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de Climatologie

# CLIMATE AND COVID-19 IN THE STATE OF PARANÁ (BRAZIL)

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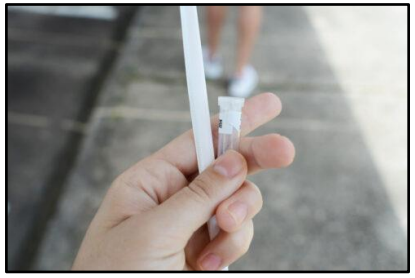

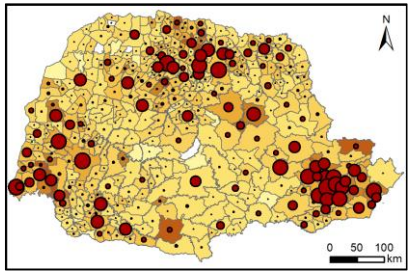


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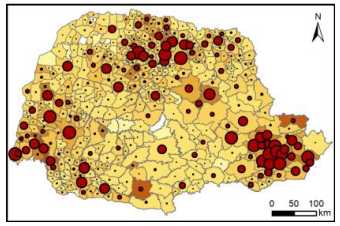
## 1. Introduction


- ✓ The relationship between climate and respiratory diseases is a classic topic in the field of climatology and epidemiology.
- ✓ The COVID-19 outbreak of coronavirus, an infectious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus, was declared a global pandemic on March 11, 2020 by the World Health Organization (WMO, 2022).
- ✓ Since the beginning of the pandemic, several scholars have tried to establish relationships between the climate and the rapid spread and contagion of the population by SARS-CoV-2 in different countries and places.
- ✓ In this context, the present study carried out an analysis relating the dynamics of climate and Covid-19 in the State of Paraná (Brazil).

# CLIMATE AND COVID19 PANDEMIC 2020 !

Table 2 - World: Climate and Covid-19 (partial)

| CITY / COUNTRY | TOTAL CASES 11/04/2020 | CLIMATE (Köppen-Geiger) |
|---|---|---|
| 01. Wuhan / China | 51.140 | Cfa |
| 02. Bergamo / Italy | 10.258 | Cfa |
| 03. Madrid / Spain | 45.849 | CSa |
| 04. New York / USA | 98.715 | Cfa |
| 05. London / England | 18.847 | Cfb |
| 06. Heinsberg / Germany | 1.573 | Cfb |
| 07. Paris / France | 3.249 | Cfb |
| 08. Tehran / Iran | 70.029 | BSk |
| 09. Guayaquil / Ecuador | 3.984 | BSh |

**Table 4.** Brazil - Climate and COVID-19 cases (partial) until 2020/04/12.

| City | Latitude | Climate type* | First case Covid-19 | Case registration** | Registration Deaths** | Lethality rate*** |
|---|---|---|---|---|---|---|
| Manaus | 3ºs | Am | 13-mar-20 | 1053 | 52 | 49.3 |
| Fortaleza | 3ºS | Aw | 15-mar-20 | 1747 | 74 | 42.3 |
| Recife | 8ºS | Am | 12-mar-20 | 960 | 65 | 67.7 |
| Brasília | 15ºS | Aw | 7-mar-20 | 614 | 14 | 22.8 |
| Rio de Janeiro | 22ºS | Aw | 5-mar-20 | 2855 | 170 | 59.5 |
| São Paulo | 23ºS | Cfa | 26-fev-20 | 6352 | 588 | 92.5 |
| BRASIL | 5ºN/34ºS | A – B – C | 26-fev-20 | 22318 | 1230 | 55.1 |

Note: *Climatic groups according to Köppen-Geiger climate classification. ** Data refer to the states, whereas most cases were registered in the capital cities. ***Lethality rate obtained by the ratio between 1000 confirmed cases and the number of deaths.

# CLIMATE AND COVID19 PANDEMIC 2020 !

**Table 2.** Climate and COVID-19 – Literature review until April 15, 2020.

| References | Type article | Country | Tested environment | Range | | | Target Virus | Outcome |
|---|---|---|---|---|---|---|---|---|
| | | | | Temperature | Relative humidity | Absolute humidity | | |
| Tan et al., 2005 | Published | China, Taiyuan | Outdoor environment | 16 - 28 °C | -- | -- | SARS | The optimum environmental may encourage virus growth. There is a higher possibility for SARS to reoccur in spring than that in autumn and winter. |
| Casanova et al., 2010 | Published | China | Laboratory | 20 than at 4 °C | 20- 50 - 80% | -- | SARS-CoV | For temperature, the viruses were inactivated more rapidly on surfaces and all humidity levels. |
| Van Doremalen et al., 2013 | Published | USA | Laboratory | 20°C | 40% | -- | MERS-CoV | MERS-CoV was more stable at low temperature and low humidity conditions. |
| Xie & Zhu, 2020 | Published | China | Outdoor environment | < 3.0 x > 3.0ºC | -- | -- | SARS-COV-2 | The mean temperature has a positive linear relationship with the number of COVID-19 cases with a threshold of 3 °C. |
| Chan et al., 2011 | Published | China | Laboratory | 22-25.0 ºC | 40-50% | -- | SARS-COV | Low temperature and humidity may facilitate COVID-19 transmission. |
| Bukhari et al., 2020 | Preprint | USA | Outdoor environment | 3-17 ºC | - | 3-9g/m3 | SARS-COV-2 | COVID-19 would not spread in warm humid regions. |
| Sajadi et al., 2020 | Preprint | USA | Outdoor environment | 5-11 ºC | 3-6 g/kg | 4-7 g/m3 | SARS-COV-2 | Established significant community spread in cities and regions along a narrow east-west distribution roughly along the 30-50o N' corridor. |

# CLIMATE AND COVID19 PANDEMIC 2020 !

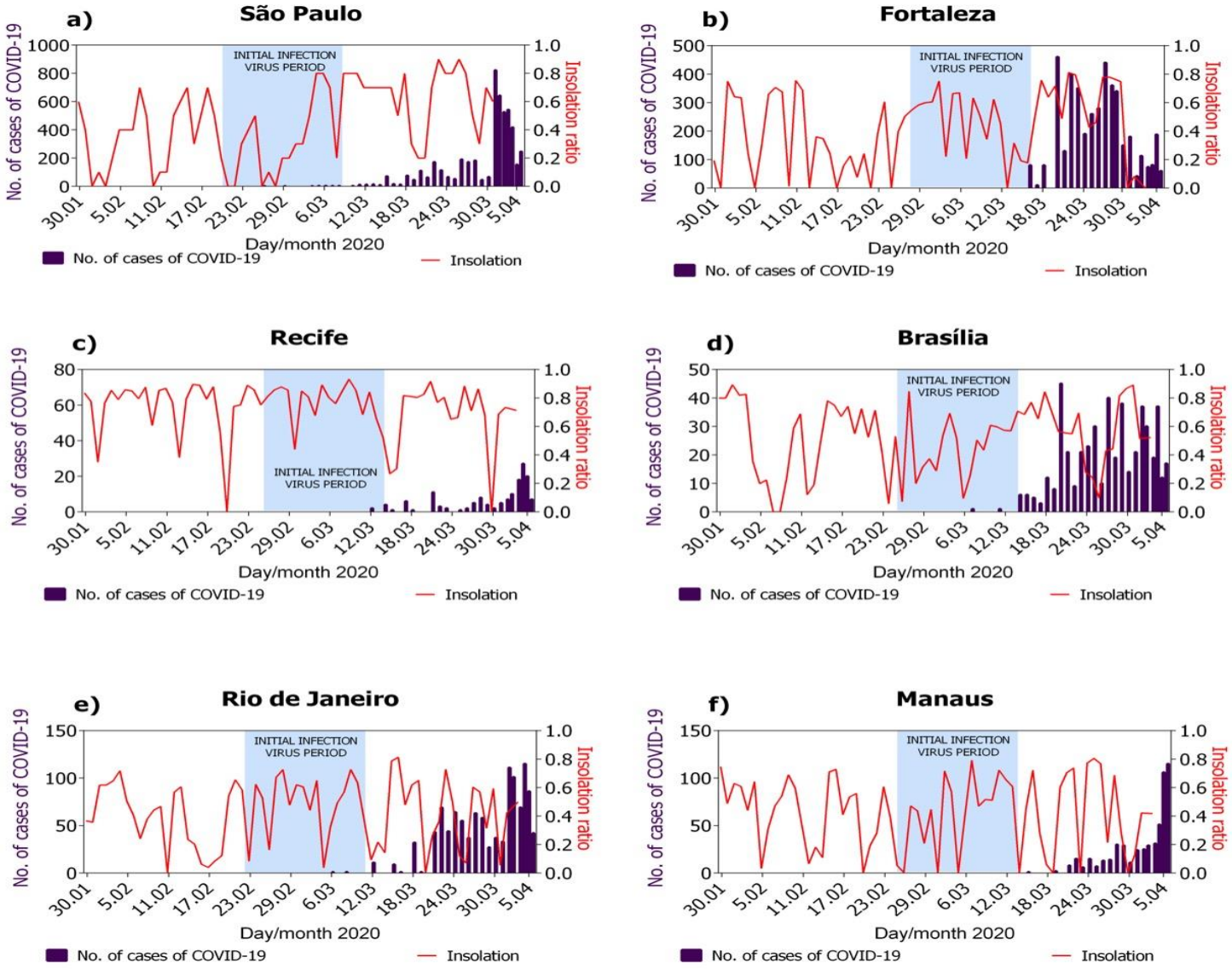



Figure 1: Brazil - Insolation ratio and cases of COVID-19 in six capital cities (from 31/01 to 05/04/2020).

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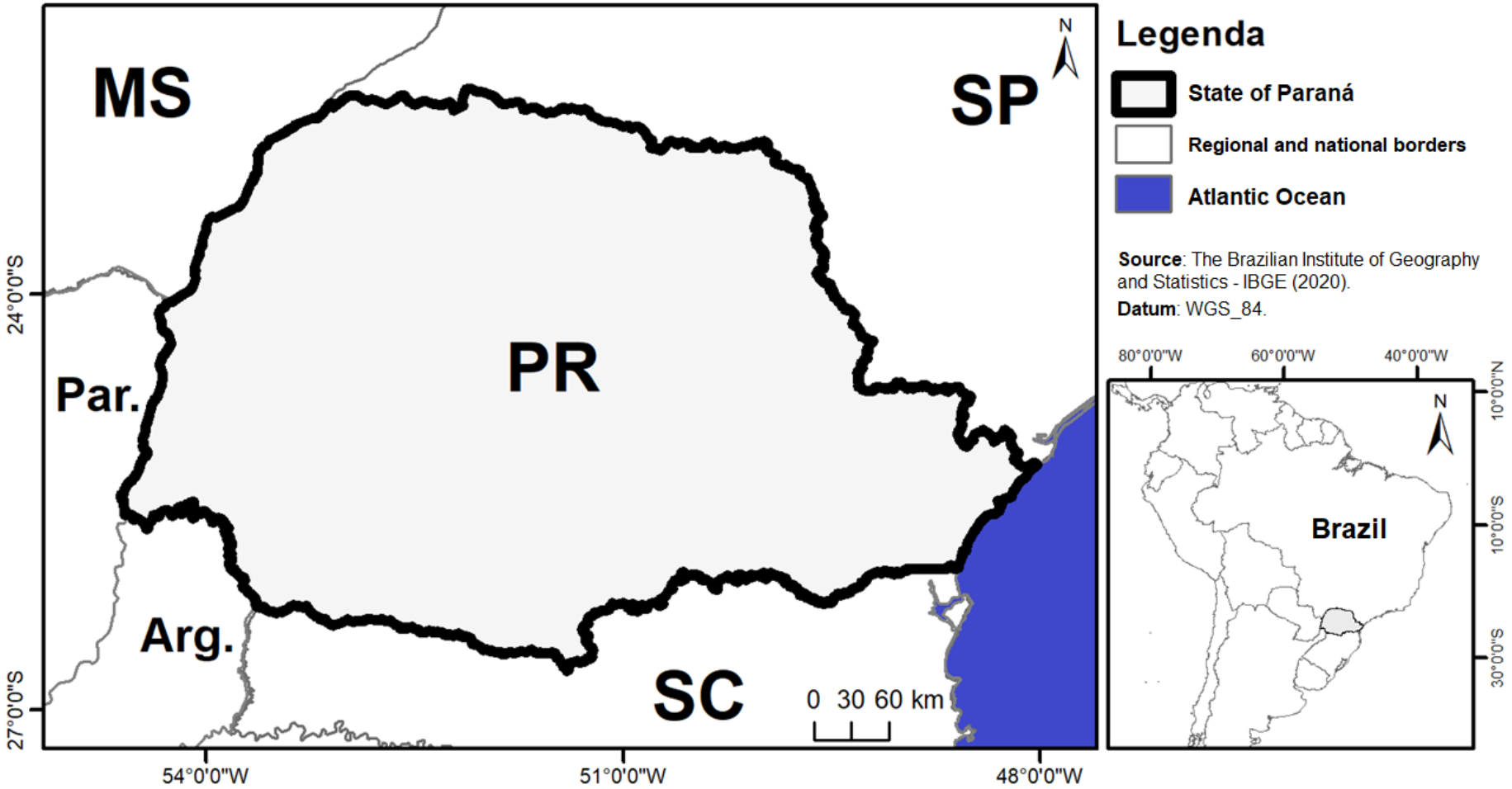


Paraná is located in the southern region of Brazil, has a population of about 11.5 million inhabitants and is characterized by two predominant climate types according to the Köppen classification (Mendonça and Danni-Oliveira, 2007): Cfa (humid temperate climate with hot summer) and Cfb (humid temperate climate with cool summer).

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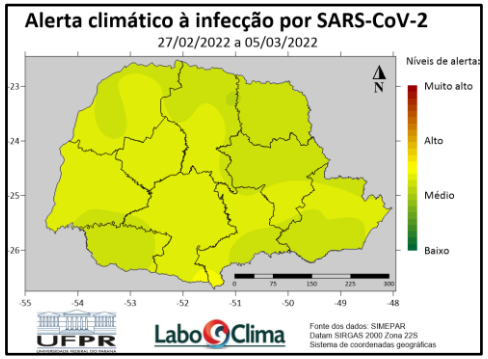
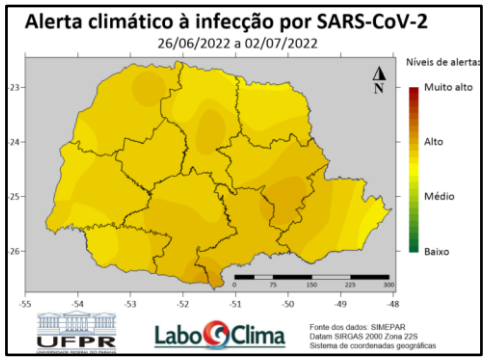
## 2. Methodology




Two examples of SACER maps.
Website:
http://www.terra.ufpr.br/portal/laboclima/sacer/

- ✓ The survey and collection of official data on cases and mortality by COVID-19 was carried out with SESA/PR - Paraná State Health Department (March 2020 to August 2021).
- ✓ COVID-19 data were organized and mapped by cities in the State of Paraná (ArcGIS Pro software).
- ✓ Climatic data (temperature, precipitation and insolation) were collected and analyzed from the four cities that had the most registered cases of COVID-19 in Paraná (Curitiba, Londrina, Maringá and Foz do Iguaçu).
- ✓ To assist data analysis, the SACER - Climate Alert System for Respiratory Diseases were used. It is a platform developed by the LABOCLIMA/UFPR (2022) to evaluate in the epidemiological weeks the parameters and weather categories (from temperature and humidity) of transmission based on the state of the art on the knowledge of the relationship between the climate and COVID-19.
- ✓ The study deals with the variations of the climate dynamics during the pandemic in a multicausal perspective, and was prepared in accordance with the concept of pathogenic complexes (Sorre, 1984), with climate being one of the important elements in this approach (Besancenot, 2001; Ab'Sáber, 2007).

## 3. Results

### 3.1. Temporal evolution of the spatial distribution of COVID-19 in Paraná

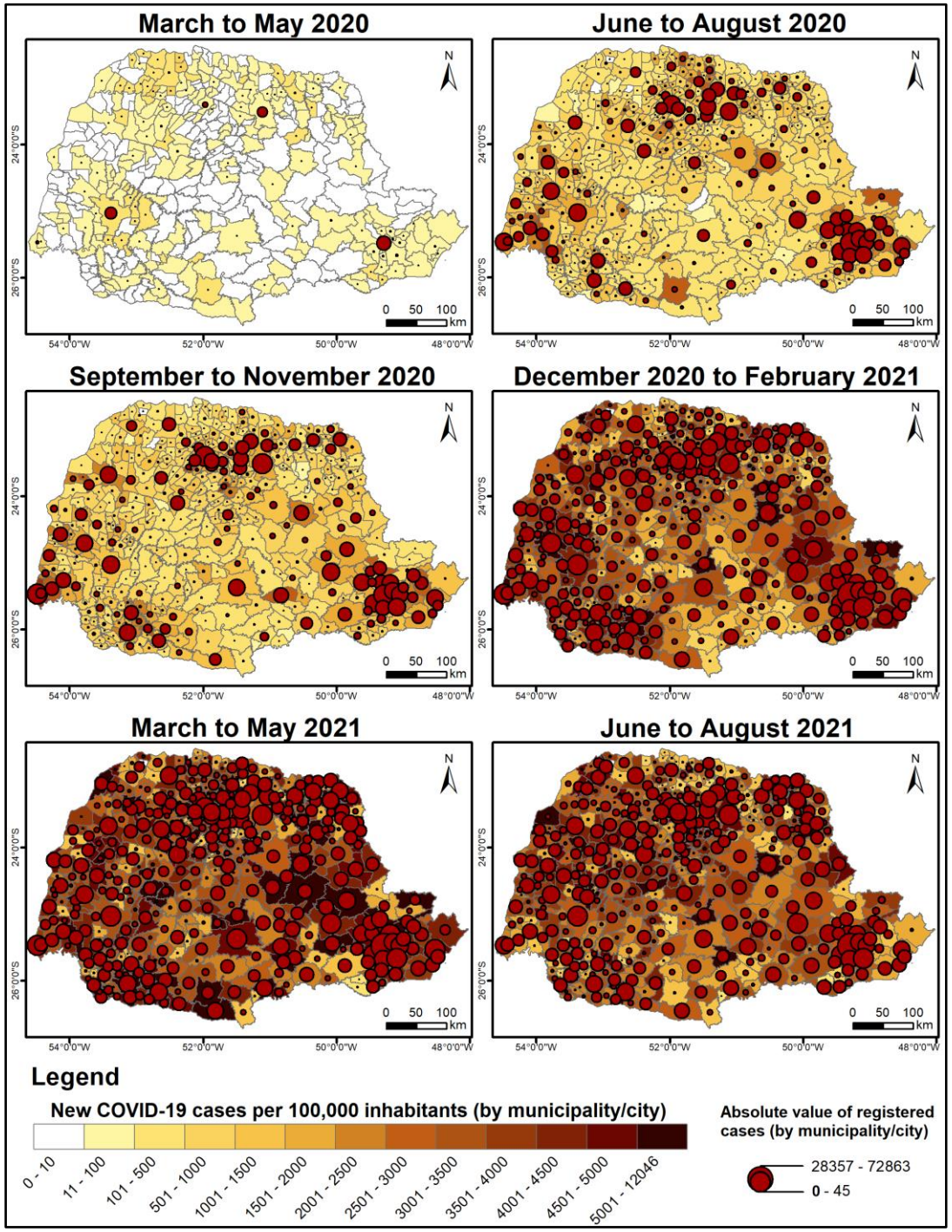



Figure 1. Quarterly maps of the temporal and spatial dynamics of COVID-19 cases in the State of Paraná (2020-2021).

## 3. Results

### 3.2. Relationship between COVID-19 and climate variability

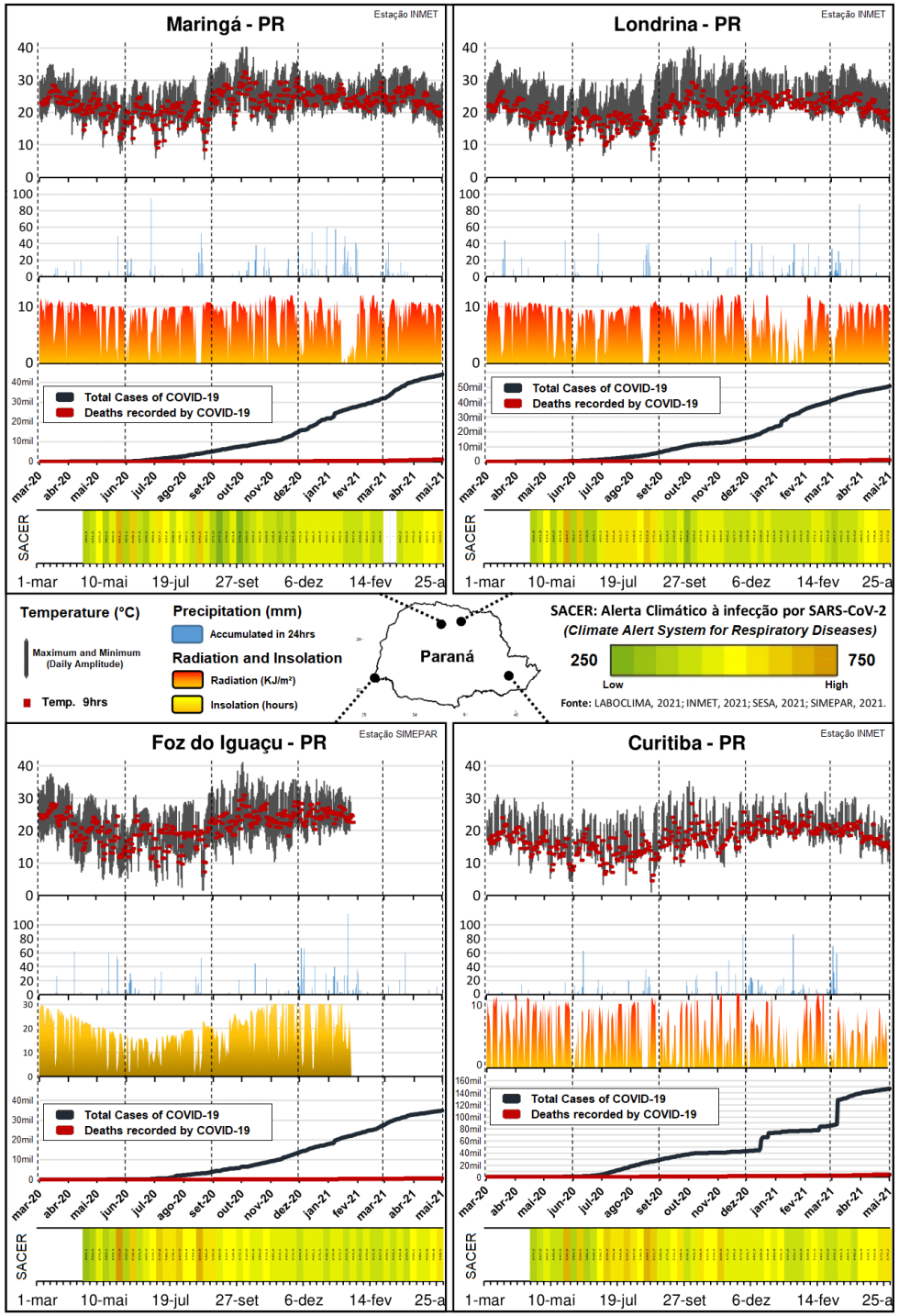



Figure 2. Climate and COVID-19: daily and weekly situation of the main cities in the State of Paraná.

## 4. Conclusion

- ✓ From the research carried out, it was possible to observe the dynamics of transmission of COVID-19 over time in the State of Paraná, as well as to highlight the variation in the number of cases/deaths in relation to atmospheric conditions and prevailing climate alert levels. Specifically, transmission was found to intensify during the autumn and winter season, although it was also important during spring and summer.

- ✓ Regarding this issue, the direct and indirect influences of the climate on the behavior of the population, especially with regard to social isolation, were evidenced in the study, considering them as complementary factors of a multicausal relationship. Based on the results obtained here, progress should be made in understanding the other factors for a better understanding of the dynamics of the pandemic, such as barrier gestures (respected or not), emergence of new variants of COVID-19, epidemiological and contagious aspects of the virus, and others, based on new scientific advances and recent literature.

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# *Merci!*

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