# NPP Multi-Biome: VAST Calibration Data, 1965-1998, R1

Get Data

Revision Date: August 28, 2013

## Summary:


This data set contains one data file in comma-delimited (.csv format) that provides observations from Australia for use in parameterizing the Vegetation and Soil-carbon Transfer (VAST) Model (version 1.1). The observations include net primary productivity (NPP), biomass, litter mass, surface horizon soil carbon concentration (i.e., mass fraction) and bulk density, and soil carbon and bulk density measurements at various depths. The data consist of 33 estimates of above-ground NPP based on cut grass swards and visual assessment of growth, 150 measurements of litterfall (leaf and fine twig), 76 measurements of above-ground biomass (phytomass), 91 determinations of fine litter mass, 341 measurements of soil carbon concentration in surface layers (to 15 cm depth), and 50 determinations of soil bulk density (to 15 cm depth). All these data were derived from 174 original literature references describing study sites throughout Australia.

VAST is a conceptual carbon (C) cycle model that depicts large scale dynamics of terrestrial C pools and the net exchange of C between the land surface and the atmosphere at a resolution of 0.05 degrees. The model consists of 10 C pools comprising two above-ground biomass pools, two litter pools, and three pools each of below-ground biomass and soil C. Below-ground pools are distributed among three soil layers (0–20, 20–50, and 50–100 cm).

**Revision Notes:** Only the documentation for this data set has been modified. The data files have been checked for accuracy and are identical to those originally published in 2001.


## Additional Documentation:

The NPP data collection contains field measurements of biomass, estimated NPP, and climate data for terrestrial grassland, tropical forest, temperate forest, boreal forest, and tundra sites worldwide. Data were compiled from the published literature for intensively studied and well-documented individual field sites and from a number of previously compiled multi-site, multi-biome data sets of georeferenced NPP estimates. The principal compilation effort (Olson et al., 2001) was sponsored by the NASA Terrestrial Ecology Program. For more information, please visit the NPP web site at http://daac.ornl.gov/NPP/npp_home.html.

## Data Citation:

**Cite this data set as follows:**

Barrett, D. J. 2013. NPP Multi-Biome: VAST Calibration Data, 1965-1998, R1. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. doi:10.3334/ORNLDAAC/576

This data set was originally published as:

Barrett, D. J. 2001. NPP Multi-Biome: VAST Calibration Data, 1965-1998. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

## Table of Contents:

## 1. Data Set Overview:

**Project:** Net Primary Productivity (NPP)

The VAST data set contains observations of NPP, biomass, litter mass, soil carbon (i.e., mass fraction), and bulk density measurements at various depths. The data consist of 33 estimates of above-ground NPP based on cut grass swards and visual assessment of growth, 150 measurements of litterfall (leaf and fine twig), 76 measurements of above-ground biomass (phytomass), 91 determinations of fine litter mass, 341 measurements of soil carbon concentration in surface layers (to 15 cm depth), and 50 determinations of soil bulk density (to 15 cm depth). All these data were derived from 174 original literature references describing study sites throughout Australia.

The VAST observation data set was used to parameterize the VAST (version 1.1) Net Ecosystem Exchange Model. VAST is a conceptual carbon cycle model which depicts large scale dynamics of terrestrial C-pools and the net exchange of C between the land surface and the atmosphere at a resolution of 0.05degrees. The model consists of ten C pools comprising two above-ground biomass pools, two litter pools, and three pools each of below-ground biomass and soil C. Below-ground pools are distributed between three soil layers (0–20, 20–50, and 50–100 cm).

The carbon content (mass fraction) of dry plant matter was assumed to be 0.42 for herbaceous vegetation and 0.45 for woody vegetation. Each observation is associated with a latitude and longitude, values of climate, soils and vegetation parameters for the 0.05-degree grid cell within which the observation lies (derived from various Australian national data sets) and the literature reference from which the observation was obtained.

Soil carbon concentrations (mass fractions) range from 0.1 to 720 mgC g-1 (0.01% to 72%), the highest value being for a moss field site in Tasmania. Average soil carbon concentration (to 15 cm depth) is about 33 mgC g-1 (3.3%). Most arid soils in Australia contain less than 10 mgC g-1 (<1%).

Area-weighted Australian-continental sums of the median value (and range of prediction intervals, 1.0 standard deviation) for inferences of NPP, live biomass, litter, and total soil carbon to 1.0 m depth were, respectively, 0.96 GtC yr-1 (0.70 - 1.34), 8.4 GtC (4.1 - 29.4), 4.4 GtC (3.7 - 5.6) and 26.9 GtC (23.8 - 30.5). The reciprocal median residence times and ranges were, respectively, 53.4 years (35.0 - 76.4), 9.2 years (4.2 - 22.7), 6.8 years (4.8 - 8.7) and 66.0 years (47.1 - 86.1).

## 2. Data Description:

This data set contains one data file (.csv format) that provides observation data from Australia for use in parameterizing the VAST (Vegetation and Soil-carbon Transfer) Model.

**Spatial Coverage**

**Site:** Australia

**Site Boundaries:** (All latitude and longitude given in decimal degrees)

| Site (Region) | Westernmost Longitude | Easternmost Longitude | Northernmost Latitude | Southernmost Latitude | Elevation (m) |
|---|---|---|---|---|---|
| Australia | 115.16 | 153.45 | -11.15 | -43.42 | 0 - 1,442 |

**Site Information**

Data used to parameterize VAST 1.1 comprised high quality observations of plant production and C pools from published studies representing as much of the climatic domain of the Australian continent as possible. These data were obtained from minimally disturbed sites to ensure a reasonable approximation to steady state. The observations were obtained by different authors from different locations, at different times, and for different reasons but by stipulating that measurements had undergone scientific peer review before publication, a level of quality control in the data set was achieved. The data represent 588 observation sites in Australia, including Tasmania.

**Spatial Resolution**

The observations were obtained by different authors from 588 different locations. Please consult original data sources for details.

**Temporal Coverage**

The observations were obtained at different times between 1965 and 1998. Please consult original data sources for details.

**Temporal Resolution**

Please consult original data sources for details.

**Data File Information**

Table 1. Files in this data set archive

| FILE NAME | TEMPORAL COVERAGE | FILE CONTENTS |
|---|---|---|

| | | |
|---|---|---|
| npp_vastdata.csv | 1965/01/01-1998/12/31 | NPP, live biomass, litter, total soil carbon, and ancillary data for 588 observation sites in Australia. |
| vastrefs.txt | 1955/01/01-1998/12/31 | References for Australia NPP, live biomass, litter, total soil carbon, and ancillary data. |

**NPP Data.** NPP estimates for 588 observation sites in Australia are provided in one file (Table 1). The variables are delimited by commas (.csv format). The first 31 lines are metadata; data records begin on line 32. Missing values are denoted by blank cells in the .csv file. All NPP units are in tC/ha/yr (dry matter weight); above-ground phytomass and fine debris littermass units are in tC/ha (dry matter weight).

Table 2. Column headings and parameter definitions in NPP file

| COLUMN HEADING | DEFINITION | UNITS |
|---|---|---|
| Latitude | Latitude of site where data were gathered | Decimal degrees |
| Longitude | Longitude of site where data were gathered | |
| Site ID | Unique site identification number | Numeric |
| Elevation | Site elevation derived from ANUDEM 0.05-degree | Meters |
| Veg_form | Percent foliage cover class of dominant overstory. Eight classes: T = Tall trees >30 m height; M = Medium trees 10 to 30 m; L = Low trees < 10 m; S = Tall shrubs > 2 m; Z = Low shrubs < 2 m; H = Hummock grasses; G = Tussock or tufted grasses; F = Other herbaceous plants. | Text |
| Veg_cover | Percent foliage cover class of dominant overstory. Four classes: 1 = < 10% cover; 2 = 10-30% cover; 3 = 30-70% cover; 4 = > 70% cover. | Numeric |
| Temperature | Mean annual temperature | degrees C |
| Precip | Mean annual precipitation | mm |
| Soil_class | Soil identification class | Unitless |
| Nutrient_class | Gross nutrient status of soil class. Three classes: 1 = Low; vegetation likely to have a major response to N, P, and K along with micronutrients; 2 = Moderate; responses by vegetation to N and P with occasional response to some micronutrients; and 3 = High; responses by vegetation to N and P uncommon except after intensive farming. | Numeric |
| Soildepth_class | Soil depth classes. Three classes: 1 = < 0.5 m depth; 2 = 0.5 to 1.5 m depth; 3 = > 1.5 m depth. | numeric |
| Pna | Above-ground fine tissue net primary productivity | tC/ha/yr |
| qPa | Above-ground phytomass | tC/ha |
| qLa | Above-ground fine debris littermass | tC/ha |
| SoilCO | Average soil C concentration (i.e., mass fraction) < 15 cm depth | mgC/g |
| rhoO | Average soil bulk density < 15 cm depth | $kg/m^3$ |
| Reference | Unique literature reference number for data source. See companion file <vastrefs.txt> for references. | Numeric |

See notes at the end of the data record for clarification of data classifications and sources.

**Sample NPP Data Record**

```
Latitude, Longitude, Site_ID, Elevation, Veg_form, Veg_cover, Temperature, Precip, Soil_class, Nutrient_class,
Soildepth_class, Pna, qPa, qLa, SoilC0, rho0, Reference
-35.33, 148.8, 5, 1156, M, 3, 9.6, 910, Um5.51, 1, 2, 5.061, -999, 16.2 -999, -999, 3
-35.33, 148.8, 6, 1156, M, 3, 9.6, 910, Um5.51, 1, 2, 3.129, -999, 9.9, -999, -999, 3
-12.67, 132.92, 12, 18, M, 2, 27.6, 1458, Dy3.43, 1, 2, 1.075, 1.395, -999, -999, -999, 6 ...
```

**Companion File.** Literature references cited in the NPP data file are listed in the text file <**vastrefs.txt**> in numerical order of reference number for data source. The reference description includes reference number, author, year of publication, journal or book title, volume, and page numbers.

**Sample Companion File Record**

| Reference No. Author/s Year Journal / Book title Volume, pages |
|---|
| 3 Wilson, S.D. and Zammit, C.A. 1992 Australian Journal of Ecology 17, 321-327. |
| 6 Cook, G.D. and Andrew, M.H. 1991 Australian Journal of Ecology 16, 375-384. |
| 7 Scanlan, J.C. 1991 Australian Journal of Ecology 16, 521-529. ... |

## 3. Data Application and Derivation:

The data set and the VAST model were compiled and developed to address the limited information available on the magnitude, variability, and spatial distribution of mean residence time of carbon in the terrestrial biosphere. The geographical distribution of continental-scale variability in steady state mean residence time of biosphere carbon stocks was determined using statistical models developed from spatially distributed data sets of point observations and a one-dimensional carbon cycle model. The steady state carbon cycle model (the VAST model) was "inverted" and solved for rate constants governing the turnover of live biomass, litter, soil carbon, and biosphere carbon for each 0.25 x 0.25 degree terrestrial grid cell over the Australian continent. Statistical models of maximum potential NPP and carbon stocks were developed from spatially distributed, geo-referenced point observations. Confidence intervals of inferences from the statistical models were then used in combination with Monte Carlo techniques to generate the prediction intervals of these turnover constants.

## 4. Quality Assessment:

Quality control on measurements was imposed by ensuring that data had undergone scientific peer review before publication. Data were assumed to correspond to "minimally disturbed" vegetation according to the following criterion: the author's description of overstory vegetation structure and species composition was the same as the Australian Survey and Land Information Group (AUSLIG) historical data set of 1788 vegetation classification, (i.e. the growth form of vegetation remained constant in the period between the historical data set and the date of the study).

Georeferencing of point observations utilized the latitude and longitude of each study site provided by authors or, where absent, obtained from an identifiable topographic feature described within the study and located on 1:1,000,000 and 1:2,500,000 scale AUSLIG maps.

For those studies where authors presented an age sequence of biomass or littermass, the oldest sites were chosen on the assumption that these measurements were more likely to be near steady state.

Measurements were averaged for those studies where multiple sites were described by authors but listed under a single latitude and longitude within one 0.05-degree grid cell. As a consequence, a small amount of information on spatial variability at local scales was lost. In cases where multiple years of NPP or litterfall measurements were available at a single site, each year's data was included because year-to-year deviations of NPP measurements from the long-term average are an important component of total variability in NPP.

Area-weighted Australian-continental sums of the median value (and range of prediction intervals, 1.0 standard deviation) for inferences of NPP, live biomass, litter, and total soil carbon to 1.0 m depth were, respectively, 0.96 GtC yr-1 (0.70 - 1.34), 8.4 GtC (4.1 - 29.4), 4.4 GtC (3.7 - 5.6) and 26.9 GtC (23.8 - 30.5). The reciprocal median residence times and ranges were, respectively, 53.4 years (35.0 - 76.4), 9.2 years (4.2 - 22.7), 6.8 years (4.8 - 8.7) and 66.0 years (47.1 - 86.1).

Sources of uncertainty contributing to the magnitude of the prediction intervals were grouped into three categories: (1) errors originating from national climatic, edaphic and vegetation data sets and from insufficient data to quantify covariance terms between NPP and carbon stocks; (2) biases that arise from insufficient knowledge of the allocation of photosynthate to below-ground tissues, from insufficient data to determine the proportion of decomposing litter carbon that is oxidized and returned to the atmosphere, and from the small sample number with which to develop statistical models; and (3) natural heterogeneity that arises from variation in microenvironment and from interspecific differences in plant and soil microbe responses to this variation.

An additional source of uncertainty in reconciling continental and global soil carbon stocks, soil carbon fluxes and modeled soil carbon residence time is specifying the soil depth beyond which heterotrophic respiration contributes an "insignificant" proportion to soil surface $CO_2$ efflux to the atmosphere. It was found that to reconcile soil carbon residence time for the Australian continent with literature values of soil carbon turnover, a decrease in the "effective" lower bound of soil $CO_2$ production was necessary, from 30 to 50 cm at temperate latitudes to around 30 cm in the tropics.

The distribution of observations in the geographic domain displays a bias. Comparison of the distribution of samples across vegetation classes against the continental area-distribution of these classes showed that a predominance of sites occurred in Tall Closed Forests (vegetation classification = T) and Medium Forests (M) even though these forests occupy <1% and 23% of continental land area, respectively. Additionally, NPP and phytomass measurements for Low Forests (L) and Shrublands (S, Z) were under-represented given that these vegetation classes occupy the majority land area of the continent (85%). Soil carbon concentration is better distributed across vegetation classes because of incorporation of data from the CSIRO National Soil Database.

The distribution of observations in the climatic domain is more representative of the continental range of mean annual temperature and mean annual rainfall than the distribution of these observations in the geographic domain. However, there is an absence of observations for NPP, phytomass, and littermass from regions of mean annual rainfall >1200 mm and mean annual temperature < 15 C. This region corresponds primarily to the remote western Tasmanian forests where no observations were available. Additionally, relatively few observations were available for regions having mean annual rainfall > 1,000 mm and mean annual temperature > 20 C which corresponds to tropical rainforest and savannas at latitudes < 15 S.

**Sources of Error**

Information not available.

## 5. Data Acquisition Materials and Methods:

Data used to parameterize VAST 1.1 comprised high quality observations of plant production and C pools from published studies representing as much of the climatic domain of the Australian continent as possible. These data were obtained from minimally disturbed sites to ensure a reasonable approximation to steady state. The observations were obtained by different authors from different locations, at different times, and for different reasons, but by stipulating that measurements had undergone scientific peer review before publication, a level of quality control in the data set was achieved.

## 6. Data Access:

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

### Data Archive Center:

Contact for Data Center Access Information:
E-mail: uso@daac.ornl.gov
Telephone: +1 (865) 241-3952

## 7. References:

Olson, R. J., K.R. Johnson, D.L. Zheng, and J.M.O. Scurlock. 2001. Global and Regional Ecosystem Modeling: Databases of Model Drivers and Validation Measurements. ORNL Technical Memorandum TM-2001/196. Oak Ridge National Laboratory, Oak Ridge, Tennessee, U.S.A.

**Additional Sources of Information:**

Barrett, D.J. 2002. Steady state net primary productivity, carbon stocks and mean residence time of carbon in the Australian terrestrial biosphere. Global Biogeochemical Cycles 16(4): 1108. doi:10.1029/2002GB001860

Barrett, D.J. 1999. Steady state carbon mean residence time in the Australian terrestrial biosphere. EOS (Supplement), Transactions of the American Geophysical Union 80(46): F51.

Wangi, Y.P., and D.J. Barrett. 2003. Estimating regional terrestrial carbon fluxes for the Australian continent using a multiple-constraint approach. Using remotely sensed data and ecological observations of net primary production. Tellus 55B: 270–289.