1.2 THE QUOTIDIAN CYCLE OF EVAPOTRANSPIRATION FROM SALTCEDAR

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1. THE SALTCEDAR MEASUREMENT SITE

This paper reports quotidian (daily) evapotranspiration measurements for 1999 at a dense saltcedar stand on the floodplain of the Rio Grande near Soccoro, NM (34°N, 107°W). The experimental plot was about 350 m wide by 1000 m long, at an elevation of 1374 m. Height of the dense saltcedar ranged from 5 to 7 m. A north (n) tower and a south (s) tower were placed about 685 m apart on the N-S centerline of the plot to support flux sensors at 15 m height. Each instrument package included a CSI data logger, a radiometer for net radiation Q, discs for soil heat flux G, and two sets of one-propeller eddy correlation (OPEC) sensors. OPEC systems measure sensible heat flux H with a sensitive, vertically oriented, propeller anemometer and a fine-wire thermocouple. OPEC latent heat flux LE is obtained as a residual in the surface energy balance G=Q+H+LE, with all 4 fluxes positive upward.

2. VERIFYING OPEC SENSIBLE HEAT FLUX

Basic flux data were obtained at 10 Hz averaged over 30-min periods for each of the 365 days of the year. All valid 30-min data were integrated into daily energy flux totals (MJ m^{-2} d^{-1}). North tower days with complete data validate in Fig. 1 the OPEC sensible heat flux measurements (nH) by comparison against results (nH3) from a CSI 3-dimensional sonic eddy correlation system.

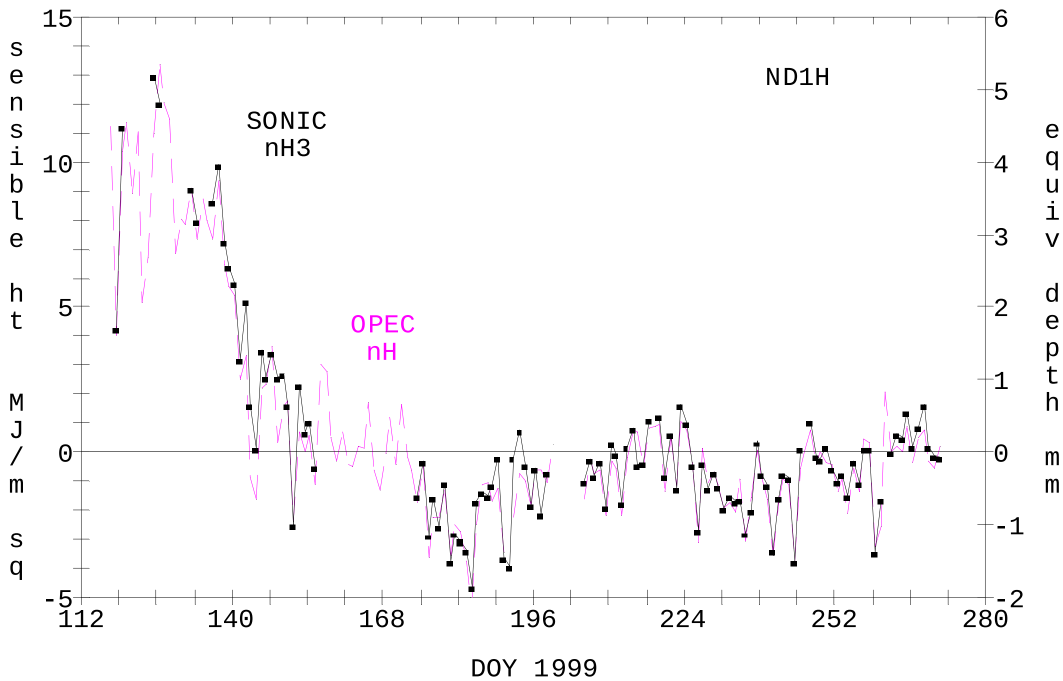

Figure. 1. Daily sensible heat (H, MJ/m^2, or mm) from OPEC and SEC measurements.

There were 114 such calibration days from DOY 112 through DOY 271. The linear relation between daily totals from the two systems is shown in Fig. 2. Agreement in Fig. 2 is excellent: nH3 = 1.01nH + 0.37, with s.d.=0.66 and R^2=0.96. Data ranged from –5 to 13 MJ m^{-2} d^{-1}. Similar excellent comparisons were obtained for daily on-tower agreement (nH1 v. nH2, and sH1 v. sH2). Figure 3 shows that sensible heat at the north tower agrees closely with that at the south tower. The good agreement among redundant sensors provides a basis for filling data gaps in order to extend flux estimates over the entire year. The Q, G and H fluxes were averaged to obtain estimates for the stand; LE and ET were calculated from these averages. Fluxes in Fig. 4 are shown as observed (4.A), and after smoothing for clarity (4.B). The Figure clearly shows spring budburst, the summer transpiration pulse, and autumn senescence.

3. SALTCEDAR EVAPOTRANSPIRATION

The quotidian energy fluxes at the saltcedar site were integrated over 365 days to yield the annual totals as shown in Fig. 5. In MJ m^{-2} yr^{-1} these are Q = 4540; G =-3; H = 1315; and LE = 3222. LE is equivalent to ET of 1315 mm of water per year. At this site budburst in the deciduous saltcedar canopy occurs around DOY 107 (April 17), by which date 10 percent of annual ET has occurred. Evapotranspiration proceeds rapidly through the summer until leaf senescence takes place about DOY 305 (Nov. 1) by which date 95 percent of annual ET has occurred. Thus about 15 percent of annual saltcedar ET occurs during the 6-month leafless period, and 85 percent occurs during the 6-month, physiologically active, in-leaf period. Figure 5 shows that there is a linear dependence of saltcedar LE upon net radiation during the summer half-year of rapid ET. Figure 6 shows that the linear function LE = 1.8 + 0.92Q provides reasonable estimates of LE over the five-month summer period DOY 140 through 290.

4. CONCLUSIONS

This document summarizes progress made in defining for calendar year 1999 the energy and water balances of riparian saltcedar on the Rio Grande in central New Mexico. The experimental program was astonishingly successful dispite the difficult and awkward site with generally inhospitable weather. Major conclusions listed below will be addressed further when this paper is expanded into a more comprehensive report.

- Daily sensible heat (H) from the one-propeller eddy correlation (OPEC) system agrees closely with sensible heat measured by a 3-dimensional sonic (SEC) system (Figs. 1 & 2).

- In theory, daily latent energy (LE) can be estimated as a residual in the surface energy balance. In practice, residual LE from OPEC and SEC agree well, and we assume that they are correct.

- Daily OPEC sensible heat (and hence LE) agrees closely at the two saltcedar towers (Fig. 3).

- Hygrometers are excluded from theOPEC system in order to avoid contamination problems from salt, moisture and dust, and to greatly simplify on-line calculations and data handling.

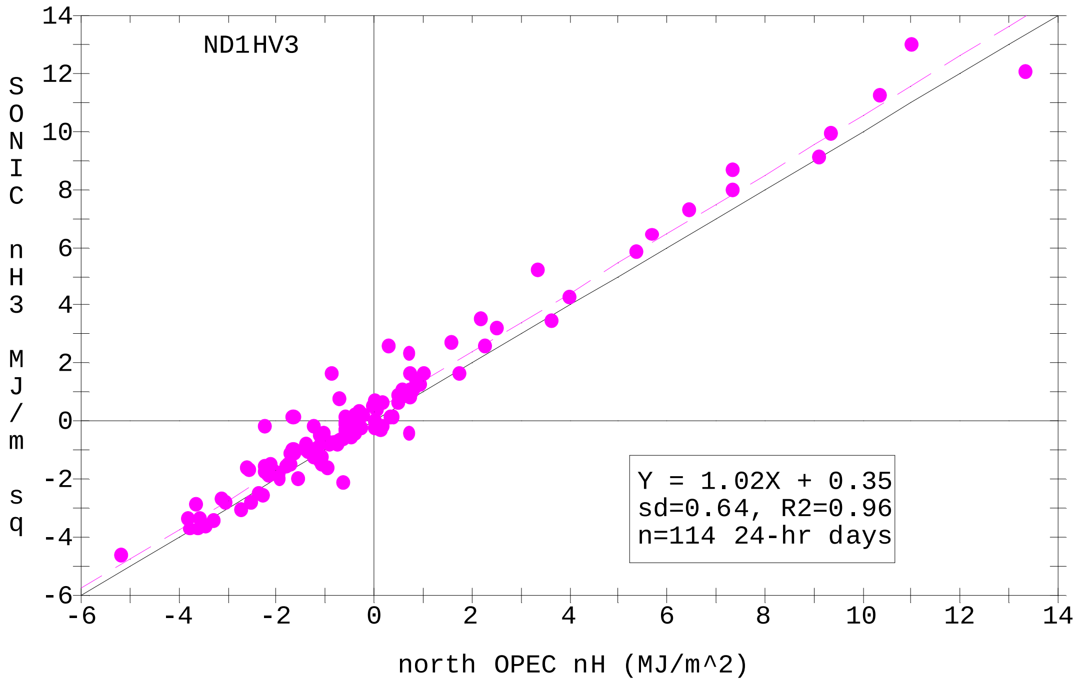

Figure 2 On the North tower, OPEC and SONIC sensible heat agree closely.

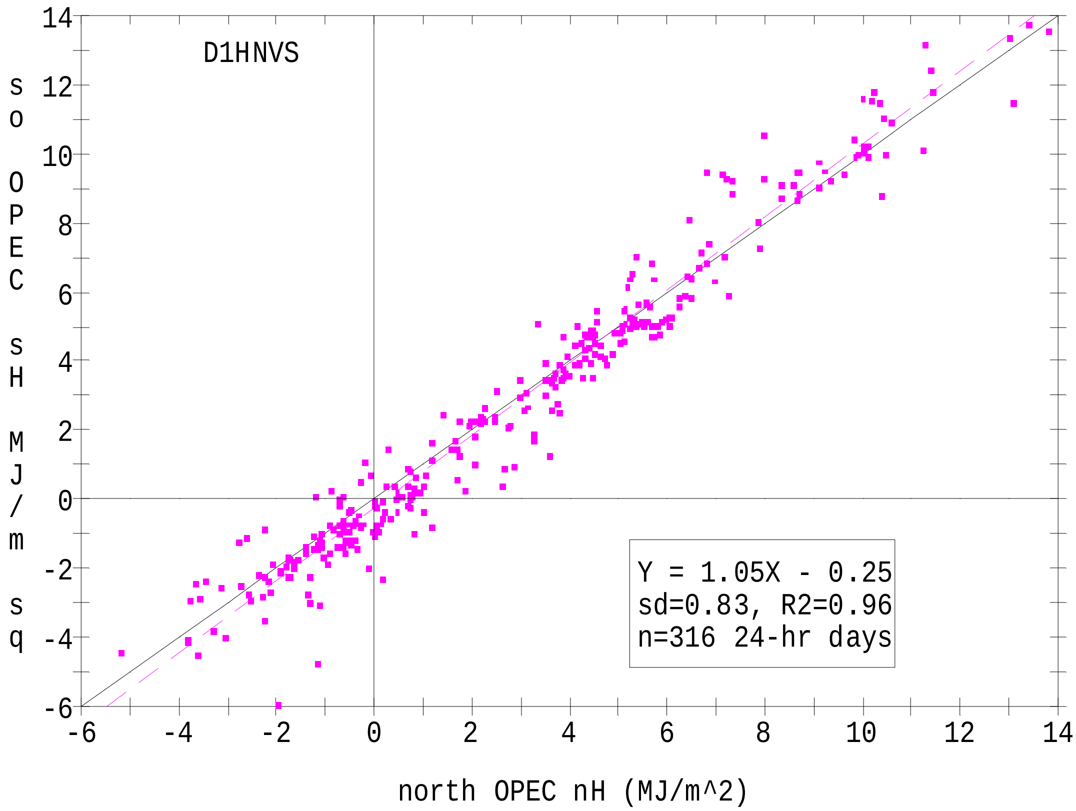

Figure 3. Daily OPEC sensible heat at the north tower agrees closely with that at south tower.

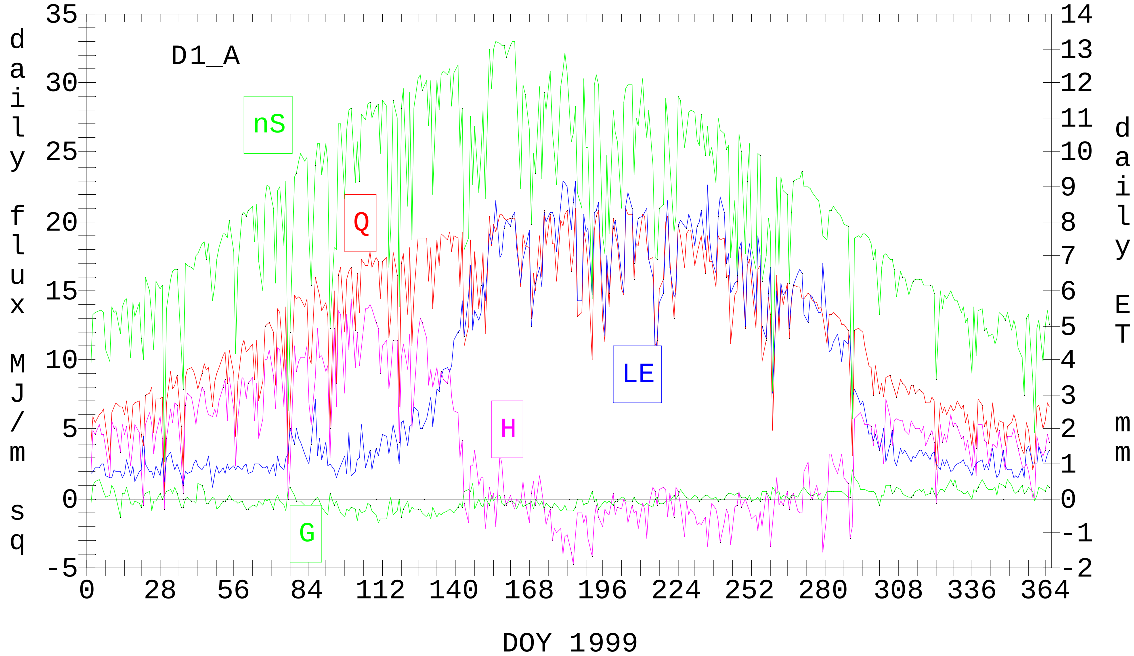

Figure 4.A. Observed daily energy and water balances of saltcedar in 1999.

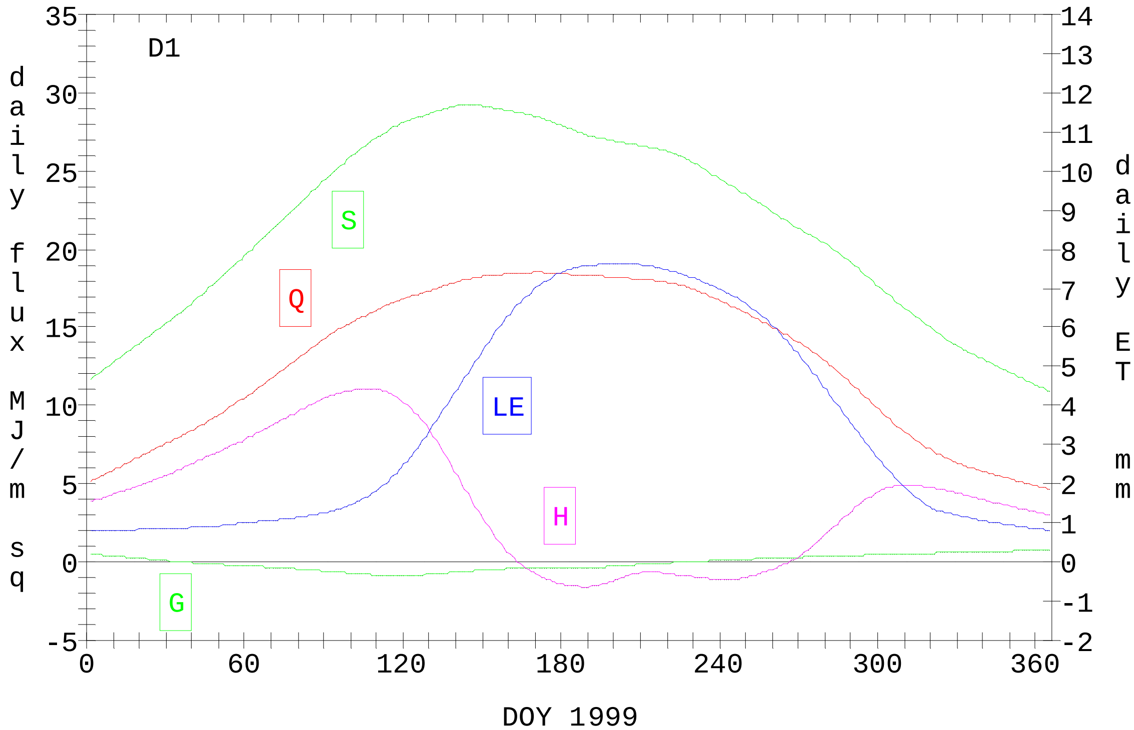

Figure 4.B. Smoothed daily water and energy balances of saltcedar in 1999.

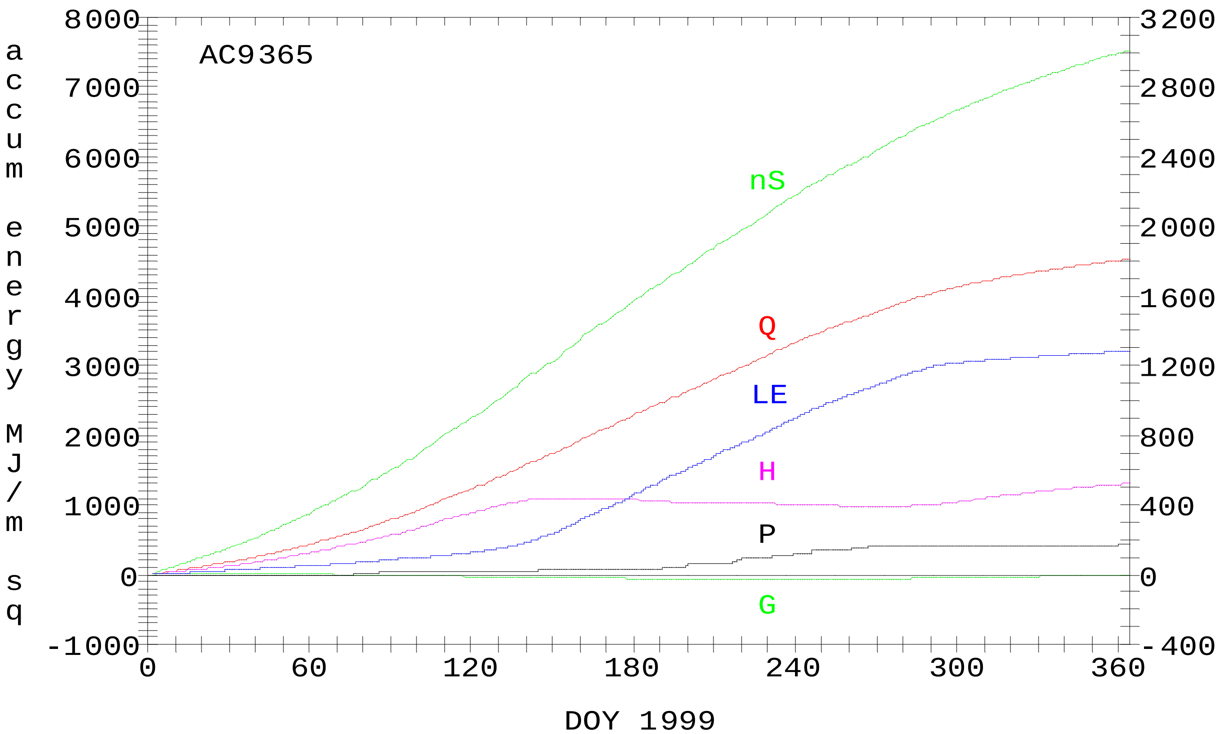

Figure 5. Cummulated energy and water balances for riparian saltcedar in 1999.

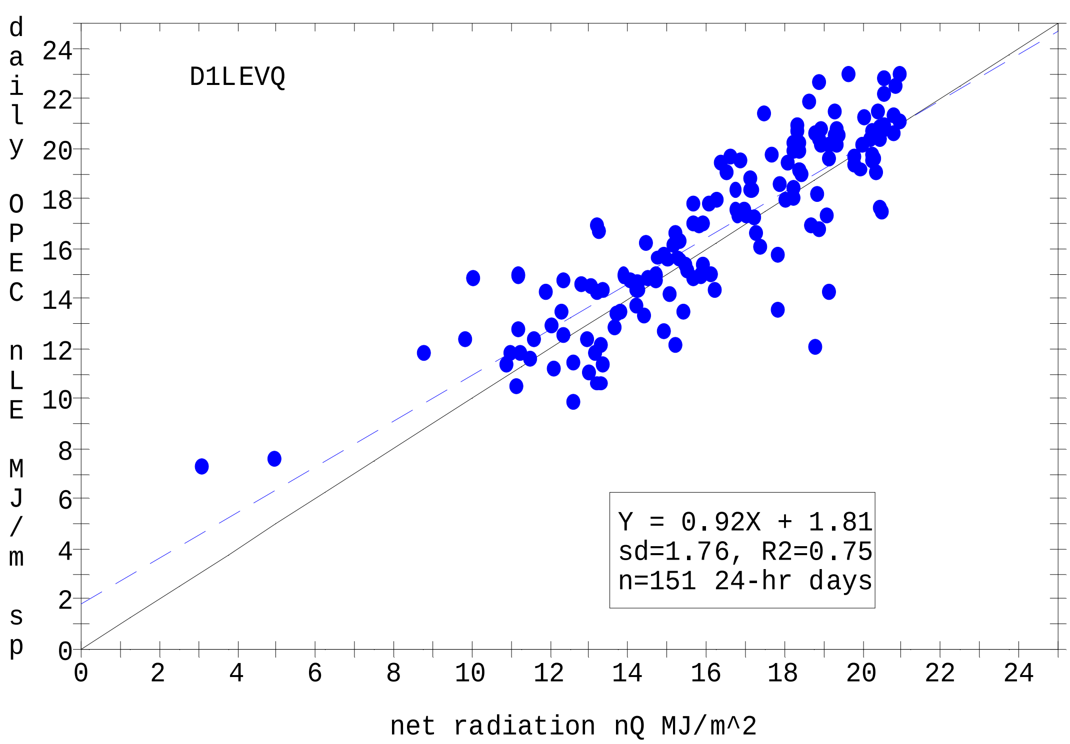

Figure 6. Daily saltcedar LE in summer is linear function of net radiation.

4. CONCLUSIONS (cont.)

- Redundant sensors provide a rational basis for filling data gaps to obtain a full year of record (i.e., 2 net radiometers, 2 soil heat flux sites, 2 climate stations, one SEC and 4 OPEC systems).

- The annual energy and water budget of deciduous saltcedar clearly shows a transpiration pulse in summer, and defines effects of spring budburst and autumn senescence (Figs. 4A & 4B).

- Saltcedar ET was 1315 mm, in 1999; 85% occurred during the summer growing season (Fig. 5).

- Daily ET from riparian saltcedar was predicted adequately through the 5-month summer period by a linear function of net radiation (Fig. 6).

5. REFERENCES

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