How to Set Trends in EdGCM

EdGCM users often like to design experiments in which the GHG or solar forcings change on an annual basis over time, such as in future climate change experiments in which GHG concentrations are assumed to be constantly changing. We suggest you begin setting up a custom experiment with trends by duplicating the Global_Warming_01 run, or one of the IPCC runs, and using the ocean setup as given for those simulations. The Modern_PredictedSST simulation would still be your control run.

Using the Setup Simulations window to create trends

There are several options for changes over time that can by typing values directly into the Setup Simulations window:

Step (ppm) – A step trend adds (subtracts) the value you type into the "change per year" box from whatever value is already set in the main Forcings section of the Setup Simulations window. For example, if you have a starting CO2 value of 315 ppm, imposing a step trend of 5 ppm for the years 1960-1990 will increase the CO2 value to 318 ppm only for 1960-1990; if no additional trend is set for the years beyond 1990, the CO2 value will return to 315 ppm for the remainder of the simulation.

Constant (ppm) – A constant trend adds (subtracts) the value you type into the "change per year" box from whatever value is already set in the main Forcings section of the Setup Simulations window. The main difference between a step trend and a constant trend is that the constant trend will remain in effect through the end of the run, unless you add a second trend to modify its influence. For example, if you have a starting CO2 value of 315 ppm, imposing a constant trend of 5 ppm for the years 1960-1990 will increase the CO2 value to 318 ppm for all years after 1960.

Linear (ppm) – A linear trend adds (subtracts) the value you type into the "change per year" box in a geometric progression, i.e., each subsequent year's value will increase by the amount you have set, but only for the years you have specified. For example, if you have a starting CO2 value of 315 ppm, imposing a linear trend of 2 ppm for the years 1960-1990 will increase the CO2 value from 315 to 317 ppm in 1960, 319 ppm in 1961, etc., through 375 ppm in 1990. If no additional trend is set for the years beyond 1990, the CO2 value will remain 375 ppm for the remainder of the simulation.

Exponential (%) – An exponential trend adds (subtracts) the value you type into the "change per year" box in an ever-increasing progression, but only for the years you have specified. For example, if you have a starting CO2 value of 315 ppm, imposing an exponential trend of 2 ppm for the years 1960-1990 will increase the CO2 value from 315 to 324 ppm in 1960 to 587 ppm in 1990. If no additional trend is set for the years beyond 1990, the CO2 value will remain 587 ppm for the remainder of the simulation.

For any given simulation, you can use one or a combination of these trend-generating methods to create your own unique trend. If you use two trends, they can even be allowed to overlap in terms of dates (e.g., a linear trend from 1960-2000 + an exponential trend from 1990 to 2100).

Creating a data file to input trends

If you want to have more than two trends for a given forcing, you'll need to create a new data file and then use that as input in your simulation setup. It's not hard, but there are a number of steps that need to be followed carefully.

How to create a new trend file:

A trend (data) file is a simple text file consisting of data in two columns: the first column is a list of years, and the second column lists the associated input values (can be GHG or solar luminosity). Neither column should have a header. The trend file should encompass the full range of years in your planned simulation, even if you only want to impose a trend for part of the run initially (as set in the Setup Simulations window). This way, the GCM always has an input value to refer to from the file.

You can use a spreadsheet program like Excel to do the initial file creation, but you'll need to save your new trend file as plain text (.txt) and finish formatting the file in an application that is designed for editing computer code. Mac users can use BBEdit or Text Wrangler for the remaining steps; Windows users can use TurboPad.

In the trend file, each line should be in the form of the following examples:

```
1957####314.90000000 (CO2 example)

1957######1.21300006 (CH4 example)

1957###1366.61980000 (solar example)
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where:
- the first 4 digits of the line are the year;
- the input value (GHG or solar) includes 8 digits to the right of the decimal (fill in with zeroes if you must); and
- there is a simple line return after the input value (including the last value in the file).

The number of spaces between the year and the beginning of the input value (as shown above by the # symbols in the examples above) will vary, but you must add enough spaces to make sure that the decimal point for the input value is ALWAYS the 12th character from the left end of the line. If you're unsure whether you have the right number of spaces, compare your file with one of the existing trends files in the EdGCM > Input Forcings folder.

Line endings in the trend file must be set to Unix, not Mac or DOS/Windows.

If the trend you want to impose starts some years after the beginning of the run or stops some years before the end, you should fill in the non-trending years with an appropriate identical (non-changing) value. For example, if you have a CO2 trend that stops in year 2080 at a value of 859 ppm, but the run itself ends in year 2100, make sure that years 2081-2100 in the trend file are assigned the value of 859 ppm as well.

Give your new trend file a distinct and descriptive name to minimize any later confusion about what the file represents.

Once it's ready, put your new trend file into the EdGCM > Input Forcings folder (where the GHG trend files reside); then it can be selected for use with a simulation. For example, go to the CO2 Trend section of Setup Simulations, enable trends, and then from the first drop-down menu choose "Data File" as the input source, and select your new file. Don't forget to specify what years you want to impose the trend on.

Before starting a run with any trends – make sure to view the trend to make sure that it makes sense, and that it looks the way you had intended! With exponential trends in particular, it's all too easy to choose too large a number and wind up with trend values that lack reality.