Supplement of

Satellite soil moisture data assimilation impacts on modeling weather variables and ozone in the southeastern US - Part 2: Sensitivity to dry deposition parameterizations

Huang et al.

Correspondence to: Min Huang (mhuang10@gmu.edu)

Table S1. The original 20 Land Use Land Cover (LULC) types for WRF-Chem simulations and the criteria applied to group them for analysis.

LULC Category	LULC Description	Grouped LULC type shown in Figure 1
1	Evergreen Needleleaf Forest	Forests
2	Evergreen Broadleaf Forest	
3	Deciduous Needleleaf Forest	
4	Deciduous Broadleaf Forest	
5	Mixed Forests	
6	Closed Shrublands	Shrub/Grass
7	Open Shrublands	
8	Woody Savannas	
9	Savannas	
10	Grasslands	
11	Permanent Wetlands	
12	Croplands	Croplands
13	Urban and Built-Up	Urban
14	Cropland/Natural Vegetation Mosaic	Croplands
15	Snow and Ice	Water and others
16	Barren or Sparsely Vegetated	
17	Water	
18	Wooded Tundra	
19	Mixed Tundra	
20	Barren Tundra	

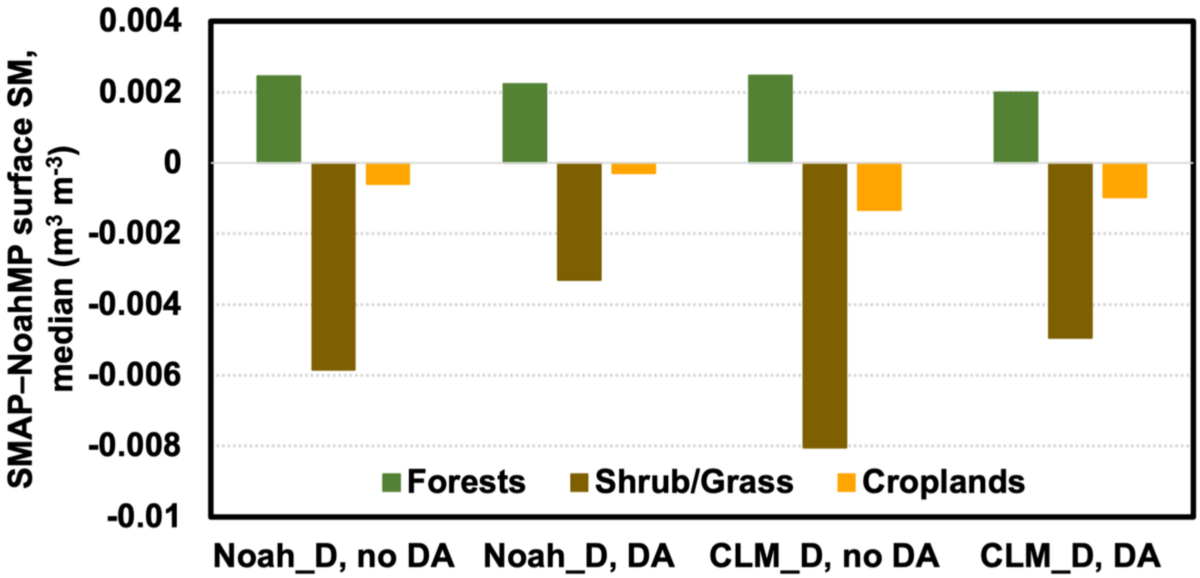

Figure S1: Surface soil moisture differences between SMAP and Noah-MP, summarized by three LULC groups.

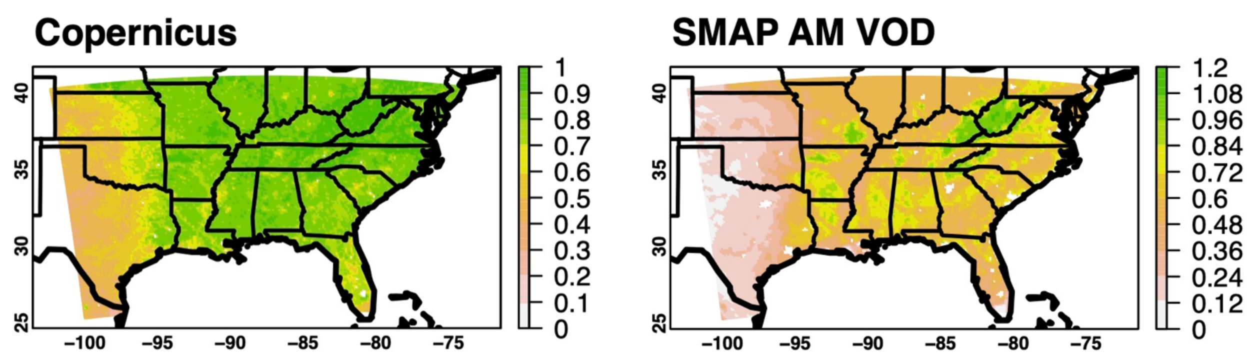

Figure S2: August 2015-2019 (left) green vegetation fraction (GVF) from a 10-day average Copernicus Global Land Service product which is computed from leaf area index and other canopy structural variables and (right) SMAP morning-time (AM) vegetation optical depth (VOD) climatology. Assuming that GVF and VOD anomalies are similar, the satellite-based, period-mean GVF data shown in Figure 2a was estimated using the following approach:

For each model grid (i,j),

$$\textbf{\textit{Derived GVF}}\ (\boldsymbol{i},\boldsymbol{j}) = \frac{\textbf{\textit{SMAP AM VOD, period mean}}\ (\boldsymbol{i},\boldsymbol{j})}{\textbf{\textit{SMAP AM VOD climatology}}\ (\boldsymbol{i},\boldsymbol{j})} \times \textbf{\textit{Copernicus GVF climatology}}\ (\boldsymbol{i},\boldsymbol{j})$$

Any derived GVF values exceeding 1.0 are considered invalid and not used.

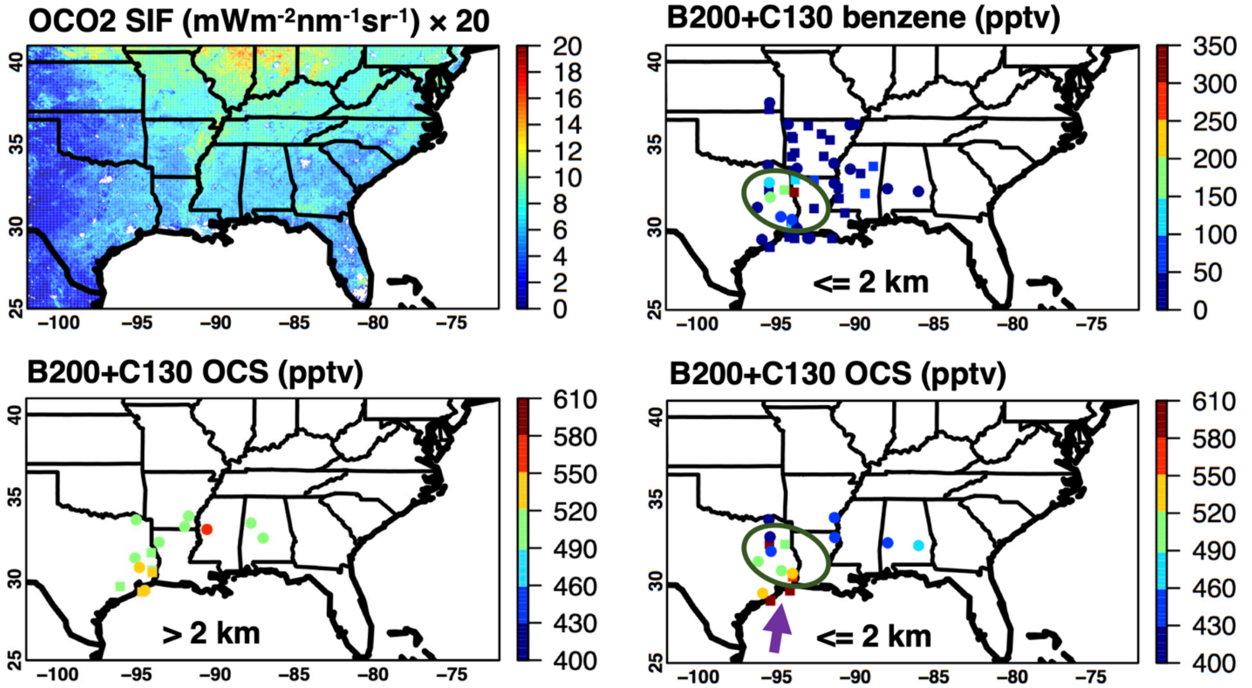

Figure S3: Proxies of gross primary productivity: (upper left) solar-induced chlorophyll fluorescence (SIF) data derived from the Orbiting Carbon Observatory-2 data during mid–late August 2021, scaled by 20; (lower) carbonyl sulfide (OCS) data during the ACT-America campaign, taken onboard the B-200 and C-130 aircraft at different altitudes; (upper right) near-surface benzene measured onboard the B-200 and C-130 aircraft during ACT-America, used to indicate influences of combustion sources. Filled squares and circles indicate B-200 and C-130 data, respectively. The green circles in the right panels locate the collocated benzene and OCS hotspots possibly affected by anthropogenic combustion sources in the eastern Texas. The purple arrow in the lower right panel points to the OCS data likely affected by oceanic emission sources.

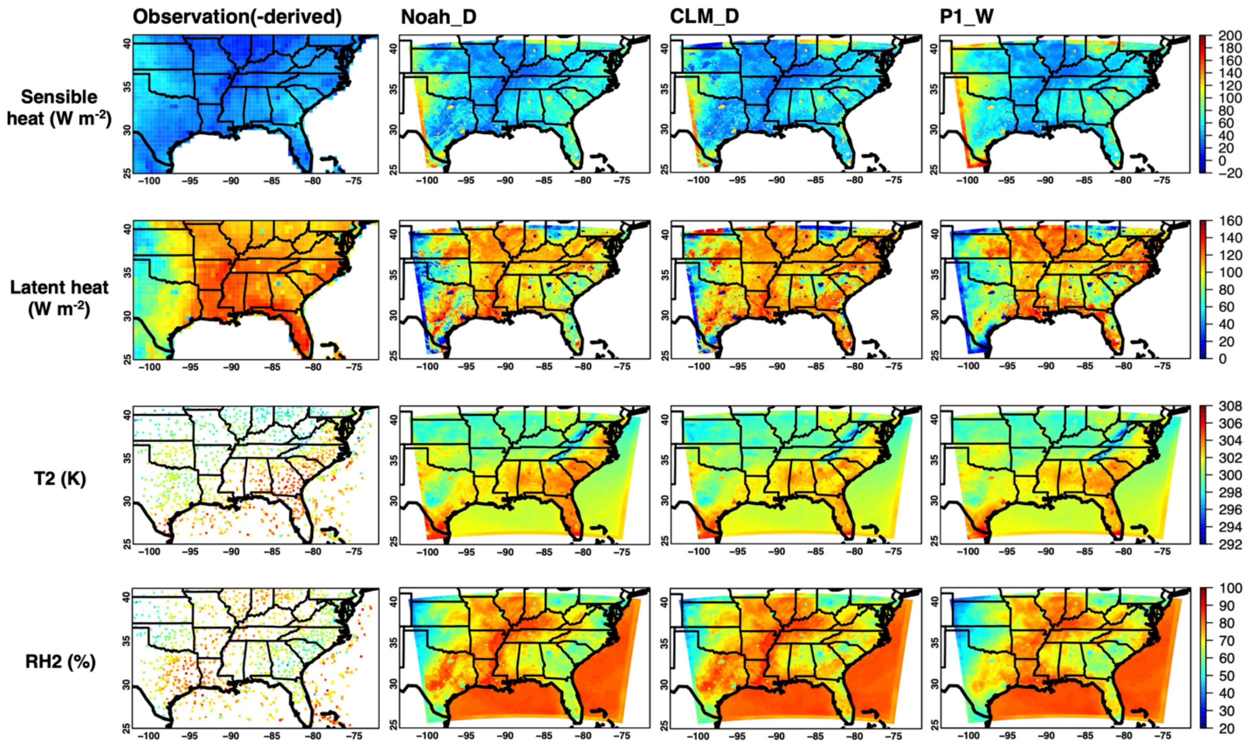

Figure S4: Period-mean (16–28 August 2016), model-based (from the Noah_D, CLM_D, and P1_W no-DA cases) sensible and latent heat fluxes, 2 m air temperature (T2) and humidity (RH2) in comparison with observation or observation-derived datasets (i.e., FLUXCOM, and the National Centers for Environmental Prediction Global Surface Observational Weather Data).

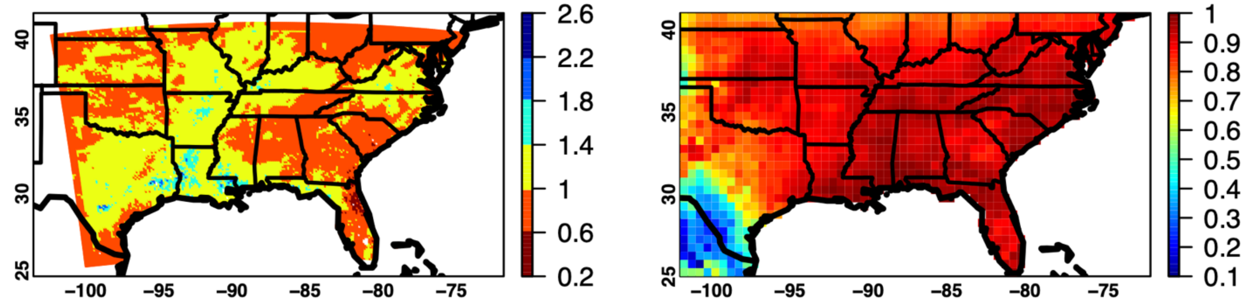

Figure S5: (left) Column-averaged soil moisture (SM) anomaly from the CLM_D case of this work and (right) 2005–2014 mean drought stress activity factor γ_d for biogenic isoprene emission calculations from Jiang et al. (2018). The SM anomaly equals to the period-mean (16–28 August 2016) SM at WRF-Chem initial times, divided by SM averaged through 00 UTC 2005-2014 August.

Across the southeastern US domain, the 2005–2014 mean γ_d values are mostly close to 1.0. In August 2016, high biogenic isoprene emission regions, including the Missouri Ozarks, were wetter than the 2005–2014 average conditions and therefore for these regions the SM direct controls on biogenic isoprene emissions were weak. However, omitting the SM direct effects on biogenic isoprene emissions over several states that were experiencing drier-than-normal soil conditions, such as Tennessee, South Carolina, Alabama, and West Virginia, may introduce relatively larger uncertainty to biogenic emission and O_3 modeling.