Atmospheric Water Isotopic Observations across National Ecological Observatory Network

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Introduction

Stable isotopes provide robust information on the structure, function, and processes of ecological systems, including hydrologic cycling. To provide publicly available continental-scale data, H_2O isotopic observations ($\delta^{18}O$ and δD) in atmosphere, precipitation, lake and stream have been incorporated as key data products in the National Ecological Observatory Network (NEON). This poster focuses on the atmospheric water vapor component at NEON's terrestrial sites nation-wide. These measurements are made along a vertical tower profile at all core sites plus Barrow, AK relocatable site (Figure 1).

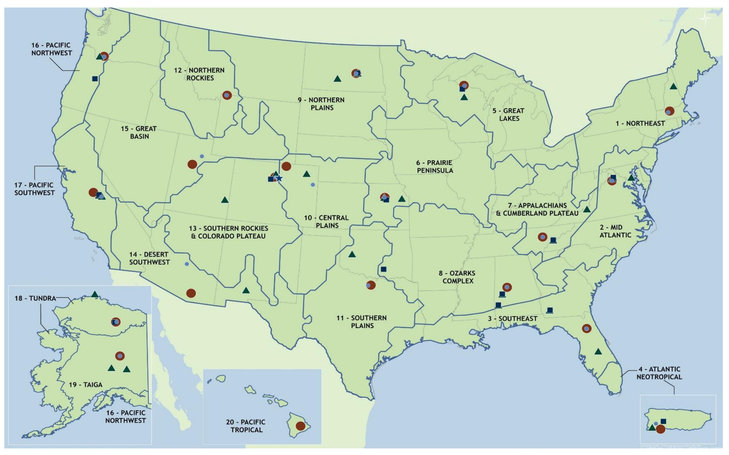


Figure 1. Map showing NEON terrestrial Core sites and Relocatable sites and aquatic sites.

Vertical Profile Measurement System

Instrumentation:

- Picarro L2130-i Analyzer with autosampler and vaporizer for periodic field validation

Sampling location:

- Sampling inlets located at multiple tower heights, which vary from 4 to 8 levels depending on ecosystem structure (see Figure 2 design scheme)
- vertical profile air sampling from the ground level through the ecosystem canopy and above the canopy to the well-mixed layer

Sampling frequency and duration:

- Continuous at ~1 Hz
- 10 minutes per measurement level

Field validation:

- Validated by $\delta^{18}O$ and δD reference standards traceable to IAEA
- Three-point validation
- Reoccurs every 23 hours.

System Schematic

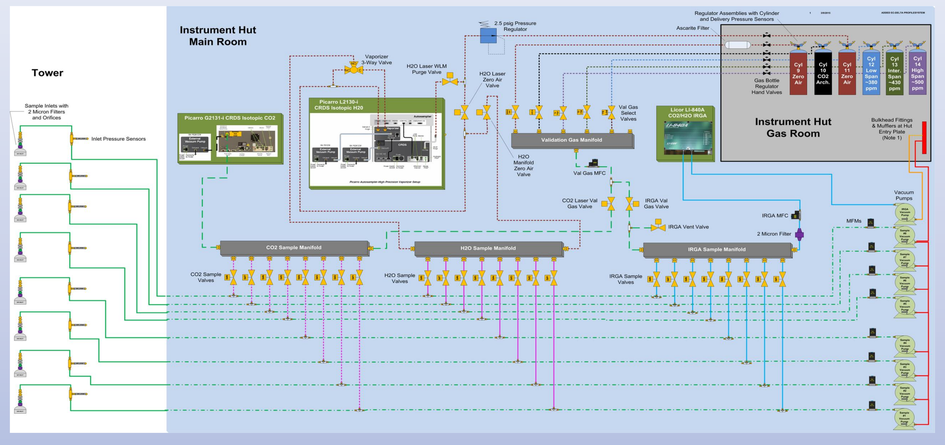


Figure 2. Design scheme of the vertical profile system including CO_2 concentration, $\delta^{13}C$, water vapor concentration, $\delta^{18}O$, and δD measurements in the atmosphere. Note that figures not drawn to scale.

Future enhancements

- **Low humidity dependence (LHD) correction**
  1). L2130-I LHD issue bias the isotopic readings at the low humidity conditions
  2). LHD curve will be characterized annually *in situ* at each site. See Figure 7 for examples
  3). LHD data will be available by request and for NEON use in the future
- **Memory correction for each injection during validation**
- **Sensor drift correction using validation data**

Data products, status and download

Data products and download:

- 9-min and 30-min averaged $\delta^{18}O$ and δD
- $\delta^{18}O$ and δD can be downloaded directly from NEON data portal http://data.neonscience.org as part of the bundled eddy covariance HDF5 data. Explore data by location or by theme or by search.
- Alternatively, $\delta^{18}O$ and δD can be downloaded using the zipsByProduct function in the neonUtilities R package. See Tutorial https://www.neonscience.org/neonDataStackR

Status of data availability:

- https://data.neonscience.org/view-data-availability
- Check data availability by site or by time
- See Figure 3 for an example

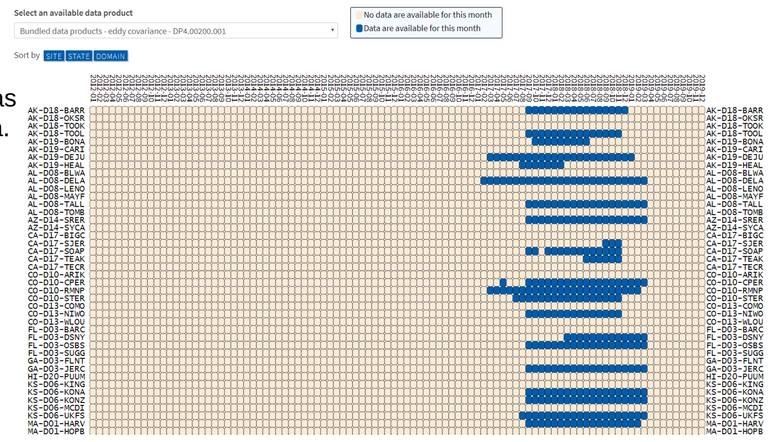
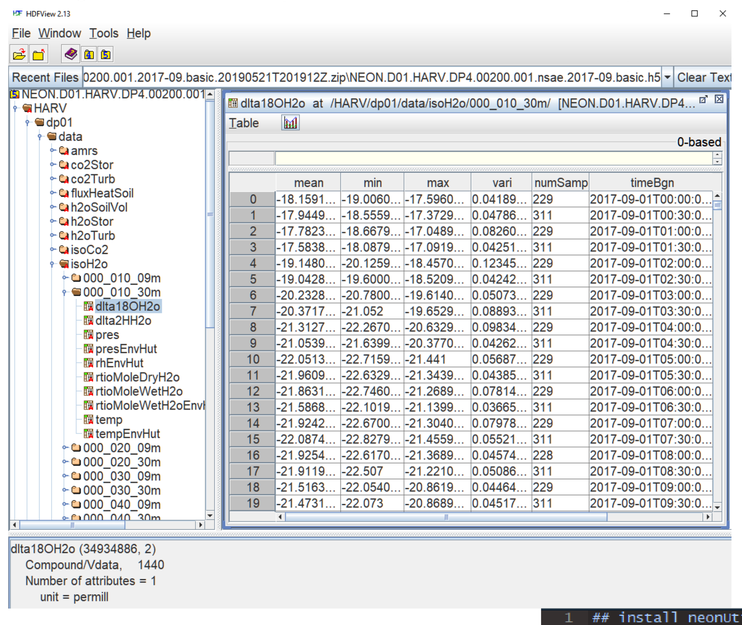


Figure 3. Data availability chart to indicate the available data by site and by month on data portal



Data format:

- csv (in case you don't want HDF5 files)
- stackEddy function in the neonUtilities R package is used to extract $\delta^{18}O$ and δD data from downloaded HDF5 files and saved them as a csv file
- See: https://www.battelleecology.org/eddy-data-intro for a full tutorial
- See Figure 5 and Figure 6 for an example

Figure 5. Example to extract isotope data in csv format using neonUtilities R package →

```r
## install neonUtilities package
install.packages("neonUtilities")

## load neonUtilities

library(neonUtilities)

## Download data via the API with the zipsByProduct funtion

zipsByProduct(dpID="DP4.00200.001", package="basic", |
              site=c("HARV"),
              startdate="2018-06", enddate="2018-07",
              savepath="C:/Users/cflorian/Desktop/neonUtilities/data",
              check.size=F)

## Use stackEddy() to extract data from bundled eddy covarince HDF5 file

HARV_H2O_isos <- stackEddy(filepath="C:/Users/cflorian/Desktop/neonUtilities/data",
                           level="dp01", var=c("dlta18OH2o"), avg=30)

## write to CSV

write.csv(HARV_H2O_isos$HARV, "HARV_H2O_isos.csv")
```

Figure 6. Example of the csv output using neonUtilities R package →

	A	B	C	D	E	F	G
1	verticalPosition	timeBgn	timeEnd	data.isoH2o.dlta18OH2o.mean	data.isoH2o.dlta18OH2o.min	data.isoH2o.dlta18OH2o.max	data.isoH2o.dlta18OH2o.vari
35	10	2018-06-01T16:30:00.000Z	2018-06-01T16:59:59.000Z	-14.17916037	-15.0489998	-13.599	0.05942128
36	10	2018-06-01T17:00:00.000Z	2018-06-01T17:29:59.000Z	-14.11073572	-14.5970001	-13.6470003	0.030672922
37	10	2018-06-01T17:30:00.000Z	2018-06-01T17:59:59.000Z	-14.52604249	-15.1689997	-13.8719997	0.048806549
38	10	2018-06-01T18:00:00.000Z	2018-06-01T18:29:59.000Z	NA	NA	NA	NA
39	10	2018-06-01T18:30:00.000Z	2018-06-01T18:59:59.000Z	-14.52499238	-15.0209999	-13.9420004	0.036748851
40	10	2018-06-01T19:00:00.000Z	2018-06-01T19:29:59.000Z	-14.41362142	-14.835	-13.9429998	0.032108111
41	10	2018-06-01T19:30:00.000Z	2018-06-01T19:59:59.000Z	-14.13941604	-14.8000002	-13.54	0.053217955
42	10	2018-06-01T20:00:00.000Z	2018-06-01T20:29:59.000Z	-13.95594284	-14.4890003	-13.4759998	0.03255408
43	10	2018-06-01T20:30:00.000Z	2018-06-01T20:59:59.000Z	-13.93016541	-14.7550001	-13.4119997	0.049804753
44	10	2018-06-01T21:00:00.000Z	2018-06-01T21:29:59.000Z	-13.77835717	-14.1920004	-13.3509998	0.03219638
45	10	2018-06-01T21:30:00.000Z	2018-06-01T21:59:59.000Z	-13.69581705	-14.599	-13.1549997	0.065567885
46	10	2018-06-01T22:00:00.000Z	2018-06-01T22:29:59.000Z	-13.53489925	-13.9280005	-13.1199999	0.029433967
47	10	2018-06-01T22:30:00.000Z	2018-06-01T22:59:59.000Z	-13.50831831	-14.4989996	-12.9040003	0.065044698
48	10	2018-06-01T23:00:00.000Z	2018-06-01T23:29:59.000Z	-13.3515461	-13.9499998	-12.8959999	0.041117098
49	10	2018-06-01T23:30:00.000Z	2018-06-01T23:59:59.000Z	-13.46814572	-14.2650003	-12.9099998	0.0554552
50	10	2018-06-02T00:00:00.000Z	2018-06-02T00:29:59.000Z	-13.40026252	-13.9069996	-12.9829998	0.029882566
51	10	2018-06-02T00:30:00.000Z	2018-06-02T00:59:59.000Z	-13.43429898	-14.2740002	-12.8540001	0.050392589
52	10	2018-06-02T01:00:00.000Z	2018-06-02T01:29:59.000Z	-13.3778865	-13.8570004	-12.9689999	0.031384694
53	10	2018-06-02T01:30:00.000Z	2018-06-02T01:59:59.000Z	-13.54719299	-14.3760004	-13.0100002	0.066733594
54	10	2018-06-02T02:00:00.000Z	2018-06-02T02:29:59.000Z	-13.45073048	-13.8879995	-13.0600004	0.027752672
55	10	2018-06-02T02:30:00.000Z	2018-06-02T02:59:59.000Z	-13.61539444	-14.5050001	-13.0389996	0.051737792
56	10	2018-06-02T03:00:00.000Z	2018-06-02T03:29:59.000Z	-13.45462412	-13.9729996	-12.967	0.041220885
57	10	2018-06-02T03:30:00.000Z	2018-06-02T03:59:59.000Z	-13.63897244	-14.4770002	-12.9569998	0.059975978
58	10	2018-06-02T04:00:00.000Z	2018-06-02T04:29:59.000Z	-13.52808511	-14.0030003	-13.0950003	0.034753571
59	10	2018-06-02T04:30:00.000Z	2018-06-02T04:59:59.000Z	-13.68092982	-14.5649996	-13.1280003	0.053285395
60	10	2018-06-02T05:00:00.000Z	2018-06-02T05:29:59.000Z	-13.58832623	-14.2130003	-13.2189999	0.037356059
61	10	2018-06-02T05:30:00.000Z	2018-06-02T05:59:59.000Z	-13.71102767	-14.7580004	-13.1280003	0.082124327

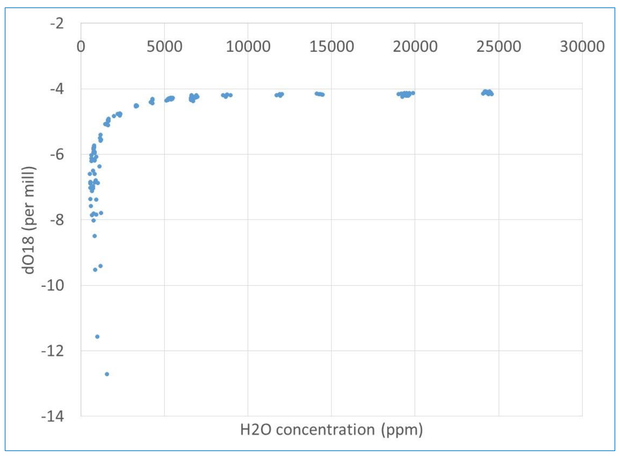
Data format:

- HDF5
- "basic" file for monthly data; "expanded" file includes detailed quality flag and quality metric (qfqm) info
- $\delta^{18}O$ and δD in atmospheric water vapor are in the dp01/isoH2o folder
- Associated metadata is included in the same file
- See Figure 4 for an example

← **Figure 4.** Example of a HDF5 file for bundled eddy covariance data.

High frequency data:

- 1Hz (in case you don't want the processed 9-min or 30-min average data)
- Follow the Level 0 Prime data download instructions (https://data.neonscience.org/api/v0/documents/EC_L0P_Download_Inst_20181119)
- Use curl or python to download



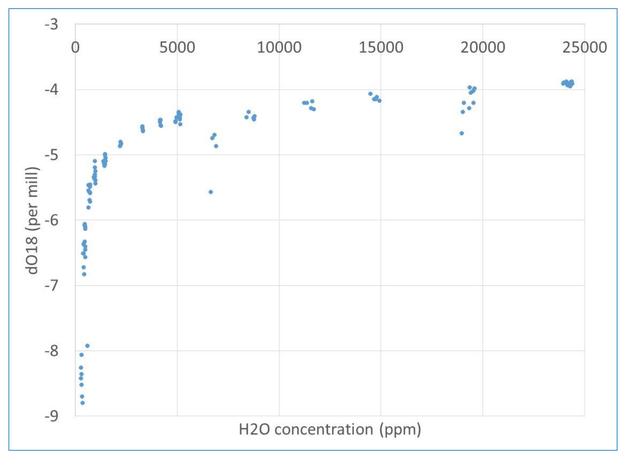


Figure 7. LHD curves at D04 GUAN site (left panel) and at D14 SRER site (right panel)

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