paper_single_series

December 5, 2024

[13]:

```
import os
import numpy as np
import pandas as pd
import warnings
from datetime import datetime
import plotly.graph_objects as go
from src.utils.post_process import merge_bursts
from src.burst_detection.python.exhaustive_search import compute_all_bursts

import utils_notebook as utils
import matplotlib.pyplot as plt
import matplotlib.cm as cm
from matplotlib.colors import BoundaryNorm
```

[14]:

```
threshold = 2.75
time_series_path = "../data/SST/mediterranean_average_processed.npy"
dates_series_path = "../data/SST/mediterranean_average_processed_dates.npy"
start_year = 1960
end_year = 2021
minimum_length = 1
maximum_length = 365
absolute = True
export = False
filename_html="example_unique_series.html"

if export:
    import plotly.io as pio
    pio.renderers.default='notebook'
```

[15]:

```
print("\033[1m"+"Parameters: "+ "\033[0m")
print(f" - threshold = \033[1m{threshold}\033[0m : z-score theshold")
print(f" - time_series_path = \033[1m\"{time_series_path}\"\033[0m: path to the␣
 ↪time series of values")
print(f" - dates_series_path = \033[1m\"{dates_series_path}\"\033[0m: path to␣
 ↪the time series of dates")
print(f" - start_year = \033[1m{start_year}\033[0m: first year to study")
print(f" - end_year = \033[1m{end_year}\033[0m: last year to study")
print(f" - minimum_length = \033[1m{minimum_length}\033[0m: minimal interval␣
 ↪length")
print(f" - maximum_length = \033[1m{maximum_length}\033[0m: maximal interval␣
 ↪length")
print(f" - absolute = \033[1m{absolute}\033[0m: whether to compute bursts in␣
 ↪absolute value or not")
print(f" - export = \033[1m{export}\033[0m: html export")
print(f" - filename_html = \033[1m\"{filename_html}\"\033[0m: html export file")
```

```
Parameters:
 - threshold = 2.75 : z-score theshold
 - time_series_path = "../data/SST/mediterranean_average_processed.npy":
path to the time series of values
 - dates_series_path =
"../data/SST/mediterranean_average_processed_dates.npy": path to the
time series of dates
 - start_year = 1960: first year to study
 - end_year = 2021: last year to study
 - minimum_length = 1: minimal interval length
 - maximum_length = 365: maximal interval length
 - absolute = True: whether to compute bursts in absolute value or not
 - export = False: html export
 - filename_html = "example_unique_series.html": html export file
```

[16]:

```
# Data loading
ts = np.load(time_series_path).astype(np.float64)
ts_date = pd.DatetimeIndex(np.load(dates_series_path))
mask = (ts_date.year >= start_year) & (ts_date.year <= end_year)
ts = ts[mask]
ts_date = ts_date[mask]
len_year = 365
first_day_of_months = np.where(ts_date[:len_year].day == 1)[0]
str_dates = ["Jan", "Feb", "Mar", "Apr", "May", "Jun", "Jul",
             "Aug", "Sep", "Oct", "Nov", "Dec"]
first_year = ts_date[0].year
first_day_of_months = np.where(ts_date[:len_year].day == 1)[0]

n_year = len(ts)//len_year
yearly_ts = np.copy(ts.reshape((n_year, len_year)))
mean = np.mean(yearly_ts, axis=0)
```

[17]:

```
# Bursts computation
bursts = compute_all_bursts(ts,n_year,threshold, len_year, abs=absolute)
union_bursts = merge_bursts(bursts) # merge burst representation
```

[18]:

```
# Computation of statistics of the bursts
```

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bursts_df, yearly_sum = utils.compute_statistics(ts, ts_date, union_bursts,␣
 ↪len_year)
```

[19]:

```
fig = go.Figure()
# Plot daily average line
fig.add_trace(go.Scatter(
    y=mean,
    mode='lines',
    line=dict(color="black", dash="dash"),
    name="Daily average"
))
# Plot each year's data as individual dotted lines
for year in range(n_year):
    fig.add_trace(go.Scatter(
        y=yearly_ts[year, :],
        mode='lines',
        line=dict(color="grey", dash="dot", width=1),
        opacity=0.4,
        name=f"{first_year + year}",
        showlegend=False,
    ))
# Add hot bursts as line segments or scatter points
for (start, end, z) in union_bursts:
    text = "Hot" if z>0 else "Cold"
    length = end - start + 1
    i_start = start % len_year
    year = start // len_year
    xs = np.arange(i_start, i_start + length)
    hover_text = [f"{ts_date[i].strftime("%d %b %Y")}" for i in range(start,␣
 ↪end+1)]
    if len(xs) > 1:
        fig.add_trace(go.Scatter(
            x=xs,
            y=ts[start:start + length],
            mode='lines',
            line=dict(width=2.5),
            name=f"{first_year + year} {text} Burst",
            hovertext= hover_text
        ))
    else:
        fig.add_trace(go.Scatter(
            x=xs,
            y=ts[start:start + length],
            mode='markers',
            marker=dict(size=6),
            name=f"{first_year + year} {text} Burst"
        ))
```

```
# Customize x-axis labels with month names
fig.update_xaxes(
    tickvals=first_day_of_months,
    ticktext=ts_date[first_day_of_months].strftime("%B"),
    tickangle=-45
)

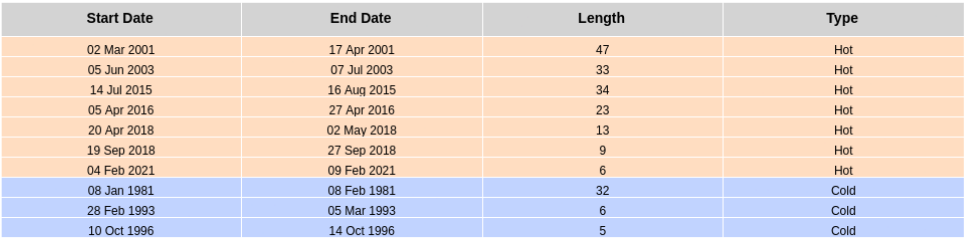
# Update layout for legend and figure size
fig.update_layout(
    legend=dict(x=1.05, y=1, orientation="v"),
    width=1100,
    height=600,
    title="Yearly Time Series with Bursts",
    xaxis_title="Days of Year",
    yaxis_title="Value"
)

# Show the plot
fig.show()
```

[20]:

```
fig = utils.plot_table(bursts_df)
fig.update_layout(
    title="Table of Bursts with Starting and Ending Dates, Length, and Type␣
 ↪(hot = zscore > 0)",
    title_x=0.5,
    width=750,
    height=450
)
fig.show()
```

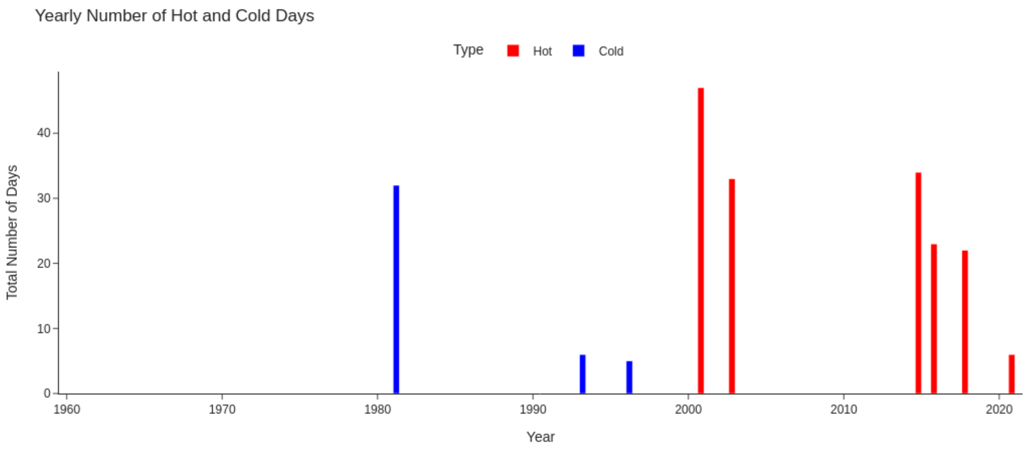
Table of Bursts with Starting and Ending Dates, Length, and Type (hot = zscore > 0)



Start Date	End Date	Length	Type
02 Mar 2001	17 Apr 2001	47	Hot
05 Jun 2003	07 Jul 2003	33	Hot
14 Jul 2015	16 Aug 2015	34	Hot
05 Apr 2016	27 Apr 2016	23	Hot
20 Apr 2018	02 May 2018	13	Hot
19 Sep 2018	27 Sep 2018	9	Hot
04 Feb 2021	09 Feb 2021	6	Hot
08 Jan 1981	08 Feb 1981	32	Cold
28 Feb 1993	05 Mar 1993	6	Cold
10 Oct 1996	14 Oct 1996	5	Cold

[21]:

```
fig = utils.plot_bars(yearly_sum)
fig.update_layout(
    barmode='group',  # Group bars next to each other
    title="Yearly Number of Hot and Cold Days",
    xaxis_title="Year",
    yaxis_title="Total Number of Days",
    template="simple_white",
    legend=dict(title="Type", orientation="h", yanchor="bottom", y=1.02,␣
  ↪xanchor="center", x=0.5),
    width=800,
    height=500
)
fig.show()
```

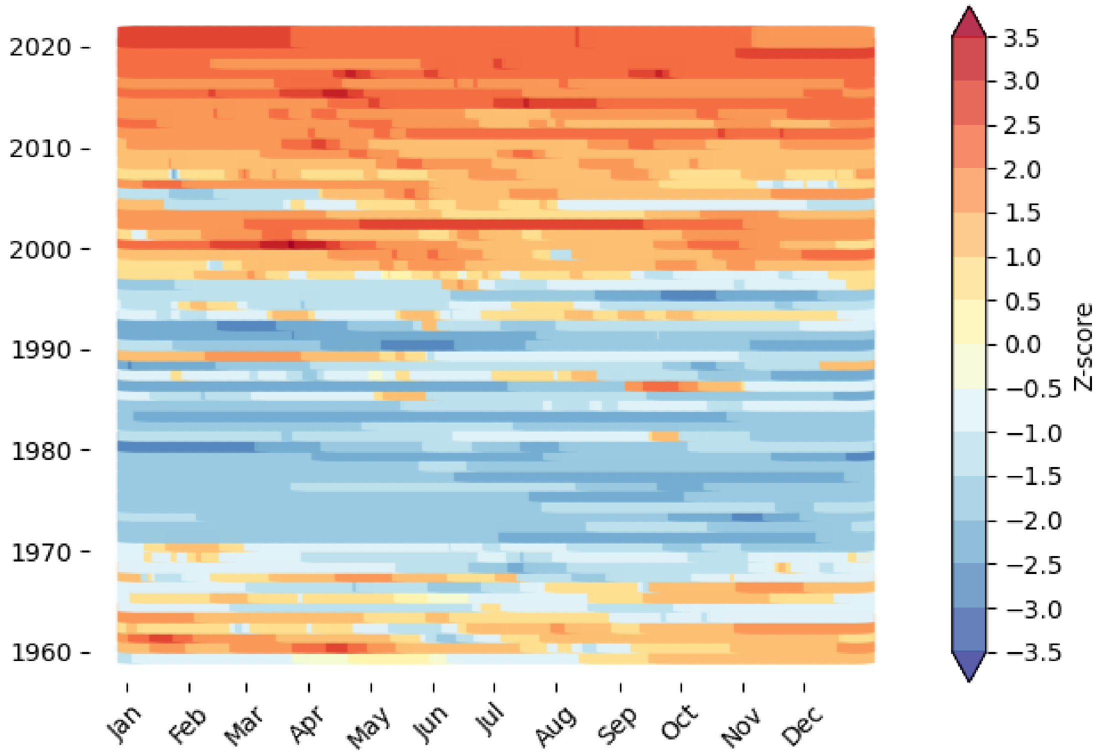


[22]:

```
z_per_day = utils.compute_daily_zscore(ts, n_year, len_year)
min_year = 1960
max_year = 2021
all_max, all_min = max(z_per_day), min(z_per_day)
print(f"Maximum: {all_max}, Minimum: {all_min}")
first_year, last_year = ts_date[0].year, ts_date[-1].year
# Discrete colorbar
abs_max = 3.5  # max(abs(all_max), abs(all_min))
levels = np.arange(-abs_max, abs_max+0.5, 0.5)
norm = BoundaryNorm(boundaries=levels, ncolors=256, extend='both')
x = np.arange(len_year)
plt.figure(figsize=(6.5,4.5))
for year in range(n_year):
    if max_year < year + first_year or year + first_year < min_year:
        continue
    plt.scatter(x, np.ones(len_year) * year + first_year, c=z_per_day[year *␣
 ↪len_year:(year + 1) * len_year],
                cmap=cm.RdYlBu_r, norm=norm, marker='s', s=50, alpha=0.8)

cbar = plt.colorbar(ticks=levels)
cbar.set_label('Z-score'), plt.xticks(first_day_of_months, str_dates,␣
 ↪rotation=45), plt.tight_layout()
for pos in ['right', 'top', 'bottom', 'left']: plt.gca().spines[pos].
 ↪set_visible(False)
plt.show()
```

```
Maximum: 3.5382557011944162, Minimum: -2.774360848504524
```

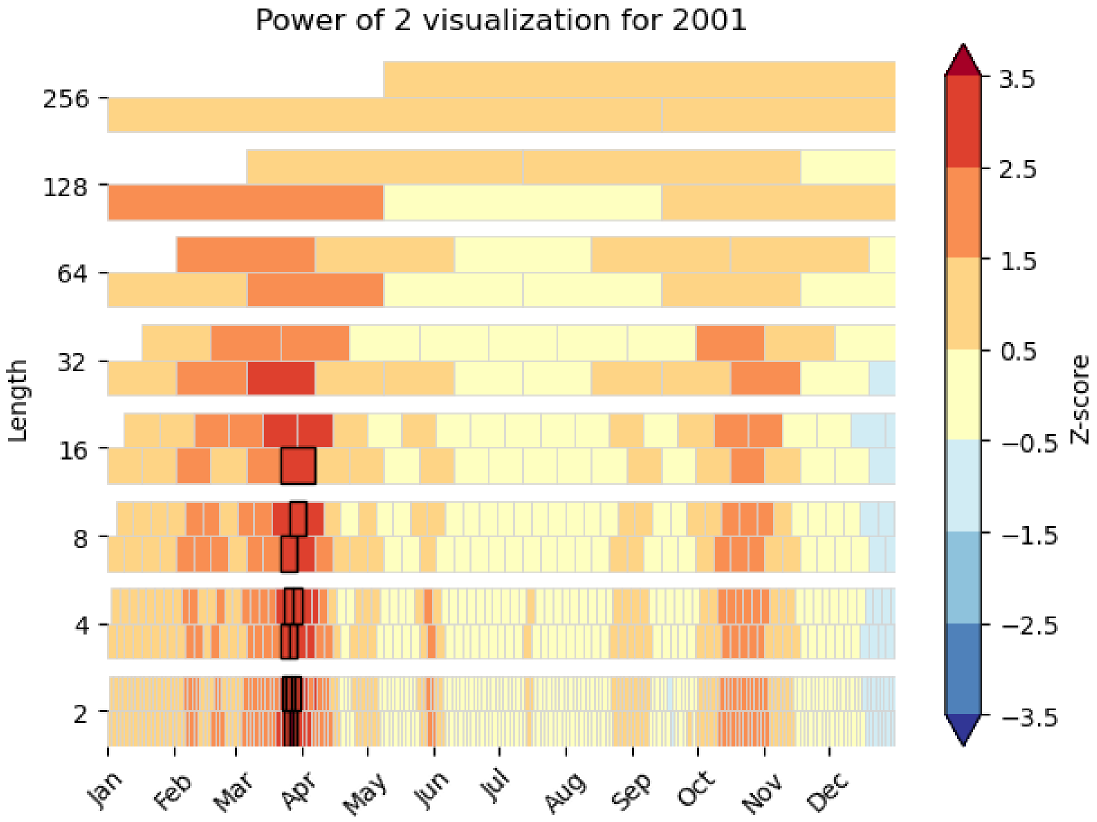


[23]:
```
year = 2001

swt_val = utils.SWT_per_year(ts, n_year, len_year)
swt = utils.z_score_SWT(swt_val, n_year, len_year, threshold, ts)

start_j = len_year * (year - first_year)
dates = ts_date[start_j:start_j+len_year]
abs_max = 3.5
fig, ax = plt.subplots()
```

```
ax.set_ylim(1, 9), ax.set_xlim(0, len_year)
utils.plot_bricks_with_z_score(swt, year - first_year, abs_max, ax)
plt.yticks(np.arange(1.4,9,1), [f"{2**i}" for i in range(1,9)]), plt.
 ↪title(f"Power of 2 visualization for {year}")
plt.xticks(first_day_of_months, str_dates, rotation=45)
plt.ylabel("Length"), plt.tight_layout()
for pos in ['right', 'top', 'bottom', 'left']: plt.gca().spines[pos].
 ↪set_visible(False)
```



[24]:
```
%%capture output
if export:
    with warnings.catch_warnings():
        warnings.simplefilter('ignore')
        os.system('jupyter nbconvert --no-input --output ' + filename_html + '␣
 ↪--to html ' + "paper_single_notebook.ipynb")
```