

# Methane emissions from the 2015 Aliso Canyon blowout in Los Angeles, CA

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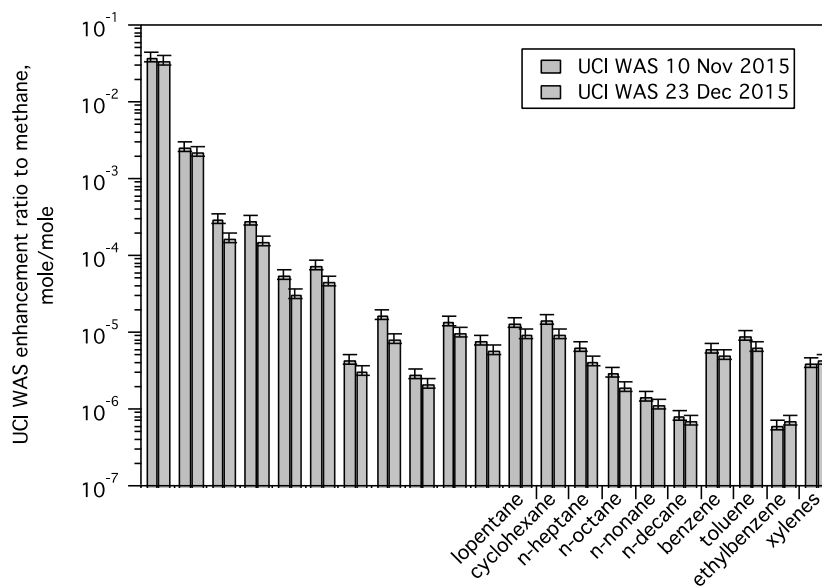


The failure on 23 Oct 2015 of one of 115 wells connected to the Aliso Canyon underground storage facility in the San Fernando Valley of California released 97,100 metric tons of methane to the atmosphere before it was permanently sealed 112 days later

Here we describe atmospheric chemical sampling used to determine leaking chemical composition, quantify the leak rate, and track its evolution over time

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Chemical composition from whole-air sampling  
enhancement ratios relative to methane

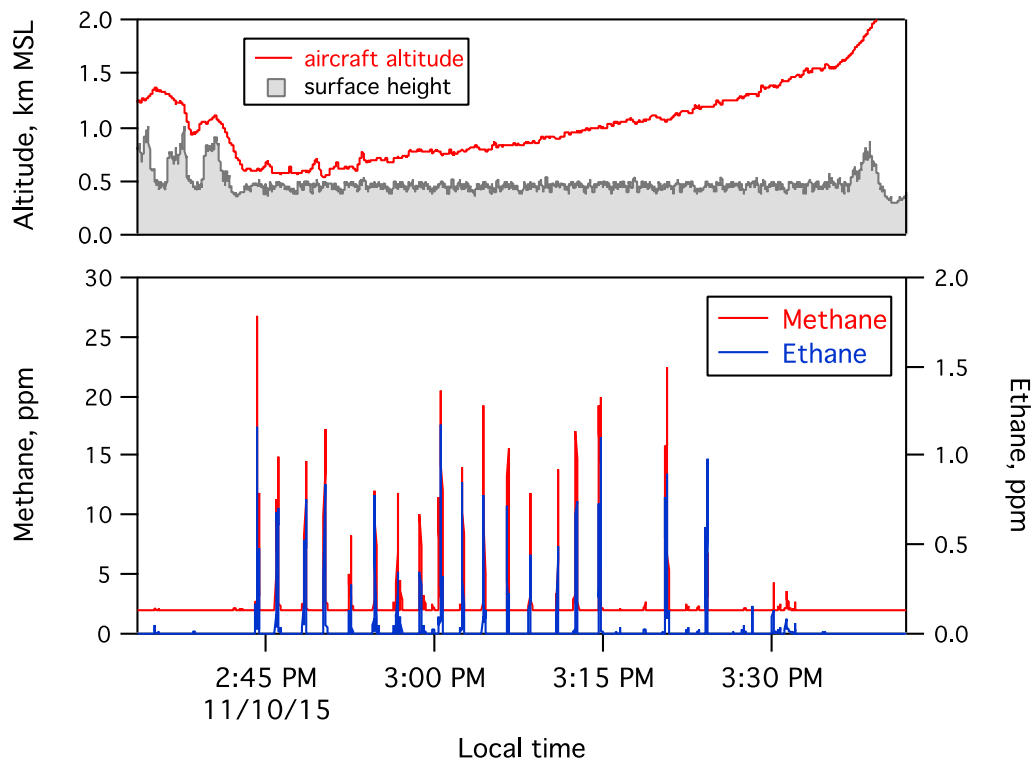


Molar enhancement ratios from UCI WAS canisters taken ~6 weeks apart:

- *define chemical composition of leaking Aliso Canyon gas and oil*
- *are consistent with reports of “oily sheens” in affected areas downwind*
- *suggest leaking chemical composition was constant over time*
- *provide a means to estimate benzene levels from methane observations*

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*Scientific Aviation Mooney TLS aircraft*

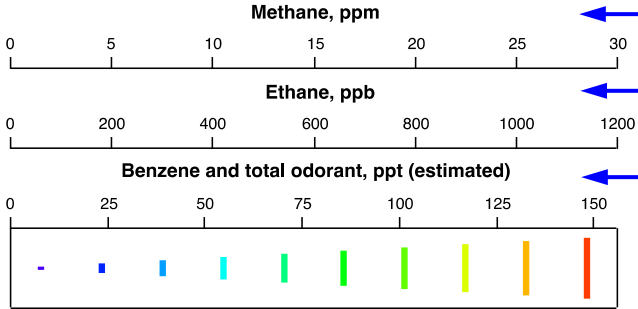


Mass fluxes were calculated from 13 flights for all horizontal crosswind transects downwind of the leak site

Two separate instruments measured methane, and one measured ethane, every 30 m along track

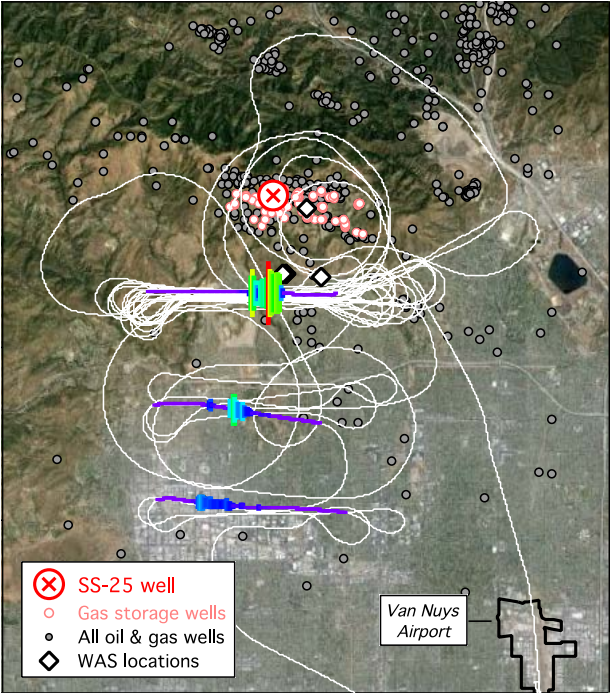
# Methane emissions from the 2015 Aliso Canyon blowout in Los Angeles, CA

10 Nov 2015 flight example



Methane and ethane measured continuously aboard the aircraft

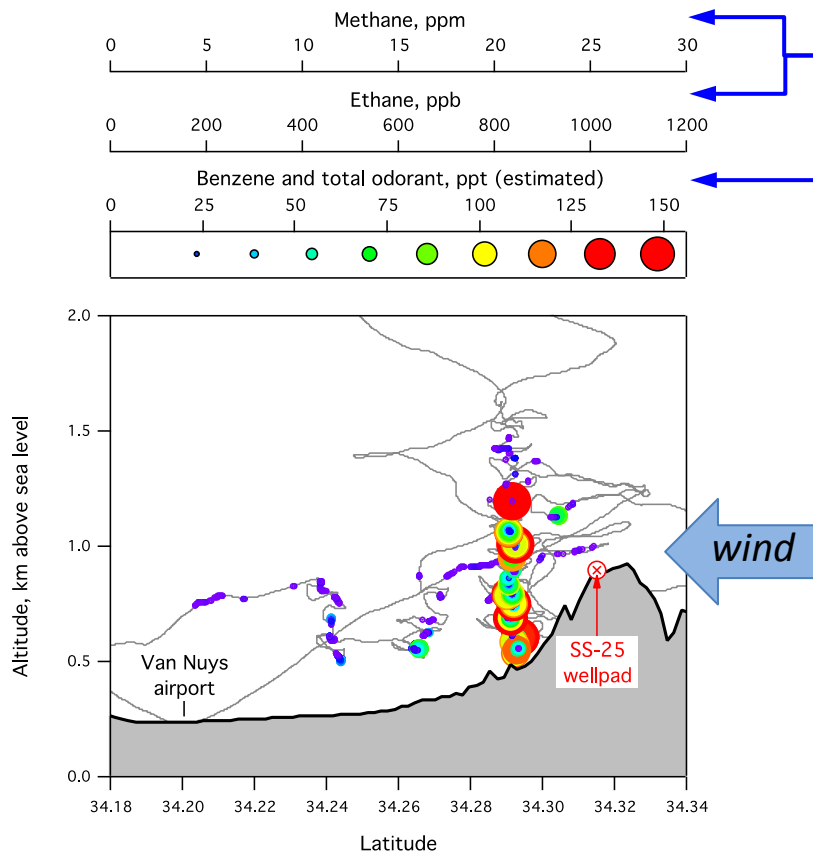
Benzene and odorant *calculated* from known, or assumed, ERs relative to methane



- Plume consistent with a single point source centered on the SS-25 wellpad within  $\pm 100\text{m}$
- Rules out any substantial contribution from other local wells or upwind sites
- Exceptionally restricted airspace access (terrain, traffic, TFRs...) dictated an agile aircraft with FAA clearance for 60m above ground
- Repeated transects at  $34.295^\circ$  latitude show the **aircraft captured the full horizontal extent** of the point source plume on each flight

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10 Nov 2015 flight example



Methane and ethane measured continuously aboard the aircraft

Benzene and odorant *calculated* from known, or assumed, ERs relative to methane

- Repeated transects at 34.295° latitude show the **aircraft captured the full vertical extent** of the point source plume on each flight

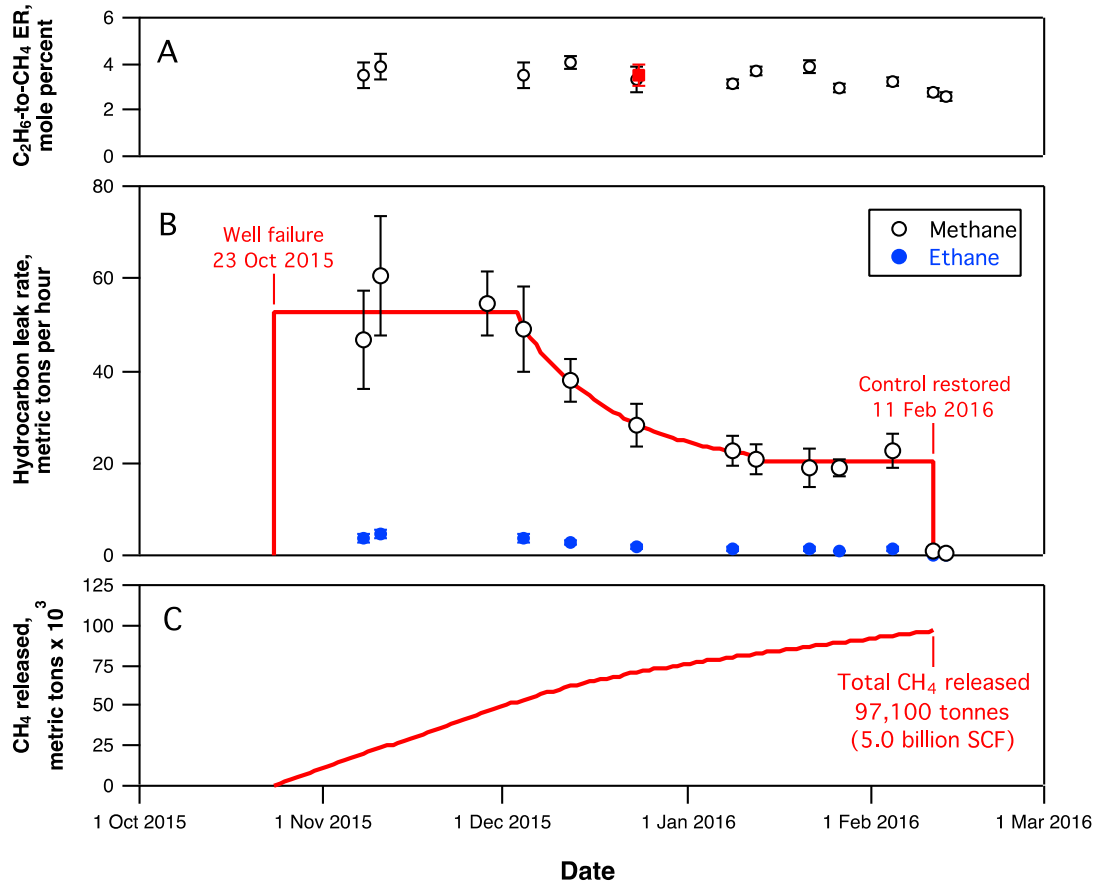
- simultaneous NOAA mobile van CH<sub>4</sub>, CO<sub>2</sub>, N<sub>2</sub>O, CO, and wind vector measurements at the surface directly below the aircraft on 11 January 2016 show negligible concentration gradients below lowest aircraft flight altitude

- integrating horizontal fluxes in the vertical provides a **direct, accurate measurement of Aliso Canyon gas leak rate, with known uncertainties**

North-south topographical cross section at the SS-25 well longitude

Aircraft altitude (grey line) scaled by chemical data for CH<sub>4</sub> > 3 ppm

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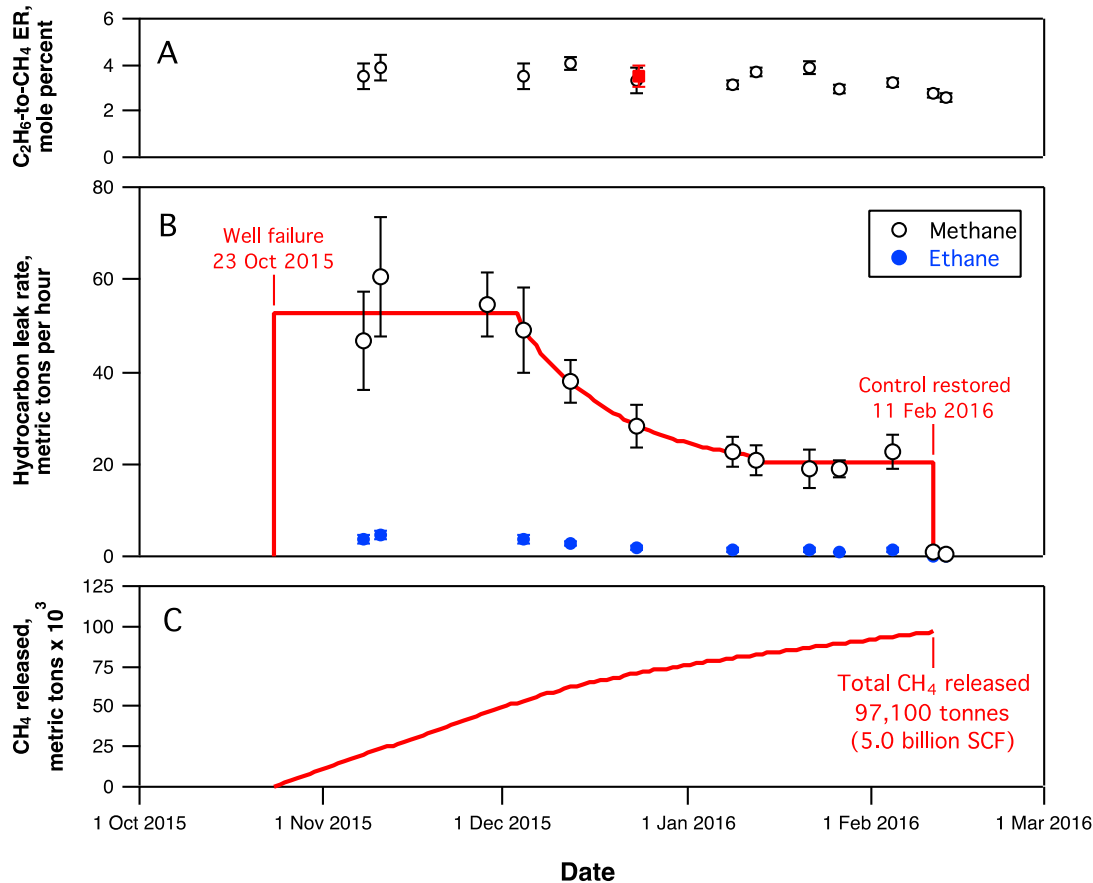
- The airborne data show that **97,100 metric tons of methane** were released to the atmosphere (only 3% of the total volume!)

- Derived flow rate is highly correlated with reservoir pressure, which was monitored continuously by SoCalGas throughout the leak

- These data provide robust constraints on flow rate for the majority of the event

- These data further provide a “prior” estimate for inverse model studies using ground-based, airborne, or orbital sensors

# Aliso Canyon in perspective



- Equal to the annually-averaged leak rate from all other CH<sub>4</sub> sources in the Los Angeles Basin combined (Peischl *et al.*, JGR, 2013)

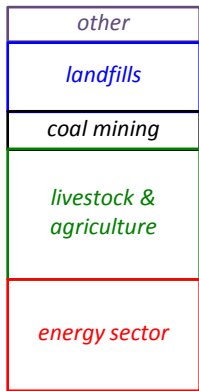
- Largest single-point accidental CH<sub>4</sub> release in U.S. history

- Significant on the scale of California emissions reduction efforts mandated under the Global Warming Solutions Act of 2006 (AB32)

- “Mitigation of the climate effect” of Aliso Canyon methane, as promised by SoCalGas, will take a substantial effort

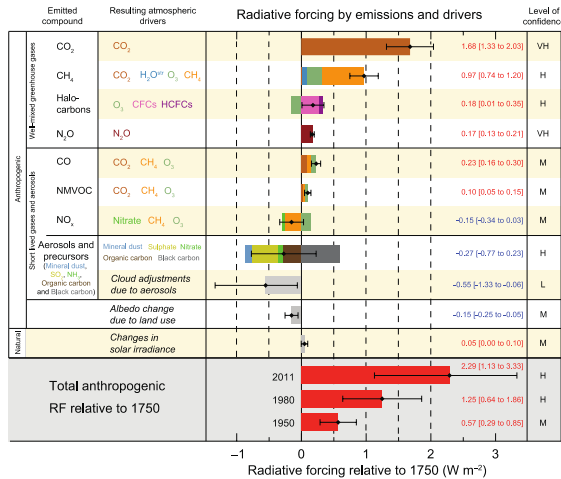
# Aliso Canyon in bigger perspective

## U.S. total CH<sub>4</sub> emissions



U.S. EPA inventory data

## AR5 radiative forcing



- The climate impact of Aliso Canyon CH<sub>4</sub> is **dwarfed** by routine emissions from oil & gas, agriculture, & landfills

- The climate impact of CH<sub>4</sub> emissions (aside from its SLCF role) is **dwarfed** by routine emissions of CO<sub>2</sub>

- Avoiding future natural gas blowouts is good, but *their complete absence* won't address any major climate issue

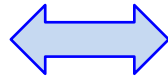
COP21 agreements include specific requirements for the Parties to account for anthropogenic GHG emissions with “accuracy and completeness”

Suggests a *robust and complementary observational and analysis system* is needed to quantify emissions across a breadth of spatial and temporal scales

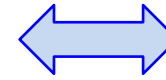


# GHG emissions monitoring and attribution requires a continuum of data

Targeted mobile observations



Long-term surface observations



Long-term column observations

Point and area source snapshots; incident response

Area, regional, and global source monitoring

Area, regional, and global source monitoring

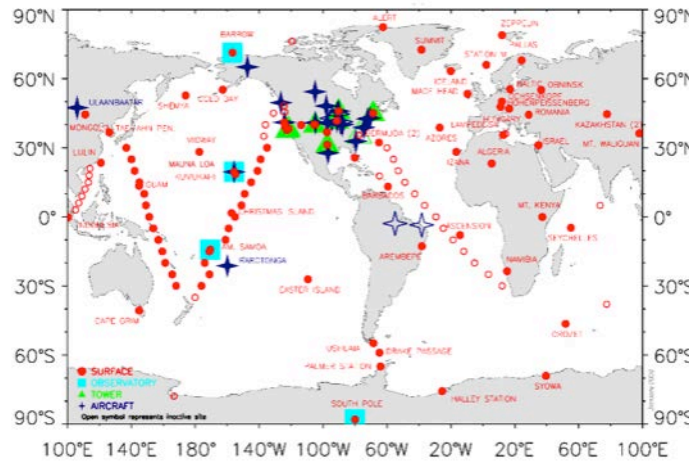
Research aircraft



Mobile laboratories



NOAA cooperative sampling network



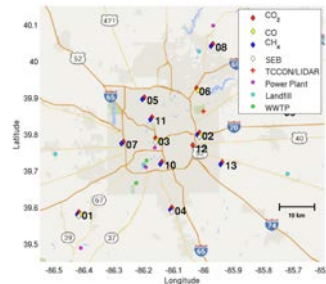
NASA OCO-2



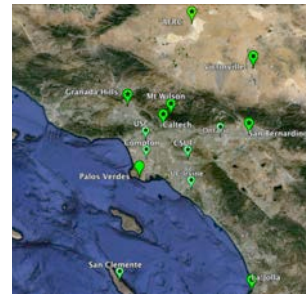
JAXA/NIES/MOE GOSAT



INFLUX (Indianapolis, IN)



Megacities Carbon Project (Los Angeles, CA)



TCCON

