The following is a collection of GLOBE resources and NASA Assets to support a unit for a middle/high school unit on Climate Change. These connections below are grouped according to scientific phenomenon tied to climate change such as *carbon cycle*, *atmospheric CO2 levels*, *sea level rise*, *ocean acidification*, and *air/surface temperatures (Urban Heat Island Effect)*.

1. **Carbon Cycle –** [**Non-Standard Implementation Flowchart**](https://www.globe.gov/documents/355050/41927208/NON-STANDARD%2BCarbon%2BCycle%2BActivity%2Band%2BProtocol%2BFlowchart/4158af4b-92f1-4327-ac99-32c3f377c07d)

|  |  |
| --- | --- |
| **2-4 Day Implementation (non-standard site selection)** | **5-7+ Day Implementation (non-standard site selection)** |
| *Essential Question: How does the carbon stored in me compare to a tree?* | *Essential Question: How does carbon storage change within and between ecosystems (or biomes)?* |
| [Carbon Cycle Introductory Activities](https://www.globe.gov/documents/355050/b9afed93-44b6-4692-869f-a061b75c5a25) | [Carbon Cycle Introductory Activities](https://www.globe.gov/documents/355050/b9afed93-44b6-4692-869f-a061b75c5a25) |
| [NASA survey technique estimates the Congo forest’s carbon](https://mynasadata.larc.nasa.gov/recent-topics/nasa-survey-technique-estimates-congo-forests-carbon) (Nov. 2017 Article) |
| [Carbon Cycle Adventure Story](https://www.globe.gov/documents/10157/2595533/CarbonCycleAdventureStory_TeacherGuide.pdf) (with carbon cycle graphic) | [Plant-a-plant classroom experiments](https://www.globe.gov/documents/10157/2519116/Strand_3D_Carbon_CycleESSP_Plant-a-Plant.pdf) (Set up and revisit in 2-3 weeks) [Experiments](https://www.globe.gov/documents/355050/41927208/PlantAPlant_TeacherGuide_AllExperiments.pdf/99c31282-eb48-4bb8-81f9-9b67ceb2f5ab) |
| What is Biomass? – [Biomass Units Learning Activity](https://www.globe.gov/documents/355050/7d34fc3b-ef3c-49b5-a7dd-fb4a74ece686) and [Human Carbon Pool (xls)](https://www.globe.gov/documents/355050/41927208/HumanCarbonPoolMiniActivity.xls/74882198-0817-481c-8f68-1d971240cc4f?version=1.0" \t "_blank) The Biomass Model has a nice (and direct) connection to climate change - once students are familiar with the model, they can change the temperature and precipitation inputs to see how biomass and carbon storage may change with climate change. See 'Extension 3' in the Biomass Model Teacher's Guide. | [Carbon Cycle Adventure story](https://www.globe.gov/documents/10157/2595533/CarbonCycleAdventureStory_TeacherGuide.pdf) (with Carbon cycle graphic) |
| [Tree circumference](https://www.globe.gov/documents/355050/41927208/TreeBiomassCarbonAnalysis.pdf/6dad96c7-7b04-432b-b02e-1038a026062f) – [C storage (xls)](https://www.globe.gov/do-globe/globe-teachers-guide/biosphere?p_p_id=globegovteacherguideportlet_WAR_globegovcmsportlet_INSTANCE_4CcA&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-1&p_p_col_count=1&_globegovteacherguideportlet_WAR_globegovcmsportlet_INSTANCE_4CcA_protocolCat=41703916) (bottom of the page) and [DATASHEET](https://www.globe.gov/documents/355050/6fc9ebef-810a-4595-b27e-d06097ad75ce) and [Tree ID Field DATASHEET](https://www.globe.gov/documents/355050/f2d9ebbe-df58-40c4-b696-d39a1f27cf93) | What is Biomass? – [Biomass Units Learning Activity](https://www.globe.gov/documents/355050/7d34fc3b-ef3c-49b5-a7dd-fb4a74ece686) The Biomass Model has a nice (and direct) connection to climate change - once students are familiar with the model, they can change the temperature and precipitation inputs to see how biomass and carbon storage may change with climate change. See 'Extension 3' in the Biomass Model Teacher's Guide. |
| [Carbon Travels Game](https://www.globe.gov/documents/10157/2595533/CarbonTravelsGame_TeacherGuide.pdf) |
| [Tree height (ICESAT 2)](https://www.globe.gov/documents/355050/6b5f1481-0fa9-45f9-8241-70924466e92a) field guide for sloped or flat ground and [DATASHEET](https://www.globe.gov/documents/355050/1bf202c4-851f-4118-ac56-2f529df6fdaa) (optional) | [Tree circumference](https://www.globe.gov/documents/355050/41927208/TreeBiomassCarbonAnalysis.pdf/6dad96c7-7b04-432b-b02e-1038a026062f) – [C storage (xls)](https://www.globe.gov/do-globe/globe-teachers-guide/biosphere?p_p_id=globegovteacherguideportlet_WAR_globegovcmsportlet_INSTANCE_4CcA&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-1&p_p_col_count=1&_globegovteacherguideportlet_WAR_globegovcmsportlet_INSTANCE_4CcA_protocolCat=41703916) (bottom of the page) and [DATASHEET](https://www.globe.gov/documents/355050/6fc9ebef-810a-4595-b27e-d06097ad75ce) and [Tree ID Field DATASHEET](https://www.globe.gov/documents/355050/f2d9ebbe-df58-40c4-b696-d39a1f27cf93) |
| [Tree height (ICESAT 2)](https://www.globe.gov/documents/355050/6b5f1481-0fa9-45f9-8241-70924466e92a) field guide for sloped or flat ground and [DATASHEET](https://www.globe.gov/documents/355050/1bf202c4-851f-4118-ac56-2f529df6fdaa) |
| [Tree mapping](https://www.globe.gov/documents/355050/db5afe97-86d3-4ce8-9d6a-a0f5cc140c32) field guide |
| [Shrub/Sapling Protocol](https://www.globe.gov/documents/355050/41927208/ShrubSaplingBiomassCarbonAnalysis.pdf/57cf20c4-a688-43f1-9799-e40341cc8e9d) - [C storage (xls)](https://www.globe.gov/do-globe/globe-teachers-guide/biosphere?p_p_id=globegovteacherguideportlet_WAR_globegovcmsportlet_INSTANCE_4CcA&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-1&p_p_col_count=1&_globegovteacherguideportlet_WAR_globegovcmsportlet_INSTANCE_4CcA_protocolCat=41703916) (bottom of the page) |
| [Herbaceous Protocol](https://www.globe.gov/documents/355050/ccd13dc4-518b-4528-b288-374f85555e4c) – C storage (xls) and [DATASHEET](https://www.globe.gov/documents/355050/530edf19-8873-4784-9f4c-bb58e9b096e7) |

|  |  |
| --- | --- |
| **Day 1[[1]](#footnote-1):** Climate Change and Carbon: What is Carbon (Cycle) – 1 class period (Introductory Activities)**Day 1:** Carbon Cycle Adventure Story – Independent Practice**Day 2:** What is Biomass (table lab)/How much C in Humans?**Day 3:** Non-Standard Field Protocols – Tree Circumference (to determine C storage), Tree Height (ICESat2) (*Assumes site set is completed prior to data collection*.) (Also can measure [Shrub/Sapling Protocol](https://www.globe.gov/documents/355050/41927208/ShrubSaplingBiomassCarbonAnalysis.pdf/57cf20c4-a688-43f1-9799-e40341cc8e9d) and [Herbaceous Protocol](https://www.globe.gov/documents/355050/ccd13dc4-518b-4528-b288-374f85555e4c) as time allows.)**Day 4:** Putting it all together CA Population and number of trees in CA | Prior Knowledge: Biomes, Ecosystems**Day 1:** Climate Change and Carbon: What is Carbon (Cycle) – 1 class period (Introductory Activities) Read NASA article on Congo’s forest sequestration.**Day 1:** Carbon Cycle Adventure Story – Independent Practice**Day 2:** What is Biomass (table lab)/How much C in Humans?**Day 3:** Carbon Travels Game**Day 4:** Tree Mapping of Study Site/CA Population and number of trees in CA**Days 5-6:** Non-Standard Field Protocols – Tree Circumference to determine C storage), Tree Height (ICESat2), Shrub/Sapling Protocol/ Herbaceous Protocol**Day 7:** Putting it all together C storage and ecosystems (or biomes) |

1. **CO2 Levels**
* BeACON Data (UCB) – [Laney College](http://beacon.berkeley.edu/sites/sensorsite.aspx?site=laney3)
* Ocean-Atmosphere CO2 Exchange - [LINK](https://sos.noaa.gov/datasets/ocean-atmosphere-co2-exchange/)
* Ocean Acidification: Saturation State [LINK](https://sos.noaa.gov/datasets/ocean-acidification-saturation-state/)
1. **Sea Level Rise**
* Understanding Sea Levels - [Link to MyNASAData](https://sealevel.nasa.gov/understanding-sea-level)
* [Sea Level Change Simulator](https://sealevel.nasa.gov/vesl/web/sea-level/slr-eustatic/)
* NASA Sea Level [Website](https://sealevel.nasa.gov)
* MyNASAData page on [Sea Level Rise](https://mynasadata.larc.nasa.gov/basic-page/sea-level-change)
* Causes of Sea Level Change – [Link to Data](https://sealevel.nasa.gov/understanding-sea-level/causes/overview)
* Sea Level Rise GLOBE Overview and Essential Questions [LINK](https://mynasadata.larc.nasa.gov/globe-connections/sea-level-rise-globe-overview)
* NASA JPL Glacier Simulator - [LINK](https://vesl.jpl.nasa.gov)
* GLOBE Protocols and Datasheets Links:
	+ [pH](https://mynasadata.larc.nasa.gov/globe-connections/sea-level-rise-protocols-and-data-sheets)
	+ [Salinity](https://mynasadata.larc.nasa.gov/globe-connections/sea-level-rise-protocols-and-data-sheets)
	+ [Temperature](https://mynasadata.larc.nasa.gov/globe-connections/sea-level-rise-protocols-and-data-sheets)
1. **Ocean Acidification**
* NASA Surface pH based on CO2 Levels [LINK](https://svs.gsfc.nasa.gov/30794)
* NOAA Ocean Acidification Surface pH [LINK](https://sos.noaa.gov/datasets/ocean-acidification-surface-ph/)
* Ocean Acidification: Saturation State [LINK](https://sos.noaa.gov/datasets/ocean-acidification-saturation-state/)
1. **Air and Surface Temperatures (*Urban Heat Island Effect*)**
* Air Temperature changes [MyNASAData Link](https://mynasadata.larc.nasa.gov/basic-page/changing-air-temperatures)
* Graphic Global Warming [Link](https://climate.nasa.gov/climate_resources/139/graphic-global-warming-from-1880-to-2017/)
* Graphic [Urban Heat Island Effect](https://www.globe.gov/web/surface-temperature-field-campaign/overview/science-of-the-surface-temperature-field-campaign)
* Making a Climograph ([GLOBE activity](https://www.globe.gov/documents/348614/353086/Making%2Ba%2BClimograph-%2BA%2BGLOBE%2BData%2BExploration/ed39aa75-0494-4db2-bfc1-35aaecf6435d))
* GLOBE Protocols – [Urban Heat Island Protocols Field Guide](https://www.globe.gov/documents/3158616/50109632/Urban%2BHeat%2BIsland%2BProtocols.pdf/386322b0-ae65-423d-bcc2-172d826ecac9) and [Urban Heat Island Data sheet](https://www.globe.gov/documents/3158616/50109632/Urban%2BHeat%2BIsland%2BDatasheet.docx/1ecd253b-a556-452e-8356-cfcc79c794cb)

Other Helpful Resources:

NASA’s A Breathing Planet, Off Balance Article and Video:

<https://www.nasa.gov/feature/goddard/carbon-climate>

NASA Global Climate Change Website:

<https://climate.nasa.gov/>

NASA Scientific Visualization Studio

([https://svs.gsfc.nasa.gov)](https://svs.gsfc.nasa.gov/)

Global Carbon Project

([http://www.globalcarbonproject.org](http://www.globalcarbonproject.org/))

Global Carbon Atlas

([http://www.globalcarbonatlas.org](http://www.globalcarbonatlas.org/en/content/welcome-carbon-atlas))

Additional Resources as a follow up to a Climate Change Unit

[http://studentclimatedata.unh.edu/data-tools.shtml](https://www.google.com/url?q=http://studentclimatedata.unh.edu/data-tools.shtml&sa=D&ust=1543266354416000&usg=AFQjCNEuBOwbruOFSINjHbMhCQg6IqVXdg)

1. “Day” based on 50-minute period – but could require more time based on grade level and content knowledge. [↑](#footnote-ref-1)