Biome-BGC: Modeling effects of disturbance and climate (Thornton et al. 2002)

ORNL DAAC citation for this data set:

Thornton, P. E. 2005. Biome-BGC: Modeling effects of disturbance and climate (Thornton et al. 2002). Model product. Available on-line [http://www.daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

Modeling Manuscript Archive Entry

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Thornton, P.E., Law, B.E., Gholz, H.L., Clark, K.L., Falge, E., Ellsworth, D.S., Goldstein, A.H., Monson, R.K., Hollinger, D., Falk, M., Chen, J. and Sparks, J.P., 2002. Modeling and measuring the effects of disturbance history and climate on carbon and water budgets in evergreen needleleaf forests. Agricultural and Forest Meteorology, 113, 185-222.

Target compute platform:
Microsoft Windows.

Model build environment:
Microsoft Visual C++ version 6.0. Produces win32 console applications as the main model executables.

Additional analysis environment requirements:
Requires IDL, a commercial software package available from Research Systems, Inc. (www.rsinc.com) for generation of scripts that automate calls to the main executables and for post-processing of model output to produce the manuscript figures. IDL Version 5.2 was used for this study, but the IDL procedures used are general enough that both older and newer versions should also work. All final output is to postscript files, so

some utility is required to read and display or print these files. The main archive file is stored as a WinZip file.

Detailed instructions:

The following instructions describe how to run Biome-BGC v 4.1.1 using the executables and procedures associated with this archive to recreate results from the published manuscript referenced above.

1. Extract the winzip file **Thornton_2002_msarch.zip** to your local disk. For the simplest possible execution, extract to the root of your **D:** drive. This will create a new directory – **D:\fluxnet2**. Extracting this way means that you won't have to change any of the path information in the IDL procedures that generate run control files. Otherwise (e.g. if you don't have a **D:** drive, or if for whatever reason you want to put this directory tree someplace other than the root of your **D:** drive, or call it something other than **D:\fluxnet2**), extract to any location you like, and either leave the directory tree name as **fluxnet2**, or rename it. In this case, you will need to edit the IDL procedures described below, replacing the path variable with the appropriate path. This variable is always defined at or very near the top of the IDL procedures, and this is the only thing you should have to change. For the rest of these instructions, paths will be given relative to the root of the directory tree: e.g. **bgc\idl** refers to the directory **D:\fluxnet2\bgc\idl**, if you follow the suggested directory naming given above.
2. Compile and run the IDL procedure **bgc\idl\make_spinup_ini.pro.** This will create a file called **spinup_ns.bat** in the **bgc\scripts** subdirectory. This is a DOS batch file that calls the Biome-BGC code in spinup mode for each of the sites. The **ns** suffix on this and other batch files refers to a **n**ew **s**oil model being used for these simulations.
3. Execute the batch file **bgc\scripts\spinup_ns.bat.** You can execute it either by double clicking, or you can open a command prompt window, navigate to the scripts subdirectory, and enter **spinup_ns.bat** on the command line. All of the analyses described here operate this way: the IDL procedure creates a batch file, and the user executes the batch file. The IDL procedures are also creating all the necessary input file (these are stored in the **bgc\ini** subdirectory). You can look at these ***.bat** files (use WordPad or Word) to see how Biome-BGC and its ancillary programs are being called.
4. Compile and run the IDL procedure **bgc\idl\make_long_spinup_ini.pro.**
5. Execute the batch file **bgc\scripts\long_spinup_ns.bat.** This extends the spinup for an additional 10,000 years, to remove the very small transients that exist after the standard spinup. This is necessary for the analysis of the effects of increasing CO2 and N deposition.
6. Compile and run the IDL procedure **bgc\idl\make_equil_ensemble2_ini.pro.**
7. Execute the batch file **bgc\scripts\equil_ensemble2_ns.bat.** This generates the 18 ensemble members for each site, as described in the paper.
8. Compile and run the IDL procedure **bgc\idl\site_history\allsites_history.pro.**
9. Execute the batch file **bgc\scripts\allsite_history.bat.** This implements the ensemble of site history simulations for each site, as described in the text. This step makes use of the executables **fire.exe**, **harvest.exe**, **fertilize.exe**, **plant.exe**, and **windthrow.exe** (also in the

bgc\scripts subdirectory), which modify the Biome-BGC v4.1.1 restart files to simulate various disturbances. The source code for these programs is available.

10. Compile and execute the IDL procedure **bgc\idl\site_history\allsites_history_noco2ndep.pro.**
11. Execute the batch file **bgc\scripts\allsite_history_noco2ndep.bat.** This replicates the simulations from step 9, except that CO_2 concentration and N deposition rates are maintained at their preindustrial levels (circa 1795).
12. Compile and run the IDL procedure **bgc\idl\site_history\historical_nee_allsites_ps_rev.pro.** This procedure does two things. First, it calls a series of additional IDL procedures that read the output from ensemble site history runs at each site, creating summaries that are used by several of the other analysis procedures stored in **bgc\analysis\site_history**). Second, it creates Figure 3 from the paper, as a postscript file: **bgc\graphics\historical_nee_allsites_rev.ps.** Because it creates the summary files used by other analysis procedures, this procedure must be called before any of the others that produce graphical output.
13. Compile and run the IDL procedure **bgc\idl\site_history\historical_nee_allsites_noco2ndep_ps_rev.pro.** This procedure produces another set of analysis files (stored in **bgc\analysis\site_history_noco2ndep**), and it also produces Figure 18 from the paper, as a postscript file: **bgc\graphics\historical_nee_allsites_noco2ndep_rev.ps.**
14. Compile and run the IDL procedure **bgc\idl\site_history\monthly_summary_graphics_ps_rev.pro.** This produces Figures 5a, 5b, 7, 9, and 11 from the paper, as multiple postscript files, all in **bgc\graphics**: these are named **monthly_summary_*_rev.ps**, where * is **et1**, **et2**, **nee**, **re**, or **gep**.
15. Compile and run the IDL procedure **bgc\idl\site_history\lai_comparison_ps_rev.pro.** This produces Figure 4 from the paper.
16. Compile and run the IDL procedure **bgc\idl\site_history\monthly_scatter_graphics_ps_rev.pro.** This produces Figures 6a, 6b, 8, and 10 from the paper. These are all stored in a single multi-page postscript file: **bgc\graphics\monthly_scatter_allvars_rev.ps.** This file includes a scatter plot for GEP, which was not included in the paper.
17. Compile and run the IDL procedure **bgc\idl\site_history\monthly_tair_graphics_ps_rev.pro.** This produces Figures 12a, 12b, 12c from the paper. These are all stored in a single multi-page postscript file: **bgc\graphics\monthly_tair_allvars_rev.ps.**
18. Compile and run the IDL procedure **bgc\idl\site_history\annual_et_comparison_rev.pro.** This produces Figure 13 from the paper. It is stored as a postscript file: **bgc\graphics\et_comparison_rev.ps.** This procedure also creates a regression summary table: **bgc\graphics\et_comparison_stats_rev.txt.**
19. Compile and run the IDL procedure **bgc\idl\site_history\annual_nee_comparison_rev.pro.** This produces Figure 14 from the paper. It is stored as a postscript file: **bgc\graphics\nee_comparison_rev.ps.** This procedure also produces a regression summary table: **bgc\graphics\nee_comparison_stats_rev.txt.**
20. Compile and run the IDL procedure **bgc\idl\site_history\FL30_history.pro.** This produces the batch file for the special set of simulations used to compare the Florida chronosequence data to model estimates of a 30-year recovery following harvest at the FL site.
21. Execute the batch file **bgc\scripts\run_fl30_history.bat.**
22. Compile and run the IDL procedure **bgc\idl\site_history\FL30_history_analysis.pro.**

23. Compile and run the IDL procedure **bgc\idl\site_history\FL30_chrono_ps.pro.** This produces Figure 15 from the paper. It is stored in a postscript file: **bgc\graphics\fl30_chrono.ps.**

Additional notes:
As indicated in the paper, I think that the value for maximum stomatal conductance used at the Floirda site is too low. I have tested this by changing it from 3 mm/s to 6 mm/s, and there is a significant improvement in the estimated ET, no important changes in LAI or the C flux variables. If you want to do a set of simulations like this, you need to modify the **FL.epc** files in **bgc\epc** and **bgc\epc\site_history.** Near the bottom of each file is the parameter value for maximum stomatal conductance. Change this from **0.003** to **0.006** **in both files**.

The source code used to produce the **bgc411_ns.exe** executable is in the **src** subdirectory tree. This tree includes project files to open and compile the code using Microsoft Visual C/C++ v6.0.

Since this paper was accepted, I have finished a new version of Biome-BGC, v 4.1.2, that addresses some minor problems in the v 4.1.1 code. It is very easy to redo this analysis using the new code, and I recommend that you use the new code for any future analysis. The new code does not significantly change any of the results from the analysis presented in the paper. The most noticeable change is that the new code has a slightly higher LAI at most of the sites, resulting in a regression slope for Figure 4 that is closer to 1.0. Let me know if you have questions on how to use the v 4.1.2 code in this analysis.