1. TITLE

1.1 Data Set Identification

ISLSCP II Global Primary Production Data Initiative Gridded NPP Data

1.2 Database Table Name(s)

Not applicable to this data set.

1.3 File Name(s)

There are 2 *.zip files with this data set in 0.5 degree (hdeg) and 1.0 degree (1deg) spatial resolution: **gppdi_npp_gridded_hdeg.zip and gppdi_npp_gridded_1deg.zip.** There are five data files when the 2 *.zip files are extrapolated.

gppdi_npp_gridded_hdeg.zip: contains the original file submitted by the investigators named **gppdi_gridded_npp_hd.csv** and is in tabular format. This file contains above ground and total Net Primary Production (NPP) for 2,335 half degree cells with associated ancillary information (See Section 8.2 for description). There are two files, **gridded_anpp_map_hd.asc** and **gridded_totnpp_map_hd.asc**, which contain the mapped above ground and total NPP, respectively.

gppdi_npp_gridded_1deg.zip: contains **gridded_anpp_map_1d.asc** and **gridded_totnpp_map_1d.asc**, and these contain the mapped above ground and total NPP respectively, at 1.0 degree x 1.0 degree spatial resolution (the pixels were averaged from the half degree map files).

1.4 Revision Date of this Document

July 1, 2011

2. INVESTIGATOR(S)

2.1 Investigator(s) Name and Title

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2.2 Title of Investigation

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2.4 Data Set Citation

Prince, S.D., D. Zheng. 2011. ISLSCP II Global Primary Production Data Initiative Gridded NPP Data. 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/1023

2.5 Requested Form of Acknowledgment

Users of the International Satellite Land Surface Climatology (ISLSCP) Initiative II data collection are requested to cite the collection as a whole (Hall et al. 2006) as well as the individual data sets. Please cite 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 Data sets: Surface Boundary Conditions and Atmospheric Forcings for Land-Atmosphere Studies, *J. Geophys. Res.*, 111, doi:10.1029/2006JD007366, 2006.

Olson R.J., K. Johnson, D. Zheng, and J.M.O. Scurlock (2001). *Global and regional ecosystem modeling: databases of model drivers and validation measurements*. ORNL/TM-2001/196, Enviro. Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, pp 84.

Zheng, D., S.D. Prince, and R. Wright (2002). Terrestrial net primary production estimates for 0.5 degree grid cells from field observations-a contribution to global biogeochemical modeling. *Global Change Biology* 9:46-64.

3. INTRODUCTION

Net Primary Production is an important component of the carbon cycle and, among the pools and fluxes that make up the cycle, and it is one of the steps that are most accessible to field measurement. While easier than some other steps to measure, direct measurement of NPP is tedious and not practical for large areas and so models are generally used to study the carbon cycle at a global scale. Nevertheless these models require field measurements of NPP for parameterization, calibration and validation. Most NPP data are for relatively small field plots that cannot represent the 0.5 degree by 0.5 degree grid cells that are commonly used in global scale models. Furthermore, technical difficulties generally restrict NPP measurements to aboveground parts and sometimes do not even include all components of aboveground NPP. Thus direct inter-comparison between field data obtained in different studies and coarse resolution model outputs can be misleading. We developed a series of methods to process data provided by others to prepare a consistent data set of NPP for 0.5 degree grid cells for a range of biomes.

The methods used for estimation of NPP include: i) aggregation of fine-scale (plot or stand-level) vegetation inventory data to larger grid cells, ii) mapping of grid cells and area weighting of field NPP observations in each mapped class, iii) direct correlation of extensive data sets of ground measurements with remotely sensed spectral vegetation indices, iv) local modeling of NPP using key independent variables, for which maps are available at the scale of the grid cell, and v) regression analysis to link productivity with controlling environmental variables. The full data set currently contains 3,654 cells (including replicate measurements) developed from 13 studies representing NPP in croplands, sparse vegetation, shrub lands, grasslands, and forests worldwide. 2,335 cells are included here after outliers were removed and all replicate measurements were averaged for each unique geographic location. Most of the data incorporated into GPPDI were wholly or partly developed by participants in the GPPDI (Zheng et al. 2002).

3.1 Objective/Purpose

To provide a suitable and consistent global NPP data set at 0.5 degree cell size for parameterizing, calibrating, and validating global terrestrial ecosystem models.

3.2 Summary of Parameters

Aboveground NPP and total NPP ($gC/m^2/yr$). These two parameters are provided in their original tabular format and on two global grids with spatial resolutions of 0.5 and 1.0 degree in both latitude and longitude.

3.3 Discussion

The data set comprises the only NPP observations at 0.5 degree x 0.5 degree resolution worldwide. It is intended to provide information for global NPP modeling and studies of the carbon cycle. Owing to the dependence on existing studies at the site scale, the cells are not evenly distributed geographically nor can they represent each biome in proportion to its global area.

The ISLSCP II staff have taken the original data cells and mapped them onto a global grid. A 1.0 degree version of this “mapped” product was also created by averaging the original 0.5 degree cells to 1.0 degree to provide consistency with all other ISLSCP II data sets. These data sets have also been made consistent with the ISLSCP II land/water mask.

4. THEORY OF ALGORITHM/MEASUREMENTS

Net primary production is formally defined as the difference between the assimilation of carbon by vegetation in photosynthesis and the losses of carbon in autotrophic respiration, measured over a time period usually of one year. The units used depend on the purpose of the study; mass of carbon per unit area per unit time is commonly used (e.g., $gCm^{-2}yr^{-1}$), but mass of dried plant or energy released on combustion units are also used. The total NPP and especially the below ground component (structural and fine roots, rhizomes, tubers etc.) is virtually impossible to measure in its entirety since all losses over the year would have to be measured. The principal losses that occur include leaf fall, death of branches, and roots, fruit and seed dispersal and grazing by herbivores. In particularly precise studies, these losses may be taken into account, and the estimated NPP will be closer to the theoretical value, however there are many other losses that are not easily measured, including insect herbivory, pollen dispersal, volatile carbon compounds, and root exudates.

Newer techniques, in which the carbon dioxide flux is measured above the canopy, avoid many of the difficulties with measurement of changes in biomass. Nevertheless flux data for multiple years are few at the present time and the measurements are of net ecosystem production, which includes heterotrophic respiration (mainly soil microbial respiration).

Most measurements of NPP in stands of vegetation, lasting for an entire year or longer, are of increments in the biomass of the standing crop. Methods vary according to the type of vegetation, but only the increment in above ground biomass, leaf production and possibly an estimate of root production are included. While these are the larger components of total NPP, the size of the under estimate is mostly unknown. In forests, many measurements consist of dimensions (such as diameter of trees at breast height) that are used with estimation equations that have been calibrated with a small sample, to estimate standing biomass. The dimensional measurements are repeated one or more years later and the difference used as the basis of an estimate of NPP. In herbaceous vegetation, end of growing season standing, above ground biomass is a frequent measurement from which total NPP is estimated.

Agricultural yield, forest inventories and rangeland inventories are potentially valuable sources of NPP data, not because they measure the ideal field variables, but because they are repeated regularly and take spatial variability of the vegetation cover into account better than many scientific studies.

5. EQUIPMENT

5.1 Instrument Description

5.1.1 Platform (Satellite, Aircraft, Ground, Person)

The NPP data in this data set were compiled from other studies and were measured using various methods and instruments. Please refer to Section 6 and the references for more detailed information on those particular studies.

5.1.2 Mission Objectives

Various.

5.1.3 Key Variables

Various.

5.1.4 Principles of Operation

See Section 5.1.1

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

None.

6. PROCEDURE

The field NPP data used to develop 0.5 degree grid cell estimates came from 13 sources worldwide. Most of the sources were participants in the GPPDI program who contributed personal data sets. Their methods and any additional processing undertaken before adding the estimates to the GPPDI database are described below. None of the sources used included all components of NPP, most commonly the belowground NPP (BNPP) was not measured. Where possible various techniques were adopted to estimate the missing components so that both aboveground NPP (ANPP) and total NPP (TNPP) could be reported. Nevertheless the accuracy of estimation of missing components is generally low, especially when relationships are established under a limited range of environmental conditions. Moreover the errors in estimated components of NPP are often difficult to estimate.

The following procedures were applied to most data sets. To convert NPP in biomass units to carbon units, factors of 0.475 and 0.45 were used for forest and grassland, respectively. Few of the source data used in this study were originally for 0.5 degree x 0.5 degree cells so the average of all the original, fine-scale cells that fell within each 0.5 degree x 0.5 degree cell were aggregated using GIS function (focal mean) to represent the NPP value for that 0.5 degree cell. Any cells with no data were excluded during the processing. For the studies in which the original resolution was coarser than 0.5 degree x 0.5 degree (e.g. inventory data at county level), resampling procedures were used. All locations were specified by the latitude and longitude at the centers of the cells.

The ISLSCP II staff have used the latitude and longitude of each of the 2,335 cells to map each cell onto an equal area, global Earth grid. During this process, some 11 cells were found to be water dominated as indicated by the ISLSCP II land/water mask. While these 11 cells are not included in the mapped files, they have been identified in the original data table.

6.1 Data Acquisition Methods

The table below lists the data sets used to develop 0.5 degree grid cell estimates of annual NPP. Studies are grouped according to the field estimation methodology and data source (alphabetically by senior authors). Each study is described in more detail in the text that follows.

Region	Vegetation Type	Estimation method	Data source	Year(s)
1) Eastern USA	Temperate forests	Inventory by county	Brown et al. (1999)	FIA latest survey interval (varying with each State)
2) Minnesota, USA	Boreal forest	Inventory, FIA, 2711 plots	Goetz & Prince (1996)	FIA latest survey interval
3) Middle-Atlantic and Maine, USA	Temperate mixed forest	Inventory, FIA, 2640 plots	Jenkins et al. (2001)	Potential NPP
4) Porozhski, SE Russia, and Maine USA. SE of USA	Boreal forest, Temperate deciduous &	Inventory, 124 stands in Russia By county in USA	Krankina et al. (pers. comm.)	Varied

	mixed forests			
5) Mid West, USA	Cropland	Inventory, NASS by county	Prince et al. (2001)	1992 for Midwest States, mean of 1982-1996 for Iowa
6) Great Plains, USA	Grassland	Inventory, rangeland	Tieszen et al. (1997)	Average
7) HJ Andrews, Oregon, USA	Temperate coniferous forest	Literature, RS	Turner et al. (2000)	1988
8) China	Forests	RS and field data	Jiang et al. (1999)	Average
9) Finland and Sweden	Conifer-dominated Boreal forest	RS and field data	Zheng et al. (pers. comm.)	Average
10) Australian Continent	Varied	Local modeling	Barrett (2000)	Potential NPP
11) Yellowstone, USA	Temperate coniferous forest	Regression analysis	Hansen et al. (2000)	1991
12) Great Plains, USA	Grassland	Regression analysis	Gill et al. (in press)	Average
13) Great Plains, USA	Grassland	Regression analysis	Sala et al. (1988)	Average
FIA=Forest Inventory Analysis; NASS= National Agricultural Statistics Service; RS=Remote Sensing				

1) Forests in Eastern USA

Brown et al. (1999) provided annual mean aboveground wood increments for both hardwood and softwood for counties of the 33 eastern states based on the US Forest Service (USFS) FIA data from 1970s to 1990s at a county level.

We selected the counties from Brown et al. (1999) with forest cover ≥ 75%. First, the county level wood increment data were resampled to 0.5 degree x 0.5 degree cells. Second, total litterfall was calculated using the method of Lonsdale (1988) applied to the centroid of the cells (see Equation 1 in Section 9.1). Third, leaf litterfall was assumed to be 70% of total litterfall (Bray & Gorham 1964; Meentemeyer 1982; Javis & Leverenz 1984; Martinez-Yrizar & Sarulhan, 1990). Fine root production was estimated based on leaf litterfall (Raich & Nadelhoffer, 1989) and coarse root production was estimated as 22.5% of aboveground woody increments (Krankina pers. comm.). Finally, ANPP and TNPP for those 0.5 degree grid cells that were entirely located within the selected counties were calculated.

2) Superior National Forest, Minnesota, USA

Plot level inventory data were obtained from the Eastwide Forest Inventory DataBase (Hansen et al. 1992). A forest cover type/species association map for the region based on multi-temporal Landsat Thematic Mapper (TM) imagery (Wolter et al. 1995) was used. The 20 associations in the land cover map were combined by Goetz (pers. comm. 2001) to 16 for which biomass and NPP were available. The NPP values for each of the 16 classes were derived from a combination of measurements of boreal forest stands in the Superior National Forest, Minnesota (Goetz & Prince 1996; Woods et al. 1991) and the average values of statewide FIA plots for approximately a 12-year interval (Jenkins et al. 2001).

Aboveground wood NPP was calculated as the difference between the two inventories, on a tree-by-tree basis, using species-specific allometric equations based on diameter at breast height, crown depth and height, aggregated to the plot level. ANPP was calculated as sum of the annual aboveground woody biomass increment and estimated litterfall for pine, spruce-fir, and hardwoods, respectively.

For the complete forest NPP estimates it was assumed that litterfall was equivalent to fine root production (Raich & Nadelhoffer 1989). Coarse root production was calculated using ratios of root biomass to above-stump biomass (Wharton et al. 1997; Wharton & Griffith 1998) for species lacking such equations. TNPP was calculated using equation 2 (see Section 9.1). NPP estimates in 0.5 degree cells were aggregated using proportional area weighting of the forest type associations and other land cover classes (Goetz pers. comm. 2001).

3) Forests in the Mid-Atlantic and Maine, USA

Jenkins et al. (2001) used 2,640 mature, closed-canopy FIA plots to estimate potential NPP (the presumed NPP in the absence of disturbance or human management). Aboveground wood production at the plot level was calculated by these authors, based on diameter at breast height and tree species using appropriate regression equations. Belowground wood production was estimated from aboveground production using indices from the literature. Litterfall data were based on vegetation types and were obtained from the database compiled by Post et al. (pers. comm. 1999). Fine root production was assumed to equal fine litterfall (Raich & Nadelhoffer 1989). TNPP was obtained from the sum of wood production (both above- and below-ground), fine litterfall, and fine root production. An aggregation was conducted for each 0.5 degree grid cell using those plots whose centers fell within that cell. Thus the accuracy of spatial NPP estimates depended partly on the number of plots (1-46) falling within a cell. We included Jenkins' 0.5 degree NPP cells into the GPPDI as provided without further processing.

4) Forests in the state of Maine, SE USA, and Porozhski Ranger District, Russia

Krankina (pers. comm.) used USFS FIA data to develop NPP estimates at 0.5 degree cell size in the SE USA and the state of Maine, USA. The SE USA cells were estimated based on a county-level survey, while the cells in Maine were based on plot- and tree-level inventory data following the methods described by Jenkins et al. (2001). Several steps were involved in the calculation of NPP: i) aboveground woody production was calculated based on FIA data; ii) litterfall estimates for hardwood and softwood forests were based on sampling; iii) BNPP was estimated as a proportion of ANPP. Finally, iv) ANPP and TNPP were calculated.

Krankina et al. (pers. comm.) also selected a sample of 4 inventory blocks with a total area of 843 ha occupied by closed canopy forest in the Porozhski Ranger District, Russia (60.25 degrees N, 31.75 degrees E). The sample contained 124 individual forest stands (110 hardwood, 14 conifer) with a wide range of ages (15-175 years). Three steps were used to obtain an area-based estimate of NPP: i) calculation of biomass for each forest stand based on wood volume, tree species, and forest age; ii) calculation of ANPP and TNPP for each individual stand polygon based on stand biomass and age using the regression equation developed by Gower et al. (in press); and iii) calculation of the mean area-weighted value of NPP for the entire sample and for several forest stand categories within the sample. The 124 stands were used as training sites to develop a forest age map and a forest type map based on satellite data over a large area. Krankina et al. (pers. comm.) aggregated fine scale NPP estimates across the area to 0.5 degree cell size.

The 0.5 degree NPP cells for the USA and Russia were incorporated into the GPPDI without further processing.

5) Crops in Midwest USA

Prince et al. (2001) used harvest yield statistics provided by the National Agricultural Statistics Service (NASS) and the agricultural census for counties that had ≥50% of land in agriculture and <20% in forest. Cropland harvest yield was converted to NPP and the remaining biological yield was estimated using harvest indices and the shoot:root biomass ratio for each crop type. No irrigated crops were included. TNPP estimates for the state of Iowa were means for

1982-96, while the estimates for other Midwest states were based on NASS data in 1992 alone. No further processing of this data set was necessary beyond resampling county-level data to 0.5 degree cells, except that we only reported the cells that were fully included in the study area.

6) Grasslands in the Great Plains, USA - I

In the Great Plains region, thirteen major grassland seasonal land cover classes were studied by Tieszen et al. (1997) with data from three distinct sources. Normalized Difference Vegetation Index (NDVI) derived from the red and infrared channels of the Advanced Very High Resolution Radiometer (AVHRR), an instrument carried on the National Oceanic and Atmospheric Administration (NOAA) series of satellites, were collected for each pixel (1 km^2) over a 5-year period (1989-93). The NDVI data were analyzed for quantitative attributes and seasonal relationships, and then aggregated to land cover classes. Data from the State Soil Geographic (STATSGO) database were used to identify dominant plant species contributing to the potential forage production in each map unit. These species were identified as C3 and C4, and contributions to production were aggregated to provide estimates of the percentages of C3 and C4 production for each intersection of the STATSGO map unit and the seasonal land cover classes. Carbon isotope values were obtained at specific sites from the soil organic matter of the upper horizon of soil cores and were related to STATSGO estimates of potential production (Tieszen et al. 1997). They applied an algorithm derived by Gill et al. (in press) to calculate the BNPP based on ANPP and hence TNPP.

The original NPP estimates were conducted at multiple spatial resolutions ranging from 1-km to 50-km cell sizes. We aggregated their finest 1 km^2 products to 0.5 degree resolution using a focal mean function (ERDAS 1999). Our aggregated 0.5 degree estimates were well correlated with Tieszen et al.'s 50-km estimates (r^2 = 0.98).

7) Forest in US Pacific Northwest (PNW), HJ Andrews, Oregon, USA

A factor that is strongly related to NPP in the PNW is stand age class (Turner et al.1995, 2000). Cohen et al. (1995) produced a stand-age class map using Landsat TM (25 m, minimum mapping unit) in an area of predominantly coniferous forest centered on the H.J. Andrews Experimental Forest in western Oregon. About 80% of the study area was covered by mixed western hemlock (*Tsuga heterophylla*) and Douglas fir (*Pseudotsuga menziesii*), and 20% by silver fir (*Abies amabalis*) (Franklin & Dyrness, 1990). The NPP estimates for each of the six stand-age classes were based on existing data relevant to the region (Turner & Long 1975; Grier & Logan 1977; Gholz et al. 1985; Vogt 1991). The fine-resolution NPP estimates were aggregated to a 0.5 degree cell using area weighting. We incorporated the NPP for this single cell as provided by Turner et al. (2000) into the GPPDI data set.

8) Forest in China

Jiang et al. (1999) used a database for China's forests assembled by the Forestry Ministry of China (1994) with biomass and NPP data from over 1000 plots together with volume growth data from more than 5500 permanent plots, combined with the NDVI images from the AVHRR, to estimate TNPP with a spatial resolution of 6 x 6 km for 33 distinct classes of forest in China (Wu 1980). The NDVI images were used to regress NPP on the NDVI using an empirical relationship (see Section 9.1, Equation 3) developed by Cheng & Zhao (1990)

A NPP map containing more than 6,500 polygons for all China was provided by Jiang et al. (1999). We then converted the polygon map to a grid file at 1 km^2 resolution. The 1 km^2 grid cells were aggregated to 0.5 degree cell size using the focal mean function. To avoid the extensive areas of forest fragmentation, we included the ninety-nine 0.5 degree cells within which forest cover accounted for 90% area of the cell, based on the 1 km^2 global land cover map by Hansen et al. (2000).

9) Forests in Northern Europe, Finland and Sweden

Total Plant Biomass (TPB) of conifer-dominated boreal forest in Finland was measured and correlated with Landsat TM NDVI data by Hame et al. (1997). It was shown by these authors that these correlations could be used to convert calibrated NDVI from AVHRR to biomass for a large area from the west coast of Norway to the Ural Mountains in Russia.

We extracted TPB for Finland and Sweden from Hame et al.'s (1997) 1 km^2 map and developed allometric relationships using 660 plots from the National Forest Inventory (NFI) data for Sweden over a 5-year period (1994-98) (Kempe pers. comm. 2000). We calculated NPP as follows (Zheng pers. comm.): i) convert TPB (kg ha^{-1}) to annual stem increment (m^3 ha^{-1}); ii) estimate total litterfall production from a statistical model (Lonsdale 1988); iii) map ANPP and TNPP for 1 km^2 grid cells based on relationships between BNPP and ANPP (Barrett 2000; Jenkins et al. 2001; Krankina (pers. comm.); Raich & Nadelhoffer 1989); iv) aggregate 1 km^2 cell to 0.5 degree .

10) Continent of Australia

In a continental-scale study in Australia, Barrett (2000) developed a statistical model from georeferenced, relational databases containing documented observations of NPP for sites that did not exhibit rapid change. The independent variables were climate, soil, and vegetation, derived from national data sets. Aboveground NPP measurements were collected from 33 sites based on grass harvest data and visual assessment of growth, together with 76 measurements of aboveground biomass and 91 determinations of fine litter mass (Barrett 2000).

Climate variables were monthly maximum and minimum temperatures and rainfall. The 1:2,000,000 Atlas of Australian soil provided soil depth class and gross nutrient status of the soil (Northcote et al. 1975). A potential vegetation map was obtained from the AUSLIG Digital Vegetation Atlas showing vegetation in 1770, before European settlement and agricultural activities started (AUSLIG, 1990). A 2-step process was adopted for developing the least square models: i) combinations of independent variables were iteratively added and removed until the variance explained by each of the regression models for NPP was maximized. ii) the regression coefficients of these models were then scrutinized to establish their validity. The below ground plant C was estimated as the product of the inferred value of aboveground plant C and a ratio of belowground to aboveground plant C (Barrett 2000). We aggregated Barrett's NPP estimates to 0.5 degree cells using the focal mean function and incorporated cells with land cover homogeneity >90% into the GPPDI data set.

11) Greater Yellowstone region, Wyoming, USA

In an area of 9,500 km^2 (44.0 degrees -45.6 degrees N and 110.6 degrees-111.7 degrees W) Hansen et al. (2000) selected 90 samples to represent different cover types and elevations. Tree ANPP was estimated by sampling tree density by species and diameter classes and estimating average annual diameter increment by tree coring. Shrub ANPP was estimated by calculating current biomass from basal area using BIOPAK (Means et al. 1994) and dividing by the assumed average life span of the shrubs. Multiple regression models were developed and the best model was applied to estimate ANPP across the entire study area at a cell resolution of about

130 m. We aggregated the finer scale ANPP estimates to produce three 0.5 degree cells in the region using the focal mean function.

12) Grassland in the Great Plains, USA - II

Sala et al. (1988) grouped the grassland productivity data for 9,498 sites collected by the USDA Soil Conservation Service (SCS) (Joyce et al. 1986) into 100 Major Land Resource Areas (MLRA), within each State. The MLRAs were based on land use, topography and elevation, climate, soils, water, and potential natural vegetation and usually represent land areas much larger than a 0.5 degree x 0.5 degree cell (USDA, 1981).

The average of the ANPP of all the sites within each MLRA in each State was calculated. Long-term averages of monthly temperature, precipitation and soil water-holding capacity were obtained for locations near the geographical center of each State's MLRAs. These variables were correlated with primary production using multiple regression.90% of the variance was accounted for in the regression. As a result, ANPP was estimated using equation 4 (see Section 9.1).

We resampled the MLRA estimates of ANPP to 0.5 degree cells. To calculate TNPP from ANPP for Sala's cells, we applied an empirical equation between ANPP and TNPP developed from data provided in the Grassland USA III study. Because there were strong linear relationships between the ANPP and TNPP estimates in Grassland III data set (r^2=0.92) and between the ANPP in Grassland III and ANPP in the Grassland II (r^2=0.92). The application was justified because i) both studies used the same equation to estimate ANPP, and ii) both studies covered the same ecological region.

13) Grassland in the Great Plains, USA - III

Parton et al. (pers. comm. 2001) estimated ANPP based on equation 4 developed from Grassland II data set (Sala et al. 1988). The precipitation inputs were from VEMAP data at 0.5 degree cell resolution (VEMAP 1995). BNPP estimates were calculated using equations 5 and 6 (Gill et al. in press) (see Section 9.1) and TNPP was the sum of ANPP and BNPP. We incorporated their 0.5 degree NPP estimates into GPPDI.

6.2 Spatial Characteristics

6.2.1 Spatial Coverage

The spatial coverage for this data set is NOT global. Values are given for 2,335 half degree cells located throughout the world.

6.2.2 Spatial Resolution

Two NPP maps are given in an equal-angle Earth grid that has a spatial resolution of 0.5 x 0.5 degree lat/long. The other two maps are given in an equal-angle Earth grid that has a spatial resolution of 1.0 x 1.0 degree lat/long.

6.3 Temporal Characteristics

6.3.1 Temporal Coverage

The data that have been compiled here were acquired during different years and/or different time periods (See Section 6.1 for details).

6.3.2 Temporal Resolution

All cells have an annual temporal resolution.

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
1) Original File (gppdi_gridded_npp_hd.csv)				
Seq_#	ID number	Min = 1 Max = 2,335	Unitless	
LAT_DD	Latitude for the center of a 0.5^{o} cell	Min = -33.75 Max = 63.75	Degree	
LONG_DD	Longitude for the center of a 0.5^{o} cell	Min = -122.25 Max = 152.75	Degree	
ANPP	Aboveground NPP	Min = 3 Max = 890 NoData = -999	$gCm^{-2}yr^{-1}$	See Section 6.1
TOTNPP	Total NPP	Min = 4 Max = 1235	$gCm^{-2}yr^{-1}$	See Section 6.1
LANDCOVER	Land cover type aggregated from 1-km global land cover map. 1 = Evergreen Needleleaf Forest 2 = Evergreen Broadleaf Forest 3 = Deciduous Needleleaf Forest 4 = Deciduous Broadleaf Forest 5 = Mixed Forest 6 = Woodland 7 = Wooded Grassland 8 = Closed Shrubland 9 = Open Shrubland 10 = Grassland 11 = Cropland	1-11	See 8.2.2 for class codes	AVHRR (Hansen et al. 2000)
SOURCE	Principal investigator(s)	N/A	Unitless	See 6.1
WATER_MASK	Value of the ISLSCP II land/water mask: 0 = Water 1 = Land	0-1	See 8.2.2	ISLSCP II
2) Mapped NPP Files (gridded_anpp_map_hd.asc and gridded_totalnpp_map_hd.asc) (gridded_anpp_map_1d.asc and gridded_totalnpp_map_1d.asc)				
ANPP	Aboveground NPP	Min = 3 Max = 890 Water = -99 NoData over	$gCm^{-2}yr^{-1}$	Original File above

		Land = -88		
TOTNPP	Total NPP	Min = 4 Max = 1235 Water = -99 NoData over Land = -88	$gCm^{-2}yr^{-1}$	Original File above

*****NOTE**: Some cells have a value of Total NPP but do not have a value of Aboveground NPP.

8.3 Sample Data Record

Sample data records for the original file **gppdi_gridded_npp_hd.csv** are given below:

```
Seq_#,LAT_DD,LONG_DD,ANPP,TOTNPP,LANDCOVER,SOURCE,WATER_MASK
1,30.25,-91.75,308,567,1,Gill,0
2,30.25,-91.25,319,603,1,Gill,1
3,30.75,-92.75,321,600,1,Gill,1
4,31.25,-93.25,296,554,1,Gill,0
5,31.25,-92.75,312,584,1,Gill,1
6,31.25,-92.25,315,597,1,Gill,1
7,31.75,-87.75,450,658,1,Brown,1
8,32.25,-92.75,297,564,1,Gill,1
9,32.25,-92.25,286,540,1,Gill,1
10,32.75,-92.75,279,533,1,Gill,1
```

8.4 Data Format

All of the files in the ISLSCP Initiative II data collection are in the ASCII, or text format. The original data file **gppdi_gridded_npp_hd.csv** has a total of 2,336 rows and 8 columns separated by a single comma. Both numerical and text fields are included as described in Section 8.2. A value of -999 denotes a missing value. Water cells are assigned the value -99. Land cells with no data are given the value -88.

The file format for the mapped NPP files **gridded_anpp_map_hd.asc** and **gridded_totalnpp_map_hd.asc** consists of numerical fields of varying length, which are delimited by a single space and arranged in columns and rows. The files are at 0.5 x 0.5 degrees and each contain 720 columns by 360 rows. All values in these ASCII files are written as signed integer numbers.

The file format for the mapped NPP files **gridded_anpp_map_1d.asc** and **gridded_totalnpp_map_1d.asc** consists of numerical fields of varying length, which are delimited by a single space and arranged in columns and rows. The files are at 1 x 1 degrees and each contain 360 columns by 180 rows. All values in these ASCII files are written as signed integer numbers.

All files are gridded to a common equal-angle lat/long grid, 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 map files are ordered from North to South and from West to East beginning at 180 degrees West and 90 degrees North.

WARNING: The 1x1 degree product is for browse use only. These data files are averaged from the original 0.5 x 0.5 degree pixels. Thus the data values at specific pixels are not exact. Use this data with caution and always refer to the original tabular data files for specific information.

8.5 Related Data Sets

ISLSCP II project information and related data sets can also be obtained from the ORNL DAAC http://daac.ornl.gov/ISLSCP_II/islscpii.html and http://www.daac.ornl.gov/NPP/html_docs/GPPDIcells_des.html .

9. DATA MANIPULATIONS

9.1 Formulas

The equations below are used in the data set description in Section 6.0:

$$\log Y = 1.02 - 0.059ELE - 0.012L \quad (r^2 = 0.63) \qquad (1)$$

where Y = leaf litterfall production (Mg $ha^{-1}yr^{-1}$)
ELE = elevation in km
L = latitude in decimal degrees.

$$TNPP = ANPP + \text{coarse root production} + \text{fine root production} \qquad (2)$$

where TNPP = Total NPP
ANPP = Aboveground NPP.

$$NPP = A(1 - \ln(1 - b*NDVI)) \qquad (3)$$

where A and b are empirical parameters that vary among vegetation types and were determined for the 33 forest classes by statistical analyses in which each forest type was represented by at least 30-50 plots.

$$ANPP = 0.6 * (APPT-56) \qquad (4)$$

where APPT = Annual mean total precipitation (mm).

$$BNPP = 0.6 * \text{Belowground biomass} * \text{root turnover rate} \qquad (5)$$

$$\text{Belowground biomass } (g\ m^{-2}) = 0.79 * ANPP - ((MAT+10)*33.3) + 1289 \qquad (6)$$

where BNPP = Belowground NPP
MAT = Mean Annual Temperature (^0C)
ANPP = Aboveground NPP

9.1.1 Derivation Techniques/Algorithms

See Section 6.0

9.2 Data Processing Sequence

9.2.1 Processing Steps and Data Sets

See Section 6.0

9.2.2 Processing Changes

None.

9.2.3 Additional Processing by the ISLSCP Staff

The original data file submitted to ISLSCP II was a table of data at points on a 0.5 x 0.5 degree grid of the globe. The ISLSCP II staff have used the latitude and longitude of each of the 2,335 cells to map each cell onto an equal area, global Earth grid. During this process, some 11 cells were found to be water dominated as indicated by the ISLSCP II land/water mask. These 11 cells are assigned a value of -88 (i.e. missing data over land) in the mapped files, and they have also been identified in the original data table. Cells over water bodies are assigned the value of -99. Finally, the 0.5 degree NPP were then processed again, averaging each cluster of 4 pixels into one pixel, reducing the resolution to 1 x 1 degree to provide a common spatial resolution with all the other data sets of the ISLSCP II data collection.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

See Sections 6.0 and 9.1. Note that 11 cells in the original data set were found to be dominated by water in the ISLSCP II land/water mask. These were not included in the mapped files.

9.4 Graphs and Plots

None.

10. ERRORS

10.1 Sources of Error

Field measurement uncertainties and gridding points to coarser scale cells introduces some uncertainty in these gridded data. Sources of error in the original data, if provided, are available in Zheng et al. (2002) (also see Section 11.2). Uncertainty introduced during data development may include: 1) difference in methodology used to estimate total litterfall production from latitude and elevation (Lonsdale 1988), which results in lower estimates of litterfall than those derived from FIA data for cells in the eastern USA based on Brown’s annual woody increment data and cells in Sweden and Finland (Zheng pers. comm.). 2) Possible lower estimates of belowground NPP (consequently for TNPP as well) for shrubland cells in Australian data (Barrett 2000) due to application of belowground/aboveground carbon allocation method (Raich and Nadelhoffer 1989) that is more suitable for forest ecosystems.

10.2 Quality Assessment

10.2.1 Data Validation by Source

We compared the widely used Miami model (precipitation based, Lieth 1975) with the grid cell NPP ($r^2 = 0.73$). The Miami model estimates of potential NPP were generally higher than the measured data.

10.2.2 Confidence Level/Accuracy Judgment

The 1x1 degree map product is for browse use only. These data files are averaged from the original 0.5 x 0.5 degree pixels. Thus the data values at specific pixels are not exact. Use this data with caution and always refer to the original tabular data files for specific information. See Section 6.1 for more information.

10.2.3 Measurement Error for Parameters and Variables

Not available at this revision.

10.2.4 Additional Quality Assessment Applied

Outlier analysis was applied to look for patterns of NPP observations within similar groups (i.e. biomes) and look for relationships between NPP and environmental variables such as precipitation, temperature, actual evapotranspiration and the DEFAC variable (Parton et al. 1993). Identified outliers (cells) based on various criteria (Olson et al. 2001) were removed from the initial data set.

11. NOTES

11.1 Known Problems with the Data

None reported at this revision.

11.2 Usage Guidance

The NPP estimates reported here represent the entire area of each 0.5 degree x 0.5 degree cell included in the data set, but not for any single point within the cell. Unknown errors exist for many reasons but unfortunately cannot be estimated because there are no “true” NPP measurements for entire 0.5 degree x 0.5 degree cells. Clearly these issues are relevant to the 1 degree versions of the data created by the ISLSCP II staff.

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 Contacts for Archive/Data Access Information

The ISLSCP Initiative II data are available 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

ANPP	Aboveground NPP
APPT	Annual mean total precipitation
AVHRR	Advanced Very High Resolution Radiometer
BNPP	Belowground NPP
DAAC	Distributed Active Archive Center
FIA	Forest Inventory Analysis (US Forest Service)
GIS	Geographic Information Systems
GPPDI	Global Primary Productivity Data Initiative (IGBP-DIS)
GSFC	Goddard Space Flight Center (NASA)
IGBP-DIS	International Geosphere Biosphere Program Data and Information System
ISLSCP	International Satellite Land Surface Climatology Project
MAT	Mean Annual Temperature
MLRA	Major Land Resource Areas
NASA	National Aeronautics and Space Administration
NASS	National Agricultural Statistics Service (US Department of Agriculture)
NDVI	Normalized Difference Vegetation Index
NFI	National Forest Inventory (Sweden)
NOAA	National Oceanic and Atmospheric Administration
NPP	Net Primary Productivity
ORNL	Oak Ridge National Laboratory

PNW	Pacific Northwest
SCS	Soils Conservation Service (US Department of Agriculture)
STATSGO	State Soil Geographic Database (US Natural Resources Conservation Service)
RS	Remote Sensing
TM	Thematic Mapper
TPB	Total Plant Biomass
TNPP	Total NPP