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Title: The Wasatch Environmental Observatory: A mountain to urban research network in the semi-arid Western US.

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Abstract

The 2,085 km^2 Jordan River Basin, and its seven sub-catchments draining the Central Wasatch Range immediately east of Salt Lake City, UT, are home to an array of hydrologic, atmospheric, climatic, and chemical research infrastructure that collectively forms the Wasatch Environmental Observatory (WEO). WEO is geographically nested within a wildland to urban land-use gradient and built upon a strong foundation of over a century of discharge and climate records. A 2200 m gradient in elevation results in variable precipitation, temperature, and vegetation patterns. Soil and subsurface structure reflect systematic variation in geology from granitic, intrusive to mixed sedimentary clastic across headwater catchments, all draining to the alluvial or colluvial sediments of the former Lake Bonneville. Winter snowfall and spring snowmelt control annual hydroclimate, rapid population growth dominates geographic change in lower elevations, and urban gas and particle emissions contribute to episodes of severe air pollution in this closed-basin.

Long-term hydroclimate observations across this diverse landscape provide the foundation for an expanding network of infrastructure in both montane and urban landscapes. Current infrastructure supports both basic and applied research in atmospheric chemistry, biogeochemistry, climate, ecology, hydrology, meteorology, resource management, and urban redesign that is augmented through strong partnerships with cooperating agencies. These features allow WEO to serve as a unique natural laboratory for addressing research questions facing seasonally snow-covered, semi-arid regions in a rapidly changing world and an excellent facility for providing student education and research training.

Site Description

The Wasatch Environmental Observatory (WEO) integrates fixed and mobile infrastructure (Fig. 1, Table 1) in central Utah, USA (40° 34' N, 111° 53' W; Fig. 2A), supporting research and training in multiple disciplines. WEO, formalized in 2018, is the result of decades-long efforts to monitor environmental phenomenon in the 2,085 km^2 Jordan River Basin (HUC: 16020204; Fig. 2B). The observatory spans gradients from relatively unimpacted mountain environments to century-old urban landscapes, all facing major challenges related to global change and a growing human population. The diversity of landscapes and stakeholders provides unique opportunities to leverage instrumentation and observations designed for basic research with operational datasets developed by local, state, and federal entities.

WEO is located at the western edge of the Rocky Mountain physiographic province and the eastern boundary of the Basin and Range province. The Wasatch fault bounds the Central Wasatch range to the west, which consists of over 2200 m of relief from the valley floor (1280 m a.s.l.) to mountain peaks (>3500 m a.s.l.; Table 2). This mountain block is lithologically and structurally complex, with rocks ranging from Precambrian quartzites and shales to Tertiary igneous intrusions (Bryant 1990). The Jordan River Basin is bordered by mountains in all directions but the northwest (Fig. 2B), resulting in a topography that promotes atmospheric temperature inversions (Fig. 3; Whiteman, Hock, Horel, & Charland, 2014). Roughly 44% of the catchment area is urban, with a human population of 1.1 million that is expected to reach 1.7 million by 2065 (Perlich, Hollingshaus, Harris, Tennert, & Hogue, 2017). The Jordan River serves as the outlet of Utah Lake and terminates in the Great Salt Lake (Fig. 2B). Seven major tributaries drain the Central Wasatch (Table 2; Fig. 2B) and represent varying degrees of a wildland to urban land-use gradient. For example, Red Butte Creek includes a USDA Forest Service Research Natural Area (RNA) in its headwaters (Ehleringer, Anrow, Anrow, McNulty, & Negus, 1992), while the headwaters of Big and Little Cottonwood creeks contain multiple ski resorts.

The region has a cold, semi-arid climate with strong elevation gradients in mean annual temperature (MAT) and precipitation (MAP), ranging from 3.3 – 11.3 °C and 420 – 1300 mm, respectively. Most precipitation falls as winter snow, while summers are typically dry. Snowmelt (April – July) drives both streamflow and regional groundwater recharge (Bardsley et al., 2013; Gabor et al., 2017; Hely, Mower, Harr, & Arnow, 1971; Jameel et al., 2016; 2018; Manning & Solomon, 2004). Water diversions and return flows, stormwater infrastructure, and effluent from multiple water reclamation facilities add hydrologic complexity to the system (Follstad Shah et al., 2019).

Mean annual air temperature has increased by approximately 1.5 °C since 1980 (Fig. 4A; Jamison, 2020; Wolf, 2020), but there has been no significant change in annual precipitation (Fig. 4B), streamflow (Fig. 4C), or water yield (the annual streamflow to precipitation ratio) over century-long records of climate and hydrology (Gelderoos, 2018; Jamison, 2020; Wolf, 2020). Recent warming has resulted in earlier initiation of snowmelt, yet at a slower rate and longer duration (Jamison, 2020). Downscaled climate models predict that more precipitation will fall as rain rather than snow and the snow line will shift upslope by 250 m in the future (Scalzitti, Strong, & Kochanski, 2016).

Consumptive use of surface water has reduced inflows to the Great Salt Lake, exposing sediment and increasing dust mobilization that impact both human health and hydrology. Dust aerosols exacerbate air pollution in a region prone to high concentrations of fine particulate matter ($PM_{2.5}$) and the formation of photochemical smog (Lin et al., 2018; Fig. 3). Dust deposition at higher elevation induces faster snowmelt above treeline (Maurer & Bowling, 2015; Skiles et al., 2018; 2019).

1.0 Data Set Name

Wasatch Environmental Observatory (WEO)

2.0 WEO Infrastructure & Observations

WEO instrumentation and data are managed by several coordinating networks at the University of Utah (Table 3), including the Gradient Along Mountain to Urban Transitions (GAMUT) network; MesoWest MesoNet (UUNET); Atwood Study Plot (ASP); Salt Lake Valley Greenhouse Gas Monitoring System (SLVGGMS), which is comprised of sensors associated with the Utah Urban CO_2 Network (UUCON), Utah Transit Authority's light rail system (UTA TRAX), and a mobile lab (UNERD); the Hallar Aerosol Research Team (HART); and Waterisotopes.org, a global database of water stable isotopes collected from environmental samples.

2.1 Hydrology

The GAMUT network includes six coupled meteorologic and aquatic sensor stations located from the headwaters of Red Butte Creek to its confluence with the Jordan River (Table 1, Fig.

2C). GAMUT infrastructure (Table 4) was installed as part of the 5-year (2012-2018) innovative Urban Transitions and Arid-region Hydrosustainability (iUTAH) program (https://iutahepscor.org/). Jones et al. (2017) detail site selection, sensors, installation methods, and procedures used to ensure data quality assurance and control (QA/QC). GAMUT aquatic sensors provide real-time stage height using pressure transducers for streams or acoustic depth sensors for stormwater drains (Table 4), from which discharge is calculated using rating curves. Quality-controlled discharge records and rating curves for seven study sites in Red Butte Creek and one storm drain (Table 5) can be obtained from the HydroShare data repository (Table 3, Supporting Information).

2.2 Hydrochemistry

GAMUT aquatic sensor stations record water temperature, pH, specific conductance, dissolved oxygen, fluorescent dissolved organic matter, phycocyanin, chlorophyll-*a*, turbidity, and nitrate on 15-minute intervals using multiparameter sondes (Tables 3 & 4). All data and metadata are uploaded to the HydroShare data repository (Table 3, Supporting Information) following QA/QC procedures described by Jones et al. (2017).

Over 20 years of water stable isotope ($\delta^{18}O$ and $\delta^{2}H$) data are available via the Waterisotopes.org database (http://waterisotopesDB.org; Table 3, Supporting Information). Table 5 includes links to three datasets related to the study of water isotopes collected from tap water, surface water, and groundwater throughout the Salt Lake Valley. Another four datasets related to the study of water isotopes in water vapor, tap water, surface water, and groundwater can be obtained from supplementary files to published papers with DOIs or the Open Science Framework (OSF) data repository (Table 5, Supporting Information). All samples collected by WEO affiliates for measurement of $\delta^{18}O$ and $\delta^{2}H$ have been analyzed in the University of Utah Stable Isotope Ratios Facility for Environmental Research (SIRFER), originally using a Thermo Finnigan Delta V IRMS and more recently by Picarro L2130i Laser Water Isotope Analyzer (Table 4).

2.3. Meteorology and Climate

Meteorology and climate are monitored via three networks associated with WEO: UUNET, GAMUT, and ASP. UUNET is part of the MesoWest program, a network of over 2800 monitoring stations in the western US (Horel et al. 2002). UUNET includes meteorologic observations from 66 locations in the WEO study area (Fig. 2B), beginning in 1997. Ten of these UUNET sites are managed by the University of Utah (Table 1). Specific instrumentation used to collect data within UUNET varies by site and over time, as noted on the MesoWest website. UUNET data are visualized in real-time through the MesoWest web interface (Table 3; Horel et al., 2002) and stored within the Synoptic Data PBC data repository (Table 3, Supporting Information). Synoptic Data PBC provides numerous automated data quality control protocols (https://developers.synopticdata.com/about/qc/). GAMUT climate stations (Fig. 2C) record incoming and outgoing radiation, vapor pressure, barometric pressure, temperature of air, terrestrial surfaces, and soils, wind speed and direction, ground-level ozone, precipitation, snow depth, photosynthetically active radiation (PAR), soil moisture and soil conductivity at 15-minute intervals. A diverse suite of sensors is used to measure these parameters (Table 4), all of which are fully described in Jones et al. (2017). Quality-controlled climate data for four study sites along Red Butte Creek (Table 5) can be obtained from the HydroShare data repository (Table 3, Supporting Information). ASP (Fig. 2B), established in 1939, is one of the oldest snow study locations in the U.S. (Skiles et al., 2018) and measures air temperature, relative humidity, wind speed and direction, snow depth, and radiation fluxes (Table 5), allowing for full snow energy balance accounting. Data from ASP are stored within the Synoptic Data PBC repository (Table 3, Supporting Information).

2.4 Atmospheric Chemistry

The UUCON Network includes eight fixed trace gas stations that span from Hidden Peak (3350 m a.s.l.) in the Little Cottonwood sub-catchment to the valley floor (Bares et al., 2019; Lin et al., 2018; Mitchell et al., 2018b). All stations monitor CO_2 concentrations, but some also record other gases (CO, CH_4, NO_x, O_3), stable isotopes, and fine particulate matter ($PM_{2.5}$). Instrumentation is detailed in Table 4 with QA/QC procedures described in Bares et al. (2019). A similar suite of sensors affixed to UTA's light rail (UTA TRAX) system and a mobile lab (UNERD) measure emissions of trace gases and $PM_{2.5}$ in the urban core. Details about these sensors (Table 4), calibration and correction procedures, and data QA/QC screening can be found in Mitchell et al. (2018a) and Mendoza et al. (2019). Together, these instruments comprise the Salt Lake Valley Greenhouse Gas Monitoring System (SLVGGMS; Lin et al., 2018), which visualizes recent data at air.utah.edu/data (CO_2 and CH_4) and https://utahaq.chpc.utah.edu/ ($PM_{2.5}$ and ozone; Table 3). In winter 2017, a multi-agency and multi-institutional campaign monitored ammonia and fine particulate matter concentrations using Twin Otter aircraft sensors (Table 4), air balloons, news helicopters, and fixed ground stations (Baasandorj et al., 2018; Table 4). A portable aerosol spectrometer is used to collect observations at ASP (Table 4). HART measurements are part of the US Department of Agriculture (USDA) UV-B monitoring program (Tables 3 & 5) and are made via instruments affixed to the roof of a University of Utah campus building, including a spectrometer and radiometer (Table 4).

2.5 Experimental Facilities for Green Infrastructure

The Green Infrastructure Research Facility (GIRF), constructed as part of the iUTAH program, is an experimental set of bioswales where hydrologic inputs, water chemistry, and vegetation can be fully manipulated (http://cepd.cap.utah.edu/red-butte-creek-research-symposium-2018/green-infrastructure-research-facility). The Landscape Lab (LL), completed in 2020, consists of eight bioswales receiving runoff from adjacent structures and streets (http://cepd.cap.utah.edu/landscape-lab). Bioswales at LL are planted with either mesic, ornamental vegetation or drought-adapted vegetation, with four replicates of each treatment. Both facilities are instrumented with soil moisture and soil temperature sensors (Table 4) and meteorologic stations (Table 4; as detailed in Jones et al., 2017). LL will soon house automated sensors recording water flow in and out of bioswales (Table 4). Climate data from GIRF (Table 5) can be obtained from the HydroShare data repository (Table 3, Supporting Information). Bioswale soil moisture, soil temperature, and water fluxes will be available from HydroShare in the future.

3.0 Complementary Infrastructure & Data Sources

WEO resources are augmented by infrastructure operated by the US Geological Survey (USGS), USDA National Resource Conservation Service (NRCS), National Ecological Observatory Network (NEON), Utah Department of Environmental Quality (UDEQ), Utah Department of Transportation (UDOT), Utah Transit Authority (UTA), and Salt Lake City and County government. Streamflow sensors managed by cooperating agencies (USGS, NEON, and Salt Lake County; Fig. 2B, Table 3) have evolved over the century of record (Fig. 4C), but the majority of stage observations are logged at 15-minute intervals from pressure and temperature corrected pressure transducers, water bubblers, or stilling wells. Complementary water quality data from across the observatory is hosted by Salt Lake County, UDEQ, USGS Hydrologic Benchmark Network (HBN), and NEON (Table 3). Supplemental weather observations are available from National Weather Service (NWS), Citizen Weather Observer Program (CWOP), UDEQ, and Purple Air (Fig. 2B, Table 3), amongst others. Here, again, a century of meteorologic records (Fig. 4A-B) provides a rich history by which to contextualize modern observations collected during a period of rapid environmental change. NRCS Snow Telemetry (SNOTEL) and UDOT manage several long-term snowpack study plots (Fig. 2B, Table 3).

4.0 Ongoing Research Themes

Ongoing research areas include hydrology, water supply, water quality, climatology, air quality, ecohydrology, and green infrastructure. Hydrologic and hydroclimate research focuses on the interactions between climate change and subsurface storage on hydrologic partitioning (Manning & Solomon, 2004; Manning, Solomon, & Thiros, 2005; Wolf, 2020). Water supply and water quality research builds on this work to understand complexities in the supply of surface and drinking water across the montane to urban land-use gradient (Follstad Shah et al., 2019; Gabor et al., 2017; Hall et al., 2016; Jameel et al., 2016; 2018). Meteorologic observations directly serve civic needs (Horel et al., 2002), while atmospheric science research focuses on elucidating the sources, drivers, fate, and health impacts of air pollution, including emissions of CO_2, fine particulate matter, and combustion by-products (Bares et al., 2018; 2019; Fiorella, Bares, Lin, Ehleringer, & Bowen, 2018; Fiorella, Bares, Lin, & Bowen, 2019; Gorski et al., 2015; Mallia et al., 2017; Lin et al., 2018; Mitchell et al., 2018b; Moravek et al., 2019; Womak et al., 2019). Ecohydrologic research focuses on understanding where plants obtain water (Bowling, Shulze, & Hall, 2017; Dawson & Ehleringer, 1991; Oerter, Siebert, Bowling, & Bowen, 2019), susceptibility to cold and drought stress (Chan & Bowling, 2017; Zenes, Kerr, Trugman, & Anderegg, 2020), and vegetation response to human land-use decisions (Grijseels, Buchert, Brooks, & Pataki, 2020). Green infrastructure facilities focus on plant-soil feedbacks in the context of managing stormwater inputs and nutrient retention within semi-arid ecosystems (Meerow, Natarajan, & Krantz, 2021).

5.0 Contributors

Contributors to WEO datasets include numerous technicians, graduate students, and faculty members formerly or currently associated with the University of Utah. Paul Brooks and Brenda Bowen facilitated the formal establishment of WEO through the University of Utah, with the support of co-authors. Paul Brooks coordinates the GAMUT network with technical support from David Bowling and Logan Jamison. David Eiriksson provided GAMUT technical support from 2013-2019. Gabriel Bowen developed and maintains the global water stable isotopes database. John Horel manages the MesoWest network, in conjunction with Alexander Jacques and contributing partners. John Horel is a shareholder and board member of Synoptic Data PBC. S. McKenzie Skiles and A. Gannet Hallar manage the ASP and HART networks, with support from cooperative agencies. John Lin operates SLVGGMS with research and technical support from Ryan Bares, David Bowling, Benjamin Fasoli, Richard Fiorella, Daniel Mendoza, Logan

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8.0 Data Availability

Data collected by WEO can be accessed through the DOIs or data repository URLs provided in Table 4 or by searching data repositories (Table 3) as described in the Supporting Information. Data collected by cooperative agencies may be visualized or obtained via the websites and data repositories listed in Table 3.

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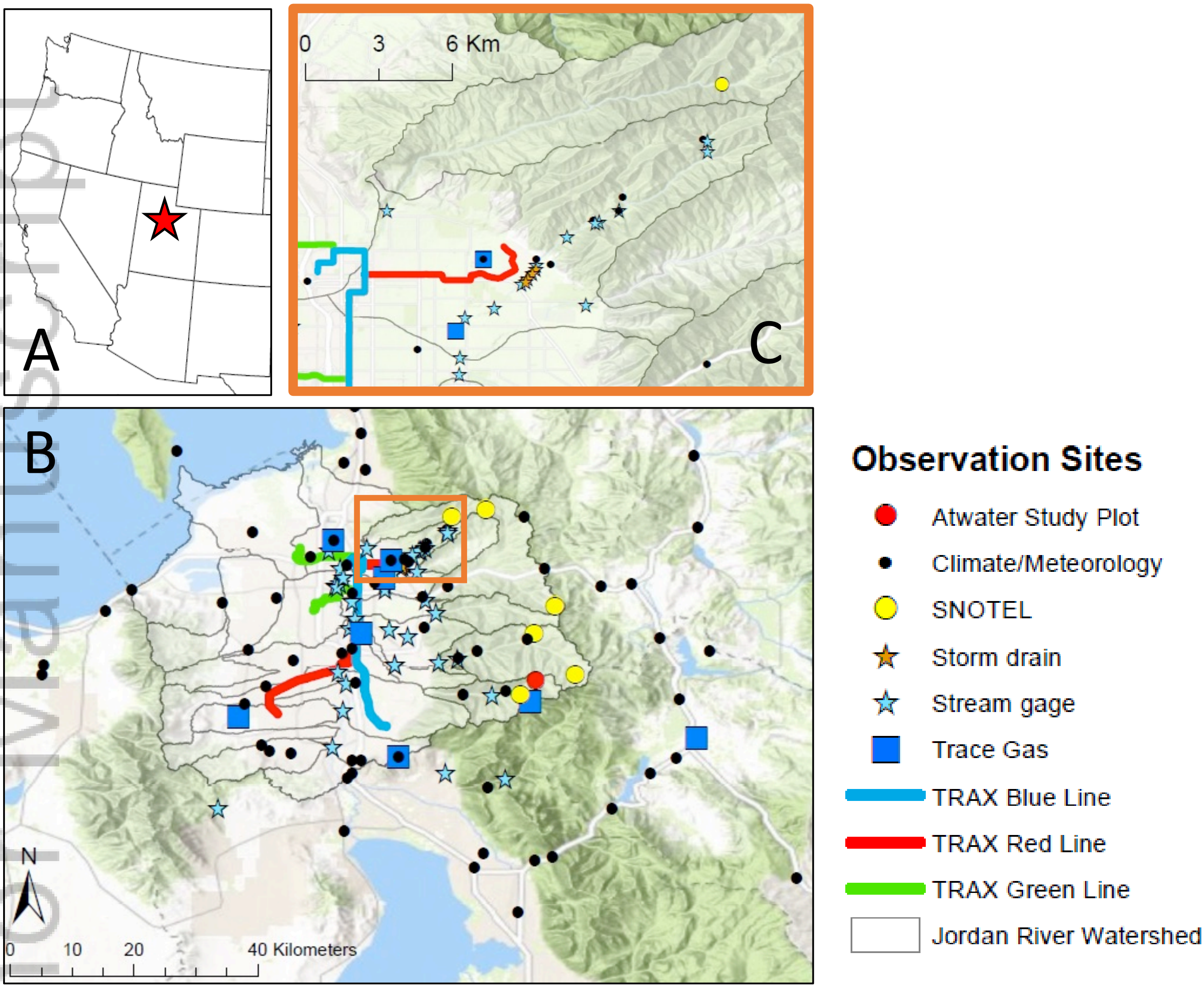
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Observation Sites
Atwater Study Plot
Climate/Meteorology
SNOTEL
Storm drain
Stream gage
Trace Gas
TRAX Blue Line
TRAX Red Line
TRAX Green Line
Jordan River Watershed

The Wasatch Environmental Observatory (WEO) combines an array of infrastructure supporting hydrologic, hydrochemical, atmospheric, climatic, meteorologic, and ecologic research within the semi-arid 2,085 km^2 Jordan River Basin, Utah, USA, which is characterized by steep gradients in elevation and montane to urban land uses. The diverse suite of fixed and mobile instrumentation managed by WEO is augmented by sensor networks operated by cooperative agencies that have recorded hydrologic and climatic data for over a century. Recent observations from the WEO network have revealed connections between water supply, water quality, and atmospheric processes, all of which are responding to rapid environmental change and population growth within the WEO study area.

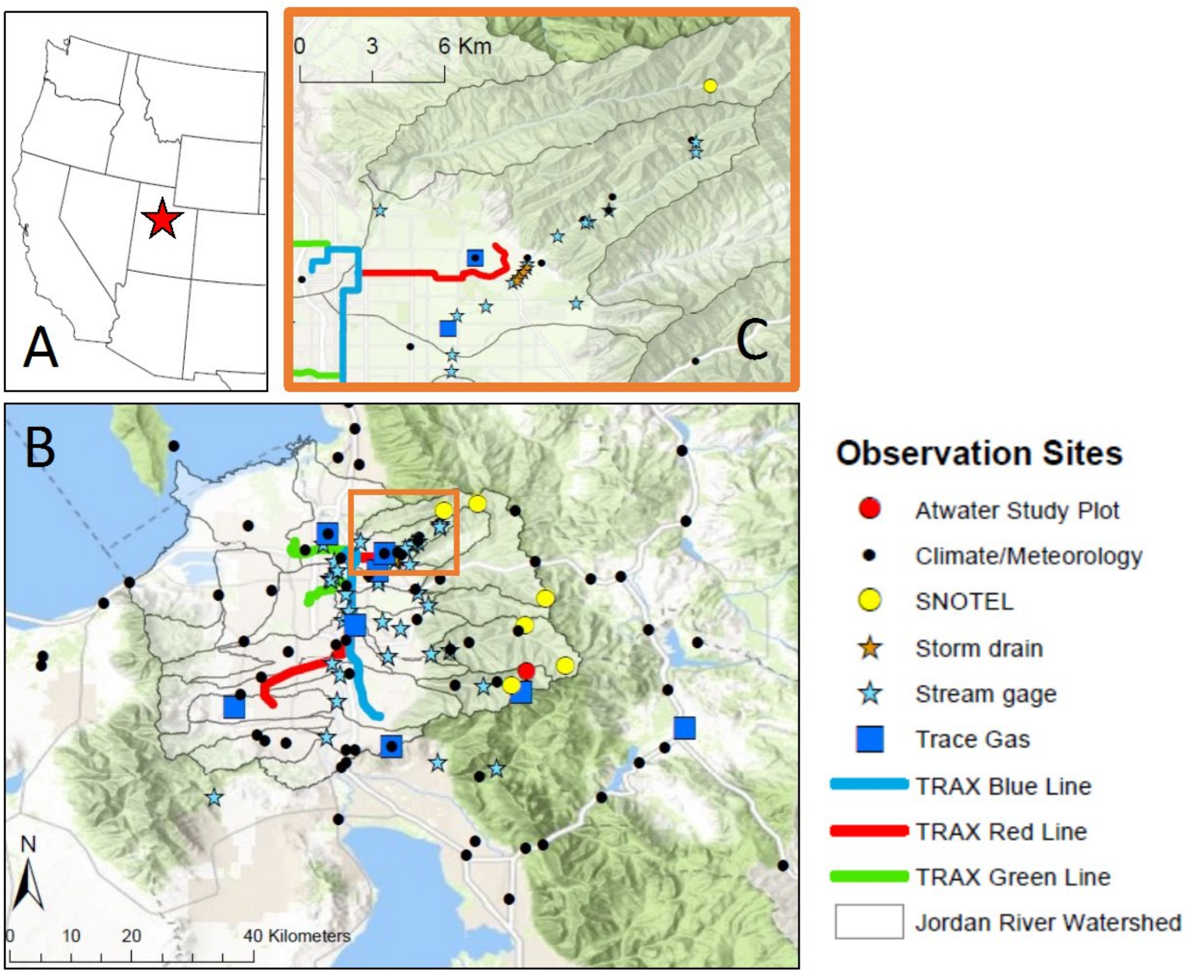


Table 1. Names and locations of fixed stations with sensors managed by the University of Utah's Wasatch Environmental Observatory (WEO). Latitude and longitude are in decimal degrees. Network names associated with acronyms are as follows: Hallar Aerosol Research Team (HART), Atwood Study Plot (ASP), Gradient Along Mountain to Urban Transitions (GAMUT), University of Utah MesoWest MesoNet (UUNET), and Utah Urban CO_2 Network (UUCON).

Sensor category	Network	Name of sensor location	Latitude	Longitude
Aerosols	HART	William Browning Building	40.77	-111.85
Aerosols & Energy Flux	ASP	Atwater Study Plot	40.59	-111.64
Climate	GAMUT	Above Red Butte Reservoir Climate	40.78	-111.81
Climate	GAMUT	GIRF Climate	40.76	-111.83
Climate	GAMUT	Knowlton Fork Climate	40.81	-111.77
Climate	GAMUT	Todds Meadow Climate	40.79	-111.80
Discharge & Water Quality	GAMUT	1300 East Aquatic	40.74	-111.85
Discharge & Water Quality	GAMUT	900 W Basic Aquatic	40.74	-111.92
Discharge & Water Quality	GAMUT	Above Red Butte Reservoir Advanced Aquatic	40.78	-111.81
Discharge & Water Quality	GAMUT	Cottams Grove Basic Aquatic	40.76	-111.83
Discharge & Water Quality	GAMUT	Foothill Drive Advanced Aquatic	40.76	-111.83
Discharge & Water Quality	GAMUT	Kowlton Fork Basic Aquatic	40.81	-111.77
Discharge & Water Quality	GAMUT	Lower Knowlton Fork Aquatic	40.81	-111.77
Discharge & Water Quality	GAMUT	Red Butte Gate Basic Aquatic	40.77	-111.82
Meteorology	UUNET	Flight Park North (FPN)	40.47	-111.89
Meteorology	UUNET	Flight Park South (FPS)	40.46	-111.90
Meteorology	UUNET	Herriman (HERUT)	40.49	-112.03
Meteorology	UUNET	Natural History Museum Utah (NHMU)	40.76	-111.82
Meteorology	UUNET	Neil Armstrong Academy (NAA)	40.71	-112.01
Meteorology	UUNET	SunCrest (SUNUT)	40.48	-111.84
Meteorology	UUNET	Trans-Jordan Landfill (TRJO)	40.56	-112.06
Meteorology	UUNET	Mountain Met Lab (MTMET)	40.77	-111.83
Meteorology	UUNET	William Browning Building (WBB)	40.77	-111.85
Meteorology	UUNET	Antelope Island Tripod (UFD09)[1]	40.93	-112.16
Stage Height	GAMUT	Connor Road Storm Drain	40.76	-111.83
Stage Height	GAMUT	Dentistry Building Storm Drain	40.76	-111.83
Stage Height	GAMUT	Fort Douglas Storm Drain	40.76	-111.83
Stage Height	GAMUT	GIRF Storm Drain	40.76	-111.83
Trace Gas	UUCON	Daybreak	40.54	-112.07
Trace Gas	UUCON	Heber	40.51	-111.40
Trace Gas	UUCON	Hidden Peak	40.56	-111.65
Trace Gas	UUCON	Intermountain Medical	40.66	-111.89
Trace Gas	UUCON	Rose Park	40.79	-111.93

Trace Gas	UUCON	Sugarhouse	40.74	-111.86
Trace Gas	UUCON	Suncrest	40.48	111.84
Trace Gas	UUCON	William Browning Building	40.77	-111.85

[1] Retired in 2019.

Table 2. Defining features distinguishing the seven sub-catchments of the Central Wasatch Range. Names of the sub-catchments are listed in order from north to south. MAT, MAP, and MAQ denote mean annual temperature, mean annual precipitation, and mean annual stream discharge, respectively. MAQ is normalized for watershed area.

Sub-catchment name (code)	Highest landmark	Altitude (m)	Area (km^2)	MAT (°C)	MAP (mm)	MAQ (mm)
City Creek (CC)	Grandview Peak	2,868	49.7	6.7	853	322
Red Butte Creek (RBC)	Unnamed	2,530	18.8	6.8	806	183
Emigration Creek (EC)	Lookout Peak	2,729	47.7	6.9	798	147
Parleys Creek (PC)	Murdock Peak	2,927	131.3	6.6	787	178
Mill Creek (MC)	Gobblers Knob	3,123	56.2	5.2	928	242
Big Cottonwood Creek (BCC)	Broads Fork Twin Peaks	3,450	129.5	4.2	1048	507
Little Cottonwood Creek (LCC)	American Fork Twin Peaks	3,502	119.4	3.3	1299	814

Table 3. Summary of data collected by WEO affiliates and cooperative agencies: data types, temporal resolution, general study locations, and numbers of study sites. URLs are links to online data visualization portals (V) and data repositories (R). Details for accessing WEO data within repositories may be found in Table 4 (direct URL links) and the Supporting Information.

Data type[1]	Timeframe[2]	Location[3]	Number of study sites	URL category	URL
WEO Sources					
Climate/Atmosphere/Air Quality					
Atwater Study Plot (ASP)	2018-present	LCC	1	R	https://mesowest.utah.edu/cgi-bin/droman/meso_base_dyn.cgi?stn=ATH20 (last 24 hours)
				R	https://download.synopticdata.com/#a/ATH20 (long-term)
GAMUT	2014-present	RBC	4	R	https://www.hydroshare.org/ (search for 'WEO')
HART	2016-present	LCC, Valley	2	R	https://uvb.nrel.colostate.eHdu/UVB/uvb-dataAccess.jsf (search for 'Utah, Salt Lake City')
UUNERD	2015-present	Valley	NA[9]	R	https://utahaq.chpc.utah.edu/aq/cgi-bin/mobile_archive.cgi (search for 'UofU Nerdmobile')
UTA TRAX	2018-present	Valley	5[10]	R	https://utahaq.chpc.utah.edu/aq/cgi-bin/mobile_archive.cgi (search for station IDs that include 'TRAX' in title)
				V	https://utahaq.chpc.utah.edu/ (ozone only)
UUCON	2013-present	Throughout	8	V	air.utah.edu
UUNET[4]	1997-present	Throughout	66	V	https://mesowest.utah.edu/ (search using map and menu)
				R	https://developers.synopticdata.com/mesonet/ (search using site ID)
Water vapor isotopes	2002-2017	Valley	1	V/R	http://waterisotopesDB.org (search using map and menu)
Hydrology/Hydrochemistry					
GAMUT storm drain	2014-present	RBC	4	R	https://www.hydroshare.org/ (search for 'WEO')
GAMUT stream gauge	2014-present	RBC	8	R	https://www.hydroshare.org/ (search for 'WEO')
Water stable isotopes[5]	1981-present	Throughout	>1300	V/R	http://waterisotopesDB.org (search using map and menu)
Cooperative Sources					
Climate/Atmosphere/Air Quality					
Weather service agencies[6]	Various[8]	Throughout	79	R	https://developers.synopticdata.com/mesonet/ (search using site ID)
CWOP[6]	Various[8]	Throughout	41	V	https://mesowest.utah.edu/ (search using map and menu)
				R	https://developers.synopticdata.com/mesonet/ (search using site ID)

NEON	2014-present	RBC	1	R	https://data.neonscience.org/data-products/explore (search by site: 'REDB' for Red Butte Aquatic Core Site)
PurpleAir[7]	2016-present	Throughout	287	V	https://www2.purpleair.com/ (search using map)
				R	https://developers.synopticdata.com/mesonet/ (search using site ID)
UDEQ	1997-present	Valley	7	V	https://air.utah.gov/; https://www.epa.gov/outdoor-air-quality-data/interactive-map-air-quality-monitors (search using interactive map)
Hydrology/Hydrochemistry					
NEON	2014-present	RBC	1	R	https://data.neonscience.org/data-products/explore (search by site: 'REDB' for Red Butte Aquatic Core Site)
NRCS SNOTEL	2000-present	Throughout	6	V/R	https://www.wcc.nrcs.usda.gov/snow/ (search using interactive map)
Salt Lake County	1908-present	Throughout	21	V/R	https://rain-flow.slco.org/; https://gisdata-slco.opendata.arcgis.com/datasets/field-parameters
USGS (discharge)	1985-present	Throughout	10[11]	V/R	https://waterdata.usgs.gov/nwis (search on site ID)
UDEQ	1975-present	Throughout	643[12]	V	https://deq.utah.gov/water-quality/databases-and-information (search map and menu for 'Salt Lake County')
USGS HBN (water quality)	1964-2021	RBC	1[13]	R	https://waterdata.usgs.gov/nwis/inventory/?site_no=10172200&agency_cd=USGS (select 'Field/Lab water-quality samples')
Elevation/Terrain					
LiDAR data	2006	Throughout	NA[9, 14]	R	https://gis.utah.gov/data/elevation-and-terrain/2-meter-lidar/

[1]Acronyms for WEO sensors represent the following networks: Gradient Along Mountain to Urban Transitions (GAMUT), Hallar Aerosol Research Team (HART), University of Utah Nerd Mobile (UNERD; mobile lab); Utah Transit Authority TRAX (UTA TRAX) light rail system, Utah Urban CO_2 Network (UUCON), and University of Utah MesoWest MesoNet (UUNET). Acronyms for cooperative agency sensors represent the following networks: Citizen Weather Observer Program (CWOP), Utah Department of Environmental Quality (UDEQ), National Environmental Observation Network (NEON), US Geological Survey (USGS) Hydrologic Benchmark Network (HBN), US Department of Agriculture National Resource Conservation Service (NRCS) Snow Telemetry (SNOTEL) network.

[2] 'Present' denotes that measurements are ongoing.

[3] Acronyms for select locations denote Little Cottonwood Canyon (LCC) and Red Butte Canyon (RBC). 'Valley' refers to the Salt Lake Valley. 'Throughout' refers to locations throughout the Jordan River Basin.

[4] The sites included in the UUNET network are those managed by the University of Utah (n = 10; Table 1) and other academic, state and commercial entities who standardize the data and provide it in real-time to MesoWest and Synoptic Data PBC.

[5] Water stable isotope data are available for rivers and streams, canals, lakes, springs, tap water, precipitation, and snow pits.

[6] Meteorologic data are provided by a number of cooperative government agencies and academic institutions.

[7] These entities are organizations who facilitate data collection via citizen science efforts.

[8] 'Various' denotes that the range of years for which data are available depends on the data source.

[9] 'NA' means 'not applicable', as the data source is either a mobile sensor deployment or a spatially explicit dataset that covers the entire region.
[10] The UTA TRAX sensor network consists of two fixed sensor locations (TRAX Hawthorne [HAWTH], TRAX Rail Line [Rail1]) and mobile deployments on three lines of the light rail system (UTA TRAX 1136 [TRX01], UTA TRAX 1104 [TRX02], UTA TRAX 1034 [TRX03]).
[11] Site IDs in the WEO study area include 10172200, 10168300, 10165600, 10164500, 10166430, 10167800, 10172371, 10171000, 10170500, 10170490.
[12] UDEQ water quality data include samples collected from a variety of habitats.
[13] 783 samples have been collected for water quality analysis during the period of record.
[14] This resource includes 0.5-meter resolution LiDAR raster data with point density of 11.93 points/m^2. Data points were collected in surveys conducted between October 18, 2013 and May 31, 2014. Spatial boundaries include 42.434 North, 39. 202 South, -111.54 East, and -112.390 West. Coordinate systems include UTM Zone 12N NAD83 (2011) for the horizontal and NAVD88 (GEOID 12A) for the vertical.

Table 4. Instrumentation, data logging frequency, and accuracy of diverse measurements collected by WEO research networks. Network names associated with acronyms are described in Table 1.

Network	Data Category	Measurement	Instrument	URL for instrument	Data logging frequency	Accuracy
GAMUT	Aquatic	Turbidity	FTS DTS 12	https://ftsinc.com/hydrology/products/sensors/dts-12-digital-turbidity-sensor/	15 min	±4%
GAMUT	Aquatic	Stage	CSI CS451	https://www.campbellsci.com/cs451	15 min	±0.1%
GAMUT	Aquatic	Water depth (storm drains)	Judd Communications Depth Sensor	http://juddcom.com/	15 min	±1 cm
GAMUT	Aquatic	Nitrate	Seabird SUNA V2	https://www.seabird.com/nutrient-sensors/suna-v2-nitrate-sensor/family?productCategoryId=54627869922	15 min	±10%
GAMUT	Aquatic	pH	YSI EXO (577602)	https://www.ysi.com/exo	15 min	±0.2 pH units
GAMUT	Aquatic	Water temperature	YSI EXO (599870)	https://www.ysi.com/exo	15 min	±0.01˚C
GAMUT	Aquatic	Specific conductance	YSI EXO (599870)	https://www.ysi.com/exo	15 min	±0.5%
GAMUT	Aquatic	Dissolved oxygen	YSI EXO (599100-01)	https://www.ysi.com/exo	15 min	±0.1 mg/L
GAMUT	Aquatic	Fluorescent dissolved organic matter	YSI EXO (599104-01)	https://www.ysi.com/exo	15 min	Linearity: R^2>0.999 for dilution of 300 ppb QS solution
GAMUT	Aquatic	Chlorophyll	YSI EXO (599102-01)	https://www.ysi.com/exo	15 min	Linearity: R^2>0.999 for dilution of Rhodamine WT solution
GAMUT	Aquatic	Cyanobacteria	YSI EXO (599102-01)	https://www.ysi.com/exo	15 min	Linearity: R^2>0.999 for dilution of Rhodamine WT solution
GAMUT	Climate	Incoming short-wave radiation	Hukseflux NR01	https://www.hukseflux.com/products/solar-radiation-sensors/net-radiometers/nr01-net-radiometer	15 min	<1.8% (calibration uncertainty)
GAMUT	Climate	Incoming long-wave radiation	Hukseflux NR01	https://www.hukseflux.com/products/solar-radiation-	15 min	<7% (calibration uncertainty)

				sensors/net-radiometers/nr01-net-radiometer		
GAMUT	Climate	Outgoing short-wave radiation	Hukseflux NR01	https://www.hukseflux.com/products/solar-radiation-sensors/net-radiometers/nr01-net-radiometer	15 min	<1.8% (calibration uncertainty)
GAMUT	Climate	Outgoing long-wave radiation	Hukseflux NR01	https://www.hukseflux.com/products/solar-radiation-sensors/net-radiometers/nr01-net-radiometer	15 min	<7% (calibration uncertainty)
GAMUT	Climate	Incoming PAR	Apogee SQ110	https://www.apogeeinstruments.com/sq-110-ss-sun-calibration-original-quantum-sensor/	15 min	±5% (calibration uncertainty)
GAMUT	Climate	Outgoing PAR	Apogee SQ110	https://www.apogeeinstruments.com/sq-110-ss-sun-calibration-original-quantum-sensor/	15 min	±5% (calibration uncertainty)
GAMUT	Climate	Surface temperature	Apogee SI111	https://www.apogeeinstruments.com/si-111-ss-research-grade-standard-field-of-view-infrared-radiometer-sensor/	15 min	±0.2˚C
GAMUT	Climate	Wind speed	CSI 5103	https://www.campbellsci.com/05103-l	15 min	±0.3 m/s
GAMUT	Climate	Wind direction	CSI 5103	https://www.campbellsci.com/05103-l	15 min	±3˚
GAMUT	Terrestrial	Soil moisture	Acclima TDT	https://acclima.com/digital-tdr-soil-moisture-sensors/	15 min	±2%
GAMUT	Terrestrial	Soil temperature	Acclima TDT	https://acclima.com/digital-tdr-soil-moisture-sensors/	15 min	±2˚C
GAMUT	Terrestrial	Bioswale soil moisture (GIRF/LL)	METER Teros 11	https://www.metergroup.com/environment/products/teros-11	15 min	±0.03 m3/m3 (generic calibration)
GAMUT	Terrestrial	Bioswale soil temperature (GIRF/LL)	METER Teros 11	https://www.metergroup.com/environment/products/teros-11	15 min	±1 °C from −40 to 0 °C, ±0.5 °C from 0 to +60 °C
GAMUT	Terrestrial	Water fluxes (LL bioswales)	FlowLine DX10 Ultrasonic Depth Sensor	https://www.flowline.com/product/echopod-dx10-ultrasonic-liquid-level-transmitter/	15 min	0.125” (3mm)

GAMUT	Climate	Precipitation	Geonor T-200B	https://geonor.com/live/products/weather-instruments/t-200b-weather-precipitation-rain-gauge/	15 min	±0.1%
GAMUT	Climate	Air temperature	Apogee ST110	https://www.apogeeinstruments.com/st-110-ss-thermistor-temperature-sensor/	15 min	±0.1˚C
GAMUT	Climate	Relative humidity	Rotronic HC2S3	https://www.campbellsci.com/hc2s3	15 min	±0.8%
GAMUT	Climate	Relative humidity	Elektronik EE08	https://www.epluse.com/en/products/humidity-instruments/humidity-measuring-modules/ee08/	15 min	±2%
GAMUT	Climate	Snow depth	Judd Communications Depth Sensor	http://juddcom.com/	15 min	±1 cm
GAMUT	Climate	Atmospheric pressure	CSI CS105	https://www.campbellsci.com/cs105	15 min	±0.5 mb
GAMUT	Climate	Ozone	2B Technologies 205	https://twobtech.com/model-205-ozone-monitor.html	15 min	Greater of ±1.0 ppb or ±2% of reading
Valley	Aquatic / Vapor	$\delta^{18}O$ and $\delta^{2}H$ of water	Picarro L2130i Laser Water Isotope Analyzer	https://www.picarro.com/products/l2130i_isotope_and_gas_concentration_analyzer	NA[2]	liquid: 0.025/0.1‰ for δ18O/δD; vapour: 0.250/0.080‰ for δ18O (for 10/100 seconds) & 1.600/0.500‰ for δD (for 10/100 seconds)
ASP	Climate	Air temperature	Vaisala hmp45c	https://www.campbellsci.com/hmp45c-l	10 min	±0.3˚C at 0˚C, ±0.2˚C at 20˚C
ASP	Climate	Relative humidity	Vaisala hmp45c	https://www.campbellsci.com/hmp45c-l	10 min	±1% at 20˚C
ASP	Climate	Wind speed	RM Young 05103	https://www.youngusa.com/product/wind-monitor/	10 min	± 0.3 m/s (0.6 mph) or 1% of reading
ASP	Climate	Wind direction	RM Young 05103	https://www.youngusa.com/product/wind-monitor/	10 min	± 3°
ASP	Climate	Incoming short-wave radiation	Hukseflux NR01	https://www.hukseflux.com/products/solar-radiation-sensors/net-radiometers/nr01-net-radiometer	1 hour	<1.8% (calibration uncertainty)

ASP	Climate	Incoming long-wave radiation	Hukseflux NR01	https://www.hukseflux.com/products/solar-radiation-sensors/net-radiometers/nr01-net-radiometer	1 hour	<7% (calibration uncertainty)
ASP	Climate	Outgoing short-wave radiation	Hukseflux NR01	https://www.hukseflux.com/products/solar-radiation-sensors/net-radiometers/nr01-net-radiometer	1 hour	<1.8% (calibration uncertainty)
ASP	Climate	Outgoing long-wave radiation	Hukseflux NR01	https://www.hukseflux.com/products/solar-radiation-sensors/net-radiometers/nr01-net-radiometer	1 hour	<7% (calibration uncertainty)
ASP	Climate	Snow depth	SR50A	https://www.campbellsci.com/sr50a	1 hour	±1 cm (0.4 in.) or 0.4% of distance to target (whichever is greatest)
ASP	Air Quality	Aerosols	GRIMM 1.109	https://www.grimm-aerosol.com	2 min	± 0.02 at 1.0 µm
HART	Air Quality	Aerosol size (fixed measurements on campus)	TSI Scanning Mobility Particle Sizer	https://tsi.com/products/particle-sizers/particle-size-spectrometers/scanning-mobility-particle-sizer-spectrometer-3938/	3 min	<2% (sizing uncertainty)
HART	Air Quality	Aerosol optical depth (fixed measurements on campus)	Multi-Filter Shadowband Radiometer	https://uvb.nrel.colostate.edu/UVB/ins-uvmfrsr.jsf	3 min	NA
UUCON	Trace gas	CO_2 and H_2O (fixed measurements on campus pre-2014)	Li-Cor 7000	https://www.licor.com/env/products/gas_analysis/LI-7000/	10 sec	~0.1 ppm
UUCON	Trace gas	CO_2, CH_4, and H_2O (fixed measurements on campus post-2014)	Los Gatos Research Off-Axis Integrated Cavity Output Spectroscope 907-0011[1]	http://www.lgrinc.com/analyzers/overview.php?prodid=23&type=gas	10 sec	~0.1 ppm
UUCON	Trace gas	CO (fixed measurements on campus)	Teledyne API 300E	https://pdf.directindustry.com/pdf/teledyne-api/analyzers-carbon-compounds-300e/22283-371500-_2.html	10 sec	0.5% of reading (measurement precision)
UUCON	Trace gas	NO, NO_2, and NO_x (fixed measurements on campus)	Teledyne API T200 U	http://www.teledyne-api.com/products/nitrogen-compound-instruments/t200u	10 sec	0.5% of reading above 5 ppb (measurement precision)

UUCON	Air Quality	$PM_{2.5}$ (fixed measurements on campus)	TEOM 1400 ab ambient particulate monitor	https://www.thermofisher.com/order/catalog/product/1400AB#/1400AB	10 sec	±1.5 µg/m3 (1-hr.), ± 0.5µg/m3 (24-hr.) (measurement precision)
UUCON	Trace gas	CO_2 (fixed measurements at 5 stations in Salt Lake Valley)	Li-Cor 6262 or 7000	https://www.licor.com/env/products/gas_analysis/LI-7000/	5 min	~0.1 ppm
UUCON	Trace gas	CO_2, CH_4, H_2O, and NO_2 (UTA TRAX measurements)	Los Gatos Research Ultra Portable Greenhouse Gas Analyzer	http://www.lgrinc.com/analyzers/ultraportable-greenhouse-gas-analyzer/	1 sec	0.3 ppm CO2, 2 ppb CH4, 100 ppm H2O, 0.05 ppb NO2
UUCON	Trace gas	O3 (UTA TRAX measurements)	2B Technologies 205	https://twobtech.com/model-205-ozone-monitor.html	2 sec	Greater of ±1.0 ppb or ±2% of reading
UUCON	Air Quality	$PM_{2.5}$ (TRAX measurements, train 1)	Met One Instruments E-Sampler	https://metone.com/products/e-sampler/	1 min	1 µg/m3
UUCON	Air Quality	$PM_{2.5}$ (TRAX measurements, train 2)	Met One Instruments ES-642 Remote Dust Monitor	https://metone.com/products/es-642/	1 sec	1 µg/m3
UUCON	Air Quality	NO_3, NH_4, SO_4, Cl, and total aerosol mass (airplane)	Aerodyne Research Aerosol Mass Spectrometer	https://csl.noaa.gov/groups/csl7/measurements/2017uwfps/finalreport.pdf	30 sec every 4.5 min	20% (concentration uncertainty)
UUCON	Air Quality	NH_3 (airplane)	Aerodyne Research Quantum Cascade Tunable Infrared Laser Differential Absorption Spectrometer	https://csl.noaa.gov/groups/csl7/measurements/2017uwfps/finalreport.pdf	30 sec	150 ppt (1σ ; measurement precision)
UUCON	Trace gas	NO, NO_2, NO_y and O_3 (airplane)	NOAA Nitrogen Oxide Cavity Ring Down Spectrometer	https://csl.noaa.gov/groups/csl7/measurements/2017uwfps/finalreport.pdf	1 sec	50 pptv (measurement precision)
UUCON	Trace gas	O_3 (airplane)	Teledyne API T400	http://www.teledyne-api.com/products/oxygen-compound-instruments/t400	1 sec	0.5% of reading above 100 ppb (measurement precision)

[1]The model 907-0011 is no longer manufactured. A newer model with the same type of technology used to measure trace gases is the GGA-24EP.
[2]Samples are collected by hand and then analyzed in a laboratory.

Table 5. Data products generated by WEO research networks between 2013-2021. All data products listed have undergone quality control assessment. Network names associated with acronyms are described in Table 1.

Network[1]	Data Category	DOI or URL[2]	Dataset Citation	Description
GAMUT	Climate	https://www.hydroshare.org/resource/6445418c7c0e426d8cb1568d296c02d1/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Network: Above Red Butte Reservoir Climate (RB_ARBR_C) Quality Controlled Data, HydroShare.	This composite resource contains quality-controlled data for select variables measured at the climate monitoring site in Red Butte Canyon Above Red Butte Reservoir (RB_ARBR_C). Each .csv file contains all of the data for a single quality-controlled variable (see Table 4 for listing). These files are updated as quality control is performed. The data values were collected by a variety of sensors at 15-minute intervals since June 2013. The file header contains detailed metadata for the site as well as the information found in each column of each datasheet.
GAMUT	Climate	https://www.hydroshare.org/resource/cde532b5d39141db9c2b22122774afae/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Network: Knowlton Fork Climate (RB_KF_C) Quality Controlled Data, HydroShare.	This composite resource contains quality-controlled data for select variables measured at the climate monitoring site in Red Butte Canyon at Knowlton Fork (RB_KF_C). Each .csv file contains all of the data for a single quality-controlled variable (see Table 4 for listing). These files are updated as quality control is performed. The data values were collected by a variety of sensors at 15-minute intervals since July 2013. The file header contains detailed metadata for the site as well as the information found in each column of each datasheet.
GAMUT	Climate	https://www.hydroshare.org/resource/e5935762e9054fc49570f02d1a28ed8a/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Network: Green Infrastructure Climate (RB_GIRF_C) Quality Controlled Data, HydroShare.	This composite resource contains quality-controlled data for select variables measured at the climate monitoring site in Red Butte Canyon at the Green Infrastructure Research Facility (RB_GIRF_C). Each .csv file contains all of the data for a single quality-controlled variable (see Table 4 for listing). These files are updated as quality control is performed. The data values were collected by a variety of sensors at 15-minute intervals since July 2013. The file header contains detailed metadata for

				the site as well as the information found in each column of each datasheet.
GAMUT	Climate	https://www.hydroshare.org/resource/79ae0f0efe2447fe9a5ab5c15427b2d8/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Network: Todd's Meadow Climate (RB_TM_C) Quality Controlled Data, HydroShare.	This composite resource contains quality-controlled data for select variables measured at the climate monitoring site in Red Butte Canyon at the Todd's Meadow (RB_TM_C). Each .csv file contains all of the data for a single quality-controlled variable (see Table 4 for listing). These files are updated as quality control is performed. The data values were collected by a variety of sensors at 15-minute intervals since November 2013. The file header contains detailed metadata for the site as well as the information found in each column of each datasheet.
ASP	Climate	https://download.synopticdata.com/#a/ATH20	ATH20 – Atwater Study Plot, Synoptic Data PBC	This dataset includes several meteorologic and climate variables (wind speed, wind chill, wind gust, net radiation, incoming and outgoing longwave radiation, net longwave and shortwave radiation, relative humidity, heat index, outgoing shortwave radiation, air temperature, solar radiation, snow depth, wind direction, wind cardinal direction, and dew point) collected at the Atwater Study Plot (ASP) between 2018-2021. Data can be requested for individual variables or a suite of variables within the period of record. Data are provided in a .csv file.
HART	Aerosols	https://uvb.nrel.colostate.edu/UVB/uvb-dataAccess.jsf	The USDA UV-B Monitoring and Research Program (2021). Salt Lake City, Utah, Network Location.	This dataset includes spectral irradiance data calibrated in situ and using two calibration factors, weighted irradiance data (erythemal and PAR), derived data products (UV index, synthetic spectra, instantaneous optical depths [aerosol and cloud], UV irradiance estimator), and ancillary climate data (air temperature, relative humidity, reflective solar irradiance, and barometric pressure). Data are provided as .xlxs, .csv, or .xml files. Data from the fixed station in Salt Lake City, Utah is available from 2019-2021.
UUCON	Fine particulate matter	https://www.esrl.noaa.gov/csd/groups/csd7/measurements/2017uwfps/	NOAA Chemical Sciences Laboratory (2017). Utah	NOAA Twin Otter aircraft and multiple ground sites throughout the region were utilized to track fine particulate matter ($PM_{2.5}$) in several basins of

			Winter Fine Particulate Study (UWFPS).	northern Utah, USA beween January 15 – February 14, 2017. Data file formats include lgor binary and ICARTT ascii.
UUCON	Trace gas	https://doi.org/10.25921/8vaj-bk51	Bares, R., Lin, J.C., Fasoli, B., Mitchell, L.E., Bowling, D.R., … & Ehleringer, J.R. (2018). Atmospheric measurements of carbon dioxide (CO_2) and methane (CH_4) from the state of Utah from 2014-09-10 to 2018-04-01 (NCEI Accession 0183632). NOAA National Centers for Environmental Information.	This composite resource contains atmospheric measurements of carbon dioxide (CO_2) and methane (CH_4) from 12 sites located across the state of Utah. Data from each site is provided in separate .csv files. QA/QC flags, measurements precision and accuracy statistics and calibrated observations are also provided.
UUCON	Trace gas	https://doi.org/10.7289/V50R9MN2	Mitchell, L.E.; Lin, J.C., Bowling, D.R., Pataki, D.E., Strong, C., … & Ehleringer, J.R. (2018). Carbon Dioxide (CO_2) mole fraction, CO_2 flux, and others collected from Salt Lake City CO_2 measurement network in Western U.S. from 2001-02-07 to 2015-10-23 (NCEI Accession 0170450). NOAA National Centers for Environmental Information.	This composite resource contains atmospheric measurements of carbon dioxide (CO_2) from the Salt Lake City CO_2 measurement network from 2001-2015 as well as several supporting data sets used to interpret the mixing ratio data. The additional data sets include atmospheric footprints (i.e. the upstream influence region on the atmospheric measurement site), fluxes of CO_2 from anthropogenic and biological sources, and gridded population in the state of Utah. All data are provided as .csv files.
UUCON	Trace gas	https://doi.org/10.1016/j.atmosenv.2018.05.044 (see supplemental file)	Mitchell, L.E., Crosman, E.T., Jacques, A.A., Fassoli, B., Leclair-Marzolf, L., Horel, J., … & Lin, J.C. (2018). Monitoring of greenhouse gases and pollutants across an urban area using a light-rail public transit platform. *Atmospheric Environment,* 187, 9-21.	This datatset contains spatial and temporal patterns of greenhouse gases and air pollutants measured along the TRAX public transit train lines in Salt Lake City, UT, USA. Data reflect averages of CO_2, CH_4, $PM_{2.5}$, O_3, and NO_2 for each transect line. Data formats include .xlxs and .kmz files.
UUCON	Water vapor isotopes	https://doi.org/10.17605/OSF.IO/EKTY3	Fiorella, R.P., Bowen, G.J. (2018). Water vapor isotope data from the Salt Lake	This dataset contains calibrated values of $\delta^{18}O$, $\delta^{2}H$, and d-excess for water vapor collected between December to February in four winters (2013-2014 to 2016-2017) from the urban core of the Salt Lake

			Valley, DJF 2013-2017. ARK c7605/osf.io/ekty3	Valley. Data are available in .rds and .dat file formats. This dataset supports analyses reported in Fiorella et al. (2018).
UUCON	Water vapor isotopes	https://osf.io/k47ft/	Fiorella, R.P. (2018). Water vapor isotope data from UOU and HDP in Salt Lake County, UT, DJF 2016-2017.	This dataset contains calibrated values of $\delta^{18}O$, $\delta^{2}H$, and d-excess for water vapor collected between December 2016 and February 2017 from the urban core within the Salt Lake Valley and an adjacent, rural high elevation site. Data are available in a .dat file format. This dataset supports analyses reported in Fiorella et al. (2019).
GAMUT	Discharge & water quality	https://www.hydroshare.org/resource/bb41efc853134d0a90fa1da0041367f5/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Network: Lower Knowlton Fork Aquatic (RB_LKF_A) Quality Controlled Data, HydroShare.	This composite resource contains quality-controlled data for stage height, discharge, dissolved oxygen (optical), pH, water temperature, turbidity, and conductivity measured using a variety of sensors (see Table 4) at 15-minute intervals at the Lower Knowlton Fork (RB_LKF_A) aquatic monitoring site in Red Butte Canyon. Each .csv file contains data for a single quality-controlled variable. These files are updated as quality control is performed. The file header contains detailed metadata for the site and the variable and method associated with each column.
GAMUT	Discharge & water quality	https://www.hydroshare.org/resource/f83c4a6ddaec4085bd152dd261a1a89c/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Network: Above Red Butte Reservoir Advanced Aquatic (RB_ARBR_AA) Quality Controlled Data, HydroShare.	This composite resource contains quality-controlled data for chlorophyll, fluorescent dissolved organic matter, nitrate, dissolved oxygen (optical), pH, water temperature, turbidity, and conductivity measured using a variety of sensors (see Table 4) at 15-minute intervals at the Above Red Butte Reservoir (RB_ARBR_AA) advanced aquatic monitoring site in Red Butte Canyon. Each .csv file contains data for a single quality-controlled variable. These files are updated as quality control is performed. The file header contains detailed metadata for the site and the variable and method associated with each column. Discharge at this site is collected by the USGS (see Table 3).
GAMUT	Discharge & water quality	https://www.hydroshare.org/resource/c0acde2d26a14a0a8a9000304a1b685a/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory	This composite resource contains quality-controlled data for stage height, discharge, dissolved oxygen (optical), pH, water temperature, turbidity, and conductivity measured using a variety of sensors

			Red Butte Network: Red Butte Gate Basic Aquatic (RB_RBG_BA) Quality Controlled Data, HydroShare.	(see Table 4) at 15-minute intervals at the Red Butte Gate (RB_RBG_BA) aquatic monitoring site in Red Butte Canyon. Each .csv file contains data for a single quality-controlled variable. These files are updated as quality control is performed. The file header contains detailed metadata for the site and the variable and method associated with each column.
GAMUT	Discharge & water quality	https://www.hydroshare.org/resource/4659632bae8a440698b1c6b0f4d3558a/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Network: Cottam's Grove Basic Aquatic (RB_CG_BA) Quality Controlled Data, HydroShare.	This composite resource contains quality-controlled data for stage height, discharge, dissolved oxygen (optical), pH, water temperature, turbidity, and conductivity measured using a variety of sensors (see Table 4) at 15-minute intervals at the Cottam's Grove (RB_CG_BA) aquatic monitoring site along Red Butte Creek. Each .csv file contains data for a single quality-controlled variable. These files are updated as quality control is performed. The file header contains detailed metadata for the site and the variable and method associated with each column.
GAMUT	Discharge & water quality	https://www.hydroshare.org/resource/47244f7407e14529944fe38333fe7612/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Network: Foothill Drive Advanced Aquatic (RB_FD_AA) Quality Controlled Data, HydroShare.	This composite resource contains quality-controlled data for stage height, discharge, chlorophyll, fluorescent dissolved organic matter, nitrate, dissolved oxygen (optical), pH, water temperature, turbidity, and conductivity measured using a variety of sensors (see Table 4) at 15-minute intervals at the Foothill Drive (RB_FD_AA) advanced aquatic monitoring site along Red Butte Creek. Each .csv file contains data for a single quality-controlled variable. These files are updated as quality control is performed. The file header contains detailed metadata for the site and the variable and method associated with each column.
GAMUT	Discharge & water quality	https://www.hydroshare.org/resource/5057577e8573433d8045b59db91b2550/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Network: 1300 East Aquatic (RB_1300E_A)	This composite resource contains quality-controlled data for stage height, discharge, nitrate, dissolved oxygen (optical), pH, water temperature, turbidity, and conductivity measured using a variety of sensors (see Table 4) at 15-minute intervals at the 1300 East (RB_1300E_A) aquatic monitoring site along Red Butte Creek. Each .csv file contains data

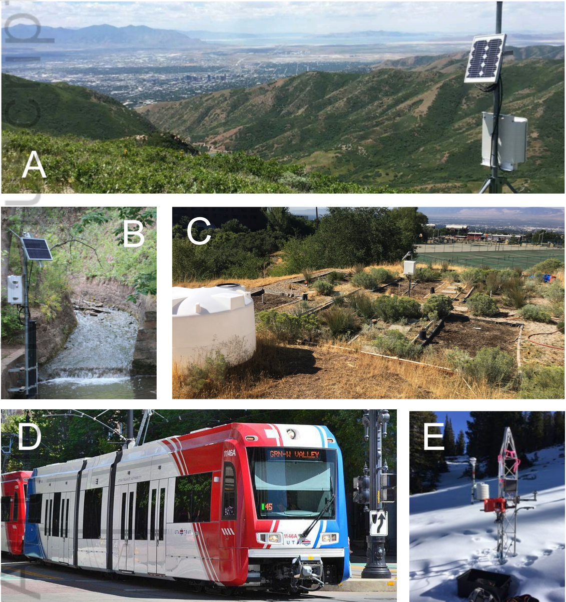
			Quality Controlled Data, HydroShare.	for a single quality-controlled variable. These files are updated as quality control is performed. The file header contains detailed metadata for the site and the variable and method associated with each column.
GAMUT	Discharge & water quality	https://www.hydroshare.org/resource/9392dbf30acc4133959ae77103ffd5c2/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Network: 900 W (1300 South) Basic Aquatic (RB_900W_BA) Quality Controlled Data, HydroShare.	This composite resource contains quality-controlled data for stage height, discharge, fluorescent dissolved organic matter, nitrate, dissolved oxygen (optical), pH, water temperature, turbidity, and conductivity measured using a variety of sensors (see Table 4) at 15-minute intervals at the 900 West (RB_900W_BA) aquatic monitoring site along Red Butte Creek. Each .csv file contains data for a single quality-controlled variable. These files are updated as quality control is performed. The file header contains detailed metadata for the site and the variable and method associated with each column.
GAMUT	Rating curve	http://www.hydroshare.org/resource/b66918eebb42426aa795351333ff6423	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Creek Network: Discharge Rating Curve at Red Butte Gate Basic Aquatic Site (RB_RBG_BA), Hydroshare.	This composite resource contains a stage-discharge relationship developed for Red Butte Creek near Red Butte Gate Basic Aquatic Site (RB_RBG_BA). Discharge measurements were collected by a SonTek FlowTracker. Files within this resource include measured stage height and discharge, as well as the curve generated from the relationship between these variables. Information on site conditions and any issues with discharge measurements are documented in a README .pdf file. Files associated with each measurement (e.g., output by the FlowTracker instrument) are contained in a .zip directory containing .xlxs files. New versions of these files will be loaded when new flow measurements are taken. Calculated discharge for this site can be found here: https://www.hydroshare.org/resource/c0acde2d26a14a0a8a9000304a1b685a/
GAMUT	Rating curve	https://www.hydroshare.org/resource/c0a5a958e95e44b5846a7d8950be7bbd/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Creek Network:	This composite resource contains a stage-discharge relationship developed for Red Butte Creek at Cottam's Grove Basic Aquatic Site (RB_CG_BA). Discharge measurements were collected by a SonTek FlowTracker. Files within this resource

			Discharge Rating Curve at Cottam's Grove Basic Aquatic Site (RB_CG_BA), Hydroshare.	include measured stage height and discharge, as well as the curve generated from the relationship between these variables. Information on site conditions and any issues with discharge measurements are documented in a README .pdf file. Files associated with each measurement (e.g., output by the FlowTracker instrument) are contained in a .zip directory containing .xlxs files. New versions of these files will be loaded when new flow measurements are taken. Calculated discharge for this site can be found here: https://www.hydroshare.org/resource/4659632bae8a440698b1c6b0f4d3558a/
GAMUT	Rating curve	https://www.hydroshare.org/resource/cf8d84ef37964fa3a10f69ce4b9f9586/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Creek Network: Discharge Rating Curve at Foothill Drive Advanced Aquatic Site (RB_FD_AA), Hydroshare.	This composite resource contains a stage-discharge relationship developed for Red Butte Creek at the Foothill Drive Advanced Aquatic Site (RB_FD_AA). Discharge measurements were collected by a SonTek FlowTracker. Files within this resource include measured stage height and discharge, as well as the curve generated from the relationship between these variables. Information on site conditions and any issues with discharge measurements are documented in a README .pdf file. Files associated with each measurement (e.g., output by the FlowTracker instrument) are contained in a .zip directory containing .xlxs files. New versions of these files will be loaded when new flow measurements are taken. Calculated discharge for this site can be found here: https://www.hydroshare.org/resource/47244f7407e14529944fe38333fe7612/.
GAMUT	Storm drain	https://www.hydroshare.org/resource/da03b8e6edf240b483eb84ee256a17d3/	University of Utah – Wasatch Environmental Observatory (2021). Wasatch Environmental Observatory Red Butte Creek Network: Dentistry Building Storm Drain (RB_Dent_SD) Quality Controlled Data, HydroShare.	This dataset contains quality-controlled data for stage height measured at 15-minute intervals within a storm drain of Red Butte Creek at the Dentistry Building (RB_Dent_SD) monitoring site. Discharge was calculated based on stage height and culvert diameter using Manning's equation. Separate .csv files contain the data for stage height and Manning's flow. The file header contains detailed

				metadata for the site and the variable and method associated with each column.
GAMUT	Water isotopes	https://doi.org/10.1021/acs.est.5b04805 (see supplemental file)	Hall, S.J., Weintraub, S.R., Eiriksson, D., Brooks, P.D., Baker, M.A., Bowen, G.J., & Bowling D.R. (2016). Stream nitrogen inputs reflect groundwater across a snowmelt-dominated montane to urban watershed. *Environmental Science and Technology*, 50(3), 1137-1146.	This supplement is a .pdf file that contains a description of the study site description, a map of sampling sites, details regarding sample collection and chemical analyses. It also contains tables providing $\delta^{18}O$, $\delta^{2}H$, and d-excess values (means and standard errors) for water samples and end members and statistical relationships between ion concentrations and discharge.
N/A	Water isotopes	https://doi.org/10.1002/2016WR019104 (see supplemental file)	Jameel, Y., Brewer, S., Good, S.P., Tipple, B.J., Ehleringer, J.R., & Bowen, G.J. (2016). Tap water isotope ratios reflect urban water system structure and dynamics across a semiarid metropolitan area. *Water Resources Research*, 52(8), 5891-5910.	This supplement is an .xlxs file that provides $\delta^{18}O$ and $\delta^{2}H$ values of tap water collected at 181 sites between spring 2013 and fall 2015 in the Salt Lake Valley, Utah, USA. Geographic coordinates of sampling locations are also provided.
N/A	Water isotopes	http://waterisotopesDB.org (Project ID: 00058)	Tap water of the Salt Lake Valley (2016). Waterisotopes.org, Project 00058.	This dataset contains $\delta^{18}O$ and $\delta^{2}H$ values and geographic coordinates of tap water collected at 795 sites in the Salt Lake Valley between 2013-2015. Data are provided as a .zip file containing two .csv files (one describing the project, one with data) and one .xlsx file providing metadata related to header descriptions associated with the data file. This dataset was used in analyses reported by Jameel et al. (2016).
N/A	Water isotopes	http://waterisotopesDB.org (Project ID: 00065)	Jordan Valley water isotopes (2018). Waterisotopes.org, Project 00065.	This dataset contains $\delta^{18}O$ and $\delta^{2}H$ values and geographic coordinates of tap water, groundwater, and surface waters collected at 187 sites in the Jordan River Valley between 2015-2017. Data are provided as a zip file containing two .csv files (one describing the project, one with data) and one .xlsx file providing metadata related to header descriptions associated with the data file. This

				dataset was used analyses reported by Jameel et al. (2018).
N/A	Water isotopes	http://waterisotopesDB.org (Project ID: 00117)	Jordan River water isotopes (2019). Waterisotopes.org, Project 00117.	This dataset includes $\delta^{18}O$ and $\delta^{2}H$ values and geographic coordinates of water, wastewater effluent, tributary inputs, and canal return flows collected at 25 sites along the Jordan River, Utah, USA in spring, summer, and fall of 2016. Data are provided as a .zip file containing two .csv files (one describing the project, one with data) and one .xlsx file providing metadata related to header descriptions associated with the data file. This dataset was used in analyses reported by Follstad Shah et al. (2019).

[1] 'N/A' denotes that the data were collected as part of a WEO-affiliated study, yet independent of the networks listed.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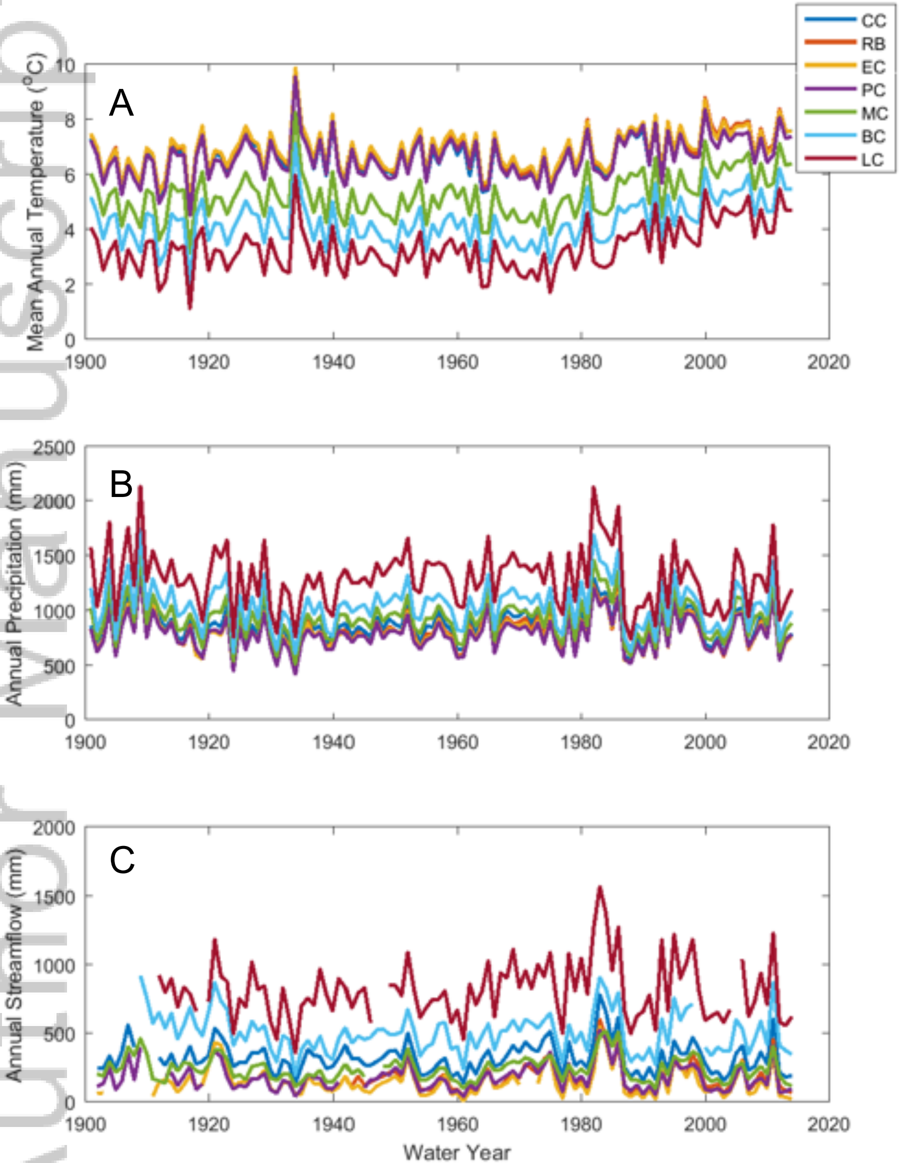
CC
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EC
PC
MC
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LC
A
Mean Annual Temperature (°C)
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2
4
6
8
10
B
Annual Precipitation (mm)
0
500
1000
1500
2000
2500
C
Annual Streamflow (mm)
0
500
1000
1500
2000
1900
1920
1940
1960
1980
2000
2020
Water Year