**Earth System Science EarthLab**

**Workshop Outline for a One-Day (8-hour) Workshop**

*Note: This outline and the associated resources will help you in a general way to prepare for and lead a workshop that introduces the Earth System Science EarthLabs module. It does not replace the need for detailed planning and preparedness on the part of workshop leaders, and it cannot anticipate the conditions of your specific situation or location. You can modify and personalize the presentation as you see fit, in response to time constraints, the physical location of the workshop, the needs or prior experiences of your participants, etc.*

*It is suggested that a group of 2 or 3 people lead the workshop. This allows each person to develop expertise with a portion of the module, and it also gives participants a change of voice and style over the course of the day.*

*The plan below allocates 7.5 hours of time for actual engagement with the module. If you want to revise the schedule or the amount of time for any section, you can use the spreadsheet Time\_Tally.xlsx to help with that. A 15-minute break in the morning and afternoon brings the time to approximately 8 hours. This does not include time for lunch, which should also be added when determining starting and ending times for the workshop. If you plan to have participants complete an evaluation of the workshop, you’ll need to shorten the amount of time allocated for some elements or possibly extend the length of the workshop.*

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| **Item** | **Notes** | **Documents/Resources** |
| **Pre-workshop Preparations** | • Be thoroughly familiar with the Earth System Science EarthLabs module (both Student and Teacher Web sites), including hands-on labs and science concepts, and be sure you have taught the entire module to high school students *at* *least twice* before deciding to lead a workshop that shares it with others. In particular, take advantage of the additional resources included in the Teacher web site to strengthen your understanding of the science. • Review the suggested workshop goals as they appear in the *Intro.pptx*. If you plan to change any goals you will most likely need to make other changes to the resources and plans included here. In any case, be sure to clarify for yourself the workshop goals before taking any additional steps. • The spreadsheet file *Time\_Tally.xlsx* includes a list of time estimates for each section of the workshop, as they are listed below in this Outline. If you wish to make changes to the workshop, the spreadsheet will give you an easy way to keep track of how changes will effect the overall time needed for the workshop, and help you make subsequent schedule revisions.• Be comfortably familiar with the computer technology that is used in the module, including the GLOBE Graphing Tool (Lab 3), Google Earth (Lab 4), the NASA Ocean Motion Ship Drift Model (Lab 5), the NASA NEO visualization tool (Lab 6 & 7), and ImageJ (Lab 7)• Identify a workshop location with wireless internet access. Partner with an institution that can provide space and possibly logistical support. (Your school? A university?)• Identify a local study site within close walking distance of the workshop location. • If possible, partner with a scientist who can be available to address the more challenging questions that might arise, both before and during the workshop, and who can provide additional background information. Remember that one of the goals is to strengthen participant grasp of the science.• Have a good match between the available space and the space requirements of the workshop (number of workshop attendees; tables for hands-on investigations; etc.) • Advertise the workshop.• Have a Web site where interested teachers can sign up to attend the workshop. • Be familiar with workshop leadership best practices (See *Best\_Practices.docx*). These were developed by teachers who have taught EarthLabs modues in the past. They call for a well-coordinated effort among all workshop leaders.• Prior to the workshop, maintain communication with applicants to hold their interest, reinforce that the workshop is happening, and provide them with updates, what then need to bring with them, etc. Recommend that everyone bring a laptop computer to the workshop.• Send participants links for downloading the most recent version of ImageJ software (<http://rsbweb.nih.gov/ij/>) and Google Earth (<http://www.google.com/earth/index.html>) and ask them to download those applications and install them on their laptops before arriving at the workshop. Send follow-up e-mails to see who has completed the downloading and to remind those who have not. • Prepare a folder with all of the images you’ll need to use when leading Lab 7.• If you expect that people might travel a long distance to attend, provide information about overnight accommodations. • Ask participants about food allergies, and make arrangements for serving lunch.• Gather all materials necessary for hands-on labs and demonstrations. (Recommend one set of **materials** for each group of 4 workshop participants.) (See *Equipment&Materials\_List.docx*)• Take photos of the local study site and print them with wide margins (see example on Student Site, Lab 2, Part A.) Make enough copies for each participant to have one.• Complete the worksheet *local\_study\_site\_work.v3.pdf* yourself at the study site to identify as many possibilities as possible. This will prepare you to help workshop participants during the workshop field trip, particularly if the study site is not one you have used previously with your students. • Have available for the workshop the set of cubes you used with your students to engage in the NOAA water cycle game. If those cubes are not available for some reason, visit <http://response.restoration.noaa.gov/training-and-education/education-students-and-teachers/water-cycle-game.html> to find resources for building a new set.• Print enough copies of the *WaterCycleDiagram.pdf* to give each participant a copy. • Be familiar with the technology set-up in the workshop space (electrical outlets; projector; etc.)• Be sure to download recent versions of Google Earth and ImageJ to your workshop computer. | Intro.pptxTime\_Tally.xlsxEquipment&Materials\_List.docxBest\_Practices.docxlocal\_study\_site\_work.v3.pdfWaterCycleDiagram.pdf |
| **Workshop Introduction** [15 minutes] | • Welcome and thank attendees• Introduce workshop leaders• Give overview of the schedule• Point out other logistics (bathrooms; location of water or refreshments; etc.) • Find out if everyone has been able to download and install ImageJ and Google Earth• Ask if there are questions about the schedule before you start.• Explain that you have a few slides to orient them to the EarthLabs project, which holds the Earth System science module, before starting work on the module itself. Show the PowerPoint *Intro.pptx* Be sure to highlight the workshop goals, which are included in the PowerPoint.• Check in with participants: Any lingering questions about what they have just seen? | Intro.pptx |
| **Lab 1**Brief Intro to Earth System[15 minutes] | • Show the PowerPoint *EarthSystem\_Intro.pptx*• Be familiar with the Word file *EarthSystem\_Intro\_NOTES.docx* so you can add important information during the PowerPoint presentation.• Reinforce the idea that the workshop will not walk teachers through the entire curriculum but will give them many of the same experiences the students will have and will strengthen their understanding of the Earth System.  | EarthSystem\_Intro.pptxEarthSystem\_Intro\_NOTES.docx |
| Earth System at the Local ScalePrep for Field trip[15 minutes] | • Announce the field trip, which is an experience that is built into the beginning of the curriculum.• The two goals of the field trip are:1) to have first hand field experience with identifying elements of the spheres, and;2) to start to identify examples of ways in which the spheres are interconnected (matter and energy moves between spheres and between elements of a single sphere) • Explain that while most schools may not have an easily available body of water that can be included in the study site, much can be learned by making observations that involve interactions among or within the pedosphere, atmosphere, and biosphere.• Distribute clipboards and the work sheet titled *Think Globally, Act Locally* (*local\_study\_site\_work.v3.pdf*) and orient teachers to the sheet and their task before leaving for the study site.• Take a first aid kit and several pairs of rubber gloves, for either medical use or for a messy object that people may want to explore but not touch.  | local\_study\_site\_work.v3.pdf |
| Field Trip[60 minutes. Allow 40 minutes at the site] | • Participants can skip Step 5, since you have already taken photos and printed sheets on which they will work after the field trip.• Be prepared to help participants who are having difficulty with this new idea of identifying interconnections. | local\_study\_site\_work.v3.pdfClip boards or cardboard backing so participants can write on work sheet.  |
| Field trip Follow-Up[20 minutes] | • Upon return to the workshop room, ask participants to share the interconnections they have discovered. • What cycles are participants familiar with? (Water cycle? Rock cycle? Carbon cycle? Nitrogen cycle?)• Reinforce the interconnections by asking *“What if…”* questions related to change: *What else will change if X changes?*(See curriculum, Lab 1, Part C for suggestions)• Explain that participants have essentially just worked through the first Lab of the curriculum, *“Think Globally, Act Locally”* and briefly project the student pages for all to see.  | Completed versions of the work sheet local\_study\_site\_work.v3.pdf |
| **Lab 2**Annotating PhotosReservoirs, processes, and flux.[40 minutes] | • Establish groups of 4 to work together on annotating the photographs• Distribute a photograph of the study site to each participant. Explain that the curriculum suggests having students take the photos. • Give groups 10-15 minutes to annotate their photos. (See curriculum Lab 2, Part A for more information)• Have participants address the Checking In and Stop and Think questions.• Explain that an activity in the curriculum which we will **not** do here (because of time constraints) but that is important, is for students to make a simplified (more abstract) sketch of the annotated photo, and to add the annotations that highlight the interconnections of the earth system. The goal is learning how to focus on and highlight the primary elements of the photograph that are cycling matter or energy within and between components of the earth system. • Show the PowerPoint slide *Abstraction\_Reservoirs\_Etc.pptx*There are two parts to this. The first slide shows an example of a simplified sketch and the second provides definitions of three terms that are key to understanding the Earth system: *reservoirs*; *processes*; and *flux.* Refer to the document Notes-about-reservoirs.docx as you show the second slide in this 2-slide PowerPoint; it provides several examples of reservoirs and processes that happen across a wide range of temporal and spatial scales. Point out that, for students, the curriculum purposely moves sequentially from local to regional to global scale examples, but that for the sake of efficiency here, we are jumping to all three scales in there examples. • This concludes Lab 2 of the student curriculum.  | Abstraction\_Reservoirs\_Etc.pptxNotes-about-reservoirs.docx |
| **Lab 3**Using local data[60 minutes] | *Note: In preparing for this, complete the graph yourself and make screen shots of the graphs so you can use them in a PowerPoint to analyze the data even if you do not have time during the workshop to complete the graph. Print copies of the instructions to hand out to teachers, so they can use their laptops for doing the actual work on the GLOBE web site.*• Use the instructions on the Student web site (Lab 3, Parts A, B, C, and D) to walk participants through the process of developing the graphs using the GLOBE data visualization tool. If possible, individuals work on their own laptops. Explain the value of having students work with actual data to uncover some of the Earth system interactions. The exercise could inspire teachers or students to collect data at their own schools. Limit this to one hour, even if some do not complete the activity, and be sure to save the last 15 minutes for analyzing the data.  |  |
| **Lab 4**Earth System at the Regional Scale [30 minutes] | • Lab 4 of the student curriculum moves the concepts of energy and matter moving through the Earth system from the local to the regional level. No need to spend a lot of workshop time on this, but share some of the key ideas with workshop participants:1. Students should realize that, even when a school’s local study site looks very different than their own, because it is in a different *region* (different topography, or different climate, or at a very different elevation, or different proximity to water, etc., the flow of matter and energy will continue to take place among the spheres, or among elements within a sphere, even though the land or species or rate of exchange is very different then what they have for a local environment. 2. Earth system processes and exchanges happen at different scales. Just as they were able to identify interconnections between spheres at the local level, similar kids of interconnections occur at the regional level. Water, air, animals, cars, trains, people, etc. transport matter and sometimes energy into or out of a region.• Briefly show the first 4 slides of the PowerPoint *Regional.pptx*, which give examples of Earth system interconnections in different regions but still at the local scale. How do the processes in these va• Next, using computer and projector, open Google Earth and show your workshop location in the center of the screen from an elevation of approximately 20,000 feet. • The concept of Region is very flexible: a region is larger than the hundreds of square yards that you might consider for a local setting, but it is smaller than the global scale, which includes the entire planet. It can have natural boundaries (a valley, peninsula, or watershed) or artificial boundaries (an arbitrary screen on Google Earth; a political boundary such as a city, town, or state; surrounding highways; etc.) Size is not important. The important concept is that it has defined boundaries, so students can discuss what enters the region and what leaves it. What are inputs and outputs? Matter and energy can enter and leave a region via the atmosphere (wind, rain) the hydrosphere (rivers, streams, groundwater), the biosphere (animals, people…via automobiles, bicycles, airplanes) and more. Students can brainstorm the various possibilities. What enters? What leaves? What is the net result? • Repeat the “What if..?” exercise of the local scale: What in the region would change if…? | Regional.pptxGoogle Earth |
| **Lab 5**Earth System at the Global Scale(45 minutes) | *NOTE: The student web site only addresses the fact that global circulation patterns exist in the atmosphere and the ocean, and that they play major roles in the global distribution of thermal energy and matter. The factors that drive the circulation patterns are not addressed on the student pages. The teacher web site does address the mechanisms that drive those circulation patterns, and it is important to address these mechanisms in a teacher workshop. Teachers should be able to explain the underlying drivers of these major circulations* *In Lab 5 of the Teacher Web site, read the section titled “Additional Resources”. One of those resources, NOAA’s 49-page ‘Currents Tutorial”, is available at <http://oceanservice.noaa.gov/education/kits/currents/lessons/currents_tutorial.pdf>**The specific section of that tutorial that addresses thermohaline circulation, or the global conveyor belt, has been extracted as a separate resource and is available here. (See ConveyorBelt\_Tutorial.pdf)*• Using the PowerPoint *Global\_Circulation.pptx ,* introduce the major atmospheric circulation cells (Hadley cells; Ferrell cells; Polar cells), how they arise as a result of the uneven solar heating of our planet’s spherical shape, and how the Coriolis effect deflects the flow of the cells to create the global wind patterns. • Highlight the impact of these atmospheric circulation patterns: they have a particular influence on climate and the biosphere by transporting water vapor, aerosols, and thermal energy across the planet. • Introduce the two major types of ocean circulation: wind-driven and thermohaline. The ocean is a significant reservoir of solar or thermal energy and plays a major role in redistributing thermal energy from the equatorial region, which receives the most intense solar radiation, towards the poles, thereby having a significant impact on Earth’s climate and biosphere. • Point out the Ocean Motion Ship Drift activity, but do not have participants use it. Students will enjoy dropping virtual bottles into the model to see where the ocean currents take them.  | Global\_AtmosphericCirculation.pptxConveyorBelt\_Tutorial.pdf |
| **Lab 6**[60 minutes]NASA NEO | *Note: To prepare yourself, read the document NASA Earth Observations (NEO): A Brief Introduction (see Using\_Neo.pdf). Print the set of instructions for using NEO provided in Lab 6A and give a copy to each pair of workshop participants. Many will find it difficult to have both the instructions for using NEO as well as the NEO program itself on their laptop screens. The work will proceed much more quickly when everyone has access to printed instructions.*• Have participants follow the instructions in Lab 6 of the Student web site for going to the NASA Neo Web site and using the NEO visualization tool. • Remind participants that the purpose of the workshop is to introduce them to the module and get them familiar enough with the activities so that they’ll be interested in returning to them to master them before they use them in class. They will not have time to master all concepts and activities during the one-day workshop.  | Using\_NEO.pdf |
| [15 minutes] | • Show teachers a completed set of cubes for the water cycle game and describe the activity and its value but do not take the time to play the game during the workshop.  |  |
| **Lab 7**[60 minutes] | *Note: The freely available software ImageJ is a multi-purpose image processing software. The only feature of ImageJ used in this activity is its capacity to combine a series of images and make them into an animation. To help prepare yourself for leading this be sure that every member of the leadership team is completely familiar with using ImageJ for this purpose, and anticipate that teachers who have not used ImageJ previously may need a lot of assistance.* *Print the set of instructions for using ImageJ to create an animation, which are available on the Teacher Web site under the* ***Additional Resources*** *section. Provide a copy to each pair of attendees. This will allow the process to move forward much more quickly.* *Have sets of 12 images on a thumb drive and be prepared to provide them to participants who are having a particularly difficult time getting their own set in a timely way.**If you are running out of time you can also distribute the images to everyone in the workshop, although ideally participants will have the opportunity to practice getting the images themselves.* • Explain that participants will continue to work with the NEO images, but this time they’ll import a set of 12 into ImageJ, where they can create an animation that runs across a full year and they will highlight the seasonal changes. • Distribute the set of simplified instructions for creating stacks. • Follow the instructions provided on the Student web site. • What patterns do participants notice at the global scale? What connections do they see? Do the animations highlight the relationship between solar energy and other variables? |  |
|  **Wrap-Up**[15 minutes] | *The continuous cycling of energy and matter interconnects Earth’s spheres, and that cycling occurs at the local, regional, and global scales. The processes that drive the cycling (combustion, decay, digestion, evaporation, etc.) can be more concrete, more easily observed or imagined at the local level, but having the experiences at the local level can help us imagine them at the regional and global scales.* *For matter, Earth can be considered a closed system (although insignificant amounts of matter are sent off into deep space as planetary probes, or arrive on Earth in the form of meteors.) But matter is neither created nor destroyed, so although it changes form, the same matter has been cycling through the ddifferent spheres and reservoirs of the Earth system since the beginning.* *For energy, Earth is an open system, but one that is stable. Solar energy is constantly arriving on Earth and the same amount of energy is constantly radiated back into space (unless Earth’s average temperature changes, in which case we lose the energy balance.) But the total amount of energy in the Earth system remains essentially the same. Energy is neither created nor destroyed, but changes form and cycles through the various spheres and reservoirs of the Earth system.*  |  |