1. TITLE

1.1 Data Set Identification

ISLSCP II Ecosystem Rooting Depths.

1.2 File Name(s)

The three files that make up this data set are named as follows:

1) **50ecosys_rootdepth_1d.asc**: Mean 50% ecosystem rooting depth in meters. This is an estimation of the rooting depth that contains 50% of all roots. 1d implies a 1degree spatial resolution (lat/long).

2) **95ecosys_rootdepth_1d.asc**: Mean 95% ecosystem rooting depth in meters. This is an estimation of the rooting depth that contains 95% of all roots. 1d implies a 1degree spatial resolution (lat/long).

3) **ecosys_rootdepth_1d.dif**: ASCII tables of "differences", or points in the original files that did not match the Land/Water mask used in this ISLSCP II date collection, and were removed from the ASCII map files (see sections 8.4 and 9.2.3 for more details).

1.3 Revision Date of this Document

October 27, 2009

2. INVESTIGATOR(S)

2.1 Investigator(s) Name and Title

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2.2 Title of Investigation

The global biogeography of roots.

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2.4 Data Set Citation

Schenk, H.J., and R.B. Jackson. 2009. ISLSCP II Ecosystem Rooting Depths. In Hall, Forrest G., G. Collatz, B. Meeson, S. Los, E. Brown de Colstoun, and D. Landis (eds.). ISLSCP Initiative II Collection. Data set. Available on-line [http://daac.ornl.gov/] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. doi:10.3334/ORNLDAAC/929

2.5 ISLSCP Initiative II Collection References

Users of the International Satellite Land Surface Climatology (ISLSCP) Initiative II data collection are requested to reference the following publications when these data are used:

Hall, F.G., E. Brown de Colstoun, G. J. Collatz, D. Landis, P. Dirmeyer, A. Betts, G. Huffman, L. Bounoua, and B. Meeson, The ISLSCP Initiative II Global Datasets: Surface Boundary Conditions and Atmospheric Forcings for Land-Atmosphere Studies, J. Geophys. Res., 111, doi:10.1029/2006JD007366, 2006.

3. INTRODUCTION

3.1 Objective/Purpose

The goal of this study was to predict the global distribution of plant rooting depths based on data about global aboveground vegetation structure and climate. Vertical root distributions influence the fluxes of water, carbon, and soil nutrients and the distribution and activities of soil fauna. Roots transport nutrients and water upwards, but they are also pathways for carbon and nutrient transport into deeper soil layers and for deep water infiltration (Johnston et al. 1983, Meek et al. 1992, Jackson et al. 1996, Smith et al. 1999, Jobbágy and Jackson 2000, 2001). Roots also affect the weathering rates of soil minerals (Bormann et al. 1998). For calculating such processes on a global scale, data on vertical root distributions are needed as inputs to global biogeochemistry and vegetation models. In the Project for Intercomparison of Land Surface Parameterization Schemes (PILPS), rooting depth and vertical soil characteristics were the most important factors explaining scatter for simulated transpiration among 14 land-surface models (Mahfouf et al. 1996, Jackson et al. 2000). Recently, the Terrestrial Observation Panel for Climate of the Global Climate Observation System (GCOS) identified the 95% rooting depth as a key variable needed to quantify the interactions between the climate, soil, and plants, stating that the main challenge was to find the correlation between rooting depth and soil and climate features (GCOS/GTOS Terrestrial Observation Panel for Climate 1997). In response to this challenge, a data set of vertical rooting depths was collected from the literature in order to construct maps of global ecosystem rooting depths. This data set is provided here as a part of the International Land Surface Climatology Project (ISLSCP) Initiative II data collection

3.2 Summary of Parameters

The parameters included in these data sets are estimates for the soil depths containing 50% and 95% of all roots, termed 50% and 95% rooting depths (*D*50 and *D*95, respectively). Together, these variables can be used to calculate estimates for vertical root distributions, using a logistic equation provided in this documentation. The data represent mean ecosystem rooting depths for 1 by 1 degree grid cells. A file that shows the differences between the original data and the ISLSCP II land/water mask is also provided.

3.3 Discussion

A global database of over 500 point measurements of vertical root profiles was assembled from the literature. It was named the ERP database (**E**cosystem **R**oot **P**rofiles) and can be accessed at the Distributed Active Archive Center (DAAC) of the Oak Ridge National Laboratory (http://daac.ornl.gov/). Each root profile in the database was associated with a geographic location, data on vegetation class, presence and dominance of plant growth forms, long-term means of monthly climate data and, where available, soil texture. Vertical root profiles were characterized by the soil depths above which 50% and 95% of all roots were located. To correct for incomplete sampling of soil profiles with depth (those profiles that did not sample deeply enough to obtain a true zero at the maximum rooting depth), incompletely sampled root profiles were extrapolated to twice the sampled depth or to 3 m depth at most based on the shape of the profile observed (see below). Non-linear regression models were developed for broad vegetation classes to quantify relationships of rooting depths with climate and soil texture.

Global gridded databases of land cover, climate, and soil characteristics were used to calculate 50% and 95% rooting depths for 1 by 1 degree grid cells globally. Vegetation characteristics that explained sizeable proportions of the variance in rooting depths included the dominant plant growth forms and the evergreen vs. drought-deciduous phenology of woody plants in water-limited environments. Abiotic variables that were most highly correlated with rooting depths included components of the water-balance, such as potential evapotranspiration and an index for deep soil water storage.

The data contain multiple sources of error that are difficult to quantify, including sample errors, extrapolation errors, and statistical errors. Other errors may have been introduced by combining in the analysis data measured in different sample intervals, at different times of the year, in different years, and by different methods. Despite these potential sources of error, strong empirical relationships of extrapolated rooting depths with climatic variables and vegetation classes were observed (Schenk and Jackson 2002a). The observed relationships with climate agreed well with predictions made on the basis of a conceptual model that links rooting depths largely to water availability (Schenk and Jackson 2002b). The model predicts that rooting depths increase if water is available at depth in the soil and if there is transpirational demand for it. The empirical data supported this model, as 95% rooting depths increased with evaporative demand and reached the greatest depths in seasonally dry tropical climates where water is stored deep in the soil during the wet season and where there are high transpirational demands throughout the year. The fact that the empirical relationships agreed with those based on mechanistic considerations suggested that the relationships could be used to estimate rooting depths for regions and climatic conditions for which few or no rooting depth data were available.

Spatially explicit global data sets of ecosystem rooting depths have not been available previously but are needed as input data to global models of vegetation structure, hydrology, and biogeochemistry (GCOS/GTOS Terrestrial Observation Panel for Climate 1997). In the past, vertical root distributions in such global models have been parameterized by using the same, average root distributions for all locations within a vegetation class (Jackson et al. 2000). The advantage of using this new, spatially explicit data set in global models over using previously published fixed root distributions for vegetation classes (e.g., Jackson et al. 1996, Zeng 2001, Schenk and Jackson 2002a) is that the potential error of underestimating rooting depths is reduced. Rooting depths for vegetation in many geographic locations greatly exceed the mean depths estimated for the respective vegetation type (Schenk and Jackson 2002a, b). Underestimates of rooting depths can potentially lead to severe underestimates of the magnitude of processes such as primary productivity and actual evapotranspiration (Kleidon and Heimann 1998, Jackson et al. 2000).

The data presented in the ISLSCP II data collection represent estimates of mean rooting depths for grid cells, not for individual points within these grid cells. Currently there are no independent data available to test these estimates of mean rooting depths for large areas. Such tests would require large sample sizes of vertical root profiles for individual grid cells. Until such data become available these maps are offered as preliminary estimates for global ecosystem rooting depths.

The original files provided by the Investigators have been modified to agree with the land/water boundaries of the ISLSCP II land/water mask. The original values for those cells that have been either modified or masked have been provided in a separate file. Users can reconstruct the original data set by using the ISLSCP II rooting depth files along with this additional file.

4. THEORY OF ALGORITHM/MEASUREMENTS

See Section 3.3 and (Schenk and Jackson 2002a) for more details.

5. EQUIPMENT

5.1 Instrument Description

The data were calculated from point measurements of vertical root profiles that were collected from the literature. These profiles were measured in a variety of ways. Predominant sampling methods included measurements of roots in soil cores, soil monoliths, and on the faces of soil profile walls. See Schenk and Jackson (2002a) for a list of methods used in the individual studies and Smit et al. (2000) for a discussion of these methods.

5.1.1 Platform (Satellite, Aircraft, Ground, Person)

See Schenk and Jackson (2002a) and Smit et al. (2000) for more details.

5.1.2 Mission Objectives

See Schenk and Jackson (2002a) and Smit et al. (2000) for more details.

5.1.3 Key Variables

See Schenk and Jackson (2002a) and Smit et al. (2000) for more details.

5.1.4 Principles of Operation

See Schenk and Jackson (2002a) and Smit et al. (2000) for more details.

5.1.5 Instrument Measurement Geometry

Not applicable to this data set.

5.1.6 Manufacturer of Instrument

Various.

5.2 Calibration

5.2.1 Specifications

5.2.1.1 Tolerance

Not applicable to this data set.

5.2.2 Frequency of Calibration

Not applicable to this data set.

5.2.3 Other Calibration Information

Not applicable to this data set.

6. PROCEDURE

Mean ecosystem rooting depths for 1 by 1 degree grid cells were calculated from point measurements of vertical root profiles that were collected from the literature. The following description of methods in sections 6.1 through 9.4 are largely taken from Schenk and Jackson (2002a).

6.1 Data Acquisition Methods

The database of 475 ecosystem root profiles (ERP) described in Schenk and Jackson (2002a) was expanded to include 519 root profiles, with data sets included if root samples were taken in at least four depth increments. For each root profile, recorded were latitude and longitude, type of roots measured (e.g., fine or total, live or dead), sampling method, units of measurements (root mass, length, number, surface area), and maximum sampling depth. More than 75% of all data were measured in terms of root biomass per sample depth interval and soil volume, and these data were converted to measurements of kg m^{-2}. Other units of measurement included number of roots per vertical profile area (~15% of the data), root length per soil volume (~8% of the data) and a few other measures (~2% of the data). Also recorded for each profile were the presence and dominance of plant life forms as described in the publications (including succulents, forbs, grasses, semi-shrubs, shrubs, and four categories of trees: needle-leaved vs. broadleaved, evergreen vs. deciduous). It was noted whether the vegetation was relatively "natural" or altered by humans (e.g., forest plantations). Where unavailable, geographic coordinates were estimated based on geographic information in the publications.

Long-term means of precipitation (monthly, Pm, and annual, Pa) were recorded from each publication or, where unavailable, were estimated from the nearest available weather station. The seasonal distribution of precipitation was estimated from 1961-1990 long-term monthly means for 0.5 degree grid cells recorded in the Climate Research Unit (CRU) Global Climatologies (New et al. 2000).

Estimates for long-term means of potential evapotranspiration, or PET(monthly, PETm and annual, PETa), as calculated by the Penman-Monteith method were taken from the global 0.5° gridded data set of Choudhury (1997) and Choudhury and DiGirolamo (1998). To estimate PET for sites in tropical cloud forests, mean values for a grid cell were halved to account for the effects of permanent cloud cover (Bruijnzeel and Proctor (1995).

Most profiles included roots from different species and life forms. Where data were given separately for species or life forms they were averaged to generate an estimated profile for the community, but the individual data were retained for the life-form analyses. Data for both late- and early successional vegetation were included. Root profiles for crops and from fertilized or ploughed soils were excluded because root distributions in such systems can be strongly influenced by management practices, a factor that we were unable to include in our analyses. Also excluded were root profiles from wetlands and seasonally flooded desert playas, grasslands, savannas, and forests. Vertical root profiles were then interpolated and extrapolated to obtain global estimates for 50% and 95% ecosystem rooting depths. Methods for processing these data are described in section 9.

6.2 Spatial Characteristics

Point measurements of vertical root profiles were available from all continents except Antarctica, with highest densities in North America and Europe (Schenk and Jackson 2002a). Spatial coverage of these point data was poor for central South America, sub-equatorial and northern Africa, northeastern Asia and northern Australia.

6.2.1 Spatial Coverage

The data provided in this data set cover the total global land area, except Antarctica and Hawaii.

6.2.2 Spatial Resolution

The data are provided in an equal-angle latitude/longitude grid with a spatial resolution of one degree in both latitude and longitude.

6.3 Temporal Characteristics

6.3.1 Temporal Coverage

The point data on which the area-based estimates of ecosystem rooting depths are based were measured between the years 1925 and 2001, but are provided here without temporal resolution. Because rooting depths were found to be correlated with long-term climatic means it appears likely that they will change as the climate changes. No long-term measurements of rooting depths are available from the same sites to substantiate this hypothesis.

6.3.2 Temporal Resolution

See above.

7. OBSERVATIONS

7.1 Field Notes

Not applicable to this data set.

8. DATA DESCRIPTION

8.1 Table Definition with Comments

Not applicable to this data set.

8.2 Type of Data

8.2.1 Parameter/ Variable Name	**8.2.2 Parameter/ Variable Description**	**8.2.3 Data Range**	**8.2.4 Units of Measurement**	**8.2.5 Data Source**
D50	Mean 50% ecosystem rooting depth per area of 1 by 1 degree grid cell	0.1 to 0.5 No Data=-88 Water=-99	m	Point measurements
D95	Mean 95% ecosystem rooting depth per area of 1 by 1 degree grid cell	0.3 to 4.6 No Data=-88 Water=-99	m	Point measurements
File ecosys_rootdepth_1d.dif				
Lat	Latitude for the center of a 1 degree cell. South latitudes are negative.	83.5 degrees to – 55.5 degrees	Decimal Degrees	Earth Grid
Long	Longitude for the center of a 1 degree cell. West longitudes are negative.	-178.5 degrees to 179.5 degrees	Decimal Degrees	Earth Grid
Orig_D50_ Removed	Original mean 50% ecosystem rooting depth value of a particular cell that was modified or masked in with the ISLSCP II land/water mask.	0.1 to 0.5 Water=-99	m	Original Files
Orig_D95_ Removed	Original mean 95% ecosystem rooting depth value of a particular cell that was modified or masked in with the ISLSCP II land/water mask.	0.3 to 4.5 Water=-99	m	Original Files

*****NOTE:** Ecosystem rooting depths are reported in m, measured from the top of the soil profile, including litter layers if they are present.

8.3 Sample Data Record

Sample data records for the file **ecosys_rootdepth_1d.dif** are given below:

ISLSCP_** Differences for the files '50ecosys_rootdepth_1d.asc' and '95ecosys_rootdepth_1d.asc'. This file contains Lat-Lon coordinates and data for each point in these two original files that differed from the ISLSCP II Land/Sea mask, and thus were removed.

Lat,Long,Orig_D50_Removed,Orig_D95_R
emoved 83.50,-41.50,0.10,0.30 83.50,-
37.50,0.10,0.30 83.50,-33.50,-99.00,-99.00
83.50,-32.50,-99.00,-99.00 83.50,-31.50,-
99.00,-99.00 83.50,-27.50,0.10,0.30 82.50,-
86.50,0.10,0.30 82.50,-85.50,0.10,0.30
82.50,-84.50,0.10,0.30 82.50,-
83.50,0.10,0.30 82.50,-62.50,0.10,0.30
82.50,-61.50,0.10,0.30 82.50,-
55.50,0.10,0.30 82.50,-53.50,0.10,0.30
82.50,-51.50,0.10,0.30 82.50,-
50.50,0.10,0.30

8.4 Data Format

All of the files in the ISLSCP Initiative II data collection are in the standard ARC GIS ASCII Grid format. The file format consists of six lines of header information followed by numerical fields of varying length, which are delimited by a single space and arranged in columns and rows. The files in this data set contain 360 columns by 180 rows. All values are written as real numbers. Missing values over land (i.e.Antarctica and Hawaii) are assigned the value of –88 while water bodies are assigned the value of –99 on all layers.

The file **ecosys_rootdepth_1d.dif** has a total of 1282 rows and 4 columns separated by a single comma. All cells in this file which were considered water bodies in the original data set were assigned a value of –99.

The files are gridded to a common equal-angle lat/long grid with a spatial resolution of 1 degree lat/long, where the coordinates of the upper left corner of the files are located at 180 degrees W, 90 degrees N, and the lower right corner coordinates are located at 180 degrees E, 90 degrees S. Data in the files are ordered from North to South and from West to East beginning at 180 degrees West and 90 degrees North.

8.5 Related Data Sets

- UMD global land cover (De Fries et al. 1998, Hansen et al. 2000). This data set is included in the ISLSCP II data collection.
- Potential evapotranspiration (PET) (Choudhury 1997, Choudhury and DiGirolamo 1998).
- CRU Global Climate Dataset (New et al. 2000), included in the ISLSCPII collection.
- Rooting zone water storage data set included in the ISLSCP II collection.

9. DATA MANIPULATIONS

9.1 Formulas

9.1.1 Derivation Techniques/Algorithms

Interpolation and extrapolation of root profiles

Ecosystem rooting depths were calculated by interpolating vertical root profiles reported in the literature to calculate the depths containing 50% (*D*50) and 95% (*D*95) of all roots in the profiles. Profiles were interpolated by fitting a non-linear smoothing function to each profile. Incompletely sampled profiles (those not sampled to the maximum rooting depth or to at least 3 m depth) were extrapolated using the same mathematical function used to interpolate completely measured profiles (see below). Tests of the accuracy of interpolations and extrapolations are discussed in Schenk and Jackson (2002a).

The non-linear model used in this study for interpolation and extrapolation of all root profiles was a logistic dose-response curve (LDR), which was fitted to cumulative root profiles:

$$r(D) = \frac{R_{\max}}{\left[1 + \left(\frac{D}{D_{50}}\right)^{c}\right]} \qquad (1)$$

In this equation, *r* (*D*) is the cumulative amount of roots above profile depth *D* (in cm, including organic layers), Rmax is the total amount of roots (i.e. total biomass, length, number etc.) in the profile, *D*50 is the depth (cm) at which *r(D)* = 0.5 *R*max, and *c* is a dimensionless shape-parameter. The LDR-model was fitted to all profiles, initially allowing Rmax to vary to obtain the best fit. To avoid excessive errors, extrapolations were restricted to a maximum sampling depth, *D*max, of either twice the sample depth or to 3 m depth, whichever was smaller, and the cumulative amount of roots at *D*max was set to 100%. Profiles sampled to the apparent maximum rooting depth or to ≥ 3 m were not extrapolated. Profiles for tundra were also not extrapolated beyond the measured depth because we assumed that permafrost was free of roots.

Relationship between vegetation class, climate, and rooting depths

Global ecosystem rooting depths calculated by the methods described in the above Interpolation section were divided into the following five vegetation classes: (1) Evergreen forests, (2) deciduous forests, (3) savannas and woodlands, (4) grasslands and croplands, (5) shrublands and deserts. Non-linear regression models were developed for each of these vegetation classes to quantify the relationship between 95% rooting depths and climatic variables.

Based on previous analyses, mean annual potential evapotranspiration (PETa) was included as climatic variable in all regression models, because it had the strongest relationships with 95% rooting depths of all climatic variables tested (Schenk and Jackson 2002a). Previous studies had also established that rooting depths are likely to be deepest where roots access water stored deeply in the soil during dry seasons (Schenk and Jackson 2002b). Therefore an additional storage term (*S*a, in meters) was included in the regression models to account for deep rooting in response to use of stored soil water. This term accounts for both the potential storage of water during a wet season and for the demand for such stored water during the dry season. It is defined as

$$S_a = \min\left[W_{sur,a}, W_{def,a}\right] \quad (2)$$

with *Wsur,a* being the long-terrm annual mean, seasonal surplus of water that is potentially available for deep storage, and with *Wdef,a* being the long-term annual mean, seasonal deficit of water, which represents the potential demand for water stored deeply in the soil. These terms are defined by:

Wsub sur,a= ∑ sub months (Psub m –PET sub m) for all months with *Pm* – PET*m* > 0 (3)

Wsub def,a= ∑ sub months (PETsub a –P sub m) for all months with PETm – Pm > 0. (4)

Significant and positive relationships between rooting depths and this storage term *Sa* were found only for climates with *Sa* > 0.1 m, and the relationships were non-linear, with rooting depths peaking or leveling off around *Sa=0.5 m.* The relationship was linearized by using the following logistic transformation of *Sa:*

$$U_a = \left[1 + \left(\frac{S_a + 0.001}{0.3}\right)^{-6}\right]^{-1}$$

Significant and positive relationships between rooting depths and this storage term *Sa* were found only for climates with *Sa* > 0.1 m, and the relationships were non-linear, with rooting depths peaking or leveling off around *Sa=0.5 m.* The relationship was linearized by using the following logistic transformation of *Sa:*

$$U_a = \left[1 + \left(\frac{S_a + 0.001}{0.3}\right)^{-6}\right]^{-1}$$

For each of the five vegetation classes listed above, 95% rooting depths were regressed as linear and quadratic functions of PET*a* and *Ua* (eq. 5) and their interactions. Non-significant terms were removed in a backward step-wise regression procedure, resulting in the following equations for the relationship between 95% rooting depths (*D*95) and climate:

Evergreen forests: $D95 = \max(0.3;\ 1.55\ PETa - 0.644\ PETa^2 + 1.96\ PETa \times Ua)$ (6)

Deciduous forests: $D95 = \max(0.4;\ 2.074\ PETa - 1.019\ PETa^2)$ (7)

Savannas and woodlands: $D95 = \max(0.4;\ 1.224\ PETa + 1.103\ PETa \times Ua)$ (8)

Grasslands and croplands: $D95 = \max(0.3;\ 0.782\ PETa + 1.367\ PETa \times Ua)$ (9)

Shrublands and deserts: $D95 = \max(0.3;\ 1.136\ PETa)$ (10)

All these equations include a correction term to ensure that predicted 95% rooting depths are not lower than 0.3 or 0.4 m, depending on vegetation class.
These limits were chose based on the data set of vertical root profiles.
The best predictors for 50% rooting depths (*D*50) were 95% rooting depths (*D*95) and PET*a*.
The following equations were used to calculate *D*50:

Grasslands& croplands: *D*50= max[0.1;10(-1.183+0.7258 log *sub10 D*95+0.1834*PETsuba*)]
(11)

All other vegetation classes: *D*50= max[0.1;10 (-0.7572+0.63321 *log sub10 D*95)]
(12)

Complete vertical root distributions for grid cells may be calculated from *D*50 and *D*95 by using equation (1), setting Rmax = 100%, and calculating the shape parameter c from:

$$c = \frac{-1.27875}{(\log_{10} D_{95} - \log_{10} D_{50})} \qquad (13)$$

9.2 Data Processing Sequence

9.2.1 Processing Steps and Data Sets

The UMD land cover classification (De Fries et al. 1998, Hansen et al. 2000), which originally contains 14 types of land cover was aggregated to six land cover types in the following way:

Land cover classification used for maps of ecosystem rooting depths	UMD Land Cover Classification
1.Water	Water
2. Evergreen forests	Evergreen needleleaf forest, evergreen broadleaf forest
3. Deciduous forests	Deciduous needleleaf forest, deciduous broadleaf forest, mixed forest
4. Savannas and woodlands	Woodland, wooded grassland
5. Grasslands and croplands	Grassland, cropland, urban built-up
6. Shrublands and deserts	Open shrubland, closed shrubland, bare ground (incl. ice)

A data set containing the fractions of cover occupied by each of the 14 UMD land cover classes for each global 0.5 by 0.5 degree grid cell was used to calculate the fractions of cover occupied in each grid cell by the six land cover classes used for calculating ecosystem rooting depths. Global, gridded data sets of PETm (Choudhury 1997, Choudhury and DiGirolamo 1998) and Pm (New et al. 2000) at a resolution of 0.5 by 0.5 degrees were used to generate a gridded data set of Sa at the same resolution. Data sets of PETa and Sa were used to calculate D95 for the five vegetation classes using equations (5) through (10). Mean D50 was calculated for each 0.5 by 0.5 degree grid cell and vegetation class using equations (11) and (12). For each 0.5 by 0.5 degree grid cell, mean D95 was calculated as the mean D95 of all five vegetation classes, weighted by the fraction of cover occupied by each respective vegetation class. Mean D95 was calculated from mean D50 of all five vegetation classes in the same way. Mean D95 and D50, respectively, for each 1 by 1 degree grid cell was calculated as the mean of the four 0.5 by 0.5 degree grid cells included in each 1 by 1 degree grid cell.

9.2.2 Processing Changes

None.

9.2.3 Additional Processing by the ISLSCP II Staff

The original files submitted by the Investigators have been modified by the ISLSCP II staff in order to match them exactly with the boundaries of the ISLSCP II land/water mask. A total of 1254 points have been identified where the ISLSCP II land/water mask has water but the original data have land. All of these points have been assigned a value of -99 on both the 50ecosys_rootdepth_1d.asc and 95ecosys_rootdepth_1d.asc files but their original values have been retained in the ecosys_rootdepth_1d.dif file.

A total of 27 points have been identified where the ISLSCP II land/water mask has land but the original data have water. In these cases the particular cell has been filled from an average of the rooting depth of all surrounding non-water cells in a 3 by 3 window around the cell. For Hawaii, it was not possible to find any non-water value to fill so this cell was assigned a value of -88 (i.e. missing data over land). All of these 27 points have a value of -99 (water) in the original data and in the ecosys_rootdepth_1d.dif file. As a final step, the Antarctic continent was masked in to the files using a value of –88.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

None.

9.4 Graphs and Plots

See Schenk and Jackson (2002a).

10. ERRORS

10.1 Sources of Error

The point data of rooting depths used to calculate mean ecosystem rooting depths for grid cells contained multiple sources of error that are difficult to quantify, including sample errors, extrapolation errors, and statistical errors. Other errors may have been introduced by combining in the analysis data measured in different sample intervals, at different times of the year, different years, and by different methods (Schenk and Jackson 2002a). Additional sources of error lie in the models used to relate rooting depths to climate. The long-term mean climatic conditions for the point locations at which rooting depths were measured may have been estimated incorrectly. Other potential errors could have been introduced by the choice of regression models and choice of variables used in the models.

Sources of error in the calculation of mean ecosystem rooting depths for 1 by 1 degree grid cells include all of the above, plus sources of errors inherent in the global data sets for P (New et al. 2000) and PET (Choudhury 1997, Choudhury and DiGirolamo 1998), as well as for land cover (De Fries et al. 1998, Hansen et al. 2000).

The user should note that the processing performed by the ISLSCP II staff may have introduced some errors as well. In particular, 26 points have been filled from an average of surrounding cells. Users should consult the ecosys_rootdepth_1d.dif file to better understand where those points are located.

10.2 Quality Assessment

10.2.1 Data Validation by Source

The data presented here represent estimates of mean rooting depths for 1 by 1 degree grid cell, not for individual points within these grid cells. Currently there are no independent data available to test these estimates of mean rooting depths for large areas. Such tests would require large sample sizes of vertical root profiles for individual grid cells.

10.2.2 Confidence Level/Accuracy Judgment

Because no measurements of mean ecosystem rooting depths exist for any 1 by 1 degree grid cell, it is impossible to judge the accuracy of these estimates. Given the multiple sources of error, estimates for individual grid cells may be associated with errors of ± 20% or more. Estimates of ecosystem rooting depths in arctic, boreal, and temperate regions generally have higher confidence levels than those in subtropical to tropical regions, where fewer point measurements of high quality were available (Schenk and Jackson 2002a).

10.2.3 Measurement Error for Parameters and Variables

Not available at this revision.

10.2.4 Additional Quality Assessment Applied

None.

11. NOTES

11.1 Known Problems with the Data

The quality of these global maps of ecosystem rooting depths is greatly affected by the quality of the PET data used (Choudhury 1997, Choudhury and DiGirolamo 1998). There are some known problems associated with these PET data, mainly in geographical regions with few weather stations and especially in mountainous areas. Because of the low resolution of the PET data in some regions, some linear banding resulting from large-scale interpolations is apparent in the D95 data set for the Himalayas and adjacent regions in China, Northern India, and Southeastern Asia, as well as for a region in central South America.

11.2 Usage Guidance

Users of these data sets should be aware of the multiple sources of error associated with these data (see section 10) and of the fact that the measurement errors for individual grid cells cannot be quantified. Because of the known problems regarding the PET data used for calculating the ecosystem root maps (see section 11.1), future users are advised to check for the availability of new global data sets of PET or to consider calculating their own estimates of PET. In either case, only PET estimates calculated by the Penman-Monteith method should be used for calculating equations 2-11, because other methods of calculating PET tend to result in substantially different estimates (Federer et al. 1996).

It should also be noted that land areas in polar and alpine regions that are covered by ice are recorded in the data set as having potential ecosystem rooting depths of D95 = 0.3 m and D50 = 0.1 m. This should not be interpreted to mean that roots exist in these areas, but that plants that may grow in such areas are likely not to exceed these given rooting depths.

Finally, we strongly advise users to note that relationships of rooting depths with vegetation classes and with long-term climatic means were used to estimate mean ecosystem rooting depths. If climate and vegetation changed, then rooting depths are likely to change as well (Schenk and Jackson 2002b). Whether such changes in rooting depths would occur more or less at the same rate as climate and vegetation change or whether changes in rooting depths would show a substantial lag behind climatic and vegetation changes is a wide open question.

Users should be aware that the original data set submitted by the Investigators has been somewhat modified to match the ISLSCP II land/water mask. Users should consult the ecosys_rootdepth_1d.dif file to locate any cells that have been modified and/or masked with the land/water mask. The ecosys_rootdepth_1d.dif can also be used with the files currently provided to re-create the original data set.

11.3 Other Relevant Information

None.

12. REFERENCES

12.1 Satellite/Instrument/Data Processing Documentation

None.

12.2 Journal Articles and Study Reports

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13. DATA ACCESS

13.1 Data Access Information

The ISLSCP Initiative II data are archived and distributed through the Oak Ridge National Laboratory (ORNL) DAAC for Biogeochemical Dynamics at **http://daac.ornl.gov** .

13.2 Contacts for Archive

E-mail**:** **uso@daac.ornl.gov**

Telephone: +1 (865) 241-3952

13.3 Archive/Status/Plans

The ISLSCP Initiative II data are archived at the ORNL DAAC. There are no plans to update these data.

14. GLOSSARY OF ACRONYMS

CRU	Climate research Unit (University of East Anglia)
D sub50	50% rooting depth
D sub95	95% rooting depth
DAAC	Distributed Active Archive Center
ERP	Ecosystem Root Profiles
GCOS	Global Climate Observing System
ISLSCP	International Satellite land Surface Climatology Project
LDR	Logistics Dose-Response
ORNL	Oak Ridge National Laboratory
P suba	Mean annual precipitation
P subm	Mean monthly precipitation
PET	Potential Evapotranspiration
PET suba	Mean annual potential evapotranspiration
PET subm	Mean monthly potential evapotranspiration
PILPS	Project for Intercomparison of Land Surface Parameterization Schemes
S suba	Annual deep soil water storage
U suba	Transformation of S suba
UMD	University of Maryland