Response to Seungcheol Oh

essd-2023-495

Title: Satellite-based Near-Real-Time Global Daily Terrestrial Evapotranspiration Estimates

Author(s): Lei Huang et al.

MS type: Data description paper

Iteration: Minor revision

In the reply, the reviewers' comments are in *italics*, our response is in normal text, and quotes from the manuscript are in **blue**.

Summary:

The study introduces a novel approach leveraging the Moderate Resolution Imaging Spectroradiometer (MODIS) to deliver global daily actual evapotranspiration (ET) estimates with a spatial resolution of 0.05°, available within a week of satellite measurements. VISEA employs a combination of a vegetation index-temperature triangle method, a daily evaporation fraction method, and a net radiation calculation that incorporates cloud coverage, utilizing inputs from both ERA5-Land and MODIS land products. The algorithm's efficacy is validated through comparisons with data from 149 flux towers, other satellite-based ET products, and GPCC precipitation data, demonstrating VISEA's comparable performance.

General Comments:

The manuscript is promising and contributes valuable insights to the field of Earth System Science Data. However, it requires minor revisions before it can be considered for publication. My suggestions mainly pertain to enhancements in figures and tables, as well as a need for a more in-depth discussion.

Re: We thank the reviewers! We have modified the manuscript following your comments from reviewers. Please see further responses below.

Abstract: Line 39: Delete ')'.

Re: we have deleted ')' in the Abstract at lines 38-39:

…e.g., surface reflectance, land surface temperature/emissivity, land cover products, vegetation indices, and albedo as inputs.

Introduction:

Line 69-87: Are there any other satellite-based daily ET products not covered in this part? If not, it's recommended to more clearly highlight why these specific ET products were chosen for discussion. Clarify that each represents unique algorithmic approaches and are widely recognized within the scientific community for their contributions to global ET estimation.

Re: The reasons for choosing these products have been clarified. We have revised this paragraph at lines 77-79:

"The selected ET products discussed in this study embody diverse and innovative algorithmic approaches that have significantly contributed to global ET estimation and gained recognition within the scientific community."

Table 2:

Please double-check the time periods listed for MOD16 and GLEAM in Table 2. It's possible that more recent data are available for both datasets, extending beyond the years currently noted in your table. Additionally, there seems to be a discrepancy between the time period for MOD16 mentioned in Figure 8, which is listed as 2001-2014, and what's noted in Table 2 as 2001-2013.

Re: we have double-checked the availability and coverage periods of MOD16 and GLEAM. We confirm that the MOD16 data, with a spatial resolution of 0.05°, is indeed available for the period from 2001 to 2014. We have updated Table 2 to accurately reflect this time period. Furthermore, we have verified that the latest available data from the GLEAM dataset extends up to the year 2020 and we used FLUXCOM to replace the old GBAF data. These updated dataset have been utilized in our analysis and is correctly cited in both Figure 7, Figure 8 and Figure 9 for the evaluation.

Table 2. The five global girded ET products and one precipitation product used for comparison with our near-real-time global daily terrestrial ET estimates.

Product name	Spatial/Temporal resolution	Time period	Theory
GLEAM	0.25°/Monthly	2001-2022	Priestly-Taylor Equation
FLUXCOM	0.5°/Monthly	2001-2016	Machine learning
MOD16	0.05°/Monthly	2001-2014	Penman-Monteith Equation
AVHRR	1°/Monthly	2001-2006	Improved Penman-Monteith Equation
PML	0.05°/8-day	2003-2018	Penman-Monteith Equation and a diagnostic biophysical model
GPCC	0.25°/Monthly	2001-2019	in-situ observations
GPC	0.5°/Daily	08/28/2022-09/01/2022	Global Unified Gauge-Based Analysis of Daily Precipitation

I suggest adding a comparison of the annual variation of ET with latitude for different remote sensing products to Figure 8 for an improved analysis. For reference, please see Figure 3 in the paper by Chen et al., 2021. https://doi.org/10.1029/2020JD032873

Re: We have added the comparison of the annual variation of ET with latitude for different remote sensing products to Figure 8 and add the paper as reference (Chen et al., 2021). And we added the full citation.

Chen, X., Su, Z., Ma, Y., Trigo, I., and Gentine, P.: Remote Sensing of Global Daily Evapotranspiration based on a Surface Energy Balance Method and Reanalysis Data, Journal of Geophysical Research: Atmospheres, 126, e2020JD032873, https://doi.org/10.1029/2020JD032873, 2021.

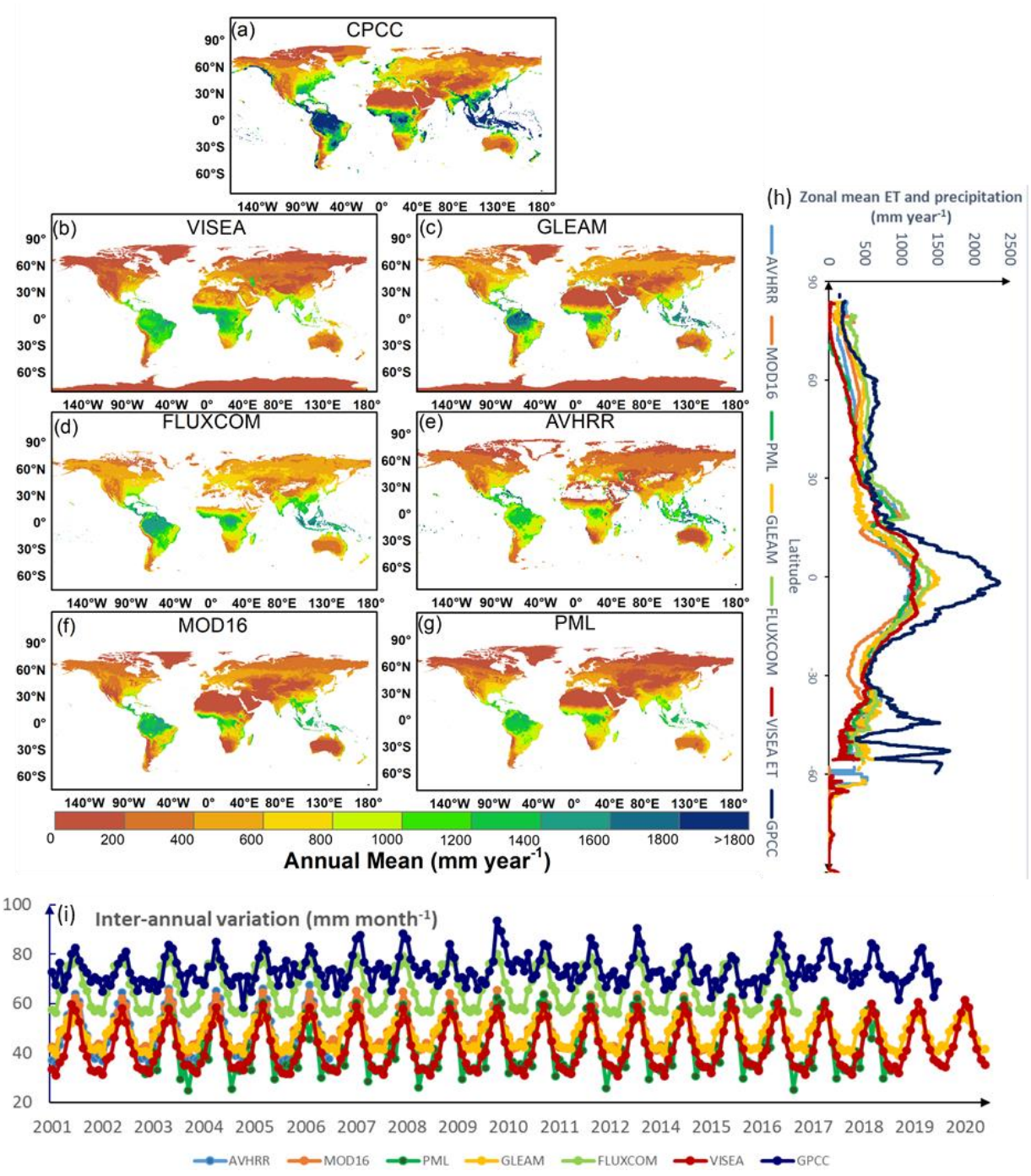

Figure 8. The spatial distribution of the multi-year average (a-g), the zonal mean (h) and inter-annual variation (i) of (a) GPCC (2001-2019), (b) VISEA (2001-2020), (c) GLEAM (2001-2020), (d) FLUXCOM (2001-2016), (e) AVHRR (2001-2006), (f) MOD16 (2001-2014) and (g) PML (2003-2018).

Discussion:

1. The discussion could benefit from a more detailed analysis of the methodological uncertainties inherent in VISEA. Consider exploring not only the input data challenges but also the underlying assumptions and limitations of the model itself.

Re: we added the discussion of the VI-Ts method uncertainties in VISEA at lines 648-655:

"As previously explained, the VI-Ts method relies on the negative linear correlation between the Vegetation Index (VI) and surface temperature (Ts) within a 5 × 5 grid. Therefore, both the variance of VI values across these grid cells and the negative correlation are essential for calculating the air temperature. However, in regions where the vegetation index and temperature data in adjacent grid cells show small variations, such as dense forests and bare lands and deserts. Also, in regions with freezing temperatures, the VI-TS method does perform well, because warmer temperature is related to increased vegetation, opposite the other regions, where there is a negative."

2. The discussion mentions several critical points regarding the sources of bias and inaccuracies but seems to lack sufficient citation from existing literature to contextualize these findings within the broader field.

Re: we added the references at line 637-640:

"However, the accuracy of shortwave radiation from ERA5-Land seems compromised in savannas (Figure 3) due to the challenges associated with simulating radiation transmission under land-use changes and aerosol pollution from natural or anthropogenic sources (Babar et al., 2019; Martens et al., 2020)."

at lines 653-655,

"Also, in regions with freezing temperatures, the VI-TS method does perform well, because warmer temperature is related to increased vegetation, opposite the other regions, where there is a positive correlation between the vegetation index and surface temperature (Cui et al., 2021)."

and lines 661-664

"Since available energy for evapotranspiration (ET) depends on net radiation (Eq. 20 and 21), addressing these uncertainties is crucial for enhancing overall model accuracy (Brutsaert, 1975; Huang et al., 2023)."

3. Conclude the discussion with specific suggestions for future research directions that could address the identified gaps and uncertainties. This may include the development of alternative methods for estimating air temperature and net radiation, the incorporation of additional variables such as soil moisture and water availability into the model, or the potential for integrating machine learning techniques to improve estimation accuracy.

Re: we added the discussion with specific suggestions for future research directions at lines 706-715:
"The accuracy of the VISEA model could be enhanced by incorporating additional satellite and climate data with higher resolution and improved accuracy. Moreover, the delay in providing ET data could be reduced to three days or less by integrating real-time updated satellite and climate data. In response to the suggestion to conclude our discussion with specific recommendations for future research directions, we recognize the importance of addressing the identified gaps and uncertainties. We propose exploring the development of alternative methods for estimating air temperature and net radiation to provide more accurate and reliable models. Additionally, incorporating variables such as soil moisture and water availability into the model could further refine its precision. By integrating these suggestions, we aim to outline a comprehensive roadmap for future research that builds upon our findings, significantly contributing to the enhancement of environmental modeling and prediction within the field."