1. TITLE

1.1 Data Set Identification

ISLSCP II Potential Natural Vegetation Cover

1.2 Database Table Name(s)

Not applicable to this data set.

1.3 File Name(s)

There are four total files in this data set. Two files contain the land cover types representing potential natural vegetation before human alteration and are named **potential_veg_XX.asc**, where XX can be either hd or 1d, meaning a spatial resolution of 0.5 and 1.0 degree in both latitude and longitude, respectively. The two other files are named **potential_veg_diffs_XX.asc** and contain those points in the original data set submitted by the Principal Investigator that have been modified in order to match the land/water mask of the International Satellite Land Surface Climatology Project (ISLSCP) Initiative II. These latter two files can be used with the **potential_veg_XX.asc** files to reconstruct the original data set.

1.4 Revision Date of this Document

February 24, 2010

2. INVESTIGATOR(S)

2.1 Investigator(s) Name and Title

Dr. Navin Ramankutty
Dept of Geography & Earth System
Science Program McGill University

Dr. Jonathan A. Foley
Institute on the Environment
University of Minnesota

2.2 Title of Investigation

Global land use data reconstruction.

2.3 Contacts (For Data Production Information)

	Contact 1	Contact2
2.3.1 Name	Dr. Navin Ramankutty	Dr. Jonathan A. Foley
2.3.2 Address	Dept of Geography & Earth System Science Program McGill University 627 Burnside Hall 805 Sherbrooke Strt W.	Institute on the Environment 1954 Buford Avenue 325 Vo Tech Bldg
City/St.	Montreal, Q.C.	St Paul, MN
Zip Code	H3A 2K6	55108
Country	Canada	U.S.A.
2.3.3 Tel. No.	(514) 398-8428	(612) 626-0553
Fax No.	(514) 398-7437	
2.3.4 E-mail	navin.ramankutty@ncgill.ca	jfoley@umn.edu

	Contact 3
2.3.1 Name	Dr. Eric Brown de Colstoun
2.3.2 Address	NASA/GSFC Code 614.4
City/St.	Greenbelt, MD
Zip Code	20771
Country	USA
2.3.3 Tel. No.	(301) 614-6597
Fax No.	(301) 614-6695
2.3.4 E-mail	eric.c.browndecolsto@nasa.gov

2.4 Data Set Citation

Ramankutty, N. and J.A. Foley. 2010. ISLSCP II Potential Natural Vegetation Cover. In Hall, Forest 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/961

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 Datasets: Surface Boundary Conditions and Atmospheric Forcings for Land-Atmosphere Studies, *J. Geophys. Res.*, 111, doi:10.1029/2006JD007366, 2006.

Ramankutty, N., and J.A. Foley (1999). Estimating historical changes in global land cover: croplands from 1700 to 1992. *Global Biogeochemical Cycles* 13(4), 997-1027.

3. INTRODUCTION

3.1 Objective/Purpose

This data set was developed to describe the state of the global land cover before alteration by humans. It forms a complement to the historical croplands data set developed by Ramankutty and Foley (1999), also included in this data collection. By overlaying the two, one can determine the extent to which natural vegetation has been cleared for cultivation. This data set can be used directly within spatially explicit climate and biogeochemical models.

3.2 Summary of Parameters

This is a global gridded data set describing the distribution of potential natural vegetation of the world, in terms of 15 major vegetation types, plus water and missing data categories. See section 8.2 for a list of the 17 categories.

3.3 Discussion

The geographic distribution of contemporary land cover types can be derived from remotely-sensed data. However, humans now dominate much of the world and there is little evidence of the pre-human-settlement natural vegetation or Potential Natural Vegetation (PNV). PNV, as defined here, does not necessarily represent the world's natural pre-human-disturbance vegetation. Rather, our definition of PNV represents the world's vegetation cover that would most likely exist now in equilibrium with present-day climate and natural disturbance, in the absence of human activities.

Ramankutty and Foley (1999) developed a technique to derive PNV data by combining satellite-based land cover data and PNV maps produced from ground-based sources. In their study, they used the global 1km land cover classification data set of Loveland *et al*. (2000) and searched for "remnant" PNV types within a larger 5 min resolution grid box. If at least 20% of a 5 min grid box has a dominant PNV type according to the Loveland *et al.* (2000) data set, then that larger grid box was assigned to the dominant PNV type. Otherwise, that grid box was assigned the PNV type from the data set of Haxeltine and Prentice (1996). The details of the procedure are described in the next section (also see figure 1 in section 9.4).

A caveat to be noted is that the derivation of PNV from satellite data in non-human dominated regions is not necessarily representative of pre-human settlement vegetation. For instance, in the eastern U.S., forests were cleared in the 19th century, but regenerated during the

20th century. The structure of the forest that is present now and seen from a satellite is not necessarily the same as that which existed before human settlement. Moreover, human activities such as fire suppression have also influenced the vegetation structure (e.g. woody encroachment), although such changes in vegetation might not be interpreted from the satellite as being human dominated.

This data set has been made consistent with the 0.5 and 1.0 degree ISLSCP II land/water masks. Points where the original data showed water and the ISLSCP II mask showed land have been filled in, where possible, from the dominant cover type of all surrounding cells. Where appropriate, ISLSCP II water points have also been forced over original land points. While the original data are available from the Center for Sustainability and the Global Environment (SAGE) at the University of Wisconsin-Madison the points that have been modified by the ISLSCP II staff have been kept in separate files. The user may reconstruct the original data by combining these points with the ISLSCP II masked PNV data.

4. THEORY OF ALGORITHM/MEASUREMENTS

To derive the PNV data set, we use the 1 km resolution land cover data set of Loveland *et al*. (2000), classified under the Olson Global Ecosystems (OGE) framework (Olson, 1994). Of the 94 OGE classes, 19 denote some degree of land use, and 12 denote some type of wetlands or land-water fringe. We first reclassify the 94 OGE classes into 15 PNV types and 3 additional classes, land use, wetlands, and water (see Table 1 below). Because wetlands are still poorly characterized in the Loveland *et al*. (2000) data, we decided to ignore them and consider only upland potential natural vegetation. Within each 5 min resolution grid cell, we search among the 1 km pixels for the dominant potential upland natural vegetation class (ignoring the land use, wetlands, and water classes) and assign that to be the PNV for that 5 min grid cell (we also use the two classes denoting 100% water to create a land-water mask at 5 min resolution). Even in regions with substantial land use, there is often some remnant PNV at 1 km resolution that helps us identify the PNV type. In some grid cells, two types share the dominant PNV class, or no PNV class exists. In such cases, we iteratively extend the search to include adjacent 1 km pixels, until we find a dominant PNV class within a slightly expanded grid cell. This procedure gives us a preliminary map of the dominant potential upland natural vegetation at 5 min resolution. However, this preliminary data set has several problems in the regions dominated by land use; often the remnant vegetation is not representative of the potential vegetation (for e.g., the result has coniferous dominated vegetation in southern Wisconsin), and furthermore, extrapolations from pixels that are far away yield wrong results. Thus we further refine this data set by using the HP (i.e. Haxeltine and Prentice (1996) data set) data to fill in the regions dominated by land use.

To determine the grid cells that need correction, we calculate the percentage of crop cover, wetlands, water, and the dominant PNV within each 5 min grid cell. We flag all the grid cells with >50% crop cover or <20% dominant PNV of all upland pixels. All the flagged grid cells are then assigned the PNV types from the HP data. We translate HP's 18 biome types easily into our 15 types prior to assigning them to the flagged grid cells. However, if both HP and Loveland *et al*. (2000) identify a forest type in a flagged grid cell, the specific forest type is determined by the Loveland *et al*. (2000) data because we believe that the Loveland *et al*. (2000) data set identifies forest type (e.g., tropical evergreen, temperate needleleaf evergreen, etc.) more accurately than HP. In addition, some climate rules are used to classify Tundra and Polar Desert,

and to separate Tropical, Temperate and Boreal Forests/Woodlands. The OGE legend identifies only tropical types and none of the other climatic zone definitions. We retain the "tropical types" in the data and separate the others based on a superimposed definition of climatic zones.

Table 1. Deriving the Potential Vegetation Data Set

Biome Type	**Loveland *et al*. (2000)-OGE Classes**
1) Tropical Evergreen Forest/Woodland	28, 29, 33, 34
2) Tropical Deciduous Forest/Woodland	32, 90
3) Temperate Broadleaf Evergreen Forest/Woodland[1]	6, 79, 891
4) Temperate Needleleaf Evergreen Forest/Woodland[2]	20, 22, 27, 772
5) Temperate Deciduous Forest/Woodland[3]	5, 25, 263
6) Boreal Evergreen Forest/Woodland[2]	3, 21, 622
7) Boreal Deciduous Forest/Woodland[3]	43
8) Mixed Forest	17, 18, 23, 24, 54, 60, 61, 63, 78
9) Savanna[4]	43, 914
10) Grassland/Steppe[4]	2, 7, 40, 41, 42, 874
11) Dense Shrubland[4]	16, 46, 47, 48, 59, 884
12) Open Shrubland[4]	11, 51, 524
13) Tundra	9, 53, 64
14) Desert[5]	8, 50, 71, 80, 81, 82, 83, 845
15) Polar desert/Rock/Ice	12, 49, 69, 70, 86
Land use	1, 10, 30, 31, 35, 36, 37, 38, 39, 55, 58, 76, 92, 93, 94
Wetlands	13, 44, 45, 65, 66, 67, 68
Water	14, 15, 73, 74, 75

TABLE NOTES: Classes ignored: 19, 56, 57, 85. The climate data are the following: (1) Absolute minimum temperature, tmin (degrees C): Dataset at 0.5 degree resolution in latitude by longitude was provided by Pat Bartlein (persn. commn.); we interpolated these further to a 5 min resolution and (2) Growing Degree Days (GDD) calculated on a 5 degree C base, GDD5 (days-degrees C): Calculated from the 0.5 degree resolution Cramer and Leemans data set of monthly averaged temperatures; and futher interpolated to a 5 min resolution. The climatic zone rules are the following: If tmin > 0 degrees C, then zone = tropical; else if tmin > –45 degrees C and GDD5 > 1200, then zone = temperate; else zone = boreal. The override is described as follows: A few grid cells in North America, in the Ozark Plateau, were changed manually from tropical deciduous to temperate deciduous forests/woodlands.

Overriding climatic rules:

1. If biome 3 occur in the tropical zone, it is reclassified as biome 1, and if it occurs in the boreal zone, it is reclassified as biome 6.
2. If biome 4 or 6 occurs in the tropical zone, it is reclassified as biome 1; if it occurs in the temperate zone it is reclassified as biome 4; and if it occurs in the boreal zone if is reclassified as biome 6.
3. If biome 5 or 7 occurs in the tropical zone, it is reclassified as biome 2; if it occurs in the temperate zone, it is reclassified as biome 5, and if it occurs in the boreal zone it is reclassified as biome 7.
4. If biome = 9, 10, 11, or 12 and GDD5 < 350, then Biome = 13.

5. If biome = 14 and GDD5 < 350, then Biome = 15.

5. EQUIPMENT

5.1 Instrument Description

The data set used the 1 km resolution land cover classification data developed at the EROS data center (Loveland *et al*., 2000). The base satellite data for the 1 km land cover product were monthly composites from the Advanced Very High Resolution Radiometer (AVHRR) Normalized Difference Vegetation Index (NDVI) measurements for the April 1992-March 1993 period.

5.1.1 Platform (Satellite, Aircraft, Ground, Person)

Not applicable to this data set.

5.1.2 Mission Objectives

Not applicable to this data set.

5.1.3 Key Variables

Not applicable to this data set.

5.1.4 Principles of Operation

Not applicable to this data set.

5.1.5 Instrument Measurement Geometry

Not applicable to this data set.

5.1.6 Manufacturer of Instrument

Not applicable to this data set.

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

6.1 Data Acquisition Methods

The satellite-derived land cover classification data set was obtained using the world wide web from the following web site – http://www.agiweb.org/pubs/globalgis/AVHRR/main.html. The Haxeltine and Prentice (1996) potential natural vegetation data set was obtained by contacting the authors. It is a gridded data set available digitally at a resolution of 0.5 degree degree in latitude by longitude.

6.2 Spatial Characteristics

6.2.1 Spatial Coverage

The data coverage is global, except for Greenland, Antarctica and some islands.

6.2.2 Spatial Resolution

The data are provided in two equal-angle latitude/longitude Earth grids with spatial resolutions of 0.5 by 0.5 and 1 by 1.0 degree in both latitude and longitude.

6.3 Temporal Characteristics

6.3.1 Temporal Coverage

The data are representative of natural conditions before human alteration.

6.3.2 Temporal Resolution

Not applicable to this data set.

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
Potential Land Cover Types	Land cover types representing potential natural vegetation before human alteration. **<u>Land Cover Classes:</u>** 0) Water Bodies 1) Tropical Evergreen Forest/Woodland 2) Tropical Deciduous Forest/Woodland 3) Temperate Broadleaf	See 8.2.2 Min=0 Max=16	Not Applicable	Ramankutty and Foley (1999)

	Evergreen Forest/Woodland 4) Temperate Needleleaf Evergreen Forest/Woodland 5) Temperate Deciduous Forest/Woodland 6) Boreal Evergreen Forest/Woodland 7) Boreal Deciduous Forest/Woodland 8) Evergreen/Deciduous Mixed Forest 9) Savanna 10) Grassland/Steppe 11) Dense Shrubland 12) Open Shrubland 13) Tundra 14) Desert 15) Polar Desert/Rock/Ice 16) No Data over Land			
Masked or Modified data	Land cover types of the original data sets. These points have been modified to match the ISLSCP II land/water masks. The land cover classes are the same as above except 0 is water bodies AND missing data. Class 16 is not present	Min=0 Max=15	Not Applicable	Original data set

***NOTE**: The original land cover categories ranged from 0 to 15, with 0 representing both water bodies and missing data. The ISLSCP II staff has created two separate categories for this original category for water bodies (Value=0) and no data over land (Value=16).

8.3 Data Format

All of the files in the ISLSCP Initiative II data collection are in the standard ArcGIS ASCII Grid, or text format. The file format consists of numerical fields of varying length, which are delimited by a single space and arranged in columns and rows. The files in this data set contains 720 columns by 360 rows for the 0.5 degree degree data sets, and 360 columns and 180 rows for the 1.0 degree data sets. Values are written as integers varying from 0 to 16 for the **potential_veg_XX.asc** files and 0 to 15 for the **potential_veg_diffs_XX.asc** files.

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 files are ordered from North to South and from West to East beginning at 180 degrees West and 90 degrees North.

8.4 Related Data Sets

There are several global and regional maps of potential natural vegetation. Some have been derived on the basis of observed relationships between climate and vegetation (e.g., Holdridge schemes, modeled vegetation such as the BIOME model simulations of Prentice *et al*. (1992)). A couple of global PNV data sets created on the basis of ground-based sources are Matthews (1983) and Haxeltine & Prentice (1996). Examples of regional PNV data sets are Kuchler (1964) for North America and White (1983) for Africa. As noted in Section 3, Ramankutty and Foley (1999) have also produced a historical cropland data set that can be used with this data set. That data set is also included in this collection. A historical land cover data set from Klein Goldewijk (2001) is also provided in this ISLSCP II collection. Related data sets can also be obtained at http://daac.ornl.gov/ISLSCP_II/islscpii.html

9. DATA MANIPULATIONS

9.1 Formulas

9.1.1 Derivation Techniques/Algorithms

Ramankutty and Foley (1999) derived a global potential natural vegetation map by synthesizing a 1-km resolution land cover data set of Loveland *et al*. (2000) with the Haxeltine and Prentice (1996) data set. The Loveland *et al*. (2000) data set was created by unsupervised classification of monthly composites of NDVI data from March 1992 to February 1993 for each 1 km pixel, followed by a postclassification procedure, which relied on a wide variety of ancillary data. The Haxeltine and Prentice (1996) data is based primarily on the vegetation map of Melillo *et al*. (1993), with further modifications from Matthews (1983), Olson *et al*. (1983), GVKG (1990), and Kuchler (1964).

9.2 Data Processing Sequence

9.2.1 Processing Steps and Data Sets

See Section 4 and Ramankutty and Foley (1999).

9.2.2 Processing Changes

See Ramankutty and Foley (1999) for more details.

9.2.3 Additional Processing by the ISLSCP II Staff

The original files were submitted in the ARCINFO ASCII format. In these original files water bodies and missing data were assigned to the same category (Value=0). The ISLSCP II staff has created two categories from this single category, assigning a value of 0 to all water bodies, and a value of 16 to missing data over land (e.g. Greenland, Antarctica). The ISLSCP II staff has also made the data sets consistent with the 0.5 and 1.0 degree land/water masks used in the collection. Points where the original data showed water and the ISLSCP II mask showed land have been filled in, where possible, from the dominant cover type of all surrounding cells in a 3 by 3 window. Points that did not have any values within this surrounding window have been assigned a value of 16 (i.e. No data over land). ISLSCP II water points have also been forced over original land points where needed. The points that have been modified have been provided in separate files that can be used to re-create the original data sets.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

An overriding correction was applied to reassign some tropical deciduous forest pixels in the Ozark plateau of North America to temperate deciduous forests/woodlands.

9.4 Graphs and Plots

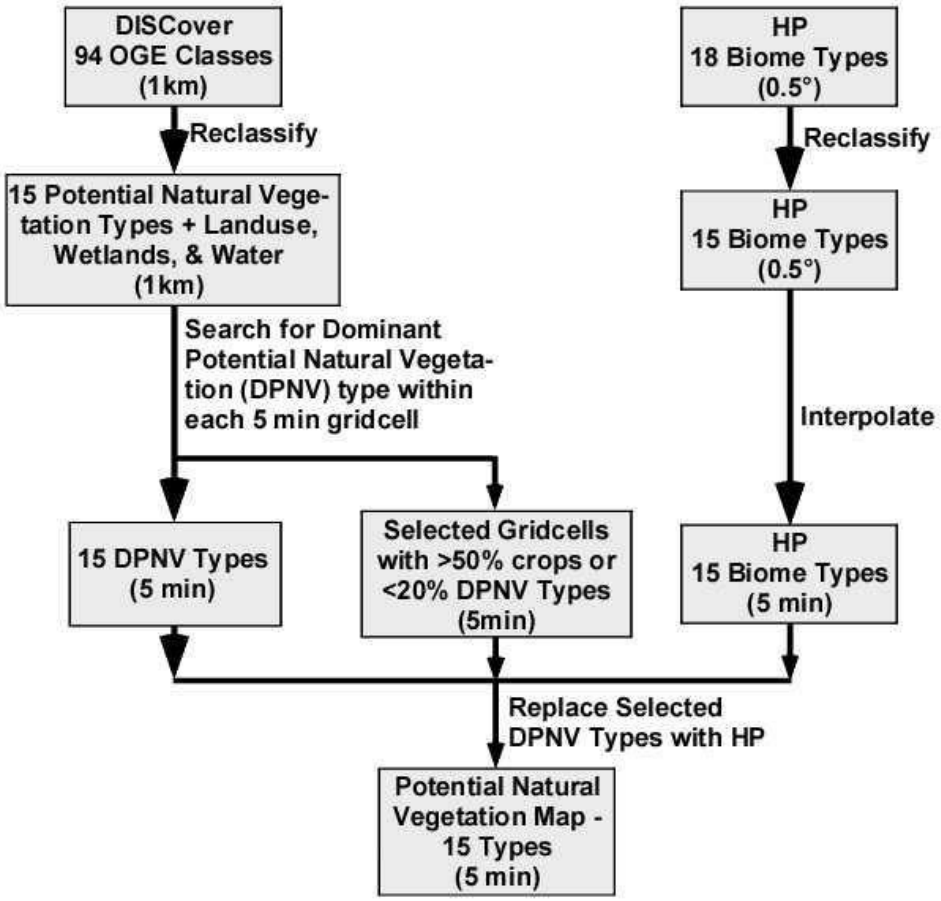

Figure 1. Algorithm for deriving potential natural vegetation. Within each 5 min grid cell of a global grid, we search for the Dominant Potential Natural Vegetation (DPNV) type among each 1 km resolution vegetation type from the DISCover data set. Here we considered only upland vegetation and ignored wetlands. In those 5 min grid cells that are dominated by land use, we replace the DPNV class by the potential vegetation types given by the Haxeltine and Prentice [1996] data set. In addition certain rules are employed during these transformations, which are described in section 4.

10. ERRORS

10.1 Sources of Error

There are several limitations to our approach of deriving potential vegetation. First, it is likely that human activities have significantly modified (without completely converting) vegetation cover (e.g., degradation of woodlands and savannas in Africa). Activities such as fire suppression have led to woody encroachment in several parts of the world, which is not necessarily interpreted as human dominated by a satellite. Hence, the dominant potential vegetation in a grid cell, as identified by the satellite data, is not necessarily the potential natural vegetation. Second, of course, errors in the satellite-derived land cover classification data set and in the Haxeltine and Prentice (1996) data set will affect the quality of our product. Furthermore, we need to include the caveat that we have used the Haxeltine and Prentice (1996) data set to fill in the regions dominated by land use. The use of a different potential vegetation data set might affect our results.

10.2 Quality Assessment

10.2.1 Data Validation by Source

A systematic quality assessment of the data set described here has not been performed. The original 1km DIScover global land cover data set has been validated from higher spatial resolution data (Scepan 1999), but only for its International Geosphere Biosphere Programme classification legend.

10.2.2 Confidence Level/Accuracy Judgment

Not available at this revision.

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

No problems are reported at this revision.

11.2 Usage Guidance

Use with caution at fine spatial scales such as local to regional scale studies. This data set was developed to describe the state of the global land cover before alteration by humans. It forms a complement to the historical croplands data set developed by Ramankutty and Foley (1999), also included in this data collection. By overlaying the two, one can determine the extent to which natural vegetation has been cleared for cultivation. This data set can be used directly within spatially-explicit climate and biogeochemical models.

The original 0.5 degree degree data set is available on the internet from the Center for Sustainability and the Global Environment (SAGE) at the University of Wisconsin-Madison (http://www.sage.wisc.edu/mapsdatamodels.html). Users may wish to re-create the original data sets at 0.5 and 1.0 degree resolutions by combining the **potential_veg_XX.asc** files with the **potential_veg_diffs_XX.asc** files. The values given in the **potential_veg_diffs_XX.asc** files,

when overlaid upon the **potential_veg_XX.asc** files, will produce the originals. Note that the ISLSCP II data range from 0 to 16 while the original files range from 0 to 15.

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

13.4 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

AVHRR	Advanced Very High Resolution Radiometer
DAAC	Distributed Active Archive Center
DPNV	Dominant PNV
GDD	Growing Degree Days
ISLSCP	International Satellite Land Surface Climatology Project
NDVI	Normalized Difference Vegetation Index
OGE	Olson Global Ecosystems framework
ORNL	Oak Ridge National Laboratory
PNV	Potential Natural Vegetation
SAGE	Center for Sustainability and the Global Environment