Testing the Climate Library

Dr. Melissa Lucash

December 28, 2014

This document describes all the testing of the final climate library that was done by M. Lucash in April and May 2014.

Please contact Melissa Lucash (lucash@pdx.edu) or Robert Scheller (rmschell@pdx.edu) with any questions.

Table of Contents

Overview

The climate library code was written originally by Rob Scheller and Amin Almassian but was later significantly revised by John McNabb. This document describes the final testing that occurred in April and May of 2014 (Tests 1- 16), which focused on testing all the various climate options to make sure they were working properly.

I tested all 6 climate time series options and all 4 climate file format options, running a total of 14 tests. All the files that I used for testing are stored here: I:\Research\Shares\scheller_lab\Lucash\AFRI_Chippewa_Project\Climate Library\Tests_April2014

and on GoogleCode. https://landis-extensions.googlecode.com/svn/trunk/clmate-generator-library/trunk/tests/v1.0/

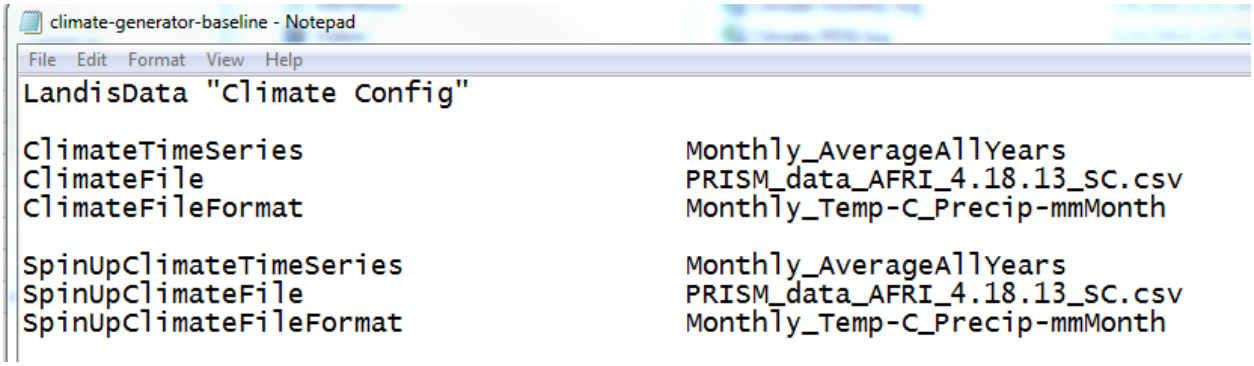
I did some additional testing in Dec of 2014 after revising Century and those are described in this document as well (Tests 17-20). These tested focused on methods that use the data from the climate library, including PET, GDD, growing season length, and regeneration.

Test 1 Testing with Monthy_AverageAllYears

I:\Research\Shares\scheller_lab\Lucash\AFRI_Chippewa_Project\Climate Library\Tests_April2014\Test_1_monthlyaverageallyears

Results summarized in **Test1_ComparingInputOutput.xls**

I used these options:



The input file, climate log file and the LANDIS output file (Century-succession-monthly-log.csv), have very similar temps and precip. Avg temps and the sum of precip in the LANDIS output are constant across years. **PASSED.**

Test 2 Testing with MonthlyAverageAllYears with 3 ecoregions

Summarized results in File: Test2_ComparingInputOutput

```
LandisData "Climate Config"

>Used prism data
ClimateTimeSeries                       Monthly_AverageAllYears
ClimateFile                             PRISM_data_AFRI_4.18.13_3ecoregions.csv
ClimateFileFormat                       Monthly_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Monthly_AverageAllYears
SpinUpClimateFile                       PRISM_data_AFRI_4.18.13_3ecoregions.csv
SpinUpClimateFileFormat                 Monthly_Temp-C_Precip-mmMonth
```

This was a very simple input file to make sure the climate library was indexing through all the ecoregions properly. I used the management.gis file from chapter 14 in the HF LANDIS training since it had 3 map codes (i.e. 3 ecoregions).

First I checked to see if an error was triggered if I gave it 3 ecoregions in the input file but the map only had one ecoregion. Landi-log-number of ecoregions **PASSED!**

Then I ran the simulation with 3 ecoregions. I put in two years of climate data and both were included in the climate-monthly-log.csv (initially we had trouble with it excluding the 2nd year of data). **PASSED!**

I created a file where ecoregion MN100 had much higher different temps than ecoregion MN101 (took temps and multiplied them by ~1.3). This was visible in the input and the output (century-montly-output) files. **PASSED!**

Test 3. Testing with Monthly_SequencedYears using only 6 years of input data

Summarized results in File: Test3_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----monthly_PRISM-------

ClimateTimeSeries                       Monthly_SequencedYears
ClimateFile                             PRISM_data_AFRI_4.18.13_SC_high.csv
ClimateFileFormat                       Monthly_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Monthly_SequencedYears
SpinUpClimateFile                       PRISM_data_AFRI_4.18.13_SC_high.csv
SpinUpClimateFileFormat                 Monthly_Temp-C_Precip-mmMonth
```

I shorted the input file to use only 6 years so it was easy to test and make sure the years were sequenced properly.

I checked to make sure the years in the input file corresponded directly with the years in the climate log file and in the LANDIS output file (Century-succession-monthly-log). **PASSED!**

I also checked to make sure that if LANDIS ran out of climate data, that it would use the last year's worth of climate data repeatedly. **PASSED!**

Test 4. Testing with MonthlySequencedYears using ~100 years of input data

Summarized results in File: Test4_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----|-monthly_PRISM-------

ClimateTimeSeries                       Monthly_SequencedYears
ClimateFile                             PRISM_data_AFRI_4.18.13_SC.csv
ClimateFileFormat                       Monthly_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Monthly_SequencedYears
SpinUpClimateFile                       PRISM_data_AFRI_4.18.13_SC.csv
SpinUpClimateFileFormat                 Monthly_Temp-C_Precip-mmMonth
```

I used a full record of years to test this option (basically the same as test 3 but with more years of input data).

I checked to make sure the years in the input file corresponded directly with the years in the climate log file and in the LANDIS output file (Century-succession-monthly-log). **PASSED!**

I also checked to make sure that if LANDIS ran out of climate data, that it would use the last year's worth of climate data repeatedly. **PASSED!**

Test 5. Testing with MonthlySequencedYears with multiple ecoregions

Summarized results in File: Test5_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----|-monthly_PRISM-------

ClimateTimeSeries                       Monthly_SequencedYears
ClimateFile                             PRISM_data_AFRI_4.18.13_3ecoregions_all.csv
ClimateFileFormat                       Monthly_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Monthly_SequencedYears
SpinUpClimateFile                       PRISM_data_AFRI_4.18.13_3ecoregions_all.csv
SpinUpClimateFileFormat                 Monthly_Temp-C_Precip-mmMonth
```

I used a full record of years and multiple ecoregions to test this option (basically the same as test 3 but with more years of input data).

I checked to make sure the years in the input file corresponded directly with the years in the climate log file and in the LANDIS output file (Century-succession-monthly-log). **PASSED!**

I also checked to make sure that LANDIS was cycling through the ecoregions properly. P**ASSED!**

Test 6. Testing with DailyAverageAllYears

Summarized results in File: Test6_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----daily_mauer dataset

ClimateTimeSeries                       Daily_AverageAllYears
ClimateFile                             Daily_Mauer_Baseline_SC.csv
ClimateFileFormat                       Daily_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Daily_AverageAllYears
SpinUpClimateFile                       Daily_Mauer_Baseline_SC.csv
SpinUpClimateFileFormat                 Daily_Temp-C_Precip-mmMonth
```

I checked to make sure that the temp and precip were actually averaged across all years in the LANDIS output file (Century-succession-monthly-log). **PASSED!**

Test 7. Testing with DailySequencedYears

Summarized results in File: Test7_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----daily_Mauer climate dataset

ClimateTimeSeries                       Daily_SequencedYears
ClimateFile                             Daily_Mauer_Baseline_SC.csv
ClimateFileFormat                       Daily_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Daily_SequencedYears
SpinUpClimateFile                       Daily_Mauer_Baseline_SC.csv
SpinUpClimateFileFormat                 Daily_Temp-C_Precip-mmMonth
```

I checked to make sure the years in the input file corresponded directly with the years in the climate log file and in the LANDIS output file (Century-succession-monthly-log). **PASSED!**

Test 8. Testing with DailySequencedYears

Summarized results in File: Test8_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----daily_Mauer

ClimateTimeSeries                       Daily_SequencedYears
ClimateFile                             Daily_Mauer_Baseline_3ecoregions.csv
ClimateFileFormat                       Daily_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Daily_SequencedYears
SpinUpClimateFile                       Daily_Mauer_Baseline_3ecoregions.csv
SpinUpClimateFileFormat                 Daily_Temp-C_Precip-mmMonth
```

I checked to make sure the years in the input file corresponded directly with the years in the climate log file and in the LANDIS output file (Century-succession-monthly-log). **PASSED!**

I also checked to make sure that LANDIS was cycling through the ecoregions properly. **PASSED!**

Test 9. Testing with DailyAverageAllYears

Summarized results in File: Test9_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----daily_ipccclimate_degC_mm/day-units

ClimateTimeSeries                       Daily_AverageAllYears
ClimateFile                             GFDLA1fi_6.20.13_SC.csv
ClimateFileFormat                       Daily_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Daily_AverageAllYears
SpinUpClimateFile                       GFDLA1fi_6.20.13_SC.csv
SpinUpClimateFileFormat                 Daily_Temp-C_Precip-mmMonth
```

This is the same test as Test 6 except I used ipcc3 daily data in this test. Test 6 used Mauer. **PASSED**!

Test 10. Testing with MonthlyRandomYears

Summarized results in File: Test10_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----monthly_PRISM-------

ClimateTimeSeries                       Monthly_RandomYear
ClimateFile                             PRISM_data_AFRI_4.18.13_SC.csv
ClimateFileFormat                       Monthly_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Monthly_AverageAllYears
SpinUpClimateFile                       PRISM_data_AFRI_4.18.13_SC.csv
SpinUpClimateFileFormat                 Monthly_Temp-C_Precip-mmMonth
```

I examined the log file to make sure the climate library was selected the right key and randomly selecting the year of climate data. **PASSED**!

I checked to make sure the variation in the LANDIS output was similar to the variation in the input file. **PASSED**!

Test 11. Testing with MonthlyRandomYears

Summarized results in File: Test11_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----daily_ipccclimate_degC_mm/day-units-

ClimateTimeSeries                       Daily_RandomYear
ClimateFile                             GFDLA1fi_6.20.13_SC.csv
ClimateFileFormat                       Daily_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Daily_RandomYear
SpinUpClimateFile                       GFDLA1fi_6.20.13_SC.csv
SpinUpClimateFileFormat                 Daily_Temp-C_Precip-mmMonth
```

I examined the log file to make sure the climate library was selected the right key and randomly selecting the year of climate data. **PASSED**!

I checked to make sure the variation in the LANDIS output was similar to the variation in the input file. **PASSED**!

I checked to make sure it would randomly select climate data to use, well beyond the number of years supplied in the input file. **PASSED**!

Test 12. Testing with DailySequencedYears with 10y timestep

Summarized results in File: Test12_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----daily_Mauer

ClimateTimeSeries                       Daily_SequencedYears
ClimateFile                             Daily_Mauer_Baseline_SC.csv
ClimateFileFormat                       Daily_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Daily_SequencedYears
SpinUpClimateFile                       Daily_Mauer_Baseline_SC.csv
SpinUpClimateFileFormat                 Daily_Temp-C_Precip-mmMonth
```

I checked to make sure it was selected the 10th year of input data and therefore correct for the time step specified in the scenario file. **PASSED**!

Test 13. Testing with DailySequencedYears with RH and wind data

Summarized results in File: Test13_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----daily_Mauer

ClimateTimeSeries                       Daily_SequencedYears
ClimateFile                             Daily_Mauer_Baseline_SC_RHonly.csv
ClimateFileFormat                       Daily_Temp-C_Precip-mmMonth

SpinUpClimateTimeSeries                 Daily_SequencedYears
SpinUpClimateFile                       Daily_Mauer_Baseline_SC_RHonly.csv
SpinUpClimateFileFormat                 Daily_Temp-C_Precip-mmMonth
```

```
LandisData "Climate Config"

>>-----daily_Mauer

ClimateTimeSeries                       Daily_SequencedYears
ClimateFile                             Daily_Mauer_Baseline_SC_windRH.csv
ClimateFileFormat                       mauer_daily

SpinUpClimateTimeSeries                 Daily_SequencedYears
SpinUpClimateFile                       Daily_Mauer_Baseline_SC_windRH.csv
SpinUpClimateFileFormat                 mauer_daily
```

I checked to make sure it would run if you supplied relative humidity alone (top options) and both wind speed and RH data (2nd option). **PASSED**!

Test 14. Testing with MonthlySequencedYears with a single ecoregion and units from the 5th assessment of the IPCC

Summarized results in File: Test14_ComparingInputOutput

I made this short file (only one year and only one ecoregion) because I was initially having some trouble with this option.

I used these options:

```
LandisData "Climate Config"

>>-----monthly_ipcc5 climate_degK_m2/sec-units-----and----monthly_PRISM-------

ClimateTimeSeries                       Monthly_SequencedYears
ClimateFile                             CanESM2_RCP8.5_raw_ML_test.csv
ClimateFileFormat                       Monthly_Temp-K_Precip-mmSec

SpinUpClimateTimeSeries                 Monthly_SequencedYears
SpinUpClimateFile                       PRISM_data_AFRI_4.18.13_test.csv
SpinUpClimateFileFormat                 Monthly_Temp-K_Precip-mmSec
```

I checked to make sure all the unit conversions were correct since the input file has temp in units of K and precip in units of kg/m2/sec. **PASSED**!

Test 15. Testing with MonthlySequencedYears with a multiple ecoregions and units from the 5th assessment of the IPCC

Summarized results in File: Test15_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----monthly_ipcc5 climate_degK_m2/sec-units-----and----monthly_PRISM-------

ClimateTimeSeries                       Monthly_SequencedYears
ClimateFile                             CanESM2_RCP8.5_raw_ML.csv
ClimateFileFormat                       Monthly_Temp-K_Precip-mmSec

SpinUpClimateTimeSeries                 Monthly_SequencedYears
SpinUpClimateFile                       PRISM_data_AFRI_4.18.13_3ecoregions_all.csv
SpinUpClimateFileFormat                 Monthly_Temp-K_Precip-mmSec
```

I checked to make sure the magnitude of the values looked reasonable and that it was cycling through the ecoregions properly. **PASSED**!

Test 16. Testing with DailySequencedYears with one ecoregion and units from the 5th assessment of the IPCC

Summarized results in File: Test16_ComparingInputOutput

I used these options:

```
LandisData "Climate Config"

>>-----daily_ipcc5 climate_degK_m2/sec-units-----and----monthly_PRISM-------

ClimateTimeSeries                       Daily_SequencedYears
ClimateFile                             CanESM2_RCP8.5_raw_ML_fakedaily.csv
ClimateFileFormat                       Daily_Temp-K_Precip-mmSec

SpinUpClimateTimeSeries                 Monthly_SequencedYears
SpinUpClimateFile                       PRISM_data_AFRI_4.18.13_test.csv
SpinUpClimateFileFormat                 Monthly_Temp-K_Precip-mmSec
```

I created a fake daily file for IPCC5 because the daily data was not available yet. Therfore my input precipitation values are very high, but I was just trying to make sure my input would match my output. **PASSED**!

Test 17. Testing PET

I examined the values for PET used in AnnualClimate_Monthly and they were often negative in the summer. Therefore I ended up using a different method for calculating PET in the code. The method I used is described in this file, along with the results from my testing (I:\Research\Shares\scheller_lab\Lucash\Landis_Documents_Testing\WaterBudget\PETCalcs.xls).

Test 18. Testing water budget

While examining PET, I started looking at available water for my AFRI single cell simulations and discovered that there was no available water in year 1 of my simulations. I also discovered that it was only snowing in MN in January and completely melting that same month (i.e. no snowpack). Therefore I ended up completely revising the water budget. All my calculations and code revisons are described in WaterCalcs.xlsx (I:\Research\Shares\scheller_lab\Lucash\Landis_Documents_Testing\WaterBudget\). I also made sure all the fluxes were reasonable and this process is documented in Testing_Output_WaterCalcs.xlsx in the same folder. When I later had difficulty getting enough N for the trees to grow, I looked at leaching and discovered I was having a huge efflux of DON from the systems now that there was more available in the system. I made minor revisions to the leaching algorithms for DON so that I wasn't getting huge amounts in TestingCNLeaching (I:\Research\Shares\scheller_lab\Lucash\Landis_Documents_Testing\TestingLeaching\).

Test 19. Testing dates for beginning and ending of growing season and growing degree days

I found that the start of the growing season was working properly if you fed in daily climate data, but NOT if you fed in monthly climate data. The growing season was WAY too long if you fed in monthly climate data (it was closer to 300 days rather than 200!). I revised the algorithms to make sure the monthly temperature interpolation worked correctly. The calculations and subsequent testing are described in the file GrowingDegreeDays.xls (I:\Research\Shares\scheller_lab\Lucash\Landis_Documents_Testing\Regeneration).
I made sure that GDD was working properly using both daily and monthly climate data, which it was.

Test 20. Testing regeneration

When I ran some landscape simulations, Eric noted that there was very little regeneration in my landscape. When I looked more closely, I realized that the soil moisture multiplier was always zero after 70 years. I looked closely at the algorithms, comparing them to the equation in Botkin from which they were developed. They looked fine, except for the base temperature. I modified the base temperature used for comparison purposes to match the literature value (in Botkin) and then the temperature multiplier looked fine. Calculations are listed in TempMultiplier.xls (I:\Research\Shares\scheller_lab\Lucash\Landis_Documents_Testing\Regeneration).