S1: Emission Factors for VFRL

Table S1. Emission factors for grid cell at standard conditions.

Categories	Emission Factor ($nmol.m^{-2}.s^{-1}$)
isoprene	15.16
MBO	0.46
pinenes	0.27
ocimenes	0.22
carene	0.20
limonene	0.21
cymene	0.03
camphor	0.05
b-caryophyllene	0.07
longifolene	0.04
methanol	1.60
acetone	0.40
acetaldehyde and ethanol	0.70
formic acid; acetic acid; pyruvic acid	0.40
ethene; ethane	1.27
methacrolein	0.10
linalool	0.20
other VOC	0.04
CO	1

S2: Tree Species composition at VFRL

Table S2. Tree species composition at VFRL with the fraction of the grid occupied by the corresponding species.

Species	Grid Fraction	Type
Quercus alba	0.2364	Broadleaf tree
Pinus virginiana	0.2006	Needleleaf tree
Quercus falcata	0.1186	Broadleaf tree
Acer rubrum	0.1146	Broadleaf tree
Liriodendron tulipifera	0.1026	Broadleaf tree
Carya	0.0453	Broadleaf tree
Fagus grandifolia	0.0443	Broadleaf tree
Quercus rubra	0.0389	Broadleaf tree
Pinus taeda	0.0277	Needleleaf tree
Liquidambar styraciflua	0.02	Broadleaf tree
Nyssa sylvatica	0.0178	Broadleaf tree
Quercus marilandica	0.0104	Broadleaf tree
Cornus florida	0.008	Broadleaf tree
Juniperus virginiana	0.0047	Needleleaf tree
Quercus prinus	0.0025	Broadleaf tree
Sassafras albidum	0.0018	Broadleaf tree
Platanus occidentalis	0.0018	Broadleaf tree
Populus deltoides	0.0015	Broadleaf tree
Carpinus caroliniana	0.0012	Broadleaf tree
Quercus stellata	0.0008	Broadleaf tree
Ilex opaca	0.0002	Broadleaf tree
Castanea pumila	0.0001	Broadleaf tree

S3: Correlation of meteorological data at VFRL with those from Weather Underground

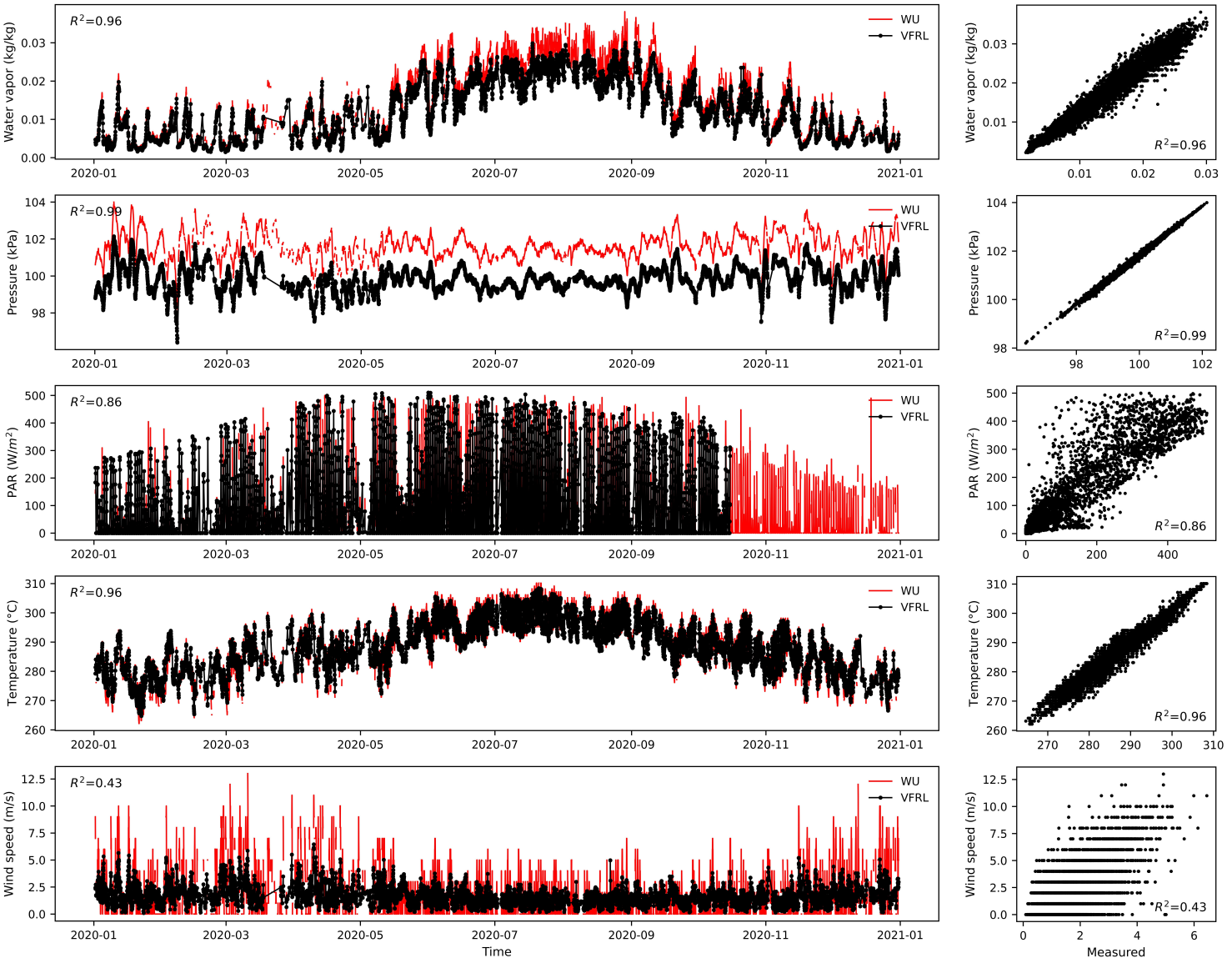

Figure S3. Timeseries of meteorological parameters measured at the Virginia Forest Research Laboratory (VFRL, black lines) and those obtained from Weather Underground identifiers as mentioned in Section 2.2 (in red). The Pearson Correlation coefficient is denoted by R.

S4: Timeseries of α-pinene with adjusted LDF values.

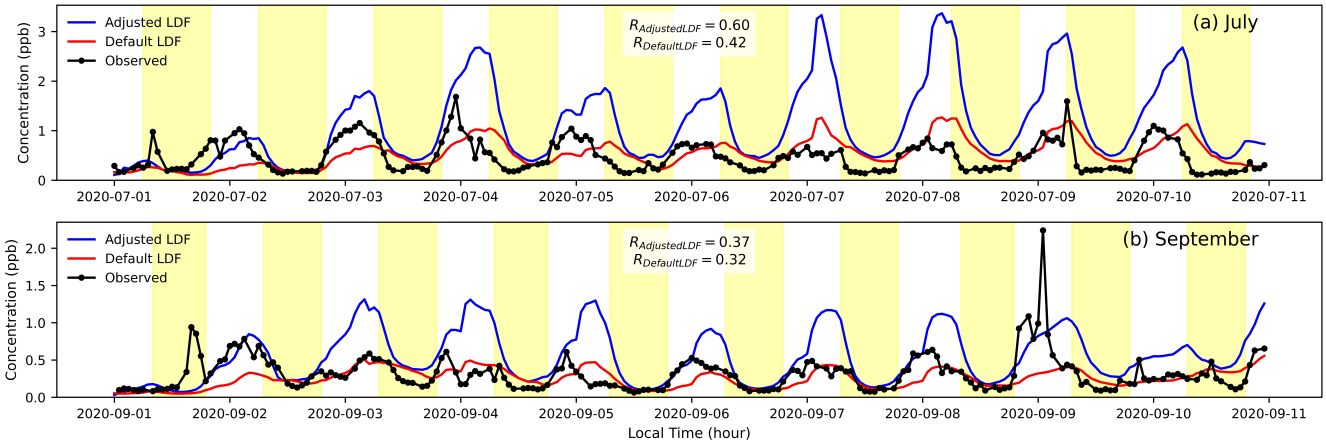

Figure S4. A snapshot of α-pinene concentrations (in ppb) for January, July, and September of 2020 using the monthly LDF as shown in Figure 6. The Pearson correlation coefficient values of the adjusted and default modeled (refer to Table 1) concentrations against the observed concentrations are reported as $R_{AdjustedLDF}$ and $R_{DefaultLDF}$.

S5: Rates of reaction for additional BVOCs added to MCMv3.3.1.

Table S5. Rates of reaction of BVOCs added to MCMv3.3.1 where $k_{OH\text{-}i}$ and $k_{O3\text{-}i}$. are the second order reaction rates of compound emphi with OH and O_3 in $cm^3.molecule^{-1}.s^{-1}$

Compound (i)	$k_{O_3\text{-}i}$ $(cm^3.molecule^{-1}.s^{-1})$	$k_{OH\text{-}i}$ $(cm^3.molecule^{-1}.s^{-1})$	References
β-phellandrene	4.77×10^{-17}	1.68×10^{-10}	Shorees et al. (1991)
Camphene	5.10×10^{-19}	5.30×10^{-11}	Gaona-Colmán et al. (2017)
Tricyclene	None	3.54×10^{-12}	US EPA (2024)
β-Thujene	1.13×10^{-17}	6.09×10^{-11}	US EPA (2024)
α-Fenchene	1.13×10^{-17}	5.96×10^{-11}	US EPA (2024)
Sabinene	8.60×10^{-17}	1.17×10^{-10}	Atkinson et al. (1990b, a)
α-Cymene	None	8.54×10^{-12}	US EPA (2024)
γ-terpinene	1.40×10^{-16}	1.77×10^{-10}	Atkinson et al. (1990b)
α-Cedrene	2.78×10^{-17}	6.70×10^{-11}	Shu and Atkinson (1994, 1995)
β-cedrene	1.70×10^{-16}	6.53×10^{-11}	Richters et al. (2015)

S6: Monthly variation of LDF throughout the year for other BVOCs.

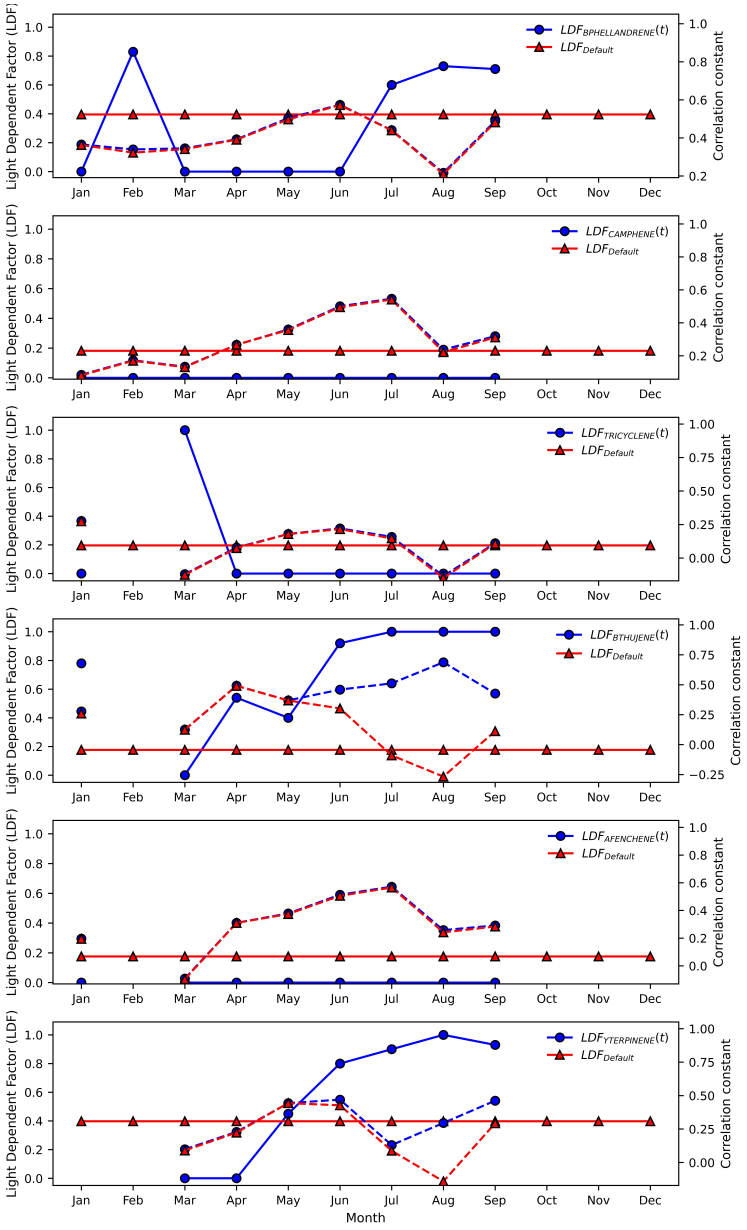

Figure S6. Monthly variation of LDF for α-fenchene, β-phellandrene, β-thujene, camphene, tricyclene and γ-terpinene estimated by maximizing the correlation between observed concentrations and those estimated by MEGANv3.2 and F0AM at VFRL. The blue markers represent the adjusted LDF values, the red line represents the LDF used by default in MEGANv3.2. The blue and red dashed lines present the LDF values and the dashed lines represent the corresponding Pearson correlation coefficients.

S7:Variation of correlation constant with LDF throughout the seasons for all BVOCs simulated.

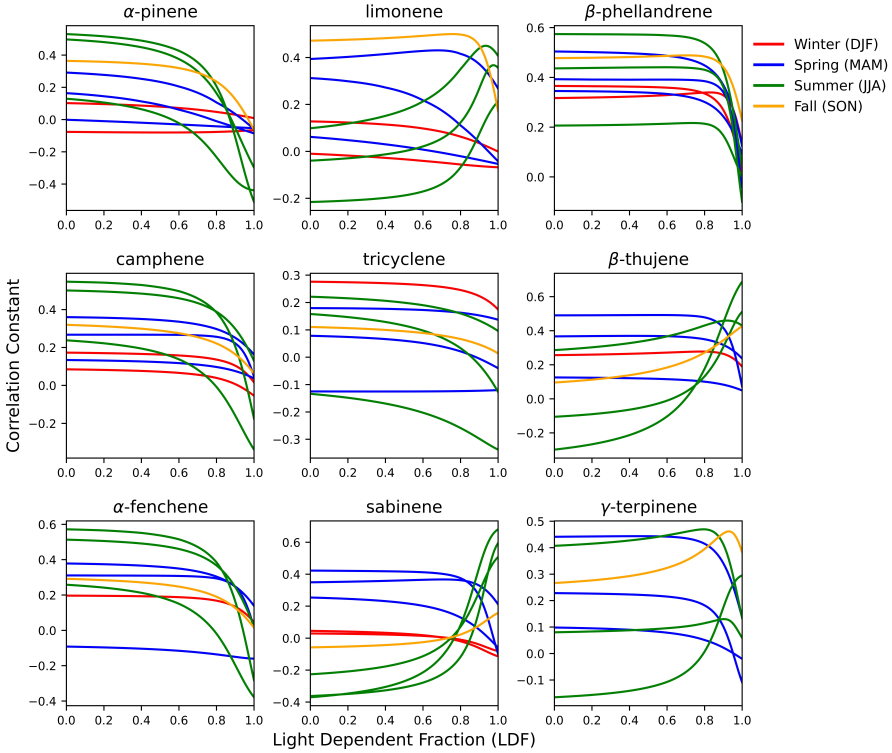

Figure S7. Variation of the Pearson correlation coefficient between modeled and measured concentration with LDF for α-pinene, limonene, β-phellandrene, camphene, tricyclene, β-thujene, α-fenchene, sabinene, and γ-terpinene at VFRL. The red lines represent winter (Dec, Jan, Feb), blue lines spring (Mar, Apr, May), green lines summer (Jun, Jul, Aug), and orange lines fall (Sep, Oct, Nov) months.

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