PNET MODELS: CARBON, NITROGEN, WATER DYNAMICS IN FOREST ECOSYSTEMS (VERS. 4 AND 5)

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PnET Models: Carbon, Nitrogen, Water Dynamics in Forest Ecosystems (Vers. 4 and 5)

Summary:

PnET (Photosynthetic / EvapoTranspiration model) is a nested series of models of carbon, water, and nitrogen dynamics in forest ecosystems. The models can be used to predict transient responses in net primary production (NPP), carbon and water balances, net nitrogen (N) mineralization and nitrification and N leaching losses, resulting from changes in climate, N deposition, tropospheric ozone and land use as well as variation in species composition. The models have been developed and validated in the Northeastern U.S. at both the site and grid level (to 1-km resolution) at the Complex Systems Research Center, University of New Hampshire, by John Aber and colleagues.

Model Product Citation:

Cite this model product as follows:

Aber, J. D., S. V. Ollinger, C. T. Driscoll, C. A. Federer, and P. B. Reich. 2005. PnET Models: Carbon, Nitrogen, Water Dynamics in Forest Ecosystems (Vers. 4 and 5). ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/817.

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Data Model Description:

Model Documentation

Extensive documentation is not provided with the models, however, complete description of each model is provided in several published papers. (Aber et al. 1995, 1996, 1997) and more recent model additions are described in Aber and Driscoll (1997) and Ollinger et al. (1997, 2002). Complete descriptions of all algorithms, a listing of all variables used in the models, with units, and sample input values for several forest types are given in these papers.

The PnET development history to date is in the companion file, PnET_changelog.pdf, and installation and execution instructions are included in compressed model files listed below.

Source Code

PnET Model Code Descriptions

The PnET model is distributed in two source code versions. The core science components of the two code bases are identical; however, each version of the model offers unique features which make them appropriate for different tasks.

- The Visual Basic version offers a GUI frontend, generates output plots and offers a number of runtime options and scenarios. At this time the Visual Basic distribution is the only version of the model which offers PnET-CN and PnET-Day functionality.
- The Visual Basic version is most appropriate for site level interactive modeling and carbon and nitrogen.
- The ANSI C version is a subset of the complete PnET suite and currently only offers PnET-II functionality.
- The C version is a command line client that focuses on portability and performance. The C version is best suited for tasks requiring high performance such as large spatial runs or monte-carlo simulations.

Feedback

The compressed files listed in the following table contain the source code and pre-built binaries together with sample data sets, documentation, user guides and technical notes for their respective PnET model version.

Model Version	Release Date	File Name (PC platform)	File Name (Unix platform)	Modeling Environment	PnET Model Functionality	Included Documentation File
PnET 5.1-1.5vb	04/21/03	pnet_vb.zip		Visual Basic	PnET-CN and PnET-Day	tutorial.doc
PnET 4.1-1.2c	09/13/02	pnet_c_win.zip	pnet_c.tar.gz	C code	PnET-II	readme

NOTE:

The first number in the version string refers to the PnET "science" version.

The second number is the version of the C or Visual Basic source code revision.

The development history of these versions is in companion file PnET_changelog.pdf.

Model scale and resolution

The original PnET uses a monthly timestep. PnET-Day uses a daily timestep. The PnET models do not have an explicit spatial scale, but they are viewed as regional (i.e., in contrast with TEM, which is global in scale (Jenkins et al. 1999)).

Inputs

Climate variables

1. monthly average radiation
2. monthly average, minimum, and maximum temperature
3. monthly total precipitation
4. monthly average insolation

Site variables

1. latitude (degrees)
2. water holding capacity (cm)
3. canopy light attenuation constant
4. foliar percent nitrogen
5. foliar retention time (years)
6. leaf specific weight (mg cm^{-2})
7. intercept of foliar N to max photosynthetic rate relationship
8. slope of the relationship
9. half saturation light level (J m^{-2} s^{-1})
10. constant effect of vapor pressure deficit on photosynthesis and transpiration
11. fraction of precipitation intercepted

The input data sets available for these models include a landuse classification map for New England, grids of climate variables, monthly (e.g. precipitation), grids of annual N and S (sulfur) atmospheric deposition and are contained in the compressed source code files as needed for the particular PnET version.

Model Output

PnET-II outputs generally include annual net primary productivity (NPP), wood production and runoff under current and climate change conditions (i.e., +6 degrees C, -15% precipitation, and 2 x CO2). Climate change predictions are presented as ratios of future to current values. PnET-CN outputs include regional predictions of equilibrium N cycling. Please check the Complex Systems Research Center, University of New Hampshire, website (www.pnet.sr.unh.edu) for additional information about PnET output data sets.

Testing and validation

PnET-Day has been validated against daily summaries of eddy correlation carbon balance measurements from the Harvard Forest (Aber et al. 1996). PnET-II has been validated against annual NPP and monthly water yield data from the Harvard Forest and Hubbard Brook ecosystems. PnET-CN maintains the predictions for NPP and water balance used for validation in PnET-II. PnET-CN compares well with field data in predicting total annual, mean seasonal, and actual time series rates of nitrate loss in streams (Aber et al. 1997a, 1997b). PnET-II predictions of foliar production and NPP were validated against data from 10 additional forest types across North America (Aber and Federer 1992). Jenkins et al. (1999) found that PnET-II predictions were sensitive to soil water holding capacity, but not to temperature.

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