

Effect of climate drivers on Australian climate

At <http://www.bom.gov.au/climate/enso/#tabs=Overview> the Bureau of Meteorology list four primary drivers on the Australian climate. These are the El Nino-Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), the Southern Annular Mode (SAM) and the Madden-Julian Oscillation (MJO). This project investigates the effect of these first three of these phenomena on the climate of Melbourne and other Australian cities. The project will ignore the MJO as it is a short-term, mainly tropical effect. For an explanation of each of these phenomena and the calculation of indices, see the relevant tabs on the Bureau webpage.

The indices for each of the climate drivers can be downloaded from:

- ENSO - <https://www.cpc.ncep.noaa.gov/data/indices/soi>
- IOD - https://psl.noaa.gov/gcos_wgsp/Timeseries/DMI/
- SAM - <https://climatedataguide.ucar.edu/climate-data/marshall-southern-annular-mode-sam-index-station-based> Sanitized versions of these files will be provided.

The climate data for Australian cities can be downloaded from <http://www.bom.gov.au/climate/data/index.shtml>. For example, to obtain Melbourne rainfall, choose:

- Section 1: Choose 'Rainfall' and 'Monthly Observations'.
- Section 2: Choose 'Melbourne' under location, and unclick 'Only show open stations'. Then choose, e.g., Melbourne (Olympic Park). This will show the station has been open since around 2013.
- Section 3: Choose 'Get Data'. This will open a new page, then to download the data as a zip archive, click 'All years of data' in the upper right hand corner. The zip archive includes a note which explains the data and two data formats; wide and long. It is probably easier to use the wide format. We want to go further back than 2013 with the analysis, so we also need to download the data from the previous location of the Melbourne Regional Office.

The monthly rainfall and mean minimum and maximum temperatures for Melbourne will be provided, however for other cities you will need to download the data from the Bureau webpage and merge the station sets.

The main objective of this project is to model the anomalies for the climate data as a function of the ENSO, IOD and SAM indices. To do this you will need to calculate the climatology, i.e., the average for each month over the recording period, and subtract this component from the climate data. Then you will need to model the climate anomalies using Linear Regression and compare this with the correlation coefficients. Once you created a model for the Melbourne data, you can then investigate the effect of each of the indices on the other Australian capital cities.

Some possible extensions or alternative avenues of investigation are: * The Linear Regression may not give very good accuracy, however the main purpose is to determine the effect of the indices on the climate. Investigate other regressors, such as Support Vector Machines, Decision Trees and Random Forest. You could also investigate the effect of regularization on Linear Regression, smoothing of the data or converting the anomalies to a classification problem. * The climate data and the indices each have a distinct seasonal component. Use the Python library statsmodels to investigate and model the timeseries. Alternatively, restrict the climate data and indices to the various seasons (DJF, MAM, JJA and SON), and investigate how effective the models are for particular seasons. * The climate data and indices appear to have distinct trends over the recording period. Investigate these trends and possibly the modelling problem with the detrended data.