# Introduction

The goal of this project was to analyze trends in terrestrial meteorological data across latitude for a single 24-hour period. To obtain a sufficiently large, unbiased set of locations for this analysis, the following criteria needed to be met:

* Randomly selected latitude/longitude coordinates to minimize spatial bias in location.
* Locations must fall on a land mass since the focus is on terrestrial meteorological conditions.
* Observed weather must be available for the locations, which narrows down locations to those proximal to areas of human habitation.

Three APIs were used to meet the criteria and obtain the meteorological data used in the analysis: 3GeoNames to generate random locations across the globe (<https://api.3geonames.org/>), the OpenWeatherMap Geocoding API to verify the availability of data (<http://api.openweathermap.org/geo/1.0/reverse>), and the OpenWeatherMap One Call API to download the data for a 24-hour period (<https://api.openweathermap.org/data/2.5/onecall/timemachine>).

Data were obtained from 600 locations for July 28, 2021. The locations are shown below.

# Methods and Analysis

3GeoNames provides an API to generate randomly selected locations across the globe. The API includes an option that limits the domain to land masses only, thus avoiding the 71% of global locations over water. The return dictionary usually includes the name of the nearest location (a town, city, or region), its country, the location’s coordinates, and the distance from the location to the original random latitude/longitude. In some cases the nearest location values are blank (likely when the queried coordinates fall in an unpopulated/wilderness area). When this occurred, the location was discarded and the process was repeated.

When a location with data was identified, the coordinates were then passed to the OpenWeatherMap Geocoding API to find the nearest available location in the OpenWeatherMap database. Sometimes OpenWeatherMap returned an empty JSON response, which likely indicated that the 3GeoNames location was too far from an OpenWeatherMap location to get a geocoding response. The Geocoding API documentation does not discuss a proximity requirement; regardless of the reason, the location for empty OpenWeatherMap responses were discarded. Valid OpenWeatherMap locations were stored in a list and the process repeated until 600 unique locations were found.

OpenWeatherMap allows for querying hourly weather conditions recorded during the previous five days in 24-hour blocks. If five days were retrieved for each of the 600 locations, it would require 3,000 API calls. However, the API call limit for free accounts is 1,000 per day. Based on this limitation, 24 hours of data were retrieved for each location, using midnight UTC one day prior to script execution for all locations (for a total of 600 calls). This ensured that the same 24-hour period was used for all locations (regardless of time zone), and that a full 24 hours of data were processed. The following parameters were assessed:

Maximum daily temperature

Minimum daily temperature

Mean daily dewpoint temperature

Mean daily relative humidity

Mean daily cloud cover

Mean daily wind speed

Maximum Temperature vs. Latitude Plot

Maximum daily temperatures are variable, but decrease towards the poles and increase towards the equator. Data are more concentrated between 30<sup>o</sup> N to 60<sup>o</sup> N, reflecting a larger proportion of the world's land area in North America, Europe, and Asia.

Minimum Temperature vs. Latitude Plot

Minimum daily temperature follows the same pattern as maximum daily temperature, but shows more of a peak in the middle of the distribution. The peak appears to be focused around 10<sup>o</sup> N to 30<sup>o</sup> N. This is due to summertime conditions in the Northern Hemisphere, when the sun's angle of incidence (and radiation intensity) is highest for latitudes in this range.

Dew Point vs. Latitude Plot

The distribution of mean hourly dew point is similar to minimum daily temperature, but with greater variability. Dew points are usually lower than the range of daily temperatures in semi-arid and arid climates.

Relative Humidity vs. Latitude Plot

As discussed at the beginning of this notebook, relative humidity represents how much of air's water-holding capacity is "filled" at the current temperature. As the gap between temperature and dew point increases, relative humidity decreases, though the degree of change varies with air temperature. The global pattern of relative humidity reflects all these factors.

Cloudiness vs. Latitude Plot

Mean hourly cloudiness is highly variable, but tends to be low in the southern hemisphere and high between 0<sup>o</sup> N and 10<sup>o</sup> N. This could be related to conditions during the day selected for analysis.

Wind Speed vs. Latitude Plot

Mean hourly wind speed is variable across latitutudes, and appears to show a lognormal distribution clustered at low wind speed.