



## Quick Start Guide

<http://edgcm.columbia.edu>

Version 3.2



IDL

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4th Dimension is copyright © 1995-2009 by 4D, Inc.  
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The GISS GCM Model II is in the public domain.

The GISS GCM is under continuous development at NASA's Goddard Institute for Space Studies (<http://www.giss.nasa.gov>). A detailed description of GISS Model II, the GCM used by *EdGCM*, is given in the following reference:

J. Hansen, G. Russell, D. Rind, P. Stone, A. Lacis, S. Lebedeff, R. Ruedy, and L. Travis, Efficient Three-Dimensional Global Models for Climate Studies: Models I and II, *Monthly Weather Review*, vol. 111, no. 4, April 1983.

\* \* \* \* \*

Although Panoply was produced at a U.S. Government research institute, the complete Panoply application cannot be considered public domain because it includes libraries provided by third parties which have individual copyrights and licenses. Please see <http://www.giss.nasa.gov/tools/panoply/> for further information, additional copies and/or updated versions of Panoply.

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## **Project Director**

Mark Chandler

## **Science Editor**

Linda Sohl

## **Lead Programmer**

Ken Mankoff

## **4th Dimension (EdGCM database)**

Michael Shopsin

Ken Mankoff

Matthew Shopsin

## **EVA (EdGCM Visualization Application)**

Ken Mankoff

## **GISS GCM Model II**

Mark Chandler

Michael Shopsin

David Rind

Jean Lerner

Jeff Jonas

Reto Ruedy

Gary Russell

Andy Lacis

## **Panoply**

Robert Schmunk

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**IDL**



Dear soon-to-be climate modelers,

In bringing users into direct contact with complex computer models such as a Global Climate Model (GCM), *EdGCM* exposes the strengths and weaknesses of computer models in a way that scientific papers and newspaper articles frequently obscure. The danger in creating a point-and-click interface for a GCM is that users might be tempted to treat the model as a black box, and then we would not be achieving ***our overarching goal: to encourage more people to learn about and use global climate models.*** *EdGCM* allows people to become familiar with both the scientific process and the tools of the trade that are an integral component of state-of-the-art climate research and climate change forecasting. We hope that courses employing *EdGCM* will encourage more students to pursue Earth science careers, and that the experience will allow them to participate in climate research at an earlier stage in their education. However, we also hope that all who use *EdGCM* in any fashion will become better informed about climate change issues that affect everyone on the planet. If *EdGCM* helps to demystify this complex but crucial subject matter, then it is fulfilling a key objective.

*EdGCM* does not require a sophisticated understanding of climate to use, but climate science is an exceptionally multi-disciplinary field and an understanding of one or more of the associated disciplines (atmosphere, oceans, geology, physics, mathematics, biology, chemistry) will definitely enrich the experience. During the past few years, we have been heartened to see *EdGCM* used at levels of education from middle school to graduate level, as well as in museums, science centers, and even in professional research projects. *EdGCM* is now in use in many countries, and on all seven continents. We welcome you to this growing community of climate modelers, and hope that your experience with *EdGCM* encourages you to appreciate even more our amazing home planet.

Happy Modeling!

Dr. Mark Chandler  
Director, The *EdGCM* Project







# Introduction to *EdGCM*

Welcome to *EdGCM*, an integrated software suite designed to simplify the process of setting up, running, analyzing and reporting on global climate model simulations. The software package includes a full copy of 4<sup>th</sup> Dimension® database software (4D, Inc.) and the NASA/Goddard Institute for Space Studies' Global Climate Model II (i.e., GISS GCM Model II). The GISS GCM Model II is currently in use for climate research at NASA labs and several universities. For a complete description of the GISS Model II, see Hansen *et al.*, 1983, included inside *EdGCM*'s Documentation folder.

*EdGCM* includes everything you need to begin exploring climate science using a research-quality computer climate model. Despite the complexity of the underlying GCM, the *EdGCM* interface and associated utilities allows the model to be operated and managed by teachers, students, and researchers with minimal training. Please note, however, that there is limited documentation, so if you have not already attended one of our training workshops you may have difficulty utilizing some of the many functions available in this package. You are welcome to contact us for help in getting started, but we are currently only offering significant support to institutions that are collaborating with us for evaluation purposes. If you would be interested in arranging a training session please DO contact us. Contact information is available at <http://edgcm.columbia.edu>.

## 1. System Requirements

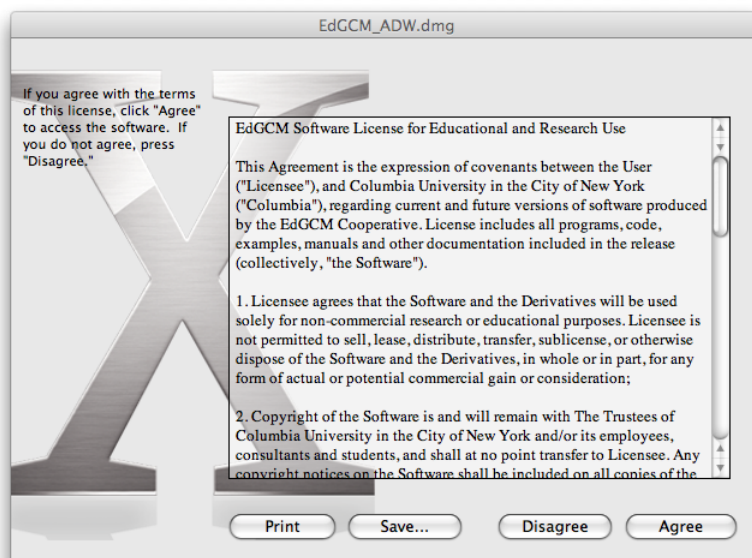
- Mac OS X 10.3.9 or higher, including Mac OS X 10.5 (Leopard); Windows 2000/XP/Vista (XP Pro or Vista Home Premium editions recommended)
- Any Mac with an Intel processor, or a G3 or better PowerPC CPU; any PC with an Intel or AMD processor running at 300 MHz or faster
- 1 GB of free disk space (for installation only; simulation results may require an additional 4-5 GB)
- 512 MB RAM minimum recommended
- Internet connection is helpful but not required



## 2. Installation Guides: Macs and Windows

### 2.1. For Mac OS X

1. Download the latest disk image (e.g., EdGCM.dmg) from the *EdGCM* web site. When the license agreement appears, click “Agree” to continue mounting the disk image on your desktop (Figure 1).



*Figure 1. Please note that EdGCM's license agreement is for academic use only.*

2. Once the disk image is mounted (Figure 2), simply drag the EdGCM folder to the desktop, or to any other desired location where you (or other users) will have write access. Launch *EdGCM* by double-clicking on the shortcut inside the *EdGCM* folder.



*Figure 2. Installation of EdGCM on a Mac is a simple drag-and-drop process.*

### Note on cross-platform compatibility

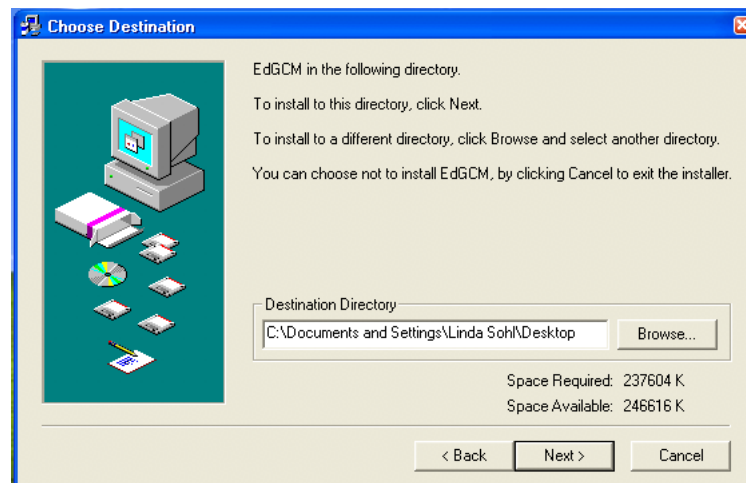
All output files produced by the Mac OS X version of *EdGCM* 3.2 are compatible for use with the Windows 2000/XP/Vista version, with the exception of files used by SuSpect, as this program currently has no Windows equivalent.



## 2.2. For Windows 2000/XP/Vista

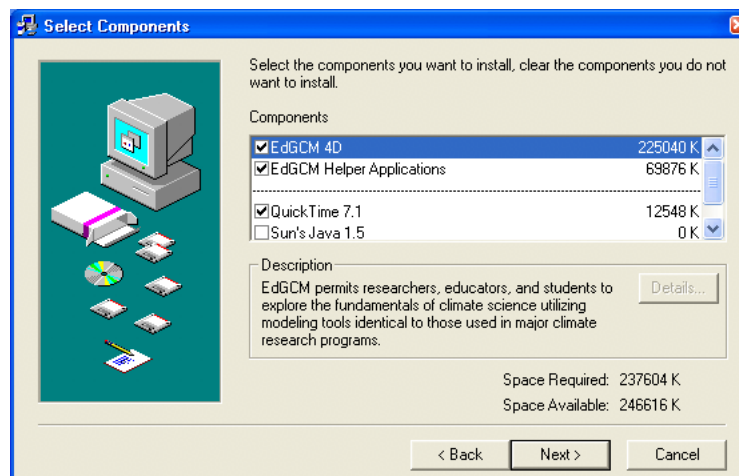
1. Download the latest installer (e.g., EdGCM.exe) from the *EdGCM* web site to your desktop, and double-click on the file name to begin the installation process. When the license agreement appears, click “Agree” to continue the installation process. Please note that you may need an administrator’s password to complete the installation; if you do, you will need to ask your IT administrator for assistance.
2. The default installation location for *EdGCM* is your desktop (Figure 3). You may choose another location, but you (or other users) must have write access for that directory (e.g., C:/>Program Files won’t work).

Figure 3. The Windows installer for *EdGCM*.



3. Select the components of the *EdGCM* package that you wish to install (Figure 4). We recommend that you leave all choices checked since QuickTime and Java are required to use *EdGCM*. The QuickTime installer will only run if you do not already have QuickTime installed. The Java installer will replace any existing copy of Java with the latest version from Sun.

Figure 4. The *EdGCM* installer for Windows will also install QuickTime and Java if needed.



4. If you do not already have QuickTime and Java on your PC, installation of these components will begin now. Simply accept the license agreements and opt for a typical setup rather than a custom installation. The installation process for these programs may take several minutes each.

5. Launch *EdGCM* from either the Start Menu or from the shortcut on your desktop.

### **Note on cross-platform compatibility**

All output files produced by the Windows version of *EdGCM* are compatible for use with the Mac version.

### *2.3. Registering Your Copy of EdGCM*

1. When you launch *EdGCM* for the first time, a dialog box will appear, asking you to register (Figure 5). If you have already purchased your copy of *EdGCM*, type in the license key exactly as given in your confirmation email, and click on the “Enter” button to complete your registration.

2. If you wish to use *EdGCM* in demo mode, leave the license field blank and click on the “Demo” button. You will then have 30 days to try out the software; the demo is fully functional during that time. While running in demo mode, the registration box will appear each time you launch *EdGCM*, reminding you of the number of days remaining in your free trial.

3. If you have been using *EdGCM* in demo mode and decide to make a purchase, leave the license field blank and click on the “Purchase” button. You will be directed first to the *EdGCM* web site to provide some basic user information, and then to the *EdGCM* online store (hosted by Kagi) to complete your credit card or PayPal purchase. Once you have received your license key, follow step 1 above to complete registration.

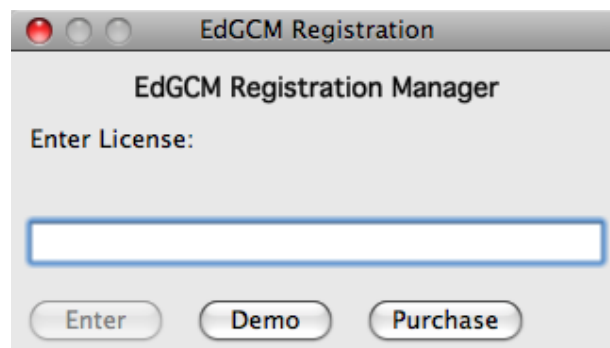


Figure 5.

### 3. Some Notes Before You Begin

#### 3.1. Performance: How Fast Will It Run?

The speed at which the GISS GCM runs is based primarily upon the speed of the computer's CPU. Other factors that play a role include the number of applications running at the same time, compiler optimizations, and whether or not your system is dual- or single-processor. The 64-bit CPUs in machines such as the PowerMac G5 allow the GCM to run significantly faster, since twice as many calculations are possible during one clock cycle than in the typical 32-bit systems used by most desktop computers.

The GISS GCM divides the atmosphere into a three-dimensional grid system. The version incorporated into *EdGCM* uses an 8° X 10° latitude by longitude grid system, and has nine vertical layers in the atmosphere and two ground layers. Running the climate model entails the solving of a series of complex physics equations for every cell in the grid, and a single simulated year involves many billions of calculations. Real-world performance has always been essential for the GISS GCM for research purposes, so the model was originally coded to be highly efficient. It has been further optimized to run at acceptable speeds on desktop computers without sacrificing any accuracy, but newer desktop computers will run the model the fastest.

Over the past four years, the number of simulated years per day (syears/day) for the GCM has increased more than twenty-fold on desktop Macs (see the table below). As a general guideline, most simulations that would be of interest (either in the classroom or for research) need to run at least 10 simulated years. Simulations with altered forcings, such as increased greenhouse gases, must run using the predicted ocean option and require a minimum of 50 simulated years to reach equilibrium.

Table of simulated model years per day. The speed at which the GISS GCM runs on a desktop computer scales closely with CPU speed. However, changes to the microchip architecture, L2 cache levels, and compilation optimizations may also have a significant impact.

Computer (OS)	CPU/CPU Speed	Simulated Years / Day
eMac (OS X 10.3)	PPC G4, 800 MHz	35
PowerMac (OS X 10.4)	PPC dual-G4, 1.42 GHz	66*
PowerMac (OS X 10.4)	PPC dual-G5, 2.0 GHz	120*
Dell OptiPlex (Win XP)	Pentium-4, 2.8 GHz	130
MacBook Pro (Vista)	Intel Core Duo, 1.8 GHz	131*
iMac (Win XP)	Intel Core Duo, 1.8 GHz	152*
MacBook Pro (OS X 10.5)	Intel Core Duo, 1.8 GHz	160*
PowerMac (OS X 10.4)	PPC quad-G5, 2.5 GHz	160*
Dell Dimension (Win XP)	Intel Core 2 Duo, 2.4 GHz	180*
Mac Pro (OS X 10.5)	Quad Core Intel Xeon, 2.8 GHz	373*

\*Per processor.





### 3.2. Power Settings On Your Machine

It is also important that you not let the computer “sleep” when the GCM is running. Sleep mode will cause the run to stop and can corrupt the files required to complete the simulation. To prevent the computer from going into sleep mode, the Energy Saver settings for your Mac (Figure 6) should be set to “never sleep the computer.” (Setting the display to sleep is fine, and will not affect your simulations). In addition, do not check the box that allows the hard disk to sleep, as this may also damage simulation output files.

You can run *EdGCM* on newer laptops as well as desktops, but you should always do so with the laptop plugged in, not while running on battery power. Note that some laptops get very hot while the model is running; you should make sure that the laptop gets ample ventilation to avoid shutdown due to overheating.

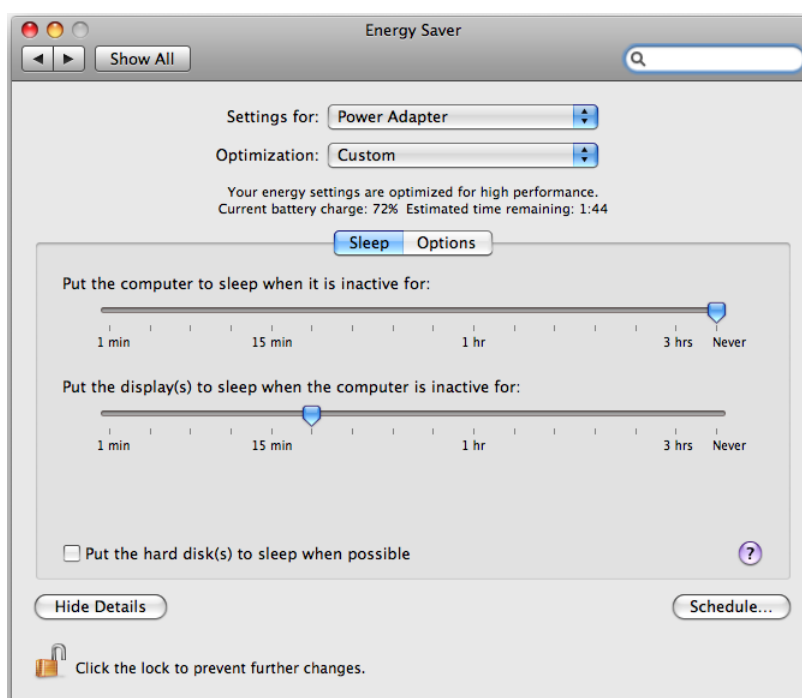


Figure 6. For Macs, the *Energy Saver* settings (within *System Preferences*) should be set such that the computer never sleeps.

For PCs, the appropriate power settings are set through the Control Panel, which is accessible from the Start Menu. In the Control Panel, double-click on “Performance and Maintenance” and then select “Power Options” to bring up a dialog box to display Power Option Properties (Figure 7). Select the Power Schemes tab, and from the drop down menu select the “Always On” option. As with Macs, allowing the monitor to go to sleep will not affect the running of the GCM.



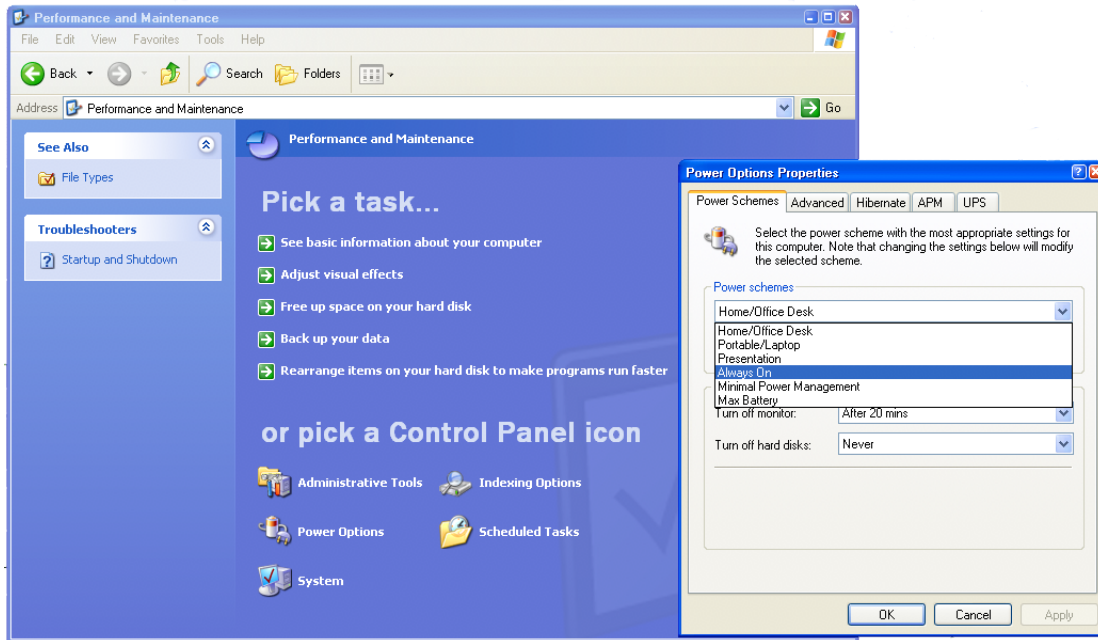



Figure 7. For PCs, the Power Scheme should be set to “Always On” to prevent the system from going into sleep mode while the GCM is running.

Under both Mac OS X and Windows 2000/XP/Vista you may run additional applications, such as Microsoft Word or Excel, while the GCM is running. You may even start more than one simulation at a time, although the simulations will then have to share processor time. On single-processor systems any additional applications will slow the GCM dramatically, but will not harm the simulation in any way. On dual-processor computers the impact on the speed of the run will be minimal unless you run many applications at once.

Finally, you can quit the *EdGCM* 4D interface once a simulation is running, because the GCM runs as a separate application in the background. However, you will need to restart the *EdGCM* 4D interface to analyze the output once the run has finished.

### 3.3. Known Software Problems and Issues

- We recommend that you NOT leave the GCM running on a Windows laptop unattended. We have found that some Pentium laptops have difficulty dissipating heat and may shutdown (hibernate) without warning causing the climate model to crash. This does not appear to harm the laptop, but it can corrupt GCM output files.
- *EdGCM* will work as described on MacOS X using the default HFS+ disk format. We do not recommend using *EdGCM* on UFS or case sensitive HFS formatted disks as some bugs may appear.



- A few PCs have exhibited strange behavior when running long simulations. The behavior has been traced to faulty cooling of CPUs, and substituting another computer has fixed the problem. Macs appear to have sufficient cooling to avoid similar problems with long simulations.

- *EdGCM* is not available for the Linux platform, as our 4D database software (the foundation for both file organization and the user interface) is available for Mac and Windows only. It is possible however to run *EdGCM* on a remote Windows machine using an rdesktop client on a Linux box. *EdGCM* also runs well on Windows XP and Windows Vista under Parallels on a Mac Intel machine.

- *EdGCM* running in native Intel mode on Macs has a serious bug that causes the GCM to stop at the end of each calendar year in simulations that use greenhouse gas trends. This requires the user to restart the GCM at the end of each simulated year. *EdGCM* versions running on PowerPC Macs or on Windows computers are unaffected.

# EdGCM Tutorial

The purpose of the following tutorial is to familiarize you with the setup, running, and post-processing of a global climate model simulation. This example is based upon one of the global warming scenarios included on your *EdGCM* CD-ROM. Although you will see the fields and options that can be changed for customized simulations, we will mainly demonstrate the use of the pre-programmed values in the global warming scenario for this tutorial. Unless otherwise indicated, each step will be the same in both the Mac and Windows versions.

There are also video tutorials for *EdGCM* version 3.2 available on our web site (<http://edgcm.columbia.edu/support/multimedia/>).

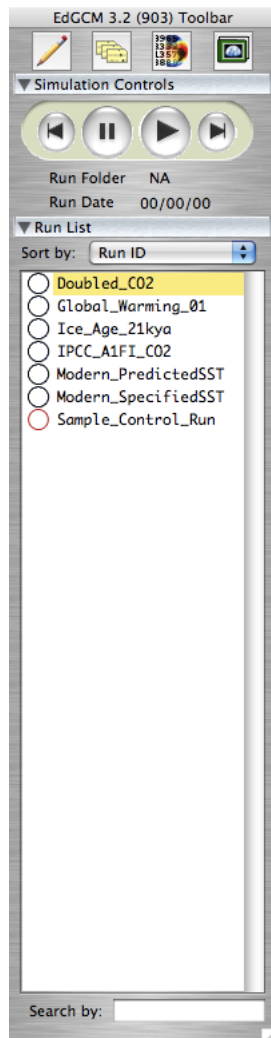


Figure 1. The basic *EdGCM* Toolbar.

## 1. Launching *EdGCM* and Setting Up a Simulation

1. **Mac:** In the *EdGCM* folder, double-click on the *EdGCM* shortcut to launch the application.

**Windows:** Double-click on the *EdGCM* shortcut on the desktop, or select *EdGCM* from the Start Menu to launch the application.

The first window that will appear will be the basic *EdGCM* Toolbar. The set of icons across the top are shortcuts to some of the key functions in the software (e.g., Setup Simulations, Analyze Output). Below these are a set of controls for starting and pausing simulations, as well as restarting and extending them.

The Toolbar also includes a list of simulations already available (the run list). The buttons in the Toolbar will automatically change to provide new options as various *EdGCM* functions are selected, but the run list will always be present. The run list may also be used to search for a particular run ID, or to sort through a long list of run IDs.



2. In the menu at the top of the screen, click once on “Window” to display the various function windows within *EdGCM* 4D, and select “Setup Simulations” (or press cmd + 1 for Macs, ctrl + 1 for Windows). To see the initial conditions for the Global\_Warming\_01 scenario, make sure it is selected in the run list. Note the changes to the Toolbar relevant to the Setup Simulations window (Figure 2).

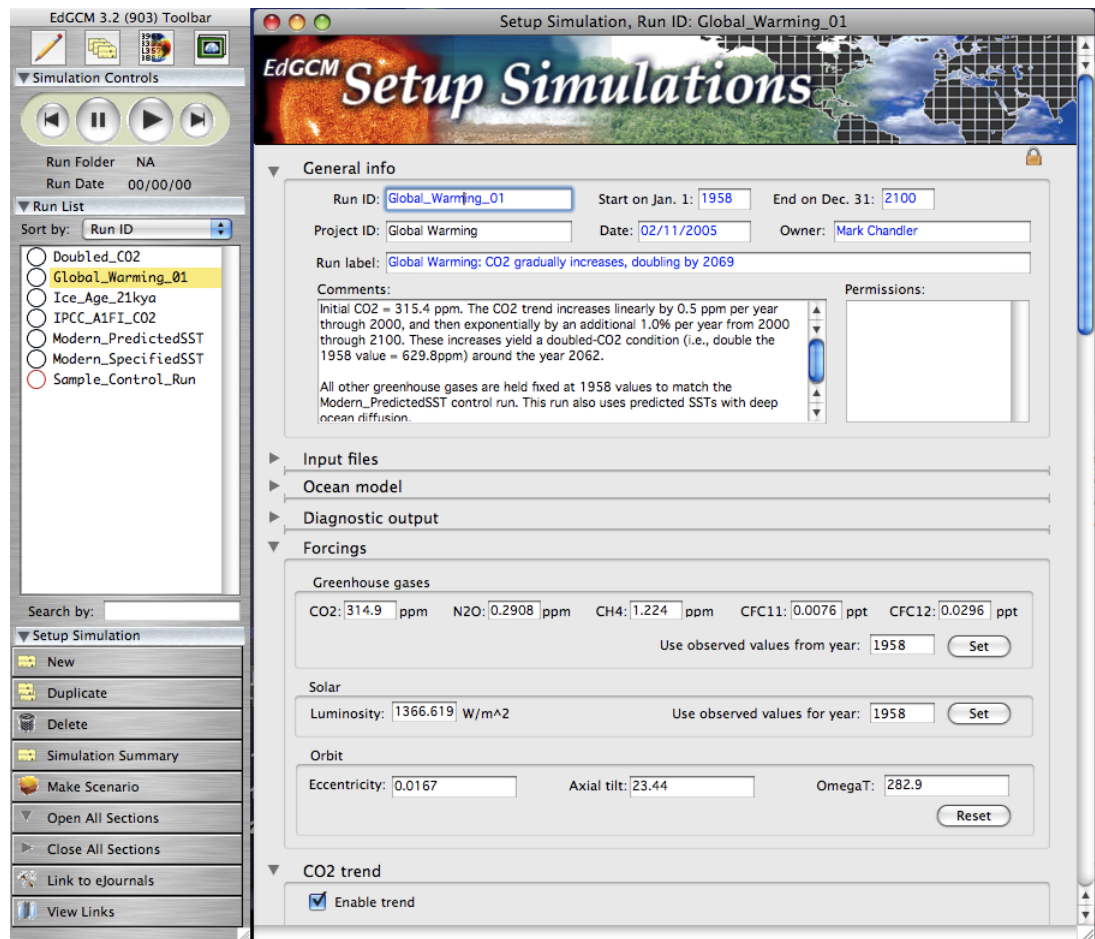


Figure 2. The Setup Simulations window and its associated Toolbar.

The comments section in the **General info** section of the Setup Simulation window provides the simulation description. This scenario was designed to induce global warming by increasing carbon dioxide in the atmosphere at the linear increasing rate of 0.3 ppm for the first 70 years of the experiment, followed by an exponential increase rate of 0.75% per year over a 130-year interval, starting with the observed value of 295.5 ppm in 1900.

The scenario included is locked, which means that none of the parameters can be changed (note the small lock icon in the upper right corner of the Setup Simulations window, below the banner). In order to create a copy of this scenario that can be modified, click the Duplicate button under “Setup Simulation” in the Toolbar. You have now created a copy of the simulation (Global\_Warming\_1\_copy in the run list) that can be modified to your specifications.



If you were to continue setting up a new scenario, the remaining sections of the Setup Simulations window would be used to input your modifications. The **Input files** section sets the geographic boundary conditions (i.e., land mass distribution, topography, vegetation distribution) at the appropriate grid resolution for the model, according to the files selected. For the modern control runs, future climate simulations and Pleistocene ice age experiments distributed with *EdGCM*, the choice of files need not be modified from the default selections. Users wanting to do paleoclimate simulations must take care that all the boundary condition files here are set appropriately for the time period of interest, or else the GCM will crash.

The **Ocean model** and **Diagnostic output** sections are intended for advanced users, and need not be modified for most simulations.

The **Forcings** section (Figure 3) allows you to set the value of solar luminosity and various greenhouse gases, the levels of which would remain uniform through the entire experiment. The values entered into this section are independent of each other and can be set to whatever values you wish. However, the GCM is not guaranteed to behave properly if the values entered are too far beyond modern values (e.g., solar luminosity set to more than 10% above or below modern; more than 20X modern carbon dioxide).

**Forcings**

**Greenhouse gases**

CO2: 314.9 ppm    N2O: 0.2908 ppm    CH4: 1.224 ppm    CFC11: 0.0076 ppt    CFC12: 0.0296 ppt

Use observed values from year: 1958    **Set**

**Solar**

Luminosity: 1366.619 W/m<sup>2</sup>    Use observed values for year: 1958    **Set**

**Orbit**

Eccentricity: 0.0167    Axial tilt: 23.44    OmegaT: 282.9

**Reset**

Figure 3. The *Forcings* section allows basic manipulation of the GCM boundary conditions.

More complex variations of the solar luminosity and various greenhouse gases are also possible by adjusting individual **Trends**. As previously noted, the simulation used for this tutorial sets a linear increase followed by an exponential increase per year for carbon dioxide. It is also possible to include a transient increase in carbon dioxide. Just to illustrate this option, open the CO<sub>2</sub> Trend section of the Setup Simulation window, click once on the second drop-down menu bar and select “Step (ppm)” as the second trend (Figure 4). Then fill in a value of 500 for the step function for the years 1970-2010.

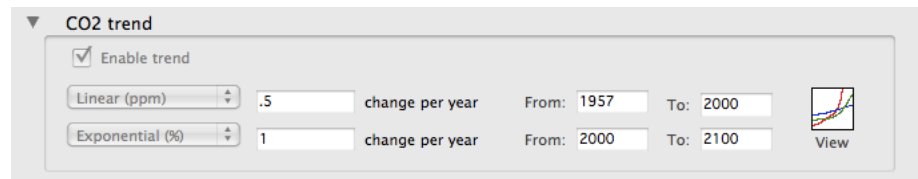


Figure 4. The CO2 trend section, like the other trend sections, permits the levels of greenhouse gases to change during the course of a simulation.

To see a graphic representation of how the level of CO2 would change through time, click on the “View” icon on the right side of the CO2 Trend section to launch the *EdGCM* Visualization Application, or EVA, and display the trends (Figure 5). More information on how to use EVA can be found in the EVA manual included in the *EdGCM* Documentation folder.

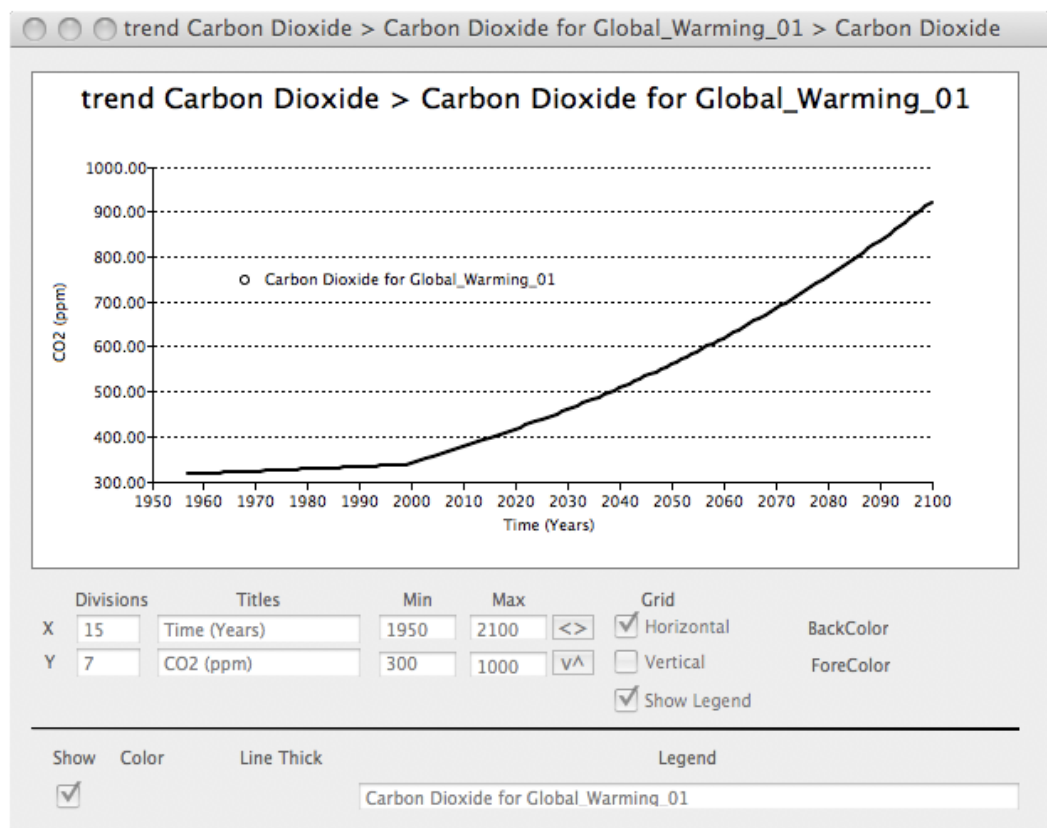


Figure 5. EVA display of changing CO2 trends as selected in Figure 4.

The **Power tools** and **Developer tools** sections are intended for advanced users, and should not be modified without special direction.

NOTE: For the purposes of this tutorial, we have already run the simulation and provided you with the output files. ***Do NOT begin a new simulation run, otherwise you will overwrite the tutorial's data files.***

If you are later running your own simulation, you need to take the following steps to get the experiment under way:

3. With the boundary conditions now set for this simulation, press the “play” button under “Simulation Controls” at the top of the toolbar. A new window will pop up to show you the progress of the model simulation in Fortran. The model will initially run through the first hour of the simulation and then stop (Figure 6), to ensure that no major error have been made in the selection of boundary conditions (e.g., a Snowball Earth land mass distribution with modern vegetation).

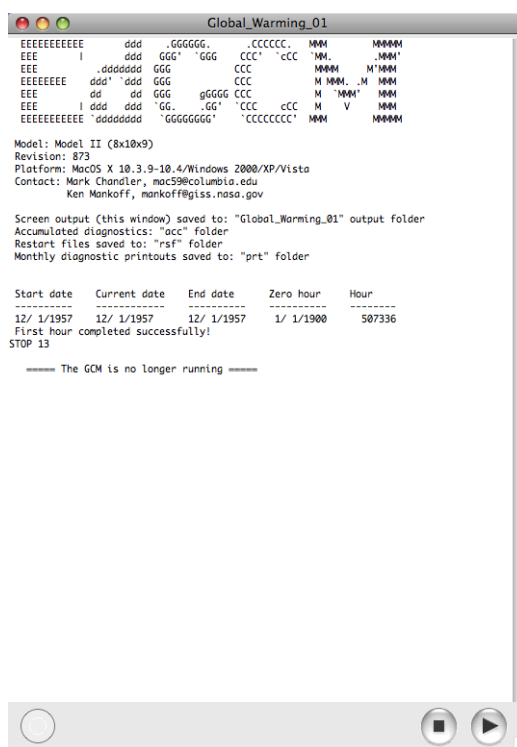


Figure 6. The first hour of a simulation was successfully completed.

4. At this point, the GCM must be restarted. Click on the “play” button at the bottom of the Fortran window in step 5, or at the top of the toolbar again, in order to restart the simulation.

Since Fortran runs independently of *EdGCM* 4D, the interface can be closed down until the run is finished and you are ready to analyze the results.

## 2. Analyzing Output

After the simulation has been completed, re-launch *EdGCM* 4D. Now select “Analyze Output” (cmd + 4 for Macs, ctrl + 4 for Windows) from the menu at the top of the screen. A window titled Analyze Output will appear (Figure 7).

The Analyze Output window is used to process four types of data: Maps, Zonal Averages, Time Series, and Vertical Slices. Each of these data types is represented as a tab in the center of the window; clicking on the tab brings you to that given data type and the list of variables available for that type. The fifth tab in this window, called Diagnostic Tables, generates tables of data like those used by NASA scientists to review their results.

On the left side of the Analyze Output window, the years run for a given simulation are displayed twice so that you may select the starting and ending dates for the interval you want to analyze. On the right side, a list of data files will appear as you process the results of the simulation.



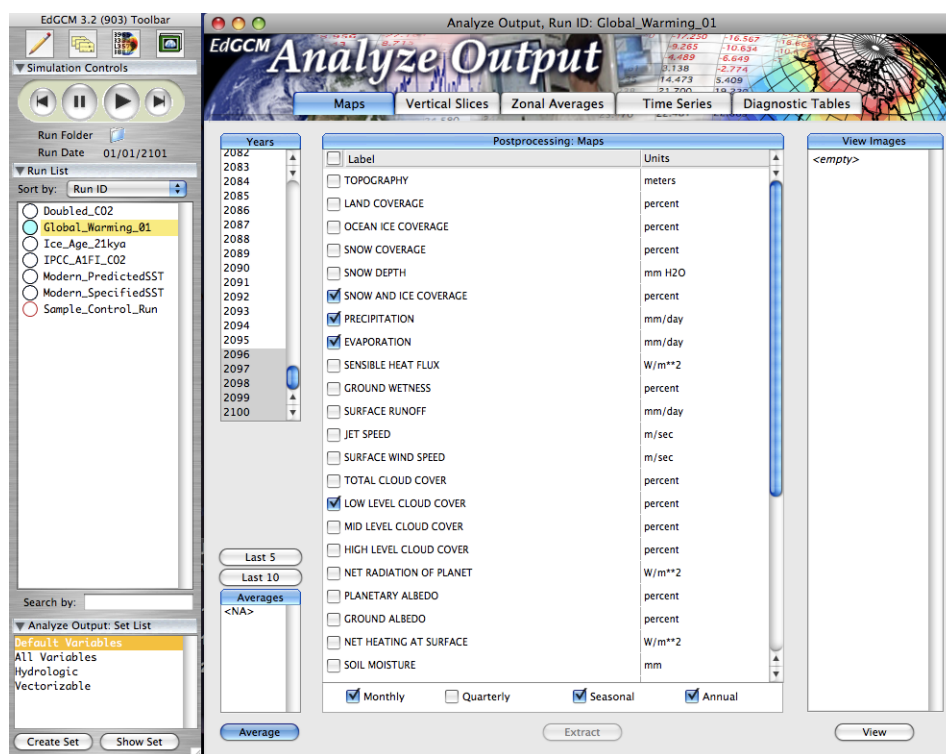


Figure 7. The Analyze Output window and associated toolbar.

**NOTE:** The first time you execute any of the Analyze Output functions that involves launching a Fortran program, you may receive a warning from your system asking if you want to run the program. Always say “Yes” to these particular warnings to ensure that EdGCM continues to function smoothly.

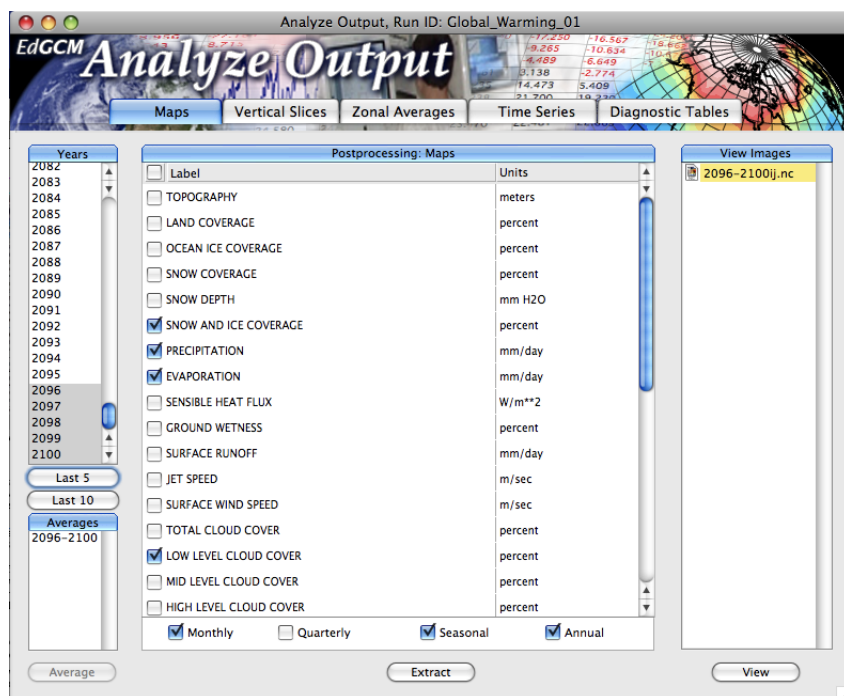
## Maps

To generate maps displaying annual, seasonal or monthly averages, click on the Maps tab (Figure 8), and then select the first and last year of the time interval over which you would like the results averaged. Typically the last five to ten years of the run are selected for averaging, a practice which helps reduce the amount of noise in the data, so these options are available as buttons just below the list of years. For this tutorial, click on the “Last 5” button, so that the last five years of the run are highlighted on the list. Then click on the “Average” button in the lower left corner of the window to run the Fortan program that averages the years selected. When the averaging program is finished, a range of years will appear under the Averages section in the lower left portion of the window. Select the range you want to work with to continue your analysis.

Next, select the variables which you would like to map in the center portion of the window, then click once on the “Extract” button located at the bottom center of the window. Another Fortran window will appear briefly while the data for the maps are being extracted, and then a file will appear in the upper right portion of the window. To view the map diagnostics, either select the file name and click the “View” button on the lower right, or else double-click on the file name itself; both actions will launch EdGCM’s visualization application, EVA.



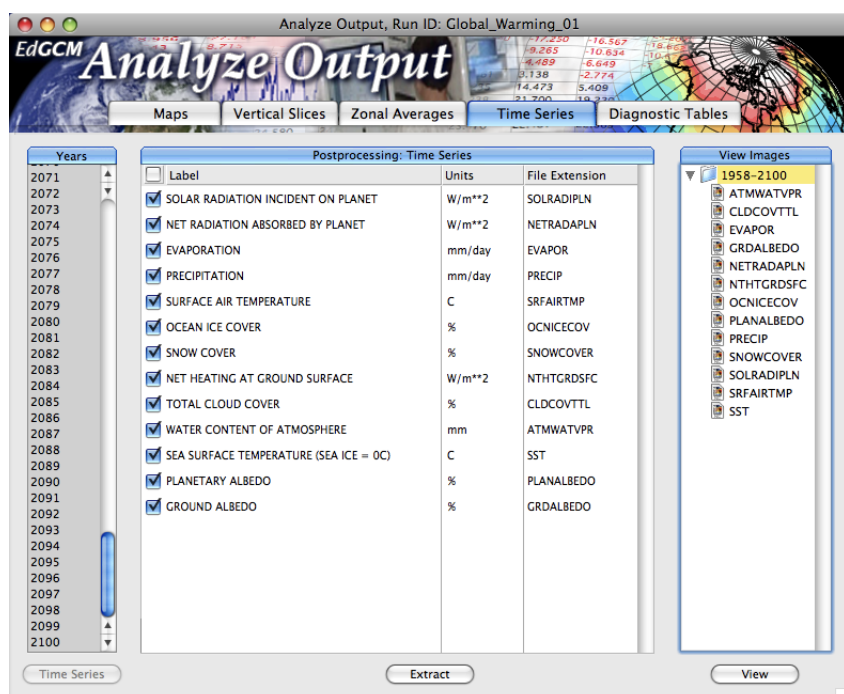
Figure 8. The Maps tab in the Analyze Output window, highlighting (in yellow) the file of extracted variables that can be viewed in map form (upper right). The icon next to the file name represents the netCDF format, a popular cross-platform format for spatial data.



## Time Series

To generate a time series that can be plotted linearly, click on the Time Series tab (Figure 9), and click on the “Time Series” button in the lower left corner of the window. This will launch another Fortran program, which may take a few minutes to run. Note that all the years available for processing are selected in the Year list by default; if you wish to view only a subsection of years, you can select them later in EVA or Excel.

Figure 9. The Time Series tab in the Analyze Output window, showing the list of files generated by post-processing. These files are given in Excel format for easy plotting with either EVA or Excel.



Once the Fortran program ends, select your variables of interest in the center portion of the window, and click on the “Extract” button below the variable list. A number of files - one for each variable you selected for extraction - will appear in the upper right portion of the window. To view any of the time series, either select the file name and click the “View” button on the lower right, or else double-click on the file name itself; both actions will launch EdGCM’s visualization application, EVA.

For many users, map variables and time series data are sufficient for a great deal of analysis in a classroom setting. For advanced users, there are additional variables and data formats accessible in the other tabs of the Analyze Output window:

## Vertical Slices

To generate vertical slices displaying spatial data along pole-to-pole transects, click on the Vertical Slices tab (Figure 10). If you have already averaged the last 5 years for any tab other than Time Series, you will already have a range of years available in the lower left portion of the window, and need not run the averaging program again; otherwise, follow the steps for averaging years described for the Maps tab above.

Next, select the variables you would like to extract in the center portion of the window, and click on the “Extract” button below the variables list, and a file of the extracted variables will appear in the upper right corner of the window. To view these variables, either select the file name and click the “View” button on the lower right, or else double-click on the file name itself; both actions will launch EdGCM’s visualization application, EVA.

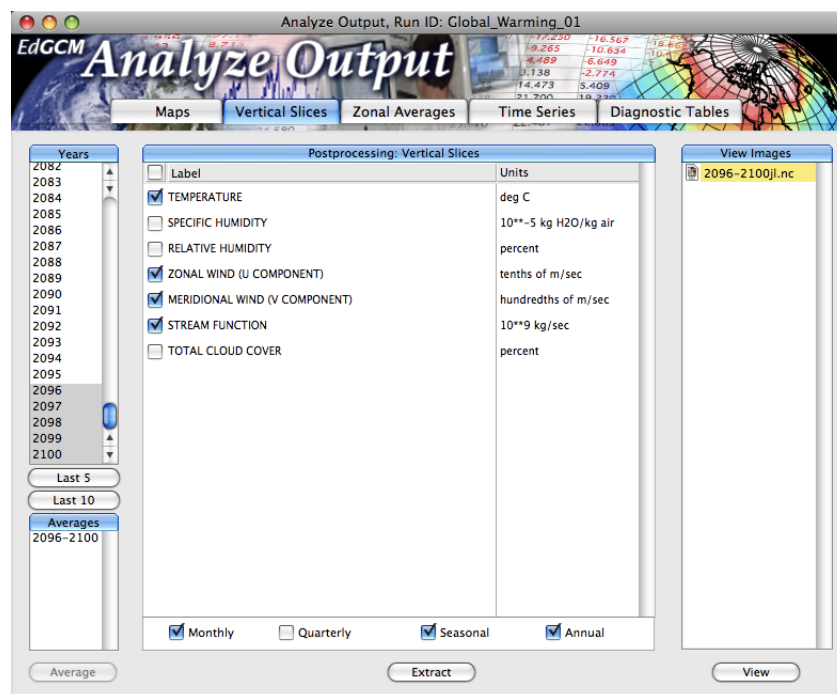


Figure 10. The Vertical Slices tab in the Analyze Output window, highlighting the file generated by post-processing. Vertical slice data files are also in netCDF format.

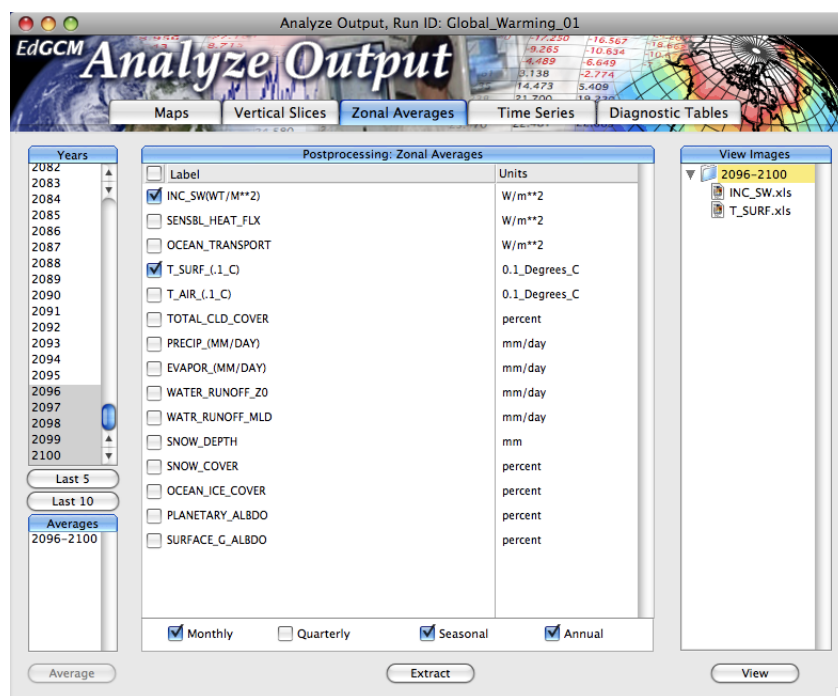


## Zonal Averages

To generate average values of certain variables along lines of latitude, click on the Zonal Averages tab (Figure 11). If you have already averaged the last 5 years for any tab other than Time Series, you will already have a range of years available in the lower left portion of the window, and need not run the averaging program again; otherwise, follow the steps for averaging years described for the Maps tab above.

Next, select the variables you would like to extract in the center portion of the window, and click on the “Extract” button below the variables list, and a file of the extracted variables will appear in the upper right corner of the window. To view these variables, either select the file name and click the “View” button on the lower right, or else double-click on the file name itself; both actions will launch EdGCM’s visualization application, EVA, by default, but these data can also be plotted in Excel if you choose.

Figure 11. The Zonal Averages tab in the Analyze Output window, highlighting the files generated by post-processing. Zonal average data files provided in Excel format.



## Diagnostic Tables

To generate tables of data showing annual, seasonal or monthly averages, click on the Diagnostic Tables tab (Figure 12). If you have already averaged the last 5 years for any tab other than Time Series, you will already have a range of years available in the lower left portion of the window, and need not run the averaging program again; otherwise, follow the steps for averaging years described for the Maps tab above.

Since the purpose of this tab is to create tables of standard set of diagnostic variables averaged over particular time periods of interest, the center portion of this tab lists options for those time periods. Typical averages selected are the January and July monthly averages (for warm/cold climate

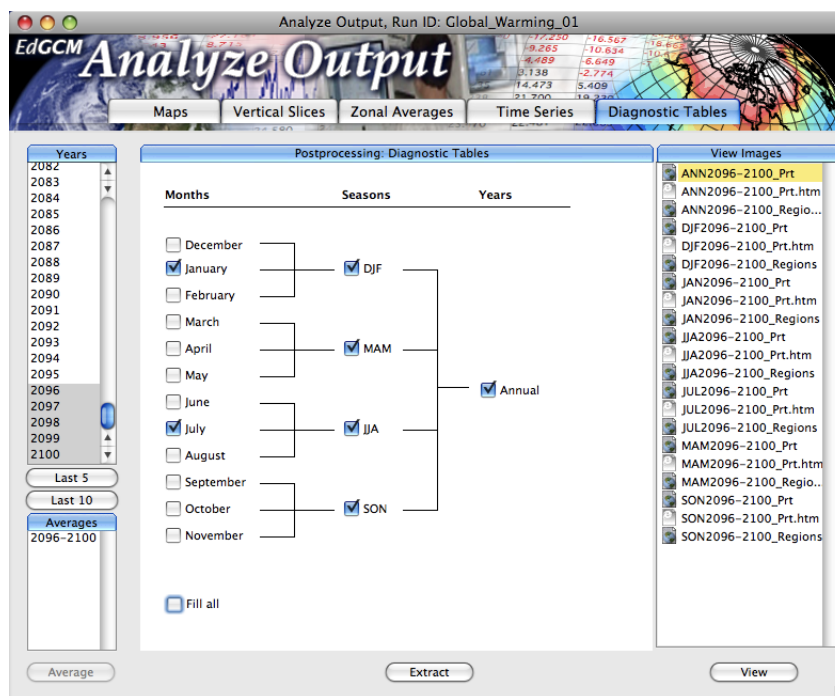


Figure 12. The Diagnostic Tables tab in the Analyze Output window, showing the list of files generated by post-processing. The icons next to the file names indicate the format of the file: Excel, HTML, and SuSpec (the latter for Macs only).

contrasts); seasonal averages; and annual averages. Select the time periods you want to review, and click on the “Extract” button at the bottom center of the window. A list of the processed data files for each time period will appear on the right side of the window (Figure 12).



### 3. Viewing Climate Model Results

The data generated by the averaging and extraction steps in Analyze Output are displayed in the right-most column of the Analyze Output window. They can be viewed by selecting an item in that column and clicking on the “View” button directly below the column. An appropriate program for viewing the data will open automatically.

#### 3.1. Viewing Maps and Plots of Data

*EdGCM* is distributed with two scientific visualization applications: EVA (*EdGCM* Visualization Application), and Panoply (from NASA/GISS). EVA is specifically designed for viewing *EdGCM*’s maps and time series results, and allows users to visualize and perform basic analyses (such as differencing) of the global climate model output. Panoply is a powerful, and more generic, Java-based viewer of netCDF earth science data files. It is particularly useful if you plan to compare your *EdGCM* results to those of other models or to observations, which must also be stored in the netCDF format. Both EVA and Panoply are quite user-friendly and are included with the standard *EdGCM* installation. Each comes with its own reference guide, so please consult those manuals for detailed information on the uses of these powerful scientific visualization tools.

#### 3.2. Viewing the Raw Data Tables

The “Diagnostic Tables” tab in *EdGCM*’s Analyze Output window produces a detailed summary of the climate model output. The format is consistent with that used by the climate model development team at NASA/GISS. Although it is a handy (and voluminous) summary of the data, the abbreviated annotations and presentation requires users to be familiar with many atmospheric science terms and, commonly, with the unique vernacular used by climate model developers. Access to these tables are primarily provided for those who have previously worked with the NASA/GISS Global Climate Models or for those who will be work on project collaborations with NASA/GISS scientists.

Windows users may choose to view Diagnostic Tables using Microsoft Excel® or, by choosing the files ending in .html, using a web browser. These are very large tables containing information on nearly all the climate variables produced by the GCM, and the html view is perhaps the most efficient way to scan the information because there are links to the specific table for each variable at the top of these files (Figure 13). Mac users have the additional option of viewing the data tables with another program we provide called SuSpect (Figure 14). SuSpect allows users to synchronize the viewing of multiple files for quicker comparison of the results from more than one simulation.





Figure 13. The HTML display of tables data begins with a series of links to tables for the individual variables selected for analysis.

The screenshot shows the SuSpec application window with the title 'ANN2096-2100.avgGlobal\_W#F71675'. The table displays climate data for the period 2096-2100. The table structure is as follows:

Global_Warming_01 (Global Warming: CO2 gradually increases, doubling by 2069MEAN OVER 60 ALL MONTHS, ANN YEARS 2096-2100)		ANN2096-2100.avgGlobal_W#F71675	
** BUDGETS (GLOBAL) **		DAY 71541, HR 0 ( 1 ANN 2096) 1760016. TO DAY 73366, HR 0 ( 1 ANN 2101) 1760760. DIF 744. HR	
	G	NH	SH
INC SH(HT/H**2)	341.8	341.8	341.8
PLANETARY ALBEDO	29.17	28.71	29.64
PLAN ALB VISUAL	35.04	34.28	35.87
PLAN ALB NEARIR	22.27	22.23	22.31
SURFACE G ALBEDO	18.83	11.58	18.06
SURF ALB VISUAL	9.78	10.13	9.43
SURF ALB NEARIR	12.19	14.04	10.34
ATMO ALB VISUAL	30.46	29.40	31.52
ATMO ALB NEARIR	17.64	16.79	18.49
ATMO ABS VISUAL	7.65	7.88	7.50
ATMO ABS NEARIR	32.22	32.43	32.00
SW ABS BELOW P0	242.1	243.7	240.5
SW ABS BELOW P1	235.6	237.2	234.0
SW ABS BY ATMOS	68.3	69.1	67.5
SW INC ON Z0	194.9	197.5	192.3
SW ABS AT Z0	173.8	174.6	173.0
SW CORRECTION	4.6	4.1	5.1

Figure 14. Mac users can employ SuSpec to view their data.



## 4. Reporting Your Results

An important feature of *EdGCM* is the ability to share simulation results and interpretations by publishing to a web site easily accessible to others. The entire process is greatly simplified through *EdGCM*'s eJournal function.

To report results:

1. Return to *EdGCM*, and select “eJournal” from the Window menu at the top. The eJournal toolbar and window will appear (Figure 15).

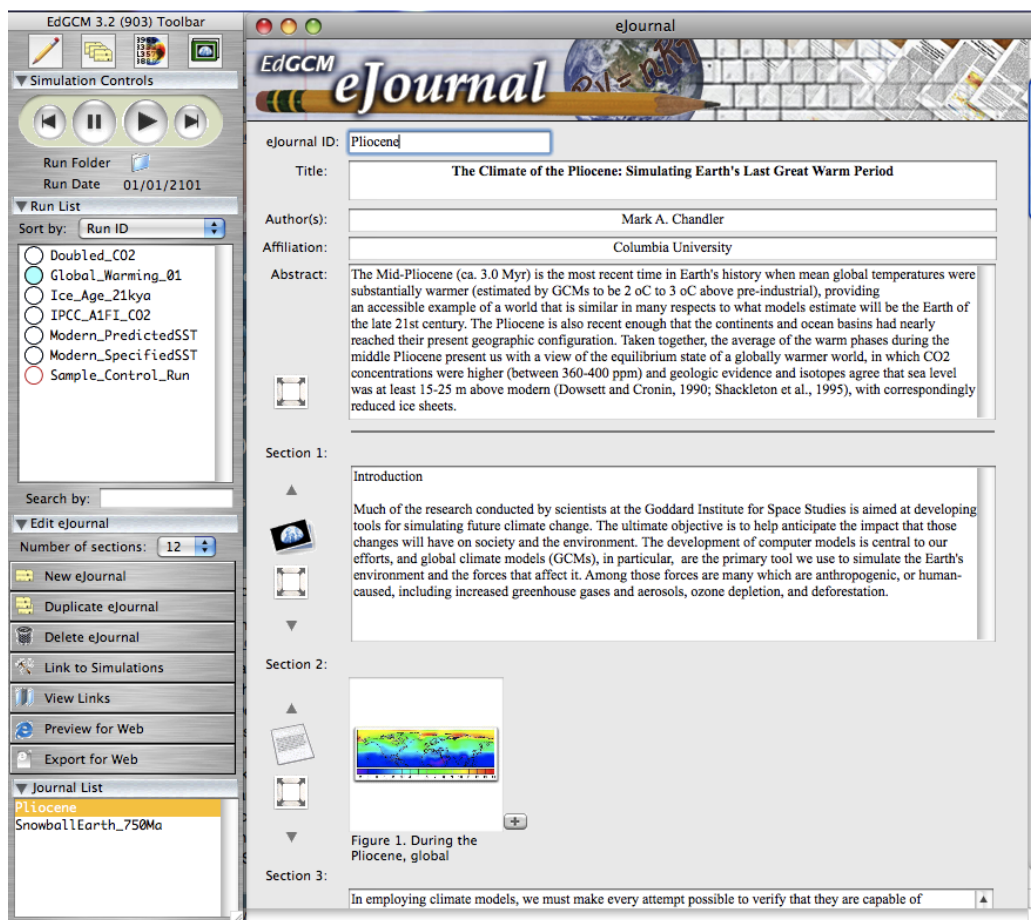


Figure 15. The eJournal setup window and its associated toolbar.

2. Note that the eJournal window is divided into sections. Each section of the eJournal (up to a maximum of 20 sections) can be used for either text descriptions or figures. To convert between one type of section to the other, simply click on the button to the left of the section (clicking on a photo button sets up the section for figures; clicking on a text button sets up the section for text).

3. Three additional figures may be added to a given section (for a total of four figures) by clicking the “+” button at the lower right corner of the figure



window. Up to two lines of figure caption text, if available, will be visible for each figure in the eJournal setup window, although longer captions will be displayed in their entirety when the eJournal is published to HTML.

4. Images of any size or format can be imported from the Image Browser (Figure 16), which is accessible from the Window menu. Images from the Image Browser may be inserted into an eJournal section by simply dragging and dropping the image into a figure box, such as the one seen in section 2 of the eJournal page in Figure 15.

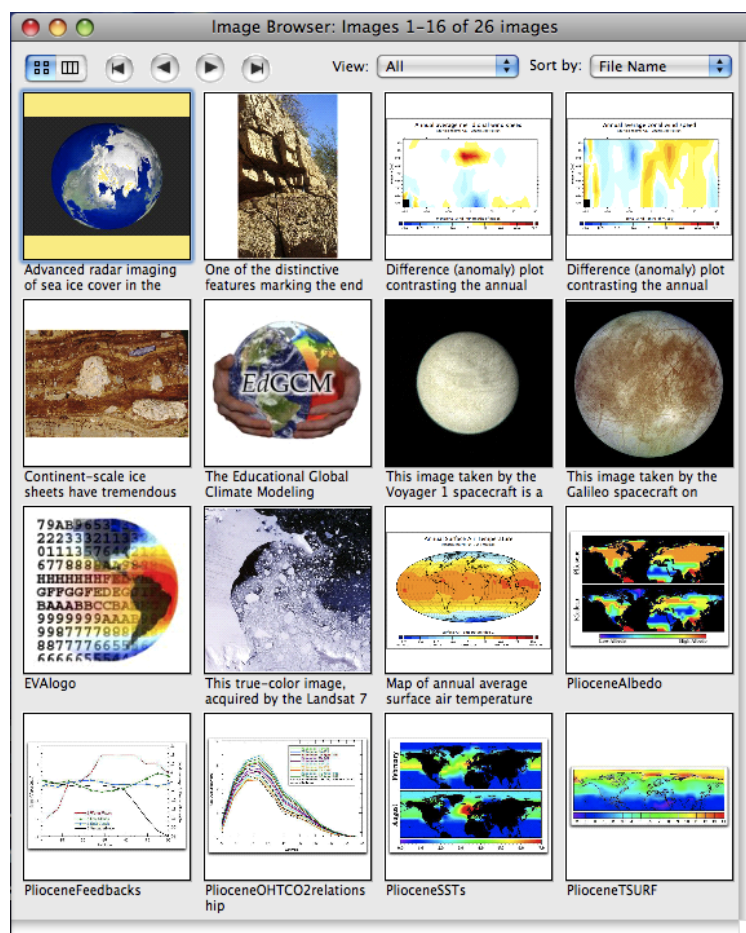


Figure 16. The Image Browser is a library of photos, graphs, and maps that can be used to illustrate key points for discussion in a student's eJournal report. The images can be sorted by name, date created or modified, or by theme (e.g., Pliocene images, global warming images). The Image Browser may be added to at any point by students or teachers.

5. To page through multiple pages of the Image Browser, click on the "forward" and "reverse" buttons in the Image Browser toolbar. It is also possible to search for images by name, or sort images by name, creation date, etc.

6. When an eJournal is ready for web publication, return to the filled-out eJournal page and click on the "eJournal to Web" button in the toolbar (see Figure 15). The eJournal page will be converted to an HTML file, which will open automatically in a new window within your default web browser (Figure 17).

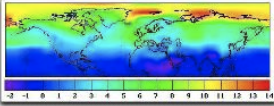
The Climate of the Pliocene: Simulating Earth's Last Great Warm Period

Mark A. Chandler  
Columbia University

The Mid-Pliocene (ca. 3.0 Myr) is the most recent time in Earth's history when mean global temperatures were substantially warmer (estimated by GCMs to be 2 to 3 deg. C above pre-industrial), providing an accessible example of a world that is similar in many respects to what models estimate will be the Earth of the late 21st century. The Pliocene is also recent enough that the continents and ocean basins had nearly reached their present geographic configuration. Taken together, the average of the warm phases during the middle Pliocene present us with a view of the equilibrium state of a globally warmer world, in which CO<sub>2</sub> concentrations were higher (between 360-400 ppm) and geologic evidence and isotopes agree that sea level was at least 15-25 m above modern (Dowsett and Cronin, 1990; Shackleton et al., 1995), with correspondingly reduced ice sheets.

**Introduction**

Much of the research conducted by scientists at the Goddard Institute for Space Studies is aimed at developing tools for simulating future climate change. The ultimate objective is to help anticipate the impact that those changes will have on society and the environment. The development of computer models is central to our efforts, and global climate models (GCMs), in particular, are the primary tool we use to simulate the Earth's environment and the forces that affect it. Among those forces are many which are anthropogenic, or human-caused, including increased greenhouse gases and aerosols, ozone depletion, and deforestation.



**Figure 1:** During the Pliocene, global temperatures, particularly at high latitudes, are believed to have been significantly warmer than today. This figure shows the Pliocene surface air temperature increase compared to the present day as simulated by the NASA/GISS

In employing climate models, we must make every attempt possible to verify that they are capable of accurately portraying Earth's climate and its sensitivity to change. Validating a GCM's equilibrium capability is done by comparing simulations of the modern climate, often referred to as current climate control simulations, to observations. However, despite our interest in anthropogenic influences on future climate, testing the GCM's sensitivity to change generally relies on our ability to understand natural climate changes from the past. Predictions of future changes gain credibility when our models can accurately simulate changes that have actually occurred. Unfortunately, historical records of most climatological variables, such as temperature and precipitation, rarely exceed 100 years in length. Moreover, many of the changes anticipated in the future are likely to exceed historical precedents. Thus, we commonly step back further in time and examine the geologic record, which contains examples of global-scale climate change similar in magnitude to that predicted to occur during the 21st century.

Figure 17. A published eJournal report.

These files can then be published to a school web site or to the student's own web space for public access. A copy may also be added to the school's eJournal library, a searchable offline database for the reports.





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## Notes