

Quantifying Methane in the Salt Lake Valley: Inversion Sensitivity and Error Characterization

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Goal

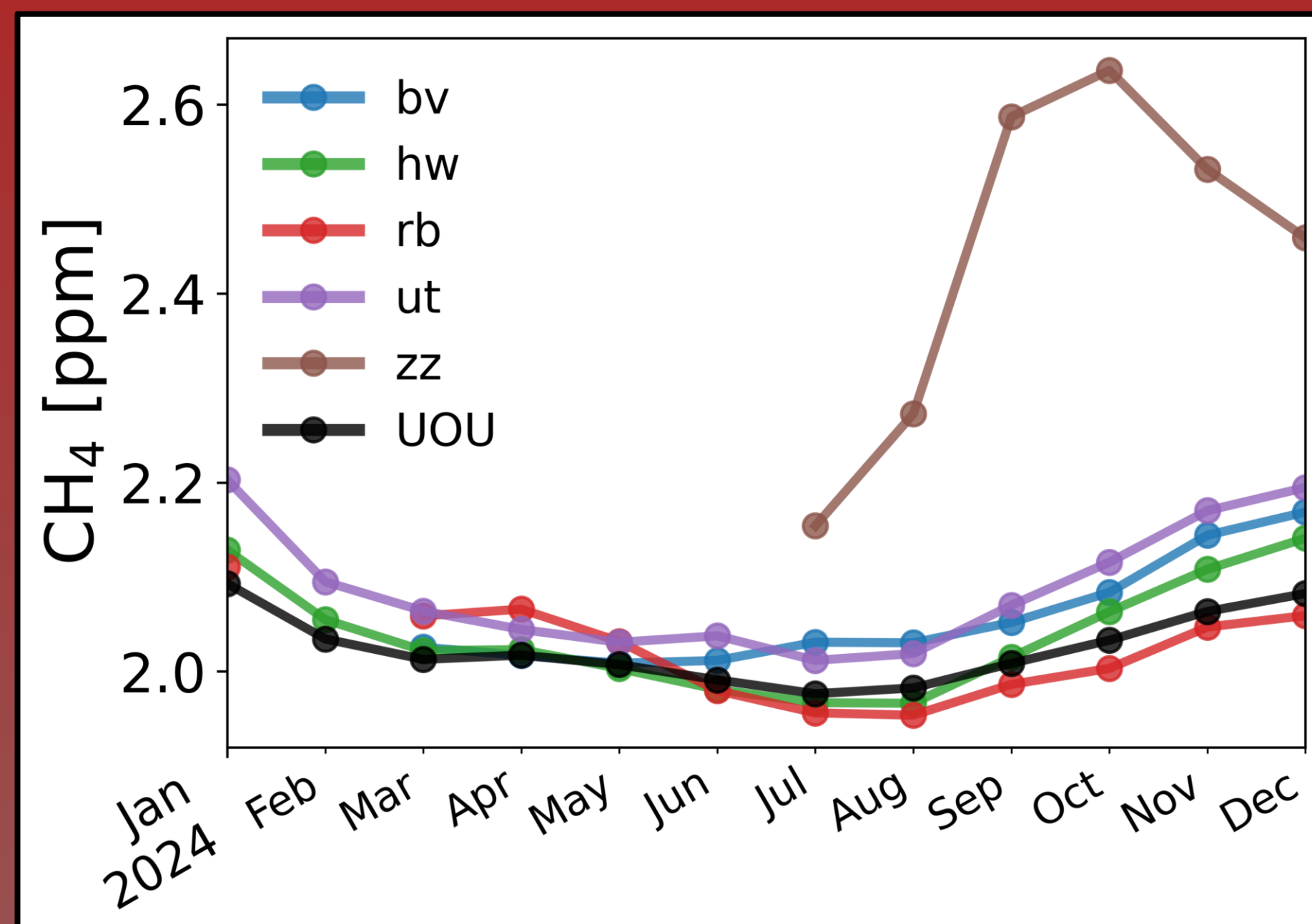
Estimate monthly methane emissions for the Salt Lake Valley



LAND ATMOSPHERE INTERACTIONS RESEARCH

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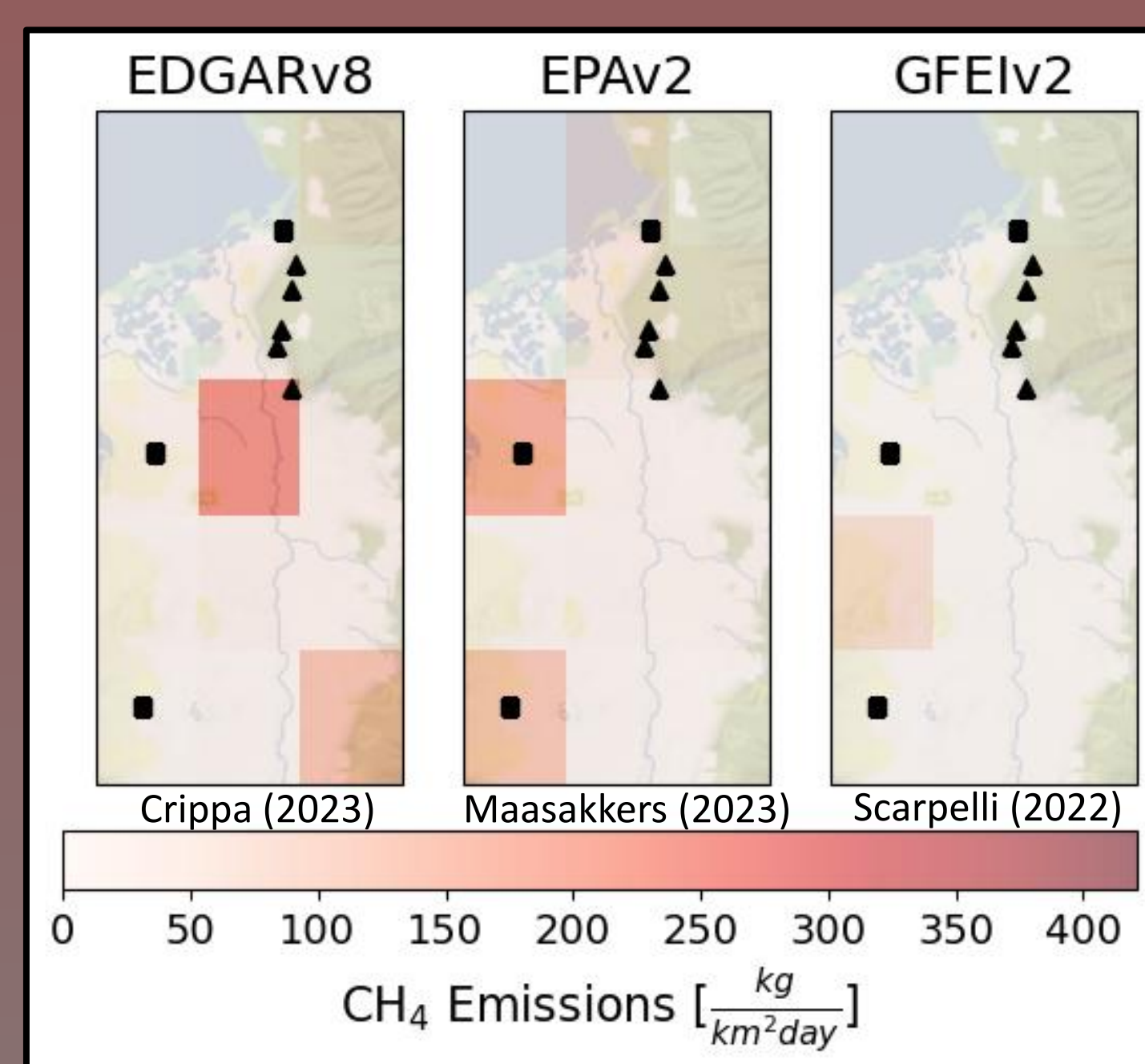
Observations



- Multiple sites across Salt Lake City proper
- Strong seasonal cycle
- Prison site sees high concentrations

STILT Footprints

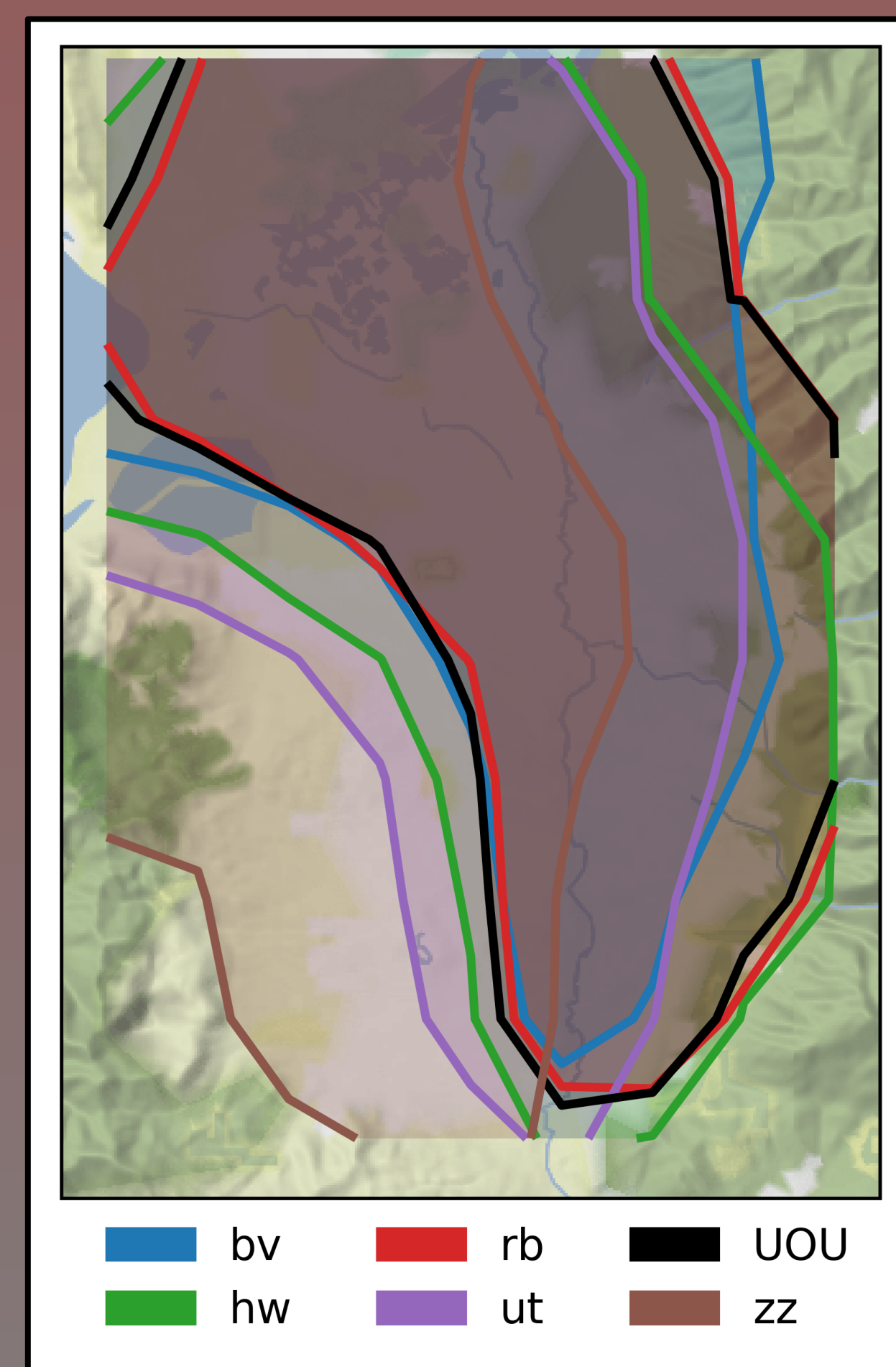
Prior Estimate



Bottom-up estimates from source activity of average methane emissions for the Salt Lake Valley

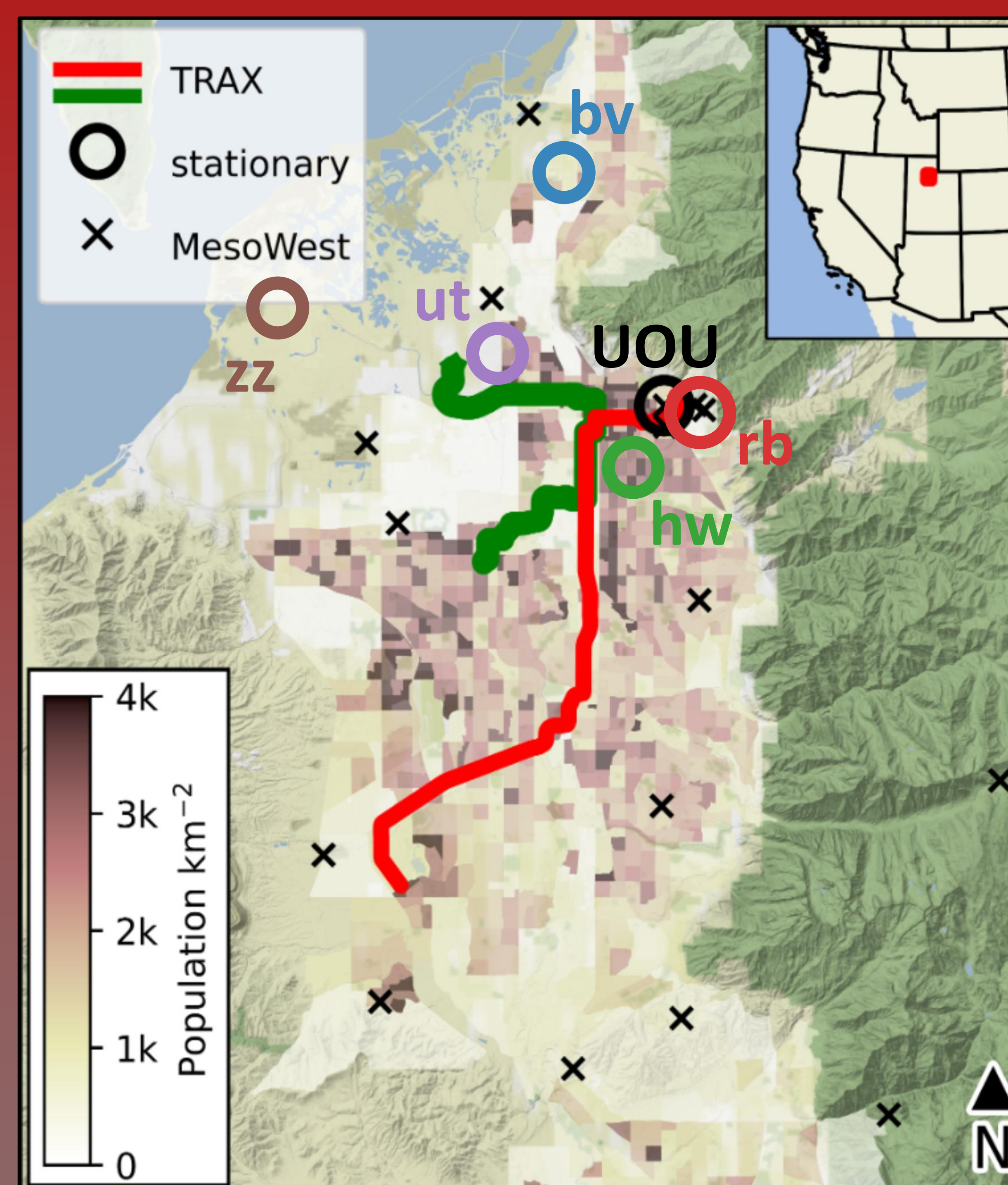
- Limited urban understanding
- Coarse resolution
- Poor spatial allocation

■ — landfill ▲ — refinery

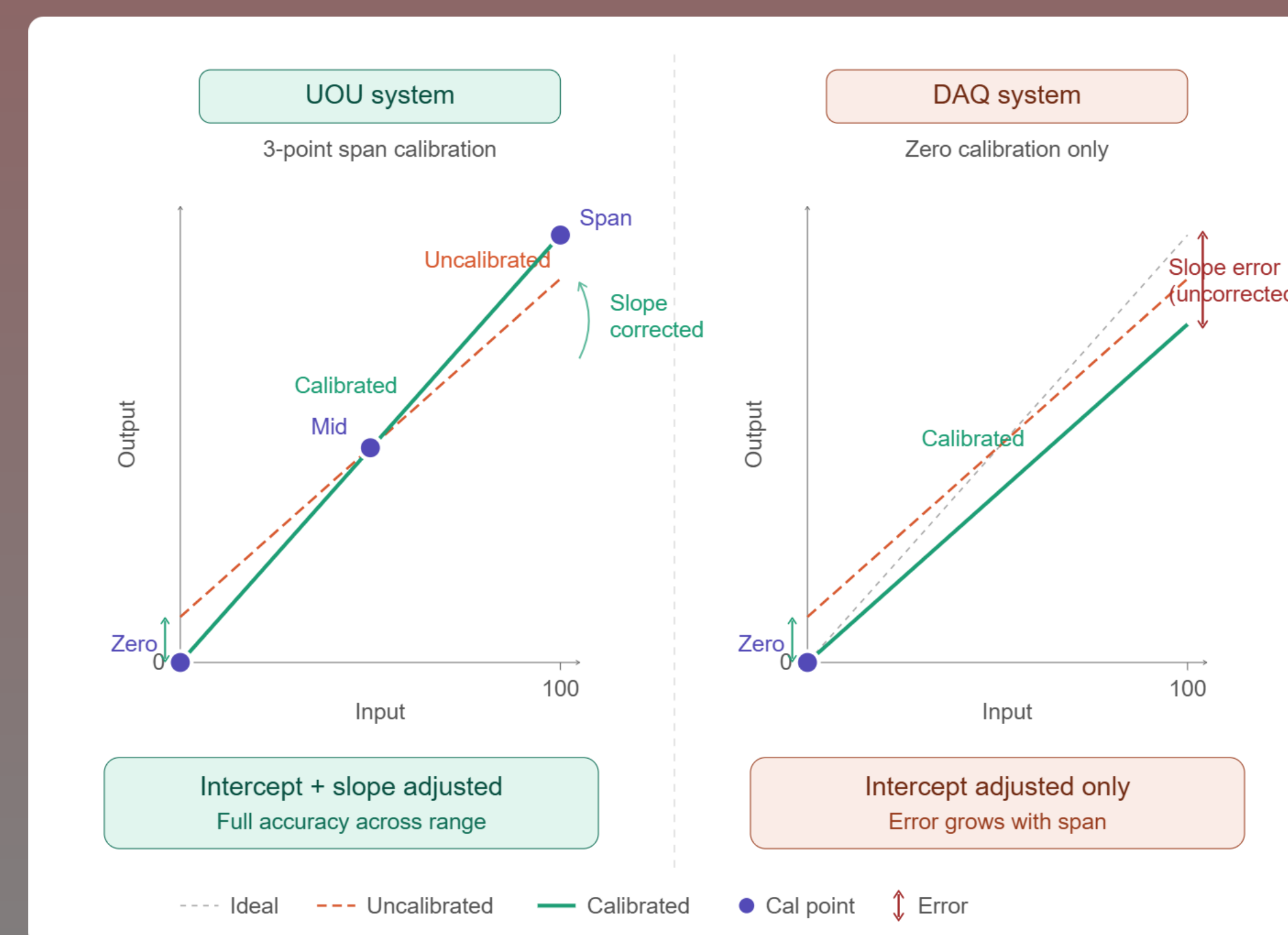


STILT footprints identify sensitivity to upwind source regions

- Poor sensitivity to the Southwest corner of the valley



Calibration



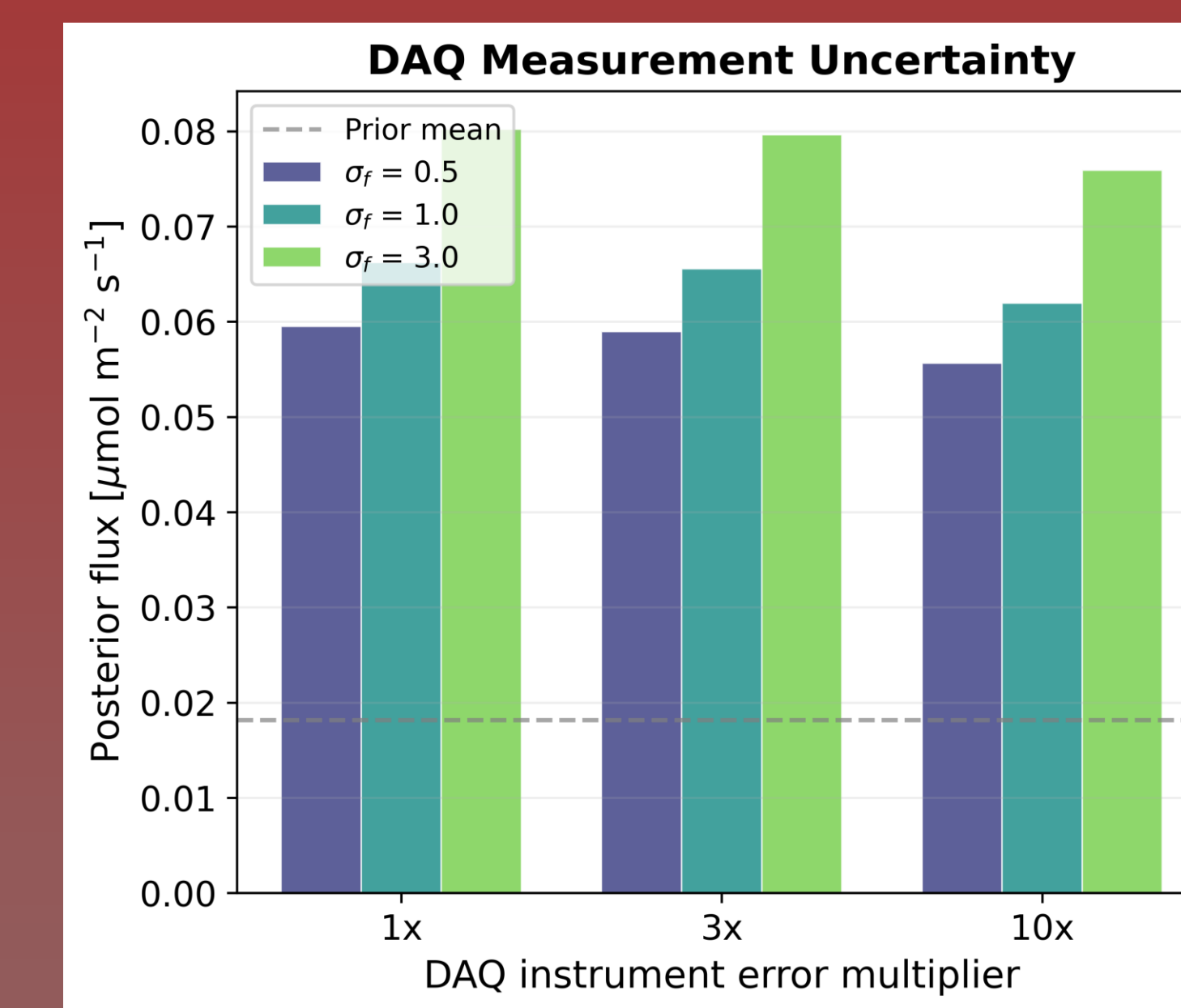
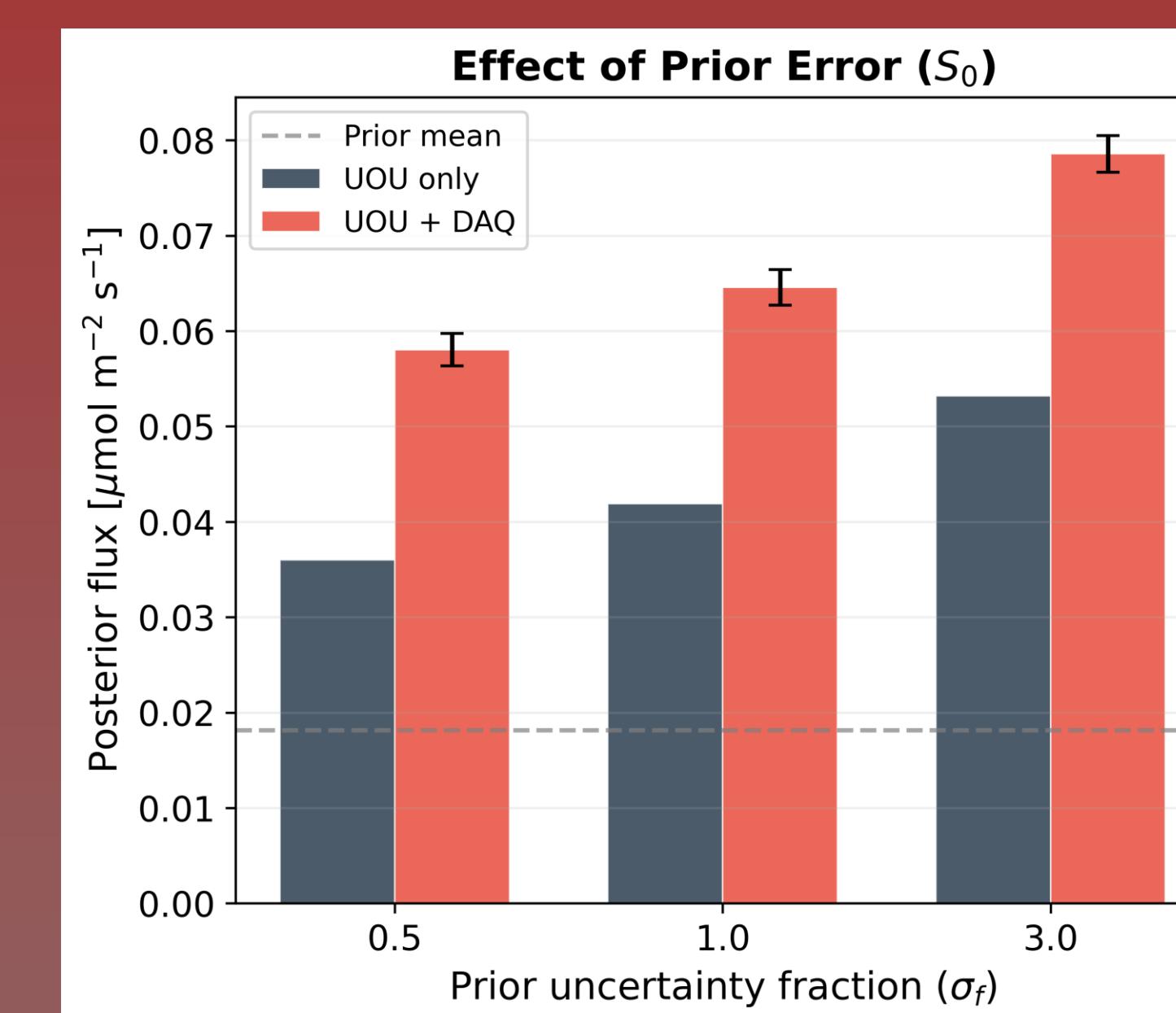
Bayesian Inversion

$$J(x) = (x - x_0)^T S_0^{-1} (x - x_0) + (z - Hx)^T S_z^{-1} (z - Hx)$$

$$\hat{x} = x_0 + (HS_0)^T (HS_0 H^T + S_z)^{-1} (z - Hx_0)$$

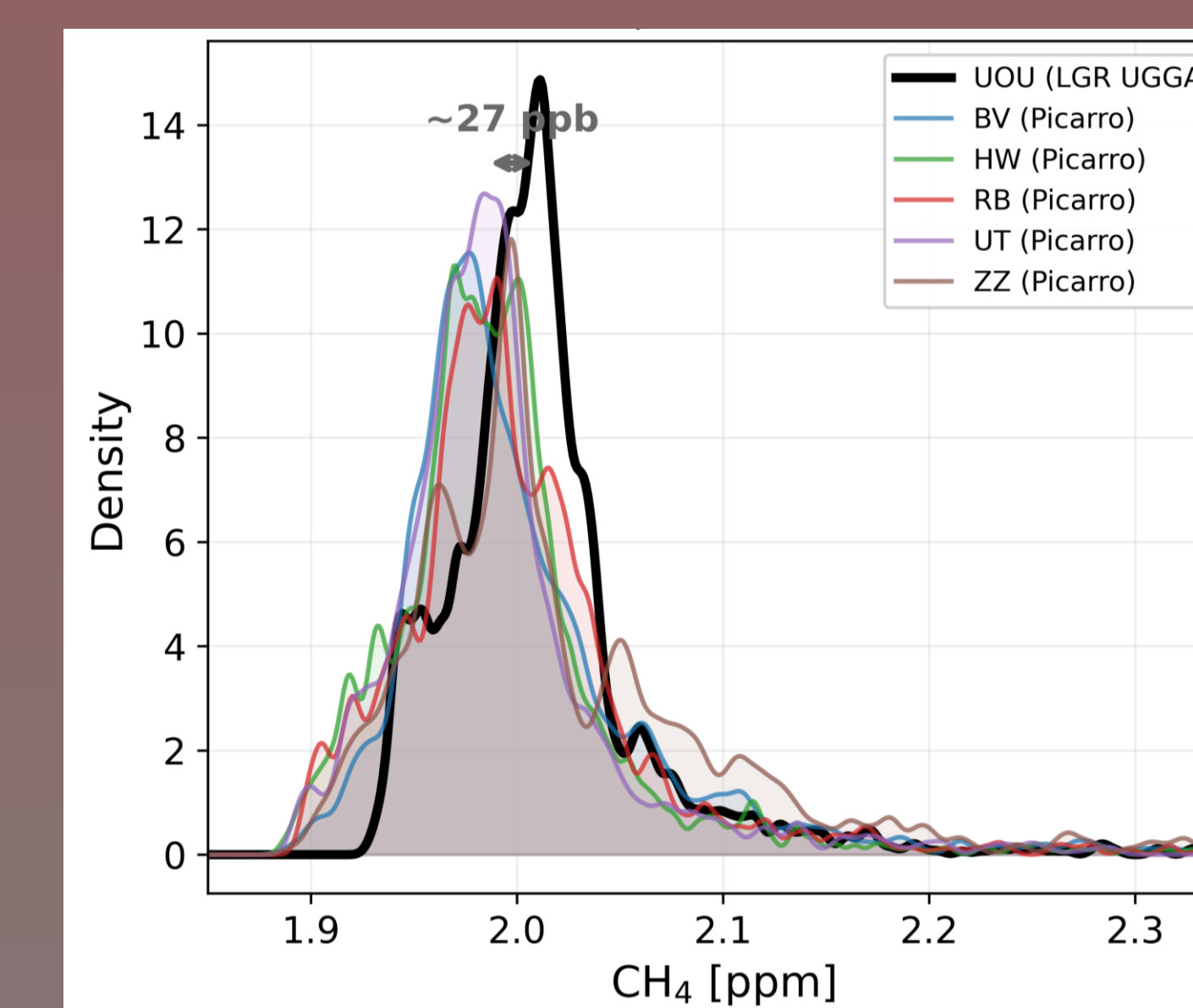
Adjusted Emissions = \hat{x} , Prior Estimate = x_0 , Observed CH_4 = z , Model predicted CH_4 = Hx_0 . Scaling that accounts for model & prior estimate uncertainties and the correlations of these uncertainties in time and space.

Posterior Sensitivity



- Larger prior error -> larger fluxes
- Including DAQ increases flux
- Posterior has little sensitivity to DAQ instrument error

Distributions



- DAQ sensors biased low
- Roughly 15-30 ppb
- Known issue with Picarro g2307

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