California is the third-largest oil-producing state in the country. In August, production reached 533,000 barrels per day. The state also accounts for 10% of US refining and produces 900 million bcf of natural gas per day. This oil and gas infrastructure releases significant amounts of methane and larger hydrocarbons (which have detrimental health effects and lead to ozone formation) in addition to nitrogen oxides, carbon oxides, and other pollutants. Quantifying this pollution is important both for understanding its impacts and for implementation of California’s emissions control policies.

For this study, two research flights were conducted over the Kern Co. oilfields in late June (figure 3), on which 80 whole air samples were collected (figure 4). Additionally, whole air samples at 29 ground sites were collected four times between February and August (figure 4). These formed a small part of the NASA Student Airborne Research Program dataset, which consists of over 1000 whole air samples collected on flights every June since 2009. Samples were analyzed in the Blake lab at UCI using a suite of GC columns and detectors (figure 5). In all, mixing ratios were measured for 46 hydrocarbons, 8 alkyl nitrates, 23 halocarbons, and 2 sulfur compounds, in addition to CO, CO2, and CH4, all with precision near 1%.

The box volume was calculated using the measured wind speed and the size of the grid of samples or modeling ozone formation from these hydrocarbon emissions. For this, the total annual emissions were estimated. The procedure was carried out four times, once for each set of ground samples. Results are shown below (figure 11).

The four sample sets gave consistent results for non-methane hydrocarbons (NMHCs), suggesting a robust model. These results were similar in magnitude and in alkane ratios to previous studies of oil and gas infrastructure emissions, and represent nearly 2% of California’s hydrocarbon emissions on 0.1% of the state’s land. Methane estimates showed large variations, likely due to high (and variable) background concentrations of methane in California’s Central Valley. Further studies may include extension of the box model with a larger grid of samples or modeling ozone formation from these hydrocarbon emissions.

Acknowledgements and sources:

The authors would like to acknowledge the invaluable assistance of Joost Galbany (NASA), the Blake lab (UCI), the organizations and participants of the NASA Student Airborne Research Program (SARP), and reporting data from the CALNEX and ARCTAS field campaigns. This work was supported by NASA SARP and the National Seabird Education and Research Center.

1. California Institute of Technology, Pasadena, CA; Kelvin@caltech.edu
2. University of California at Irvine, Irvine, CA

Abstract ID: 1503202