Instructions for installing and running the stim-cbmcfs3 package

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**Overview:** The stsim-cbmcfs3 package integrates the Carbon Budget Model for the Canadian Forest Sector (CBM-CFS3) into the ST-Sim simulation model. In its current form, the package runs as a single-cell model without any transitions for a particular spatial unit (ecological boundary x administrative boundary) and species type. The package has been validated against CBM-CFS3 simulations for the 5 combinations of spatial unit and species types listed in “Crosswalk - Spatial Unit and Species Type Demo.csv”. The package runs in conjunction with a template ssim library that has the CBM-CFS3 stocks and flows parameterized but is not specific to any location/spatial unit (ecological boundary x admin boundary) or species type. The general wokflow to use the stsim-cbmcfs3 package is as follows:

1. Install the CBM-CFS3 Operational Scale model.
2. Pre-run the CBM-CFS3 for a particular spatial unit and species type with no disturbance events and with Wildfire as the historic disturbance type to get age-specific initial biomass and DOM carbon stocks for the stsim-cbmcfs3 package. Note that this step will not be necessary in future once we fix the volume to carbon conversion equations (for initial Biomass carbon stocks) and once we create our own DOM carbon spin-up model (for initial DOM carbon stocks). For now, these CBM-CFS3 runs will also serve as validation scenarios.
3. Run an external R script (**modifyTemplate\_Demo.R**) to modify the ssim template. This script creates a working copy of the template library and further parameterizes it for a particular spatial unit and species type. This will create all the necessary definitions, sub-scenarios and full scenario to run the stsim-cbmcfs3 package. For now, you need to have pre-run the CBM-CFS3 for your spatial unit and species type to be able to initialize biomass and DOM carbon stocks. This script will take the CBM-CFS3 simulation results and massage them to be input as state attribute values for initial carbon stocks.
4. Run the stsim-cbmcfs3 package. In the SyncroSim UI you have the option of running the stsim-cbmcfs3 package in 2 steps (1. CBM-CFS3 Pathways and 2. ST-Sim) or all at once (All). The first step runs an R script called transformer.R (it comes with the stsim-cbmcfs3 package) that mines the CBM-CFS3 database to parameterize the following:
   1. the state attribute values for age-specific total net growth (sometimes called NPP)
   2. the flow pathway multipliers to partition net growth among the biomass carbon stocks (also age specific).
   3. the flow pathways multipliers for the biomass turnover rates and for the DOM transfer, decay and emission rates. None of these are age specific.

The second step runs ST-Sim SF now that it has been parameterized based on the CBM-CFS3 database.

1. Run external R scripts (**modifyTemplate\_Demo.R** and **createValidationScenario.R**) to create a full scenario that will hold the validation results from the CBM-CFS3 simulation of the same spatial unit and species type.

**External Files:** You will need the following files to run the stsim-cbmcfs3 package (available in S3 zip file):

* **CBM-CFS3 Template.ssim** – a ssim library with stocks and flows parameterized corresponding to the CBM-CFS3. Note that this template is not parameterized for any particular spatial unit or species type.
* **modifyTemplate\_Demo.R** – an R script that will modify the template ssim library to further parameterize it for a particular spatial unit and species type
* **createValidationScenario.R** – an R script that is a function to import the output data from a CBM-CFS3 run into a ST-Sim results scenario. This makes validation much easier as you can take advantage of ST-Sim charting to plot ST-Sim runs vs. CBM-CFS3 runs.
* **Crosswalk - Spatial Unit and Species Type Demo.csv** – provides a crosswalk between the spatial units (ecological boundary x administrative boundary) and species type in CBM-CFS3 with the terminology used in ST-Sim.

The following external files are only necessary if you **do not re-run** the CBM-CFS3 simulations on your own for the spatial units and species types listed in Crosswalk - Spatial Unit and Species Type Demo.csv. If you will be running CBM-CFS3 simulations then you will generate these files on your own.

* CBM-CFS3 simulation results for the spatial units and species types listed in Crosswalk - Spatial Unit and Species Type Demo.csv:  
  **PacificMaritime\_BC\_DouglasFir\_NoDisturbance.txt MixedwoodPlains\_ON\_Pine\_NoDisturbance.txt MixedwoodPlains\_ON\_Maple\_NoDisturbance.txt BorealShieldWest\_ON\_Softwood\_NoDisturbance.csv  
  BorealShieldWest\_ON\_Hardwood\_NoDisturbance.csv**

The following external file is only necessary if you **do re-run** the CBM-CFS3 simulations for the spatial units and species types listed in Crosswalk - Spatial Unit and Species Type Demo.csv

* Merchantable volume curves for the spatial units and species types listed in Crosswalk - Spatial Unit and Species Type Demo.csv **FIA\_Growth\_Curve\_Calculator\_Demo.xlsx** – The volume curves used to run the CBM-CFS3 on the Maritime Pacific and Mixedwood Plains ecological regions.

**Linear\_GrowthCurve.csv** – The volume curve used to run the CBM-CFS3 on the Boreal Shield West ecological regions. Note that this linear curve is unrealistic but was used to model debugging.

**Instructions to install and set up the stsim-cbmcfs3 package:**

The stsim-cbmcfs3 package is an add-on to ST-Sim that requires both the stsim and stsim-stockflow packages.

1. Install SyncroSim v2.1.10
   1. See email from Leonardo
2. Install stsim, stsim-stockflow and stsim-cbmcfs3 package
   1. Within the SyncroSim UI, go to File>Packages
   2. Click the “Install” button
   3. Select the stsim, stsim-stockflow, stsim-cbmcfs3 packages from the list of options and click ok
   4. You should now see these three packages in the list of Installed Packages
3. Modify the SyncroSim session specified in the stsim-cbmcfs3 package  
   \*Note this is a workaround for now since you will not be installing SyncroSim v2.1.10 with a setup pack. With the set-up pack installation the package scripts will automatically detect your SyncroSim session.
   1. Use Windows Explorer to navigate to the Packages folder for SyncroSim v2.1.10
   2. In this folder you will see a folder for each of your installed packages, open the stsim-cbmcfs3 folder
   3. Open the transformer.R script and modify line 22 to point to the folder on your computer where SyncroSim v2.1.10 is installed:  
      e.g. mySession = session("C:/Users/bronw/Documents/Apex/SyncroSim/2-1-10-Beta")

**Instructions to run the stsim-cbmcfs3 package without pre-running the CBM-CFS3 simulations** (instead of running CBM-CFS3 you will use the CMB-CFS3 simulation results provided on S3)**:**

*Note that if you want to run your own CBM-CFS3 simulations then see instructions on page 5.*

1. Install the CBM-CFS: <https://www.nrcan.gc.ca/climate-change/impacts-adaptations/impacts-forests/carbon-accounting/carbon-budget-model/13107?utm_campaign=DFATD&utm_medium=twitter&utm_source=tweet44>
   1. Note that you need to install the CBM-CFS3 even if you are not pre-running the CBM-CFS3 simulations because you need to have the CBM-CFS3 database downloaded and saved on your computer.
2. Make sure that Microsoft Access Database Engine is installed so that you can connect to the CBM-CFS3 database (it is a MS Access database) from R x64bit
   1. Install AccessDatabaseEngine\_X64.exe from <https://www.microsoft.com/en-us/download/details.aspx?id=13255>
3. Modify the template ssim library (CBM-CFS3 Template.ssim) to parameterize it for a specific spatial unit and species type.
   1. Open the R script modifyTemplate\_Demo.R in RStudio
   2. Modify lines 1 – 34 of this R script based on your computer set up and spatial unit and species type
      1. Note that you need to specify the directory (crosswalkDir), name (crosswalkSTSUName), and row number for a particular spatial unit and species type of the “Crosswalk - Spatial Unit and Species Type Demo.csv” file. For now you can only work with a single spatial unit and species type combination at a time but soon we will modify the script to be able work with multiple spatial units and species types.
   3. Run the R script up to and including line 328. These lines of code will create all the necessary definitions and sub-scenarios to run the stsim-cbmcfs3 package for a particular spatial unit and species type. Note: the code parameterizes initial carbon stocks using state attribute values. These initial stock values come from the CBM-CFS3 runs. Eventually we will replace the initial biomass carbon stocks with volume to carbon equations using the expansion factors provided in the CBM-CFS3 database. Eventually we will replace the initial DOM carbon stocks with our own version of the spin-up (make-list) model. Optional: at this point you can open the library you created called myLibraryName (e.g. "CBM-CFS3 Demo BC Pacific Maritime Doug Fir.ssim") in the SyncroSim UI to look at the sub-scenarios created and to move them into folders.
4. Run scenarios using your working copy of the template ssim library (e.g. "CBM-CFS3 Demo BC Pacific Maritime Doug Fir.ssim")
   1. Run the modifyTemplate\_Demo.R script lines 328 – 347 to create and run a full scenario. Note you can also create and run the full scenario from the SyncroSim UI if you prefer. In the SyncroSim UI you have the option of running the stsim-cbmcfs3 package in 2 steps (1. CBM-CFS3 Pathways and 2. ST-Sim) or all at once (All). See description of these 2 steps above in the Overview section.
5. Create a validation scenario for the same spatial unit and species type
   1. Run the modifyTemplate\_Demo.R script lines 349 – 360 to create a full scenario that will hold the validation results from the CBM-CFS3 simulation of the same spatial unit and species type.
   2. Switch to the SyncroSim UI and refresh all if you have libraries open. For the validation scenario you just created, run only step 2 (aka “ST-Sim”). This will create an empty results scenario that we will populate with CBM-CFS3 simulation results.
   3. Switch back to RStudio and run modifyTemplate\_Demo.R line 363.
      1. Note that this line calls a function (sourced from createValidationScenario.R). This function has an argument called validationDataWide which is used to specify your CBM-CFS3 simulation data (e.g. validationDataWide =CBMSimulationData). For these simulations with no disturbances, our validation data is the same as our initial carbon stock data (i.e. they come from the same CBM-CFS3 simulations).
   4. Switch back to the SyncroSim UI and refresh all libraries. Now you can compare your ST-Sim results with the CBM-CFS3 simulation results.

**Instructions to pre-run the CBM-CFS3 simulations:**

1. Launch the CBM-CFS3 Operational Scale UI and use the Stand-level Project Creator to pre-run the CBM-CFS3 for a particular spatial unit and species type with no disturbance events and with Wildfire as the historic disturbance type
   1. Start by running one of the spatial units and species types combinations listed in “Crosswalk - Spatial Unit and Species Type Demo.csv”. The volume curves are provided in on S3.
   2. Once the simulation is complete create a custom view that includes the following stocks:  
      - 5 Biomass stocks: Merchantable, Foliage, Other, Coarse Roots, Fine Roots

- 9 DOM stocks: Aboveground Very Fast DOM, Aboveground Fast DOM, Medium DOM, Aboveground Slow DOM, Belowground Very Fast DOM, Belowground Fast DOM, Belowground Slow DOM, Branch Snag, Stem Snag

* 1. Export the data in the view to a txt file. Do not change any defaults. Note that the default is to produce a comma delimited file with an extension .txt. Record the filename in the column “CBMSimulationDataFileName” of the “Crosswalk - Spatial Unit and Species Type Demo.csv”.