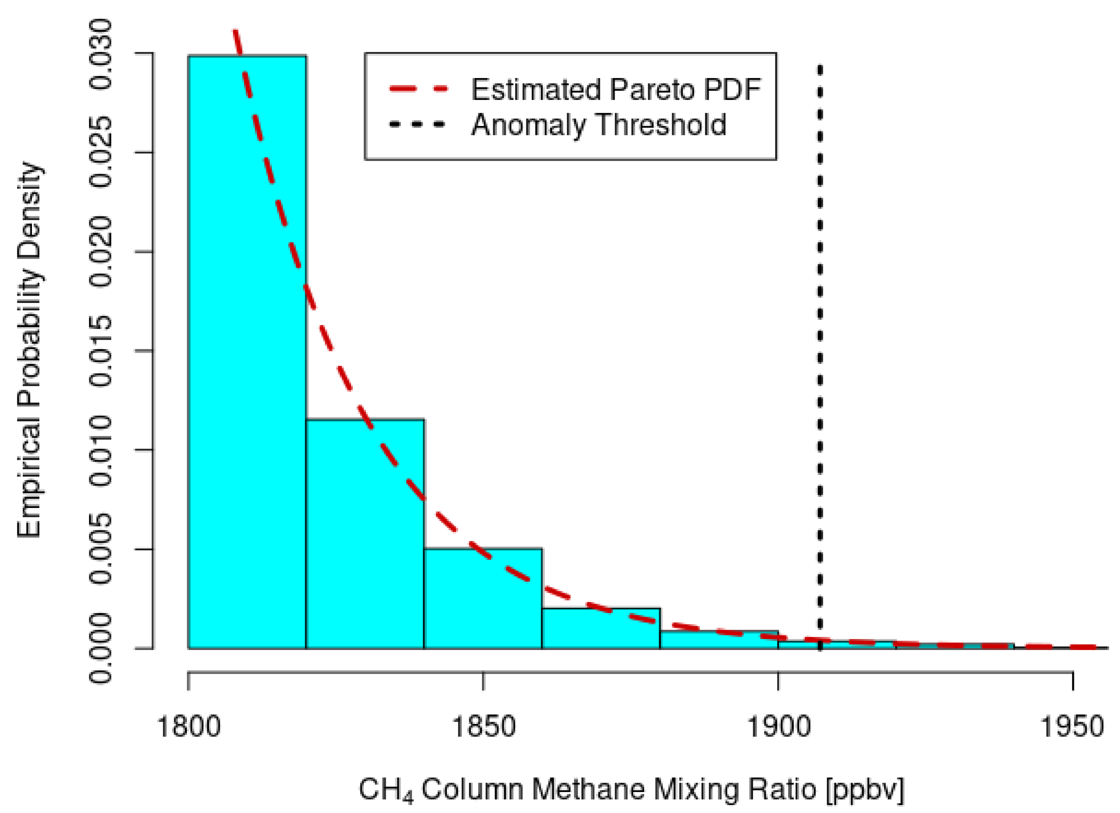

Figure 2: Bootstrapped Pareto Distribution for CH_4 with Anomaly Threshold.

The Denver-Julesburg (DJ) Basin Region

- Created estimates for data scarcity on various timescales.
- Identified areas containing consistently high CH_4 levels.

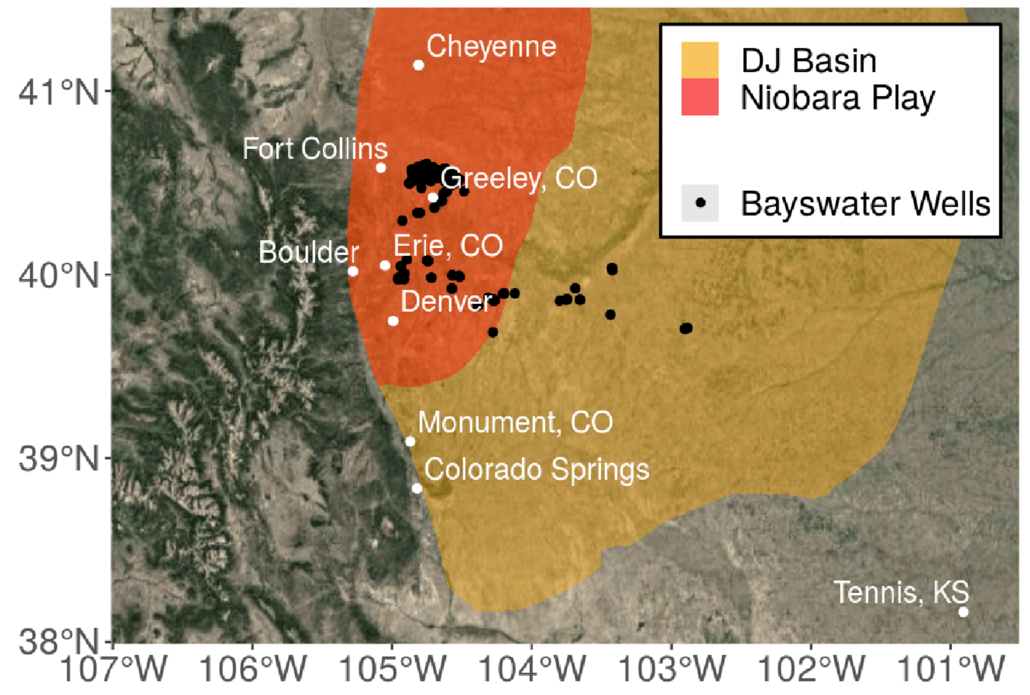

Figure 3: Locations of Interest within the DJ Basin.

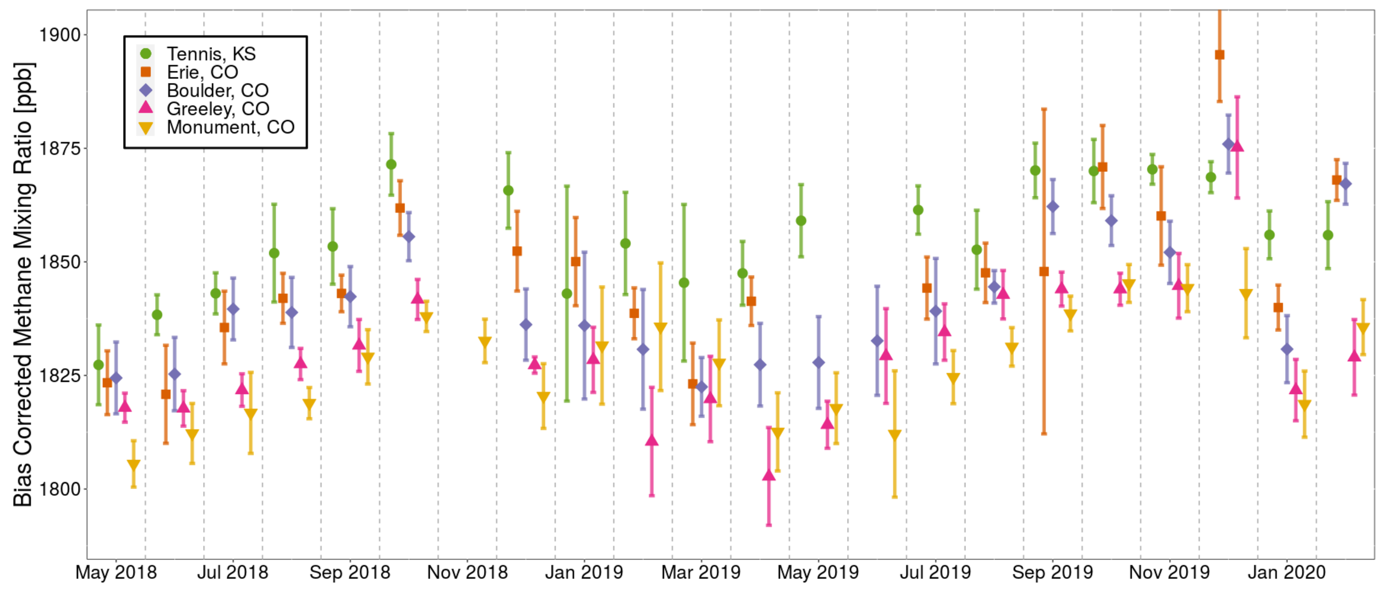

Figure 4: Monthly Time Series of TROPOMI CH_4 Data. Five Locations in the DJ Basin are Selected to Show the Range of Typical CH_4 Concentrations.

The Haynesville Shale Region

- Created a seasonal model and short-term forecasting tool for atmospheric CH_4 concentrations with ARIMA & DFT.
- Explored a land-water mask to filter out low quality data.
- Identified areas with regularly elevated CH_4 concentrations.

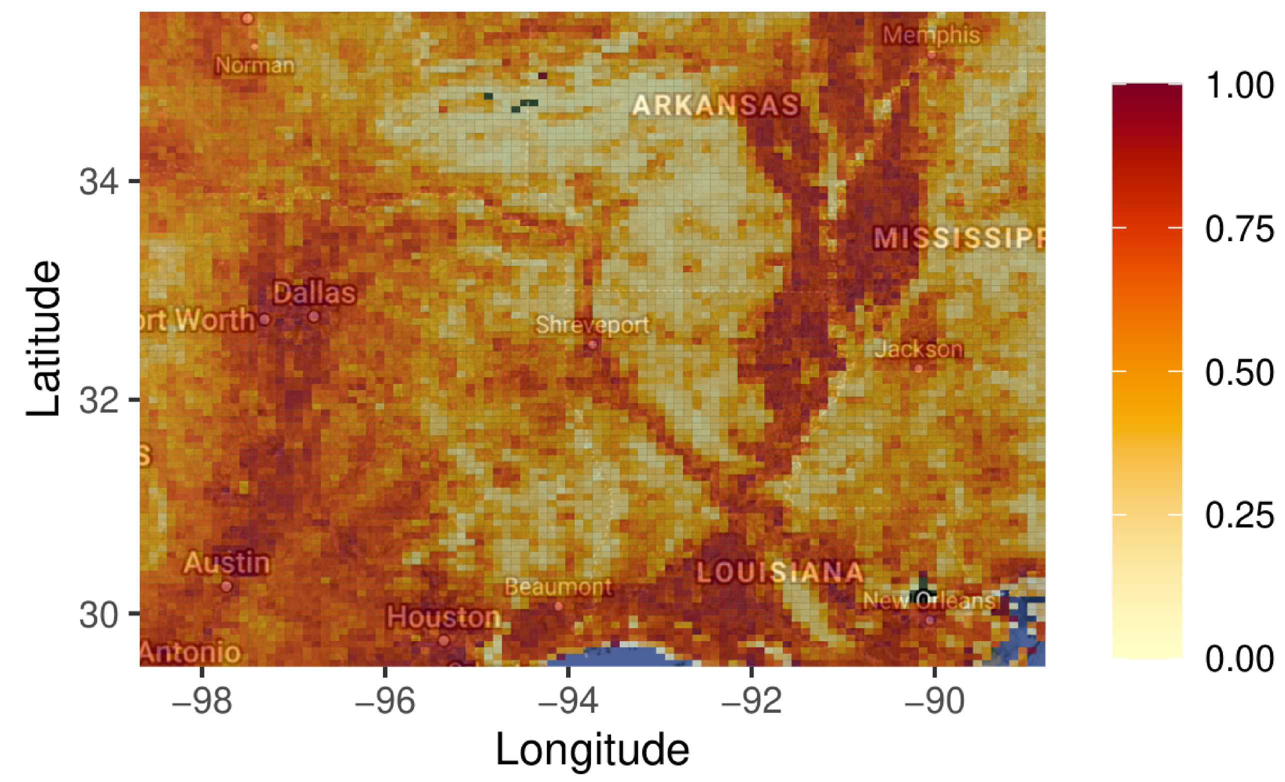

Figure 5: Estimated Proportion of Days with Above-Average CH_4 Levels.

The Southern Wetlands Region

- Created a linear model for atmospheric CH_4 concentration as a function of other TROPOMI data products and time.
- Model explains 65.7% of variability in CH_4.

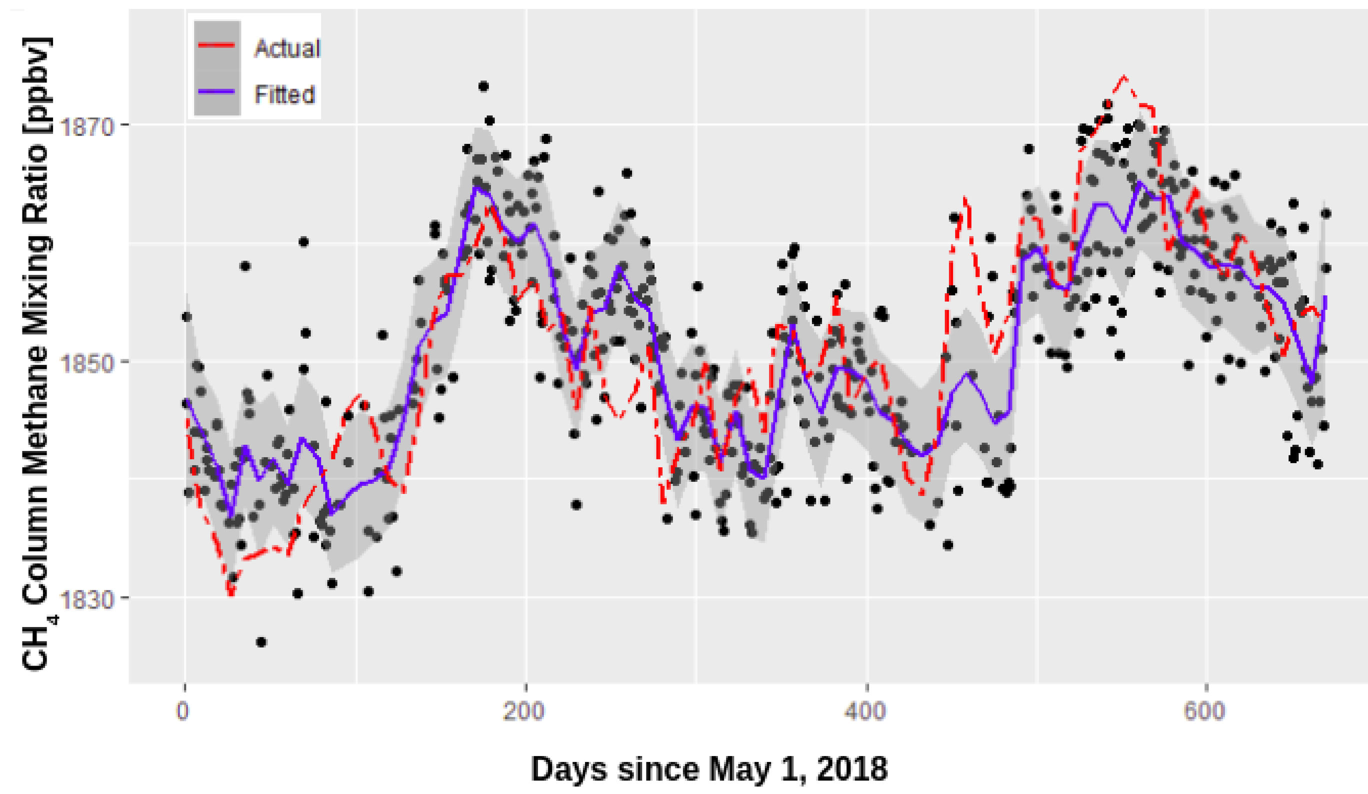

Figure 6: Estimated CH_4 Levels versus Time Over the Southern Wetlands.

The Bakken Formation

- Examined relationship between atmospheric CH_4 concentration and natural glas flaring.
- Model reveals slight positive association between flaring temperature and CH_4 level.

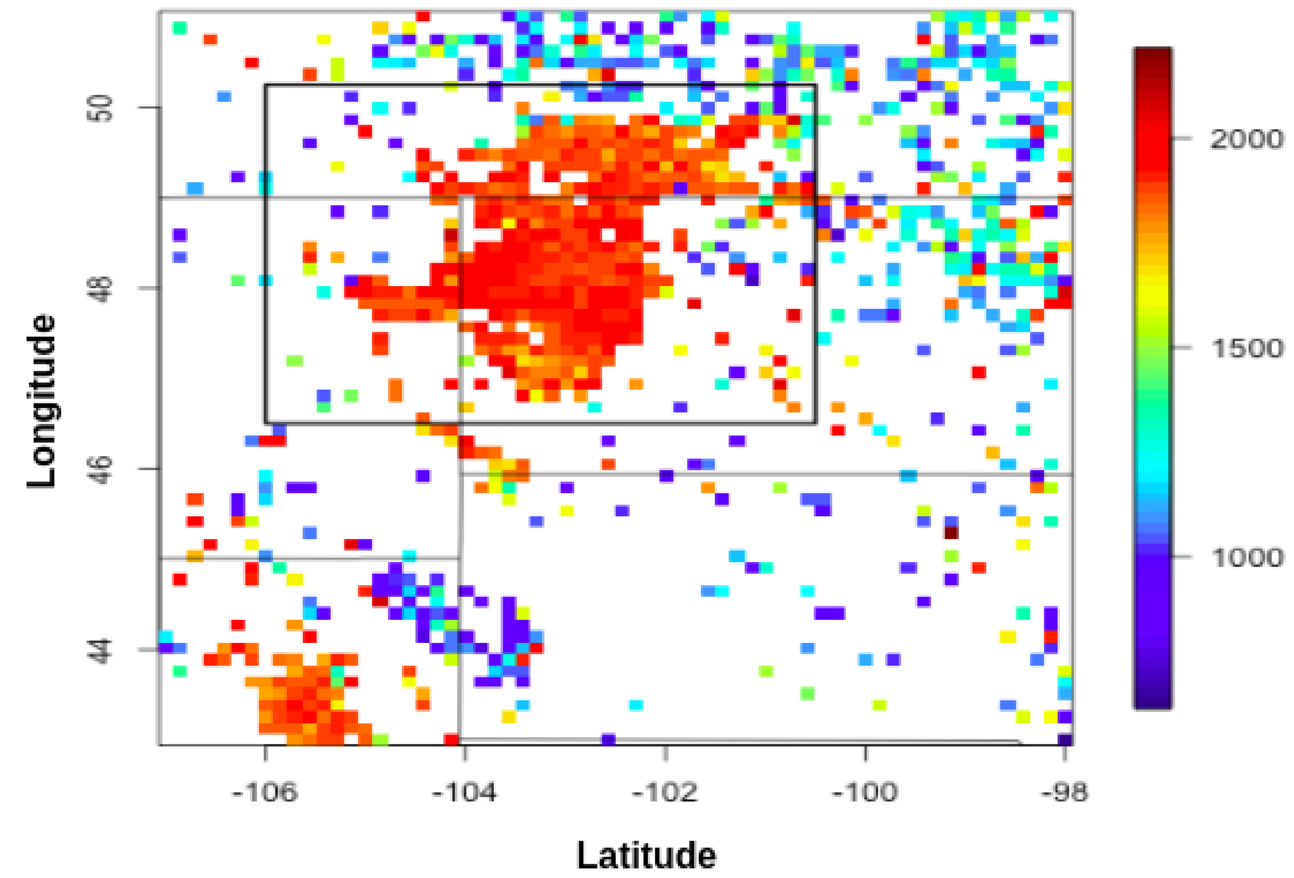

Figure 7: Flaring Temperatures Over the Bakken Formation in Degrees Kelvin.

Acknowledgements

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If you are interested in more technical details, contact Dr. Hammerling at hammerling@mines.edu.