COMBINING MODELING AND MEASUREMENT TECHNIQUES

Shari Beth Libicki, PhD

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RACIE

RAMBOLL   Bright ideas. Sustainable change.

FACILITY SCALE

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EPA STATE AND TRIBAL GRANT

- The City of Richmond along with the Bay Area Air Quality Management District (BAAQMD) established a three-year community air monitoring program to monitor emissions from the Chevron Refinery.

- As a part of the United States Environmental Protection Agency (US EPA) State and Tribal Grant (STAG), Ramboll will apply modeling and numerical analysis techniques to determine whether the complex dataset can be used to infer or estimate emissions from the Refinery.

- The goals of the project are:

  - Make use of a rich data set that has previously been under-utilized

  - Evaluate covariation within all pollutants measured to allow a reduction in parameters measured.

  - Evaluate whether a combination of data analytics and dispersion modeling with US EPA's AERMOD model can determine distinct sources of emissions from the refinery to use monitoring to measure emissions

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A RICH DATASET?

- Three open-path fenceline monitors and three multi pollutant community monitors (CMS)

- Measures Hazardous Air Pollutants, Criteria Air Pollutants, Hydrocarbons including Benzene, Hydrogen Sulfide (H_2S), Sulfur Dioxide (SO_2), Volatile Organic Carbon and many more.

- Chevron operates GLMs by permit

- How can the data be better used?

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DATA COMPLETENESS

Dataset	Field	Atchison Village	North Richmond	Point Richmond
CMS	Benzene	3%	2%	2%
	Toluene	19%	12%	12%
	o-Xylene	13%	13%	12%
	m-Xylene	6%	2%	2%
	Ethylbenzene	0.6%	0.2%	0.2%
	Hexane	30%	20%	19%
	3-methylpentane	6%	2%	2%
	1,2,3-trimethylbenzene	0.07%	0.03%	0.03%
	2,2,4-trimethylpentane	3%	1%	1%
	H2S	21%	21%	21%
	NH3	87%	86%	86%
	BC	99%	99%	96%
	PM	56%	59%	62%
TDL	H2S	0%	0%	0.00%
UV	SO2	3%	6%	4%

- "Completeness" only includes data above detection limit.

- Only pollutants such as Ammonia, Black Carbon (BC) and Particulate Matter (PM) have a high degree of completeness at the community monitors, but several confounding sources of BC and PM in the area.

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ONLY ONE POLLUTANT CONTAINED ENOUGH VARIABILITY

- Chevron provided ground-level measurements (GLM) of H_2S and SO_2.

- Air District provided daily emissions data as measured in the Continuous Emissions Monitoring System (CEMS).

  - GLM and CEMS data are more complete for 2016/2017 compared to fence-line/CMS.

Dataset	Field	FCC				SRU Train 1				SRU Train 2				SRU Train 3			
		2014	2015	2016	2017	2014	2015	2016	2017	2014	2015	2016	2017	2014	2015	2016	2017
Chevron – CEMS	SO2 1 Hr Avg (ppm)	N/A	N/A	99%	99%	N/A	N/A	86%	94%	N/A	N/A	89%	93%	N/A	N/A	77%	88%
	SO2 Emissions Rate	N/A	N/A	N/A	99%	N/A	N/A	N/A	100%	N/A	N/A	N/A	100%	N/A	N/A	N/A	100%

		Golden Gate				Gertrude				Castro				San Pablo			
Dataset	Field	2014	2015	2016	2017	2014	2015	2016	2017	2014	2015	2016	2017	2014	2015	2016	2017
Chevron - GLM	SO2 1 Hr Avg (ppm)	40%	97%	99%	88%	42%	81%	87%	96%	42%	100%	100%	100%	33%	91%	91%	94%

- SO_2 offers most complete dataset; few confounding sources of SO_2 in the area including a sulfuric acid manufacturing plant and the Richmond terminal.

- Using supervised machine learning algorithm to predict SO_2 emissions from the refinery on an hourly basis based on features, including but not limited to meteorological data, **dispersion coefficients** and monitoring data.

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CITY SCALE

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BACKGROUND

AB617

- Funds community level air measurement, education, and emissions reductions

- Targets disadvantaged communities

AB617 Funded Project in Richmond, CA ("Air Rangers")

- Fill PM and NO_2 monitoring gaps

- Understand the refinery's impact

- Communicate actionable data to the public in near-realtime

- Facilitate healthy outdoor recreation

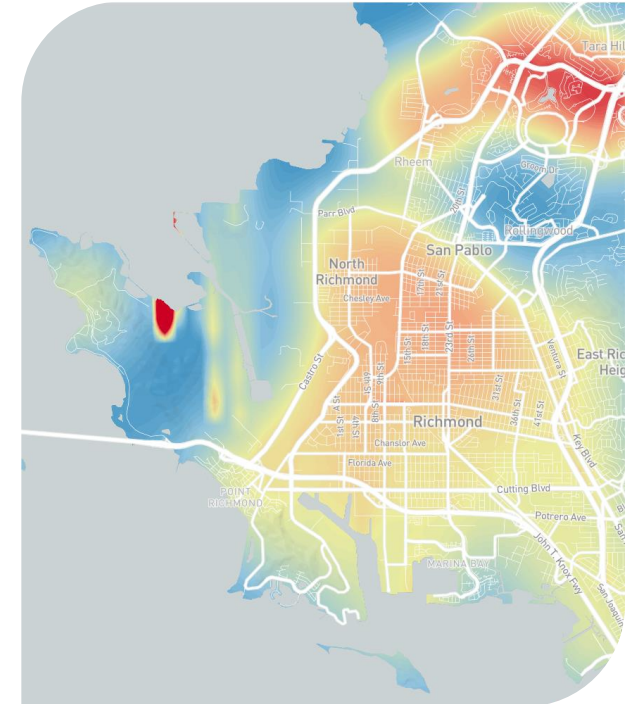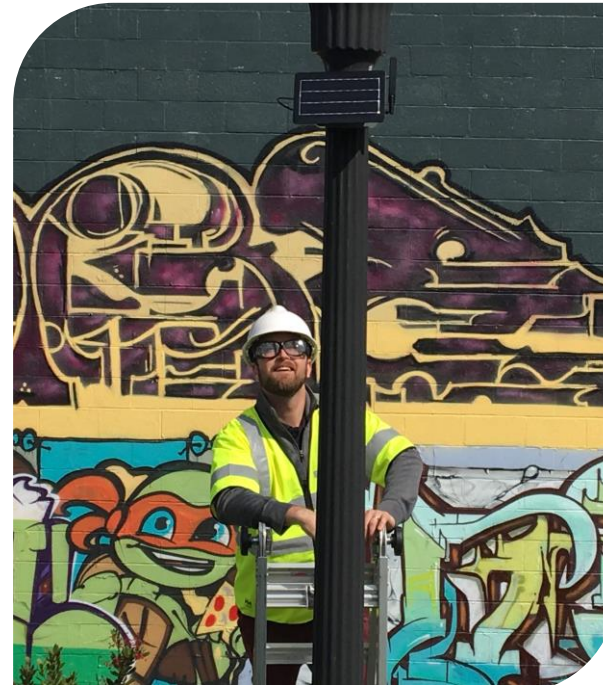- Local work force development for disadvantaged youth

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SB 535 Disadvantaged Communities
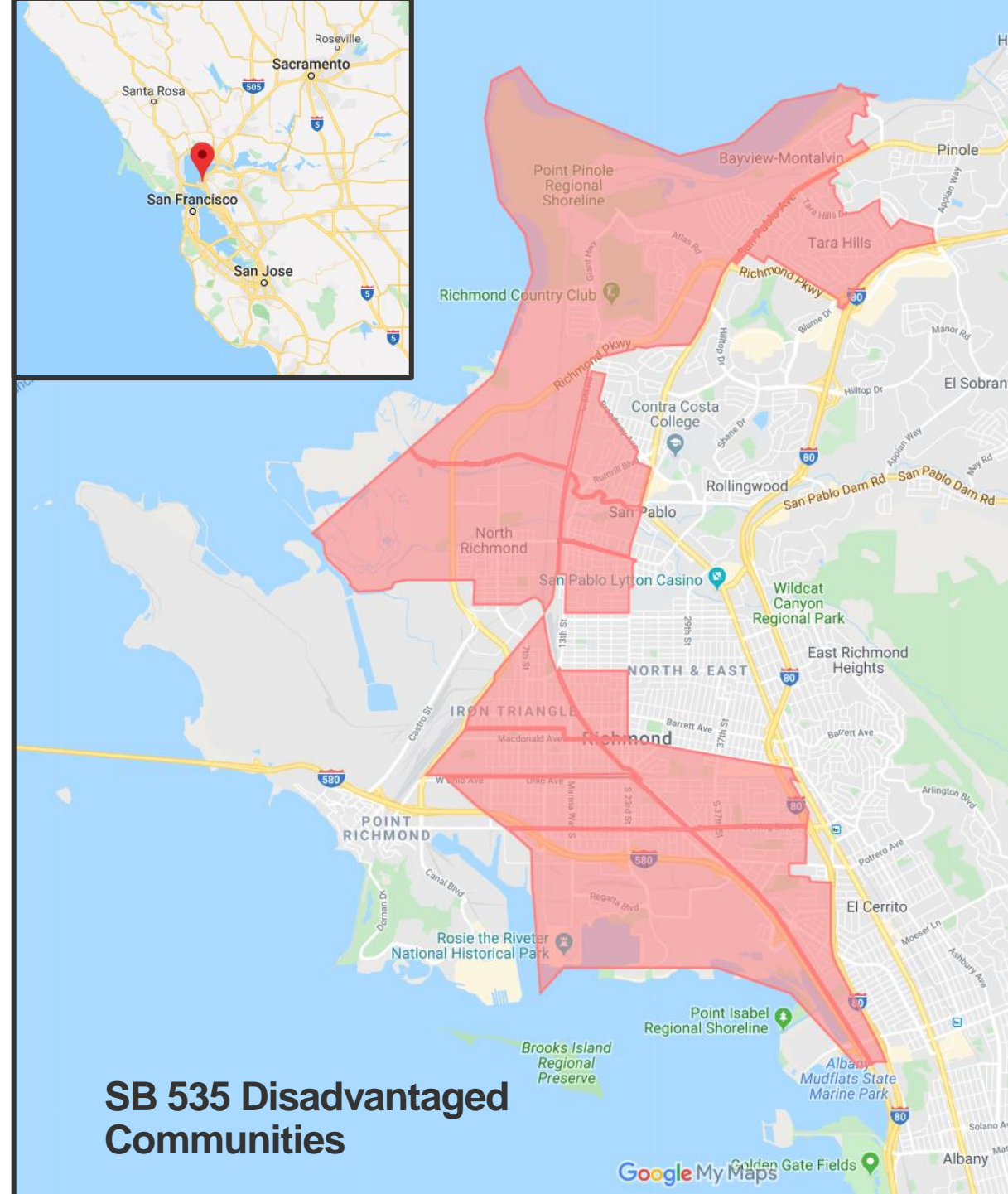
AIR RANGERS COMMUNITY AIR PROTECTION GRANT

Action Plan

Team of City, NGOs, scientists

Site **50** PM & NO_2 sensors; take **70** toxic metals samples

Communicate hyper-local air quality to the public, **hourly**

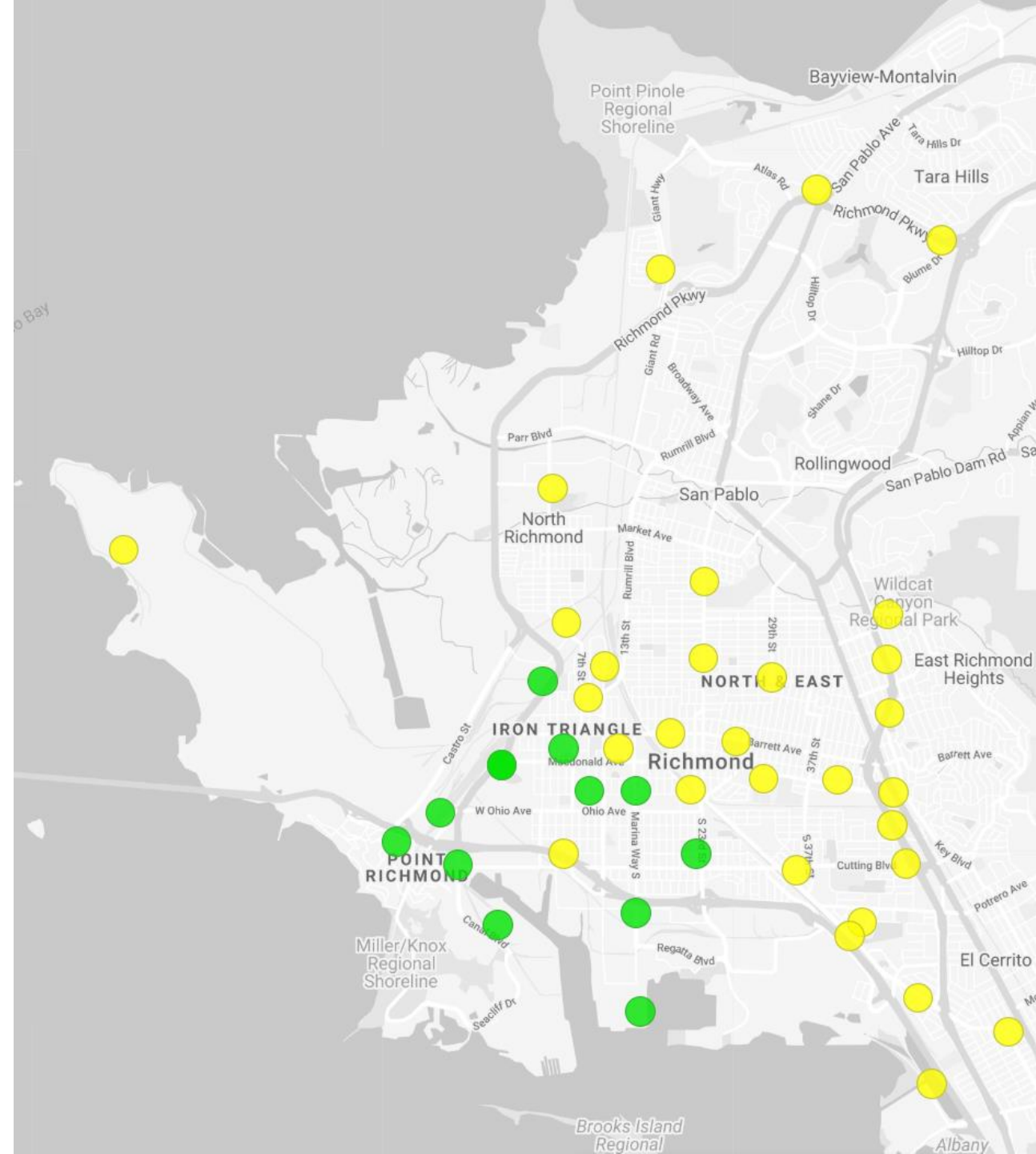**Hourly hotspot ID and source attribution**
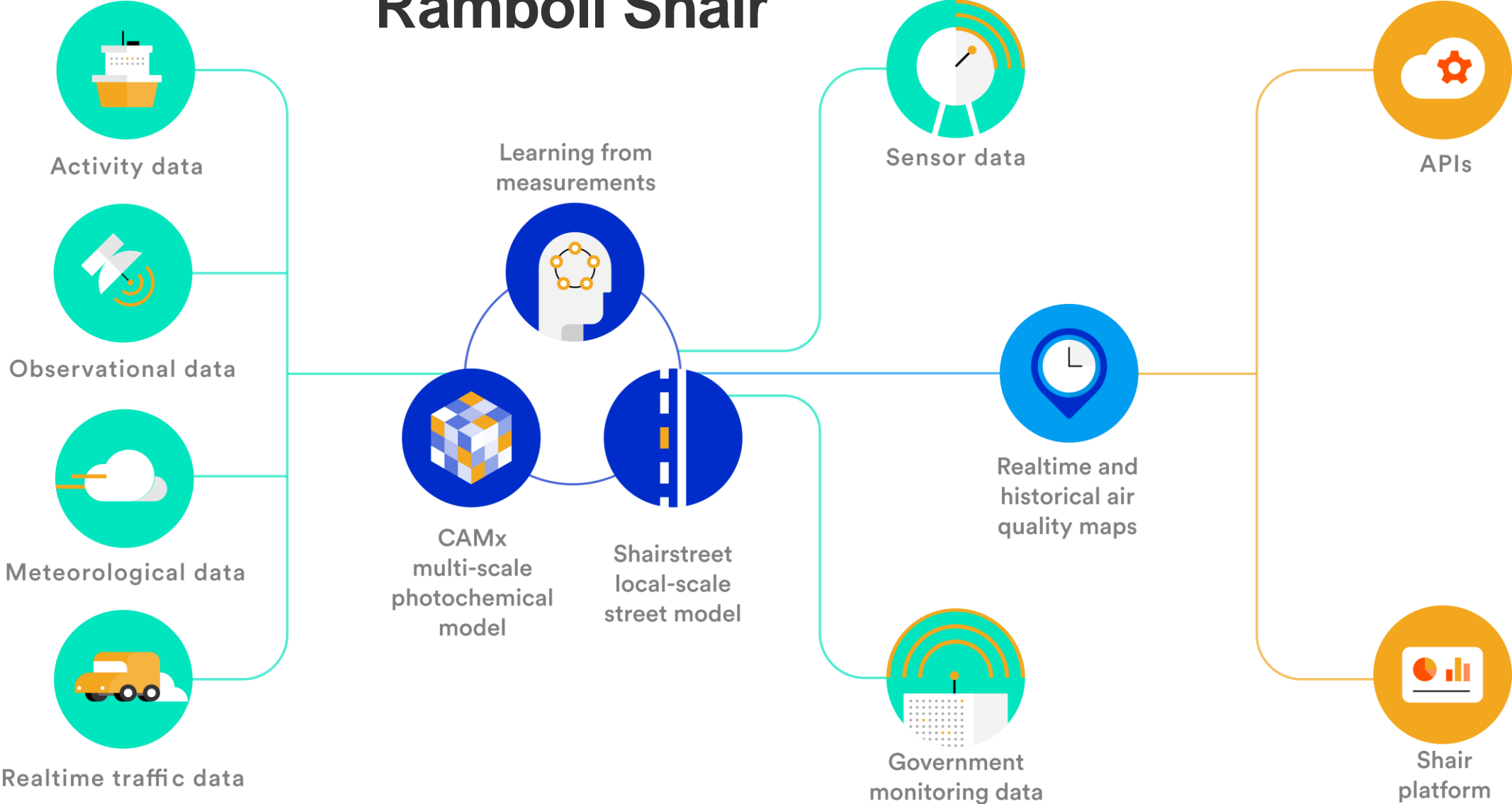
SENSOR NETWORK IN RICHMOND

- Network of up to 50 low-cost Clarity sensors

- Pollutants: $PM_{2.5}$, PM_{10}, and NO_2

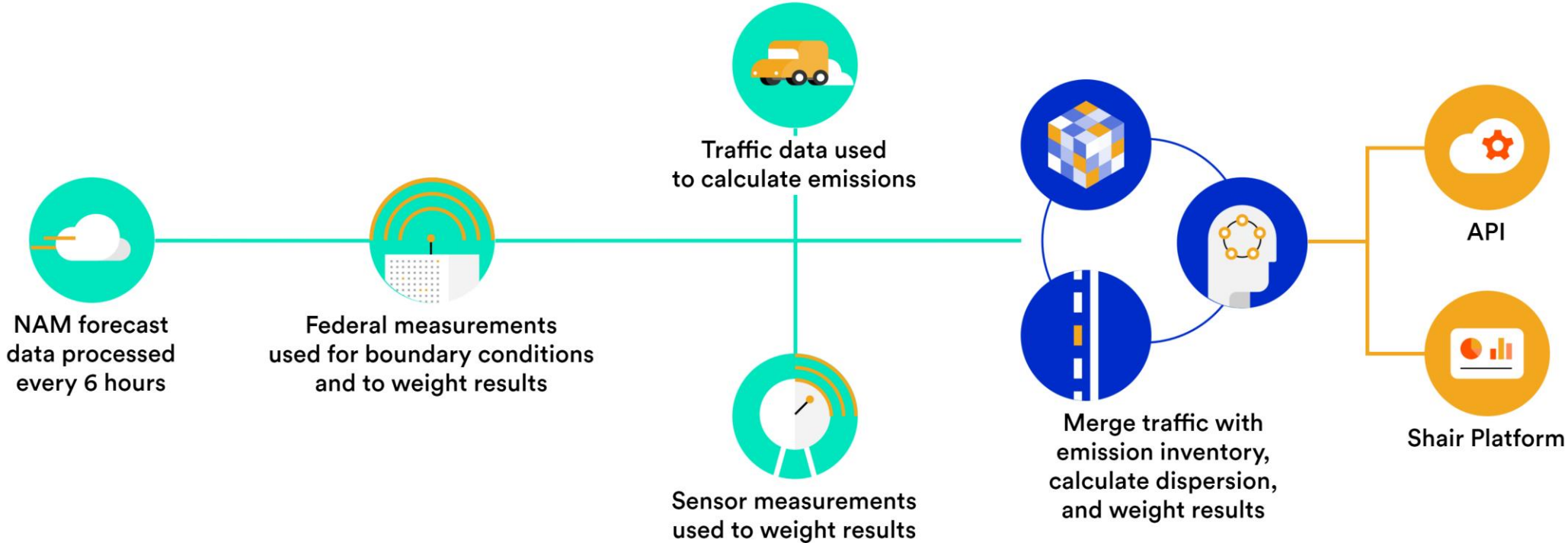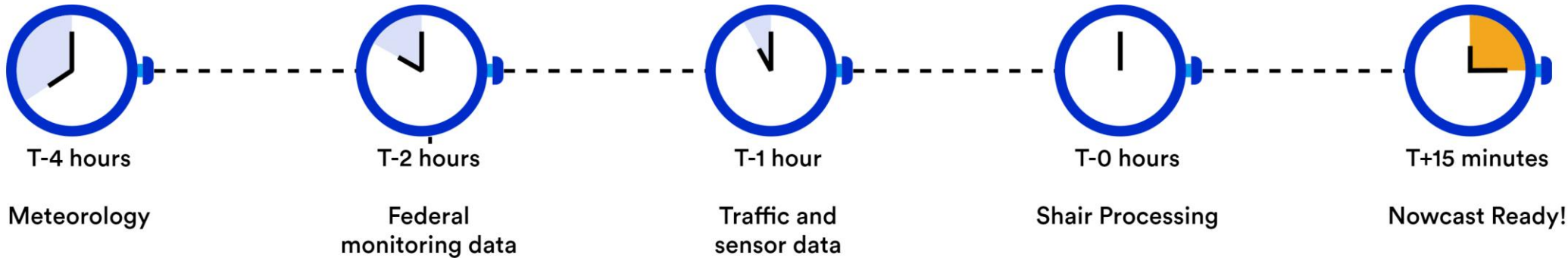- Sited in greenways, parks, and near high traffic roadways, and industrial centers
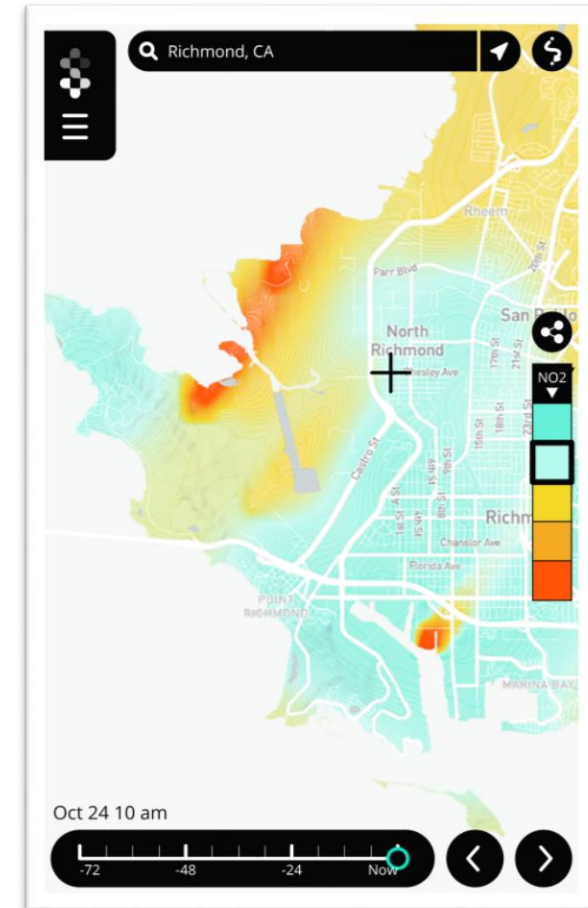

Groundwork Richmond Air Rangers

Ramboll Shair

Activity data

Observational data

Meteorological data

Realtime traffic data

Learning from measurements

CAMx multi-scale photochemical model

Shairstreet local-scale street model

Sensor data

Government monitoring data

Realtime and historical air quality maps

APIs

Shair platform

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Ramboll Shair Nowcast Data Timing

T-4 hours	T-2 hours	T-1 hour	T-0 hours	T+15 minutes
Meteorology	Federal monitoring data	Traffic and sensor data	Shair Processing	Nowcast Ready!

NAM forecast data processed every 6 hours

Federal measurements used for boundary conditions and to weight results

Traffic data used to calculate emissions

Sensor measurements used to weight results

Merge traffic with emission inventory, calculate dispersion, and weight results
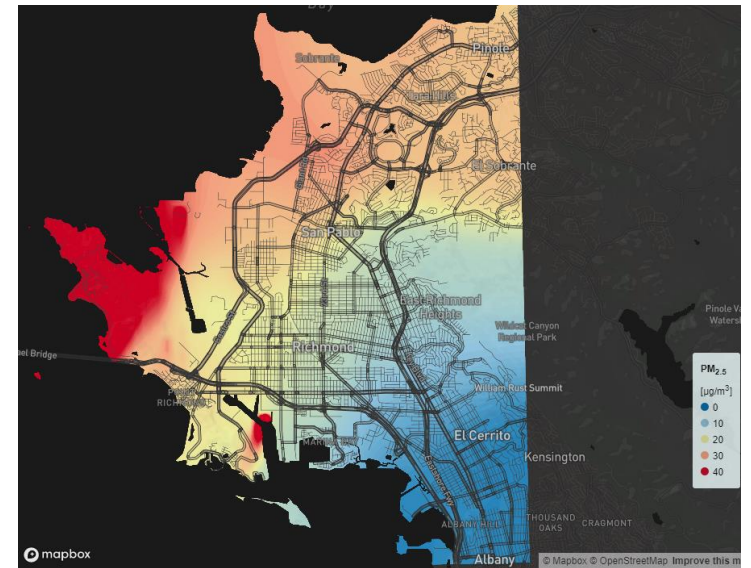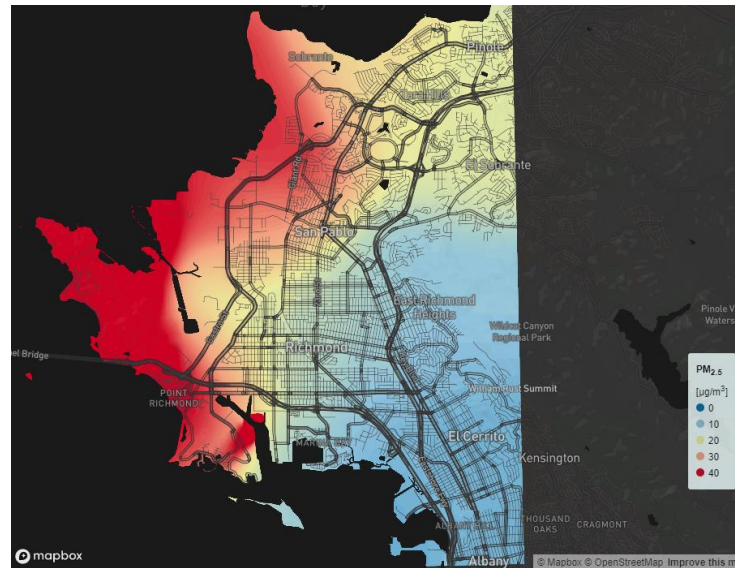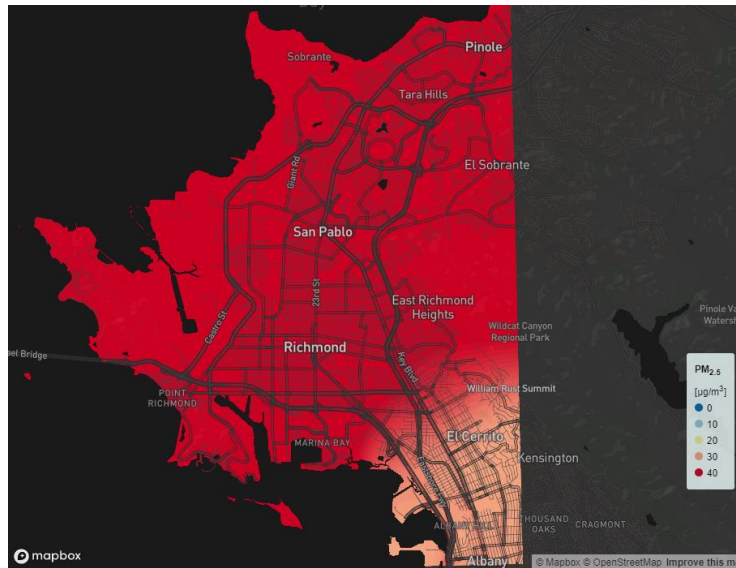
API

Shair Platform

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COMMUNICATING RESULTS

Web/phone app for Richmond is being developed

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WHERE CAN DATA-DRIVEN MODELS ADD VALUE THAT FENCELINE SYSTEMS MAY MISS?

- Spatial variation affecting people where they live and spend time

SHAIR OUTPUT WILL BE USED BY STAKEHOLDERS

Groundwork Richmond

- Targeted tree planting as an air pollution intervention

City of Richmond

- Integrate hourly Shair output into the City's web data dashboard
- Investigate air quality data-driven land use planning activities
- Communicate information to the public in near-realtime

Richmond citizens

- Engage with their environment
- Plan healthier outdoor activities
- Take precautionary actions during localized pollution events

**Richmond-San Pablo Community Air Monitoring Steering Committee**

- Identify major emissions sources
- Inform their official Community Emissions Reduction Plan (December 2020)

Source Allocation?

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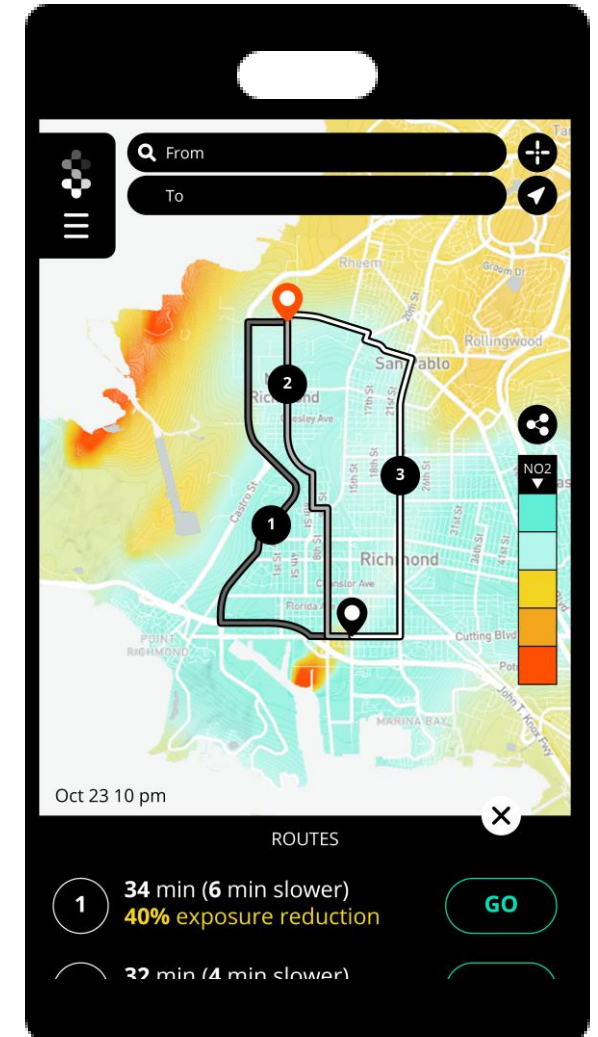
HOW CAN SOURCE ALLOCATION BE MOST EFFECTIVELY USED?

- Continuous feedback and comparison of model and measurement every hour helps us learn where model and measurement consistently disagree, pinpointing hotspots we don't know exist or errors in our emissions inventory so we can improve source allocation over time

- Used by:
  - Community?
  - City?
  - District?

Emissions Inventories → **Air Quality Modelling** ↔ **Air Quality Monitoring** →

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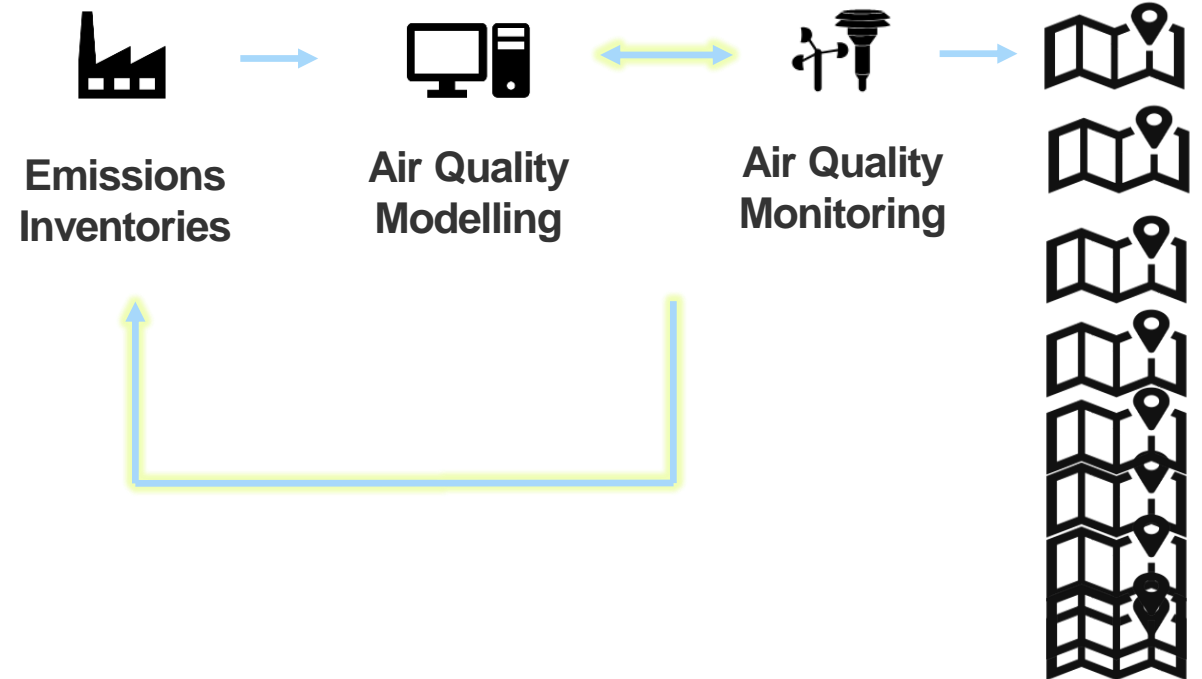
THANK YOU

Shari Beth Libicki, PhD + the Shair Team
slibicki@Ramboll.com