ExampleLab

September 9, 2024

Preamble

The file air.2m.mon.mean.nc is monthly mean 2m air temperatures from the NCEP/DOE reanalysis 2. Note that the latitudes are not equally spaced.

The file 1850-2022.csv are the annual and global mean air temperature anomalies from the NOAA GlobalTemp dataset. The reference period is 1971-2000.

Hints

- I've minimized the cells to show you what it will look like when you submit the notebook. However you will probably want to expand the cells to look at what is there.
- To calculate a global mean you will need to area weight the data. If each grid cell has a size dr_x radians in the longitude direction and dr_y radians in the latitude direction then the solid angle element of the cell is

  $$dA = dr_x dr_y \cos(r_y)$$

  and the area weighted mean of f is

  $$\overline{f} = \frac{\sum_{ij} f_{ij}\, dA_{ij}}{\sum_{ij} 1\, dA_{ij}}$$

- The temperature anomaly of something is

  $$T' = T - \overline{T}$$

How would create consistent anomalies for 2 different datasets?

Questions

1. Analysing the 2m air temperature dataset

1.1

- Load the datafile data/air.2m.mon.mean.nc
- What variables does it contain?

1.2

- Make a map of annual mean air temperature for 1979

1.3

- What pattern(s?) can you see in the plot?

2. Comparison with the NOAA Global temperature dataset

2.1

- Load the datafile data/global/1850-2022.csv.
- What is the resolution of that data? -What does it represent?

2.2

- Describe how you will calculate the global temperature anomalies from both datasets and ensure that they are consistent.

2.4

- Calculate and plot the global annual mean temperature anomalies of both datasets.

Answers

1.1

- The datafile contains 2m surface temperature from the NCEP Reanalysis.

1.2

- **Figure 1** shows the annual mean surface air temperature from the NCEP Reanalysis

1.3

The 3 patterns that I see are 1) there is a clear north to equator to pole temperature gradient 2) the south pole is colder than the north pole 3) 2m Temperatures are cooler over high topography.

2.1

- The data is annually averaged.
- The data are global temperature anomalies relative to a fixed averaging period.

2.2

- Since the NOAA Global temp data are annually averaged temperature anomalies we need to calculate the global mean, annually averaged temperature anomalie for both NOAA Global temp data and the NCEP reanalysis data.
- To do this we will compute the 1980-2000 average and subtract it from both time series in order to make sure that we are comparing consistent anomalies.

2.3

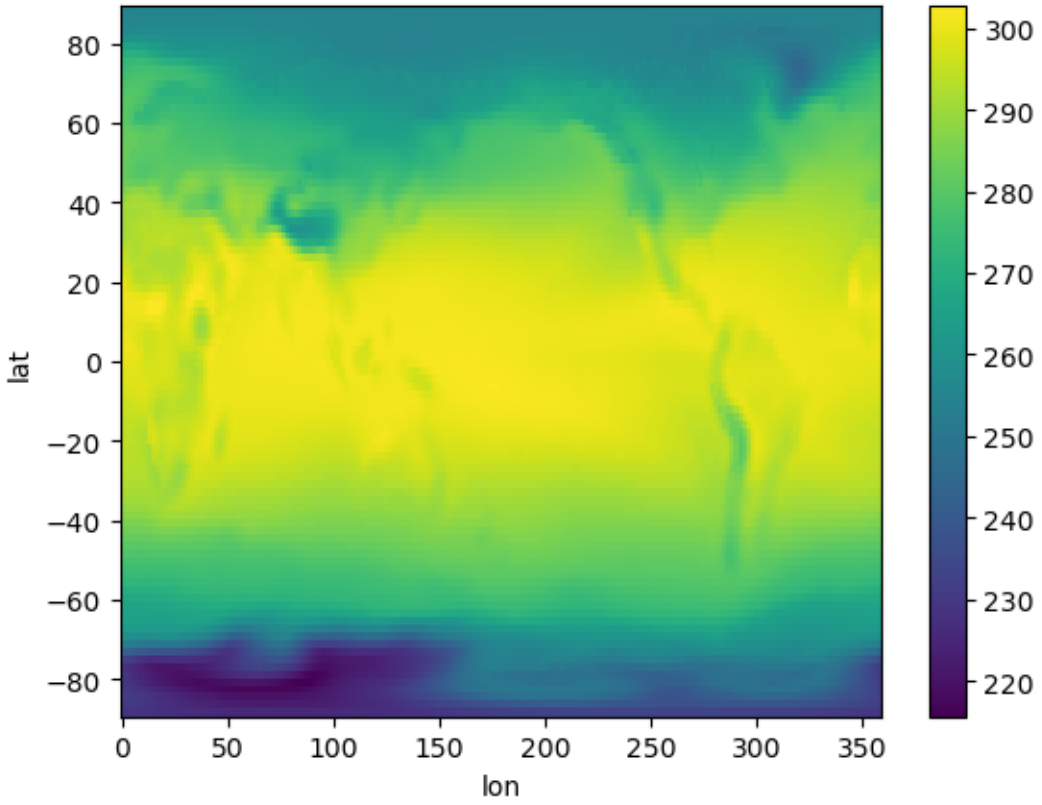
- Figure 2 shows the results. The match between the anomalies shows that we are calculating the anomalies consistently.

Workbook Cells

```
<xarray.Dataset>
Dimensions:    (lat: 94, lon: 192, time: 540, nbnds: 2, level: 1)
Coordinates:
  * lat        (lat) float32 88.54 86.65 84.75 82.85 … -84.75 -86.65 -88.54
  * lon        (lon) float32 0.0 1.875 3.75 5.625 … 352.5 354.4 356.2 358.1
  * time       (time) datetime64[ns] 1979-01-01 1979-02-01 … 2023-12-01
  * level      (level) float32 2.0
Dimensions without coordinates: nbnds
Data variables: (12/16)
    time_bnds  (time, nbnds) datetime64[ns] …
    dlwrf      (time, lat, lon) float32 …
    ulwrf      (time, lat, lon) float32 …
    dswrf      (time, lat, lon) float32 …
    uswrf      (time, lat, lon) float32 …
    lhtfl      (time, lat, lon) float32 …
    …          …
    prate      (time, lat, lon) float32 …
    cprat      (time, lat, lon) float32 …
    runof      (time, lat, lon) float32 …
    nlwrf      (time, lat, lon) float32 …
    nswrf      (time, lat, lon) float32 …
    netsrf     (time, lat, lon) float32 …
Attributes:
    Conventions:    CF-1.0
    title:          Monthly NCEP/DOE Reanalysis 2
    comments:       Data is from \nNCEP/DOE AMIP-II Reanalysis (Reanalysis-2)…
    platform:       Model
    source:         NCEP/DOE AMIP-II Reanalysis (Reanalysis-2) Model
    institution:    National Centers for Environmental Prediction
    dataset_title:  NCEP-DOE AMIP-II Reanalysis
    References:     https://www.psl.noaa.gov/data/gridded/data.ncep.reanalysi…
    source_url:     http://www.cpc.ncep.noaa.gov/products/wesley/reanalysis2/
    history:        created 2002/03 by Hoop (netCDF2.3)\nConverted to chunked…

Text(0.5, 0.98, 'Figure 1')
```

Figure 1

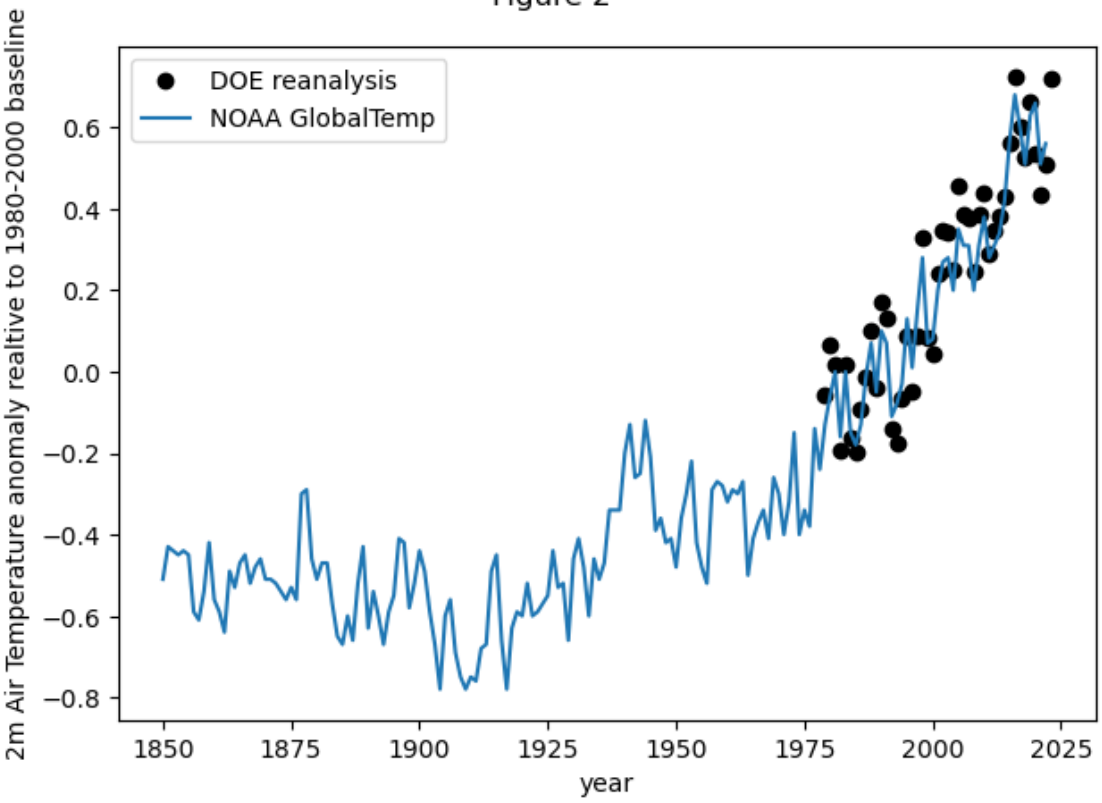


	Year	Anomaly
0	1850	-0.16
1	1851	-0.08
2	1852	-0.09
3	1853	-0.10
4	1854	-0.09
..	…	…
168	2018	0.86
169	2019	0.98
170	2020	1.01
171	2021	0.86
172	2022	0.91

[173 rows x 2 columns]

```
shape of dA: (94,)
check sum area elements: 1.0002316823634434
```

Figure 2


DOE reanalysis
NOAA GlobalTemp
2m Air Temperature anomaly realtive to 1980-2000 baseline
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
1850
1875
1900
1925
1950
1975
2000
2025
year