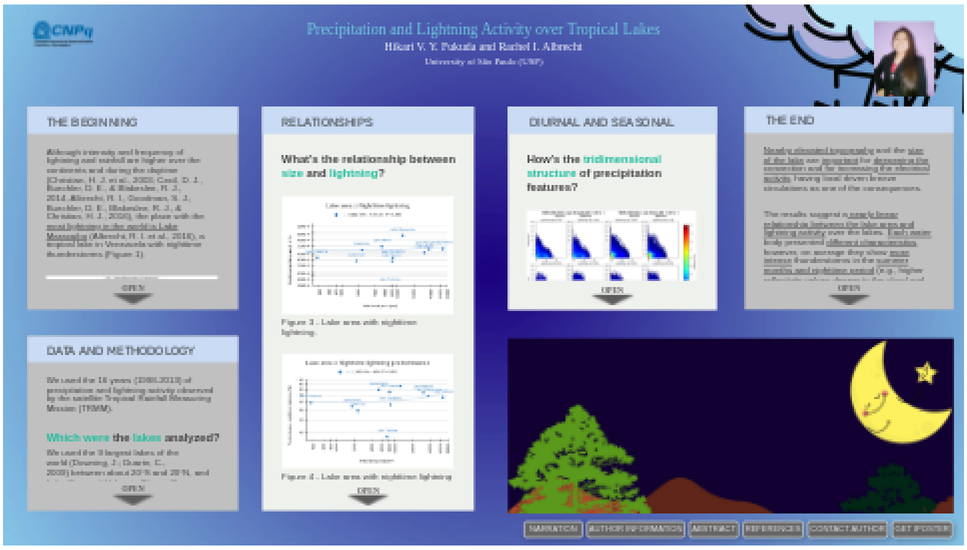
Precipitation and Lightning Activity over Tropical Lakes



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PRESENTED AT:

THE BEGINNING

Although intensity and frequency of lightning and rainfall are higher over the continents and during the daytime (Christian, H. J. et al., 2003; Cecil, D. J., Buechler, D. E., & Blakeslee, R. J., 2014, Albrecht, R. I., Goodman, S. J., Buechler, D. E., Blakeslee, R. J., & Christian, H. J., 2016), the place with the most lightning in the world is Lake Maracaibo (Albrecht, R. I. et al., 2016), a tropical lake in Venezuela with nighttime thunderstorms (Figure 1).

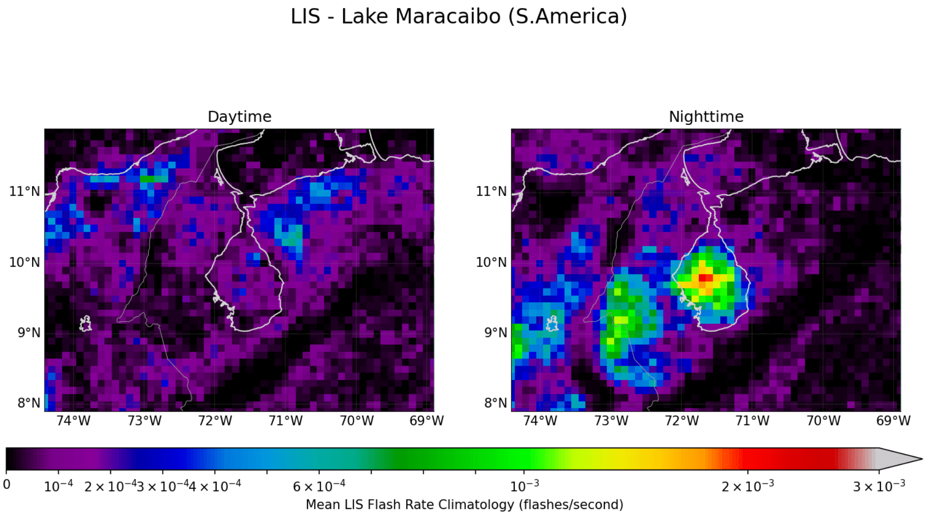

Figure 1 - Mean flash rate climatology at daytime and nighttime over Lake Maracaibo.

Several other tropical lakes with similar physical features (e.g., large area and elevated topography nearby), also exhibit deep nocturnal convection driven by locally forced convergent flow.

Why do we study precipitation and lightning over tropical lakes?

The large lakes are more frequently over the Northern Hemisphere and in middle latitudes (Downing, J.; Duarte, C., 2009), however, these areas show less concentration of storms and lightning density (Christian, H. J. et al., 2003; Cecil, D. J. et al., 2014, Albrecht, R. I. et al., 2016).

What's the objective?

To study the relationship between the physical characteristics (size, shape, local topography and water temperature) of tropical lakes and the precipitation and lightning activity of their thunderstorms.

DATA AND METHODOLOGY

We used the 16 years (1998-2013) of precipitation and lightning activity observed by the satellite Tropical Rainfall Measuring Mission (TRMM).

Which were the lakes analyzed?

We used the 9 largest lakes of the world (Downing, J.; Duarte, C., 2009) between about 20°S and 20°N, and Lake Kivu and Valencia (Figure 2).

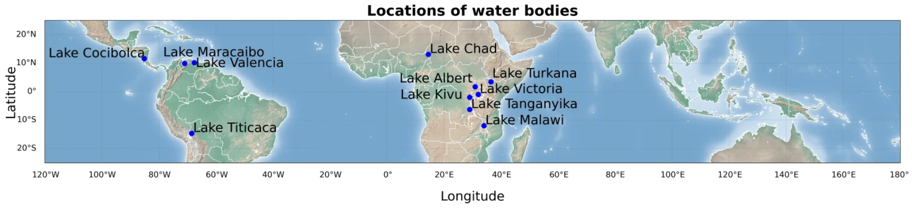

Figure 2 - Location of lakes.

What were the methods?

1. <u>Relationship size and lightning:</u> scatter plots of the lake area with the mean lightning and nighttime lightning predominance over the lakes. Linear regression fit and determination coefficient (Figure 3-4);

2. <u>Relationship elevation and lightning:</u> graphs of percentage elevation amplitude and nighttime lightning predominance with the mean lightning rate in nighttime (19-06 LT) (Figure 5);

3. <u>Diurnal and seasonal:</u>

- <u>3D structure:</u> Cumulative Frequency Altitude Diagram - CFAD (Yuter and Houze Jr., 1995) (Figure 6-7);

- <u>Diurnal and annual cycle:</u> time series graphs with the averages every 12 minutes throughout the day and monthly averages of electrical activity and volumetric rain (Figure 8).

RELATIONSHIPS

What's the relationship between size and lightning?

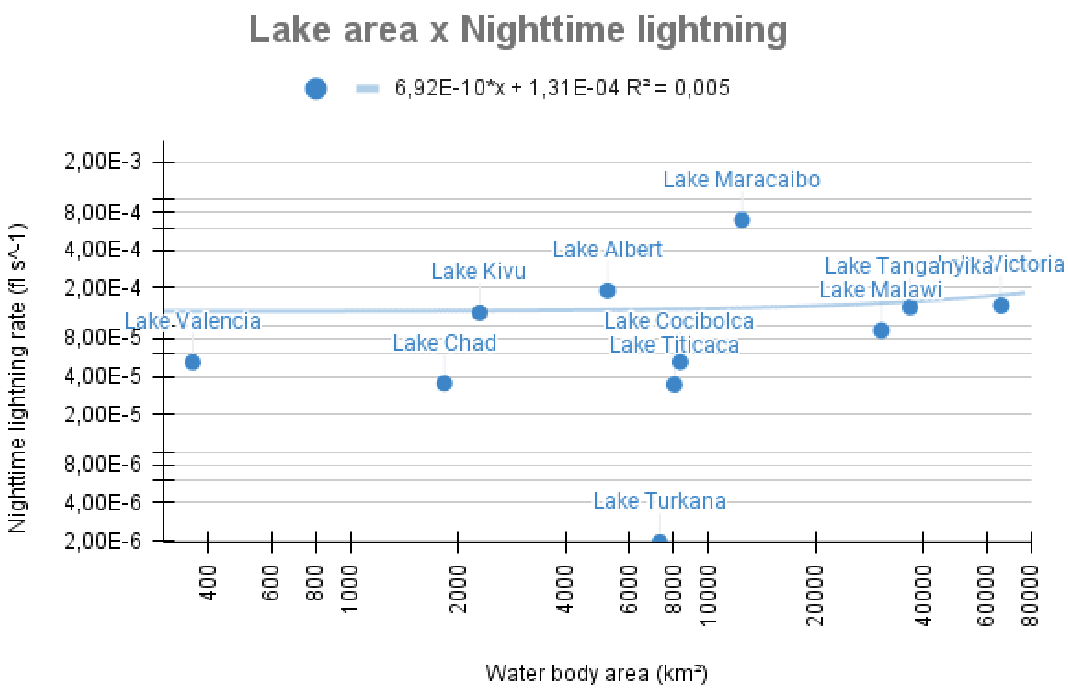

Figure 3 - Lake area with nighttime lightning.

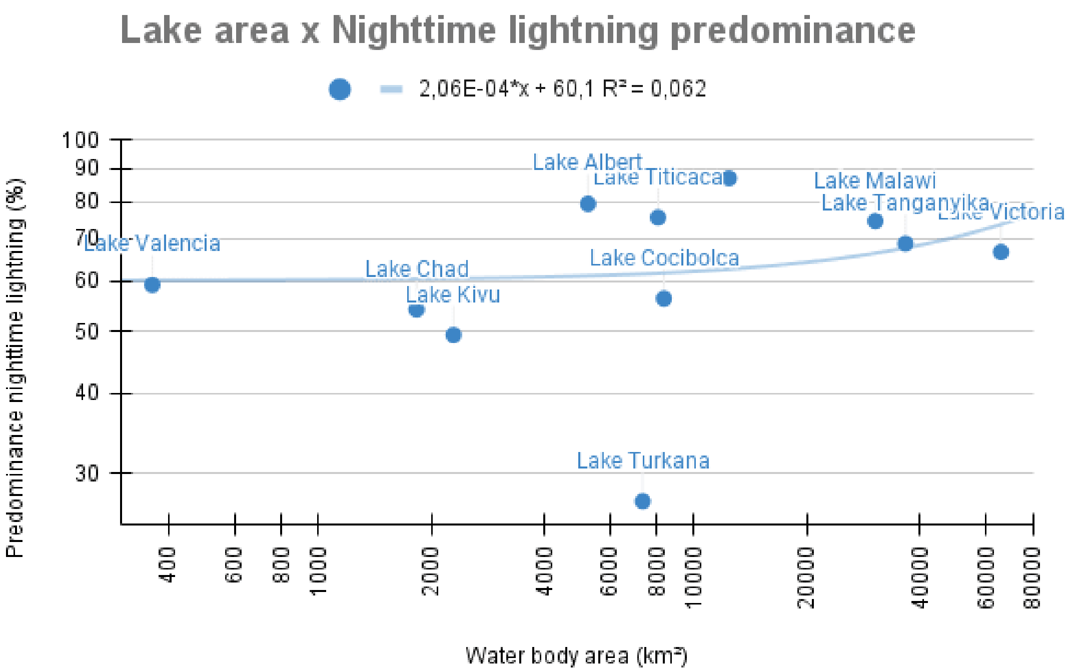

Figure 4 - Lake area with nighttime lightning predominance.

What's the relationship between elevation and lightning?

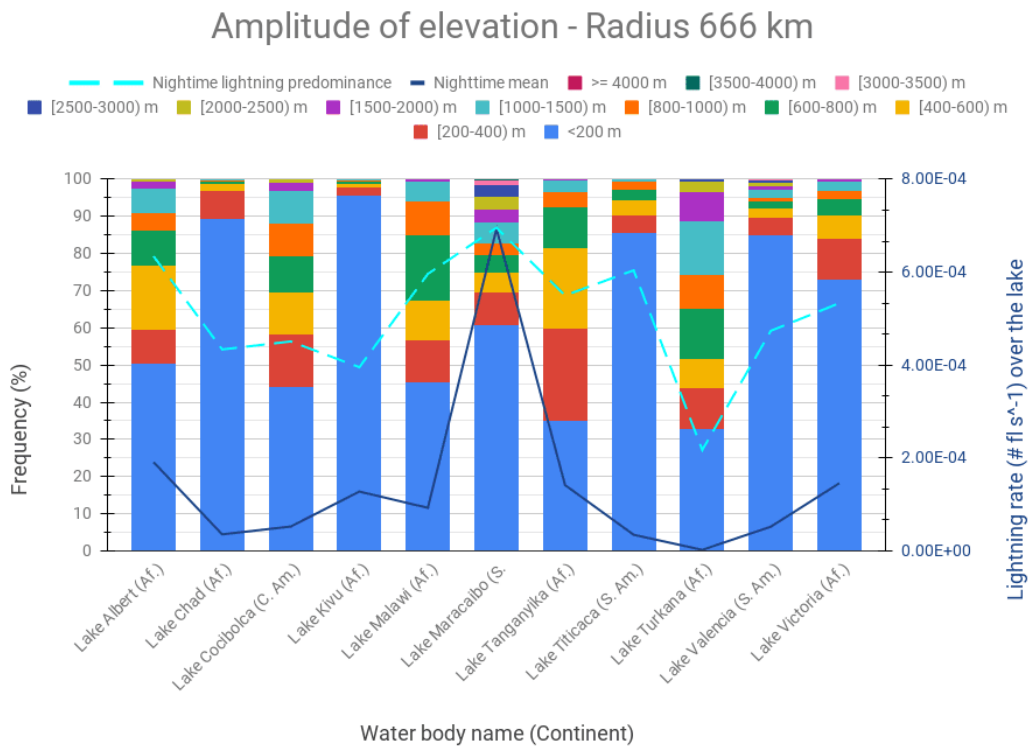

Figure 5 - Percentage of elevation's amplitude in a radius of 666 km with the nighttime lightning predominance and mean lightning rate at nighttime.

DIURNAL AND SEASONAL

How's the tridimensional structure of precipitation features?

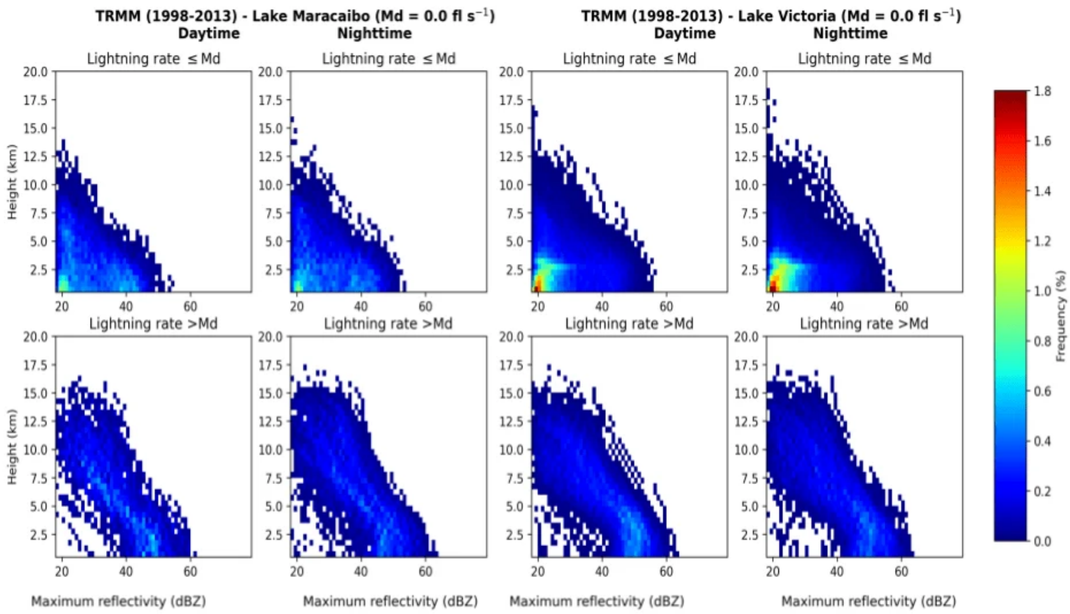

Figure 6 - Storms' CFADs with different situations of lightning rate over Lake Maracaibo and Victoria during daytime and nighttime.

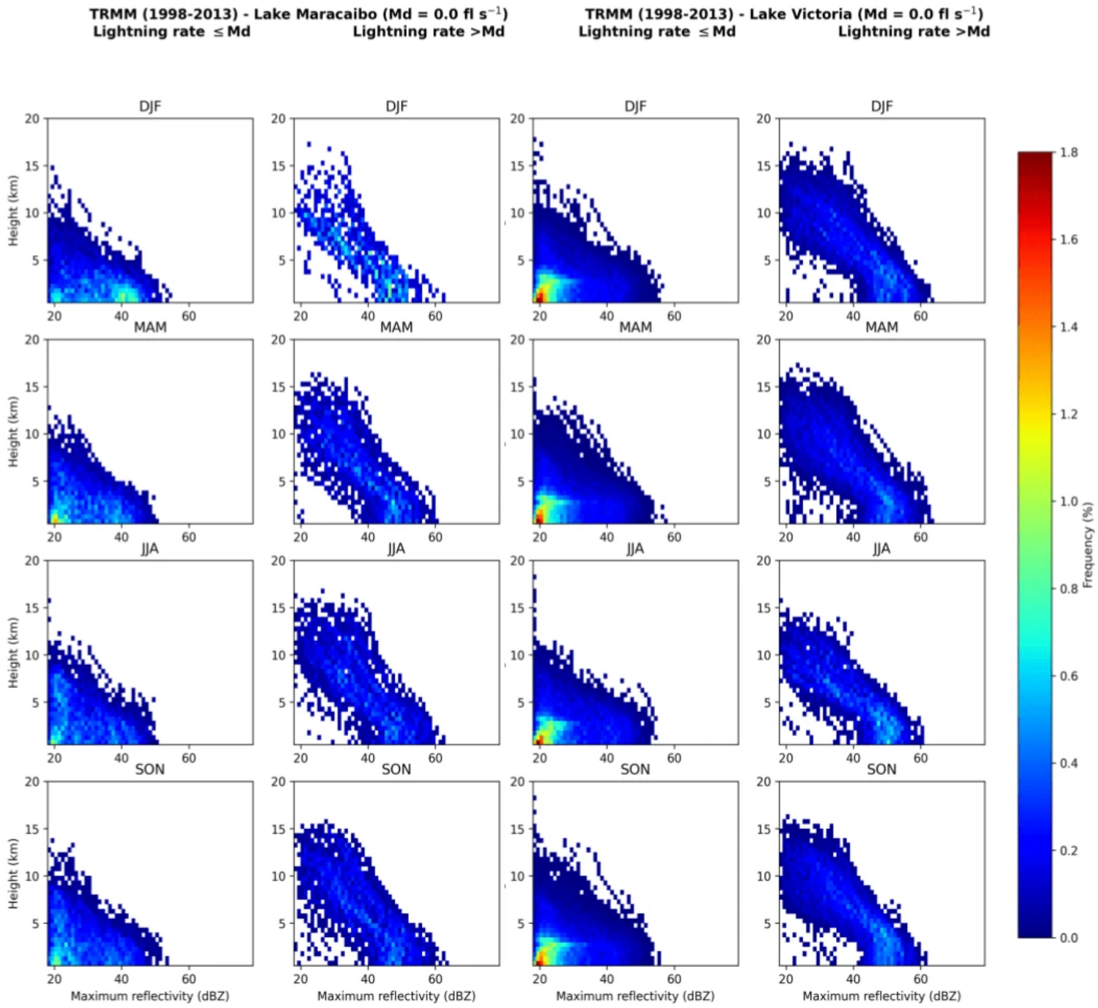

Figure 7 - Storms' CFADs with different situations of lightning rate over Lake Maracaibo and Victoria during seasons.

How's the rainfall and lightning with the diurnal and annual cycle?

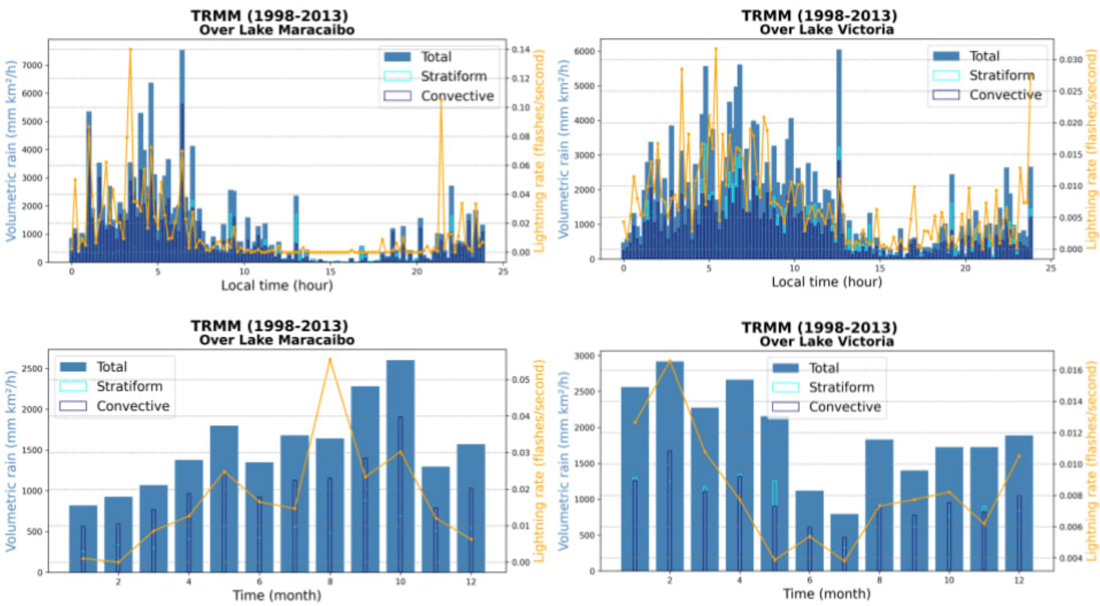

Figure 8 - Time series graphs over the day and months over Lakes Maracaibo and Victoria.

THE END

Nearby elevated topography and the size of the lake are important for deepening the convection and for increasing the electrical activity, having local driven breeze circulations as one of the consequences.

The results suggest a nearly linear relationship between the lake area and lightning activity over the lakes. Each water body presented different characteristics, however, on average they show more intense thunderstorms in the summer months and nighttime period (e.g., higher reflectivity values deeper in the cloud and higher convective precipitation volume).

More information and figures (https://sites.google.com/iag.usp.br/labnuvens/dados-e-materiais/diversos/agu-fall-meeting-hikari)

On the website: https://sites.google.com/iag.usp.br/labnuvens/dados-e-materiais/diversos/agu-fall-meeting-hikari (https://sites.google.com/iag.usp.br/labnuvens/dados-e-materiais/diversos/agu-fall-meeting-hikari).

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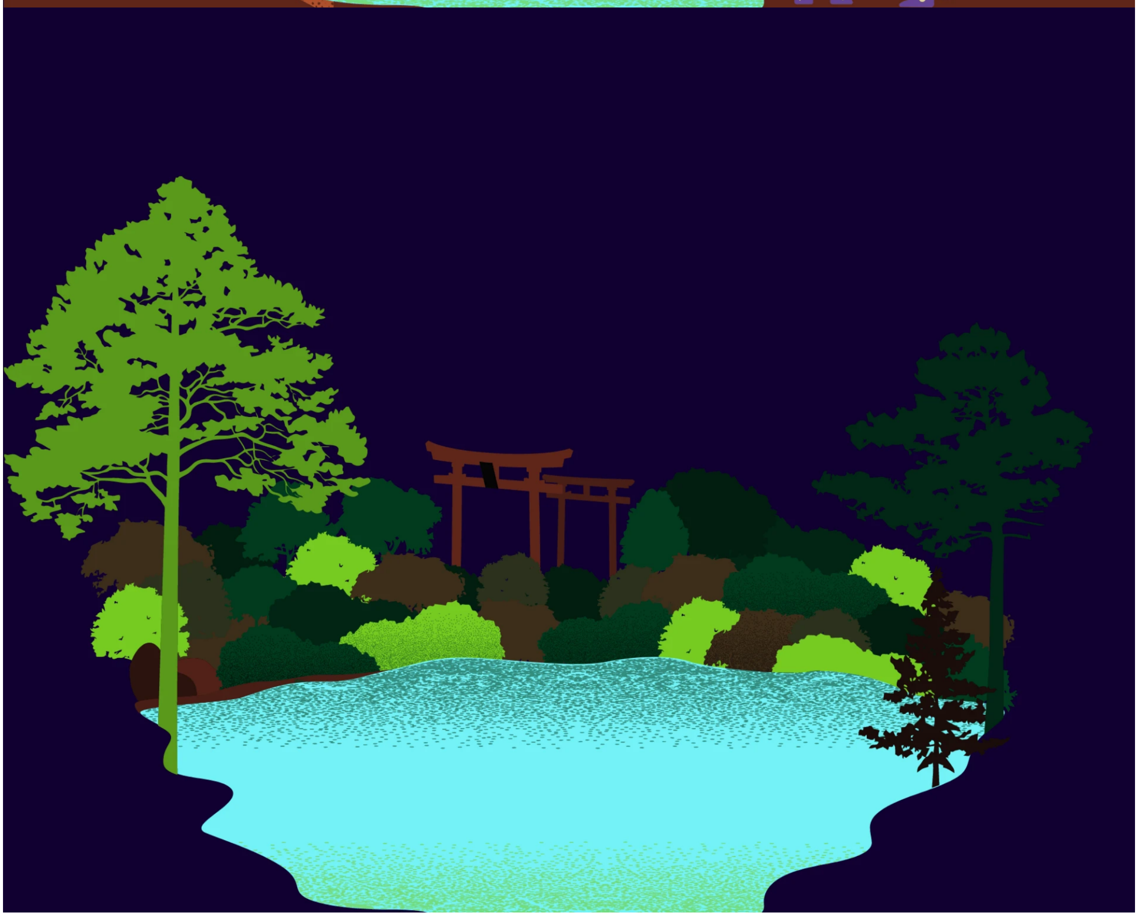

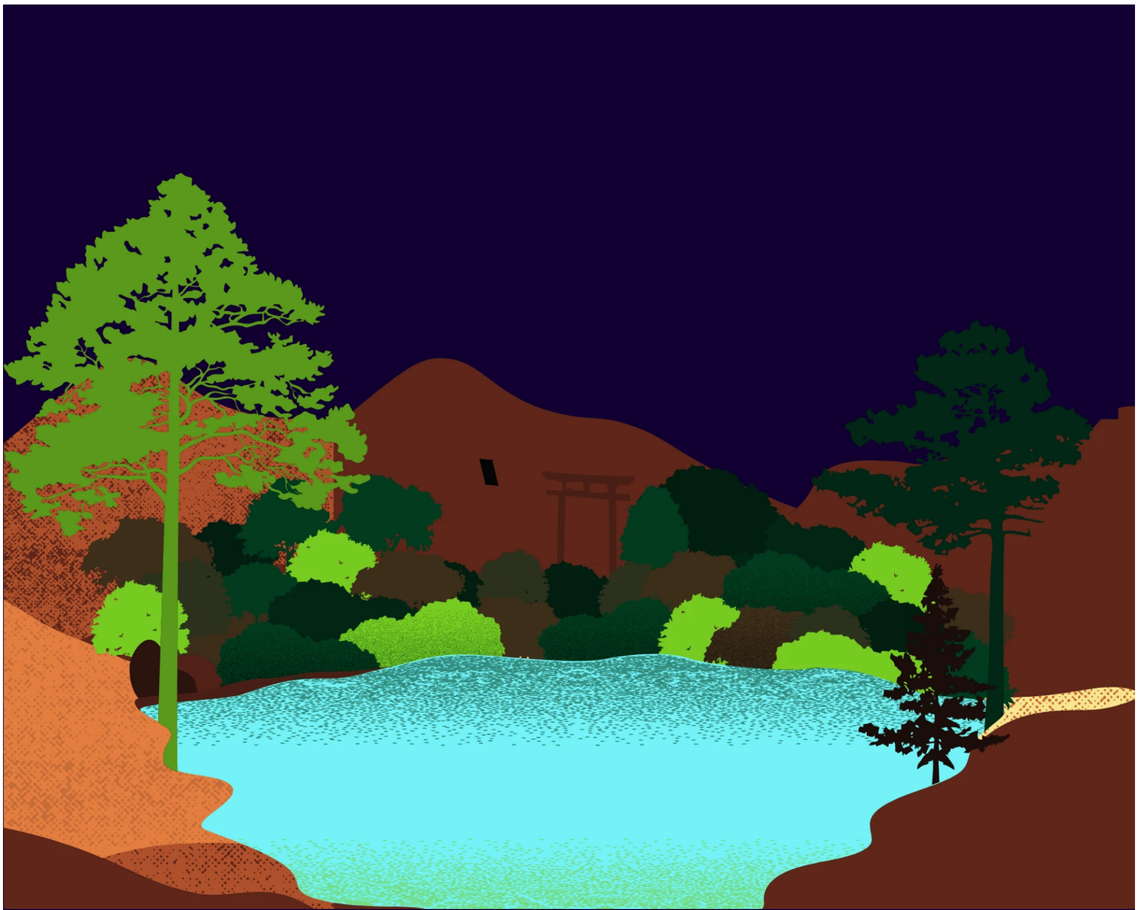

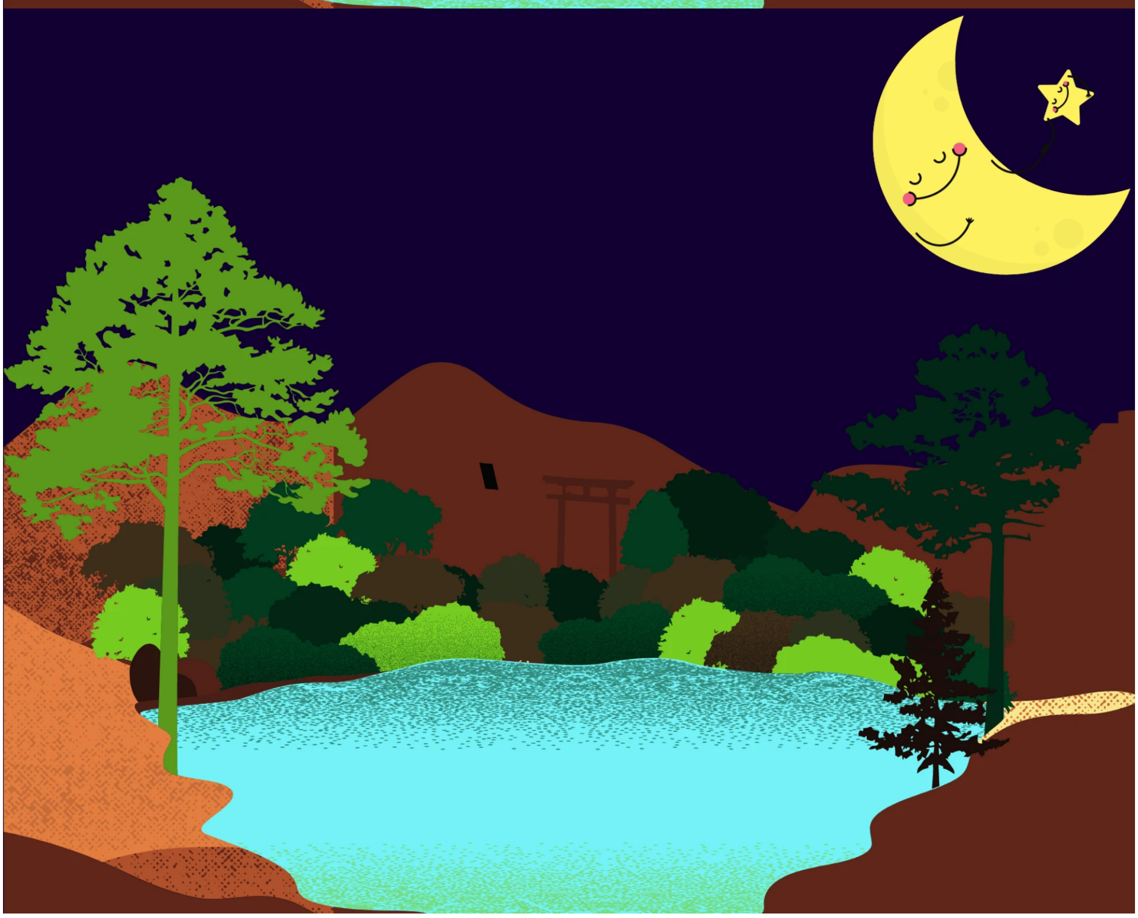

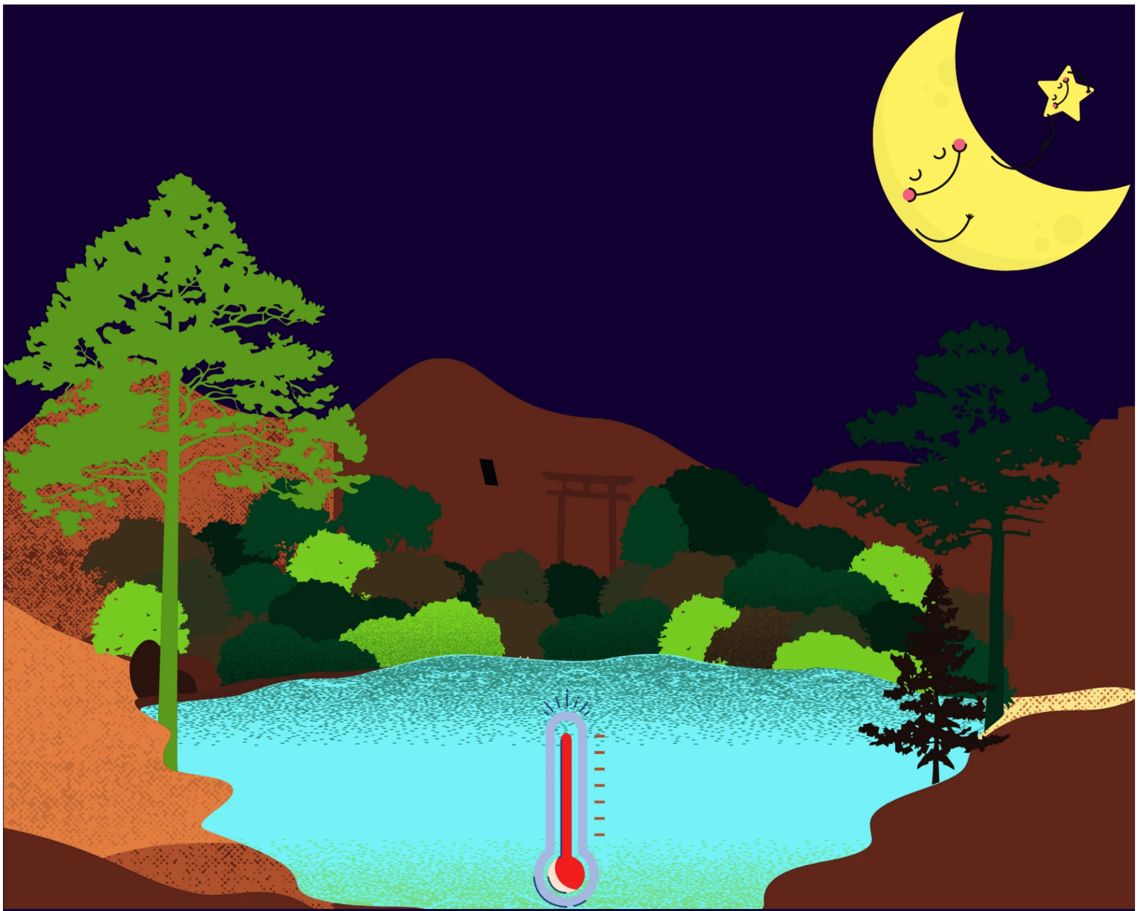

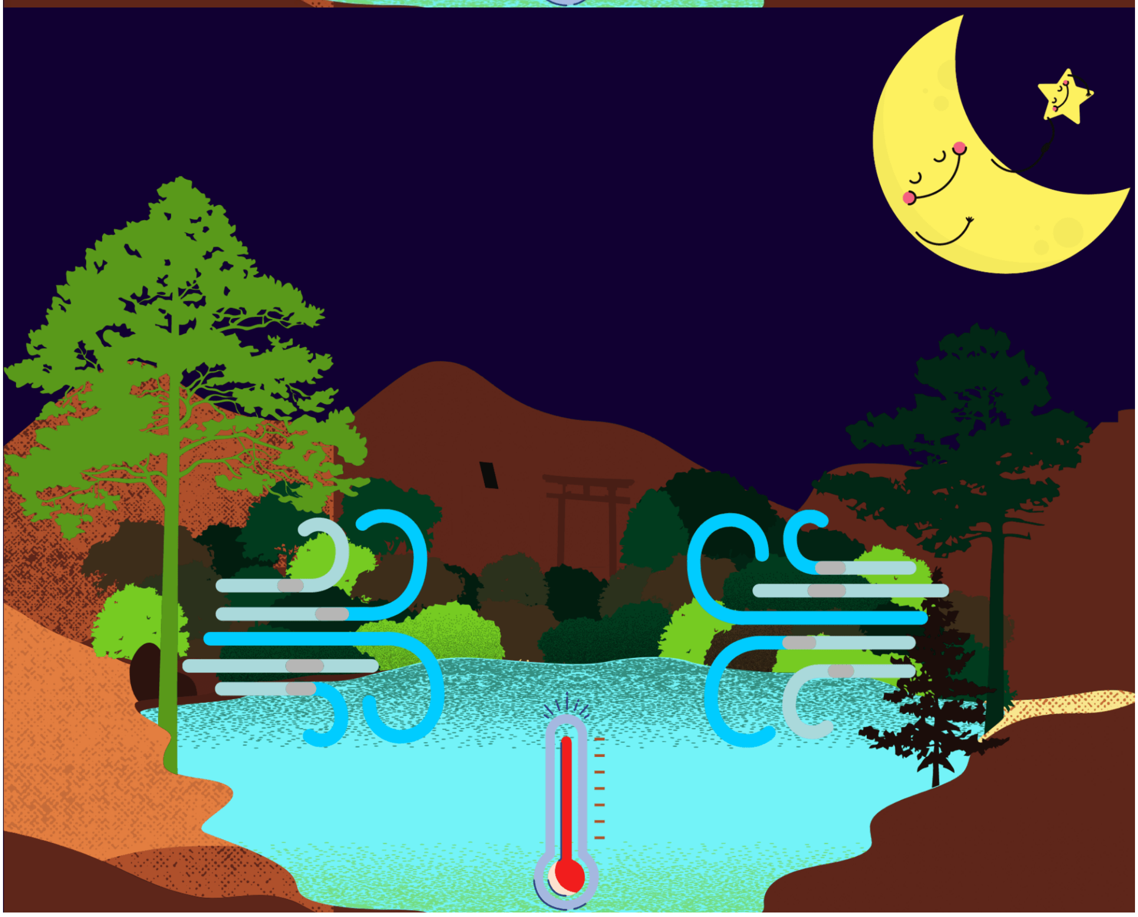

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ABSTRACT

Although the intensity and frequency of lightning and rainfall are higher over the continents and during the daytime, the place with the most lightning in the world is Lake Maracaibo, a tropical lake in Venezuela with nighttime thunderstorms. Lake Maracaibo is a very large and warm lake surrounded by Andes mountains, the perfect scenario for convergent windflow (mountain–valley, lake, and sea breezes) over the lake nearly year-round, contributing to nocturnal thunderstorm development over 290 days per year on average. Several other tropical lakes with similar physical features (e.g., large area and elevated topography nearby), also exhibit deep nocturnal convection driven by locally forced convergent flow. We use the 16 years of precipitation and lightning activity observed by the Tropical Rainfall Measuring Mission (TRMM) to study the relationship between the physical characteristics (size, shape, local topography and water temperature) of tropical lakes and the precipitation and lightning activity of their thunderstorms. We found that nearby elevated topography and the size of the lake are important for deepening the convection and for increasing the electrical activity, having local driven breeze circulations as one of the consequences. Our results also suggest a nearly linear relationship between the lake area and lightning activity over the lakes. Each water body presented different characteristics, however, on average they show more intense thunderstorms in the summer months and nighttime period (e.g., higher reflectivity values deeper in the cloud, lower minimum brightness temperature, higher convective precipitation volume).

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