

Canopy nitrogen - mosaic (DP3.30018.002)

Measurement

Site-level maps of canopy nitrogen content (%N) generated by linking foliar chemistry measurements from georeferenced samples (DP1.10026.001) with NEON's spectrometer orthorectified surface directional reflectance data product (DP1.30006.001). Maps for %N and ancillary information are provided as 1 x 1 km tiles in geotiff (.tif) format at 1 m spatial resolution. Individual files include 1) canopy nitrogen percent (files ending in nitrogen.tif), 2) canopy nitrogen model uncertainty (files ending in nitrogen_uncertainty.tif), 3) classification result for needle vs. non-needle model (files ending in nitrogen_classification.tif), and 4) valid pixel mask based on NDVI threshold (files ending in nitrogen_valid.tif).

Collection methodology

Canopy nitrogen is a model derived from the "Spectrometer orthorectified surface directional reflectance - flightline" data product (DP1.30006.001) and the "Plant foliar trait" data product (DP1.10026.001). See documentation for those data products for sensor details and collection methodology.

For information about disturbances, land management activities, and other incidents that may impact data at NEON sites, see the [Site management and event reporting \(DP1.10111.001\)](#) data product.

Maintenance and calibration

Calibration activities are conducted on the NIS every winter between flight seasons in the NEON AOP lab where it measures known radiance sources in a controlled environment. Calibration/validation flights are flown at the beginning and end of every flight season for positional and timing accuracy as well as measuring radiance and reflectance over well-characterized, homogenous targets. In each domain collected, an in-situ calibration is conducted where the NIS records radiance from a known portable mercury lamp positioned directly under the sensor. Finally, at the start and end of each flight line flown, a set of on-board calibrations are made. These calibration activities allow any variances in the spectral response of the focal plane to be characterized, recorded, and tracked.

Data processing and derivation

Generalizable predictive models of percent Nitrogen (%N) at 47 NEON terrestrial sites were developed by combining Level-1 1-m-resolution spectrometer orthorectified surface directional reflectance - flightline (DP1.30006.001) with ground-based measurements of %N from sunlit leaves that spatially and temporally overlapped with the imagery. Image spectra were extracted within sampling bounds for all tree crowns and herbaceous-clip strips across the 47 sites. Noisy and atmospheric absorption bands were removed, retaining the spectral regions 418.59-1335.04 nm, 1460.23-1770.72 nm, and 1986.06-2396.71 nm. To reduce the effects of internal canopy shade, the spectra were brightness-normalized by dividing the reflectance at each

wavelength by the full-spectrum reflectance norm. The spectra were then divided into training, validation, and test sets using stratified sampling to ensure proportional geographic representation. To address the class imbalance between woody and herbaceous cover spectra, crown-specific subsampling was applied, limiting the number of pixels sampled per crown to five.

A Support Vector Machine (SVM) classifier was trained on spectra from foliar samples across all sites and years to categorize vegetation into "needle" and "non-needle" types, achieving an overall accuracy of 96.6%. These classes were defined due to the observed difference in model parameters between classes. No further classes were added to maintain a high number of training samples per class. A 100-model ensemble of regression models, including Random Forest, Support Vector, and Partial Least Squares, were constructed to predict %N using 327 reflectance bands. The best performance was delivered by the Random Forest models. Generalized Random Forest regression models were trained separately for needle and non-needle vegetation. Preliminary results indicated a promising capability to predict foliar nitrogen from NEON data collected in both field and airborne contexts, with an R^2 of 0.52 and an RMSE of 0.46.

The implementation of the Bidirectional Reflectance Distribution Function (BRDF) and topographic corrections to the recently collected airborne hyperspectral data from 2022 to 2025 has been completed. These corrections are currently being applied to hyperspectral data collected from 2013 to 2021. Once processing of the earlier data is finished, foliar trait maps will be generated using the corrected bi-directional reflectance. However, the preliminary maps provided here were created using uncorrected (directional) surface reflectance flight lines (DP1.30006.001). Additionally, the models (Support Vector Machine and Random Forest) were trained on this directional reflectance data.

Data quality

Canopy nitrogen (%) maps are provided as 1 x 1 km geotiff (.tif) files and include the following additional layers:

- a) Canopy nitrogen model uncertainty showing the uncertainty associated with the %N predictions from each decision tree in the final Random Forest model for each 1 m pixel within the tile.
- b) Classification result for needle vs non-needle model, which is a binary map generated using SVM classification, where needle types are coded as 0 and non-needle types as 1 for each 1 m pixel within the tile. The "non-needle" class includes all vegetation types that are not needleleaf, such as broadleaf trees, shrubs, herbaceous cover, and others. Separate random forest regression models have been developed to predict foliar nitrogen values for needle and non-needle vegetation types.
- c) Valid pixel mask based on NDVI threshold of 0.2, where values less than 0.2 are set to 0 ("non-valid"). This mask is intended to enable exclusion of non-vegetated areas, such as roads, water bodies, built-up areas, bare rock, and so forth.

Pixels with missing data are coded -9999.

Please note that quality checks are comprehensive but not exhaustive; therefore, unknown data quality issues may exist. Users are advised to evaluate quality of the data as relevant to the scientific research question being addressed, perform data review and post-processing prior to analysis, and use the data quality information and issue logs included in download packages to aid interpretation.

Standard calculations

For wrapper functions to download data from the API, and functions to merge tabular data files across sites and months, NEON provides the `neonUtilities` package in R and the `neonutilities` package in Python. See the [Download and Explore NEON Data](#) tutorial for introductory instructions in both programming languages.

Canopy nitrogen content (%) maps should be masked using the NDVI mask to exclude non-vegetated areas.

Documentation

For more information on data product documentation, see:
<https://data.neonscience.org/data-products/DP3.30018.002>

Citation

To cite data from value: "Canopy nitrogen - mosaic" (DP3.30018.002), see citation here:

<https://data.neonscience.org/data-products/DP3.30018.002>

For general guidance in citing NEON data and documentation, see the citation guidelines page:

<https://www.neonscience.org/data-samples/guidelines-policies/citing>

Contact Us

NEON welcomes discussion with data users! Reach out with any questions or concerns about NEON data:

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