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CENTURY: MODELING ECOSYSTEM RESPONSES TO CLIMATE CHANGE, VERSION 4 (VEMAP 1995)

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CENTURY: Modeling Ecosystem Responses to Climate Change, Version 4 (VEMAP 1995)

Summary:

The CENTURY model, Version 4, is a general model of plant-soil nutrient cycling that is being used to simulate carbon and nutrient dynamics for different types of ecosystems including grasslands, agricultural lands, forests, and savannas. CENTURY is composed of a soil organic matter/ decomposition submodel, a water budget model, a grassland/crop submodel, a forest production submodel, and management and events scheduling functions. It computes the flow of carbon, nitrogen, phosphorus, and sulfur through the model's compartments. The minimum configuration of elements is carbon (C) and nitrogen (N) for all the model compartments. The model structures for C, N, phosphorus (P) and sulfur (S) in organic matter are identical; the inorganic components are computed for the specific inorganic compound. Carbon uptake in CENTURY is controlled primarily by nitrogen availability (VEMAP 1995). Elevated CO₂ influences net primary production (NPP) predictions by altering the C:N ratio of decomposing organic matter, as well as soil moisture. The soil organic matter sub-model includes three soil organic matter pools (active, slow, and passive) with different potential decomposition rates, above and below ground litter pools, and a surface microbial pool (decomposition of surface litter). The water budget model calculates monthly evaporation, transpiration, water content of the soil layers, snow water content, and saturated flow of water between soil layers. Both plant production sub-models (a grassland/crop sub-model and a forest production sub-model) assume that the monthly maximum plant production is controlled by moisture and temperature, and that maximum plant production rates depend on the availability of nutrients. The grassland/crop production model simulates plant production for different herbaceous crops and plant communities (e.g., warm or cool season grasslands, wheat, and corn). The forest model simulates the growth of deciduous or evergreen forests in juvenile and mature phases. To simulate savanna or shrubland ecosystems, CENTURY combines the grassland and forest sub-models with simulation of nutrient competition and shading effects.

This archived CENTURY 4.0 product has a specialized gridded structure that was designed and used for VEMAP simulations. This version of the model simulates processes on a cell-by-cell basis for each identified cell of interest within the defined grid. There is no inter-cell communication when running the simulations.

The CENTURY Model Version 4.0 embodied the best understanding to date of the biogeochemistry of carbon, nitrogen, phosphorus, and sulfur. The primary purpose of the model was to provide a tool for ecosystem analysis, to test the consistency of data and to evaluate the effects of changes in management and climate on ecosystems. Evolution of the model continued as our understanding of biogeochemical processes improves. The identification of problem areas where processes were not adequately quantified was key to further developments. Model application led to the identification of needed research and new experimentation to improve understanding.

The [CENTURY V4 Users Manual](#) is included as a companion file and more information can be found at: <http://www.nrel.colostate.edu/projects/century/research.htm>.

Results from the VEMAP model simulations can be found in Kittel et al. (2004) at the ORNL DAAC (<http://www.daac.ornl.gov>).

Data Citation:

Cite this data set as follows:

Parton, W. J., D. S. Ojima, and D. S. Schimel. 2005. CENTURY: Modeling Ecosystem Responses to Climate Change, Version 4 (VEMAP 1995). ORNL DAAC, Oak Ridge, Tennessee, USA. <http://dx.doi.org/10.3334/ORNLDAAC/820>.

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Parton, W.J., R. McKeown, V. Kirchner, D. Ojima (1992) CENTURY Users' Manual, Natural Resource Ecology Laboratory, Colorado State University, Ft. Collins.

Robert L. Sanford, Jr.; William J. Parton; Dennis S. Ojima; D. Jean Lodge. 1991. Hurricane effects on soil organic matter dynamics and forest production in the Luquillo Experimental Forest, Puerto Rico: Results of simulation modeling. Biotropica 23:364-372.

Model Product Description:

Overview:

This specialized version of the model runs simulations on a cell-by-cell basis for each identified cell of interest within the defined grid. There is no inter-cell communication when running the simulations.

The VEMAP simulations of CENTURY were run for the continental U.S using a 1/2 degree grid.

- midpoint of the upper left hand corner at latitude -124.25, longitude 48.75
- midpoint of the lower right hand corner at latitude -67.25, longitude 25.25.

The VEMAP grid has 48 rows and 115 columns. 3168 cells were simulated.

Results from the VEMAP exercise can be found at the ORNL DAAC's VEMAP Project page (<http://www.daac.ornl.gov/VEMAP/vemap.html>).

To run a Gridded Century simulation the model expects to read an initialization file named century.init. This driver file contains information about the type of simulation to be run and the location and file names of the input files that will be used to run the simulation. The weather files used for the VEMAP simulations are in netCDF format. The geog.nc netCDF file is used to obtain the site specific parameters required to run a single grid cell. The soil texture information for a given grid cell is extracted from ASCII files organized by row and column to match the VEMAP grid.

Target computer platform(s):

The VEMAP simulations were run on UNIX using a specialized gridded version of the Century 4.0 model.

Model build environment:

A Gridded Century spinup simulation will use the lu*.100 files to get the initial information required for a Century simulation. At the end of the spinup simulation the information that is required for initializing a subsequent simulation, run as an extension of the spinup simulation, will be saved in a netCDF file named site.nc. The initialization information in the site.nc file represents the state of the site at the end of the spinup simulation and will be used to set the initial conditions for the subsequent simulations.

The phase1.ncdf file contains mean weather data for each of the grid cells simulated in the Century VEMAP runs. There is one year of monthly data for each cell. The pptT1.nc, tnT1.nc, and txT1.nc files contain several years of monthly transient weather for each grid cell. These files hold precipitation, minimum temperature, and maximum temperature values respectively.

The mbd1_m1.v2, mcl1_m1.v2, and msa1_m1.v2 files contain bulk density, clay, and sand values, respectively, for the VEMAP grid cells.

When running a VEMAP simulation Gridded Century will write the simulation output to several netCDF files.

Source code files:

- *.f - Fortran 77 source code files
- *.inc - Fortran include files
- *.c - C source code files

*.h - C header files

Makefile_util - Makefile used to build the Century executable on a SUN OS

Landuse types as defined for the VEMAP simulations:

lu Description

- 1 Tundra
- 2 Subalpine Coniferous Forest
- 3 Maritime Coniferous Forest
- 4 Continental Coniferous Forest
- 5 Cool Temperate Mixed Forest
- 6 Warm Temperate/Subtropical Mixed Forest
- 7 Temperate Deciduous Forest
- 10 Temperate Mixed Xeromorphic Woodland
- 11 Temperate Coniferous Xeromorphic Woodland
- 13 Temperate/Subtropical Deciduous Savanna
- 14 Warm Temperate/Subtropical Mixed Savanna
- 15 Temperate Coniferous Savanna
- 17 C3 Grasslands
- 18 C4 Grasslands
- 19 Mediterranean Shrubland
- 20 Temperate Arid Shrubland
- 21 Subtropical Arid Shrubland

Parameter files:

crop.100 - grass/crop options

cult.100 - cultivation options

fert.100 - fertilizer options

fire.100 - fire options

biome specific fix files:

arcfix.100 - used for landuse type 1

borfix.100 - used for landuse type 2

drygfix - used for landuse types 11, 17, 20, and 21

drytrpfix.100 - used for landuse type 19

ffix.100 - used for landuse types 3, 4, 5, 6, and 7

gfix.100 - used for landuse types 13, 14, 15, and 18

graz.100 - grazing options

harv.100 - harvest options

irri.100 - irrigation options

omad.100 - organic matter addition options

tree.100 - tree options

trem.100 - tree removal options

<site>.100 - landuse type specific site files

Feedback

lu1.100

lu2.100

lu3.100

lu4.100

lu5.100

lu6.100

lu7.100

lu10.100

lu11.100

lu13.100

lu14.100

lu15.100

lu17.100

lu18.100

lu19.100

lu20.100

lu21.100

Sample initialization files:

century.new.spin - example century.init file for a spinup run

century.tran.vveg1940.NoCO2.No24Burn - example century.init file for a transient weather run

(NOTE: The Gridded Century executable expects to read a file named century.init. These example files would have to be renamed before running the simulation. The VEMAP simulations did not use the nitrogen deposition grid file or the nitrogen deposition scalars file so these files, referenced in the initialization files, are not included in the archive.)

Weather files:

phase1.ncdf - mean weather data

pptT1.nc - transient precipitation

tnT1.nc - transient minimum temperature

txT1.nc - transient maximum temperature

Soil files:

mbd1_m1.v2 - bulk density

mcl1_m1.v2 - clay

msa1_m1.v2 - sand

Technical documentation for Century Version 4.0:

[CENTURY V4 Users Manual](#)

Document Information:

2005/8/23

Document Review Date:

2005/8/23



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