Analysis of root-zone soil moisture control on evapotranspiration in two agriculture fields in Australia

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Abstract: Soil moisture content in the root-zone is an important variable in modelling hydrological and biophysical processes and agricultural applications. In addition to the microwave remote sensing, there is a growing interest in mapping high-resolution soil moisture content using remotely sensed thermal signals or evapotranspiration (ET). This new technique is based on the assumption that the evaporative fraction (EF) or the ratio of surface temperature to air temperature (T_s: T_a) is controlled by soil water content available for bare soil evaporation or vegetation transpiration. However, there are a number of environmental and biological factors contributing to EF and T_s: T_a such as net radiation, vegetation biomass and growth stage, etc. This work investigates effectiveness of the EF and T_s: T_a based root-zone soil moisture estimation.

Introduction

The study was conducted in two rain-fed agriculture fields at Dookie, Victoria, Australia. Two meteorological towers were installed in two different agriculture fields. Study site 1 is a pasture land covered with lucerne which is used for sheep grazing. Wheat and Canola are grown as rotational crops in study site 2. Turbulent fluxes, surface reflectance, meteorological parameters and soil moisture measurements were measured using tower based observations. This study uses the data acquired from wheat and lucerne sites in 2012.

Methodology

Evaporative fraction (EF) has been obtained by averaging EFs for each latent heat and sensible heat flux measurements. Surface temperature and air temperatures were calculated by averaging the mid day values from 12 pm to 2 pm. A time series noise free NDVI has been produced from spectral sensors installed at study sites.

Results and discussion

The correlation between EF and T_s: T_a was good throughout the vegetation period with an R^2 value of 0.68. Most of the data points either fitted or were closely distributed around the 1:1 line (Figure1).The exponential model appears to provide reasonable estimates of EF using soil moisture with an R^2 value of 0.78 (Figure 2). An important hypothesis here is that, beyond a certain threshold net radiation and vegetation biomass, there exists a strong relation between EF and soil water content.

Conclusion

It is hypothesized that EF exhibits consistent correlations with soil water available for vegetation. EF shows different levels in lucerne site where external environmental factors (sheep grazing) influences the vegetation biomass conditions (see figure 3). The correlation between the ET and soil moisture is strong when ET is water limited and correlation become weak when ET is energy limited. EF vs. soil moisture at surface and root-zone of soil is sensitive to vegetation biomass and net radiation.

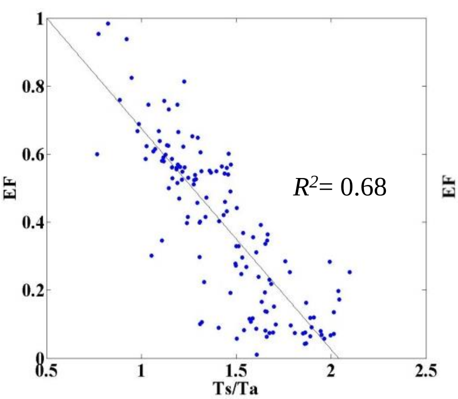

Figure 1: Comparison of Ts/Ta and EF

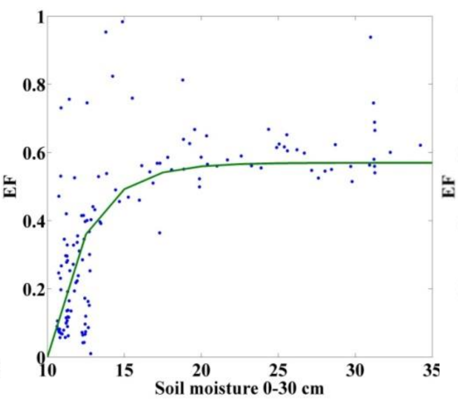

Figure 2: Exponential relationship between soil moisture 0-30 cm and EF @ wheat site

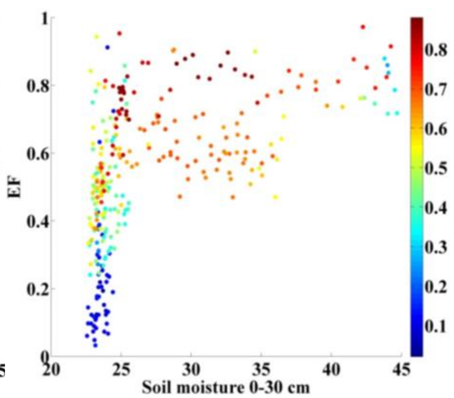

Figure 3: EF vs. soil moisture from 0-30 cm with respect to NDVI @ lucerne site

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