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How to read and plot NetCDF MERRA-2 data in Python

Download the companion **Jupyter Notebook** (https://docserver.gesdisc.eosdis.nasa.gov/public/project/notebooks/How_to_read_and_plot_NetCDF_MERRA-2_data_in_Python.ipynb)

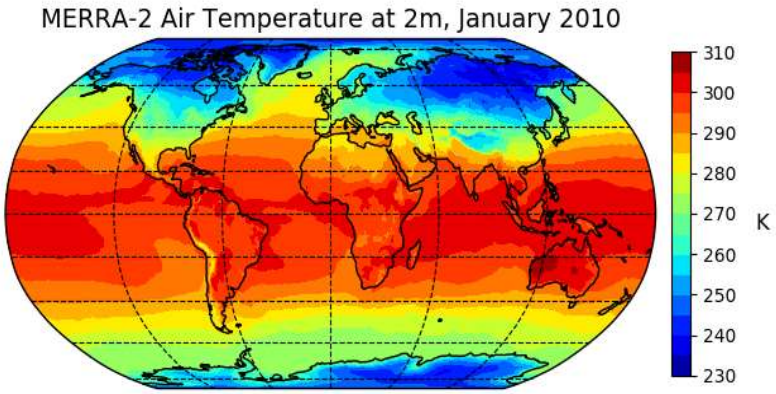
Overview:

This How-To shows how to read and plot NetCDF4 data from the Modern-Era Retrospective analysis for Research and Applications - 2 (MERRA-2) using Python.

Example:

Example data: MERRA-2 Monthly 0.5 x 0.625 degree 2 meter air temperature (M2TMNXSLV_V5.12.4) for January 2010.

Example image:



Estimated Time to complete the following procedures: 20 minutes

Prerequisites:

Python and the free packages: numpy (http://www.numpy.org/), netCDF4 (http://unidata.github.io/netcdf4-python/), matplotlib (http://matplotlib.org/), and cartopy (https://scitools.org.uk/cartopy/docs/latest/). Matplotlib and cartopy are only needed for plotting. This script was tested using Python 3.7.

Procedure:

The user must register with Earthdata to access the data. To register, follow the steps at: data-access. (https://disc.gsfc.nasa.gov/data-access)

To download data from the GES DISC, users must be logged in using their Earthdata username and password.

1. After registering with Earthdata, go to https://disc.gsfc.nasa.gov/ (https://disc.gsfc.nasa.gov)
2. Search for '**M2TMNXSLV_5.12.4**' and click on the dataset link.
3. Once on the dataset page, the data can be accessed by multiple means in the 'Data Access' box. For this How-To, we will use an https service by clicking 'Online Archive'.

- Click on the '2010' folder and download the 'MERRA2_300.tavgM_2d_slv_Nx.201001.nc4 (https://goldsmr4.gesdisc.eosdis.nasa.gov/data/MERRA2_MONTHLY/M2TMNXSLV.5.12.4/2010/MERRA2_300.tavgM_2d_slv_Nx.201001.nc4)' file.

4. Run the following Python cells, which will demonstrate how to read-in and plot 3-dimensional NetCDF data in Python

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Import the required Python libraries. They are used to read and plot the data. If any of the following import commands fail, check the local Python environment and install any missing packages.

```
import numpy as np
from netCDF4 import Dataset
import matplotlib.pyplot as plt
import cartopy.crs as ccrs
```

Read in NetCDF4 file (add a directory path if necessary):

```
data = Dataset('MERRA2_300.tavgM_2d_slv_Nx.201001.nc4', mode='r')
```

Run the following line below to print MERRA-2 metadata. This line will print attribute and variable information. From the 'variables(dimensions)' list, choose which variable(s) to read in below.

```
print(data)
```

Read in the 'T2M' 2-meter air temperature variable:

```
lons = data.variables['lon'][:]
lats = data.variables['lat'][:]
T2M = data.variables['T2M'][:,:,:]
```

If using MERRA-2 data with multiple time indices in the file, the following line will extract only the first time index.
Note: Changing `T2M[0,:,:]` to `T2M[10,:,:]` will subset to the 11th time index.

```
T2M = T2M[0,:,:]
```

Start Plotting Data

Plot the data using matplotlib and cartopy

```
# Set the figure size, projection, and extent
fig = plt.figure(figsize=(8,4))
ax = plt.axes(projection=ccrs.Robinson())
ax.set_global()
ax.coastlines(resolution="110m",linewidth=1)
ax.gridlines(linestyle='--',color='black')
```

```
# Set contour levels, then draw the plot and a colorbar
clevs = np.arange(230,311,5)
plt.contourf(lon, lat, T2M, clevs, transform=ccrs.PlateCarree(),cmap=plt.cm.jet)
plt.title('MERRA-2 Air Temperature at 2m, January 2010', size=14)
cb = plt.colorbar(ax=ax, orientation="vertical", pad=0.02, aspect=16, shrink=0.8)
cb.set_label('K',size=12,rotation=0,labelpad=15)
cb.ax.tick_params(labelsize=10)
```

Save the plot as a PNG image

```
fig.savefig('MERRA2_t2m.png', format='png', dpi=360)
```