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RESPONSES OF OZONE TO CHANGES OF EMISSIONS UNDER THE REPRESENTATIVE CONCENTRATION PATHWAY 4.5 SCENARIO OVER BRAZIL

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Outline

I. Introduction
II. Experiment Design
III. Ozone Changes
IV. Conclusions

Introduction

BACKGROUND: ● More than 90% of the world’s population does not breathe clean air (WHO, 2017)
● Ozone (O_3) is a secondary pollutant with high impact on health
● Future emissions (technology and mitigation policies)
● Climate change

Introduction

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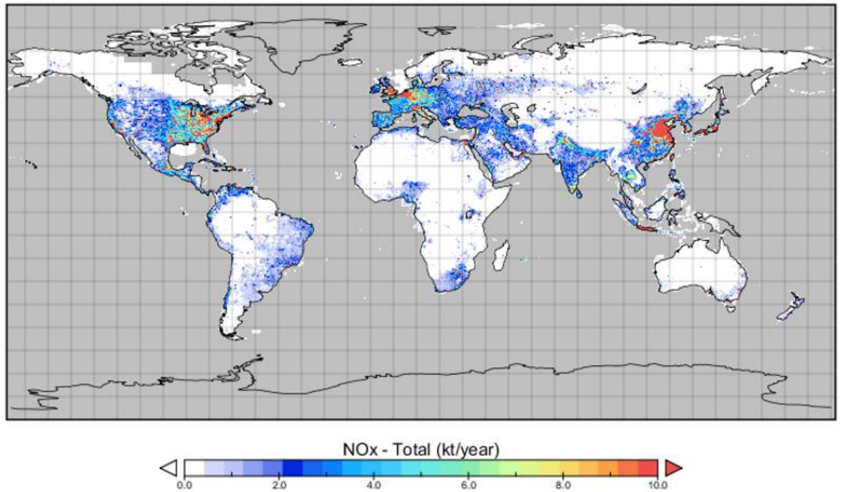
"What will **air quality** look like in the **future**?"

OBJECTIVE: How future changes in **emissions** will affect O_3 for Brazil

Experiment Design: Models and Inputs

ECLIPSE-v5a
(Klimont et al., 2017)

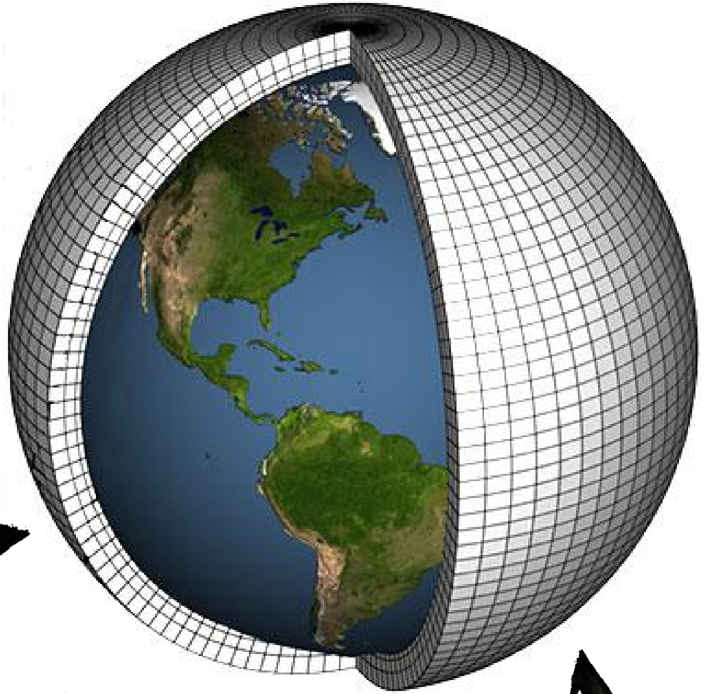
0.5° × 0.5°



GAINS (Greenhouse Gas and Air Pollution Interactions and Synergies)
(Aman et al., 2011)

EmissV R-Package
(Schuch et al., 2018)

WRF-Chem Weather Research and Forecast with Chemistry
(Grell et al,. 2005)



AR5-RCP 4.5
(Bruyère et al., 2015)

Experiment Design: Scenarios

AR5 climate scenario for 2020

RCP 4.5 is a Representative Concentration Pathway climate scenario, with GHG radiative forcing reaching 4.5 W m^{-2} by 2100 considering low-to-moderate GHG emissions (2000-2100)

Eclipse-v5a emission scenarios

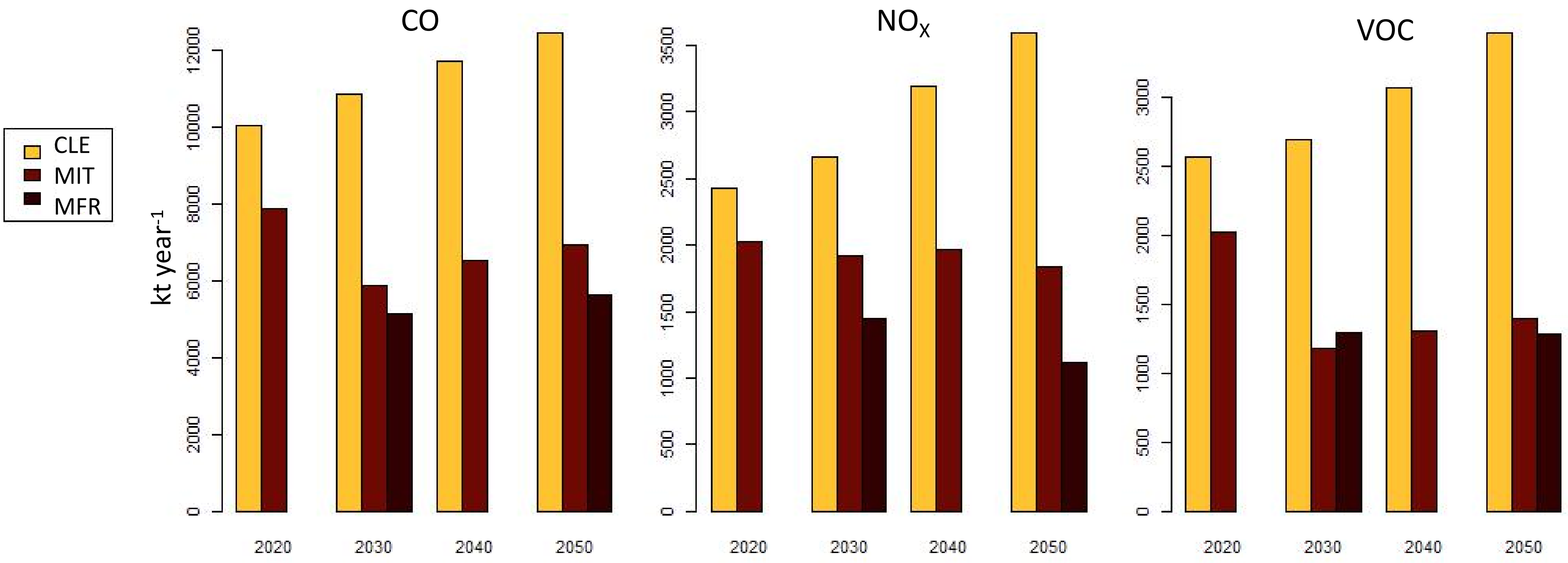
- **CLE** (current legislation scenario):
    - Baseline emissions/reference emissions (*existing legislation frozen by the year 2015*)
    - Higher emissions
    - Available for 2020, 2030, 2040 and 2050

- **MIT** (mitigation):
    - Technological improvements on key sectors
    - Available for 2020, 2030, 2040 and 2050

- **MFR** (maximum feasible reduction):
    - Unconditional implementation of technologies with the lowest emission factors
    - Lower emissions
    - Available for 2030 and 2050

Experiment Design: Emission Scenarios

Total emission for Brazil for Eclipse scenarios for 2020-2050



Experiment Design: Model Setup

WRF domains for Brazil (36km) and Midwest region (09km)

WRF-Chem *versoin 4.0.2*

Parameterization	Option
Radiation	RRTMG scheme (longwave and shortwave) [*Clough et al., 2005*]
Surface layer	Revised MM5 Monin-Obukhov scheme [*Jiménez et al., 2012*]
Land surface	Unified Noah land-surface model [*Chen and Dudhia, 2001*]
Boundary layer	YSU scheme [*Hong et al., 2006*]
Cumulus clouds	Grell 3D Ensemble scheme [*Grell et al., 2002*]
Cloud microphysics	Morrison 2-moments [*Morrison et al., 2009*]
Gas-phase chemistry	CBMZ [*Zavari and Peters, 1999*]
Photolysis	Fast-J photolysis [*Barnard et al. 2004; Wild et al., 2000*]
Aerosol chemistry	MADE [*Ackermann et al., 1998*]
Secondary organic aerosol	SORGAN [*Schell et al., 2001*]

[a] RRTMG: Rapid Radiative Transference Model; MM5: Fifth-Generation Penn State/ National Center for Atmospheric Research (NCAR) Mesoscale Model; NOAH LSM: NOAH: N—National Centers for Environmental Prediction, O—Oregon State University, A—Air Force, H—Hydrologic Research Lab, now Office of Hydrologic Dev, LSM: Land Surface Model,; YSU: Yonsei University Scheme; CBMZ: Carbon Bond mechanism version Z; MADE: modal aerosol dynamics model for Europe; SORGAM: secondary organic aerosol model.

Simulation period: 31 July to 10 August
(2 days for model *spin-up*)

Experiment Design: Ozone Changes

Changes (%) in surface O_3 concentrations:

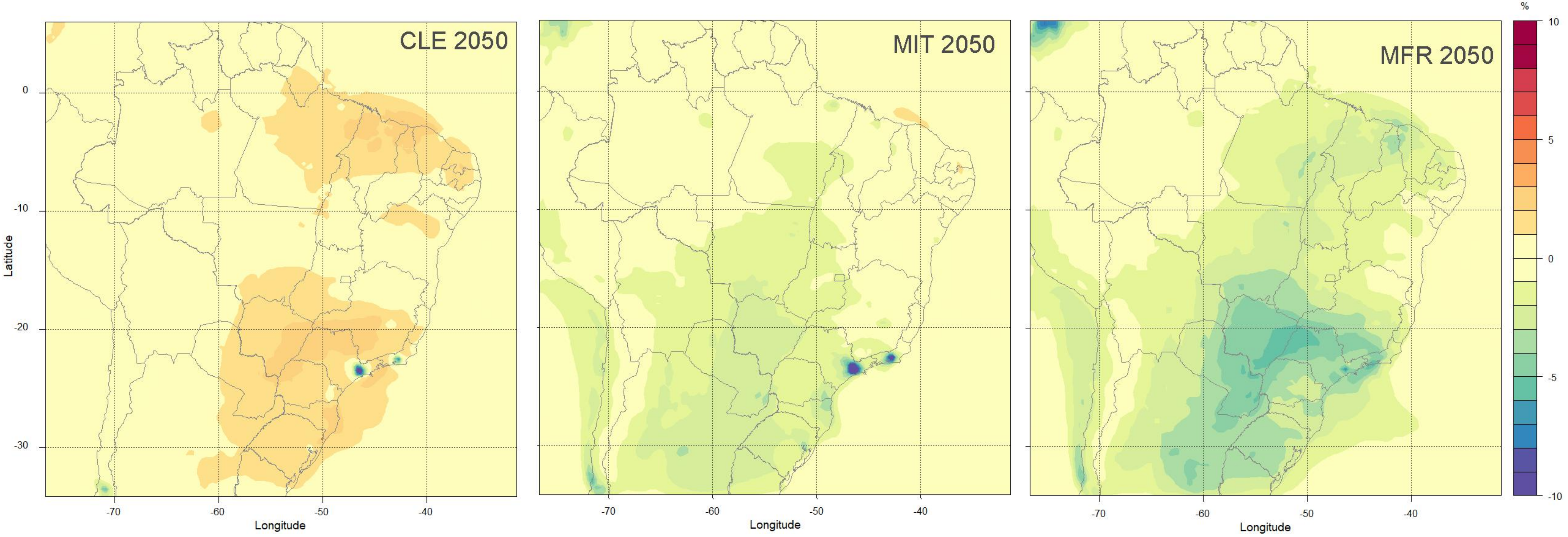
$$\Delta C = 100 \times (\text{sensitivity run}/\text{reference run} - 1)$$

- **Reference run**: **RCP 4.5** and **CLE** for 2020

- **Sensitivity runs**: **RCP 4.5** for 2020 and **CLE, MIT** or **MRF** for 2030-2050

Ozone Changes: 36km Domain

Changes (%) in surface O_3 concentrations



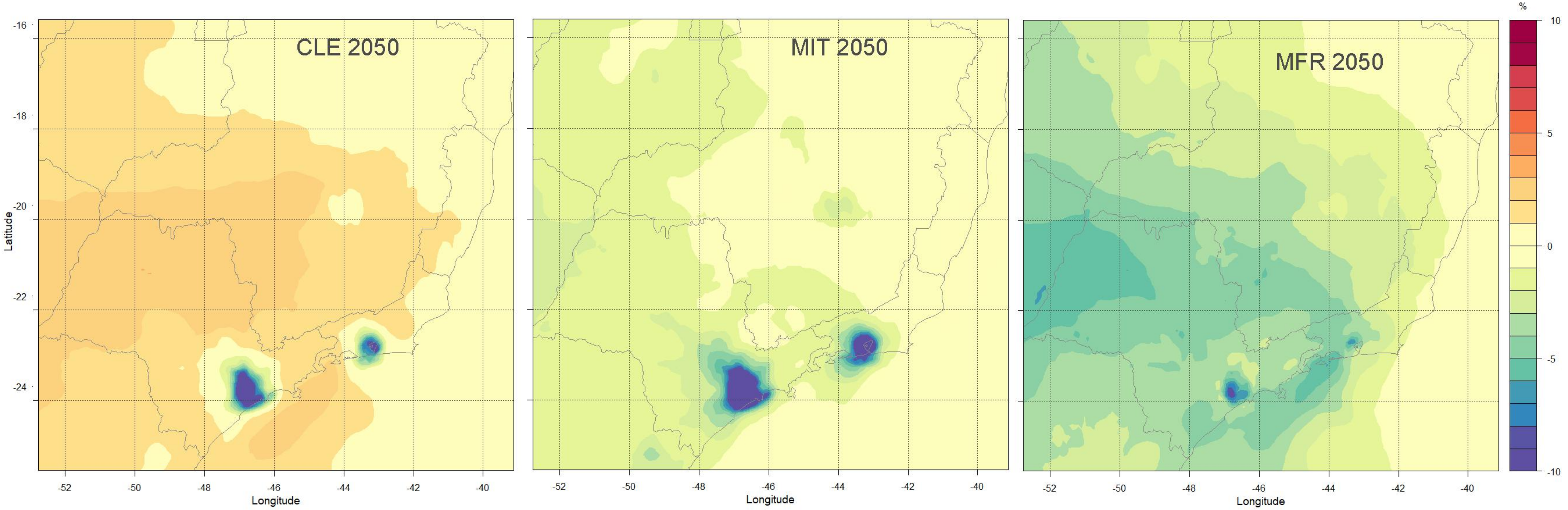
- Two big areas: **+ 3%**
- Metropolitan areas: **- 10%**

- Big area: **- 2%**
- Metropolitan areas: **- 10%**

- Big area: **- 5%**

Ozone Changes: 09km Domain

Changes (%) in surface O_3 concentrations

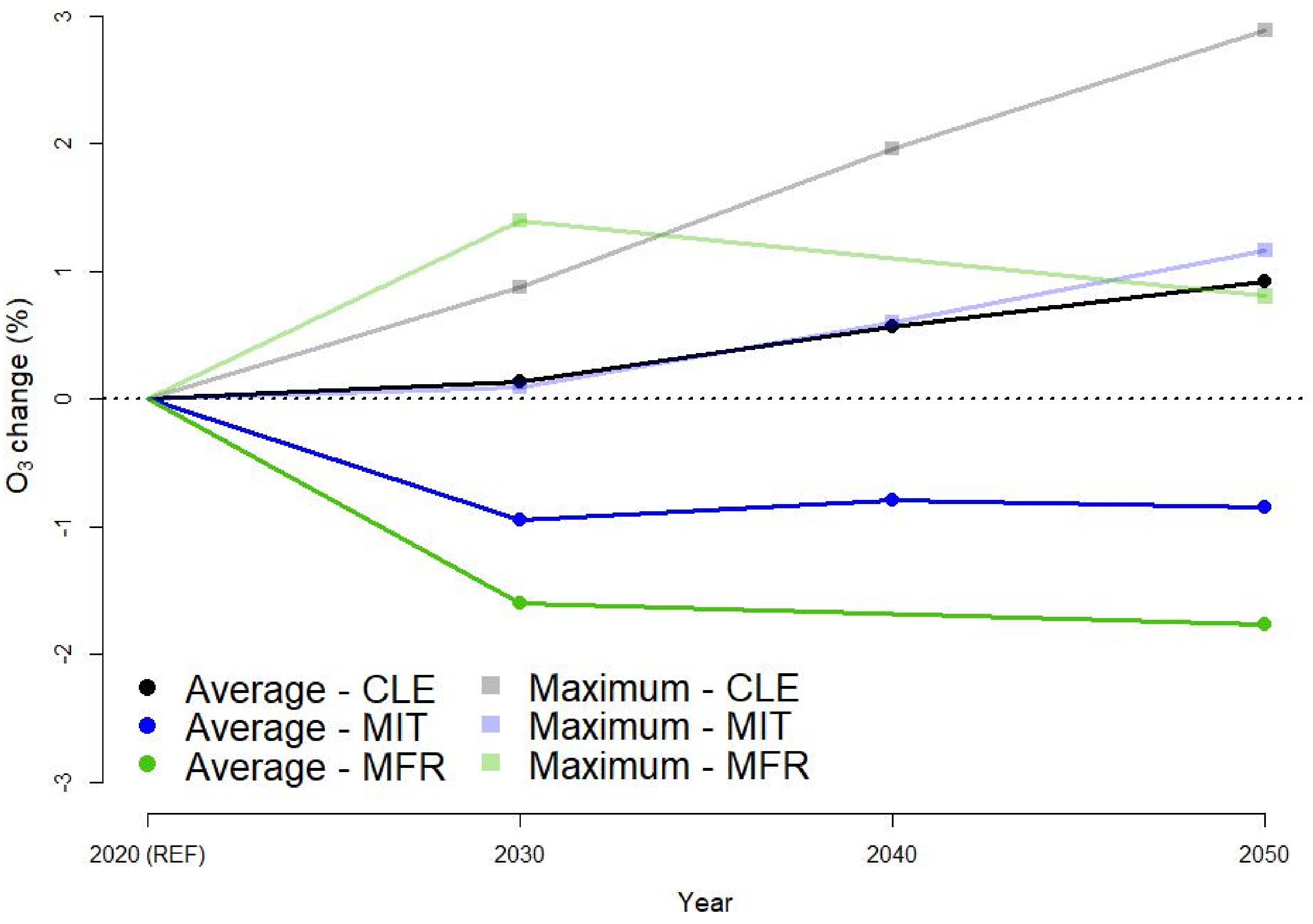


- MASP: **- 11 %**
- MARJ: **- 7.5 %**
- Midwest region: **+ 2 %**

- MASP: **- 15 %**
- MARJ: **- 11 %**
- Midwest region: **- 1 %**

- MASP: **- 6.5 %**
- MARJ: **- 4.5 %**
- Midwest region: **- 5 %**

Ozone Changes: Comparison



Average / Maximum O_3 change for CLE, MIT and MFR (2030 to 2050).

Conclusions

● Non-linear and non-homogeneous responses of O_3 concentration to emission changes

● Spatial patterns linked to emissions from big urban centers such as São Paulo, Rio de Janeiro and Northeast region

● MFR is the scenario with the greatest improvement of O_3 covering a significant area, São Paulo/Mato Grosso do Sul states presented an average reduction of 4.5%

● MIT presented reduction of 15% MASP / 11% MARJ

● The CLE presented the worst air quality, increasing up to 3% in O_3 for two large areas

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Thank you!

Any questions:

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