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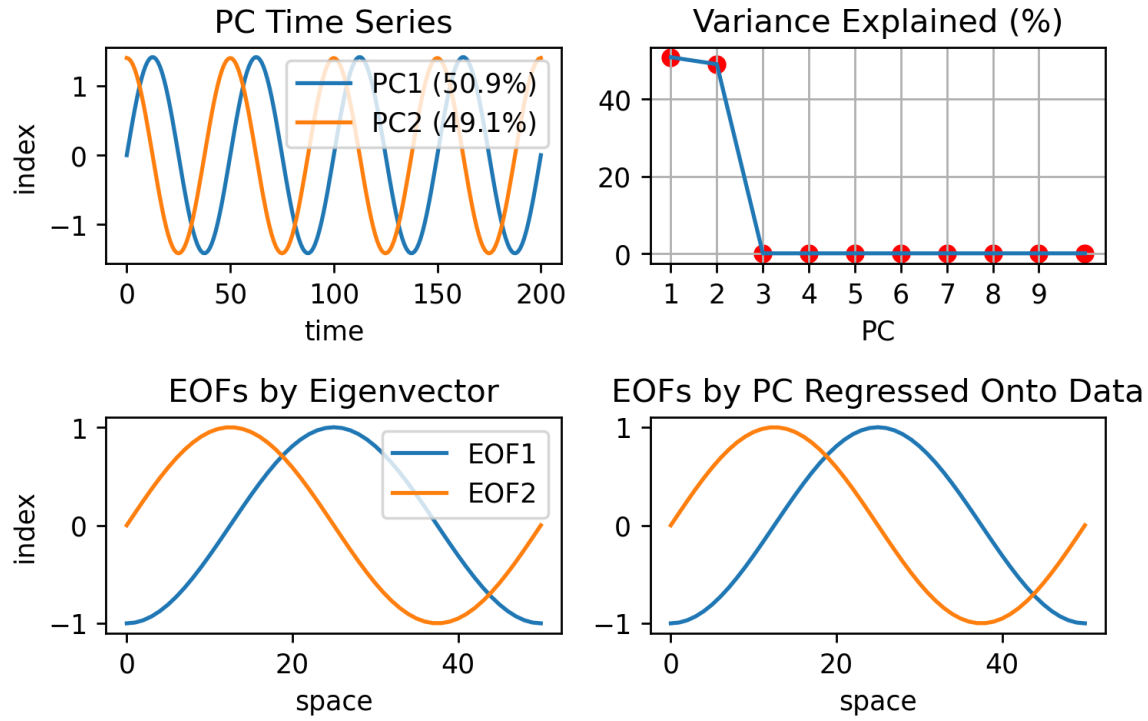
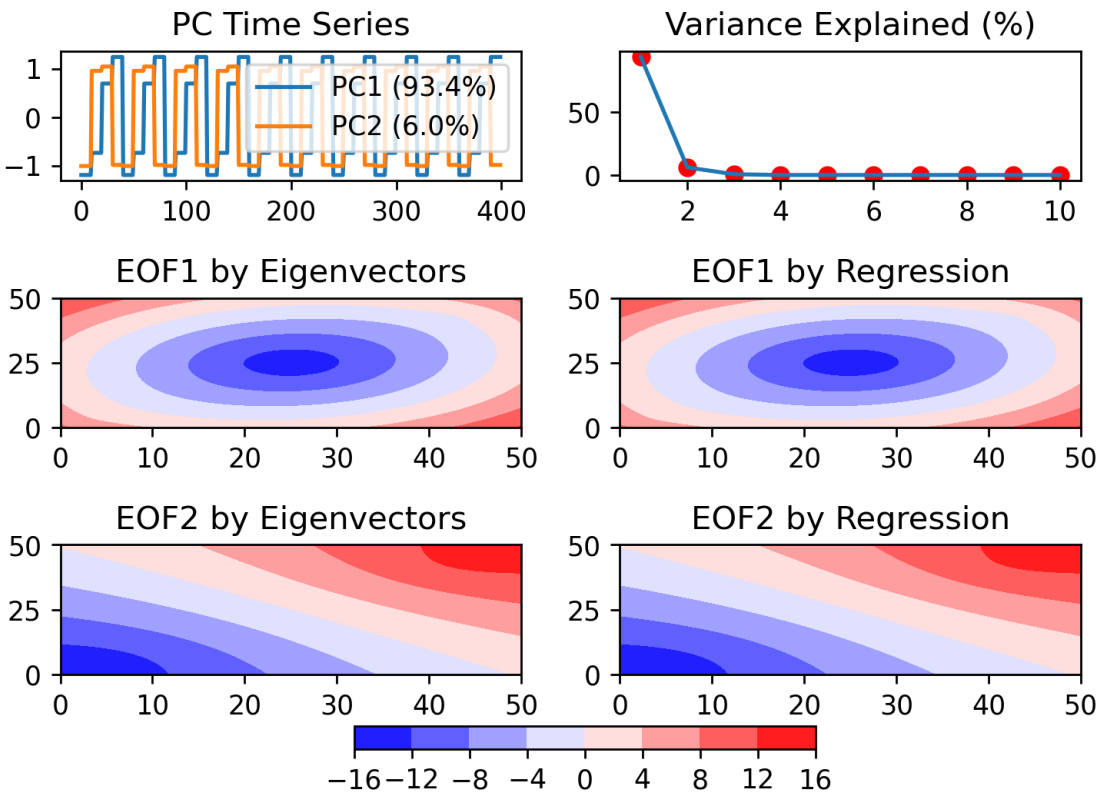
METEO 515 HW5
Code available at https://github.com/wefoust/Meteo515_AtmosStats

Question 1



The figure depicts the PC time series, variance explained, and EOFs of the sinewave dataset. The PC time series represents an "index" for the EOF patterns. The original dataset is a sine wave that completes 1 cycle and propagates in time. Due to the structure of the data, the two leading principal components explain all the variance. At time t=0 the index of the leading PC is nearly zero, while the index of the second PC is rounded to 1.4. In this case, the second EOF explains nearly all of the variance in the data at t=0. This is reflected in the EOFs where the second EOF pattern matches the original data. Although a pattern exists for the first EOF, the PC is zero at this time and this pattern does not capture the variance in the data. The amplitudes of the PCs oscillate in time, but the oscillation are out of phase. Thus, the leading PC begins to capture more of the variance as the sine wave propagates in time. At t=50 the sine wave will complete a cycle and the second EOF will capture all the variance.

Question 2



The figure shows the PCs, variance explained, and EOFs of the bullseye dataset. Given the structure of the data, the centered bullseye modes (modes 1 and 4) are reflected in the leading EOF pattern, which suggests they are the most dominant modes of variability. With modes 1 and 4, the bullseyes are collocated in the center, but amplitude of the values between the two patterns are additive inverses of each other. Comparatively, a bullseye appears in both modes 2 and 3, but the bullseye is located in the lower left or upper right corner respectively. Since the bullseyes are not collocated, they do not contribute as much to the variability in the original data.

The leading two principal components show periodicity, which is also shown in the original data. Since there is a phase shift between the PCs, the respective indices or “weights” vary in time, and periodically represent the original data in a similar manner to the sine wave dataset.

The bullseye pattern of EOF1 captures over 90% of the variability in the original data. However, the pattern is not a perfect paraboloid or “bullseye”. It is stretched towards the lower left and upper right corner of the domain, and in the direction of the bullseyes in modes 2 and 3. This stretching is fully accounted for in the second EOF. Although it captures modes 2 and 3 well, it explains little of the variance compared to the leading EOF.