Increased propane emissions from the United States over the last decade

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Why Propane?

- It is the second most abundant non-methane hydrocarbon (NMHCs) after ethane
- It contributes to photochemical air pollution, including ozone and aerosol formation
- It is useful for distinguishing thermogenic from natural emissions of methane
- Recent atmospheric observations at remote stations suggest a reversal of earlier atmospheric declines [Helmig et al., 2016, Nature Geos.] that is largely due to increasing oil and natural gas production from the U.S. (Fig. 1)
- Reported production of propane has increased by a factor of 1.8 since 2011, primarily from Gulf Coast states (Fig. 2).

Observational Evidence for Increased Propane Emissions from the U.S.

- Larger mole fractions of C3H8 observed at sites in the CONUS relative to those at remote sites, confirming C3H8 emissions from the U.S.
- Large positive trends were observed at sites strongly influenced by oil and gas production, indicating likely increased C3H8 emissions from oil and gas production activities.

Research Questions

- How much propane is emitted from the U.S. each year? What are the primary emitting sources of propane within the U.S.?
- Has propane emission increased as a result of increased oil and gas production? If so, by how much? From which region have emissions increased the most?

What have we already known about U.S. propane emissions?

From emissions inventories:
- U.S. emissions of propane are primarily emitted from anthropogenic sources (with estimated emissions of 2.8 ± 0.7 Tg/yr). (Emissions from biomass burning and oil and gas production were estimated at < 0.02 Tg/yr)
- C3H8 is mainly emitted from populated areas and from oil and gas production regions.
- Inventory projected emissions after 2000 declined (Fig. 3).

Previous regional atmosphere-based “top-down” studies suggest propane emissions:
- Smaller scale inventory estimates (State of Colorado) largely underestimate propane emissions in recent years (Petron et al., 2012, 2014).
- Propane emissions are primarily from natural gas production and processing, liquefied petroleum gas production, and geological seeps (Petron et al., 2015, Wuebbles et al., 2012).

Propane Emissions and Emission Trend Inferred from Atmospheric Observations

Spatial Distribution:
- Results indicate the majority of C3H8 emissions are from oil and gas production regions; but emissions from populated areas are also important to explain the atmospheric observations as shown in the Bayesian Information Criterion (BIC) test.

Seasonality:
- Observed spatial distribution of emissions is consistent with emissions largely from regions of oil and gas production activity; and chemical loss that occurs during transport or sampling to remote stations.

Annual Emissions and Emission Trend:
- Estimated propane emissions show an increase from 2011 to 2014, coincident with the increase of propane production (Helmig et al., 2015). The U.S. related emission increase contributes to the observed recent increases in propane atmospheric concentrations at remote stations (Helmig et al., 2015).
- Observed annually-derived national propane emissions are about 10 times higher than those projected by the MACCity inventory for the same time period.