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DEVELOPMENT OF A CLIMATOLOGICAL DATABASE FOR DRYLAND AGRICULTURAL RESEARCH

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1. INTRODUCTION

The USDA-ARS Columbia Plateau Conservation Research Center (CPCRC) near Pendleton, OR has a meteorological monitoring network consisting of seven remote meteorological stations. The stations are located on private cooperator properties in northeastern Oregon. The network, shown in Figure 1 and Figure 2, collects hourly and daily meteorological data for agricultural research and archival in a climatological database.

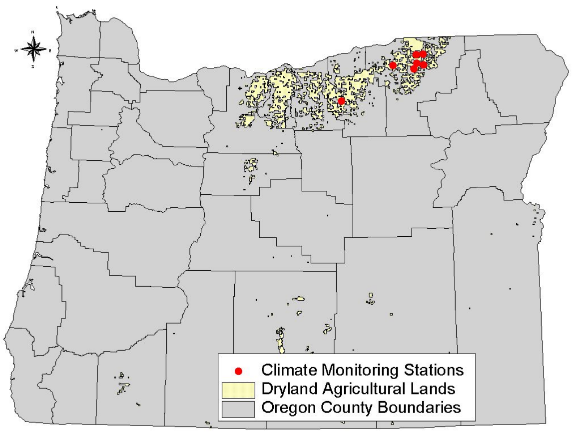

Figure 1. USDA-ARS climate monitoring site locations in association with dryland agricultural lands on the Columbia Plateau in eastern Oregon (September 2002).

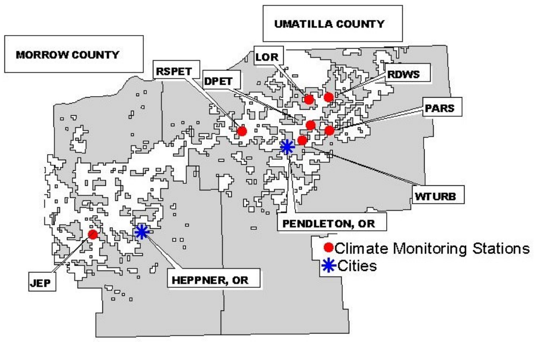

Figure 2. Detailed monitoring site locations, dryland agricultural lands, and major city locations in Umatilla and Morrow Counties, Oregon (September 2002).

Historically, data collection in this region has been sporadic with few monitoring locations. Monitoring has generally been conducted in urban areas (towns) that often do not reflect the overall climatic conditions of the area, especially considering the extreme variability between measurements collected on ridges, watershed basins, and on north-facing or south-facing hillslopes.

2. NETWORK DESCRIPTION

The ARS-CPCRC meteorological monitoring network consists of seven remote weather stations continuously collecting meteorological data for use in ARS and collaborating research projects. Each monitoring site in the network collects wind speed, wind direction, air temperature, relative humidity, 1" and 4" soil temperature, solar radiation, precipitation, 4" soil water content (and additional depths at select locations), and calculated Penman-Monteith evapotranspiration (PET).

The data are retrieved via cellular telephone telemetry to a PC located at CPCRC. The data are used in studying weather/climate effects on soil erosion, plant stress associated with developing sustainable soil and water conservation systems, cropping system water use and storage, climate model validation, as well as, providing the foundation for a long-term regional database of climatic conditions on the Columbia Plateau.

Several stations are located in close proximity to one another; however, the network configuration (site placement) is necessary due to the occurrence of extremely variable microclimates in relatively short distances. The Blue Mountains (located south and east of the Columbia Plateau) induce dramatic changes in temperature and precipitation patterns due to upslope/downslope and drainage winds. At locations in the foothill zones, (where much of the network is located), annual precipitation totals can vary by as much 25 mm to 50 mm for every 1-2 km due to orographic lifting, as well as the tracking of individual storm systems.

Factors in selecting ARS monitoring station location included: proximity to research areas (plots or fields), access for vehicles and landowner permits, and site security. Figure 3 shows a typical monitoring site installation.

The stations in the network are sited, installed, and operated following recommended practices outlined by EPA, NOAA, and other agencies. One major exception is the measurement height of the wind speed and direction sensors. EPA and NOAA recommend a measurement height of 10 m above ground level. The ARS sites measure the wind speed and wind direction at 3 m. This height is used in order to provide measurements more representative of the research activities in the canopy and at ground level (Oviatt and Wilkins, 2002).

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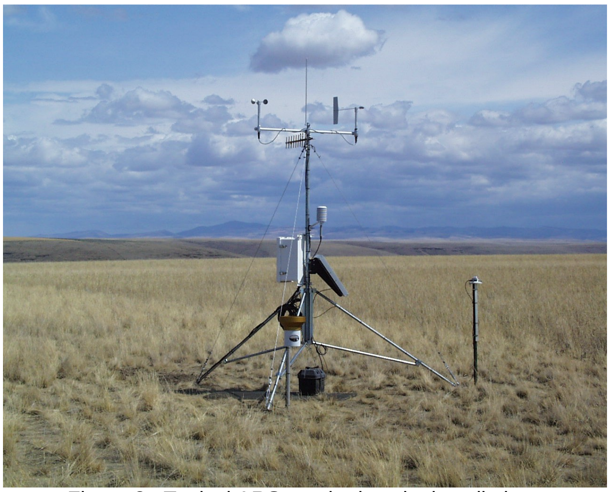

Figure 3. Typical ARS monitoring site installation.

The stations in the network have been installed and made operational during the period June 2000 through August 2002. Table 1 provides the installation date, physical coordinates, and elevation for each site. In the dryland agricultural areas, the crop water year begins September 1, and ends August 31 of the following year. Five of the seven sites were installed prior to September 1, 2000 (PARS, DPET, RDWS, LOR, RPSET). Two full crop water years have been collected (for most parameters) at these locations.

Table 1. Site Coordinates and Elevations.

Site	Install Date	Latitude	Longitude	Elevation
PARS	06/00	45° 43'	118° 38'	453 m
DPET	01/00	45° 43'	118° 39'	428 m
RDWS	05/00	45° 49'	118° 38'	546 m
LOR	06/00	45° 48'	118° 41'	545 m
RPSET	01/00	45° 44'	119° 30'	314 m
WTURB	02/02	45° 40'	118° 45'	313 m
JEP	08/02	45° 20'	119° 47'	706 m

The network scheme was originated on existing research plots (initial 5 sites), and expanded as new research projects (WTURB) and cooperative agreements (JEP) have been established. Due to the varied topography and site placement, springtime and early summer convective thundershowers often impact monitoring sites resulting in increased crop vigor and yield due to precipitation, or damage from wind events.

Table 2 provides a listing of the parameters currently monitored at each site. All monitoring sites currently monitor soil water content at the 4" depth (a critical soil depth for seed environment and root growth and development). The Jepsen (JEP) site was installed during August 2002. Four soil water content sensors were installed through the soil profile to maximum depth at bedrock (4", 8", 12", and 16"). This measurement approach of the entire soil profile (rootzone) will be applied to new monitoring sites as they are added to the network.

Table 2. Parameters Monitored at Each Site

Site Name	Parameters Measured *
PARS	WS, WD, T, RH, SR, P, S1, S4, PET,M4
DPET	WS, WD, T, RH, SR, P, S1, S4, PET, M4
RDWS	WS, WD, T, RH, SR, P, S1, S4, PET, M4
LOR	WS, WD, T, RH, SR, P, S1, S4, PET, M4
RPSET	WS, WD, T, RH, SR, P, S1, S4, PET, M4
WTURB	T, RH, S1, S4, PET. M4
JEP	WS, WD, T, RH, SR, P, S1, S4, PET, M4, M8, M12, M16

* WS = Wind Speed (m/s)
WD = Wind Direction (deg)
T = Air Temperature (deg C)
RH = Relative Humidity (%)
SR = Solar Radiation (Langleys/Day)
P = Precipitation (mm)
S1= Soil Temperature (deg C)
S4= Soil Temperature (deg C)
PET= Calc. Penman-Monteith Potential Evapotranspiration (adj. w/ seasonal K-Factor)
M4 = 4" Soil Volumetric Water Content (%)
M8 = 8" Soil Volumetric Water Content (%)
M12 = 12" Soil Volumetric Water Content (%)
M16 = 16" Soil Volumetric Water Content (%)

As new cooperative partnerships are formed with growers and other agencies, it is anticipated that the network may be expanded to increase coverage area, and thus the informational value of the network.

3. INITIAL OBSERVATIONS

Since the monitoring network has been installed for a relatively short period of time (2 crop water years), the initial data findings and comparisons still need to be reviewed in general terms. As the data network continues long-term operation, specific climatic trends and tendencies can be identified and used to develop decision tools for the regional agricultural community.

Precipitation has varied between sites in the initial phases of monitoring. Table 3 and Figure 4 provide the crop year precipitation for the last 2 years, as well as, the annual mean for each site location. The data indicate expected rainfall distribution from higher elevation sites to lower elevation sites (from east to west). However, sites located in relative proximity to each other (PARS/DPET and RDWS/LOR) did not consistently collect similar amounts of total precipitation. This was not only evident in the annual totals, but individual storm (event) totals indicated differences, as well. It is important to note that approximately 2-3 kilometers separate the PARS and DPET sites. The same approximate distance separates the LOR and RDWS sites.

Daily variances have also been observed in minimum temperatures, maximum temperatures, and daily total shortwave radiation. These cumulative differences verify the topographic and site locations influences on climate. As the network is operated for extended periods over several years, certain patterns will be more readily identified. The direct relationship between site placement and micrometeorology is already evident. It will be important to follow these relationships in a long-term study.

Table 3. ARS Monitoring Network Annual Precipitation (mm/year)

Crop Year	PARS*	DPET*	RDWS#	LOR#	RSPET&
2000-2001	390	402	372	355	285
2001-2002	329	278	258	297	200
2-Year Avg	360	340	315	326	243
Annual Mean	419	419	375	375	279

* Annual Mean PARS and DPET from Pendleton Experiment Average 1931-2001

Annual Mean RDWS and LOR determined from PDT NWS and Pendleton Exp Station Data

& Annual Mean from Echo, OR Long-Term Data and PDT NWS Data

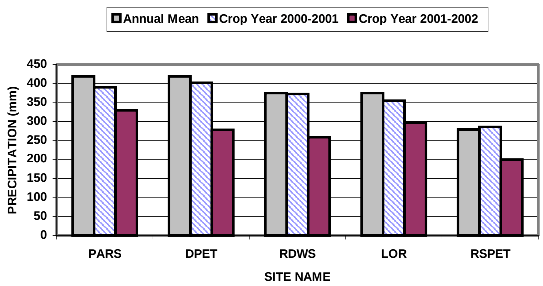

Figure 4. Annual Precipitation (mm/year) for Crop Year 2000-2001, 2001-2002, and Annual Mean By Site Location.

4. SUMMARY AND DATA APPLICATIONS

Historically, cropping system development and modeling has been limited by lack of site-specific climate data in the Pacific Northwest. Many growers and producers in the region have relied on site-specific information or knowledge of local conditions; however, researchers have traditionally used and generated climatic data sets from weather stations located at experiment stations or in municipal/urban areas. The weather and climate generators used in agricultural models have most frequently used the NOAA Class I and II station climatic databases for reference and generation of site-specific averages and ranges (temperature, precipitation, etc.). While the NOAA data are accurate, and reliable for the collection location, they do not provide a site-specific reference. As a result, the output from models used to predict crop development, crop water usage (dryland), soil erosion, and disease incidence (among other emphasis areas), has not been comparable to actual and measured conditions in the field. Additionally, the NOAA stations do not collect continuous PET or soil water content data, as does the ARS network.

Through the implementation and development of the ARS climate-monitoring network on the Columbia Plateau, a concise agricultural climate data collection system has been put in place to achieve the following:

- Disseminate important site-specific weather data to growers, extension agents, and other agencies.
- Database for developing decision aids (tools) for grower/extension agent use based on soil water storage to allow for choosing between various cropping practices.
- Provide a database for developing agricultural models for use by growers and other agencies.
- Continue adding to database to assist in developing sustainable cropping systems for the Columbia Plateau.
- Integrate the network data into a national agro-climatic database for use by agencies, growers, and researchers, outside the Pacific Northwest.

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6. REFERENCES

Oviatt, H.S., and D.E. Wilkins, 2002: USDA-ARS meteorological monitoring in northeast Oregon. *2002 Columbia Basin Agricultural Research Center Annual Report*. **1040.** Oregon State University Agricultural Experiment Station.