

## 7.2 PORTABLE AUTOMATED RESEARCH MICROMETEOROLOGICAL STATIONS (PARMS) DEPLOYED AT THE TAR CREEK SUPERFUND SITE FOR ENHANCED ENVIRONMENTAL MONITORING

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### 1. Introduction

Recently, portable automated research micrometeorological stations (PARMS; Fig. 1) were designed and fabricated by staff at the Oklahoma Climatological Survey (OCS) to provide enhanced observations of atmospheric conditions at remote locations.

During 2005, four PARMS were deployed at the Tar Creek Superfund site near Picher, Oklahoma to provide enhanced environmental monitoring. At this location multiple research objectives were identified including: quantifying precipitation variability at the Tar Creek watershed for initialization into hydrologic models, investigating the spatial variability of surface observations across the watershed, and comparing radar estimated precipitation and variability with in situ observations. Future research will also include an air quality monitoring focus whereby the PARMS will collect vital meteorological information in concert with sensors that sample particulates in the atmosphere. This paper will provide background information on the PARMS at Tar Creek as well as results from the ongoing precipitation study.

### 2. PARMS

The Oklahoma Mesonet is an environmental monitoring network of over 100 automated stations across Oklahoma (Brock et al. 1995; Shafer et al. 2000). The permanent stations collect observations that have been utilized by a wide range of users including scientists, decision makers, emergency managers, and K-12 students. To keep pace with the innovation represented by the Oklahoma Mesonet, a project was developed

to design and build a portable network of automated stations used to study atmospheric conditions at various spatial and temporal scales.

A number of key criteria were established in the concept phase that contributed to the final design of the stations:

- The PARMS must collect research quality data.
- The PARMS must be durable enough to withstand extended periods of deployment in the field.
- The PARMS must be user friendly such that students and researchers can utilize the equipment for a variety of research projects.
- Unlike typical Mesonet sites which are fixed in one location, the PARMS must be easily deployable from one location to another.
- The PARMS must be able to function as a portable network as well as individual stations.

Each station includes sensors to measure standard meteorological variables including air temperature and humidity at 1.5 m, downwelling solar radiation, and rainfall. However, the sites also include a 3-dimensional sonic anemometer at 2 m, a net radiometer, an infrared temperature sensor to measure surface skin temperature, and a pyranometer mounted to measure reflected shortwave radiation. The combination of sensors allows the sites to measure additional variables of the surface and radiation budgets including sensible heat flux and albedo. Furthermore, the stations were designed to be highly mobile. As such, a site can easily fit into the bed of a pickup truck or on a trailer, and deployed in remote locations with approximately 30 minutes of arrival. Once deployed, the sites operate in a network manner and collect research quality observations at 1-minute intervals and transmit the data to OCS.

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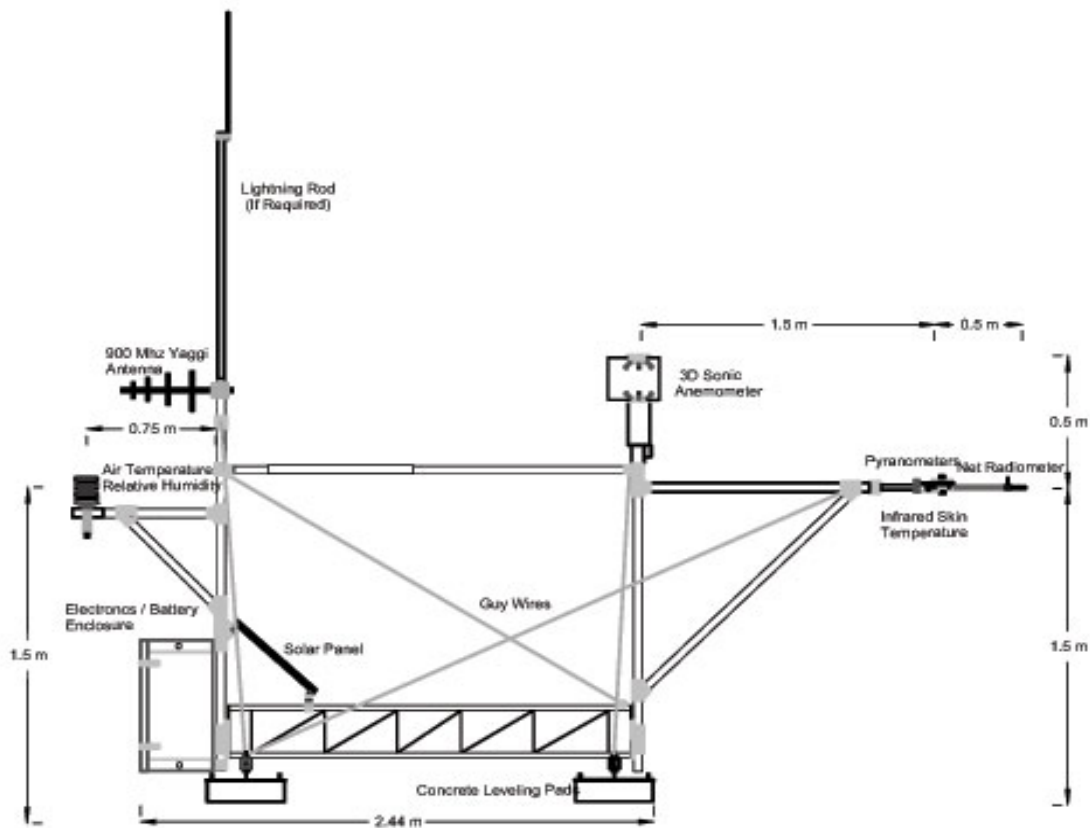


Figure 1. Diagram of a PARMS

### 3. The Tar Creek Superfund Site

The 40 square mile Tar Creek Superfund Site in northeastern Oklahoma is part of the 1,188 square mile historic zinc and lead mines known as the Tri-State Mining District in Missouri, Kansas, and Oklahoma. The district's historic lead and zinc production ranks as one of the highest in the world, with total ore production estimated to have been slightly more than 0.5 billion short tons, with production high during World War II. Mining began in the early 1900's and continued until the 1960's. The by-products of the mining operation were highly acidic mine water and large amounts of discarded mine and mill tailings, discarded in chat piles or settling ponds. The principle pollutants are lead, cadmium, and zinc, and chat was freely used and placed throughout the area by individuals and municipal and county agencies. There are approximately 30,000 people residing in the area, and most of the land on the Tar Creek site is allotted Indian Land.

On May 1, 2003, the Environmental Protection Agency (EPA) signed a Memorandum of Understanding (MOU) with the U.S. Department of the Interior and the U.S. Department of the Army to develop and implement solutions to the human health and environmental threats posed by the Tar Creek site. The MOU gives the federal agencies the opportunity to coordinate with the affected Indian tribes, the State of Oklahoma, local communities, and other stakeholders in determining the most effective manner for resolving the issues at this site ([http://www.epa.gov/region6/6ra/6ra\\_tar\\_creek.htm](http://www.epa.gov/region6/6ra/6ra_tar_creek.htm)).

### 4. PARMS Deployment at Tar Creek

During 2005, four PARMS were deployed at the Tar Creek Superfund site near Pitcher, Oklahoma. The PARMS were deployed across the watershed in two transects including the Miami, OK (MIAM) Mesonet site (Fig. 2). Both the east-west and north-south transects span approximately 13 km and the site orientation provides observations across the watershed.

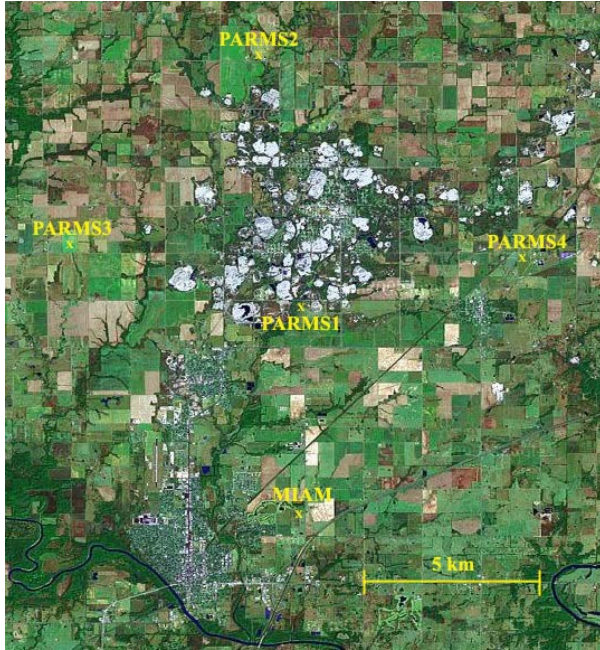


Figure 2. Locations of PARMS across the Tar Creek Watershed.

Each PARMS is equipped with a Freewave DGR-115R 900Mhz radio to allow the station to communicate with the other stations. These radios have operated with a line of sight range of over 8 km at Tar Creek. PARMS1 has been designated as the master site and is equipped with an Airlink Raven GPRS modem which transmits the data collected from the other sites via a cell phone connection back to OCS. Thus, data from the PARMS are transmitted to Norman, OK in near real time.

Three primary research objectives exist at the Tar Creek location regarding the PARMS: quantify the variability of precipitation at the Tar Creek watershed for initialization into hydrologic models, investigate the spatial variability of surface observations across the watershed, and comparing radar estimated precipitation and variability with in situ observations.

### 5. Initial Observations at Tar Creek

Initial data collection has focused primarily on the variability of precipitation at the four PARMS

### Rainfall across the Tar Creek Watershed

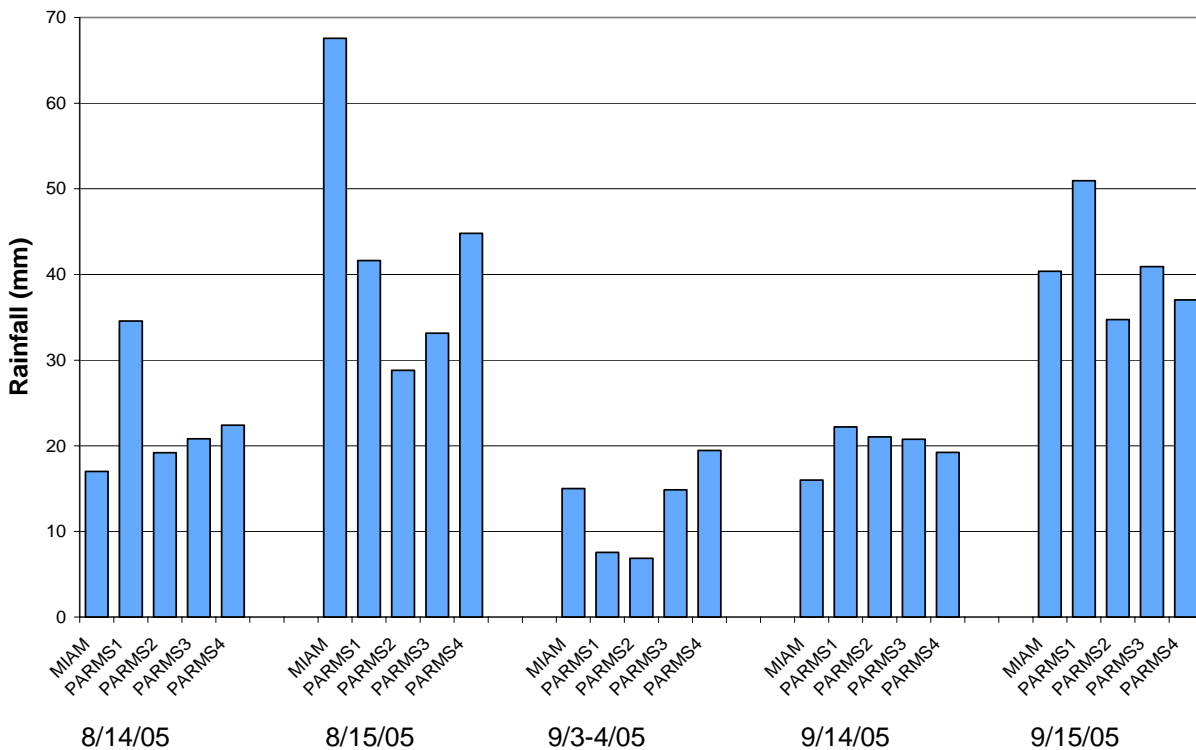


Figure 3. Precipitation totals for five separate rainfall events across the Tar Creed Watershed for each of the 4 PARMS and the MIAM Mesonet site.

and MIAM. During August and September 2005, five separate significant rain events occurred (greater than 6 mm across all sites) across the Tar Creek Watershed (Fig. 3). The initial observations show a significant amount of variability. On some occasions, there was minimal variability in the amount of precipitation between sites, such (e.g., 14 September 2005). However, other events yielded increased variability. For example, during both the 15 August 2005 and 3-4 September 2005 events some sites registered more than double the precipitation at other sites. Additionally, the variation in precipitation does not appear to have a consistent bias. Only PARMS3 was never a minimum or maximum for these five events. Another interesting note is that PARMS1, the central site of the network, was the event maximum on three occasions.

## 6. Conclusions

Four PARMS have been deployed to collect real time observations in and around the Tar Creek Watershed near Pitcher, OK. The site deployment includes multiple research objectives. Initial observations of one of these goals have been collected and the data have revealed varying

results (i.e., some events appear to be relatively homogeneous over the region and others yield greater variability). Over the upcoming months, additional events will be evaluated, as well as the other primary research objectives of the Tar Creek PARMS deployment.

## 7. References

- Brock, F. V., K.C. Crawford, R. L. Elliott, G. W. Cuperus, S. J. Stadler, H. L. Johnson, and M.D. Eilts, 1995: The Oklahoma Mesonet: a technical overview. *J. Atmos. Oceanic Technol.*, **12**, 5-19.
- Shafer, M. A., C. A. Fiebrich, D. S. Arndt, S. E. Fredrickson, T. W. Hughes, 2000: Quality assurance procedures in the Oklahoma Mesonet, *J. Atmos. Oceanic Tech.*, **17**, 474-494.
- EPA Region 6 Perspectives from the Regional Administrator: [http://www.epa.gov/region6/6ra/6ra\\_tar\\_creek.htm](http://www.epa.gov/region6/6ra/6ra_tar_creek.htm)