**BIOL101 Biology and Society**

**Understanding Global Climate Change**

**Part III: The Future**

**EXERCISE 1: Exploring Differences in Temperature**

What is the difference in climate and weather? Read through the information on this website: <https://www.climate.gov/maps-data/primer/comparing-climate-and-weather>

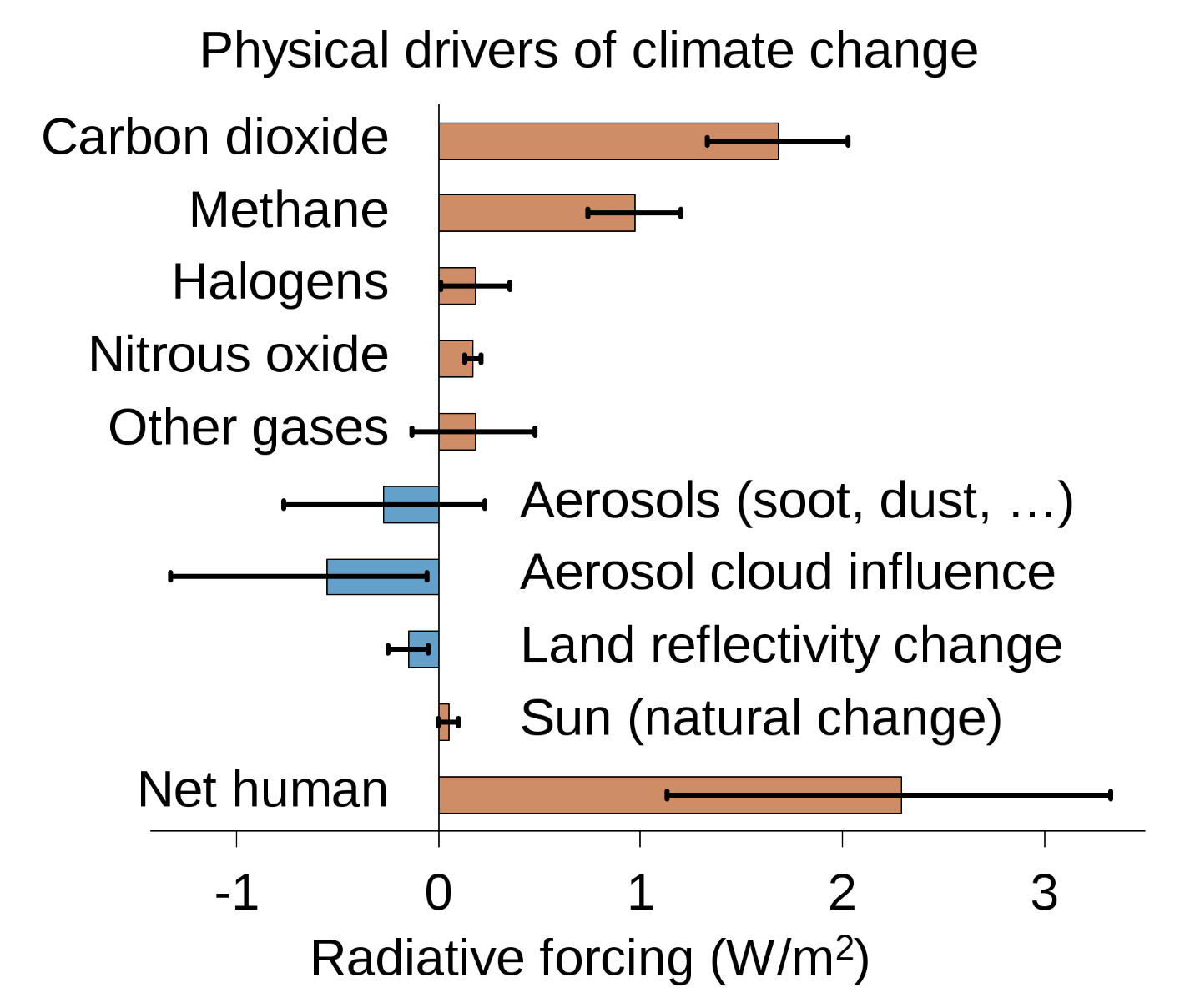
1. After you have finished reading, describe your ideas about the two terms below and explain the differences.

Next, Visit the following website to complete an interactive simulation for how temperature has changed since you were born. Use the questions to help guide you, and fill in the answers. <https://www.nytimes.com/interactive/2018/08/30/climate/how-much-hotter-is-your-hometown.html?emc=edit_clim_20180831&nl=climate-fwd&nlid=8174675320180831&te=1>

1. Enter Hilo, HI and the year you were born into the interactive and press enter. On average, how many days did Hilo reach above 90 degrees the year you were born?
2. Scroll downward using the bar on the right of the screen. As of 2017, how many days on average did Hilo have at above 90 degrees?
3. What is the difference in the number of days expected to reach 90 degrees or more in Hilo between when you were born and the most recent year for the simulation?
4. How will this change by the time you are 80 years old - what is the range of days expected to reach 90 degrees or more?
5. Examine at least one other city that you care about. Name the city and explain why it is important to you. How many days have or will have reached 90 degrees and above the year you were born? In 2017? By the time you are 80?

**EXERCISE 2: Understanding Climate Change in the Future**

Watch the following video on How Climate Scientists Predict the Future: <https://www.youtube.com/watch?v=i9EyFghIt5o>



Climate models simulate present day climate based on knowledge of how the heat and energy move around the earth. In accordance with the basic laws of thermodynamics, as Earth absorbs energy from the sun, it must eventually emit an equal amount of energy to space. The difference between incoming and outgoing radiation is known as a planet’s **radiative forcing** (RF). In the same way as applying a pushing force to a physical object will cause it to become unbalanced and move, a climate forcing factor will change the climate system. When forcings result in incoming energy being greater than outgoing energy, the planet will warm (positive RF). Conversely, if outgoing energy is greater than incoming energy, the planet will cool.

Another way to refer to climate forcings is to call them **climate drivers**. Natural climate drivers include changes in the sun’s energy output, regular changes in Earth’s orbital cycle, and large volcanic eruptions that put light-reflecting particles into the upper atmosphere. Human-caused, or anthropogenic climate drivers include emissions of heat-trapping gases (also known as greenhouse gases) and changes in land use that make land reflect more or less sunlight energy. Since 1750, human-caused climate drivers have been increasing, and their effect dominates all natural climate drivers.

Across the globe, in response to increases in heat-trapping gases such as carbon dioxide (CO2) in the atmosphere, temperature and precipitation patterns are changing. The rate of climatic change in the next century is expected to be significantly higher than it has been in the past. At our current rate of emissions, the Intergovernmental Panel on Climate Change (IPCC) estimates that CO2 levels in the atmosphere will double or triple during the next century, and the climate system will respond.

To estimate future climate, the radiative forcing for the future must first be estimated. Climate scientists have defined four possible scenarios for the future that they use as consistent inputs for calculating climate in the future. Each scenario is based on a plausible future pathway regarding global emissions of greenhouse gases. The scenarios, known as **Representative Concentration Pathways**, or **RCPs**, specify the amount of radiative forcing (RF) in 2100 relative to 1750. Examine the table on the next page from the IPCC’s 2013 report. Each of the four RCP scenarios differ by the amount of greenhouse gas radiative forcing applied to the model simulation. In short, a positive greenhouse gas radiative forcing means greenhouse gases are causing Earth to receive more incoming solar radiation (insolation) than it is radiating back towards space. All RCP scenarios are based on positive greenhouse gas radiative forcing values.

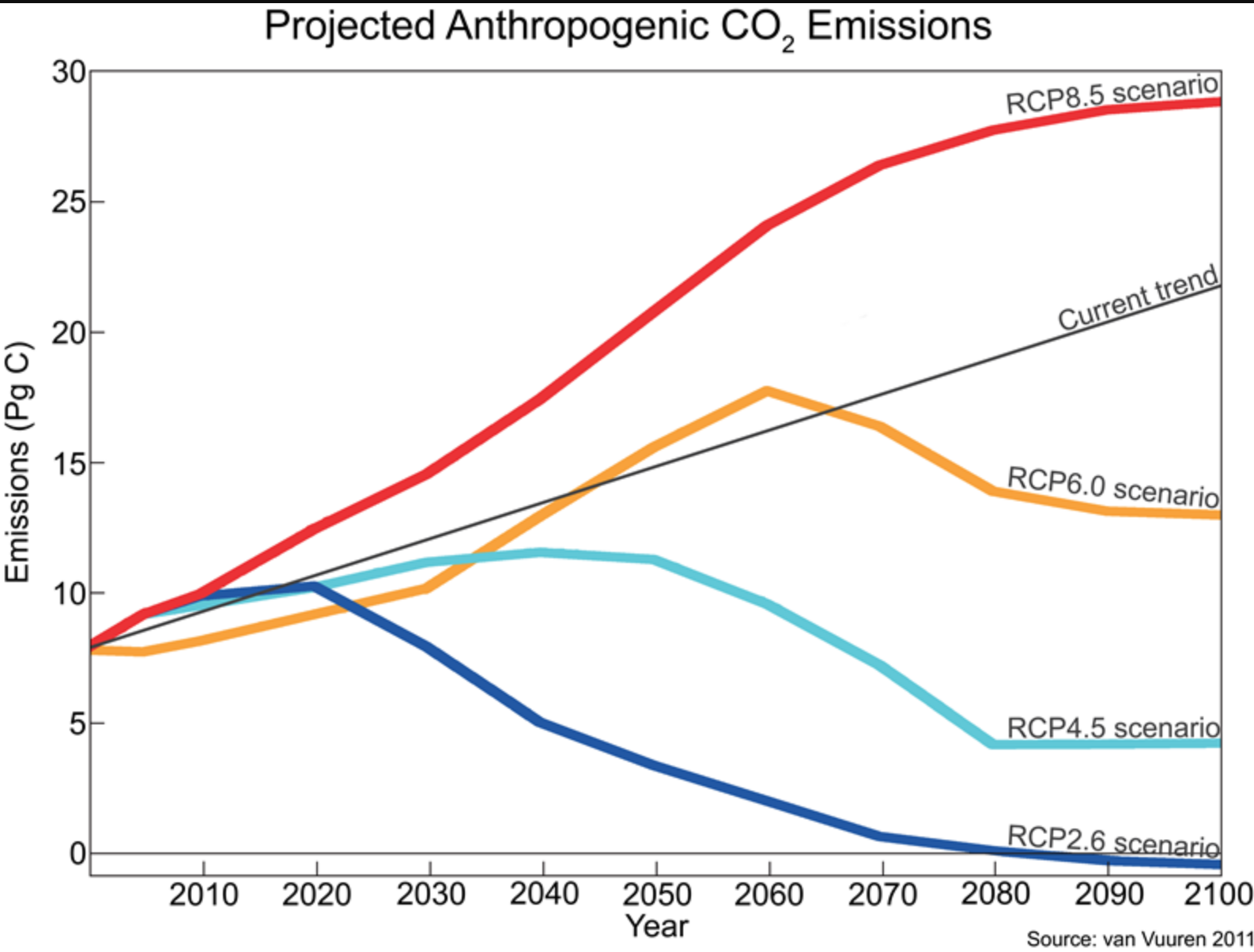
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Representative Concentration Pathway (RCP)** | **Forcing compared to 1750 (W/m2)** | **Climate policy associated with scenario** | **CO2 Equivalent (ppm)** | **Projected global average temperature increase by 2100 (oC)** |
| 2.6 | 2.6 | Mitigation | 475 | 1.0 |
| 4.5 | 4.5 | Stabilization | 630 | 1.8 |
| 6.0 | 6.0 | Stabilization | 800 | 2.2 |
| 8.5 | 8.5 | None | 1313 | 3.7 |

In this exercise, you will be engaging with one of the four RCP scenarios: the **RCP 2.6, RCP 4.5, RCP 6.0, and RCP 8.5**, which correspond to greenhouse gas radiative forcings of 2.6 W/m2 (Watts per meter squared), 4.5 W/m2, 6.0 W/m2 and 8.5 W/m2, respectively. Climate scientists use RCP scenarios in their future climate change projection models because the future state of Earth’s climate system is dependent on the amount of greenhouse gas emissions. It is uncertain how much the world can reduce greenhouse gas emissions and the different RCP scenarios account for the possible pathways the Earth’s climate could develop through the year 2100.

As Earth’s climate continues to change, understanding how temperature is expected to change across the world and how these changes are dependent on the amount of future greenhouse gas emissions. When people are able to see the future impacts of climate change, they are more likely to take action and help reduce the amount of greenhouse gas emissions to keep future projections closer to the RCP 2.6 (best case) scenario.

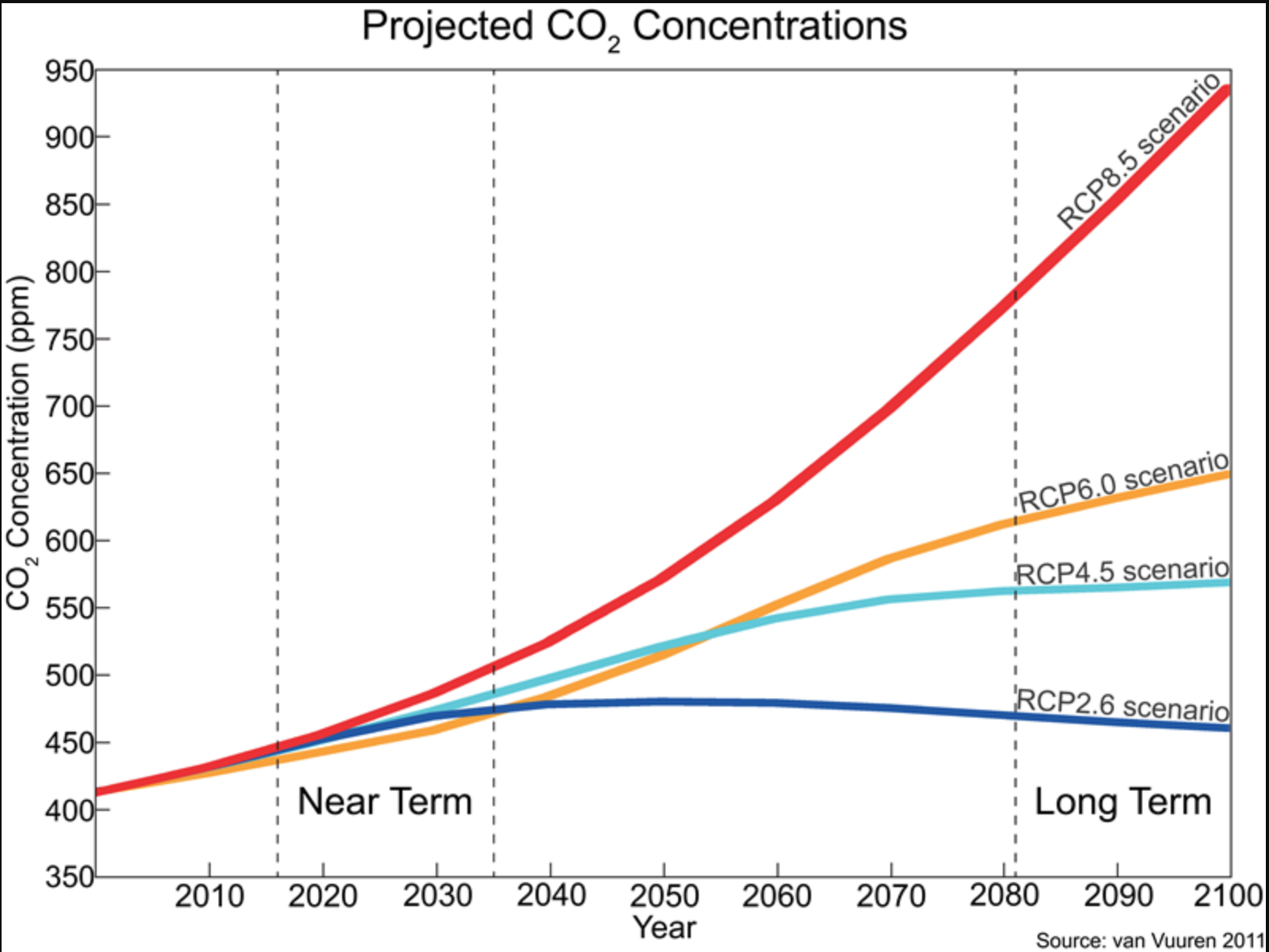
1. With respect to the representative concentration pathways (RCP), what is the largest of the four hypothesized radiative forcings from pre-industrial times to 2100? The anthropogenic radiative forcing from 1750-2011 was 2.3 W/m2.
2. What is the difference in CO2 concentration between the RCP 2.6 and RCP 8.5 scenarios for 2100 in ppm?
3. What is the difference in temperature between RCP 2.6 and RCP 8.5 scenarios for 2100?

Next, you will evaluate how the RCP scenarios compare to the best-case scenario (smallest change from the historic period of the last 150 years) of RCP 2.6 in terms of global temperature projections. The figure below shows current and projected anthropogenic (human-caused) CO2 emissions over the rest of the century.



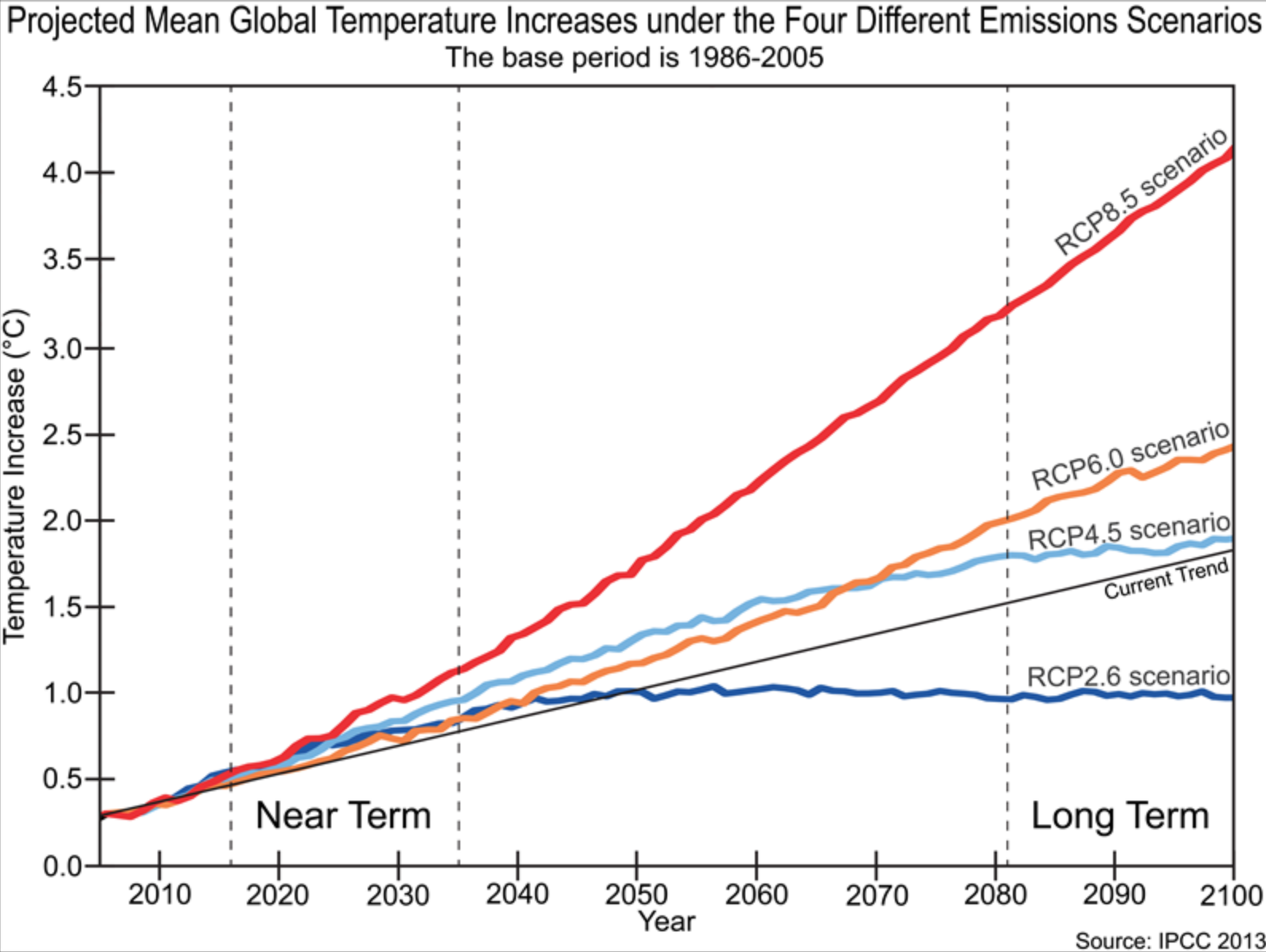
1. In the figure on the left, what two emissions scenarios most closely represent the current trend in CO2 emissions?

The figure below shows projected CO2 concentrations over the rest of the century. The atmospheric lifetime of CO2 is approximately 100 years, while the lifetime of CH4 is roughly a decade. Near-term climate change is for the period 2016-2035, while long-term climate change is 2081-2100.



1. In the figure to the right, why are CO2 concentrations increasing under the RCP4.5 scenario when emissions are decreasing?

Combining the results from many climate models shows provides information like that provided in the figure below; it shows projected changes in the mean global temperature from 2005 to 2100. The values are differences from the mean global temperature from 1986-2005; therefore, the values are anomalies. The black line is an extrapolation of the linear trend in observed global temperature from 1979-2015.



1. If we assume the current trend in temperatures will continually occur until 2035, then how would you describe the projected changes from the four different scenarios in the near term (i.e., 2016-2035)?
2. Which scenario produces projections in the long term (i.e., 2081-2100) that most closely resembles the current trend in temperatures?

**EXERCISE 3: What Difference Does a Few Degrees Make?**

Does a few degrees temperature actually change much on the planet? To learn more about this, examine, compare, and contrast the impacts of global climate changing 1.5 **and** 2 degrees Celsius (oC) on the following factors using the following interactive website. The data, like what we have been using to examine future RCP scenarios comes from the 2013 report by the Intergovernmental Panel on Climate Change, or IPCC, the world authority on Climate. <https://www.nytimes.com/interactive/2018/10/07/climate/ipcc-report-half-degree.html>.

1. Name four major effects that global climate change of 1.5 and/or 2 oC will have on the world and the world’s population.
2. What percentage of insects, plants and vertebrates will lose more than ½ of their livable habitat (home environment) range?
3. What will happen to coral reefs as the temperature rises?

1. How much of the population will be exposed to sea level rise?

1. At current rates of warming, between what range of years will the world likely cross the 1.5 oC threshold? How old will you be when it is likely to begin?
2. Specifically, what needs to happen to greenhouse emissions to hold the world at 1.5 oC? 2 oC?
3. Which of the effects projected to happen at these rises in global temperatures feels most important to you? Why?

**EXERCISE 4: Exploring Solutions**

We now have a better idea about what climate change is, its causes, how we know it is happening and what it may look and feel like across the world and locally. We also know that globally and at a government level, initiatives are afoot to manage the effects of climate change. As you have learned, humans have the power to affect climate—in fact, there is vast evidence that humans are at the root of the problem of climate change. The burning of fossil fuels for transportation and power has caused increased concentrations of greenhouse gases in the atmosphere, which has led to global warming and climate change. Because humans are contributing to the problem of climate change, it only makes sense that humans can be the source of the solution as well.

Every action - big or small, positive or negative - influences the likely impact of climate change. Because of that, every choice each of us makes - today and tomorrow - will contribute to what we and future generations will experience and must adapt to. We know there is still time to choose actions that will lessen the impacts of climate change. What part will you play as an individual, as a family, and as a community? This includes making choices that influence the government, as well as business, and other decision makers.

Choose one area where you would like to make a concerted effort at making a difference through your own choices: **Food, Environment, Transportation**, or **Energy.** Remember that small changes can make a difference...if everybody makes a small effort in their daily lives, the effects add up. Although it may feel like you are just one person and can't make that much of a difference, each person's effort contributes to the greater good, and the cumulative effect of everybody's actions is immense. In addition, your behavior can inspire others to also take action to protect the environment.

1. What small actions within your chosen area could you make in your life?
2. How might broad changes in this area impact our lives in the future and the lives of future generations?
3. What role/s do we as citizens have in the future? What values may guide us in how new innovations and changes are funded, created, and used?
4. Lastly, describe how this course has affected your ideas or thoughts about biology, climate change, and your life in general. In your answer, include ideas about each of the following:
   1. *How do you think learning more about biology and climate change has changed the way you look at your own life or other life on our planet?*
   2. *What current events or things are happening in our community, our island ecosystem, or our biosphere that your study of biology has helped you to better understand?*

For each question, use at least 3-5 sentences for your answer.