Health Impact Assessment of per Ton of Air Toxics and Its Regulatory Applications

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Motivation

- California Air Toxics Assessment (CATA)
  - High resolution statewide assessment - bridges the scale between national (AirToxScreen/NATA) and regional efforts (e.g., MATES).
  - Support CARB's Air Toxics Programs (AB1807, AB2588, AB617) and EJ programs.
  - Triennial modeling to support trend analysis: 2012 and 2017 completed, 2021 in-progress.
- Health risk assessment is typically required during the rulemaking process.
- Incidence-Per-Ton (IPT) is a useful metric to compare potential health benefits from emission reductions in different regions and between emission sectors.

CATA modeling framework

- 2012 and **2017**
- Exposure and cancer risk of 12 air toxics modeled by two air quality models:
  - CALPUFF**: diesel PM**, arsenic, cadmium, nickel, lead, hex. chromium.
  - CMAQ: benzene, 1,3-butadiene, formaldehyde, acetaldehyde, perchlorobenzene, p-dichloroethylene.
- 2-km gridded meteorology from WRF
- **30+ emission source categories** (e.g., on-road mobile, locomotives, TRU, OGV, agriculture, stationary point) in CALPUFF

Emission source sectors for DPM and metals

Diesel particulate matter (DPM)

Heavy metals

VOCs

On-road Mobile (road-following line sources)

Trucks, passenger cars, etc.

Off-Road Mobile (corridors or 1km x 1km gridded)

- OGV (transit, maneuver, at-berth), CHE, CHC
- Locomotives
- Aircraft
- TRUs

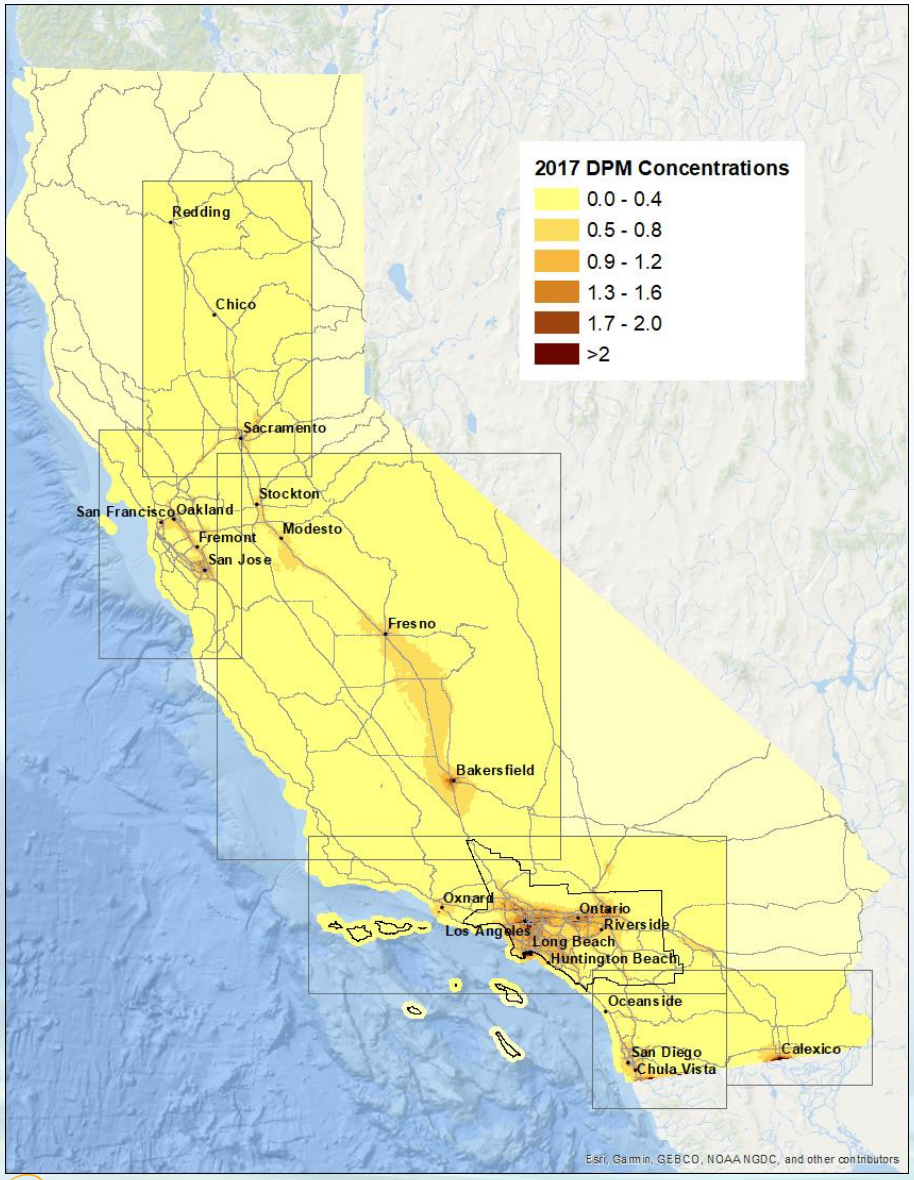
Area Sources (1km x 1km)

- Agricultural activities
- Construction
- Ag and Rx burning, wildfires, charbroil, etc.
- Other aggregated sources (pumps, back-up generators, forklifts, etc.)

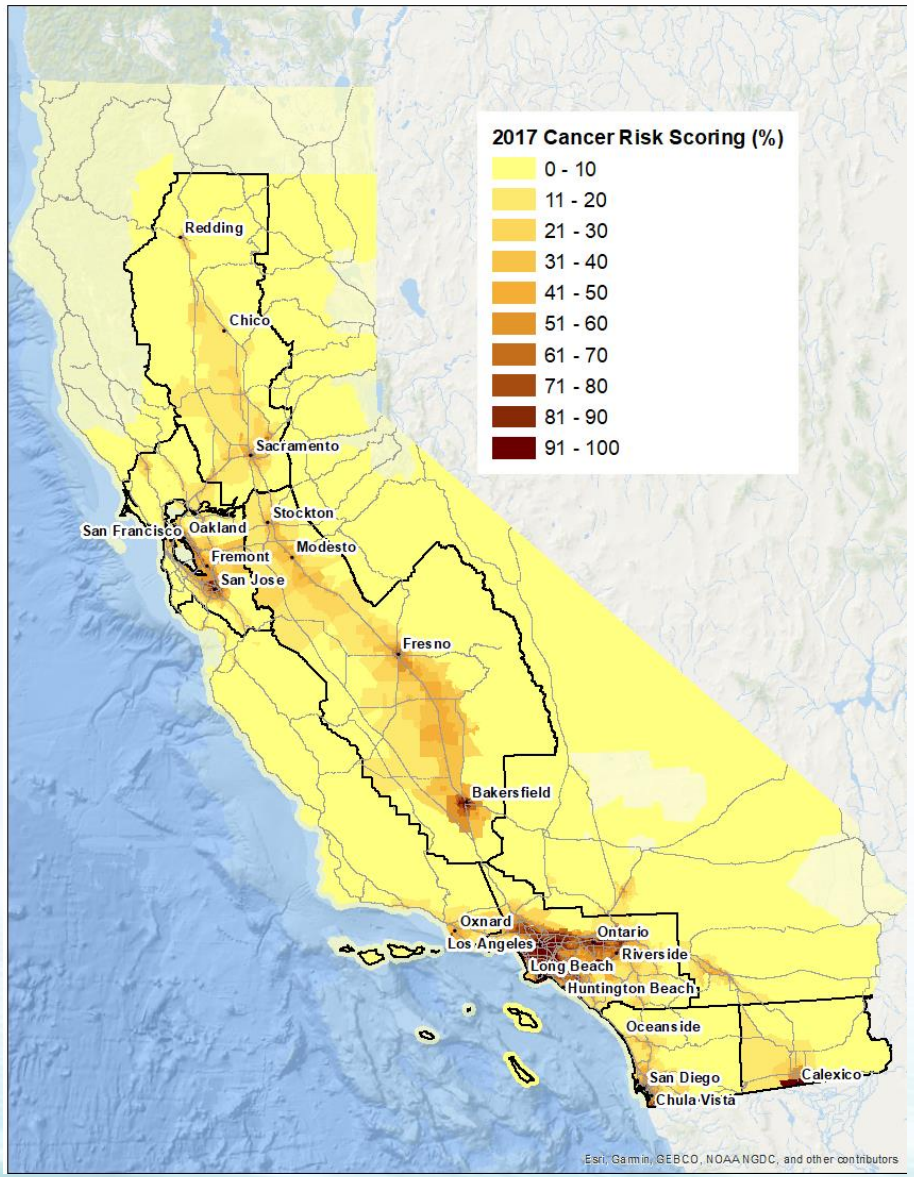
Stationary Sources

- refineries, power generation plants, chemical processing plants

Model results



OEHHA risk assessment guidelines



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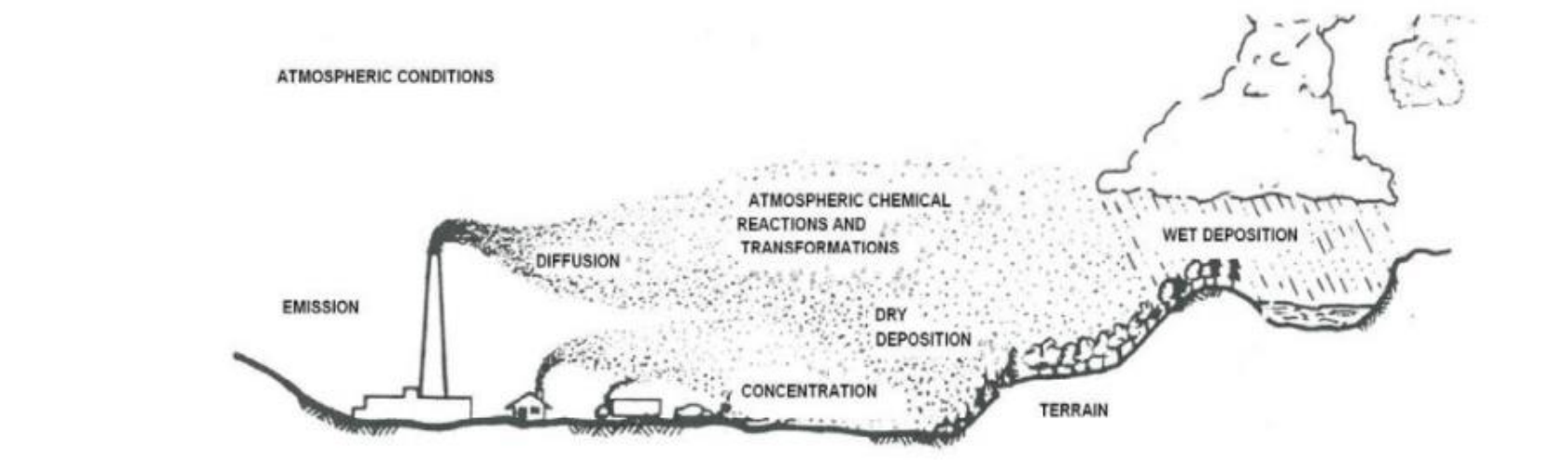
Incidence-Per-Ton (IPT)

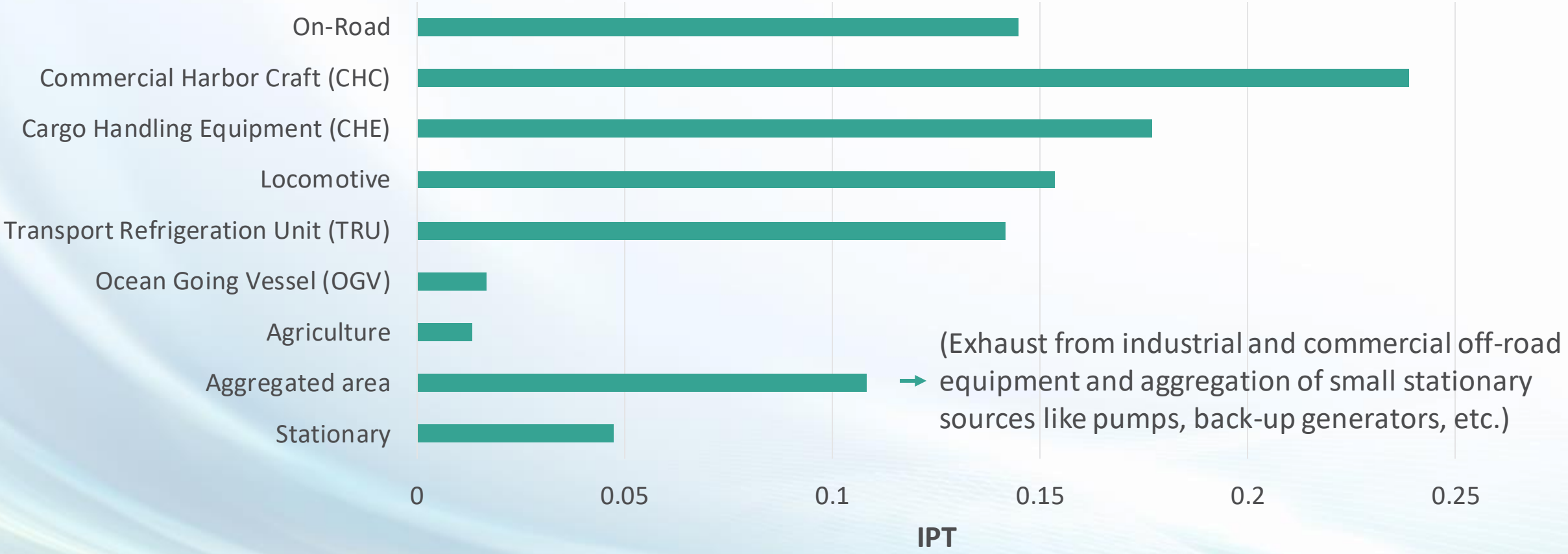
$$\text{IPT} = \frac{Incidence\ (Pop\text{–}weighted\ cancer\ risk\ (per\ million)\ or\ cancer\ burden)}{Total\ emissions\ (tons\ per\ year)}$$

A metric that can quantify the complex relationship between emissions and its health impact. By providing a **quick estimate of the health benefit that would result from an emission control measure for a particular region and source type**, it can be used for comparing scenarios, or estimating future projections.



https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/primer-bc-aq-dispersion-modelling-guideline.pdf

2017 Statewide DPM IPT



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Large variability across source types and regions

IPT generally higher for on-road and inland off-road mobile sources.

Smaller domains, more localized impact.

Inland canals

	Bay Area	Sac Valley	San Joaquin Valley	South Coast	San Diego	Imperial
On-Road	0.78	0.61	0.4	0.54	1.2	1.98
CHC	0.33	0.34	0.29	0.94	1.49	4.74
CHE	0.46	0.53	0.55	0.39	0.98	4.62
Locomotive	0.78	0.63	0.43	0.56	1.01	0.31
TRU	0.52	0.58	0.41	0.49	1.04	4.85
OGV Anchorage	0.41	0.0	0.0	0.29	0.0	0.0
OGV At-Berth	0.18	0.26	0.0	0.22	0.6	0.0
OGV Maneuver	0.21	0.32	0.31	0.3	0.66	0.0
OGV Transit+military	0.12	0.25	0.22	0.11	0.24	0.0
Agriculture	0.08	0.11	0.1	0.14	0.17	0.43
Aggregated Area	0.56	0.37	0.2	0.4	0.74	2.78
Stationary	0.23	0.41	0.09	0.12	0.22	0.05

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Example of regulatory application

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$$\text{IPT} = \frac{Cancer\ Risk\ (per\ million)}{Total\ emissions\ (tons\ per\ year)}$$

Scenario: an OGV-at berth regulation in the County of San Diego proposes a DPM emission reduction of 10 tons per year.

=> The resulting cancer risk reductions at the County level would be about 6 chances per million people.

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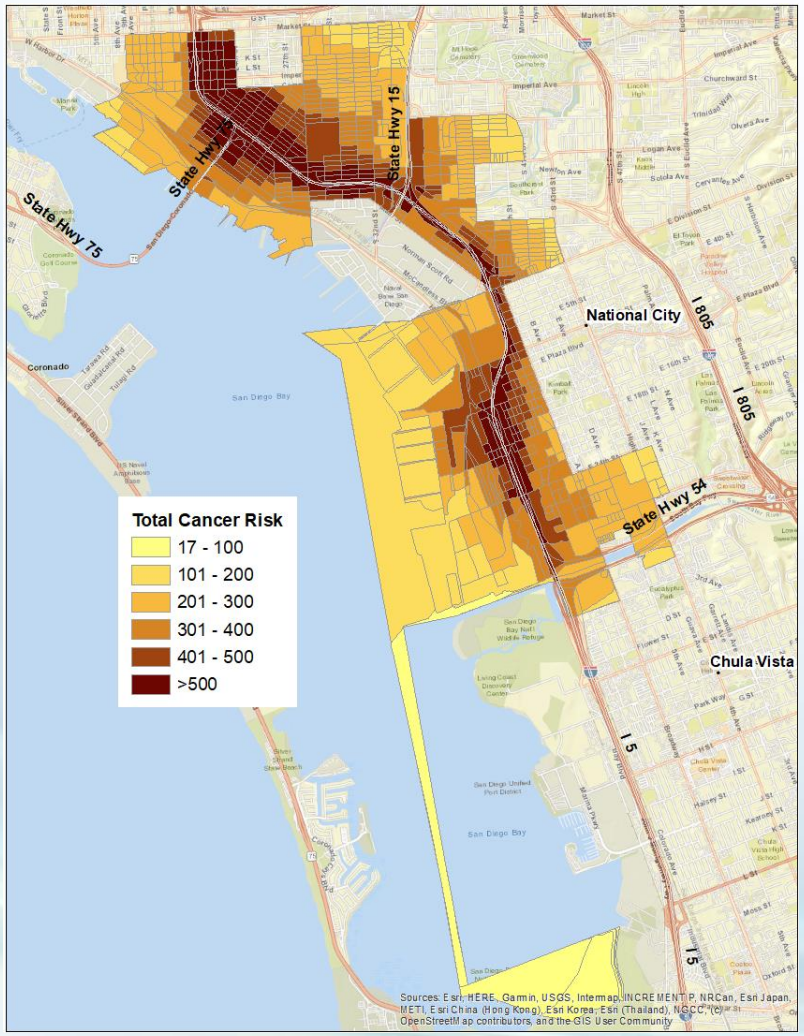
Example of Community-level Application



SD Basin-wide, all emissions

Category	IPT
Locomotive	1.01
CHE	0.98
On-Road	1.2
OGV (at berth)	0.6
OGV-maneuver	0.66

Portside Local Emissions Only

Category	2017 DPM Risk (cases per million)	2017 DPM emissions (TPY)	IPT
Locomotive	11.9	0.29	41.0
CHE	1.0	0.06	16.7
On-Road	137.1	3.71	37.0
OGV (at berth)	10.7	3.18	3.4
OGV-maneuver	0.03	0.01	3.0

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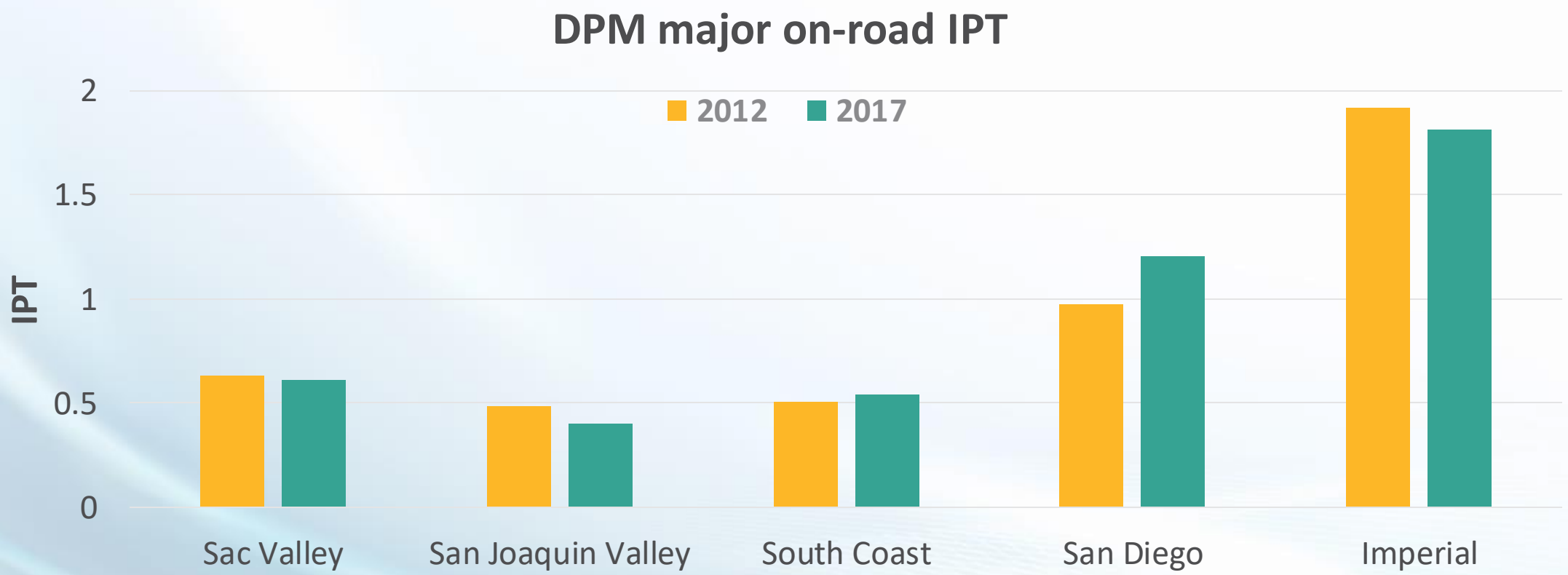
Change in time: 2012 v.s. 2017



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Conclusions

- CATA is an ongoing initiative at CARB designed to assess the exposure and health risks from major air toxics on a triennial basis in California.
- From CATA results, IPT values can be calculated. It's a metric that simplifies the complex and non-linear relationship between emissions and health impact on population.
- IPT values are best used as relative values. It can be used to compare the effect of regulations, e.g., where can we reduce emissions to achieve the most effective risk reductions. It can also help predict future health benefit from a regulation or policy.
- IPT values can differ significantly across scale, regions, and emission source type. For community-level applications, e.g., to inform Community Emission Reduction Plans (CERPs) under AB 617, one should use the results at that scale and location.
- On-road DPM IPT values remained similar from 2012 to 2017.