SIOC 221A: HW1

In [15]:
```
import numpy as np
import matplotlib.pyplot as plt
import netCDF4
import datetime as dt
import matplotlib.dates as mdates
import pandas as pd
```

Q1: Download 2021 SST from Scripps Pier

In [32]:
```
url = 'http://thredds.sccoos.org/thredds/dodsC/autoss/scripps_pier-2021.
nc = netCDF4.Dataset(url)

time = nc['time'][:]
temp = nc['temperature'][:]
sal = nc['salinity'][:]
p = nc['pressure'][:]
chl = nc['chlorophyll'][:]
station = nc['station'][:]
lon = nc['lon'][:]; lat = nc['lat'][:]
zeta = nc['depth'][:]
```

In [34]:
```
# let's figure out our time units
units = nc['time'].units
print(units)
cal = nc['time'].calendar
print(f'{cal} calendar')
```

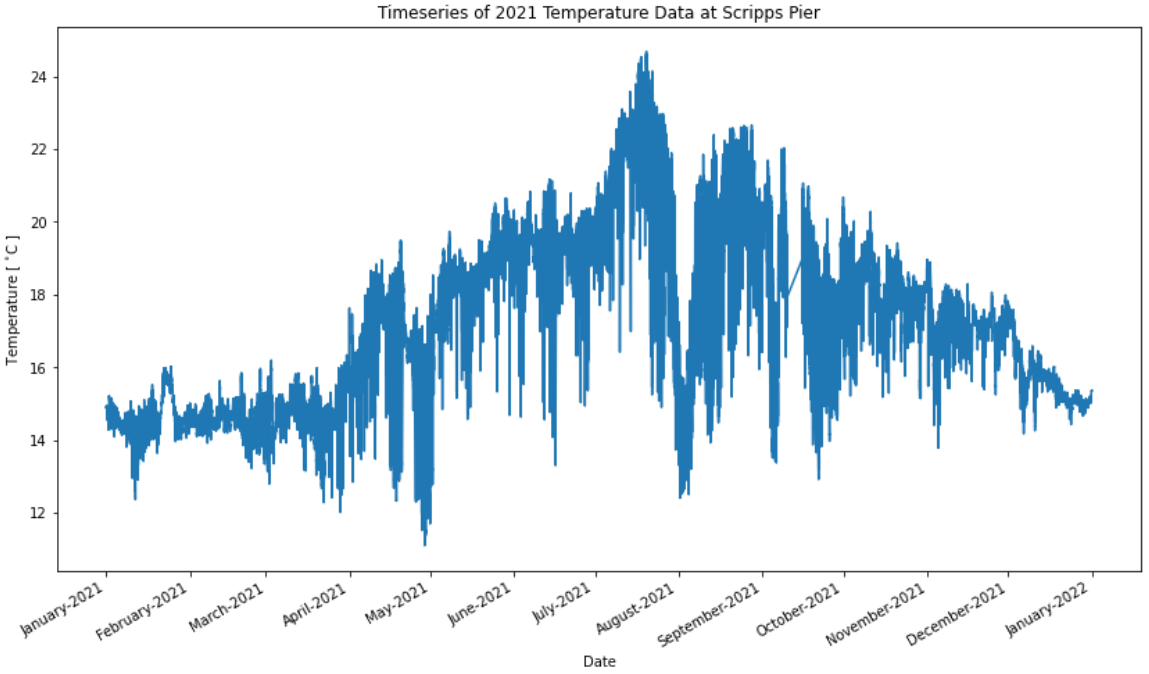
```
seconds since 1970-01-01 00:00:00 UTC
julian calendar
```

In [35]:
```
# time units = 'seconds since 1970-01-01 00:00:00 UTC'
# but! in julian calendar... so?

start_time = dt.datetime(1970,1,1)
time_array = np.array(time.data)
dates = [start_time + dt.timedelta(seconds=float(tt)) for tt in time_arr
```

In [36]:
```
# part a: produce line plot of 2021 temps

fig,ax = plt.subplots(1,1,figsize=(14,8))
ax.plot(dates,temp) #,c=temp,cmap='Spectral_r')
ax.xaxis.set_major_formatter(mdates.DateFormatter('%B-%Y'))
ax.xaxis.set_major_locator(mdates.MonthLocator())
fig.autofmt_xdate()
ax.set(title='Timeseries of 2021 Temperature Data at Scripps Pier', xlab
plt.show()
```



Observations from plot:

I notice the temperature variability is higher in the summer than in the winter. A seasonal trend is visible - with higher summer temperatures than winter temperatures. There is a sharp drop in August, which then returns to a bit less than the previous temperature state after about a week.

In [37]:
```
# part b: compute mean and stdev

temp_mean = np.nanmean(temp)
print(f'Temperature Mean of 2021 is: {temp_mean} deg C')
temp_std = np.std(temp)
print(f'Temperature Standard Deviation of 2021 is: {temp_std} deg C')
```

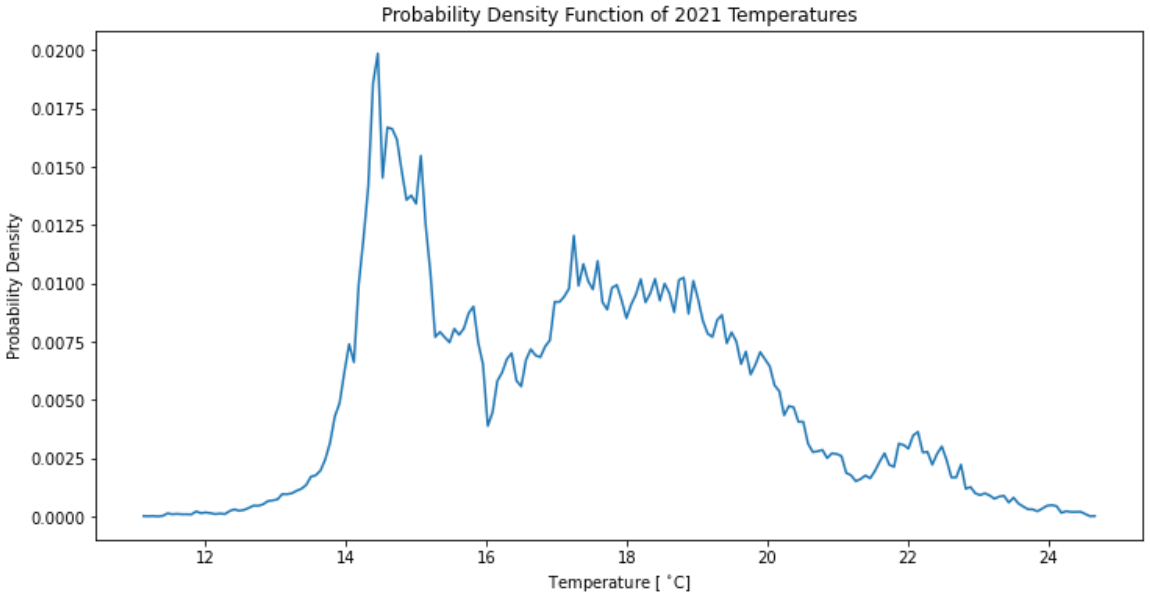
```
Temperature Mean of 2021 is: 17.273984909057617 deg C
Temperature Standard Deviation of 2021 is: 2.425363302230835 deg C
```

In [45]:
```
# part c: empirical probability density function

[num_bin,bin_edges] = np.histogram(temp,bins=200)
mid_bins = (bin_edges[1:]+bin_edges[0:-1])/2

fig,ax = plt.subplots(1,1,figsize=(12,6))
ax.set_title('Probability Density Function of 2021 Temperatures')
ax.set_xlabel(r'Temperature [ $^{\circ} $C]'); ax.set_ylabel('Probabilit
plt.plot(mid_bins,num_bin/sum(num_bin))
plt.show()

print(sum(num_bin))
```



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The temperature mean and standard deviation tell us about the average temperature throughout the year and the standard deviation tells us about the variability across temperature measurements.

The PDF shown of the 2021 temperature dataset looks potentially like a trimodal distribution, more than anything we specifically discussed in class. There are 3 peaks, or 3 most frequent occurences, in the temperature observations, which are around 15 degrees, in the range of 18 degrees, and 22 degrees.

Q2: Extending the record

In [46]:

```
years = np.arange(2005,2022) # going from 2005 to 2021
year_string = [str(yy) for yy in years]

url_base = 'http://thredds.sccoos.org/thredds/dodsC/autoss/scripps_pier-
urls = [url_base+yy+'.nc' for yy in year_string]
time = np.array([])
temp = np.array([])
sal = np.array([])
p = np.array([])
chl = np.array([])
station = np.array([])
lon = np.array([]); lat = np.array([])
zeta = np.array([])

for n,fn in enumerate(urls):
    # read current file:
    nc = netCDF4.Dataset(fn)
    t_now = nc['time'][:]
    t_here = nc['temperature'][:]
    s_here = nc['salinity'][:]
    p_here = nc['pressure'][:]
    c_here = nc['chlorophyll'][:]
    s_here = nc['station'][:]
    lon_here = nc['lon'][:]; lat_here = nc['lat'][:]
    z_here = nc['depth'][:]

    # append to extended record
    time = np.append(time,t_now)
    temp = np.append(temp,t_here)
    sal = np.append(sal,s_here)
    p = np.append(p,p_here)
    chl = np.append(chl,c_here)
    station = np.append(station,s_here)
    lon = np.append(lon,lon_here); lat = np.append(lat,lat_here)
    zeta = np.append(zeta,z_here)

s0 = dt.datetime(1970,1,1)
dates = [s0+dt.timedelta(seconds=float(tt)) for tt in time.data]

# trying to make a dataframe with all data, but noticed that matplotlib
SP = pd.DataFrame({'dates':np.array(dates),'temp':temp,'p':p,'chl':chl})
# information I couldn't add because size requirements: 'sal':sal, 'stat
```

In [48]:

```
# Q2 part a: do the same thing
# compute mean and stdev - but finding & excluding anamalous data

outlier = np.nonzero(temp>50)

print(temp[outlier])
```

```
[97.]
```

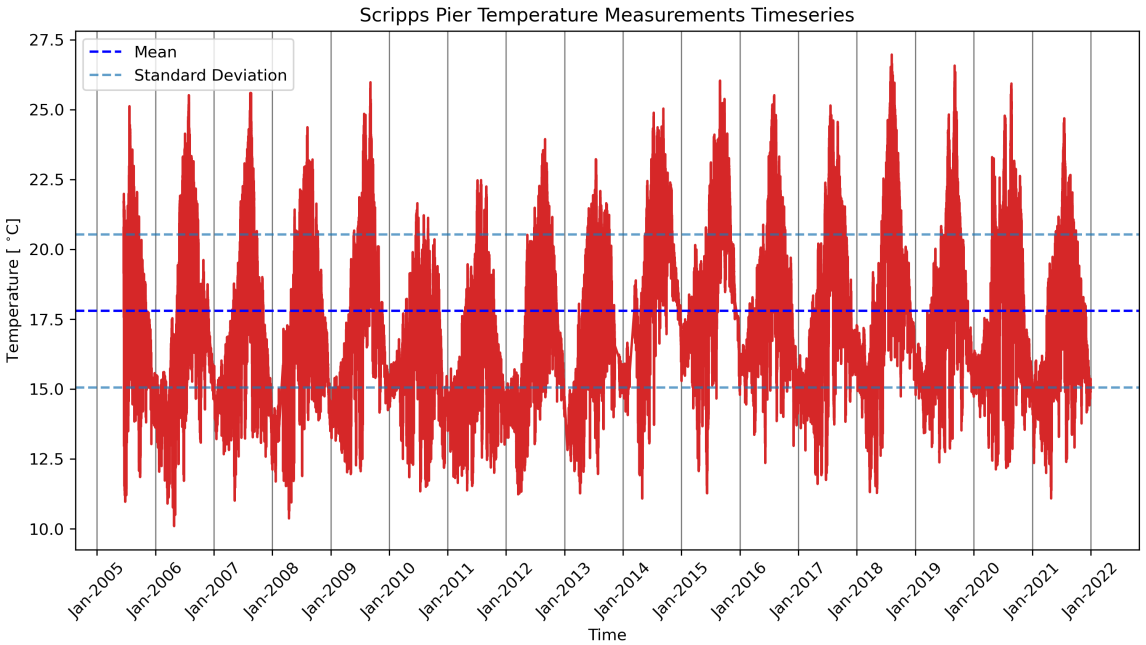
In [49]:

```
# physically, doesn't make sense to find anything over 50 deg in the oce

SP.temp[SP.temp>50] = np.nan
temp[temp>50] = np.nan # also saving as temp because for some reason mat


temp_mean = np.nanmean(SP.temp)
temp_std = np.std(SP.temp)
```

```
/tmp/ipykernel_132401/3622008675.py:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-do
cs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  SP.temp[SP.temp>50] = np.nan
```

In [50]:

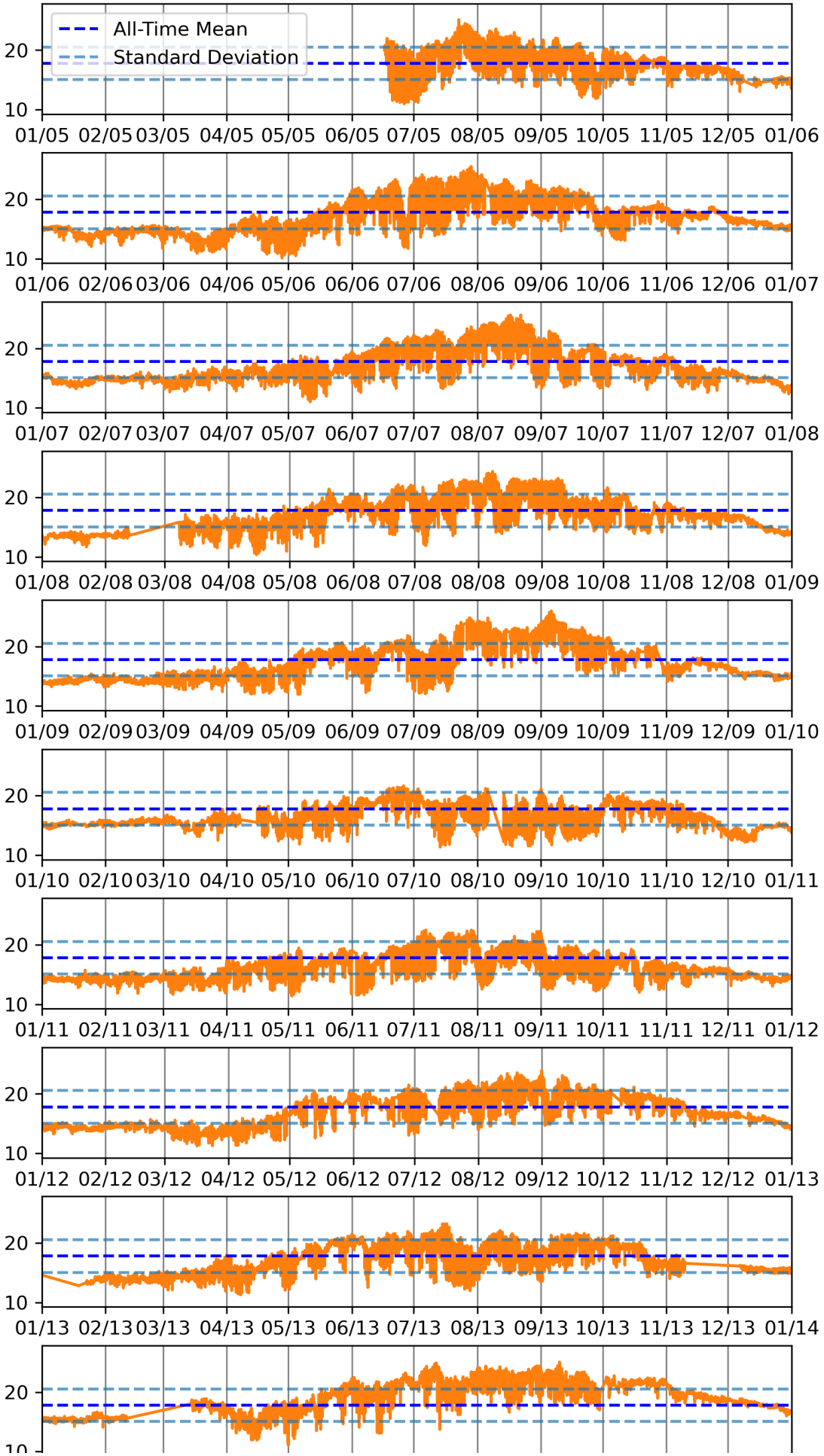
```
fig,ax = plt.subplots(1,1,figsize=(12,6),dpi=300)
ax.plot(dates,temp,color='tab:red')
m = ax.axhline(y=temp_mean,linestyle='--',color='blue',label='Mean');
s1 = ax.axhline(y=temp_mean+temp_std,linestyle='--',color='tab:blue',alpl
s2 = ax.axhline(y=temp_mean-temp_std,linestyle='--',color='tab:blue',alpl
ax.xaxis.set_major_formatter(mdates.DateFormatter('%b-%Y')) # b is short
ax.xaxis.set_major_locator(mdates.YearLocator())
ax.tick_params(axis='x',rotation=45)
ax.set(title='Scripps Pier Temperature Measurements Timeseries',xlabel='
ax.grid(which='major',axis='x',color='tab:gray')
handles = ['Mean','Standard Deviation']
ax.legend([m,s2],handles,loc='best')
plt.show()
```

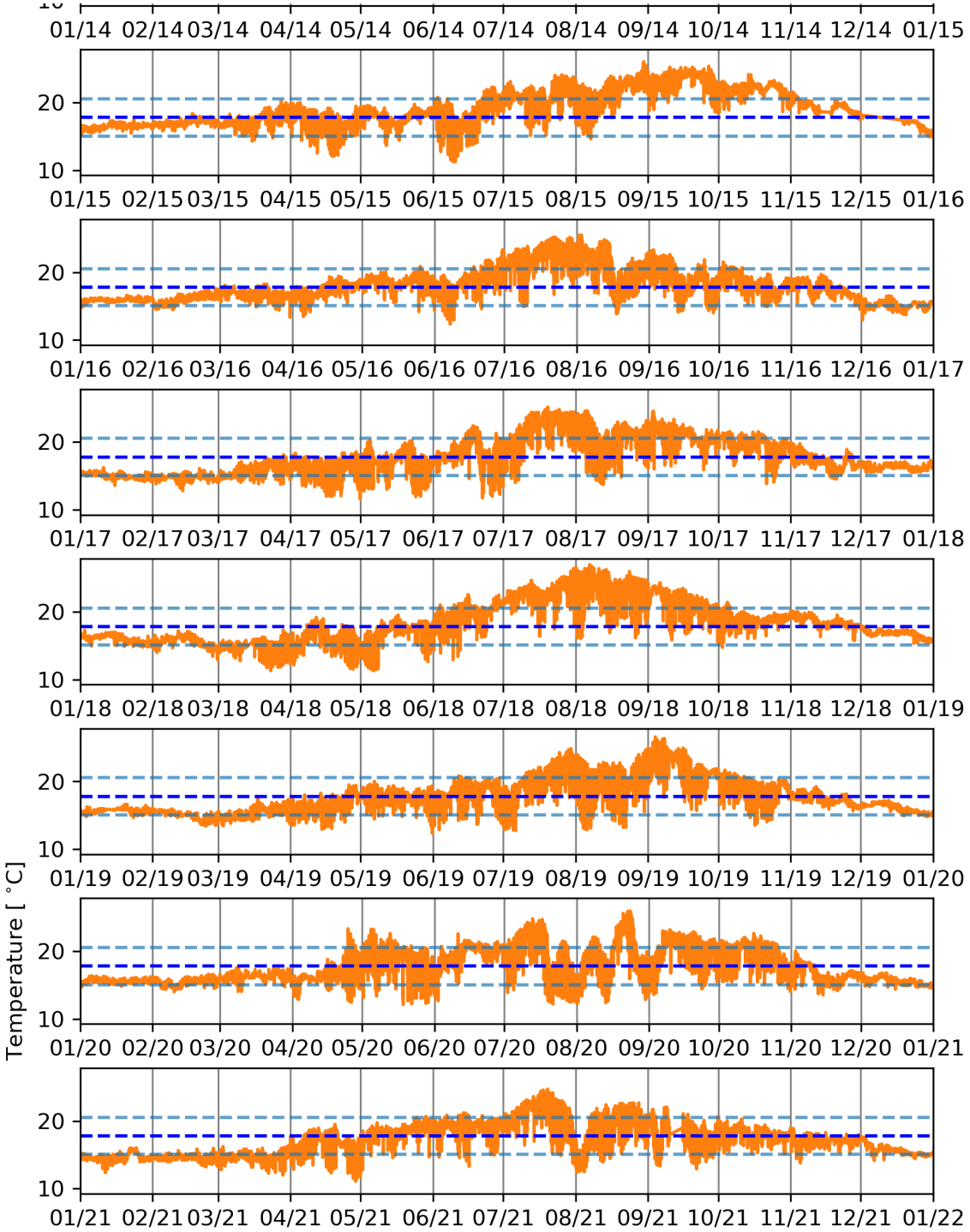


In [55]:

```
# now plotting every year to look more closely at trends:

num_yr = len(years);

fig,ax = plt.subplots(figsize=(6,20),dpi=300)
plt.suptitle('Scripps Pier Temperature Measurements Timeseries',fontweigl
aa = 0;
for num,yr in enumerate(years):
    aa = aa + 1;
    ax = plt.subplot(num_yr,1,aa)
    ax.plot(dates,temp,color='tab:orange')
    ax.set_xlim([dt.datetime(yr,1,1), dt.datetime(yr+1,1,1)])
    m = ax.axhline(y=temp_mean,linestyle='--',color='blue',label='All-Ti
    s1 = ax.axhline(y=temp_mean+temp_std,linestyle='--',color='tab:blue'
    s2 = ax.axhline(y=temp_mean-temp_std,linestyle='--',color='tab:blue'
    ax.xaxis.set_major_formatter(mdates.DateFormatter('%m/%y')) # b is s
    ax.xaxis.set_major_locator(mdates.MonthLocator())
    if aa == num_yr-1:
        ax.set(xlabel='Time',ylabel=r'Temperature [ $ ^{\circ} $C]')
    ax.grid(which='major',axis='x',color='tab:gray')
    handles = ['All-Time Mean','Standard Deviation']
    if aa == 1:
        ax.legend([m,s2],handles,loc='best')

plt.subplots_adjust(left=0.05,
                    bottom=0.05,
                    right=0.95,
                    top=0.95,
                    wspace=0.1,
                    hspace=0.35)

plt.show()
```

Scripps Pier Temperature Measurements Timeseries





Q's: What do you observe in these results? In what ways are the 2021 results different from the 2005-2021 results? Is 2021 unusual? Is the sharp temperature change in August 2016 unusual?

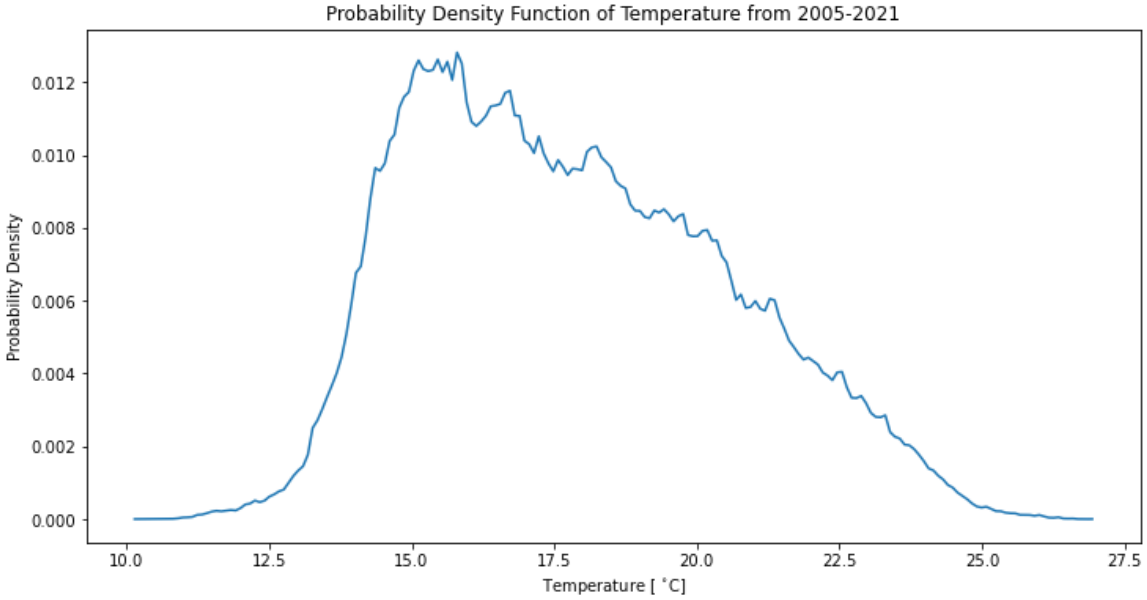
2021 doesn't look especially unusual. A few other years have a drop in temperature during August/around August or later. The overall climatology looks pretty similar, where there is the most variability in the summer and less in the winter.

The 2021 reuslts are different because on average the temperatures seem higher than preceding years, especially those in the beginning of the dataset (closer to 2005)

those in the beginning of the dataset (closer to 2005).

In [57]:

```
# part c: empirical probability density function

[num_bin,bin_edges] = np.histogram(SP.temp[~np.isnan(SP.temp)],bins=200)

mid_bins = (bin_edges[1:]+bin_edges[0:-1])/2

fig,ax = plt.subplots(1,1,figsize=(12,6))
plt.plot(mid_bins,num_bin/sum(num_bin))
ax.set_title('Probability Density Function of Temperature from 2005-2021
ax.set_xlabel(r'Temperature [ $^{\circ} $C]'); ax.set_ylabel('Probabilit
plt.show()
```



The PDF of the 2005-2021 data looks more like a Gaussian distribution than the 2021 dataset, but it looks like there is some skew to the data - where the higher temperatures fall off more slowly versus the colder temperatures fall off more steeply.