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## Regional Climate Modelling in the Northeast of Brazil

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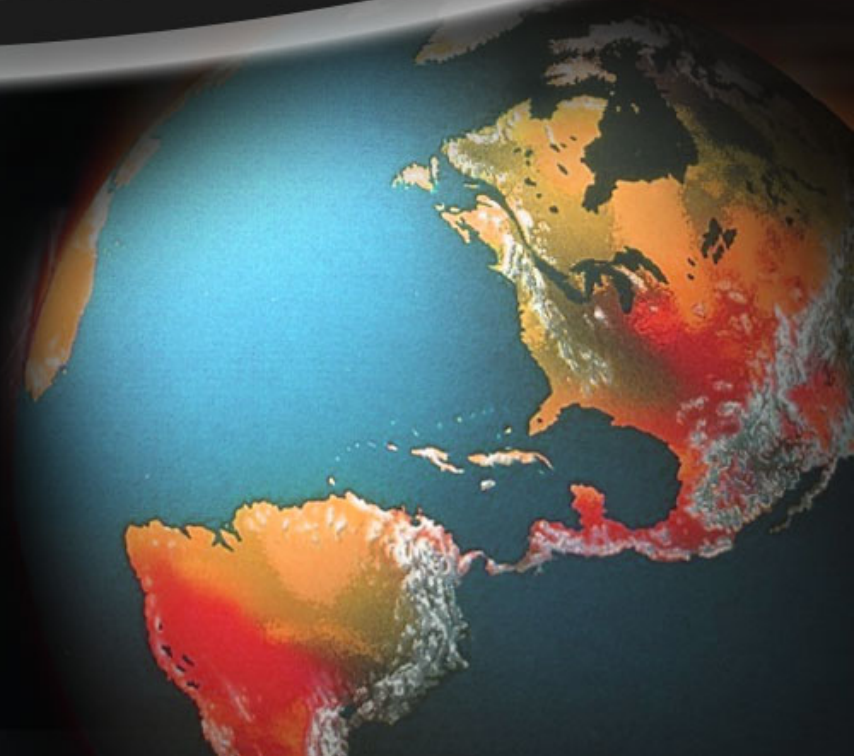
**DCAC/PPGCC**



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## Regional Climate Modeling Work Group

# Regional Climate Modeling Work Group

Prof. Dr. Cristiano Prestrelo
Coordinator

Prof. Dr. Cláudio Moisés
Coordinator

# Regional Climate Modeling Work Group

**Scientific initiation scholarship students**

1 – Jessica Cristina
2 – Any Caroline
3 – Wendy Pires

**Master Student**

1 – Felipe Jeferson
2 – Moniki Dara
3 – Gustavo Matsubara

**Doutorate Student**

1 – Alcindo Mariano
2 – Biancca Medeiros
3 – Rosária Ferreira
4 – Layara Campelo
5 – Patricia Nunes
6 – Maria Leidinice

**Pos-Doc**

1 – Keila Mendes
2 – Helder da Silva

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Climatic Characteristics of Northeast Brazil

Extreme climatic events over NEB

Climate Change Vulnerability

Regional Climate Modeling - Experiment

# Climatic Characteristics of Northeast Brazil

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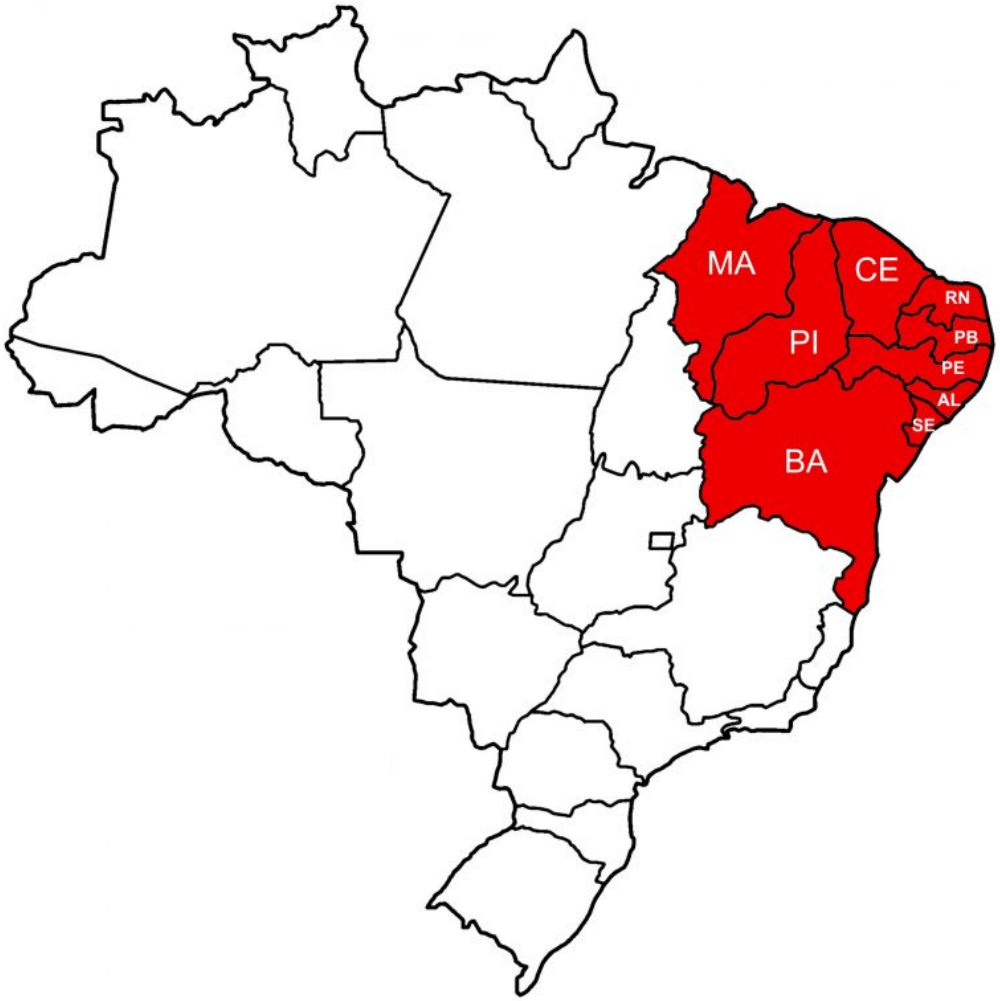
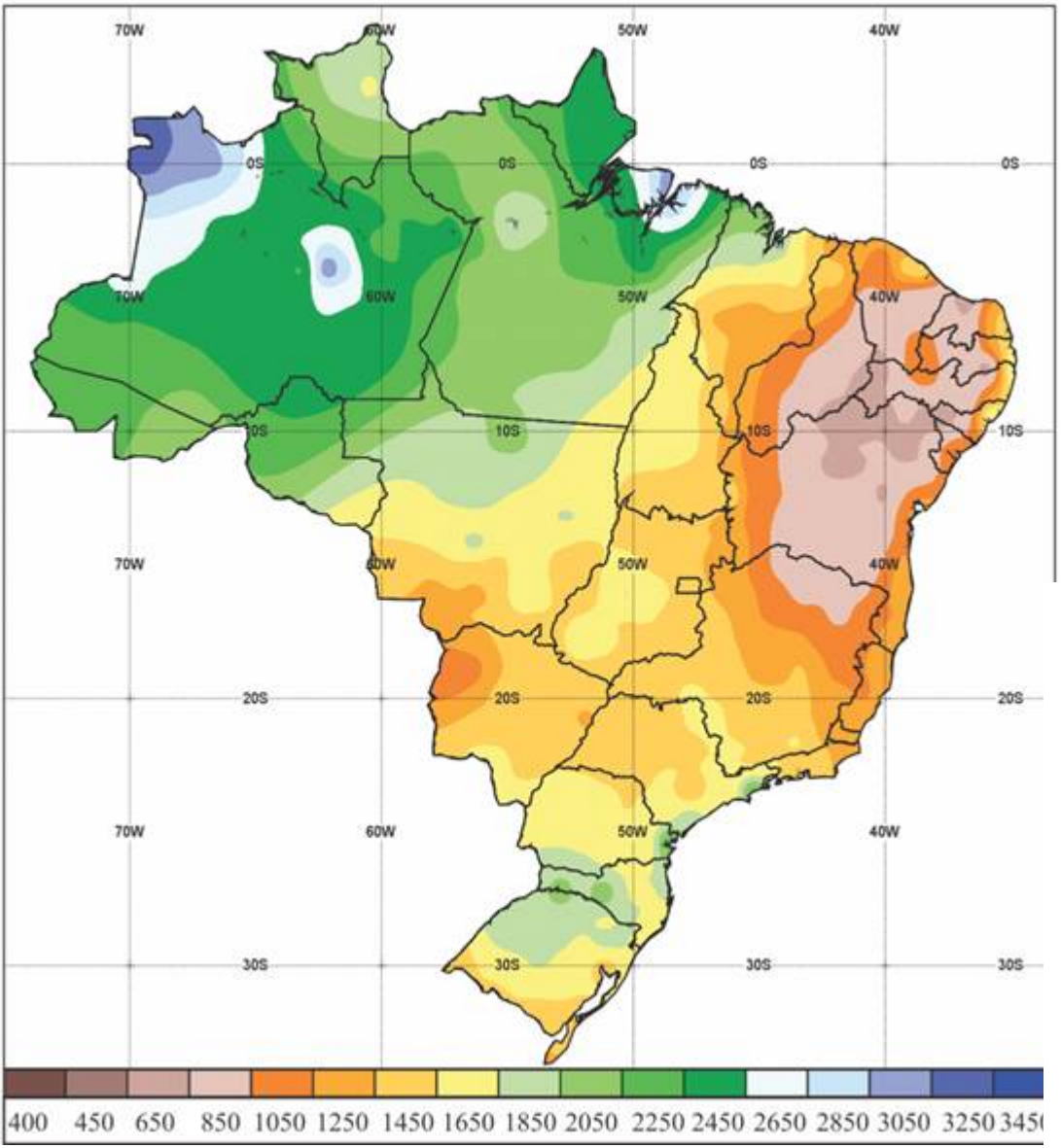
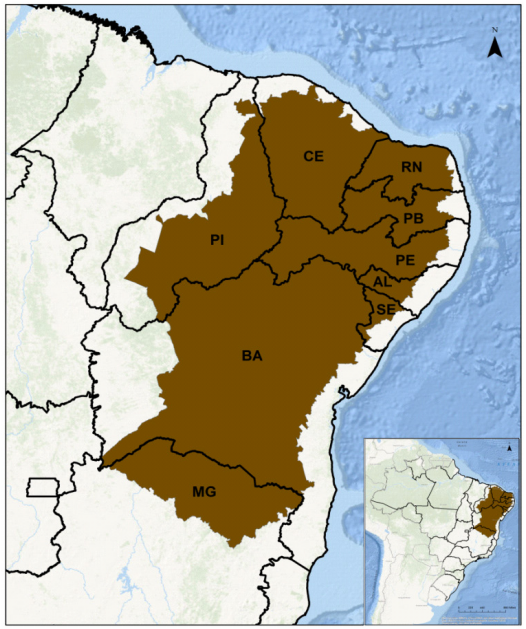



Northeast Brazil (NEB) covers an area about ~1,6 km$^2$, corresponding around 18% of Brazilian territory.

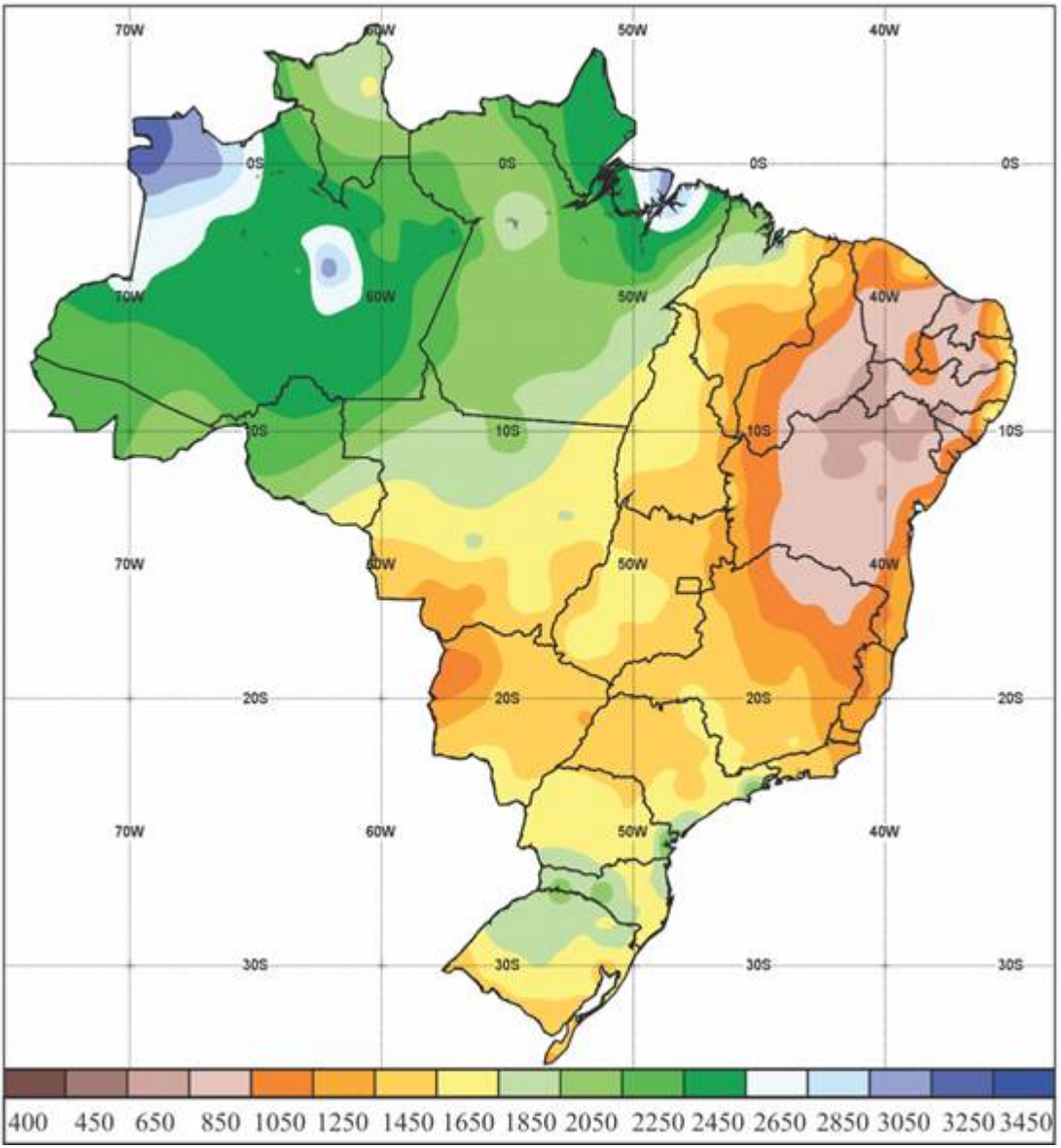



Climate normals of accumulated annual precipitation (mm) for the period of 1981-2010 in Brazil. Source: Inmet (2018).

The annual accumulated precipitation does not exceed 500 mm in some areas of the semiarid Northeast; in contrast, there are areas like the coastland of the NEB where the annual rainfall is more than 1500 mm.




Geographical location of Brazilian Semiarid.




Climate normals of accumulated annual precipitation (mm) for the period of 1981-2010 in Brazil. Source: Inmet (2018).

Due to this great extension, the region can be divided into subregions, such as coast area, semiarid regions, and Amazon forest (the northwest of Maranhão state).

Each of these subregions has different climatic characteristics (Alvares et al. 2013).

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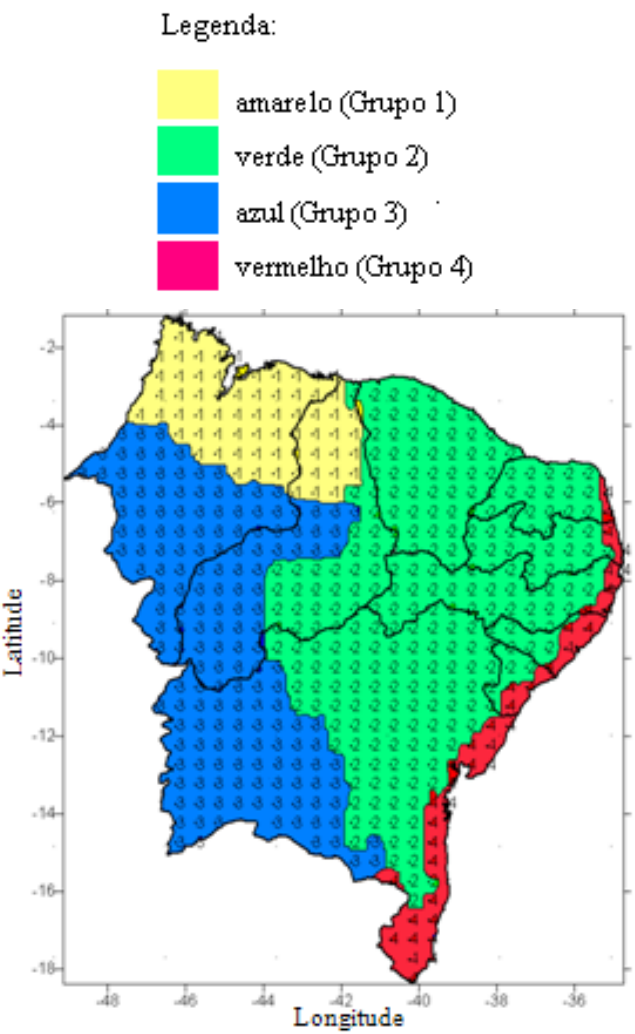


Each of these subregions has different climatic characteristics due to the action of different atmospheric systems, like the

Intertropical Convergence Zone (ITCZ) (Uvo 1989);

the upper tropospheric cyclonic vortex (UTCV) (Kousky and Gan 1981);

the easterly waves disturbances (EWD) (Riehl 1945);

the squall lines (SL) (Kousky 1980);

Front Systems (FS) in the southern part of the state of Bahia (Kousky 1979);

and the South Atlantic Convergence Zone (SACZ) (Kodama 1992).

# Extreme Climatic Events over NEB

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Drought episodes in NEB have been reported since the 16th century

A list of events updated to 2016 follows:

1583, 1603, 1624, 1692, 1711, 1720, 1723-1724, 1744-1746, 1754, 1760, 1772, 1766-1767, 1777-1780, 1784, 1790-1794, 1804, 1809, 1810, 1816- 1817, 1824-1825, 1827, 1830-1833, 1845, 1877-1879, 1888-1889, 1891, 1898, 1900, 1902-1903, 1907, 1915, 1919, 1932-1933, 1936, 1941-1944, 1951-53, 1958, 1966, 1970, 1976, 1979-1981, 1982-1983, 1986-87, 1992-1993, 1997-1998, 2001-2002, 2005, 2010 e 2011-2016.

(Araújo 1982, Magalhães et al. 1988, Gutierrez et al. 2014, Wilhite et al. 2014, Marengo et al. 2016b).

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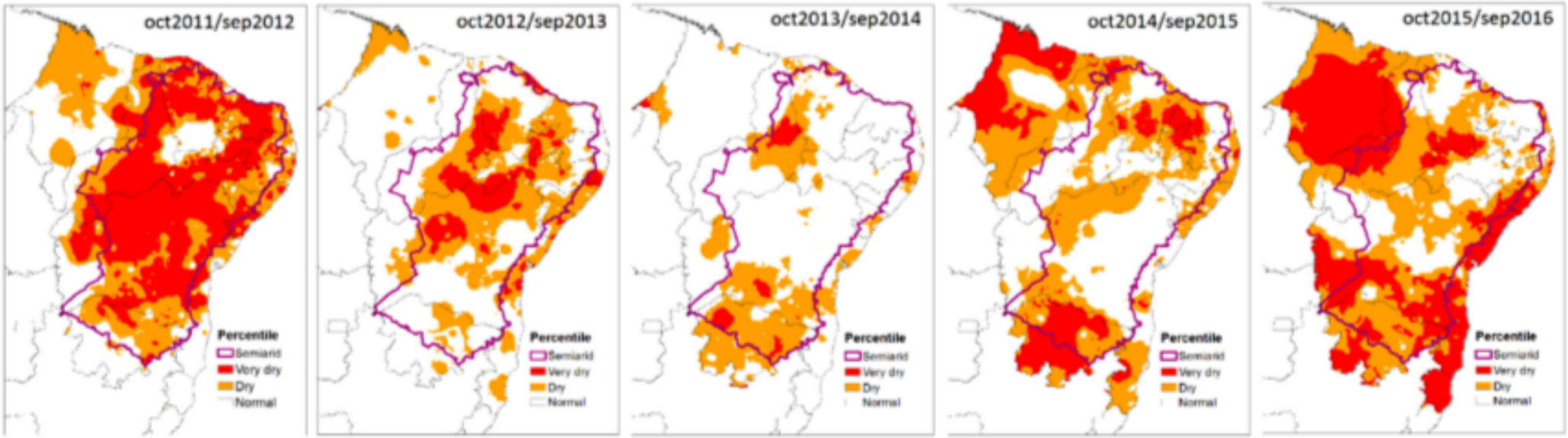


**Figure 2** Percentile of precipitation to hydrologic years 2011-2012, 2012-2013, 2013-2014, 2014-2015 and 2015-2016.

Cunningham et al 2017

The recent drought of 2011/2016 reached approximately 1100 cities, and affected approximately 23 million people.
Northeast had losses of R$ 104 billion due to lack of water. Of this total, R$ 74.6 billion was in agriculture, R$ 20.6 billion in cattle raising and R$ 1 billion in industry.

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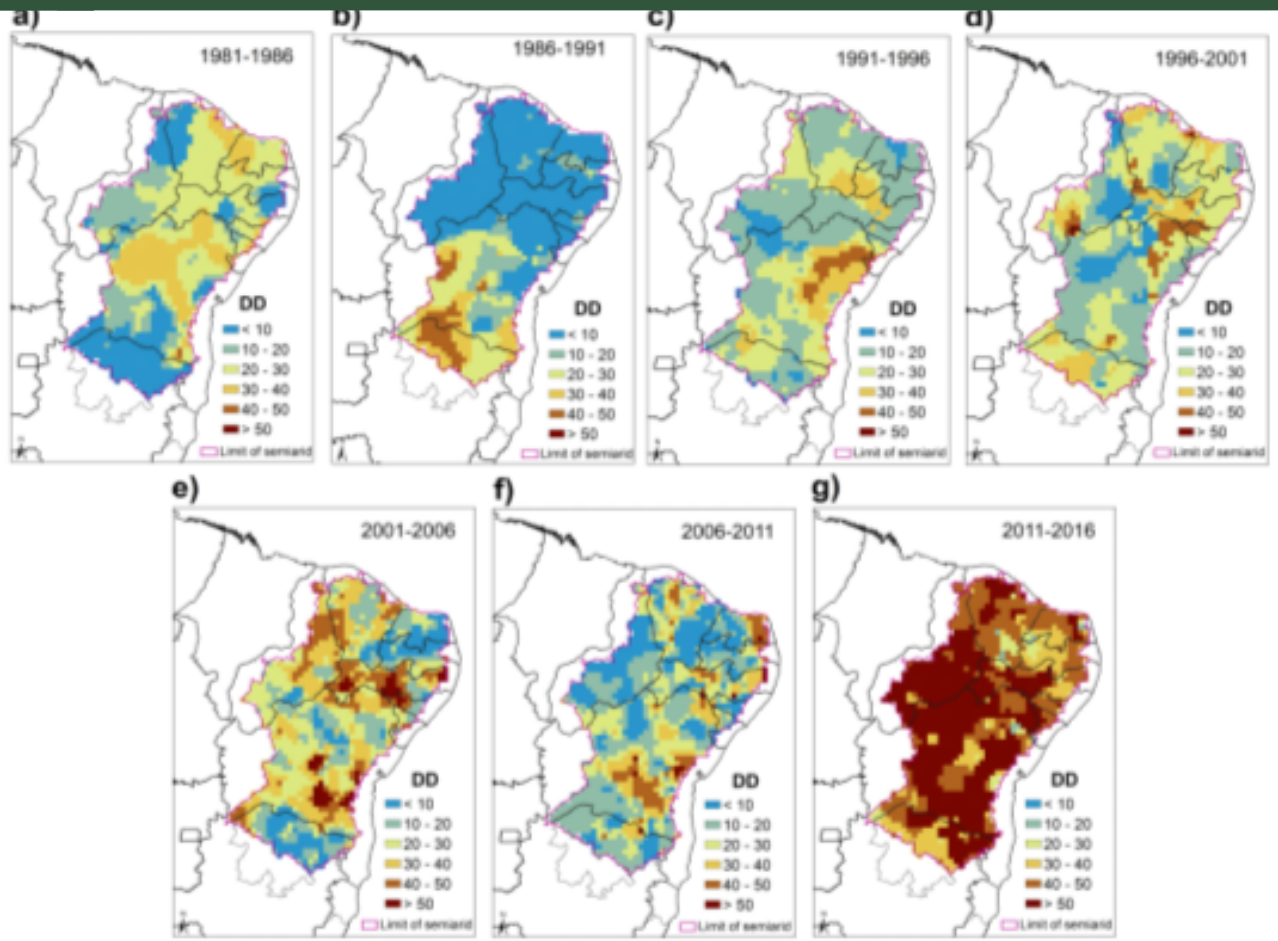


**Figure 4** Drought duration maps for a) 1981-1986, b) 1986-1991, c) 1991-1996, d) 1996-2001, e) 2001-2006, f) 2006-2011 and g) 2011-2016 quinquennials, according to SPI data. (Source: Brito et al., 2017).

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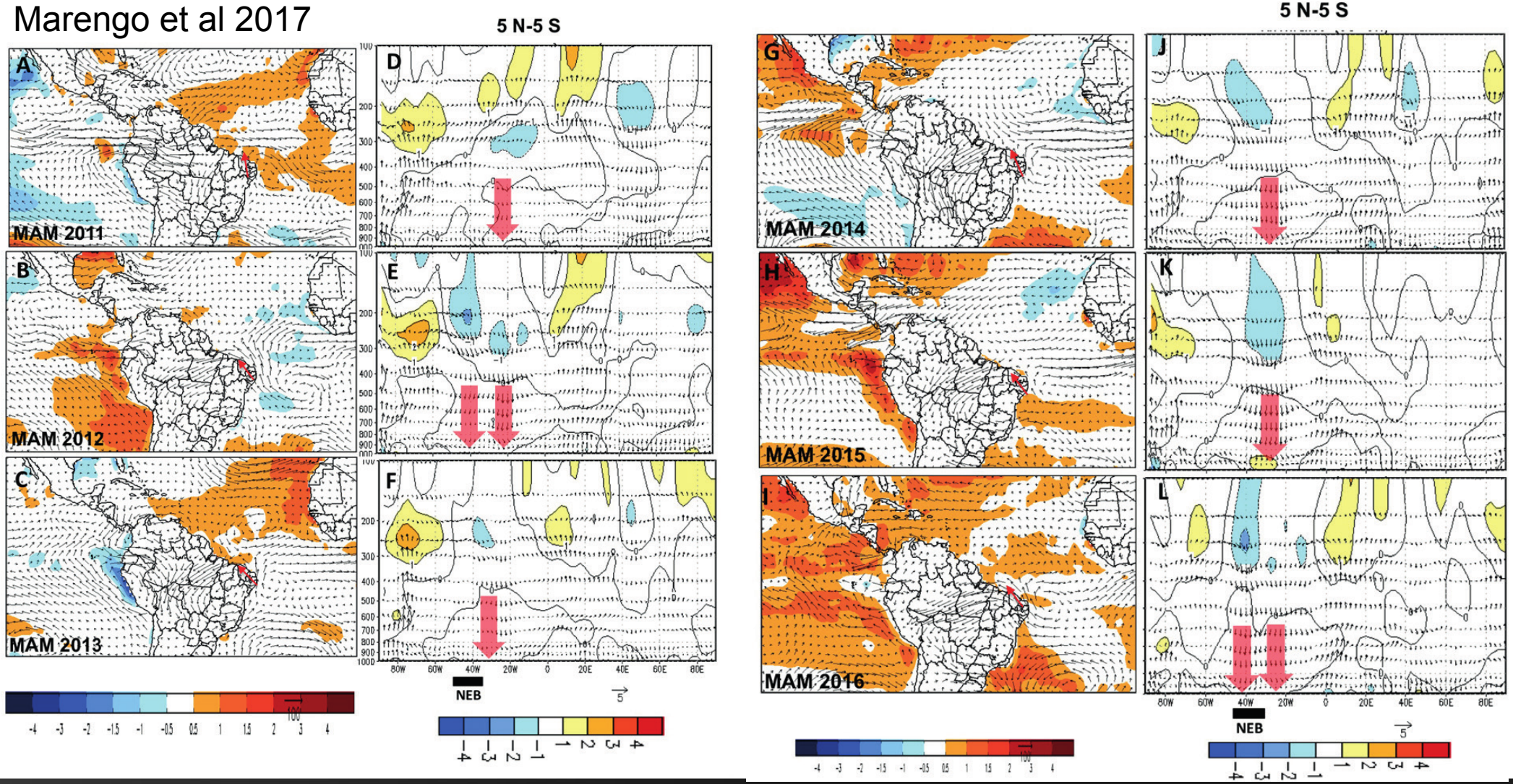
## Marengo et al 2017



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## Climate Change Vulnerability

# Caatinga Biome

Caatinga is a type of desert vegetation.

The name "Caatinga" is a Tupi word meaning "white forest" or "white vegetation" (caa = forest, vegetation, tinga = white).

Caatinga It covers nearly 10% of Brazil's territory. It is home to 26 million people and more than 2000 species of vascular plants, fish, reptiles, amphibians, birds, and mammals.

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## Caatinga Biome

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## Caatinga Biome

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SCVI was built by coupling the RCCI (using climate projections from CMIP5 - Coupled Model Inter-comparison Project Phase 5) with a high-resolution map of population density (Goldewijk et al. 2010) and Brazil's human development index at the municipality level (MHDI) based on the 2010 census.

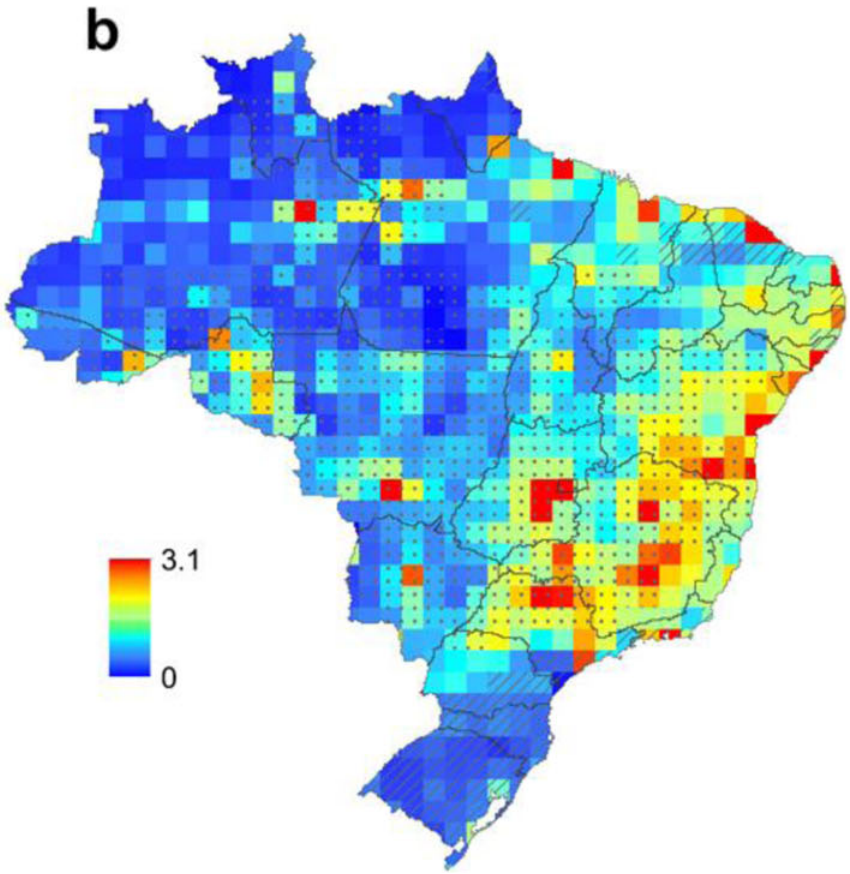
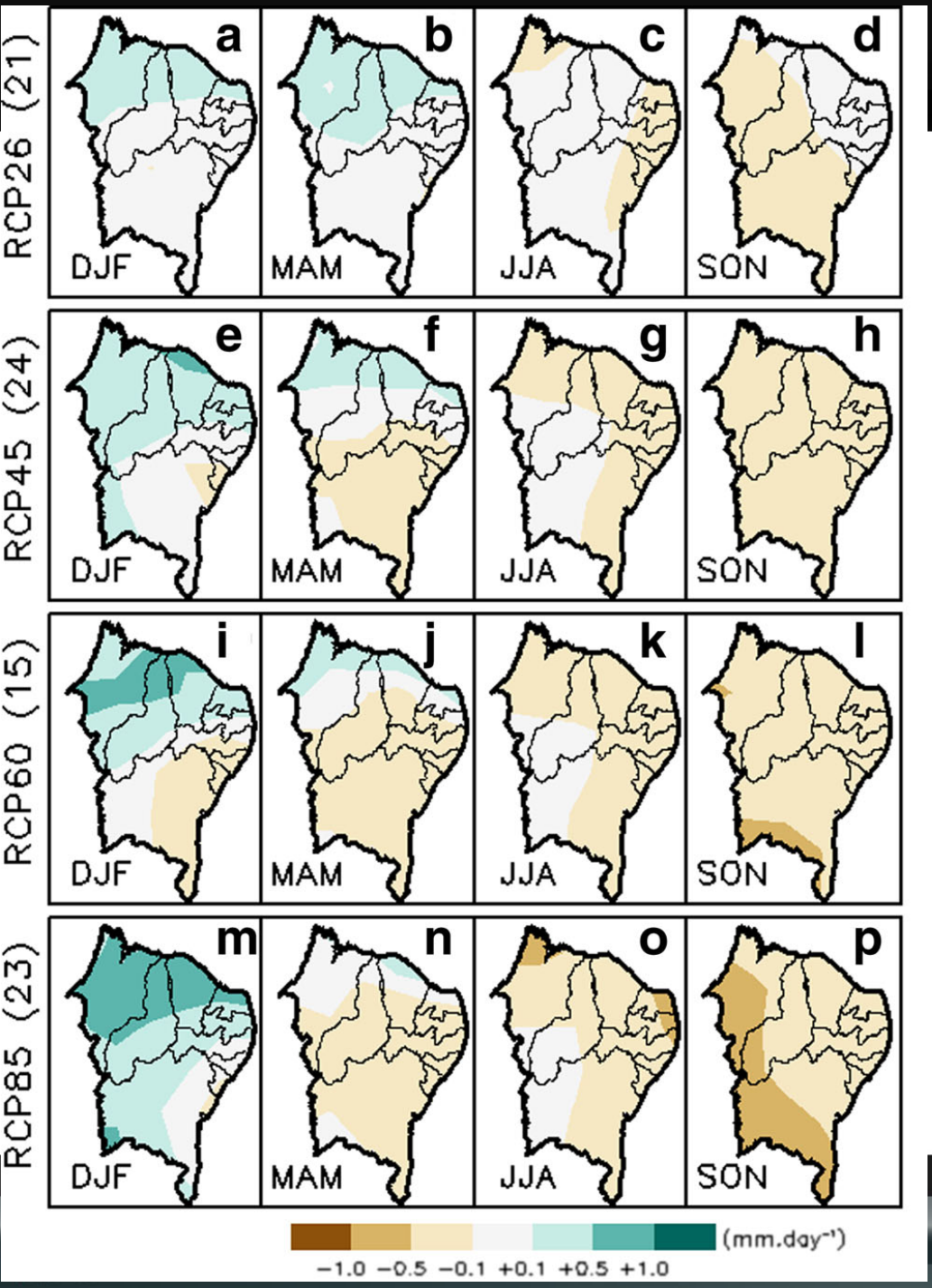
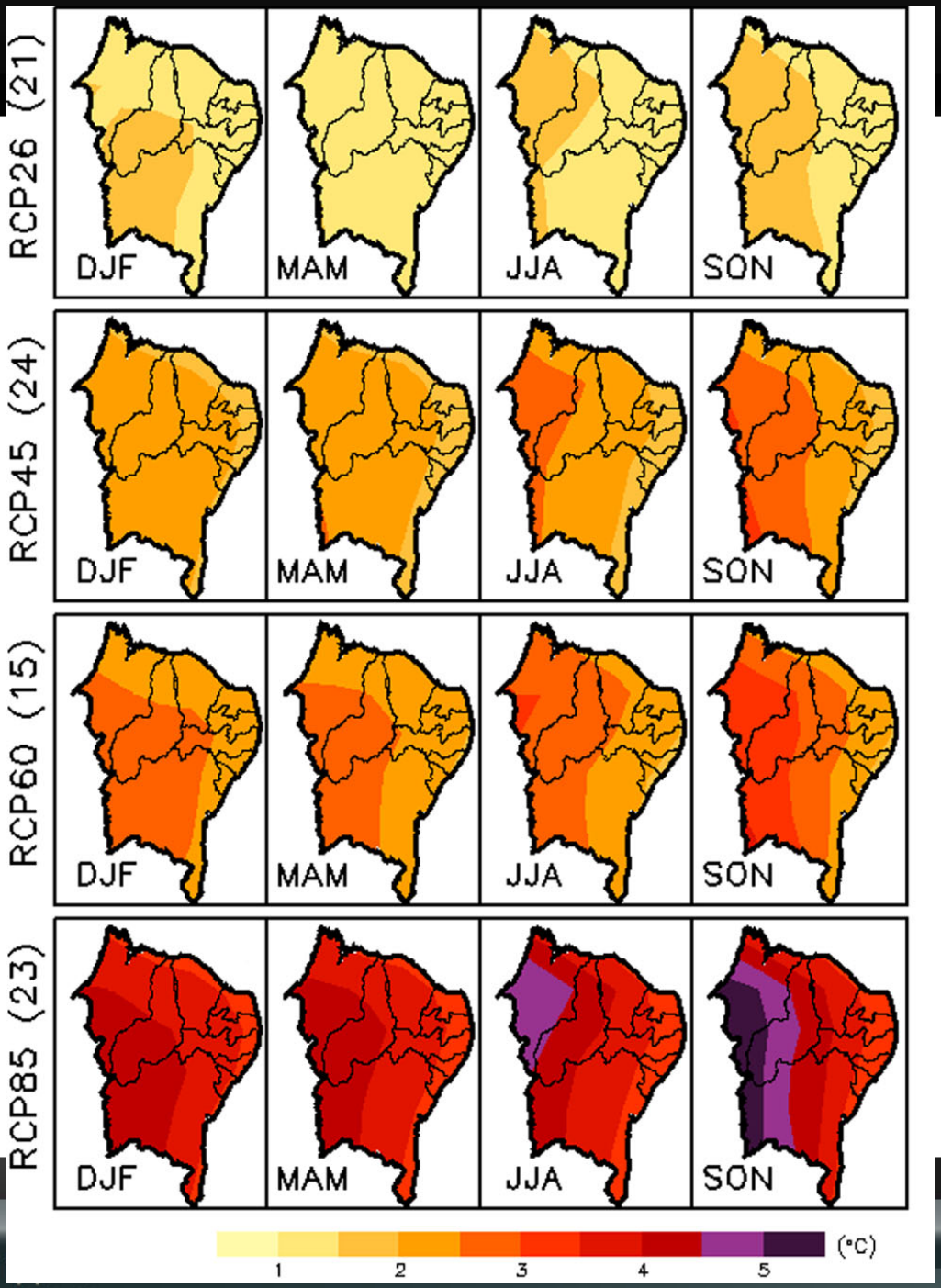


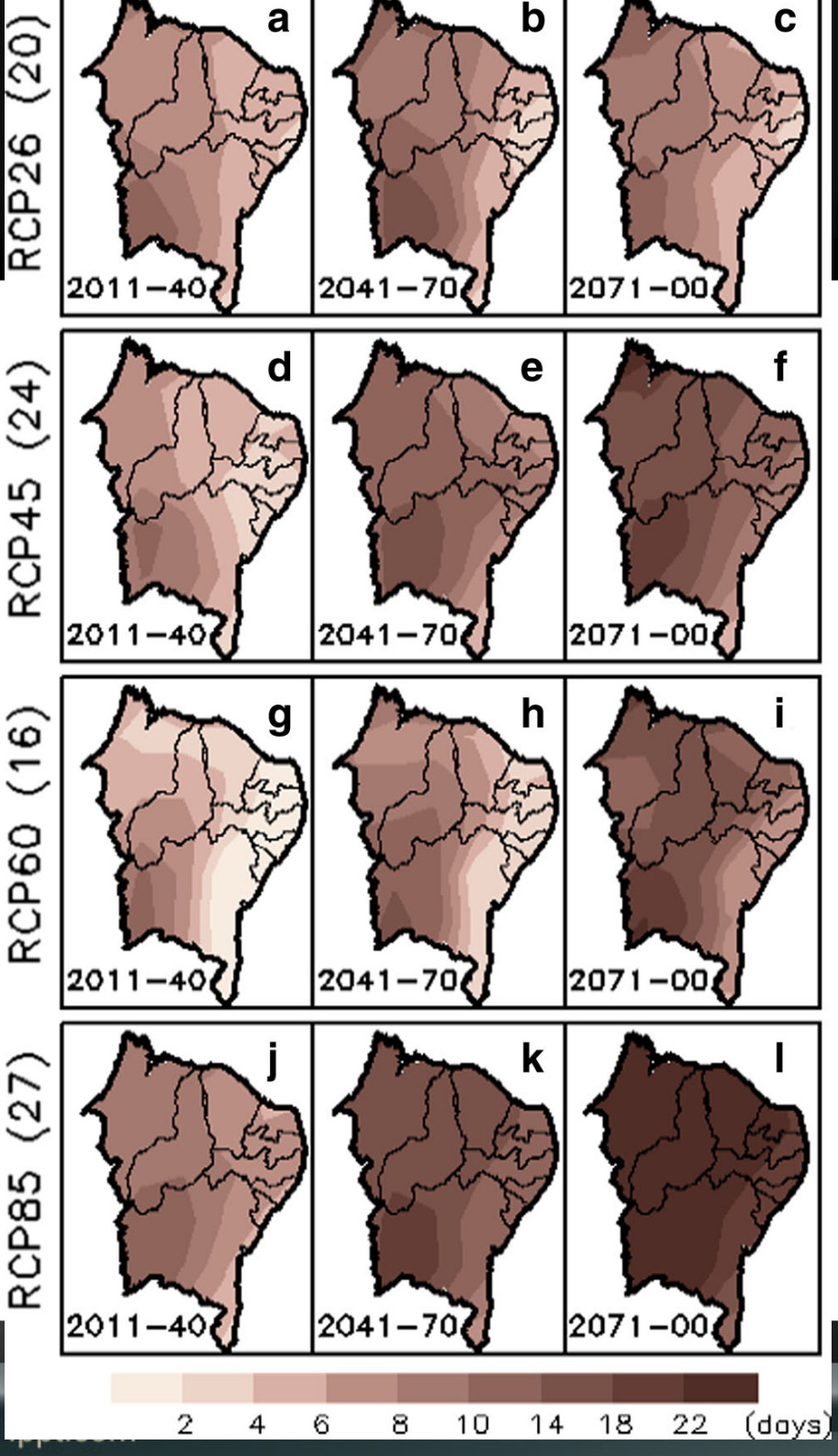

Figure. b SCVI calculated with social indicators for the year 2010 and climatic data from CMIP5.




Rainfall anomaly projections, at the end of century (2071-2100) in mm/day relative to 1961-1990.




Projections of temperature anomalies ºC, at the end of century (2071-2100) relative to 1961-1990.




Projections of consecutive dry days (CDD; days).

# Regional Climate Modeling - Experiment

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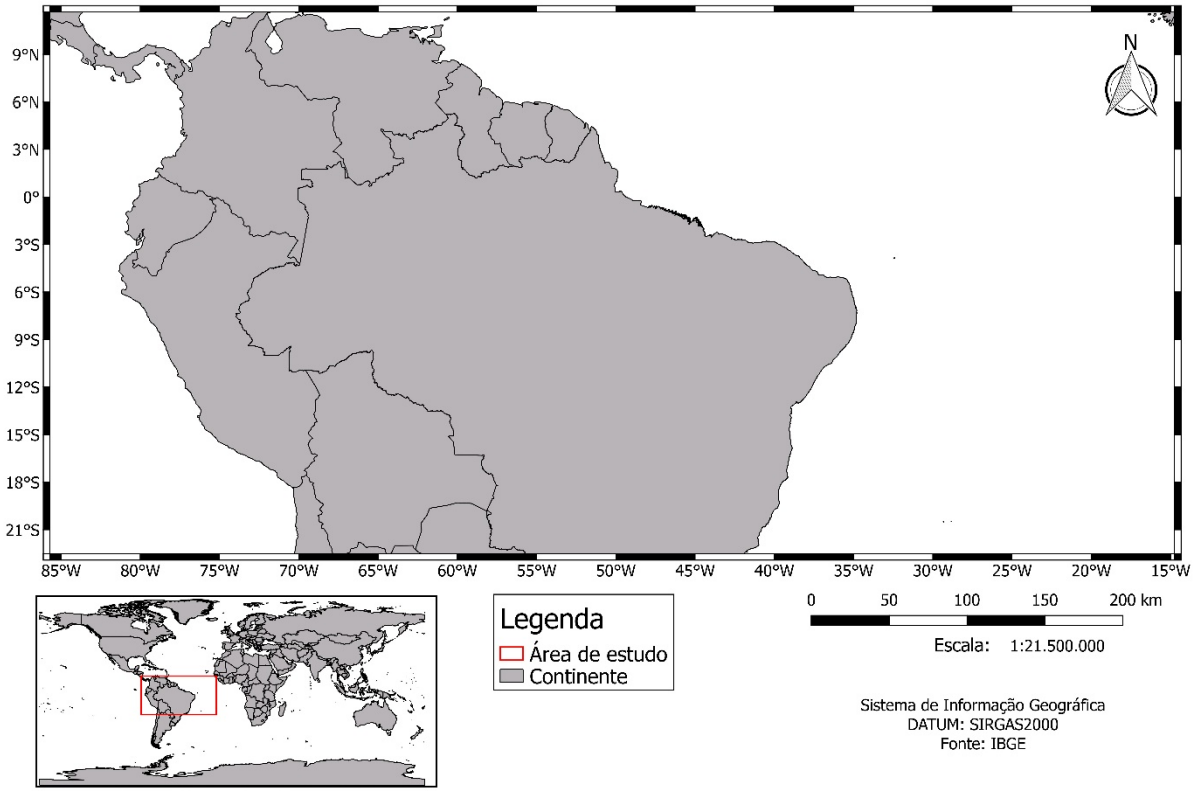


Domain.

For all experiments:

| Dynamic core | MM4 hydrostatic |
|---|---|
| Number of point in x axis | 160 |
| Number of point in y axis | 80 |
| Grid spacing | 50km |
| Vertical levels | 18 with top at 5 hPa |
| Microphysics | SUBEX (Pal et al., 2007) |
| Boundary Layer Turbulence | Holtslag (1991) |
| Sea Surface Temperature | Weekly Optimal Interpolation (NOAA) |
| Large Scale Atmospheric Conditions | ERA_Interim (Dee et al., 2011) |
| Soil-Vegetation-Atmosphere interface | BATS |
| Central Latitude | 5S |
| Central Longitude | 50W |

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Numerical experiments characteristics:

| Experiment | Period | Convection | Status |
|---|---|---|---|
| Test 1 | Jan 2012 to Dec 2013 | Tiedtke | ok |
| Test 2 | Jan 2012 to Dec 2013 | Emanuel | ok |
| Experiment 1 | Jan 1981 to Dec 2010 | Emanuel | ok |
| Experiment 2 | Jan 1981 to Dec 2010 | Grell | ok |

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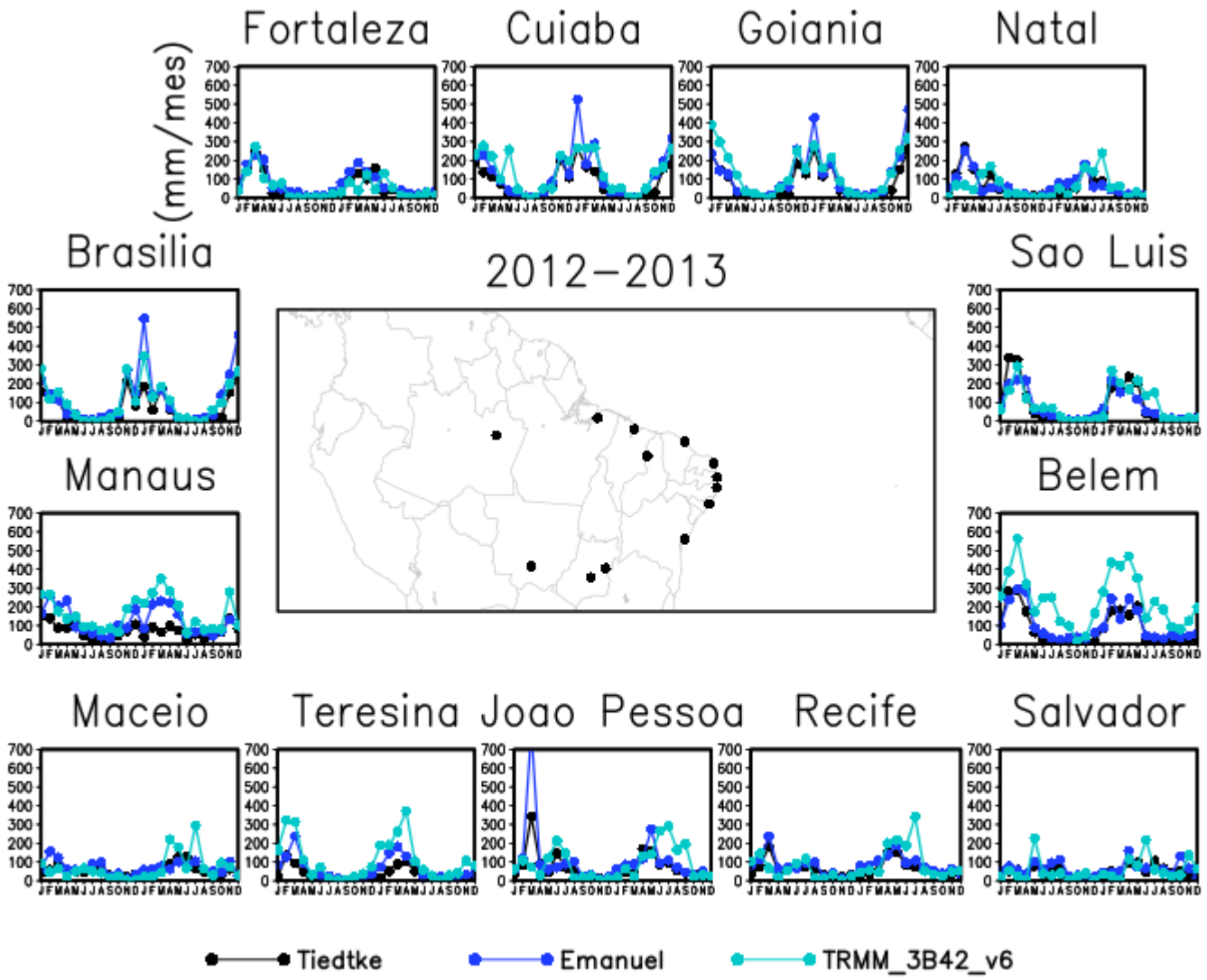
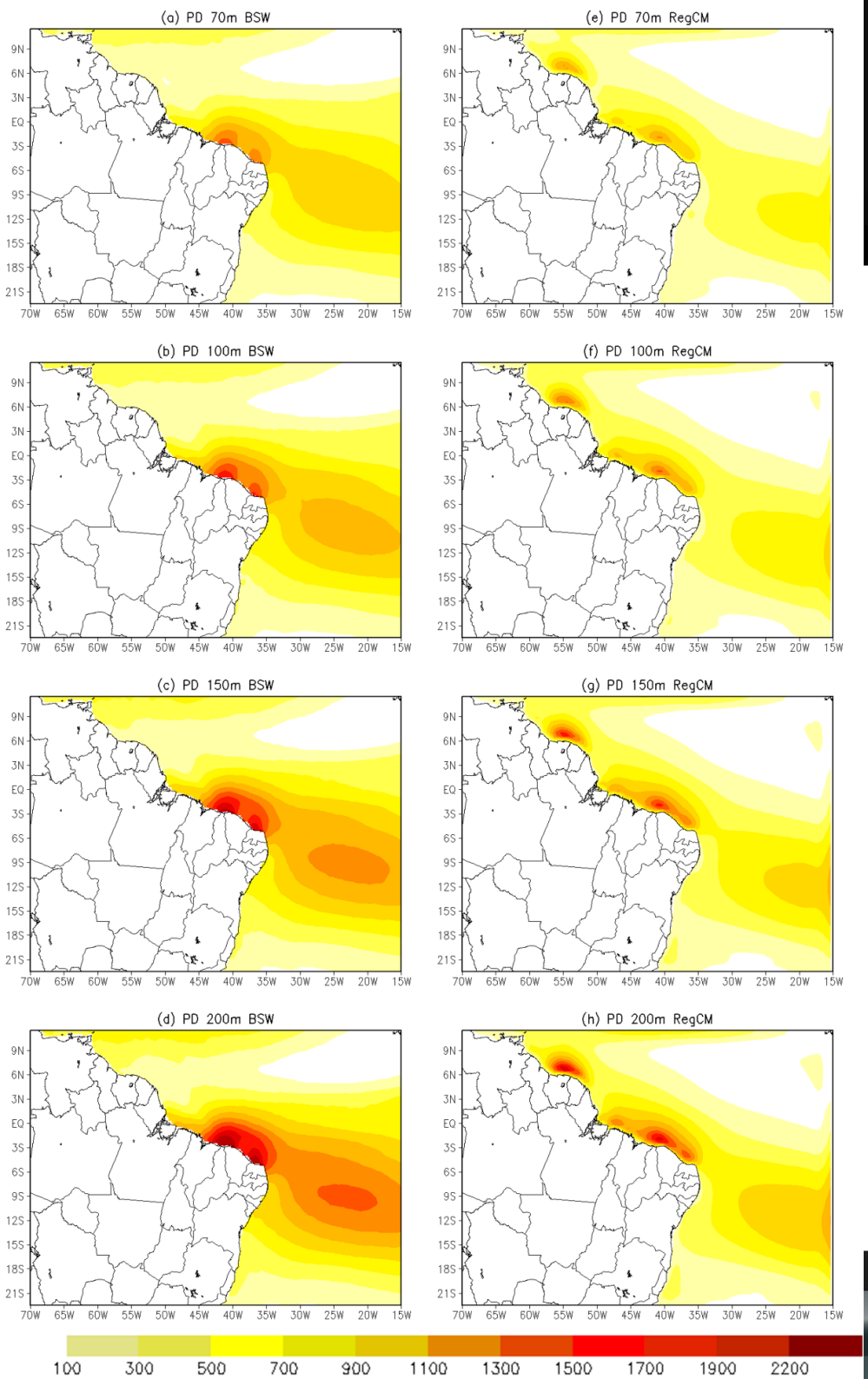



accumulated precipitation (month)

Black Line (Test 1) - Tiedtke

Dark blue Line (Test 2) - Emanuel

Light blue Line ("observation") - TRMM




Wind power density variability (W $m^{-2}$) in austral spring at 70, 100, 150 and 200 height (1981-2010) obtained by BSW and simulated by Regcm4.

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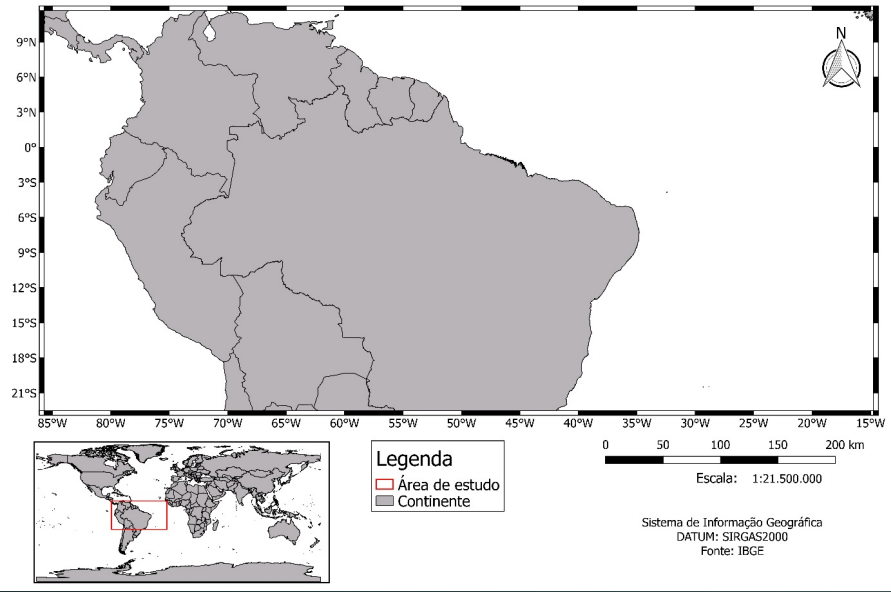
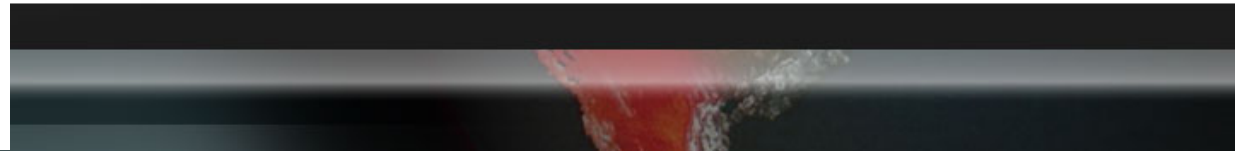
Perspectives

New experiments:

- Now we are producing dynamic downscaling of future climate change scenarios (RCP2.6 and RPC8.5);



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These two simulations are available and can be used by KLIMAPOLIS members.

| Experiment | Period | Convection | Status |
|---|---|---|---|
| Experiment 1 | Jan 1981 to Dec 2010 | Emanuel | ok |
| Experiment 2 | Jan 1981 to Dec 2010 | Grell | ok |

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## Obrigado!!

## Regional Climate Modelling in the Northeast of Brazil

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