Global Daily Near-Surface Atmospheric Vapor Pressure Deficit Derived from AMSR-E and AMSR2 (2002-2017)

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URL:
http://files.ntsg.umt.edu/data/LPDR_v2/ Binary/VPD

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I. Data introduction

The global daily near-surface atmospheric Vapor Pressure Deficit (VPD) data set was generated using Version 2 (v2) University of Montana land parameter data record (LPDR) (Du et al., 2017), which was derived from the Advanced Microwave Scanning Radiometer (AMSR) sensors. The LPDR v2 archived the long-term (2002-2017) global daily land parameters, including daily maximum and minimum surface air temperature at approximate 2-m screen height (T_{mx} and T_{mn}), total column atmospheric precipitable water vapor (*PWV*), vegetation optical depth (*VOD*), which is a negative natural logarithm of the vegetation transmissivity (Γ) to land surface microwave emissions; surface fractional open water cover (*fw*), and volumetric soil moisture (*vsm*). The LPDR outputs for surface air temperature (T_s;°C), *PWV* (mm), *fw* (dimensionless), and Γ (dimensionless) were used for global estimation of daily AMSR VPD dynamics from 2002 to 2017.

II. Algorithm description

The VPD (kPa) calculation relies on the determination of the saturation vapor pressure e_s (kPa) at a given air temperature T_a (°C) and the actual vapor pressure e_a (kPa).The dependence of e_s on T_a is theoretically described by the Clausius-Clapeyron relationship and normally approximated by the Magnus formula in applications. Similarly, e_a was calculated as the saturation vapor pressure at dew-point temperature T_d (°C). Accordingly, the AMSR VPD was empirically estimated using VPD observations from the global weather station observations and AMSR LPDR outputs related to surface air temperature and humidity. Specifically, the AMSR VPD record was derived using empirical regressions between the in situ VPD observations from weather stations and the corresponding AMSR LPDR parameters for T_s, Γ, *PWV*, *fw*, and the ancillary inputs for surface elevation (*H; km*) and geographic latitudes (*Lat; radian*). The final regression forms (Eqs. 1-2) of the retrieval algorithms account for the possible effects of terrain, vegetation, geo-location, and water body cover on both surface air temperature and humidity.

$$\mathrm{VPD_{PM}} = 0.13 + 0.66\mathrm{e_{s0}} - 1.45\Gamma + 2.50\Gamma^2 - 0.11H - 2.21fw - (0.02Lat + 0.02)PWV \quad (1)$$

$$\mathrm{VPD_{AM}} = -0.52 + 0.59\mathrm{e_{s0}} + 0.88\Gamma + 1.00\Gamma^2 + 0.04H - 3.23fw + (0.01Lat - 0.02)PWV \quad (2)$$

where

$$e_{s0} = 0.611 \cdot \exp(17.27 \cdot \frac{T_s}{T_s + 237.3})$$

Based on Equations (1) and (2), the twice daily global VPD estimates were generated from the LPDR for respective AMSR ascending (p.m.) and descending (a.m.) overpasses. The availability of the AMSR VPD retrievals is consistent with the availability of the regression inputs from the LPDR, where no retrievals are performed under sub-optimal conditions, including frozen soil, severe precipitation, RFI, and snow cover (Du et al., 2018).

III. Data File Information

The AMSR VPD data files are provided in binary format. Each daily file contains a 2-D array (1383 columns × 586 rows) of 32-bit float-type data containing the retrieved VPD values. The data are projected into 25 km global EASE-Grid (v1) format. The fill value is -999.0. The file naming convention is described below:

AMSRU_Mland_{year}{day of year}{overpass (A or D)}. VPD

The string "AMSRU_Mland" represents global land parameters derived from both AMSR-E and AMSR2 observations. The year string contains four digits. The day-of-year is the day in three digits since January 1 of the year. The overpass character is either 'A' for ascending (afternoon; P.M.) or 'D' for descending (morning; A.M.). The file extension "VPD" is an indicator of the VPD parameter.

IV. Accuracy and performance

The AMSR-derived VPD record shows strong correspondence (correlation coefficient ≥ 0.80, p-value < 0.001) and overall good performance (0.48 kPa $\leq$ Root Mean Square Error $\leq$ 0.69 kPa) against independent VPD observations from the Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) data. The estimated AMSR VPD retrieval uncertainties vary with land cover type, satellite observation time, and underlying LPDR data quality. A detailed VPD accuracy and performance assessment was conducted over the global domain and is summarized elsewhere (Du et al. 2018).

V. Data version

Current VPD products were generated using LPDR Version 2 data.

VI. Data citation and acknowledgements

As a condition of using these data, we request that you acknowledge the authors of this data set by referencing the following peer-reviewed publication:

[1] Du, J., Kimball, J., Reichle, R., Jones, L., Watts, J. and Kim, Y., 2018. Global Satellite Retrievals of the Near-Surface Atmospheric Vapor Pressure Deficit from AMSR-E and AMSR2. Remote Sensing, 10(8), p.1175.

[2] Du, J., J.S. Kimball, L.A. Jones, Y. Kim, J. Glassy, and J.D. Watts, 2017. A global satellite environmental data record derived from AMSR-E and AMSR2 microwave earth observations, 2017. Earth System Science Data, 9, 791-808, https://doi.org/10.5194/essd-9-791-2017.

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