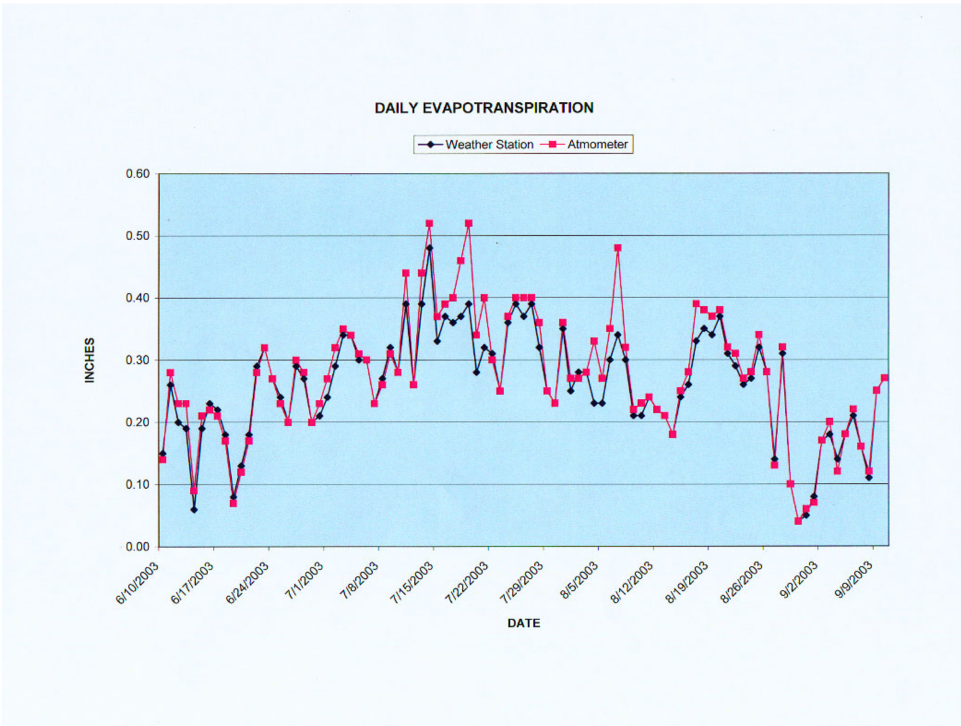
Using Atmometers for Irrigation Scheduling in Oklahoma

In the Spring of 2003, as the State Irrigation Engineer for USDA - Natural Resources Conservation Service in Oklahoma, I led an effort to educate Oklahoma irrigators in the value of evapotranspiration (ET) irrigation scheduling. In early 2003, I had discovered a research paper from Colorado State University on atmometers, which appeared to me to have potential as an economical tool for estimating evapotranspiration. I sought out resources for commercially available atmometers and found a source that sold the devices. The cost of a commercially available atmometer at that time was about $175.00. The atmometer is a device that acts as a mini-weather station. The commercial unit I found consists of a PVC container approximately 2 ½ inches in diameter by 16 inches tall. It is capped off with a ceramic evaporator surface and a disposable wafer that wicks up water to a canvas cloth of a specified weave. This device works by siphoning distilled water in the container through a straw connected to the ceramic cap. A site tube on the side of the PVC container has a direct scale to read the amount of water evaporated through the device.

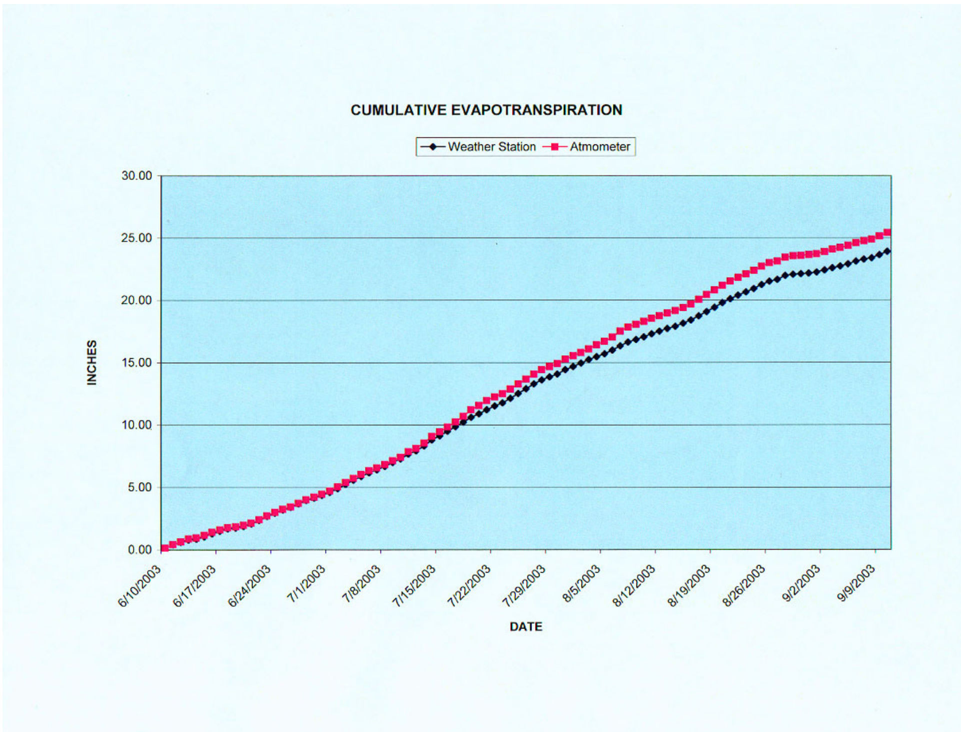
In the summer of 2003, NRCS in Oklahoma purchased a dozen atmometers to distribute to field offices for demonstration purposes. I set up an atmometer on site with a state operated Mesonet weather station at Woodward, Oklahoma. I located the atmometer on this site to compare evapotranspiration estimates from the two sources. I read the atmometer daily and recorded evapotranspiration estimates based on fully mature alfalfa. I also obtained daily evapotranspiration readings for the weather station from the Oklahoma Mesonet website. At this same time and in cooperation with Oklahoma State University, we located another atmometer on site with a weather station located at the OSU research station at Goodwell, Oklahoma. OSU researchers took daily readings from both sources and provided the data to NRCS. Readings at both sites were taken for approximately three months during the typical summer crop growing season. Daily evapotranspiration readings taken at the Woodward site is shown in Graph 1 below:

Graph 1



Graph 1 indicates that the atmometer estimated daily evapotranspiration very closely to what the Mesonet weather station estimated. The only exceptions to this appeared to be on days when temperatures exceeded 100 degrees Fahrenheit. In these cases, the atmometer had exaggerated readings that were greater than those from the weather station. Over the 2003 summer crop growing season, cumulative evapotranspiration from the atmometer at the Woodward site exceeded that from the Mesonet by only 1.49 inches or a difference of approximately 6.2% as indicated in Graph 2 below:

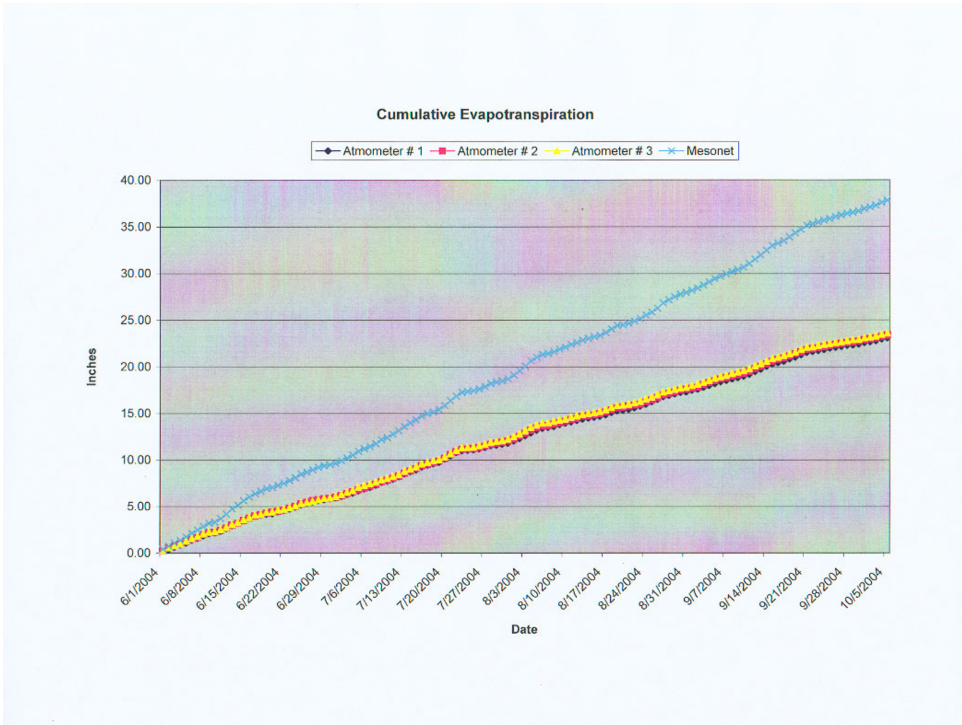
Graph 2



The field trial with OSU at Goodwell provided very similar results to the results in Graphs 1 and 2 above. The results in Graph 2 above indicated to NRCS that over a growing season, an atmometer can provide reasonable estimates of evapotranspiration similar to readings from a fully equipped weather station. Compared to a weather station costing thousands of dollars, the atmometer we found to be a simple and affordable device that could effectively be used by Oklahoma irrigators.

During this same time, NRCS ran a field trial with three atmometers at a single remote location to determine the consistency of readings between the devices. We also located these devices near a tree canopy to compare the readings of these 3 atmometers to the Woodward Mesonet site which is located on an unprotected short grass site. With the atmometers located in a different environment we anticipated that the readings would be less than those at the Mesonet site. Readings were taken daily with the cumulative evapotranspiration shown in Graph 3 as follows:

Graph 3



The results shown in Graph 3 indicated to NRCS that atmometers consistently provide accurate readings in comparison to each other when located at the same site. The results also indicated to us that an atmometer located in the same environment as an irrigators crop is a more valuable tool for scheduling than using readings from a remote weather station.

NRCS decided based on these field trials to move forward with promoting the atmometer as a tool for irrigation scheduling. Under the Environmental Quality Incentives Program (EQIP), Oklahoma NRCS in 2004 offered a ten dollar per acre incentive payment to irrigators to set up an evapotranspiration irrigation scheduling program using atmometers. The purpose of the program was to assist irrigators in the efficient use of irrigation water and to help conserve water resources.

Under this incentive program, an irrigation water management (IWM) plan is developed with the irrigator that identifies the irrigation system flow available to each field as well as the crops and soils in each field. This IWM plan establishes the management allowable depletion (MAD) for each field and a plan for saving water. I developed a "pocket sized" irrigation scheduling recordbook for irrigators to use to keep readings from the atmometer and to schedule irrigations based on the checkbook method. The recordbook also contains crop coefficient tables, a place to record monthly soil moisture readings, a place to record system flows, a scheme for scheduling, and other useful irrigation formulas to assist them in scheduling their irrigations. I also developed an automated version of the recordbook for the convenience of those irrigators that prefer to work with spreadsheets. NRCS in Oklahoma currently has thousands of acres and hundreds of irrigators in EQIP contracts receiving these irrigation water management (IWM) incentive payments.

Water savings is the ultimate goal of EQIP irrigation payment incentives. In Cimarron County, Oklahoma in 2004 NRCS worked with 8 irrigators in the Ogallala aquifer in a specific study to strictly use the atmometer as their scheduling tool versus their normal irrigation decision making process. In most cases the irrigators decision making process was simply based on their past experiences and they used no formal scheduling process. These irrigators selected fields near each other with the same crops and soils. On one field, they scheduled their irrigations using evapotranspiration estimates from the atmometer and the other field they used what they had used in the past to schedule their irrigations. The results of this study are shown in Table 1 below:

Table 1

Water Savings Achieved

1. 86 acres	alfalfa	20.8 acre feet	21% savings
2. 30 acres	corn	10.4 acre feet	26% savings
3. 125 acres	grass	20.9 acre feet	18% savings
4. 125 acres	corn	25.6 acre feet	14% savings
5. 63 acres	corn	1.4 acre feet	1% savings
6. 118 acres	wheat	2.0 acre feet	4% savings
7. 118 acres	corn	15.0 acre feet	15% savings
8. 116 acres	corn	10.0 acre feet	10% savings
TOTAL SAVINGS		106.1 acre feet	13.6% savings

These irrigators achieved an average of 13.6 % water savings during this crop growing season. These irrigators were quite impressed with the results of the study and saw the value of irrigation scheduling using evapotranspiration.

Conclusion:

Based on the work NRCS has done with irrigators in Oklahoma, atmometers are an easy to read, accurate, inexpensive tool for irrigators to use when scheduling their irrigations. NRCS in Oklahoma has concluded that notable water savings are realized using evapotranspiration irrigation scheduling methods and continues to promote this method using atmometers.