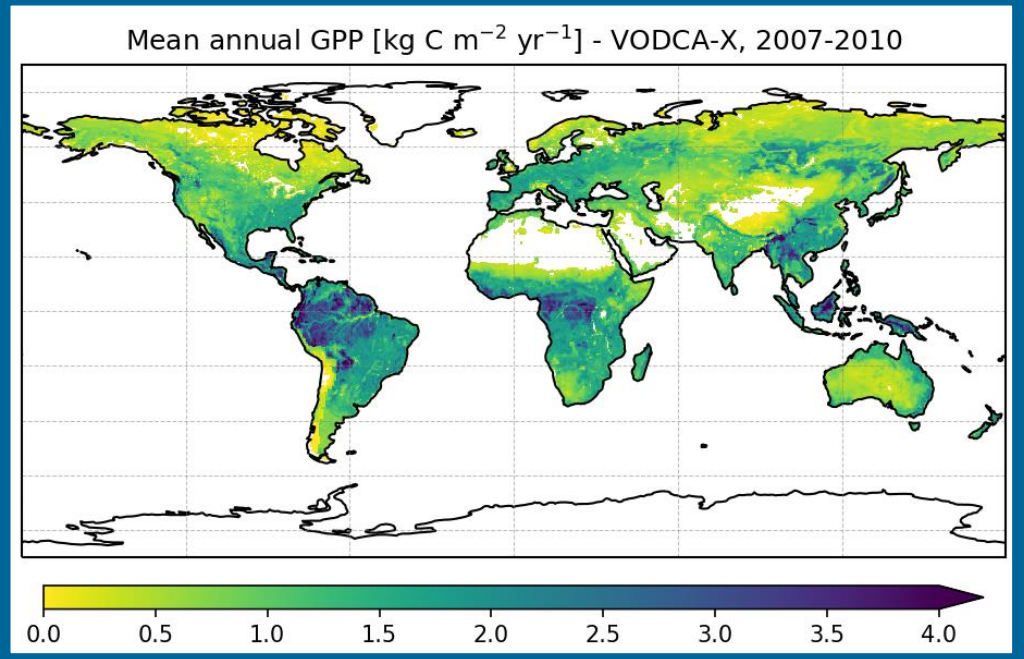
TECHNISCHE UNIVERSITÄT WIEN

A new global Gross Primary Production (GPP) dataset based on microwave Vegetation Optical Depth Climate Archive (VODCA)

Benjamin Wild (benjamin.wild@tuwien.ac.at)[1], Irene Teubner[1,2], Leander Moesinger[1] and Wouter Dorigo[1]

[1] Department of Geodesy and Geoinformation, TU Wien, Austria
[2] Zentralanstalt für Meteorologie und Geodynamik (ZAMG), 1190 Vienna, Austria



Introduction

Novel microwave VOD-based GPP estimation approach to complement existing products[1]

Long-running (30+ years) microwave Vegetation Optical Depth Climate Archive (VODCA)[2]

30+ years of global (0.25°) GPP estimates based on microwave VOD

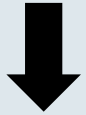
[1] Teubner, Irene E., et al. "A carbon sink-driven approach to estimate gross primary production from microwave satellite observations." Remote Sensing of Environment 229 (2019): 100-113.

[2] Moesinger, Leander, et al. "The Global Long-term Microwave Vegetation Optical Depth Climate Archive VODCA." Earth System Science Data 12.1 (2020): 177-177.

Motivation

- Global state of the art GPP products are so far derived from optical EO products (e.g. FLUXCOM GPP) which are:
  - affected by weather conditions.
  - typically underestimating high productivity (e.g. in tropical regions).[3,4]

- Teubner et al. developed an independent sink-driven approach by upscaling in-situ (FLUXNET) GPP based on VOD which:
  - is unaffected by cloud coverage
  - is more accurate in highly productive regions
  - **allows estimating GPP for 30+ years by using VODCA developed by Moesinger et al.**



Enabling long-term analysis of global ecosystem dynamics independent from cloud coverage

Results I

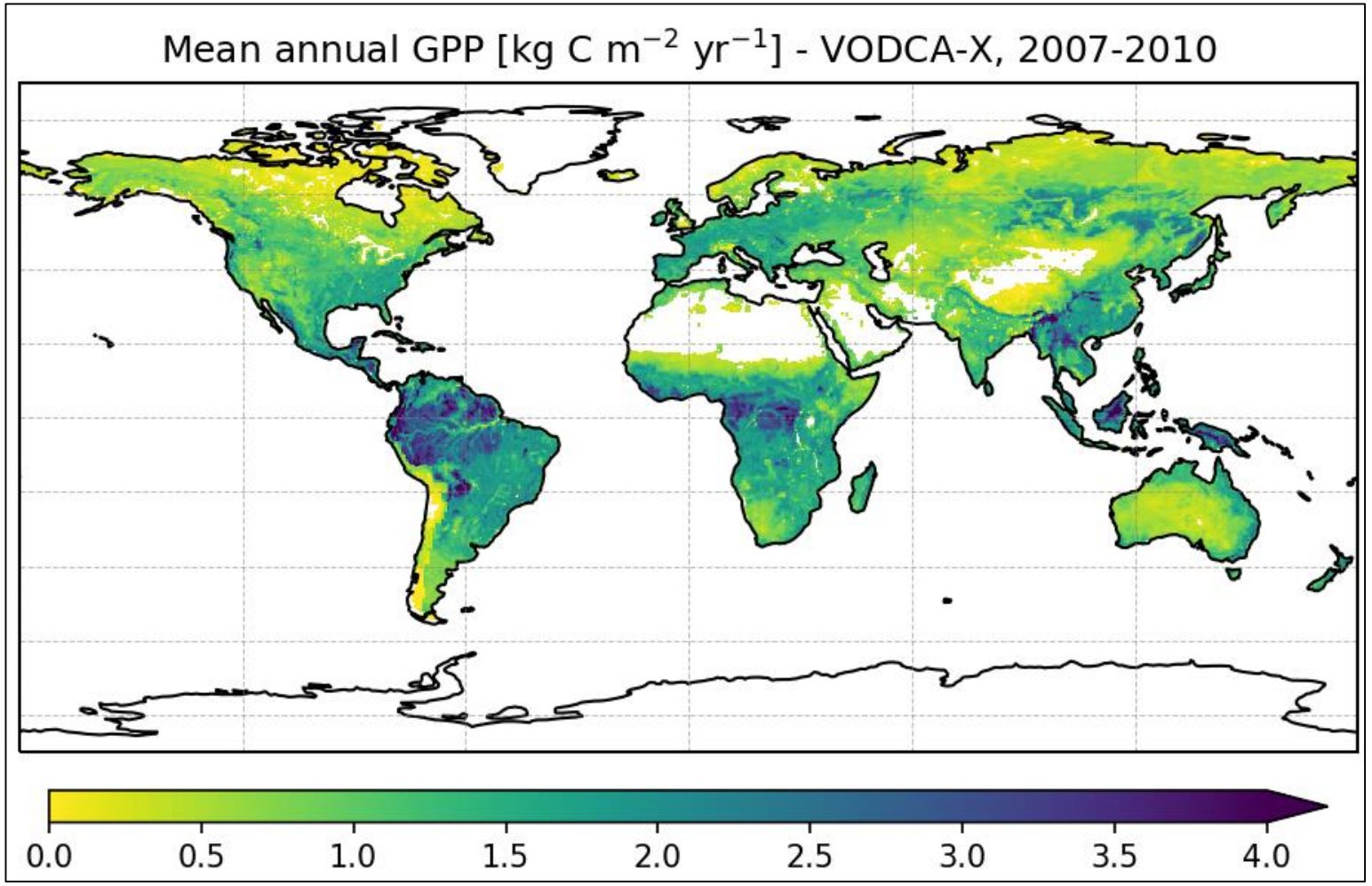


Figure 1: Mean annual GPP - estimated from X-Band VODCA

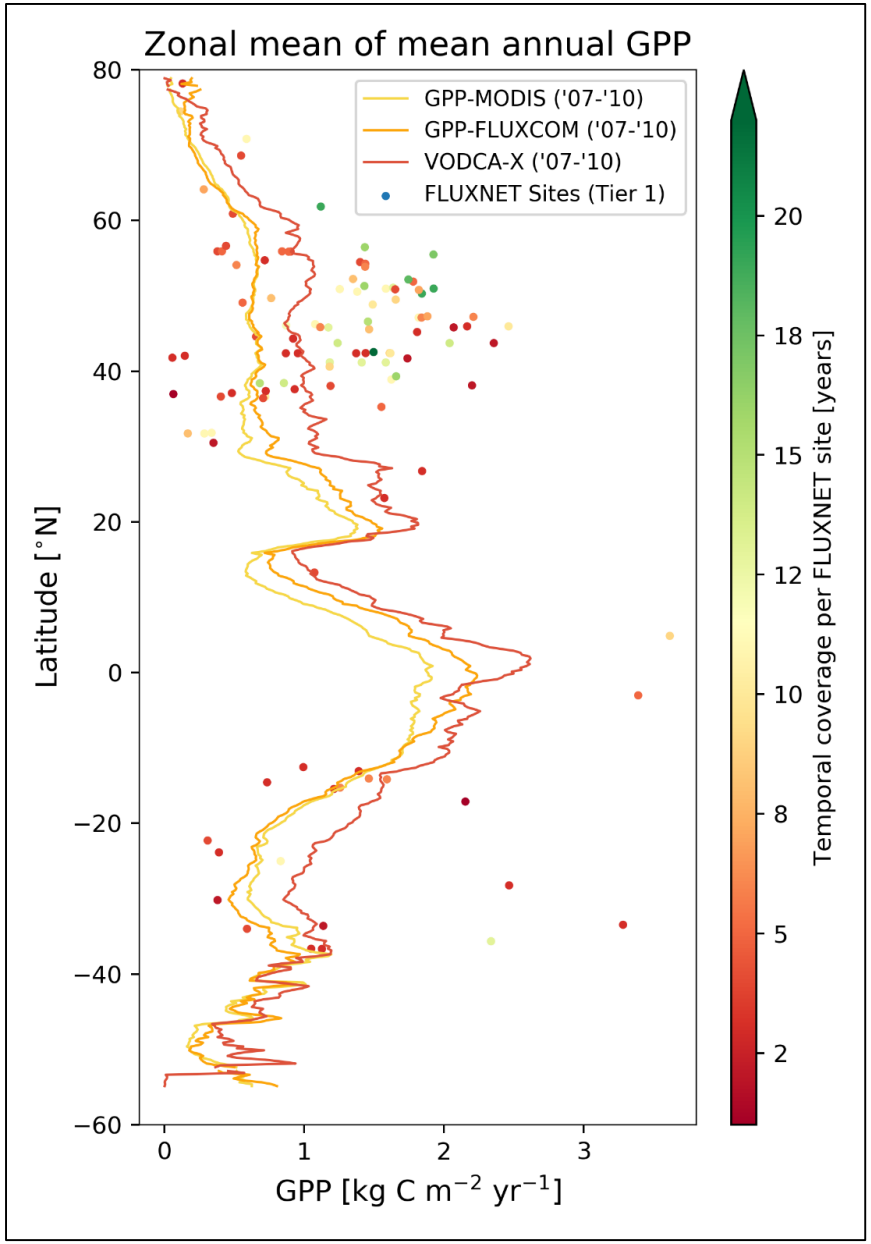


Figure 2: Zonal mean of mean annual GPP

Results II

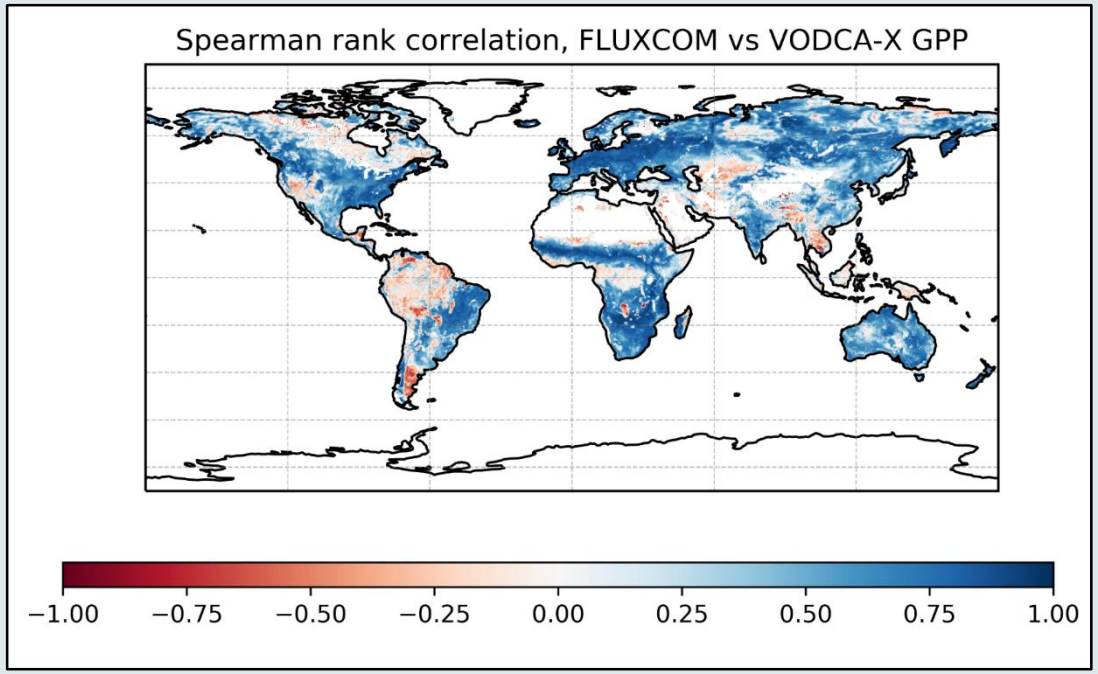


Figure 3: Correlation between FLUXCOM and VODCA-X GPP

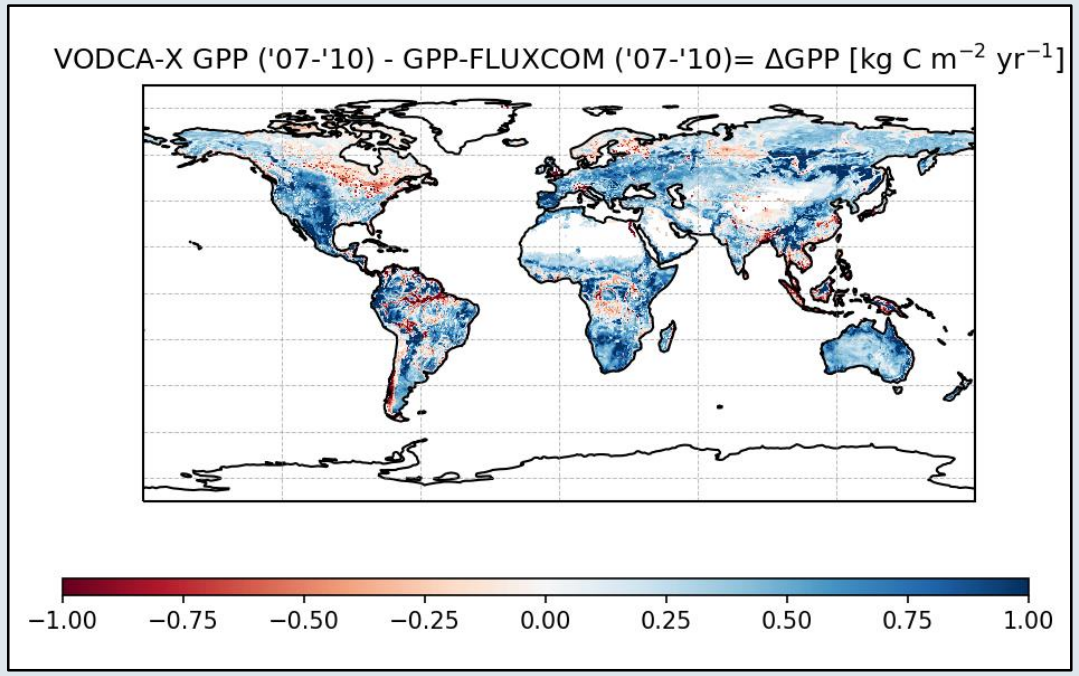


Figure 4: Bias between VODCA-X GPP and FLUXCOM GPP

- VODCA-X GPP shows good aggreement with MODIS and FLUXCOM GPP with a tendency to overestimate GPP
- In regions with high productivity VODCA-X GPP generally correspnds better with in-situ GPP than MODIS/FLUXCOM GPP
- **Results confirm that VODCA can be used to extend the GPP estimates to the past three decades**

Appendix

- VOD: **V**egetation **O**ptical **D**epth
  - Degree of microwave radiation that is attenuated by vegetation
  - Can be derived from microwave satellite observations at different frequencies (e.g. L/C/X/Ku-Band)
  - Depends on vegetation density, type, water content, etc. [5]

- FLUXNET GPP:
  - *"FLUXNET is a global network of micrometeorological flux measurement sites that measure the exchanges of carbon dioxide, water vapor, and energy between the biosphere and atmosphere."* [6]
  - FLUXNET15 GPP (Tier 1): ~115 stations, 1998-2014[7]
  - Average observation length per site: ~7 years
  - Stations unevenly distributed across the biomes (cf. Figure 2)

List of References

1. Teubner, Irene E., et al. "A carbon sink-driven approach to estimate gross primary production from microwave satellite observations." Remote Sensing of Environment 229 (2019): 100-113.

2. Moesinger, Leander, et al. "The Global Long-term Microwave Vegetation Optical Depth Climate Archive VODCA." Earth System Science Data 12.1 (2020): 177-177.

3. Wang, Lunche, et al. "Evaluation of the latest modis gpp products across multiple biomes using global eddy covariance flux data." *Remote Sensing* 9.5 (2017): 418.

4. Jung, Martin, et al. "Scaling carbon fluxes from eddy covariance sites to globe: Synthesis and evaluation of the FLUXCOM approach." Biogeosciences 17.5 (2020): 1343-1365.

5. Jackson, T. J., Schmugge, T. J., 1991. Vegetation effects on the microwave emission of soils. Remote Sens. Environ. 36, 203–212. URL http://www.sciencedirect.com/ science/article/pii/003442579190057D, doi:10.1016/0034-4257(91)90057-D

6. Baldocchi, D., E. Falge, L. Gu, R. Olson, D. Hollinger, S. Running, P. Anthoni, C. Bernhofer, K. Davis, R. Evans, J. Fuentes, A. Goldstein, G. Katul, B. Law, X. Lee, Y. Malhi, T. Meyers, W. Munger, W. Oechel, K.T. Paw U, K. Pilegaard, H.P. Schmid, R. Valentini, S. Verma, T. Vesala, K. Wilson, and S. Wofsy, 2001: FLUXNET: A New Tool to Study the Temporal and Spatial Variability of Ecosystem-Scale Carbon Dioxide, Water Vapor, and Energy Flux Densities. *Bull. Amer. Meteor. Soc.,* **82**, 2415–2434, https://doi.org/10.1175/1520-0477(2001)082<2415:FANTTS>2.3.CO;2

7. FLUXNET website: site summary, https://fluxnet.fluxdata.org/sites/site-list-and-pages/ , visited on: 02.05.2020