

# Local Methane (CH<sub>4</sub>) Dynamics at the SGP ARM Site: Meteorological Influences and Source Attribution

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## Motivation

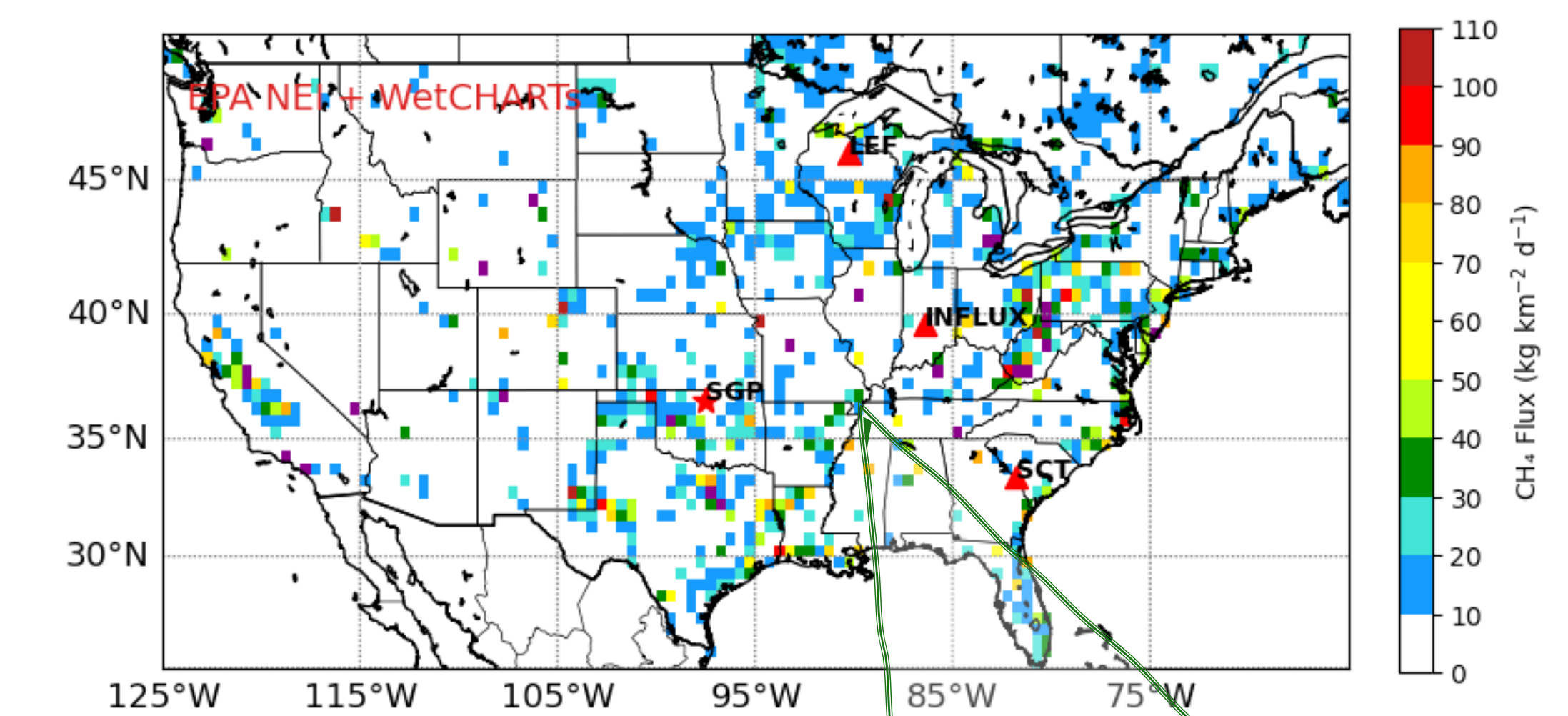


Fig 1: SGP, INFLUX, LEF, and SCT site with CH<sub>4</sub> emission inventories (EPA NEI (anthropogenic)-WetCHARTs (wetlands))

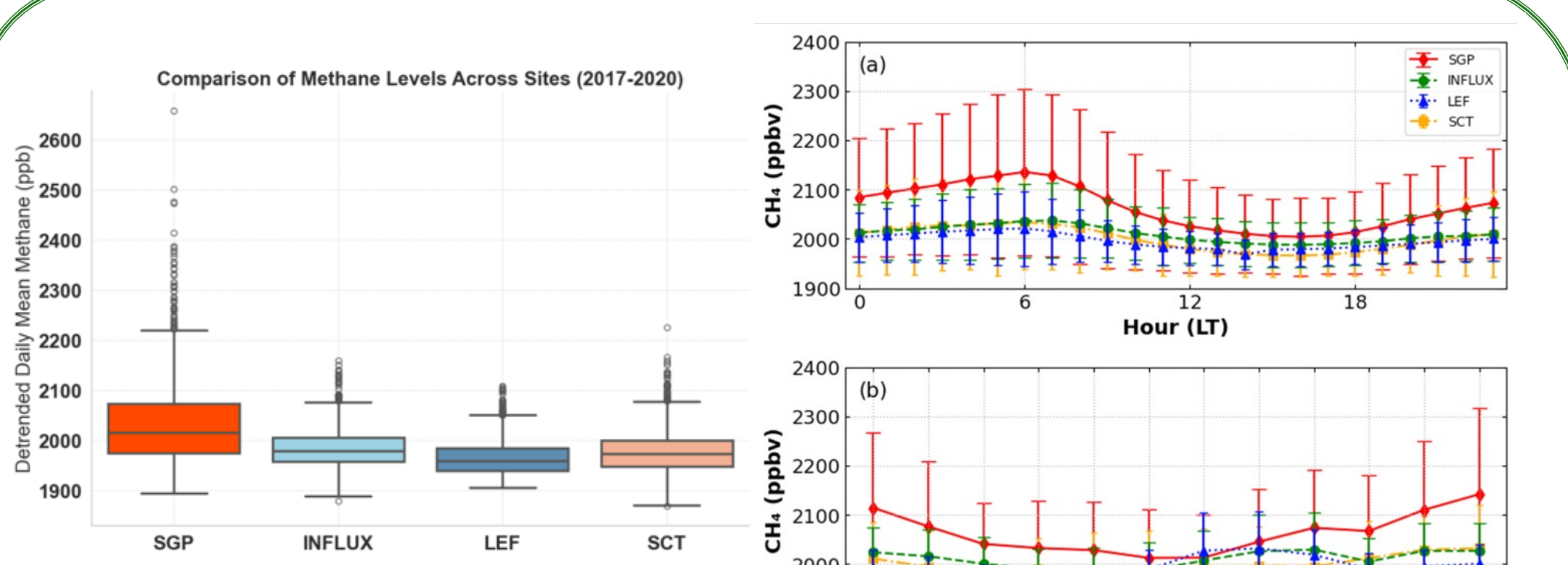


Fig 2: Comparative analysis of detrended daily mean CH<sub>4</sub> across four sites (2017-2020)  
The SGP site records higher CH<sub>4</sub> than other sites, larger diurnal and seasonal variations of four sites

**Research question: WHY does the SGP site exhibit such elevated CH<sub>4</sub>?**

- Meteorological influences?
  - Extra stable Planetary Boundary Layer (PBL)
  - Low-level Jet – common in the US Great Plains
- Any local sources?
  - Oil well, natural gas pipeline, livestock,...

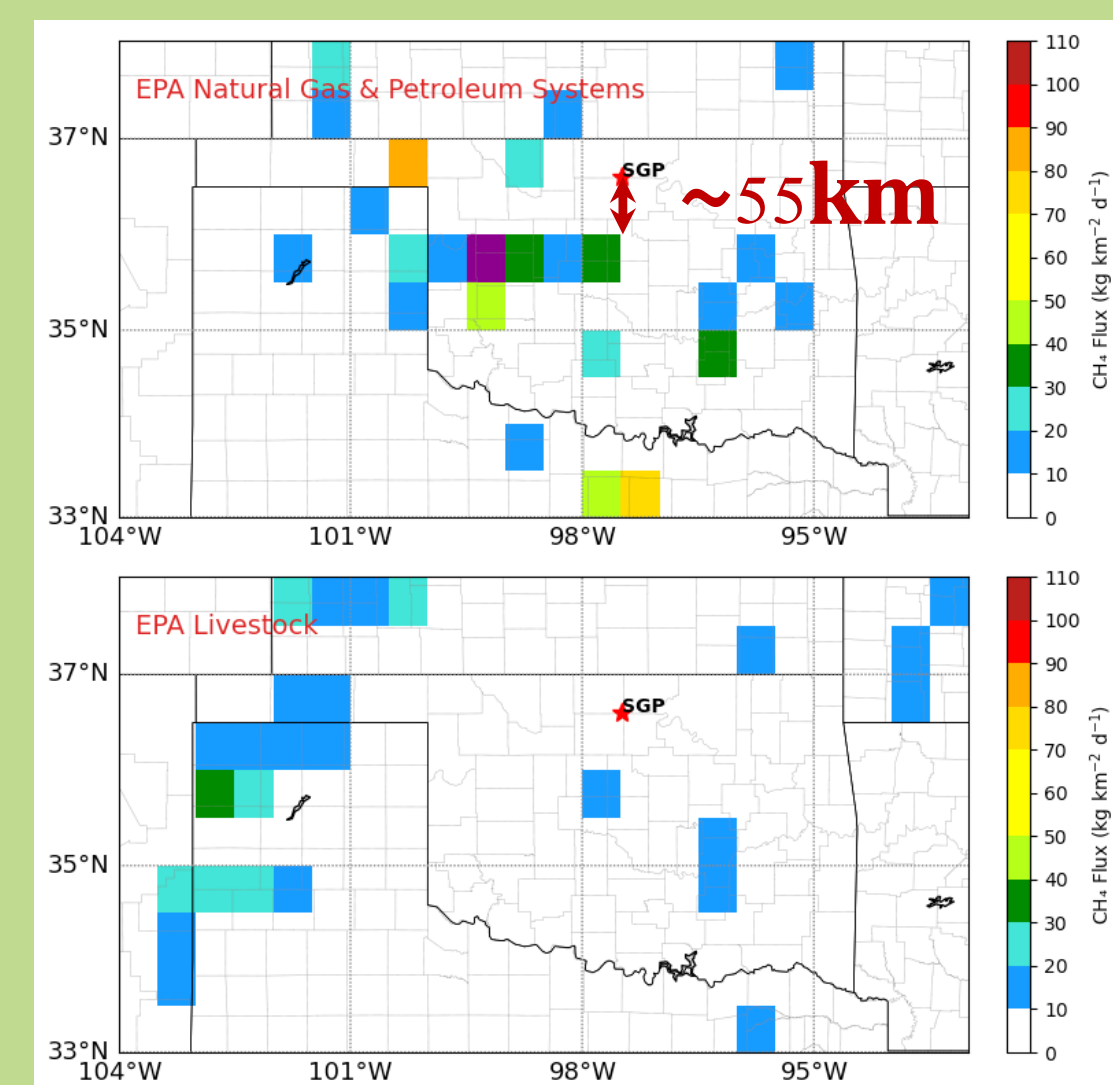


Fig 4: SGP CH<sub>4</sub> emission from EPA NEI from Natural Gas & Petroleum System (above) and Livestock (below)

**NO Strong Local CH<sub>4</sub> emissions indicated by inventories.**

## Results

### METEOROLOGICAL INFLUENCES

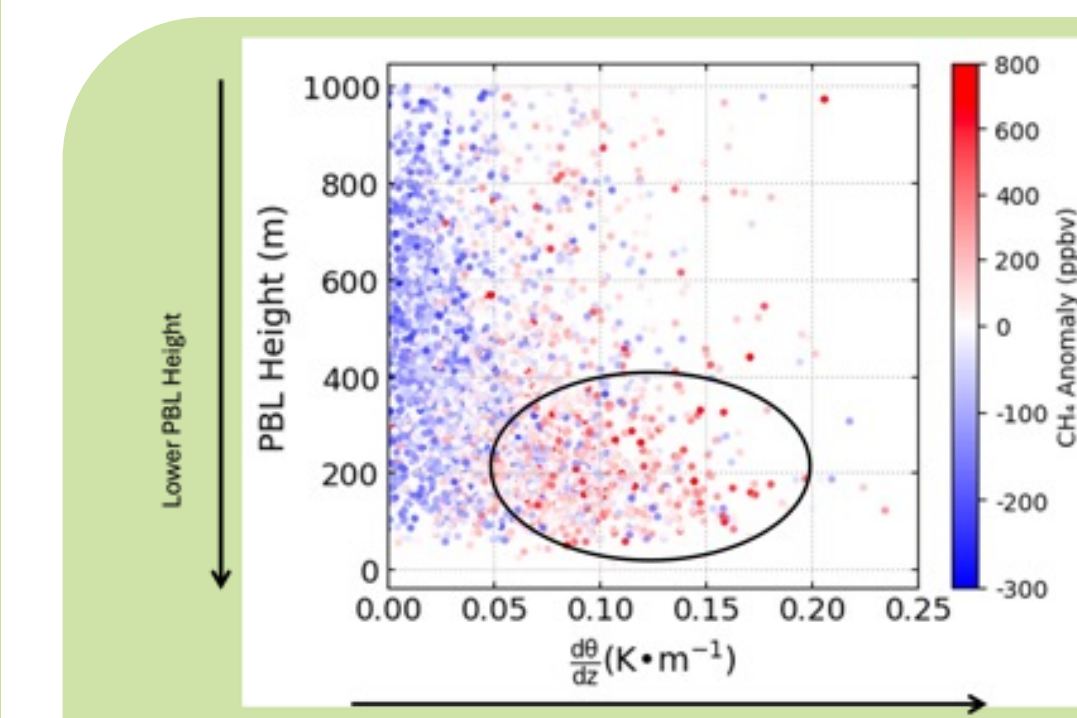


Fig 5: Scatter of potential temperature inversion versus PBL Heights colored by CH<sub>4</sub> anomalies

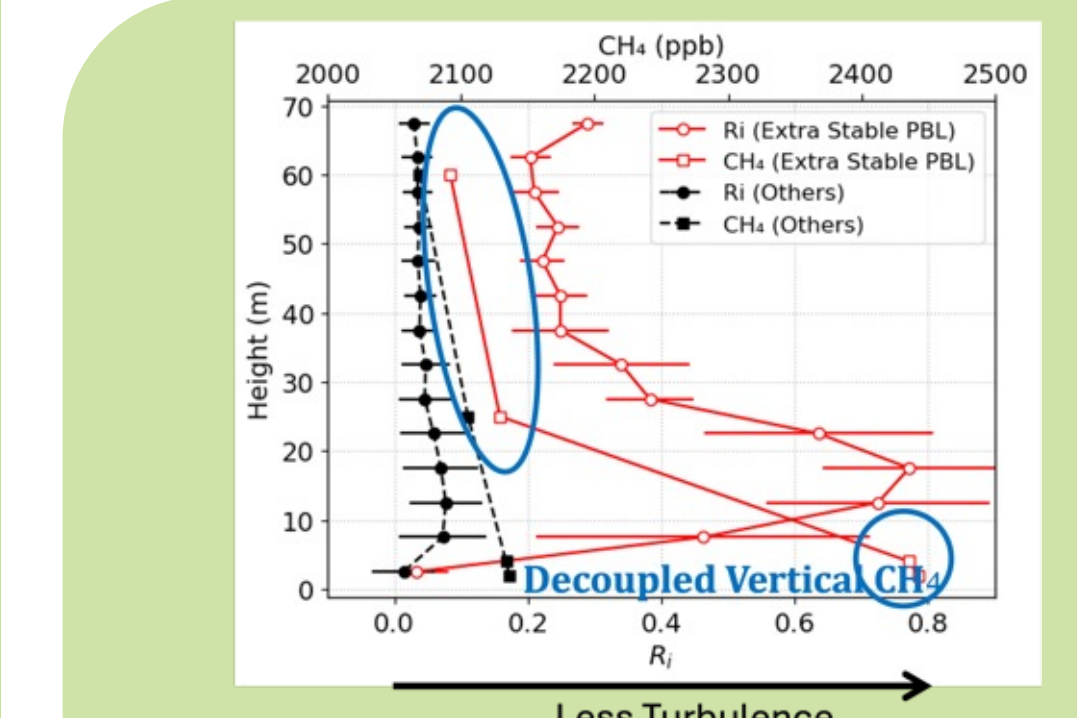


Fig 6: Gradient Richardson Number (Ri) and CH<sub>4</sub> at stable PBL and other conditions

**CH<sub>4</sub> Near Surface 2 m:**  
High CH<sub>4</sub> near surface in a more stable PBL.

**CH<sub>4</sub> at multiple heights: 2, 4, 25, and 60m:**  
Extra stable PBL inhibit turbulence, trapping CH<sub>4</sub> close to the surface and preventing its upward dispersion.

### LOCAL SOURCES FOUND IN THE FIELD CAMPAIGN ON JUNE 26, 2024

**Quantifying CH<sub>4</sub> Mass Balance Method:**  
PBLH = 10m: 72.4 kg/hr  
PBL H= 60m: 347.8 kg/hr

**Methane (ppb)**

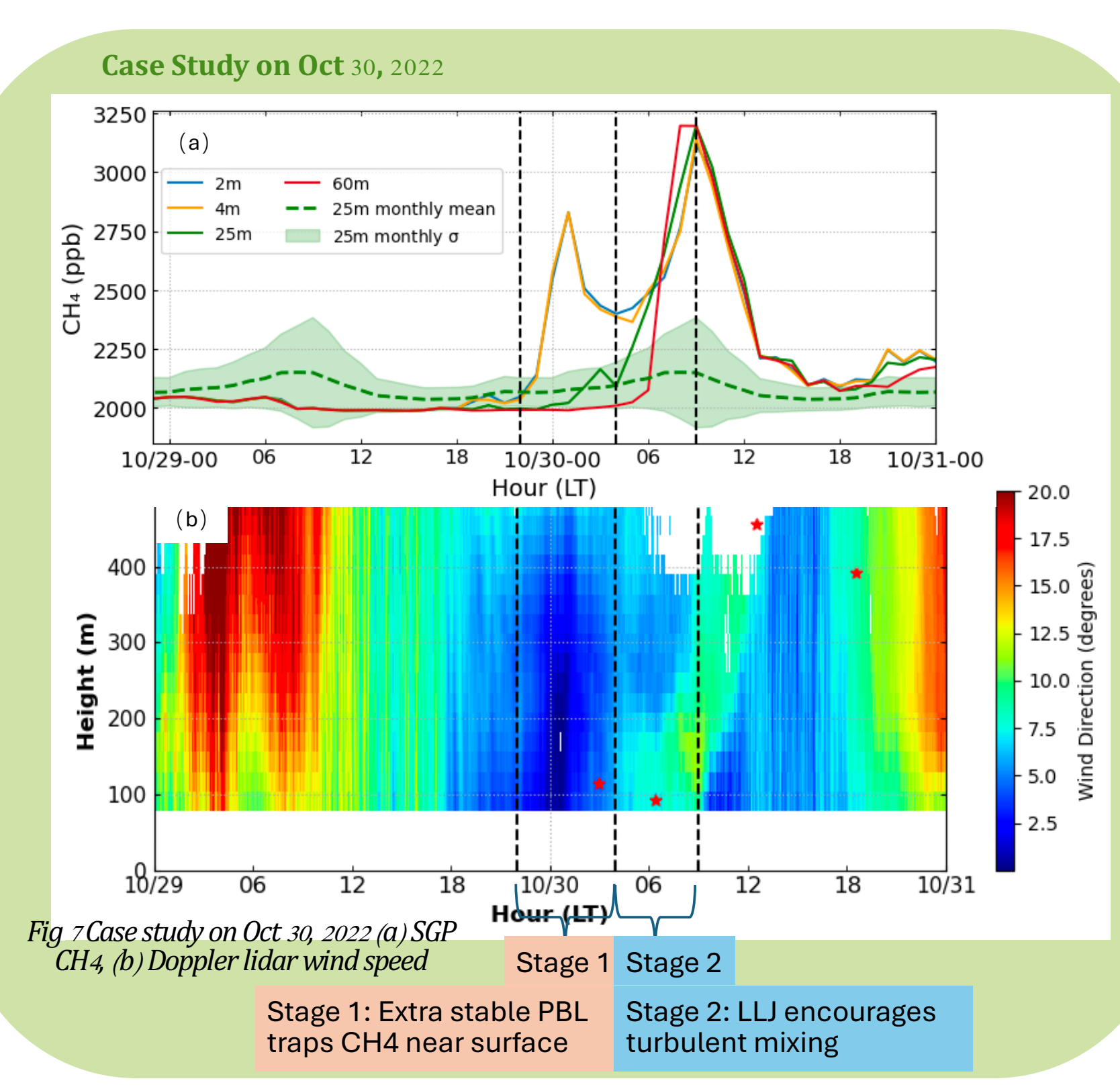


Fig 7: Case study on Oct. 30, 2022 (a) SGP CH<sub>4</sub>, (b) Doppler lidar wind speed

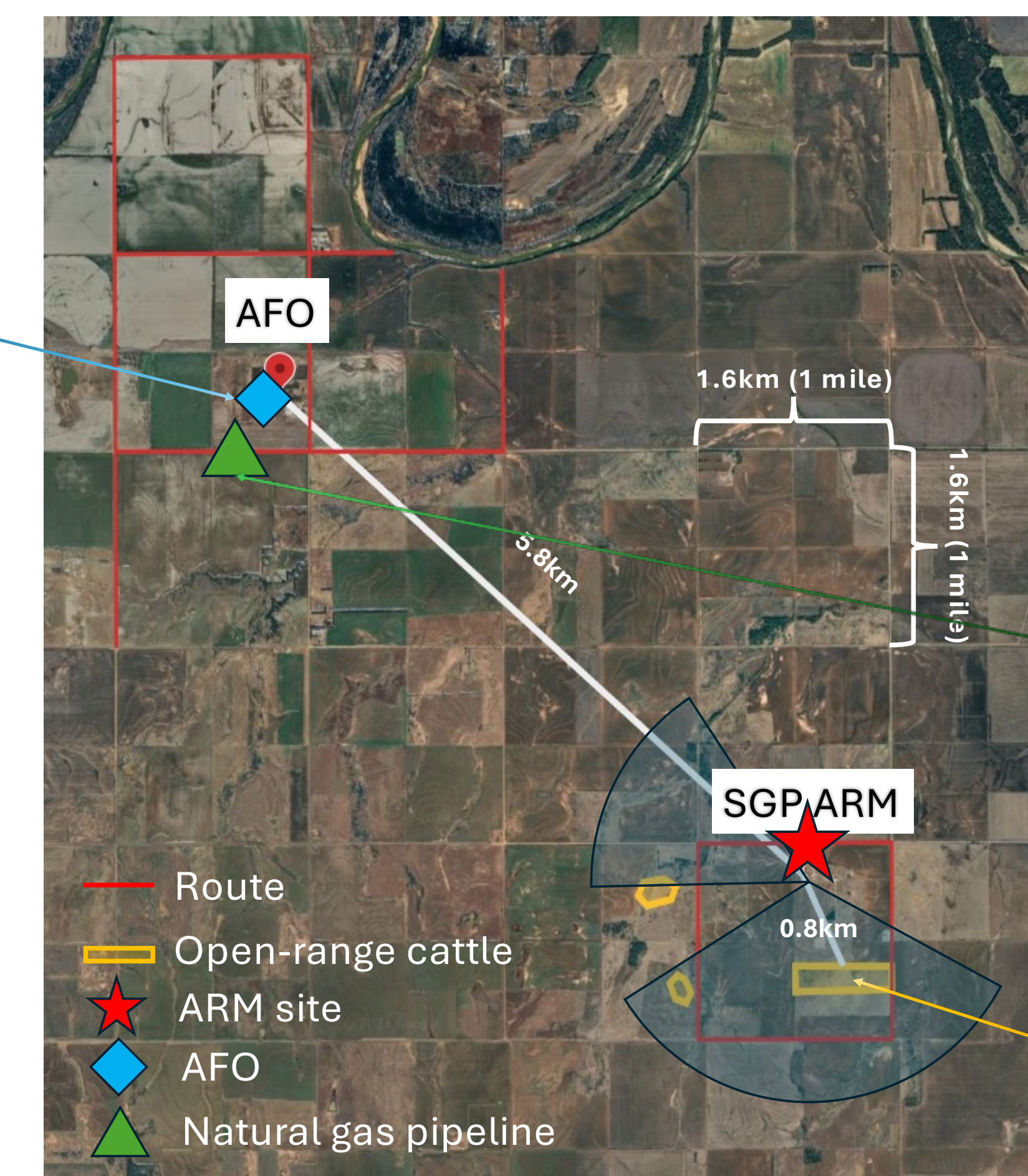


Fig 8: Field campaign map. Emissions include (1) Animal Feeding Operations (AFO), (2) Natural gas pipeline leak and (3) Open-range cattle

**Livestock CH<sub>4</sub> emissions may be underestimated near the SGP site**

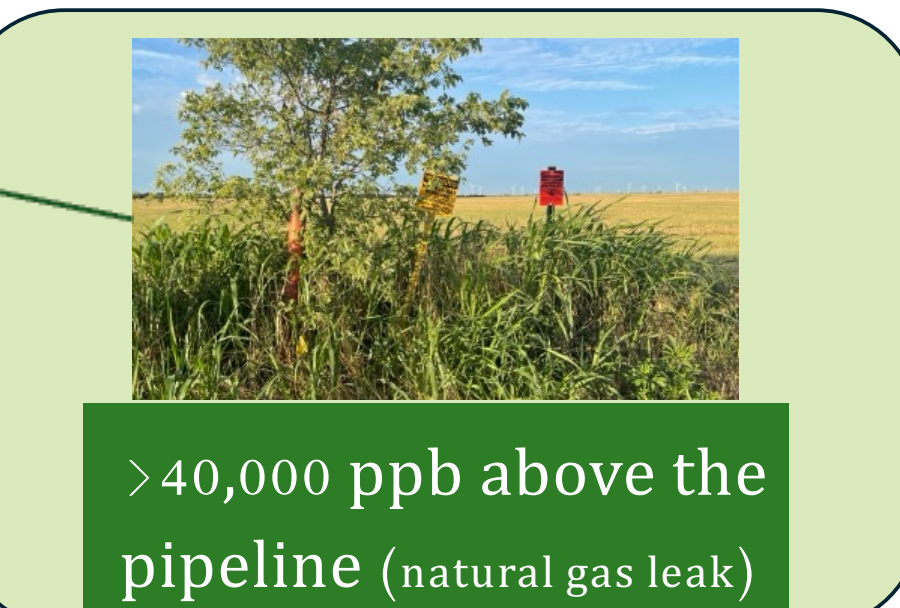
## Highlights

- **High CH<sub>4</sub> at SGP site:** The SGP site consistently shows higher CH<sub>4</sub>, larger diurnal and seasonal variations compared to other U. S. sites
- **Meteorological Influences:** A stable PBL at the SGP site restricts vertical air mixing, trapping CH<sub>4</sub> near the surface.
- **Emission Attributions:** Field campaigns indicate significant local CH<sub>4</sub> emissions from cattle and natural gas sources, which are not fully accounted for in existing emission inventories.

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Fig 9: Qingyu Wang installing instruments on truck (credit: Wesley Honeycutt) QR code: Qingyu's LinkedIn profile



>40,000 ppb above the pipeline (natural gas leak)



35 cattle: ~8.1 kg/hr