SSEBop Evapotranspiration Products
(Version 4.0, July 2016)

Evapotranspiration (ET) is the combination of transpiration from vegetation and evaporation from soil. Actual ET (ETa) is produced using the operational Simplified Surface Energy Balance (SSEBop) model (Senay et al., 2012) for the period 2000 to present. The SSEBop setup is based on the Simplified Surface Energy Balance (SSEB) approach (Senay et al., 2011, 2013) with unique parameterization for operational applications. It combines ET fractions generated from remotely sensed MODIS thermal imagery, acquired every 8 days, with reference ET using a thermal index approach. The unique feature of the SSEBop parameterization is that it uses pre-defined, seasonally dynamic, boundary conditions that are unique to each pixel for the "hot/dry" and "cold/wet" reference points. The original formulation of SSEB is based on the hot and cold pixel principles of SEBAL (Bastiaanssen et al., 1998) and METRIC (Allen et al., 2007) models.

ETa data and anomaly products (current vs. 2001 – 2015) are available at:
http://earlywarning.usgs.gov/usewem/eta_energy.php.
The actual ET data unit is millimeters (mm) and the associated color ramp (see Figure 1a.) is available for download as a .style file for ArcGIS and as txt file with RGB color codes. The *SSEBop_symbology* folder includes instructions on how to add the color ramp in ArcMap and further suggestions on the data visualization.
The anomalies are the ratio of ETa and the corresponding median ETa, expressed as a percent value and have the color ramp (see Figure 1b.) attached. The color ramp, txt file with RGB color codes, and colormap file (.clr) are available in the *SSEBop_symbology* folder.
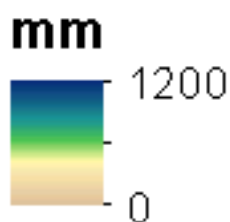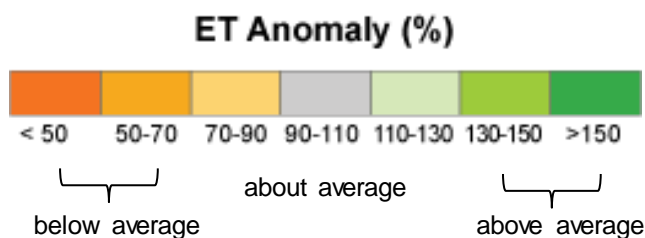

Figure 1a.   Figure 1b.

Listed below are all ET products offered:

Monthly ET products:
ET data products for every month in a year as .tif file in a zip folder. The associated color ramp is available as download on the website.
ET anomaly products for every month in a year as graphics (.png and .pdf), as well as .tif file including the color ramp.

Yearly ET products:
ET data products as .tif files in a zip file. The associated color ramp is available as download on the website.
ET anomaly products for every year as graphics (.png and .pdf), as well as .tif including the color ramp.

Cumulative ET anomaly products:
ET data and anomaly products are cumulative in intervals of 8-day periods and grouped by major growing season:

- **April – October**

For display purposes the season graphics begin on April 01 (091), but the data include the entire 8-day period (day 089 – 096). ET anomaly products for every year as graphics (.png and .pdf), as well as .tif including the colorramp.
In addition the End of Season grid (sum from April – End of October) is available as .tif file in a zip folder.

References:
Allen, R.G., Tasumi, M., Trezza, R., 2007. Satellite-based energy balance for mapping evapotranspiration with internalized calibration (METRIC) – Model. ASCE J. Irrigation and Drainage Engineering 133, 380-394.
Bastiaanssen, W.G.M., M. Menenti, R.A. Feddes, and A. A. M. Holtslag, 1998. The surface energy balance algorithm for land (SEBAL): Part 1 formulation. Journal of Hydrology 212–213: 198–212.

Senay, G.B., M. Budde, J.P. Verdin, and A.M. Melesse, 2007. A coupled remote sensing and simplified surface energy balance approach to estimate actual evapotranspiration from irrigated fields. Special issue: Remote sensing of natural resources and the environment. SENSORS, 1, 979-1000.

Senay, G.B., M. Budde, J.P. Verdin, 2011. Enhancing the Simplified Surface Energy Balance (SSEB) approach for estimating landscape ET: Validation with the METRIC model. Agricultural Water Management, 98: 606-618.

Senay, G.B., S. Bohms, R. Singh, P.A. Gowda, N.M. Velpuri, H. Alemu and J.P. Verdin, 2013. Operational evapotranspiration mapping using remote sensing and weather datasets: A new parameterization for the SSEB approach. Journal of American Water Resources Research. In Press.