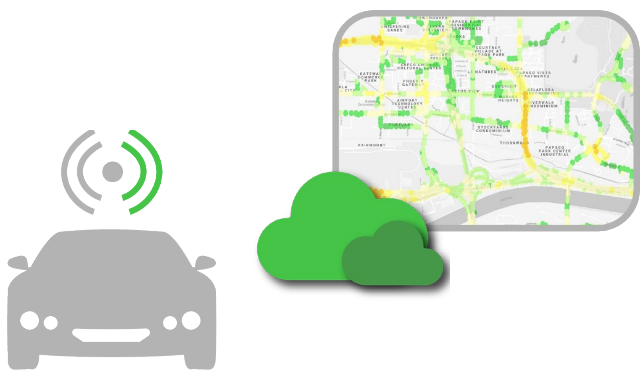
AIRLIB

Improved vehicle cabin air quality by control of air recirculation using spatiotemporally-resolved interactive map



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Key facts

In-cabin pollution often reaches toxic levels

Traffic pollution is responsible for millions of deaths each year worldwide

Automotive Air Quality Sensor have been used for >30 years

(~ 8 million/yr)

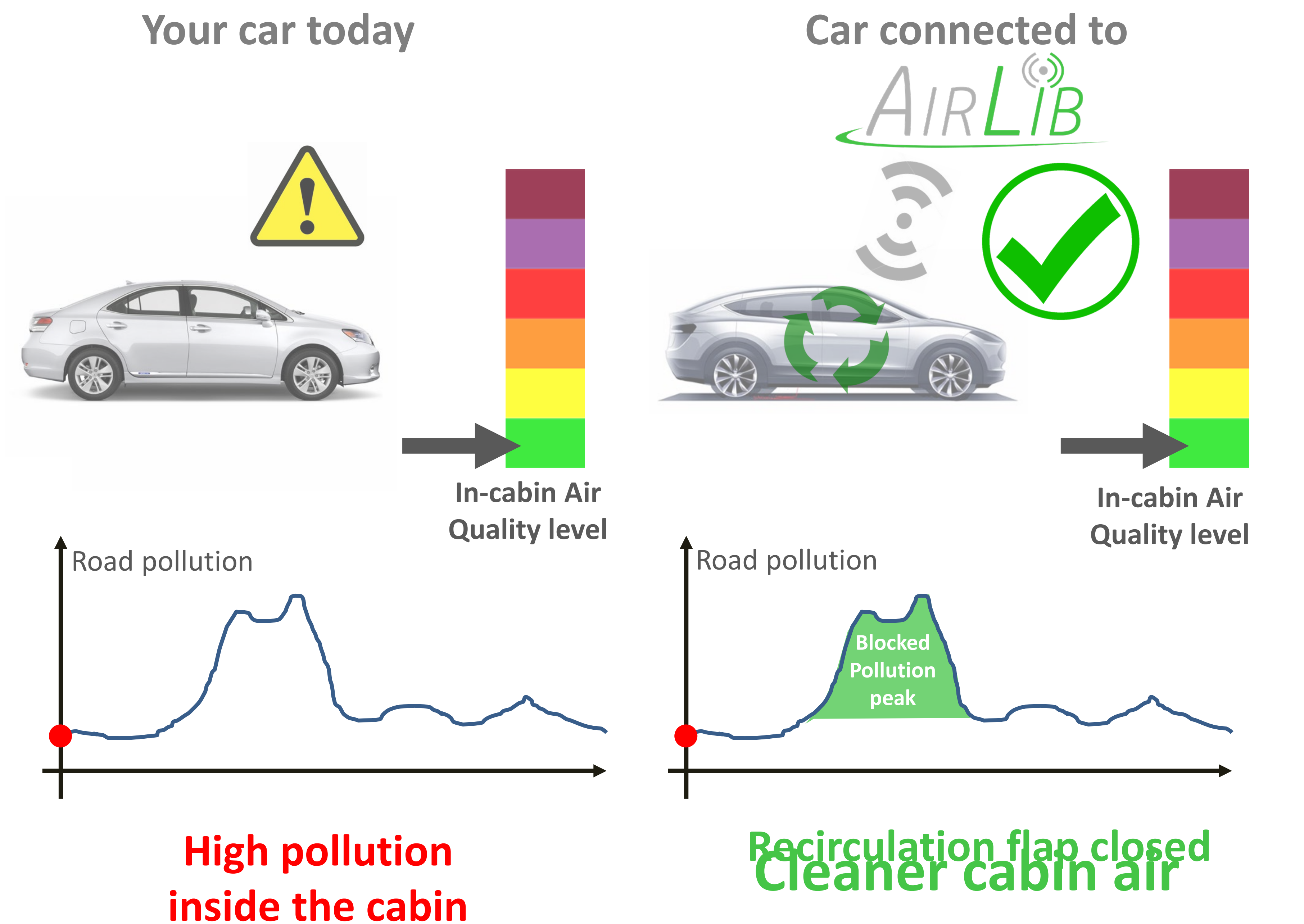
Managing the recirculation flap is a must

but is reserved to high-end cars

Purpose of the study

Evaluate in-cabin pollution reduction
with map-based flap control

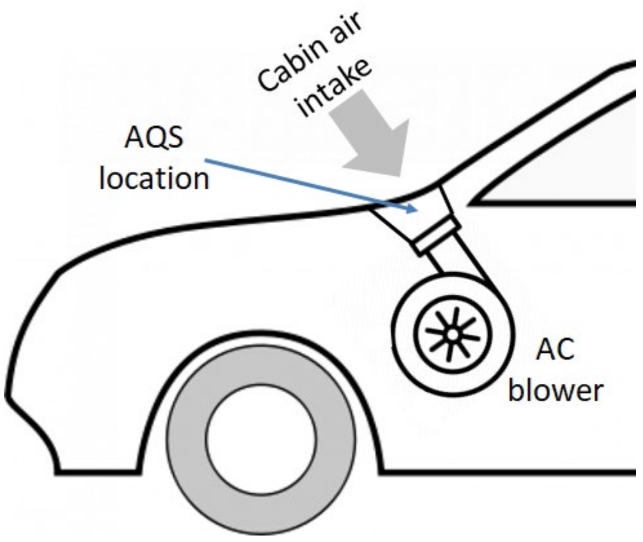
Why ➔ Could be implemented on 100% of connected cars


Your car today
Car connected to
AIRLIB
In-cabin Air Quality level
In-cabin Air Quality level
Road pollution
Road pollution
Blocked Pollution peak
High pollution inside the cabin
Recirculation flap closed
Cleaner cabin air

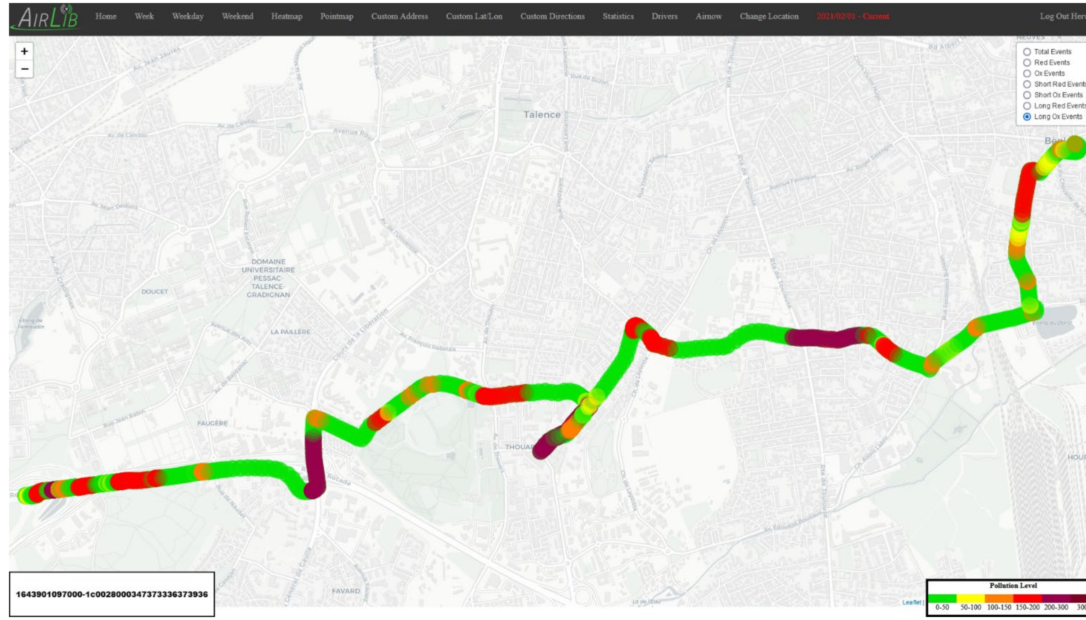
step 1: Data collection

Collection of data from Automotive Air Quality Sensors on-board city cars

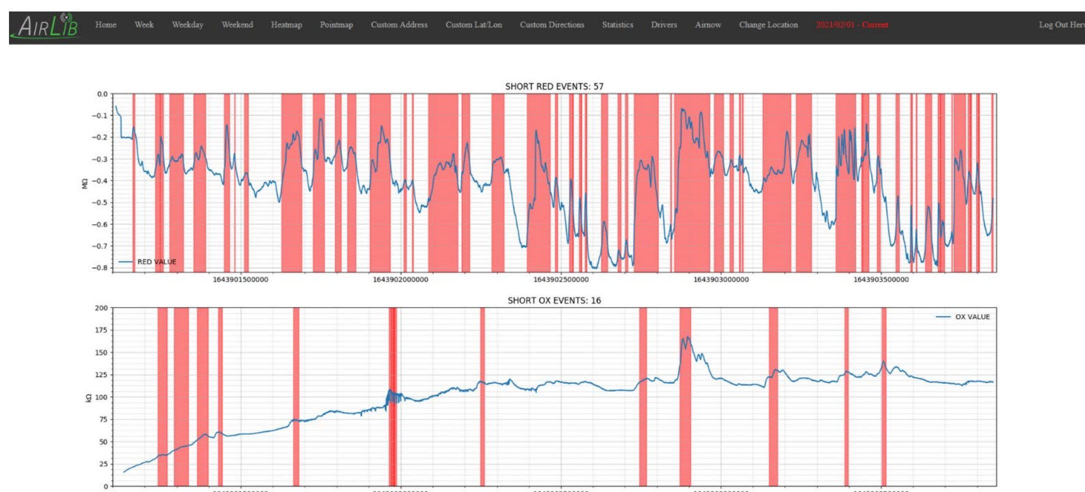
- GPS / GSM
- Metal oxide dual sensor
- CO-VOC & NO_2 values every 200ms
- European major city ~ 1 m inhab.
- Metro area ~ 500km^2, City center area 50 km^2
- 40 cars / 9 months / > 10k trips



Trip path example



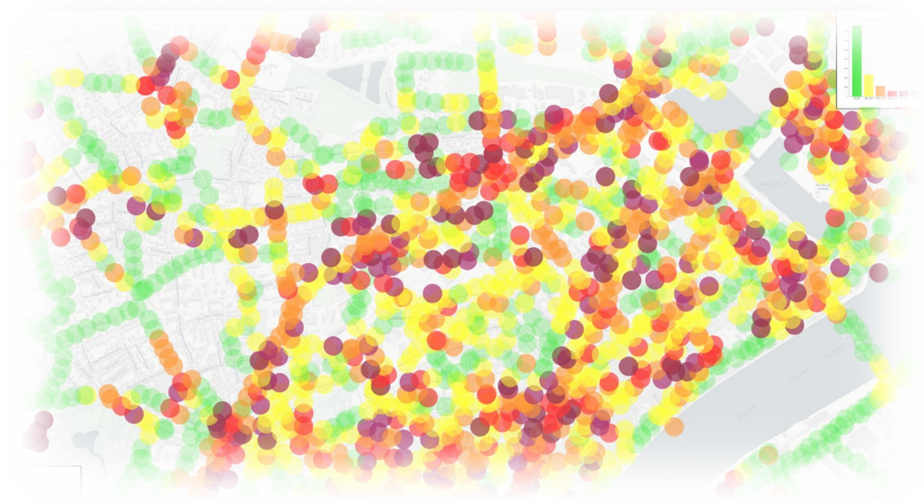
Sensor signals example



step 2: Air Quality maps

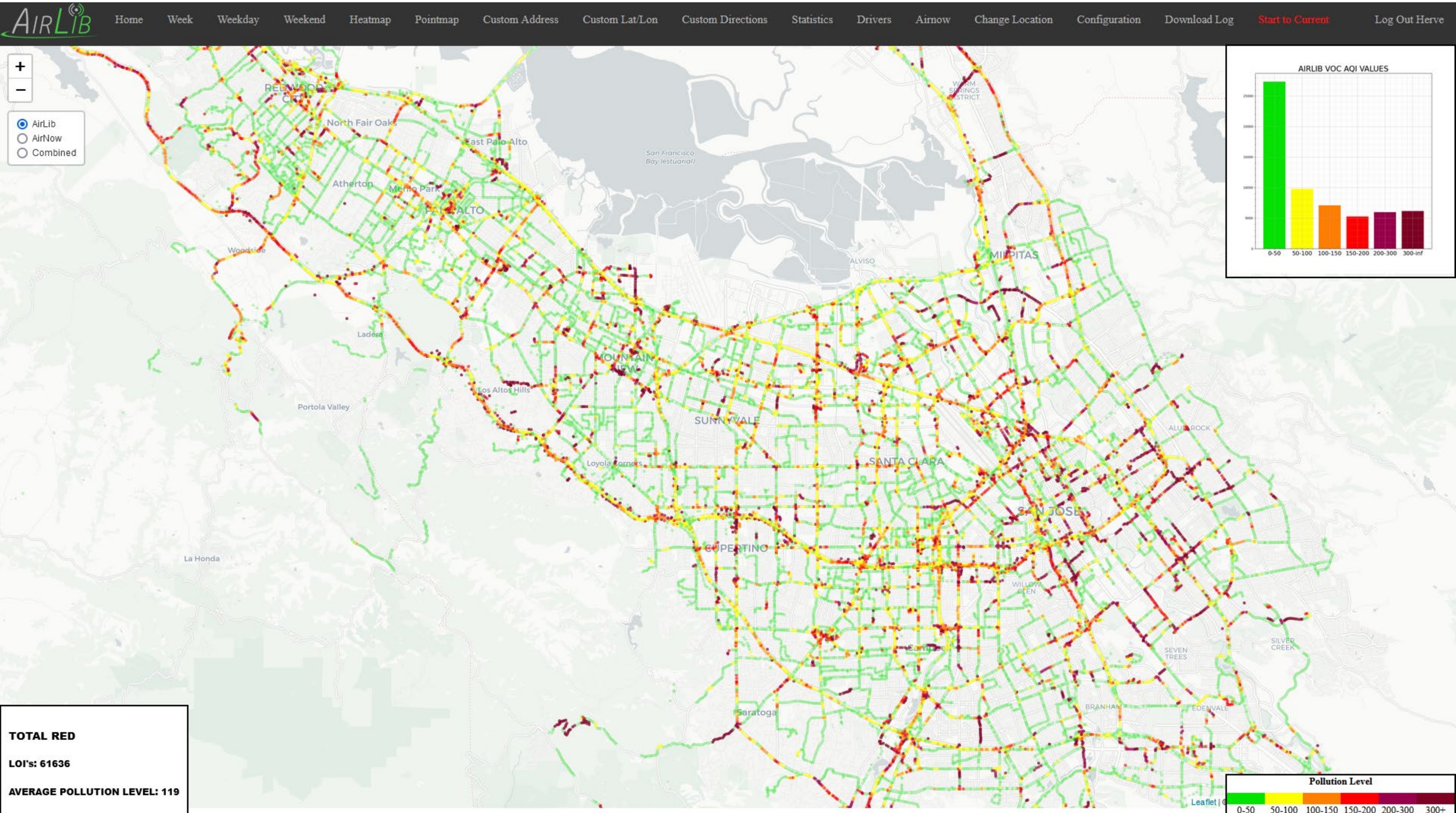
Calculation of high-resolution air quality maps using 10k trips data

- Approx 50 meter pitch
- ~ 32k gridpoints
- Based on detected “pollution events”
- Study done on CO/VOC only
- Average coverage ~40 times
- One Air Quality index per gridpoint



Map examples

Bay area



Map examples

Paris, France

step 3: Flap control

Recirculation flap control algorithm based on map indices

- Closes if pollution ahead of car is high
- Reopens if pollution ahead is lower
- Minimum time between flap movement 60s
- Maximum close time 450s

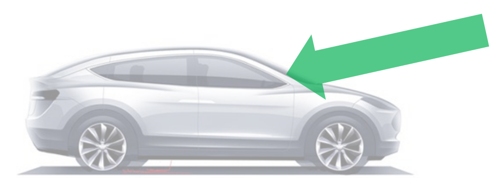
➔ Applied to trips as if the car received the flap recommendations real-time

step 4: Calculation of in-cabin pollution

"Dilution" of the in-cabin air with external air when the flap is open

Assumptions:

- AC blower speed is constant
- The car is airtight
- The flap is either 100% closed or 100% open
- The initial in-cabin pollution is zero
- In-cabin air "dilution" varies with the ACH
  (Air Change per Hour)



Flap open → dilution by external air

Flap closed → no dilution

Total Passenger Exposure over trip = $\sum$ in-cabin pollution indices

step 5: Comparisons

The Total Passenger Exposures were calculated for a set of 50 trips

- Case 1: map-based flap control
- Case 2: flap always open
- Case 3: periodic flap closures with same overall closed time as case 1
- 3 different Air Changes per Hour for each case: 12/h, 30/h, 40/h

Results

Exposure reduction vs open flap case

	Passenger exposure reduction MAP-BASED FLAP CONTROL
Average of 50 trips with ACH = 12/h	56%
Average of 50 trips with ACH = 30/h	45%
Average of 50 trips with ACH = 40/h	42%

- 42% to 56% exposure reduction vs open flap
- Reduction goes down when blower speed goes up (higher ACH)

Results

Comparison to periodic flap closures

	Passenger exposure reduction MAP-BASED FLAP CONTROL	Passenger exposure reduction PERIODIC CLOSED FLAP 66% of time
Average of 50 trips with ACH = 12/h	56%	26%
Average of 50 trips with ACH = 30/h	45%	9%
Average of 50 trips with ACH = 40/h	42%	5%

% reduction vs open flap case

- Improvement vs **<u>same closed time</u>** without map control is significant
- The delta goes up when the blower speed goes up

Conclusion

Map-based flap control improves in-cabin air quality significantly

Purely software solution

Deployable worldwide

Limited investment with important societal health benefits

Next steps

Requires data collection by cars with on-board AQS

AQS data from 100k cars could bring better air to > 200 million car users

A single OEM could enable it!

And make it available to all OEMs …

… for example via Android automotive

THANK YOU !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LAVEEN VILLAGE
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