APPENDIX B. PRIESTLEY-TAYLOR UC DAVIS APPROACH

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SUMMARY

The semi-empirical Priestley-Taylor (PT) approach was originally developed to monitor monthly evapotranspiration (ET) at a 1 km resolution at a continental and global scale, by integrating satellite data from Moderate Resolution Imaging Spectroradiometer (MODIS) and AmeriFlux tower measurements (Jin et al., 2011). We here made our first attempt to adapt the PT method for high spatial resolution ET estimate by using Landsat satellite data. This automated remote sensing (RS) data-driven approach has a potential to estimate more accurate ET by model calibration and multi-satellites data fusion in a cost-efficient way.

The PT approach is based on a simplified modification of more theoretical Penman-Monteith equation (Priestley and Taylor, 1972), to eliminate the need for a long list of input data. Available energy dominates the rate of evapotranspiration under well-watered conditions, and a PT coefficient, representing the eco-physiological constraint, is then used to downscale the equilibrium potential ET to actual ET.

Daily available energy: Landsat and MODIS satellite observations, and CIMIS-spatial weather data are used to estimate daily available energy. Incoming solar radiation is provided by CIMIS-Spatial, estimated with the model developed for the European Solar Radiation Atlas (ESRA) and the Heliosat programme (Hart et al., 2009); total shortwave albedo, fraction of shortwave energy reflected by surface, is derived from Landsat spectral surface reflectance (Figure B-1). Air temperature from CIMIS-Spatial (Hart et al., 2009) is used to derive incoming longwave radiation. Instantaneous land surface temperature (LST) during satellite overpass is derived using single channel method (Jimenez-Munoz et al., 2014) from sharpened Landsat thermal data (Gao et al., 2012b). To estimate daily mean surface temperature and thus outgoing longwave radiation, diurnal temperature curve is derived by fitted with four or more acquisitions of MODIS surface temperature at the same day or adjacent days, and then used to adjust the Landsat instantaneous land surface temperature. Ground heat flux is estimated as a function of net radiation (Rn) and leaf area index (LAI) (Gao et al. 2012a).

PT coefficient: The partition of available energy into latent heat for evapotranspiration depends on both atmospheric demand and biological processes. The PT coefficient represents the downscaling of potential equilibrium ET by ecophysiological constraints due to plant response to environmental conditions, such as drought (Fisher et al., 2008). It was approximated as an empirical function of leaf area index, soil moisture, and temperature (Jin et al., 2011); the parameters of this function was calibrated for each plant functional type using AmeriFlux field measurements sites encompassing a broad range of temperature and soil moisture (Jin et al., 2011).

For this preliminary report, we used the existing parameters calibrated for one general agriculture land cover type, mostly with agriculture AmeriFlux tower sites in midwest, as developed in Jin *et al.* (2011), due to the limitation of available field measurements of ET in

California; we also removed the soil moisture control as our first attempt to adapt the PT ET approach originally developed for large scale estimate, which would most likely cause high bias in ET estimate. We are in the process of developing an PT optimization approach tailored for crop type specific PT parameters in California.

Temporal interpolation: This approach estimates daily-average clear sky ET at 30m spatial resolution on the date of Landsat satellite overpass, every 16 day if no cloud obscures the scene. Various methods are in development to generate monthly ET estimates by combining observations from other satellite sensors to increase the temporal frequency of remote sensing estimates. For this preliminary report, daily crop coefficient (Kc) is first calculated by dividing PT-based daily ET estimate by CIMIS-Spatial reference ET (ET_0) at the Landsat acquisition date. For other days when Landsat data is not available, e.g., without acquisition or with cloud, a linear interpolation is used to estimate Kc, which is then multiplied by CIMIS-Spatial ET_0 to estimate daily ET for the missing days.

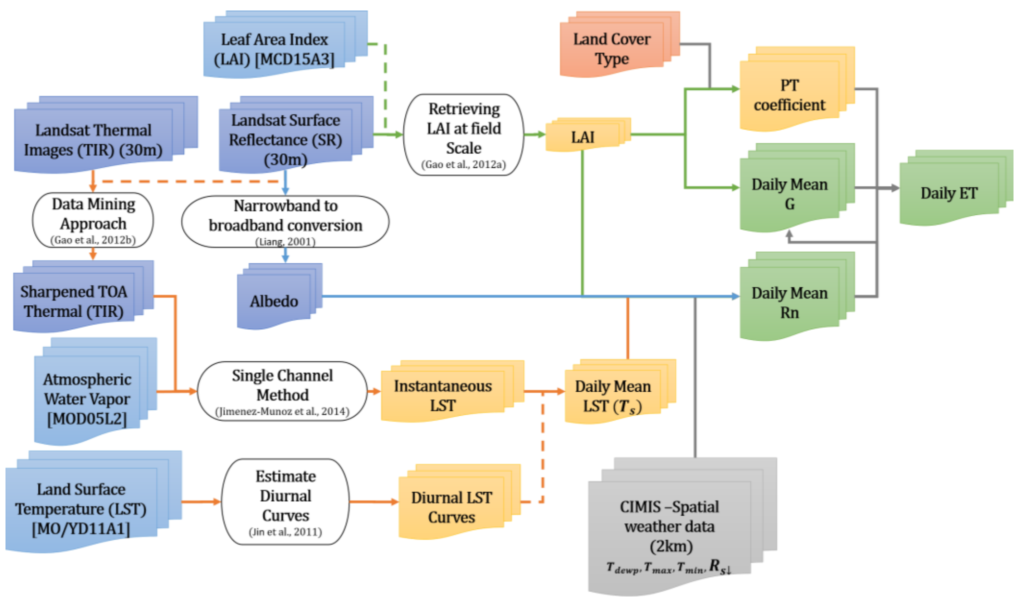

Figure B-1. UC Davis-Priestley-Taylor Evapotranspiration Method Flowchart

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