

## Collecting High-Quality Data to Determine Climate Changes Now and in the Future

Climate change is having wide ranging impacts to society and ecosystems globally. For example, climate change can alter rainfall, influence agricultural crop yields, affect human and animal health, cause changes to our oceans and forests, and even impact our energy supply. Environmental observations are fundamental to advance our understanding of how climate has changed, is changing, and will change in the future.

The U.S. Climate Reference Network (USCRN), developed by NOAA in the early 2000s, provides the Nation with long-term, high quality observations of air temperature, precipitation, and soil moisture and temperature collected in relatively stable and pristine environments. The USCRN's measurements also provide critical anchor points for evaluating other observing networks, both public and private. Society and the economy benefit from the USCRN as its data are used in the decision support activities for a number of applications including weather warnings, water resource management, and reinsurance. Data are also used to improve both short- and long-term forecasts to protect lives and property.

In collaboration with NOAA's National Centers for Environmental Information (NCEI), Air Resources Laboratory (ARL) researchers provide the overall



ARL Engineer Working on a USCRN Site in Wolf Point, MT. Photo: NOAA

management, engineering design and measurement capabilities and expertise for operating the USCRN stations, which includes the deployment and maintenance of the sites and regular calibration of the sensors. ARL also provides analysis of emerging sensor technologies for future applications. The near real-time and long-term archived data for all sites are served to the public by the NCEI. Unlike weather observing networks, USCRN was specifically designed with climate in mind, and the most unique feature is a triple sensor redundancy for air temperature, precipitation, and soil moisture and temperature, which is key in producing the highest quality climate data possible.



USCRN Site in Denali National Park, AK Photo: NOAA

Currently, the USCRN consists of 114 stations in the 48 contiguous States; 19 stations installed in Alaska; and 2 stations in Hawaii. An additional station is located in Canada to benchmark the U.S. networks with our North American partners. Each station is strategically placed away from urban and suburban influences to avoid any possible locally-induced biases in the climate record. All of the stations in the contiguous U.S. are equipped with air temperature, precipitation, soil moisture and temperature, and relative humidity (RH) sensors. Additionally, there are ancillary sensors measuring wind speed, solar radiation, ground temperature, and wetness to assist with the quality control of the primary air temperature and precipitation climate variables. The National Integrated Drought Information System (NIDIS) has supported the USCRN soil and RH sensors since 2009. Since demand for drought-related information is required across the country (as a result of more areas experiencing more frequent short-term droughts), the USCRN data allows the NIDIS Program to better determine drought's physical, hydrological, and socio-economic impacts on an on-going basis.



A map of the USCRN stations. Seven locations have paired sites for data comparisons. Source: NOAA

The USCRN implements the ten climate monitoring principles recommended by the National Research Council (NRC 1999). For more information, see the following references:

National Research Council (NRC), 1999: Adequacy of Climate Observing Systems, National Academy Press, Washington, D.C.

Diamond , H.J., T.R. Karl, M.A. Palecki, C.B. Baker, J.E. Bell, R.D. Leeper, D.R. Easterling, J.H. Lawrimore, T.P. Meyers, M.R. Helfert, G. Goodge, and P.W. Thorne, 2013: U.S. Climate Reference Network after one decade of operations: status and assessment. Bull. Amer. Meteor. Soc., 94(4); doi: 10.1175/BAMS-D-12-00170.

Karl, T.R., V.E. Derr, D.R. Easterling, C.K. Folland, D.J. Hoffman, S. Levitus, N.Nicholls, D.E. Parker, and G.W. Withee, 1995: Critical issues for long-term climate monitoring. Climatic Change, 31, 185-221.

Soil moisture information is critical for weather and climate, runoff potential, flood control, soil erosion, prediction of crop yields, and reservoir management. Soil moisture plays an important role in the development of weather patterns and the production of precipitation. While there are other soil moisture networks in the U.S., (e.g., USDA Soil Climate Analysis Network), the USCRN is the only ground-based soil moisture network that spans the entire contiguous U.S. with a distribution of stations in nearly all the many different topographical, vegetation, and climate environments of the country. It is also an integral part of the National Soil Moisture Network, a joint effort between NOAA and the U.S Geological Survey.



A configuration of a typical U.S. Climate Reference Network Station. Source: NOAA, National Centers for Environmental Information

## For More Information, Contact:

National Oceanic and Atmospheric Administration Air Resources Laboratory NCWCP, R/ARL, Rm. 4204 5830 University Research Court College Park, MD 20740

Howard J. Diamond, PhD – USCRN Program Manager Email: howard.diamond@noaa.gov

U.S. Climate Reference Network http://www.ncdc.noaa.gov/crn/

Air Resources Laboratory www.arl.noaa.gov