6.4 Climate Reference Network Site Reconnaissance: Lessons Learned and Relearned

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1. INTRODUCTION AND BACKGROUND

Records from existing climate networks are burdened with significant data inhomogeneities due to station moves, instrument changes, and changes in observation procedures, often of undetermined date or character. These inhomogeneities make it very difficult to separate true climate trends from other sources of climate variability (Karl et al. 1989, NRC 1999). The U.S. Climate Reference Network (US CRN) was established to provide well-calibrated and well-characterized baseline information in support of research into climatic change and variability across the United States. The network will be deployed in phases. The initial distribution will provide more or less geometrically uniform coverage across the contiguous United States. Location of the first fifty stations is guided by the need to capture the annual average climatic signal for the contiguous US. An important constraint on site locations is the need for pieces of property with stable ownership and usage practices remaining essentially unchanged for many decades to come, to provide environmental stability. This paper will summarize experiences in attempting to locate places that meet the criteria necessary to accomplish the desired goals of the network.

Long-term stable environments are taken here to mean essentially uninfluenced for 50 years or more by significant changes to the immediate environmental surroundings. This is crucial with regard to possible future encroachments by human structures. Sites are assessed on their suitability to detect, monitor, and quantify climatic trends and variations that are not unduly influenced by unrepresentative local environmental factors like topography, proximity to a body of water etc. Stations will be located to ensure that major nodes of the Nation's climate variability are captured while accounting for regional spatial representativeness, including orographic, biotic, and other environmental factors. High-risk sites are avoided; such as flood plains or low areas adjacent to river basins, estuaries, and coastal offshore barrier islands); nearby rock walls/cliffs and other blockages; and persistent periods of extreme snow depths (e.g., several meters/tens of feet). As a practical matter sites must initially be located where electric power can be accessed. The eventual selection of a US CRN instrument site will be the result of a balance between competing demands, such as those highlighted above and an assessment of the "quality of measurements." We employ a classification scheme described by Leroy (1998) to document the "meteorological measurements representativity" " for each site, and discuss issues that arise from employing that scheme in the desired geographical settings.

2. SCOPE OF ACTIVITIES

Spatial density studies provide guidance on the approximate geographic locations for a fully populated network of observing sites (e.g., Janis et al. 2002). Climate experience, knowledge and judgment are required to select appropriate areas and then identify and study more specific pieces of property representing the climate of the biomes within these areas. The survey experts assess local-scale characteristics that determine the suitability of specific sites to represent the prevailing climate. A practical matter involves discovering key personnel involved in the management and sanctioning of the property for official uses (Table 1). Interviewing such personnel to take advantage of their local knowledge of the sites in question and identifying the official contact person for site visits and follow-up agreements is regular practice.

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Table 1 Model process for site investigation and validation (approximate total time 7 days).

Identify Potential Geographic Locations (0.5 – 1.5 days) Which elevations? Is there historical compatibility? Which biomes [plant communities that are characteristic of climatic area]? Which climate regimes: east, west, coast, coast range, western valley, mountains, high plateau, etc.?
Identify Possible Host Organization/Partners (2.0 days) Identify and contact representatives of these areas. Describe the program and type of commitment needed, send material, and ask about specific locations, learn procedures they will internally require. Describe the need for nearby (paired) site when applicable. Arrange meetings and travel schedule, coordinate logistics with state climatologist (if collaborating) and with the institutional partner.
Travel to Site/Conduct Assessment (3.0 days) Fly to destination airport, drive to potential sites, conduct physical documentation of site and backup site, sketches, photo documentation, visit with site sponsor. Insure snowfall will be dealt with properly, that power is available, that local cooperator(s) will be able to monitor and tend to sites regularly, for the next several decades, obtain commitments to not disturb site for next several decades. Identify nature of communications, reliability of communications, and any idiosyncrasies for both sites.
Write Evaluation and Recommendation (0.5 day)

When investigating geographic locations for stable long-term environmental characteristics suitable for USCRN the goal is to identify long-term, stable environments that are likely to undergo little human modification in the foreseeable future. Criteria for selecting geographic locations and specific instrument sites are grounded in a strong likelihood that the sites will remain essentially uninfluenced for 50 years or more by significant changes to the immediate environmental surroundings. This is particularly true with regard to possible future encroachments by human structures. This criteria means observing sites will be in rural areas and suggests the use of national and state parks and properties operated by Universities, Audubon Society, Arboretums, Botanical Gardens, etc. Sites should be located where subsequent data can be used to detect, monitor, and quantify climatic trends and variations, i.e. places where observational values are least influenced by local environmental factors.

USCRN sites may be located near an observing station with high quality long-term records, such as a U.S. Historical Climate Network (USHCN) site. Location near other observing network sites, such as the National Atmospheric Deposition Program (NADP) or Surface Solar Radiation (SURFRAD) network provide additional advantages, such as complimentary observations and local technical response support.

2.1 Site Identification Research Techniques

Geographic locations for USCRN will primarily consist of single instrumentation sites. Specific locations, therefore, will be based on a very high confidence that the property and the host organization will be reliable and stable. Examples are astronomical observatories, such as the one on Mauna Loa, and other long-term research locations, such as National Parks. For paired sites, identifying two different host organizations in a given geographical location lowers the risk of both being abandoned if one host decides to end support during the first 50 years. In this way, paired sites may lower the risk against losing an instrument site and its associated climate signal by not having another long-term site in the nearby vicinity. However, it is often not possible to find nearby sites under the management of two different hosts. Research in this arena suggests paired stations share 95% of their minimum temperature variance at a separation distance of 30 km with maximum temperature being less restrictive. Based on this we have maintained separation distances below 25 km as a rule-of-thumb for spacing paired sites (Hubbard 1994). Paired sites should be far enough apart to minimize the risk that a single natural event (e.g., flood, tornado, etc.) would destroy both sites. Conversely, they need to be close enough such that both sites capture the area's climate signal, particularly with respect to temperature.

The survey teams attempt to obtain remotely as much information for each proposed piece of property as possible, including: latitude, longitude, elevation, digital photos of specific pieces of property, physical condition of property and surrounding area, aerial photos and topographic maps (e.g., www.geographynetwork.com, topozone.com, and terraserver.com).

2.2 Site Validation Techniques

On-site investigation is required to evaluate the pieces of property for suitability and acceptability under requirements of long-term stability of ecotone and landscape characteristics with regard to human modifications. Local environmental and nearby terrain factors have an influence on the quality of a measurement. The selection of a USCRN instrument site will be the result of a balance between competing demands. The area occupied by an individual instrument site is typically about 18 m x 18 m (Fig. 1).

Validation will be guided by the Leroy (1998) classification scheme. We will use these methods to judge the regional representativeness of meteorological measurements at each site. This scheme is being used by Meteo-France to classify their network of approximately 550 stations. The most desirable local surrounding landscape is a relatively large and flat open area with low local vegetation in order that the sky view is unobstructed in all directions except at the lower angles of altitude above the horizon. No significant obstructions should exist within 300 meters of the instrument tower (WMO 1996).

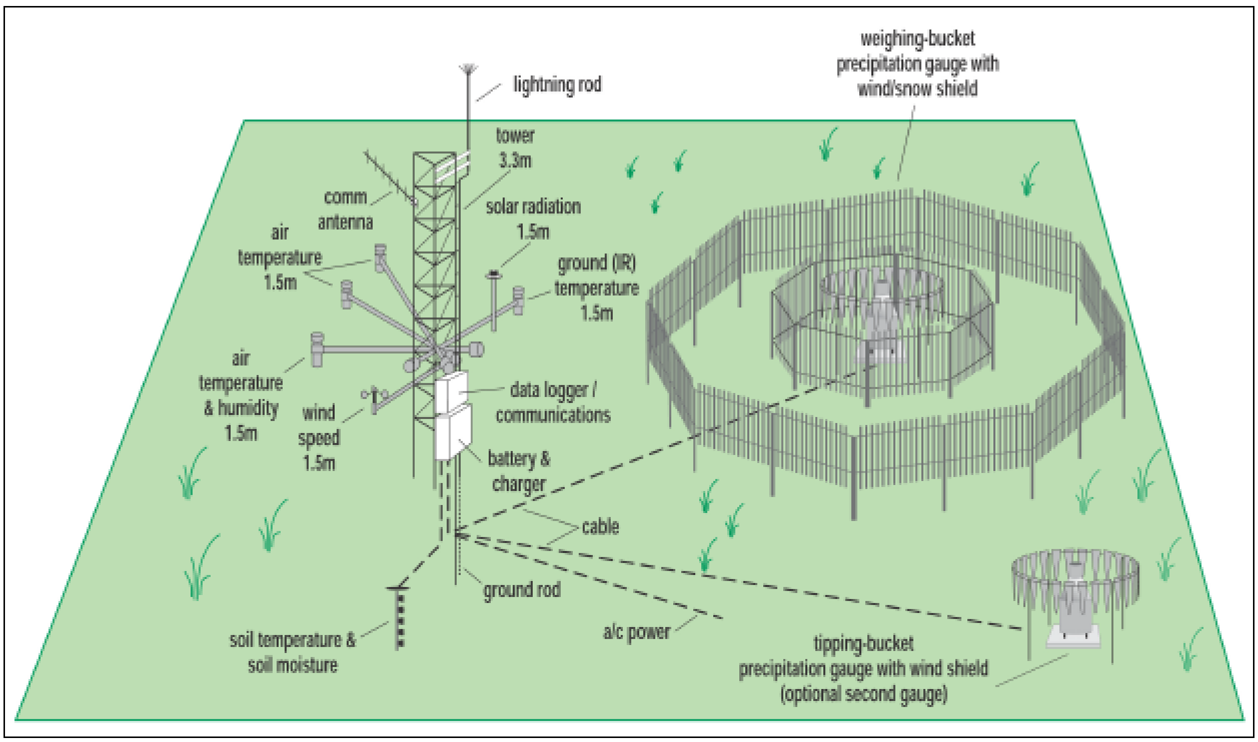

Figure 1 Schematic representation of typical USCRN site configuration.

3. LESSONS LEARNED

Competing and sometimes opposite considerations are at work when evaluating a potential piece of property. Siting requirements for one element may be inappropriate for other elements. Low vegetation, open land and wide exposure may be great for a wind measurement, but may not be very good for precipitation, where the goal is to slow down the wind and reduce gage under catch. One way to resolve such competing considerations is to resort to the fundamental purpose of USCRN, which is to focus on temperature and precipitation, and remember that the other elements are merely supportive measurements to help sort out unusual behavior of the temperature and precipitation measurements.

One repeated theme was that property managers and a variety of others often covet open pieces of property desirable for USCRN sites. In national parks, such open spaces are especially protected against visual conspicuousness of artificial structures. Often, particularly in heavily vegetated areas, open land is open for a reason, typically a reason undesirable for USCRN. Commonly, floods (of the 10-50 year return variety) are the agent for maintaining open space and parklands.

The A/C power requirement proves to be very restrictive. In Glacier National Park, for example, there are just two suitable properties for locating USCRN stations. One of these, on the west side, is an already heavily instrumented clearing in the woods, and there is barely room to squeeze in yet another platform. Though a site near existing stations offers possibilities for development of transfer functions, a new station near existing stations may not contribute as much knowledge as two stations in different climate regimes. The concurrence of the host is essential in order for a site to be enthusiastically embraced. Many potential hosts express reservations about this issue of how many sites or sensor platforms should be co-measuring the same patch of ground.

During the course of the many visits, we began to become familiar with the poor condition of many NWS coop sites. It became clear during the site visits that the USCRN will provide an indeed very useful reference value for simply understanding the prior existing thermometer and precipitation gage record.

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