# National Wildlife Federation Eco-Schools : Development of Climate Related School Lessons Using NASA Data Sets

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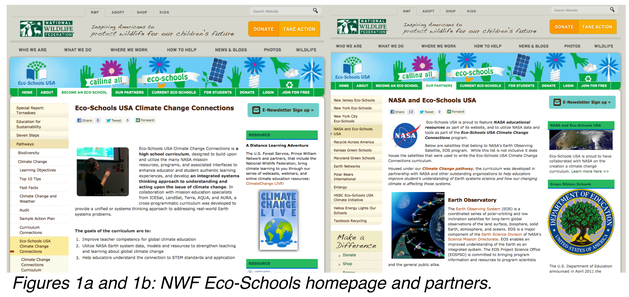
## Introduction

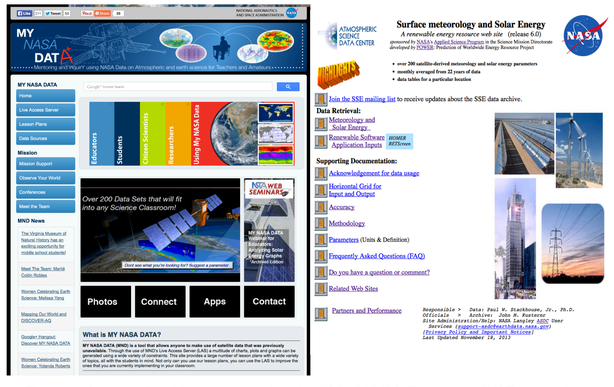
The National Wildlife Federation (NWF) and its Eco-Schools USA program is focused providing an engaging educational experience to help students better understand the essential principles of Earth's systems and the impact of climate change on them. The program is aimed to provide those students with the ability to communicate about climate change and apply knowledge in decision making. To achieve these objectives, the NWF partnered with NASA scientists and developed the Eco-Schools USA Climate Change Connections (CCC) is a 9th-12th grade curriculum. CCC is designed to build upon and utilize the many NASA mission resources, programs, and associated interfaces to enhance authentic learning experiences for both educators and students. It seeks to develop an integrated systems-thinking approach to understanding and acting upon the issue of climate change. In collaboration with mission specialists from ICESat, LandSat, Terra, AQUA, AURA, a cross programmatic curriculum was developed to provide a unified or systems-thinking approach to addressing real-world Earth systems problems (see NWF web page below). The curriculum is available for free on the National Wildlife Federation web site at:

http://www.nwf.org/Eco-Schools-USA/Become-an-Eco-School/Pathways/Climate-Change/What-is-Climate-Change-Connections.aspx




*Figures 1a and 1b: NWF Eco-Schools homepage and partners.*

In this presentation, we provide an overview of the Climate Change Connections lesson curriculum but focus specifically on a couple of example exercises where NASA data sets are used to teach basic lessons about aspects of the climate system as it pertains to the built environment. In particular, we show how data adapted from NASA's GEWEX Surface Energy Budget (http://gewex-srb.larc.nasa.gov) are applied to a lesson in solar energy. These data sets are made available directly through NASA web portals entitled "My NASA Data" (http://mynasadata.larc.nasa.gov - Fig. 2a) and the Prediction of Worldwide Renewable Energy Resource (POWER – http://power.larc.nasa.gov). At the POWER web portal there is a link to the Surface meteorology and Solar Energy web portal (SSE – http://eosweb.larc.nasa.gov) providing data sets tailored specifically to the assessment of solar energy resource at any location on the globe (Fig. 2b). Here, we depict the sources of these data and their subsequent usage in the Eco-Schools USA CCC Lessons.




*Figures 2a and 2b: Homepages for the "My NASA Data and SSE web sites.*

## Eco-Schools USA Climate Change Connections Overview

The main web page for the NWF Eco-Schools USA Climate Change Connections (CCC) is shown in Fig. 1a. The web page clearly describes the purposes and objectives of the curriculum and in addition provides other links and information available. It is important to note that two teacher's workshop were held with the express purpose of introducing the teachers to the various data sets and concepts presented in the curriculum and Having them work through the lessons. The teachers then provided feedback on a large variety of issues regarding the ease of use of these materials in the classroom. A number of NASA scientists were invited to make presentations as well. These workshops provided feedback crucial to improving the curriculum and better ensuring usage by teachers in the classroom.


*Figure 2: Front page of curriculum overview report.*

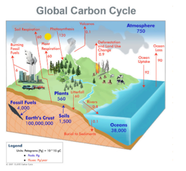
The document "National Wildlife Federation Presents Eco-Schools USA Climate Change Connections (see Fig. 2 above) provides a comprehensive overview of the curriculum available at the link:

http://www.nwf.org/pdf/2013%20NASA/CCC%20Curriculum%20Introduction.pdf

The curriculum lessons are divided into 4 modules. Those modules and the lessons included in each, with short descriptions of each lesson are given below as described in the overview document above.

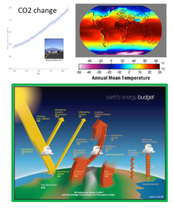
**Module I: Introduction to Eco-Schools USA and NASA Data**

3 introductory lessons concerning:
- Eco-Schools USA program
- NASA data availability through "My NASA Data"
- An overview of to the carbon Cycle in the Atmosphere



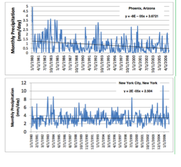

**Module II: Factors Influencing Temperature**

6 lessons concerning:
- Surface land temperature and thermal infrared radiation
- Surface albedo
- Surface land cover and its changes
- Understanding and evaluating trends




**Module III: How Climate Affects Natural and Human Systems**

9 lessons concerning:
- Arctic sea ice, sea surface temperature, land temperature and plant/animal/human habitats
- Precipitation patterns and variability
- Sea level rise and coastal communities




**Module IV: Renewable Energy and a Call to Action**

3 lessons concerning:
- Solar and wind energy resources and their potential to produce energy at local schools
- Some possible climate actions at a student's local school

*Figures 4a-d: The modules of the CCC curriculum with brief descriptions.*

Together all modules contain 27 lessons. Here, we highlight Lesson #19 from Module IV on the solar resources and the potential for solar power at individual locations.

## Lesson #19: Solar Power Potential At Your School

The main objectives of this lesson are shown by the front page of the lesson in Fig. 5 (this format is used for all lessons).

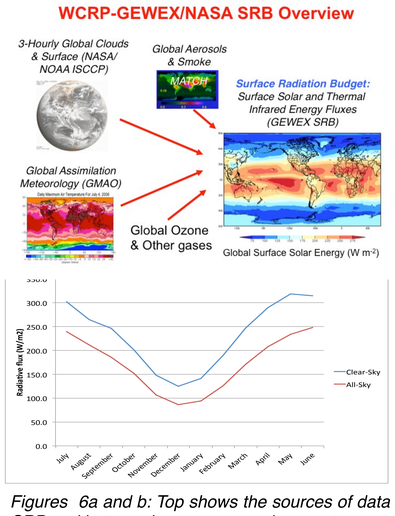
There are 3 parts to this particular lesson. Each with step-by-step procedures and follow on questions.

For this lesson:
- Part 1: Gathering information on solar energy in your area
- Part 2: Estimate the solar energy potential for your school
- Part 3: Put what you've learned in a global context.


*Figure 5: First page of lesson #19*

### Part 1: Gathering Data

For this part, the student follows instructions to download data from the "My NASA Data Web" site (see 1st column left). The data required for this lesson, archived at the "My NASA Data" site are taken from the World Climate Research Programme (WCRP) Global Energy and Water Exchanges Project (GEWEX) Surface Radiation Budget (SRB) project based at NASA Langley and supported by NASA. Below is a schematic illustrating the satellite sources and assimilation model (both atmospheric aerosol assimilation data sets (atmospheric models optimized with a variety of observations) used to estimate the global solar irradiance (Fig. 6a). The products describe the surface solar and thermal infrared energy fluxes currently spanning for July 1984 to December 2007. Through the My NASA data Web site, a variety of solar irradiance quantities can be downloaded for a specific location, zonal averages, global maps and time series.




*Figures 6a and b: Top shows the sources of data for SRB and bottom shows an example output.*

A monthly averaged annual cycle is provided as a sample image showing surface solar fluxes for clear-sky (no clouds) and all-sky conditions at a specific location on the globe (Fig. 6b).

Through NASA Earth Science Applied Science program GEWEX SRB fiuxes along with selected inputs are tailored specifically to the renewable energy and agricultural industries. SSE fluxes are used next.

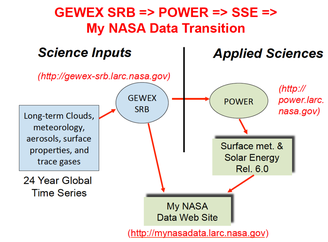



*Figure 7: Schematic illustrating delivery of data products to "My NASA Data" web portal.*

### Part 2: Estimating the Solar Energy Potential For Your School

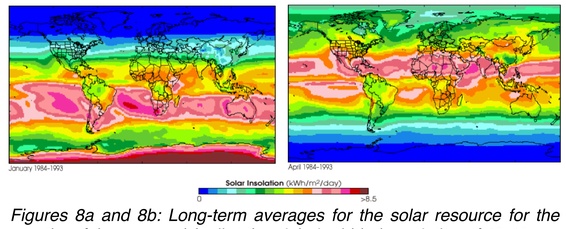
For this part, the student follows instructions to download data from the "My NASA Data Web" site but from the web site entitled Surface meteorology and Solar Energy (SSE Release 6). The web site SSE contains parameters specifically designed for solar energy systems and is capable of providing those parameters at any location on the globe. Here the students, specify their location and obtain the amount of solar energy in engineering units received at their school's location. If they have obtained information regarding their school buildings typical power usage, then they can estimate the size of the solar panels needed to replace or supplement that power. The table below provides a sample output of the exercise.

| Month | Days/month | Monthly Averaged Energy Usage by Your school (kWh/month)* | Monthly Averaged Insolation Incident On A Horizontal Surface (kWh/m²/day) | Monthly Averaged Insolation Incident On A Horizontal Surface (kWh/m²/month) | Area required to meet school's energy needs (m2) -- Assuming 100% efficiency | Area required to meet school's energy needs (m2) -- Assuming 20% efficiency |
|---|---|---|---|---|---|---|
| Jan | 31 | 32,500 | 2.27 | 70.37 | 462 | 2309 |
| Feb | 28 | 32,500 | 3.01 | 84.28 | 386 | 1928 |
| Mar | 31 | 32,500 | 4.09 | 126.79 | 256 | 1282 |
| Apr | 30 | 32,500 | 4.96 | 148.8 | 218 | 1092 |
| May | 31 | 32,500 | 5.6 | 173.6 | 187 | 936 |
| Jun | 30 | 32,500 | 5.95 | 178.5 | 182 | 910 |
| Jul | 31 | 32,500 | 5.74 | 177.94 | 183 | 913 |
| Aug | 31 | 32,500 | 5.06 | 156.86 | 207 | 1036 |
| Sep | 30 | 32,500 | 4.48 | 134.4 | 242 | 1209 |
| Oct | 31 | 32,500 | 3.66 | 113.46 | 286 | 1432 |
| Nov | 30 | 32,500 | 2.56 | 76.8 | 423 | 2116 |
| Dec | 31 | 32,500 | 2.06 | 63.86 | 509 | 2545 |
| Annual Average | | | 4.12 | 125.47 | 295 | 1476 |

* based on average energy usage for a Wisconsin school

### Part 3: Providing a Global Context

For this final part, the student follows instructions to download more data from the "My NASA Data Web" site through the SSE web site but this time for regional and global areas. Then the student answers questions about the distribution of solar irradiance for various locations and seasons, noting the variability of the annual cycles.




*Figures 8a and 8b: Long-term averages for the solar resource for the months of January and April* at the global gridded resolution of 1ºx1º.

## Conclusions

On this poster, we have provided a general sketch of the National Wildfire Federation's Eco-Schools USA Climate Change Connections curriculum. Aimed at 9th-12th graders, the lessons address some of the fundamental concepts involved in climate change research using data sets made available from NASA research to provide a more thorough hand-on type approach. With this curriculum, it is our desire that educators utilize this curriculum to attract and retain students in STEM disciplines and inspire the next generation of Earth Scientists**.**

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