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# Drought Monitoring in East Africa







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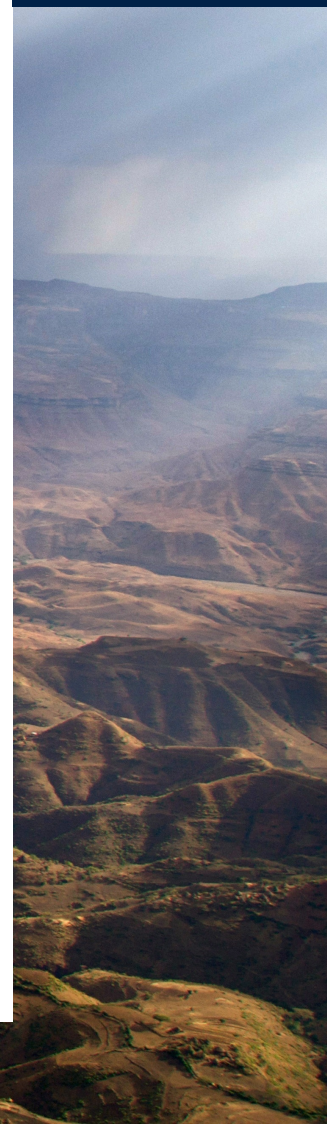
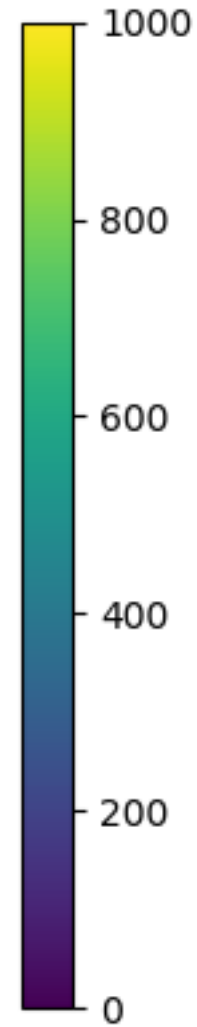
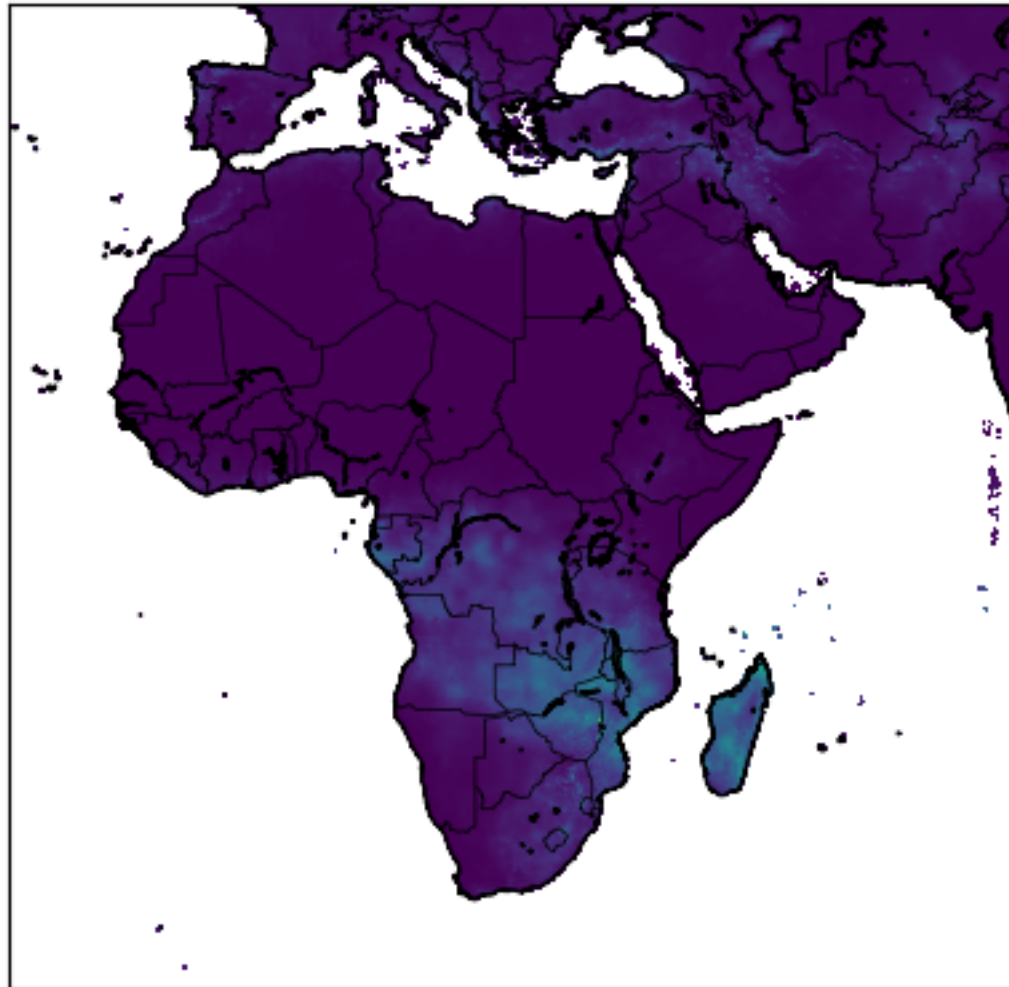
Why the rains fail?

Can we **detect** drought early?

How can we **improve**  
**outcomes?**



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





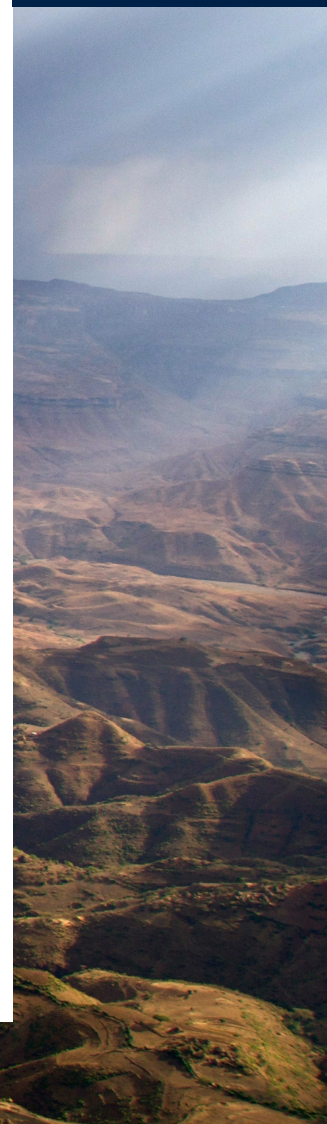
```
[In [21]: %timeit %run plot_server.py
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/matplotlib/
This call to matplotlib.use() has no effect because the backend
has already been chosen; matplotlib.use() must be called *before* pylab,
matplotlib.pyplot, or matplotlib.backends is imported for the first time.

warnings.warn(_use_error_msg)
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/mpl_toolkits/b
b = ax.ishold()
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/mpl_toolkits/b
See the API Changes document (http://matplotlib.org/api/api\_changes.html)
for more details.
ax.hold(b)
[1] 38155 killed ipython
→ output_files
```

```
[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 for the first time.
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/mpl_toolkits/basemap/_init_.py:3342: MatplotlibDeprecationWarning: The ishold function was deprecated in version 2.0.
b = ax.ishold()
/Users/TommyLees/anaconda3/lib/python3.6/site-packages/mpl_toolkits/basemap/_init_.py:3381: MatplotlibDeprecationWarning: axes.hold is deprecated.
See the API Changes document (http://matplotlib.org/api/api\_changes.html)
for more details.
ax.hold(b)
[1] 38155 killed ipython
→ output_files
```

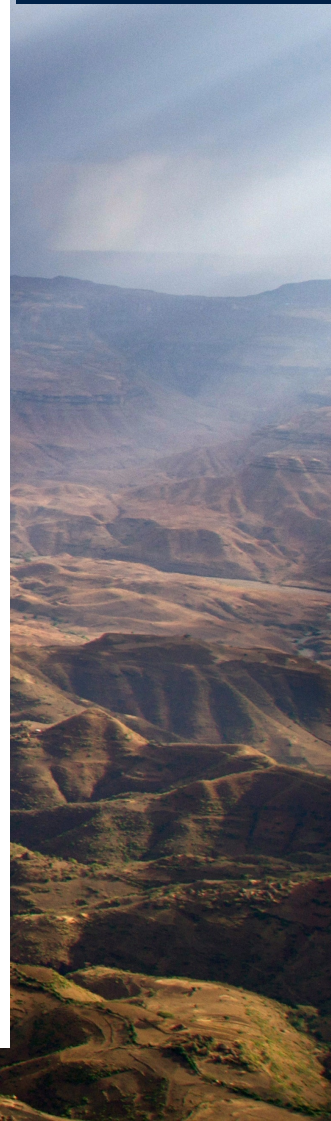
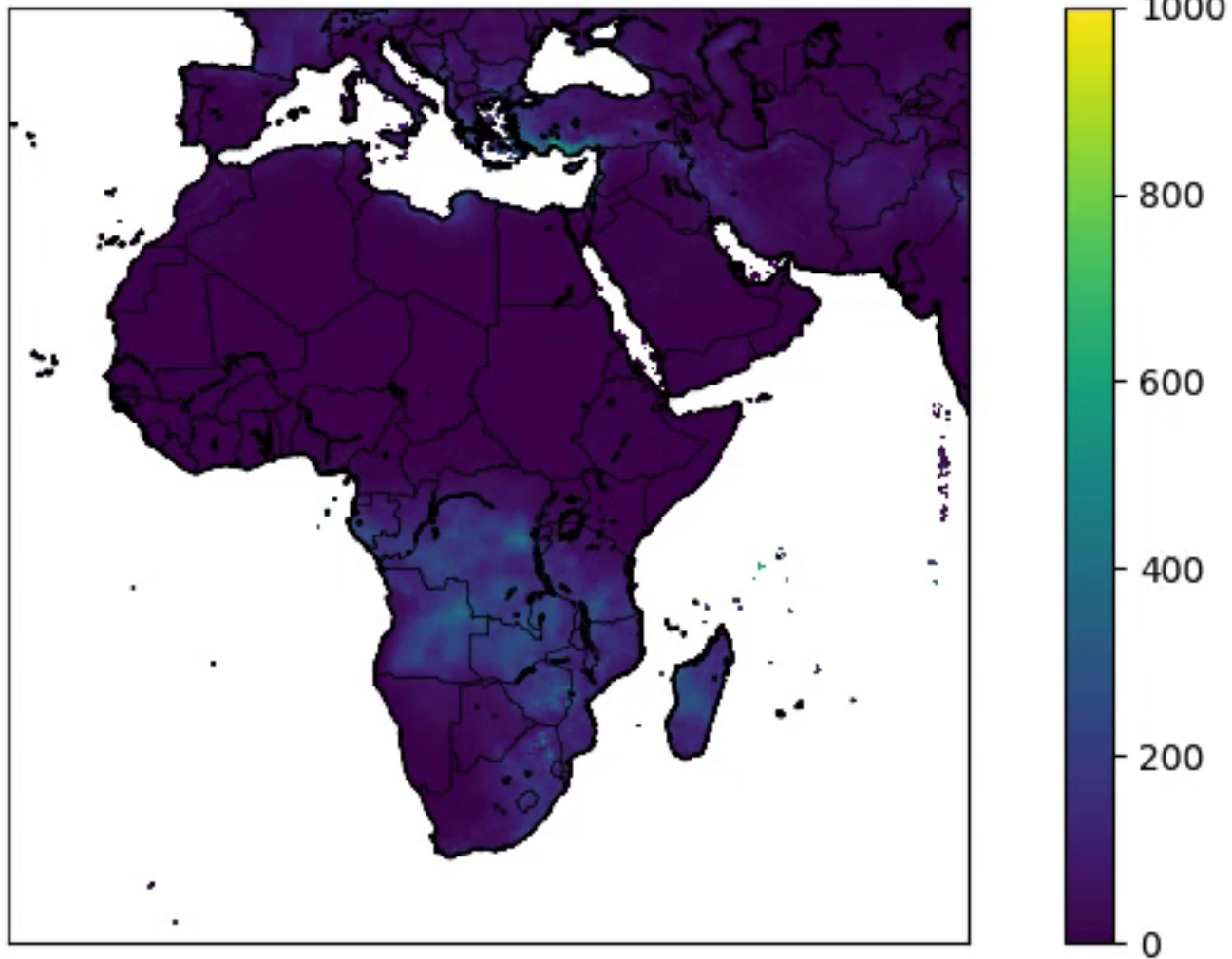


1981-02-28 00:00:00 Rainfall (mm/month).





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







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```

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-serial  host292.jc     host319.jc     *mmyjob[2]    Mar  9 00:10
9753534    chri411    RUN       short-serial  host292.jc     host312.jc     *mmyjob[4]    Mar  9 00:10
9753534    chri411    RUN       short-serial  host292.jc     host321.jc     *mmyjob[3]    Mar  9 00:10
9753534    chri411    RUN       short-serial  host292.jc     host258.jc     *mmyjob[9]    Mar  9 00:10
9753534    chri411    RUN       short-serial  host292.jc     host135.jc     *mmyjob[1]    Mar  9 00:10
9753534    chri411    RUN       short-serial  host292.jc     host247.jc     *mmyjob[6]    Mar  9 00:10
9753534    chri411    RUN       short-serial  host292.jc     host088.jc     *mmyjob[8]    Mar  9 00:10
9753534    chri411    RUN       short-serial  host292.jc     host173.jc     *mmyjob[7]    Mar  9 00:10
9753534    chri411    RUN       short-serial  host292.jc     host266.jc     *mmyjob[5]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[10]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[11]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[12]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[13]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[14]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[15]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[16]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[17]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[18]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[19]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[20]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[21]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[22]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[23]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[24]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[25]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[26]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[27]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[28]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[29]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *myjob[30]    Mar  9 00:10
9753534    chri411    PEND     short-serial  host292.jc     *mviob[31]    Mar  9 00:10

```

# Huge performance boost!

```

[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]$

```

output\_video4.avi  
 AVI movie - 5.4 MB  
 Created Today, 00:07  
 Modified Today, 00:07  
 Last opened Today, 00:07





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3 minutes



4200 minutes



1500x faster



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Maybe a **little** optimistic ...







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

```
open .
```

```
^
SyntaxError: invalid syntax
```

```
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/2_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]:
```

Still 218x

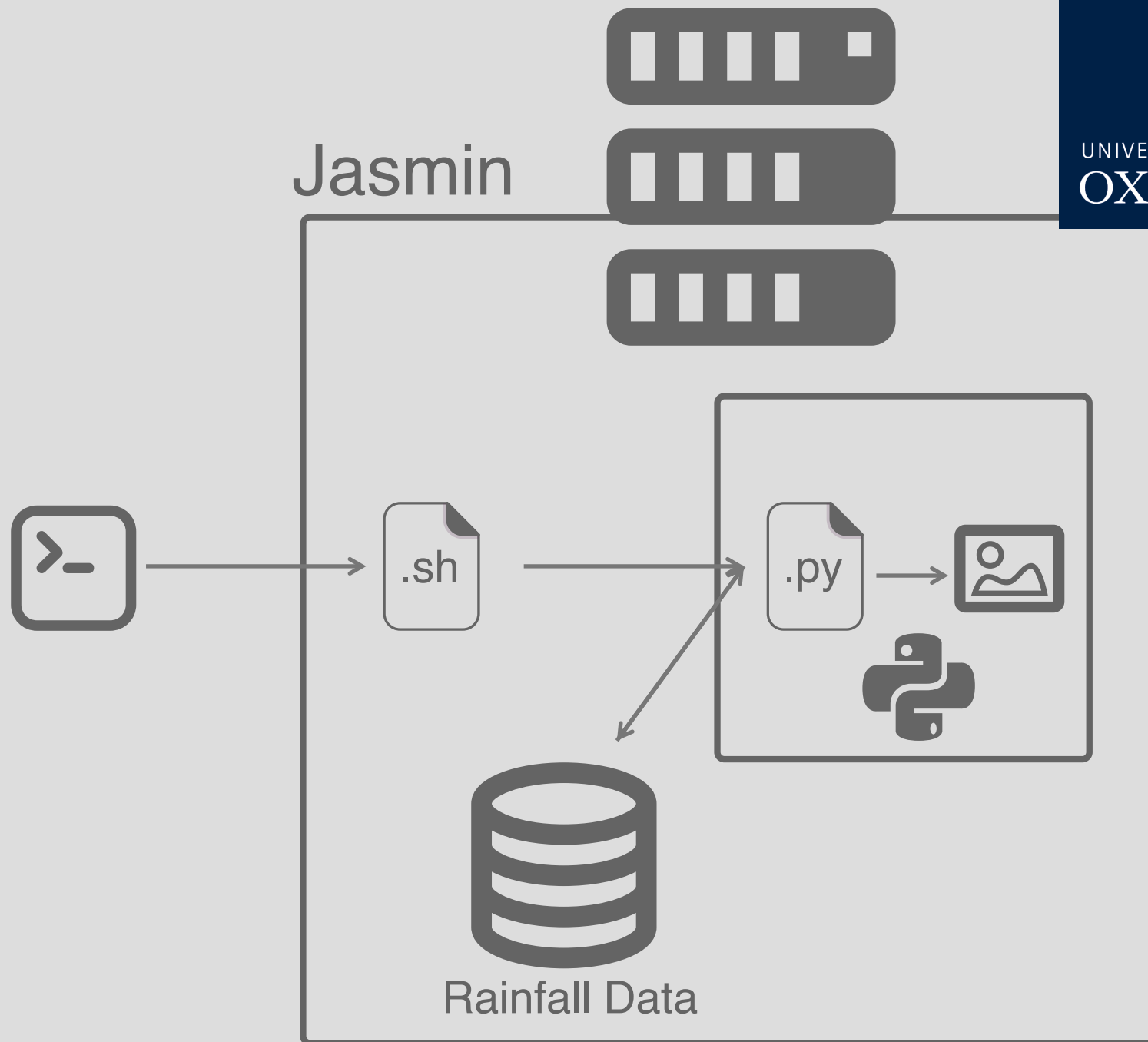
117s

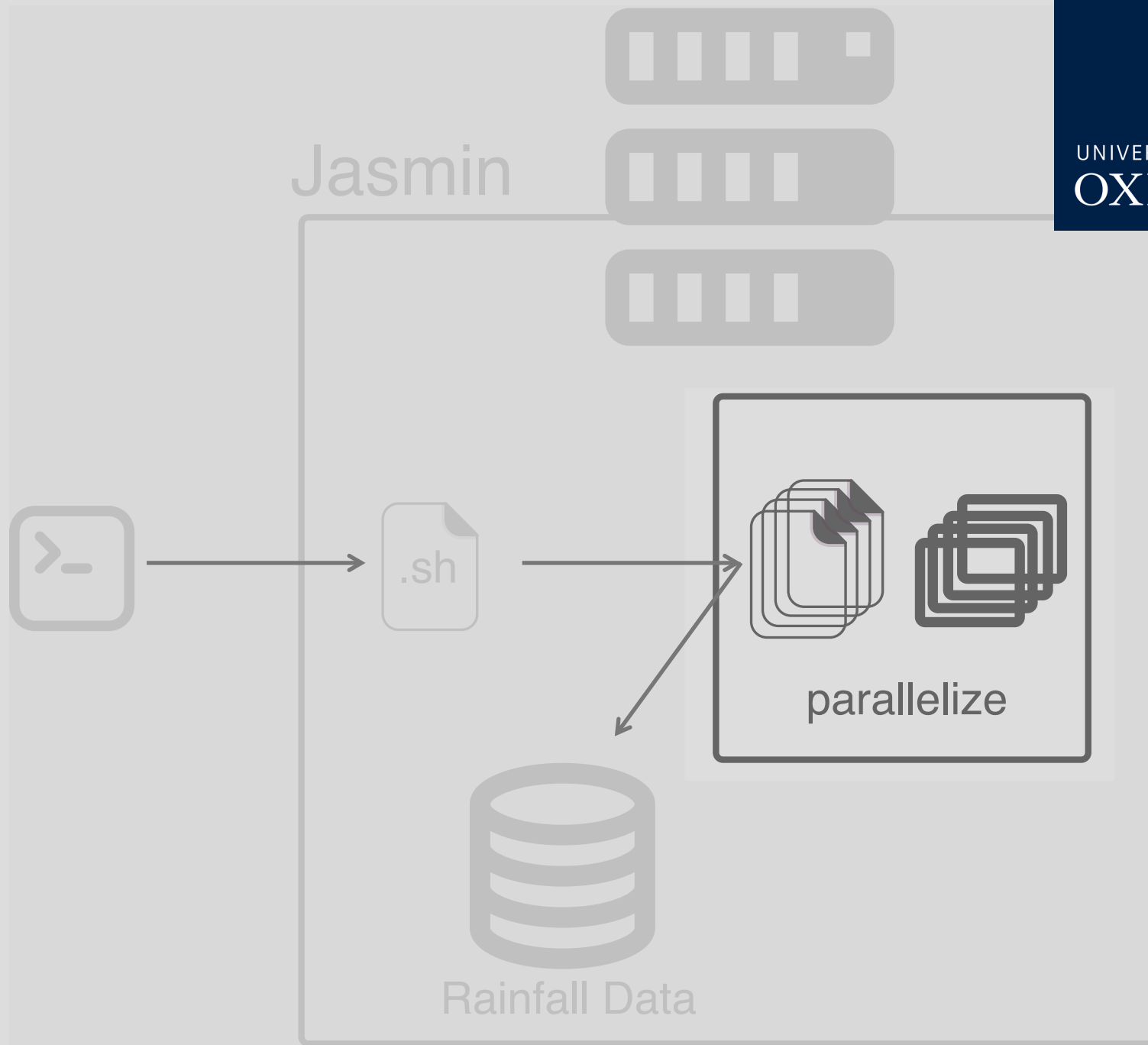
0.48s



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Jasmin



Rainfall Data



# Future

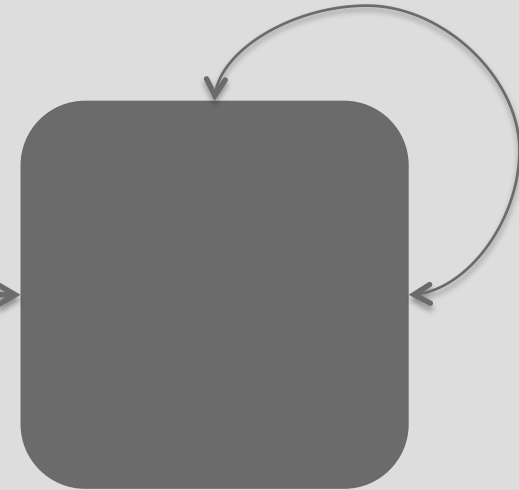
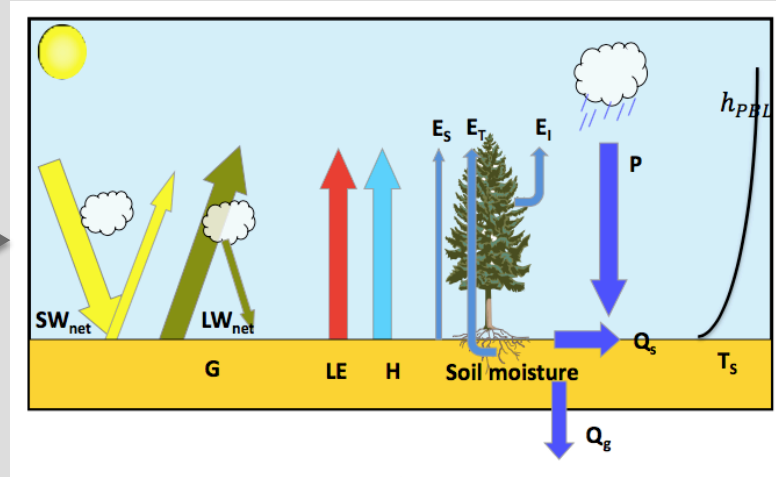
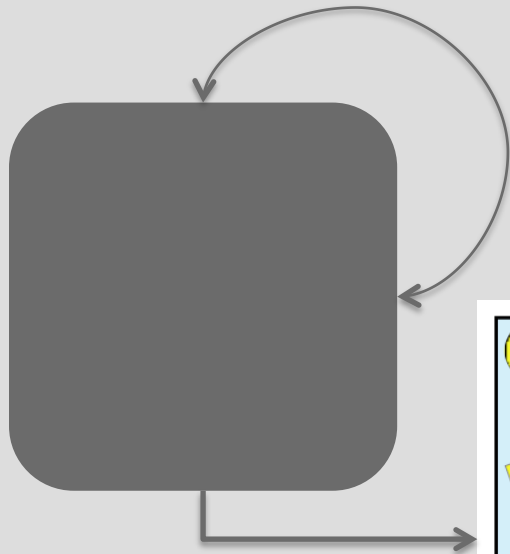
## Applications



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# Land Surface Modelling



# Bayesian Modelling

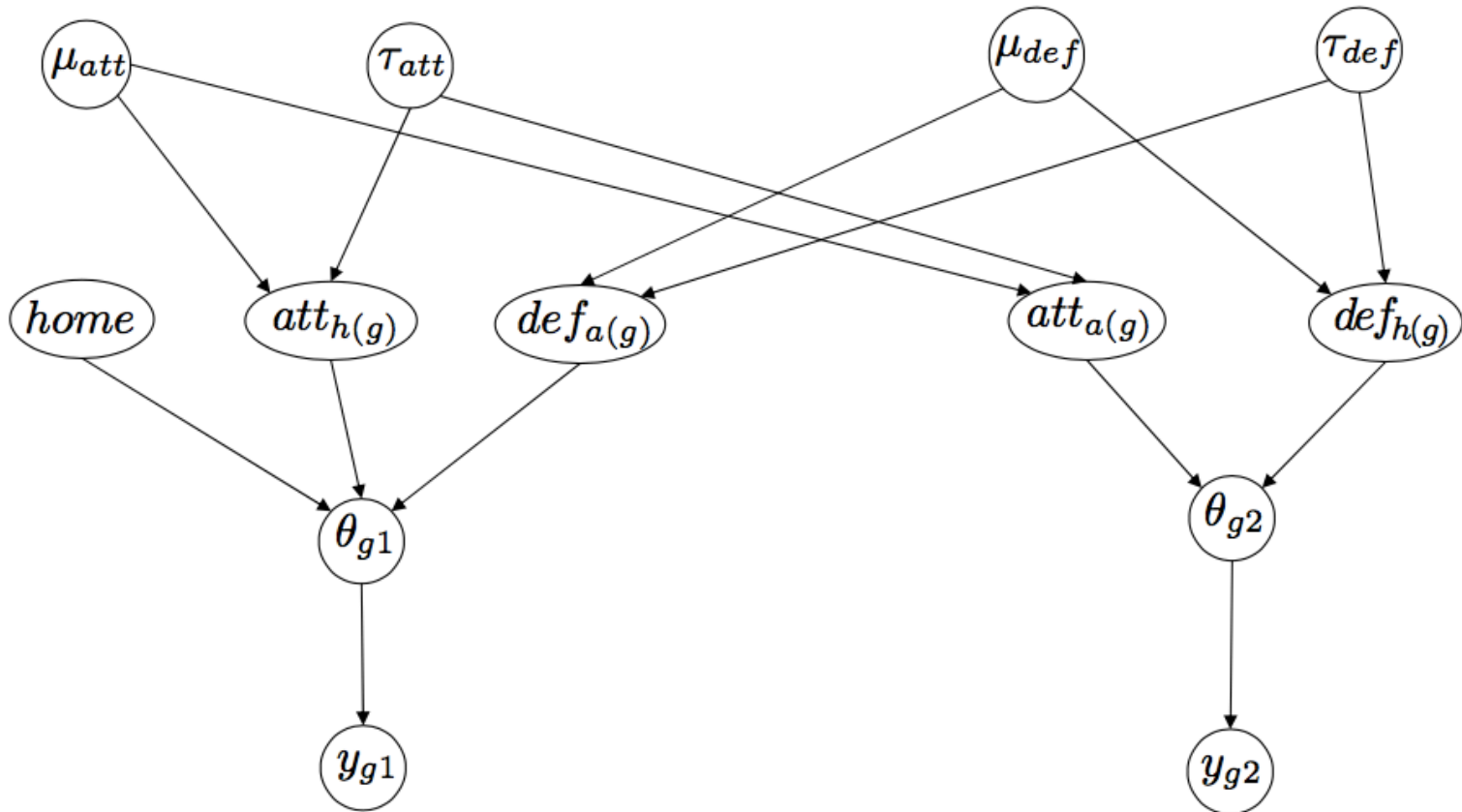


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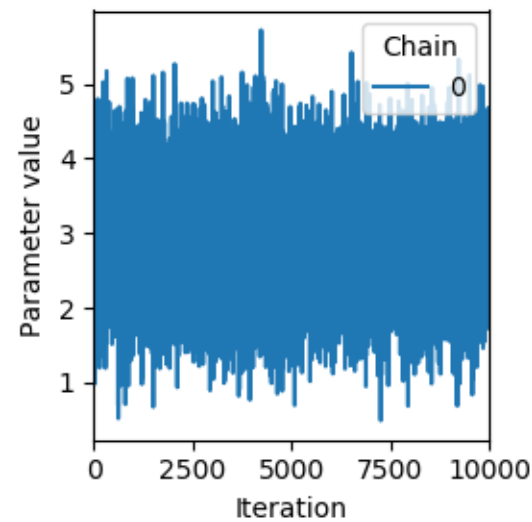
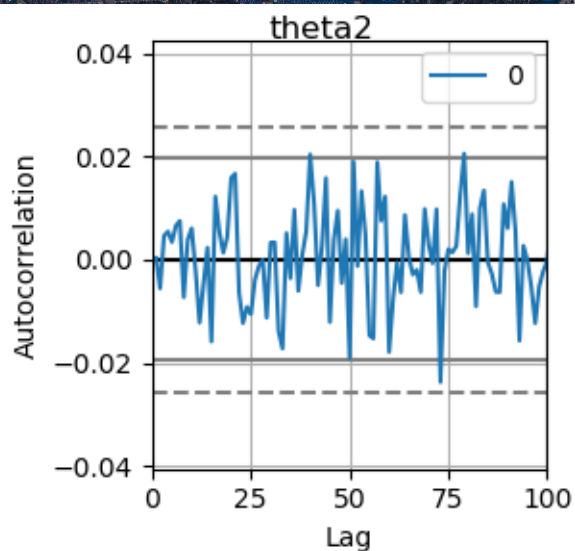
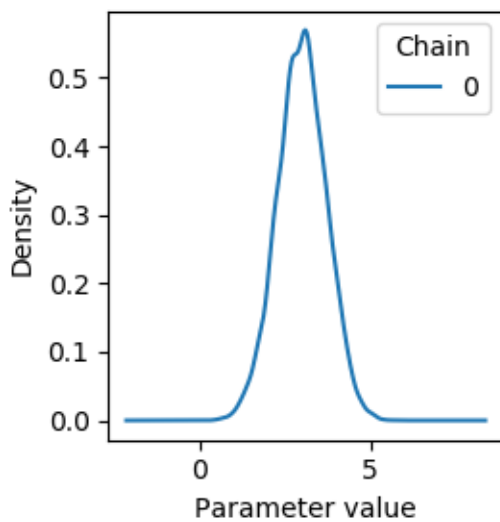
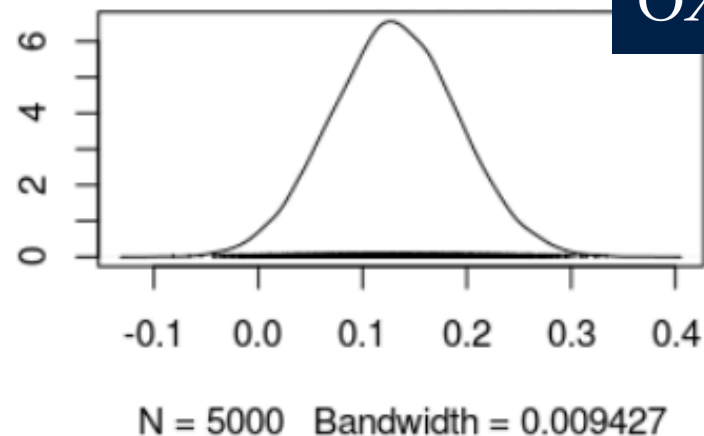
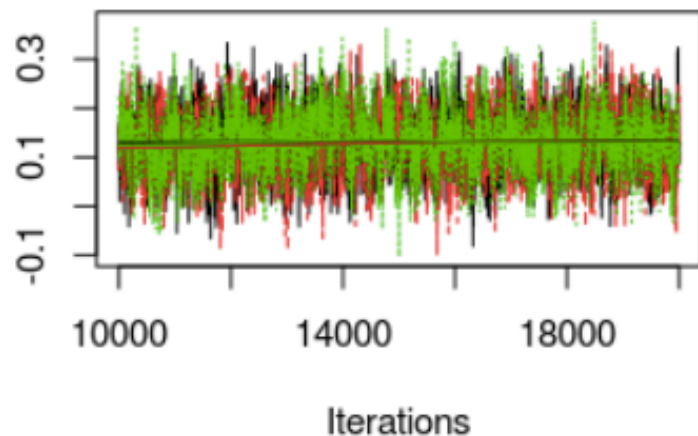




# Bayesian Modelling







Less of this.



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**More** of this.

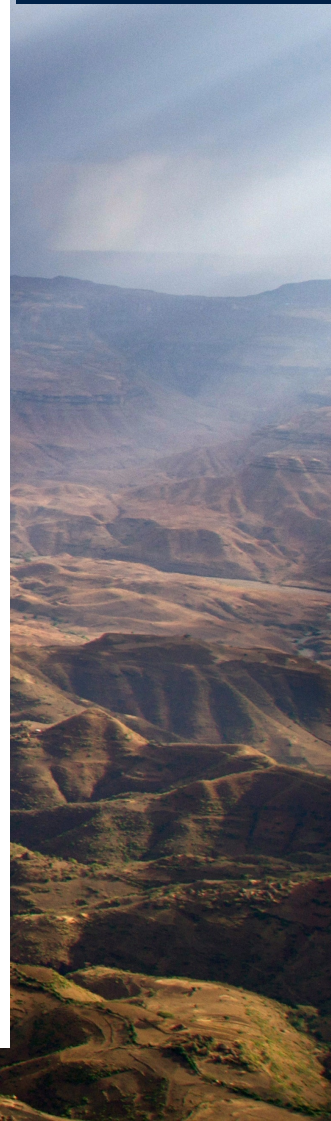
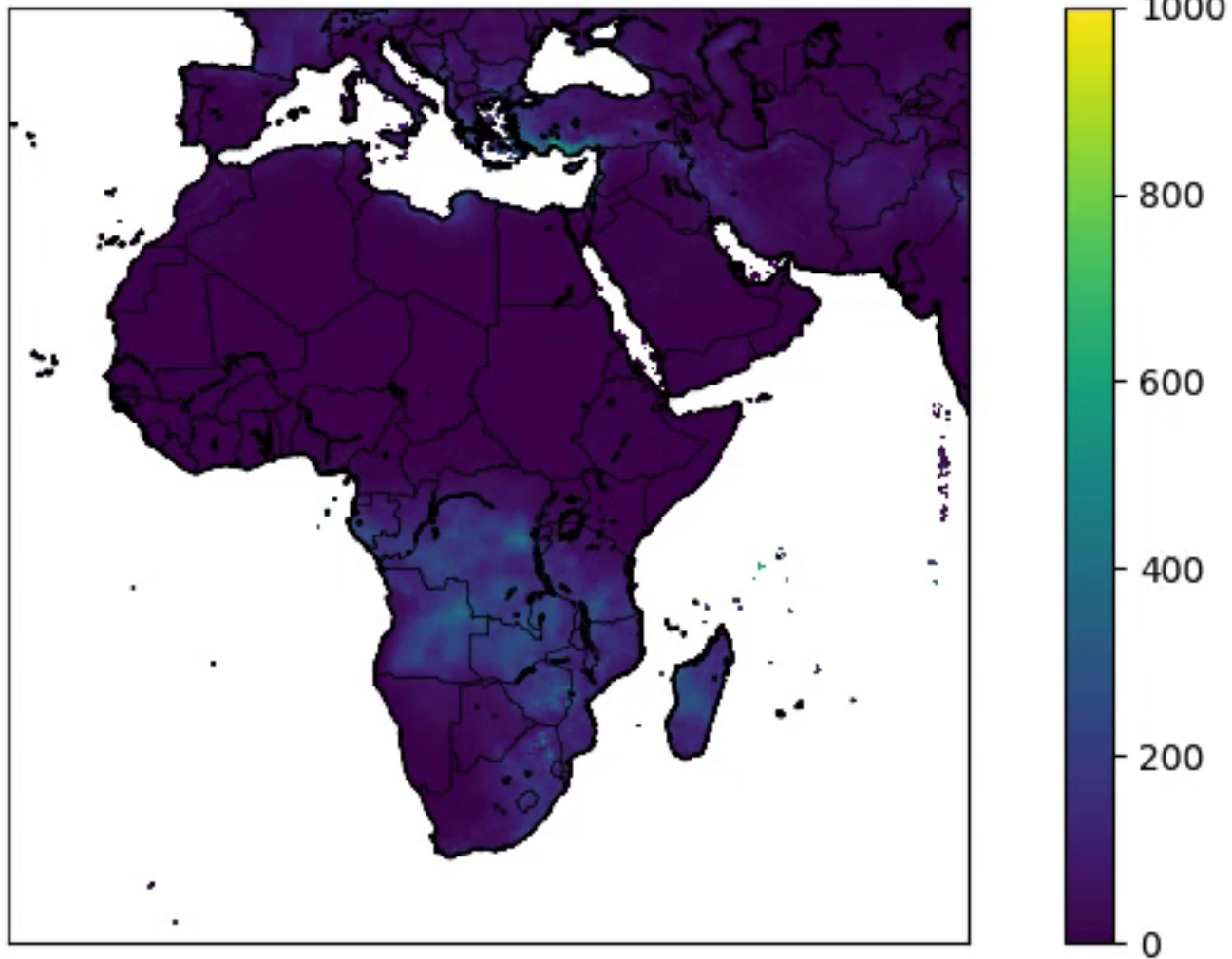


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1981-01-31 00:00:00 Rainfall (mm/month).





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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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```



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





```
#!/bin/bash
```

```
#BSUB -o output
```

```
#BSUB -e error
```

```
#BSUB -q short-serial
```

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

```
i=$((LSB_JOBINDEX-1))
```

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

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

1. Bsub stuff

2. Set working directory

3. Change the python file

4. Run the python file



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

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

```
i=$((LSB_JOBINDEX-1))  
sed '1s/./*/TIME_SLICE = '${i}'/' plot_year.py > plot_year_${i}.py
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```
#!/bin/bash  
#BSUB -o output  
#BSUB -e error  
#BSUB -q short-serial
```

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

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

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

1. Bsub stuff

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-J "tommyjob[1-420]"



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```
#!/bin/bash
```

```
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1. Bsub stuff

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cd /work/scratch/chri4118
```

2. Set working directory

```
i=$((LSB_JOBINDEX-1))
```

3. Change the python file

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

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

4. Run the python file



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

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

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

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

1. Bsub stuff

2. Set working directory

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4. Run the python file



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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





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



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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',llcrnlon=-28.,llcrnlat=-42.,urcrnlon=76.,urcrnlat=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}')
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0. THIS IS THE LINE we sed

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TIME_SLICE = 1
```

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# Import Modules
```

```
...
```

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

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

```
...
```

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

```
plt.savefig(f'/work/scratch/chri4118/output_plots/map_{TIME_SLICE}')
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TIME_SLICE = 1
```

```
# Import Modules
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```
...
```

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```

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

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

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)
```

0. THIS IS THE LINE we sed edit!

1. Import Modules

2. Get the month (for the title)

3. Locate the netCDF

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

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

4. Extract the Data

```
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}')
```

5. Make the map

6. Save the figure



```
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!

1. Import Modules

2. Get the month (for the title)

3. Locate the netCDF

4. Extract the Data



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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).')
```

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```
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```

6. Save the figure