prcp

May 20, 2022

```python
[1]: import cartopy.crs as ccrs # for geographic plotting
     import cartopy.feature as cfeature
     from IPython.display import Image
     import xarray as xr
     import xclim as xc
     import matplotlib.pyplot as plt
     import numpy as np
     import pandas as pd
     import seaborn as sns
     import xclim as xc
     import xarray as xr
     from matplotlib.cm import get_cmap
```

```python
[2]: #pr_file = '/lhome/cra2022/climriskdata/EUR-11/
     ↪MPI-M-MPI-ESM-LR_MPI-CSC-REMO2009_v1/historical/pr/
     ↪pr_EUR-11_MPI-M-MPI-ESM-LR_historical_r1i1p1_MPI-CSC-REMO2009_v1_day_19710101-20001231_LL.
     ↪nc'
     pr_file = '/lhome/cra2022/climriskdata/EUR-11/
     ↪ICHEC-EC-EARTH_CLMcom-CCLM4-8-17_v1/historical/pr/
     ↪pr_EUR-11_ICHEC-EC-EARTH_historical_r12i1p1_CLMcom-CCLM4-8-17_v1_day_19710101-20001231_LL.
     ↪nc'

     ds_pr = xr.open_dataset(pr_file)

     ds_pr
```

```
[2]: <xarray.Dataset>
     Dimensions:    (time: 10958, bnds: 2, lon: 471, lat: 409)
     Coordinates:
       * time       (time) datetime64[ns] 1971-01-01T12:00:00 … 2000-12-31T12:00:00
       * lon        (lon) float64 -10.0 -9.9 -9.8 -9.7 -9.6 … 36.7 36.8 36.9 37.0
       * lat        (lat) float64 30.0 30.1 30.2 30.3 30.4 … 70.5 70.6 70.7 70.8
     Dimensions without coordinates: bnds
     Data variables:
         time_bnds  (time, bnds) datetime64[ns] …
         pr         (time, lat, lon) float32 …
     Attributes: (12/31)
```

```
CDI:                        Climate Data Interface version ?? (http:/…
history:                    Tue Dec 03 12:33:45 2019: cdo mergetime /…
source:                     CLMcom-CCLM4-8-17
institution:                Climate Limited-area Modelling Community …
Conventions:                CF-1.4
institute_id:               CLMcom
…                           …
project_id:                 CORDEX
table_id:                   Table day (Sept 2013) 0cf1782745489246c9f…
modeling_realm:             atmos
realization:                12
cmor_version:               2.9.1
CDO:                        Climate Data Operators version 1.9.3 (htt…
```

[3]:
```python
pr_mm = ds_pr.pr * 86400
pr_mm.attrs['units'] = 'mm/day'
prcp_7100 = pr_mm.sel(lat=slice(30,45))


prcp_7100
```

[3]: <xarray.DataArray 'pr' (time: 10958, lat: 151, lon: 471)>
array([[[0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
         0.00000000e+00, 2.22020473e-12, 4.03624392e-12],
        [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
         0.00000000e+00, 1.28831671e-13, 2.62442667e-13],
        [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
         8.87266091e-11, 2.44231905e-10, 1.35861168e-10],

        …,
        [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
         2.69370427e+00, 2.85255349e+00, 2.98664141e+00],
        [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
         2.11261474e+00, 2.33556996e+00, 2.73669809e+00],
        [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
         2.08802852e+00, 2.30924225e+00, 2.34956811e+00]],

       [[0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
         4.10828379e-05, 1.14201253e-06, 8.08296211e-08],
        [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
         8.88015841e-06, 4.50167978e-07, 2.31968882e-08],
        [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
         4.95579283e-04, 1.92686404e-04, 5.11345174e-05],

        …,
        [1.45842915e+01, 1.82373018e+01, 2.37268855e+01, …,
         0.00000000e+00, 0.00000000e+00, 1.34570852e-14],
        [1.47729321e+01, 1.44655359e+01, 1.47432891e+01, …,
         0.00000000e+00, 0.00000000e+00, 1.33150132e-13],
        [1.66081829e+01, 1.64558037e+01, 1.64846948e+01, …,
```

```
              1.04567978e-15, 1.00141341e-13, 4.26283907e-12]],


            [[0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
              0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
             [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
              0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
             [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, …,
              0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
             …,
             [2.69742144e+00, 1.96990404e+00, 1.54154766e+00, …,
              0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
             [6.34309135e+00, 4.99667628e+00, 3.31557873e+00, …,
              0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
             [6.10968762e+00, 6.34401985e+00, 5.60388104e+00, …,
              0.00000000e+00, 0.00000000e+00, 0.00000000e+00]]])
    Coordinates:
      * time     (time) datetime64[ns] 1971-01-01T12:00:00 … 2000-12-31T12:00:00
      * lon      (lon) float64 -10.0 -9.9 -9.8 -9.7 -9.6 … 36.7 36.8 36.9 37.0
      * lat      (lat) float64 30.0 30.1 30.2 30.3 30.4 … 44.6 44.7 44.8 44.9 45.0
    Attributes:
        units:    mm/day
```

```python
[4]: mon_prcp_7100= prcp_7100.resample(time = 'M').sum()


     #mon_prcp_9120
```

```python
[5]: clim_prcp_7100 = mon_prcp_7100.sum('time')/30
     clim_prcp_7100
```

```
[5]: <xarray.DataArray 'pr' (lat: 151, lon: 471)>
     array([[ 84.3692805 ,  89.2173168 ,  97.87006362, …,  59.65846032,
              60.5534002 ,  60.82567926],
            [ 90.46041087,  95.81613939, 103.4936188 , …,  62.38406383,
              63.14261294,  63.91003826],
            [ 96.93514045, 104.34171305, 115.32176808, …,  64.41129366,
              63.52604046,  63.51305603],
            …,
            [817.36023862, 819.02829222, 819.77452139, …, 309.59414218,
             317.13727913, 324.13977525],
            [821.02071924, 823.29696915, 825.86093566, …, 306.47941304,
             315.93464735, 325.32238985],
            [823.3182008 , 827.27309899, 832.68753891, …, 309.46056559,
             321.50165544, 333.37087434]])
     Coordinates:
       * lon      (lon) float64 -10.0 -9.9 -9.8 -9.7 -9.6 … 36.7 36.8 36.9 37.0
       * lat      (lat) float64 30.0 30.1 30.2 30.3 30.4 … 44.6 44.7 44.8 44.9 45.0
```

```
[6]: del ds_pr
     del prcp_7100
```

```
[6]: #del data_precip
```

```
[7]: ds_pop = xr.open_dataset('/lhome/cra2022/climriskdata/EUR-11S/
     ↪Estimated_population/Estimated_population_2020_LL.nc')
     ds_pop_medi = ds_pop.sel(lat=slice(30,45))
```

```
[8]: col_map = get_cmap("turbo_r").copy()
     col_map.set_under("white")
     precip_levels = np.arange(100,1200,200.)

     fig = plt.figure(figsize=(30,10))
     ax = plt.axes(projection=ccrs.PlateCarree())


     #Include a ready-to-use colormap with cmap=<colormap_name>
     a = clim_prcp_7100.plot.contourf(ax=ax, transform=ccrs.PlateCarree(),
      ↪cmap=col_map, levels = precip_levels, add_colorbar=False)
     d = ds_pop_medi.population.plot.contourf(ax=ax, transform=ccrs.
      ↪PlateCarree(),levels=[0,500000], colors='none', hatches=['','+++'],
      ↪add_colorbar=False)

     # Hatch color has to be changed afterwards has edgecolor
     d.collections[1].set_edgecolor('Black')

     # Add a contour for clarity
     ds_pop_medi.population.plot.contour(ax=ax, transform=ccrs.PlateCarree(),
      ↪levels=[500000], colors = 'Black', linewidths=1, add_colorbar=False)

     ax.add_feature(cfeature.COASTLINE, linestyle='-')
     ax.add_feature(cfeature.BORDERS, linestyle=':');
     ax.add_feature(cfeature.OCEAN, zorder=10)

     cbar = fig.colorbar(a, ax=ax, fraction = 0.1, label=r'liters per year (mm)')

     gl = ax.gridlines(crs=ccrs.PlateCarree(), draw_labels=True,
                   linewidth=2, color='white', alpha=0.5, linestyle='--',
      ↪zorder=11)
     gl.top_labels = False # suppress gridline labels on the top
     gl.right_labels = False # suppress gridline labels at the right edge

     ax.set_title('')
     #ax.set_title('Time:{}'.format(nice_time), loc='right');
     ax.set_title('Average Precipitation (1971 - 2000) with populated areas (> 500k)
      ↪in 2020', fontsize=24)
```

```
plt.savefig("/lhome/cra2022/l.quirino.2_2022/Quirino_Leonardo/Project/
  ↪Precip7100_Pop_2020.png", dpi = 300, bbox_inches="tight",pad_inches=0)
```

Average Precipitation (1971 - 2000) with populated areas (> 500k) in 2020