

Adapted from SANTOS, Ana Paula Paes dos et al. Climatic Diagnostics associated with anomalous lightning incidence during the summer 2012/2013 in Southeast Brazil In: *Royal meteorological society*, Vale Institute of technology: Belém, 2017

[1] Given the high incidence of cloud-to-ground (CG) lightning in some regions and various types of damage caused by them, scientists around the world have dedicated their research to the understanding of these events. From monitoring periods and areas of greater concentration of electrical activities it is possible to issue alerts of important characteristics such duration and severity of storms, allowing preventive measures to be taken to minimize the impacts (Santos *et al.*, 2016).

[2] For this, analyses of the lightning incidence in diverse time scales of storms have been developed over the years, in an attempt to understand the processes involved in the occurrence of the phenomenon. Although most lightning have no contact with the surface of the planet (Rakov and Uman, 2003), those that reach the ground can cause expressive damage to structures built by man as well as fatalities. These damages consist of electric systems failures, breakdowns in telecommunications towers and buildings, burning of electronic equipment, among others (Santos *et al.*, 2016), causing damage to society estimated at 500 million dollars a year in Brazil (Pinto, 2005, 2009).

[3] Although the knowledge generated by these studies is of great relevance, there is still a need for the development of more detailed research to identify peculiarities of regions with high concentrations of lightning, as well as the climatic phenomena that modulate them. Associated with this information, the alert in relation to increase of the frequency of the extreme climatic events caused by the intensification of the global warming, divulged by the Intergovernmental Panel in Climate Change – IPCC (2013; 2014) in its latest report, AR5, strengthens the development of research that may point to influences on the formation and development of electrical storms. Past research has revealed that lightning incidence into the Gulf Coast of Mexico is associated with the occurrence of El Niño Southern Oscillation (ENSO), in which cold episodes (La Niña) resulted in a decrease in lightning incidence, and warm episodes (El Niño), would be associated with an increase in the incidence of the phenomenon (Lajoie and Laing, 2008).

[4] To the southwest of the Indian Ocean, statistical analyses showed that ENSO is the main modulator of the electrical activity, with contribution above 56.8% of the studied events. In this region the Indian Ocean Dipole has an important influence, being able to explain the variability of lightning incidence above 49%, in some regions of the southwest Indian Ocean. However, the Madden-Julian Oscillation did not have an expressive impact on the electrical activity on this ocean (Bovalo *et al.*, 2012).

[5] The current literature would benefit greatly from similar studies to those described above for the region of South America, in particular for Brazil. Thus, the objective of this work is to understand which climatic variability modes and dynamic mechanisms are associated to the lightning incidence in a specific region of Brazil, the State of São Paulo, during the summer, focusing on the extreme event occurred during the austral summer (period from December 2012 to February 2013, DJF).

[6] The importance of the development of this type of study for the State is reinforced by São Paulo presenting the highest rates of urbanization and great importance in the economic and social scenario of the Country. The results obtained may serve as a basis for climate forecasting, as well as for the construction and improvement of warning systems, aiming at planning preventive measures to reduce damages to society.

[7] Finally, one of the main justifications for this kind of evaluation is that studies of this nature for this phenomenon in this region are still very incipient. However, it is of great relevance for the understanding and monitoring of the regional climate, and can serve as a scientific basis that can be used to make environmental decisions that minimize the impacts caused by the lightning incidence.

[8] **RESULTS:** In the monthly analysis, the highest discharge density was observed in the months of December 2012 and February 2013. In January, it was a month that presented below-average discharge density (with values above  $-2.0$  flashes  $\text{km}^{-2}$ ). It is observed that both the highs recorded in December and February, and the minimum recorded in January, occurred in greater proportions over the capital and Metropolitan Region of São Paulo (MRSP –  $23^{\circ}$  S/ $46^{\circ}$  W), that is, during the period with positive anomalies (DJF, December and February), there was a large concentration of lightning on the MRSP and in January the maximum negative anomaly was also observed on MRSP.

[9] The high lightning incidence observed in this event, caused great impacts to the population, as in the city of Ourinhos, in the interior of the State, where a lightning strike caused a fire in a reservoir, with almost five million litres of fuel. In Bertioga, on the coast of São Paulo, the lightning incidence resulted in two fatalities, when struck by lightning as they left the beach. In the capital, São Paulo, there were daily records above 2000 flashes, in the month of February. These facts highlight the great power of destruction and the impact caused by extreme events of discharges.

## **RESPONDA DE ACORDO COM O TEXTO. AS RESPOSTAS DEVEM SER EM PORTUGUÊS**

1) **Considere o parágrafo [1].** A partir de quais elementos pesquisáveis podem ser emitidos alertas sobre as características dos eventos de raios “CG”? E quais as consequências destas previsões? (3,0 pts)

Os elementos são: períodos de monitoramento e as áreas de maior concentração de atividades elétricas.

As consequências são: possibilidade de medidas preventivas que minimizem o impacto destes eventos

2) **Considere o parágrafo [4].** Neste trecho do texto, são mencionados fatores de importante influência sobre a atividade elétrica no Oceano Índico. Analise as alternativas abaixo.

|     |  |
|-----|--|
| I   | ENSO é o principal modulador da atividade elétrica do oceano com uma contribuição superior a 50% dos eventos estudados.                                      |
| II  | O Dipole tem importante influência, podendo explicar a variabilidade da incidência de raios, superior a 49% em algumas regiões do sudoeste do Oceano Índico. |
| III | ENSO é um dos moduladores da atividade elétrica do oceano com uma interferência superior a 50% dos eventos estudados.  |

Sinalize a alternativa que contém a afirmação correta. (1,5 pts)

- a) **Alternativas I e II estão corretas.**
- b) Alternativas II e III estão corretas.
- c) somente a alternativa II está correta.
- d) Somente a alternativa III está correta.

Considere os parágrafos [2] e [3]. Assinale Verdadeiro (V) ou Falso (F). (1,5 pts)

|   |  |   |
|---|--|---|
| a | Ainda há a necessidade da realização de pesquisas detalhadas para a identificação das regiões com maior incidência de raios nas regiões brasileiras. | V |
| b | Todos os raios que incidem na superfície do planeta causam fatalidades diretamente ligadas a falhas do sistema elétrico.                             | F |
| c | El Niña é o fenômeno resultante de quedas de temperatura.  | V |

3) **Considere o parágrafo [5].** Qual o objetivo deste estudo? (1,0 pts)

**O objetivo é compreender quais modos de variabilidade climática e mecanismos dinâmicos estão associados à incidência de raios em uma região específica do Brasil.**

4) **Considere o parágrafo [6].** Neste trecho é ressaltada a importância do desenvolvimento deste tipo de pesquisa para o estado de São Paulo. Quais características deste estado brasileiro a autora menciona para justificar esta importância e quais consequências este tipo de estudo pode trazer? (3,0 pts)

**São Paulo apresenta os mais altos índices de urbanização e grande importância nos cenários econômico e social do país.**

Resultados deste estudo podem servir de base para previsões climáticas, bem como para a construção e melhoramento de sistemas de advertência, visando medidas preventivas para reduzir os danos à sociedade.