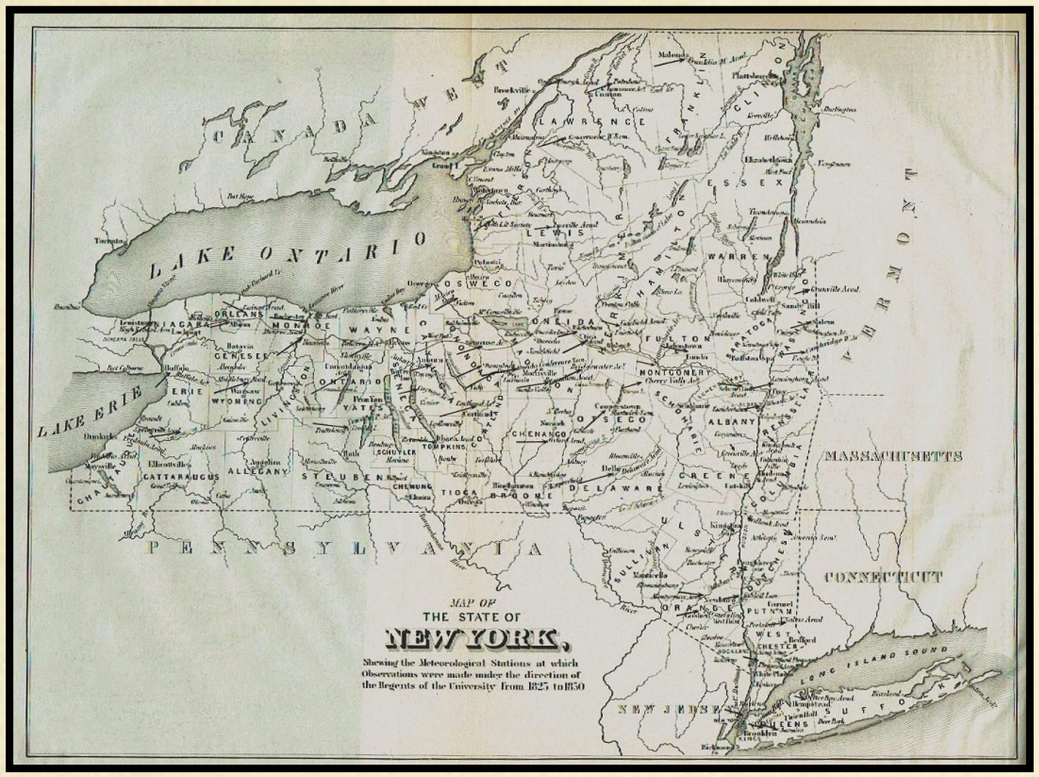
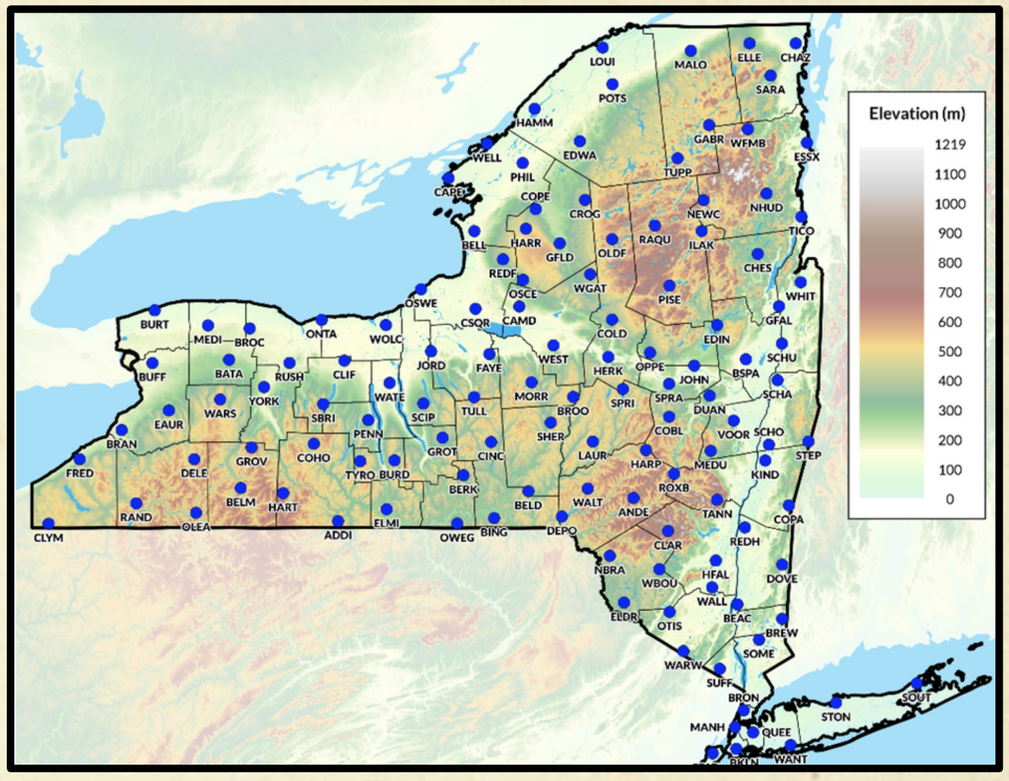
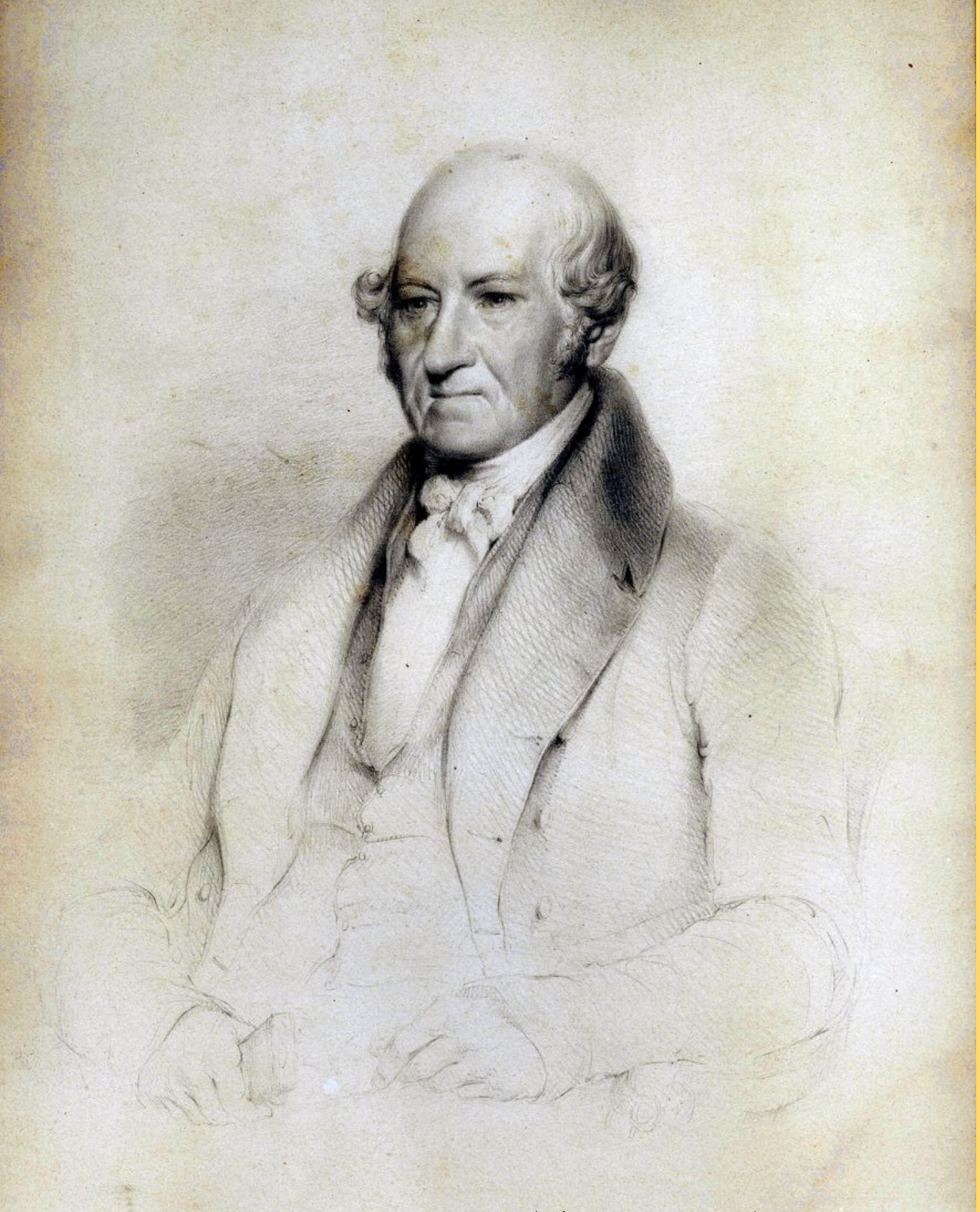
A 200-year-old Database for Climate Change Study from Archives of the New York Academy System: New York State's (and the World's) First Mesonet 1826-1872





Conrad Vispo PhD & Anna Duhon MA *Hawthorne Valley Farmscape Ecology Program*
Anton Seimon PhD *Bard College Center for Environmental Policy*
Kerissa Fuccillo Battle PhD *Community Greenways Collaborative, Inc*

25th NROW meeting, Albany NY
14 November 2024



Simeon DeWitt (1756-1834)
By M.E.D. Brown,
www.albanyinstitute.org

Nearly 200 years ago in this very city, Simeon DeWitt, then vice-chancellor of the New York State Board of Regents, bequeathed us both a treasure trove of data and a challenge of analysis.

In an 1825 letter marking the Regents' initiation of a NY meteorological and phenological network that would span some 70 academies and two and half decades, he wrote,

77

SIR

I take the liberty to inclose to you the proceedings instituted under the authority of the University of the State of New-York, for obtaining such meteorological observations, to be made in a uniform manner in different parts of our territory, as will furnish materials for composing a general statement, showing the comparative characters of our climates and the phenomena of our seasons. In doing this, I indulge the hope that, within the sphere of your influence, you will feel disposed to use that influence in seconding our views. The usefulness of the information thus intended to be acquired, is universally admitted, and is indeed too obvious to need any illustration, especially with gentlemen so capable of appreciating it as you are. We have nearly fifty academies, besides six colleges, under the patronage of our government, spread over the state from the Atlantic Ocean to Lake Erie and the river St. Lawrence. From these we shall have regular reports of their observations, a summary of which will be annually published with the journals of the legislature, and will thus be preserved probably for ages, among our most important public documents, whereby future generations will be enabled, at any period hereafter, however remote, to ascertain what changes time may have produced in our climates. This may be deemed deserving of some consideration in addition to the immediate practical uses which the philosopher, the physician, and the agriculturalist may draw from a mass of information thus accumulated.

I have long considered the practice, to which custom has given a sanction, for ascertaining mean temperatures, as materially defective. I have therefore availed myself of the opportunity offered by the present occasion, to draught such rules for the purpose as appeared to me the least exceptionable. Should they be viewed by others in the same light, no objections against their being generally adopted can outweigh the advantages to be derived from a uniform practice for the attainment of the common end, contemplated by all who engage in such undertakings.

I am, respectfully,
Your obed't. humble serv't.

Albany, Nov. 24. 1825

S. DeWitt

To John Vaughan Esquire

665

”From these [i.e., from the statewide network of participating academies] we shall have regular reports of their observations, a summary of which will be annually published with the journals of the legislature, and will thus be preserved probably for ages, among our most important public documents, whereby future generations will be enabled, at any period hereafter, however remote, to ascertain what changes time may have produced in our climates.”

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To John Vaughan Esquire

665

This talk:

- Simeon DeWitt and his times
- The extent and constraints of the data we have inherited
- Fruitful paths for its use in the context of modern climate change

77

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S. DeWitt

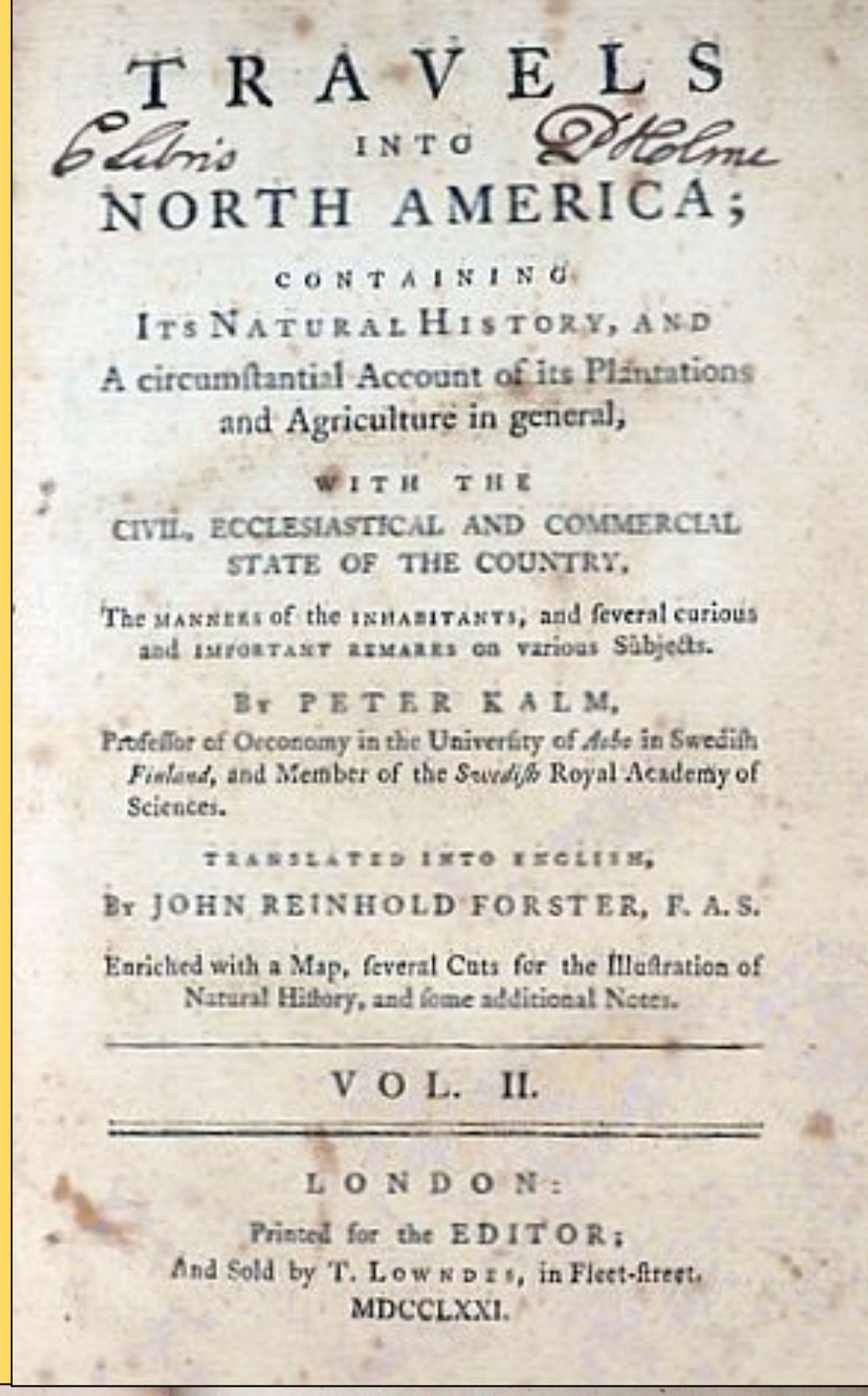
To John Vaughan Esquire

665

To what degree is NYS Mesonet both the honored descendent of DeWitt's efforts and the key to answering his implicit challenge?

<u>Climate was one focus of interest</u> in the late 1700s and early 1800s. There were various reasons for this, including:

- Advice (propaganda) to European colonists.
- Concern and curiosity about climate change.
- The relationship between human health and climate.
- Climatic effects on agriculture and life in general.
- Curiosity about how the W



TRAVELS
Kalm's INTO Holme's
NORTH AMERICA;

CONTAINING
ITS NATURAL HISTORY, AND
A circumſtantial Account of its Plantations and Agriculture in general,
WITH THE
CIVIL, ECCLESIASTICAL AND COMMERCIAL STATE OF THE COUNTRY,
The MANNERS of the INHABITANTS, and ſeveral curious and IMPORTANT REMARKS on various Subjects.

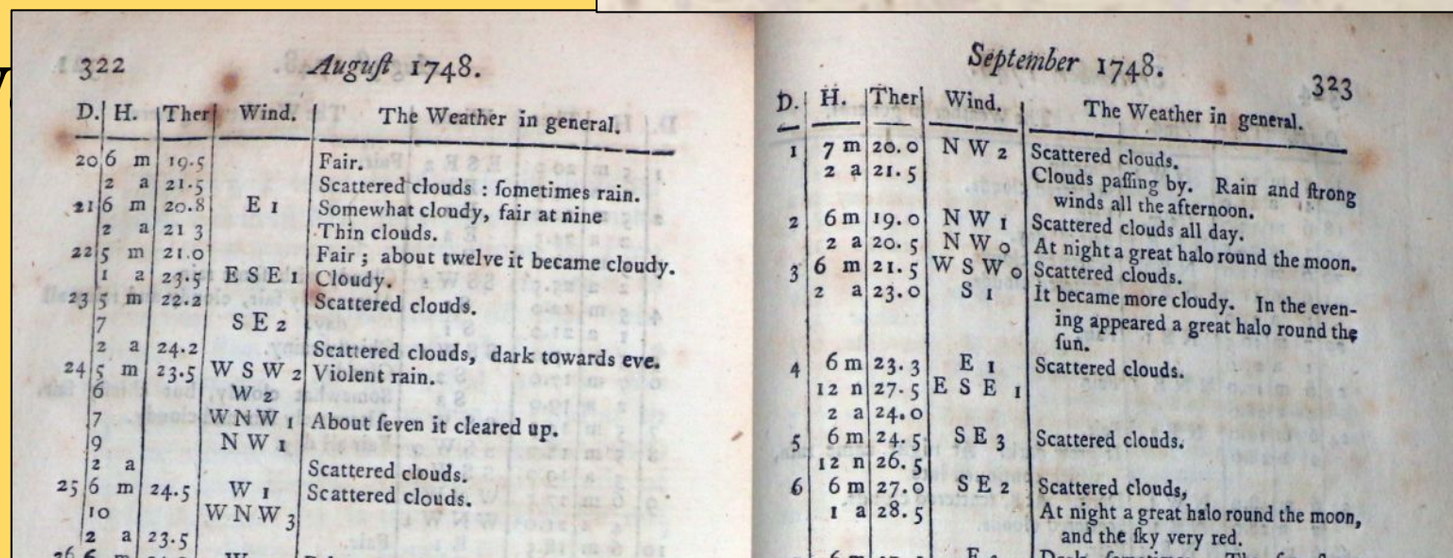
BY PETER KALM,
Profeſſor of Oeconomy in the Univerſity of *Abo* in Swediſh *Finland*, and Member of the *Swediſh* Royal Academy of Sciences.

TRANSLATED INTO ENGLISH,
BY JOHN REINHOLD FORSTER, F. A. S.

Enriched with a Map, ſeveral Cuts for the Illuſtration of Natural Hiſtory, and ſome additional Notes.

VOL. II.

LONDON:
Printed for the EDITOR;
And Sold by T. LOWNDES, in Fleet-ſtreet.
MDCCLXXI.



322 *Auguſt* 1748.

D.	H.	Ther	Wind.	The Weather in general.
20	6 m	19.5		Fair.
	2 a	21.5		Scattered clouds : ſometimes rain.
21	6 m	20.8	E 1	Somewhat cloudy, fair at nine
	2 a	21 3		Thin clouds.
22	5 m	21.0		Fair ; about twelve it became cloudy.
	1 a	23.5	E S E 1	Cloudy.
23	5 m	22.2		Scattered clouds.
	7		S E 2	
	2 a	24.2		Scattered clouds, dark towards eve.
24	5 m	23.5	W S W 2	Violent rain.
	6		W 2	
	7		W N W 1	About ſeven it cleared up.
	9		N W 1	
	2 a			Scattered clouds.
25	6 m	24.5	W 1	Scattered clouds.
	10		W N W 3	
	2 a	23.5		

September 1748. 323

D.	H.	Ther	Wind.	The Weather in general.
1	7 m	20.0	N W 2	Scattered clouds.
	2 a	21.5		Clouds paſſing by. Rain and ſtrong winds all the afternoon.
2	6 m	19.0	N W 1	Scattered clouds all day.
	2 a	20.5	N W 0	At night a great halo round the moon.
3	6 m	21.5	W S W 0	Scattered clouds.
	2 a	23.0	S 1	It became more cloudy. In the evening appeared a great halo round the ſun.
4	6 m	23.3	E 1	Scattered clouds.
	12 n	27.5	E S E 1	
	2 a	24.0		
5	6 m	24.5	S E 3	Scattered clouds.
	12 n	26.5		
6	6 m	27.0	S E 2	Scattered clouds,
	1 a	28.5		At night a great halo round the moon, and the ſky very red.

Meteorological records collected by Peter Kalm during is mid-18th century

In 1792, DeWitt proposed **the creation of a nationwide network** to gather temperature and phenological information.

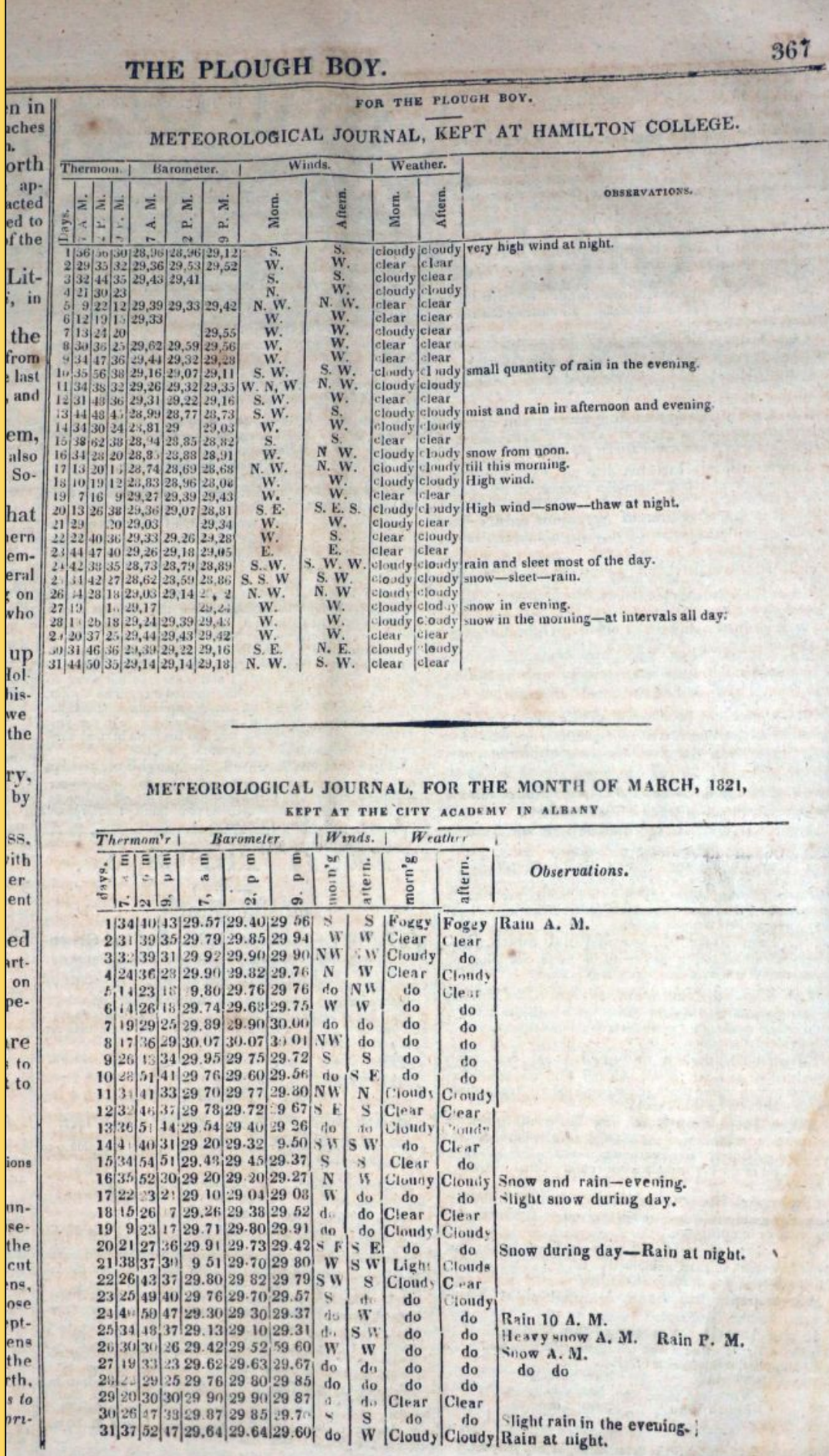
It would be more than 25 years before he could begin to realize his dream.

DeWitt's proposed meteorological & phenological chart of 1792.

In the early 19th century, the value of simultaneous measurements from multiple geographic locations was recognized.

While often small-scale/short-lived, these efforts highlighted **methodological challenges** the Regents considered:

- The availability of standardized meteorological equipment.
- The timing and number of temperature readings (in an era without data loggers).
- Where & how to locate meteorological equipment.



THE PLOUGH BOY. 367

FOR THE PLOUGH BOY.

METEOROLOGICAL JOURNAL, KEPT AT HAMILTON COLLEGE.

Days.	Thermom. 7 A. M.	Thermom. 2 P. M.	Thermom. 9 P. M.	Barometer. 7 A. M.	Barometer. 2 P. M.	Barometer. 9 P. M.	Winds. Morn.	Winds. Aftern.	Weather. Morn.	Weather. Aftern.	OBSERVATIONS.
1	36	50	30	28,96	28,96	29,12	S.	S.	cloudy	cloudy	very high wind at night.
2	29	35	32	29,36	29,53	29,52	W.	W.	clear	clear	
3	32	44	35	29,43	29,41		S.	S.	cloudy	clear	
4	21	30	23				N.	W.	cloudy	cloudy	
5	9	22	12	29,39	29,33	29,42	N. W.	N. W.	clear	clear	
6	12	19	15	29,33			W.	W.	clear	clear	
7	13	24	20			29,55	W.	W.	cloudy	clear	
8	30	36	25	29,62	29,59	29,56	W.	W.	clear	clear	
9	34	47	36	29,44	29,32	29,28	W.	W.	clear	clear	
10	35	56	38	29,16	29,07	29,11	S. W.	S. W.	cloudy	cloudy	small quantity of rain in the evening.
11	34	38	32	29,26	29,32	29,35	W. N. W	N. W.	cloudy	cloudy	
12	31	48	36	29,31	29,22	29,16	S. W.	W.	clear	clear	
13	44	48	45	28,99	28,77	28,73	S. W.	S.	cloudy	cloudy	mist and rain in afternoon and evening.
14	34	30	24	28,81	29	29,03	W.	W.	cloudy	cloudy	
15	38	62	38	28,94	28,85	28,82	S.	S.	clear	clear	
16	34	28	20	28,80	28,88	28,91	W.	N. W.	cloudy	cloudy	snow from noon.
17	13	20	15	28,74	28,69	28,68	N. W.	N. W.	cloudy	cloudy	till this morning.
18	10	19	12	28,83	28,96	28,06	W.	W.	cloudy	cloudy	High wind.
19	7	16	9	29,27	29,39	29,43	W.	W.	clear	clear	
20	13	26	38	29,36	29,07	28,81	S. E.	S. E. S.	cloudy	cloudy	High wind—snow—thaw at night.
21	29		20	29,03		29,34	W.	W.	cloudy	clear	
22	22	40	36	29,33	29,26	29,28	W.	S.	clear	cloudy	
23	44	47	40	29,26	29,18	29,05	E.	E.	clear	clear	
24	42	38	35	28,73	28,79	28,89	S. W.	S. W. W.	cloudy	cloudy	rain and sleet most of the day.
25	31	42	27	28,62	28,59	28,86	S. S. W	S. W.	cloudy	cloudy	snow—sleet—rain.
26	24	28	18	29,03	29,14	29,2	N. W.	N. W	cloudy	cloudy	
27	19		16	29,17		29,24	W.	W.	cloudy	cloudy	snow in evening.
28	14	26	18	29,24	29,39	29,43	W.	W.	cloudy	cloudy	snow in the morning—at intervals all day.
29	20	37	25	29,44	29,43	29,42	W.	W.	clear	clear	
30	31	46	36	29,39	29,22	29,16	S. E.	N. E.	cloudy	cloudy	
31	44	50	35	29,14	29,14	29,18	N. W.	S. W.	clear	clear	

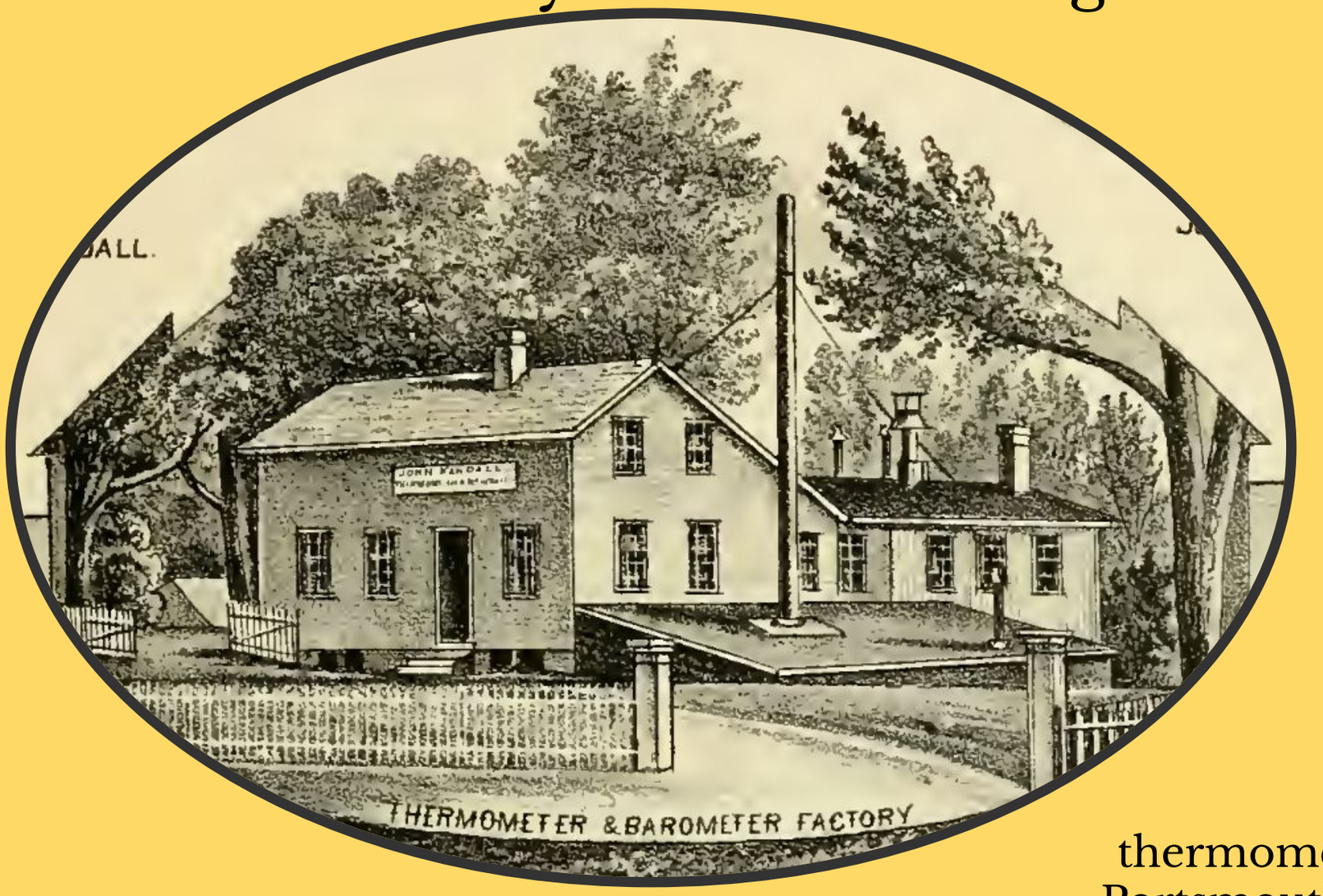
METEOROLOGICAL JOURNAL, FOR THE MONTH OF MARCH, 1821,

KEPT AT THE CITY ACADEMY IN ALBANY.

days.	Thermom'r 7 a m	Thermom'r 2 p m	Thermom'r 9 p m	Barometer 7 a m	Barometer 2 p m	Barometer 9 p m	Winds. morn'g	Winds. aftern.	Weather morn'g	Weather aftern.	Observations.
1	34	40	43	29.57	29.40	29 56	S	S	Foggy	Foggy	Rain A. M.
2	31	39	35	29 79	29.85	29 94	W	W	Clear	Clear	
3	32	39	31	29 92	29.90	29 90	NW	W	Cloudy	do	
4	24	36	28	29.90	29.82	29.76	N	W	Clear	Cloudy	
5	14	23	18	29.80	29.76	29 76	do	NW	do	Clear	
6	14	26	18	29.74	29.68	29.75	W	W	do	do	
7	19	29	25	29.89	29.90	30.00	do	do	do	do	
8	17	36	29	30.07	30.07	30 01	NW	do	do	do	
9	26	18	34	29.95	29 75	29.72	S	S	do	do	
10	28	51	41	29 76	29.60	29.56	do	S E	do	do	
11	31	41	33	29 70	29 77	29.80	NW	N	Cloudy	Cloudy	
12	32	46	37	29 78	29.72	29 67	S E	S	Clear	Clear	
13	36	51	44	29.54	29 40	29 26	do	do	Cloudy	Cloudy	
14	4	40	31	29 20	29.32	9.50	S W	S W	do	Clear	
15	34	54	51	29.48	29 45	29.37	S	S	Clear	do	
16	35	52	30	29 20	29 20	29.27	N	W	Cloudy	Cloudy	Snow and rain—evening.
17	22	23	21	29 10	29 04	29 08	W	do	do	do	Slight snow during day.
18	15	26	7	29.26	29 38	29 52	do	do	Clear	Clear	
19	9	23	17	29.71	29.80	29.91	do	do	Cloudy	Cloudy	
20	21	27	36	29 91	29.73	29.42	S E	S E	do	do	Snow during day—Rain at night.
21	38	37	30	9 51	29.70	29 80	W	S W	Light	Clouds	
22	26	43	37	29.80	29 82	29 79	S W	S	Cloudy	Clear	
23	25	49	40	29 76	29.70	29.57	S	do	do	Cloudy	
24	40	50	47	29.30	29 30	29.37	do	W	do	do	Rain 10 A. M.
25	34	48	37	29.13	29 10	29.31	do	S W	do	do	Heavy snow A. M. Rain P. M.
26	30	30	26	29.42	29 52	59 60	W	W	do	do	Snow A. M.
27	19	33	23	29.62	29.63	29.67	do	do	do	do	do do
28	23	29	25	29 76	29 80	29 85	do	do	do	do	
29	20	30	30	29 90	29 90	29 87	do	do	Clear	Clear	
30	26	47	33	29.87	29 85	29.70	S	S	do	do	Slight rain in the evening.
31	37	52	47	29.64	29.64	29.60	do	W	Cloudy	Cloudy	Rain at night.

While still a challenge, **the economic and standardized production of meteorological equipment** was becoming a reality.

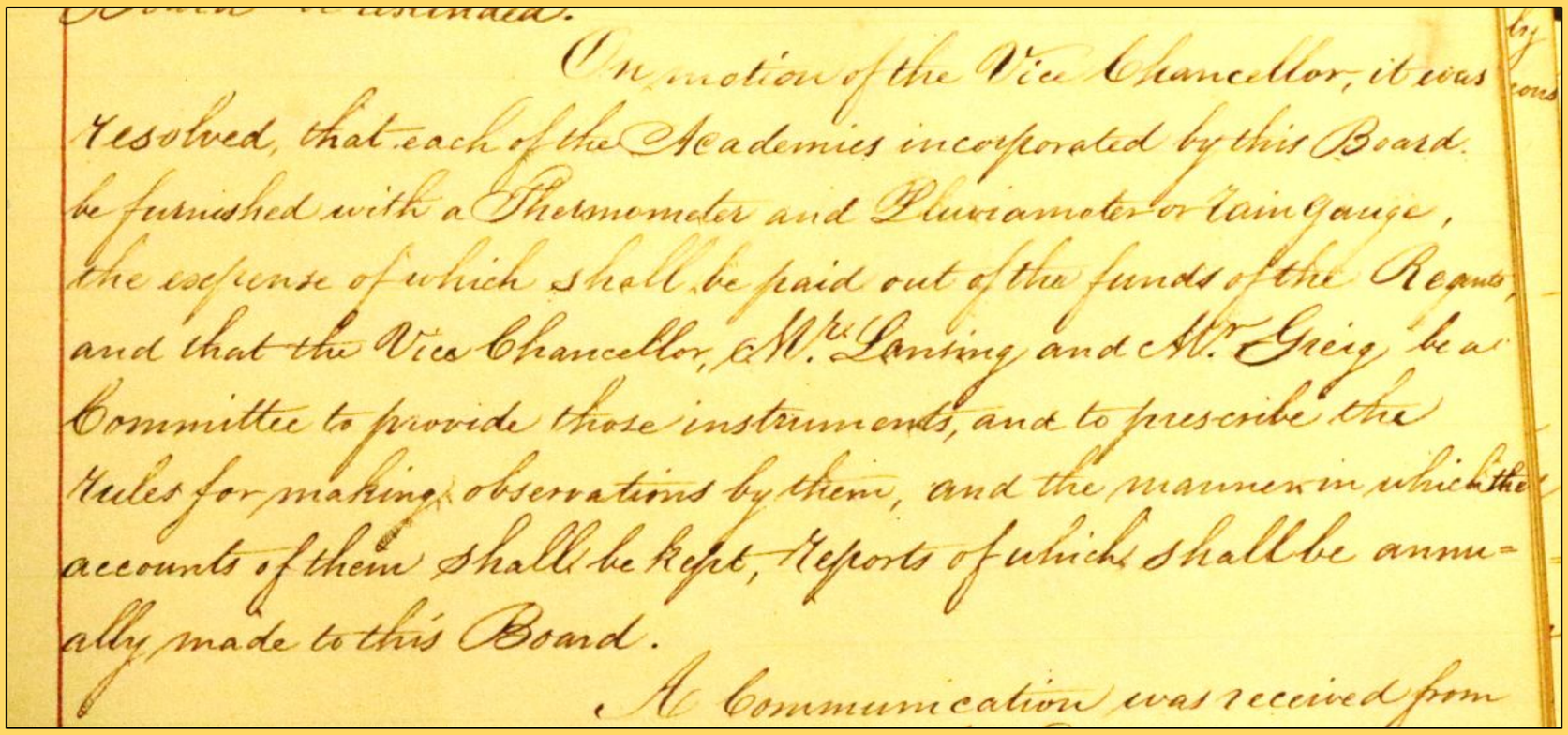
The expertly calibrated thermometers by Thomas Kendall of New Lebanon NY would be a key tool for the Regents.



A ca. 1828 Kendall thermometer, courtesy of the Portsmouth (ME) Antheneum.

<u>In March of 1825, the Regents established that a [Kendall] thermometer, a rain gauge & instructions would be provided to each Academy</u> and that reports would be expected.

Later that year, a second resolution put teeth in that measure by tying compliance with funding.



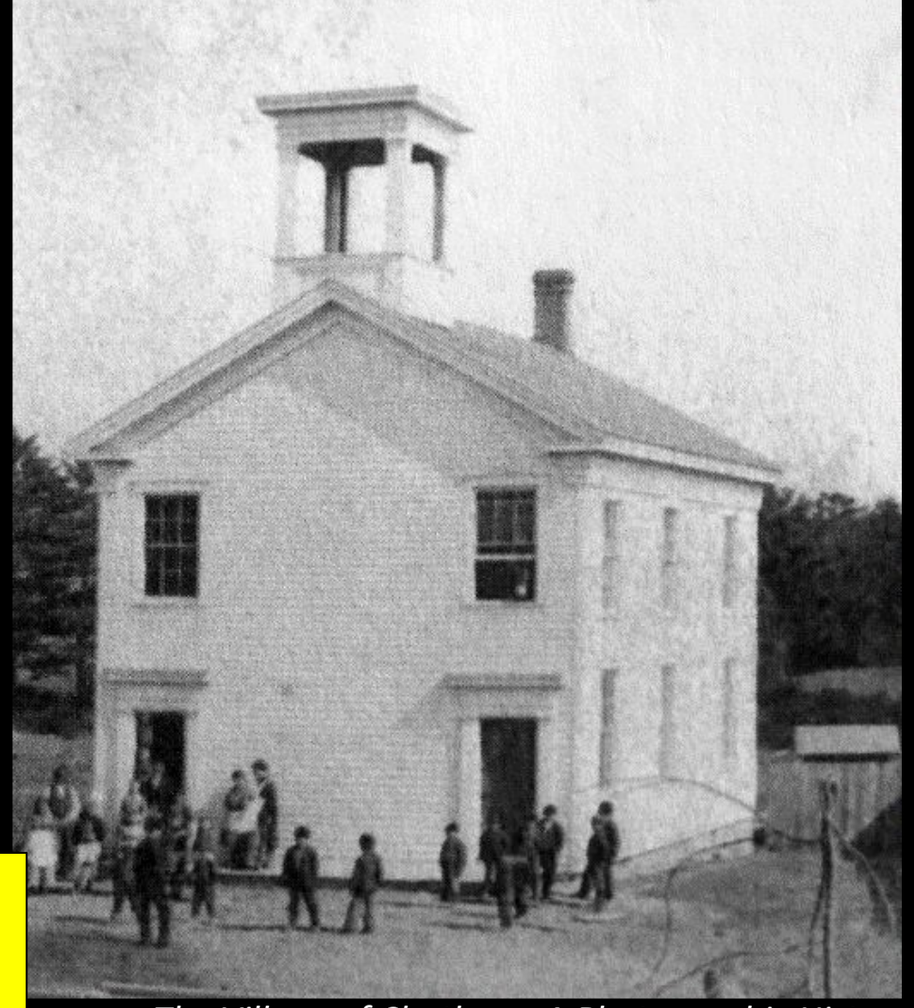
On motion of the Vice Chancellor, it was
Resolved, that each of the Academies incorporated by this Board
be furnished with a Thermometer and Pluviameter or rain Gauge,
the expense of which shall be paid out of the funds of the Regents,
and that the Vice Chancellor, Mr. Lansing and Mr. Greig be a
Committee to provide those instruments, and to prescribe the
Rules for making observations by them, and the manner in which the
accounts of them shall be kept, Reports of which shall be annu-
ally made to this Board.
A Communication was received from

The original motion as it appears in the minutes of the Regents.

The Academy and Boarding Home, 1855

From an engraving by Howland

The Academi



The Village of Chatham: A Photographic History

spencertownacademy.org

Historic Hudson

With that, the Academies network was off and running. Academies were instructed to:

- **Place thermometers in a grass-covered place where there was free air circulation and the absence of direct sunlight** or radiation from “neighboring bodies”.

- **Place rain gauge at least as far from any object as that object’s height**.

- **Take temperature measurements at three times daily**: in the “morning, when it shows the lowest degree, every afternoon when it shows the highest degree, and every evening an hour after sunset”.

- **Record rain gauge measurements “as often as necessary;** at least before the gage is quite filled, and at all events at the end of every month”.

- **Record wind direction, weather (cloudy/fair, rain/snow/mix),**

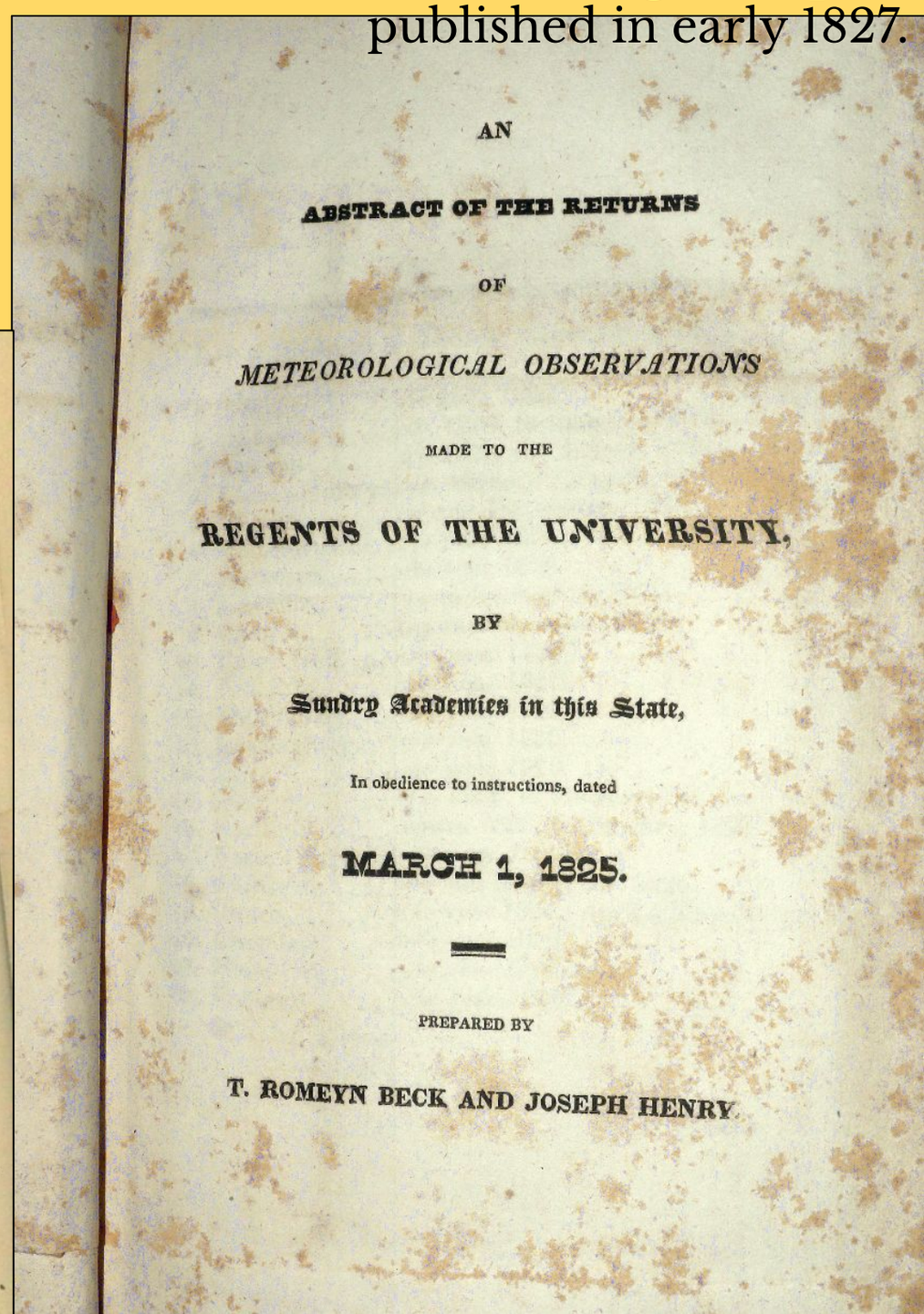
<u>These techniques and instructions largely persisted through the early years of the network</u> <u>(i.e., until ca. 1850)</u> except for the substitution, after experimentation, of the DeWitt conical rain gauge in 1834.

Replica of first Regents rain gauge; Smithsonian

Our replica of a DeWitt conical rain

As DeWitt's initial letter mentioned, **the returns were summarized & published in the Annual Reports of the Regents.**

The first annual meteorological report published in early 1827.



AN

ABSTRACT OF THE RETURNS

OF

METEOROLOGICAL OBSERVATIONS

MADE TO THE

REGENTS OF THE UNIVERSITY,

BY

Sundry Academies in this State,

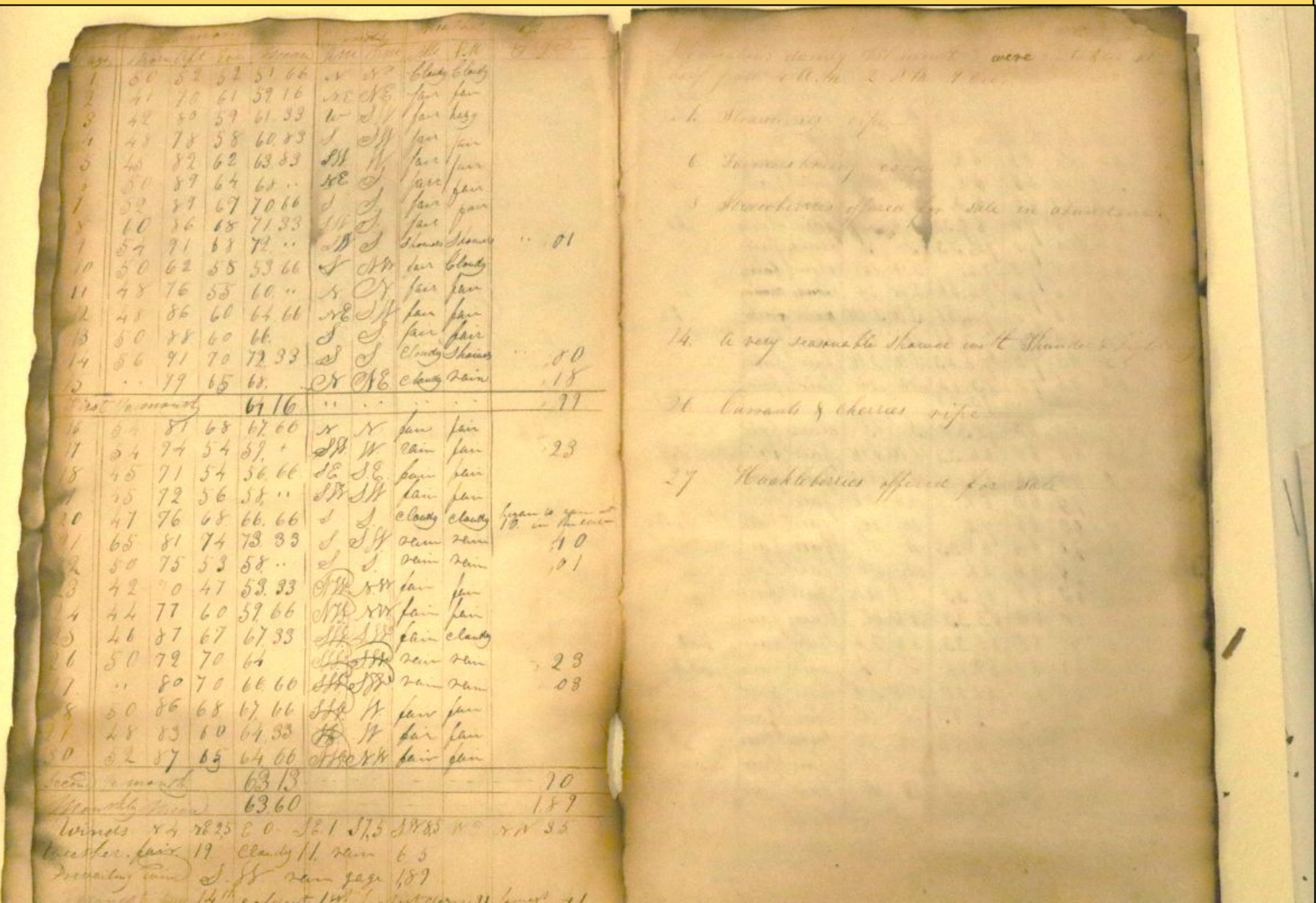
In obedience to instructions, dated

MARCH 1, 1825.

PREPARED BY

T. ROMEYN BECK AND JOSEPH HENRY.

An original 1826 return from one of the academies.



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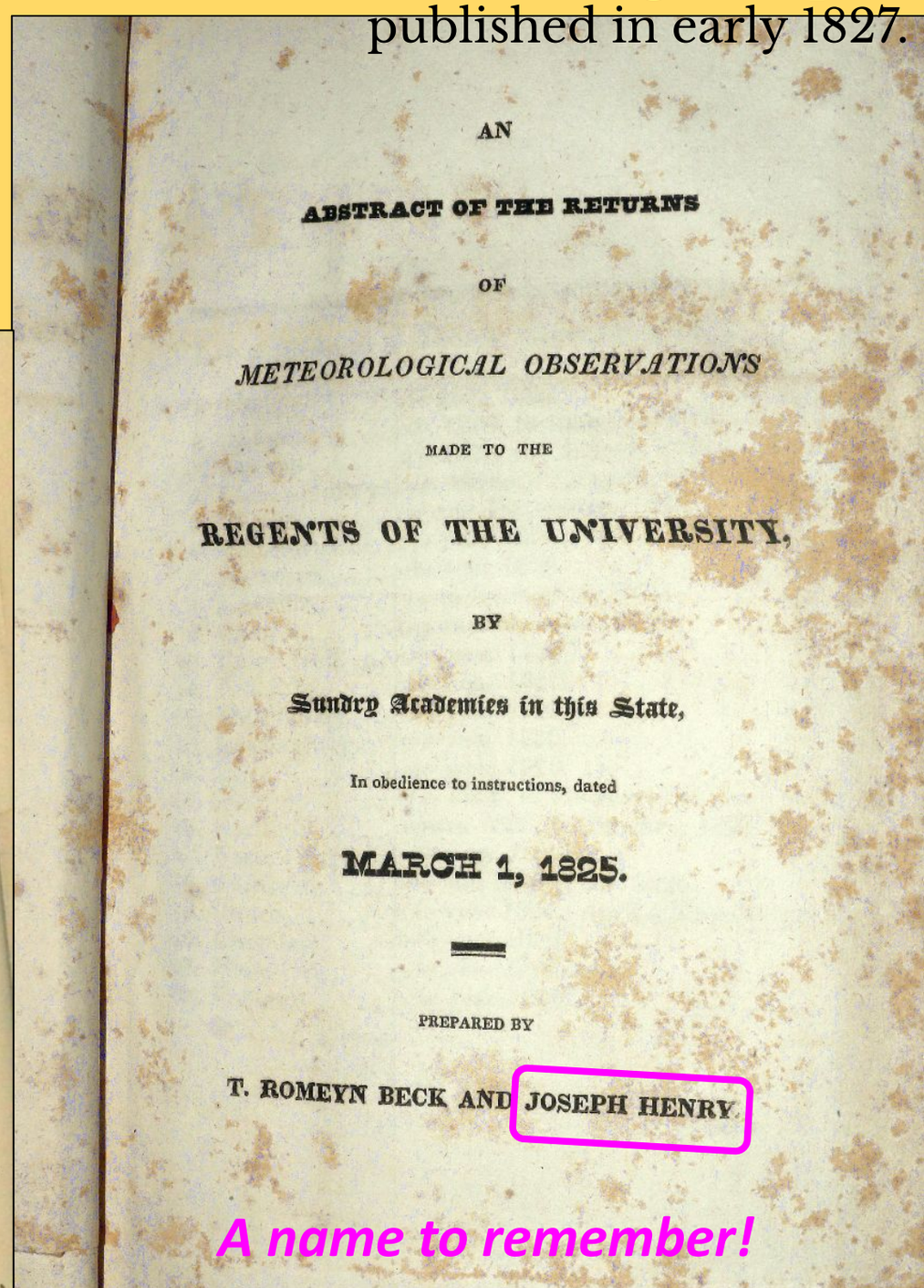

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A name to remember!

An original 1826 return from one of the academies.

In the Spring before his death, Simeon DeWitt wrote in his last report as Chancellor,

The example set by our State, it is hoped, will be ultimately followed by every state in the Union; and when that shall be consummated ...[will be] without a parallel in any other part of the world, in relation to this department of universal knowledge.

28 February 1834

What were the data that DeWitt & his colleagues left us, and what, given the establishment of the NYS Mesonet, can we do with them?

By Ezra Ames,

Academy Network: Two Periods

Period 1

Period 2

1826

1849

1850

1863

1872

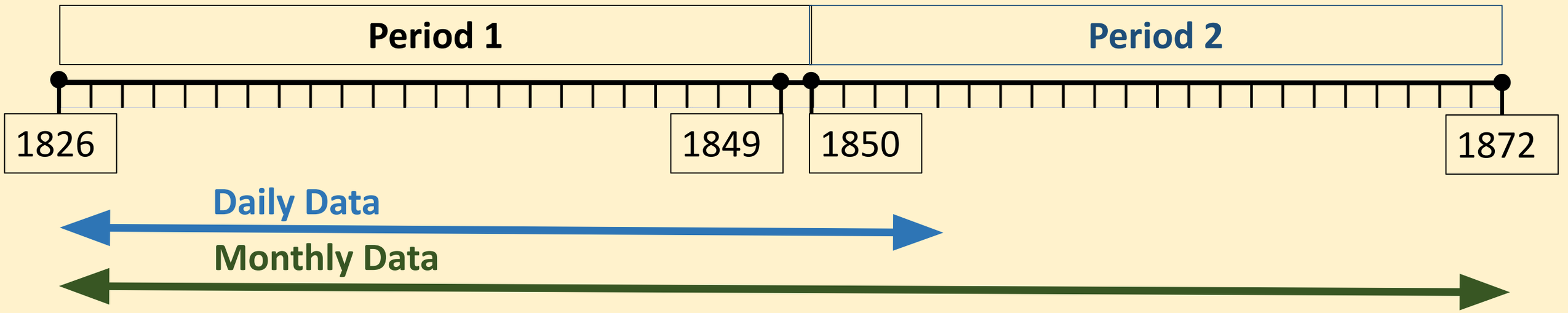
New protocols

Regents stop payments to academies (Civil War)

- Regents decide to revamp network
- Align with emerging national Smithsonian Institute network in conference with **Joseph Henry**
- **Arnold Guyot** selects and begins delivering equipment to academies

Photograph of Joseph Henry, Library of Congress

Academy Network: Two Periods

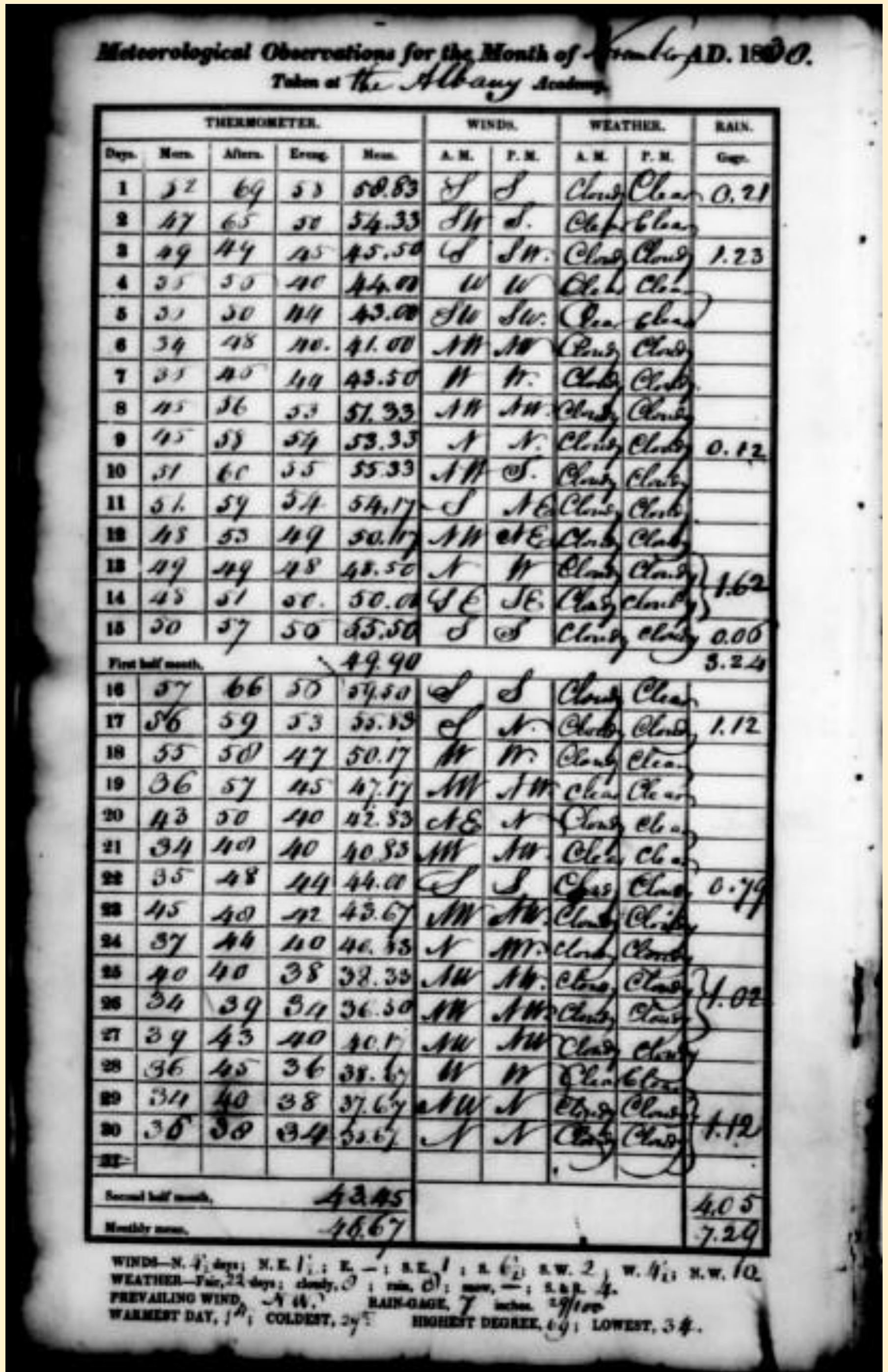


- **Weather Observations**
  - Thermometer (3x/day)
  - Rain Gauge (daily or event level)
  - Weather Direction
- **Initial Standardized Instructions**

- **Expanded Observations**
  - Synchronous temperatures
    6am - 2pm - 10pm
  - Max and min thermometers
  - Barometer
  - Psychrometer
  - Rain Gauge
  - Snow Gauge
  - Weather Vane
- **Expanded Instructions and Registers**
- **New Stations**

Academy Network: Two Protocols

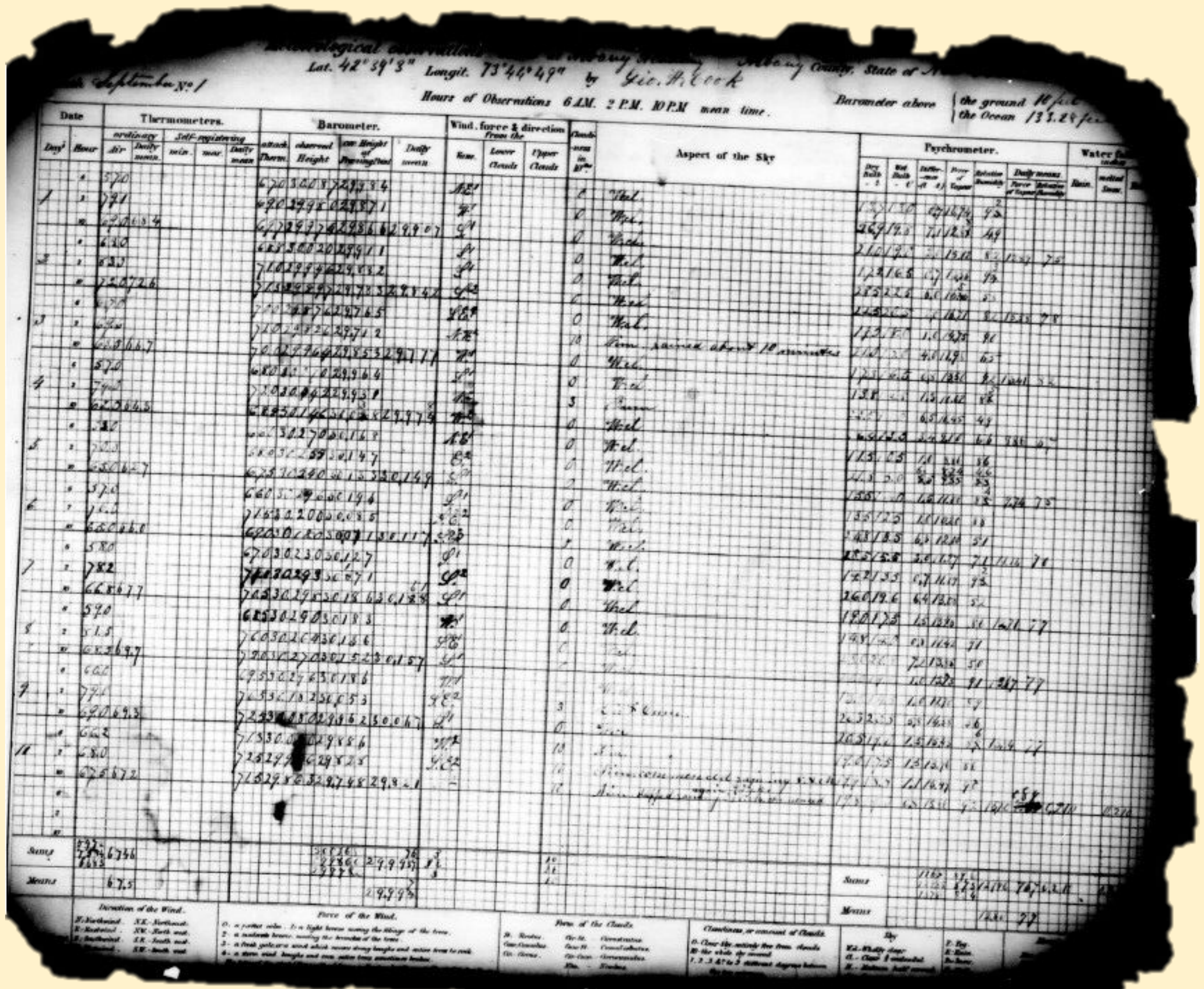
Period 1	Period 2
1826 – 1849	1850 – 1872



Meteorological Observations for the Month of November **A.D. 1830.**
Taken at the Albany **Academy.**

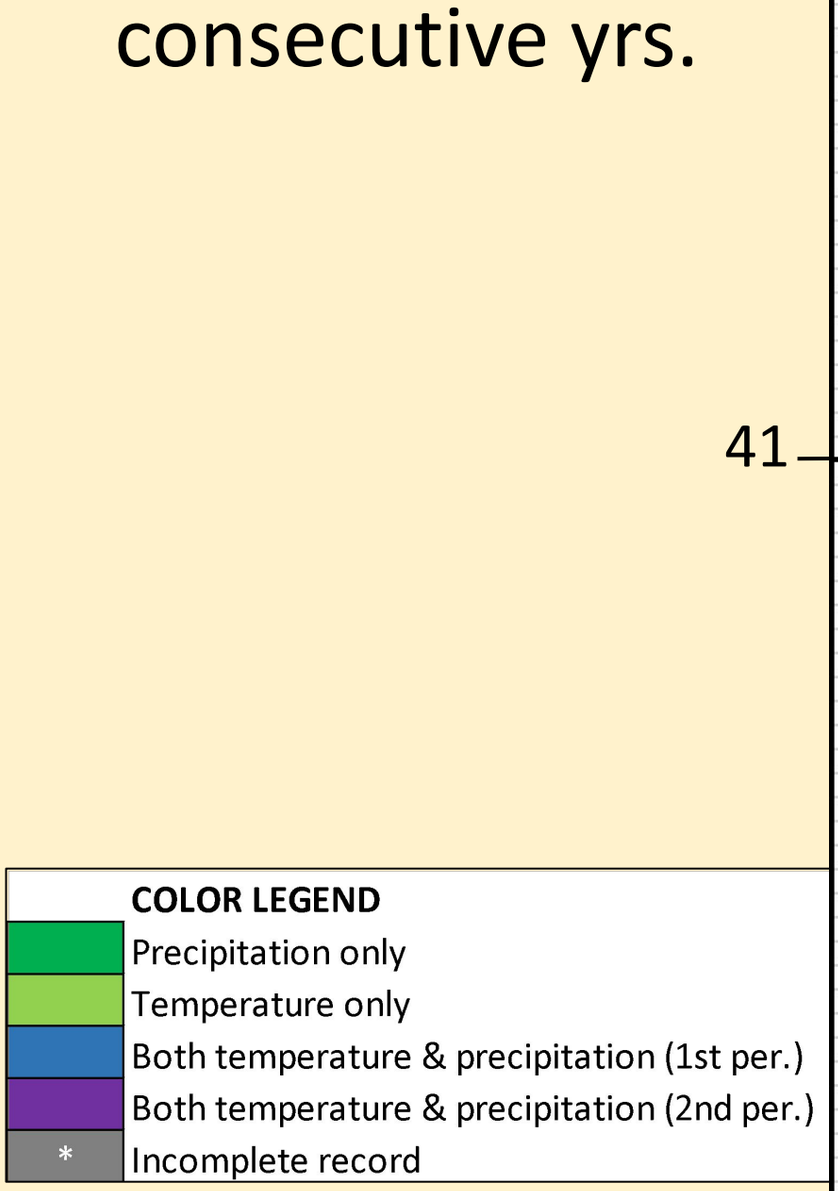
	THERMOMETER.				WINDS.		WEATHER.		RAIN.
Days.	Morn.	Aftern.	Even'g.	Mean.	A.M.	P.M.	A.M.	P.M.	Gage.
1	52	69	53	58.83	S	S	Cloudy	Clear	0.21
2	47	65	51	54.33	SW	S.	Clear	Clear	
3	49	44	45	45.50	S	SW.	Cloudy	Cloudy	1.23
4	35	55	40	44.00	W	W	Clear	Clear	
5	35	50	44	43.00	SW	SW.	Clear	Clear	
6	34	48	40.	41.00	NW	NW	Cloudy	Cloudy	
7	35	45	49	43.50	W	W.	Cloudy	Cloudy	
8	45	56	53	51.33	NW	NW.	Cloudy	Cloudy	
9	45	55	54	53.33	N	N.	Cloudy	Cloudy	0.12
10	51	60	55	55.33	NW	S.	Cloudy	Cloudy	
11	51	59	54	54.17	S	NE	Cloudy	Cloudy	
12	43	53	49	50.17	NW	NE	Cloudy	Cloudy	
13	49	49	48	48.50	N	W	Cloudy	Cloudy	1.62
14	45	51	50.	50.00	SE	SE	Cloudy	Cloudy	
15	50	57	50	55.50	S	S	Cloudy	Cloudy	0.00
First half month.				49.90					3.24
16	57	66	50	59.50	S	S	Cloudy	Clear	
17	56	59	53	55.83	S	N.	Cloudy	Cloudy	1.12
18	55	50	47	50.17	W	W.	Cloudy	Clear	
19	36	57	45	47.17	NW	NW.	Clear	Clear	
20	43	50	40	42.83	NE	N	Cloudy	Clear	
21	34	40	40	40.83	NW	NW.	Clear	Clear	
22	35	48	44	44.00	S	S	Clear	Clear	0.79
23	45	40	42	43.67	NW	NW.	Cloudy	Cloudy	
24	37	44	40	40.33	N	NW.	Cloudy	Cloudy	
25	40	40	38	38.33	NW	NW.	Cloudy	Cloudy	1.02
26	34	39	34	36.50	NW	NW	Cloudy	Cloudy	
27	39	43	40	40.17	NW	NW	Cloudy	Cloudy	
28	36	45	36	38.67	W	W	Clear	Clear	
29	34	40	38	37.67	NW	N	Cloudy	Cloudy	1.12
30	36	38	34	35.67	N	N	Cloudy	Cloudy	
31									
Second half month.				43.45					4.05
Monthly mean.				46.67					7.29

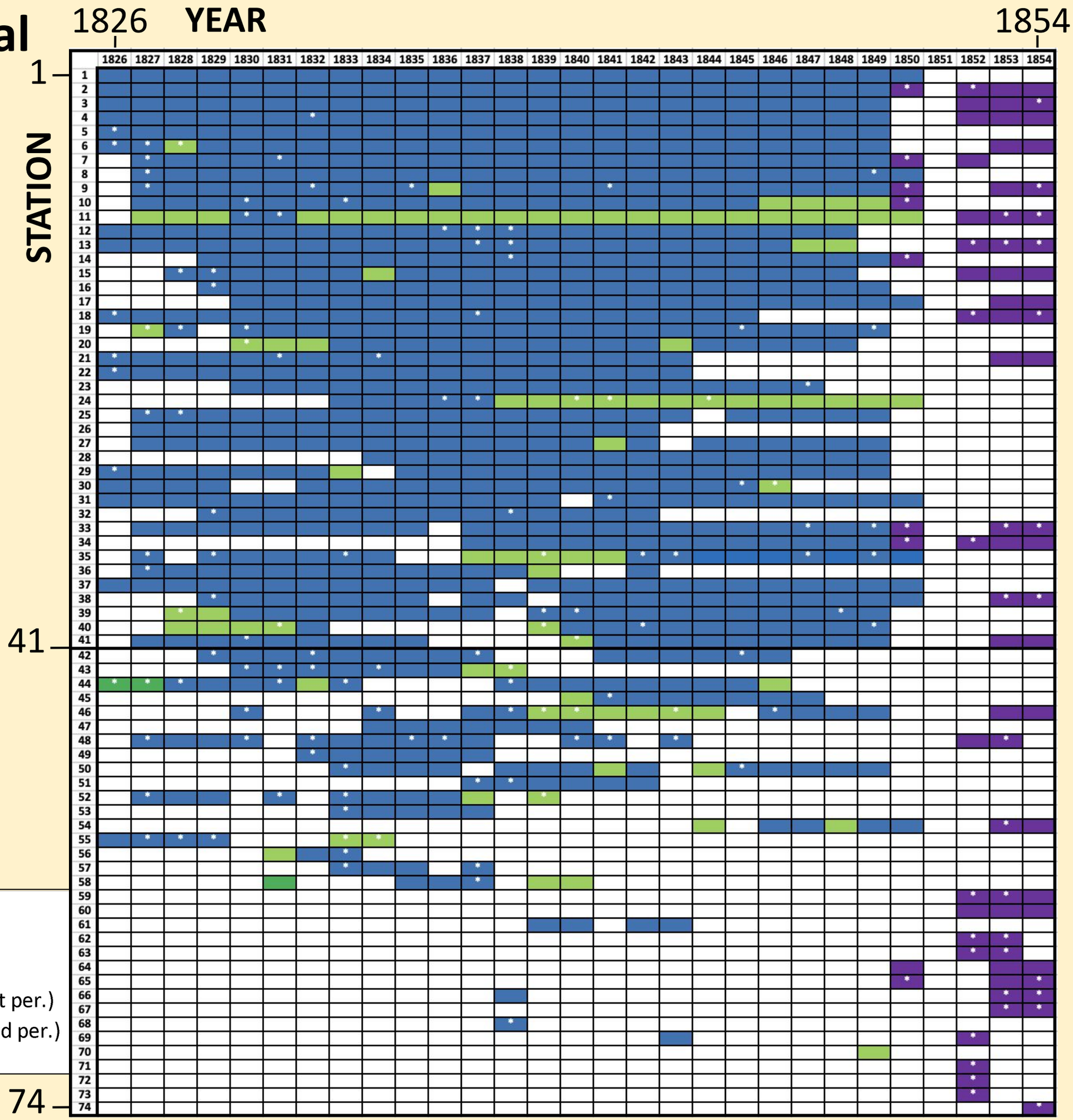
WINDS—N. 4½ days; N.E. 1½; E. —; S.E. 1; S. 6½; S.W. 2; W. 4½; N.W. 10.
WEATHER—Fair, 22 days; cloudy, 8; rain, 8; snow, —; S.&R. 4.
PREVAILING WIND, N.W. RAIN-GAGE, 7 inches. 29/100
WARMEST DAY, 1st; COLDEST, 29th. HIGHEST DEGREE, 69; LOWEST, 34.



Daily Meteorological Data (on microfilm)

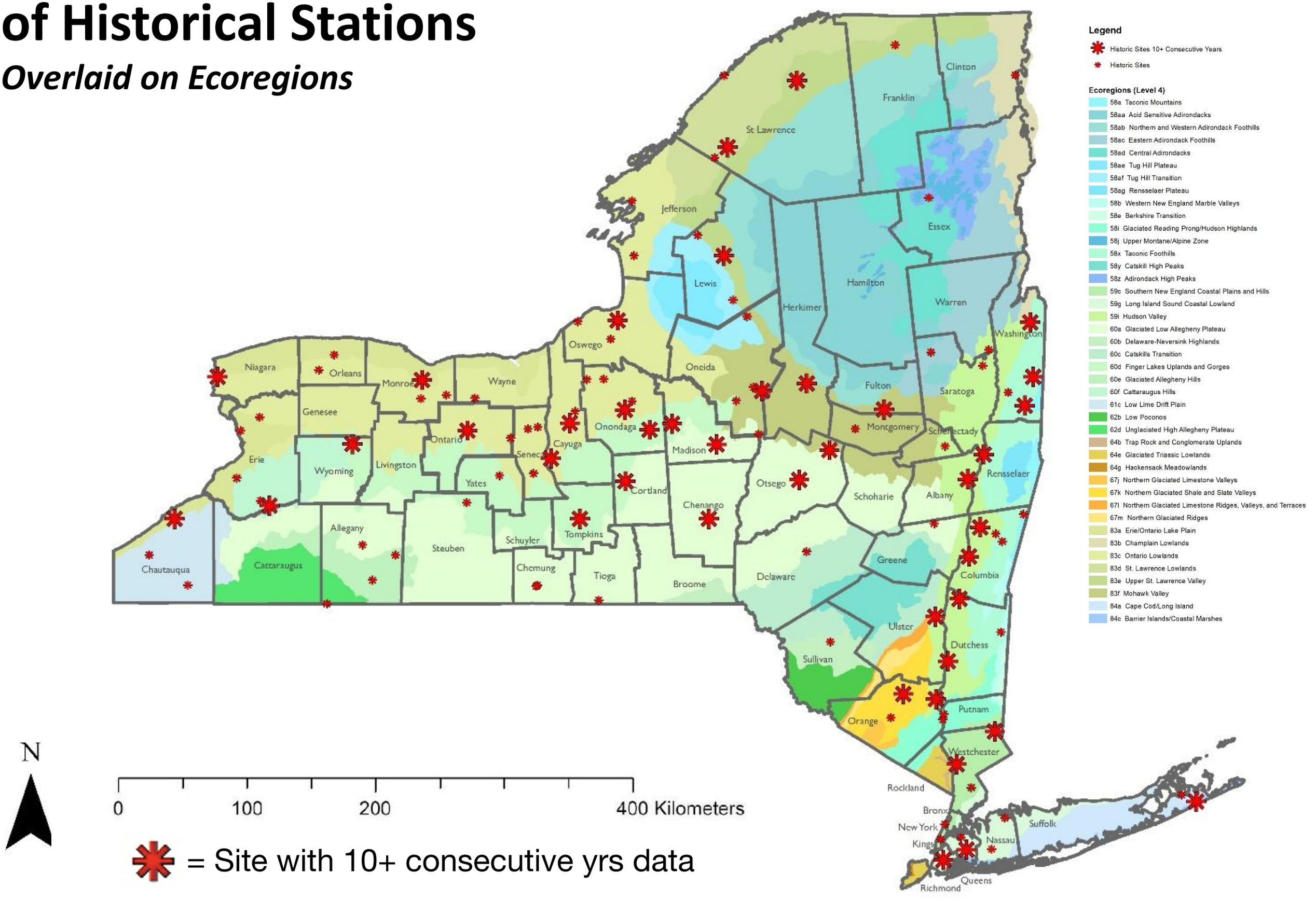
- 74 stations
- 1826-1854
- 41 stations: 10+ consecutive yrs.





Geographic Distribution of Historical Stations

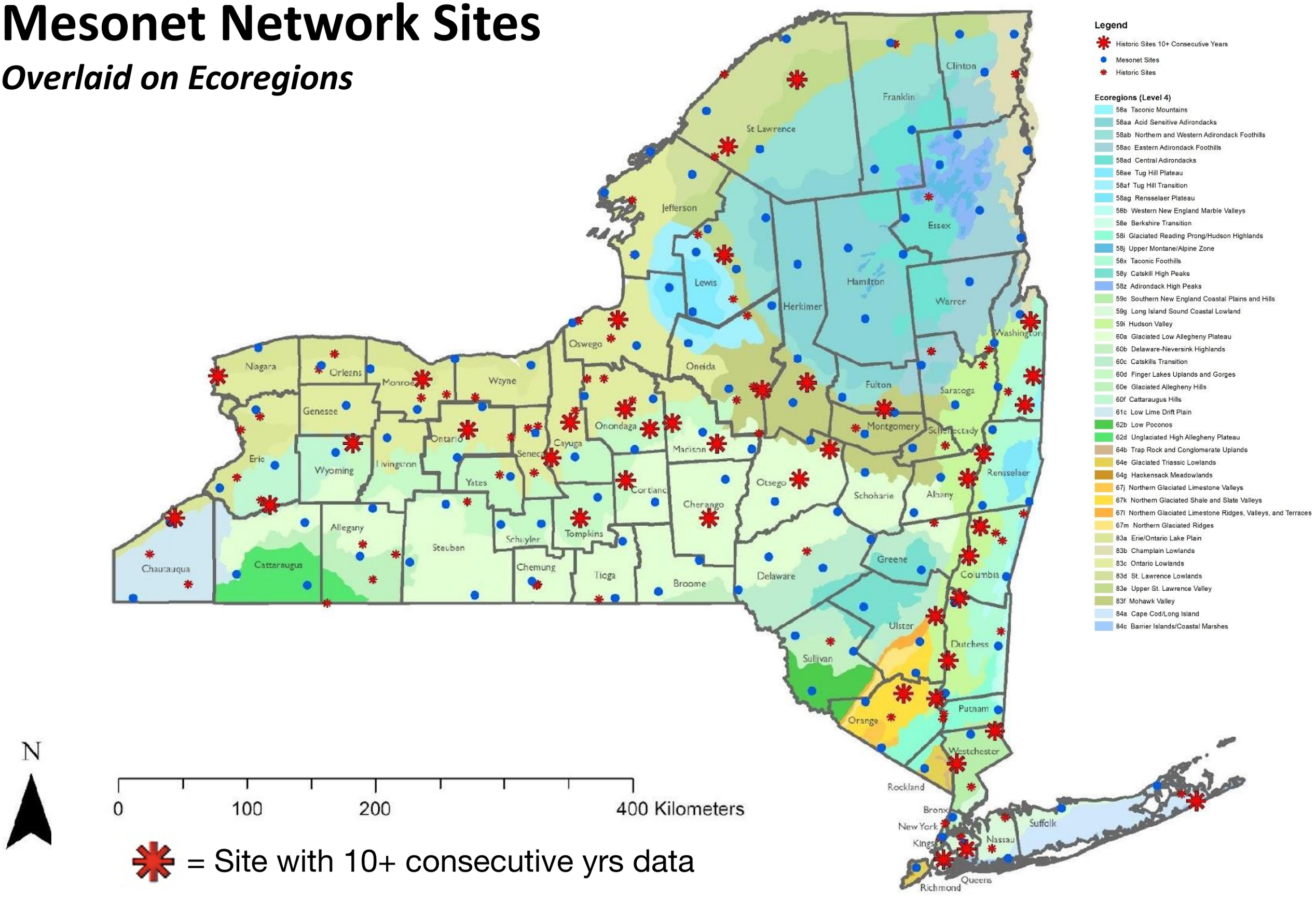
Overlaid on Ecoregions



Academies and NYS

Mesonet Network Sites

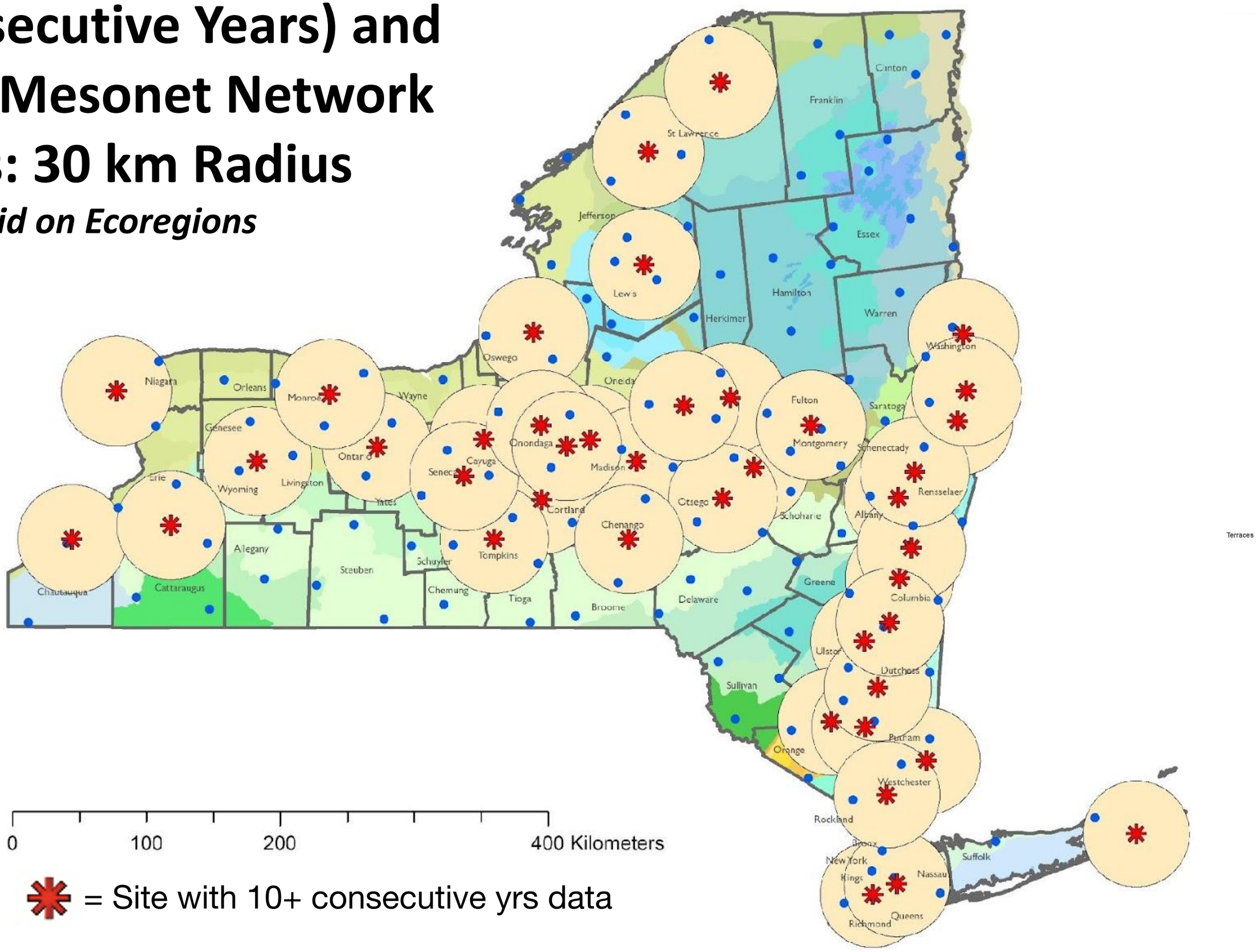
Overlaid on Ecoregions



= Site with 10+ consecutive yrs data

Academies (10+ Consecutive Years) and NYS Mesonet Network Sites: 30 km Radius

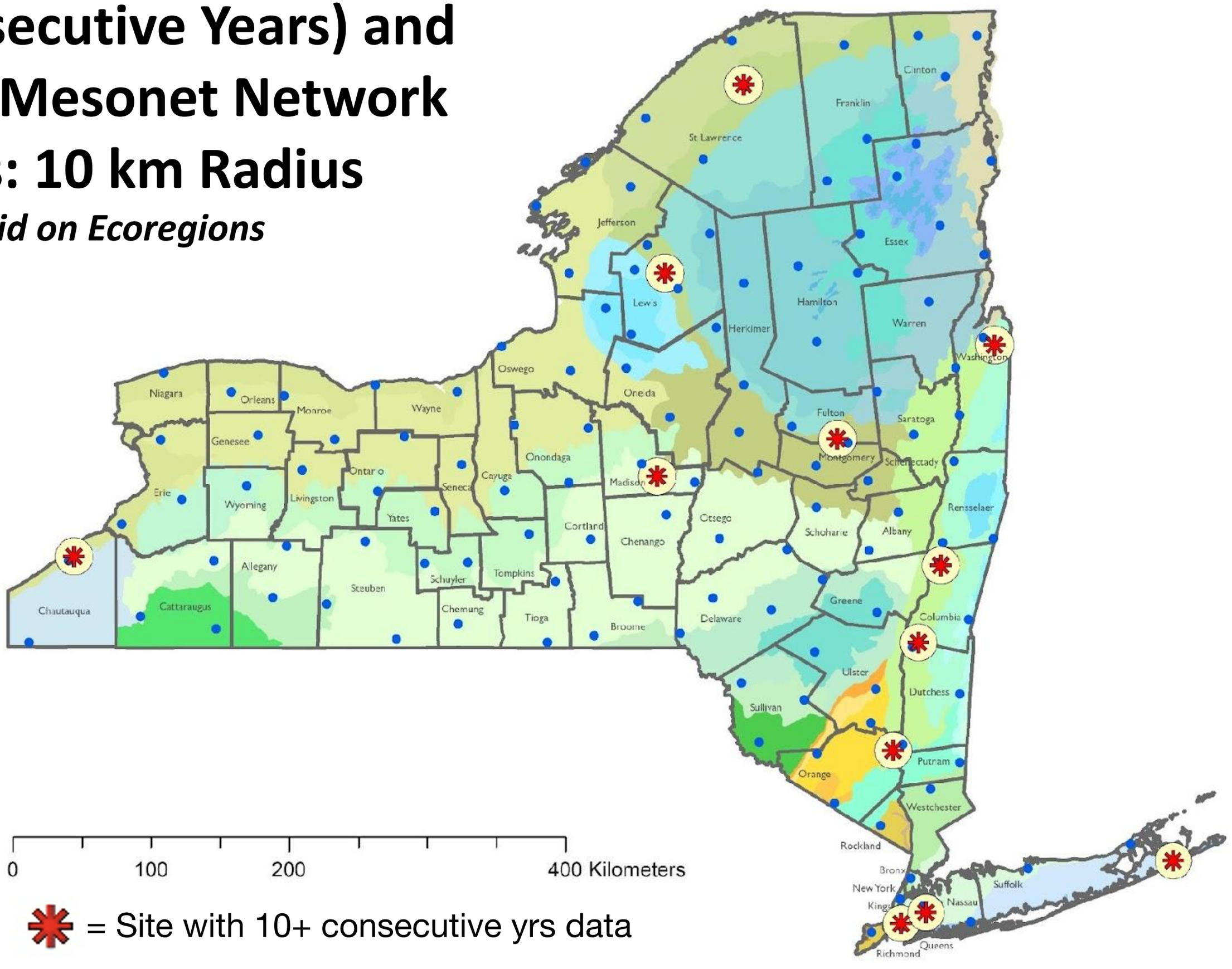
Overlaid on Ecoregions



Terraces

Academies (10+ Consecutive Years) and NYS Mesonet Network Sites: 10 km Radius

Overlaid on Ecoregions



Using Network for Historical/Modern Comparisons

Journal of Ecology | BRITISH ECOLOGICAL SOCIETY

RESEARCH ARTICLE | Open Access

Citizen science across two centuries reveals phenological change among plant species and functional groups in the Northeastern US

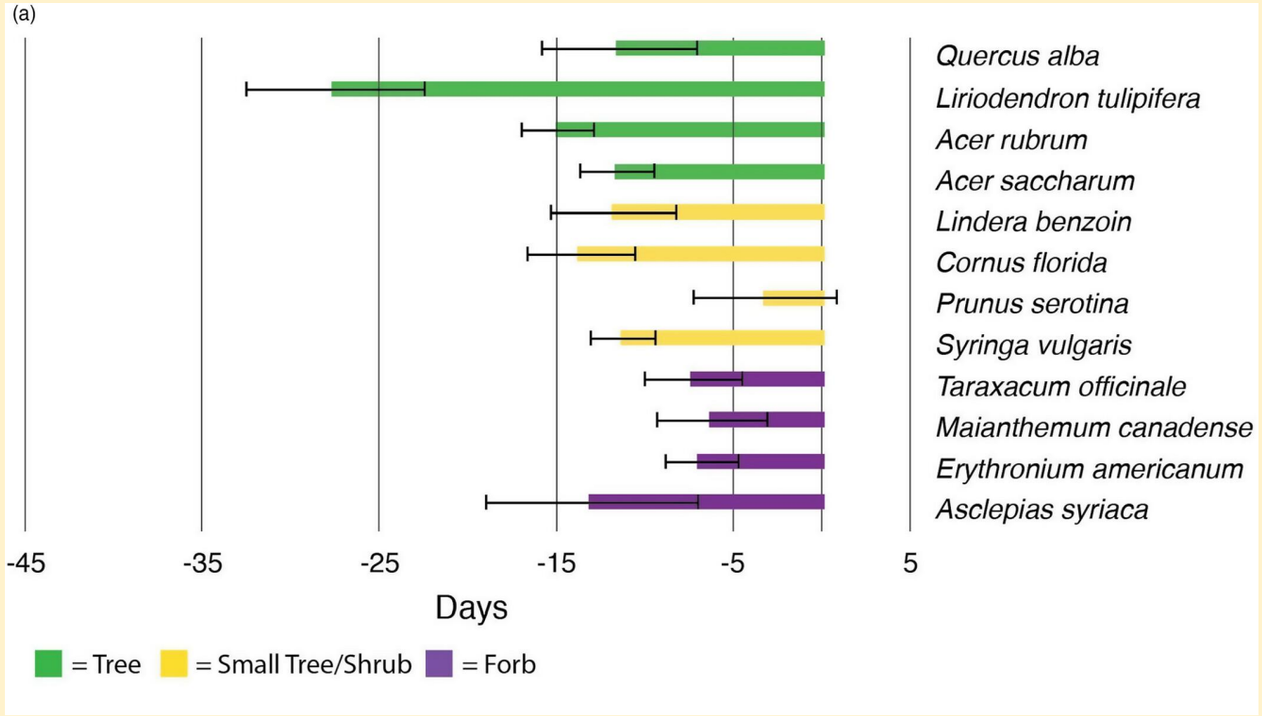
Kerissa Fuccillo Battle, Anna Duhon, Conrad R. Vispo, Theresa M. Crimmins, Todd N. Rosenstiel, Lilas L. Armstrong-Davies, Catherine E. de Rivera

First published: 16 May 2022 | https://doi.org/10.1111/1365-2745.13926 | Citations: 4

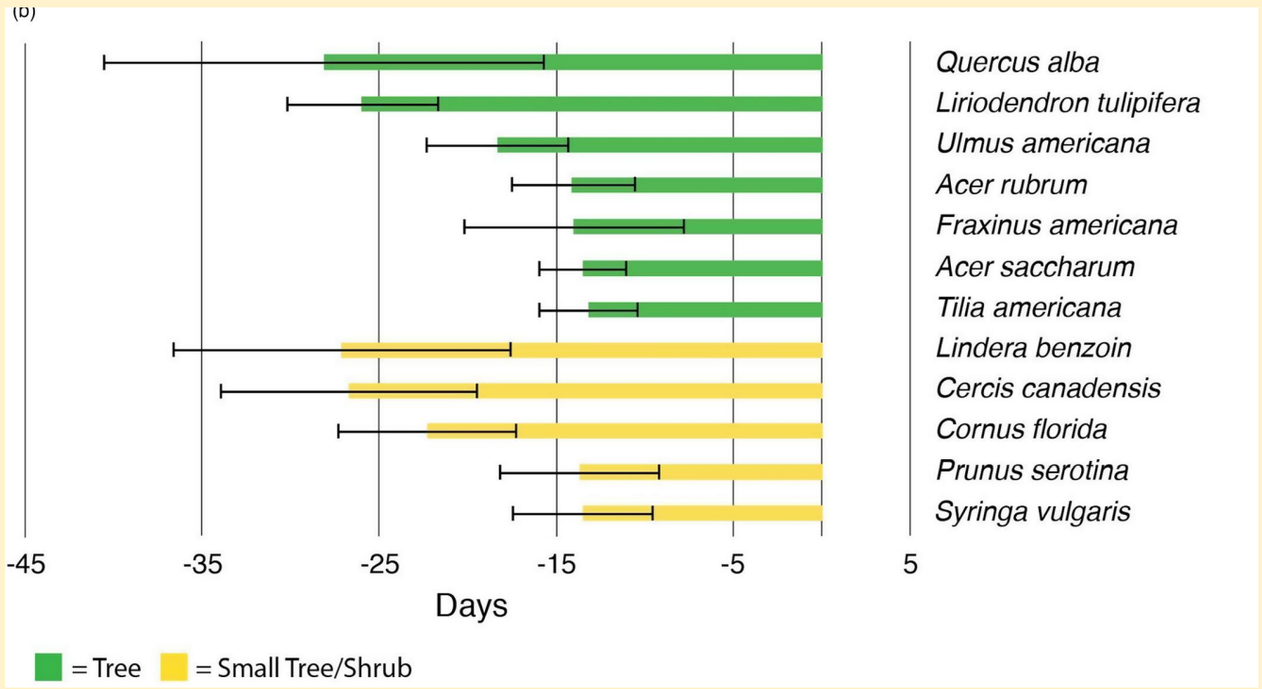
Handling Editor: Charles Kwit

How can the meteorological data deepen this understanding?

First Flower Date: Average 10.5 Days Earlier



First Leaf Date: Average 19 Days Earlier

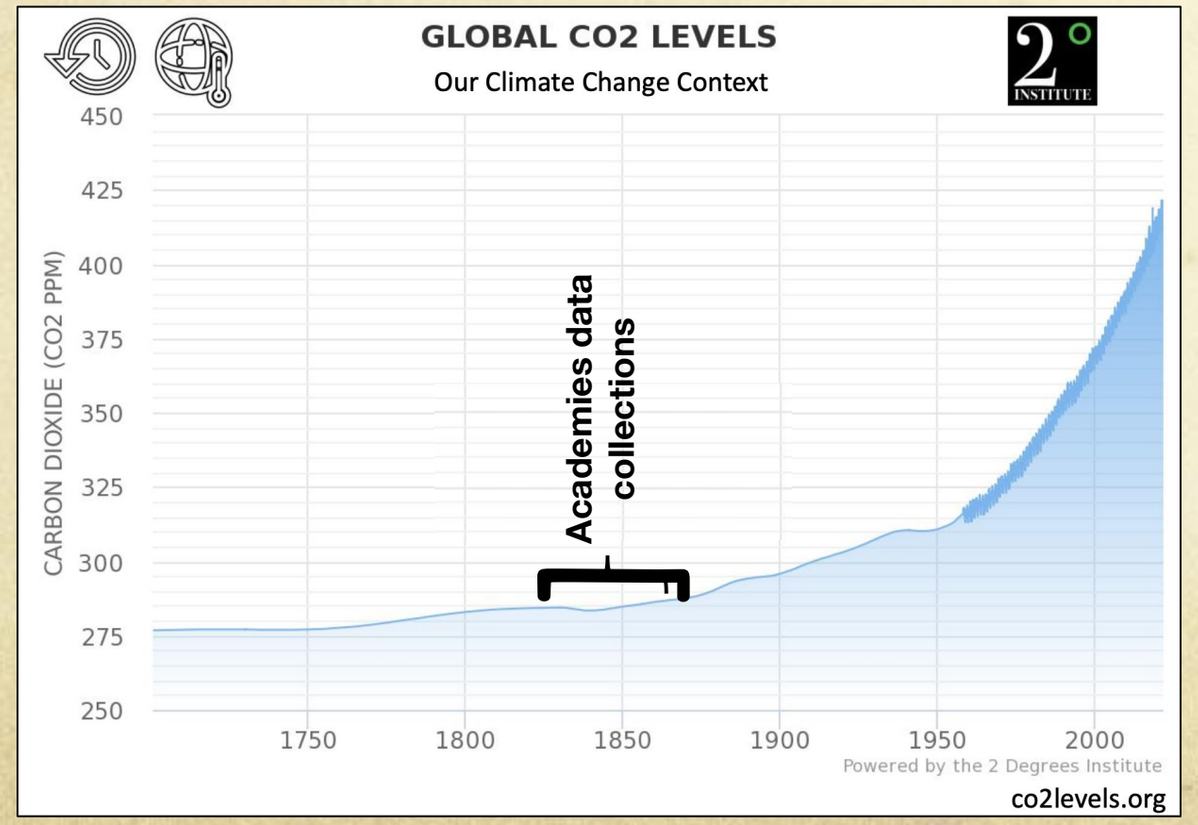


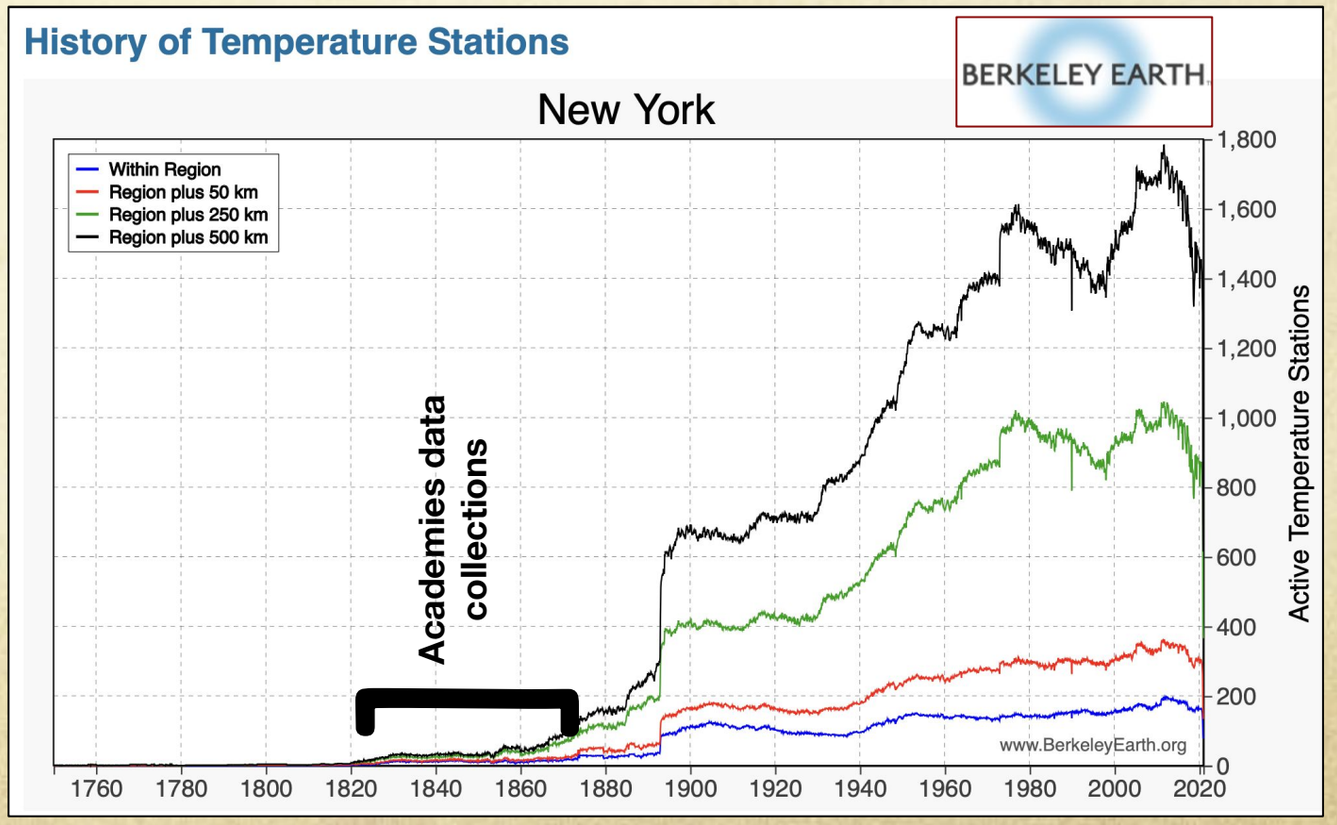
Proposal: Perform collaborative study with NYSM and interested researchers

- create digitized database of historical Academies observations
- conduct studies comparing the pre-Industrial past with contemporary conditions, as represented by the first decade of observations recorded by the NYSM.

<u>Offers new purpose for NYSM</u>: climate change not specified among primary objectives (but could be).

<u>Outreach opportunities to inform the general public</u> on magnitude and significance of local change, and its impacts on natural and human systems.





Climate Data Rescue as a first step

Digitization of data records will require combining machine OCR and human inputs

Copernicus Climate Change Service

Best Practice Guidelines for Climate Data Rescue

Clive Wilkinson[1,2,5], Stefan Brönnimann[3], Sylvie Jourdain[4], Emeline Roucaute[4], Rick Crouthamel & IEDRO Team[5], Philip Brohan[6], Antonia Valente[7], Yuri Brugnara[3], Manola Brunet[2,8], Gilbert P. Compo[9,10]

IEDRO – International Environmental Data Rescue Organization

IEDRO { *Saving Data, Saving Lives* INTERNATIONAL ENVIRONMENTAL DATA RESCUE ORGANIZATION }

Establishing parity with contemporary NYSM data

- **Digitizing 1000+ station-years of handwritten data into tabular form suitable for analysis**
    - *Tabular monthly summaries allow mathematical check*
- **Inconsistencies of early meteorological equipment/observers**
    - *Care was taken to test, adjust and standardize equipment at the time*
    - *Observers were largely professionals, often scientists, who took this work seriously*
    - *Geographic extent allows for nearest neighbor comparisons*
- **Until recently: Lack of modern data to compare to**
    - *NYSM now offers research-grade data in proximity to most Academic sites*

Research opportunities – a selection of themes to explore

1) Preparation of analogous data series from paired-site contemporary NYSM observations, matching time of day and event-duration characteristics

2) Assessment of station temperature means and extremes, diurnal temperature range changes and growing season length;

3) Evaluation of urban heat island evolution and magnitude by comparing urban and rural locations across two centuries, to contrast conditions over a 10-fold increase in state population since 1826 and corresponding urban expansion;

Research opportunities – a selection of themes to explore

4) Generation of historic and present-day probability distribution functions of precipitation at paired sites to examine intensity shifts under the current warming climate

5) Generation of gridded interpolation products for assimilation into historical reanalyses;

6) Reconstruction of historic Plant Hardiness Zones during one of the coldest periods of the late-Holocene for contrast with present conditions.

Acknowledgements

- We salute the memory of the erudite individuals, observers and archivists who so diligently pioneered the systematic data collection of the Academies network
- The Archives of the New York State Museum

Resources

Historical Phenology Data Browser – for New York State
https://hpdata.hvfarmscape.org

Copernicus: Best Practice Guidelines for Climate Data Rescue
http://www.c3.urv.cat/docs/publicacions/2019/Deliverable_BestPracticeGuidelines_Part1.pdf

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