Reply to RC1 for the manuscript "A global satellite environmental data record derived from AMSR-E and AMSR2 microwave earth observations" by Du Jinyang, John S. Kimball, Lucas A. Jones, Youngwook Kim, Joseph Glassy, and Jennifer D. Watts.

Dear Anonymous Referee #1, thank you for your constructive comments on our manuscript. Please find below our responses to all of the comments (in ***bold and italic***). The reviewer recommendations and resulting changes have been incorporated into the revised manuscript and are highlighted in blue.

This ms describes a valuable data product for high temporal resolution land surface dynamics (Land Parameter Data Record; LPDR) constructed from two passive microwave time series (AMSR-E and AMSR2). The variables retrieved include surficial volumetric soil moisture, air temperature at 2 m, precipitable water vapor, fractional open water,and vegetation optical depth (VOD), all retrieved at 25 km resolution for ascending and descending passes.
I have just a few concerns about this well-written ms.

Reply: Thank you for your comments and summary. We've attempted to address all of your concerns and recommendations in the revised paper, which are summarized in the following sections.

The authors should reconsider labeling the surface air temperature retrievals as the daily Tmax and Tmin. There is no guarantee that these are the diel extrema common to meteorological and climatological usage since there are a limited number observa-tions per day over much of the land surface. These observations are very valuable particularly in those many parts of the planet where there are few temperature stations or the accessibility to the temperature data is restricted.

Reply: We understand the reviewer's concern. As the reviewer stated, AMSR-E/2 has limited observations per day over much of the land surface. In our prior studies, microwave effective surface air temperature (T_s) directly estimated from the T_b observations of AMSR-E/AMSR2 ~1:30 AM/PM overpasses were found to be well correlated with the daily air temperature extrema measured from global weather stations (Jones et al., 2010; Du et al., 2015). The daily T_{mx} and T_{mn} retrievals were therefore estimated based on T_s as shown in Eqs. 3-4, calibrated and validated using independent WMO weather station air temperature measurements as detailed in Section 2.2, Section 3.2 and Table 2. The initial LPDR version 1 database (Jones and Kimball, 2010) refers to the resulting surface air temperature records as T_{mx} and T_{mn}, so we elected to use the same terminology to avoid confusion. However, the reviewer is correct that the AMSR temperature retrievals may diverge from true diel T_{mx}/T_{mn} conditions for some areas and conditions partly due to model calibration uncertainty using sparse weather station measurements. We included an additional cautionary statement to this effect in the revised manuscript (Section 4.3) as follows, while the resulting uncertainty from these assumptions is represented in the LPDR temperature accuracy assessment using independent weather station measurements (Table 2).

"We also note that the LPDR surface air temperatures are derived from ascending/descending orbit T_b retrievals empirically adjusted to represent daily T_{mx}/T_{mn} conditions using in situ temperature measurements from sparse global weather stations. Thus the LPDR results may deviate from actual daily maximum and minimum temperature conditions for some areas and periods; these and other uncertainties impact LPDR accuracy and performance, which are evaluated in the following temperature assessment."

The reference (Jones and Kimball, 2010) is listed below:

Jones, L. A. and Kimball, J. S.: updated 2012. Daily Global Land Surface Parameters Derived from AMSR-E, Version 1. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. 2010. doi: http://dx.doi.org/10.5067/JIKQZ6WO5C5M. [Date Accessed 01/10/2016].

The authors have chosen to display the dispersion about mean as standard deviation in units in some maps but as "temporal SD variability (%)" in others. Displaying the temporal variation consistently the percent coefficient of variation (%CV=100*SD/mean) would make it easier to understand relative variation of each retrieved quantity across continents, biomes, and ecoregions.

Reply: We accepted the reviewer's suggestion and displayed the temporal variations consistently by the percent coefficient of variation. Figure 4 and 6 of the revision were re-plotted accordingly as shown below. The coefficient of variation is highly sensitive to small mean values, so we added the following sentence in the manuscript "Relatively large CV values in regions with average dry-air conditions (e.g. Tibetan Plateau) reflect strong sensitivity of the CV metric to small mean humidity values in the denominator (*%CV=100*SD/mean*)".

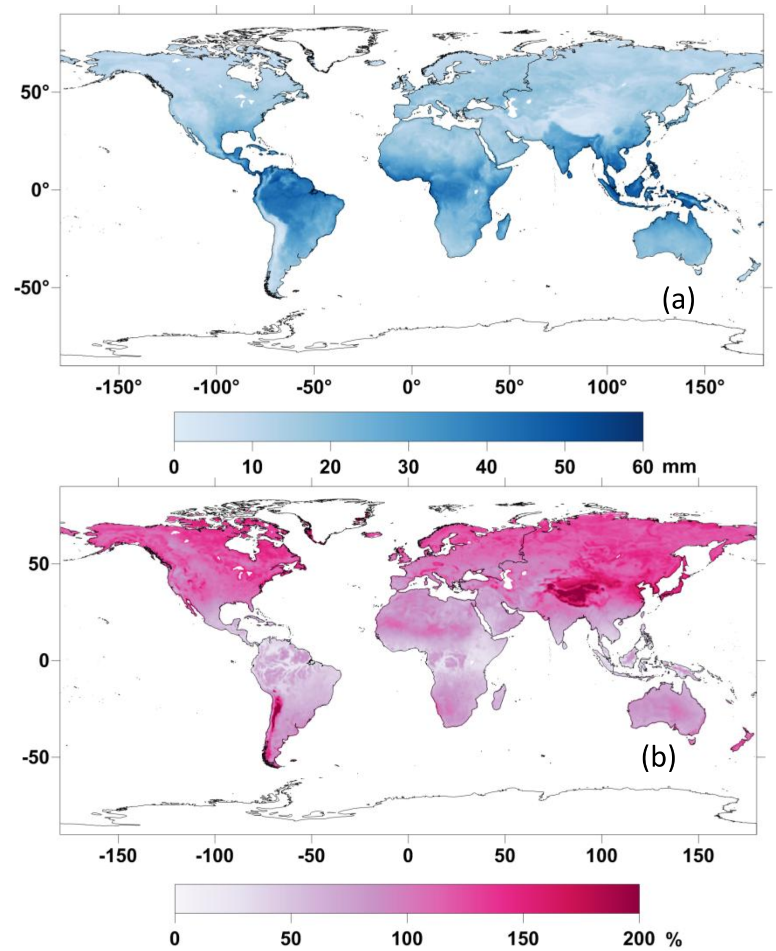


Figure 4: LPDR *PWV* climatology mean (a) and 2 times coefficient of variation (b) from the combined 2003-2010 and 2013-2015 record.

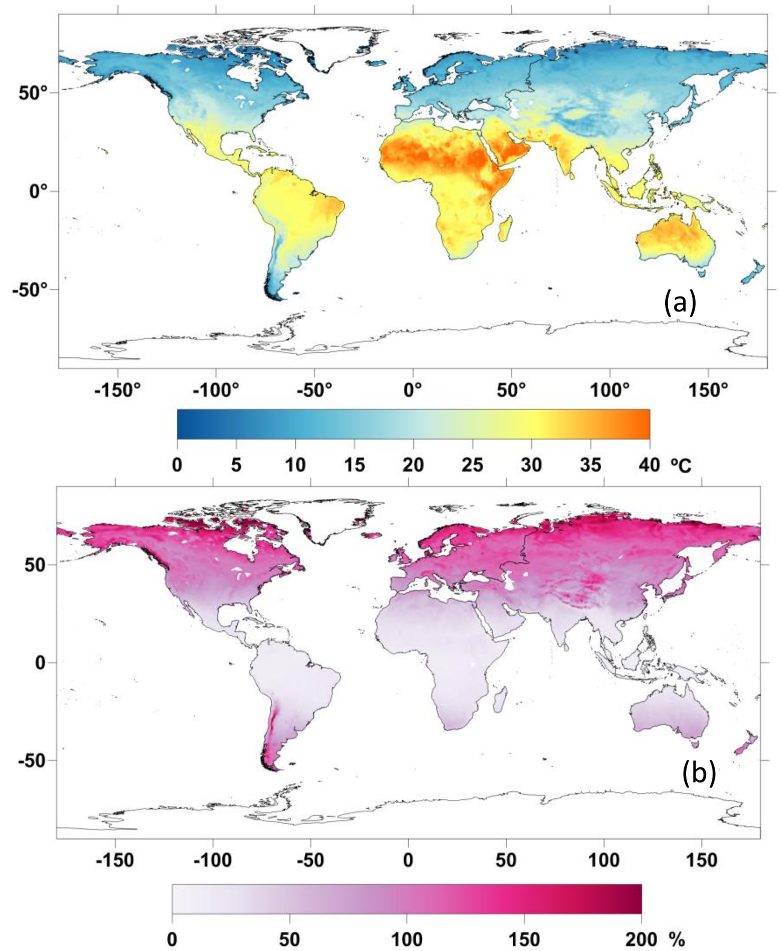


Figure 6: LPDR T_{mx} mean (a) and 2 times coefficient of variation (b) for years 2003-2010 and 2013-2015.

The authors choose to use the AVHRR GIMMS-3g NDVI dataset to compare with the LPDR VOD data. Why? The MODIS data record (for instance, NBAR at CMG resolution) offers a higher SNR.

Reply: In our previous studies, the LPDR v1 AMSR-E *VOD* record was assessed globally (Jones et al., 2011) and regionally (Jones et al. 2014) based on the MODIS vegetation indices products. The evaluation results of the previous and current studies are consistent, including generally favorable correlations between *VOD* and optical vegetation indices; and reduced correspondence at higher biomass levels. This information is included in the revised manuscript (Section 4.4) as follows: "The evaluation results of the previous and current studies are consistent, including generally favorable correlations between *VOD* and optical vegetation indices; and reduced correspondence at higher biomass levels."

In the current study, the GIMMS3g NDVI dataset was used for the *VOD* evaluation, and provides the opportunity to study global vegetation changes over a relatively longer record (since 1981) (Zhu et al., 2016). The current LPDR evaluations using GIMMS3g NDVI provide baseline information for possible long-term multi-sensor vegetation studies, where the LPDR *VOD* record can potentially be extended using similar, but longer-term (since 1987) T_b observations from other space-borne microwave radiometers (e.g. SMMR, SSM/I, SSMIS).

Can we see a table of the land area with high QC retrievals by season?

Reply: The percentages of land areas having high QC retrievals were summarized by seasons and sensor orbits for the respective Northern Hemisphere and Southern Hemisphere as shown in Table 6, which has been added to the revised manuscript and presented below:

Table 6: The percentages of land areas having high QC retrievals summarized by seasons and sensor orbits; seasons aggregated by spring (MAM), summer (JJA), autumn (SON), and winter (DJF) months of the Northern Hemisphere.

	Ascending		*Descending*	
	Northern Hemisphere	*Southern Hemisphere*	Northern Hemisphere	*Southern Hemisphere*
MAM	95.8%	92.6%	93.1%	88.4%
JJA	95.3%	92.6%	94.4%	89.2%
SON	95.1%	93.5%	93.4%	89.2%
DJF	76.5%	92.2%	73.0%	88.3%

Are the Spearman correlations substantially different from the Pearson correlations?

Reply: The differences between Spearman and Pearson correlation coefficients are generally small (within 0.04 in the statistics for *mv*, *V*, T_{mn} and T_{mx}; and approximately 0.09 for *VOD*). For *fw*, the differences between the two correlation coefficients are small (< 0.04) if very small MOD44W *fw* (< 0.005) values are excluded; otherwise relatively large differences (~ 0.17) exist between the two types of correlations.

Can you provide a third digit for the RMSD and bias values in Tables 1, 2, and 4?

Reply: According to the reviewer's suggestion, a third digit is provided for the statistics results listed in Tables 1 to 4 as follows:

Table 1: Comparisons of *fw* global averages over AMSR-E (2003-2010) and AMSR2 (2013-2015) periods in relation to the MOD44W static open water map. All products were projected into a consistent 25.0 km resolution EASE-GRID format; positive and negative bias indicates *fw* over- and under- estimation, respectively, relative to the static water map.

AMSR-E/2 *fw* vs MOD44W						
	R*		RMSD*		Bias	
	Asc*	Dsc*	Asc*	Dsc*	Asc*	Dsc*
AMSR-E	0.767	0.750	0.057	0.057	0.016	0.012
AMSR2	0.795	0.775	0.054	0.054	0.017	0.013

* R denotes Pearson correlation coefficient; RMSD denotes Root Mean Square Difference; Asc and Dsc denote respective ascending and descending orbits.

Table 2: LPDR daily T_{mn}, T_{mx} and ascending/descending orbit based *PWV* accuracy in relation to respective in-situ air temperature measurements and AIRS PWV observations for 142 global WMO site locations for selected years 2010 (AMSR-E) and 2013 (AMSR2).

	T_{mx} (ºC)			T_{mn} (ºC)		
	R	*RMSE*	Bias*	*R*	*RMSE*	*Bias*
AMSR-E	0.928	3.428	0.637	0.899	3.307	0.061
AMSR2	0.917	3.484	0.260	0.899	3.150	0.265
	PWV (mm) *from Ascending Orbits*			*PWV* (mm) *from Descending Orbits*		
	R	*RMSE*	Bias	*R*	*RMSE*	*Bias*
AMSR-E	0.926	4.241	0.266	0.923	4.788	0.197
AMSR2	0.914	4.473	-0.369	0.911	4.941	-0.050

*Bias is calculated from retrievals minus observations.

Table 3: Pearson correlations [*R*] between LPDR *VOD* and GIMMS3g NDVI climatology monthly means for the aggregate 2003-2010 and 2013 to 2015 observation record. The comparisons were made for all global vegetation and selected land cover areas, including: ENF, EBF, DNF, DBF, grassland and cropland. Both products were projected into a consistent 25.0 km resolution EASE-GRID format. *VOD* results are delineated for LPDR ascending and descending orbit records.

Pearson correlation coefficient	Global	ENF	EBF	DNF	DBF	Grassland	Cropland
Ascending	0.878	0.715	0.218	0.893	0.201	0.903	0.665
Descending	0.937	0.898	-0.116	0.944	0.871	0.951	0.845

Table 4: Summary of satellite LPDR soil moisture retrieval accuracy in relation to in situ surface soil moisture measurements from four globally distributed validation watersheds.

Statistics	Little River (USA; 2003-2005)	Little Washita (USA;2003-2005)	Naqu (China; 2010-2011)	Yanco (Australia; 2009-2011)	All Sites*
			Ascending Orbits		
R	0.627	0.762	0.790	0.755	0.815
RMSE*	0.035	0.036	0.051	0.059	0.045
Bias	0.041	0.053	-0.102	-0.042	0.012
			Descending Orbits		
R	0.696	0.733	0.831	0.787	0.835
RMSE*	0.032	0.036	0.042	0.055	0.042
Bias	0.071	0.086	-0.063	-0.031	0.038

R is correlation coefficient; RMSE (Root Mean Square Error) and Bias are in cm^3/cm^3. *RMSE and All Sites statistics except bias are calculated with watershed bias corrected.

How about a specific comment on the odd descending correlation between VOD and NDVI for EBF?

Reply: As suggested by the reviewer, the following discussion was added in the revision "Weaker and even negative *VOD* and NDVI correlations in EBF regions coincide with lower characteristic canopy seasonality in the tropics, but may reflect degraded signal-to-noise due to persistent cloud and atmospheric aerosol effects limiting effective NDVI retrievals, and VOD and NDVI saturation over dense canopies (Jones et al., 2011). For dense canopies, NDVI seasonality can be strongly driven by the onset of new leaves flushing (Maeda et al., 2016) while the asynchrony between leaf flush and vegetation growth may also affect the *VOD* and NDVI correlations (Jones et al., 2014)."

The added reference is listed below:

Maeda, E.E., Moura, Y.M., Wagner, F., Hilker, T., Lyapustin, A.I., Wang, Y., Chave, J., Mõttus, M., Aragão, L.E. and Shimabukuro, Y.: Consistency of vegetation index seasonality across the Amazon rainforest, Int. J. Appl. Earth Obs. Geoinf., 52, 42-53, 2016.

The figures need tuning to improve their accessibility. About 8% of the male population suffers from some degree of difficulty distinguishing red from green (aka color blindness). Figures 1-3, 5-6, 8, and S1-S3 all use red and green together. Consult http://colorbrewer2.org for better colormaps. Figure 1 is too busy. Consider reducing the number of cover classes which should help the color issue. The blue circles are particularly difficult to find against the background.

Reply: We accepted the reviewer's suggestion and changed the color schemes of Figures 2-4, 6-7, 9 of the revised manuscript and S1-S3 of the supplementary material to avoid using red and green colors together. For Figure 2, the land cover classes are kept consistent with the IGBP classifications since the specific land cover information is needed in the follow-on analysis and discussions. The revised figures are also presented as follows:

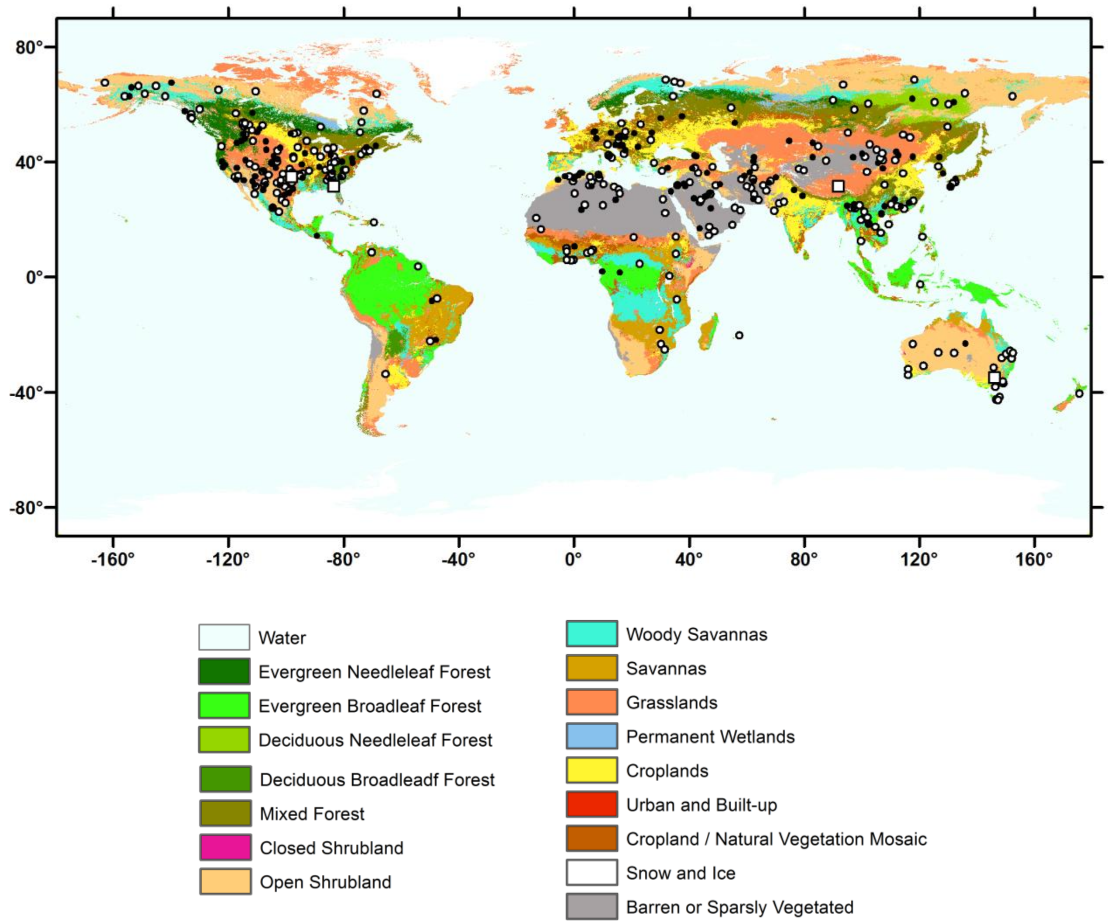


Figure 2: Global distribution of WMO weather station locations where collocated AIRS observations and WMO air temperature measurements were used for calibrating (white circles) and validating (black circles) the LPDR *PWV*, T_{mx} and T_{mn} estimates; the locations of the four independent soil moisture networks used for validating the LPDR *vsm* retrievals are also shown (white rectangles).

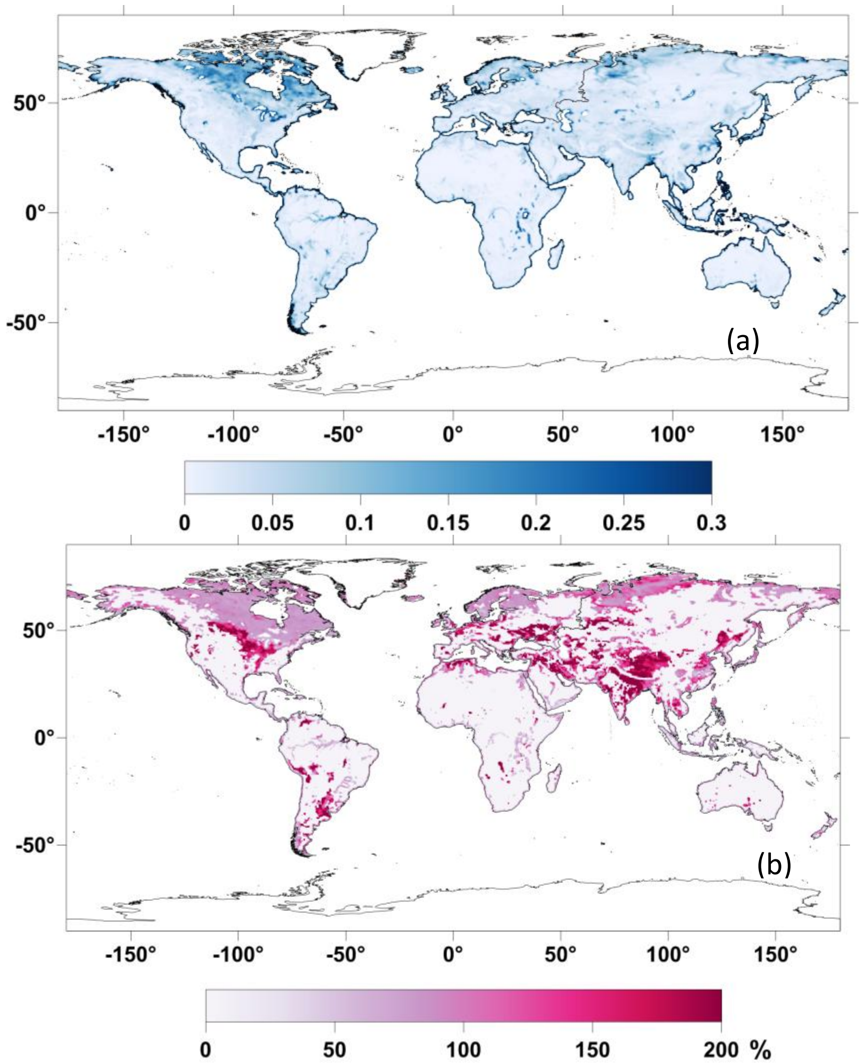


Figure 3: LPDR fractional water mean (a) and 2 times the coefficient of variation (b) over years 2003-2010 and 2013-2015.

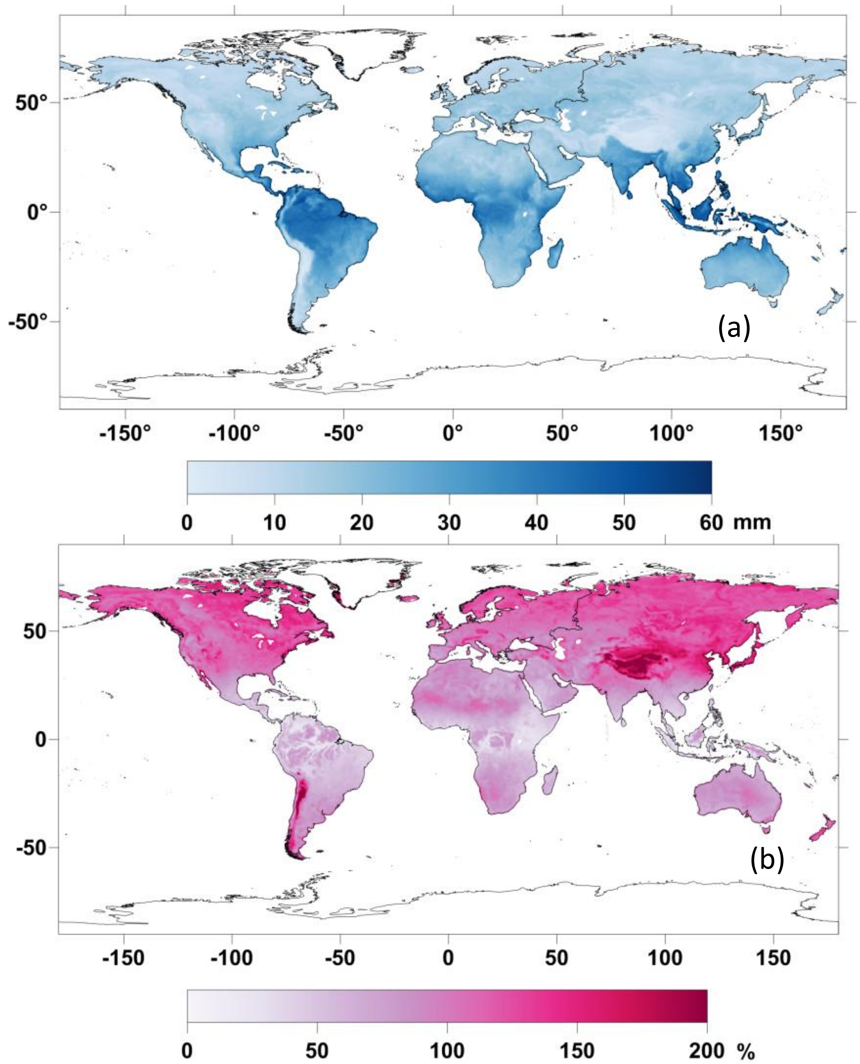


Figure 4: LPDR PWV climatology mean (a) and 2 times the coefficient of variation (b) from the combined 2003-2010 and 2013-2015 record.

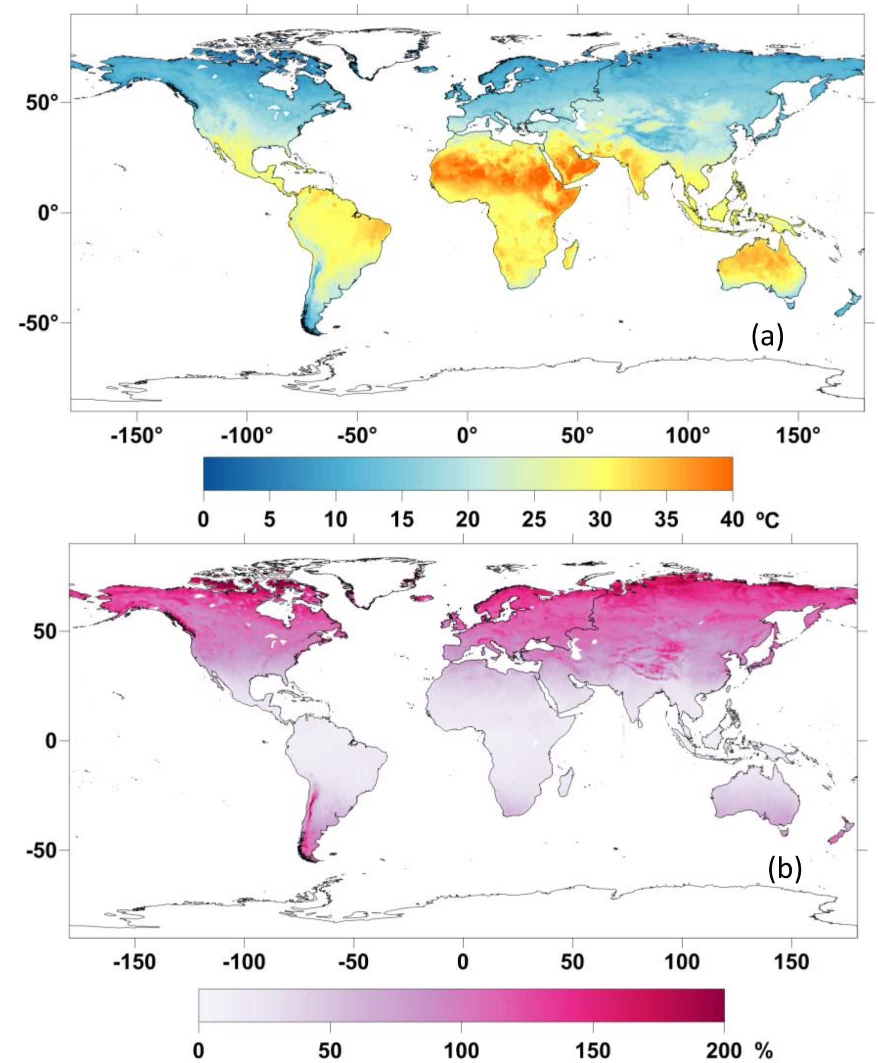


Figure 6: LPDR T_{mx} mean (a) and 2 times the coefficient of variation (b) for years 2003-2010 and 2013-2015.

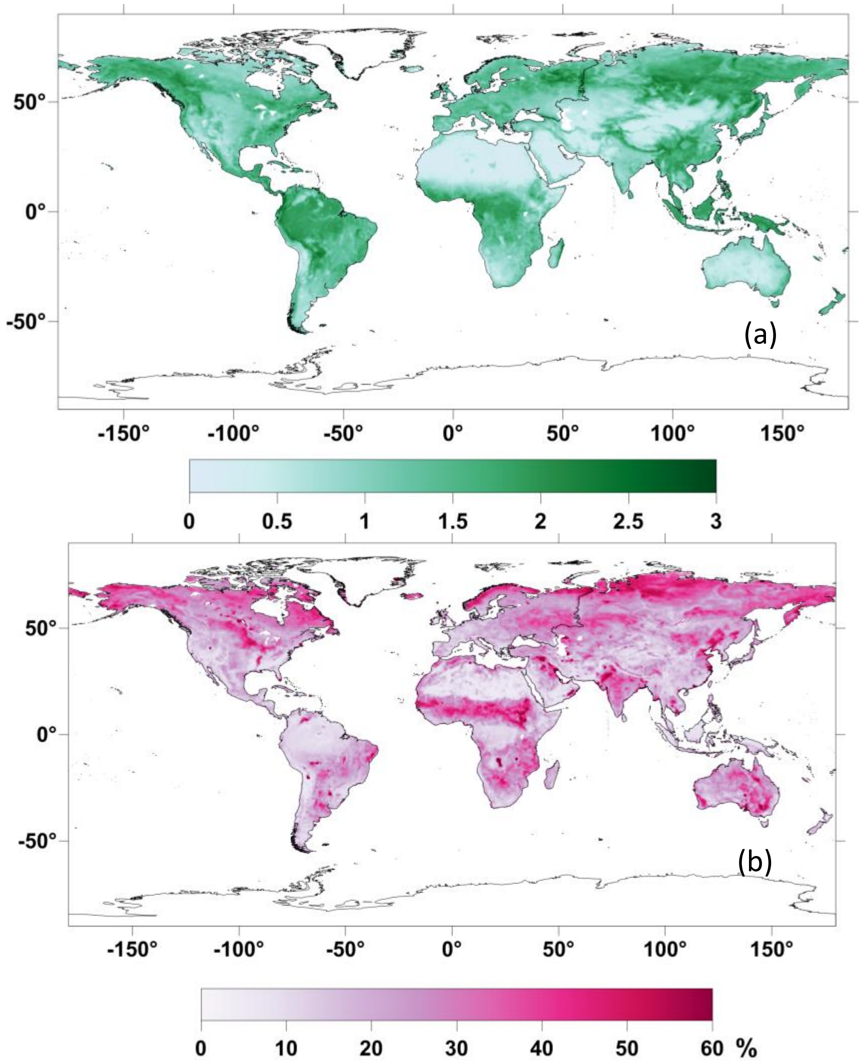


Figure 7: Annual mean (a) and 2 times the coefficient of variation (b) of LPDR 25-km global X-band *VOD* daily estimates from AMSR-E/2 ascending observations encompassing years 2003-2010 and 2013-2015.

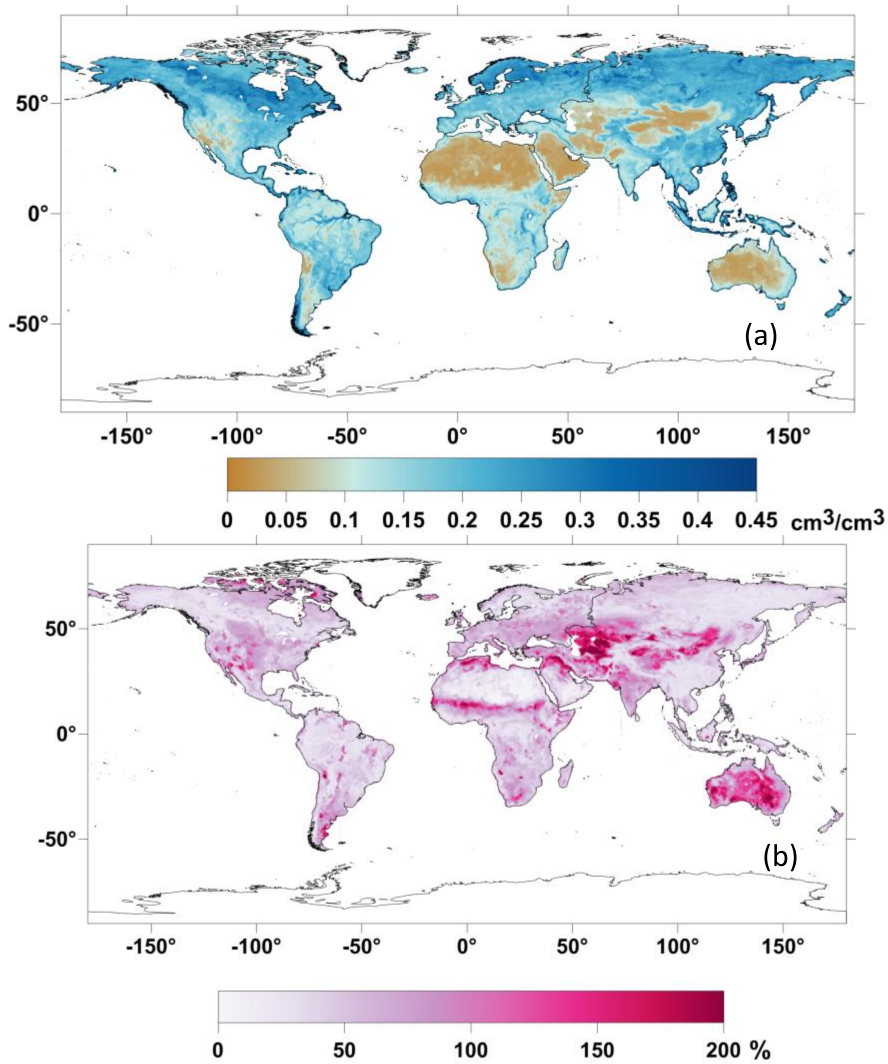
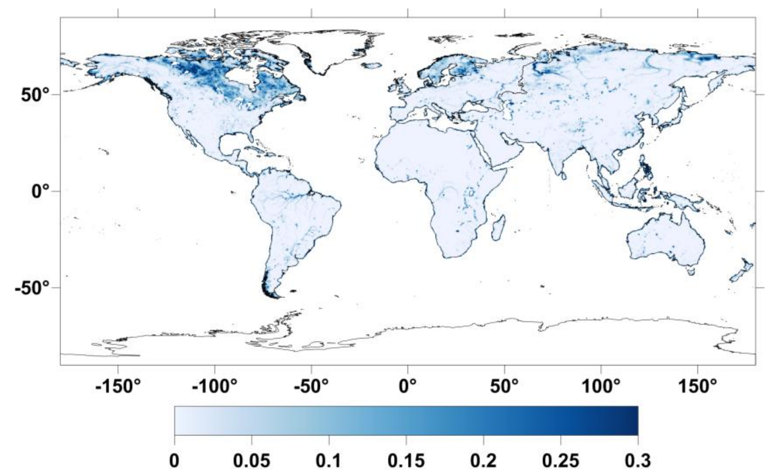
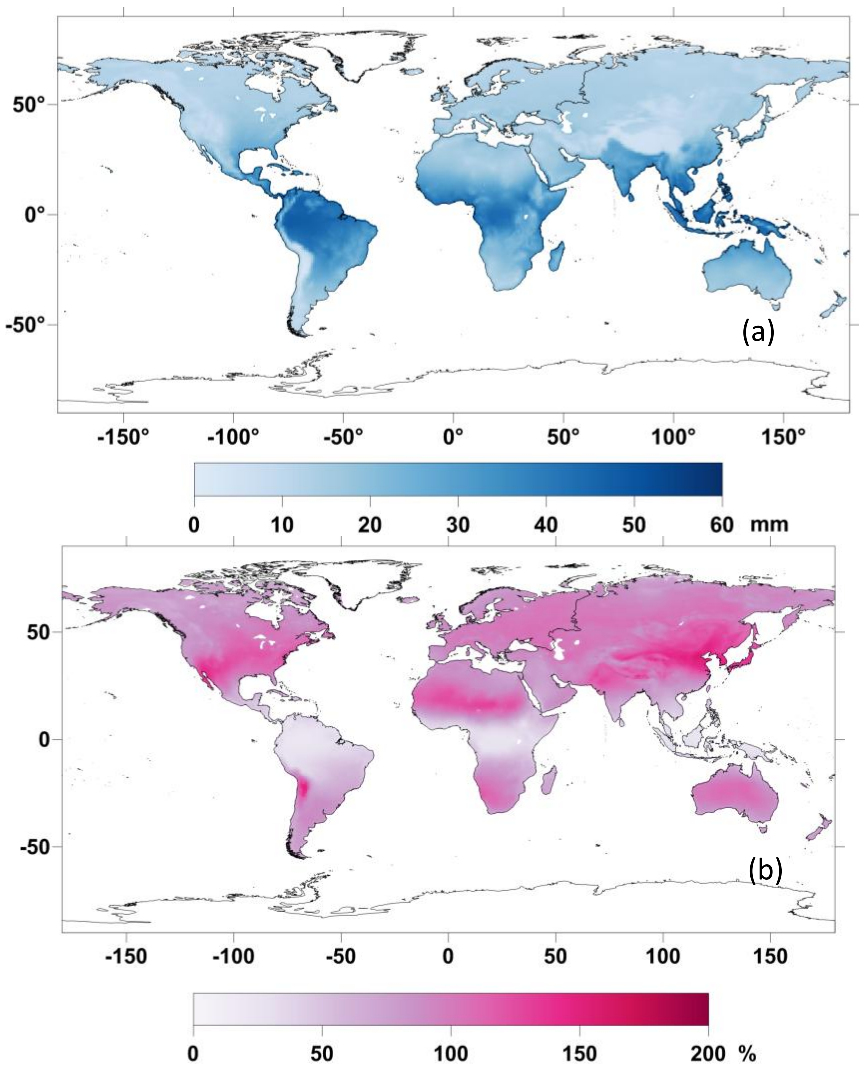


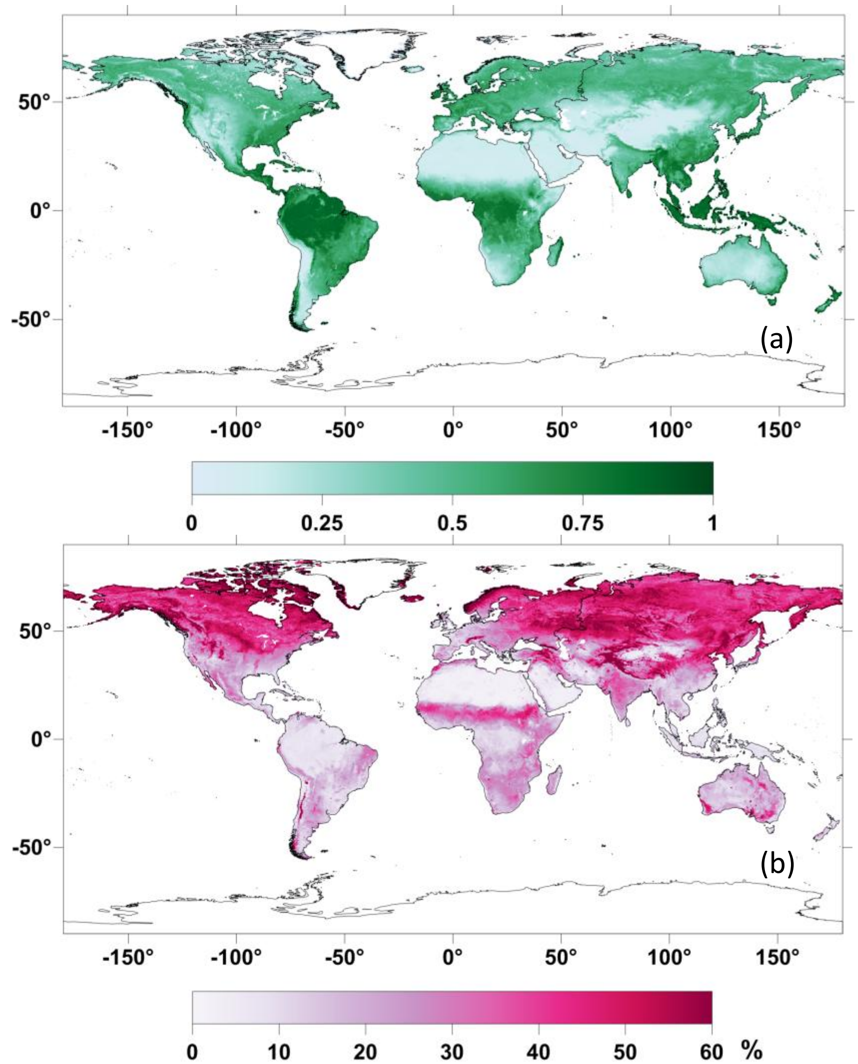
Figure 9: LPDR 25-km X-band volumetric soil moisture (*vsm*) mean (a) and 2 times the coefficient of variation in percentage of mean values (b) derived from the aggregate 2003-2010 and 2013-2015 observation record.



Supplementary Figure 1: The 25-km MOD44W static water map aggregated from original 250-m resolution.



Supplementary Figure 2: AIRS climatology atmosphere precipitable water vapor (*PWV*) mean (a) and 2 times the coefficient of variation (b) for years 2003-2010 and 2013-2015.



Supplementary Figure 3: Annual mean (a) and the coefficient of variation (b) of GIMMS3g NDVI over years 2003-2010 and 2013-2015

Perhaps I missed them at the distribution portal, but where are the geospatial metadata for the LPDR that are compliant with either FGDC or ISO standards?

Reply: Please check the metadata file at http://files.ntsg.umt.edu/data/LPDR_v2/GeoTIFF/LPDR_V2_meta.xml . The metadata file was made in Directory Interchange Format (DIF), which is widely used by the NASA Global Change Master Directory (GCMD).