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Drought Monitoring in East Africa





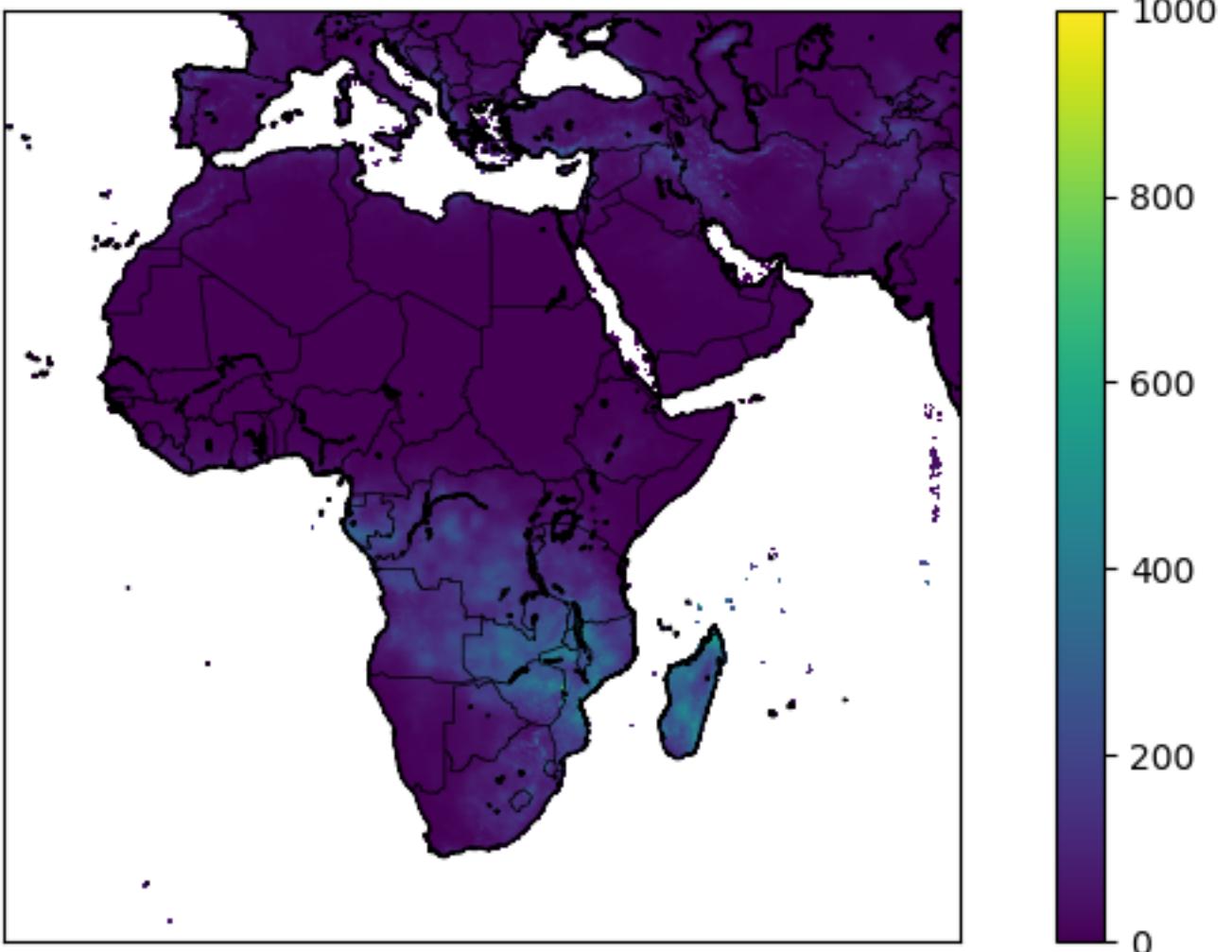
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Why the rains fail?

Can we **detect** drought early?

How can we **improve**
outcomes?

1981-02-28 00:00:00 Rainfall (mm/month).



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```
[In [21]: %timeit %run plot_server.py
```

```
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/matplotlib/backends/backend_tkagg.py:1405: UserWarning: This call to matplotlib.use() has no effect because the backend has already been chosen; matplotlib.use() must be called *before* pylab, matplotlib.pyplot, or matplotlib.backends is imported from the first time.
```

```
    warnings.warn(_use_error_msg)
```

```
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/mpl_toolkits/basemap/__init__.py:1405: UserWarning: b = ax.ishold()
```

See the API Changes document (http://matplotlib.org/api/api_changes.html) for more details.

```
    ax.hold(b)
```

```
[1] 38155 killed
```

```
→ output_files
```

```
ipython
```

DTP Timetable
2017-18 v8.pdf

dtp_project_overview_rese...l_phd.pdf

```
[In [21]: %timeit %run plot_server.py
```

```
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/matplotlib/_init_.py:1405: UserWarning:
```

This call to matplotlib.use() has no effect because the backend has already been chosen; matplotlib.use() must be called *before* pylab, matplotlib.pyplot, or matplotlib.backends is imported from the first time.

```
    warnings.warn(_use_error_msg)
```

```
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/mpl_toolkits/basemap/__init__.py:1405: UserWarning: The ishold function was deprecated in version 2.0.
```

```
    b = ax.ishold()
```

See the API Changes document (http://matplotlib.org/api/api_changes.html) for more details.

```
    ax.hold(b)
```

```
[1] 38155 killed
```

```
    ipython DTP Timetable  
    2017-18 v8.pdf
```

```
→ output_files
```

```
output_video3.avi
```

```
AVI movie - 5.4 MB
```

```
Created Today, 00:07
```

```
Modified Today, 00:07
```

```
Last Accessed Today, 00:07
```

```
Dimensions --
```

```
Add To...
```

```
Lees_Extend
```

```
latex_stuff
```

```
img_shrunk.png
```

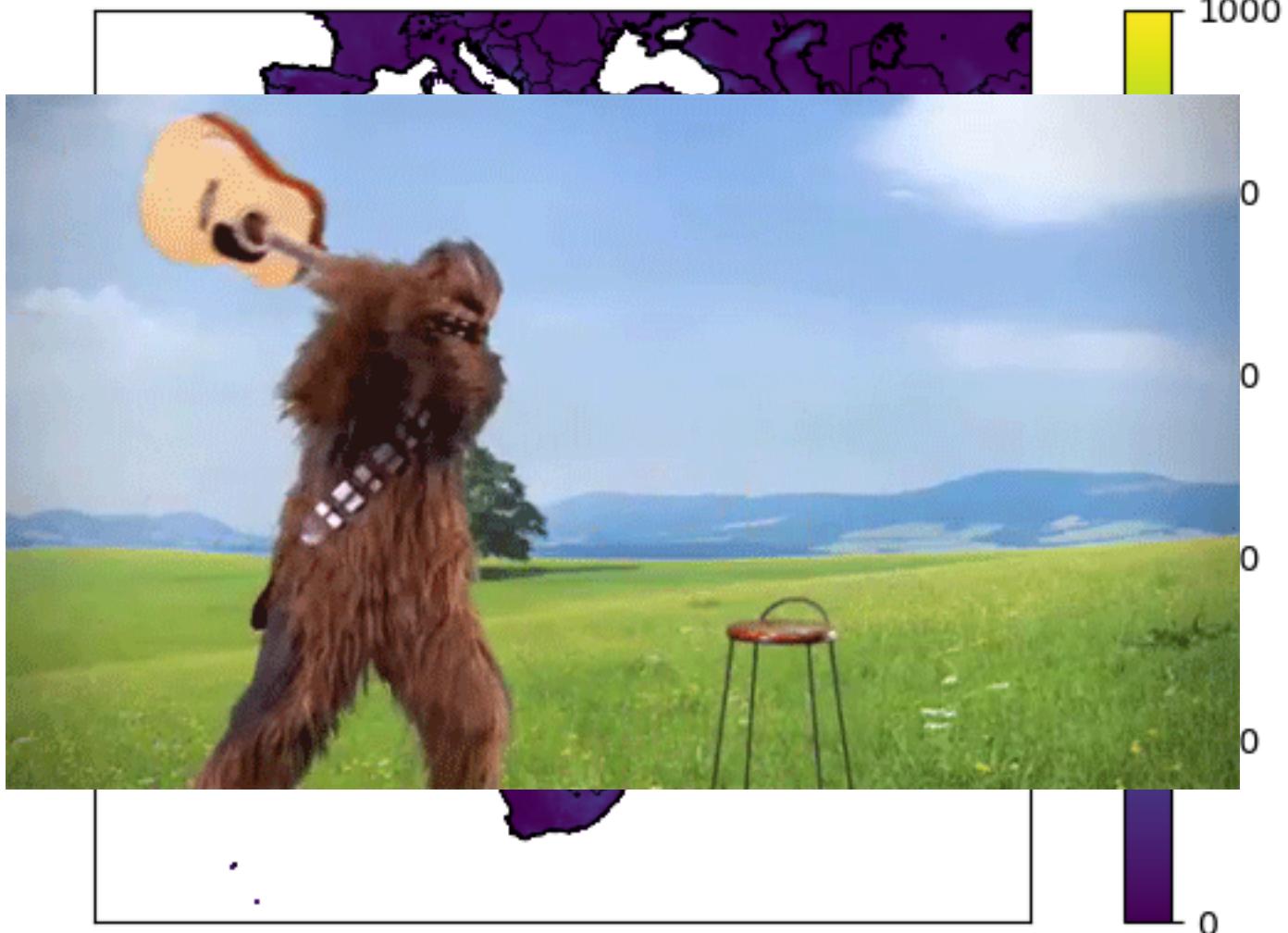
```
IMG_7718.jpg
```

```
[system]
```



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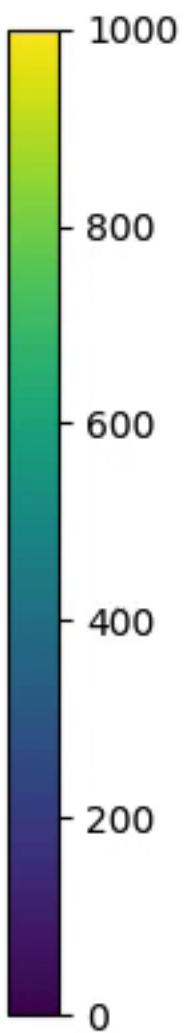
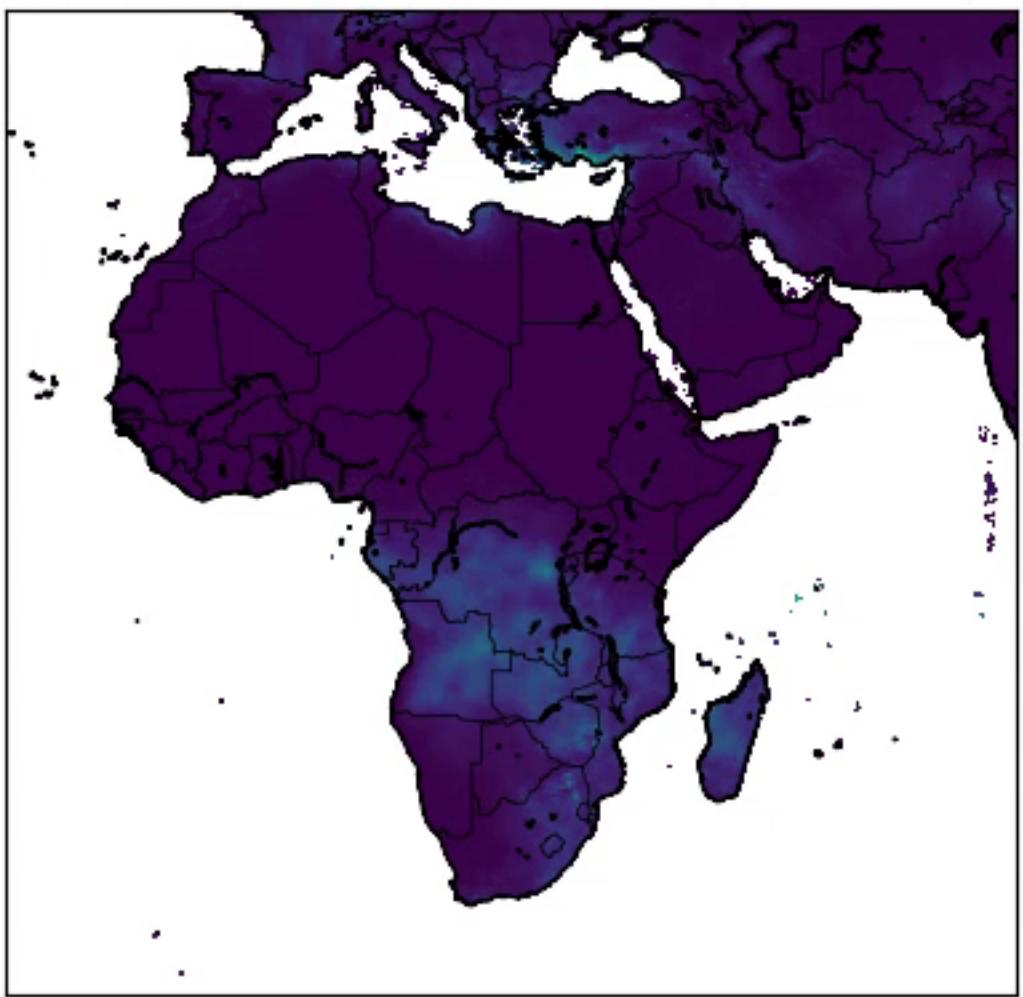
1981-02-28 00:00:00 Rainfall (mm/month).





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1981-01-31 00:00:00 Rainfall (mm/month).





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Huge performance boost!

output_video4.avi

AVI movie - 5.4 MB

Created Today, 00:07
Modified Today, 00:07
Last opened Today, 00:07

```
africa_chirps_final.nc core.43572 nohup.out output_plots plot.sh plot_year.py
[chri4118@jasmin-sci3 chri4118]$ bsub -outdir /work/scratch/chri4118 -J "tommyjob[1-420]" < plot.sh
Job <9753534> is submitted to default queue <short-serial>.
[chri4118@jasmin-sci3 chri4118]$ bjobs
JOBID    USER    STAT  QUEUE   FROM_HOST EXEC_HOST   JOB_NAME   SUBMIT_TIME
9753534  chri411 RUN   short-seri host292.jc. host319.jc. *mmyjob[2] Mar  9 00:10
9753534  chri411 RUN   short-seri host292.jc. host312.jc. *mmyjob[4] Mar  9 00:10
9753534  chri411 RUN   short-seri host292.jc. host321.jc. *mmyjob[3] Mar  9 00:10
9753534  chri411 RUN   short-seri host292.jc. host258.jc. *mmyjob[9] Mar  9 00:10
9753534  chri411 RUN   short-seri host292.jc. host135.jc. *mmyjob[1] Mar  9 00:10
9753534  chri411 RUN   short-seri host292.jc. host247.jc. *mmyjob[6] Mar  9 00:10
9753534  chri411 RUN   short-seri host292.jc. host088.jc. *mmyjob[8] Mar  9 00:10
9753534  chri411 RUN   short-seri host292.jc. host173.jc. *mmyjob[7] Mar  9 00:10
9753534  chri411 RUN   short-seri host292.jc. host266.jc. *mmyjob[5] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[10] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[11] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[12] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[13] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[14] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[15] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[16] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[17] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[18] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[19] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[20] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[21] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[22] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[23] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[24] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[25] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[26] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[27] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[28] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[29] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[30] Mar  9 00:10
9753534  chri411 PEND  short-seri host292.jc. *myjob[31] Mar  9 00:10
[chri4118@jasmin-sci3 chri4118]$ date
Fri Mar  9 00:13:10 GMT 2018
[chri4118@jasmin-sci3 chri4118]$ bjobs
No unfinished job found
[chri4118@jasmin-sci3 chri4118]$
```



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3 minutes



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4200 minutes

1500x faster



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Maybe a little optimistic ...





```
In [4]: open_elegant_scipy    doing_bayesian_an  
File "<ipython-input-4-83dd1fa6c7dc>", line 1  
open .
```

```
[SyntaxError: invalid syntax]
```

```
esian_methods    code_wars    wrkr22776.pdf    chile_phd_drought  
for hackers      _predicti...chile.pdf
```

```
In [5]: %time %run plot_year.py
```

```
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/matplotlib/__init__.py:1  
This call to matplotlib.use() has no effect because the backend has already  
been chosen; matplotlib.use() must be called *before* pylab, matplotlib.pyplot,  
or matplotlib.backends is imported for the first time.
```

```
    warnings.warn(_use_error_msg)
```

```
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/mpl_toolkits/basemap/__i  
old function was deprecated in version 2.0.
```

```
    b = ax.ishold()
```

```
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/mpl_toolkits/basemap/_i  
ld is deprecated.
```

See the API Changes document (http://matplotlib.org/api/api_changes.html)
for more details.

```
    ax.hold(b)
```

```
CPU times: user 1min 38s, sys: 6.18 s, total: 1min 45s
```

```
Wall time: 1min 57s
```

```
In [6]:
```



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Still 218x

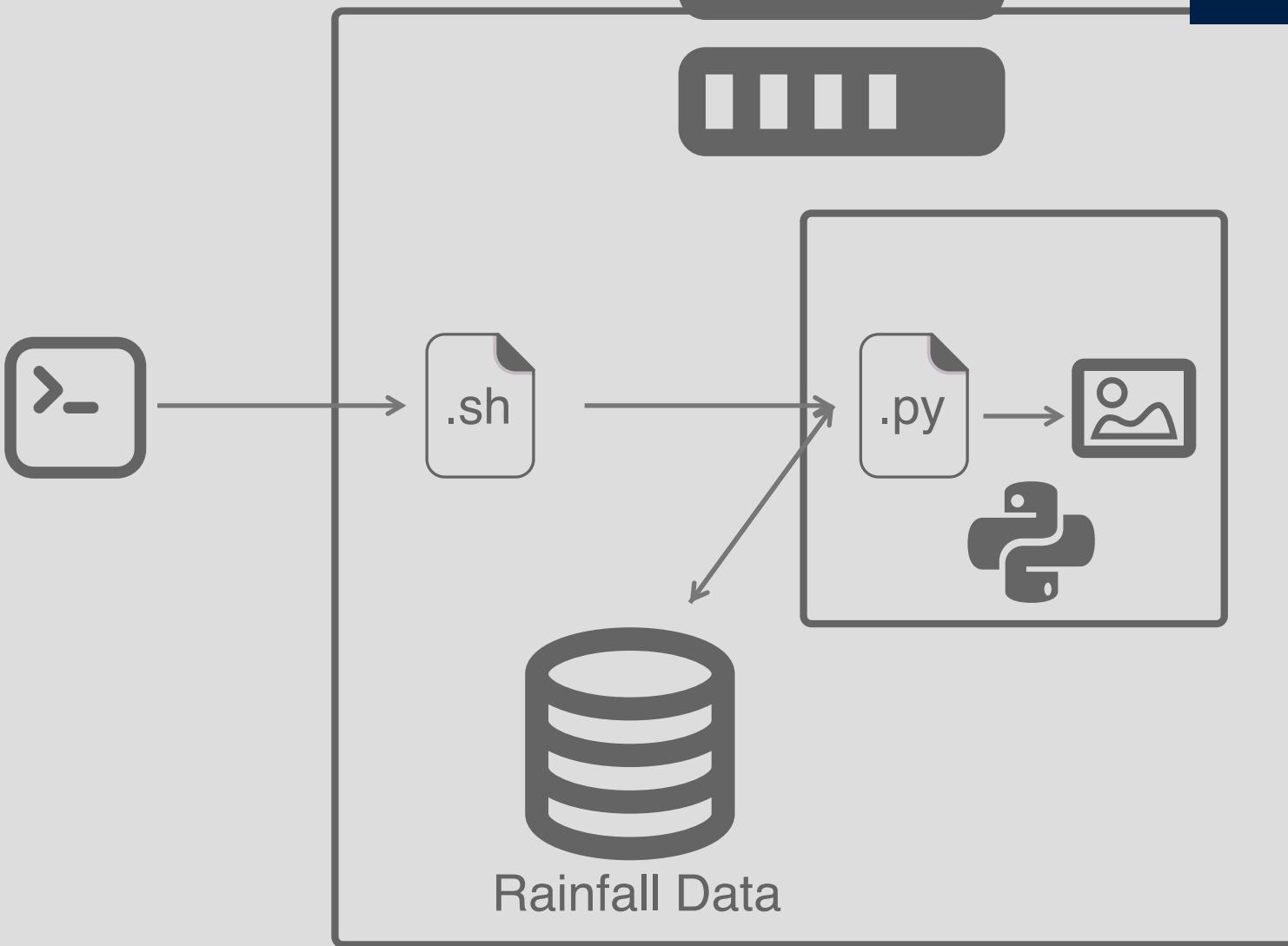
117s

0.48s

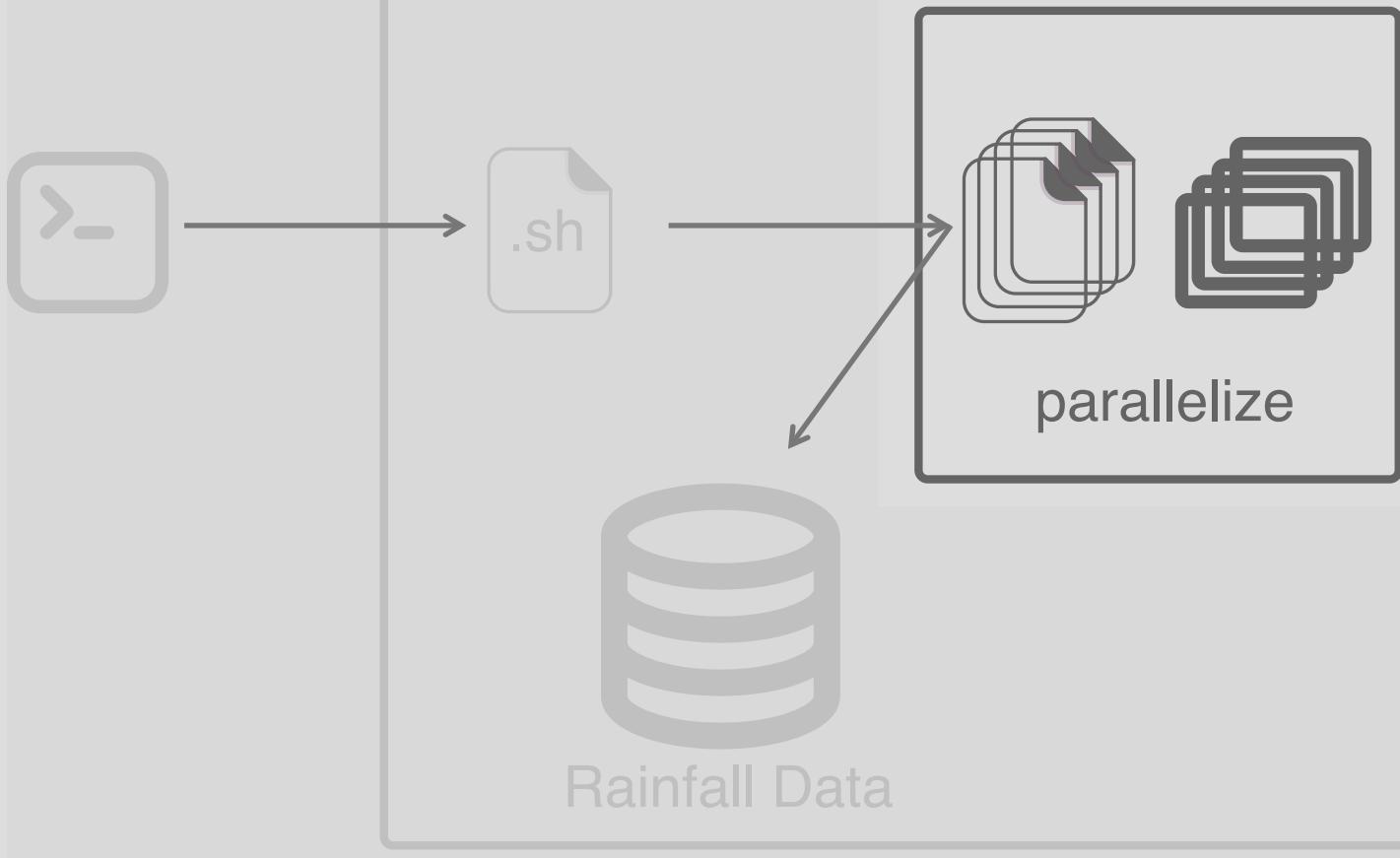


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Jasmin



Jasmin





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Jasmin



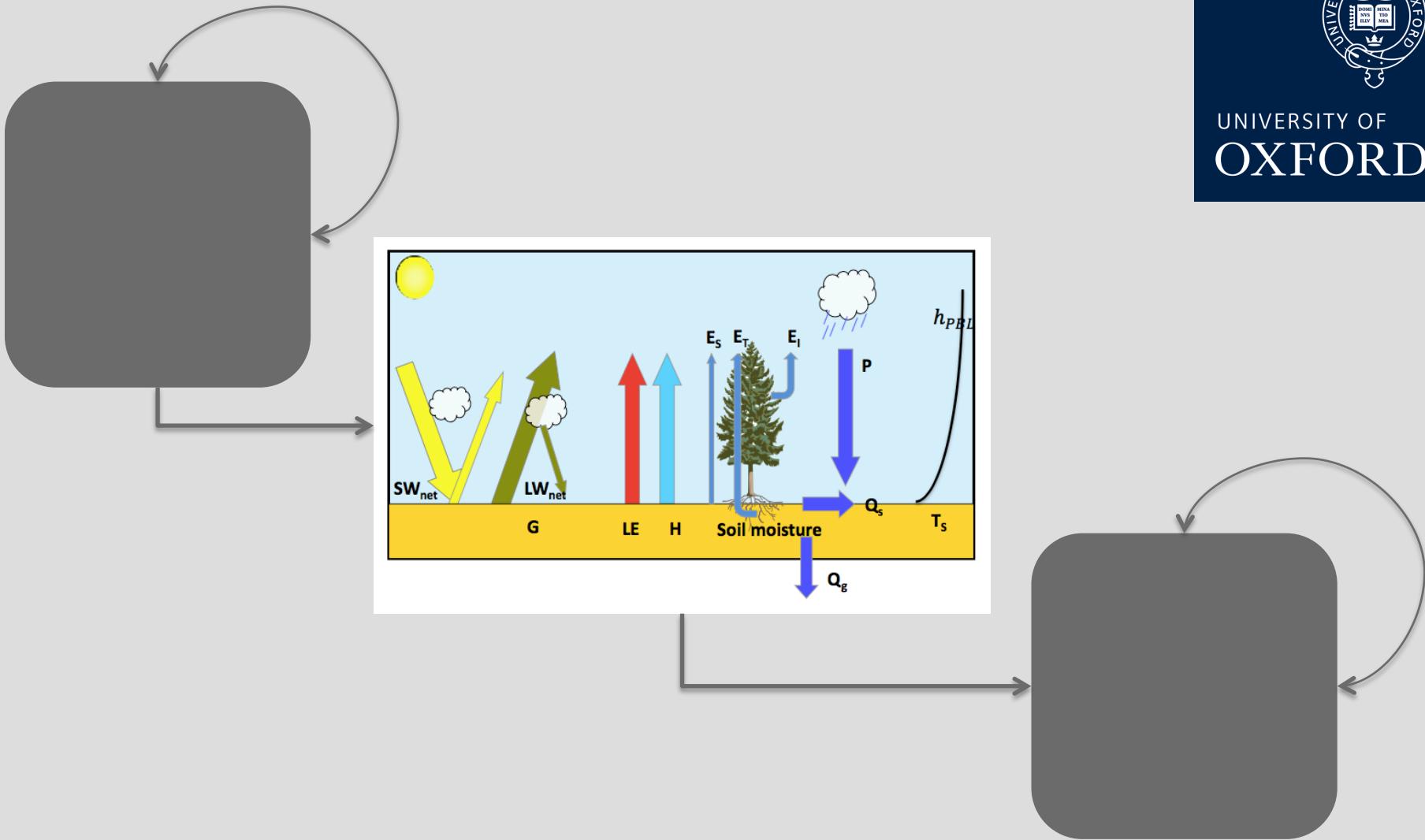
Rainfall Data



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Future Applications





Land Surface Modelling

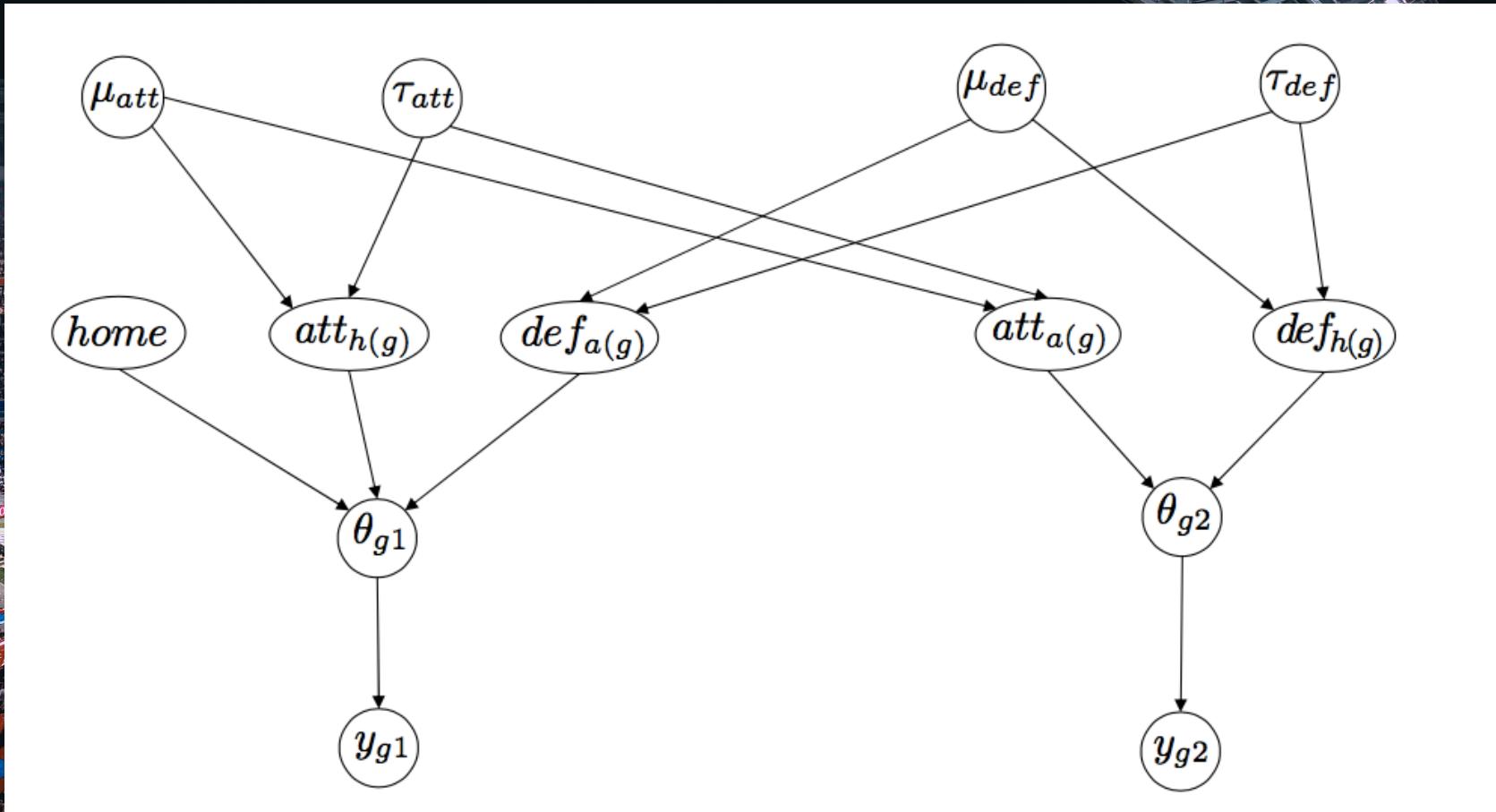


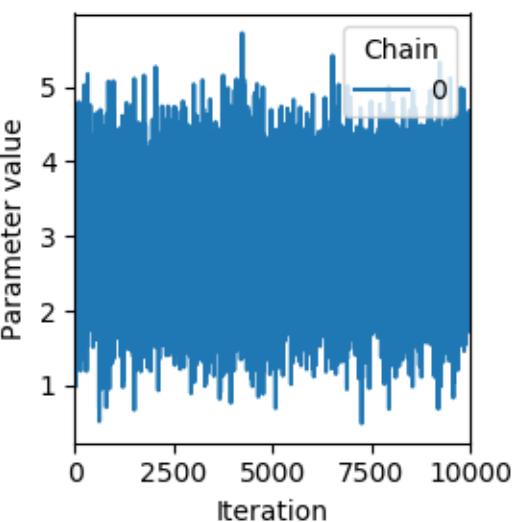
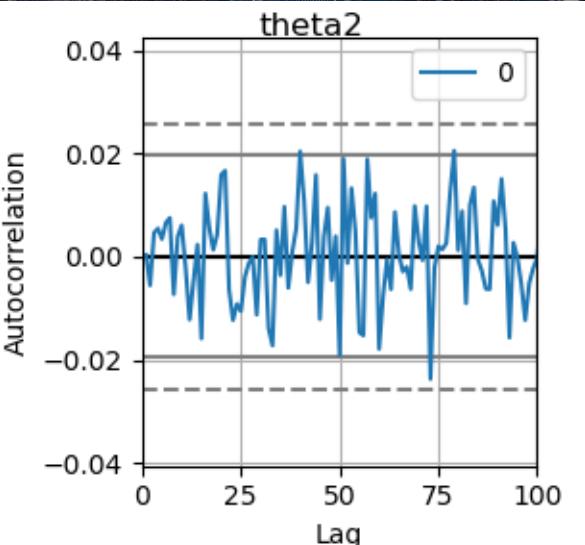
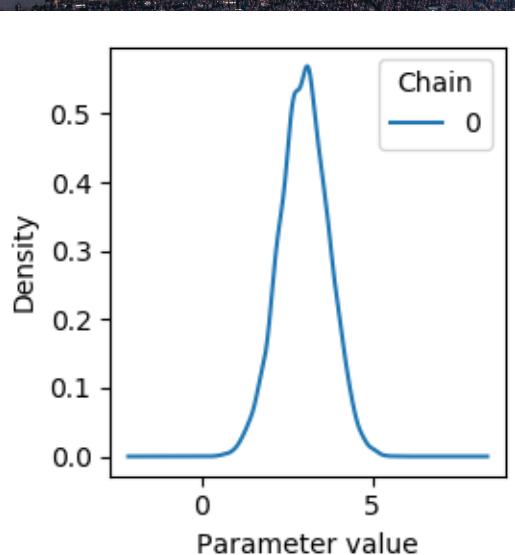
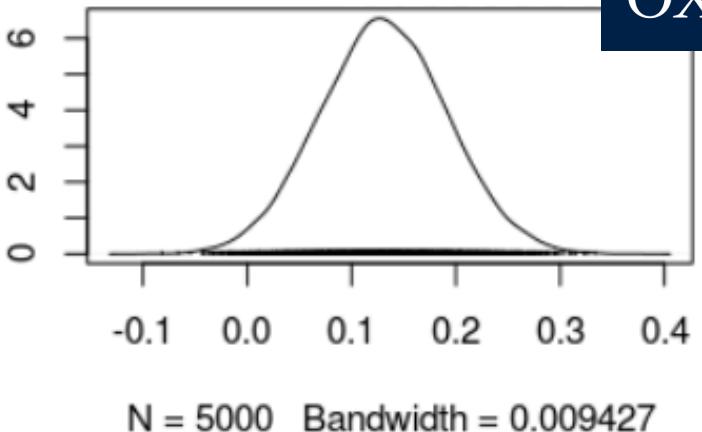
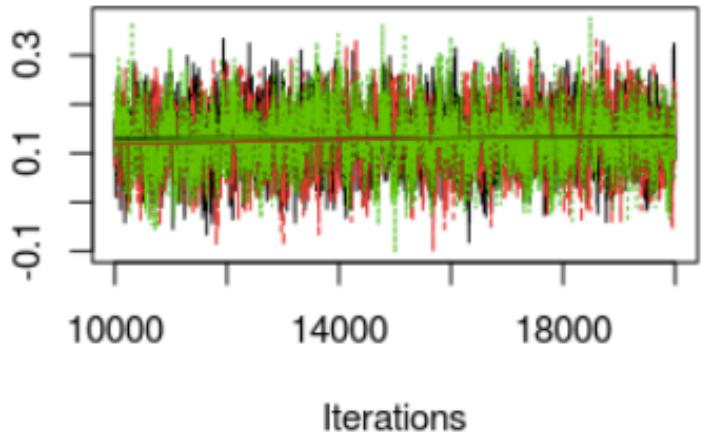
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Bayesian Modelling



Bayesian Modelling







Less of this.

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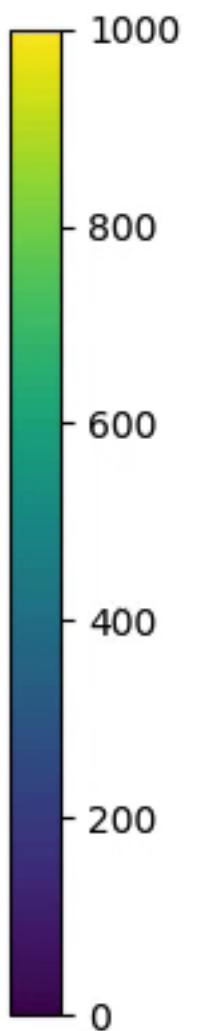
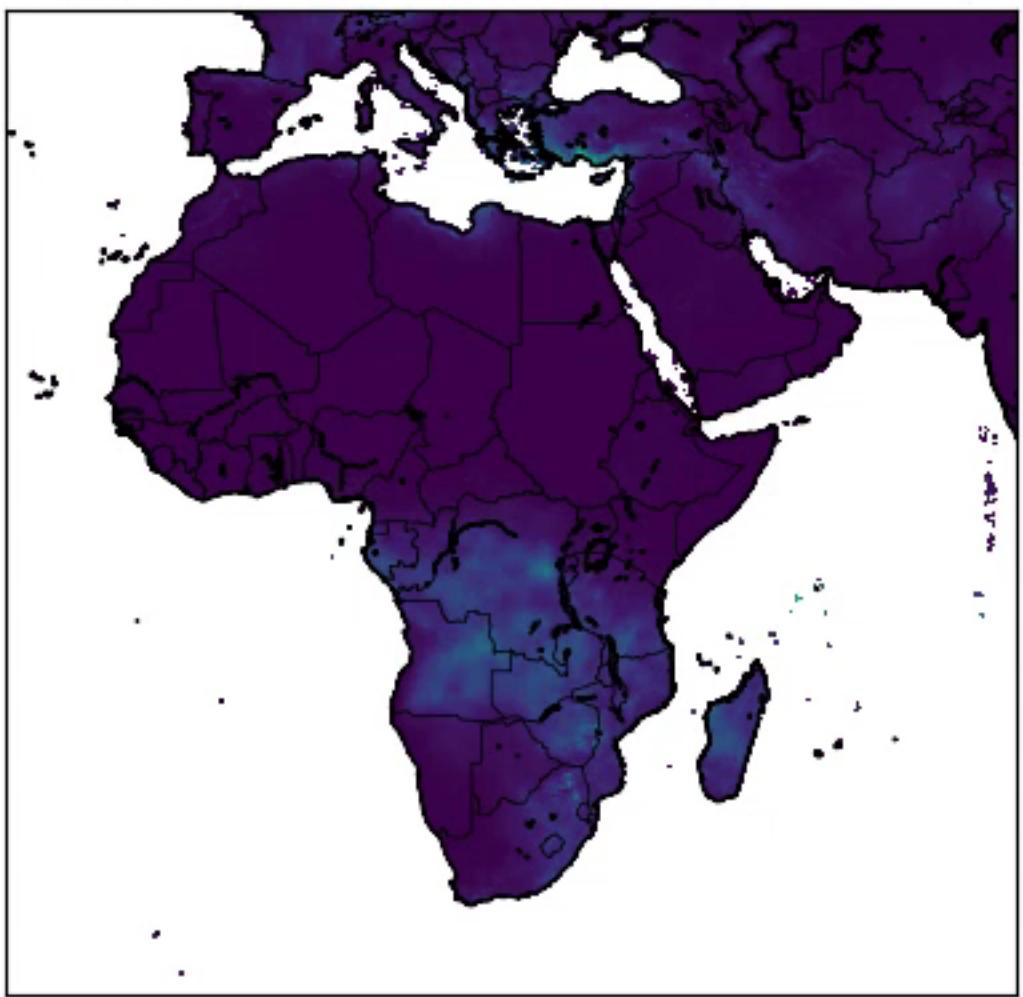
More of this.





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1981-01-31 00:00:00 Rainfall (mm/month).





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```
bsub -outdir /work/scratch/chri4118 -J "tommyjob[1-420]" < plot.sh
```



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bsub -outdir /work/scratch/chri4118 -J "tommyjob[1-420]" < plot.sh



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bsub -outdir /work/scratch/chri4118 -J "tommyjob[1-420]" < plot.sh
```



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bsub -outdir /work/scratch/chri4118 -J "tommyjob[1-420]" < plot.sh



.sh



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```
#!/bin/bash
#BSUB -o output
#BSUB -e error
#BSUB -q short-serial
```

1. Bsub stuff

```
cd /work/scratch/chri4118
```

2. Set working directory

```
i=$((LSB_JOBINDEX-1))
sed '1s/.*/TIME_SLICE = '${i}'/' plot_year.py > plot_year_${i}.py
```

3. Change the python file

```
python3 plot_year_${i}.py
```

4. Run the python file



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.sh

```
#!/bin/bash
#BSUB -o output
#BSUB -e error
#BSUB -q short-serial
```

1. Bsub stuff

```
cd /work/scratch/chri4118
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.sh

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#BSUB -o output
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i=$((LSB_JOBINDEX-1))
sed '1s/.*/TIME_SLICE = '${i}'/' plot_year.py > plot_year_${i}.py
```

3. Change the python file

```
python3 plot_year_${i}.py
```

4. Run the python file



.sh



-J "tommyjob[1-420]"

```
#!/bin/bash
#BSUB -o output
#BSUB -e error
#BSUB -q short-serial
```

1. Bsub stuff

```
cd /work/scratch/chri4118
```

2. Set working directory

```
i=$((LSB_JOBINDEX-1))
sed '1s/.*/TIME_SLICE = '${i}'/' plot_year.py > plot_year_${i}.py
```

```
python3 plot_year_${i}.py
```

4. Run the python file



.sh

```
#!/bin/bash
#BSUB -o output
#BSUB -e error
#BSUB -q short-serial
```

1. Bsub stuff

```
cd /work/scratch/chri4118
```

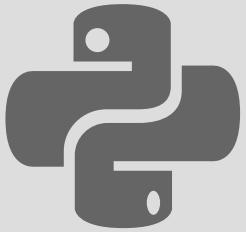
2. Set working directory

```
i=$((LSB_JOBINDEX-1))
sed '1s/.*/TIME_SLICE = '${i}'/' plot_year.py > plot_year_${i}.py
```

```
python3 plot_year_${i}.py
```

3. Change the python file

4. Run the python file



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```
TIME_SLICE = 1
```

0. THIS IS THE LINE we sed edit!

```
# Import Modules
```

```
...
```

1. Import Modules

```
# get the current month
```

```
month_range = pd.date_range('1/1/1981','1/1/2017', freq='M')
month = month_range[TIME_SLICE]
```

2. Get the month (for the title)

```
# prep input file
```

```
INPUT_FILE = "africa_chirps_final.nc"
dataset = Dataset(INPUT_FILE)
```

3. Locate the netCDF

```
# Read in precipitation values (for ONE time slice, 2D), latitude and longitude (both 1D)
```

```
precip = dataset['precip'][TIME_SLICE,:,:]
latitude = dataset['latitude'][:]
longitude = dataset['longitude'][:]
```

4. Extract the Data

```
# make the map using Basemap
```

```
map_1 = Basemap(projection='merc',llcrnrlon=-28.,llcrnrlat=-42.,urcrnrlon=76.,urcrnrlat=48.,resolution='i') 5. Make the map
```

```
...
```

```
plt.title(f'{month} Rainfall (mm/month).')
```

```
plt.savefig(f'/work/scratch/chri4118/output_plots/map_{TIME_SLICE}' )
```

6. Save the figure



```
sed '1s/.*/TIME_SLICE = '${i}'/'
```

```
TIME_SLICE = 1
```

0. THIS IS THE LINE we sed

Import Modules

```
...
```

```
# get the current month
month_range = pd.date_range('1/1/1981', '1/1/2017', freq='M')
month = month_range[TIME_SLICE]
```

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# prep input file
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# Read in precipitation values (for ONE time slice, 2D), latitude and longitude (both 1D)
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plt.title(f'{month} Rainfall (mm/month).')
plt.savefig(f'/work/scratch/chri4118/output_plots/map_{TIME_SLICE}')
```

1. Import Modules

2. Get the month (for the title)

3. Locate the netCDF

4. Extract the Data

6. Save the figure



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```
TIME_SLICE = 1
```

0. THIS IS THE LINE we sed edit!

```
# Import Modules
```

```
...
```

1. Import Modules

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# get the current month
```

```
month_range = pd.date_range('1/1/1981', '1/1/2017', freq='M')
```

```
month = month_range[TIME_SLICE]
```

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INPUT_FILE = "africa_chirps_final.nc"
dataset = Dataset(INPUT_FILE)
```

```
# Read in precipitation values (for ONE time slice, 2D), latitude and longitude (both 1D)
```

```
precip = dataset['precip'][TIME_SLICE,:,:]
```

```
latitude = dataset['latitude'][:]
```

```
longitude = dataset['longitude'][:]
```

3. Locate the netCDF

```
# make the map using Basemap
```

```
map_1 = Basemap(projection='merc',llcrnrlon=-28.,llcrnrlat=-42.,urcrnrlon=76.,urcrnrlat=48.,resolution='i')
```

```
...
```

```
plt.title(f'{month} Rainfall (mm/month).')
```

```
plt.savefig(f'/work/scratch/chri4118/output_plots/map_{TIME_SLICE}')
```

4. Extract the Data

5. Make the map

6. Save the figure



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```
TIME_SLICE = 1

# Import Modules
...

# get the current month
month_range = pd.date_range(1/1/1981, 1/1/2017, freq='M')
month = month_range[TIME_SLICE]
```

prep input file

```
INPUT_FILE = "africa_chirps_final.nc"
dataset = Dataset(INPUT_FILE)
```

```
# Read in precipitation values (for ONE time slice, 2D), latitude and longitude (both 1D)
precip = dataset['precip'][TIME_SLICE,:,:]
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```

```
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plt.savefig(f'/work/scratch/chri4118/output_plots/map_{TIME_SLICE}'')
```

0. THIS IS THE LINE we sed edit!

1. Import Modules

2. Get the month (for the title)

3. Locate the netCDF

4. Extract the Data

6. Save the figure



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```
TIME_SLICE = 1

# Import Modules
...

# get the current month
month_range = pd.date_range(1/1/1981, 1/1/2017, freq='M')
month = month_range[TIME_SLICE]

# prep input file
INPUT_FILE = "africa_chirps_final.nc"
dataset = Dataset(INPUT_FILE)
```

Read in precipitation values (for ONE time slice, 2D), latitude and longitude (1D)

```
precip = dataset['precip'][TIME_SLICE,:,:]
latitude = dataset['latitude'][:]
longitude = dataset['longitude'][:]
```

```
# make the map using Basemap
map_1 = Basemap(projection='merc',llcrnrlon=-28.,llcrnrlat=-42.,urcrnrlon=76.,urcrnrlat=48.,resolution='i') 5. Make the map
...
plt.title(f'{month} Rainfall (mm/month).')
plt.savefig(f'/work/scratch/chri4118/output_plots/map_{TIME_SLICE}' )
```

0. THIS IS THE LINE we sed edit!

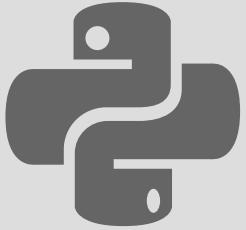
1. Import Modules

2. Get the month (for the title)

3. Locate the netCDF

4. Extract the Data

6. Save the figure



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```
TIME_SLICE = 1

# Import Modules
...
# get the current month
month_range = pd.date_range(1/1/1981, 1/1/2017, freq='M')
month = month_range[TIME_SLICE]

# prep input file
INPUT_FILE = "africa_chirps_final.nc"
dataset = Dataset(INPUT_FILE)

# Read in precipitation values (for ONE time slice, 2D), latitude and longitude (both 1D)
precip = dataset['precip'][TIME_SLICE,:,:]
latitude = dataset['latitude'][:,:]
longitude = dataset['longitude'][:]

# make the map using Basemap
# 5. Make the map
map_1 = Basemap(projection='merc', llcrnrlon=-28., llcrnrlat=-42., urcrnrlon=76.,
urcrnrlat=48., resolution='i')

...
plt.title(f'{month} Rainfall (mm/month).')
Save the figure
plt.savefig(f'/work/scratch/chri4118/output_plots/map_{TIME_SLICE}')
```

0. THIS IS THE LINE we sed edit!

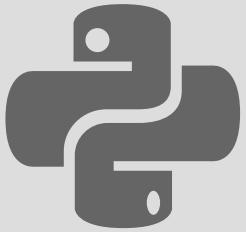
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2. Get the month (for the title)

3. Locate the netCDF

4. Extract the Data

6.



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```
TIME_SLICE = 1  
  
# Import Modules  
...  
  
# get the current month  
month_range = pd.date_range(1/1/1981,1/1/2017,freq='M')  
month = month_range[TIME_SLICE]  
  
# prep input file  
INPUT_FILE = "africa_chirps_final.nc"  
dataset = Dataset(INPUT_FILE)  
  
# Read in precipitation values (for ONE time slice, 2D), latitude and longitude (both 1D)  
precip = dataset['precip'][TIME_SLICE,:,:]  
latitude = dataset['latitude'][:]  
longitude = dataset['longitude'][:]  
  
# make the map using Basemap  
map_1 = Basemap(projection='merc',llcrnrlon=-28.,llcrnrlat=-42.,urcrnrlon=76.,urcrnrlat=48.,resolution='i')  
...  
  
plt.title(f'{month} Rainfall (mm/month).')  
plt.savefig(f'/work/scratch/chri4118/output_plots/map_{TIME_SLICE}')
```

0. THIS IS THE LINE we sed edit!

1. Import Modules

2. Get the month (for the title)

3. Locate the netCDF

4. Extract the Data

5. Make the map

6. Save the figure