IRIS 2022 Seismology Skill Building Workshop OSL

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Started on	Saturday, September 10, 2022, 9:37 AM
State	Finished
Completed on	Saturday, September 10, 2022, 12:38 PM
Time taken	3 hours 1 min
Marks	19.67/31.00
Grade	**63.44** out of 100.00

Question 1
Correct
1.00 points out of 1.00
Flag question

You should start by logging into the OSL and moving to the jupyter directory. Then what do you need to do to start a new notebook and make sure it is being save with an informative name?

Select one or more:
- [x] a. Run `jupyter notebook` from the command line ✓ 1 of 3 correct
- [ ] b. Click Save
- [ ] c. Run `python` from the command line
- [x] d. Click to rename from Untitled to Spectrograms ✓ 1 of 3 correct
- [x] e. Click New, then Click iris ✓ 1 of 3 correct
- [ ] f. Click iris, then Click New

Check

Correct
Marks for this submission: 1.00/1.00.

Question 2
Correct
1.00 points out of 1.00
Flag question

Change the first cell to a Markdown type, and then add some text introducing that this notebook will be showcasing how to create spectrograms of various earthquake and non-earthquake signals. Take a minute to try to write out an explanation to a fellow student about what a spectrogram is and why it is useful. Please copy and paste what you wrote in your notebook into the answer here as well.

Answer: create spectrograms of various earthquake and non-earthquake signals ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 3
Correct
1.00 points out of 1.00
Flag question

After you finish with the Markdown cell, the next cell should be a Code cell for your library imports. For this notebook, you will need matplotlib for plotting, UTCDateTime for time formatting, and ObsPy for requesting waveform data. Which of the following would be needed?

Select one or more:
- [x] a. from obspy.clients.fdsn import Client ✓ 1 of 3 correct answers. Add this to the Code cell in your Notebook and run it.
- [ ] b. from obspy.Clients.fdsn import client
- [x] c. import matplotlib.pyplot as plt ✓ 1 of 3 correct answers. Add this to the Code cell in your Notebook and run it.
- [x] d. from obspy import UTCDateTime ✓ 1 of 3 correct answers. Add this to the Code cell in your Notebook and run it.
- [ ] e. from matplotlib import plot
- [ ] f. import UTCDateTime as UTCDateTime

Check

Correct
Marks for this submission: 1.00/1.00.

Question 4
Partially correct
0.67 points out of 1.00
Flag question

Make sure you added the correct answers from the previous question to your Code cell and run it to import the functions we will need. Next create a Markdown cell to describe that the first spectrogram examples we will consider are a comparison of an earthquake and an explosion with similar energy release (magnitude ~ 3) from a similar location. We will examine the IU.TUC.00.BHZ recordings for these events, which are available from the IRIS data center. Which of the following would be needed to define variables for these request parameters?

Select one or more:
- [ ] a. station = "BHZ"
- [x] b. channel = "BHZ" ✓ 1 of 5 correct answers.
- [x] c. station = "TUC" ✓ 1 of 5 correct answers.
- [x] d. client = Client("IRIS") ✓ 1 of 5 correct answers.
- [ ] e. network = "TUC"
- [x] f. network = "IU" ✓ 1 of 5 correct answers.
- [ ] g. channel = "00"
- [ ] h. Client = client("IRIS")
- [ ] i. location = "IU"
- [ ] j. location = "00"

Check

Partially correct
Marks for this submission: 0.80/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 5
Correct
0.67 points out of 1.00
Flag question

If you haven't already done so, you should create a Code cell and put the correct answers from the previous question into this cell. You don't need to run it yet, because there are more parameters to add to it.

We will first examine data from an earthquake near the Arizona-New Mexico border starting at 06:15:50 UTC time on July 11, 2014. Which of the following would properly set the start and end times for 2 minutes of data in the correct format for an ObsPy client waveform request?

Select one or more:
- [x] a. endt = UTCDateTime("2014-07-11T06:17:50") ✓ 1 of 2 correct answers. Add this to the Code cell in your Notebook but you don't need to run it yet.
- [ ] b. startt = UTCDateTime("July 11, 2014 06:17:50")
- [ ] c. startt = UTCDateTime("July 11, 2014 06:15:50")
- [ ] d. endt = UTCDateTime("July 11, 2014 06:15:52")
- [ ] e. startt = UTCDateTime("2014-07-11T06:17:50")
- [ ] f. endt = UTCDateTime("2014-07-11T06:15:52")
- [x] g. startt = UTCDateTime("2014-07-11T06:15:50") ✓ 1 of 2 correct answers. Add this to the Code cell in your Notebook but you don't need to run it yet.
- [ ] h. endt = UTCDateTime("July 11, 2014 06:17:50")

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 6
Correct
0.67 points out of 1.00
Flag question

Which of the following would be needed to retrieve the seismogram using these parameters and store it in a Stream object named st?

Select one or more:
- [ ] a. get_waveforms(
- [x] b. st = ✓ 1 of 8 answers
- [ ] c. starttime=startt,
- [ ] d. location=location,
- [ ] e. network=network,
- [x] f. client.get_waveforms(✓ 1 of 8 answers

- [ ] g. channel=channel,
- [x] h. endt) ✓ 1 of 8 answers
- [ ] i. endtime=endt)
- [x] j. location, ✓ 1 of 8 answers
- [x] k. station, ✓ 1 of 8 answers
- [x] l. channel, ✓ 1 of 8 answers
- [ ] m. station=station,
- [x] n. network, ✓ 1 of 8 answers
- [x] o. startt, ✓ 1 of 8 answers

Check

Correct, if you have not done so already, add this to the end of your code cell st = client.get_waveforms(network, station, location, channel, startt, endt)

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 7

Correct

0.00 points out of 1.00

Flag question

After you have run the Code cell to request the seismogram, you can add a short Markdown cell to explain that you will extract a seismic trace from the stream you just downloaded and then you will plot the trace.

How would you extract a Trace object called **tr** from the Stream object **st** we just downloaded?

Select one:

- [ ] a. tr.trace(st)
- [ ] b. tr.st[0]
- [ ] c. st[0]
- [ ] d. tr = st.trace()
- [x] e. tr = st[0] ✓ Correct. Add this to a new Code cell in your Notebook and run it.
- [ ] f. st.trace()

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Question 8

Correct

0.00 points out of 1.00

Flag question

If you haven't already, start a new Code cell for the correct answer from the previous question. Then we need to plot the seismogram, and I would suggest this format for the plotting command:

```
fig = tr.plot()
```

Using the`fig =`prefix ensures that a single plot will appear in your Jupyter notebook when you run the cell. So go ahead and run the cell now to see what the seismogram looks like. Hopefully you will see a fairly simple seismogram for this earthquake. What is the S-P (S minus P) time in seconds for this earthquake?

Answer: 20 ✓

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Question 9

Correct

0.67 points out of 1.00

Flag question

The next piece of code you will enter into your Notebook will enable you to plot a spectrogram for this earthquake. First, I am going to recommend a change to the figsize parameter for matplotlib with this command:

```
plt.rcParams['figure.figsize'] = (12, 4)
```

This will ensure that the spectrogram is approximately the same size as the seismogram you just plotted. I find the default size of the spectrogram plot to be too short, so this command sets the plot to be 12 inches wide and 4 inches tall.

Next we will use the spectrogram() function from ObsPy, which you can read about here:

https://docs.obspy.org/packages/autogen/obspy.imaging.spectrogram.spectrogram.html

Most of my colleagues prefer the percent overlap of the sliding window to be 50%, so we will need to specify that parameter when we call this function. And the window length is an important parameter that should be defined based on the time duration of the signal you are interested in. I will recommendations for this during the assignment, and I would recommend a window length of 2 seconds for this seismogram.

Which of the following commands would plot a spectrogram of the trace with these parameters?

Select one:

- [ ] a. fig = tr.spectrogram(per_lap=50, wlen=2)
- [x] b. fig = tr.spectrogram(per_lap=.5, wlen=2) ✓
- [ ] c. fig = tr.spectrogram(per_lap=.5, window=2)
- [ ] d. fig = st.spectrogram(percent=50, wlen=2)
- [ ] e. fig = st.spectrogram(per_lap=.5, wlen=2)
- [ ] f. fig = tr.spectrogram(percent=50, window=2)
- [ ] g. fig = st.spectrogram(percent=.5, wlen=2)
- [ ] h. fig = st.spectrogram(per_lap=50, window=2)
- [ ] i. fig = st.spectrogram(percent=.5, window=2)
- [ ] j. fig = tr.spectrogram(percent=.5, window=2)

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 10

Correct

1.00 points out of 1.00

Flag question

Make sure you have added the correct answer from the previous question to the Code cell in your Notebook and run it. What does the spectrogram look like? Take a minute to try to write out a description to a fellow student about the patterns you see in the spectrogram and what you think is important. Please copy and paste what you wrote in your notebook into the answer here as well.

Answer: Its purple and yellowish colored plot in which we cna see traces. ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 11

Correct

0.67 points out of 1.00

Flag question

Now assess: Which of the following are true about the spectrogram?

Select one or more:

- [x] a. The energy starts abruptly in time. ✓ 1 of 3 correct answers
- [ ] b. The energy stops abruptly in time.
- [x] c. An abrupt burst (<10 s) of energy can be seen across almost all observed frequencies (between 1 and 9 Hz). ✓ 1 of 3 correct answers
- [ ] d. An abrupt burst (<10 s) of energy can be seen on frequencies less than 5 Hz.
- [x] e. The energy stops gradually over time. ✓ 1 of 3 correct answers
- [ ] f. There is sustained energy strongest at a particular frequency that gradually glides from lower to higher frequencies over time.
- [ ] g. The sustained energy pattern is repeated at higher frequencies that represent harmonic resonance.
- [ ] h. There is sustained energy strongest at a particular frequency that gradually glides from higher to lower frequencies over time.
- [ ] i. The energy starts gradually over time.

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 12

Correct

1.00 points out of 1.00

Flag question

Next we will examine a seismogram from an explosion of similar size at the same station. The time to request for this event is December 27, 1999 at 20:58:30, and you should request the same length of time as for the earthquake. Be sure to add a short Markdown cell to explain this and then add a Code cell that will set the new time and download the corresponding seismogram. Which of the following would be needed to accomplish this?

Select one or more:

- [x] a. startt = UTCDateTime("1999-12-27T20:58:30") ✓ 1 of 3 correct answers
- [x] b. st = client.get_waveforms(network, station, location, channel, startt, endt) ✓ 1 of 3 correct answers
- [x] c. endt = UTCDateTime("1999-12-27T21:00:30") ✓ 1 of 3 correct answers
- [ ] d. endt = UTCDateTime("1999-12-27T20:00:30")
- [ ] e. startt = UTCDateTime("1999-12-27T21:58:30")
- [ ] f. st = client.get_waveforms(net, sta, loc, cha, starttime, endtime)

Check

Correct
Marks for this submission: 1.00/1.00.

Question 13

Correct

1.00 points out of 1.00

Flag question

If you haven't already done so, you should create a Code cell and put the correct answers from the previous question into this cell and run it. Next you should extract the seismogram trace from the downloaded stream and plot the trace. Which of the following would accomplish this?

Select one or more:

- [ ] a. tr = st.trace()
- [ ] b. fig = plot(st)
- [ ] c. st = tr.trace()
- [x] d. tr = st[0] ✓ 1 of 2 correct answers
- [ ] e. st = tr[0]
- [ ] f. fig = plot(tr)
- [x] g. fig = tr.plot() ✓ 1 of 2 correct answers
- [ ] h. fig = st.plot()

Check

Your answer is correct.

Correct
Marks for this submission: 1.00/1.00.

Question 14

Correct

0.67 points out of 1.00

Flag question

If you haven't already done so, you should create a Code cell and put the correct answers from the previous question into this cell and run it. Hopefully you will see a fairly simple seismogram for this explosion. What is the S-P (S minus P) time in seconds for this earthquake?

Answer: 20 ✓

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 15

Correct

1.00 points out of 1.00

Flag question

Which of the following commands would plot a spectrogram of the explosion with the same parameters as for the earthquake?

Select one:

- ( ) a. fig = tr.spectrogram(percent=.5, window=2)
- ( ) b. fig = st.spectrogram(percent=.5, wlen=2)
- ( ) c. fig = st.spectrogram(per_lap=50, window=2)
- (•) d. fig = tr.spectrogram(per_lap=.5, wlen=2) ✓
- ( ) e. fig = tr.spectrogram(per_lap=50, wlen=2)
- ( ) f. fig = st.spectrogram(percent=50, wlen=2)
- ( ) g. fig = st.spectrogram(percent=.5, window=2)
- ( ) h. fig = tr.spectrogram(per_lap=.5, window=2)
- ( ) i. fig = st.spectrogram(per_lap=.5, wlen=2)
- ( ) j. fig = tr.spectrogram(percent=50, window=2)

Check

Correct
Marks for this submission: 1.00/1.00.

Question 16

Correct

0.67 points out of 1.00

Flag question

If you haven't already done so, you should create a Code cell and put the correct answers from the previous question into this cell and run it. Which of the following are true about the explosion spectrogram?

Select one or more:

- [x] a. An abrupt burst (<10 s) of energy can be seen on frequencies less than 5 Hz. ✓ 1 of 3 correct answers
- [ ] b. There is sustained strongest energy at a particular frequency that gradually glides from higher to lower frequencies over time.
- [x] c. The energy starts abruptly in time. ✓ 1 of 3 correct answers
- [ ] d. There is sustained strongest energy at a particular frequency that gradually glides from lower to higher frequencies over time.
- [ ] e. An abrupt burst (<10 s) of energy can be seen across almost all observed frequencies (between 1 and 9 Hz).
- [ ] f. The energy stops abruptly in time.
- [x] g. The energy stops gradually over time. ✓ 1 of 3 correct answers
- [ ] h. The sustained energy pattern is repeated at higher frequencies that represent harmonic resonance.
- [ ] i. The energy starts gradually over time.

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 17

Correct

0.33 points out of 1.00

Flag question

Which of the following best describes the difference between earthquake and explosion signals?

Select one:

- ( ) a. Earthquakes typically have energy restricted to frequencies lower than explosions.
- ( ) b. Earthquakes typically have energy over a narrower range of frequencies than explosions.
- (•) c. Earthquakes typically have energy over a wider range of frequencies than explosions. ✓ Correct. Although this earthquake has energy at frequencies higher than the explosion, it also has energy at the frequencies common for explosions. This highlights how it can be difficult to discern between them if only look at a narrow range of frequencies.
- ( ) d. Earthquakes typically have energy at the same range of frequencies as explosions.
- ( ) e. Earthquakes typically have energy restricted to frequencies higher than explosions.

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.33/1.00**.

Question 18

Correct

1.00 points out of 1.00

You are ready to move on to a different set of signals. In this case, you will get a chance to examine ice quakes from Antarctica. This case was described briefly in the webinar and the journal article describing these signals is available on Moodle. Take a minute to compose a Markdown cell desribing this case.

Then you can open a Code cell to make the request for the seismogram to investigate. The station parameters you should use for requesting this signal are:

Flag question

```
client = Client("IRIS")
net = "XV"
sta = "B15A"
loc = "01"
cha = "HHZ"
```

The time to request for this event is October 27, 2005 at 08:15:00, and you should request one hour of data. Be sure to add a short Markdown cell to explain this and then add a Code cell that will set the new time and download the corresponding seismogram. Which of the following would be needed to accomplish this?

Select one or more:

- [ ] a. startt = UTCDateTime("2005-10-27T09:15:00")
- [ ] b. tr = client.get_waveforms(network, station, location, channel, startt, endt)
- [x] c. endt = UTCDateTime("2005-10-27T09:15") ✓ 1 of 3 correct answers
- [ ] d. endt = UTCDateTime("2005-10-27T10:15:00")
- [ ] e. startt = UTCDateTime("2005-09-27T09:15:00")
- [ ] f. st = client.get_waveforms(network, station, location, channel, startt, endt)
- [x] g. startt = UTCDateTime("2005-10-27T08:15") ✓ 1 of 3 correct answers
- [x] h. st = client.get_waveforms(net, sta, loc, cha, startt, endt) ✓ 1 of 3 correct answers
- [ ] i. tr = client.get_waveforms(net, sta, loc, cha, starttime, endtime)
- [ ] j. endt = UTCDateTime("2005-09-27T10:15:00")

Check

Correct
Marks for this submission: 1.00/1.00.

Question 19

Correct

1.00 points out of 1.00

Flag question

Now add a Code cell to plot the seismogram using the commands you used earlier. How does this signal look different from the earthquake and explosion we looked at earlier?

Select one or more:

- [ ] a. This signal is a lot smaller than the earthquake and explosion.
- [ ] b. This signal is a lot larger than the earthquake and explosion.
- [ ] c. This signal is a lot shorter than the earthquake and explosion.
- [x] d. This signal is a lot longer than the earthquake and explosion. ✓ 1 of 2 correct answers.
- [x] e. This signal does not have clear P and S wave arrivals. ✓ 1 of 2 correct answers.
- [ ] f. This signal has easier to recognize P and S wave arrivals.

Check

Correct
Marks for this submission: 1.00/1.00.

Question 20

Correct

0.67 points out of 1.00

Flag question

Now add a Code cell to plot the spectrogram using the commands you used earlier, but since this seismogram is so much longer, use a window length of 25 seconds this time. What does the spectrogram look like? (Hint: look closely!)

Select one:

- ( ) a. A small amount of energy in multiple, clearly-seen horizontal lines at the bottom of the plot
- ( ) b. No energy at all
- ( ) c. Energy that gradually glides from lower to higher frequencies over time
- ( ) d. An abrupt burst (<10 s) of energy can be seen across almost all observed frequencies.
- ( ) e. Energy that gradually glides from higher to lower frequencies over time
- ( ) f. An abrupt burst (<10 s) of energy can be seen on frequencies less than 5 Hz.
- (•) g. A very small amount of energy in a thin line at the bottom of the plot ✓

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 21

Correct

1.00 points out of 1.00

Flag question

Trying to get the color scale to best represent the range of energy we want to investigate is a common issue with spectrograms, so the default plot settings of the ObsPy spectrogram() function often do not work well. Fortunately, we can adjust the matplotlib figure with a few commands. The main thing we want to do is change the range of amplitudes shown in the spectrogram. If we change the maximum value of the amplitude range, we will see more small-scale variations in our spectrogram. To know how to change the maximum value, we need to print the limits of the color range, and it takes a few steps to do this:

```
fig = tr.spectrogram(show=False, per_lap=.5, wlen=25)
ax = fig.axes[0]
im = ax.images[0]
print(im.get_clim())
```

I know it's a little confusing, but the first 3 commands are creating a figure object (stored as **fig**), extracting the plot (axes, stored as **ax**), and then extracting the image inside the plot (stored as **im**). That last command prints the limits of the color range (clim). What is the maximum value of the color range?

Answer: 8985.243403218552 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 22

Correct

1.00 points out of 1.00

Flag question

Let's try setting the maximum value of the color range to be an order of magnitude smaller, so focusing on the lower 10% of the amplitude variations. This set of commands should accomplish this:

```
fig = tr.spectrogram(show=False, per_lap=.5, wlen=25)
ax = fig.axes[0]
im = ax.images[0]
im.set_clim(vmax=800)
```

What does the spectrogram look like when you apply this?

Select one:

- ( ) a. Energy that gradually glides from higher to lower frequencies over time
- ( ) b. An abrupt burst (<10 s) of energy can be seen across almost all observed frequencies.
- ( ) c. A very small amount of energy in a thin line at the bottom of the plot
- ( ) d. Energy that gradually glides from lower to higher frequencies over time
- ( ) e. An abrupt burst (<10 s) of energy can be seen on frequencies less than 5 Hz.
- ( ) f. No energy at all
- (•) g. A small amount of energy in several thin horizontal lines at the bottom of the plot ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 23

Correct

0.67 points out of 1.00

Flag question

We can make an additional adjustment to just show a particular range of frequencies:

```
fig = tr.spectrogram(show=False, per_lap=.5, wlen=25)
ax = fig.axes[0]
ax.set_ylim(0.5, 8)
im = ax.images[0]
im.set_clim(vmax=800)
```

Which of the following describe the spectrogram?

Select one or more:

- [x] a. The sustained energy pattern is repeated at higher frequencies that represent harmonic resonance. ✓ 1 of 4 correct answers

b. The energy stops gradually over time.

c. There is sustained energy strongest at a particular frequency that gradually glides from higher to lower frequencies over time.

d. There is sustained energy strongest at a particular frequency that gradually glides from lower to higher frequencies over time. ✓ 1 of 4 correct answers

e. The energy stops abruptly in time. ✓ 1 of 4 correct answers

f. An abrupt burst (<10 s) of energy can be seen on frequencies less than 5 Hz.

g. The energy starts abruptly in time. ✓ 1 of 4 correct answers

h. An abrupt burst (<10 s) of energy can be seen across almost all observed frequencies (between 1 and 9 Hz).

i. The energy starts gradually over time.

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question 24

Correct

0.33 points out of 1.00

Flag question

You are ready to move on to our last set of signals to review. In this case, you will get a chance to examine the effects of the 2002 Magnitude 7.8 Denali earthquake on the San Andreas Fault. Take a minute to compose a Markdown cell describing this before you start the code.

Then open a Code cell to make the request for the seismogram to investigate. The station parameters you should use for requesting this signal are:

```
client = Client("NCEDC")
net = "BK"
sta = "PKD"
loc = ""
cha = "HHE"
startt = UTCDateTime("2002-11-03T22:18")
endt = UTCDateTime("2002-11-03T22:41")
```

You should note that we are using a different Client for this recording, as the data for the PKD station along the San Andreas Fault is hosted by the Northern California Earthquake Data Center (NCEDC). Now that you have set the parameters, make sure to add commands for requesting the waveform stream, extracting the trace, and then plot the seismogram. How does this signal look different from the earthquake and explosion we looked at earlier?

Select one or more:

a. This signal is a lot smaller than the earthquake and explosion.

b. This signal is a lot shorter than the earthquake and explosion.

c. This signal does not have clear P and S wave arrivals. ✓ 1 of 3 correct answers.

d. This signal has easier to recognize P and S wave arrivals.

e. This signal is a lot larger than the earthquake and explosion. ✓ 1 of 3 correct answers.

f. This signal is a lot longer than the earthquake and explosion. ✓ 1 of 3 correct answers.

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.33/1.00**.

Question 25

Correct

1.00 points out of 1.00

Flag question

Since this is a shorter seismogram than the ice quake example, we will use a smaller window length when generating the spectrogram:

```
fig = tr.spectrogram(per_lap=.5, wlen=10)
```

What does this spectrogram look like?

Select one:

a. Energy that gradually glides from higher to lower frequencies over time

b. Several horizontal lines of energy at the bottom of the plot

c. A series of short energy bursts at frequencies lower than 1 Hz.

d. Very little or no energy at all ✓

e. A series of short energy bursts at frequencies higher than 1 Hz.

f. An abrupt burst (<10 s) of energy can be seen on frequencies less than 5 Hz.

g. An abrupt burst (<10 s) of energy can be seen across almost all observed frequencies.

h. Energy that gradually glides from lower to higher frequencies over time

Check

Correct
Marks for this submission: 1.00/1.00.

Question 26

Correct

0.00 points out of 1.00

Flag question

The lack of useful energy to interpret in this plot may be due to the linear scale we are using since the seismogram appears to have low frequency waves in it. We can adjust the spectrogram to use a log scale for frequencies like this:

```
fig = tr.spectrogram(per_lap=.5, wlen=10, log=True)
```

What does this spectrogram look like?

Select one:

a. An abrupt burst (<10 s) of energy can be seen across almost all observed frequencies.

b. A series of short energy bursts at frequencies lower than 1 Hz. ✓

c. No energy at all

d. A series of short energy bursts at frequencies higher than 1 Hz.

e. Energy that gradually glides from lower to higher frequencies over time

f. Energy that gradually glides from higher to lower frequencies over time

g. An abrupt burst (<10 s) of energy can be seen on frequencies less than 5 Hz.

h. A small amount of energy in several thin horizontal lines at the bottom of the plot

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Question 27

Correct

0.00 points out of 1.00

Flag question

The energy at low frequencies from the surface waves of such a larger earthquake are too big to see anything at high frequency. For example, we cannot see the P wave, which would have energy around 1 Hz. One way to deal with this is to change the amplitude scale to a decibel-type logarithmic system. This would bring the very large amplitudes close to the smaller amplitudes on the color scale. We can use the dbscale parameter to accomplish this:

```
fig = tr.spectrogram(show=False, per_lap=.5, wlen=10, log=True, dbscale=True)
```

Hopefully this spectrogram looks different and shows signals at a variety of different frequencies. Since P wave energy typically occurs around 1 Hz, what does this spectrogram suggest is the arrival time of the P wave in seconds along the x-axis?

Answer: 100 ✓

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Question 28

Correct

1.00 points out of 1.00

Flag question

This spectrogram should also illustrate something is going on at higher frequencies later in time that we could not see in the first log spectrogram plot. We can limit the frequency range to focus on this and go back to a linear scale instead of log:

```
fig = tr.spectrogram(show=False, per_lap=.5, wlen=10, dbscale=True)
ax = fig.axes[0]
ax.set_ylim(0, 20)
im = ax.images[0]
print(im.get_clim())
```

The last line of code prints the minimum and maximum value of the color limit (clim). What is the maximum value of the color limit once we have switched to the dbscale type?

Answer: 134.0755363067488 ✓

Check

Correct
Marks for this submission: 1.00/1.00.

Question 29

Correct

0.00 points out of 1.00

Flag question

We can enhance the signals in this plot by focusing the color limits with specific minimum and maximum values. And it wouldn't hurt to try the popular 'plasma' color map:

```
fig = tr.spectrogram(show=False, per_lap=.5, wlen=10, dbscale=True, cmap='plasma')
ax = fig.axes[0]
ax.set_ylim(0, 20)
im = ax.images[0]
im.set_clim(vmin=-10, vmax=50)
```

What does this visually-enhanced spectrogram look like?

Select one:

- a. A small amount of energy in several thin horizontal lines at the bottom of the plot
- b. Energy that gradually glides from higher to lower frequencies over time
- c. An abrupt burst (<10 s) of energy can be seen on frequencies less than 5 Hz.
- d. An abrupt burst (<10 s) of energy can be seen across almost all observed frequencies.
- e. Energy that gradually glides from lower to higher frequencies over time
- f. No energy at all
- g. A series of short energy bursts at frequencies higher than 1 Hz. ✓
- h. A series of short energy bursts at frequencies lower than 1 Hz.

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Question 30

Correct

0.00 points out of 1.00

Flag question

Since this visually-enhanced spectrogram reveals some high frequency signals that we cannot see in the original seismogram, we can use a filter to see these signals in the seismogram. When modifying seismograms in ObsPy, it is often a good idea to create a new copy of the seismogram and then apply the modifications to it:

```
ftr = tr.copy()
```

Which of the following commands would successfully filter the seismogram to focus on these high frequency signals?

Select one:

- a. tr.filter(type='highpass', min=2.0, max=20.0)
- b. tr.filter(type='bandpass', freqmin=2.0, freqmax=20.0)
- c. tr.filter(type='highpass', freqmin=2.0, freqmax=20.0)
- d. tr.filter(type='bandpass', min=2.0, max=20.0)
- e. ftr.filter(type='bandpass', min=2.0, max=20.0)
- f. ftr.filter(type='bandpass', freqmin=2.0, freqmax=20.0) ✓ Correct. Add this to your next Code cell.
- g. ftr.filter(type='highpass', min=2.0, max=20.0)
- h. ftr.filter(type='highpass', freqmin=2.0, freqmax=20.0)

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Question 31

Correct

0.00 points out of 1.00

Flag question

Go head an plot the filtered seismogram:

```
fig = ftr.plot()
```

What does the high frequency seismogram show? To help, you will want to review this paper to find out what it is:

https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2008GL036080

Select one:

- a. tremor on the Denali Fault triggered by surface waves from a large earthquake on the San Andreas Fault
- b. tremor on the Denali Fault triggered by surface waves from a large earthquake on the Denali Fault
- c. tremor on the San Andreas Fault triggered by surface waves from a large earthquake on the San Andreas Fault
- d. surface waves from a large earthquake on the San Andreas Fault triggered by tremor on the San Andreas Fault
- e. surface waves from a large earthquake on the San Andreas Fault triggered by tremor on the Denali Fault
- f. tremor on the San Andreas Fault triggered by surface waves from a large earthquake on the Denali Fault ✓
- g. surface waves from a large earthquake on the Denali Fault triggered by tremor on the Denali Fault
- h. surface waves from a large earthquake on the Denali Fault triggered by tremor on the San Andreas Fault

Check

Correct
Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Finish review