



Air pollution exposure studies in São Paulo: Insights for Smart cities

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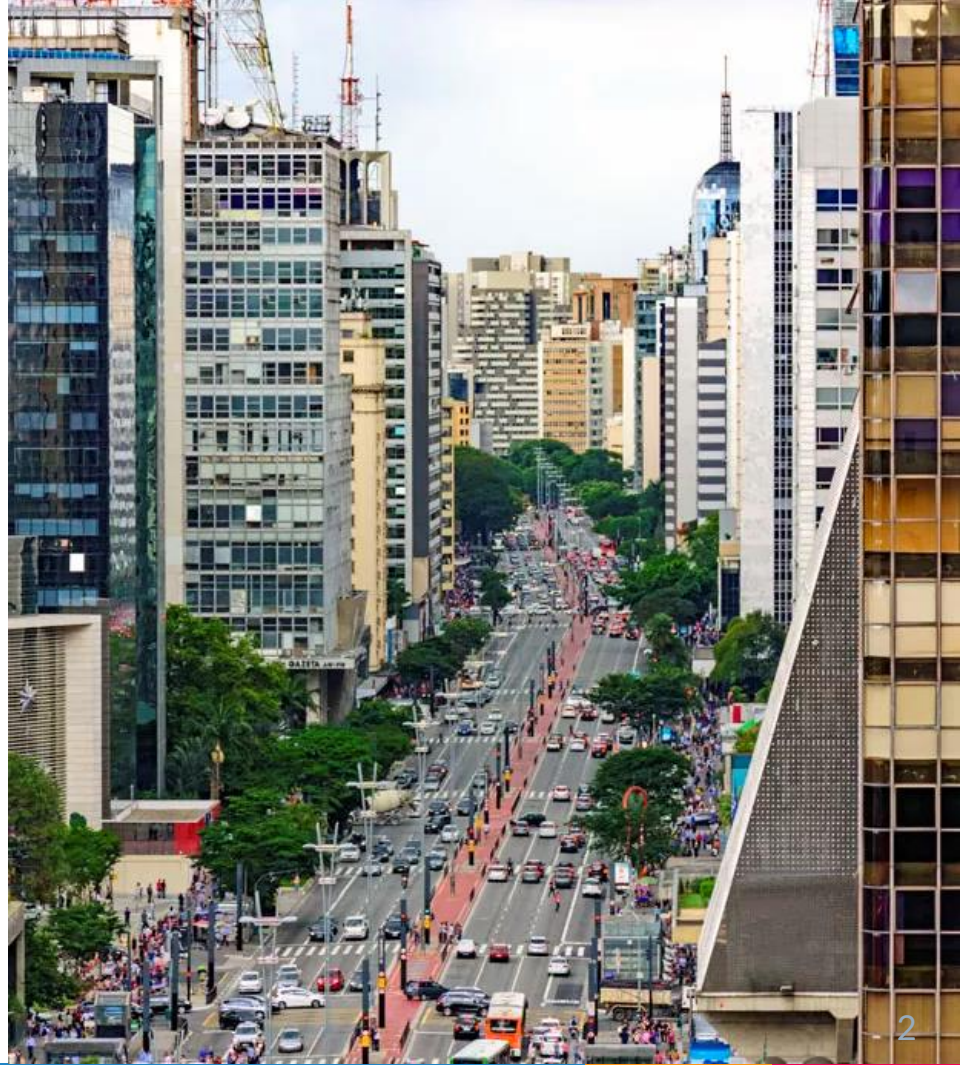
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School of Public Health
Department of Environmental Health



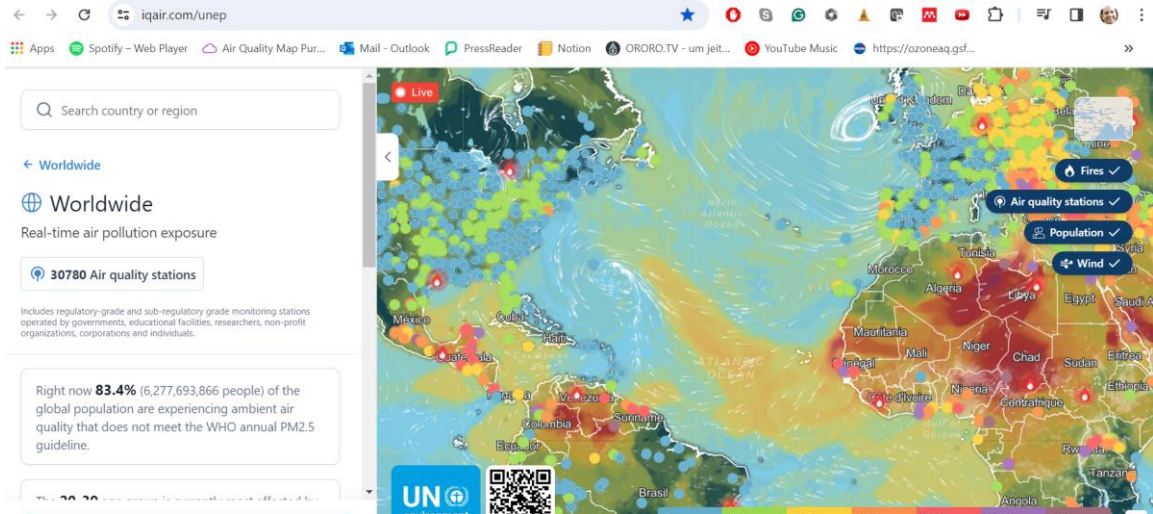
A FACULDADE DE SAÚDE PÚBLICA APOIA OS
OBJETIVOS DE DESENVOLVIMENTO SUSTENTÁVEL

Do you know how is
the air quality in
your city?

<https://s2.glbimg.com/d4VRvKCAY7IHVzvezugYYfSEmV0=/smart/e.glbimg.com/og/ed/f/original/2017/07/19/thinkstockphotos-637800520-cortada.jpg>



Right now more than 80% of global population breath air considered not safe by WHO



Choosing the route from your home to work based on air quality conditions

Daily route suggestion based on traffic Information + Air quality information

- Waze, Google Maps...



Is this a dream or are smart cities towards reaching this?



Review

The rise of low-cost sensing for managing air pollution in cities

[Prashant Kumar](#)^{a, b}, [Lidia Morawska](#)^c, [Claudio Martani](#)^d, [George Biskos](#)^{e, f, g},
[Marina Neophytou](#)^h, [Silvana Di Sabatino](#)ⁱ, [Margaret Bell](#)^j, [Leslie Norford](#)^k, [Rex Britter](#)^l

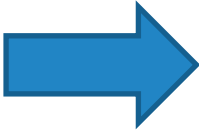


In-car particulate matter exposure

- **Project CArE-Cities: Clean Air Engineering for Cities**
 - Funded by Research England under the Global Challenges Research Fund (GCRF)
 - PI: Prof Prashant Kumar – University of Surrey (UK)
 - Ten participating countries
 - Brazilian team: Fatima Andrade, Thiago Nogueira and Veronika Brand



In-car particulate matter exposure



In-car particulate matter (PM) exposure

- PM exposure during off-peak hours was 91% and 40% less than morning and evening peak hours.
- PM concentrations were highest during windows-open, followed by windows-closed + fan-on and recirculation.

Science of the Total Environment 750 (2021) 141395

Contents lists available at ScienceDirect

 Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv



In-car particulate matter exposure across ten global cities

Prashant Kumar^{a,b,*}, Sarkawt Hama^a, Thiago Nogueira^{a,c,d}, Rana Alaa Abbass^a, Veronika S. Brand^{a,d}, Maria de Fatima Andrade^d, Araya Asfaw^e, Kosar Hama Aziz^f, Shi-jie Cao^{a,g,h}, Ahmed El-Gendyⁱ, Shariful Islam^j, Farah Jeba^j, Mukesh Khare^k, Simon Henry Mamuya^l, Jenny Martinez^{a,m}, Ming-Rui Meng^h, Lidia Morawska^{a,n}, Adamson S. Muula^o, S.M. Shiva Nagendra^p, Aiwerasia Vera Ngowi^l, Khalid Omer^f, Yris Olaya^m, Philip Osano^q, Abdus Salam^j

Environment International 155 (2021) 106688

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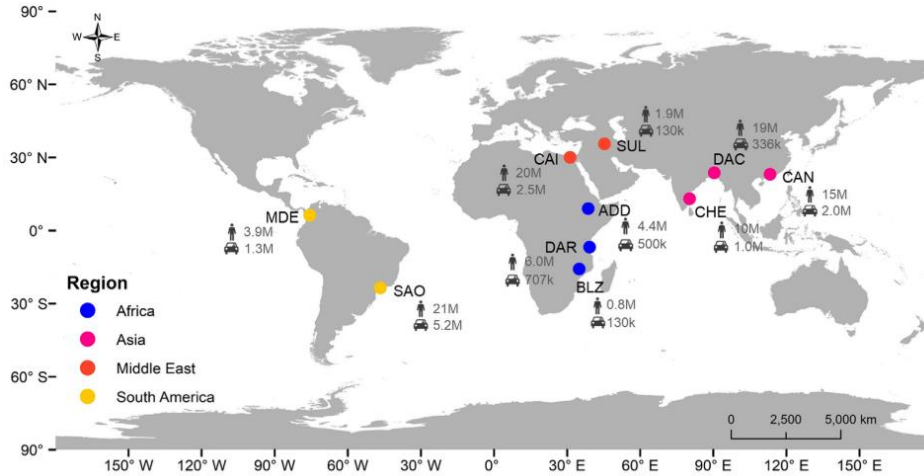
journal homepage: www.elsevier.com/locate/envint



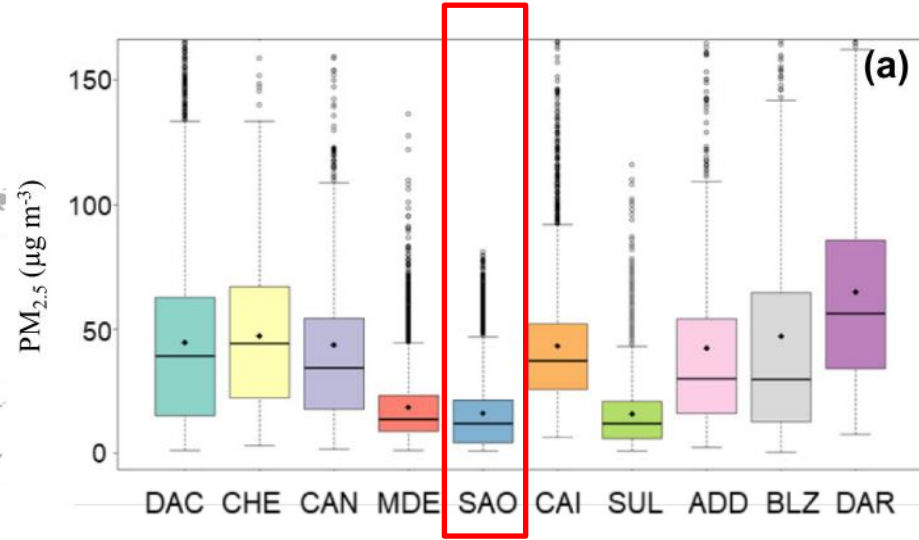
Potential health risks due to in-car aerosol exposure across ten global cities

Prashant Kumar^{a,b,*}, Sarkawt Hama^a, Rana Alaa Abbass^a, Thiago Nogueira^{a,c,d}, Veronika S. Brand^{a,d}, K.V. Abhijith^a, Maria de Fatima Andrade^d, Araya Asfaw^e, Kosar Hama Aziz^f, Shi-jie Cao^{a,g}, Ahmed El-Gendy^h, Mukesh Khareⁱ, Adamson S. Muula^{j,o}, S.M. Shiva Nagendra^k, Aiwerasia Vera Ngowi^l, Khalid Omer^f, Yris Olaya^m, Abdus Salamⁿ

In-car particulate matter exposure



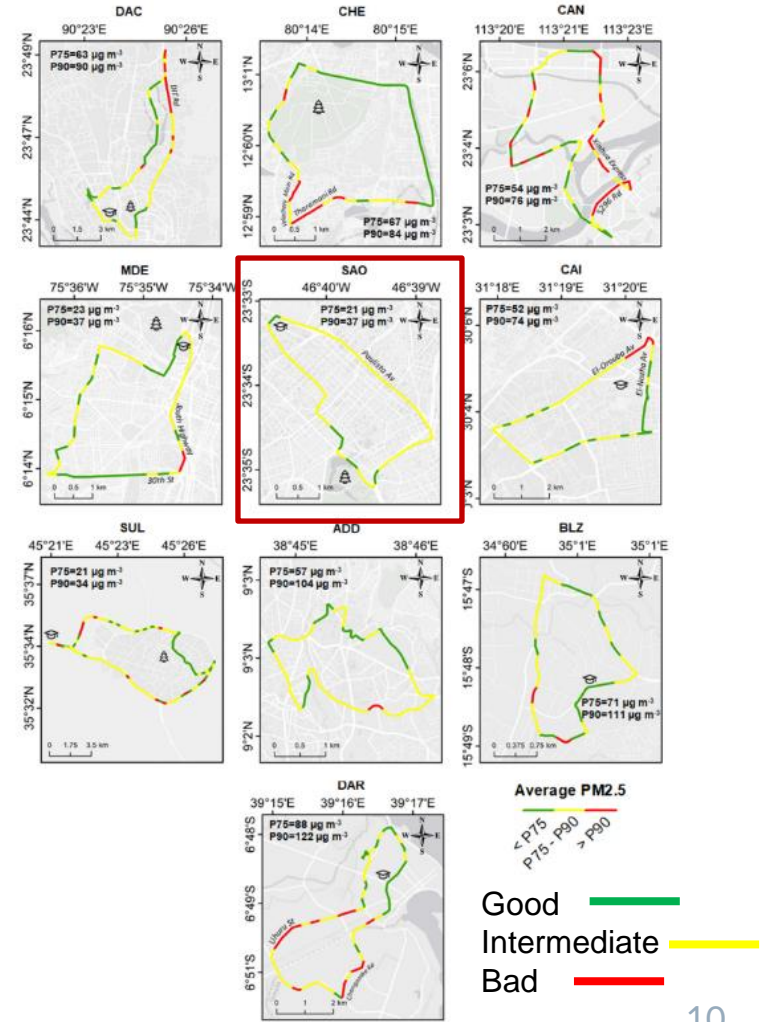
Dhaka (DAC), Chennai (CHE), Guangzhou (CAN), Medellín (MDE), **São Paulo (SAO)**, Cairo (CAI), Sulaymaniyah (SUL), Addis Ababa (ADD), Blantyre (BLZ), and Dar-es-Salaam (DAR)



Boxplot of PM_{2.5} and concentrations (µg m⁻³) measured during all settings and times of the day for the ten cities as denoted by city code.

In-car particulate matter exposure

- Georeferenced dataset helps identify regions with high air pollutants concentration (hotspots)
- High buildings unfavorable to air pollutants dispersion
- Green area help decrease air pollution in Sao Paulo



Kumar, P. et al. Sci. Total Environ. 750, 141395 (2020).
 Kumar, P. et al. Environ. Int. 155, 106688 (2021).

Exposure to air pollutants during commuting in different transport microenvironments in São Paulo

Measurements in-car, bus, subway and bike

- **Project Astrid - accessibility, social justice and transport emission impacts of transit-oriented development strategies**

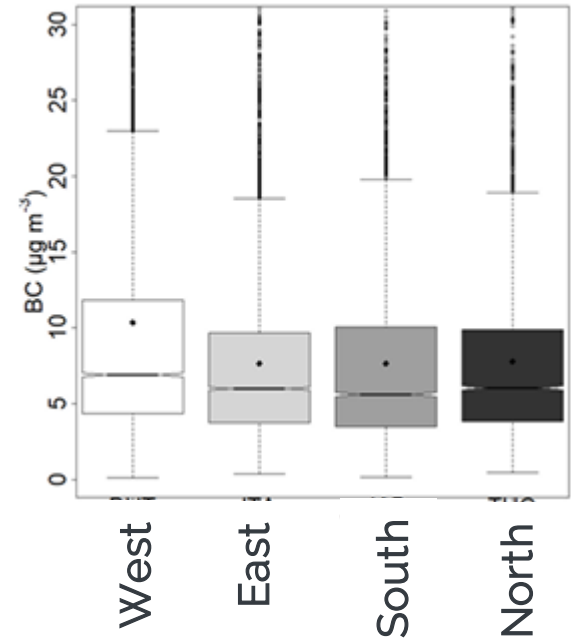
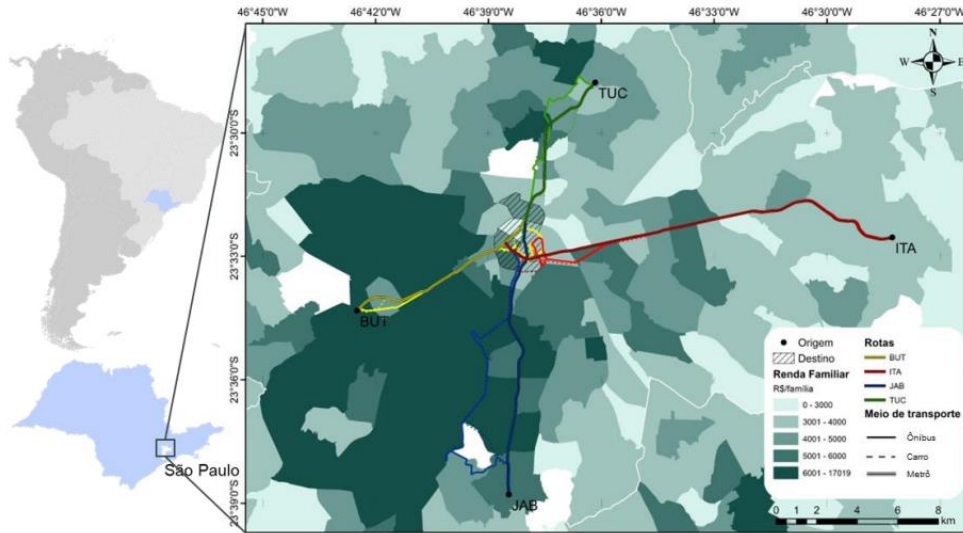


- Funded by Fapesp (Grant # 15/50128-9)
- PI: Prof Fatima Andrade – USP
- Institution abroad: University of Twente and University of Surrey



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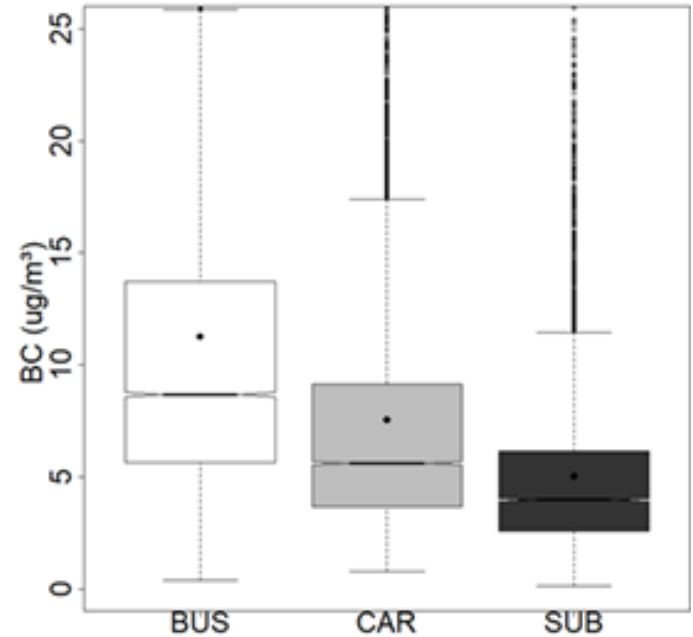
Exposure to air pollutants during commuting in different transport microenvironments in São Paulo



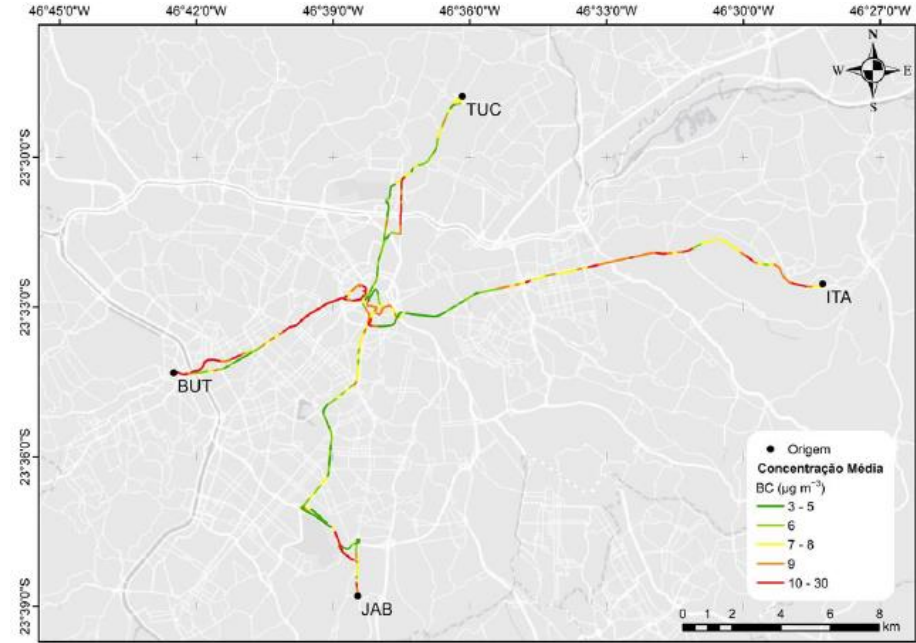
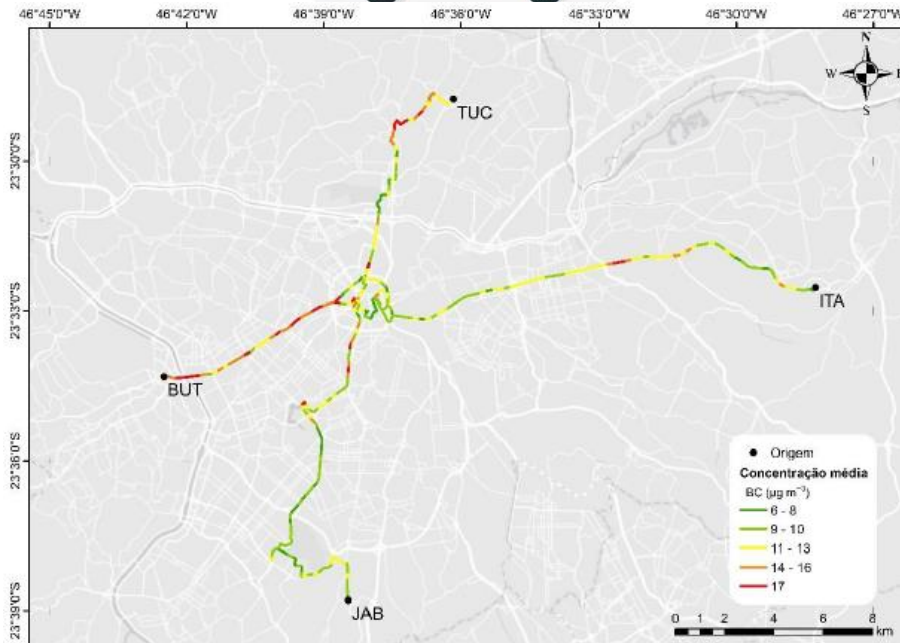
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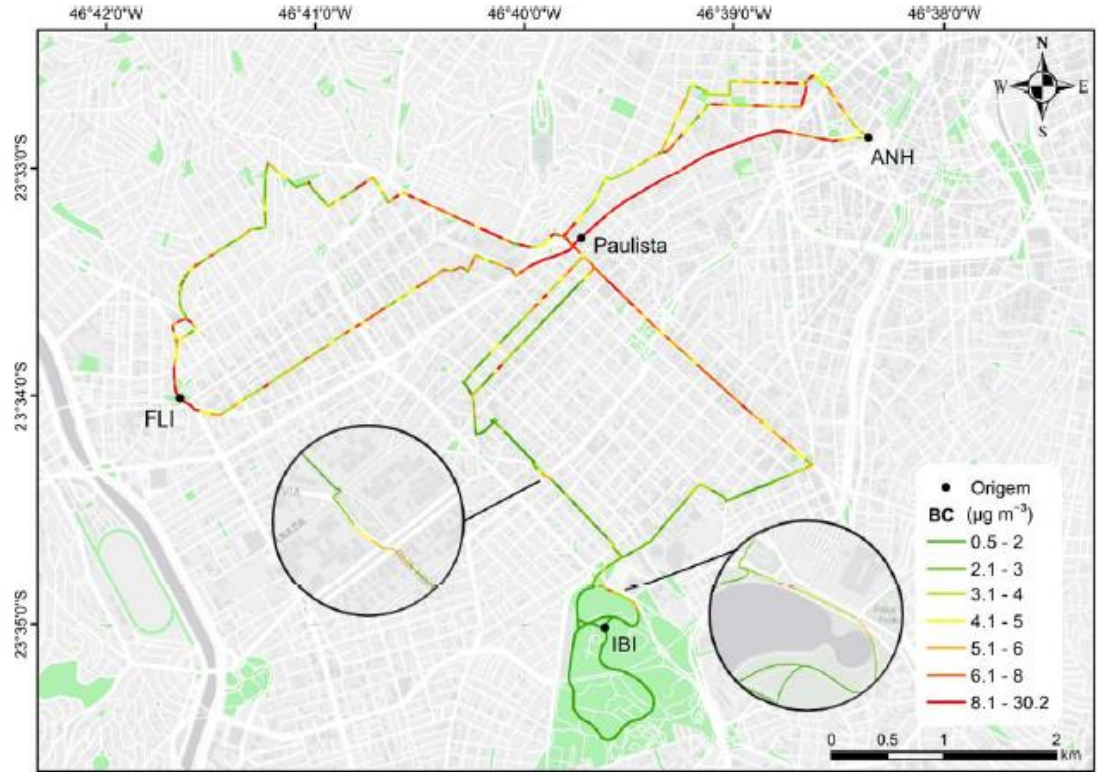
Exposure to air pollutants during commuting in different transport microenvironments in São Paulo



Exposure to air pollutants during commuting in different transport microenvironments in São Paulo



- Busy routes versus quiet routes
- Cycling in green parks reduce exposure to air particles pollution



Final Remarks

- ▶ Low-cost sensors for air pollution monitoring can become important tools for smart cities,
- ▶ real-time data to the population about air pollution conditions
 - street, parks, and inside public transportation (bus, subway, train...)
- ▶ Helping people choose the best daily route to avoid exposure to air pollution



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Acknowledgments

Thank you!

