User's Guide

For the Wetland-DNDC Model

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ACKNOWLEDGMENTS

This model was developed with financial support from the Southern Global Change Program, USDA Forest Service and the National Council for Air and Stream Improvement (NCASI), and also from NASA's TECO and EOS programs.

The researchers involved in the model development are Changsheng Li (USA), John Aber (USA), Carl Trettin (USA), Yu Zhang (Canada), Jianbo Cui (Canada), Sun Ge (USA), Klaus Butterbach-Bahl (Germany), Hans Papen (Germany), Genwei Cheng (China), and Harbin Li (USA).

1. Introduction

Wetland-DNDC is a computer simulation model of water, carbon (C) and nitrogen (N) biogeochemistry in forested wetland ecosystems. The model can be utilized for estimating forest production, ecosystem C dynamics and emissions of trace gases including methane (CH_4), nitrous oxide (N_2O), nitric oxide (NO), dinitrogen (N_2), and ammonia (NH_3). This User's Guide provides an overview of the Wetland-DNDC architecture, the interfaces with specific functionality and features, the work environment, and compilation of databases.

The guide is divided into eight sections. Section 1 is this introduction. Section 2 is a brief overview of the model structure and the scientific basis. Section 3 deals with system requirements and installation. Section 4 provides a step-by-step guide for setting up the input parameters required by the model runs. Section 5 explains how to view and interpret the modeled results. Section 6 includes three appendix specifying the definitions related to all of the input parameters required for the model runs at site and regional scales. Section 7 is an index of useful key words. All references cited in the Guide are listed in Section 8.

It is recommended to review the publications listed in the references for obtaining an adequate understanding of the scientific concepts underlining the model functions.

2. Model Description

Wetland-DNDC was constructed by integrating hydrological and forest biogeochemical processes at site and watershed scales. Two existing models, FLATWOODS, a distributed hydrological model (Ge, 1993), and PnET-N-DNDC, a forest biogeochemical model (Li et al., 2000), were adopted and modified for the integration. Several new features were developed to support the integration, which included (1) quantification of water table fluctuation and lateral flows, (2) simulation of soil redox potential dynamics and its effects on C and N biogeochemistry, and (3) characterization of forest structure with three layers, namely upper-story, under-story and ground growth.

Water table dynamics plays a key role in linking the hydrology and the forest biogeochemistry. In the site mode, Wetland-DNDC provides three options to define the fluctuation of water table: (1) using observed water table depths, (2) using a set of empirical hydrological parameters developed from historical observations of water table dynamics, and (3) using a hydrological model based on the local climatic, vegetation and soil conditions at the site scale. In the watershed scale, the soil hydrological features (e.g., water table depth, surface and ground water influx and efflux, percolation, infiltration, and diffusion) are calculated by tracking precipitation, throughfall, evaporation, transpiration, and leaching rates at a daily or hourly time step. When Wetland-DNDC is run in the watershed mode, a pre-prepared GIS database is required to hold the spatially differentiated input parameters including daily meteorological data, topography, soil properties, initial water table depth, forest type and age, and management. A grid system is utilized to link Wetland-DNDC to the GIS database.

In Wetland-DNDC, forest growth is simulated by tracking photosynthesis, respiration, C allocation, N uptake, water demand, and litterfall at a daily time step. Nine forest types have been included in Wetland-DNDC. They are pine, spruce, hemlock, fir, oak, hardwoods, birch, beech and rainforest. The physiological and phonological parameters for the forests were mainly adopted from the PnET model (Aber et al., 1995). The under-story shares the same plant types as above listed for the upper-story. The ground-growth plants include moss, herbaceous and lichens. The growths of upper-story, under-story and ground-growth are simulated based on their competitions for light, water and N (Zhang et al., 2002).

Soil biogeochemistry is modeled in Wetland-DNDC for estimating soil organic carbon (SOC) decomposition, nitrification, denitrification, methanogenesis and methanotrophy in the saturated and unsaturated zones of the soil profile. The forest soil profile consists of an organic section (the forest floor) and a mineral section (the mineral soil). The initial SOC profile is calculated based on latitude, forest type, forest age, and soil fertility. The calculated initial SOC content and the organic layer depth can be modified by the users during the input procedure. Soil redox potential (i.e., Eh) is calculated at a daily time step for each soil layer to govern the microbial oxidation-reduction processes including production and consumption of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and nitric oxide (NO) in the entire soil profile. Diffusion of the substrates in the soil matrix is calculated to quantify the fluxes of the gases emitted into the atmosphere. The detailed descriptions of the functions adopted in Wetland-DNDC have been published in former papers related to the DNDC model (e.g., Li et al. 1992; Li et al., 2000; Li 2000).

Wetland-DNDC has been calibrated and validated at site scale against numerous field data sets measured in forest ecosystems in North America and Europe (Stange et al., 2000; Butterbach-Bahl et al., 2001a and 2001b; Zhang et al., 2002).

3. Software and Hardware Requirements

The WETLAND-DNDC model can be operated on IBM-PC computers with 486 or better capabilities or on workstations. Computers with a RAM of 64 MB or more and a speed of 350MHz or higher are recommended. The output files produced from a 100-year run requires about 0.5 MB of disk space.

Wetland-DNDC requires Windows 98, 2000, NT, ME or XP installed.

Colour graphics is essential for successful use of the Wetland-DNDC package. The graphics display should be set as 1024 by 768 pixels to ensure the best graphic output.

A mouse or similar input device is required for operating the interactive graphics programs of the Wetland-DNDC package.

4. Installation

The Wetland-DNDC model is available at http://www.dndc.sr.unh.edu or in CD-ROM. The model package is a self-extracting zip file. After downloading the package into the hard drive of your computer, unzip the file first, and then click "Install" to automatically create all of the necessary directories and allocate all the supporting files contained in the package.

5. Input for Site-Scale Simulation

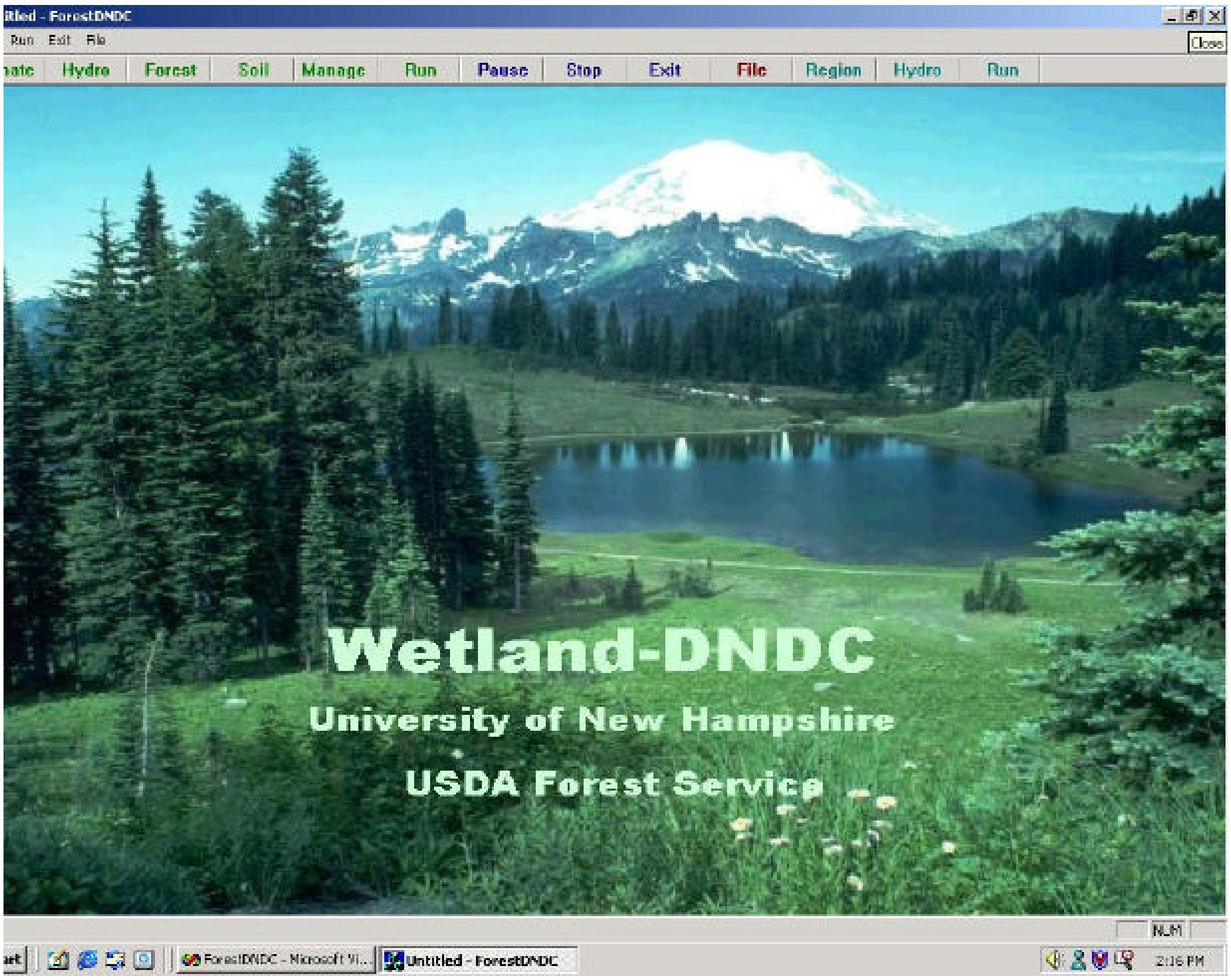

Figure 1. Wetland-DNDC workspace

5.1 Getting started

After the installation procedure, you should have a directory, WetlandDNDC, in your C drive. Enter C:\WetlandDNDC and click "Wetland_DNDC", and then you will see a workspace presented on the screen as shown in Figure 1. By clicking the buttons you will be able to send your input data to the model or run the mode in the site or regional mode.

5.2 Overview of modeling session

If you run Wetland-DNDC at site scale, the buttons marked with the words in green will allow you to manually type in all of your input information for climate, hydrology, forest, soil and management. For regional runs, you will need to use the buttons marked with the words in blue to select the pre-prepared database and execute the hydrological and biogeochemical simulations.

When a simulation is started, Wetland-DNDC first reads all of the driving parameters from a series of files, which were automatically created by the model during the input procedure. Hydrological processes, soil climate, plant growth, and soil biogeochemistry are calculated consecutively at a daily time step. At the end of each simulated year, an annual report is prepared to summarize the major pools and fluxes of water, C and N in the ecosystem. Optionally, daily record can be turned on during the input procedure, so that all of the major pools and fluxes can be recorded for each simulated day. Wetland-DNDC simulates forest water, C and N dynamics through a year to several hundred years.

Input procedure is started by defining climate parameters. Since some of the later input parameters are processed based on the early input data, following the climate—hydrology—forest—soil—management sequence during the input procedure is necessary for success simulations.

5.3 Input of climate information

Clicking button "Climate" will open a dialog box for inputting site and climate information (Figure 2). On this page, you can type in site name, latitude, N concentration in rainfall, atmospheric CO_2 content and number of total simulated years for the simulation. The definitions for the items shown on the page are described as follows:

[***Site name***]: A string for site name;

[***Latitude***]: The latitude (decimal unit) of site location;

[***N in precipitation***]: Annually averaged N (dissolved nitrate and ammonium) concentration in rainfall in unit mg N/l or ppm;

[***Atmospheric background CO2 concentration (ppm) (350)***]: Atmospheric background CO_2 concentration (default value is 350 ppm);

[***Simulated years***]: An integer number of total simulated years.

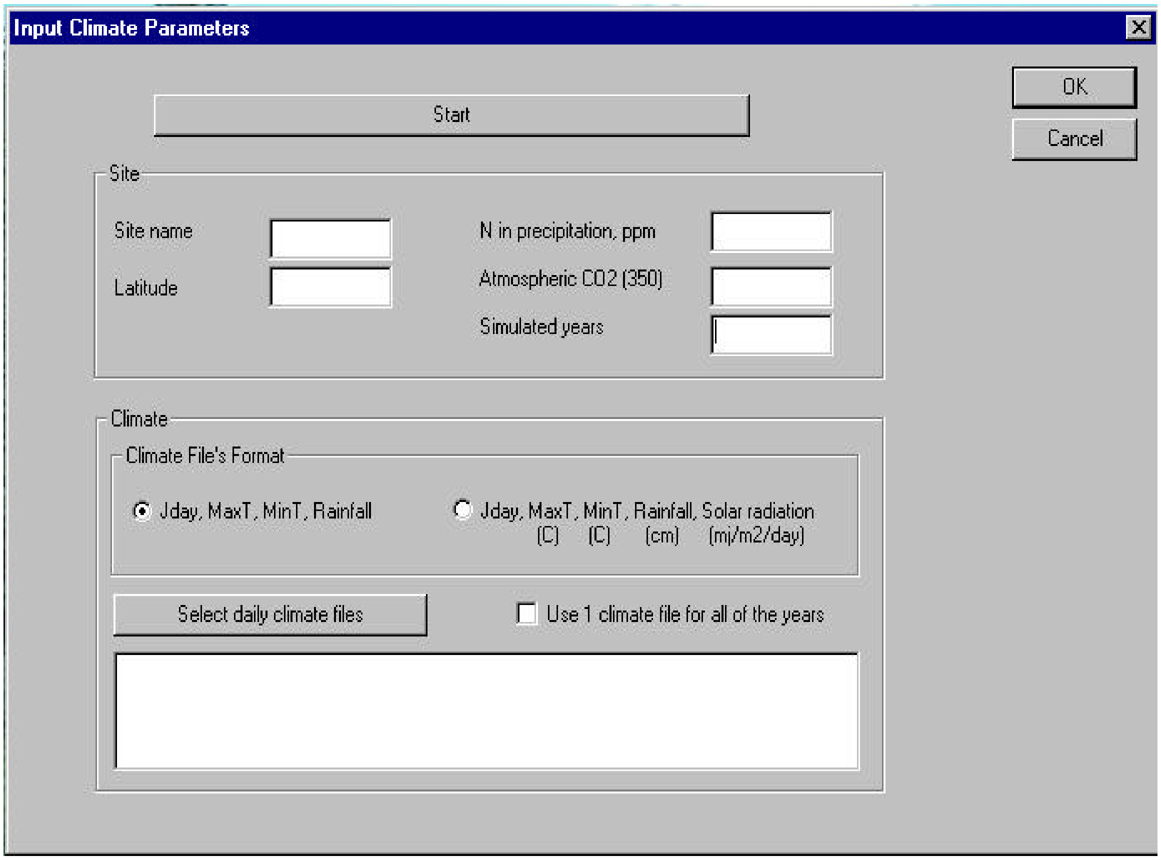

Figure 2. Dialog box for inputting site and climate information

There are two different formats for meteorological data files containing (1) daily air maximum and minimum temperatures and precipitation, or (2) daily air maximum and minimum temperatures, precipitation and solar radiation. After selecting the climate file format, you can click button "Select daily climate files" to browse and select the desired climate file(s). After specifying all of the parameters on the page, click button 'OK' to store the information in the computer. The information for each input parameter will be automatically saved in the hard drive, and will remain even after the model runs.

Wetland-DNDC requires daily meteorological information to drive the hydrological as well as the biogeochemical processes embedded in the model. The meteorological data files must be prepared in advance. The detailed information for constructing the meteorological files is provided in Appendix A.

5.4 Input of hydrological information

Click button "Hydro" to start input process for hydrological features. If you select

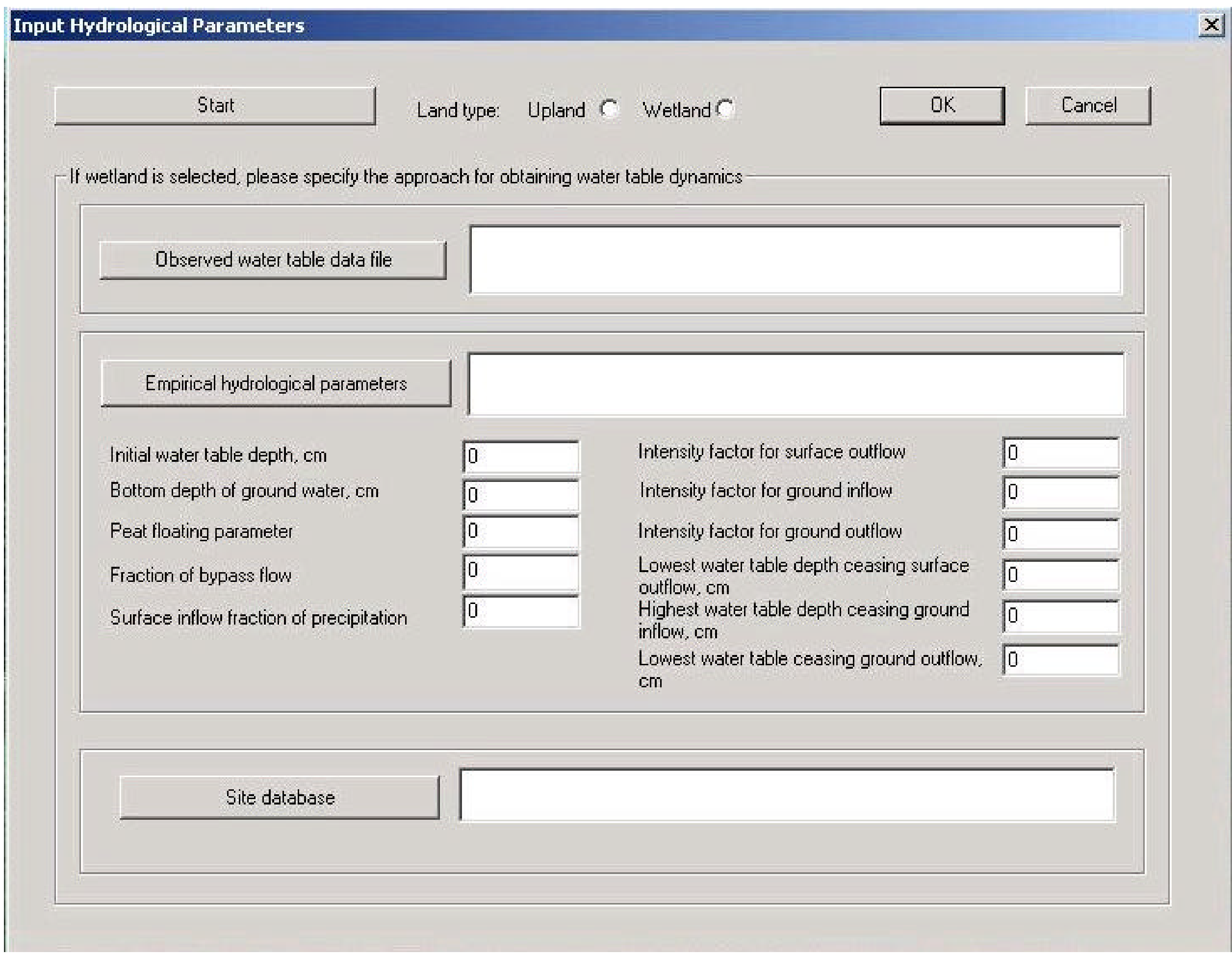

Figure 3. Dialog box for inputting hydrological parameters

"Upland", the dialog box will automatically close after your selection. If you select "Wetland", you will need to specify an approach to obtain water table dynamics from three options. The options are (1) using observed water table data file, (2) using empirical hydrological parameters, and (3) using site database to run a hydrological model. By clicking one of the optional bars, you will specify your choice by selecting the corresponding data file (Figure 3). Double-clicking a selected file name will delete it from the box. Detailed information for preparation of the hydrological files is described in Appendix B. Reviewing and following the example files are always a decent way to learn how to prepare the files. In the package you received, the example files for observed daily water table data, empirical hydrological parameters, site data and regional data are stored in C:\Data\Database_ObservedWaterTable\, C:\Data\Database_EmpiricalHydroParameters, C:\Data\Database_Site\ and C:\Data\Database_Region, respectively.

If you have selected the option of empirical hydrological parameters, the values for the parameters will be automatically shown on the screen. These parameters include:

[***Initial water table depth*** (cm)]: Initial depth of water table. Positive values mean the water table is above the ground; negative values mean below the ground.

[***Bottom depth of ground water*** (cm)]: Depth of the bottom of groundwater.

[***Peat floating parameter***]: Deviation of the peat ground induced by floating effect.

[***Fraction of bypass flow*****]**: Fraction of surface water delivered into soil profile through a macro-porous medium.

[***Surface inflow fraction of precipitation***]: Fraction of precipitation entering the wetland.

[***Intensity factor for surface outflow***]: Index for surface water outflow from the wetland.

[***Intensity factor for ground inflow***]: Index for ground water entering the wetland.

[***Intensity factor for ground outflow***]: Index for ground water outflow from the wetland.

[***Lowest water table depth ceasing surface outflow*** (cm)]: The lowest depth of water table where surface water outflow ceases.

[***Highest water table depth ceasing ground inflow*** (cm)]: The highest depth of water table where ground inflow ceases.

[***Lowest water table ceasing ground outflow*** (cm)]: The lowest depth of water table where ground water outflow ceases.

These empirical hydrological parameters can be derived from field measurements for specific wetland (see Zhang et al., 2002).

When you finish with the hydrological inputs, click OK to save the information.

5.5 Input of forest information

Click button "Forest" to input forest parameters (Figure 4).

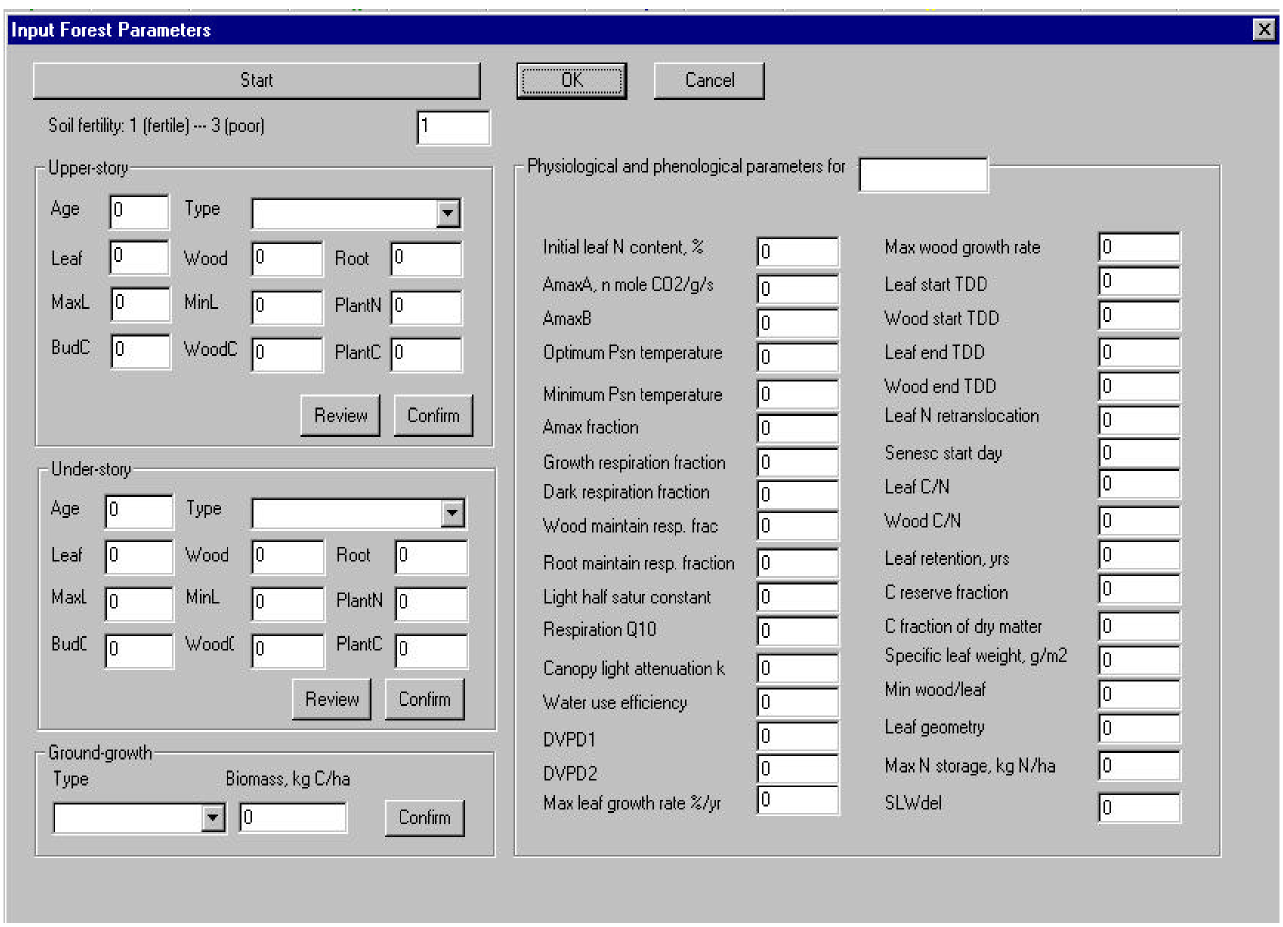

Figure 4. Dialog box for inputting forest parameters

The input parameters required for this dialog box include soil fertility, ages and types of upper-story, under-story and ground-growth of the forest.

[***Soil fertility***]: This is a float number from 1.0 (for poor soil) to 3.0 (for fertile soil).

[***Upper-story age***]: Age of upper-story trees.

[***Upper-story type***]: Dominant type of upper-story trees.

[***Under-story age***]: Age of under-story bushes.

[***Under-story type***]: Dominant type of under-story bushes.

[***Ground-growth type***]: Dominant type of ground plants.

[***Leaf***]: Initial leaf biomass, kg C/ha.

[***Wood***]: Initial woody biomass, kg C/ha.

[***Root***]: Initial root biomass, kg C/ha.

[***MaxL***]: Maximum leaf biomass, kg C/ha.

[***MinL***]: Minimum leaf biomass, kg C/ha.

[***PlantN***]: Initial plant N storage, kg N/ha.

[***BudC***]: Initial available C stored in buds, kg C/ha.

[***WoodC***]: Initial available C stored in woody biomass, kg C/ha.

[***PlantC***]: Initial available C stored in forest, kg C/ha.

After defining the age and type for each forest layer, click "Review" to browse the relevant default values for biomass and other physiological and phenological parameters. These values can be altered by the users to suit their specific tree species. By clicking "Confirm" you will save all of the parameters into files. The definitions for the physiological and phenological parameters are listed as follows:

[*Initial leaf N content* %]: Initial N concentration in foliage, % by weight.

[*AmxA, n mole CO2*/g/s] and **[*AmaxB*]**: Coefficients for photosynthesis curve.

[*Optimum Psn temperature*]: Optimum temperature for photosynthesis, ºC.

[*Minimum Psn temperature*]: Minimum temperature for photosynthesis, ºC.

[*Amax fraction*]: Daily Amax as a fraction of instantaneous Amax.

[*Growth respiration fraction*]: Growth respiration as a fraction of gross photosynthesis.

[*Wood maintain resp. frac*]: Wood maintenance respiration as a fraction of gross photosynthesis.

[*Root maintain resp.frac*]: Root maintenance respiration as a fraction of gross photosynthesis.

[*Light half satur constant*]: Half saturation light intensity, μ mole/m^2/second.

[*Respiration Q10*]: Effect of temperature on respiration.

[***Canopy light attenuation*** *k*]: Light attenuation constant.

[***Water use efficiency***]: Water demand for producing a unit of biomass.

[*DVPD 1*] and **[*DVPD2*]:** Coefficients for calculating vapor pressure deficit.

[*Max N storage*]: Maximum N content in forest, kg N/ha.

[*Max leaf growth rate*]: Maximum foliage growth rate, %/year.

[*Max wood growth rate*]: Maximum wood growth rate, %/year.

[*Leaf start TDD*]: Accumulative thermal degree days for starting leaf growth.

[*Wood start TDD*]: Accumulative thermal degree days for starting wood growth.

[*Leaf end TDD*]: Accumulative thermal degree days for ceasing leaf growth.

[*Wood end TDD*]: Accumulative thermal degree days for ceasing wood growth.

[*Leaf N retranslocation*]: Fraction of leaf N transferred to plant N storage during senescence.

[*Senesc start day*]: Starting Julian day for senescence.

[*Leaf C/N*]: C/N ratio in foliage.

[*Wood C/N*]: C/N ratio in woody biomass.

[*Leaf retention. Yrs*]: Time span of leaf retention, years.

[*C reserve fraction*]: Fraction of available C for plant reserve.

[*C fraction of dry matter*]: C/dry matter ratio.

[*Specific leaf weight, g/m2*]: Specific leaf weight, g dry matter/m^2 leaf.

[*Min wood/leaf*]: Minimum wood/leaf ratio.

[*Leaf geometry*]: Leaf geometry index.

[*SLWdel*]: Change in specific leaf weight with foliage biomass, g dry matter/(m^2 leaf * g foliage mass).

5.6 Input of soil information

Clicking button "Soil" on the top toolbar to input soil parameters (Figure 5). .

Types of the forest floor and the mineral soil need to be defined first. After specifying the types of the forest floor and mineral soil, click the bar "Obtain default values" to achieve default values for other soil parameters including thickness, number of layers, pH, SOC content, bypass flow index, and soil skeleton (stone fraction). By pushing the bar "Review and modify", you will see more default soil parameters shown in the table :Parameters". All of the default values can be changed by users. Clicking the bar

"Confirm" will complete the soil input procedure and record the parameters into the hard disk.

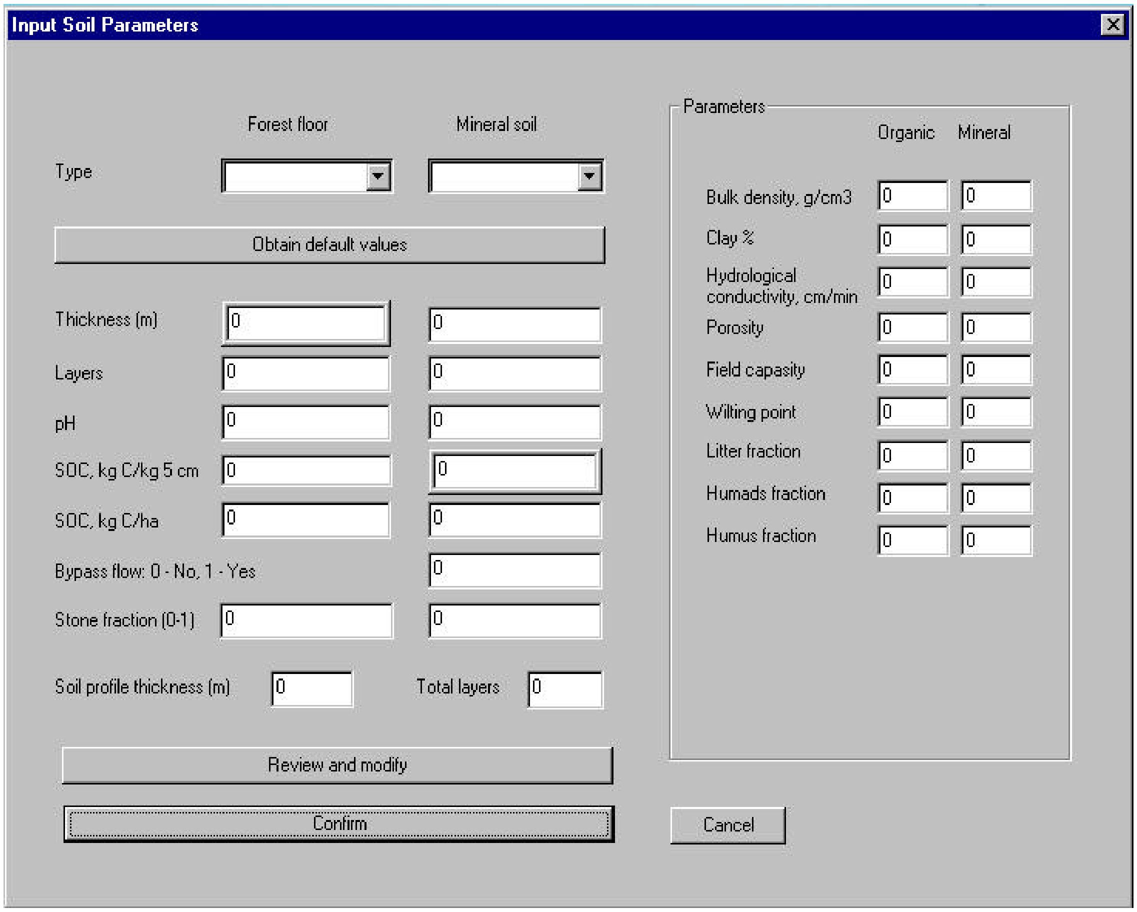

Figure 5. Dialog box for inputting soil parameters

[***Forest floor type***] is defined based on quality of the organic matter in the forest floor. The categories are rohhumus, moder, and mulls.

[***Mineral soil type***] is defined based on proportions of sand, silt and clay in a soil. There are 12 soil types including sand, loamy sand, sandy loam, silt loam, loam, sandy clay loam, silty clay loam, clay loam, sandy clay, silty clay, clay, and organic soil.

[***Thickness of forest floor***] is the total thickness of the organic layer. The default thickness is 1.5 and 0.2 m for wetland and upland forests, respectively.

[***Thickness of mineral soil***] is the total thickness of the mineral layers of the soil profile. The default thickness is 0.02 and 0.3 m for wetland and upland forests, respectively.

[***pH***] is soil acidity.

[***SOC, kg C/kg 5cm***] is soil organic carbon concentration at the top soil (0-5 cm). The unit is kg C/kg soil.

[***SOC, kg C/ha***] is soil organic carbon content in the entire organic or mineral profile. The unit is kg C/ha.

[***Bypass flow***] is water flow through the macro pore. 0 is no bypass flow; 1 indicates there is bypass flow.

[***Stone fraction***] is fraction of stone content in the soil.

[***Soil profile thickness*** (m)] is the total thickness of the entire soil profile including the forest floor and the mineral layers.

[***Total layers***] is the number of total organic and mineral layers.

[***Bulk Density*** *(g/cm^3)*] is soil bulk density. The unit is g soil per cubic cm.

[***Clay % (0-1)***] is clay fraction by weight.

[***Hydrologic conductivity***] is soil saturated hydrological conductivity. The unit is cm per minute.

[***Porosity***] is pore volumetric fraction of the soil.

[***Field Capacity***] is the maximum water-filled fraction of total porosity in a freely drained soil.

[***Wilting Point***] is the maximum water-filled fraction of total porosity at which the plant starts wilting permanently.

[***Litter fraction***] is decomposing plant or animal residue C percent of total SOC.

[***Humads fraction***] is living microbial biomass C and active humus C percent of total SOC.

[*Humus fraction*] is resistant humus C percent of total SOC.

5.7 Input of management information

Click the “Manage” button on the toolbar to input management-related parameters. Forest

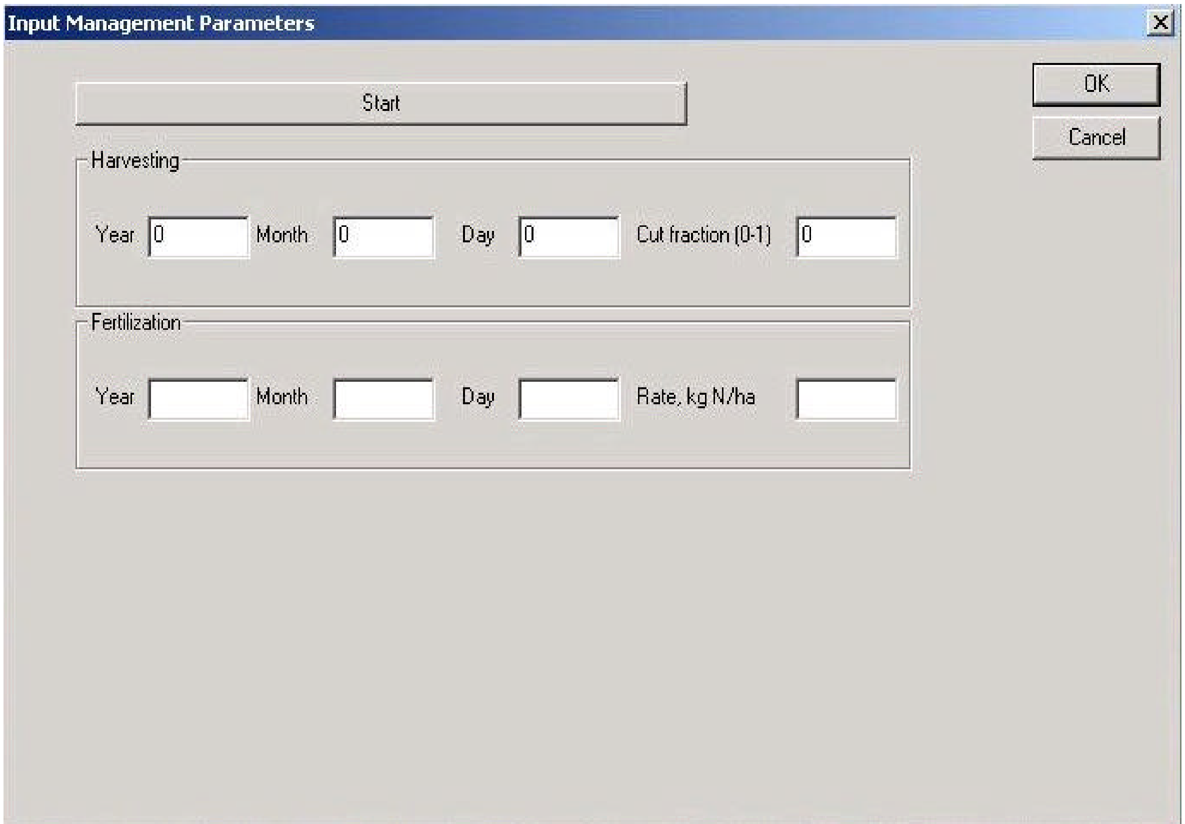

Figure 6. Dialog box for inputting management parameters

harvest is defined by its timing and cutting percent of the upper-story plants. Fertilization is defined by its timing and nitrogen application rate (kg N/ha) (Figure 6).

By clicking the button OK, you will complete the input procedure for running Wetland-DNDC at site scale. During the input procedure, all of the input parameters are converted into a series of internal files, which are stored in the hard disk of your computer and accessible to Wetland-DNDC.

6. Execution of Site-Scale Simulation

By clicking the Run button given in the top toolbar, you will command Wetland-DNDC to read in all of the input parameters, and execute the relevant calculations. Six graphic windows will appear on the screen to demonstrate the daily dynamics of several fundamental features during the model runs (Figure 7).

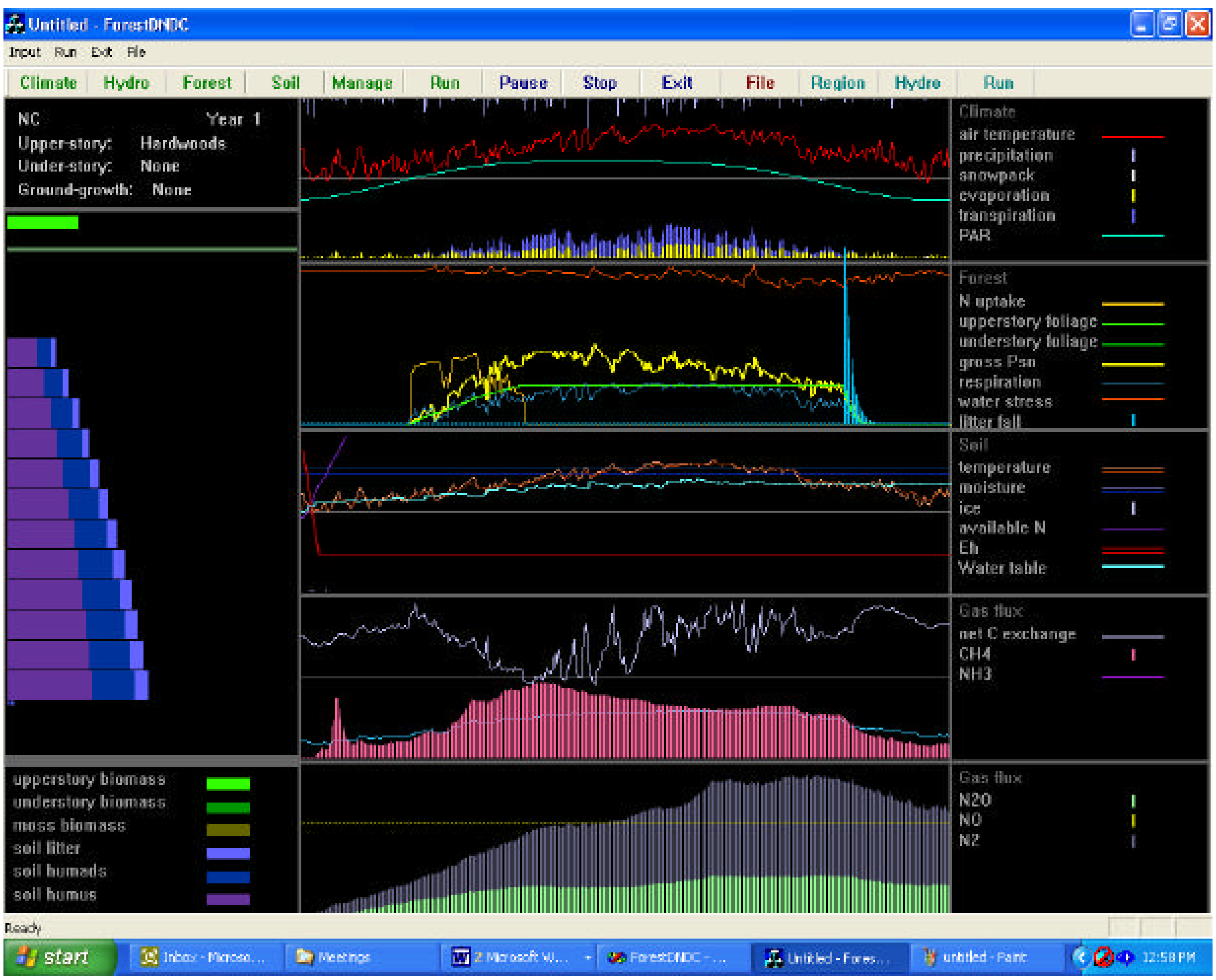

Figure 7. Windows demonstrating daily dynamics of water, C and N pools and fluxes during the model runs

Window 1 (up-left corner) shows site name, simulated year, and forest type.

Window 2 (middle-left) shows daily soil carbon profiles.

Window 3 (top-right) shows daily air temperature, precipitation, snow pack, evaporation, transpiration, and radiation (PAR).

Window 4 (second in the right) shows forest N uptake, upper-story and under-story foliage biomass, gross photosynthesis, respiration, water stress, and litter fall.

Window 5 (third in the right) shows soil temperature, moisture, ice content, available N, Eh, and water table depth.

Window 6 (forth in the right) shows daily rates of decomposition, nitrification, denitrification, methanogenesis, and methanotrophy.

Window 7 (fifth in the right) shows daily net C exchange, CH_4 and NH_3 fluxes.

Window 8 (bottom in the right) shows daily N_2O, NO and N_2 fluxes.

These windows provide an opportunity to allow users to observe the model runs but not any precise results.

7. Regional Simulation

All of input data required for regional simulations must be prepared in advance. The data usually include grid name or ID, location, land-use type, forest type and age, meteorological data, soil properties, and management measures. Appendix 2 provides an example of the input data files for simulations at watershed or regional scale.

Click the button "Region" to specify a region, for which a database has been prepared in advance. Then click the button "Hydro" in blue to initiate the hydrological simulation that will produce daily water table depths for each grid. When the hydrological

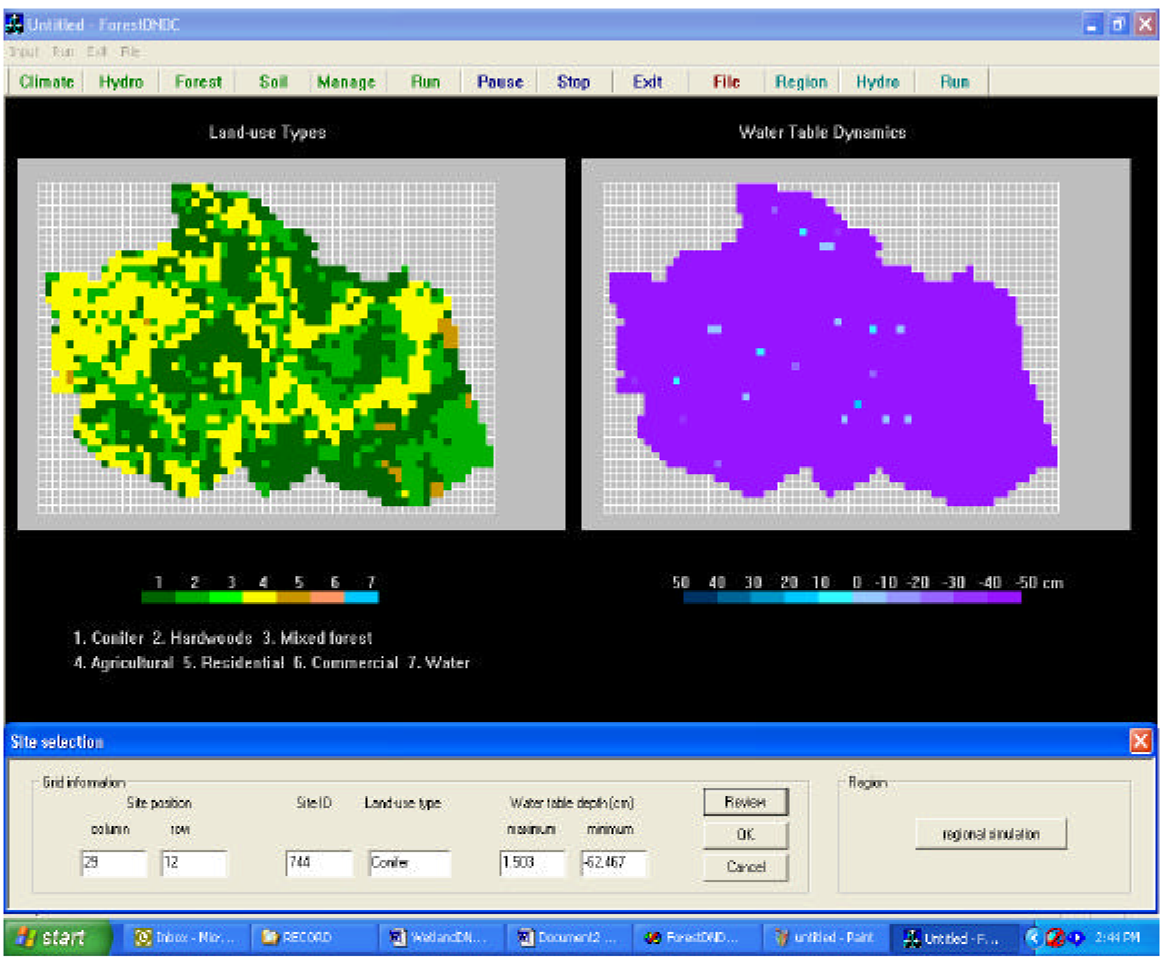

Figure 8. Hydrological simulation at regional scale

simulation is accomplished, you can use the mouse curser to select a specific grid in the land-use map or in the water table map for a later biogeochemical simulation (Figure 8). After clicking a grid, a dialog box will appear. Click the button Review in the dialog box to review the location, ID, land-use type and water table fluctuation range of the selected grid. You can firm your selection by clicking OK; or re-select a grid by clicking Cancel. If you want to simulate all of the grids for their biogeochemical processes, just click the button Regional simulation in the dialog box. The above-described procedure will create daily water table depth files for the selected grid(s) to support your biogeochemical simulations later.

Clicking the button Run in blue will start the forest growth and soil biogeochemistry simulations for the selected grid(s). The names and formats of simulated results are same as the result files produced during the site-scale simulations.

8. View of Modeled Results

Model results are recorded in a series of files located at C:\WetlandDNDC\Result\Record\. The files are

- Balance_ForestC_yr;
- Balance_ForestN_yr;
- Balance_SoilC_yr;
- Balance_SoilN_yr;
- Day_Climate_yr;
- Day_Ecosystem_yr;
- Day_ForestFloor_yr;
- Day_Gas_yr;
- Day_GroundGrowth_yr;
- Day_Hydrology_yr;
- Day_MineralSoil_yr;
- Day_UnderStory_yr;
- Day_UpperStory_yr;
- MultiYr_Record
- Year_yr.

The Balance_* files record mass balances for C and N in the forest or in the soil. The Day_* files record daily climatic conditions, water table dynamics, and C and N pools and fluxes in different segments of the forest ecosystem. The Year_* file is an annual summary for the most important pools and fluxes occurring in the ecosystem. All of the output files are in a plain text format. They can be easily re-processed with any word processors, spreadsheets, or graphic software.

9. Appendices

Appendix A

Format of meteorological data files

Climate is considered to be one of the most important forces driving forest biogeochemistry and evolution. WETLAND-DNDC requires daily maximum and minimum air temperature and precipitation. Photosynthetically active radiation (PAR) is optional. The meteorological data file must be prepared in advance. The files should have a plain text (i.e., ASCII) format. Each year must have an individual file.

In the meteorological files, the first row contains a string of the file name. The first column is Julian day; the second maximum air temperature (ºC), the third minimum air temperature (ºC), and forth precipitation (cm water/day). Following is an example of the climate file.

HG95

1	2.12	-2.31	0
2	-1.25	-3.58	0.24
3	-2.69	-5.11	0
4	-5.65	-11.25	0
5	-7.62	-12.81	0
6	-8.19	-13.81	0
7	-5.3	-13.68	0
8	-6.78	-8.5	0
9	-0.6	-7.65	0
10	0.98	-0.68	1.72

Appendix B

Format of regional data files

Regional database must prepared in advance for simulating forest hydrology and biogeochemistry at regional scale. The database consists of eight files.

File 1:

15.3 (Latitude);
0.80 (potential evaporation correction factor);
3 (Number of rows);
3(number of columns);
9 (number of active grid);
5 (number of simulated years)

File 2:

Grid ID; conifer acreage; hardwoods acreage; mixed forest acreage; agricultural land acreage; residential land acreage; commercial land acreage; water; Area

1	35	21.	120.	0.	0.	0.	0.	0.01
2	155	0.	0.	220.	0.	0.	0.	0.01
3	12	235	0.	0.	0.	0.	0.	0.01
4	100.00	0.	0.	0.	0.	0.	0.	0.02
5	100.00	0.	0.	0.	0.	0.	0.	0.02
6	100.00	0.	0.	0.	0.	0.	0.	0.02
7	100.00	0.	0.	0.	0.	0.	0.	0.02
8	100.00	0.	0.	0.	0.	0.	0.	0.01
9	100.00	0.	0.	0.	0.	0.	0.	0.01

First day of seasons

106 (spring) 183(summer) 289(fall) 335 (winter)

File 3:

Transpiration weighting factor for layer 1, 2, 3
0.15 (layer 1) 0.65 (layer 2) 0.20(layer 3)

File 4:

Initial moisture contents at 3 layers; Initial maximum moisture content at layer 3

25.0 (layer 1) 40.0 (layer 2) 100.0 (layer 3) 150.0 (layer 3)

File 5:

Initial water-table elevation (m) at each grid
0.26 (grid 1) 0.26 (grid 2) 0.26(grid 3)
0.26 (grid 4) 0.26 (grid 5) 0.26(grid 6)
0.26 (grid 7) 0.26 (grid 8) 0.26(grid 9)

File 6:

1.0 (Coefficient of transpiration in X, Y)
0 (flag)
100 (Distance between rows, m);
0 (flag)
100 (Distance between clowns, m);
0 (flag)
0.1 (Specific capacity);
0 (flag)
5.00 (Hydraulic conductivity);
-7 (flag)
1.5 (m)

Bottom of aquifer (m):

0.66 (grid 1) 0.66 (grid 2) 0.66(grid 3)
0.66 (grid 4) 0.66 (grid 5) 0.66(grid 6)
0.66 (grid 7) 0.66 (grid 8) 0.66(grid 9)

7(flag) 1 (m)

Top elevation (m):
0.66 (grid 1) 0.66 (grid 2) 0.66(grid 3)
0.66 (grid 4) 0.66 (grid 5) 0.66(grid 6)
0.66 (grid 7) 0.66 (grid 8) 0.66(grid 9)

File 7:

0.20 (Power Index of distribution function of soil water capacity)
0.80 (Declining coefficient of subsurface flow)
0.97 (Declining coefficient of ground flow)
0.01 (Coefficient of shallow ground water releasing)
0.01 (Coefficient of deeper ground water releasing)

0.90	(Drainage index of ground water)
0.80	(Snowmelt rate)
0.40	(Snow evaporation ratio of PET)
0.60	(Pipe flow rate)
0.60	(Frost coefficient of soil moisture)
-1.0	(Critical air temperature for snowpacking, ºC)
-3.0	(Specific air temperature for soil frost, ºC)
0.40	(Soil saturate capacity)
0.20	(Field water capacity)
0.10	(Wilt point of soil)
200.	(Thickness of layer 1, cm)
300.	(Thickness of layer 2, cm)
500.	(Thickness of layer 3, cm)
5.50	(Drainage coefficient of unsaturated soil)

File 8:

Y	M	D	Jday	Daily rainfall (mm);	Air temperature;	Measured water table (m)
0	1	1	1	.00	14.5	.28
0	1	2	2	.30	10.8	.28
0	1	3	3	.00	8.3	.28
0	1	4	4	.00	7.2	.28
0	1	5	5	.00	5.9	.28
0	1	6	6	.00	13.1	.27
0	1	7	7	19.60	15.0	.26
0	1	8	8	.00	8.6	.30
0	1	9	9	.30	9.7	.30
0	1	10	10	.00	12.5	.30

10. Publications

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The Wetland-DNDC model is still under development. If you have any comments or suggestions, please send them to Changsheng.li@unh.edu. We will keep updating the model and publish it at http://www.dndc.sr.unh.edu.

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