



Supplement of

Modeling on the drought stress impact on the summertime biogenic isoprene emissions in South Korea

Yong-Cheol Jeong et al.

Correspondence to: Yuxuan Wang (ywang246@central.uh.edu)

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Table S1: Five drought categories by DEDI drought index

Drought category	Chance of occurrence	DEDI threshold (South Korea)
Extreme drought	2% or less	$DEDI \leq -2.02$
Severe drought	2 – 10 %	$-2.02 < DEDI \leq -1.15$
Moderate drought	10 – 20 %	$-1.15 < DEDI \leq -0.75$
Incipient drought	20 – 30 %	$-0.75 < DEDI \leq -0.49$
Normal/Wet	More than 30 %	$-0.49 < DEDI$

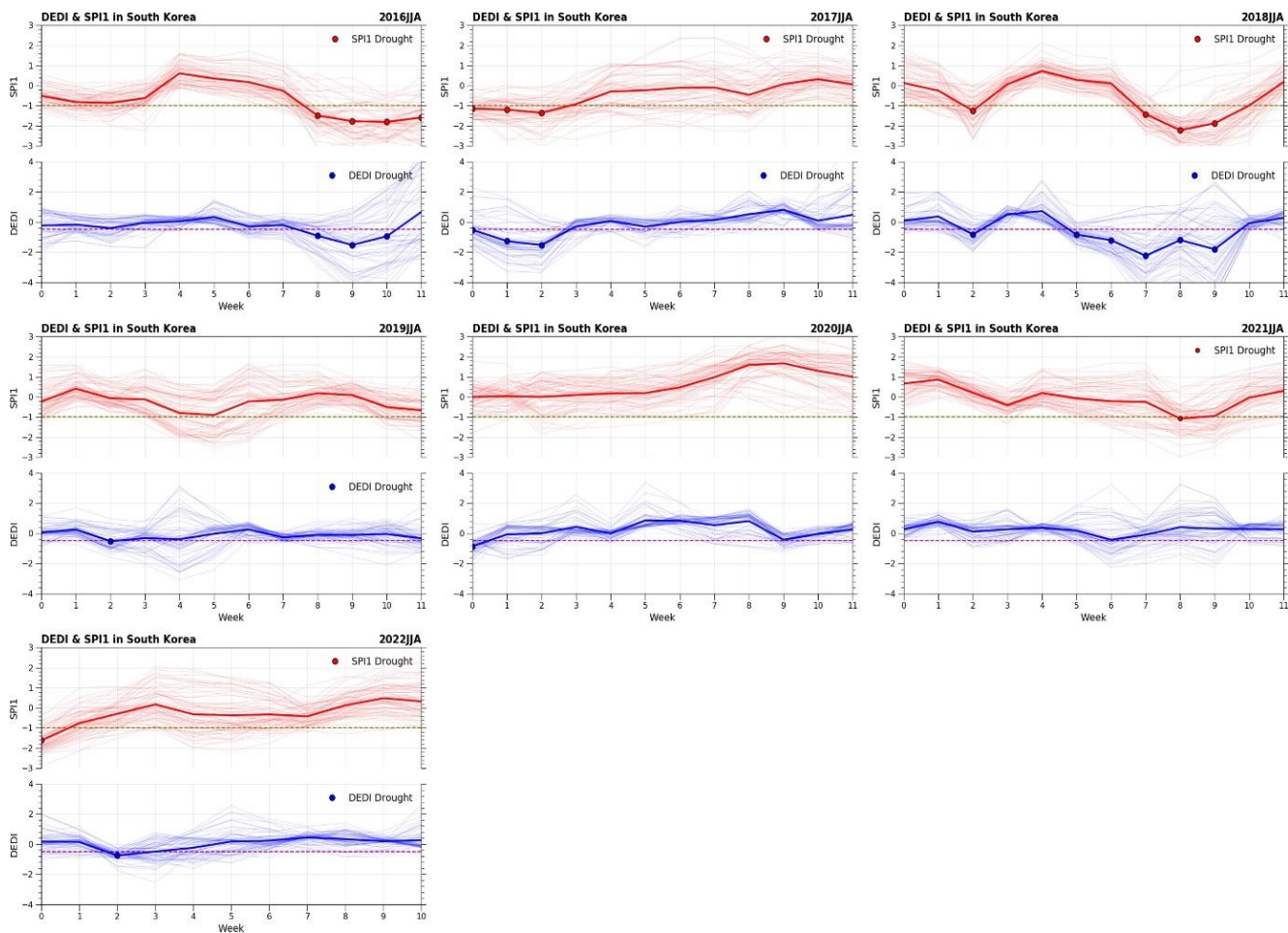


Figure S1: The SPI1 index (red line) and DEDI index (blue line) in the recent seven summers (2016JJA – 2022JJA) in South Korea. The thin red (blue) lines indicate the SPI1 (DEDI) indices at all available in-situ sites in South Korea and the thick red (blue) line indicates the averaged SPI1 (DEDI) value. The olive and magenta dashed lines denote the drought threshold value in the SPI1 (-1) and DEDI (-0.49), respectively, and the circle was indicated if each averaged index (bold line) was below than this threshold (drought condition).

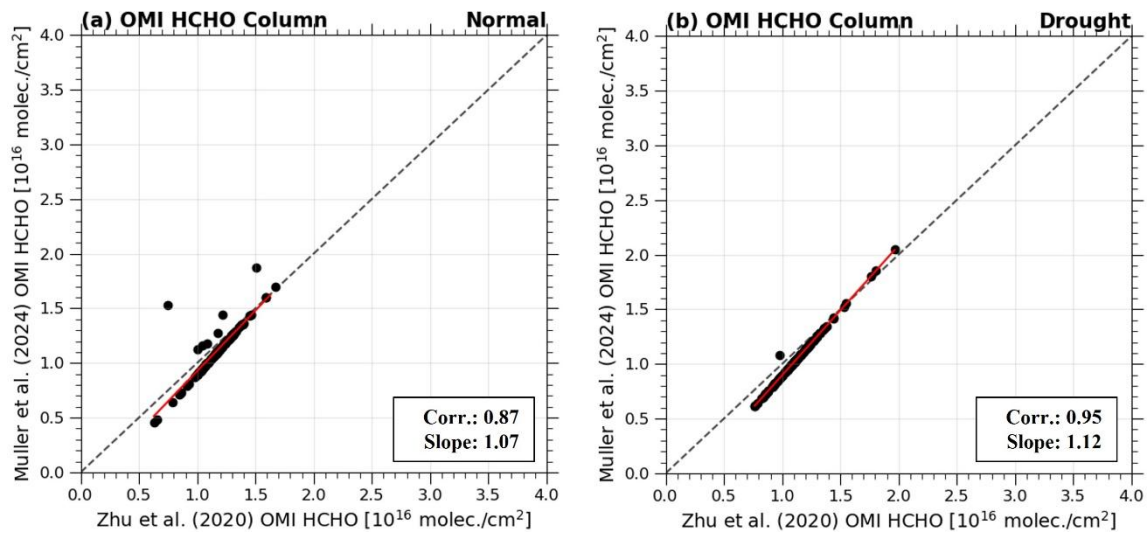


Figure S2: Scatterplot between two bias-corrected OMI HCHO columns following Zhu et al. (2020) and Müller et al. (2024) under (a) normal and (b) drought conditions. The method in Zhu et al. (2020) was used in this study. Each dot denotes HCHO column value at each grid point in South Korea. The gray dashed line denotes 1:1 line and the red line denotes linear regression line. The slope for the regression line is shown at the right side of the panel with the correlation coefficient (Corr.) between two HCHO columns.

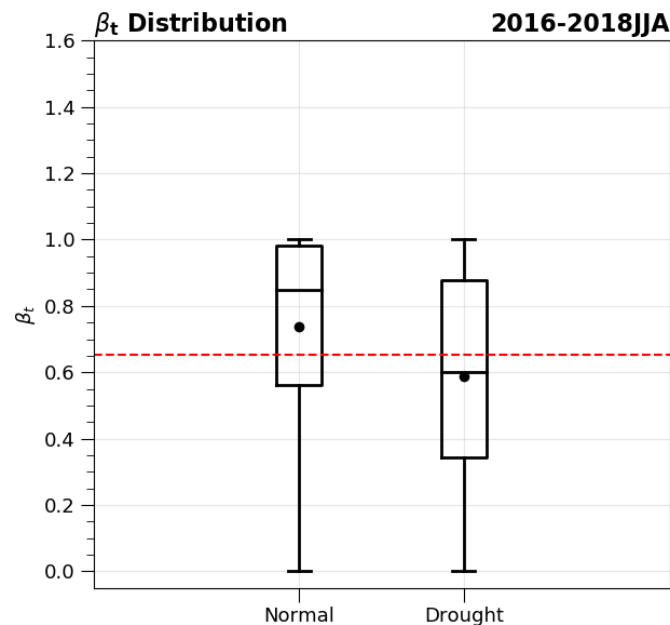


Figure S3: The boxplot for soil moisture stress (β_t) values from the ecophysiology module under the normal and the drought conditions in South Korea. The red dashed line denotes a 60% percentile value of β_t under the drought condition.

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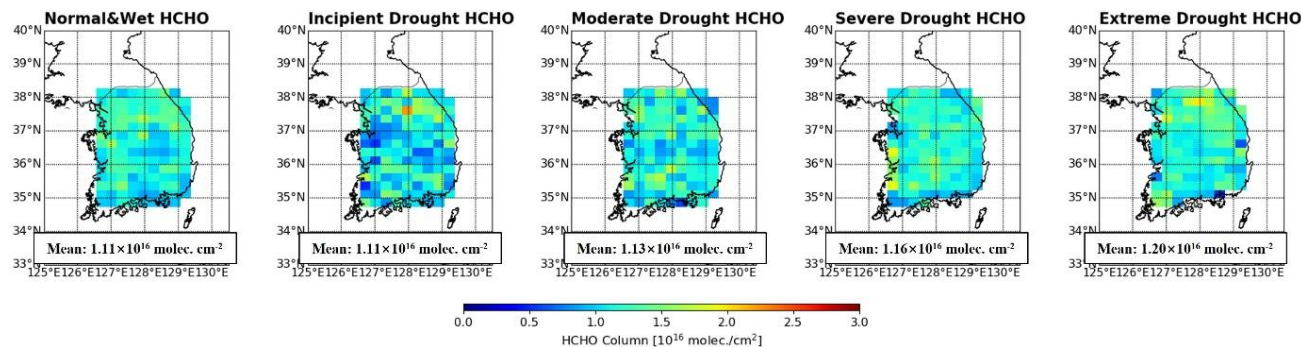


Figure S4: The OMI HCHO columns under five drought categories based on DEDI drought index.

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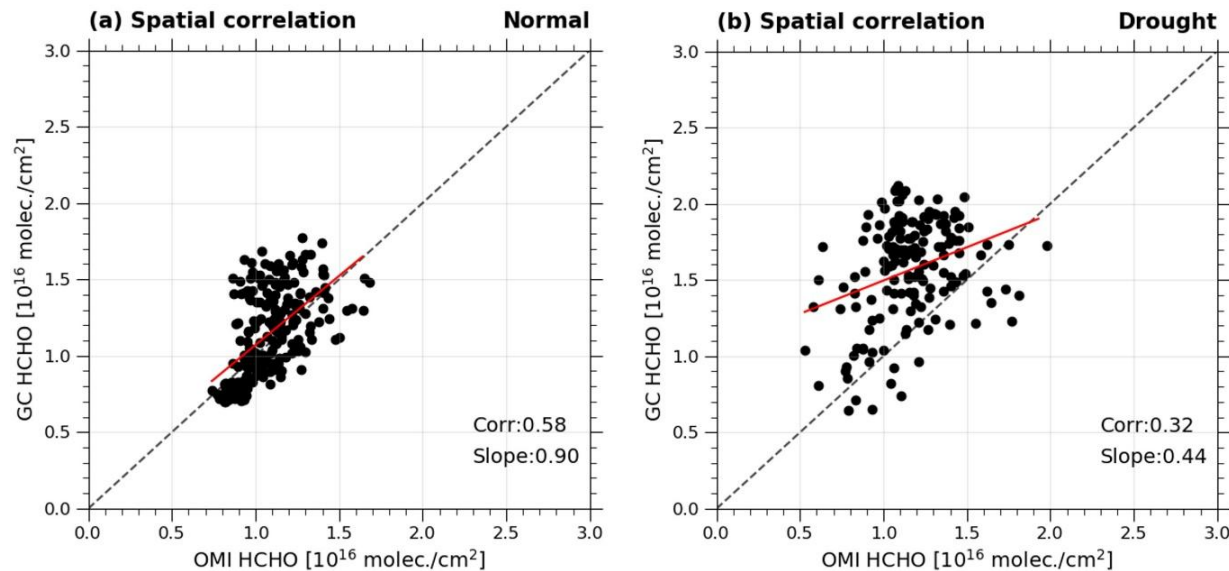


Figure S5: (a) Scatterplot of the OMI HCHO column and the GEOS-Chem HCHO column under the normal condition in South Korea. Each dot denotes HCHO column value at each grid point in South Korea. The gray dashed line denotes 1:1 line and the red line denotes linear regression line. The slope for the regression line is shown at the right side of the panel with the correlation coefficient (Corr.) between two HCHO columns. (b) Same as a but for the drought condition.

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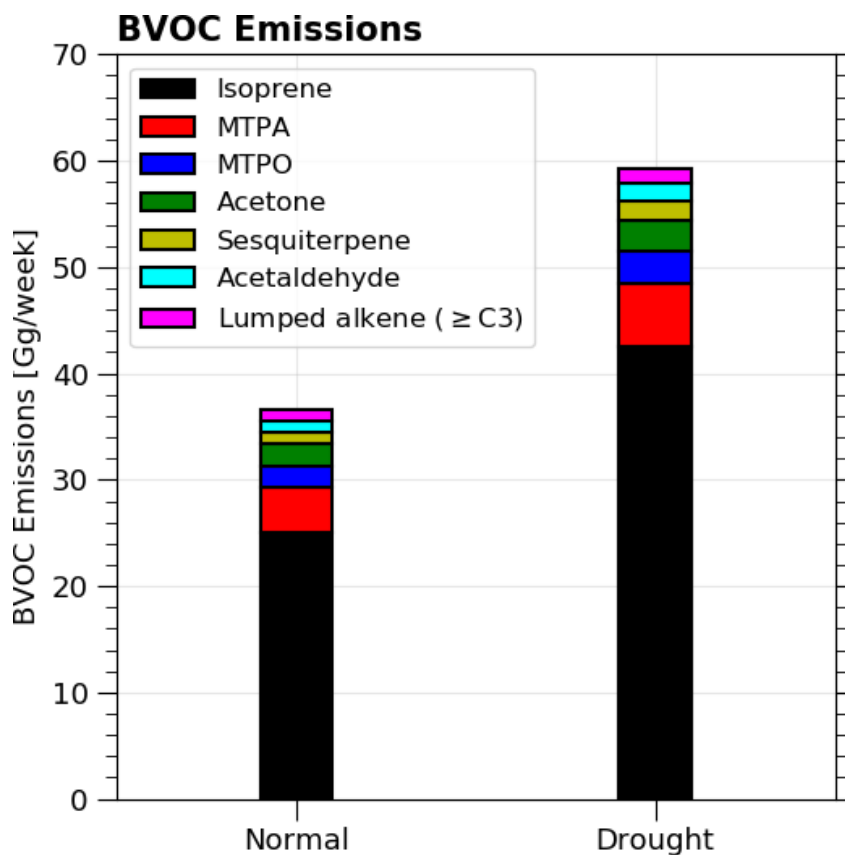
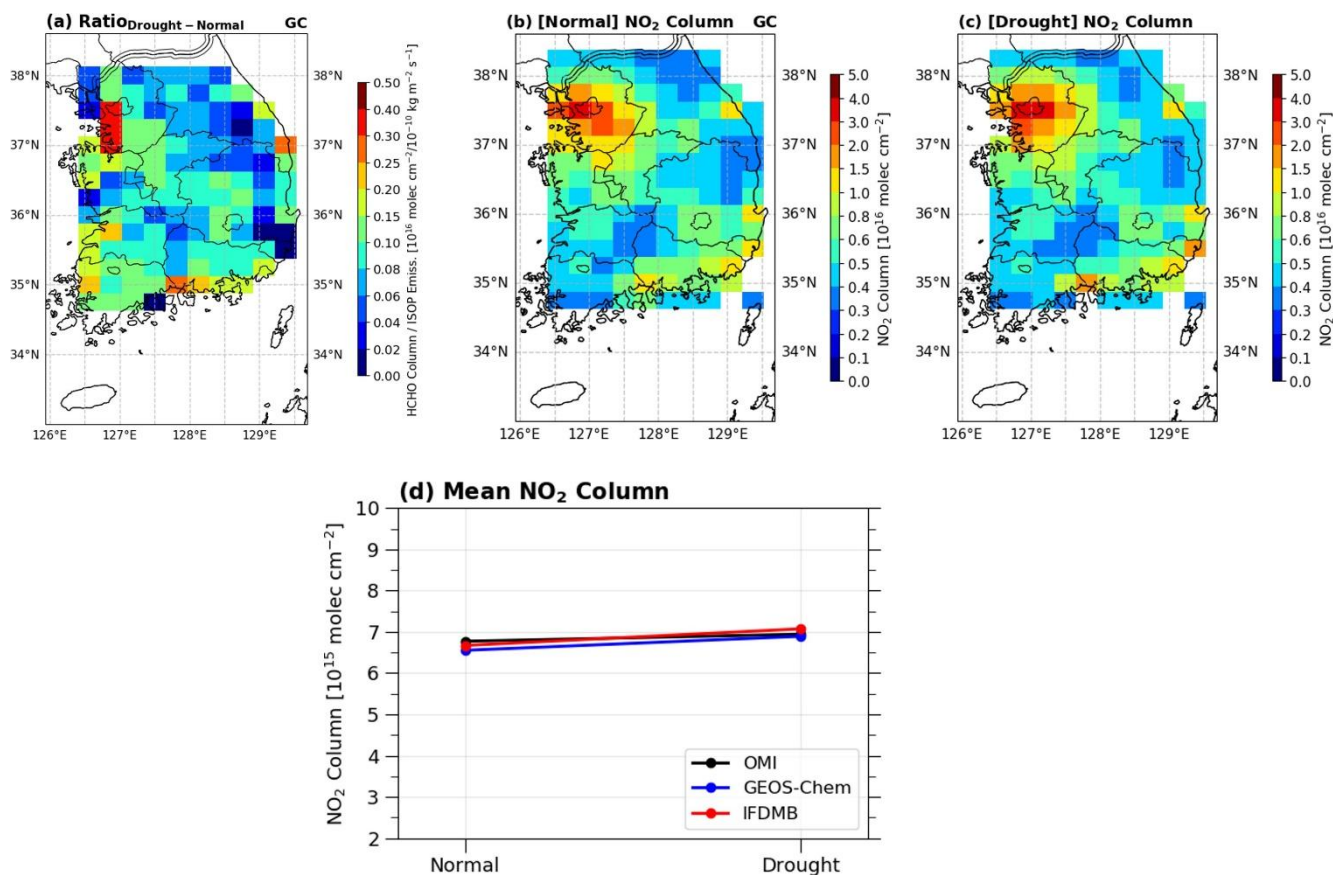


Figure S6: The total amounts of each BVOC emission under the normal and the drought conditions in South Korea in the standard GEOS-Chem. The each BVOCs emission include isoprene, MTPA (monoterpenes including α -pinene, β -pinene, sabinene, and carene), MTPO (monoterpenes including myrcene, ocimene, and other monoterpenes), acetone, sesquiterpene (farnesene, β -caryophyllene, and other sesquiterpene), acetaldehyde, and lumped alkene ($\geq C3$).



60 Figure S7: (a) A ratio between the modeled HCHO column change (Drought – Normal) and the modeled isoprene emissions change in the standard GEOS-Chem. NO₂ column under (b) the normal and (c) the drought conditions in South Korea in the standard GEOS-Chem. (d) Mean NO₂ column under the normal and the drought conditions in South Korea in OMI (black), in standard GEOS-Chem (blue), and in IFDMB (red), respectively.

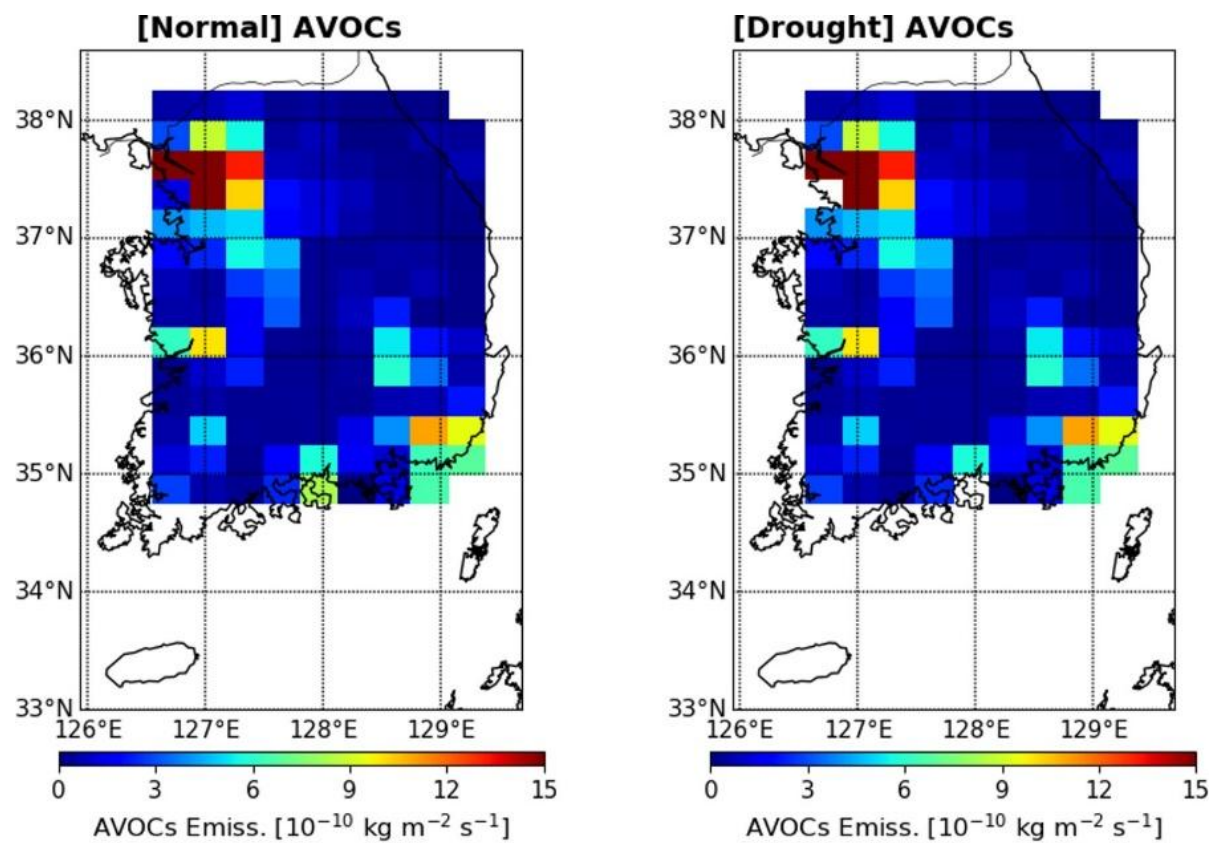


Figure S8: The spatial distribution of anthropogenic VOC (AVOC) emissions under normal condition (left) and drought condition (right).

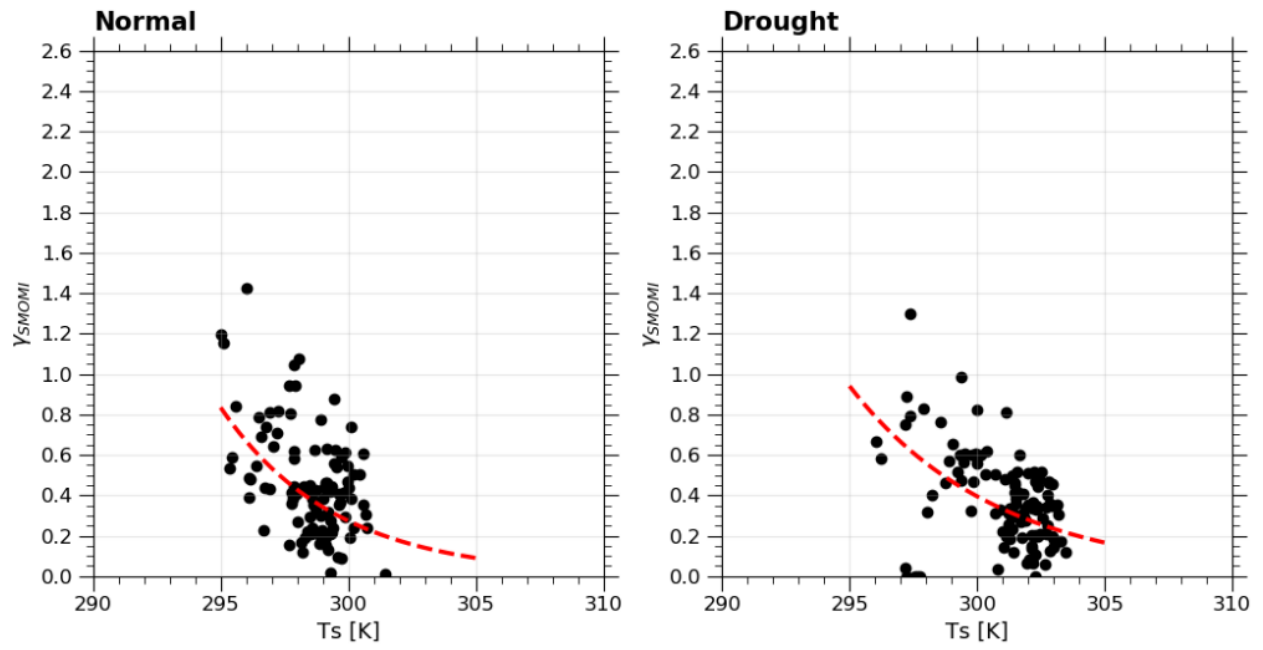


Figure S9: γ_{SM_OMI} with respect to the surface temperatures in (c) the normal and (d) the drought conditions. The red dotted lines indicate the fitted lines.

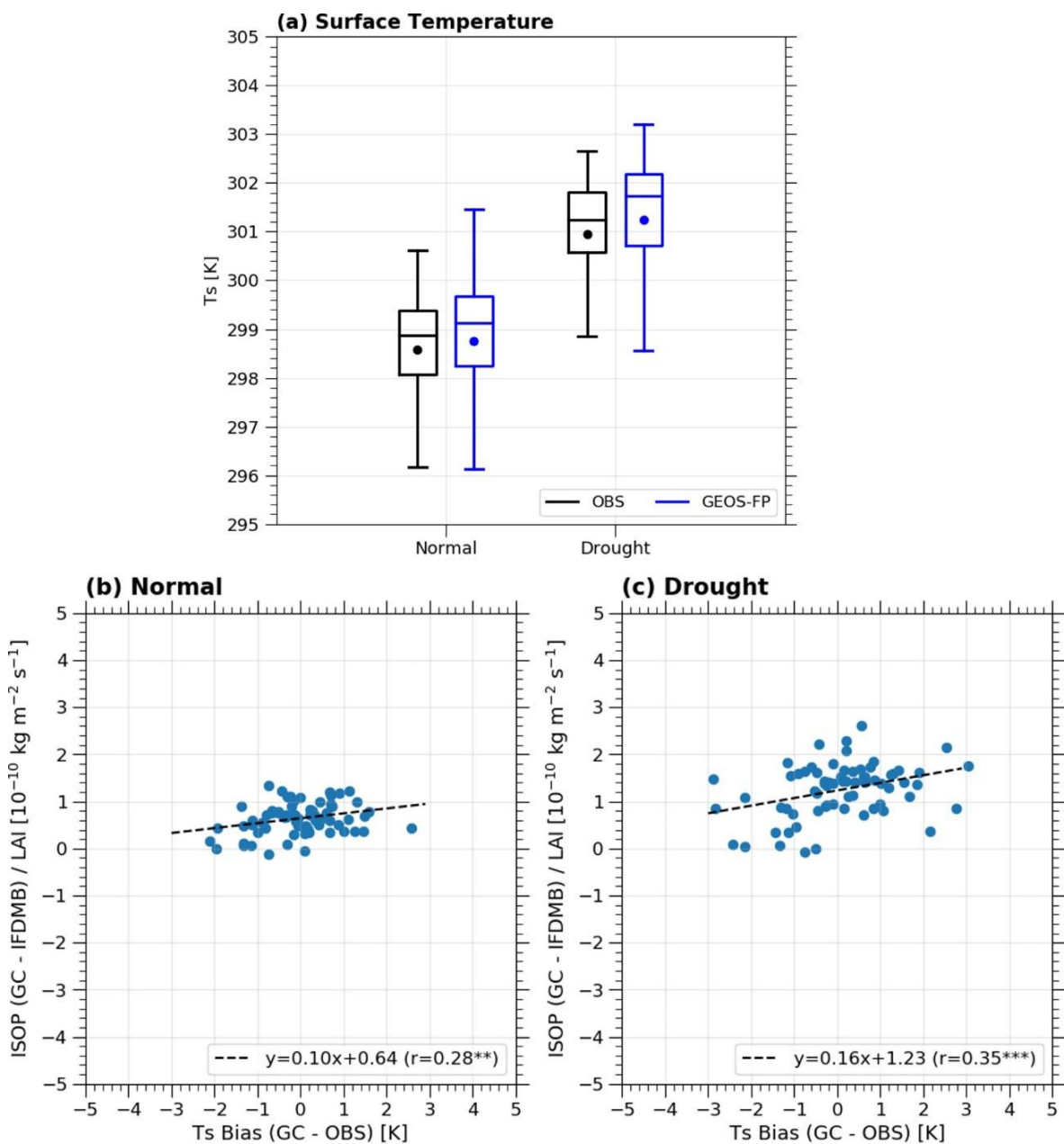


Figure S10: (a) The boxplot for surface temperature (T_s) under the normal and drought conditions in South Korea. The black and blue boxes are T_s from the observation and from the GEOS-FP, respectively. The observed surface temperature data was provided by Korea Meteorological Administration. The scatterplots between biogenic isoprene emission change (standard GEOS-Chem – IFDDB) and T_s bias (GEOS-FP – observation) under (b) the normal and (c) the drought conditions. The biogenic isoprene emission changes were divided by LAI. The regression equation and correlation coefficient (r) were shown in the right bottom of each figure. The ** (***) indicates a statistically significant r value at a 95% (99%) confidence level.