# SIO221A

# Problems Week 2


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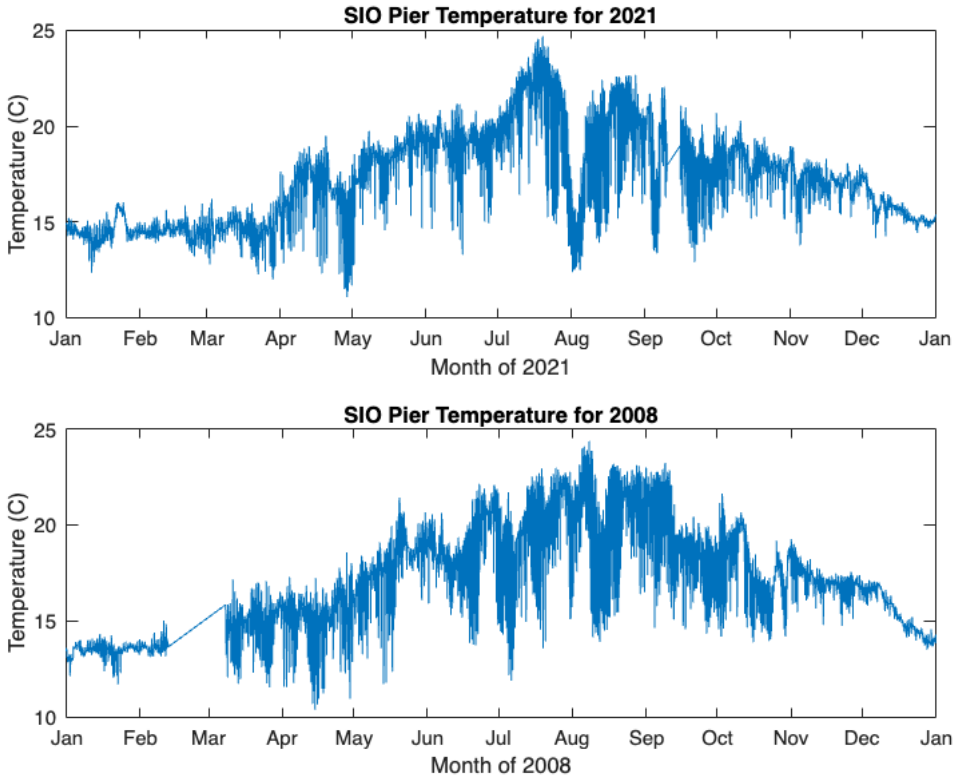
```
clear
close all
```

## 1. Visual evaluation

```
% Create reference date for time vector
date0 = datenum(1970,1,1);

% Load data
SIO_Pier_2021.time = double(ncread('http://sccoos.org/thredds/dodsC/autoss/scripps_pier-2021.nc','time'))/3600/24+date0;
SIO_Pier_2021.temperature = ncread('http://sccoos.org/thredds/dodsC/autoss/scripps_pier-2021.nc','temperature');
SIO_Pier_2021.pressure = ncread('http://sccoos.org/thredds/dodsC/autoss/scripps_pier-2021.nc','pressure');

SIO_Pier_2008.time = double(ncread('http://sccoos.org/thredds/dodsC/autoss/scripps_pier-2008.nc','time'))/3600/24+date0;
SIO_Pier_2008.temperature = ncread('http://sccoos.org/thredds/dodsC/autoss/scripps_pier-2008.nc','temperature');
SIO_Pier_2008.pressure = ncread('http://sccoos.org/thredds/dodsC/autoss/scripps_pier-2008.nc','pressure');
```

Plot temperature vs time for 2021 and 2008

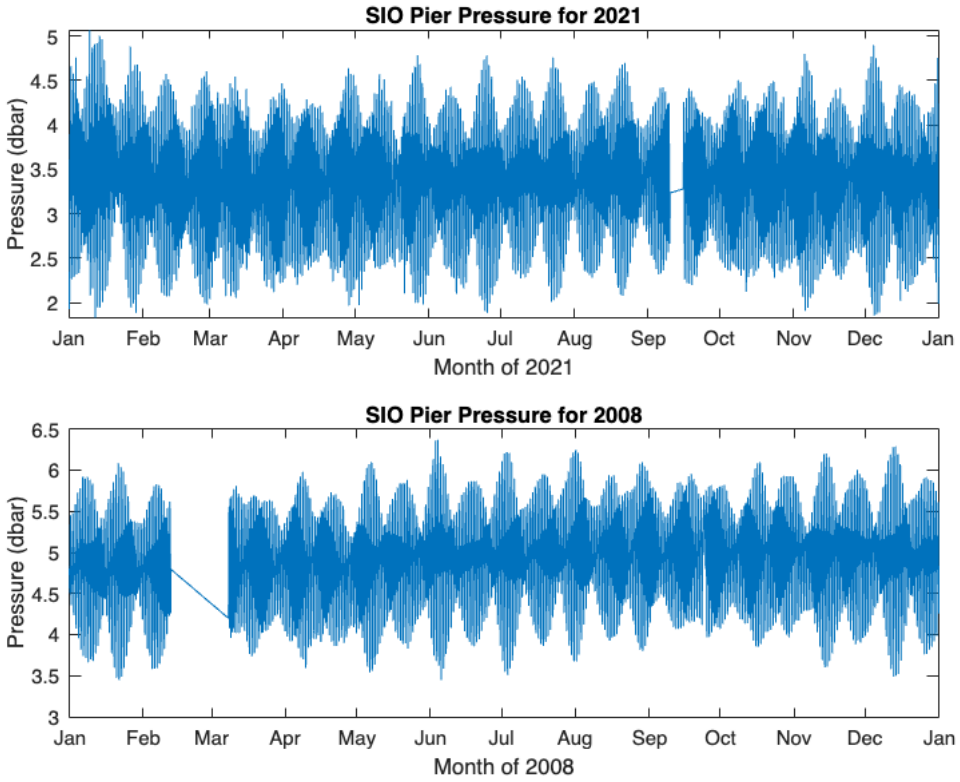
```
figure(101)
subplot(211)
plot(SIO_Pier_2021.time,SIO_Pier_2021.temperature)
datetick('x','mmm')
ylabel('Temperature (C)')
xlabel('Month of 2021')
title('SIO Pier Temperature for 2021')

subplot(212)
plot(SIO_Pier_2008.time,SIO_Pier_2008.temperature)
datetick('x','mmm')
ylabel('Temperature (C)')
xlabel('Month of 2008')
title('SIO Pier Temperature for 2008')
```




2021 and 2008 data are covered. The shapes of the annual SSTs are quite similar. 2008 data seems to have more oscillations in July, August, and September than 2021. Also January, Feburary SST of 2008 is a little bit lower than 2021.

Plot pressure vs time for 2021 and 2008

```
figure(102)
subplot(211)
plot(SIO_Pier_2021.time,SIO_Pier_2021.pressure)
datetick('x','mmm')
ylabel('Pressure (dbar)')
xlabel('Month of 2021')
title('SIO Pier Pressure for 2021')

figure(102)
subplot(212)
plot(SIO_Pier_2008.time,SIO_Pier_2008.pressure)
datetick('x','mmm')
ylabel('Pressure (dbar)')
xlabel('Month of 2008')
title('SIO Pier Pressure for 2008')
```




The pressure data of 2021 and 2008 are very different from each other, which surprise me. The 2021 pressure have a range of 2 to 5 dbar, while for 2008 pressure is 4 to dbar.

## 2. Means

```
stats_mean_2021 = stats_mean(SIO_Pier_2021.temperature,SIO_Pier_2021.pressure);
stats_mean_2008 = stats_mean(SIO_Pier_2008.temperature,SIO_Pier_2008.pressure);
```

```
display('Temperature - 2021:')
```

```
Temperature - 2021:
```

```
display(['Mean ± standard error: ',num2str(stats_mean_2021(1,1)), ' ± ', num2str(stats_mean_2021(1,3)),'°C'])
```

```
Mean ± standard error: 17.274 ± 0.0067464°C
```

```
display('Temperature - 2008:')
```

```
Temperature - 2008:
```

```
display(['Mean ± standard error: ',num2str(stats_mean_2008(1,1)), ' ± ', num2str(stats_mean_2008(1,3)),'°C'])
```

```
Mean ± standard error: 17.1388 ± 0.0108°C
```

```
display('Pressure - 2021:')
```

```
Pressure - 2021:
```

```
display(['Mean ± standard error: ',num2str(stats_mean_2021(1,2)), ' ± ', num2str(stats_mean_2021(1,4)),'°C'])
```

```
Mean ± standard error: 3.3561 ± 0.0014123°C
```

```
display('Pressure - 2008:')
```

```
Pressure - 2008:
```

```
display(['Mean ± standard error: ',num2str(stats_mean_2008(1,2)), ' ± ', num2str(stats_mean_2021(1,4)),'°C'])
```

```
Mean ± standard error: 4.9021 ± 0.0014123°C
```

The mean SST and pressure between 2008 and 2021 are both **not** consistent within error bars.

## Subsample (Once per Day)

```
SIO_Pier_2021.temperature_daily = downsample((SIO_Pier_2021.temperature),360);
SIO_Pier_2021.pressure_daily = downsample((SIO_Pier_2021.pressure),360);

SIO_Pier_2008.temperature_daily = downsample((SIO_Pier_2008.temperature),360);
SIO_Pier_2008.pressure_daily = downsample((SIO_Pier_2021.pressure),360);
```

```
stats_mean_2021_sub = stats_mean(SIO_Pier_2021.temperature_daily, SIO_Pier_2021.pressure_daily);
stats_mean_2008_sub = stats_mean(SIO_Pier_2008.temperature_daily, SIO_Pier_2008.pressure_daily);
```

```
display('Temperature - 2021:')
```

```
Temperature - 2021:
```

```
display(['Mean ± standard error: ',num2str(stats_mean_2021_sub(1,1)), ' ± ', num2str(stats_mean_2021_sub(1,3)),'°C'])
```

```
Mean ± standard error: 17.5467 ± 0.1261°C
```

```
display('Temperature - 2008:')
```

```
Temperature - 2008:
```

```
display(['Mean ± standard error: ',num2str(stats_mean_2008_sub(1,1)), ' ± ', num2str(stats_mean_2008_sub(1,3)),'°C'])
```

```
Mean ± standard error: 16.8757 ± 0.1905°C
```

```
display('Pressure - 2021:')
```

```
Pressure - 2021:
```

```
display(['Mean ± standard error: ',num2str(stats_mean_2021_sub(1,2)), ' ± ', num2str(stats_mean_2021_sub(1,4)),'°C'])
```

```
Mean ± standard error: 3.4613 ± 0.029095°C
```

```
display('Pressure - 2008:')
```

```
Pressure - 2008:
```

```
display(['Mean ± standard error: ',num2str(stats_mean_2008_sub(1,2)), ' ± ', num2str(stats_mean_2021_sub(1,4)),'°C'])
```

```
Mean ± standard error: 3.4613 ± 0.029095°C
```

After subsampling the data once per day (N decreases and standard deviation increases), the mean pressure between 2008 and 2021 now become consistent within error bars, but the mean SST between the two years are still not consistent within error bars.

## 3. Variance

```
stats_var_2021 = stats_variance(SIO_Pier_2021.temperature,SIO_Pier_2021.pressure);
stats_var_2008 = stats_variance(SIO_Pier_2008.temperature,SIO_Pier_2008.pressure);
```

```
display('Temperature - 2021:')
```

```
Temperature - 2021:
```

```
display(['Variance ± standard error: ',num2str(stats_var_2021(1,1)), ' ± ', num2str(stats_var_2021(1,3)),'°C'])
```

```
Variance ± standard error: 5.8824 ± 0.02314°C
```

```
display('Temperature - 2008:')
```

```
Temperature - 2008:
```

```
display(['Variance ± standard error: ',num2str(stats_var_2008(1,1)), ' ± ', num2str(stats_var_2008(1,3)),'°C'])
```

```
Variance ± standard error: 7.1457 ± 0.040828°C
```

```
display('Pressure - 2021:')
```

```
Pressure - 2021:
```

```
display(['Variance ± standard error: ',num2str(stats_var_2021(1,2)), ' ± ', num2str(stats_var_2021(1,4)),'°C'])
```

```
Variance ± standard error: 0.25777 ± 0.001014°C
```

```
display('Pressure - 2008:')
```

```
Pressure - 2008:
```

```
display(['Variance ± standard error: ',num2str(stats_var_2008(1,2)), ' ± ', num2str(stats_var_2021(1,4)),'°C'])
```

```
Variance ± standard error: 0.25984 ± 0.001014°C
```

The SST variance between 2008 and 2021 are **not** consistent within error bars. But the pressure variance between 2008 and 2021 are consistent within error bars.

## Subsample (Once per Day)

```
stats_var_2021_sub = stats_variance(SIO_Pier_2021.temperature_daily, SIO_Pier_2021.pressure_daily);
stats_var_2008_sub = stats_variance(SIO_Pier_2008.temperature_daily, SIO_Pier_2008.pressure_daily);
```

```
display('Temperature - 2021:')
```

```
Temperature - 2021:
```

```
display(['Variance  ± standard error: ',num2str(stats_var_2021_sub(1,1)), ' ± ', num2str(stats_var_2021_sub(1,3)),'°C'])
```

```
Variance  ± standard error: 5.7241 ± 0.42724°C
```

```
display('Temperature - 2008:')
```

```
Temperature - 2008:
```

```
display(['Variance  ± standard error: ',num2str(stats_var_2008_sub(1,1)), ' ± ', num2str(stats_var_2008_sub(1,3)),'°C'])
```

```
Variance  ± standard error: 6.2057 ± 0.67311°C
```

```
display('Pressure - 2021:')
```

```
Pressure - 2021:
```

```
display(['Variance  ± standard error: ',num2str(stats_var_2021_sub(1,2)), ' ± ', num2str(stats_var_2021_sub(1,4)),'°C'])
```

```
Variance  ± standard error: 0.30474 ± 0.022746°C
```

```
display('Pressure - 2008:')
```

```
Pressure - 2008:
```

```
display(['Variance  ± standard error: ',num2str(stats_var_2008_sub(1,2)), ' ± ', num2str(stats_var_2021_sub(1,4)),'°C'])
```

```
Variance  ± standard error: 0.30474 ± 0.022746°C
```

The SST variance between 2008 and 2021 are **not** consistent within error bars. The pressure variance between 2008 and 2021 are still consistent within error bars.

## 4. Extreme Values

I used Charlotte's code as reference, I was struggling on this problem. I get the idea but I don't know how to code.

```
extreme_temp21 = stats_mean_2021(1,1) + 3*std(SIO_Pier_2021.temperature)
```

```
extreme_temp21 = single 24.5501
```

```
extreme_temp08 = stats_mean_2008(1,1) + 2*std(SIO_Pier_2008.temperature)
```

```
extreme_temp08 = single 22.4851
```

```
[num_per_bin_temp21,bins_temp21]=hist(SIO_Pier_2021.temperature,1000);
[num_per_bin_temp08,bins_temp08]=hist(SIO_Pier_2008.temperature,1000);
PDF_temp21 = num_per_bin_temp21./sum(num_per_bin_temp21);
PDF_temp08 = num_per_bin_temp08./sum(num_per_bin_temp08);
CDF_temp21 = cumtrapz(PDF_temp21);
CDF_temp08 = cumtrapz(PDF_temp08);

prob_3sig_temp21 = 1-CDF_temp21(find(bins_temp21>extreme_temp21,1,'first'));
prob_2sig_temp08 = 1-CDF_temp08(find(bins_temp08>extreme_temp08,1,'first'));

disp(['For the 2021 observed PDF, the likelihood of an extreme temperature event 3 sigma greater than the mean is:', num2str(p
```

```
For the 2021 observed PDF, the likelihood of an extreme temperature event 3 sigma greater than the mean is:0.0023212 %
```

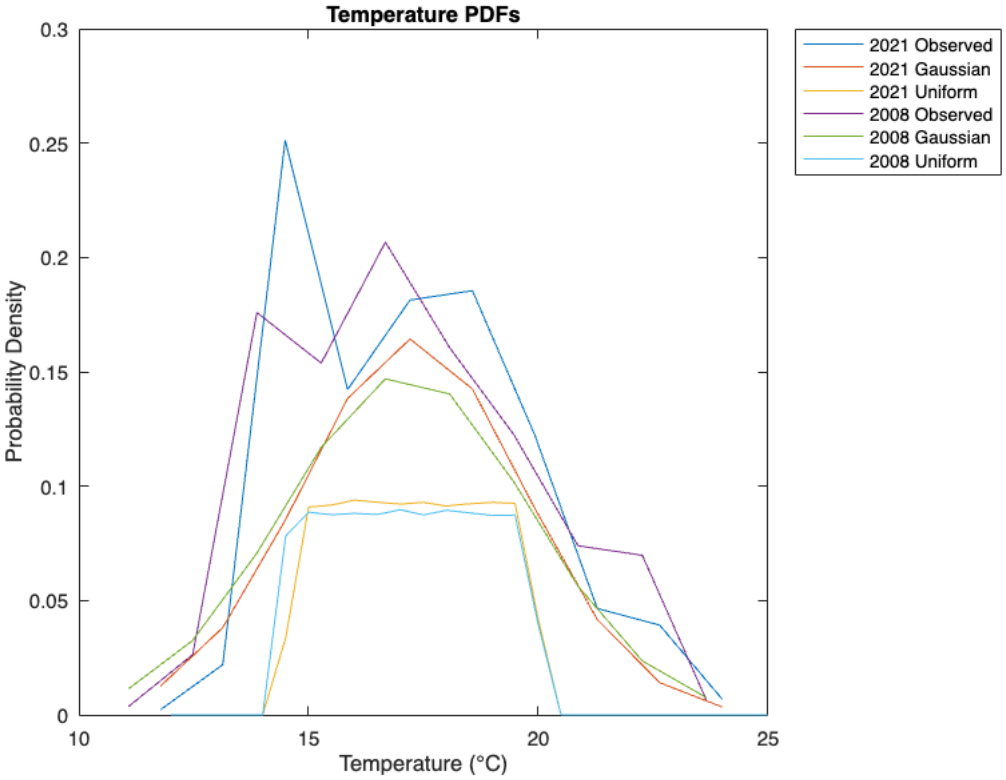
```
disp(['For the 2008 observed PDF, the likelihood of an extreme temperature event 2 sigma greater than the mean is:', num2str(p
```

```
For the 2008 observed PDF, the likelihood of an extreme temperature event 2 sigma greater than the mean is:1.9824 %
```

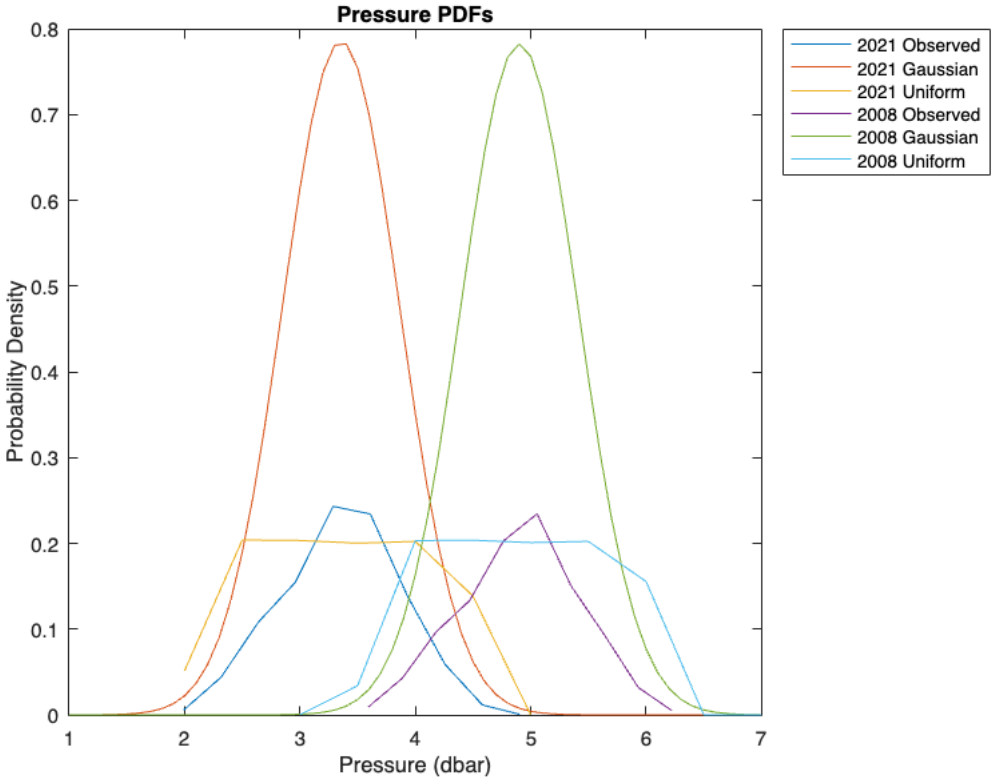
## 5. Probability Density Functions

```
%PDF - temperature
[num_per_bin_temp21,bins_temp21]=hist(SIO_Pier_2021.temperature);
[num_per_bin_temp08,bins_temp08]=hist(SIO_Pier_2008.temperature);
PDF_temp21 = num_per_bin_temp21./sum(num_per_bin_temp21);
PDF_temp08 = num_per_bin_temp08./sum(num_per_bin_temp08);

%PDF - pressure
[num_per_bin_press21,bins_press21]=hist(SIO_Pier_2021.pressure,10);
[num_per_bin_press08,bins_press08]=hist(SIO_Pier_2008.pressure,10);
PDF_press21 = num_per_bin_press21./sum(num_per_bin_press21);
PDF_press08 = num_per_bin_press08./sum(num_per_bin_press08);

%Gaussian - temperature
gauss_temp21 = 1/std(SIO_Pier_2021.temperature)/sqrt(2*pi).*exp(-(bins_temp21-stats_mean_2021(1,1)).^2 /(2*std(SIO_Pier_2021.t
gauss_temp08 = 1/std(SIO_Pier_2008.temperature)/sqrt(2*pi).*exp(-(bins_temp08-stats_mean_2008(1,1)).^2 /(2*std(SIO_Pier_2008.t

%Gaussian - pressure
bins_gauss_press21 = 1:0.1:7;
bins_gauss_press08 = 1:0.1:7;
gauss_press21 = 1/std(SIO_Pier_2021.pressure)/sqrt(2*pi).*exp(-(bins_gauss_press21-stats_mean_2021(1,2)).^2 /(2*std(SIO_Pier_2
gauss_press08 = 1/std(SIO_Pier_2008.pressure)/sqrt(2*pi).*exp(-(bins_gauss_press08-stats_mean_2008(1,2)).^2 /(2*std(SIO_Pier_2

%Uniform - temperature
uni_temp21 = (rand(100000,1)-.5)*sqrt(std(SIO_Pier_2021.temperature))/std(rand(100000,1))+stats_mean_2021(1,1);
uni_temp08 = (rand(100000,1)-.5)*sqrt(std(SIO_Pier_2008.temperature))/std(rand(100000,1))+stats_mean_2008(1,1);
[num_per_bin_temp21,bins_uni_temp21]=hist(uni_temp21, 12:0.5:25);
[num_per_bin_temp08,bins_uni_temp08]=hist(uni_temp08, 12:0.5:25);
PDF_uni_temp21 = num_per_bin_temp21 / sum(num_per_bin_temp21);
PDF_uni_temp08 = num_per_bin_temp08 / sum(num_per_bin_temp08);

%Uniform - pressure
uni_press21 = (rand(100000,1)-.5)*sqrt(std(SIO_Pier_2021.pressure))/std(rand(100000,1))+stats_mean_2021(1,2);
uni_press08 = (rand(100000,1)-.5)*sqrt(std(SIO_Pier_2008.pressure))/std(rand(100000,1))+stats_mean_2008(1,2);
[num_per_bin_press21,bins_uni_press21]=hist(uni_press21, 2:0.5:5);
[num_per_bin_press08,bins_uni_press08]=hist(uni_press08, 3:0.5:7);
PDF_uni_press21 = num_per_bin_press21 / sum(num_per_bin_press21);
PDF_uni_press08 = num_per_bin_press08 / sum(num_per_bin_press08);
```

```
clf
figure
plot(bins_temp21,PDF_temp21)
hold on
plot(bins_temp21,gauss_temp21)
plot(bins_uni_temp21,PDF_uni_temp21)
plot(bins_temp08,PDF_temp08)
plot(bins_temp08,gauss_temp08)
plot(bins_uni_temp08,PDF_uni_temp08)
title('Temperature PDFs')
xlabel('Temperature (°C)')
ylabel('Probability Density')
legend('2021 Observed','2021 Gaussian','2021 Uniform','2008 Observed','2008 Gaussian','2008 Uniform',location='northeastoutsid
```




```
figure
plot(bins_press21,PDF_press21)
hold on
plot(bins_gauss_press21,gauss_press21)
plot(bins_uni_press21,PDF_uni_press21)
plot(bins_press08,PDF_press08)
plot(bins_gauss_press08,gauss_press08)
plot(bins_uni_press08,PDF_uni_press08)
title('Pressure PDFs')
xlabel('Pressure (dbar)')
ylabel('Probability Density')
legend('2021 Observed','2021 Gaussian','2021 Uniform','2008 Observed','2008 Gaussian','2008 Uniform',location='northeastoutsid
```


Pressure PDFs
Probability Density
Pressure (dbar)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1
2
3
4
5
6
7
2021 Observed
2021 Gaussian
2021 Uniform
2008 Observed
2008 Gaussian
2008 Uniform