FSI_demo

January 23, 2020

1 Flood Severity Index

FSI (Flood Severity Index)represents the return period of a fllod (2-yr, 5-yr, 20-yr) expressed from the runoff data from Global Flood Awareness System (GLOFAS). The GLOFAS data consists of daily discharge data obtained from the HTESSEL and Lisflood models forced by ECMWF reanalysis dataset.

The probability of exceedance is calculated from the annual maxima of volumetric flow for the period 1981-2017. The thresholds were estimated from a Gumbel distribution using the methods of L-moments. The severity is based on a 2-yr return period (medium), 5-yr return period (high), and 20-yr return period (severe).

The cumulative density function of the Gumbel distribution is: $e^{-e^{-(x-\mu)/\beta}}$

Therefore, the threshold Q_t for a t-year flood is given by: $Q_t = \mu - \beta * (log(-np.log(1 - 1/t)))$

[1]:
```
import xarray as xr
import numpy as np
#import pandas as pd
import glob as glob
import os
import scipy.stats as stats
from datetime import date
import matplotlib.pyplot as plt

bounding_box = [23,48,3,15]
# path + folders
path = '/Volumes/Data HD/ClimateData/GlofasClim'
folders = os.listdir(path)
years=[]
for folder in folders:
    try:
        year = int(folder)
        years.append(year)
    except:
        continue

years = np.sort(np.array(years))
```

```
# get netcdf files
for idx, i in enumerate(years):
    nc_files = (glob.glob(path+'/'+str(i)+'/*.nc'))
    file_names=[]
    for file in nc_files:
        file_names.append(file)
    file_names.sort()
    #open
    data = xr.open_mfdataset(file_names)
    # get the values for the bounding box
    p_ = data.sel(lat=slice(bounding_box[3], bounding_box[2]),\
                  lon=slice(bounding_box[0],bounding_box[1]))
    val = p_.dis24.values

    try: maxyear
    except NameError: maxyear = np.zeros([len(years),np.shape(val)[1],
                                          np.shape(val)[2]])
    maxyear[idx,:,:] = np.nanmax(val,axis=0)
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[55]:
```
#Figure
import seaborn as sns

temp = maxyear[:,70,70]
param = stats.gumbel_r.fit(temp)
vals = np.random.gumbel(param[0],param[1],10000)

sns.distplot(temp, hist = True, kde = True,
                 label = 'GLOFAS')
sns.distplot(vals, hist = False, kde = True,
                 label = 'Gumbel')
ax.legend()
#hist,edges = np.histogram(temp)
#hist_norm = hist/sum(hist)
#rand_gumbel = np.random.gumbel(param[0],param[1],1000)
#hist_gumbel,edges_gumbel =  np.histogram(rand_gumbel)
#hist_gumbel_norm = hist_gumbel/sum(hist_gumbel)

#fig,ax = plt.subplots(figsize=[15,10])
#ax.plot(edges[0:10],hist_norm)
#ax.plot(edges_gumbel[0:10],hist_gumbel_norm)
```

```
No handles with labels found to put in legend.
```

[55]: <matplotlib.legend.Legend at 0x1c2541d890>

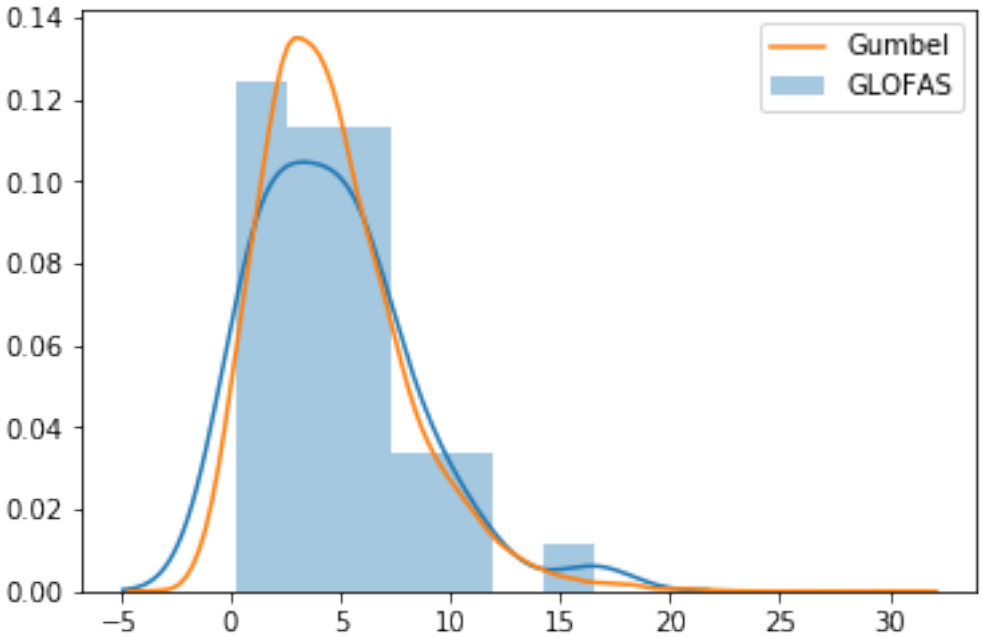

Figure 1: Probability distribution of yearly Q maxima inferred from daily data (in blue) shown with a theoretical gumbel distirbution.

NOTE: To see the visualization below, you need to be able to run the notebook and download the data from the MINT platform. A movie is available here: https://youtu.be/tUmzj6AQEVQ

[1]:
```
import pandas as pd
import numpy as np
from bokeh.io import output_notebook, show
from bokeh.models.widgets import Slider
from bokeh.plotting import figure
import numpy as np
import xarray as xr
import holoviews as hv
import geoviews as gv
import geoviews.feature as gf

from cartopy import crs
from geoviews import opts

gv.extension('matplotlib','bokeh')

gv.output(size=150)
import xarray as xr
```

```
import cartopy.crs as ccrs
```

[2]:
```
d = xr.open_dataset('/Users/deborahkhider/Documents/MINT/Flooding/results/
 ↪GloFAS_FloodIndex_all.nc')
v = d['flood'].resample(time="1MS").mean(dim="time")
```

```
//anaconda3/envs/climate/lib/python3.7/site-packages/xarray/core/nanops.py:140:
RuntimeWarning: Mean of empty slice
  return np.nanmean(a, axis=axis, dtype=dtype)
```

[3]:
```
dataset = gv.Dataset(v, vdims='flood')

ensemble = dataset.to(gv.Image, ['lon', 'lat'],dynamic=True)
gv.output(ensemble.opts(cmap='Oranges', colorbar=True, backend='bokeh',␣
 ↪width=700, tools=['hover']) * gf.coastline() * gf.borders,
          backend='bokeh')
```

```
:DynamicMap   [time]
   :Overlay
      .Image.I     :Image   [lon,lat]   (flood)
      .Coastline.I :Feature   [Longitude,Latitude]
      .Borders.I   :Feature   [Longitude,Latitude]
```

[5]:
```
from IPython.display import HTML

# Youtube
HTML('<iframe width="560" height="315" src="https://www.youtube.com/embed/
 ↪tUmzj6AQEVQ?rel=0&amp;controls=0&amp;showinfo=0" frameborder="0"␣
 ↪allowfullscreen></iframe>')
```

[5]:
```
<IPython.core.display.HTML object>
```

[ ]:
```

```