2.1 NWS PLANS FOR UPPER AIR SYSTEM DATA CONTINUITY

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1. INTRODUCTION

The National Weather Service (NWS) is developing the Radiosonde Replacement System (RRS) to replace its antiquated Microcomputer Automatic Radio-theodolite (MicroART) system, which has been in operation since the late 1980s. Types of radiosondes flown in the current NWS network include the Sippican B2®, MARK II®, and the Vaisala RS 80®. These radiosondes will be phased out of the NWS upper air network with the introduction of the new Global Positioning System (GPS) radiosondes. Two radiosonde vendors, Sippican and Intermet®, have developed radiosondes of this new design with Vaisala beginning to develop a similar model.

The RRS is comprised of a new GPS tracking antenna referred to as the telemetry receiving system or TRS, 1680 MHz GPS radiosondes and Signal Processing System (SPS), and a new NT-based workstation. In addition to the deployment of the RRS, a new surface weather observing system called the Radiosonde Surface Observing Instrumentation System (RSOIS), and precision digital barometers will be deployed at most of the102 locations from the Caribbean to Guam and from Alaska to Pago Pago, American Samoa in the Southern Hemisphere.

One significant impact the new GPS radiosondes will have on operations will be changes to sensors for temperature, pressure, and relative humidity measurements, which have differing characteristics than current radiosondes fielded. As a result, a data continuity study is needed for assessing these sensors in a variety of climatic and meteorological conditions. This paper will discuss the approach used by NWS to meet the climate community's goals for data continuity.

2. DATA CONTINUITY GOALS

Dr. Thomas C. Peterson and Imke Durre from the National Climatic Data Center (NCDC) wrote in their report for the 15 January 2003 Meeting of NOAA's Council on Long-term Climate Monitoring: "The goal of this report is to define a continuity strategy for the Radiosonde Replacement System (RRS) transition. But more than that, it is to develop some metrics to assess what the appropriate strategy should be. When working on this assessment, it became clear that consideration should be given to radiosonde continuity beyond the RRS transition, beyond it in both time and space. Specifically, this means looking to the more distant future of NWS radiosondes and also looking at the Caribbean Hurricane Upper Air Stations (CHUAS) that the NWS supports, particularly the Caribbean GCOS Upper Air Network (GUAN) stations."

"In order to adequately assess the bias caused by the RRS transition, it is recommended that approximately 200 dual sonde flights be performed at each station. They represent a cost of about $45K for expendables per station. They are also enough dual sonde flights for the 95% confidence limit on the impact of the RRS transition induced discontinuity on a CONUS averaged tropospheric time series to be less than 0.05°C. The 0.05°C threshold was selected because it is one third of the controversial difference between two global satellite-derived tropospheric temperature time series adjustments for the discontinuity associated with the NOAA-9 polar orbiting satellite."

"The dual sonde flights are recommended to take place at a minimum of 17 and preferably 19 carefully but subjectively selected NWS radiosonde climate stations: four stations in Alaska, nine in the CONUS, five in the tropical Pacific and one NWS station in the Caribbean. In addition, one NWS supported CHUAS GUAN station was recommended for dual sonde flights."

The climate community is interested in upper tropospheric and lower stratospheric temperature changes, which might result in a climate change signature to occur. These are typically on the order of a mean temperature departure of 0.05°C or greater over a decade.

They also wrote in their report: "The second of ten basic "climate monitoring principles" endorsed by the National Research Council (NRC) and United Nations Framework Convention on Climate Change (UNFCC) is of particular relevance. It reads: Principle 2. Parallel Testing: Operate the old system simultaneously with the replacement system over a sufficiently long time period to observe the behavior of the two systems over the full range of variation of the climate variable observed. This testing should allow the derivation of a transfer function to convert between climatic data taken before and after the change. When the observing system is of sufficient scope and importance, the results of parallel testing should be documented in peer-reviewed literature."

"Radiosondes, which unarguably meet the "sufficient scope" and "importance" criteria mentioned in the preceding Principle, are tested for accuracy and reproducibility in environmental chambers or factory tests, but natural exposure cannot be fully simulated in artificial or limited flight conditions. Instrument biases

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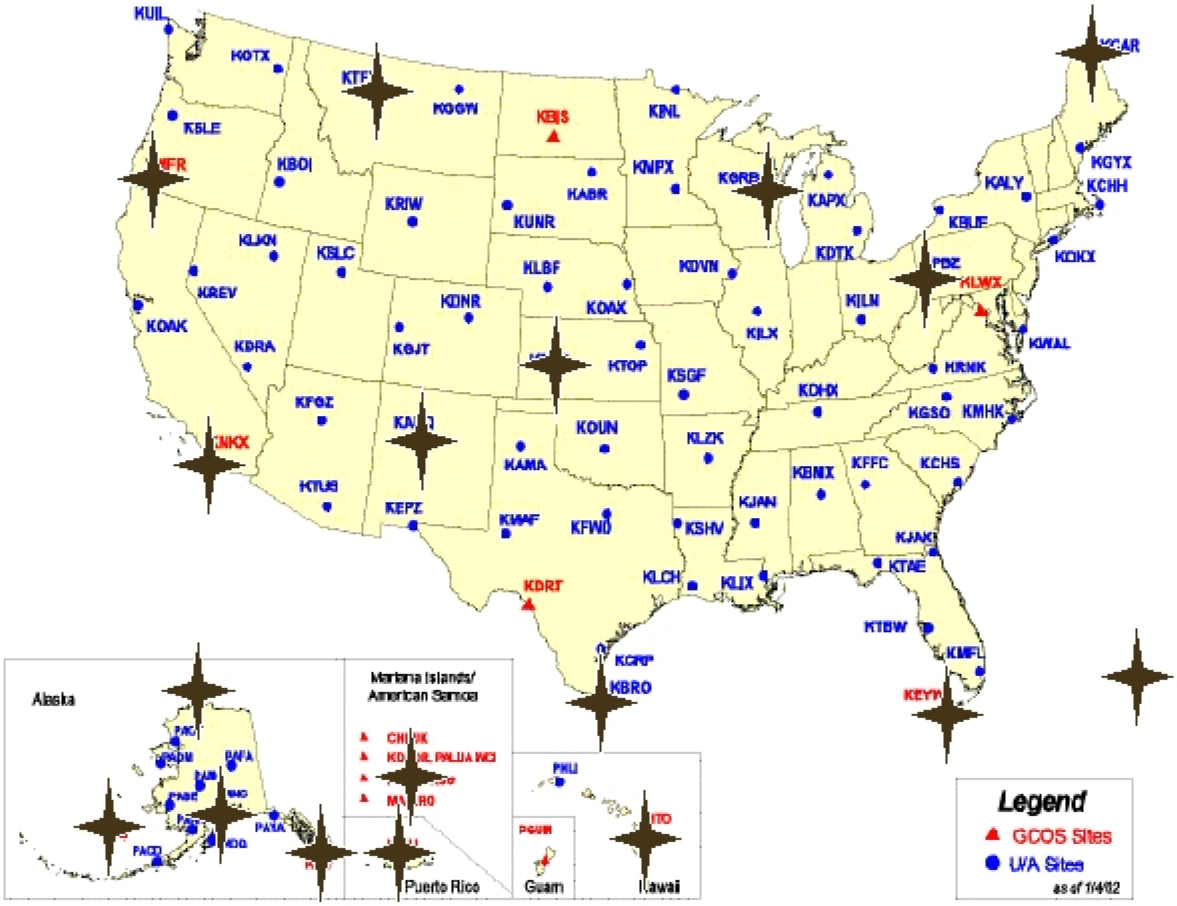

Figure 1. Potential candidate locations for the Data Continuity Study.

can vary with altitude, sensor, atmospheric conditions, sun angle, time of day, and other changes. Atmospheric quantities are continuously variable in time and space. Therefore, to address these data continuity concerns and to adhere to the climate monitoring principles, repeated measurements of the same quantities in a range of field environments will likely be required in order to determine differences between dissimilar radiosonde suites."

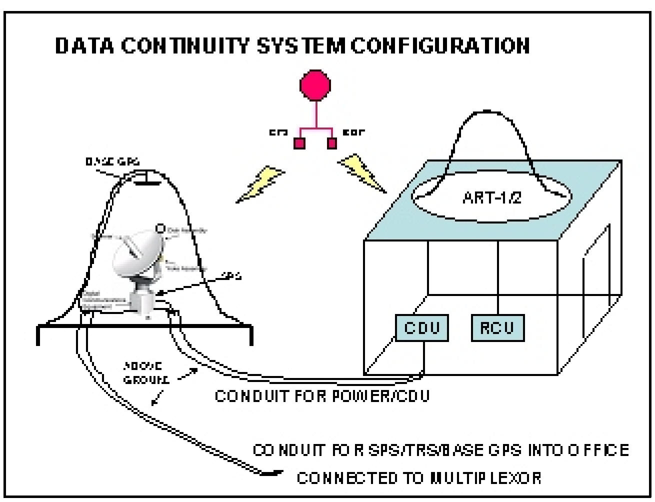

Figure 2 Dual Flight Configuration

3. NWS PLANS

In order to meet the climate community's goals as described in Section 2, the NWS is developing a plan, which will be described in this section.

The NWS plans to meet these goals through the selection of a number of NWS locations meeting the diversity of meteorological and climatological conditions as suggested in Section 2. Figure 1 illustrates potential candidates recommended in the Peterson/Durre report for these locations. However, a final set of locations will not be selected until sometime in 2004.

The basic plan, as is shown in Figures 2 and 3, is to place the RRS on the ground inside its own radome near the location of the MicroART system, which is the legacy system. MicroART will continue to be the commissioned system, while RRS will be left in an "un-commissioned" mode, i.e., its data continuity state, until the study is completed for that site. Legacy and RRS radiosondes will be tied to the same balloon flight train suspended at the same distance below the balloon to ensure a fair in situ measurement. There may be more than 200 dual soundings per station required to meet the goals above.

Upper air measurements from the locations selected will carry out the dual flights when conditions permit and still attempt to capture as many diverse conditions as possible. The plan is to cover four seasons for sub-tropical locations and at least two seasons for the tropics, where conditions do not vary enough to warrant four season testing. Of great interest will be the solar angle effects on the temperature sensor and verification of the corrections being applied by NWS. Note, the Sippican radiosonde used at most climate-designated sites do not have their temperature measurements solar corrected on-site; rather they are corrected at the National Centers for Environmental Prediction.

Telemetered signals from each radiosonde are then transmitted to their respective ground system and processed into high resolution data sets. These are then transmitted to NCDC for further processing and analysis. All dual flights will be synoptic in nature with MicroART used to transmit the official upper air observation.

Because of the relatively slow rate of deployment for the RRS, i.e., two sites per month, and the number of radomes on hand to support the study, it will require at least two years to complete the deployment to the data continuity sites and one year after receipt of a radome to complete the data gathering portion of the study at each location. At the writing of this paper, the earliest the study could start would be in late 2004 or early 2005.

4. NCDC PROCESSING

When the high-resolution data sets are received at NCDC, they will perform a quality control check to determine if the dual flight was deemed acceptable. A web site will post the results and keep track of each station's activities. If a quality control problem exists, the station will be notified quickly in order to correct the problem. If, for some reason, the problem cannot be corrected, that dual flight may be culled from the results and another may need to be taken.

NCDC will be processing the various data sets received from each station and entering them into a data base for future analysis by scientists attempting to determine the transfer function as described in Section 2. Statistical techniques will be employed to ascertain this function and report their findings at the end of the study.

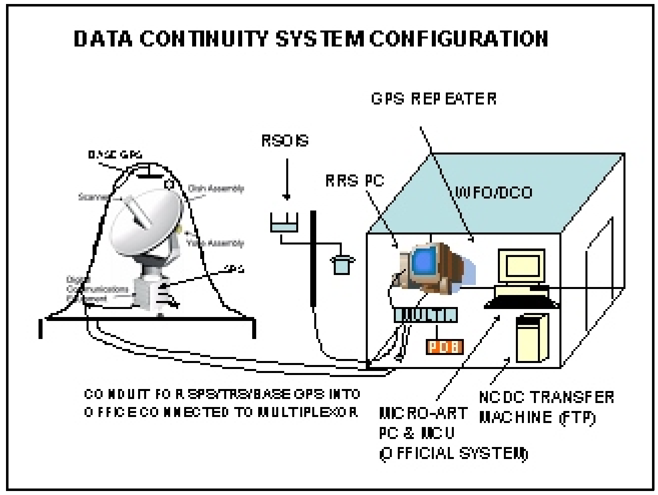

Figure 3. Office Environment

5. CONCLUSION

The planning effort delineated in this paper is meant to educate the reader about the general NWS plans for transitioning the RRS radiosondes into NWS operations. The transition to new radiosondes will necessitate a data continuity study for determining differences between these and current radiosondes in order to meet the climate community's goals.

6. REFERENCES

Peterson, Thomas C, and Durre, Imke, December 31, 2002: A Climate Continuity Strategy for the Radiosonde Replacement System Transition, prepared for the January 2003 15 Meeting of NOAA's Council on Long-term Climate Monitoring, by, National Climatic Data Center/NESDIS/NOAA.

7. ACKNOWLEDGMENTS

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