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MDPI

Data Descriptor

Daily Precipitation Data for the Mexico City Metropolitan Area from 1930 to 2015

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Abstract: The Metropolitan Zone of Mexico City, as well as the associated basin, includes the territories of Mexico City, some municipalities of the State of Mexico and the state of Hidalgo. In addition, this area is the most densely populated in Mexico. The region is influenced by mid-latitude and tropical weather systems and is vulnerable to extreme hydrometeorological events. In this context, we developed a dataset from the records of 136 geolocated sites that includes daily precipitation data from the CLImate COMputing (CLICOM) project and the Mexico City Water System. The data spans the period from 1930 to 2015 for the rainy months (June–October) from stations with records of 20 or more years. In each recording site, automatic and manual data quality control were performed to verify the consistency of the daily precipitation data. We believe that our highly dense precipitation dataset will be useful for climate, trend and extreme events analysis. Additionally, the data will allow validating simulations of numerical atmospheric models. The dataset is public, and it was previously used in other research to determine areas susceptible to flooding due to heavy rain events and to develop a web mapping application of daily precipitation data.

Dataset: http://atlas.atmosfera.unam.mx/docs/data/daily_precipitation_database.xlsx

Keywords: daily precipitation; daily accumulated precipitation; heavy rain; observational networks; CLICOM; SACMEX; Metropolitan Zone of Mexico City; Mexico City; Mexico

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1. Summary

The Metropolitan Zone of Mexico City (MZMC) (Figure 1) includes the entire Mexico City state, 59 municipalities of the State of Mexico and one municipality of the state of Hidalgo. The MZMC has 21,804,515 inhabitants in an area of 7954 km^2 [1], and it is the most densely populated region in Mexico [1]. In addition, it is one of the largest urban agglomerations in the world and the first in Latin America [2].

The MZMC has an elevation between 1799 and 5381 m above mean sea level, with important mountain ranges and volcanoes in the west, south and east. Its climate is influenced by its complex orography and by changes in the landscape caused by human activities since the pre-Hispanic period [3,4]. This region is impacted by mid-latitude and tropical weather systems and is particularly vulnerable to extreme hydrometeorological events.

According to the Intergovernmental Panel on Climate Change (IPCC) in its special Global Warming of 1.5 °C report, it is estimated that several regional climate changes will

occur due to global warming of between 1.5 °C and 2.0 °C [5]. Projections for precipitation are uncertain, but the report highlights robust increases in mean precipitation in the Northern Hemisphere (high latitudes). However, for Mexico, decreases in the mean precipitation are reported. On the other hand, increases in precipitation during extreme events are projected in regions located in high latitudes with high elevations, as well as in eastern Asia and in eastern North America. However, in Mexico, the projected changes in heavy precipitation are insignificant [5].

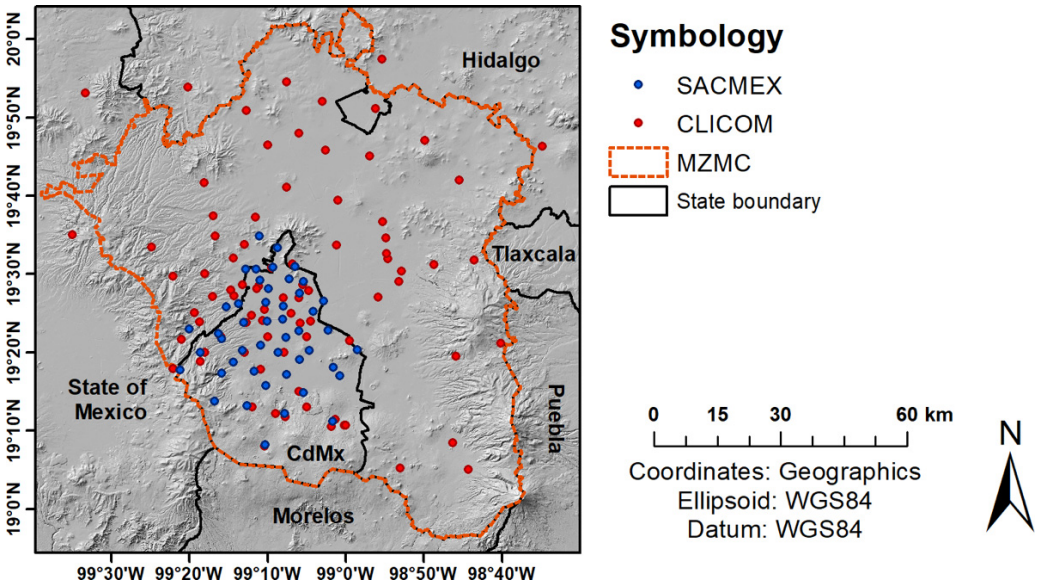


Figure 1. Geographical distribution of the 136 recording sites used to generate the daily precipitation dataset for the MZMC.

The data reported by the IPCC are global and lack sufficient spatial resolution to provide details about the regional and local structured of precipitation in the MZMC. Although there are information and local maps in the literature about the levels of precipitation in the MZMC [6–9], they are not updated and not fully available. Under these considerations, we built a daily precipitation dataset for the rainy months in Mexico (June–October) using data from 136 geolocated sites in the MZCM from the CLImate COMputing (CLICOM) project [10] and the Mexico City Water System (Sistema de Aguas de la Ciudad de México (SACMEX) in Spanish) observation networks for the 1930–2015 period. Each recording site has at least 20 years of data. To verify the consistency of the daily precipitation, data quality control was performed automatically and manually.

The dataset is now available for further research, and it was previously used to determine flood areas in Mexico City for different return periods [11] and to develop a web mapping application of the precipitation data [12].

2. Data Description

The CLICOM surface stations are managed by the Mexican National Weather Service (Servicio Meteorológico Nacional (SMN) in Spanish). The data reported here was obtained through the web tool http://clicom-mex.cicese.mx, accessed on 22 March 2022. On the other hand, the SACMEX network is managed by the Mexico City Water System (https://aplicaciones.sacmex.cdmx.gob.mx/pluviometro/, accessed on 22 March 2022). In both cases, the precipitation data correspond to the accumulated rainfall during 24 h, covering from 8:00 a.m. to 8:00 a.m. of the next day (local time) for CLICOM and from 6:00 a.m. to 6:00 a.m. (local time) for SACMEX.

The SACMEX network has rain gauges (model TB3) from the HyQuest Solutions brand. These gauges have an accuracy level of ±2% from 0 to 250 mm/h and a resolution

of 0.01 inches (0.0254 cm) [13]. The model of the rain gauges for the CLICOM network was not available.

The daily precipitation dataset for the MZMC is provided in the daily_precipitation_database.xls spreadsheet that includes the description of each recording site and their daily precipitation data for the rainy months (June–October) in the 1930–2015 period.

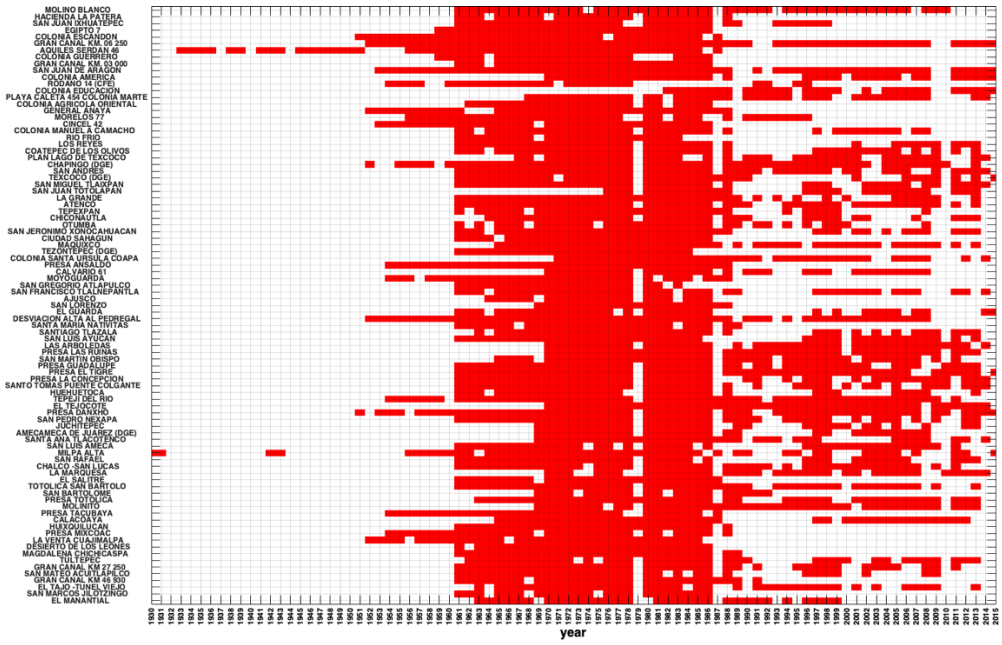
The spreadsheet data provides the following information:

- ID: short name of the site (alphanumeric values);
- Name: long name of the site (alphanumeric values);
- State: state where the site is located (Mexico City, State of Mexico, Hidalgo);
- Location: place of the recording site (alphanumeric values);
- Recording period: see Figure 2 (alphanumeric values);
- Altitude: vertical distance in meters (alphanumeric values);
- Source: observational network (CLICOM, SACMEX);
- Latitude: y-coordinate (decimal degrees);
- Longitude: x-coordinate (decimal degrees);
- Data includes observations from 89 CLICOM and 47 SACMEX stations (Figure 1).

The daily precipitation tables provide the day, month and year of the daily accumulated precipitation data for each recording site (described above). NaN indicates "no data":

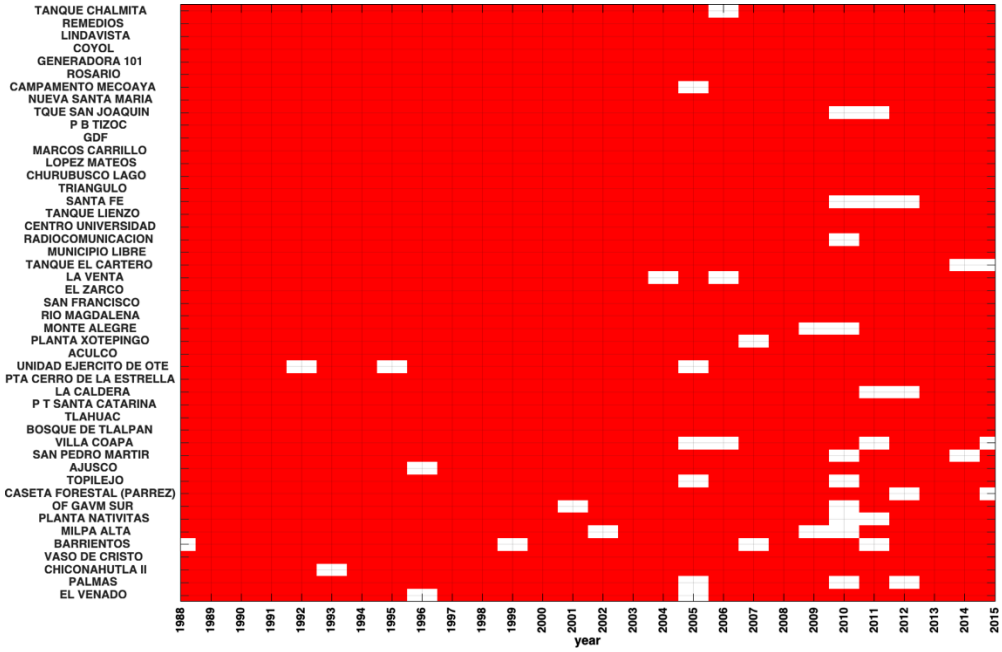
- Day: identifies the day (values from 1 to 31);
- Month: identifies the month (values from 6 to 10);
- Year: identifies the year (values from 1930 to 2015);
- Station IDs: divided into two spreadsheets: one for the CLICOM and another for the SACMEX stations (numeric values indicating millimeters per day (mm day^{-1}) or the NaN indicator).

The data periods are from 1930 to 2015 and from 1988 to 2015 for the CLICOM and SACMEX networks, respectively. According to the results of the monitoring and quality control in each station, the data interval varied from 20 to 60 years (Figure 3).



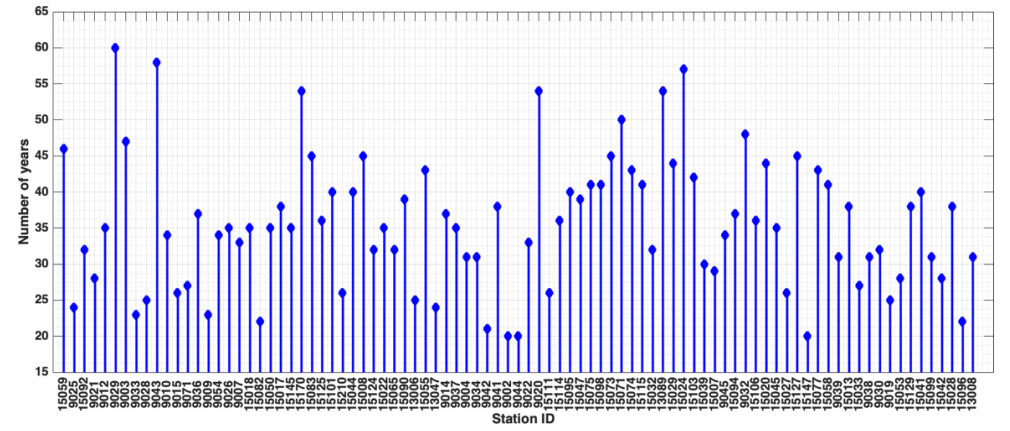
(**a**)

Figure 2. *Cont.*

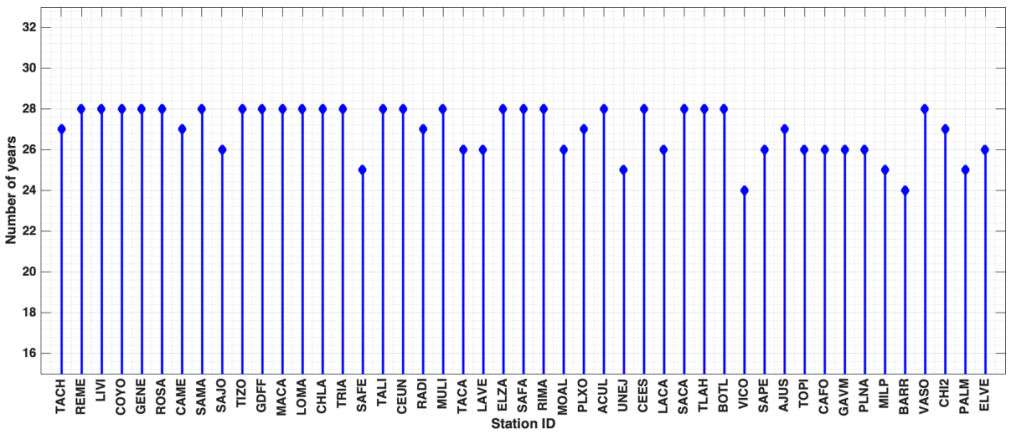


(**b**)

Figure 2. Years with data available during the rainy season (June–October): (**a**) CLICOM recording sites and (**b**) SACMEX stations.



(**a**)



(**b**)

Figure 3. Number of years with daily precipitation data for each recording site: (**a**) CLICOM and (**b**) SACMEX.

3. Methodology

The data were organized in folders identified with the station ID. Each folder contained files classified by year, with the daily precipitation information sorted by state and network. We processed the data from 95 CLICOM stations. Although the data already had initial quality control performed by the SMN, an additional control was carried out as part of this project to generate a more robust dataset. The number of stations analyzed and processed from the SACMEX network was 78.

Our quality control process considered the following aspects:

1. An annual time series of daily precipitation was generated for each station. These series were plotted and examined to select only those stations with 100% data during the 5 months of the rainy season (June–October);
2. To detect anomalous precipitation behavior, the automatically generated time series from the previous step were manually reviewed. In case of doubt in the behavior of the daily precipitation record, such as a very high value, this was verified by comparing the measurement with other data sources:
    a. The inventory of flood events that occurred in Mexico City during the 1920–2018 period [11];
    b. The information reported during the hurricane seasons (https://smn.conagua.gob.mx/es/, accessed on 22 March 2022);
    c. Data from the precipitation numerical forecast system (http://grupo-ioa.atmosfera.unam.mx/pronosticos/index.php, accessed on 22 March 2022).
3. If the suspicious behavior was verified, then the station data was discarded. The discarded stations were those that did not meet the 100% data criterion or because they had less than 20 years of information. For the CLICOM data, 6 stations out of the 95 originally selected were removed, and for the SACMEX data, 31 stations were removed. With the information of the remaining 136 stations that met the criteria previously established, we generated the present database (daily_precipitation_database.xlsx).

With the purpose of providing data to different users, we also made available all the daily precipitation data from the 173 stations initially considered. This dataset did not follow any selection criteria or processing (daily_precipitation_database_all.xlsx), and it has the same format as the one previously described.

4. User Notes

Both datasets are available through the following links: http://atlas.atmosfera.unam.mx/docs/data/daily_precipitation_database.xlsx (accessed on 22 March 2022) and http://atlas.atmosfera.unam.mx/docs/data/daily_precipitation_database_all.xlsx (accessed 22 March 2022). In the future, we will include the daily precipitation data for the month of May. Any updates made to the dataset will be made available at this same site.

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Data Availability Statement: Data can be freely downloaded at http://atlas.atmosfera.unam.mx/docs/data/daily_precipitation_database.xlsx (accessed on 22 March 2022). More data are available at http://atlas.atmosfera.unam.mx (accessed on 22 March 2022).

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Conflicts of Interest: The authors declare no conflict of interest.

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