Regional MODIS NPP for Europe

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1. Conclusions

- New version of MODIS Net Primary Production (NPP) recalibrated for European conditions and uses new European focused climate data.
- This data is more accurate when compared to European terrestrial measures of NPP than the widely used Global MODIS NPP (Running et al., 2004).
- This data is calibrated against crop statistics and National Forest Inventory (NFI)
- Shortcomings:
  - NFI data does not capture NPP from grasses, shrubs or small trees within a forest
  - No other harmonized terrestrial crop NPP dataset that can be used for validation
  - Could also be improved by also using a local land cover map.

2. Objective

Use European NPP and climate data to develop a new MODIS NPP data product focused on Europe.

2. Introduction

The MODerate Resolution Imaging Spectro-radiometer (MODIS) sensor measures terrestrial vegetative NPP globally every 8 days on up to a 500mx500m resolution. Researchers from around the world use this data to study their particular regions of the globe. This, however, is a misuse of this Global NPP data product. To calculate NPP MODIS relies on an algorithm, MOD17 (Zhao, et.al. 2005). To derive NPP from remotely sensed data MOD17 also uses climate data and bio-physiological constants that describe different cover-types. The global NPP product is calibrated and validated against an average global NPP estimate. This inherently will skew results to areas that either have high NPP or have a disproportionately large number of data points that contribute to this average value. The global NPP product also uses a climate data product which is developed for global scales. This climate data does not include local level effects such as those from orographic features and creates artificial delineation in the NPP dataset. To use MODIS NPP across smaller regions, even on the continental scale, one must develop new MODIS NPP data products.

3. Data

- Forest: NFI data from 13 different countries obtained through the FORMIT project to derive the average NPP for forest cover types for the period 2000-2010. Flux tower data from 99 towers for Gross Primary Production calibration.
- Crops: Crop NPP was calculated from statistics taken from the Eurostat website
- Climate: Downscaled E-OBS (European Observations) (Moreno & Hasenauer, 2015).
- Digital Elevation Model: GTOPO30 U.S.G.S., EROS Data Center, Sioux Falls, South Dakota
- MODIS Products: FAPAR, Land Cover, LAI

4. Methods

1. Assemble Climate Data:
   - Min and max temperature, shortwave radiation (swrad) and vapor pressure deficit (vpd).
   - Use the MtClim algorithm to produce sward, vpd (Thornton & Running, 1999).
   - Produce slope/aspect and east/west horizon required by MtCLim using Envi and Daymet (Thornton, Running, & White, 1997).
2. Calibrate MOD17 GPP for each cover-type against median flux tower values.
3. Calibrate MOD17 NPP against NFI data and national crop statistics
4. Validate against International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forest) derived NPP.

5. Results

- Both the GPP and NPP match the target median values from the flux towers and NFI sites.
- Box plots show a considerable improvement over the original global MODIS NPP values.
- Our new NPP and GPP values don't have the same variation as the terrestrial data.
- However the new variation is better than the original global MODIS' NPP variation.
- Every country from which we have NFI data shows improvement over the original MODIS.
- Validation against ICP Forest NPP shows that accuracy varies depending on cover type.

Calibration

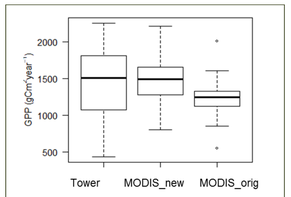

Fig 1. GPP of Flux towers, New European MODIS, and original Global MODIS

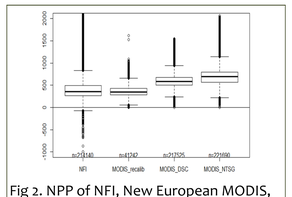

Fig 2. NPP of NFI, New European MODIS, MODIS with new climate data but without recalibration and original Global MODIS

Comparison

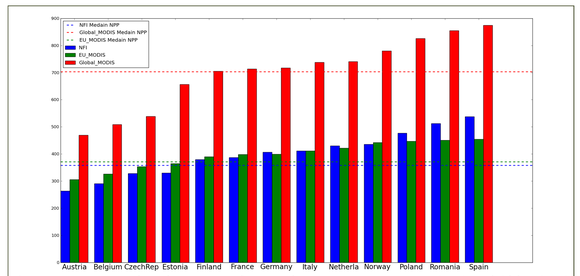

Fig 3. Forest NPP values by country for NFI data, New European MODIS and Old MODIS

Validation

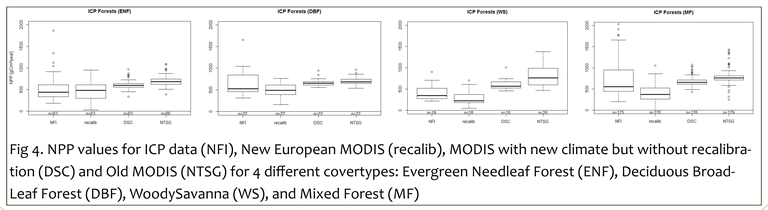

Fig 4. NPP values for ICP data (NFI), New European MODIS (recalib), MODIS with new climate but without recalibration (DSC) and Old MODIS (NTSG) for 4 different covertypes: Evergreen Needleaf Forest (ENF), Deciduous Broad-Leaf Forest (DBF), WoodySavanna (WS), and Mixed Forest (MF)

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6. Discussion

- The median of our dataset matches that of the NFI data and crop statistics
- The validation shows that the mixed forest and woody savanna covertypes have a noticeable level of error. This happens because every mixed forest and woody savanna has a different mix of species. On average our calibration forest plots have a different type of species mix than does the ICP forest plots.
- The new dataset decreases the overall NPP of Europe for forested land from the original global NPP data set.
- The crop NPP is increased from the old dataset to the new.
- The overall NPP of Europe in the new dataset has a median of 464.0 gC/m²/yr compared to the old NPP of 584.9 gC/m²/yr.
- The NPP trend of Europe fluctuates throughout the continent with Southern Italy and Sweden seeing the highest increase in NPP and Spain and the Balkans seeing the greatest decrease.
- The median trend value however is almost 0.0.
- In general crop NPP was increased and forested NPP was decreased.
- Nearly All of Scandinavia's NPP was decreased except for portions of Finland.
- Low elevation NPP was especially decreased.
- Middle and low latitudes saw the largest difference.
- Shrublands and grasslands were not recalibrated, because of lack of empirical data, so any difference in these areas are based solely on the difference between the input climate data.

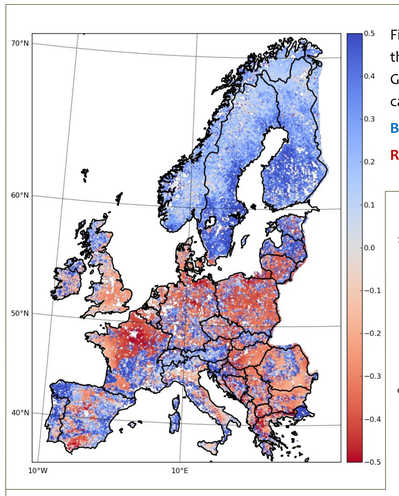

Fig 5. Difference between the Old Global MODIS NPP and the New European MODIS NPP as a percentage of the Old Global MODIS NPP. Average NPP from 2000-2012 used for calculation.

BLUE = Old NPP Greater Than New NPP

RED = New NPP Greater Than Old NPP

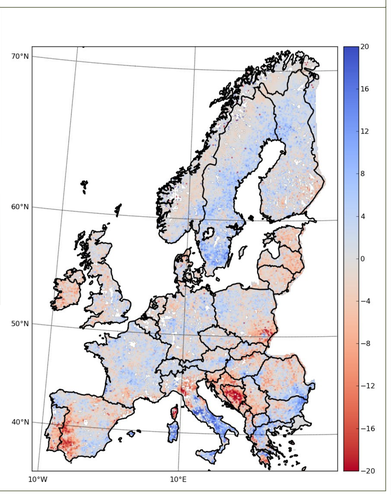

Fig 6. NPP trend from 2000-2012. Values are of the slope of the linear regression line.

BLUE = Increasing NPP from 2000 through 2012

RED = Decreasing NPP from 2000 through 2012

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