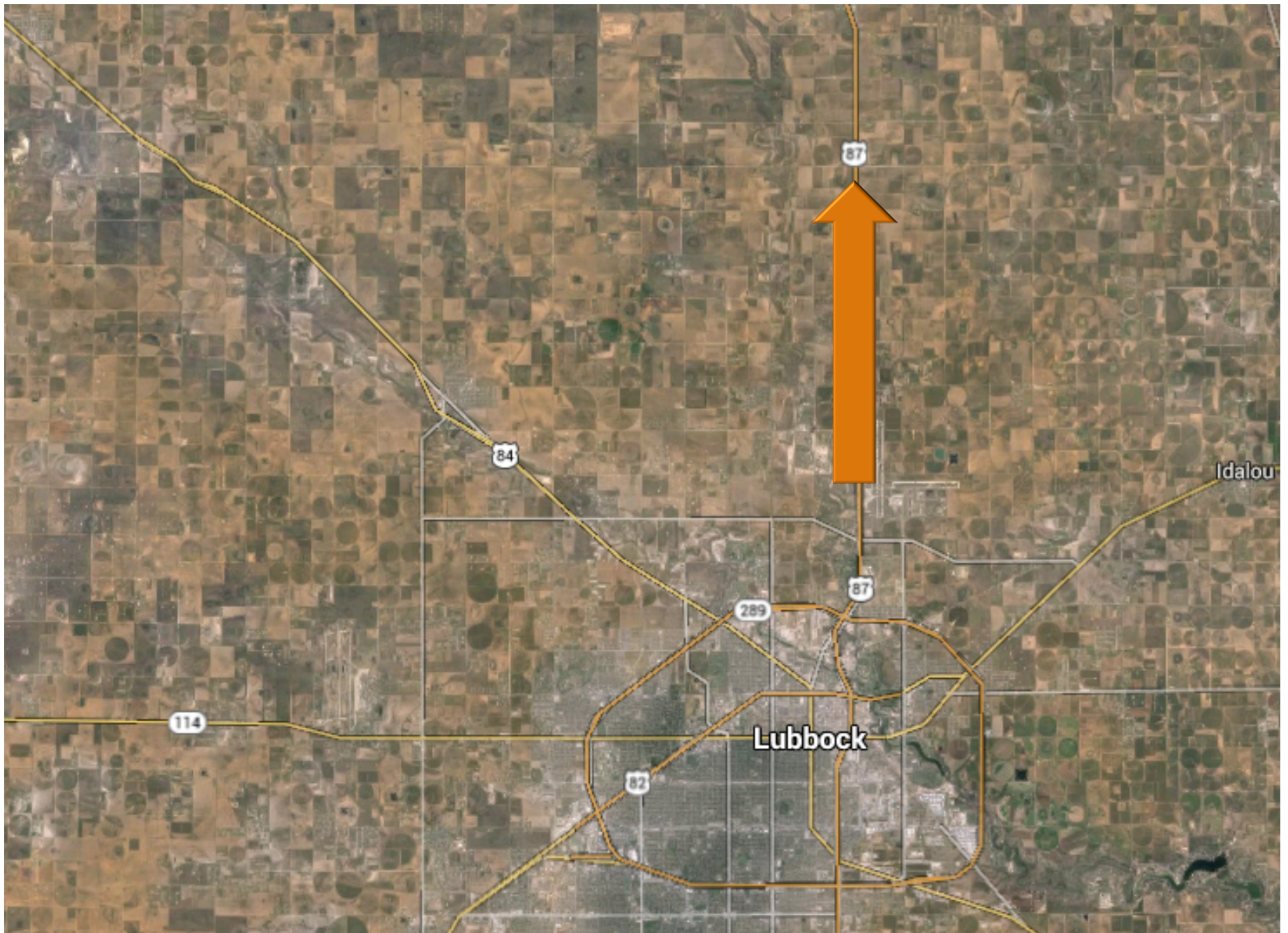




Climate Exercise – Day 1

KATHARINE HAYHOE



87

84

112

289

87

82

Lubbock

Idalou

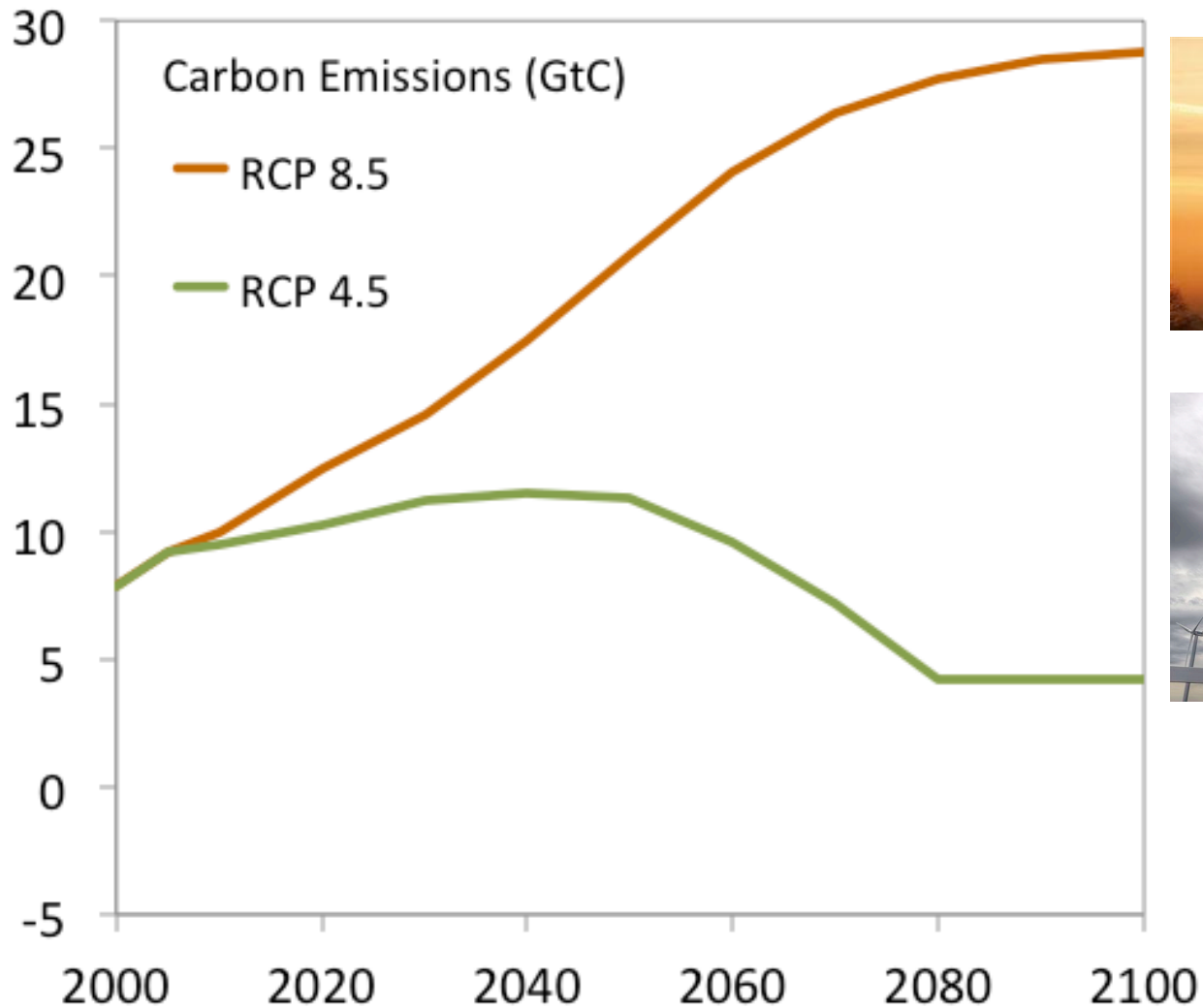


Planning for the future
based on the past
is like driving down the road
looking in the rear-view mirror.

WHAT ARE INDICATORS?

- *Indicators* are metrics that can be used to understand how climate conditions are changing.
- We are using indicators based on maximum and minimum temperature and precipitation.
- This code allows you to calculate three types of indicators:
 1. Annual or seasonal averages
 2. Days per year above or below a threshold
 3. Record hot, cold, and wet conditions each year

We calculate indicators for 2 futures



THE STEPS FOR TODAY

- STEP ONE: Open the statistical programming package R on your computer. Follow the instructions so the program knows where to find the directories it will need. The information you will need to enter should be written on the whiteboard here in the room.
- STEPS TWO and THREE: Calculate climate indicators using two types of data: (1) weather station data for one of 64 different stations around India, and (2) gridded data covering all of India.

**JUST FOLLOW THE INSTRUCTIONS
AND ASK FOR ASSISTANCE IF YOU NEED IT!**

IF YOU HAVE TIME ...

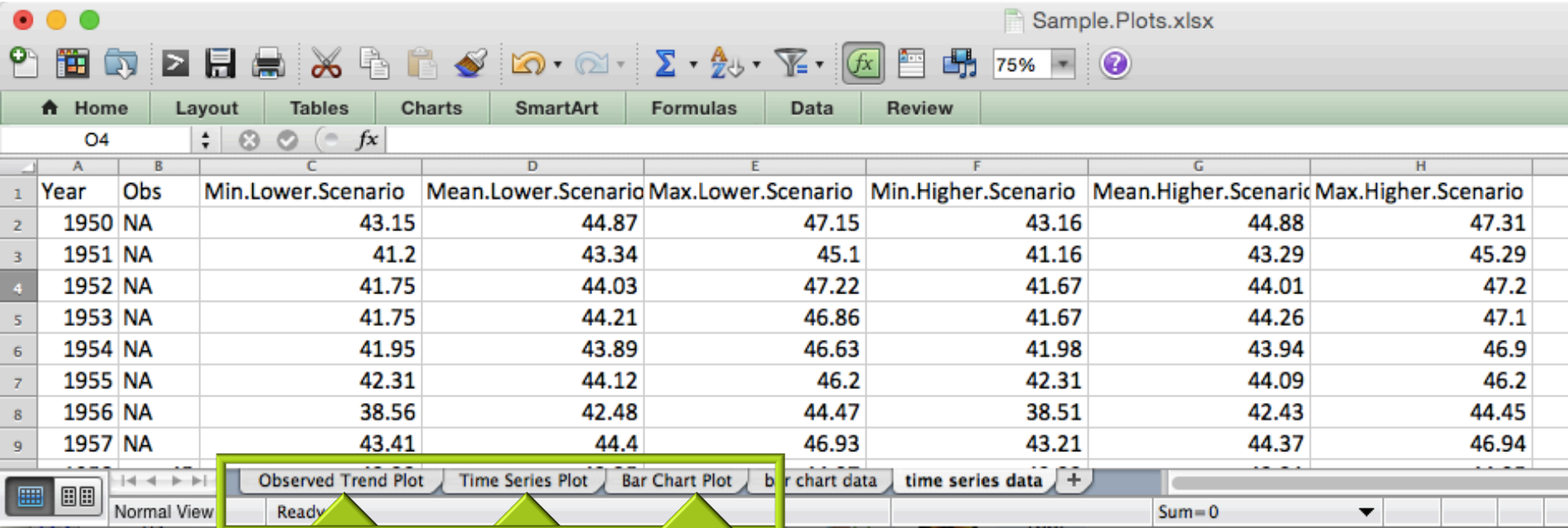
- STEPS FOUR and FIVE: Plot the weather station projections using Excel, and plot the gridded data using a program called Panoply.

SAMPLE.PLOTS -> 3 TYPES OF EXCEL PLOTS

The screenshot shows the Microsoft Excel interface with a data table and a chart selection menu. The data table has the following columns: Year, Obs, Min.Lower.Scenario, Mean.Lower.Scenario, Max.Lower.Scenario, Min.Higher.Scenario, Mean.Higher.Scenario, and Max.Higher.Scenario. The chart selection menu is open, showing options for 'bar chart data' and 'time series data'. Two large orange arrows point upwards from the bottom of the image towards the 'bar chart data' and 'time series data' options in the menu.

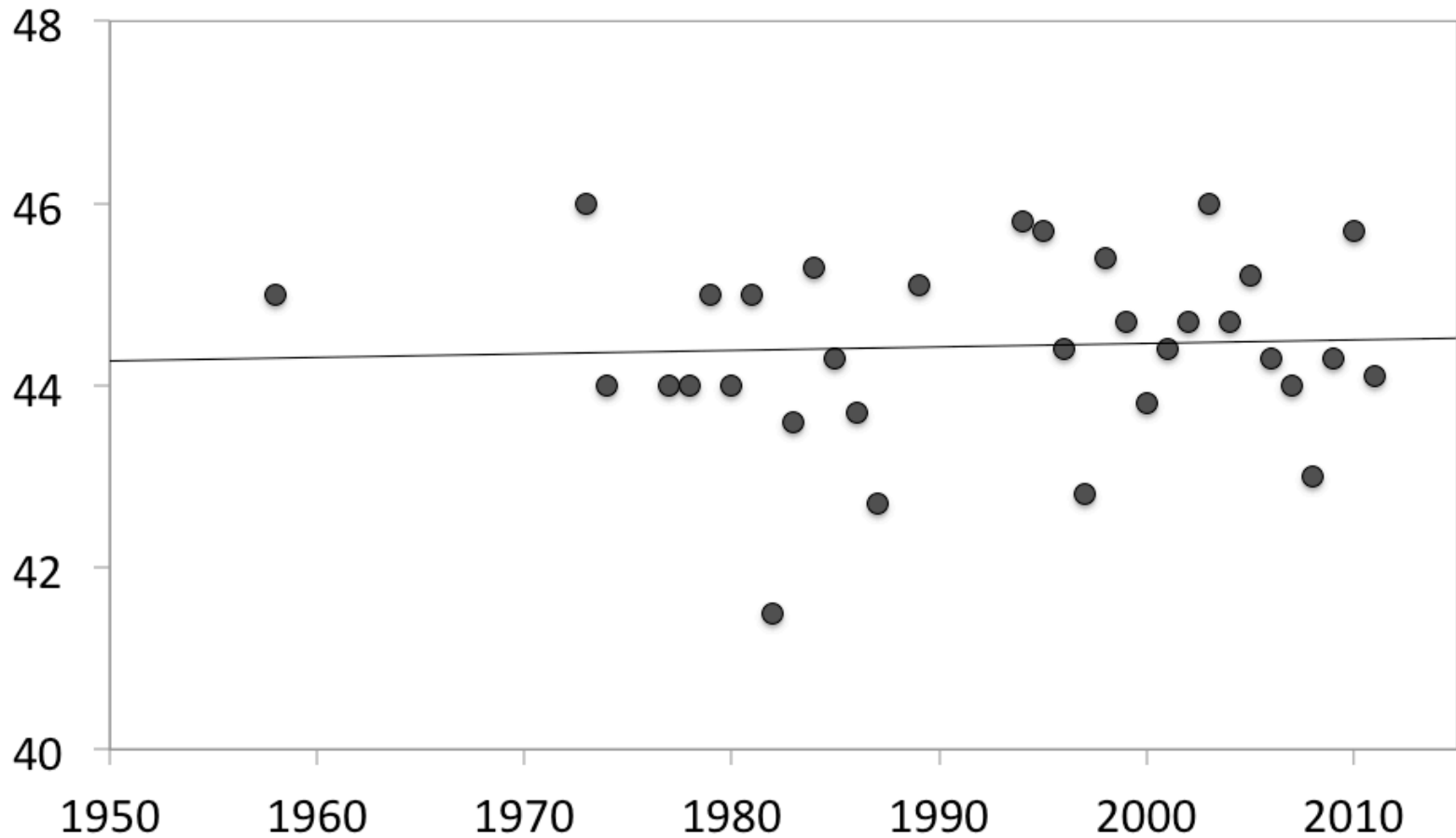
	A	B	C	D	E	F	G	H
1	Year	Obs	Min.Lower.Scenario	Mean.Lower.Scenario	Max.Lower.Scenario	Min.Higher.Scenario	Mean.Higher.Scenario	Max.Higher.Scenario
2	1950	NA	43.15	44.87	47.15	43.16	44.88	47.31
3	1951	NA	41.2	43.34	45.1	41.16	43.29	45.29
4	1952	NA	41.75	44.03	47.22	41.67	44.01	47.2
5	1953	NA	41.75	44.21	46.86	41.67	44.26	47.1
6	1954	NA	41.95	43.89	46.63	41.98	43.94	46.9
7	1955	NA	42.31	44.12	46.2	42.31	44.09	46.2
8	1956	NA	38.56	42.48	44.47	38.51	42.43	44.45
9	1957	NA	43.41	44.4	46.93	43.21	44.37	46.94

SAMPLE.PLOTS -> 3 TYPES OF EXCEL PLOTS



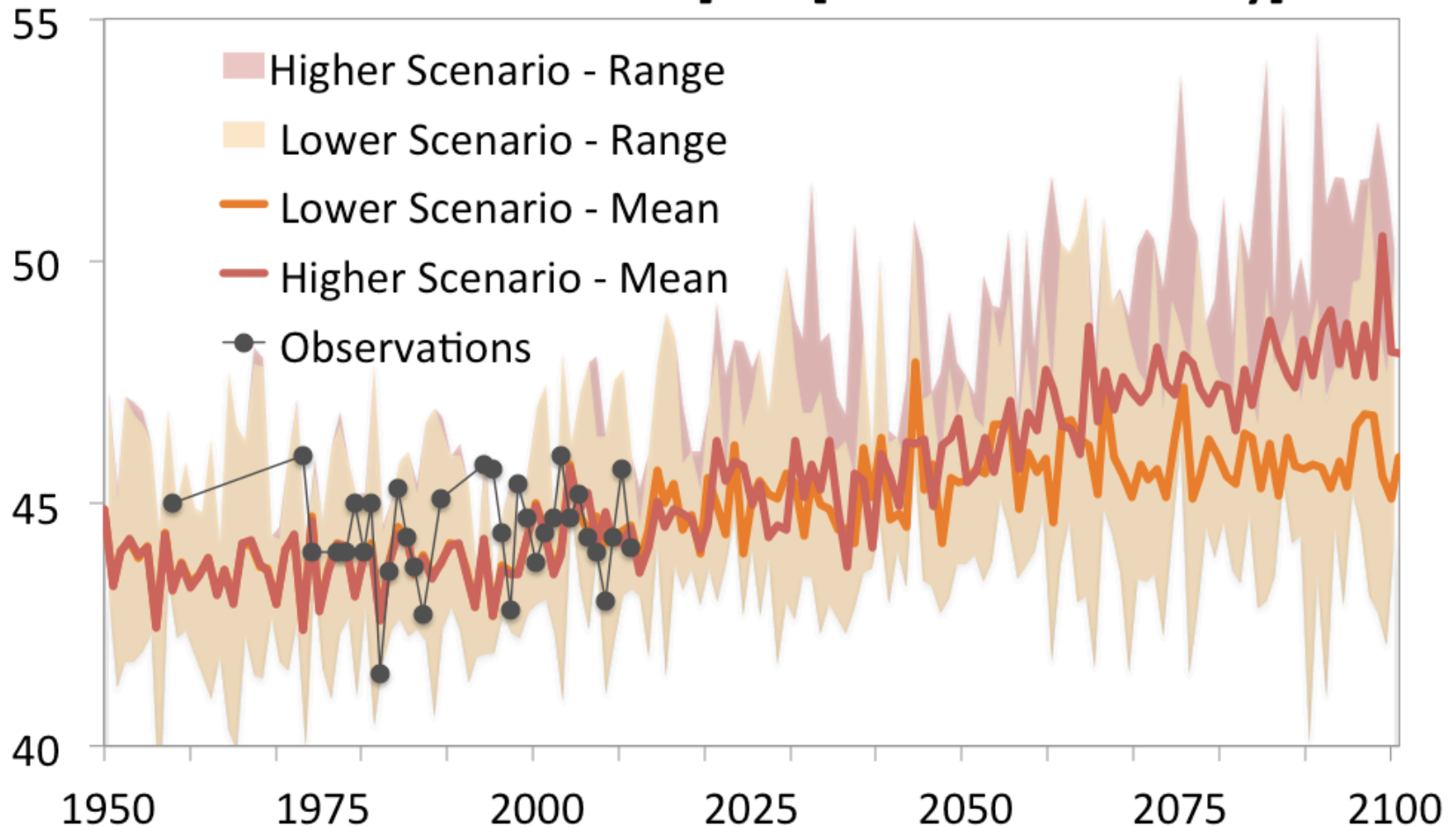
SAMPLE.PLOTS -> 3 TYPES OF EXCEL PLOTS

Observed trend in average temperature on the hottest 3 days of the year at Jabalpur



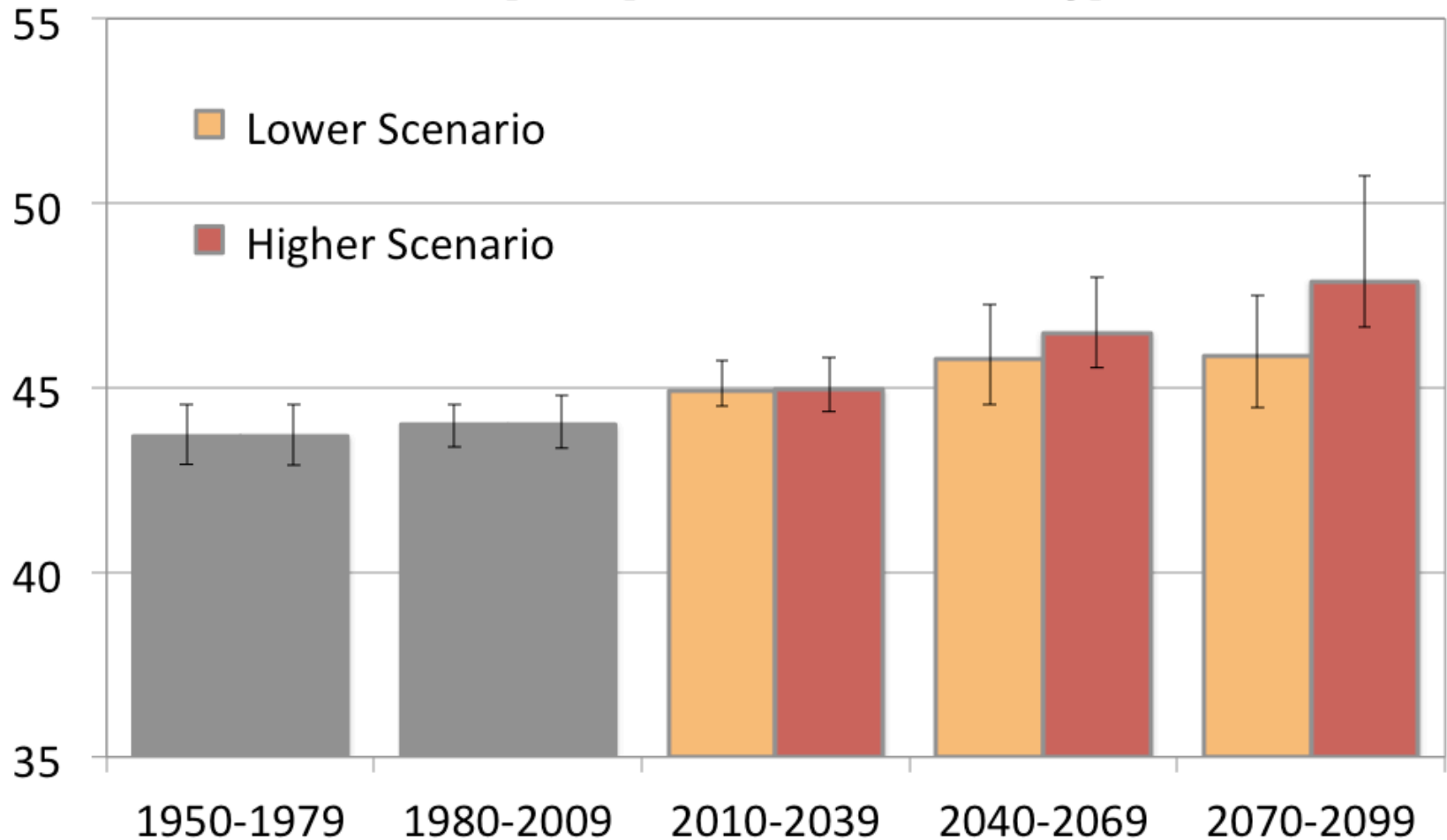
SAMPLE.PLOTS -> 3 TYPES OF EXCEL PLOTS

Observed and Projected Future Change in [insert name of variable here] for [insert name of city]



SAMPLE.PLOTS -> 3 TYPES OF EXCEL PLOTS

Projected changes in [insert name of variable here] for [insert name of city]



PANOPLY -> MAPS

The screenshot shows the Panoply software interface. At the top, there are icons for 'Create Plot', 'Combine Plot', and 'Open Dataset'. Below these are tabs for 'Datasets', 'Catalogs', and 'Bookmarks'. The main window is titled 'Sources' and contains a table of datasets. The table has three columns: 'Name', 'Long Name', and 'Type'. The first row is selected and highlighted in blue. Below the table, there is a 'Show:' dropdown menu set to 'All variables'. To the right of the table, a panel displays the NetCDF metadata for the selected file, including file type, dimensions, and variables.

Name	Long Name	Type
india.map.pr.average.from.ma...	india.map.pr.average.from.may.to.aug...	Local File
lat	lat	1D
lon	lon	1D
rcp45.pr.average.from.may...	rcp45.pr.average.from.may.to.aug	Geo2D
rcp85.pr.average.from.may...	rcp85.pr.average.from.may.to.aug	Geo2D
time	time	1D

Show: All variables

File "india.map.pr.average.from.may.to.aug.nc"
File type: NetCDF-3/CDM

```
netcdf file:/Users/khayhoe/Desktop/testing.india/india.map
dimensions:
  lon = 200;
  lat = 160;
  time = UNLIMITED; // (5 currently)
variables:
  double lon(lon=200);
    :units = "degrees_east";
    :long_name = "lon";

  double lat(lat=160);
    :units = "degrees_north";
    :long_name = "lat";

  int time(time=5);
    :units = "beginning_of_30y_climatological_period";
    :long_name = "time";

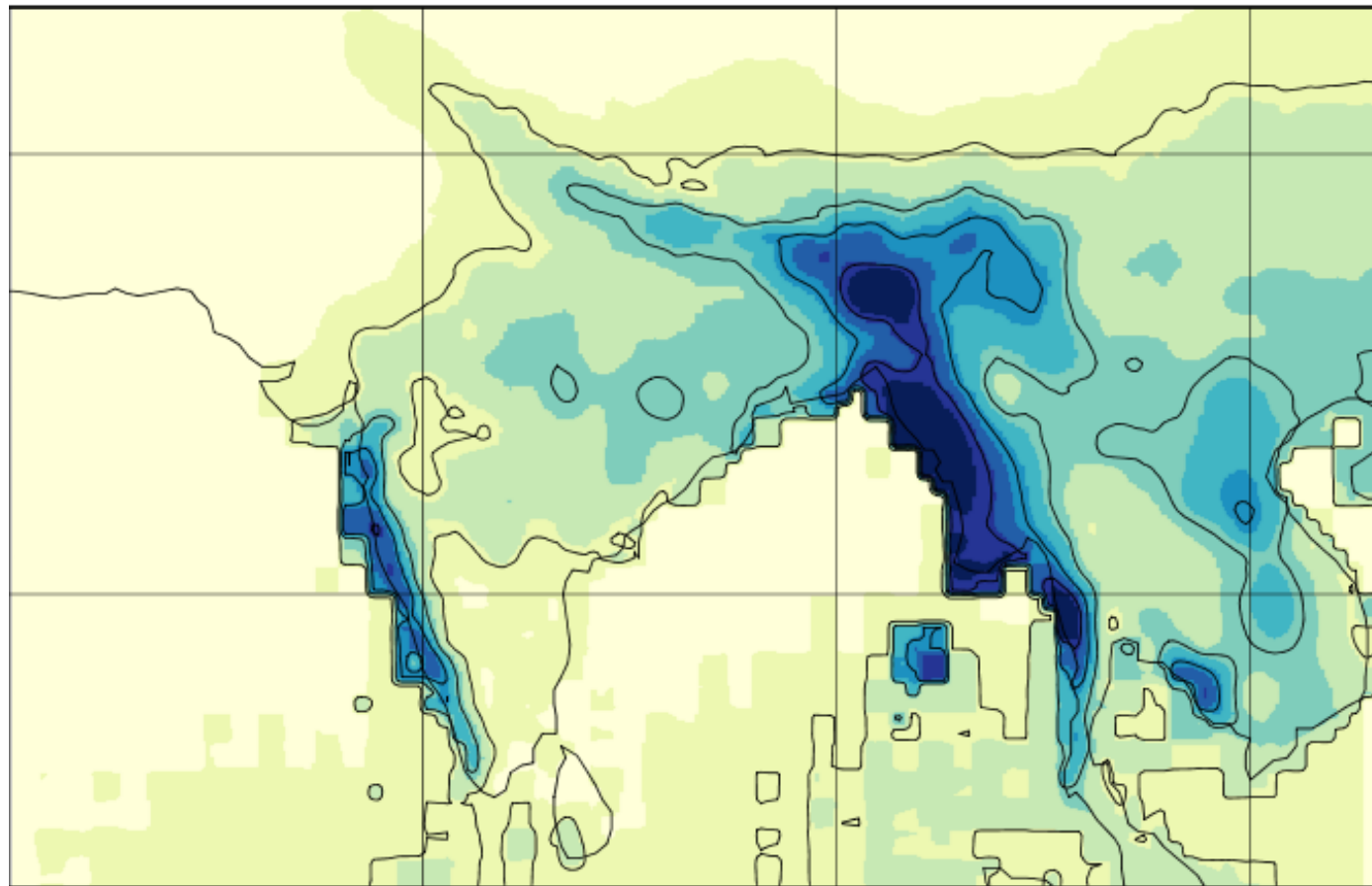
  float rcp45.pr.average.from.may.to.aug(time=5, lat=160);
    :units = "mm";
    :_FillValue = 1.0E30f; // float

  float rcp85.pr.average.from.may.to.aug(time=5, lat=160);
    :units = "mm";
    :_FillValue = 1.0E30f; // float

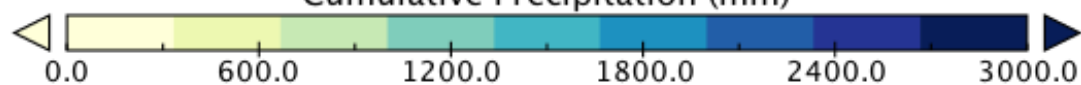
}
```

PANOPLY -> MAPS

Monsoon Season Precipitation (May-Aug) for 2070-2099



Cumulative Precipitation (mm)



IF YOU HAVE TIME ...

- STEPS FOUR and FIVE: Plot the weather station projections using Excel, and plot the gridded data using a program called Panoply.
- STEPS SIX and SEVEN: Explore the differences between station data versus gridded data, and calculate many more indicators.