Status of MODIS SR

MODIS SR Product suite

Collection 6: (Released in 2015)

Bands 1 through 7

250m, 500m, 0.05 deg.

Daily, 8 days

Status and Updates:

- MODIS SR collection 6 (LaSRC: Land Surface Reflectance Code) is the basis for a variety of SR product (VIIRS, AVHRR, Landsat, Sentinel 2) assuring consistency and traceability in the SR products from multiple satellites/instruments.
- Validation stage IV (AERONET) and cross-comparison with MODIS is on-going.

Known Issues:

- None

Recent Publications:

- Doxani, G., Vermote, E., Roger, J.C., Gascon, F., Adriaensen, S., Frantz, D., Hagolle, O., Hollstein, A., Kirches, G., Li, F. and Louis, J., 2018. Atmospheric correction inter-comparison exercise. Remote Sensing, 10(2), p.352.
- Skakun, S., Franch, B., Vermote, E., Roger, J.C., Becker-Reshef, I., Justice, C. and Kussul, N., 2017. Early season large-area winter crop mapping using MODIS NDVI data, growing degree days information and a Gaussian mixture model. Remote Sensing of Environment, 195, pp.244-258.
- Breon F.M., Vermote E.F., Murphy E., Franch B., (2015) Measuring the directional variations of land surface reflectances from MODIS, IEEE transactions on Geoscience and Remote Sensing, 53 (8), 4638-4649.

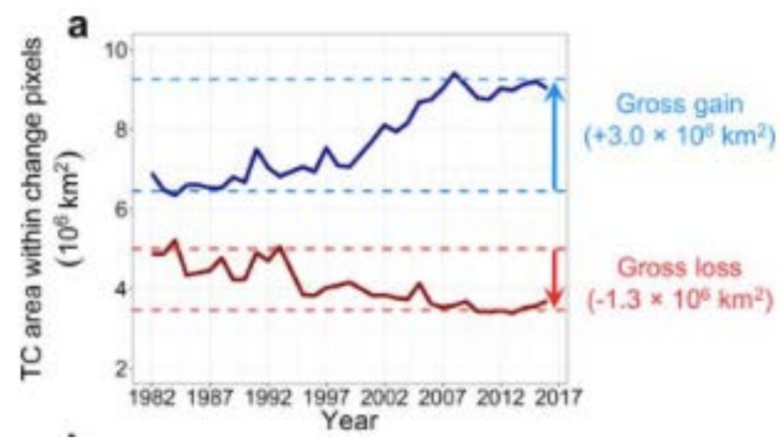
nature
International journal of science

Letter | Published: 08 August 2018

Global land change from 1982 to 2016

Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend

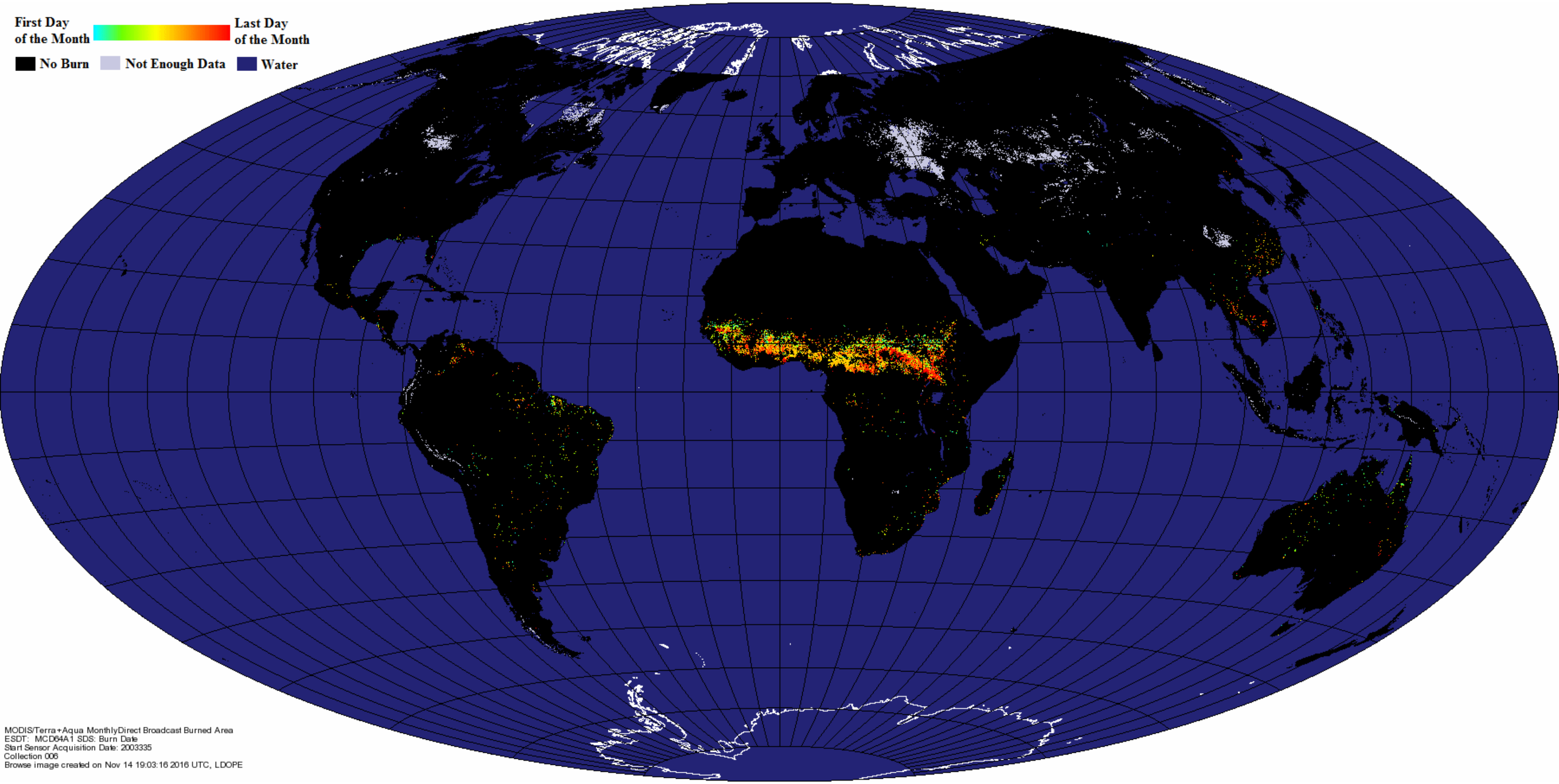
Nature **560**, 639–643 (2018) | Download Citation



“Contrary to popular opinion, tree cover increased by 2.24 million square kilometers (more than 850,000 square miles), an increase of about 7 percent during the time period.”

Development of a Global Burned Area Earth System Data Record

Louis Giglio[1], Luigi Boschetti[2], David Roy[3], Varaprasad Bandaru[1], Chris Justice[1]
[1]University of Maryland, [2]University of Idaho, [3]South Dakota State University



December 2003 MODIS Burned Area Product

Status of MODIS Burned Area

MODIS Burned Area Product

Collection 6: (released 2017)

- MCD64A1: Monthly L3 500 m SIN Grid
- MCD64CMH: Monthly CMG (released 2018)

Status and Updates:

- Stage-2 validation complete.
- Stage-3 validation in preparation.

Known Issues:

- Edge fix for 26 tiles (patch 6.0.8).

Recent Publications:

- Giglio, L., Boschetti, L., Roy, D. P., Humber, M. L., and Justice, C. O., 2018, The Collection 6 MODIS burned area mapping algorithm and product. *Remote Sensing of Environment*, 217:72–85.
- Humber, M. L., Boschetti, L., Giglio, L., and Justice, C. O., 2018, Spatial and temporal intercomparison of four global burned area products, *International Journal of Digital Earth*.
- Andela et al., 2017, A human-driven decline in global burned area. *Science*, 356:1356-1362.

RESEARCH ARTICLES | ECOLOGY

A human-driven decline in global burned area

N. Andela[1,2,*], D. C. Morton[1], L. Giglio[3], Y. Chen[2], G. R. van der Werf[4], P. S. Kasibhatla[5], R. S. DeFries[6], G. J. Collatz[1], S. Han...

+ See all authors and affiliations

Science 30 Jun 2017:
Vol. 356, Issue 6345, pp. 1356-1362
DOI: 10.1126/science.aal4108

Article | Figures & Data | Info & Metrics | eLetters | PDF

Burn less, baby, burn less

Humans have, and always have had, a major impact on wildfire activity, which is expected to increase in our warming world. Andela *et al.* use satellite data to show that, unexpectedly, global burned area declined by ~25% over the past 18 years, despite the influence of climate. The decrease has been largest in savannas and grasslands because of agricultural expansion and intensification. The decline of burned area has consequences for predictions of future changes to the atmosphere, vegetation, and the terrestrial carbon sink.

Science, this issue p. 1356

Status of MODIS Active Fire

MODIS Active Fire Products

Collection 6: (released 2015)

- MOD14/MYD14: Terra/Aqua L2 Swath
- MOD14A1/MYD14A1: L3 Daily 500-m SIN Grid
- MOD14A2/MYD14A2: L3 8-day 500 m SIN Grid
- MCD14ML: Monthly fire locations

Status and Updates:

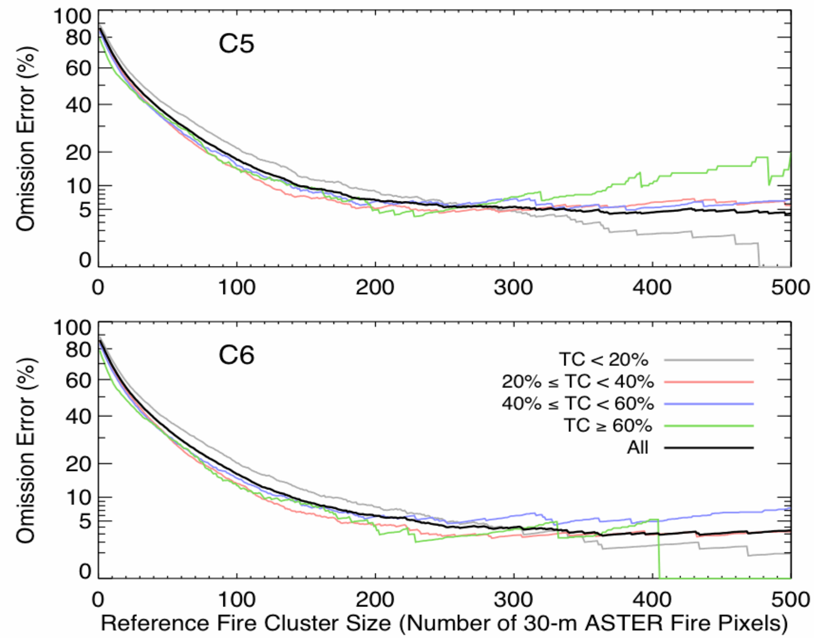
- Widely used mature product.
- Stage-2 validated.

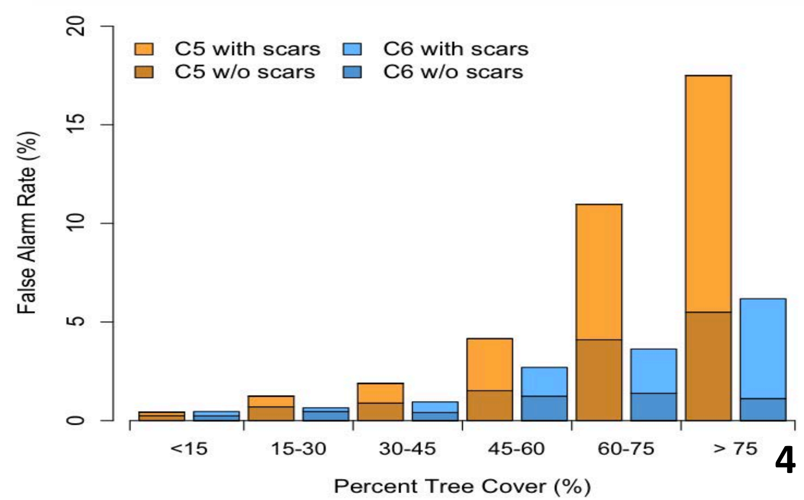
Known Issues:

- None.

Recent Publications:

- Giglio, L., Schroeder, W., and Justice, C. O., 2016, The collection 6 MODIS active fire detection algorithm and fire products. *Remote Sensing of Environment*, 178, 31-41.





Status of MODIS GPP/NPP, ET/PET products and an LST for fun.

MODIS GPP/NPP and ET/PET products.

Collection 6:

- MOD17A3H: MODIS/Terra Annually L4 500 m SIN Grid
- MYD17A3H: MODIS/Aqua Annually L4 500 m SIN Grid
- MOD17A2H: MODIS/Terra 8-day L4 500 m SIN Grid
- MYD17A2H: MODIS/Aqua 8-day L4 500 m SIN Grid
- MOD16A3: MODIS/Terra Annually L4 500 m SIN Grid
- MYD16A3: MODIS/Aqua Annually L4 500 m SIN Grid
- MOD16A2: MODIS/Terra 8-day L4 500 m SIN Grid
- MYD16A2: MODIS/Aqua 8-day L4 500 m SIN Grid

Status and Updates:

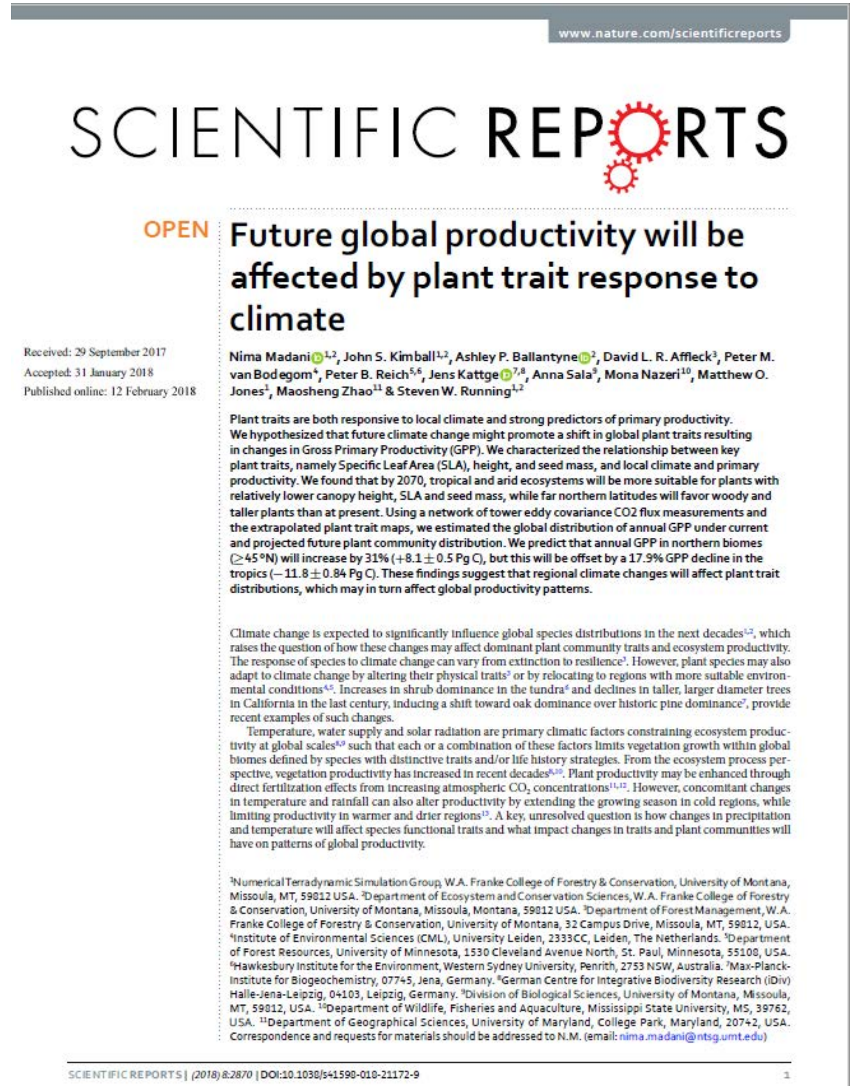
- *Creation of an optimized FPAR/LAI climatology.*
- *This climatology will be used to obtain gap free GPP/NPP and ET/PET products for the upcoming collection 6.1.*

Known Issues:

- Important gaps due to cloud contamination in heavily clouded areas.

Recent Publications:

- Alvaro Moreno, Gustau Camps-Valls, Jens Kattge, Nathaniel Robinson, Markus Reichstein, …, Steven W. Running (2018). A methodology to derive global maps of leaf traits using remote sensing and climate data, **Remote Sensing of Environment**, 218, 69-88.
- Madani, N., Kimball, J. S., Ballantyne, A. P., Affleck, D. L., Bodegom, P. M., Reich, P. B., ... & Zhao, M. (2018). Future global productivity will be affected by plant trait response to climate. **Scientific reports**, 8(1), 2870.
- He, M., Kimball, J. S., Maneta, M. P., Maxwell, B. D., Moreno, A., Beguería, S., & Wu, X. (2018). Regional Crop Gross Primary Productivity and Yield Estimation Using Fused Landsat-MODIS Data. **Remote Sensing**, 10(3), 372.
- Jones, M. O., Running, S. W., Kimball, J. S., Robinson, N. P., & Allred, B. W. (2018). Terrestrial primary productivity indicators for inclusion in the National Climate Indicators System. **Climatic Change**, 1-14.
- David J. Mildrexler, Maosheng Zhao, Warren B. Cohen, Steven W. Running, Xiaopeng Song, Matthew O. Jones. 2018, Thermal Anomalies Detect Critical Global Land Surface Changes. J. Applied Meteorology and Climatology, 57, 391-411.



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SCIENTIFIC REPORTS

OPEN

Future global productivity will be affected by plant trait response to climate

Received: 29 September 2017
Accepted: 31 January 2018
Published online: 12 February 2018

Nima Madani[1,2], John S. Kimball[1,2], Ashley P. Ballantyne[2], David L. R. Affleck[3], Peter M. van Bodegom[4], Peter B. Reich[5,6], Jens Kattge[7,8], Anna Sala[9], Mona Nazeri[10], Matthew O. Jones[1], Maosheng Zhao[11] & Steven W. Running[1,2]

Plant traits are both responsive to local climate and strong predictors of primary productivity. We hypothesized that future climate change might promote a shift in global plant traits resulting in changes in Gross Primary Productivity (GPP). We characterized the relationship between key plant traits, namely Specific Leaf Area (SLA), height, and seed mass, and local climate and primary productivity. We found that by 2070, tropical and arid ecosystems will be more suitable for plants with relatively lower canopy height, SLA and seed mass, while far northern latitudes will favor woody and taller plants than at present. Using a network of tower eddy covariance CO2 flux measurements and the extrapolated plant trait maps, we estimated the global distribution of annual GPP under current and projected future plant community distribution. We predict that annual GPP in northern biomes ($\geq$45 °N) will increase by 31% ($+8.1 \pm 0.5$ Pg C), but this will be offset by a 17.9% GPP decline in the tropics (-11.8 ± 0.84 Pg C). These findings suggest that regional climate changes will affect plant trait distributions, which may in turn affect global productivity patterns.

Climate change is expected to significantly influence global species distributions in the next decades[1,2], which raises the question of how these changes may affect dominant plant community traits and ecosystem productivity. The response of species to climate change can vary from extinction to resilience[3]. However, plant species may also adapt to climate change by altering their physical traits[3] or by relocating to regions with more suitable environmental conditions[4,5]. Increases in shrub dominance in the tundra[6] and declines in taller, larger diameter trees in California in the last century, inducing a shift toward oak dominance over historic pine dominance[7], provide recent examples of such changes.

Temperature, water supply and solar radiation are primary climatic factors constraining ecosystem productivity at global scales[8,9] such that each or a combination of these factors limits vegetation growth within global biomes defined by species with distinctive traits and/or life history strategies. From the ecosystem process perspective, vegetation productivity has increased in recent decades[8,10]. Plant productivity may be enhanced through direct fertilization effects from increasing atmospheric CO_2 concentrations[11,12]. However, concomitant changes in temperature and rainfall can also alter productivity by extending the growing season in cold regions, while limiting productivity in warmer and drier regions[13]. A key, unresolved question is how changes in precipitation and temperature will affect species functional traits and what impact changes in traits and plant communities will have on patterns of global productivity.

[1]Numerical Terradynamic Simulation Group, W.A. Franke College of Forestry & Conservation, University of Montana, Missoula, MT, 59812 USA. [2]Department of Ecosystem and Conservation Sciences, W.A. Franke College of Forestry & Conservation, University of Montana, Missoula, Montana, 59812 USA. [3]Department of Forest Management, W.A. Franke College of Forestry & Conservation, University of Montana, 32 Campus Drive, Missoula, MT, 59812, USA. [4]Institute of Environmental Sciences (CML), University Leiden, 2333CC, Leiden, The Netherlands. [5]Department of Forest Resources, University of Minnesota, 1530 Cleveland Avenue North, St. Paul, Minnesota, 55108, USA. [6]Hawkesbury Institute for the Environment, Western Sydney University, Penrith, 2753 NSW, Australia. [7]Max-Planck-Institute for Biogeochemistry, 07745, Jena, Germany. [8]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, 04103, Leipzig, Germany. [9]Division of Biological Sciences, University of Montana, Missoula, MT, 59812, USA. [10]Department of Wildlife, Fisheries and Aquaculture, Mississippi State University, MS, 39762, USA. [11]Department of Geographical Sciences, University of Maryland, College Park, Maryland, 20742, USA. Correspondence and requests for materials should be addressed to N.M. (email: nima.madani@ntsg.umt.edu)

Status of Terra/Aqua MODIS BRDF, Albedo and NBAR

MODIS BRDF Albedo NBAR Products

Collection V006:

- MCD43A: 500 m SIN grid
- MCD43A1: BRDF/Albedo Model Parameters
- MCD43A2: BRDF/Albedo Quality
- MCD43A3: Albedo
- MCD43A4: NBAR
- MCD43C: 0.05 degree CMG
- MCD43C1: CMG BRDF/Albedo Model Parameters
- MCD43C2: CMG BRDF/Albedo Model Snow-Free Parameters
- MCD43C3: CMG Albedo
- MCD43C4: CMG NBAR
- MCD43D: 30 Arc-Second CMG (1 – 40)
- MCD43GF: CMG Gap-Filled Snow-Free

Status and Updates:

- New daily retrievals are being used extensively for phenology studies.
- Snow free Gap Filled V006 products (MCD43GF) are under production

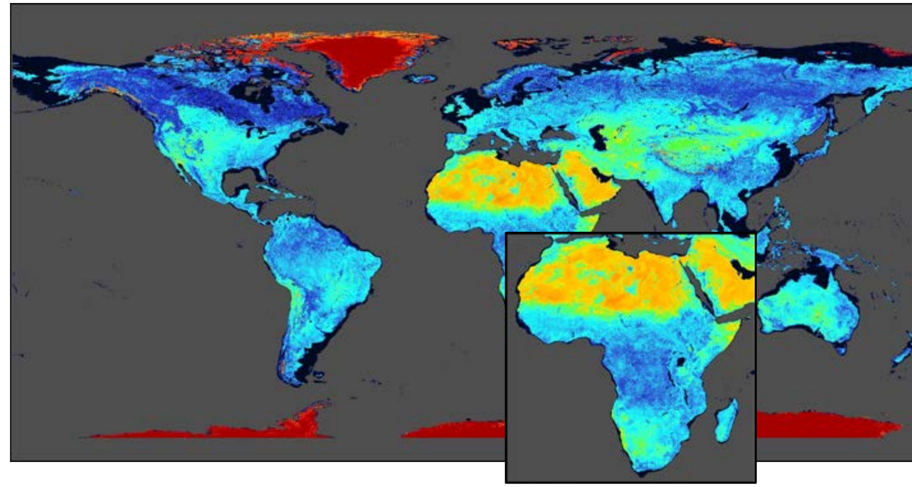
Known Issues:

- None

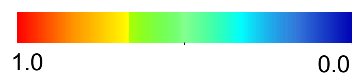
Recent Publications:

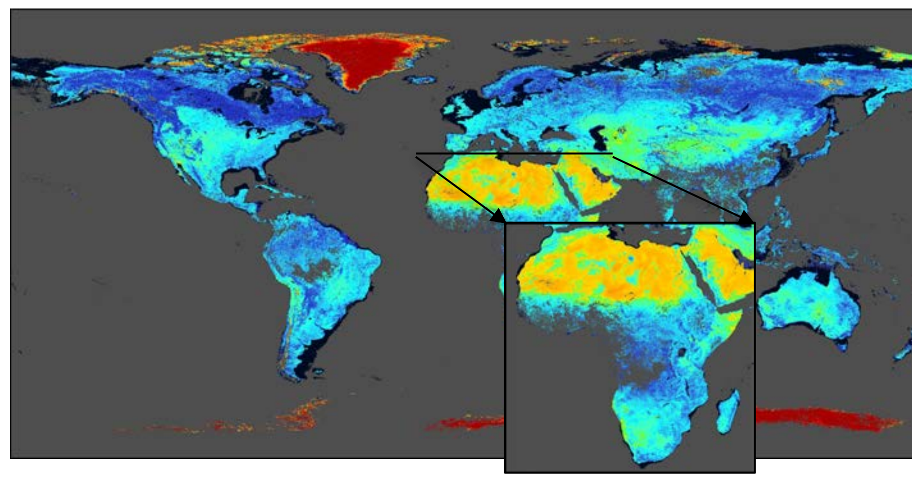
- Wang, Z., Schaaf, C. B., Sun, Q., Shuai, Y., & Román, M. O. (2018). Capturing Rapid Land Surface Dynamics with Collection V006 MODIS BRDF/NBAR/Albedo (MCD43) Products. Remote Sensing of Environment, 207(February), 50–64. https://doi.org/10.1016/j.rse.2018.02.001

- Sun, Q., Wang, Z., Li, Z., Erb, A., & Schaaf, C. B. (2017). Evaluation of the Global MODIS 30 Arc-Second Spatially and Temporally Complete Snow-Free Land Surface Albedo and Reflectance Anisotropy Dataset. International Journal of Applied Earth Observation and Geoinformation, 58, 36–49. https://doi.org/10.1016/j.jag.2017.01.011



MCD43GF: DOY250, 2010
Shortwave Broadband WSA



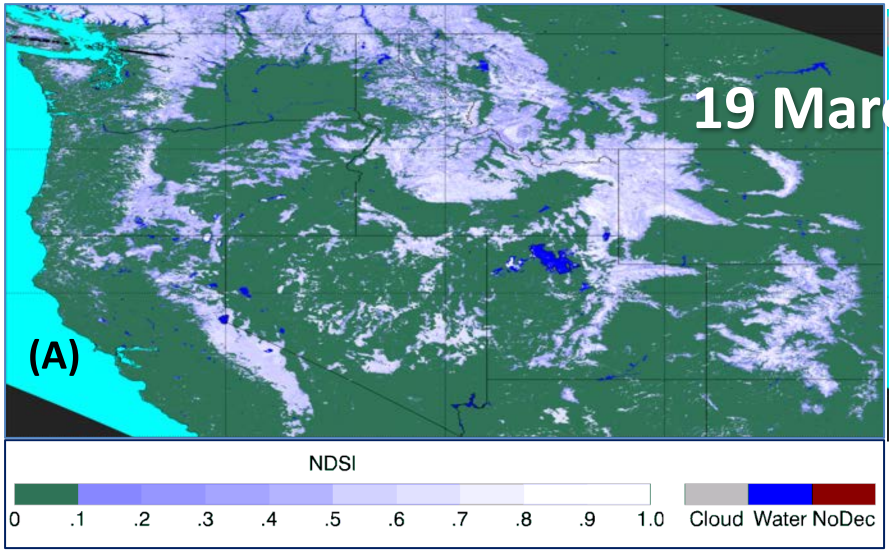


MCD43D61: DOY250, 2010
Shortwave Broadband WSA

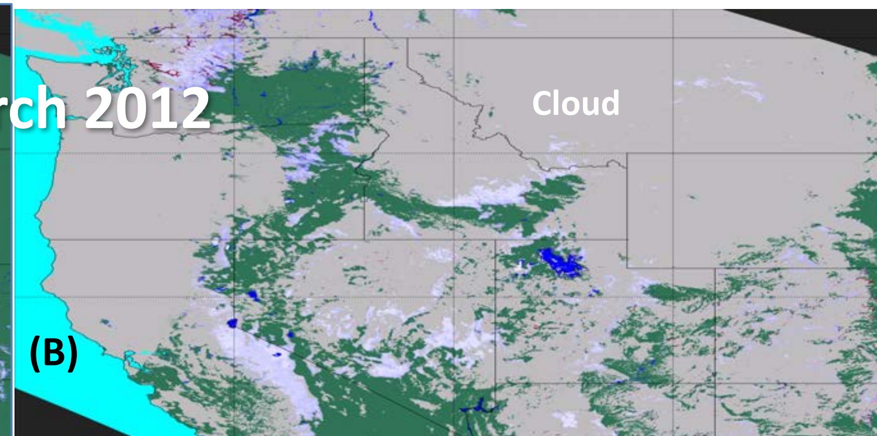
Generating continuous time series of daily snow cover with the MODIS Cloud-Gap-Filled (CGF) Product

Dorothy Hall[1] and George Riggs[2]
[1]ESSIC / University of Maryland, [2]SSAI

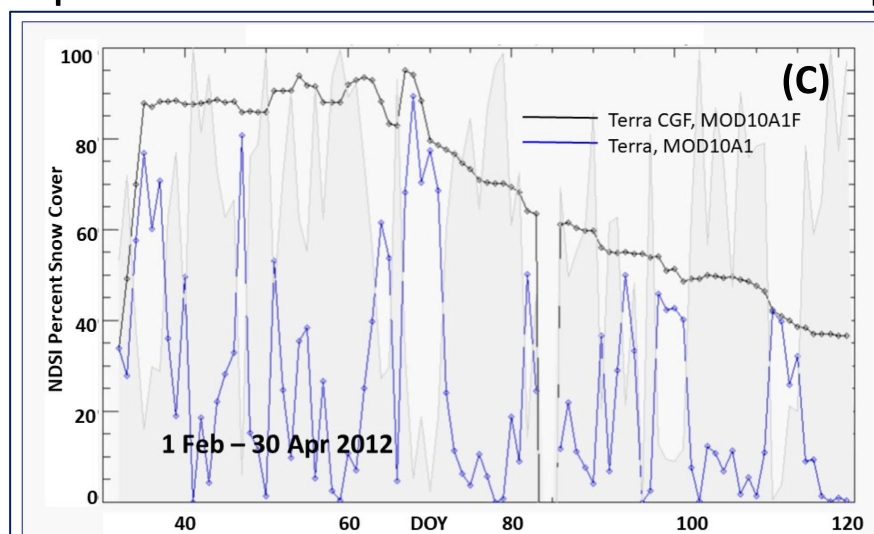
Cloud-Gap Filled Daily Snow Map



Daily Snow Map with Cloud



Comparison of Terra CGF and the standard Terra snow maps



The cloud-gap filled (CGF) MODIS product provides a consistent and continuous cloud free snow cover map (A) compared to the daily snow cover product (B) that has clouds which cause gaps in a time series of snow observations. The CGF maps are able to capture snow buildup and depletion (C), for example in Wind River Range, Wyoming, 1 Feb to 30 April 2012 (C).

Status of MODIS Cryosphere Products

Dorothy Hall[1] and George Riggs[2]
[1]ESSIC / University of Maryland, [2]SSAI

MODIS Snow Cover Product

Collection 6.1:

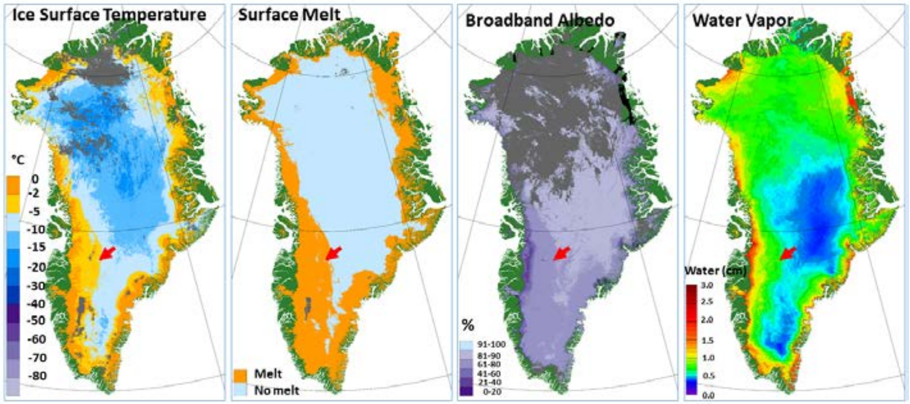
- New -- M*D10A1F: Daily Cloud-gap-filled product MODIS/Terra/Aqua L3 500 m SIN Grid
- M*D10_L2 revised algorithm and data content, improved snow cover detection

Status and Updates:

- Snow cover algorithm: revised low visible reflectance screen and added two algorithm QA bit flags
- Product user guides updated for C6.1

Known Issues:

- Investigating cloud/snow confusion and affect of aerosols on the snow cover algorithm



A unique MODIS multi-layer Greenland IST and surface albedo product was generated by our team and is archived at NSIDC.

Recent Publications:

- Hall, D.K., R.I. Cullather, J.C. Comiso, N.E. DiGirolamo, S.M. Nowicki and B.C. Medley, 2018: A multilayer IST – albedo product of Greenland from MODIS, *Remote Sensing [Special Issue: Remote Sensing of Essential Climate Variables and their Applications]*. Feature Paper. *10*(4), 555; https://doi:10.3390/rs10040555.
- Hall, D.K., A. Frei and N.E. DiGirolamo, 2018: On the frequency of lake-effect snowfall in the Catskill Mountains, *Physical Geography,* https://doi:10.1080/02723646.2018.1440827.
- Riggs, G.A., D.K. Hall and M.O. Román, 2017: Overview of NASA's MODIS and Visible Infrared Imaging Radiometer Suite (VIIRS) snow-cover Earth System Data Records, *Earth System Data Records,* 9:765-777, https://www.earth-syst-sci-data-discuss.net/essd-2017-25/.

Status of MODIS Long Term VI Time Series

MODIS VI Suite (in its 19th year)

Collection 5: (Suspended in 2018)

Collection 6: (Released in 2015)

Collection 7: (In prep)

Status and Updates:

- *Improved QA compositing scheme*
- *Multiple and ongoing algorithm adjustments to deal with changes in upstream products and/or issues*
- *Ongoing opportunistic validation (using NEON data)*

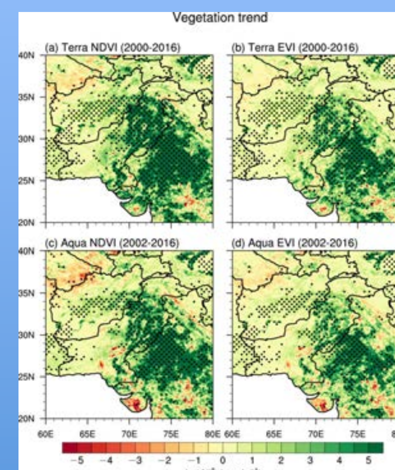
Known Issues:

- The 2010 (C6) decision to use pre-composited 8-day surface reflectance inputs is causing spatial consistency issues that will be addressed in C6.1/C7

Recent Publications:

- Jarchow, C. J., Didan, K., Barreto-Muñoz, A., et al. (2018). Application and Comparison of the MODIS-Derived Enhanced Vegetation Index to VIIRS, Landsat 5 TM and Landsat 8 OLI Platforms: A Case Study in the Arid Colorado River Delta, Mexico. *Sensors*, *18*(5), 1546.
- EL-Vilaly, M. A. S., Didan, K, et al. (2018). Characterizing Drought Effects on Vegetation Productivity in the Four Corners Region of the US Southwest. *Sustainability*, *10*(5), 1643.
- El-Vilaly MA, Didan K, et al. Vegetation productivity responses to drought on tribal lands in the four corners region of the Southwest USA. Frontiers of Earth Science. 2017 May:1-5. DOI 10.1007/s11707-017-0646-z
- Peng D, Zhang X, Wu C, Huang W, et al. Intercomparison and evaluation of spring phenology products using National Phenology Network and AmeriFlux observations in the contiguous United States. Agricultural and forest meteorology. 2017 Aug 15;242:33-46.

MODIS NDVI/EVI product suite continues to lead and drive science and applications with more than 12,000 publications mentioning and/or using the MODIS NDVI/EVI time series, with multiple high end journal articles appearing annually.

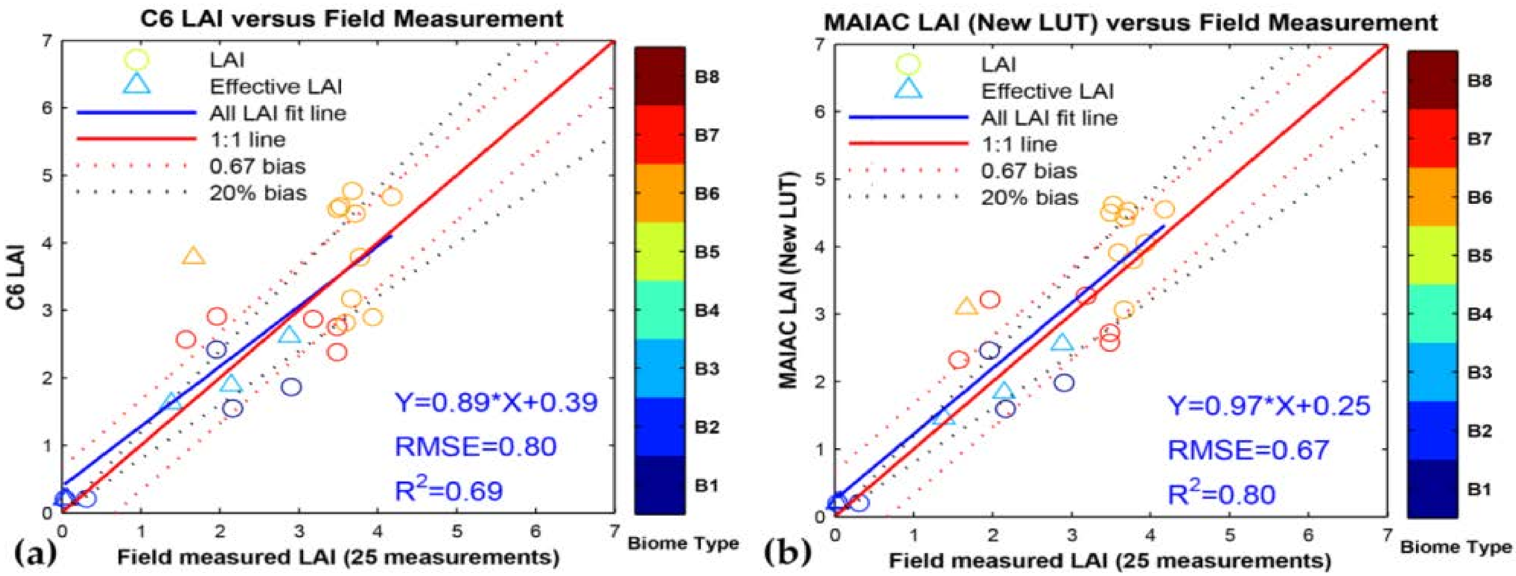


Jin, Q., & Wang, C. (**2018**). The greening of Northwest Indian subcontinent and reduction of dust abundance resulting from Indian summer monsoon revival. *Scientific reports*, *8*(1), 4573.

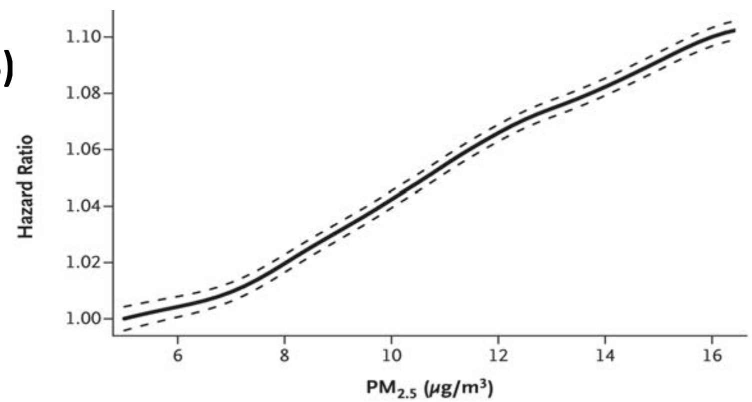
Advancing MODIS-VIIRS Climate Data Records with Algorithm MAIAC

Alexei Lyapustin[1], Yujie Wang[2], Sergey Korkin[3], Dong Huang[4]
[1]NASA GSFC; [2]UMBC; [3]USRA; [4]SSAI

(A)



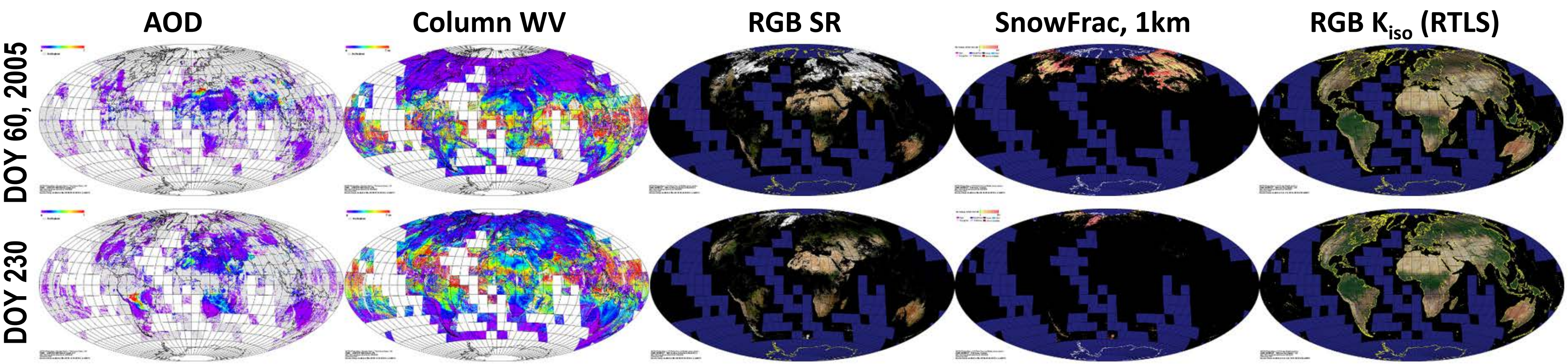
(B)



Risk of death (7.3%) at 10μg/m³ increase in $PM_{2.5}$ (Di et al., Air Pollution and Mortality in the Medicare Population, ***The New England Journal of Medicine***, doi: 10.1056/NEJMoa1702747)

MAIAC MODIS algorithm improves the quality of cloud/snow detection, aerosol retrievals and atmospheric correction. **(A)** Chen et al., (2017) showed improvement in LAI retrieval when using MAIAC surface reflectance as input; **(B)** Di et al. (2017) shows the risk of mortality curve as a function of air quality at $PM_{2.5}$ levels well below the National Ambient Air Quality Standards (35μg/m³). National daily 1km $PM_{2.5}$ for this study (2000-2012) was obtained using MAIAC AOD from MODIS.

Status of MODIS MAIAC (MCD19)



MCD19 Product Suite

Collection 6: (Released in Spring of 2018)

- MCD19A1: Surface Reflectance
  - Daily L3 1 km: BRF in bands 1-12; Snow grain size and snow fraction;
  - Daily L3 500 m: BRF in bands 1-7;
- MCD19A2: Atmospheric properties
  - Daily L3 1 km: CM, AOD, CWV, Plume Injection Height (for detected smoke)
- MCD19A3: BRDF/Albedo
  - 8-Day L3 1 km: RTLS BRDF, instantaneous albedo in bands 1-8;

Status and Updates:

- Fixing known issues for C6.1

Known Issues:

- Regional aerosol models cause AOD discontinuity in 3 regions (Sahel, Southern Africa, West India)
- Detection of sea ice
- Seasonality of aerosol models (to add)
- Missing some bright salt pans

Recent Publications:

- Lyapustin et al., 2018. MODIS Collection 6 MAIAC Algorithm, ***Atm. Meas. Techniques,*** doi:10.5194/amt-2018-141.
- Cooper et al., 2018. Assessing snow extent data sets over North America to inform and improve trace gas retrievals from solar backscatter, ***Atm. Meas. Techniques***, doi:10.5194/amt-11-2983-2018.
- Liang F. et al., 2018. MAIAC-based Long-term Spatiotemporal Trends of PM2.5 in Beijing China, ***Science of The Total Environment***, doi: 10.1016/j.scitotenv.2017.10.155.
- Chen et al., 2017. Prototyping of LAI and FPAR Retrievals from MODIS Multi-Angle Implementation of Atmospheric Correction (MAIAC) Data. ***Remote Sensing***, doi:10.3390/rs9040370

Status of MODIS LAI/FPAR

MODIS LAI/FPAR Product

Collection 6: (Released in 2015)

- MOD15A2H: MODIS/Terra 8-Day L4 500 m SIN Grid
- MYD15A2H: MODIS/Aqua 8-Day L4 500 m SIN Grid
- MCD15A2H: MODIS/Terra+Aqua 8-Day L4 500 m SIN Grid
- MCD15A3H: MODIS/Terra+Aqua 4-Day L4 500 m SIN Grid

Status and Updates:

- *L2G–lite 500 meter surface reflectance used* as input, instead of reflectance at 1km resolution MODAGAGG .
- New *multi-year land cover product at 500m* resolution, in place of the 1km resolution static land cover product.

Known Issues:

- N/A.

Recent Publications:

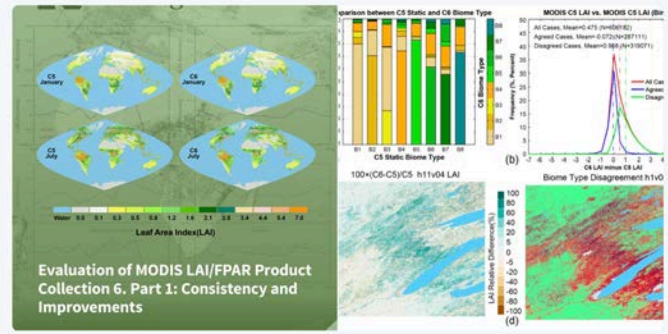
- Chen et al., (under review). China and India lead in greening of the world through land-use management. ***Nature Sustainability***.
- Xu et al., 2018. An integrated method for validating long-term leaf area index products using global networks of site-based measurements. ***Remote Sens. Environ.***, doi:10.1016/j.rse.2018.02.049
- Chen et al., 2017. Prototyping of LAI and FPAR Retrievals from MODIS Multi-Angle Implementation of Atmospheric Correction (MAIAC) Data. ***Remote Sensing***, doi:10.3390/rs9040370

Remote Sensing MDPI @RemoteSens_MDPI · Jan 9

Cover Story: Yan, K.; Park, T.; et al. 2016

Evaluation of #MODIS #LAI/ #FPAR Product #Collection6. Part 1: Consistency and Improvements

mdpi.com/137902



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ARTICLES
https://doi.org/10.1038/s41893-017-0004-x

nature sustainability

Increased vegetation growth and carbon stock in China karst via ecological engineering

Xiaowei Tong[1], Martin Brandt[2], Yuemin Yue[1,3*], Stephanie Horion[2], Kelin Wang[1,3*], Wanda De Keersmaecker[4], Feng Tian[2], Guy Schurgers[2], Xiangming Xiao[5,6], Yiqi Luo[5,7,8], Chi Chen[9], Ranga Myneni[9], Zheng Shi[5], Hongsong Chen[1,3] and Rasmus Fensholt[2]

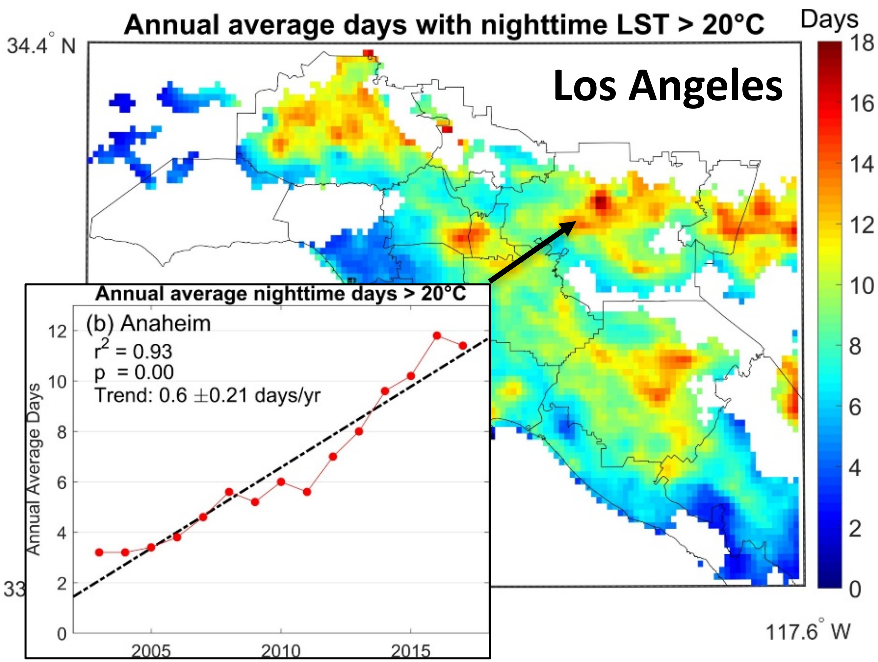
nature ecology & evolution

ARTICLES
https://doi.org/10.1038/s41559-018-0630-3

Coupling of ecosystem-scale plant water storage and leaf phenology observed by satellite

Feng Tian[1,2*], Jean-Pierre Wigneron[3*], Philippe Ciais[4], Jérôme Chave[5], Jérôme Ogée[3], Josep Peñuelas[6,7], Anders Ræbild[2], Jean-Christophe Domec[8], Xiaoye Tong[2], Martin Brandt[2], Arnaud Mialon[9], Nemesio Rodriguez-Fernandez[9], Torbern Tagesson[1,2], Amen Al-Yaari[3], Yann Kerr[9], Chi Chen[10], Ranga B. Myneni[10], Wenmin Zhang[2], Jonas Ardö[1] and Rasmus Fensholt[2]

MODIS LST Detects Rising Temperatures and Heat Wave Trends in Urban Environments



Hulley et al. 2018, RSE

New MOD21 LST product can pinpoint current and future communities that are most vulnerable to the detrimental effects of heat waves and extreme heat in urban areas. Heat vulnerability maps derived from this data can advise local governments on effective climate adaption and mitigation strategies.

LETTER

doi:10.1038/nature13462

Strong contributions of local background climate to urban heat islands

Lei Zhao[1,2], Xuhui Lee[1,2], Ronald B. Smith[3] & Keith Oleson[4]

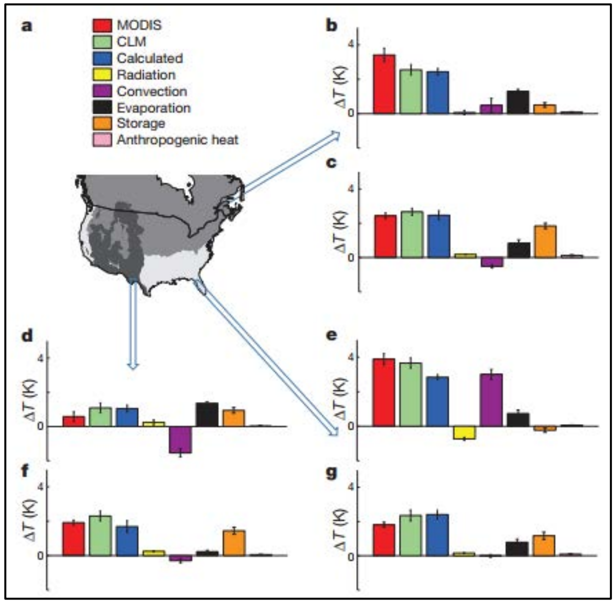


Figure 2 | Attribution of UHI intensity in three Köppen–Geiger climate zones. **a**, Map of climate zones: white, mild temperate/mesothermal climate; grey, continental /microthermal climate; dark grey, dry climate. **b**, **d**, **e**, Daytime values of MODIS and modelled ΔT and its component contributions in each of the three zones (see arrows). **c**, **f**, **g**, Night-time values in each of the three zones (see arrows). Green bars denote model-predicted ΔT and blue bars denote UHI intensity calculated as the sum of the component contributions. Error bars, 1 s.e. for each climate zone.

Status of MODIS LST&E

Status and Updates:

- New LST&E product in Collection 6, reprocessing underway at MODAPS. Release Fall 2018
- All issues with product/code resolved. All attributes, metadata, browse images cleared by LPDAAC

MOD21 LST&E Products:

Collection 6: (Release Fall 2018)

- MxD21 L2: Daily 5-min L2 Swath 1km
- MxD21A1: Daily L3 Global 1km
- MxD21A2 8-day L3 Global 1km

Collection 6.1: (Release 2019)

- MxD21C1: Daily 0.05 degree Climate Modeling Grid (CMG)
- MxD21C2: 8-day 0.05 degree Climate Modeling Grid (CMG)
- MxD21C3: Monthly 0.05 degree Climate Modeling Grid (CMG)

Known Issues:

- Limited support through next funding cycle resulting in semi-orphaned products.
- LST&E (MxD11/MxD21) have 10 different product types! Results in user confusion, reduced usability.
- No support or plan forward to retire MxD11 suite of products. Requires analyzing and comparing MxD11/MxD21 products. Potential to reduce to 5 product types from MxD21 (JPL product).

Publications/Documentation:

- *Hulley, G. C., Malakar, N., Islam, T., Freepartner, R, (2017), NASA's MODIS and VIIRS Land Surface Temperature and Emissivity Products: A Consistent and High Quality Earth System Data Record, IEEE TGRS, DOI: 10.1109/JSTARS.2017.2779330.*
- *Malakar, N. K., and G. C. Hulley (2016), A water vapor scaling model for improved land surface temperature and emissivity separation of MODIS thermal infrared data, Remote Sensing of Environment, 182, 252-264*
- *User guide and ATBD available at: https://modis.gsfc.nasa.gov/data/dataprod/mod21.php*