Two Possible Project Areas in the Atmospheric Circulation

Mean Meridional Circulation variability

Using the definition of the mass-meridional stream function in *either* pressure coordinates *or* isentropic coordinates investigate the seasonal variability of the mean meridional circulation.

$$\Psi_p(\phi,p) = \frac{2\pi a\cos\phi}{g}\int_p^{p_s}[v]dp$$

$$\Psi_\theta(\phi,\theta) = 2\pi\cos\phi\int_{\theta s}^{\theta}[\sigma v]dp$$

where ϕ is the latitude, p_s denotes the surface pressure, and $\sigma = -\frac{1}{g}\frac{\partial p}{\partial\theta}$ represents the "pseudo-density" in isentropic coordinates.

(a) For each season , compute and plot the meridional circulation averaged over all days in that month for all years. For example, average over Dec 1960 through February 1961, average over Dec 1961 through February 1962, etc to get the "DJF" mean.

Also do the March-May (MAM), June-Aug (JJA), SON (Sept-Nov) means

(b) Identify the Hadley cells and Ferrel cells.

(c) Compute the interannual standard deviation of seasonal mean Hadley and Ferrel cells.

Impact of tropical variability on the area where you live

First, choose a variable like surface temperature, precipitation, surface pressure and calculate the time series of that variable averaged over your domain of interest.

This could be daily time series for all winters, or all summers, or a time series of monthly means. Call this the "local" time series.

Second, Plot the resulting time series alongside standardized values of one tropical forcing mechanism. (To standardize a time series, remove the time mean, and divide all values by the temporal standard deviation.)

The tropical forcing time series could be:

-(i) The so-called Nino3 index that measures the eastern tropical Pacific SST – this measures the El-Nino Southern Oscillation (ENSO) phenomena (this is a monthly time series) [The Niño 3 index is an average of the sea surface temperatures in the region 150 degrees West - 90 degrees West (longitude) and 5 degrees North to 5 degrees South (latitude).]
-(ii) Extended Indian Monsoon Rainfall (EIMR) index. Extended Indian Monsoon Rainfall index is defined as the monthly *anomaly* precipitation averaged over 10N – 30N and 70E – 110E.
-(iii) The Madden Julian Oscillation (MJO) index can be computed using the 200-hPa zonal mean zonal wind averaged over 10N-10S.
MJO index: The 6-hourly values are first filtered with a 90-30 day filter, that is a filter which retains only periods of 30-90 days. The filtered values are then squared and passed through a 90-day running mean.

How to filter: A simple 30-90 band-pass filter can be computed by first taking a 30-day running mean of the time series (S30) and a 90-day running mean of the time series (S90). The band-passed time series is obtained by subtracting the two filtered time series, S2-S3. *

Third, Plot a scatter plot for standardized values of the tropical forcing index vs. your chosen local index.

Fourth, Calculate the correlation and regression coefficients between your local index and the standardized values of the tropical forcing index .

Fifth: the incidence of extreme events. Say you are interested in estimating the number of extreme cold events in your area during summers corresponding to the opposing phases of the EIMR. In this case you define extreme cold events as days when the temperature of your region dip 2 standard deviations below their long-term climatological mean and the contrasting phases of the EIMR when the standardized EIMR index is 1 standard deviation about its long term mean.

Sixth Provide a physical interpretation of your results.

* 5 Steps involved:
STEP 1: compute 30-day running mean (S30)
STEP 2: compute 90-day running mean (S90)
STEP 3: take difference S30-S90 (band pass time series)
STEP 4: square
STEP 5: compute 90-day running mean