1. At this question, I open the netCDF file firstly.

1.1. As the information showed in the website, I got the region of Nino 3.4. By the latitude and longitude data, I use sel() to extract the region data. Correction was necessary to make it more exact, and I corrected the data with latitude using the method that was mentioned in the lecture.

   To compute monthly climatology for this region, I used groupby() function, and then I plotted it, as Figure 1 shows. Then I subtracted climatology from SST time series to obtain anomalies and plotted it, as Figure 2 shows.

   Finally, I calculated the moving average of the anomalies to get the Nino 3.4.

1.2. At the above question, I have got the Nino 3.4. I plotted it in black line, in the meantime I plotted two lines which are used to identify the El Nino phenomenon and La Nina phenomenon. I plotted them in Figure 3.

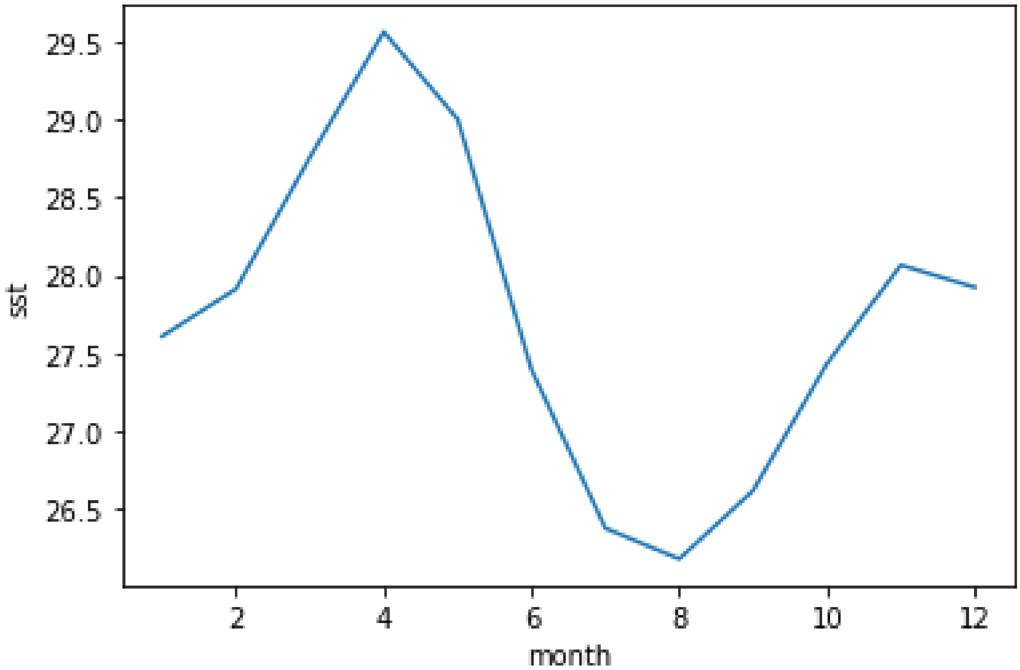

Figure 1. The Monthly Climatology for SST (sea surface temperature) from Nino 3.4 region

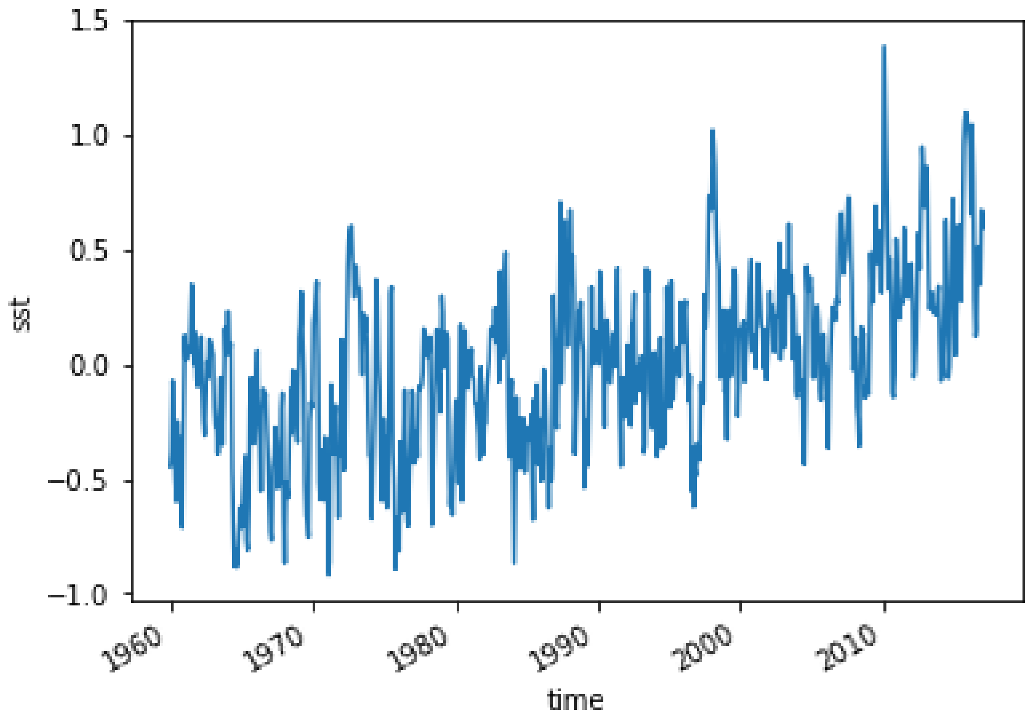

Figure 1. The Monthly Anomalies for SST (sea surface temperature) in Nino 3.4 region

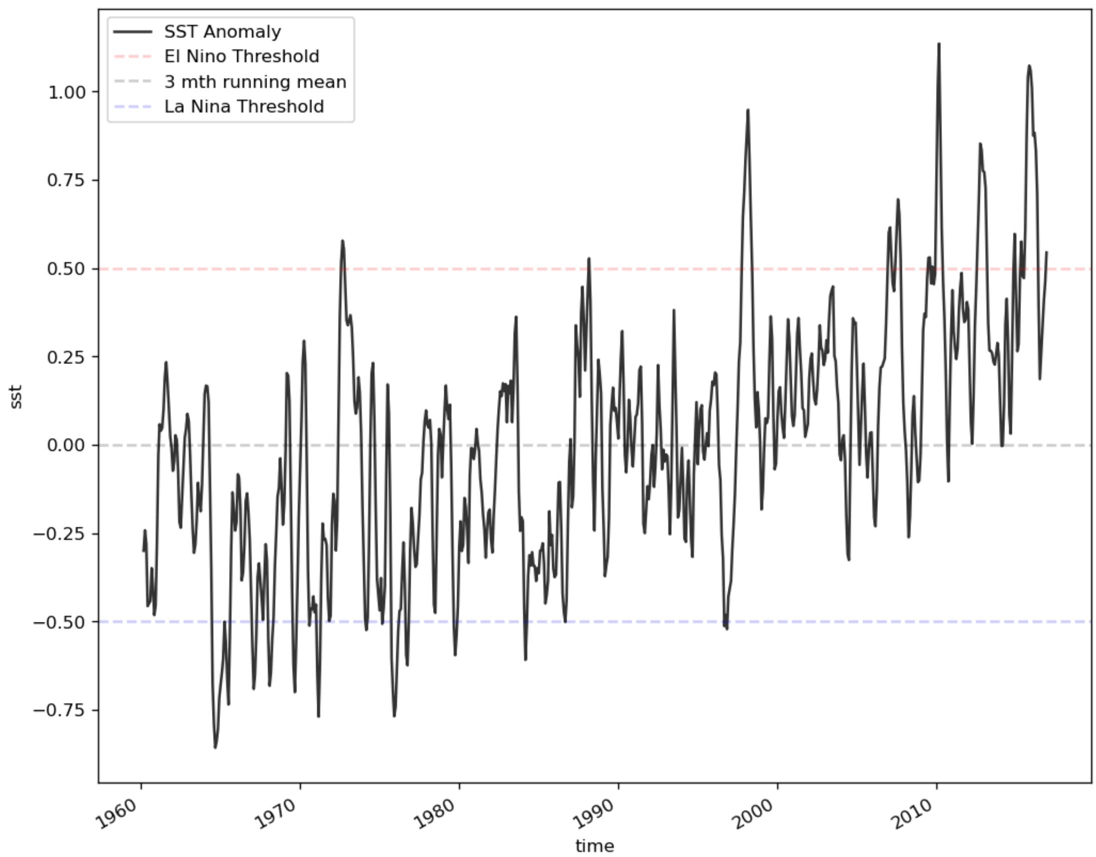

Figure 3. 3-months Running Mean SST Anomalies for SST in Nino 3.4 region

2. Firstly, I read the file and showed it.

2.1. At this question, I plotted two figures. The first figure (Figure 4) showed the 2D plots of the time-mean TOA longwave, shortwave, and solar radiation for all-sky conditions respectively. The second figure (Figure 5) showed the 2D plots of the add up data of the variables above and the TOA net flux respectively. We could find that the two plots in Figure 5 look as the same with each other, and it verified that they are equivalent to each other.
2.2. At this question, I subtracted the TOA net flux from the add up data. Then I plotted it as a 2D plot in Figure 6. We could find that the result showed low difference between the two data and it also verified that they are equivalent to each other.
2.3. At this question, I considered the area of each grid. I multiplied the area and the TOA data so that I got the amount of the radiance. The unit of the amount data should be W (calculated as $W/m^2 * m^2 = W$). The plot of net radiation in each 1-degree latitude band is showed in Figure 7.
2.4. At this question, I extracted the data of low and high cloud area regions with where() function. The four 2D maps are showed in Figure 8, including time-mean outgoing shortwave and longwave radiation for high and low cloud area.
2.5. At this question, I used weighted() function to correct the TOA data, and I extracted the low and high cloud area regions to calculate the global mean values of shortwave and longwave radiation. I plotted them in Figure 9. Compared with global mean values, high cloud area regions tend to have a higher shortwave radiation and lower longwave radiation. Low cloud area regions get a opposite result.

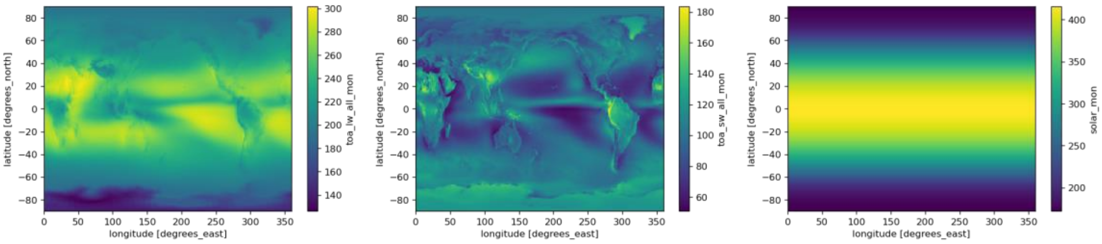

Figure 4. 2D Plot of the Time-mean TOA Longwave, Shortwave, and Solar Radiation for all-sky conditions

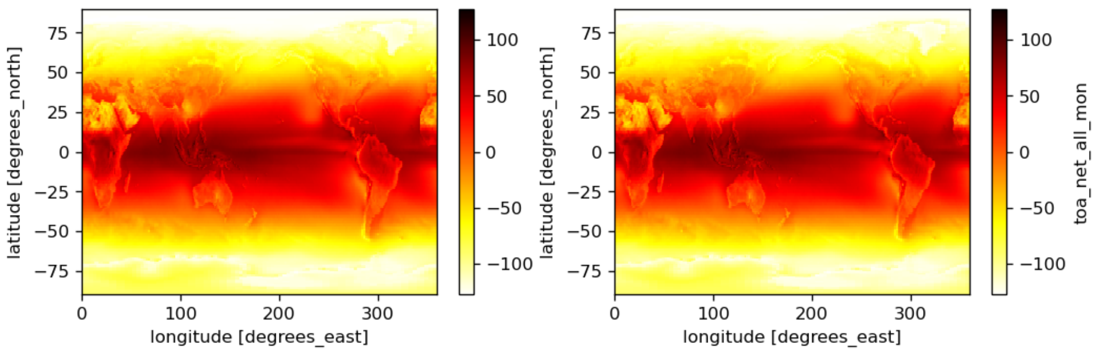

Figure 5. Add up of the above Variables and the Time-mean TOA Net Flux

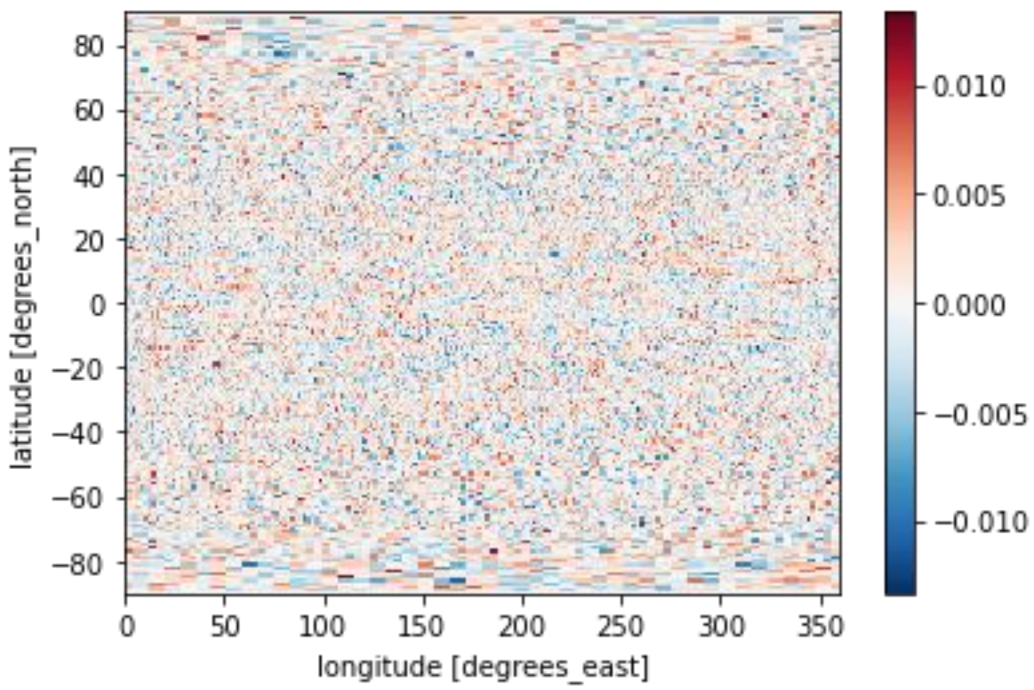

Figure 6. Plot of the Differences between the Add up Data and TOA Net Flux

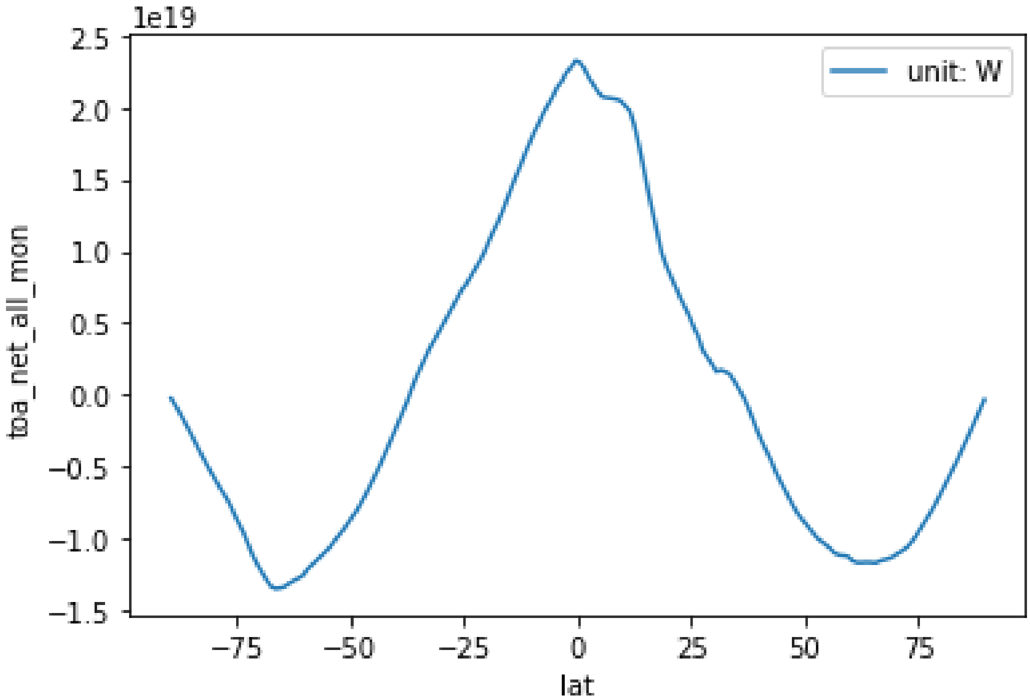

Figure 7. the Total Amount of Net Radiation in each 1-degree Latitude Band

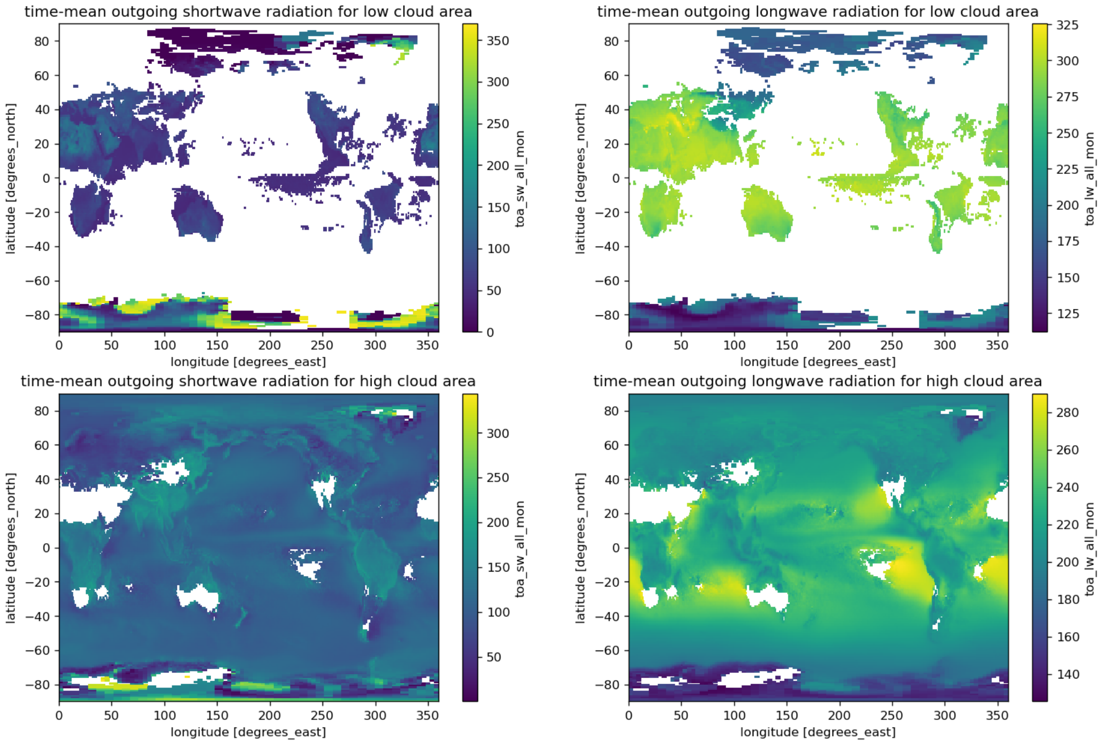

Figure 8. Time-mean Outgoing Shortwave and Longwave Radiation for Low and High Cloud Area Regions

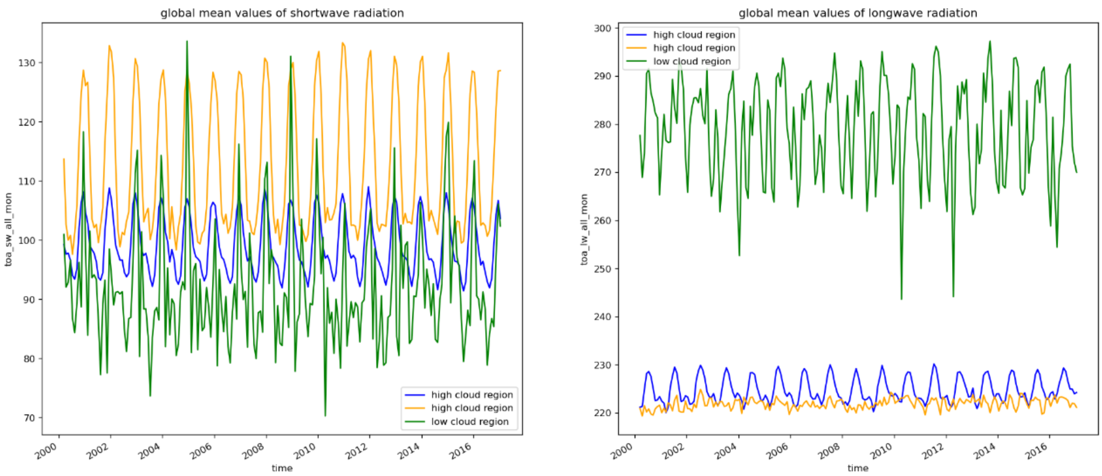

Figure 9. Global Mean Values of Shortwave and Longwave Radiation for Low and High Cloud Area Regions

3. At this question, I downloaded a temperature data from ERA5, and read it as dataset. The file could be downloaded at (https://pan.baidu.com/s/1cG24X7uvX4F7IksWYGWV_A, code：51qw).

3.1. I used a method similar to Q1.1 to get the time series of t2m (temperature on 2m from the surface) with monthly seasonal cycle removed. The plot is showed in Figure 10.

3.2. I made 5 different plots using the dataset in Figure 11-15. The first one is the plot of the global monthly climatology of t2m. We could find that the highest temperature existed in

July and the lowest one in February. Then, I plotted the global average temperature, with a separation to northern hemisphere and southern hemisphere. It's interesting that the amplitude of northern hemisphere is higher than in southern hemisphere. The third one is about the average temperature of each latitude. The regions in higher latitude have a lower average t2m. The fourth plot is a box plot, which calculate the distribution of t2m. The last one is a 2D map about the difference of global annual average temperature in 2010 and 2020. In this plot we could know the global warming in some regions in the ten years.

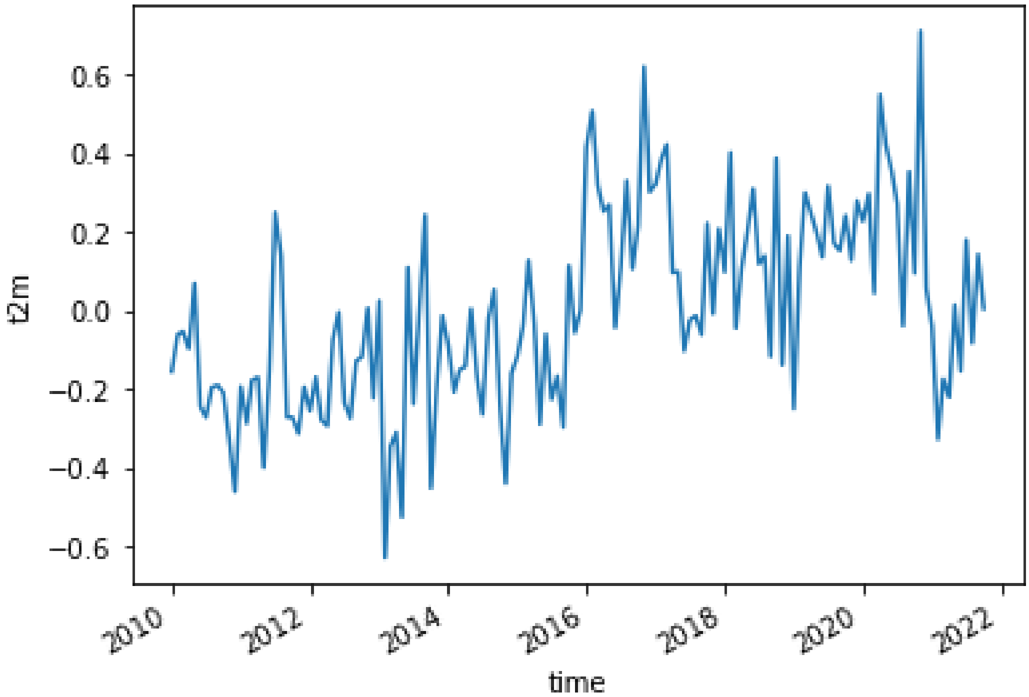

Figure 10. Time Series of a Certain Variable with Monthly Seasonal Cycle Removed

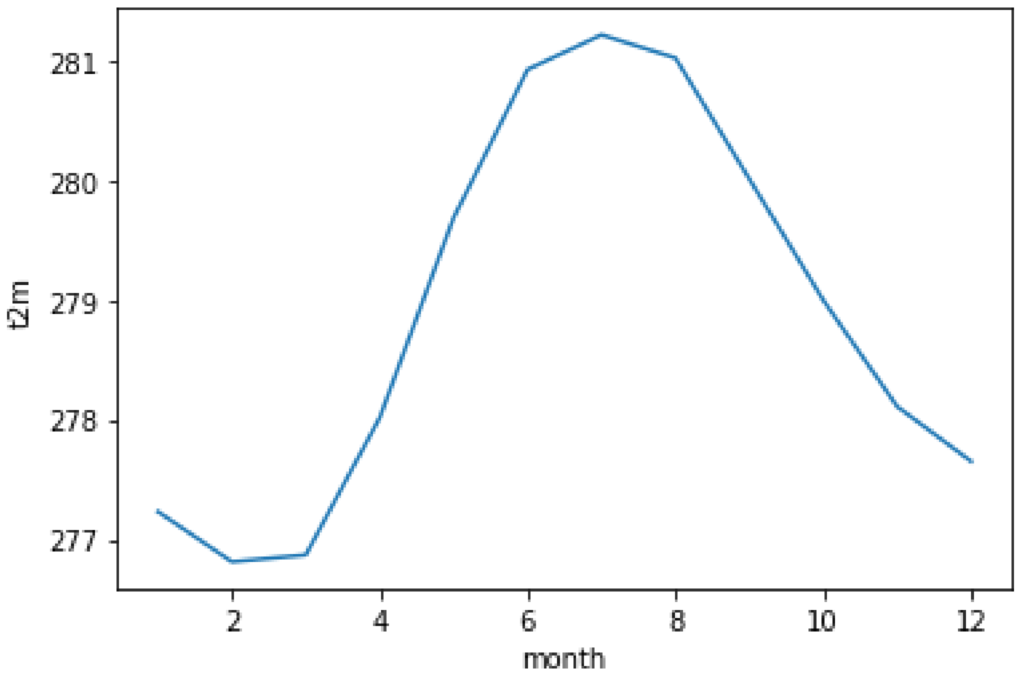

Figure 11. Global Monthly Climatology of t2m

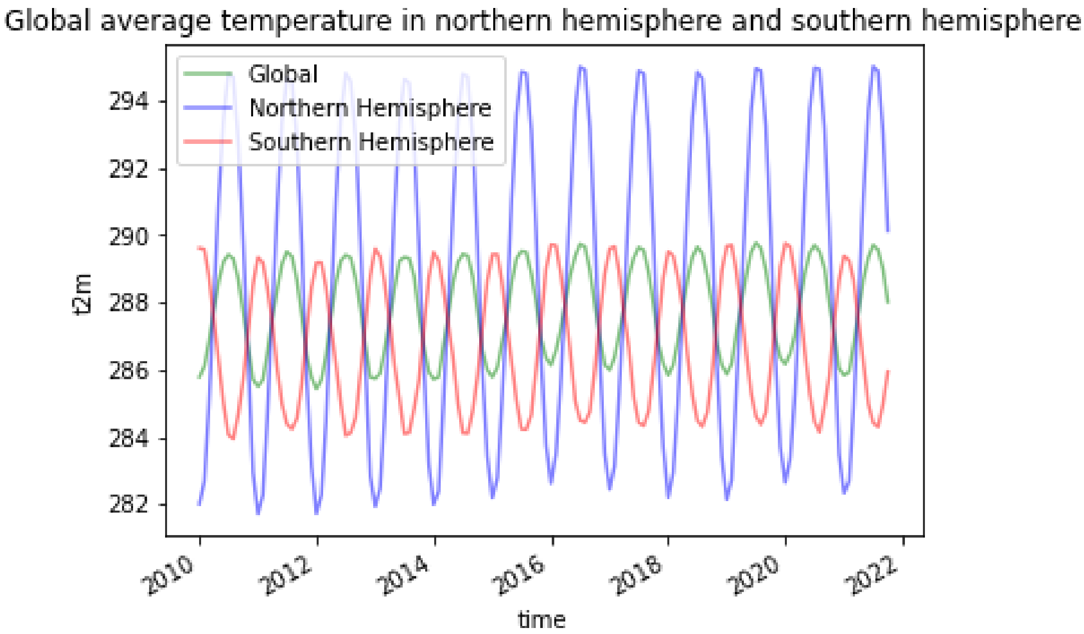

Figure 12. Global Average Temperature in Northern Hemisphere and Southern Hemisphere

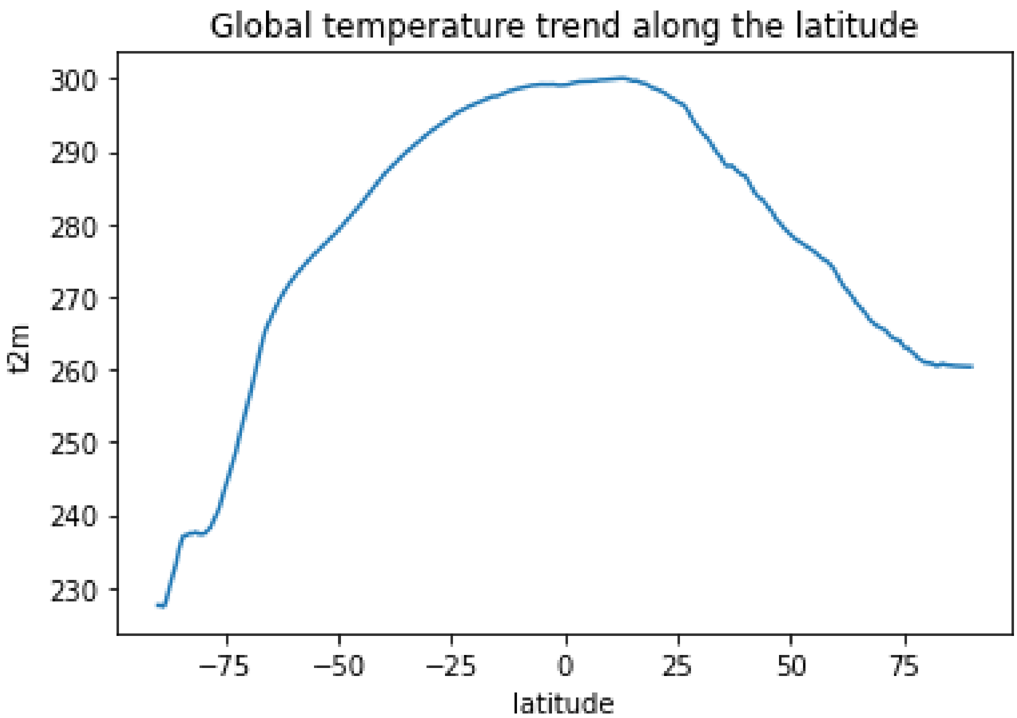

Figure 13. Average t2m of each Latitude Band

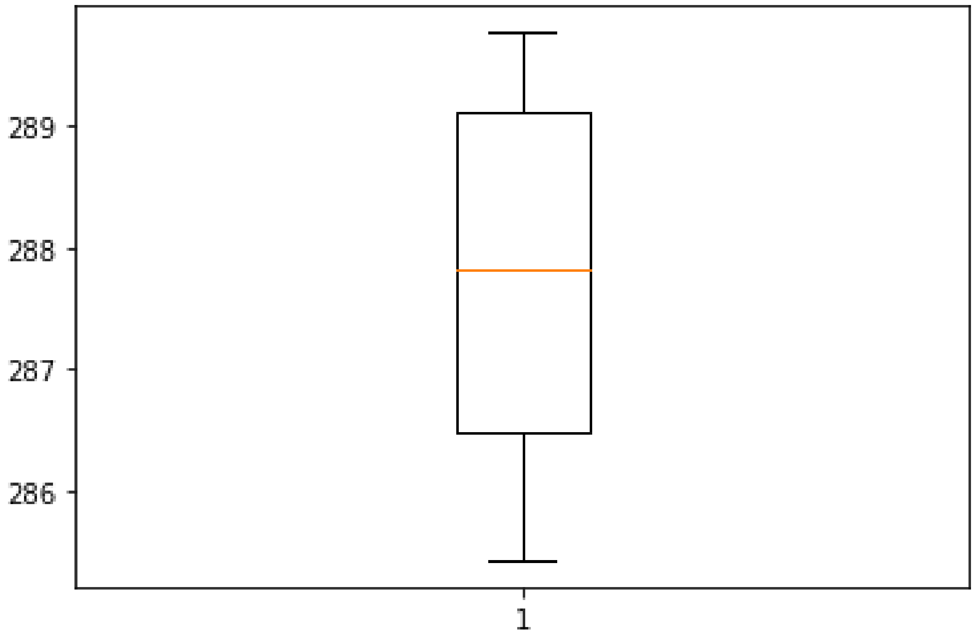

Figure 14. Distribution of t2m

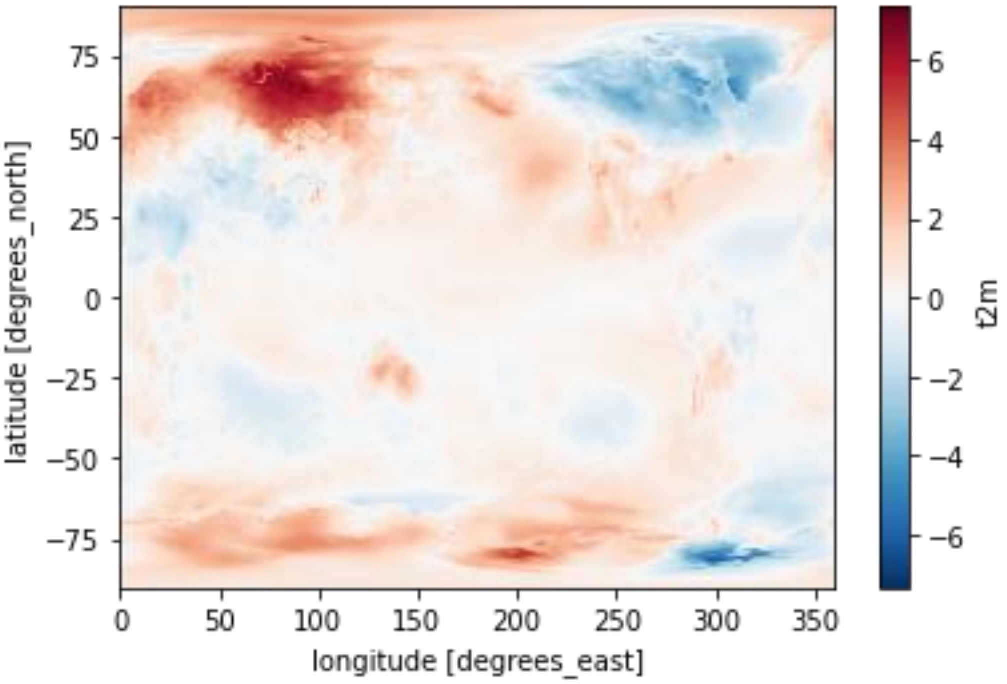

Figure 15. Difference of Global Annual Average Temperature in 2010 and 2020