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ARM Facilities Newsletter

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Atmospheric Radiation Measurement Program

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Eddy Correlation Systems Receive Upgrade

Eight eddy correlation (ECOR) flux measurement systems are now deployed throughout the ARM SGP CART site. These systems are used to determine the flux (flow) of sensible heat, the flux of latent heat, and air momentum just above cropland a few hundred feet upwind of the ECOR locations. (Sensible heat is energy we feel as warmth. Latent heat is the energy that evaporated water vapor measured in the atmosphere.)

The ECOR systems actually measure wind velocity and temperature fluctuations, water vapor, and barometric pressure. The surface flux values for sensible heat, latent heat, and momentum are calculated from these measurements.

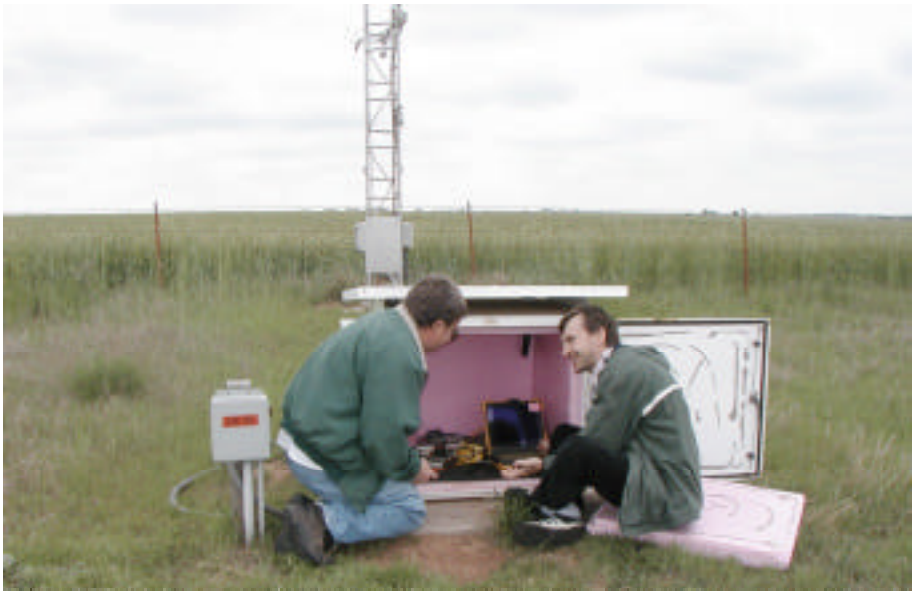

Figure 1. ARM field technician Mike Rainwater (left) and ECOR instrument mentor Dr. Mikhail S. Pekour install new computer equipment in the ECOR shelter.

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The surface energy fluxes are needed to understand interactions between the land surface and the atmosphere that are important driving forces of our daily weather. The values are also important to farmers who raise crops and use irrigation systems.

Figure 2. The ECOR system mounted in a field. The sonic anemometer is at the end of the boom on the left. The infrared hygrometer is to the right of the anemometer.

An ECOR system has a sonic anemometer to measure wind speed components in two horizontal directions and one vertical direction. The sonic anemometer transmits ultrasonic sound pulses between transducers and determines wind speed by measuring the travel time between the two points. Air temperature is also derived from the sonic anemometer data. Water vapor density is determined by using an infrared hygrometer, which measures the absorption of infrared radiation along a light path.

Since the initial installation of the ECOR systems, technology has advanced, pushing the current setups toward obsolescence. In addition, the original ECOR systems did not allow for remote data retrieval. Data had to be collected manually every two weeks when an ARM field technician visited the site for scheduled maintenance. If the ECOR system failed during a two-week unattended period, data were lost, or data quality suffered. Component failure was all too common, and it caused many periods of downtime for the instruments.

The computer hardware, sonic anemometers, and infrared hygrometers are now being replaced in each ECOR system. The upgraded systems will allow data to be downloaded to the ARM data archive on a near-real-time basis via the Internet. The instrument mentor (the scientist who specializes in the operation of the ECOR systems) will be able to monitor the system's operation and the data quality from his office near Chicago. The upgraded instruments will be more reliable, will provide more stable data streams, and will cut the costs of ECOR operation.

ARM also employs 14 energy balance Bowen ratio (EBBR) systems to estimate sensible and latent heat fluxes over the SGP CART site. The EBBR system measures air temperature, relative humidity, soil temperature and moisture, soil heat flow, barometric pressure, net radiation, and winds. From these measurements, the system calculates the same quantities as does the ECOR, but with a technique called the Bowen ratio approach. ARM uses both types of systems to estimate surface energy fluxes because each system has advantages and disadvantages. The EBBR and ECOR are both very sensitive to their surroundings. The EBBR will not perform well over a vegetation surface whose height changes over time, because it makes measurements with sensors located close to the ground. As grasses or field crops grow, they interfere with the accuracy of the measurements. The ECOR system is much more useful over changing vegetation surfaces. Using both types of instrument systems gives scientists access to more complete data covering various surface types.

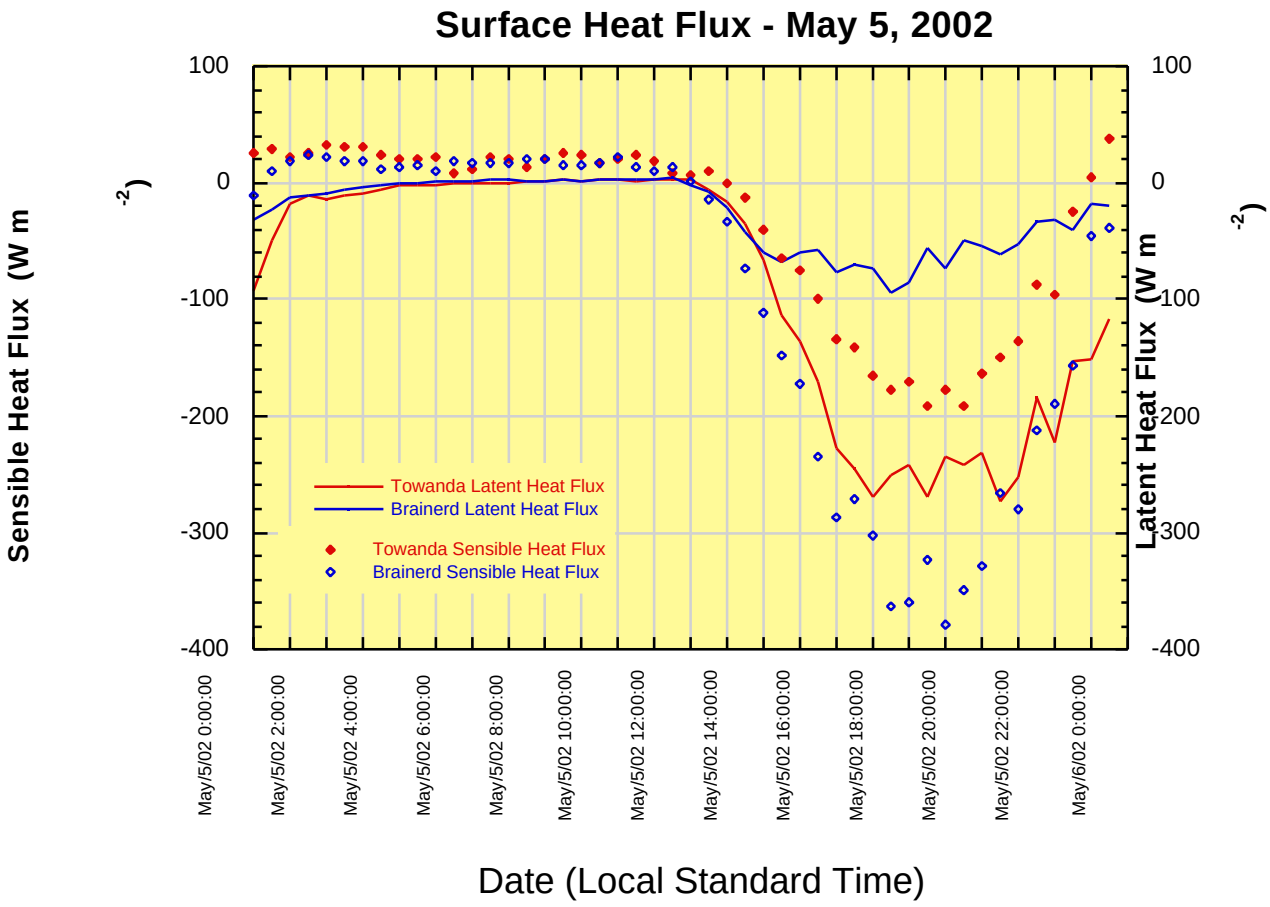

Figure 3. Surface heat flux data from ECOR systems at Towanda and Brainerd, Kansas. The system at Brainerd is installed over bare soil, and the Towanda system is over vegetation. Note that sensible heat flux is greater over bare soil, while latent heat flux is greater over vegetation.