

Redução das emissões para o atendimento dos padrões de qualidade do ar



Leonardo Hoinaski



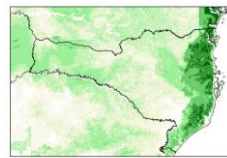
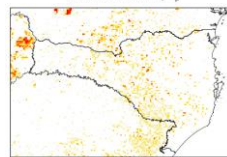
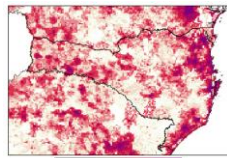
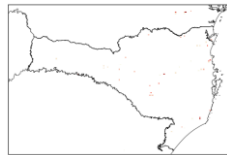
Como cheguei aqui?

- Professor Adjunto do Departamento de Engenharia Sanitária e Ambiental da Universidade Federal de Santa Catarina;
- Estudando poluição do atmosférica desde 2007;
- Interesse por modelagem da qualidade do ar, monitoramento da qualidade do ar e efeitos da poluição no meio ambiente;
- Desenvolvimento de bases de dados.



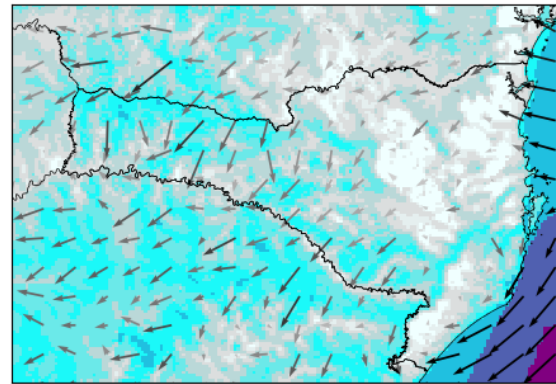
Projeto – Gestão da qualidade do ar em SC

Emissões



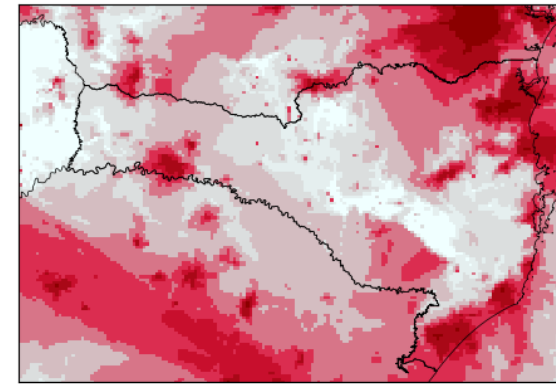
Modelos de emissão

Meteorologia



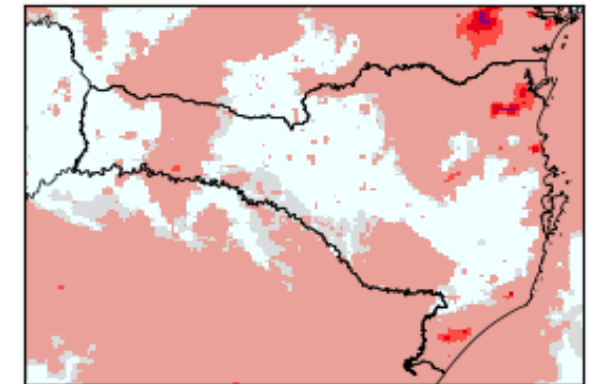
Modelo meteorológico

Qualidade do ar



Modelo de qualidade do ar

Avaliação do impacto



Análise de risco



GOVERNO DE SANTA CATARINA

Secretaria do Desenvolvimento Econômico Sustentável

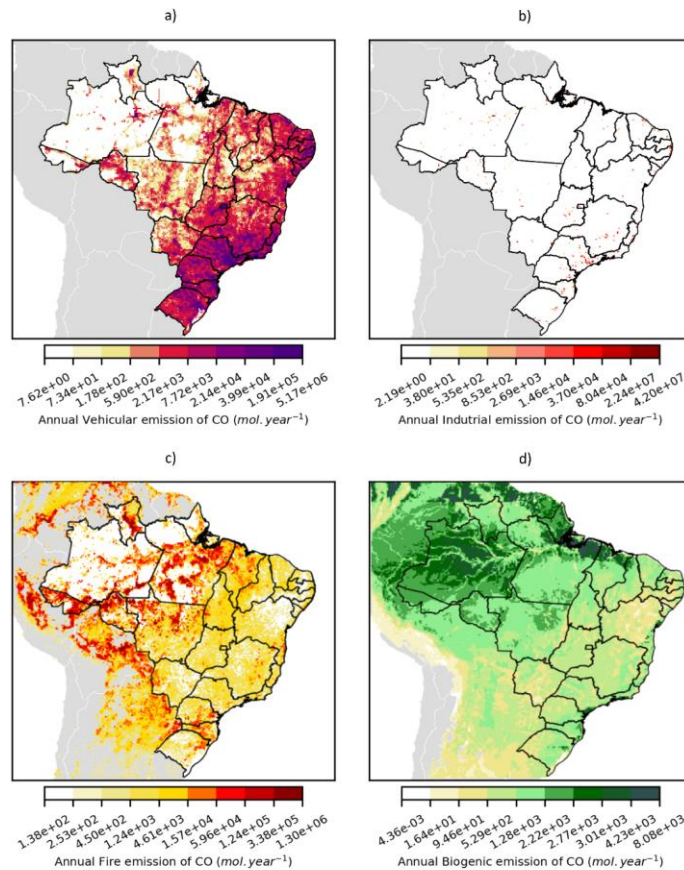


FAPESC

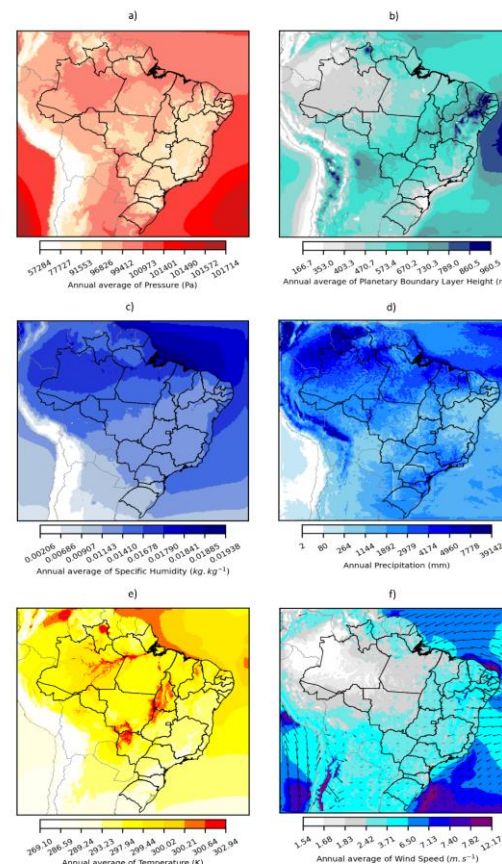
FUNDAÇÃO DE AMPARO À PESQUISA E INOVAÇÃO DO ESTADO DE SANTA CATARINA

BRAIN – Brazilian Atmospheric Inventories

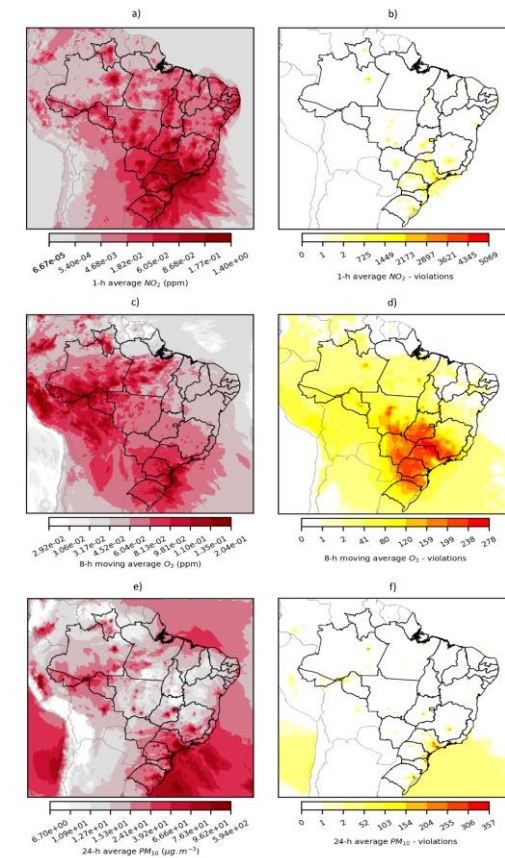
Emissões



Meteorologia



Qualidade do ar



BRAIN – Brazilian Atmospheric Inventories

Earth System Science Data

ARTICLES & PREPRINTS ▾ SUBMISSION POLICIES ▾ PEER REVIEW ▾ LIVING DATA PROCESS EDITORIAL BOARD ABOUT ▾ ↗

Preprint

Preprints / Preprint [essd-2023-305](https://doi.org/10.5194/essd-2023-305)

<https://doi.org/10.5194/essd-2023-305>
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Abstract Assets Discussion Metrics

05 Oct 2023

Status: a revised version of this preprint is currently under review for the journal *ESSD*.

Brazilian Atmospheric Inventories – BRAIN: A comprehensive database of air quality in Brazil

Leonardo Hoinaski ✉, Robson Will, and Camilo Bastos Ribeiro

a) Annual Vehicular emission of CO (mol. year⁻¹)

b) Average NO₂ - violations

c) Annual Fire emission of CO (mol. year⁻¹)

d) Average O₃ - violations

e) Annual average of Temperature (K)

f) Annual average of Wind Speed (m. s⁻¹)

g) 24-h average PM₁₀ (µg. m⁻³)

h) 24-h average PM₁₀ - violations

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- Preprint (2772 KB)
- Metadata XML
- Supplement (38300 KB)
- BibTeX
- EndNote

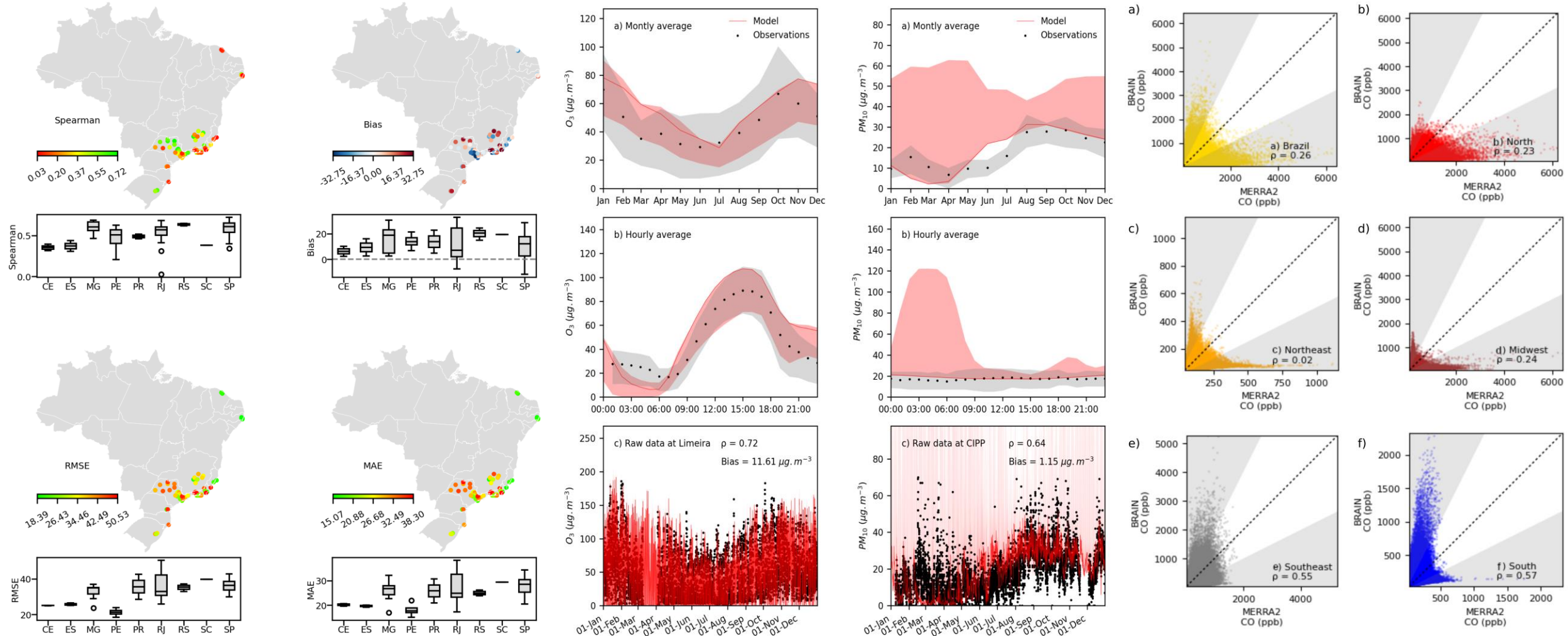
Short summary

We introduce the Brazilian Atmospheric Inventories – BRAIN, the first comprehensive database for...



Qual a qualidade destes dados?

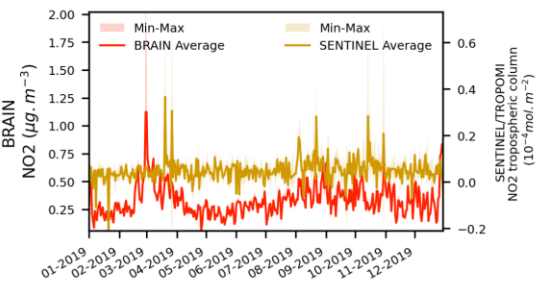
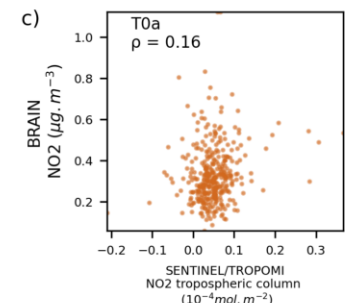
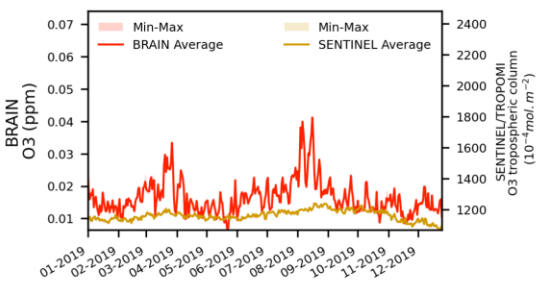
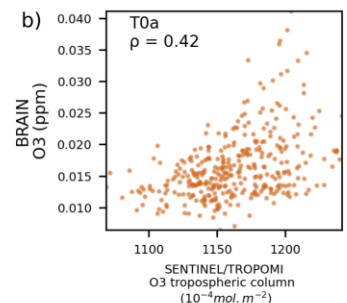
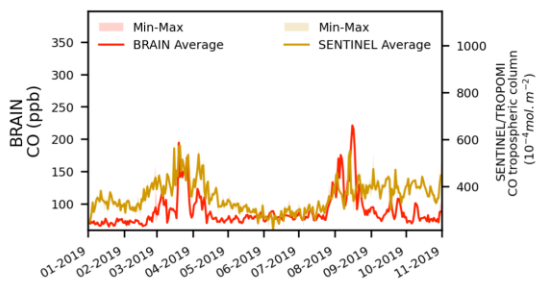
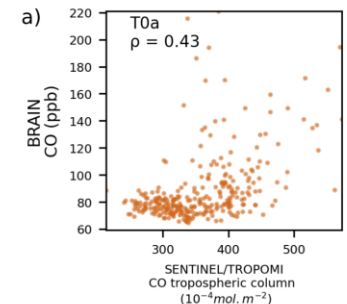
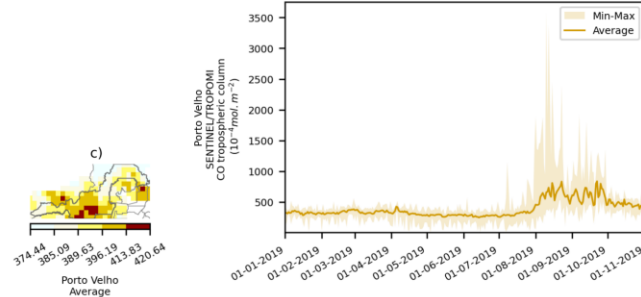
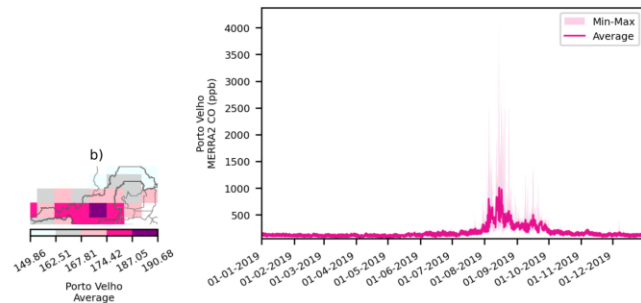
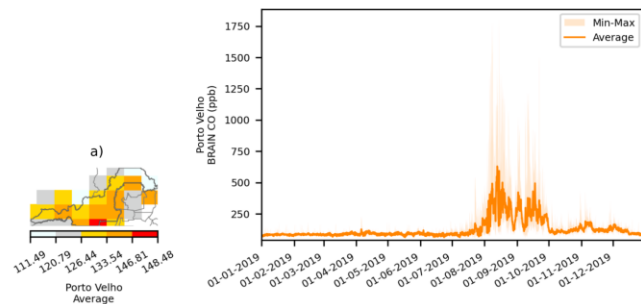
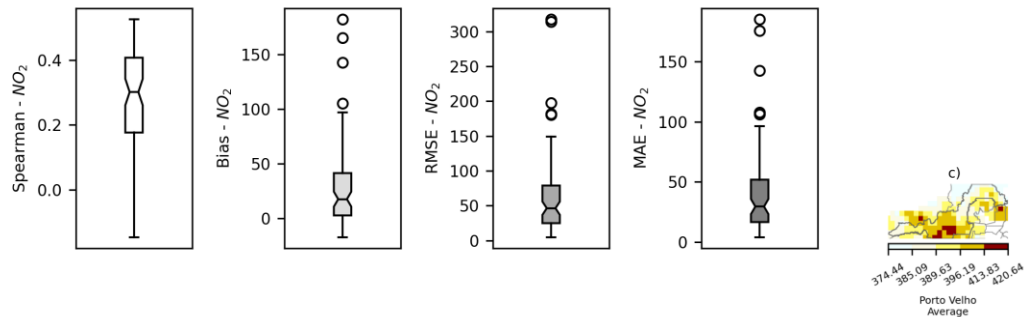
Performance do BRAIN



Performance do BRAIN

Desempenho em locais onde a queima de biomassa é dominante;

Desempenho em áreas preservadas.



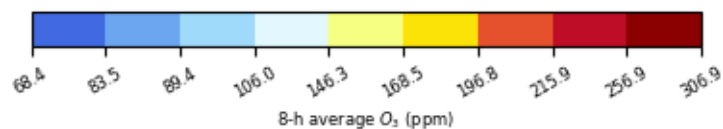
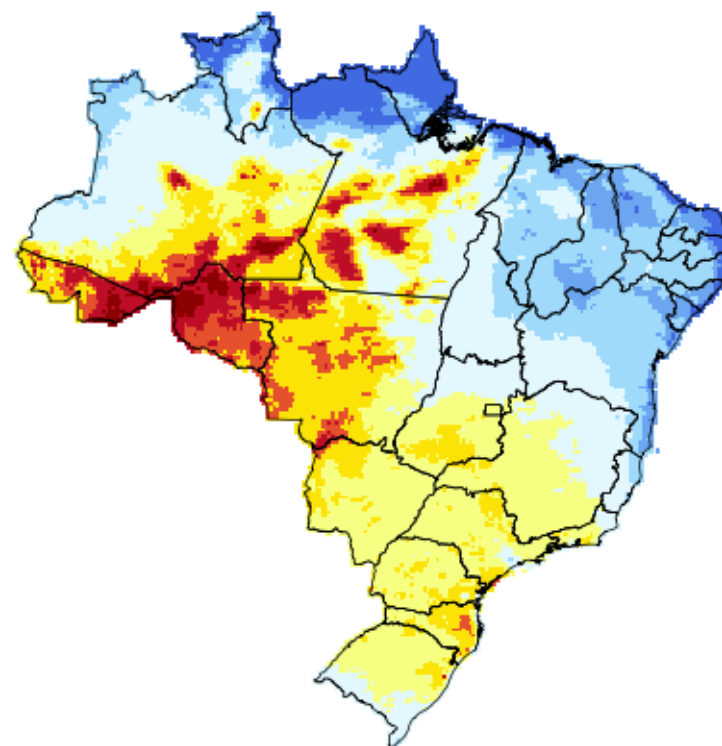
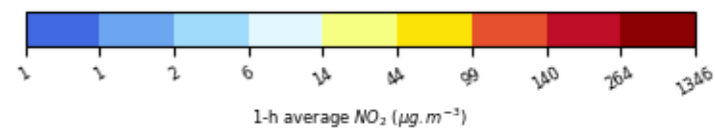
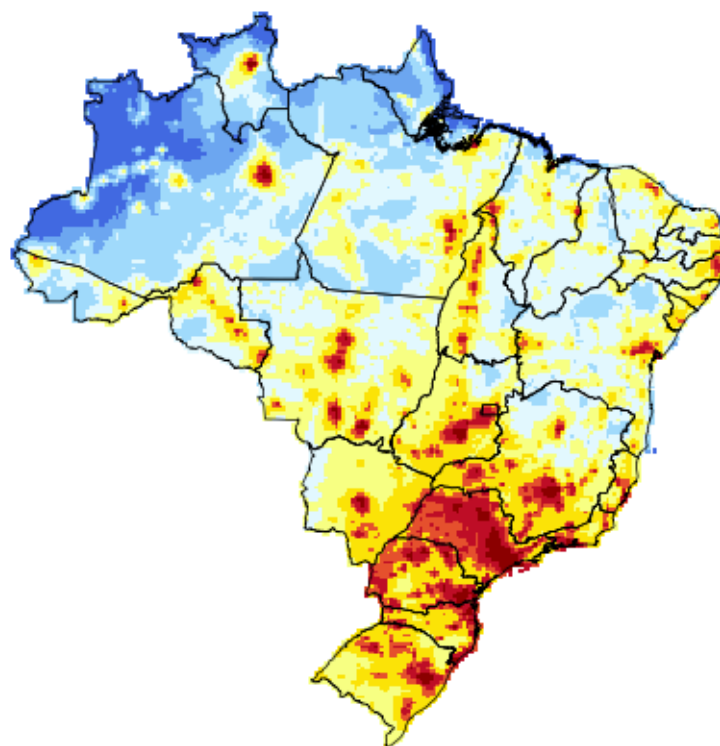
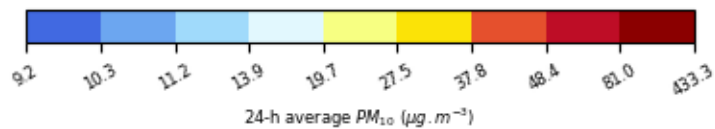
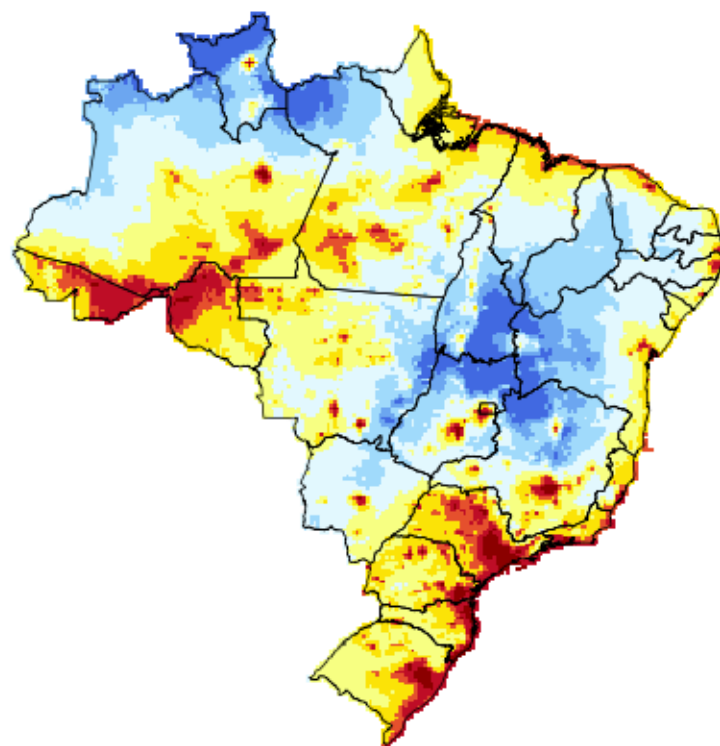
O que podemos fazer com o BRAIN?

- Preenche lacunas de monitoramento da qualidade do ar;
- Fornece dados de emissão para averiguar o efeito na qualidade do ar;
- Dados com a mesma resolução espacial e temporal;
- Formulação de políticas públicas em todo Brasil.

Pergunta de 1 milhão

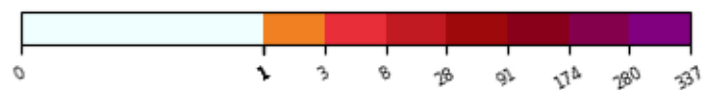
Qual a redução das emissões necessária para atender os padrões de qualidade do ar?

Cenário atual - 2020



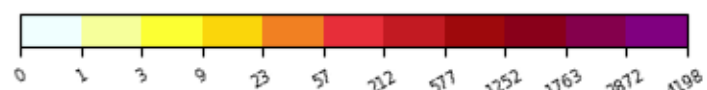
Cenário atual – 2020

PM10 – PI-1 = 120 $\mu\text{g}/\text{m}^3$



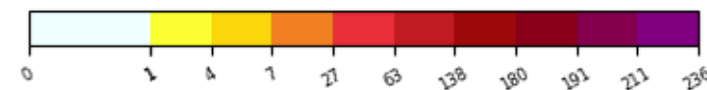
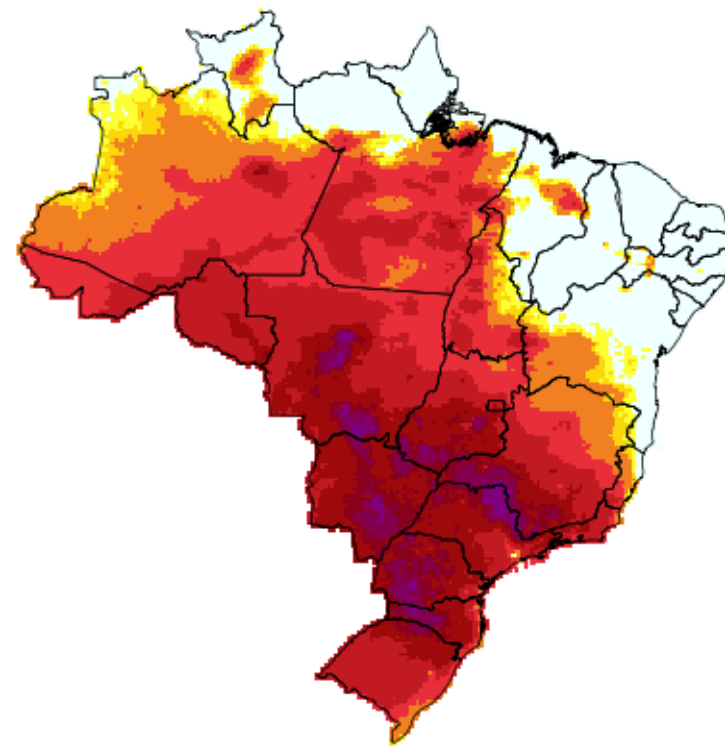
24-h average PM_{10} - violations

NO_2 – PI-1 = 260 $\mu\text{g}/\text{m}^3$



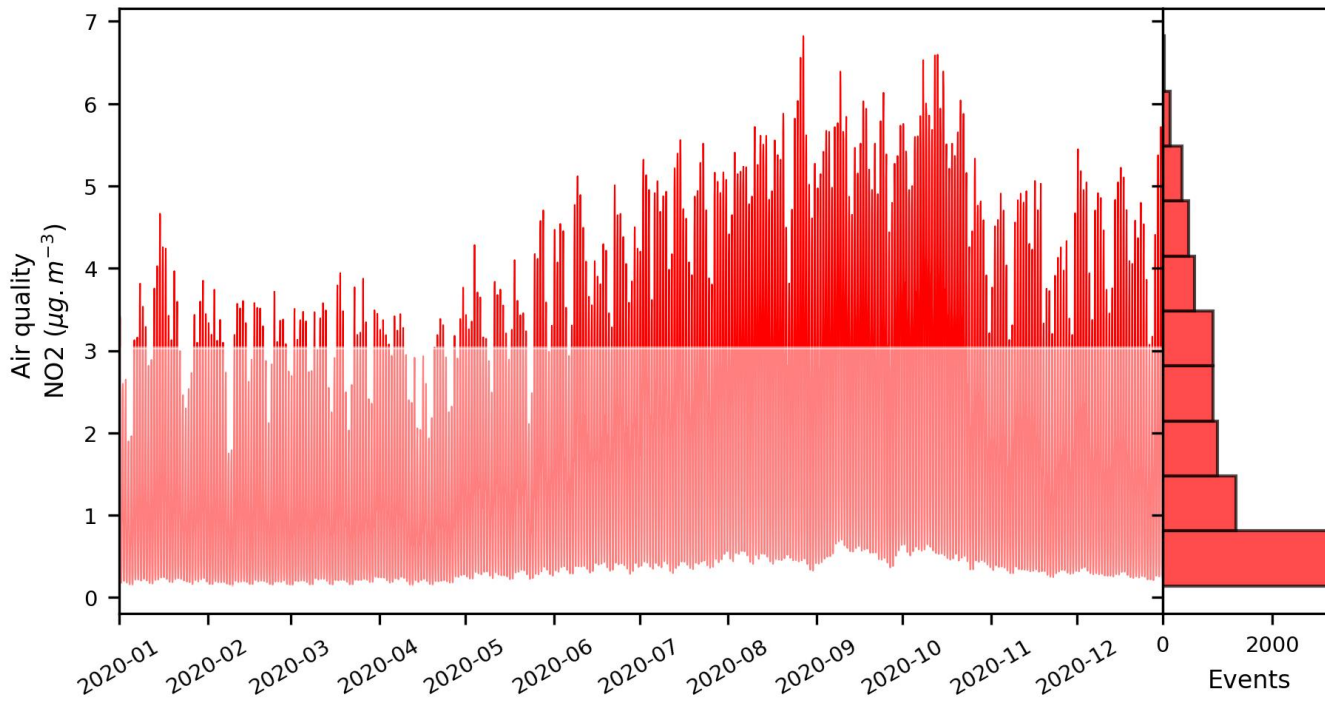
1-h average NO_2 - violations

O_3 – PI-1 = 140 $\mu\text{g}/\text{m}^3$



8-h average O_3 - violations

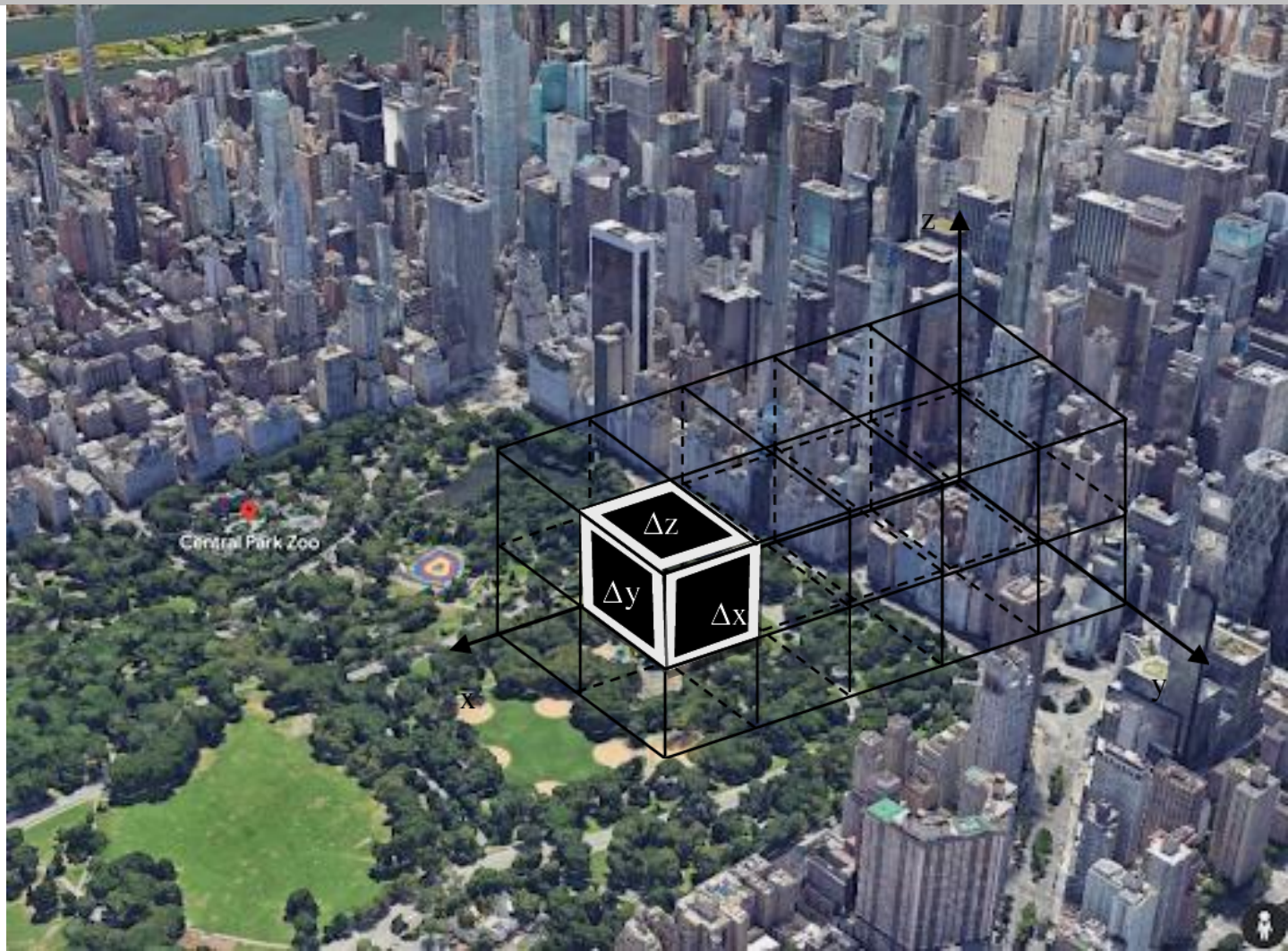
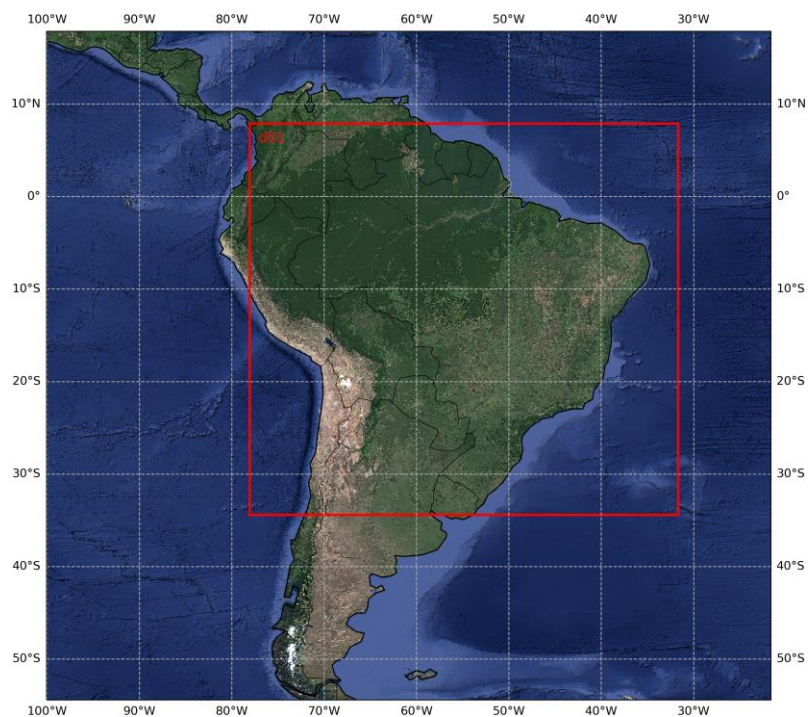
Seleção de eventos críticos



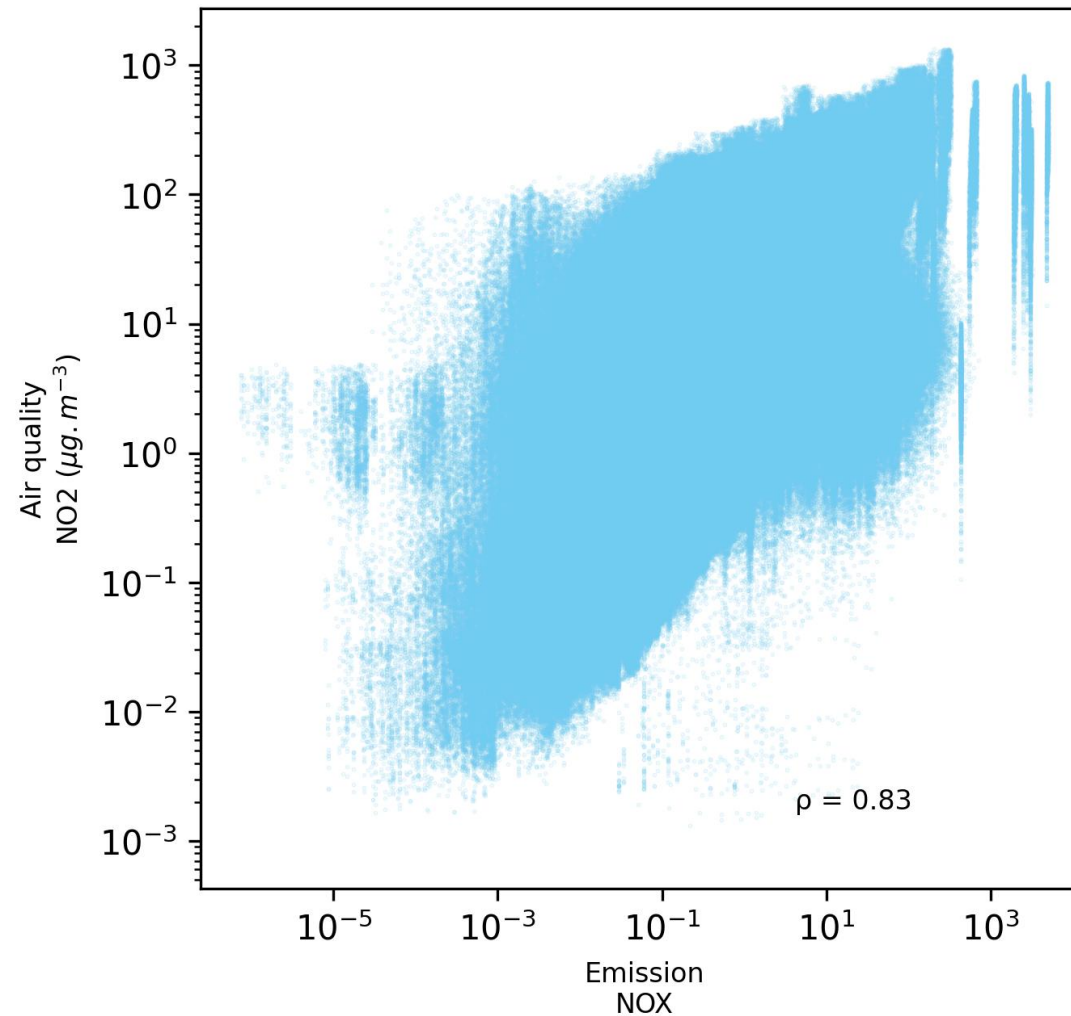
- Removendo 1% das maiores concentrações
- Selecionando dados dentro do Brasil
- Média do domínio em cada hora/8horas/dia
- Seleção de 25% maiores eventos

Análise por volume

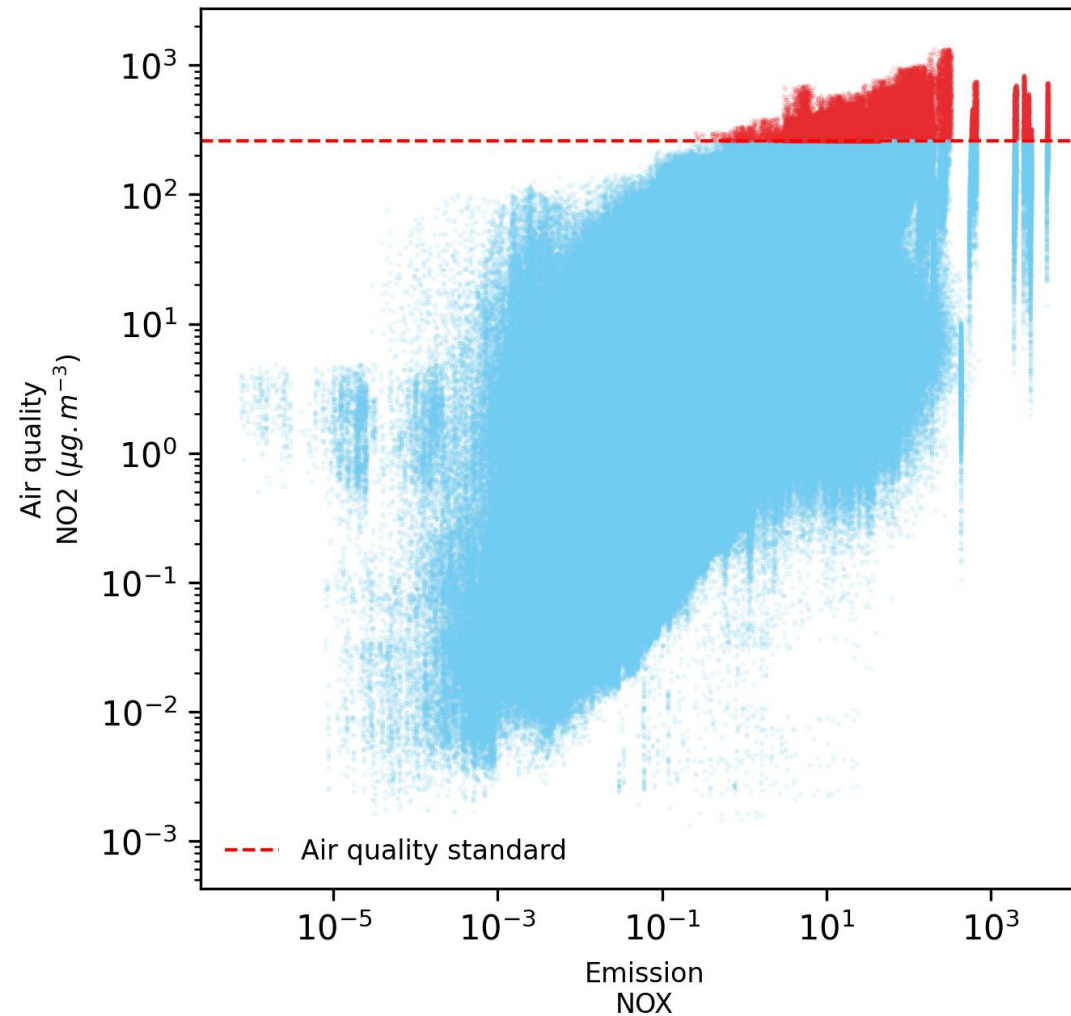
- Domínio cobre o Brasil;
- Resolução de 20x20km
- Concentrações no nível da superfície (~30m)



Categorização dos dados

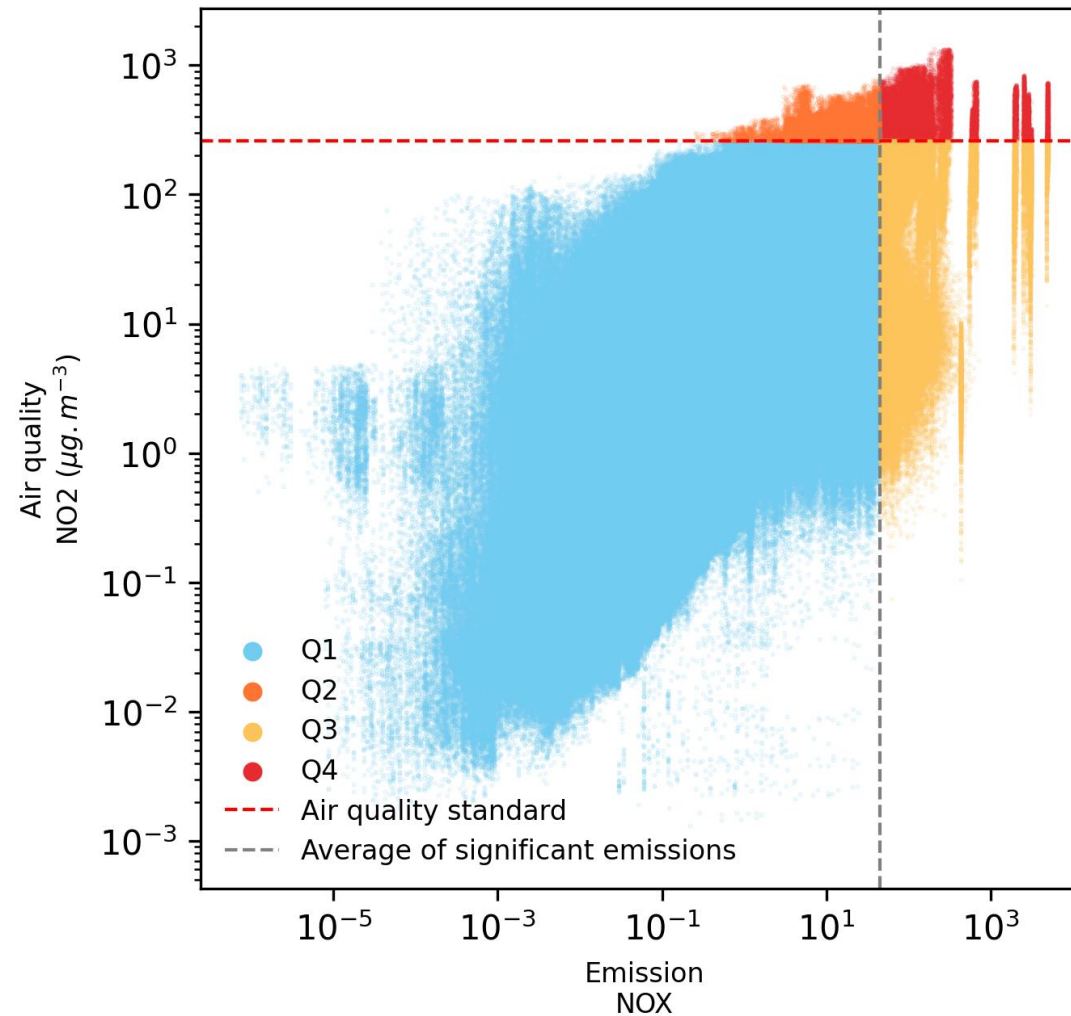


Categorização dos dados



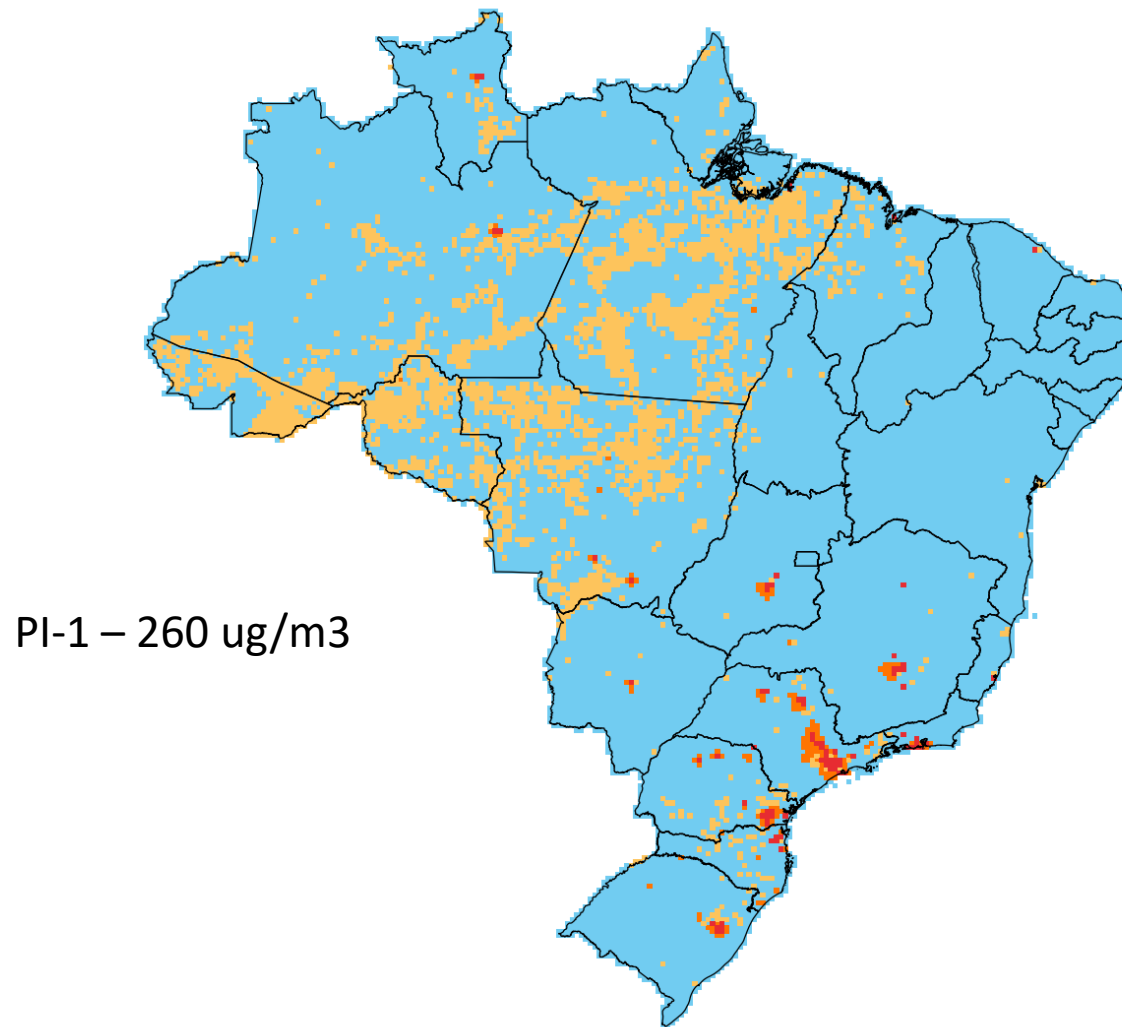
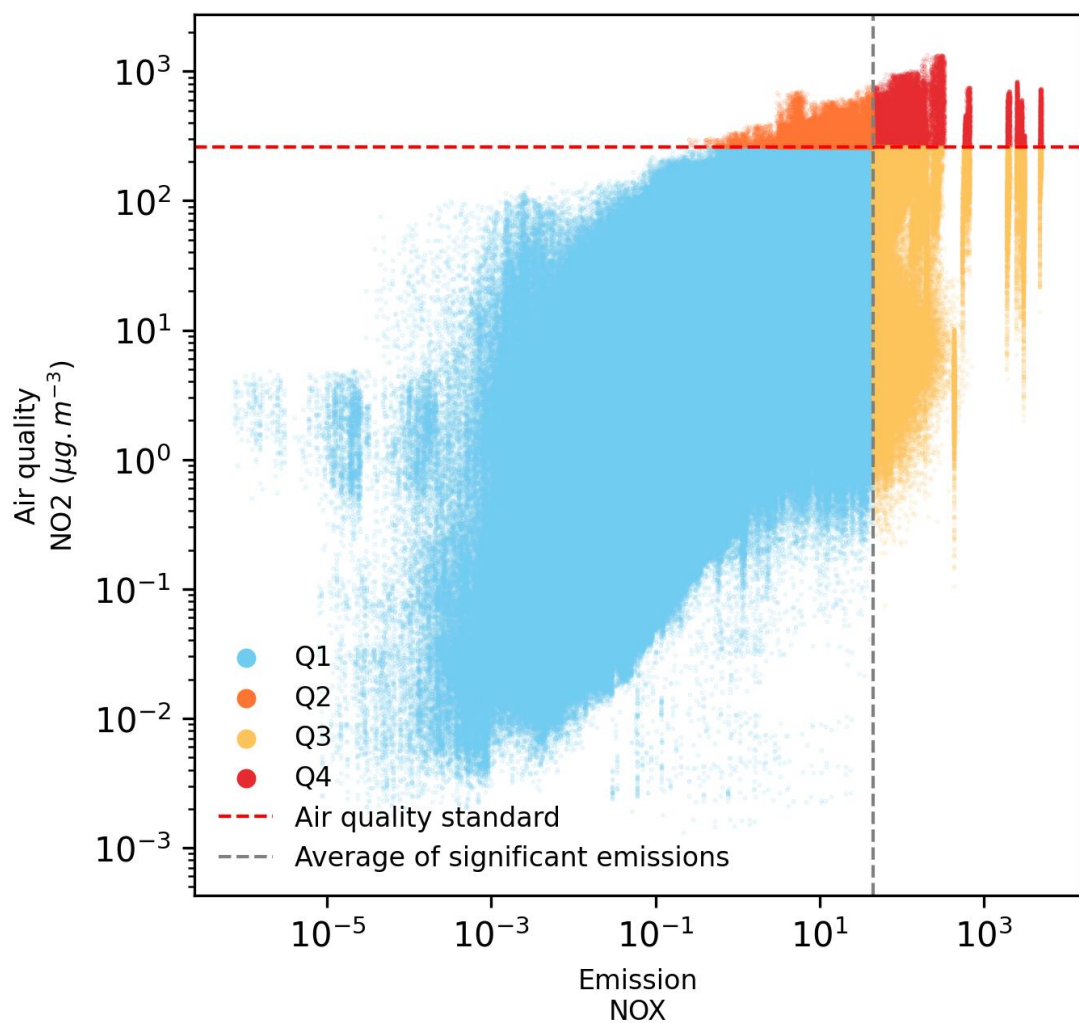
PI-1 – $260 \mu\text{g}/\text{m}^3$

Categorização dos dados

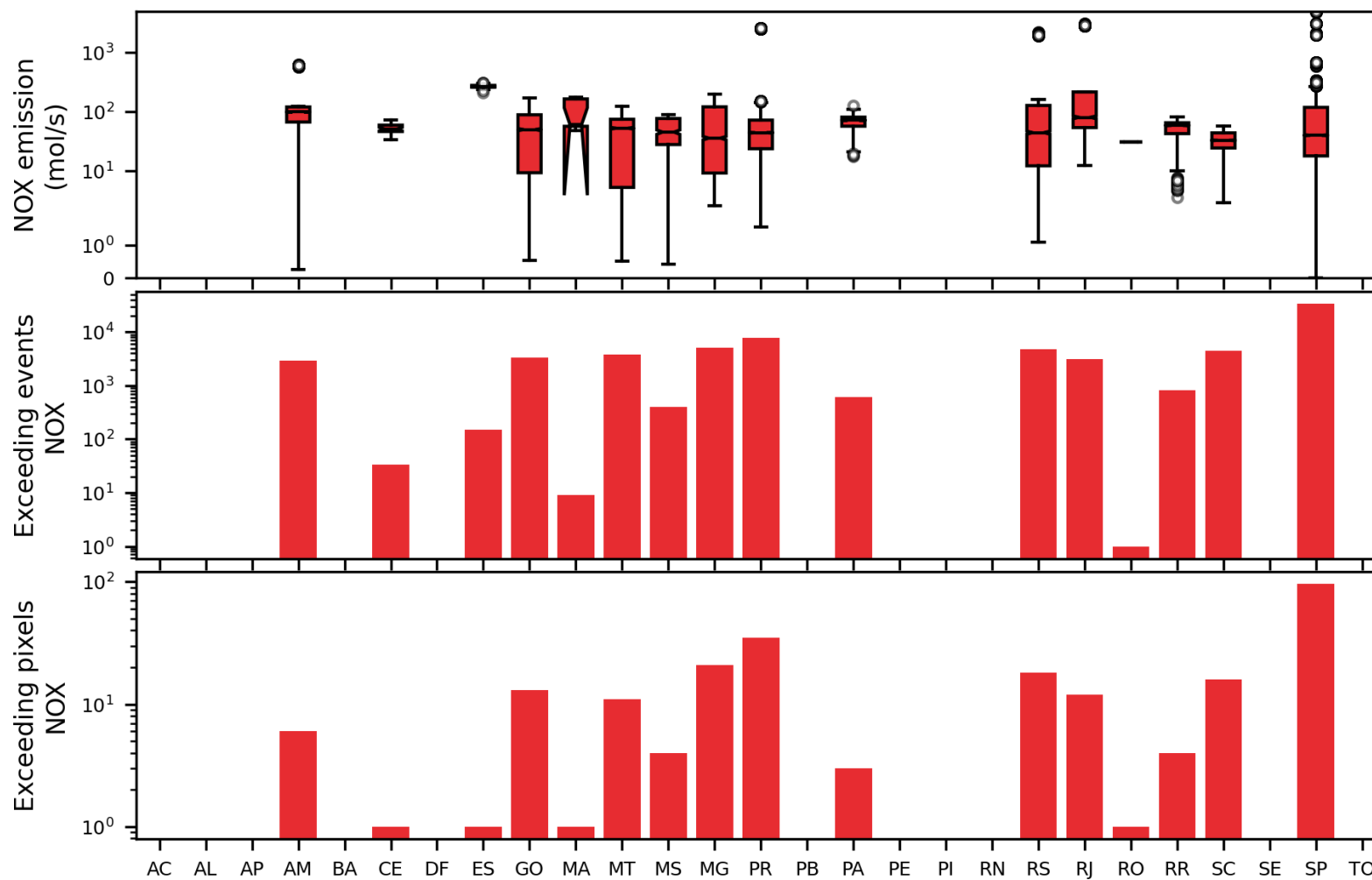


PI-1 – $260 \mu\text{g}/\text{m}^3$

Categorização das áreas

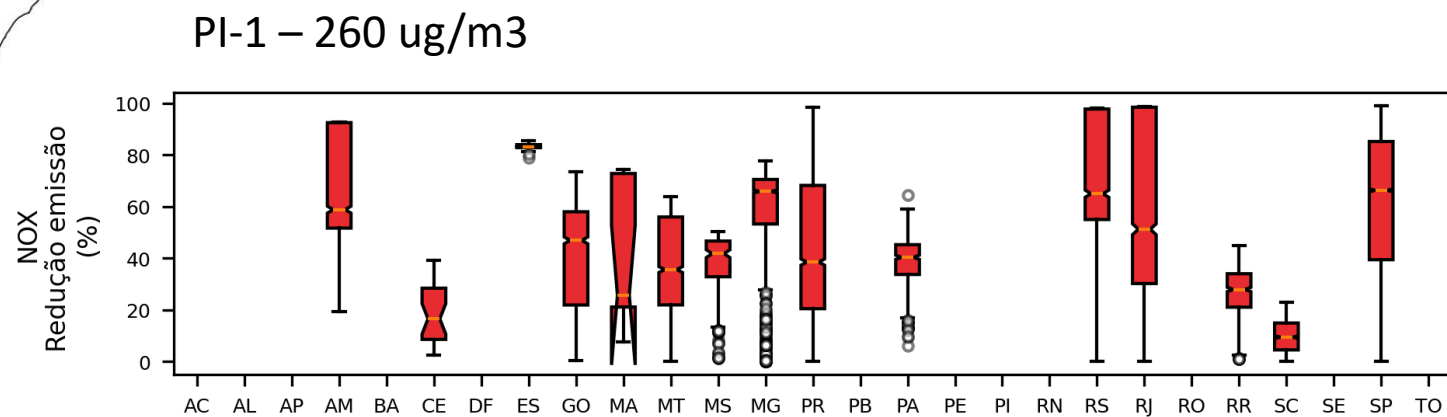
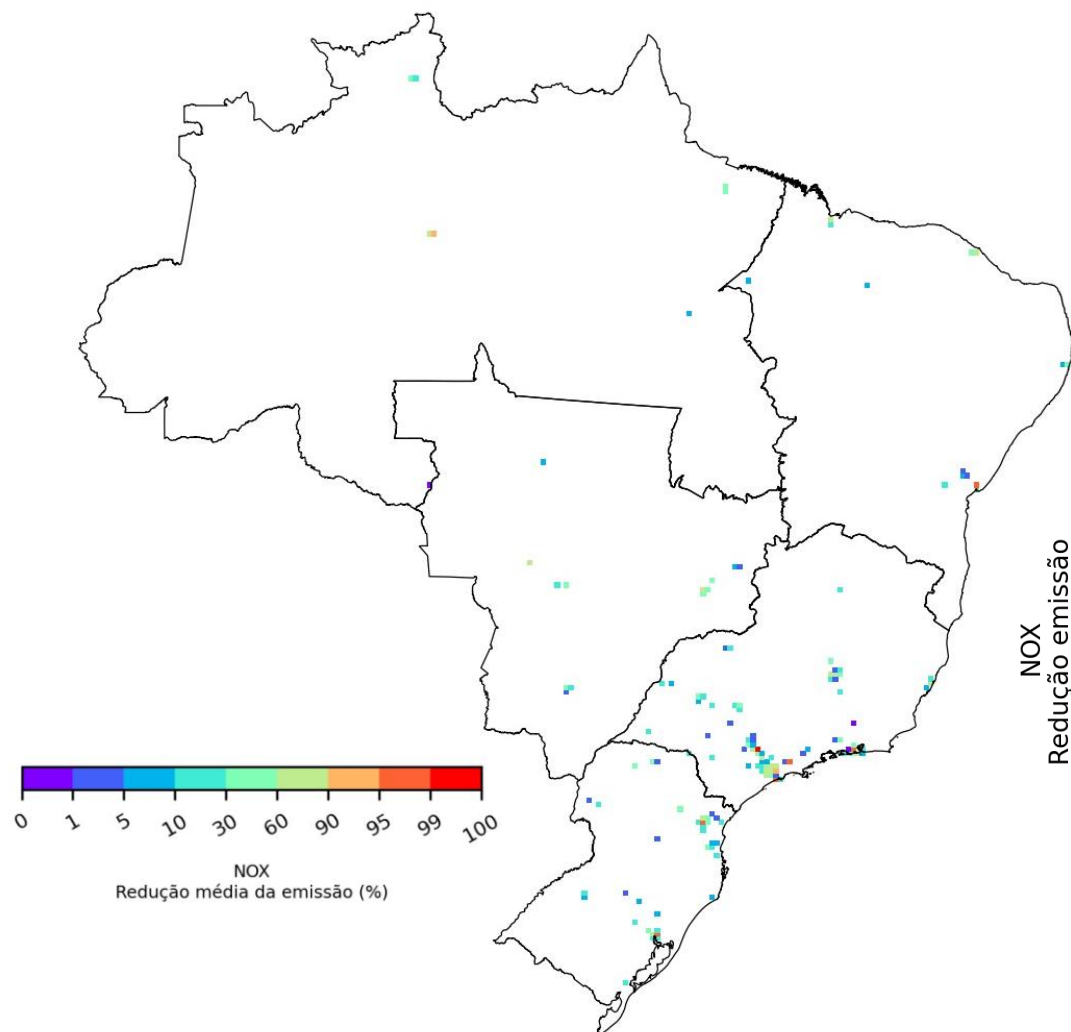


Análise das áreas críticas



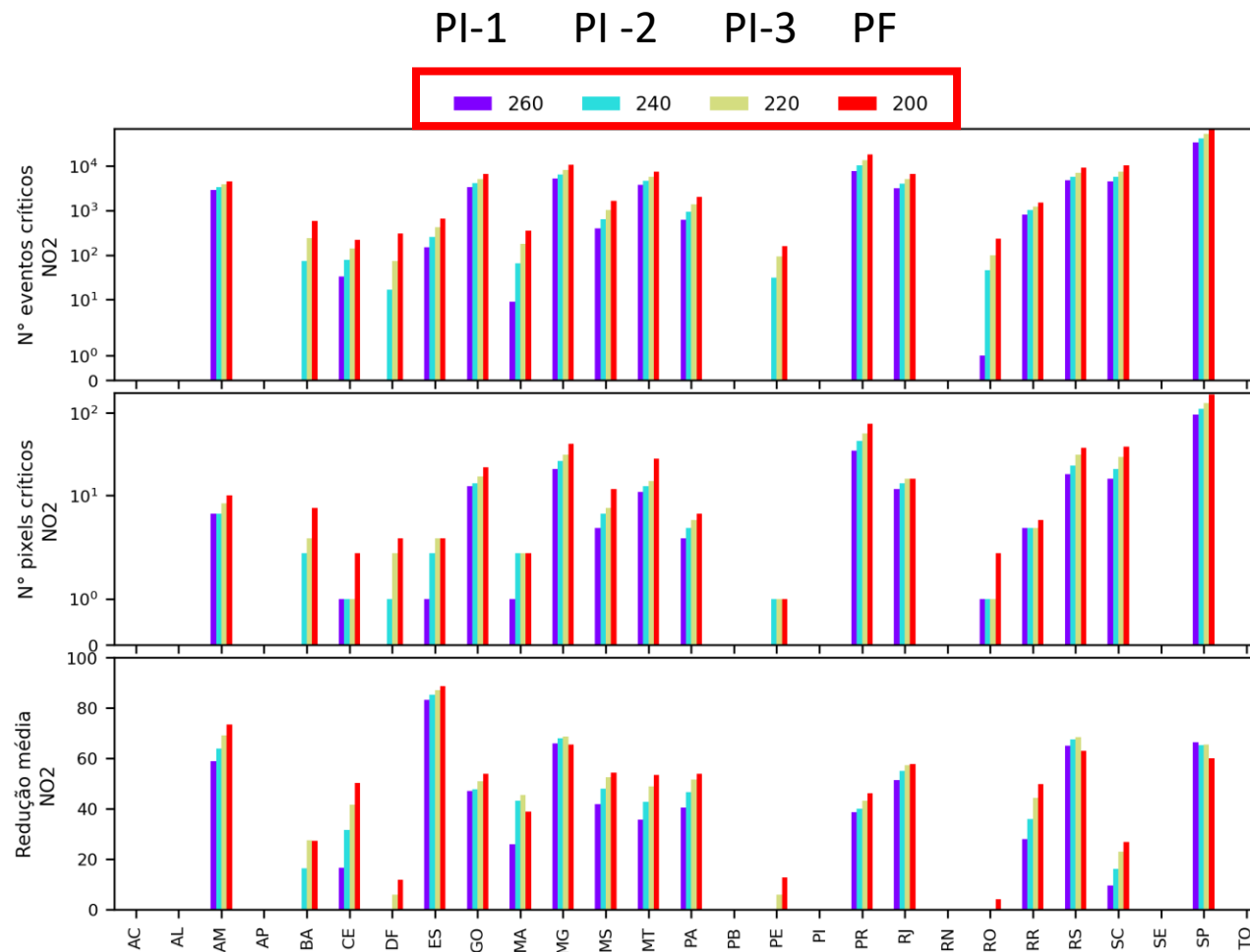
PI-1 – 260 ug/m³

Redução das emissões nas áreas críticas



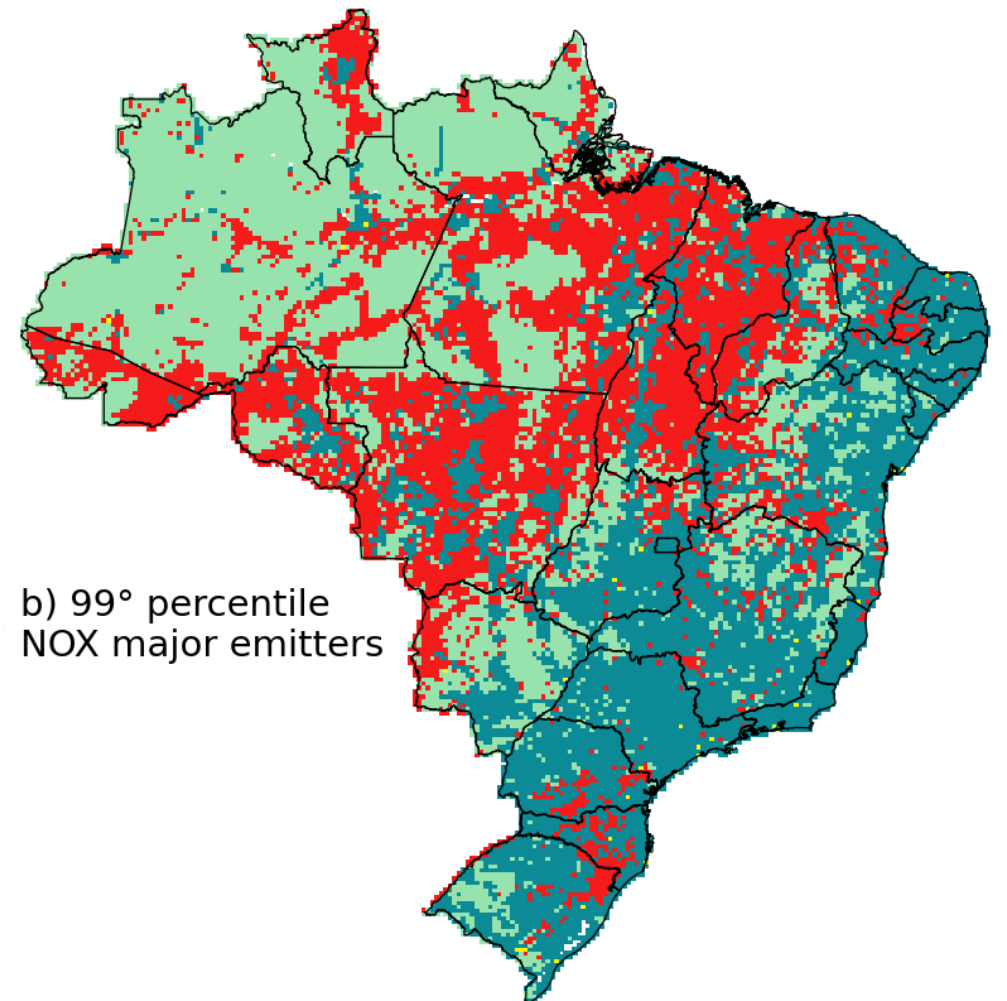
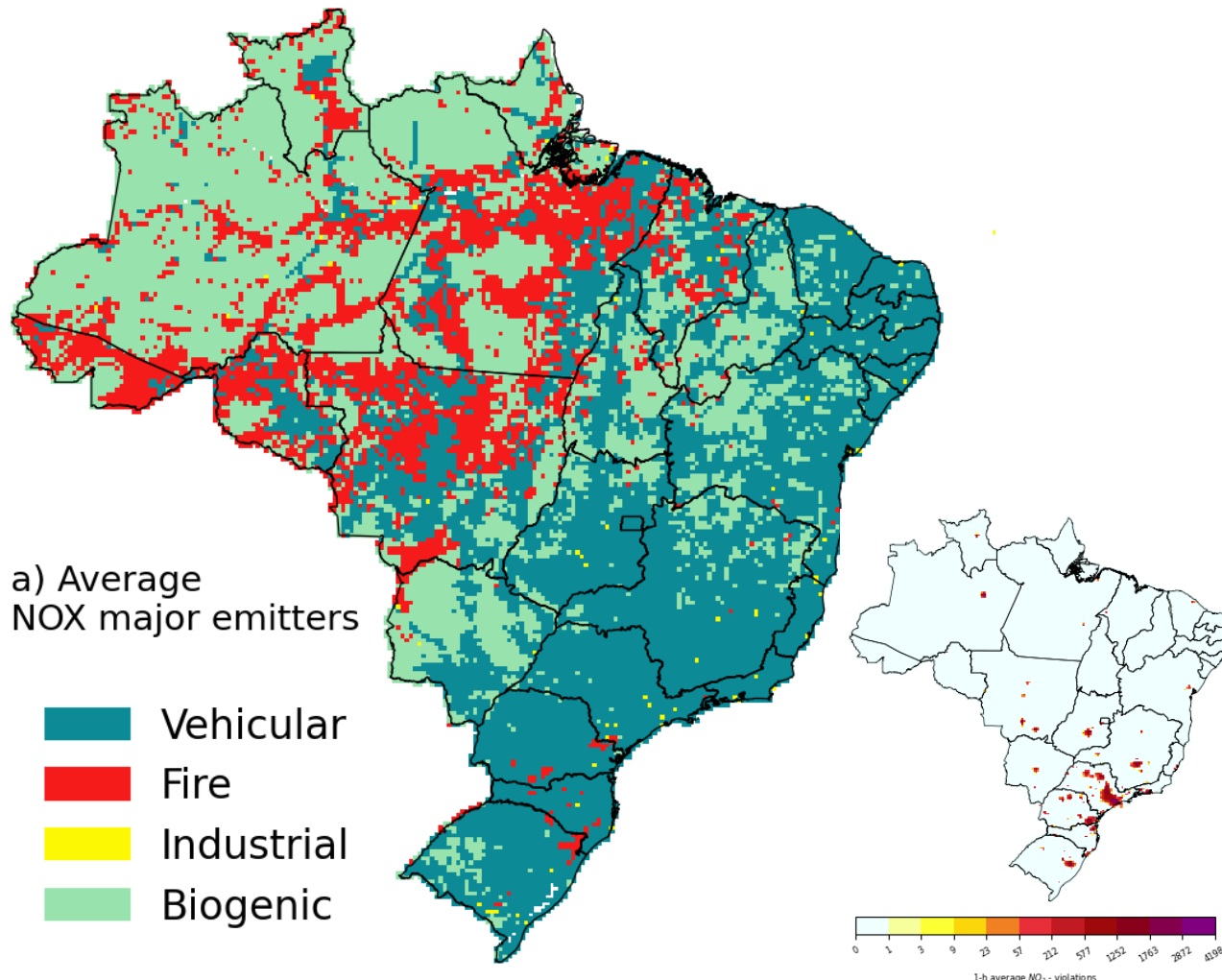
Padrões vs Eventos críticos

NO2

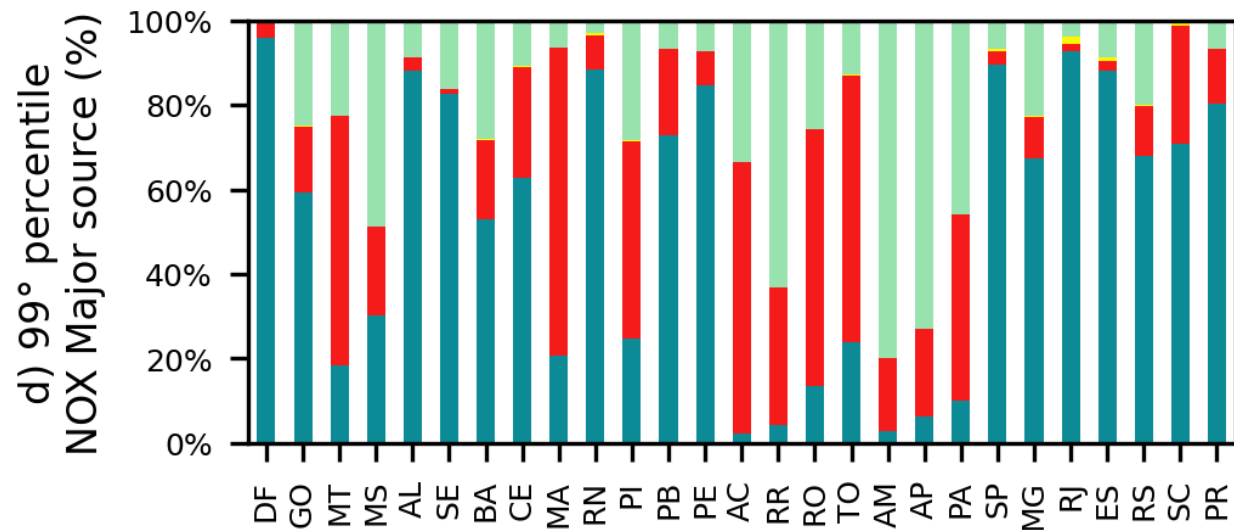
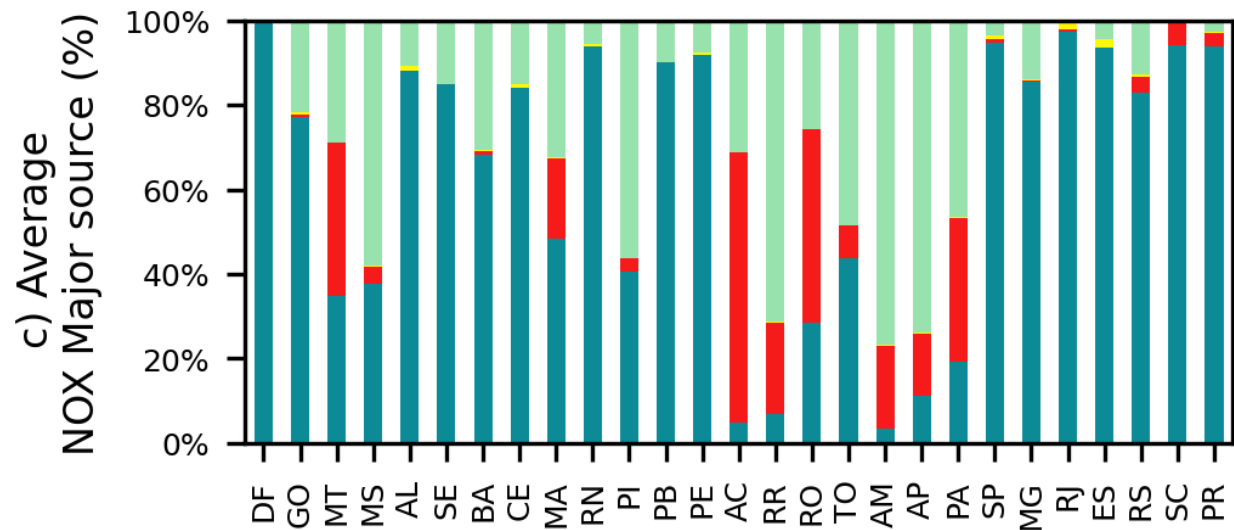


Identificação do problema

Principais emissores



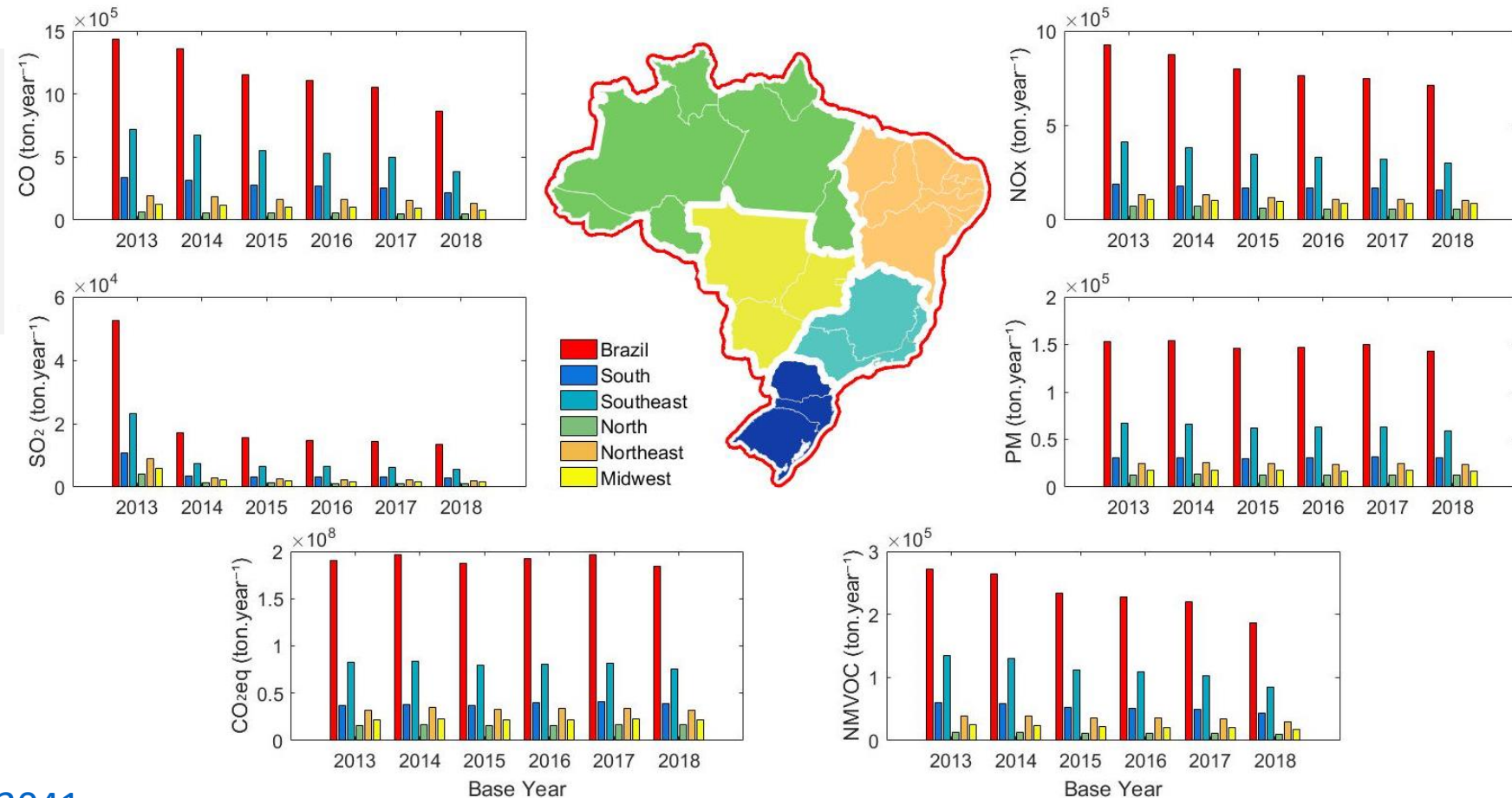
Principais emissores



Quais medidas devemos tomar?

Mitigação das emissões veiculares

Redução das emissões observadas em todos os estados, para a maioria dos poluentes.



Transportation Research Part D 100 (2021) 103041

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Brazilian vehicular emission inventory software – BRAVES

Thiago Vieira Vasques^a, Leonardo Hoinaski^{b,*}

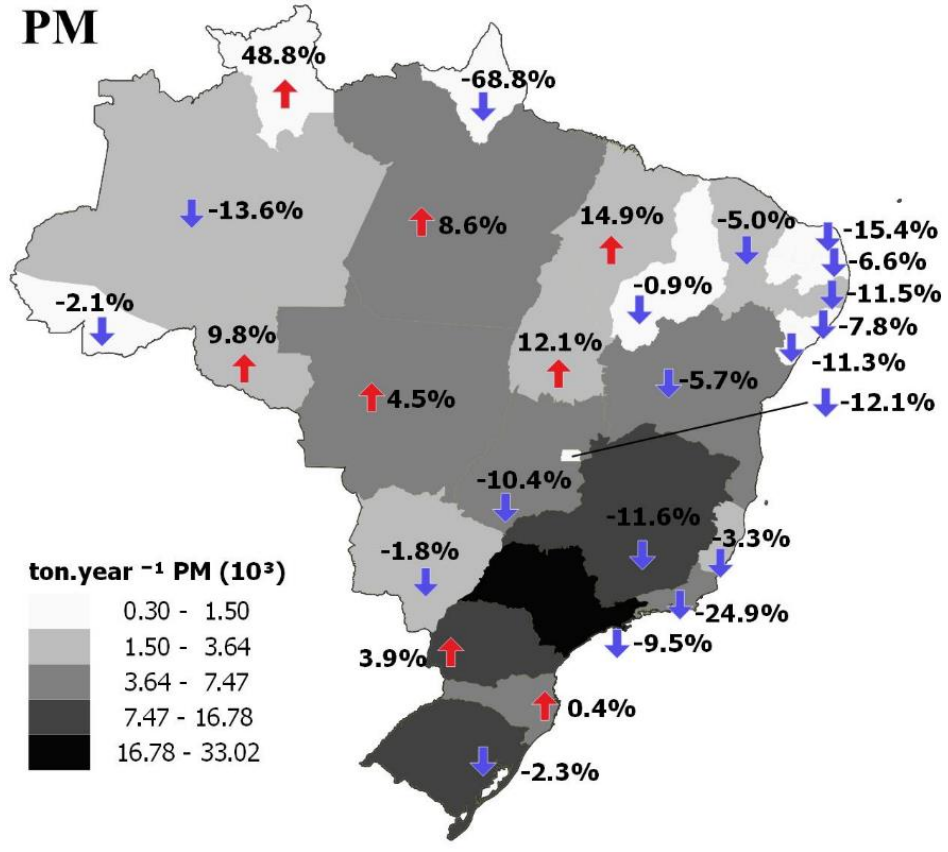
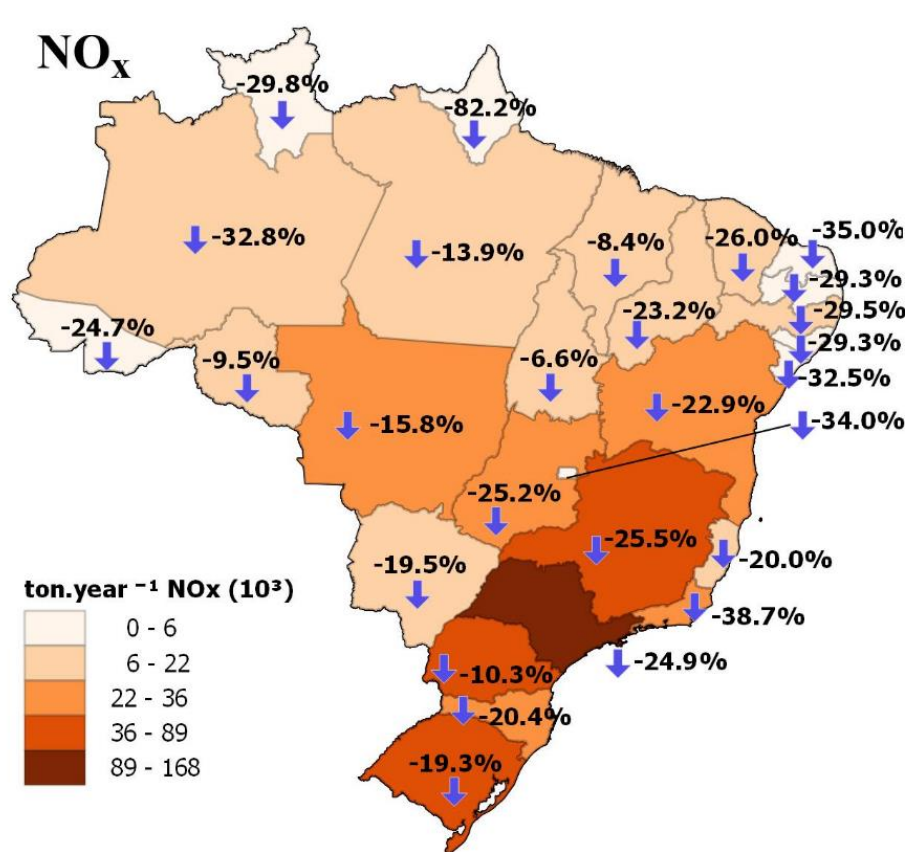
^a Postgraduate Program in Environmental Engineering, Federal University of Santa Catarina, Florianópolis, Santa Catarina, Brazil
^b Department of Sanitary and Environmental Engineering, Federal University of Santa Catarina, Florianópolis, Santa Catarina, Brazil

<https://doi.org/10.1016/j.trd.2021.103041>

Mitigação das emissões veiculares



Redução entre 2013 e 2018;
Melhoria da tecnologia;
Material particulado é dominado pela ressuspensão do solo.



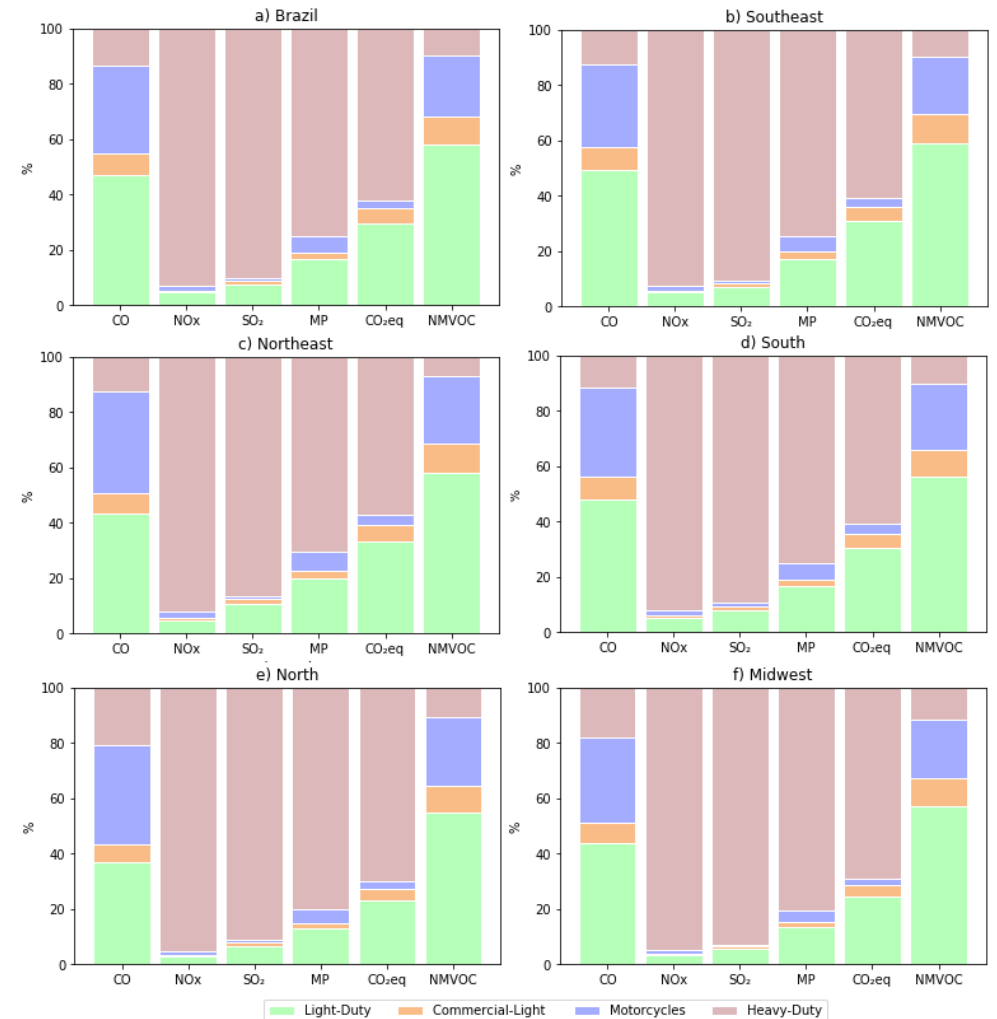
Mitigação das emissões veiculares



Veículos pesados dominam a emissão de NOx, SOx e PM10;

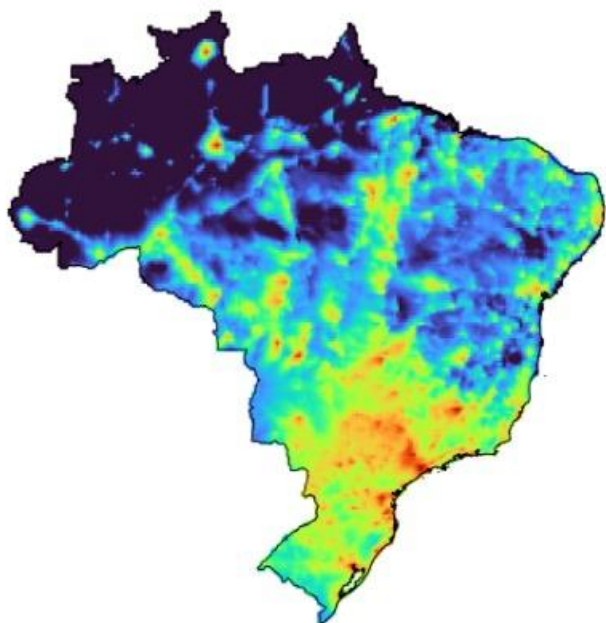
Veículos leves dominam as emissões de NMVOC e CO;

Perfil semelhante nas regiões.



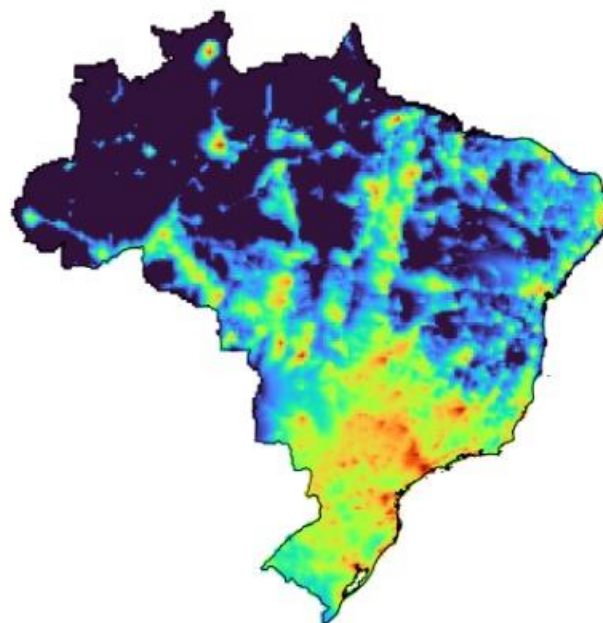
Mitigação das emissões veiculares – Simulações NO₂

(a) baseline



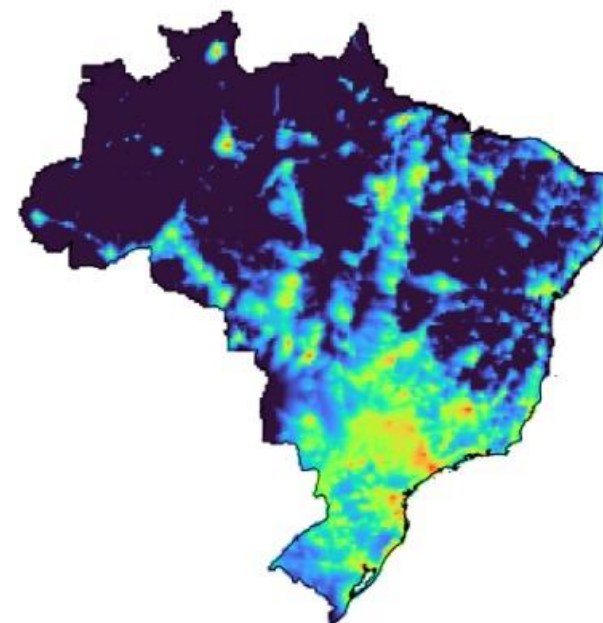
Todas as fontes

(b) vehicular



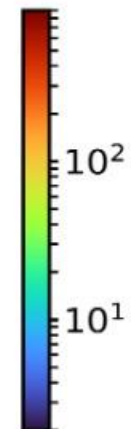
Veiculares atuais

(c) best vehicular

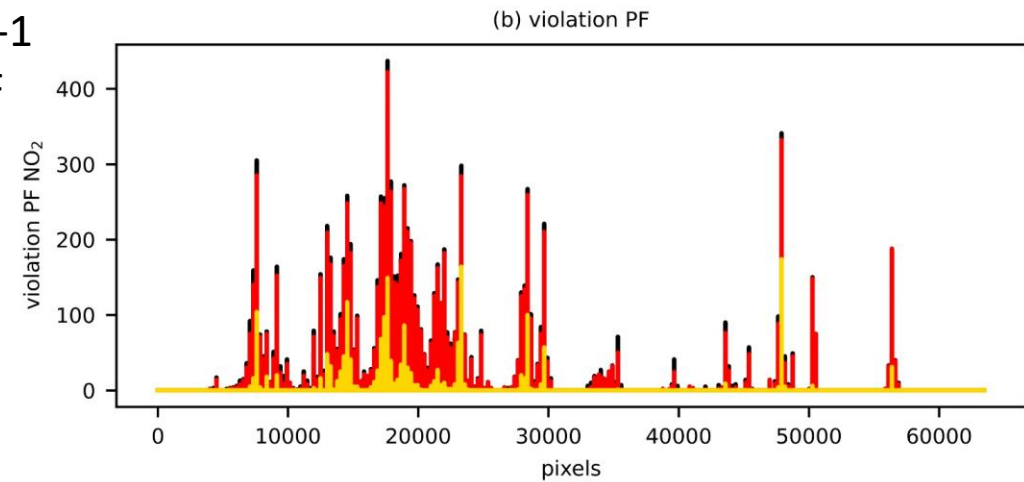
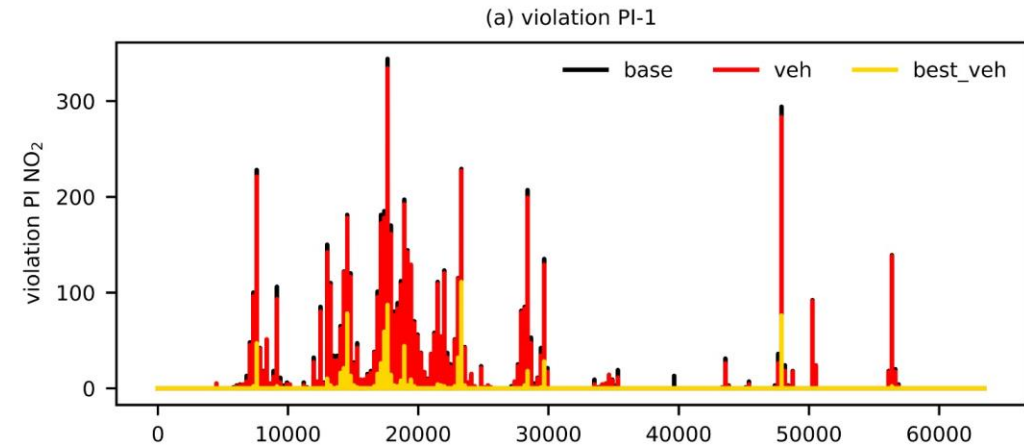
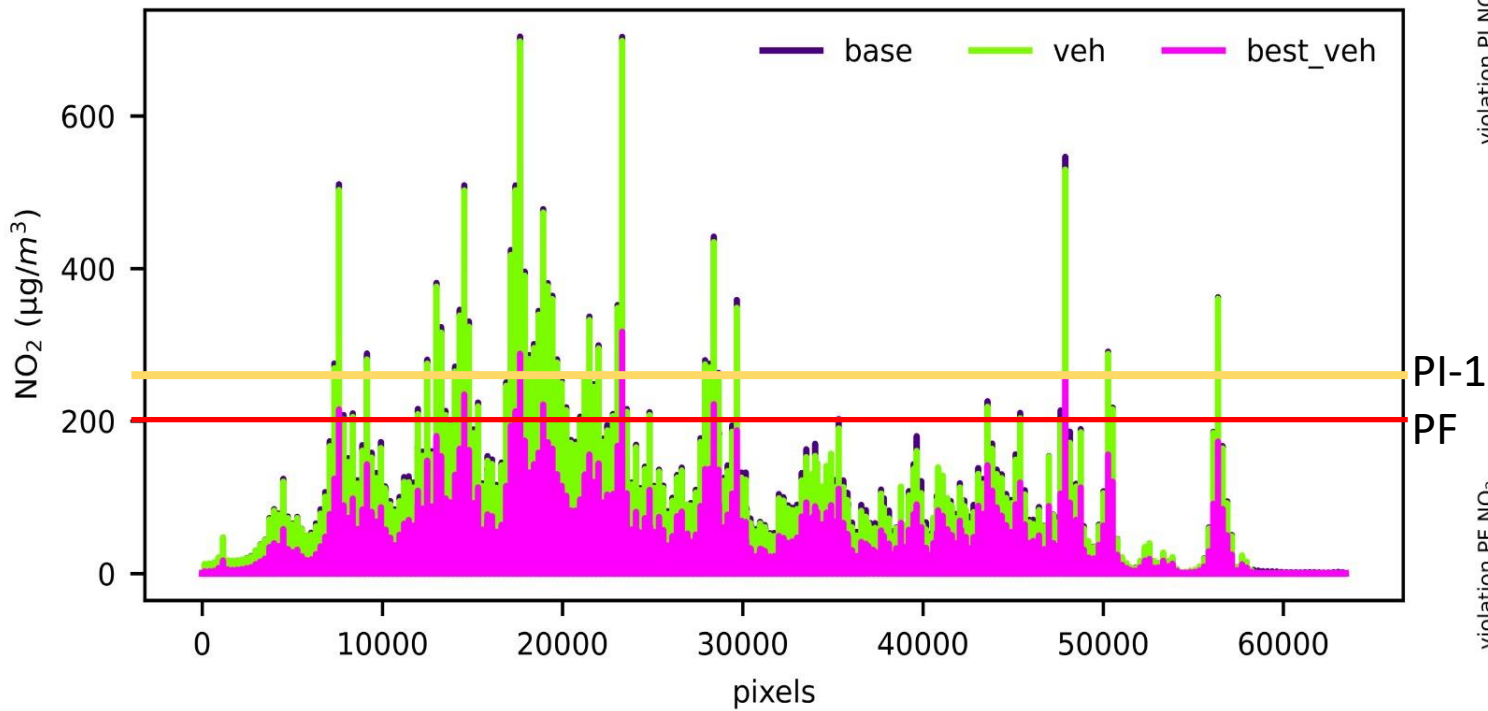


Veiculares com melhor tecnologia disponível de combustão

NO₂ ($\mu\text{g}/\text{m}^3$)



Mitigação das emissões veiculares – Simulações NO₂

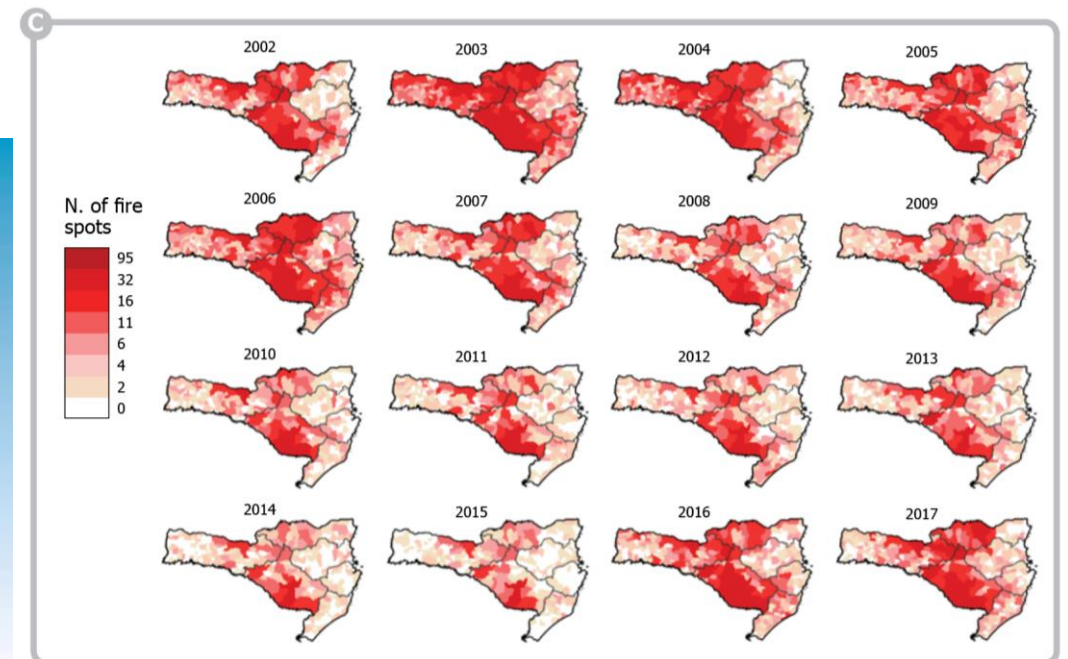
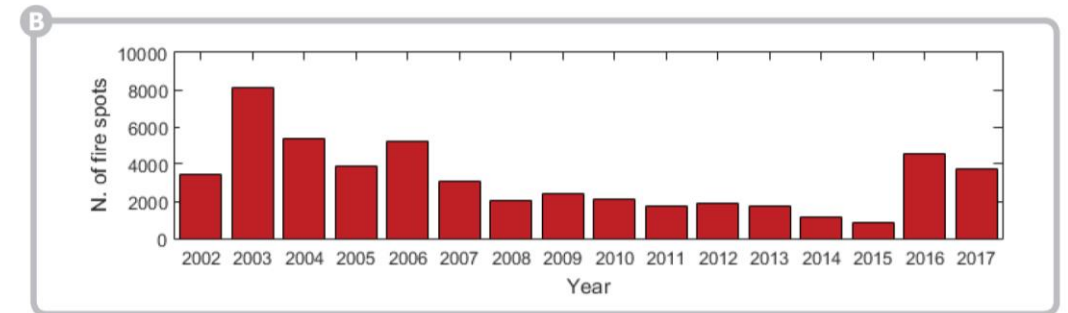


Mitigação das queimadas

Já observamos reduções bruscas nas emissões das queimadas em outros anos;

Exemplo de SC;

Vasta literatura.



Mitigação das emissões industriais

Revisão dos procedimentos de licenciamento;

Avaliação de impacto considerando concentração de fundo e emissores colocalizados;

Definição de áreas que não atendem os padrões para melhoria dos processos industriais (melhor tecnologia disponível);

Usar experiência de órgãos internacionais de referência no controle da poluição.



LCOAR
LABORATÓRIO DE CONTROLE DA QUALIDADE DO AR

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hoinaski.prof.ufsc.br

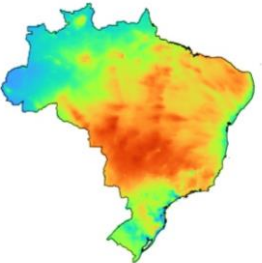
lcqar.ufsc.br

Mitigação das emissões veiculares – Simulações O₃

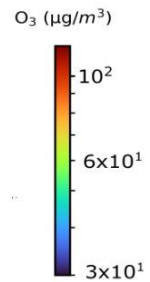
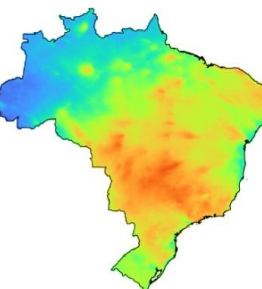
(a) baseline



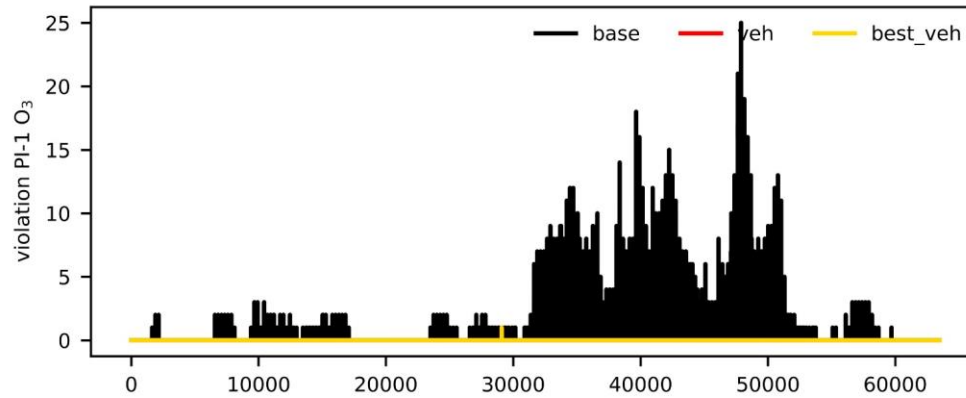
(b) vehicular



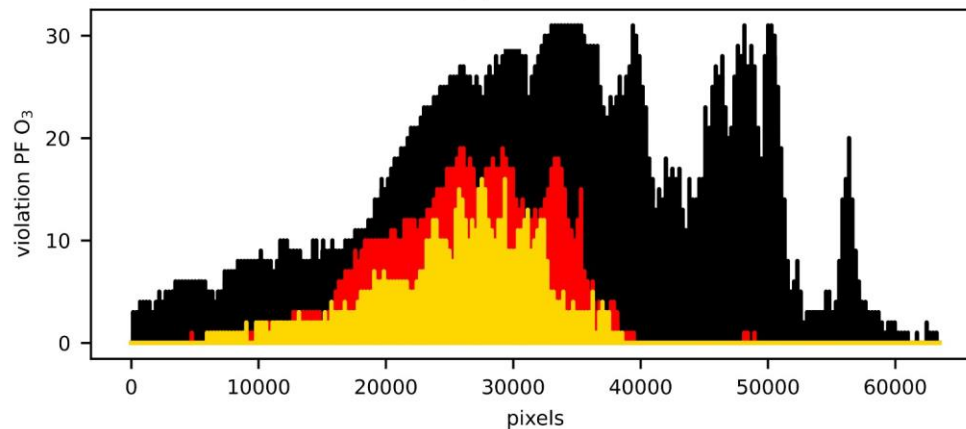
(c) best vehicular



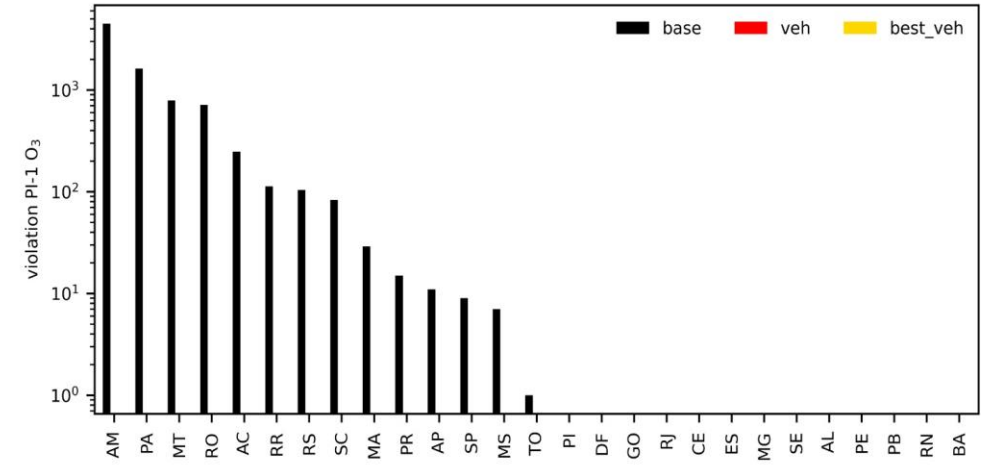
(a) violation PI-1



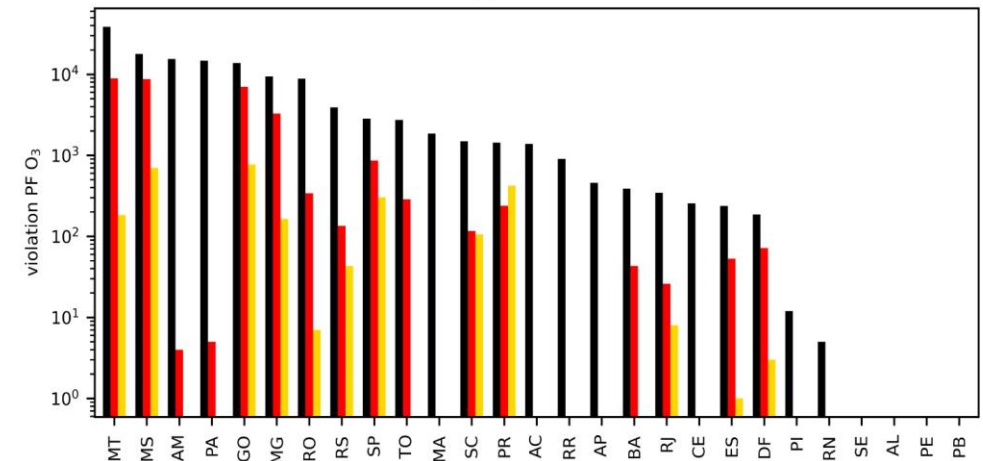
(b) violation PF



(a) violation PI-1



(b) violation PF



Mitigação das emissões industriais



Referências

- Hoinaski, L., Vasques, T.V., Ribeiro, C.B., Meotti, B.: Multispecies and high-spatiotemporal-resolution database of vehicular emissions in Brazil, *Earth Syst. Sci. Data*, 14, 2939–2949, <https://doi.org/10.5194/ESSD-14-2939-2022>, 2022.
- Hoinaski et al.: Avaliação do impacto das emissões veiculares, queimadas, industriais e naturais na qualidade do ar em Santa Catarina, https://lqcar.ufsc.br/novo/wp-content/uploads/2021/06/Avalia%C3%A7%C3%A3o-do-impacto-das-emiss%C3%B5es_Santa-Catarina_2020.pdf, (last access Jul 2023), 2020.
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