6.10 THE CLIMATE REFERENCE NETWORK

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The U.S. Climate Reference Network (CRN) is a network of climate stations now being developed as part of a National Oceanic and Atmospheric Administration (NOAA) initiative. The primary goal of its implementation is to provide future long-term homogeneous observations of temperature and precipitation that can be coupled to past long-term observations for the detection and attribution of present and future climate change. Data from the CRN will be used in operational climate monitoring activities and for placing current climate anomalies into an historical perspective. The CRN will also provide the USA with a reference network that meets the requirements of the Global Climate Observing System (GCOS). If fully implemented, the network will consist of about 250 stations nationwide.

1. INTRODUCTION

The primary concept for the Climate Reference Network (CRN) is to provide the meteorological community with near real time high quality measurements of temperature and precipitation. The CRN program design ensures that there is high quality meteorological data disseminated on an hourly basis. The design of the system includes, system design, calibration, ingest, quality control, and dissemination. As with any meteorological system it is important to perform field intercomparisons and control studies to provide information about decisions made on the selection of systems. These include intercomparisons of temperature shields, and raingauge shields. The research component of the CRN program will continue studies on new sensors and measurement systems in the ensuing years.

Another aspect of a network is the geographic location of stations. The CRN program is conducting a number of studies to examine the optimum placement of stations to capture long-term trends in temperature and precipitation for the U.S to monitor climate change over the next 50-100 years.

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2. INSTRUMENTATION AND METHODOLOGY

TEMPERATURE

A number of studies have been conducted in recent years that examine the errors associated with various non-ventilated shield designs, Richardson et. al. (1999), Tanner et. al. (1996) and Brock et. al. (1995). Most of these studies have addressed the flow reduction inside the shield with respect to the ambient windspeed, temperature difference inside and outside of the shield, and the solar radiation impinging on the temperature sensor inside the shield. In most cases these studies were addressing the temperature errors associated with using unaspirated shields. This is because most networks (excluding Automated Surface Observing System) use non-aspirated shields. The lack of ventilation causes inadequate coupling of the sensor to the ambient air and is the greatest source of error in air temperature measurements (Brock et. al., 1995). One of the CRN goals is to provide the highest quality measurement of temperature that is possible and therefore it was decided that all CRN stations would have aspirated temperature measurements.

Currently, there are two types of non-aspirated air temperature radiation shields commonly used for air temperature observations in weather station networks in the United States. These shields are the Cotton Region Shelter (CRS), and the Maximum–Minimum Temperature System (MMTS). The geometrical design of the shield influences the airflow characteristics inside a shield. Thus, it is necessary to investigate the airflow and to characterize its effects on the errors in the air temperature measurements. Previous studies of airflow dynamics of radiation shields have been conducted by wind tunnel experiments (Brock et al. 1995) and numerical simulations . Air temperature errors due to radiative heating inside the shields were inversely proportional to the airflow speed through the shield. When the airspeed was low (<2 m s1) and the insolation was high (>700 W m2), the air temperature errors were quite large, >2°C (Brock et al. 1995). There is little information available on temperature response for the CRS and MMTS shields. The most recent work (Lin et. al. 2000) actually quantifies temperature measurement errors as a function of windspeed and solar insolation inside the CRS and MMTS. To date the temperature data that has been used historically to examine climatic data trends and extremes have been derived from either a CRS or MMTS. A direct result of this in terms of the design of the CRN was to include the measurement of windspeed at 1.5 meters and global solar radiation. In the long term when a CRN station is collocated with an existing coop or ASOS site correlations can be physically determined between the existing measurement of temperature and the aspirated temperature from the CRN station.

PRECIPITATION

The measurement of precipitation is complicated by the fact that it can occur in liquid or solid form. There are three established methods of measuring liquid precipitation (i.e., rain) tipping-bucket; weighing-bucket; and vibrating-wire. To measure solid precipitation (i.e., snow), the instruments have to be heated.

The problem of under-catch in precipitation gauges resulting from wind-induced turbulence at the gauge orifice can seriously affect the utility of precipitation data for climate change studies. This under-catch is even more significant during the winter due to the deleterious effect of the wind on snowfall. Additionally, tipping-bucket gauges under-measure precipitation during heavy-rain events and snow events (McKee et al. 1995 and 1996). This is an issue to which careful attention is being paid during the evaluation phase for selection of the type(s) of precipitation gauge(s) for the CRN.

A study has been conducted at the NCAR Marshall field site to examine the effect that different windshields have on the measurement of water equivalent during snowfall events and liquid precipitation events. The wind shields included a WMO Double Fence Intercomparison Reference shield (DFIR), a smaller version of the DFIR, Large Wyoming, Small Wyoming, Double Alter, and a Single Alter. The analysis of the events are being evaluated and a decision on the windshield configuration for the CRN will be determined in the fall of 2001.

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