Spatio-temporally resolved methane fluxes from the Los Angeles Megacity

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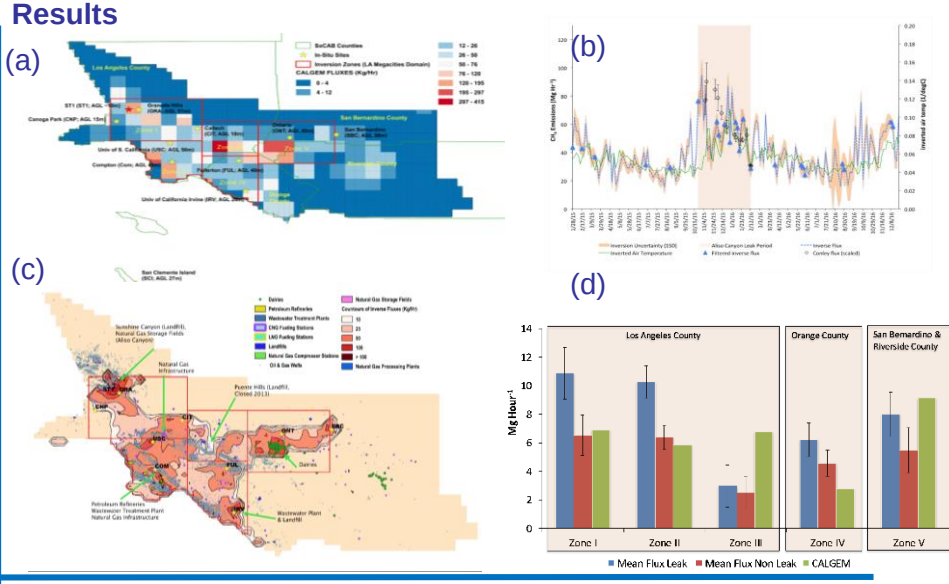
Science Focus/Objectives

1. Characterize basin and sub-basin scale temporal variability in fluxes including the onset and disappearance of large CH_4 sources in SoCAB and Los Angeles Megacity,
   - Aliso Canyon Natural Gas Leak Anomaly and closure of Puente Hills Landfill
2. Identify the spatial locations sources of major CH_4 emissions in the basin,
   - Hot-spots and cold-spots of emissions
3. Evaluate the ability of a relatively sparse measurement network to update fluxes and identify spatio-temporal anomalies.
   - Fluxes constraints by the network

Results



Methodology (Inverse Modeling)

$$L_{\mathbf{s},\boldsymbol{\beta}} = \frac{1}{2}(\mathbf{z}-\mathbf{Hs})^T\mathbf{R}^{-1}(\mathbf{z}-\mathbf{Hs}) + \frac{1}{2}(\mathbf{s}-\mathbf{X}\boldsymbol{\beta})^T\mathbf{Q}^{-1}(\mathbf{s}-\mathbf{X}\boldsymbol{\beta})$$

$\mathbf{z}_{(n,1)}$ are hourly CH_4 measurements, $\mathbf{H}_{(n,p)}$ is a Jacobian matrix representing the sensitivity of measurements to underlying flux, $\mathbf{s}_{(p,1)}$ are the CH_4 fluxes to be estimated, $\mathbf{R}_{(n,n)}$ is the model-data mismatch error covariance matrix, $\mathbf{X}_{(p,k)}$ is a matrix of covariates, $\boldsymbol{\beta}_{(k,1)}$ are the coefficients or weights of individual covariates to be estimated, and $\mathbf{Q}_{(p,p)}$ is the error covariance matrix (aka prior covariance) that describes the deviations of $\mathbf{s}$ from $\mathbf{X}\boldsymbol{\beta}$.

- Transport: WRF-STILT
- Non-negativity constraint: Lagrange Multiplier
- Uncertainty: Simulations
- Result Evaluation: RMSE, Correlation Coefficient, Reduced Chi-Square and Model Resolution (Averaging Kernel) matrix

Conclusions

1. The onset of the Aliso Canyon leak was captured by inversions. However, sustained contribution of the leak to basin CH_4 emissions was not captured due to limited sensitivity of the network to the leak location.
2. The closure of the Puente Hills landfill that represents a policy decision was captured in inversions and we are not aware of any other regional inverse modeling study (not based on dedicated aircraft flights) that has accomplished this in an area with a dense CH_4 emanating infrastructure such as SoCAB.
3. Spatially, the study utilized model resolution matrix to identify sources of major emissions in the basin. These sources were aligned with facilities identified with infrastructure inventory
4. The study also reaffirmed existing theories that a fraction of variability in enhancement and emissions in the basin is correlated with air temperature and energy demand.