trees_ibm Documentation

Release 0.2.2

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Jun 04, 2019

Contents:

Introduction

trees-ibm is a python package designed to implement individual-based models of forests. Each tree is individually simulated throughout its life.

trees-ibm* intends to provide a simple base for modellers building forest models.

Installation Instructions

The easiest way to install *trees-ibm* is through pip (the python package manager).

Make sure you have pip installed and then run:

```
pip install trees_ibm
```

You will need installation permissions in your system.

CHAPTER 3

Model Description

Examples

The code below simulates an area of 1 hectare. Starting from a treeless landscape, every year seeds on the seed bank have the change to germinate. The simulation goes on for 300 years

```python
import trees_ibm
import matplotlib.pyplot as plt
import numpy as np
import random



################################################################
#                       PFT CREATION                          #
################################################################

par_1=dict(
    wood_density=0.35,
    max_agb=200,
    max_dbh=145,
    h0=3.3,
    h1=0.60,
    cl0=0.80,
    cd0=0.60,
    cd1=0.68,
    cd2=0.0,
    rho=0.55,
    sigma=0.70,
    f0=0.77,
    f1=-0.18,
    l0=2.0,
    l1=0.10,
    Iseed=0.03,
    Nseed=20,
    m=0.5,
    rg=0.25,
    Mb=0.015,
```

```
    pmax=2,
    alpha=0.36,
    Dmort=10,
    Dfall=0.45,
    pfall=0.3,
    DdeltaDmax=0.33,
    deltaDmax=0.012,
    m_max=0.12,
    Fdisp=1.0,
    Adisp=0.118,
    Nfruit=30)


par_2=dict(
    wood_density=0.35,
    max_agb=200,
    max_dbh=58,
    h0=4.6,
    h1=0.4,
    cl0=0.80,
    cd0=0.60,
    cd1=0.68,
    cd2=0.0,
    rho=0.55,
    sigma=0.70,
    f0=0.77,
    f1=-0.18,
    l0=2.0,
    l1=0.10,
    Iseed=0.01,
    Nseed=15,
    m=0.5,
    rg=0.25,
    Mb=0.03,
    pmax=3.1,
    alpha=0.28,
    Dmort=10,
    Dfall=0.45,
    pfall=0.3,
    DdeltaDmax=0.34,
    deltaDmax=0.012,
    m_max=0.12,
    Fdisp=1.0,
    Adisp=0.118,
    Nfruit=30)

par_3=dict(
    wood_density=0.35,
    max_agb=200,
    max_dbh=58,
    h0=4.8,
    h1=0.4,
    cl0=0.30,
    cd0=0.60,
    cd1=0.68,
    cd2=0.0,
    rho=0.41,
```

```
        sigma=0.70,
        f0=0.77,
        f1=-0.18,
        l0=2.0,
        l1=0.10,
        Iseed=0.05,
        Nseed=21,
        m=0.5,
        rg=0.25,
        Mb=0.03,
        pmax=6.8,
        alpha=0.23,
        Dmort=10,
        Dfall=0.45,
        pfall=0.3,
        DdeltaDmax=0.23,
        deltaDmax=0.019,
        m_max=0.12,
        Fdisp=1.0,
        Adisp=0.118,
        Nfruit=30)

par_4=dict(
        wood_density=0.35,
        max_agb=200,
        max_dbh=44,
        h0=4.3,
        h1=0.4,
        cl0=0.30,
        cd0=0.60,
        cd1=0.68,
        cd2=0.0,
        rho=0.40,
        sigma=0.70,
        f0=0.77,
        f1=-0.18,
        l0=2.0,
        l1=0.10,
        Iseed=0.02,
        Nseed=50,
        m=0.5,
        rg=0.25,
        Mb=0.04,
        pmax=11,
        alpha=0.20,
        Dmort=10,
        Dfall=0.45,
        pfall=0.3,
        DdeltaDmax=0.60,
        deltaDmax=0.029,
        m_max=0.12,
        Fdisp=1.0,
        Adisp=0.118,
        Nfruit=30)

par_5=dict(
        wood_density=0.35,
```

```
    max_agb=200,
    max_dbh=16,
    h0=4.3,
    h1=0.3,
    cl0=0.30,
    cd0=0.60,
    cd1=0.68,
    cd2=0.0,
    rho=0.52,
    sigma=0.70,
    f0=0.77,
    f1=-0.18,
    l0=2.0,
    l1=0.10,
    Iseed=0.03,
    Nseed=50,
    m=0.5,
    rg=0.25,
    Mb=0.021,
    pmax=7,
    alpha=0.30,
    Dmort=10,
    Dfall=0.45,
    pfall=0.3,
    DdeltaDmax=0.33,
    deltaDmax=0.011,
    m_max=0.12,
    Fdisp=1.0,
    Adisp=0.118,
    Nfruit=30)


par_6=dict(
    wood_density=0.35,
    max_agb=200,
    max_dbh=16,
    h0=3.0,
    h1=0.60,
    cl0=0.30,
    cd0=0.60,
    cd1=0.68,
    cd2=0.0,
    rho=0.47,
    sigma=0.70,
    f0=0.77,
    f1=-0.18,
    l0=2.0,
    l1=0.10,
    Iseed=0.02,
    Nseed=50,
    m=0.5,
    rg=0.25,
    Mb=0.045,
    pmax=12,
    alpha=0.20,
    Dmort=10,
    Dfall=0.45,
```

```
        pfall=0.3,
        DdeltaDmax=0.60,
        deltaDmax=0.029,
        m_max=0.12,
        Fdisp=1.0,
        Adisp=0.118,
        Nfruit=30)



FT1=trees_ibm.trees_ibm.Tree.TreeFactory(new_cls_name="FT1", new_parameters=par_1)
FT2=trees_ibm.trees_ibm.Tree.TreeFactory(new_cls_name="FT2", new_parameters=par_2)
FT3=trees_ibm.trees_ibm.Tree.TreeFactory(new_cls_name="FT3", new_parameters=par_3)
FT4=trees_ibm.trees_ibm.Tree.TreeFactory(new_cls_name="FT4", new_parameters=par_4)
FT5=trees_ibm.trees_ibm.Tree.TreeFactory(new_cls_name="FT5", new_parameters=par_5)
FT6=trees_ibm.trees_ibm.Tree.TreeFactory(new_cls_name="FT6", new_parameters=par_6)


##################################################################

database_name="example_1.h5"

topology=trees_ibm.Tree_Grid(x_max=5,y_max=5,delta_h=0.5,patch_area=400,I0=860,
→lday=12,phi_act=365,k=0.7)
world=trees_ibm.Tree_World(topology=topology)

world.create_HDF_database(database_name)

world.initial_update()
dispersal_settings={'mode':'external',
                    'clear':False}

world.run_simulation(n=3600,dispersal_settings=dispersal_settings,h5file=database_
→name)
```

All the data generated during the simulation is now stored in the HDF5 database. We can access this data to run analyses or simply visualize some aspects of our simulation. The code below the Net Ecosystem Exchange and Carbon Stocks using one of the plotting functions available in the visualization module within trees_ibm.

```
from trees_ibm.visualization import plot_NEE, plot_stocks
import matplotlib.pyplot as plt
from tables import open_file
database_name="example_1.h5"


h5file=open_file(database_name,"r")
nee_table=h5file.root.sim_1.trees.sys_lvl.NEE
nee=nee_table.col("nee")
plot_NEE(nee)
fig_name="NEE_"+database_name.split(".")[0]+".png"
plt.savefig(fig_name,format="png")

Stocks={"AGB":[],"Dwood":[],"Sfast":[],"Sslow":[]}
stocks_table=h5file.root.sim_1.trees.sys_lvl.Stocks
Stocks["AGB"]=stocks_table.col("agb")
Stocks["Dwood"]=stocks_table.col("dead_wood")
Stocks["Sfast"]=stocks_table.col("soil_fast")
```
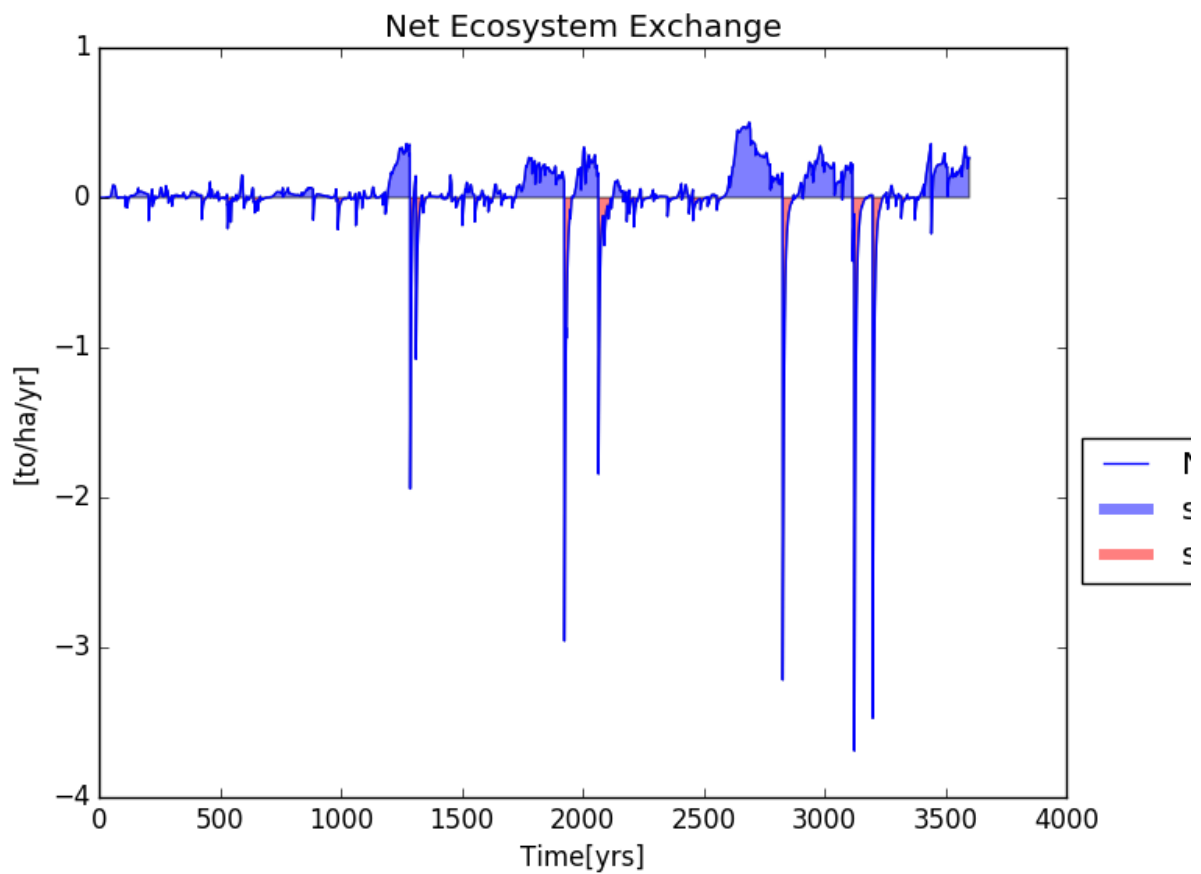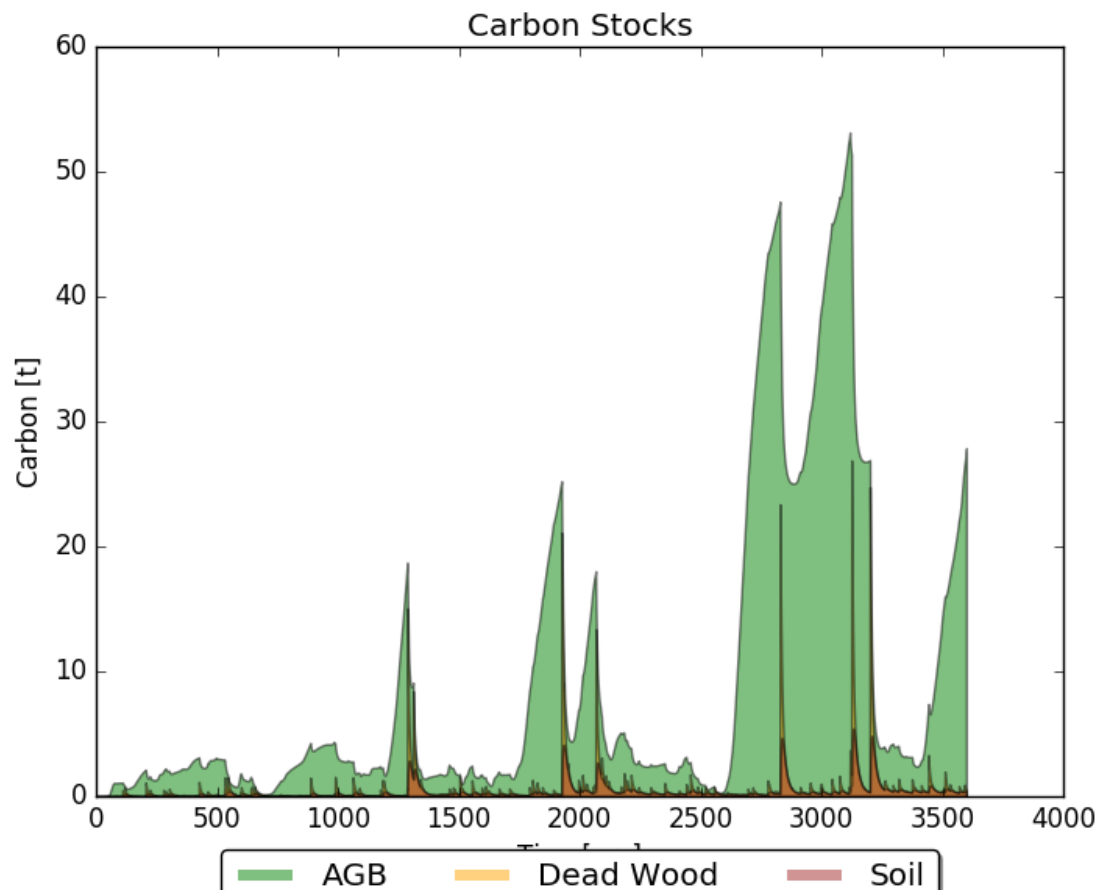
```
Stocks["Sslow"]=stocks_table.col("soil_slow")
plot_stocks(Stocks)
fig_name="Stocks_"+database_name.split(".")[0]+".png"
plt.savefig(fig_name,format="png")

h5file.close()
```

Carbon Stocks

CHAPTER 5

Modules

5.1 World Module

5.2 Topology Module

5.3 Tree Agent Module

5.4 Visualization Module

How to contribute

trees_ibm is still in it's early stages of development and help is very much appreciated!

You can contribute by:

- Adding features to the codebase
- Expanding the testing suite
- Improving the documentation
- Reporting/fixing bugs
- Suggesting new features
- Giving your input on the biological meaning of the model assumptions/formulation

6.1 How to Report Issues

To report an issue, please use the GitHub issues tracker. When reporting issues, please mention the following details:

- Which version you are using
- What was the source code that generated the problem (if applicable)
- Which platform are you running on
- How to reproduce the issue
- What was the result of the issue
- What were you expecting to get

Reducing the source code that caused the issue to a bare minimum is always very helpful.

6.2 Workflow for Pull Requests

In order to contribute, please fork off of the `develop` branch and make your changes there. Your commit messages should detail *why* you made your change in addition to *what* you did (unless it is a tiny change).

If you need to pull in any changes from `develop` after making your fork (for example, to resolve potential merge conflicts), please avoid using `git merge` and instead, `git rebase` your branch.

Additionally, if you are writing a new feature, please ensure you write appropriate test cases and place them under `src/tests/`.

Finally, please test your code and ensure that it runs locally before submitting a pull request.

Thank you for your help!

6.3 Running the tests

trees-ibm includes a set of tests. They are included in the /src/tests/ directory. They require the pytest package.

To run all tests go to the src directory and run:

```
python -m pytest
```

You can also specify on module:

```
python -m pytest test_world.py
```

CHAPTER 7

Indices and tables

- genindex
- modindex
- search