The Global Historical Climatology Network GHCN hourly (GHCNh) dataset

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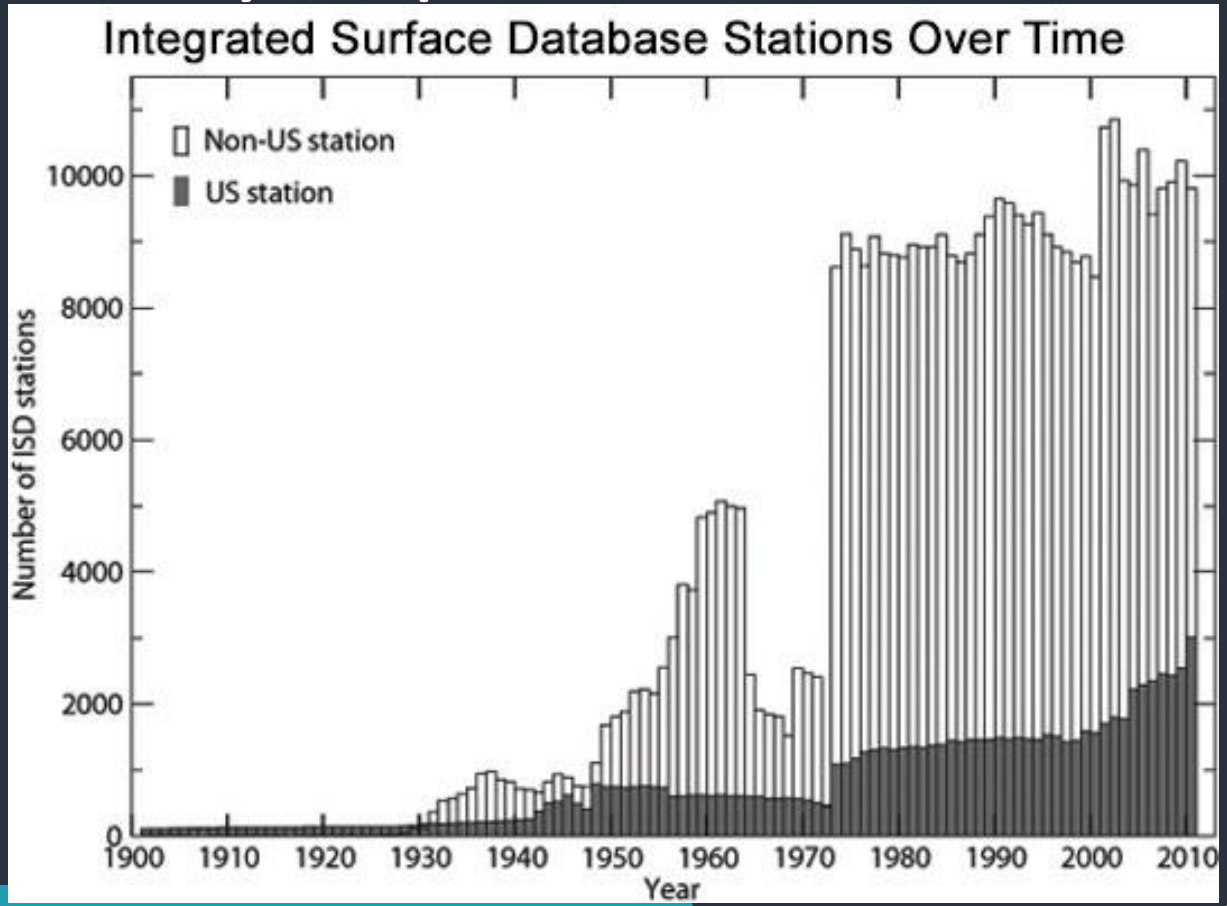
Progress towards a harmonized database of weather station observations over global land areas

NOAA
National Satellite and Information Service

May 9, 2023

Global Hourly Reports in ISD

- Collaboration between 14th Weather Squadron and NCEI (NCDC) since the early 2000s
- Combined Surface Weather Observations databases from NOAA/NCEI and U.S. Air Force



U.S. Air Force Surface Weather Observations Database

557TH WEATHER WING

- Provide daily updates of decoded surface weather observations
- Periodic re-issue of complete database

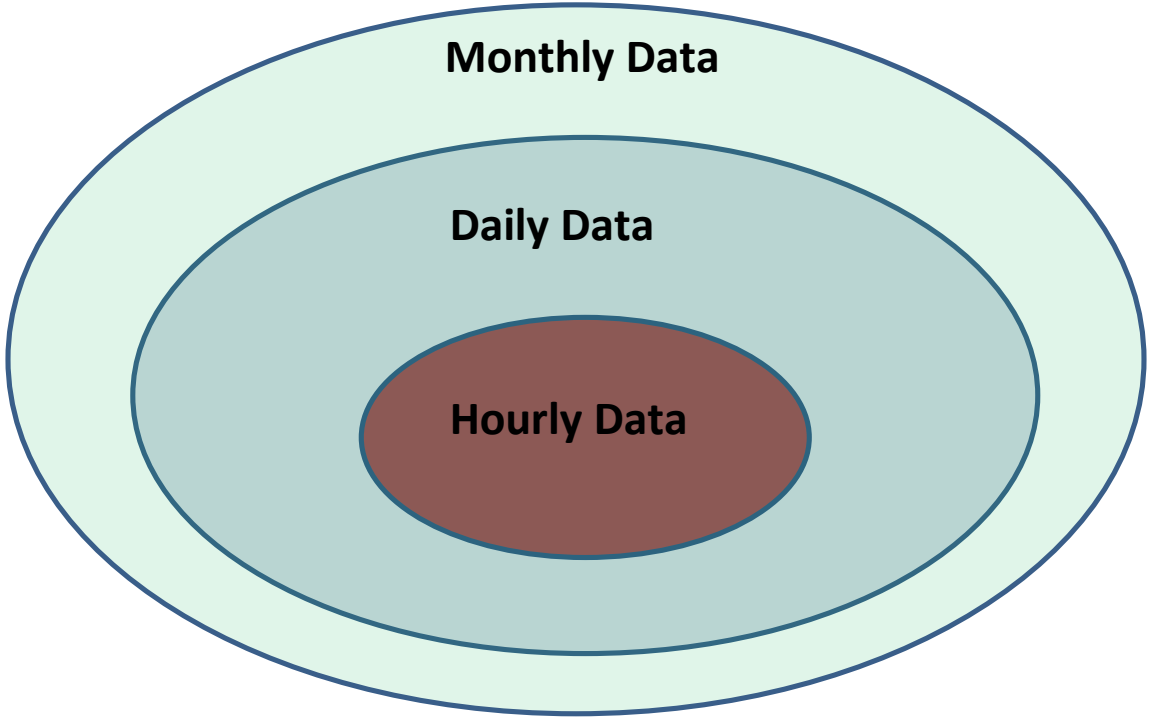
SAO
FM-12
METAR/FM-15
FM-16
.
.

National Weather Records Center keypunch operators, 1950s

Interior view of Grove Arcade with staff, R.M. White (COB) and Bill Hodge, in 1964

Digital Archives

- Monthly data was generally the first to be keyed retrospectively
- Many impediments to sharing of daily data (including IPR restrictions) whereas hourly reports shared formally in support of numerical weather prediction and aviation safety
- Many more stations with daily reports compared to hourly



GHCNh

- Goal had been to bring ISD under the GHCN management umbrella for many years
- An opportunity arose around 2016 to partner with Europe's Copernicus Climate Change Service (C3S) initiative to build a Global Land and Marine Observations Database (GLAMOD–based largely on ICOADS and GHCN)
- C3S main focus was to enhance hourly database in support of 20th Century reanalysis

Goals in transition from Integrated Surface Data (ISD) to GHCNh

- Re-establish a clear connection to Subject Matter Experts for the hourly dataset
- Expand partnerships and data holdings and integrate rescued data
- Align sub-daily data with GHCN daily
- Provide a more user friendly format and clear lineage of raw input sources
- Facilitate the process of addressing data bugs

Harmonized Land Station Data

- Must be built from multiple source archives
  - Requires reformatting native formats to a common format (not trivial!)
  - Requires some mechanism for ongoing integration of newly available historical sources (from data rescue and relaxed data sharing restrictions)
- Requires a system for documenting, tracking and addressing errors
- Fulfill the need to provide short time-delay updates for climate monitoring and other applications
- Management of station histories & other metadata (e.g., multiple identifiers and aliases often with overlaps and changes over time)

NCEI and C3S partners

- have reformatted and integrated >100 hourly data sources which have been reconciled into ~25,000 unique land surface station records
- First iterations were focused on six primary meteorological elements (air temperature, dew point temperature, surface and station pressure, wind speed and direction
- GHCNh beta provides a number of additional elements from the large databases provided by the U.S. Air Force and NOAA, including relative humidity, wet bulb temperature, cloud observations, visibility, and significant weather reports

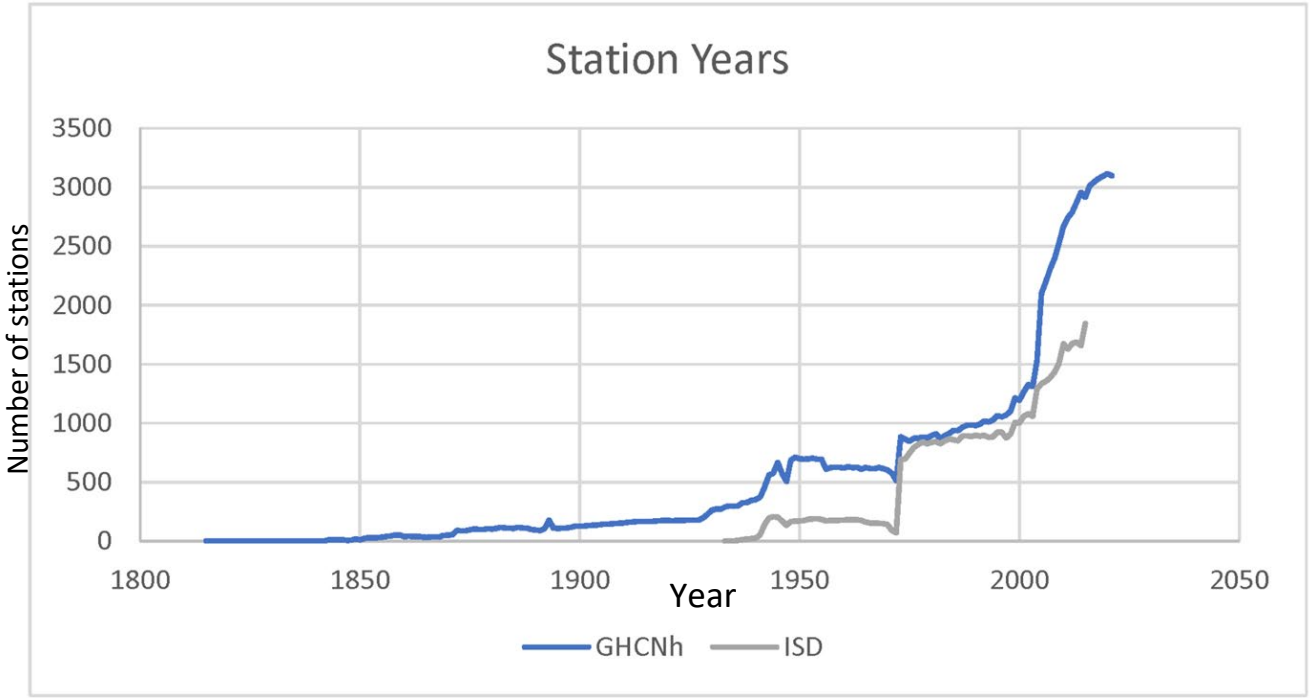
Sub-daily Elements*

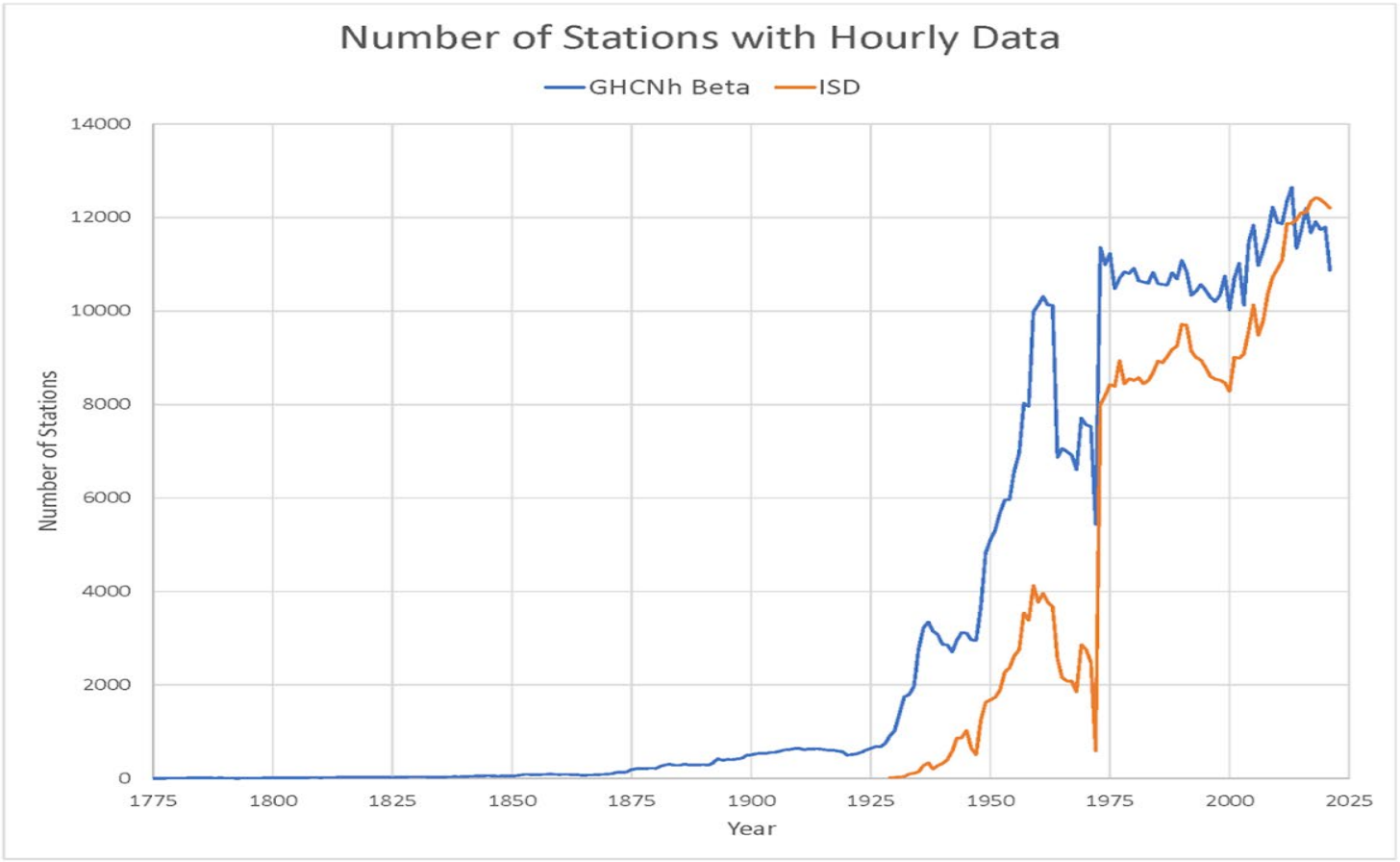
Dry Bulb Temperature
Dew Point Temperature
Station Pressure
Sea Level Pressure
Wind Speed & Direction

Wet Bulb Temperature
Relative Humidity
Observed Weather Types (rain, fog, haze etc)
Pressure Tendency
Altimeter setting
Cloud observations
Depth of snow on the ground
Hourly Precipitation
Wind Gust

*Variable list covers what is necessary for the Local Climatological Data Product (LCD). More to follow

Hourly Data for U.S. Stations




Number of Stations with Hourly Data
GHCNh Beta
ISD
Number of Stations
14000
12000
10000
8000
6000
4000
2000
0
1775
1800
1825
1850
1875
1900
1925
1950
1975
2000
2025
Year

GHCNh

Basic format is pipe-separated values (psv) with header for each station file

Use of real numbers with intuitive variable names

NCEI Common Access tools being developed for subsetting

Unit conversion option for downloads

GHCNh format

Station_ID|Station_name|Year|Month|Day|Hour|Minute|Latitude|Longitude|Elevation|
temperature|temperature_Measurement_Code|...

USW00003812|ASHEVILLE AP|1940|11|01|12|00|35.4317|-82.5378|645.6|10.6||5|SAO-Airway|
314|723150-03812|9.4||5|SAO-Airway|...

Replaces…

0276723150038121940110112 00G+35433-082483SAO +0639KAVL
99991585900365002445EN001600599+01065+00945101695ADDGA1999+002445999GD14995+99
99999GF11818599999999999999999MA1999999093745MW1805EQDN01

Data Access

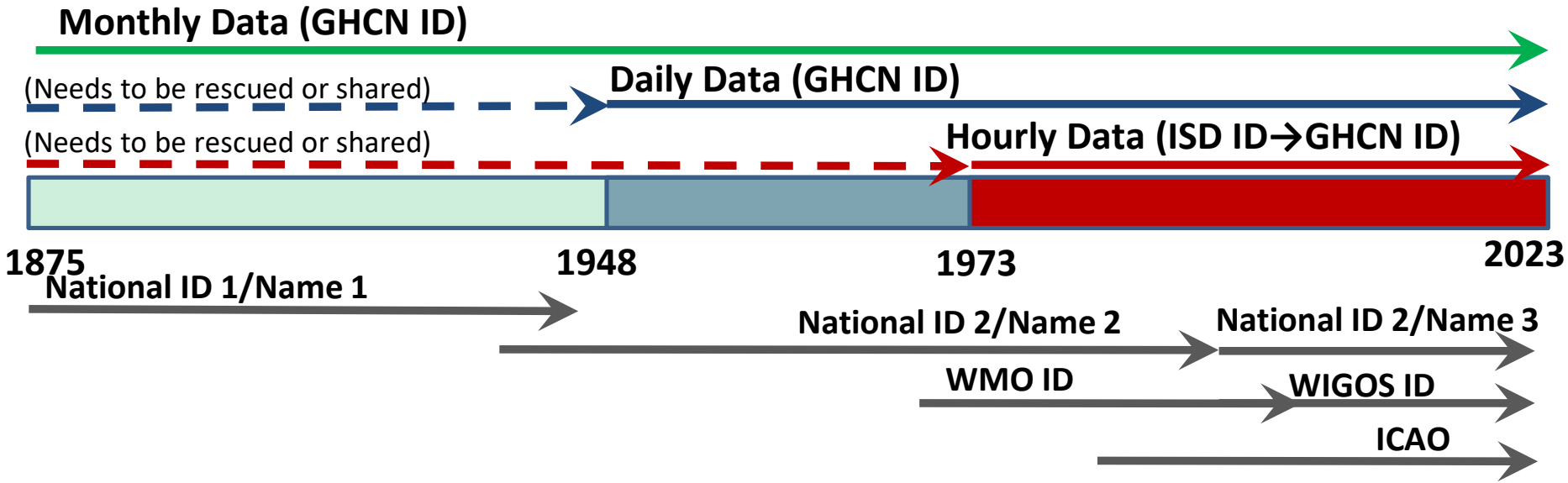
Data moving from NCEI's common access WAF

https://www.ncei.noaa.gov/data/global-historical-climatology-network-hourly/v1beta/

Soon to ceph S3 bucket version of common access

Hypothetical Station Record

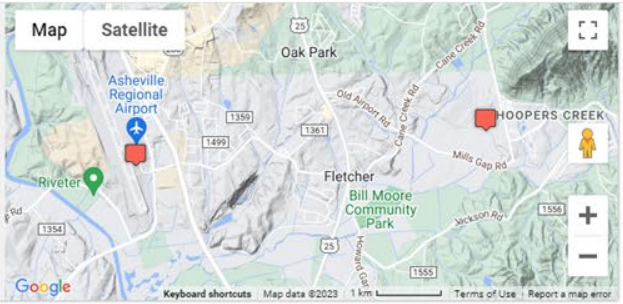
Station X



- Large effort required to ingest and reconcile station history sources and resolve inconsistencies with the station histories and digital data record
- HOMR is the “glue” that binds the data together and controls membership in NCEI’s in situ data access systems

ASHEVILLE REGIONAL AIRPORT, NC
1961-04-10 to Present

ASHEVILLE HENDERSONVILLE AP, NC
1941-06-26 to 1961-04-09



ASHEVILLE REGIONAL AIRPORT, NC
1961-04-10 to Present

Station-Level (MSHR) Data | Element-Level (PHR) Data | Location Data | Misc Data

	1/1/1970	1/1/1980	1/1/1990	1/1/2000	1/1/2010	Present
Coop Name	ASHEVILLE WSO AIRPORT		ASHEVILL...	ASHEVILLE REGIONAL AIRPORT		
Principal Name	ASHEVILLE AP		ASHEVILLE REGIONAL AP	ASHEVILLE REGIONAL AIRPORT		
Pub Name					ASHEVILLE REGIONA...	
State/Province	NC					
County	BUNCOMBE					
Country	UNITED STATES					
GHCND ID	USW00003812					
GHCNMLT ID	USW00003812					
COOP ID	310300					
WBAN ID	03812					
FAA ID		AVL				
ICAO ID		KAVL				
NWSLI ID		AVL				
WMO ID		72315				
NCDC ID	20013756					
GHCNH ID	USW00003812					
Latitude	35.43333			35.43178	35.431...	35.43...
Longitude	-82.55			-82.53787	-82.5...	-82.5...

Current alignment of GHCNd and GHCNh

Cross references	GHCNh	GHCNd
GHCNh	23,225	5,033
GHCNd	5,033	123,346

Further alignments likely with each new release

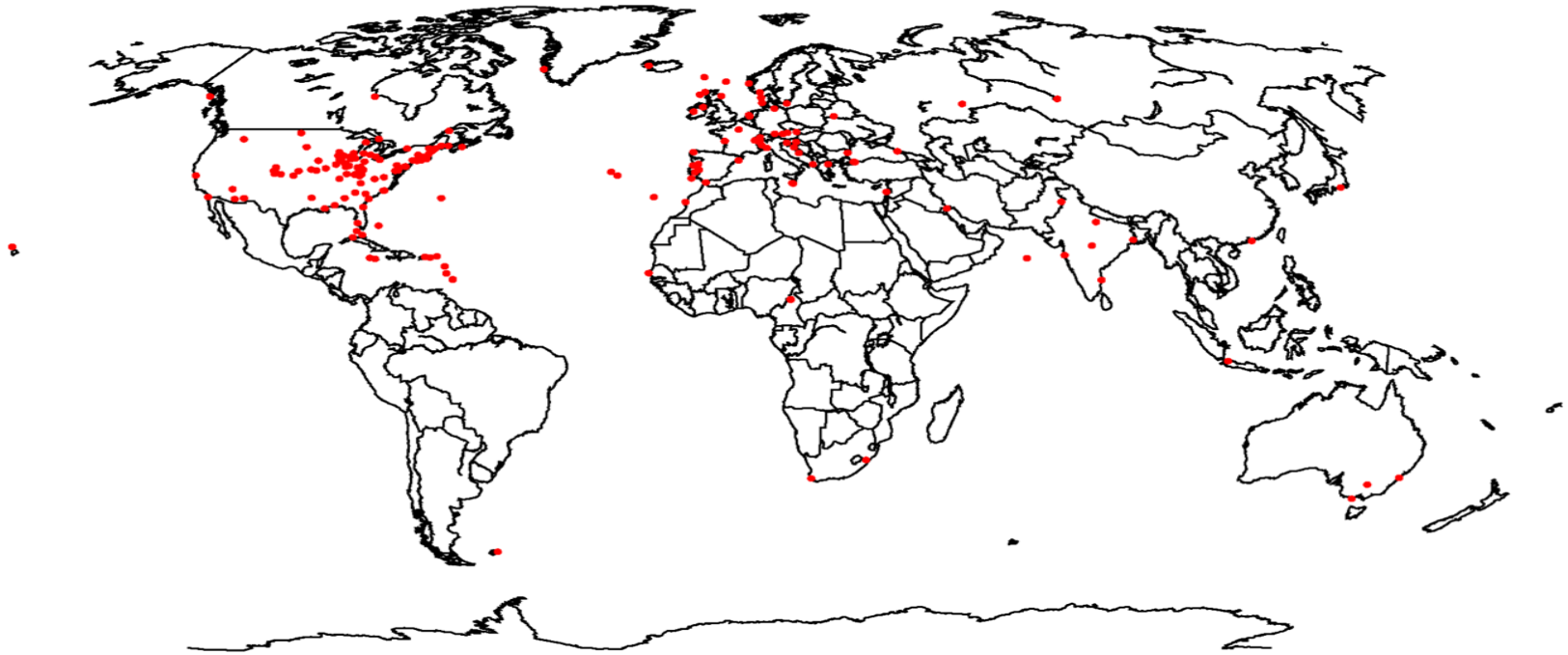
1775

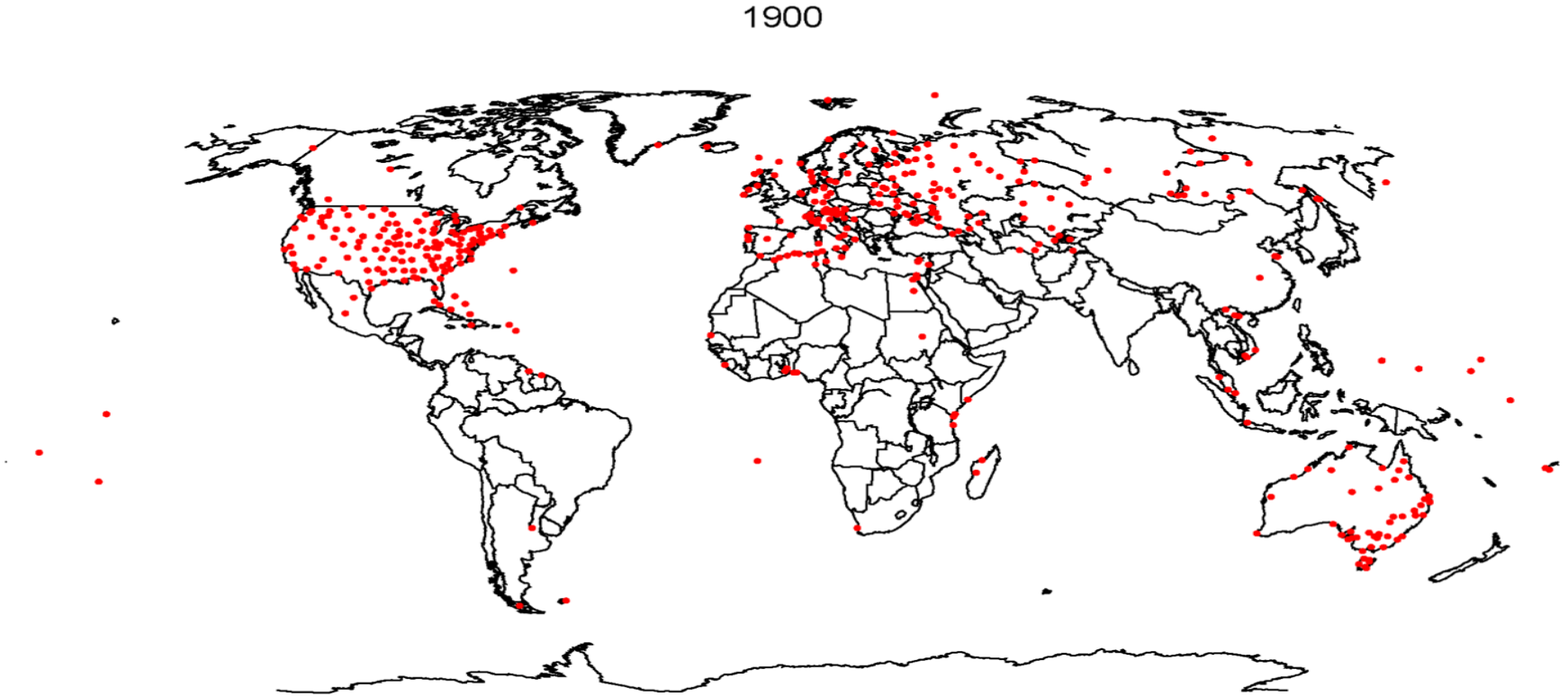
1800

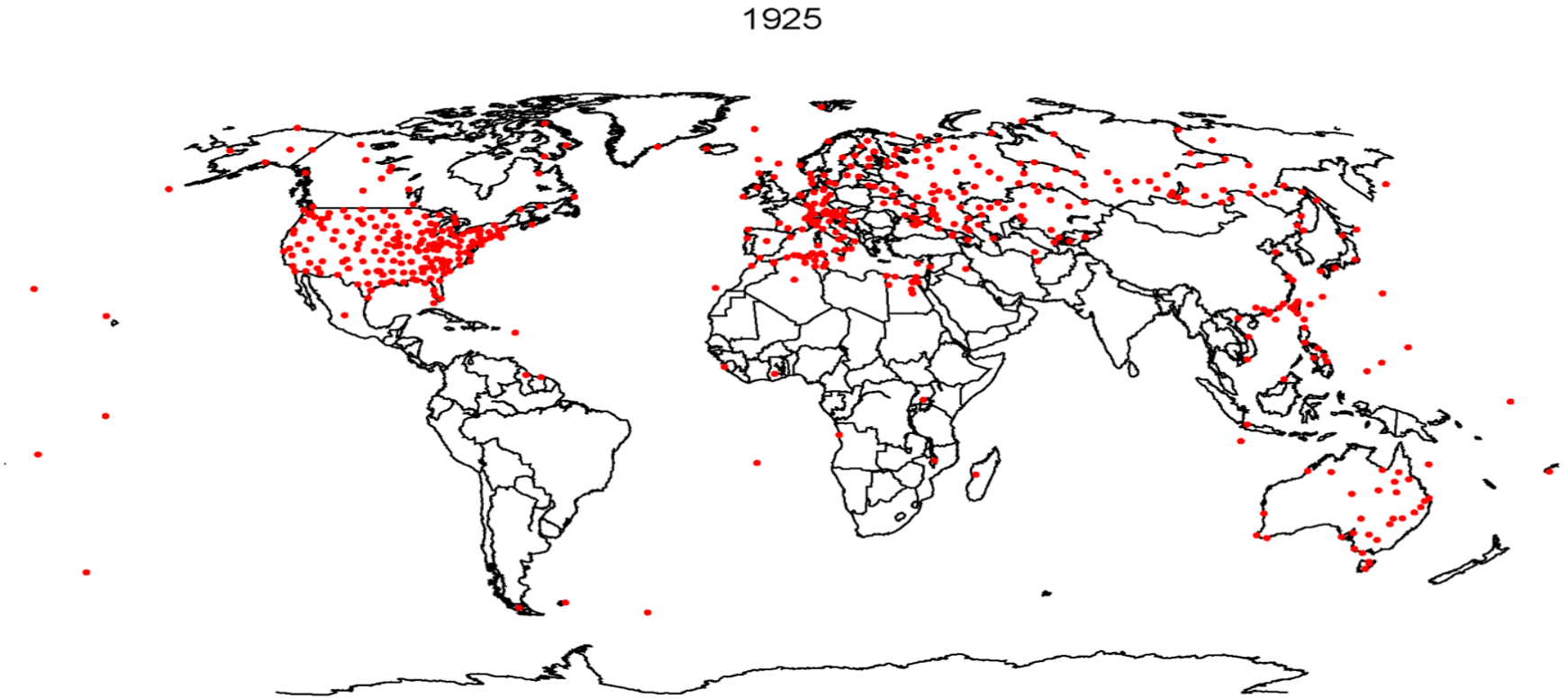
1825

1850

1875




1900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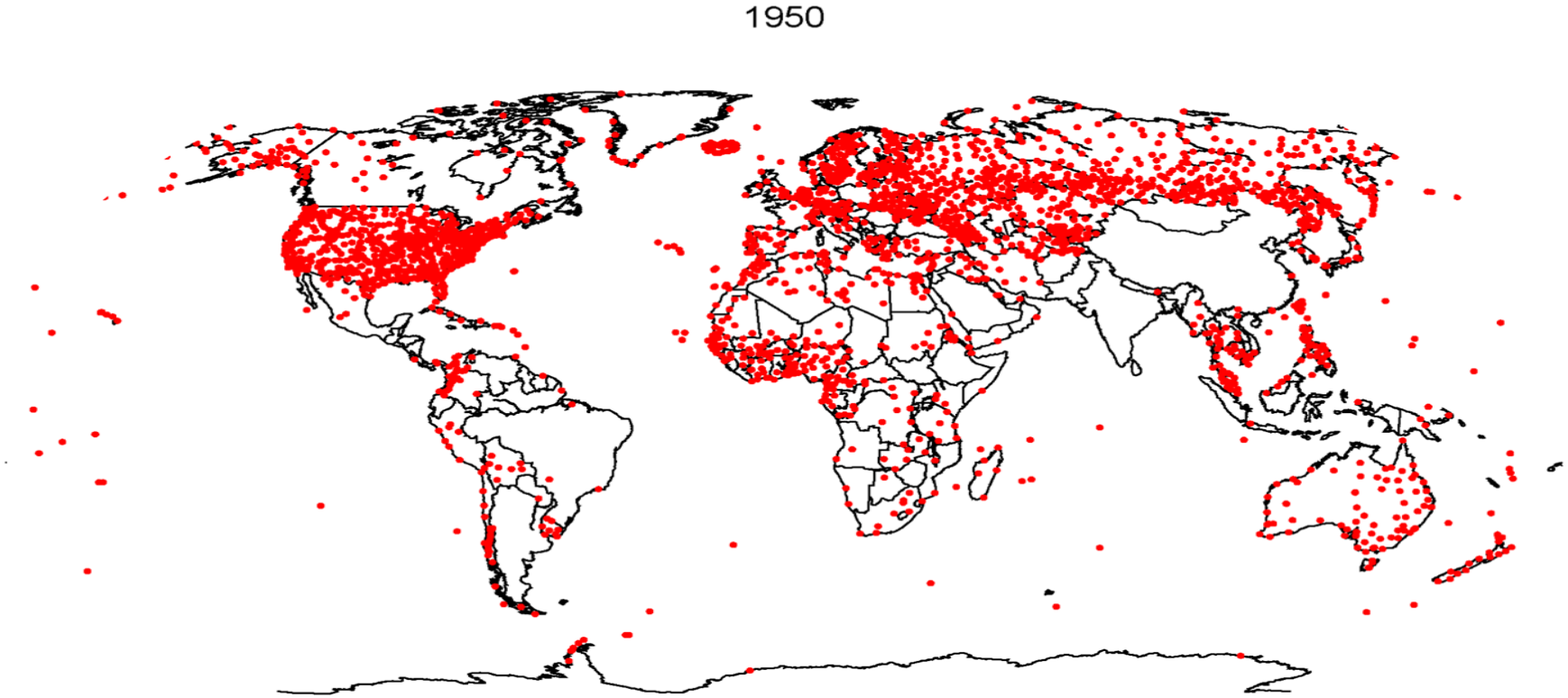
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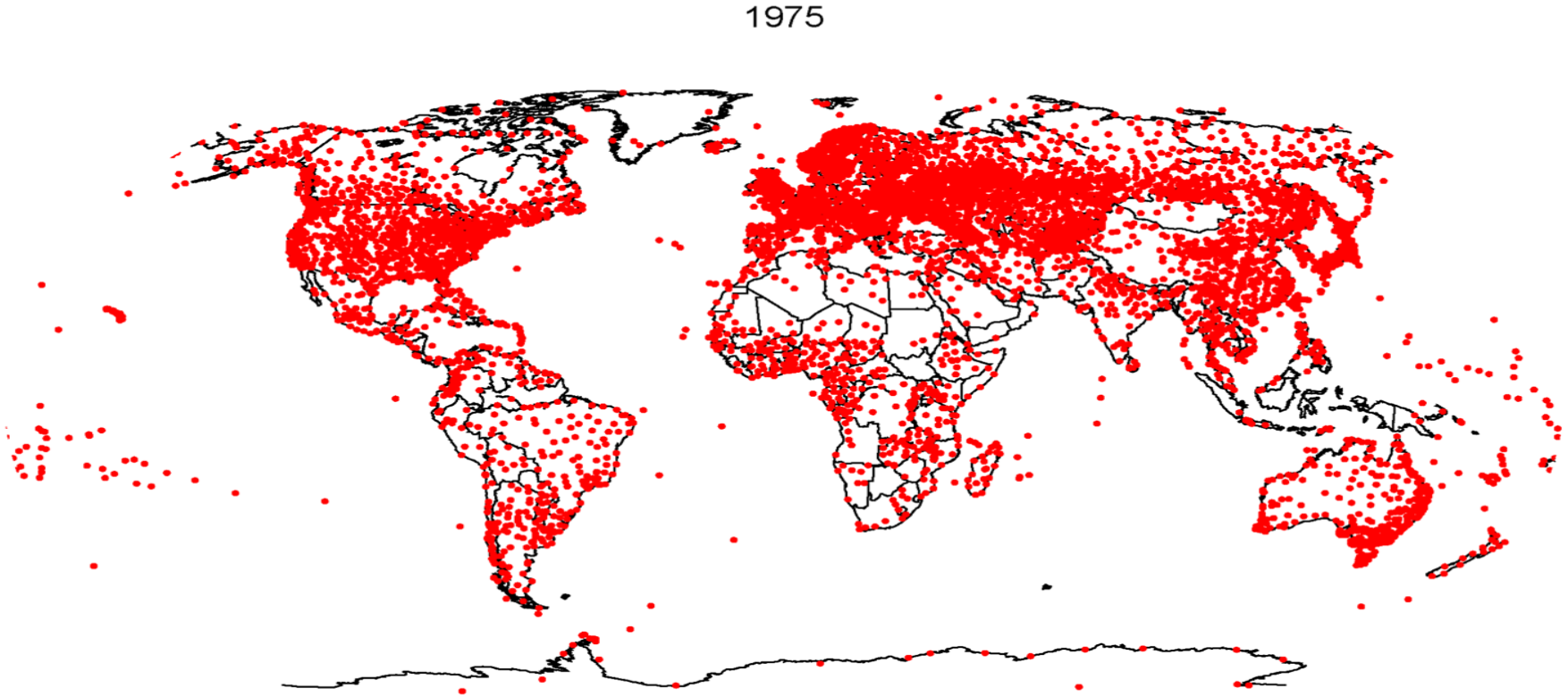
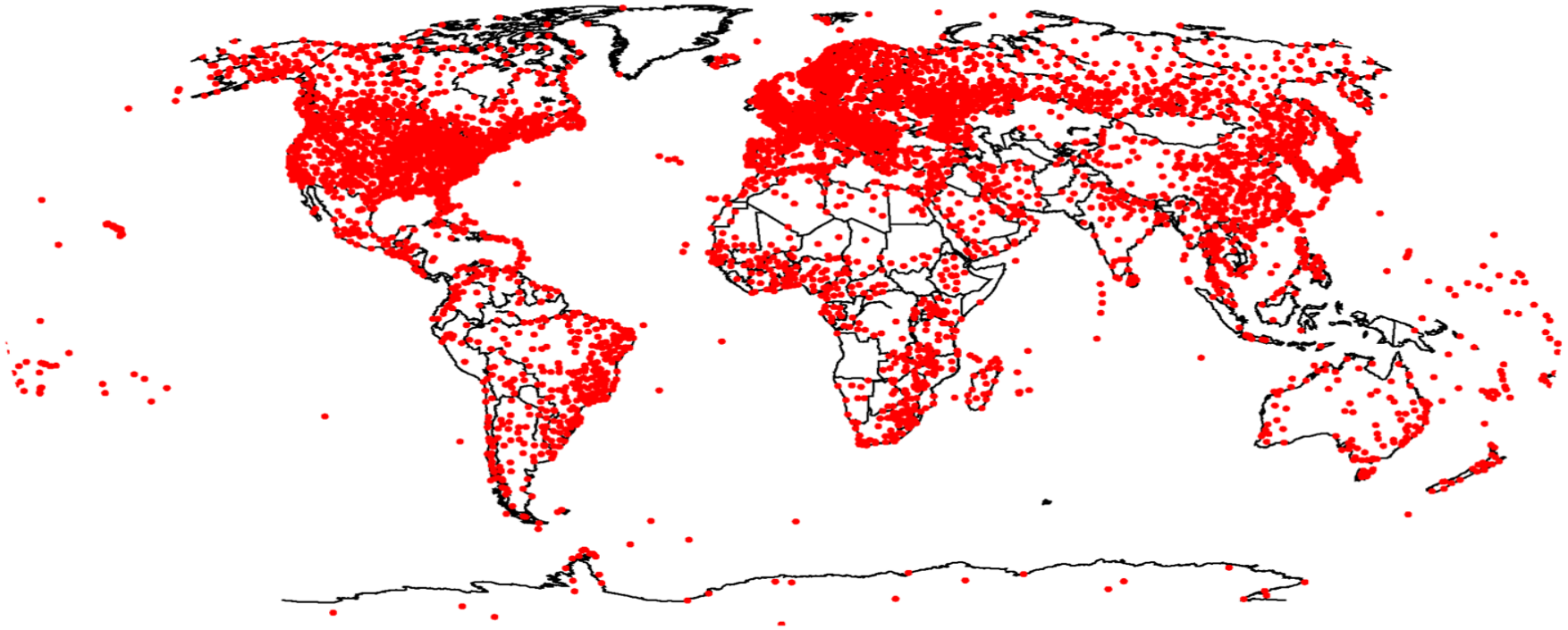

1975

2000



Dependent Products

- Substantial effort required this past year to build Local Climatological Data from Global Summary of the Month (GSOM), GHCNd and GHCNh
- Synoptic Summary of the Day (GSOD version 2) is also forthcoming

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Current Location: Elev: 2118 ft. Lat: 35.4318° N Lon: -82.5379° W
Station: **ASHEVILLE REGIONAL AIRPORT, NC US WBAN: 72315003812 (Unknown)**

Local Climatological Data
Daily Summary
December 2022

Generated on 01/26/2023

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Date	Temperature (F)							Degree Days (base 65F)		Sun (LST)		Weather	Precipitation (in)			Pressure (inHg)		Wind	Maximum Wind Speed = MPH / Direction = Degrees			
	Max	Min	Avg	Dep	ARH	ADP	AWB	Heat	Cool	Rise	Set	Weather Type	TLC	Snow Fall	Snow Depth	Avg Stn	Avg SL	Avg Speed	Peak Speed	Peak Dir	Sust. Speed	Sust. Dir
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
01	53	28	41	-1.9				24	0	0721	1717		0.00	0.0	0	28.07		8.9	35	340	24	340
02	56	26	41	-1.6				24	0	0722	1717		0.00	0.0	0	28.12		6.6	36	190	23	170
03	64*	46	55	12.6				10	0	0722	1717	RA	0.03	0.0	0	28.01		10.0	29	180	22	190
04	50	33	42	-0.1				23	0	0723	1717		0.00	0.0	0	27.92		2.8	16	340	14	340
05	43	38	41	-0.8				24	0	0724	1717	RA BR	0.32	0.0	0	27.84		6.4	15	160	10	150
06	55	40	48	6.4				17	0	0725	1717	RA BR	0.30	0.0	0	27.88		5.2	13	160	10	160
07	63	49	56	14.7				9	0	0726	1717	RA FG BR	0.41	0.0	0	27.95		2.5	13	340	9	340
08	61	55	58	16.9				7	0	0727	1717	RA BR	0.45	0.0	0	27.92		2.2	13	110	9	140
09	56	46	51	10.2				14	0	0727	1717	RA BR	0.11	0.0	0	27.87		4.3	15	170	12	140
10	49	44	47	6.4				18	0	0728	1718	BR	0.00	0.0	0	27.91		5.8	13	130	12	170
11	50	44	47	6.7				18	0	0729	1718	BR	T	0.0	0	27.85		3.5	12	140	8	330
12	58	45	52	11.9				13	0	0730	1718		0.00	0.0	0	27.83		4.1	13	150	9	160
13	46	37	42	2.1				23	0	0730	1718		0.00	0.0	0	27.92		5.7	14	150	10	150
14	42	37	40	0.3				25	0	0731	1718	RA BR	0.76	0.0	0	27.79		7.3	16	170	13	200
15	48	37	43	3.5				22	0	0732	1719	RA BR	0.81	0.0	0	27.53		4.6	15	180	12	340
16	50	31	41	1.7				24	0	0732	1719		0.00	0.0	0	27.58		6.1	25	290	17	300
17	50	27	39	-0.1				26	0	0733	1719		0.00	0.0	0	27.60		4.3	23	310	17	330
18	40	28	34	-4.9				31	0	0734	1720		0.00	0.0	0	27.76		9.3	26	350	21	340
19	46	21	34	-4.8				31	0	0734	1720		0.00	0.0	0	28.02		3.4	15	330	13	330
20	40	28	34	-4.6				31	0	0735	1721		0.00	0.0	0	28.05		2.3	13	190	10	180
21	47	29	38	-0.4				27	0	0735	1721	RA BR UP	T	0.0	0	27.99		5.3	17	170	14	180
22	45	33	39	0.7				26	0	0736	1722	RA BR	0.14	0.0	0	27.70		5.2	22	170	17	170
23	41	2	22	-16.1				43	0	0736	1722	RA	0.10	0.0	0	27.48		15.0	42	300	33	300
24	24	0*	12	-26.0				53	0	0737	1723		0.00	0.0	0	27.73		13.9	34	350	26	330
25	31	12	22	-15.9				43	0	0737	1723		0.00	0.0	0	27.79		12.2	27	340	21	320
26	34	12	23	-14.8				42	0	0738	1724		0.00	0.0	0	27.88		3.8	19	340	15	340
27	45	24	35	-2.6				30	0	0738	1725		0.00	0.0	0	27.93		4.6	17	350	14	340
28	52	19	36	-1.5				29	0	0738	1725		0.00	0.0	0	27.97		2.0	15	170	12	160
29	62	23	43	5.6				22	0	0739	1726		0.00	0.0	0	28.04		3.4	20	210	16	210
30	53	28	41	3.7				24	0	0739	1727	RA FG BR UP	0.03			27.96		2.9	12	160	9	180
31	54	46	50	12.7				15	0	0739	1727	RA FG BR	0.13	0.0	0	27.75		3.2	14	110	9	120
	48.6	31.2	39.9									Monthly Averages | Totals	3.59			27.86	30.16	5.8				
	-0.9	1.9	0.5									Departure from Normal (1981-2010)	0.00s									

Degree Days

	Monthly		Season-to-date	
	Total	Departure	Total	Departure
Heating	777	-17	1697	
Cooling	0	0	991	

Number of days with...

	Temperature				Precipitation		Snow	Weather	
	Max		Min						
	>=90°	<=32°	<=32°	<=0°	>=0.01"	>=0.1"	>=1"	T-Storms	Heavy Fog
	0	2	16	1	12	10	0		2

Date of 5-sec to 3-sec wind equipment change

2008-10-16

Sea Level Pressure

		Date	Time
Maximum	30.52	02	0801
Minimum	29.50	23	0319

Greatest...

24-Hr... Precip	24-Hr... Snowfall	Snow Depth
1.57		
Date		
14-15		

Station Augmentation

Name:ASHEVILLE FIRE STATION Lat: N/A Lon: N/A Elevation: N/A Distance: 0.25mi N Elements: SNOW Equipment: SNOWBOARD

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Current Location: Elev: 2118 ft. Lat: 35.4318° N Lon: -82.5379° W
Station: **ASHEVILLE REGIONAL AIRPORT, NC US WBAN: 72315003812 (Unknown)**

Local Climatological Data
Hourly Observations
December 2022

Generated on 01/26/2023

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Date	Time (LST)	Station Type	Sky Conditions	Visibility	Weather Type (see documentation)	Dry Bulb Temp		Wet Bulb Temp		Dew Point Temp		Rel Hum %	Wind Speed (MPH)	Wind Dir (Deg)	Wind Gusts (MPH)	Station Press (inHg)	Press. Tend	Net 3-Hr Change (inHg)	Sea Level Press. (inHg)	Report Type	Precip Total (in)	Altimeter Setting (inHg)
					AU | AW | MW	(F)	(C)	(F)	(C)	(F)	(C)											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
01	0054	7	CLR:00	10.00		33	0.6	27	-2.8	16	-8.9	49	14	340	25	27.96	3	-0.03	30.25	FM-15	0.00	30.26
01	0100	4		9.94		33	0.6	27	-2.8	16	-8.9	49	14	340		27.94	3	-0.03	30.25	FM-12		
01	0154	7	CLR:00	10.00		32	0.0	26	-3.3	15	-9.4	50	14	340	25	27.99			30.28	FM-15	0.00	30.28
01	0254	7	CLR:00	10.00		31	-0.6	26	-3.3	15	-9.4	52	11	340		28.02			30.32	FM-15	0.00	30.32
01	0354	7	CLR:00	10.00		30	-1.1	25	-3.9	15	-9.4	54	11	340	23	28.05	3	-0.08	30.36	FM-15	0.00	30.35
01	0454	7	CLR:00	10.00		30	-1.1	25	-3.9	15	-9.4	54	13	340	21	28.06			30.38	FM-15	0.00	30.36
01	0554	7	CLR:00	10.00		29	-1.7	24	-4.4	15	-9.4	56	16	340	25	28.09			30.41	FM-15	0.00	30.39
01	0654	7	CLR:00	10.00		29	-1.7	24	-4.4	15	-9.4	56	17	340	26	28.09	0	-0.04	30.42	FM-15	0.00	30.39
01	0700	4		9.94		29	-1.7	24	-4.4	15	-9.4	56	17	340		28.06	9	+0.04	30.42	FM-12		
01	0754	7	CLR:00	10.00		28	-2.2	24	-4.4	15	-9.4	58	21	340	33	28.10			30.42	FM-15	0.00	30.40
01	0854	7	CLR:00	10.00		30	-1.1	25	-3.9	15	-9.4	54	16	340	29	28.12			30.44	FM-15	0.00	30.42
01	0954	7	CLR:00	10.00		34	1.1	27	-2.8	13	-10.6	42	13	010	20	28.15	3	-0.06	30.48	FM-15	0.00	30.45
01	1054	7	CLR:00	10.00		40	4.4	30	-1.1	9	-12.8	28	14	340	22	28.15			30.47	FM-15	0.00	30.45
01	1154	7	CLR:00	10.00		46	7.8	33	0.6	5	-15.0	18	10	350	21	28.12			30.44	FM-15	0.00	30.43
01	1254	7	CLR:00	10.00		49	9.4	35	1.7	7	-13.9	18	8	010		28.12	8	+0.03	30.43	FM-15	0.00	30.42
01	1300	4		9.94		49	9.4	35	1.7	7	-13.9	18	8	010		28.09	8	+0.03	30.43	FM-12		
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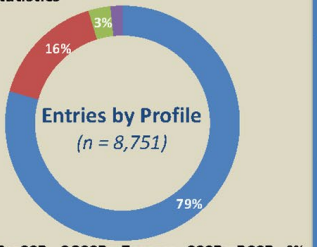
01	1554	7	CLR:00	10.00		52	11.1	36	2.2	8	-13.3	17	3	010		28.10	5	+0.02	30.41	FM-15	0.00	30.40
01	1654	7	CLR:00	10.00		50	10.0	36	2.2	10	-12.2	20	0	000		28.10			30.42	FM-15	0.00	30.40
01	1754	7	CLR:00	10.00		46	7.8	35	1.7	18	-7.8	32	7	VRB		28.12			30.44	FM-15	0.00	30.42
01	1854	7	CLR:00	10.00		42	5.6	33	0.6	17	-8.3	36	6	180		28.15	3	-0.05	30.47	FM-15	0.00	30.45
01	1900	4		9.94		42	5.6	33	0.6	17	-8.3	36	6	180		28.12	3	-0.05	30.47	FM-12		
01	1954	7	CLR:00	10.00		39	3.9	31	-0.6	17	-8.3	41	0	000		28.15			30.49	FM-15	0.00	30.46
01	2054	7	CLR:00	10.00		36	2.2	30	-1.1	19	-7.2	50	3	150		28.15			30.49	FM-15	0.00	30.46
01	2154	7	CLR:00	10.00		32	0.0	28	-2.2	22	-5.6	66	3	170		28.15	0	-0.01	30.49	FM-15	0.00	30.46
01	2254	7	CLR:00	10.00		31	-0.6	28	-2.2	22	-5.6	69	0	000		28.16			30.49	FM-15	0.00	30.47
01	2354	7	CLR:00	10.00		29	-1.7	27	-2.8	22	-5.6	75	0	000		28.15			30.47	FM-15	0.00	30.46
02	0054	7	CLR:00	10.00		28	-2.2	26	-3.3	22	-5.6	78	0	000		28.14	8	+0.01	30.46	FM-15	0.00	30.44
02	0100	4		9.94		28	-2.2	26	-3.3	22	-5.6	78	0	000		28.10	8	+0.01	30.46	FM-12		
02	0154	7	CLR:00	10.00		27	-2.8	25	-3.9	22	-5.6	81	0	000		28.14			30.46	FM-15	0.00	30.44
02	0254	7	CLR:00	10.00		27	-2.8	25	-3.9	22	-5.6	81	3	180		28.14			30.45	FM-15	0.00	30.44
02	0354	7	CLR:00	10.00		26	-3.3	25	-3.9	22	-5.6	84	0	000		28.15	3	0.00	30.46	FM-15	0.00	30.45
02	0454	7	CLR:00	10.00		28	-2.2	26	-3.3	23	-5.0	81	0	000		28.15			30.47	FM-15	0.00	30.45
02	0554	7	CLR:00	10.00		29	-1.7	27	-2.8	23	-5.0	78	6	140		28.15			30.48	FM-15	0.00	30.46
02	0654	7	FEW:02 120	10.00		30	-1.1	28	-2.2	24	-4.4	79	0	000		28.16	3	-0.02	30.49	FM-15	0.00	30.47
02	0700	4		9.94		30	-1.1	28	-2.2	24	-4.4	79	0	000		28.13	3	-0.02	30.49	FM-12		
02	0754	7	SCT:04 120	10.00		32	0.0	29	-1.7	24	-4.4	73	3	150		28.18			30.51	FM-15	0.00	30.49
02	0854	7	BKN:07 120	10.00		37	2.8	32	0.0	25	-3.9	62	3	170		28.17			30.50	FM-15	0.00	30.48
02	0954	7	OVC:08 100	10.00		38	3.3	33	0.6	24	-4.4	57	7	180		28.17	1	-0.01	30.51	FM-15	0.00	30.48
02	1054	7	OVC:08 110	10.00		42	5.6	34	1.1	22	-5.6	45	8	160		28.16			30.49	FM-15	0.00	30.47
02	1154	7	BKN:07 110	10.00		44	6.7	36	2.2	24	-4.4	45	7	170		28.12			30.45	FM-15	0.00	30.43
02	1254	7	CLR:00	10.00		49	9.4	38	3.3	22	-5.6	35	7	140		28.10	8	+0.07	30.42	FM-15	0.00	30.40
02	1300	4		9.94		49	9.4	38	3.3	22	-5.6	35	7	140		28.07	8	+0.07	30.42	FM-12		
02	1354	7	BKN:07 120	10.00		53	11.7	46	7.8	39	3.9	59	16	180	26	28.07			30.39	FM-15	0.00	30.37
02	1454	7	BKN:07 120	10.00		54	12.2	47	8.3	40	4.4	59	17	180	26	28.06			30.37	FM-15	0.00	30.36
02	1554	7	BKN:07 120	10.00		54	12.2	48	8.9	43	6.1	67	15	170	22	28.07	5	+0.03	30.38	FM-15	0.00	30.37

NCEI Annual User Engagement Report

User Engagement — FY 2022 — Online

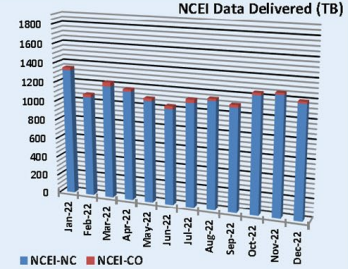
Engager Statistics

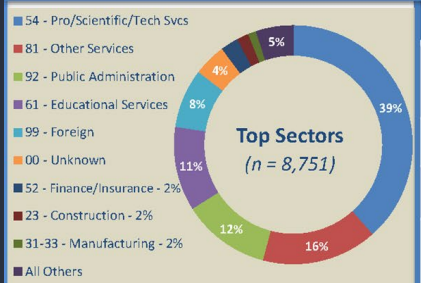


Interactions

8,751 entries	14,058 TB delivered
392 orders	3.66 B web hits

NCEI Data Delivered (TB)

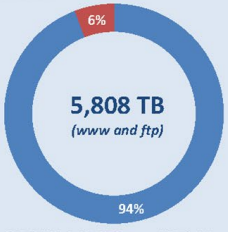




Sectors

Top Sectors	Data Downloaded Stats
PST	5,473 TB (NC)
Other Services	335 TB (CO)
Public Administration	

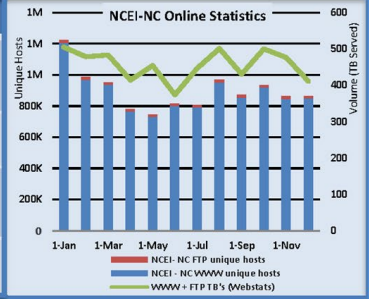
Data Downloaded



Data Type

Most Requested Products	NCEI-NC Online Stats
LCD	10.6 M www Hosts
GHCN-D	186 K FTP Hosts
ISD	5,473 TB Served

NCEI-NC Online Statistics



NOAA Satellite and Information Service | National Centers for Environmental Information

FTP Download Statistics - December 2022

Dataset	Number of requests	% of total	Tbytes	%bytes	directory
ISD	17,811,938	58.53%	3.72	19.39%	ftp://ftp.ncei.noaa.gov/pub/data/noaa/
Global Summary of the Day	7,034,435	23.12%	0.35	1.83%	ftp://ftp.ncei.noaa.gov/pub/data/gsod/
GHCNd	3,880,890	12.75%	5.51	28.76%	ftp://ftp.ncei.noaa.gov/pub/data/ghcn/daily/
ncei/data					
LCD	373,506	0.13%			https://www.ncei.noaa.gov/data/local-climatological-data/

The Near Future

- Next integration of additional sources occurring this month
- Daily updates and common access tools in next 1-2 months
- Transition to full operations later this year
- GHCNh to flow into ACIS similar to GHCNd

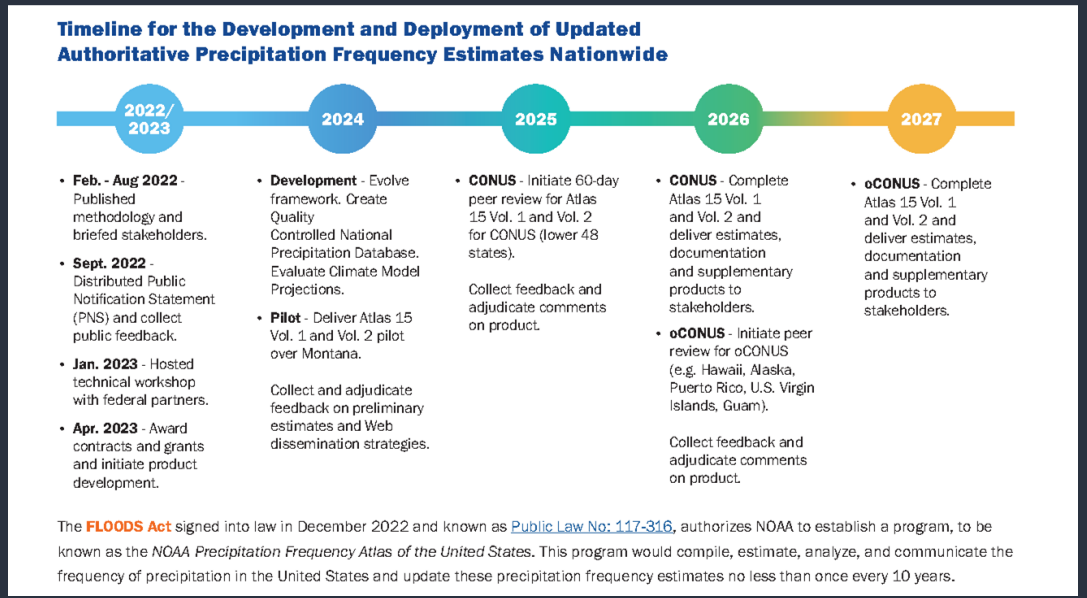
Atlas 15/BIL funding

Goal 1: Stewardship of U.S. Hourly and Sub-hourly precipitation observations in GHCNh

- On track to add Cooperative Observer Hourly Precipitation Data (active and historic hourly and 15-minute data)
- ASOS High resolution (5-minute totals)
- U.S. Climate Reference Network High resolution data (all variables)
- Some HADS data
- Data rescue and QC information collected by Atlas 14/15 team

(thanks to Sam Cunningham and Karen Orcutt)

Goal 2: Enhanced data access



Medium Term

- Integration of additional sources once per year according to in kind agreement between C3S and NCEI
- Alignment of data and station histories at the margins where necessary
- Enhanced connection to WMO's Oscar Surface and WIGOS identifiers
- Addition of new networks (?)
- Better access tools (graph databases?)

Conclusion

- GHCN now part of larger effort that ties into more systematic data rescue and data sharing partnerships through C3S
- Stewardship of land station data supports a wide variety of climate applications and services
- Need to take the long view of continuous reconciliation of data/station history issues and addition of new sources

Thank You!