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Long term characterization of heat waves in Brazil and their impacts on mortality rates

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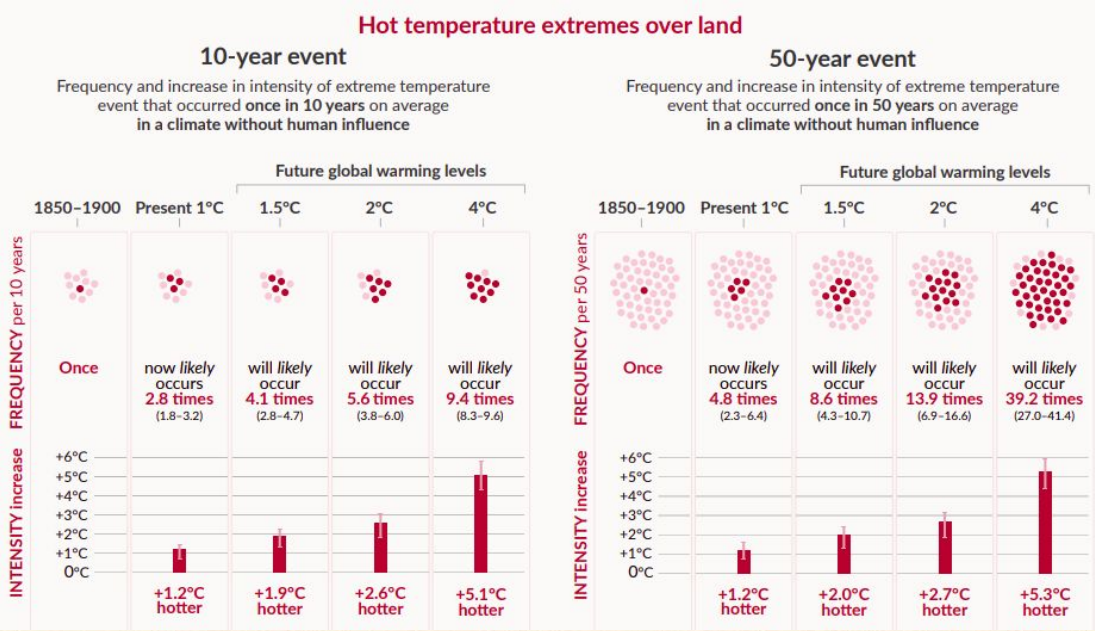
Extreme events: heatwaves (HW)

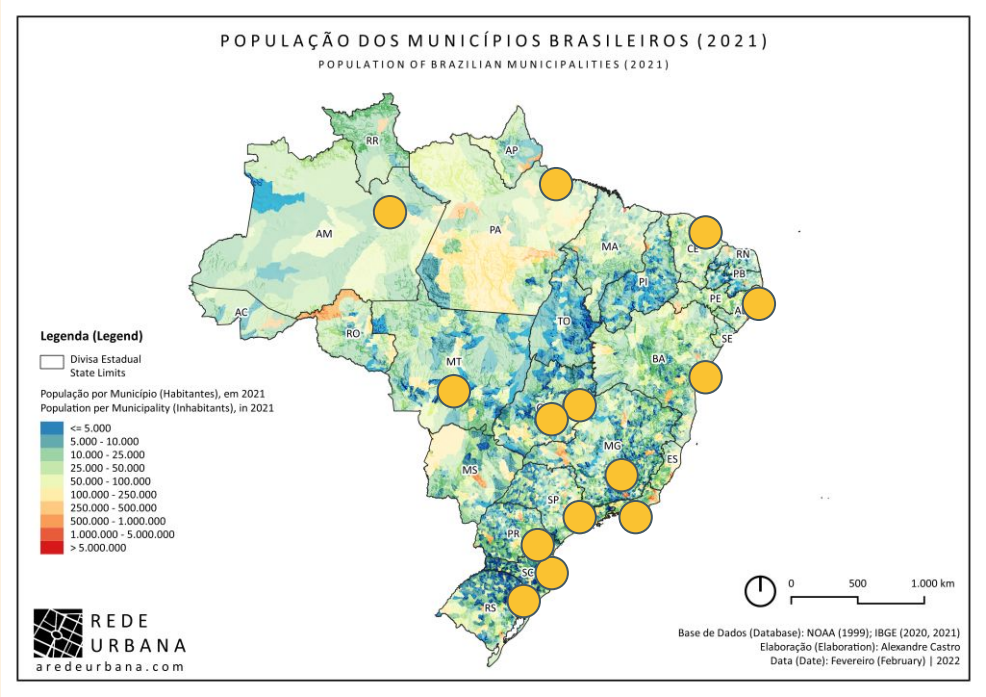
Overall definition: a period of consecutive days where conditions are excessively hotter than normal (Perkins; Alexander, 2013)



Source: Summary for Policymakers (SPM) - AR6 Climate Change IPCC 2021

- There are many **adverse impacts** on human health, agriculture, wildfire frequency and intensity, and infrastructure. (Zuo et al., 2015)
- Concurrence of hot and dry events **(compound events)** cause considerably more impacts than those related to the occurrence of an isolated event (Zscheischler & Seneviratne, 2017).

Brazilian Metropolitan Regions (MRs)



Metropolitan regions in the North (Manaus and Belém), Northeast (Recife, Salvador, and Fortaleza), Central-West (Goiânia, Brasília, and Cuiabá), Southeast (São Paulo and Rio de Janeiro) and South (Curitiba, Porto Alegre, and Florianópolis) of Brazil.

- # Identification of heatwaves

Excess Heat Factor (EHF)

Long-term and short-term temperature anomalies (Nairn and Fawcett, 2014).

$$EHF = EHIsig \times max\,(1, EHIaccl) \quad [°C^2]$$

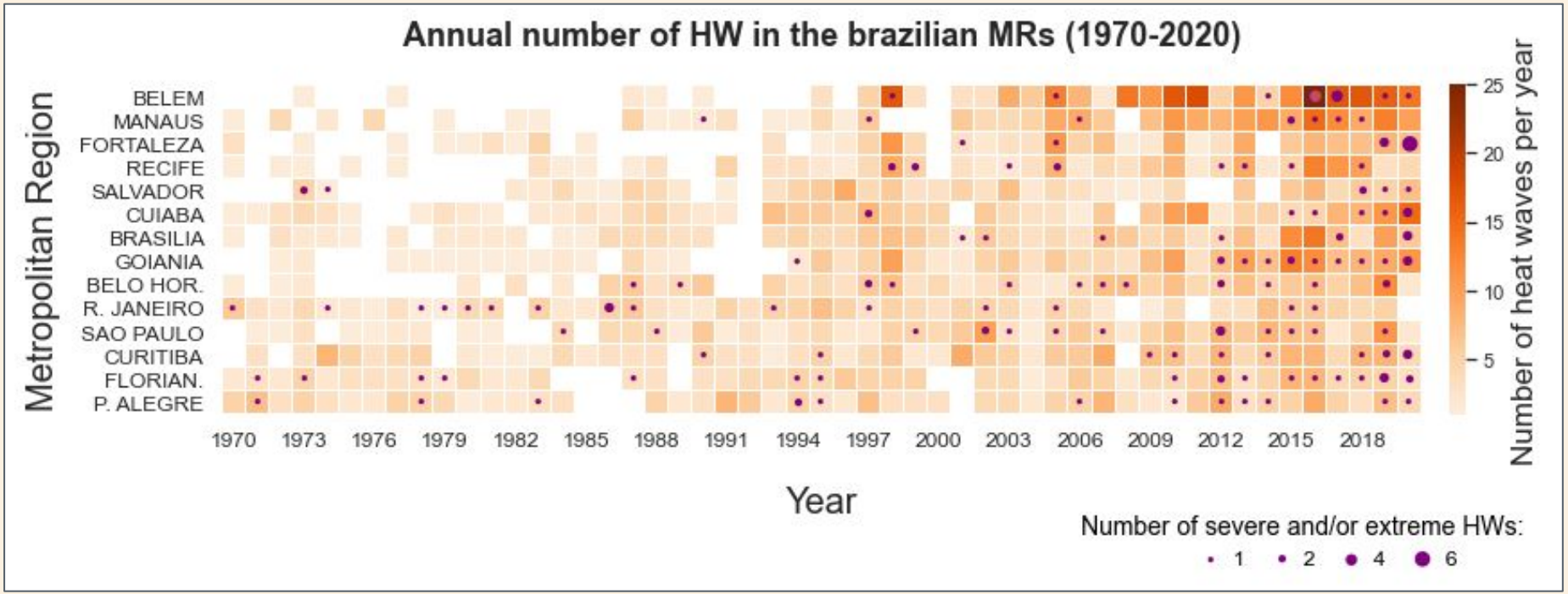
EHF>0 → heatwave condition

- # Excess Mortality

$$\frac{O}{E} = \frac{M_i}{(M_1 + M_2 + ... + M_{i-1} + M_{i+1} + ... + M_k)/(k-1))}$$

- Observed mortality during heatwaves (M_i)
- Reference periods (M_1, M_2, ….,M_{k-1},M_k), with the same duration.
- Mortality is normalized by annual population.

Occurence of heatwave over the last 50 years in Brazil



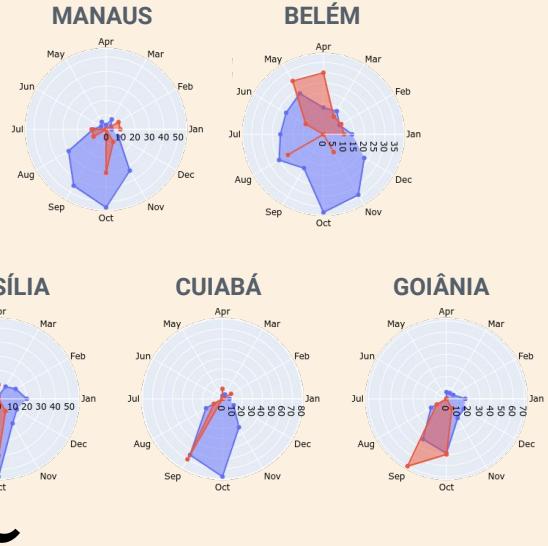
- Increase in number of heatwaves, mostly after 1990s, mainly over low-latitude regions.
- Severe and extreme events in all MR in the last 5 years.

Seasonality of heatwave occurrence

North and Central-West

Low Intensity
Severe/Extreme

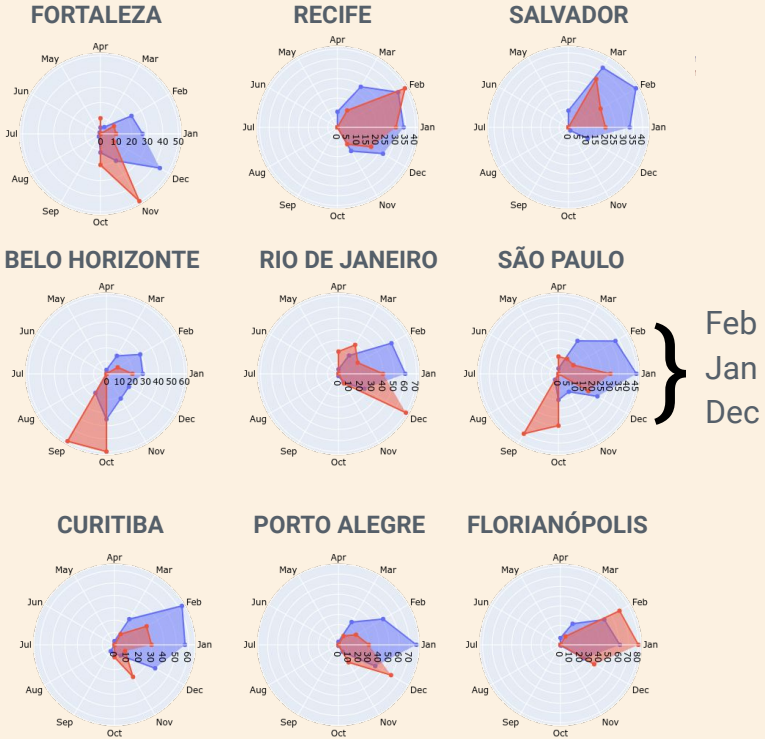
September/October - Dry season



Aug, Sep, Oct

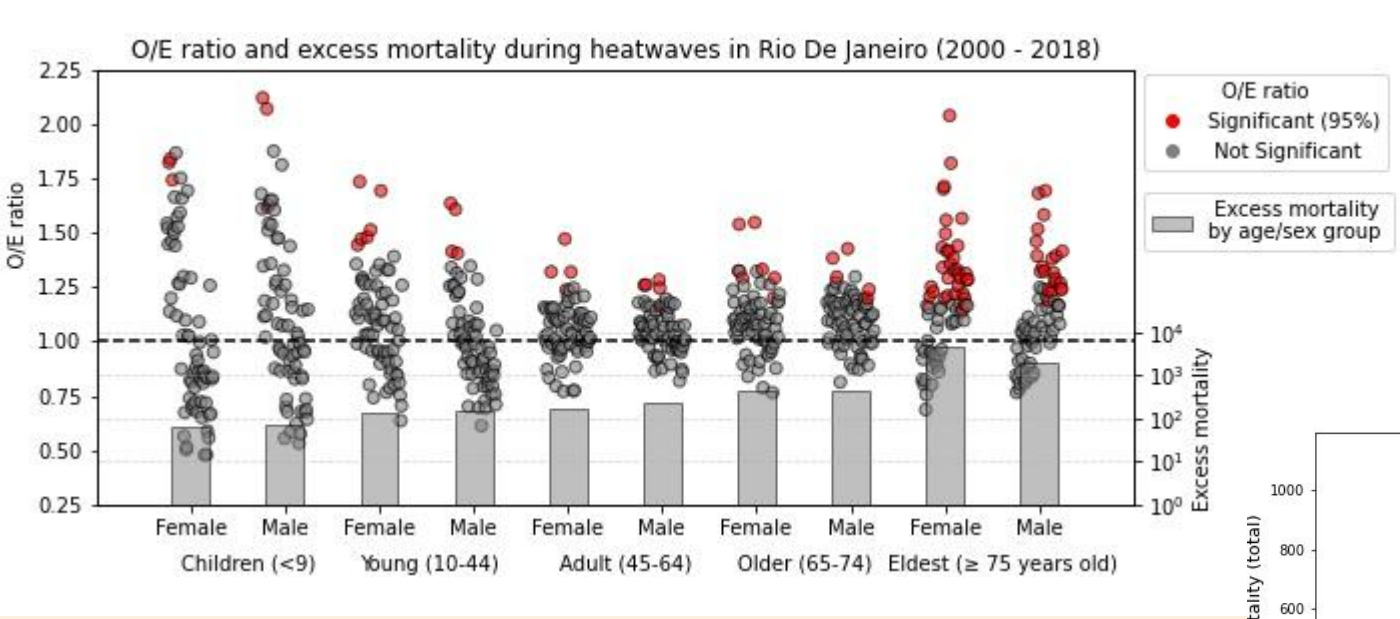
Northeast, Southeast and South

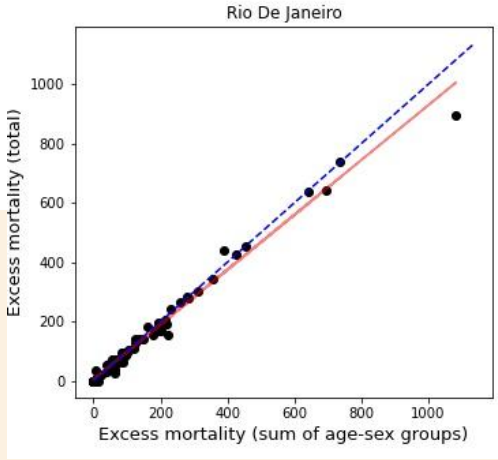
Dec/Jan/Feb (summer/wet season)



Feb
Jan
Dec

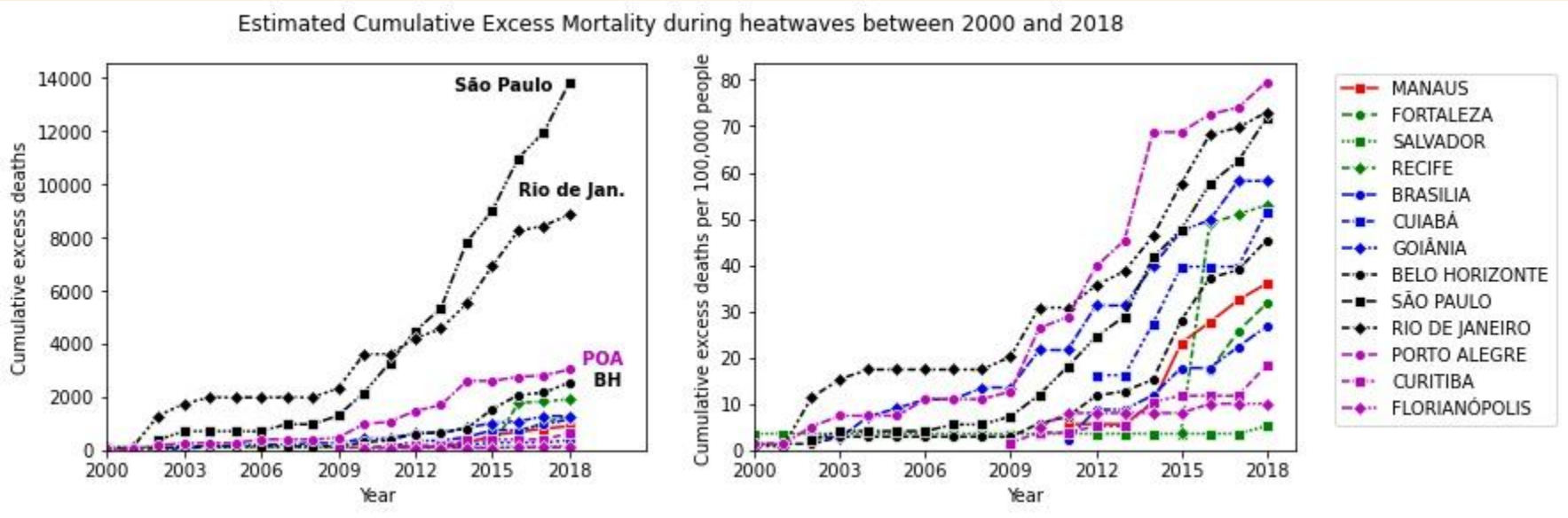
O/E ratio and excess mortality (Rio de Janeiro)





- Older (65-74), Elderly (>75) and female are the most affected.
- Correlation - excess mortality: sum of age-sex groups x total.
- Similar results were obtained for all MR.

Accumulated Excess Mortality (2000 - 2018)



- São Paulo and Rio de Janeiro add up to around 14,000 and 9000 deaths, respectively.
- All metropolitan regions have recorded an **increase in mortality over the last 10 years**.

Metropolitan Region	HW-related mortality rate (per 100,000 people)		
	2001-2009	2010-2018	2001-2018
Salvador	0.00	0.18	0.09
Florianópolis	0.00	1.11	0.56
Curitiba	0.18	1.85	1.02
Brasília	0.00	2.97	1.48
Fortaleza	0.00	3.52	1.76
Manaus	0.00	4.00	2.00
Belo Horizonte	0.17	4.72	2.44
Cuiabá	0.00	5.73	2.86
Recife	0.00	5.89	2.94
Goiânia	1.50	4.96	3.23
São Paulo	0.81	7.16	3.99
Rio de Janeiro	2.15	5.86	4.01
Porto Alegre	1.26	7.43	4.35

- During the first period a half of the MR did not register significant excess mortality.
- In the second period, all MR recorded excess mortality.
- In all cases, an increase in mortality rate was observed.
- Mortality rates were higher in MRs of the south and southeast, with an older population.