# APPENDIX D. DisALEXI

**MARTHA ANDERSON**

## SUMMARY

The Atmosphere-Land Exchange Inverse (ALEXI) flux disaggregation approach (DisALEXI) is a multiscale flux modeling system based on principals of surface energy balance and using remotely sensed maps of landsurface temperature (LST) as primary input. The system is built on the Two-Source Energy Balance (TSEB) algorithm (Kustas & Norman, 1999; Norman, Kustas, & Humes, 1995), which partitions fluxes and composite temperatures between nominal soil and canopy components of the modeling scene based on the local fraction of vegetation cover. Using thermal infrared (TIR) retrievals of LST from an array of satellite (geostationary and polar orbiting) and airborne sensors, the ALEXI/DisALEXI package provides self-consistent ET retrievals from field up to global scales (Anderson et al., 2011). A data fusion approach is applied to fuse high spatial/low temporal resolution ET retrievals from Landsat (30m/16-day) with low spatial/high temporal resolution data from polar instruments like MODIS or VIIRS (375m-1km/~daily) to generate daily actual ET "datacubes" with both high spatial and temporal resolution (30m/daily). With the TSEB foundation, the system can also provide partitioned estimates of the soil evaporation (E) and transpiration (T) components of ET (see Figure D-1).

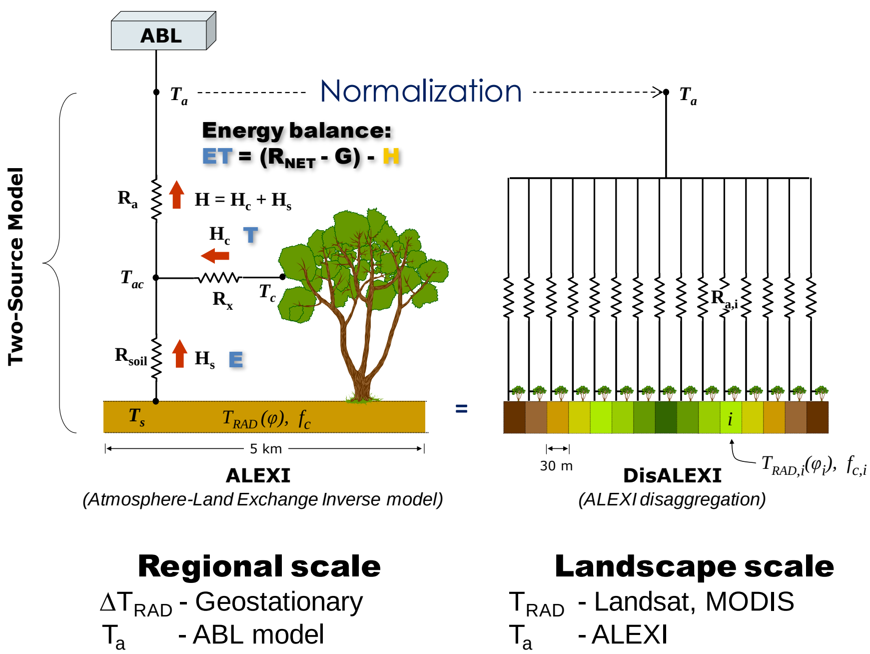


**Figure D-1. Schematic diagram of the ALEXI and DisALEXI modeling system**

**ALEXI:** For regional applications, the TSEB is run in a time-differential mode using measurements of the morning rise in LST that can obtained from geostationary satellite platforms. The advantage of this mode is that it makes the base model less sensitive to errors in the LST retrieval – time changes in LST can be measured more accurately than absolute instantaneous LST. Using hourly TIR data from the Geostationary Operational Environmental Satellites (GOES), the Atmosphere-Land Exchange Inverse (ALEXI) model is used in NOAA's GOES ET and Drought (GET-D) system to produce operational maps of daily actual ET over North America at 8-km resolution. A parallel research version is run daily at 4 km over the continental U.S. Meteorological inputs, including insolation, are obtained from the Climate Forecast System Reanalysis (CFSR). The ALEXI data can be extracted over the full state of California to provide regional context for the localized ET evaluations presented here over the CA Delta.

**DisALEXI:** An associated flux disaggregation algorithm (DisALEXI; Anderson et al., 2012; Anderson et al., 2004; Norman et al., 2003), also built on the TSEB landsurface representation, can be used to downscale the GOES-based ALEXI flux estimates to finer spatial scale using LST data from moderate to high resolution TIR imaging systems. In this case study, we utilized thermal data from the Moderate Resolution Imaging Spectroradiometer (MODIS) at 1-km resolution and near daily coverage and from Landsat 7 and 8 at 60-100 m resolution and weekly-monthly revisit (based on cloud cover). MODIS disaggregation uses standard MODIS LST, leaf area index and albedo products. For Landsat disaggregation, the Landsat TIR imagery have been downscaled to the 30-m resolution of the Landsat reflectance bands using the Data Mining Sharpener (DMS) tool developed by Gao et al. (2012b) to sharpen field edges. MODIS-consistent LAI inputs to Landsat-DisALEXI are generated following methods in Gao et al., (2012a).

**Data fusion:** The daily but coarse resolution MODIS ET retrievals generated over the CA Delta have been combined with periodic but high resolution Landsat retrievals, obtained on days with mostly clear Landsat 7 or 8 overpasses, using the Spatial Temporal Adaptive Reflectance Fusion Model (STARFM; F. Gao, Masek, Schwaller, & Hall, 2006), described schematically in Figure D-2. The output from this system is a timeseries of 30-m resolution maps of actual ET generated at daily timesteps. The fusion system has been evaluated over rainfed corn and soybean fields in the Walnut Creek watershed in Iowa, and both rainfed and irrigated corn and cotton in Bushland, Texas and Mead, Nebraska (Cammalleri, Anderson, Gao, Hain, & Kustas, 2013; Cammalleri, Anderson, Gao, Hain, & Kustas, 2014). The same approach has also been successfully applied to a vineyard study area in California, USA (Semmens et al., 2015) and a managed pine-plantation in North Carolina, USA (Yang et al., 2016), with typical errors of 10% at the daily timestep.

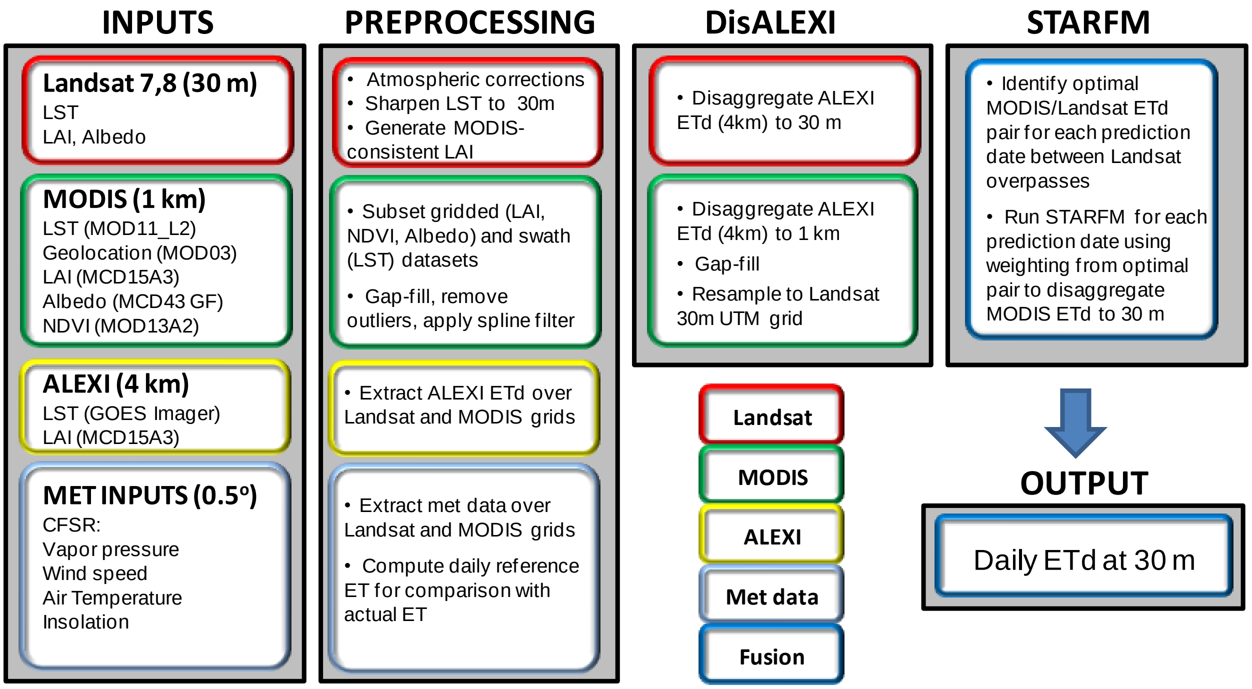


**Figure D-2. ALEXI/DisALEXI data fusion flowchart for computing daily ET (ETd) at 30m resolution.**

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