Development of Surface Renewal as stand-alone user friendly tool to measure grapevine evapotranspiration

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Ever-increasing competition between agricultural, municipal, and conservation entities for limited water supplies in the Western US is forcing farmers to continually improve irrigation water use efficiency. Simple and inexpensive technology is needed to better estimate crop water use (i.e. evapotranspiration-ET) in real-time. Accurate and site-specific measurement of ET would enable growers to precisely match crop demands by replacing lost water via irrigation inputs. Our collaborative team has developed surface renewal as a simple, inexpensive, and stand- alone technique to fill this technology gap. Research grade systems needed to measure ET typically cost more than $10,000; our new system measures ET with the same accuracy for $500.

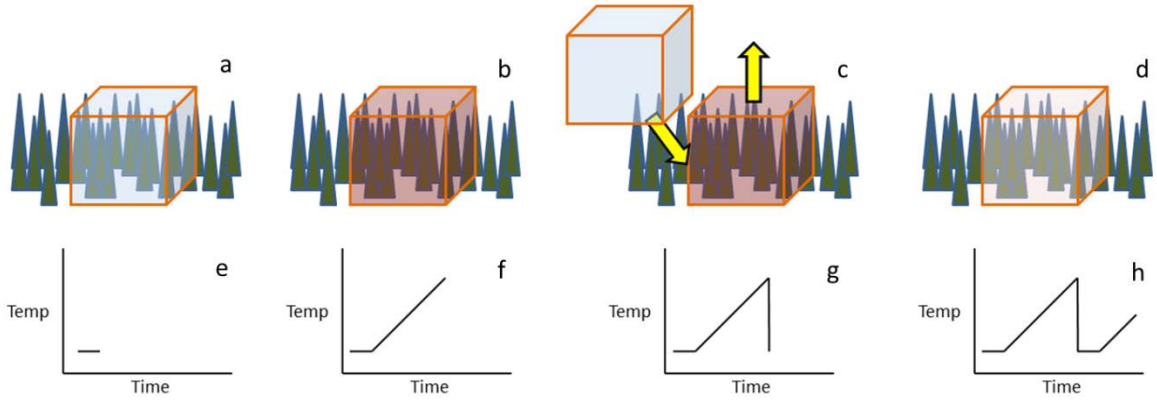

Figure 2: Theoretical representation of surface renewal describing how air parcels interact with a plant canopy surface. The air parcels are assumed to be the same height as the canopy. After an air parcel comes in contact with a surface ‘a‘, the parcel experiences a quiescent period, where little energy exchange occurs and is reflected by minimal temperature change with time ‘e‘. Eventually, the parcel exchanges energy and mass with the surface and, in this period, the parcel heats up as indicated by the red color in ‘b’ as captured by temperature measured with fine wire thermocouples ‘f‘. A new, cool parcel of air will sweep in and force the warmer air parcel to eject out from the surface ‘c‘. This action is captured as a sharp decline in the temperature trace ‘g‘ as the cool air parcel replaces the warmer one. The cycle then continues to repeat itself (d & h).

Surface Renewal works by measuring the energy balance of a crop surface, where sensible heat (i.e. heat transfer to the air) flux measurements are taken in conjunction with net radiation and ground heat flux measurements. The remainder of the energy balance goes into evaporating water (i.e. evapotranspiration). Historically, surface renewal has required calibration against another ET measurement technique (i.e. Eddy CoVariance, which costs $10,000), but our recent improvements make calibration against another measurement technique unnecessary. We have: 1) three patents pending; 2) successfully tested our technique in numerous experimental and commercial vineyards; and 3) functional and commercially available system based on our recent improvements. We have also discovered that the technique can be used to detect stress signals from grapevine crop surfaces that could be used to trigger timing of irrigation events.