Name: _____ Period: ____

Climatic 2: Keep Those Fossil Fuels in the Ground

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The CO_2 we've dumped into the atmosphere won't disappear
It's gonna last a hundred years while trappin' heat up in the air[1]
The reason temperature's up less than one degree
Is the climate's inertia it responds slowly,

Oceans two miles deep and water's high specific heat means
Oceans have absorbed the heat what a feat and
Heat absorbing ice over Greenland and the poles absorbs more heat it's kept things under control[2]

And keep in mind the notion that the ocean is a huge carbon sink[3]
Keepin' CO_2 levels just below the brink
But it's lookin like the seas, with their dying coral reefs
Can't absorb more CO_2, what we gonna do?[4]

Emissions over nine billion tons a year and rising[5]
Is there a climate tipping point over the horizon?
Is there an increase, that will release
Positive feedback[6],with no turning back?

CHORUS

Keep those fossil fuels in the ground!
We don't need that carbon up there![7]
Keep those fossil fuels in the ground!
Keep 'em buried For another couple million years!
Keep those fossil fuels in the ground!
It's time to protect the atmosphere!
Keep those fossil fuels in the ground!
Act like you care!

I mean one degree C seems fine no one's dyin' from the heat (except sometimes)
What's the big deal if we go up four or five
Degrees it's just warmth we'll all survive
Summer's fun! Who likes cold? Maybe we'll thrive!

Life's sweet in hot Iberia, in tropical Liberia,
The Russians would love a warmer Siberia
But wait! Up one degree, we're melting Arctic seas.
Note the glaciers' in retreat if you please

Arctic sea ice cover fell way down in '07,[8]
With a repeat performance in two thousand eleven,[9]
And the thickness of the ice is declining faster,[10]
A harbinger of climatological disaster.
CHORUS

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[1] See "Carbon is Forever," in *Nature Reports*, http://www.nature.com/climate/2008/0812/full/climate.2008.122.html

[2] This is a summary of an extended argument in *The Case for Young People and Nature: A Path to a Healthy, Natural, Prosperous Future*, by James Hansen et. al, available at http://www.columbia.edu/~jeh1/mailings/2011/20110505_CaseForYoungPeople.pdf

[3] The concept of "carbon sink" in general and the oceans' role as carbon sinks can be explored at http://en.wikipedia.org/wiki/Carbon_sink

[4] See "Ocean Carbon Sinks Feeling the Heat" at http://articles.cnn.com/2011-07-11/world/atlantic.ocean.carbon.warming_1_carbon-emissions-ocean-carbon-co2?_s=PM:WORLD

[5] Note that emissions are nine billion tons of *carbon*. The amount of carbon dioxide is 3.67 times larger, or 33 billion tons. That's because the atomic weight of carbon is 12 atomic mass units, while that of CO_2 is 44 atomic mass units.

[6] A positive feedback loop is one where a stimulus brings about a stronger response, which in turn acts as a stronger stimulus. In the context of climate change, there are several troublesome positive feedback loops where the initial stimulus is human initiated release of carbon dioxide. This warms the planet (see my first video about the greenhouse effect). But then this warming leads to changes on the planet that lead to more warming, and so one. Two of the changes discussed in this series are methane release (in this video) and changes in albedo in the last video.

[7] Just to be clear: we don't need the *extra* carbon caused by release of fossil fuels. We need the base level of 280 ppm to maintain the base-level of the greenhouse effect that makes our planet habitable.

[8] See "Arctic Sea Ice Shatters All Previous Record Lows," http://nsidc.org/news/press/2007_seaiceminimum/20071001_pressrelease.html

[9] See http://earthobservatory.nasa.gov/Features/WorldOfChange/sea_ice.php

[10] You can explore interactive images and read about this at http://www.nasa.gov/topics/earth/features/thick-melt.html

If emissions keep rising at expected rates,
There'll be no summer sea ice in few decades,[11]
We'll see permafrost melting, with potential gain
of billions of tons of released methane.[12]

Which traps 20 times the heat of CO_2
If that methane escapes,the climate is screwed![13]
As positive feedback unleashes more warming,
We need to act now on this 1 degree warning.

CHORUS
BRIDGE
If we let CO_2 keep rising
The effects will hardly be surprising
Flooded coastlines, habitats in disarray
We know this all NOW, we gotta act today!

Not to mention the danger of sea level rise,
From thermal expansion and melting glacial ice
It could be many meters, or maybe one or two,
But they're not gonna like it in Tuvalu![14]

To avoid a future where most wildlife dies,
We need to (we got to) stop this temperature rise
And CO_2's effect isn't just in degrees,
Yeah CO_2 has increased ocean acidity!

That right, pH falling, ocean life filled with grief
At the relentless demise of the Earth's coral reefs[15]
A system on which half a billion depend,
Reefs, heatwaves, ocean's rising part of a trend,

Of damage unleashed by a one degree gain,
If we go up two or three imagine the pain!
So let's stop the warming, let's do it now,
Hang on for the next part where we can see how![16]

CHORUS

[11] See http://www.newscientist.com/article/dn21626-arctic-sea-ice-may-have-passed-crucial-tipping-point.html, or http://www.noaa.gov/features/monitoring_1008/arcticice.html

[12] This methane release seems to be well underway. See http://www.independent.co.uk/news/science/vast-methane-plumes-seen-in-arctic-ocean-as-sea-ice-retreats-6276278.html

[13] See NY Times, As Permafrost Thaws, Scientists Study the Risks http://www.nytimes.com/2011/12/17/science/earth/warming-arctic-permafrost-fuels-climate-change-worries.html?pagewanted=all. You can also read about this at the Huffington post: http://www.huffingtonpost.com/2013/02/22/permafrost-melting-rate-2013_n_2741486.html

[14] For the US EPA's discussion of sea level rise, see http://www.epa.gov/climatechange/effects/coastal/index.html. For more about Tuvalu (a small Pacific island atoll), see http://www.smithsonianmag.com/travel/tuvalu.html

[15] For a discussion of the problems associated with ocean acidification caused by human carbon dioxide emissions, see http://www.nrdc.org/oceans/acidification/

[16] An agreement to limit global temperature increase to less than two degrees was one of the outcomes of the Copenhagen accords. You can read a summary at http://www.c2es.org/international/copenhagen-climate-summit-summary. According to James Hansen, a 2 degree rise would be disastrous. See http://blogs.scientificamerican.com/observations/2011/12/06/two-degree-global-warming-limit-is-called-a-prescription-for-disaster/

Some Useful Vocabulary and Concepts

1. *Specific Heat*: the heat required to raise the temperature of the unit mass of a given substance by a given amount (usually one degree).
2. *Thermal expansion:* When water heats up, it expands. Thermal expansion of the Earth's ocean water has already caused some rise in sea levels.
3. Tuvalu is a low-lying Pacific Island nation. Like many such nations, it would be at significant risk if sea levels were to rise.

Questions:

1. How long does the CO_2 we've emitted into the atmosphere last?_____
2. List three features of our planet that have helped control temperature increase?
   a. _____
   b. _____
   c. _____
3. What does it mean to say "the oceans are a huge carbon sink?"

4. Read the footnotes for the following question. In terms of carbon emitted, how high have emissions been? _____. How high have CO2 emissions been? _____

5. Again, read the footnotes. What's a positive feedback loop?

6. You might need to look at *Climatic 1: The Greenhouse Effect* to answer this question. What would happen if there were no carbon dioxide in the atmosphere?

7. What have been some planetary changes we've experienced from the 0.8° C temperature increase that can be attributed to human greenhouse gas emissions?

8. What could happen if significant amounts of permafrost melt?

9. What are two factors that could cause sea level to rise?

10. Carbon dioxide emissions have also caused what change in ocean chemistry, and what have been some of the impacts of this change?
11. Conclusion: List the three most important points that "Keep Those Fossil Fuels in the Ground" tries to communicate.
    a. _____
    b. _____
    c. _____

12. Do you agree with the idea that we should "Keep Those Fossil Fuels in the Ground"? What would happen if we did?

Name:_____
Date:_____

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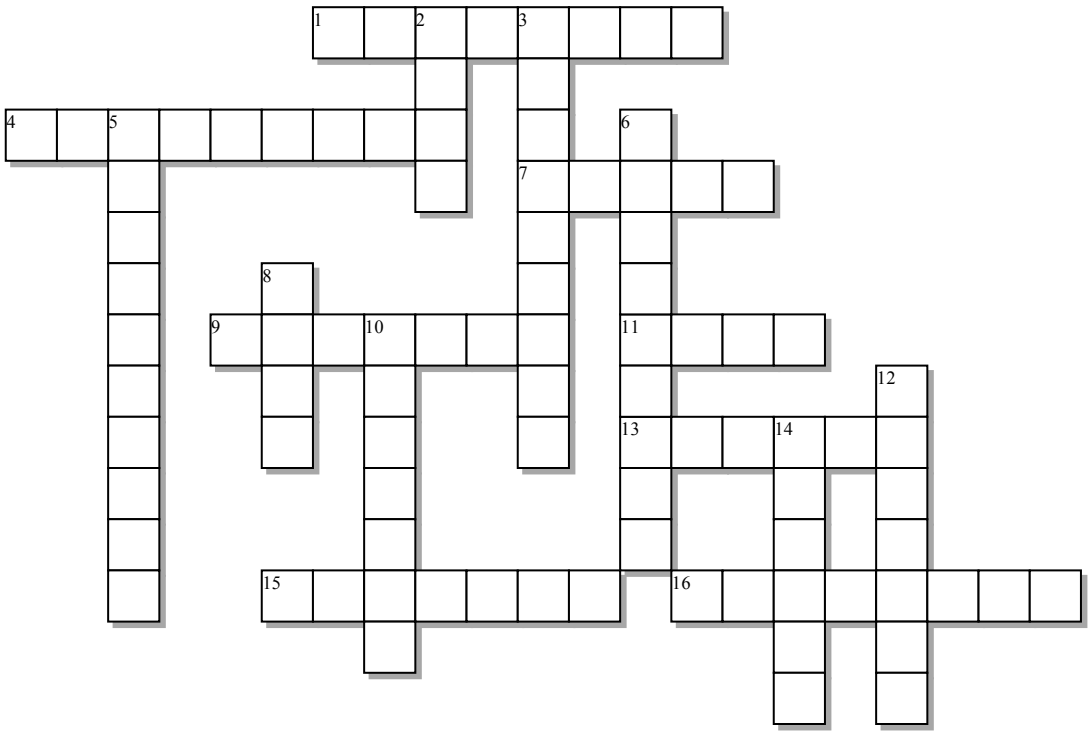
Keep Those Fossil Fuels in the Ground!



Across:

1 - The kind of feedback that builds on itself to increase a process or a trend

4 - Thermal _____ of water could increase sea levels, even without any additions from glaciers

7 - A reef building organism that's been harmed by increased ocean acidity

9 - A powerful greenhouse gas, 20 times more effective at trapping heat than carbon dioxide

11 - Emissions of carbon are at _____ billion tons per year.

13 - The northern ocean that's experienced dramatic losses in ice cover

15 - Our climate system has a lot of this, causing it (thus far) to change slowly

16 - Moving ice masses that have been declining around the planet

Down:

2 - The ocean is a huge carbon _____

3 - Sea ice is declining in extent and in _____

5 - Frozen ground that could release both carbon dioxide and methane if it thaws

6 - This ice covered island has absorbed a lot of heat

8 - Water is able to hold a lot of _____

10 - Carbon dioxide lasts in the atmosphere for about one _____ years

12 - Carbon dioxide has increased this quality of sea water

14 - An island nation threatened by sea level rise.

Possible Answers:

Arctic, Greenland, Tuvalu, acidity, coral, expansion, glaciers, heat, hundred, inertia, methane, nine, permafrost, positive, sink, thickness