Title

Abstract

Keywords

Introduction

Methods

Data

The input datasets used for the updated version of the SSEBop model are listed in Table X.

|  |  |  |  |
| --- | --- | --- | --- |
| **Dataset** | **Abbreviation** | **Source** |  |
| Land Surface Temperature | Ts | MODIS |  |
| Emissivity |  | MODIS |  |
| NDVI |  |  |  |
| Tmax | Ta |  |  |
| Reference ET | ETo,d |  |  |
| Albedo | α |  |  |
| Temperature difference | dT |  |  |
| Temperature correction | c |  |  |
| Clear-sky net radiation | Rn |  |  |
|  |  |  |  |
|  |  |  |  |

Model Parameter updates in Version 5

Used all new versions of input data for daymet, WorldClim, MODIS.

Parameters new to the model are the Albedo Desert Mask, ….

Albedo Desert Mask

Different approaches to artificially increase LST temperature to reduce ET in high reflectance areas were tested and the Koeppen Climate Zones were used to mask out high temperature areas. The value of 500 was chosen during analysis of the Albedo data and the condition of the Albedo correction for filling the missing data extent, which is parameterized to increase LST if the Albedo value is greater than 250 and the NDVI is greater than 0 and it’s a high temperature area. Those areas are defined in the Albedo Desert mask. The Albedo mask is not including lakes or small islands like the Florida Keys. Therefore, the mask was spatially enhanced by the dT grid’s spatial extent to include as much detail as possible.

The climate zone data were taken from http://koeppen-geiger.vu-wien.ac.at/ and are created by Dr. Markus Kottek and Dr. Franz Rubel ([Kottek et al. (2006)](http://koeppen-geiger.vu-wien.ac.at/present.htm), [Rubel and Kottek (2010)](http://koeppen-geiger.vu-wien.ac.at/shifts.htm) and [Rubel et al. (2017)](http://koeppen-geiger.vu-wien.ac.at/alps.htm)). For the mask we used the classes BWk, BWh, BSk, BSh and created a raster file with value 1 for those 4 classes and value 2 for the other areas.

Desert and Water mask

Water mask: MODIS Landuse product (MCD12Q1) from 2013, extract water (value 0) from raster file, resample to 1 km (from 500m), and extract just the inland water features.

To avoid covering vegetation around lakes where there is possible no water, a water occurance raster, where water = 1 and the sum of all water pixel from 2003-2013 is 12 (the number of years) -> that mean there is stable water (or min extent). Water\_occurance\_mask.tif is showing water where all 12 years had water.

ET calculation = water bodies identified in the mask are replaced with PET \*0.85 (85%).

Desert mask: after some testing of different extents and methods to delineate the deserts we decided on following: 10x10 median cfactor raster and max MODIS NDVI < 0.2, when both interest then is desert. NDVI is used for smoothing out the edges and make sure no irrigation is adjusted (included) in the mask.

ET calculation = ET desert identified in the mask are replaced with ET \* 0.32.

Correction coefficient of 0.32 was derived from (2003-2015)

Where, if that values >= 3 (3 times ET) then take the average (zonal) for the values from . The average for those pixels = 0.32. Note: Had to take out outliers’ value 20000 to not skew the average.

Rn calculation

The Rs equation is an update from the SSEBop ET model Version 4.  
For ‘interior’ locations, where land mass dominates and air masses are not strongly influenced by a large water body, kRs ≅ 0.16, which was used in the Rs calculation.

Ra calculation

In Version 4, the extraterrestrial radiation Ra was calculated using a 10km latitude grid, which caused smaller Islands and coastal areas to be partially or completely missing.

dT calculation

Updated Rn lead to improved dT values

Temperature correction (dynamic c factor)

The temperature correction coefficient is used to create the lower temperature boundary – Tcold - for the ETf calculation. The coefficient is based on the ratio of LST and maximum air temperature.

Input data sets for the so-called c factor are:

LST

dekadal median NDVI (2003-2017)

Tmax (Worldmet)

temp diff (dT)

For tcorr grid process use script: 1\_MODIS\_DynamicCfactor\_medianC.py under D:\Stornext\fewspsnfs2\FEWS\Users\Stefanie\operational\GlobalET

c factor calculation:

The c factor is based on the ratio of LST and Tmax (maximum air temperature) conditioned and summarized by a set of different conditions.

condition: median NDVI (2003-2017) must be between 0.7 – 1.0

condition: is between -10 and 5K

condition: LST > 270K

The Tcorr values that meet all 3 conditions are then summarized by a grid based on MODIS tiles, but divided further from 1 MODIS tile into 25 tiles (5x5 tiles). That number was determined based on that there are 90 rows and 180 columns overall.

calculate value with

set all c factor values to 0 when there are less than 30 pixels after applying the 3 conditions.

This avoids a c factor value based on just a couple pixels.

Smooth the raster with Focal Statistics of a rectangle (200x200)

At this point the c factor grid has gaps, to fill those, following median data sets need to be created:

D-Dmean-Amedian-ZAmedian-Smooth

1) Dmean: dekad mean value 2003-2017

2) Amedian: annual median of the mean value, i.e. median of the mean of 36 values

3) 3median: use the annual median and the Focal Stats tool with cell size 3x3 (660x660 km) to create

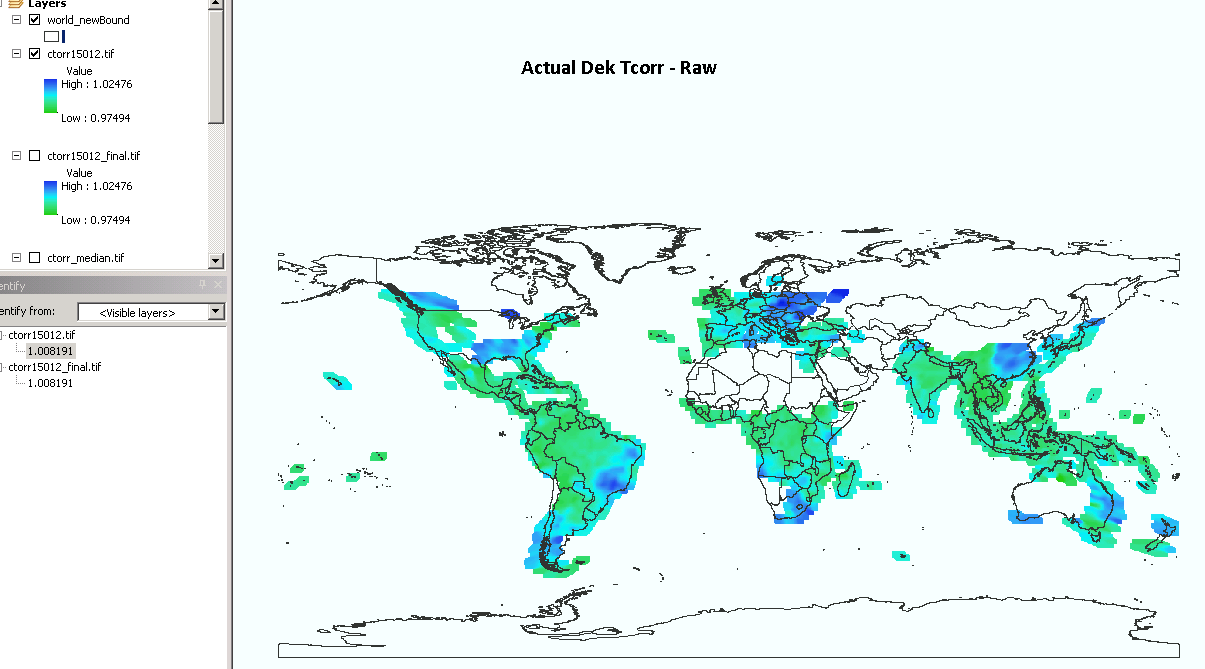
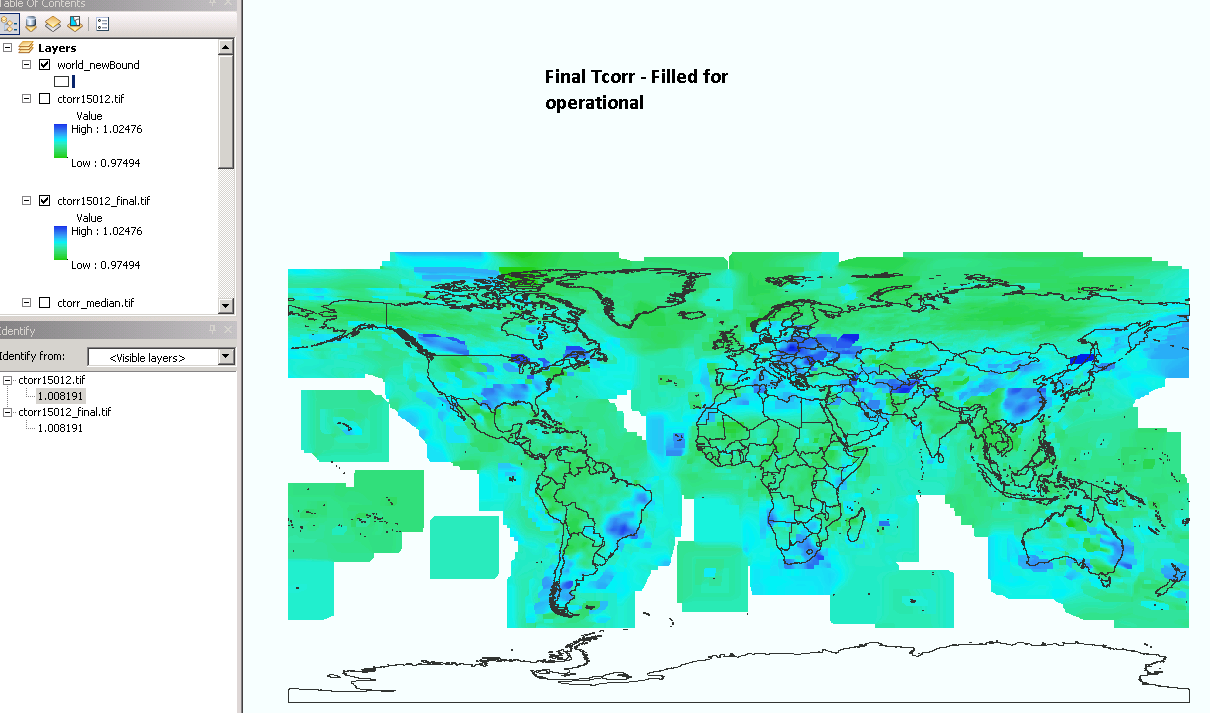
1 median grid for filling

4) 3median: use the annual median and the Focal Stats tool with cell size 10x10 (2200x2200 km) to

create 1 median grid for filling

Once the median data sets are created, all NODATA values in the smoothed ctorr rasters is going to be replaced with the median data sets in the order noted above. This will fill all the gaps and ensures a complete smooth c factor grid.

Graphics show before and after the filling step.

Global actual ET estimation

Create ETf,

apply PAPA algorithm

created QA raster,

create ETa

Analysis of Global actual ET

MPI ET data? Flux tower data? Water Balance for a big river basin like the Nile? Comparing it to Landsat ET using Google earth engine to create Global sample ET for analysis?

Results

Discussion

Conclusion

Acknowledgements

References