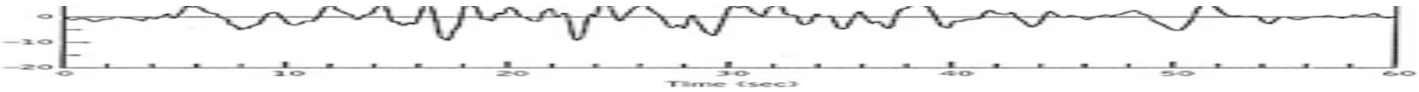


Restless Earth: Investigating the "hum" of the Earth's crust

For the next thirty seconds, sit as still and quiet as you possibly can.

Did you feel it? Did you hear it? Did you feel the ground vibrating beneath your chair or hear the persistent "hum" of Earth's crust?

Whether we can feel it or not, the crust of the earth is always vibrating. You may have experienced the sensation of feeling the ground shake in an earthquake, but earthquakes are sudden, short-term shaking events caused by shifting of the earth's crust around and within tectonic plates. Even in the absence of an earthquake the ground is always in a state of vibration. Some scientists call this constant shaking "Earth's hum". Though we can't hear it, the crust of the earth is always "humming" as small-scale seismic waves called ***"microseism"*** pass through it. In this exercise you will be investigating the cause of "Earth's hum"

Prerequisite Learning:

1. Use Internet resources to define the term ***"microseism"***, in our own words. Use at least three online resources to synthesize your own definition. Write your definition in the space below, or on separate paper, according to your teacher's directions.

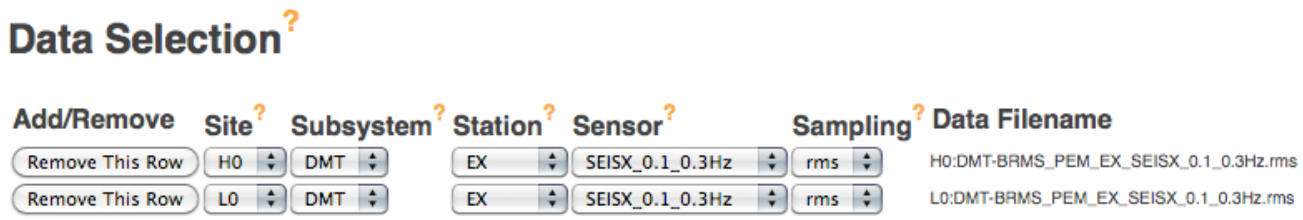
2. Based on your research about the term microseism, identify what causes microseism and what *doesn't* cause microseism. Write your ideas in the space below or on separate paper, as instructed by your teacher.

Part I: How do we know the ground is constantly vibrating?

In this section of the activity you will be using the LIGO e-lab plotting tool to show evidence of constant ground vibration.

Go to the LIGO e-lab interface at http://www.i2u2.org/elab/ligo/home/project.jsp .

- Click "Student Home".
  a) If you are part of a LIGO e-lab user group, log in using the login and password given to you by your teacher.
  b) If you are not part of a LIGO e-lab user group, click "Log in as guest"
- At the top of the screen, point the mouse at the word "Data", then click "Bluestone" to enter the Bluestone plotting screen.
- "Burp" the system by clicking the "Plot" button before entering any date ranges.
- Using the date selection calendars above the plot area, set the start date for your plot at January 1, 2010. Set the end date at December 31, 2010.
- Set the Data Selection as shown below…



- After setting the date and Data Selection, "check" the box that says "Y-axis Log Scale", then click "Plot"
- Using the small blue icon to the lower right of your plot, stretch the plot downward until it is roughly square.

1. Save your plot in the e-Lab plot archive (use the "Save Plot" button). You will be including the image in a lab report when you are finished with this activity.

2. Enter you response to the following questions (type responses on this sheet, or write on separate paper, according to your teacher's instructions)

    a. What evidence do you see on the plot to suggest that the ground was vibrating continuously throughout 2010?

    b. On the plot, the yellow line shows ground vibration at the LIGO Observatory in Hanford, Washington, while the blue line shows ground vibration at the LIGO Observatory in Livingston, Louisiana. What evidence suggests that this ground shaking is a global phenomenon, rather than a local event?

    c. Does the ground shaking shown on the plot remain at the same intensity over the course of the year? *Describe* aspects of the plot that support your thinking.

    d. What might cause the winter-summer fluctuations in ground vibration that appears on the plot? Propose a *hypothesis* to explain what you see.

Part II: Examining a potential cause of earth's constant vibration.

An important part of scientific investigation is to read about the discoveries other people have made. When scientists make discoveries based on research and experimentation, they publish their findings in professional journals. To get an idea of what causes the continuous vibration that goes on in the earth's crust, you will be reading some short segments from a number of articles. The links below will take you to the articles, and the instructions will tell you what information to read. As

you read each article, use the space provided to write notes, or write notes on separate paper, whichever your teacher prefers.

Article 1: Can Sea Waves Cause Microseisms? By M.S. Longuet-Higgins
Read the first paragraph of the Introduction on the first page of the article. In your notes, write down ideas that might help you determine what causes "microseism".

Notes:

Article 2: Storm and Surf Microseism By F.W. van Straten
Read the first paragraph at the top of page 98 of the article. Read the first paragraph of the "Discussion", by B. Gutenberg *on page 101 of the article. In your notes write down ideas from the title of the article and from what you read about what might cause "microseism".*

Notes:

Article 3: Characteristics of ambient seismic noise as a source for surface wave tomography
By Yingjie Yang, et al.
Read paragraph 4 on page 2 of the article. In your notes write down information from the article that might help you determine the cause of "microseism".

Notes:

Article 4: Earth's hum linked to coastal waves By Catherine Brahic
Read the entire article. In your notes write down specific details about how ocean waves might cause "microseism"

Notes:

Part III: Comparing microseism with ocean wave heights

The articles you just read strongly suggest that the predominant cause of microseism is wave activity in the oceans. How can we use seismic data from LIGO in conjunction with other data sources to see for ourselves how ocean waves affect the seismic climate at the LIGO observatories? The following exercises will help you identify and examine the relationship between ocean waves and microseism.

1. Using data from the National Data Buoy Center you can plot wave heights for various locations in the Pacific and Atlantic Oceans, and the Gulf of Mexico. Follow the directions below to create a graph of wave heights in the northern Pacific Ocean from January 1, 2010 through December 31, 2010. By comparing your wave graph with your plot of seismic activity at LIGO you can get an idea of whether or not ocean waves are related to ground vibrations.

a. Go to the National Data Buoy Center at http://www.ndbc.noaa.gov
b. Zoom in on the region of the map showing the Gulf of Alaska and the coasts of Oregon and Washington.
c. Use the mouse pointer to find the buoy in the gulf of Alaska called "46085 – Central Gulf of Alaska Buoy" and click on it.
d. In the window that opens, click "View History".
e. Click the link that says "Search historical meteorological data for observations that meet your threshold conditions".
f. Set the year for "2010". In the first row of the "Search Criteria" box, enter "Wave Height" for *Select Observations*. Under "First Range Limit", select the *greater than* symbol, then enter 3.5.
g. Click "Submit"
h. In the table below, or on separate paper, enter the number of "Records Matching Search Criteria" for each month.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

i. Repeat steps a-h, except this time choose the buoy called "46041 Cape Elizabeth". Complete the table for the Cape Elizabeth buoy.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

j. Analyze the data you collected from the National Data Buoy Center and comment on what you see. Write your comments in the space below, or on separate paper, depending on your teacher's instructions. Write about how the number of waves greater than 3.5 meters high in the winter months compares with the number of such waves in the summer months. Also compare the wave data from the Gulf of Alaska buoy with the wave data from the Washington Coast buoy and comment on your findings.

2. It might be helpful to look at the wave data graphically and compare it to the microseism plot you made earlier in this exercise.

3. Examine your Microseism/Wave Height plot carefully, then answer the following questions in the space provided, or on separate paper.

a. As thoroughly as possible, describe how the yearly pattern of microseism at LIGO Hanford and LIGO Livingston compares to the yearly wave height trends in the northern Pacific Ocean.