



Supplement of

Implementation of the ORACLE (v1.0) organic aerosol composition and evolution module into the EC-Earth3-AerChem model

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Table S1: Global average surface concentrations of POA, SOA-sv, SOA-iv, and total OA from standalone TM5-MP simulation using the VBS configuration, presented for annual, DJF, MAM, JJA, and SON periods

OA	Annual	DJF	MAM	JJA	SON
	($\mu\text{g m}^{-3}$)	($\mu\text{g m}^{-3}$)	($\mu\text{g m}^{-3}$)	($\mu\text{g m}^{-3}$)	($\mu\text{g m}^{-3}$)
TM5-MP					
POA	0.32	0.40	0.24	0.33	0.32
SOA-sv	0.14	0.10	0.14	0.17	0.15
SOA-iv	0.30	0.38	0.27	0.26	0.30
Total OA	1.07	1.09	0.91	1.16	1.11

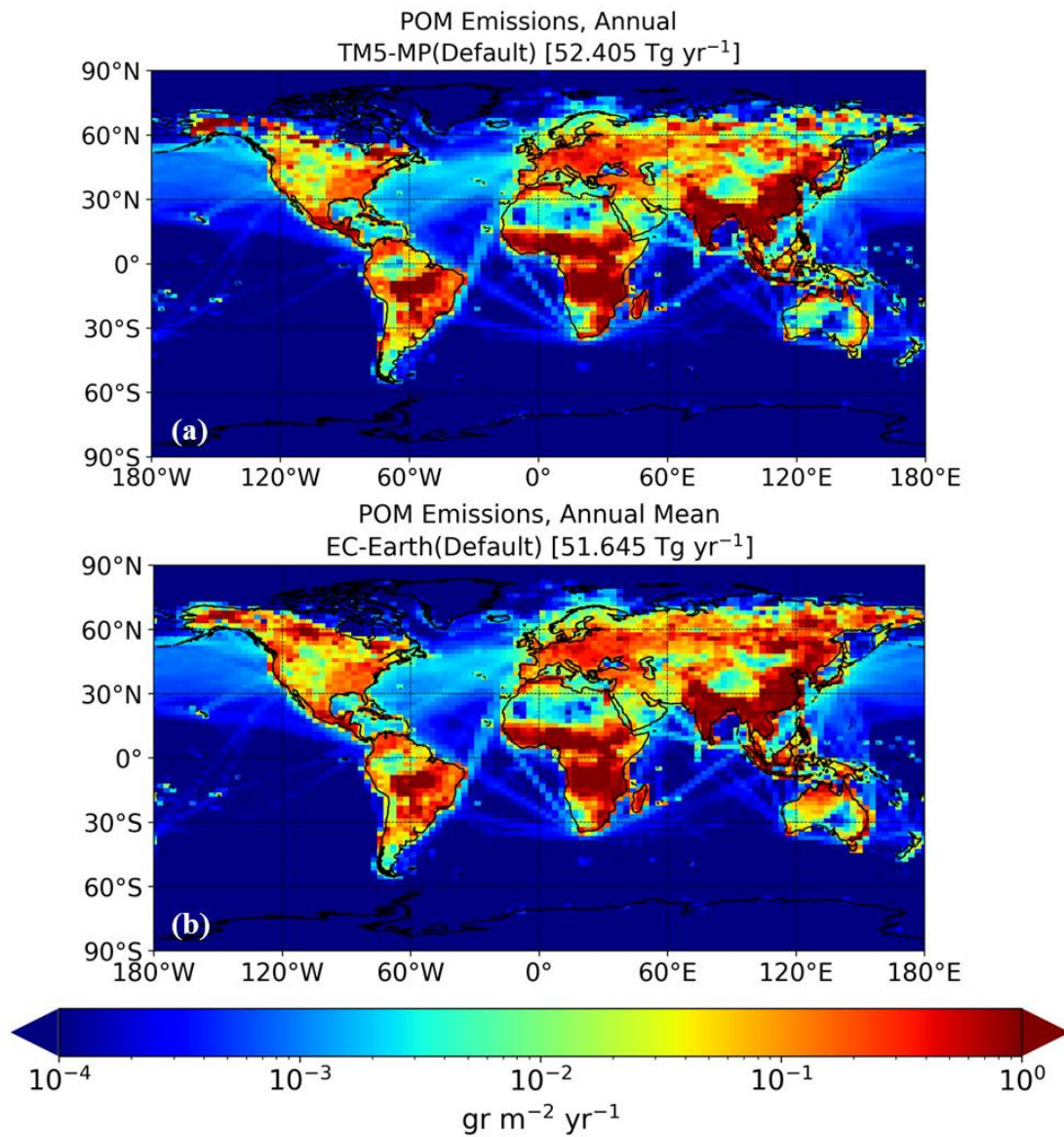


Figure S1. Annual POA emissions (in gr m⁻² yr⁻¹) applied in the default simulation of: **(a)** standalone TM5-MP during 2005, and **(b)** EC-Earth during 2000-2010.

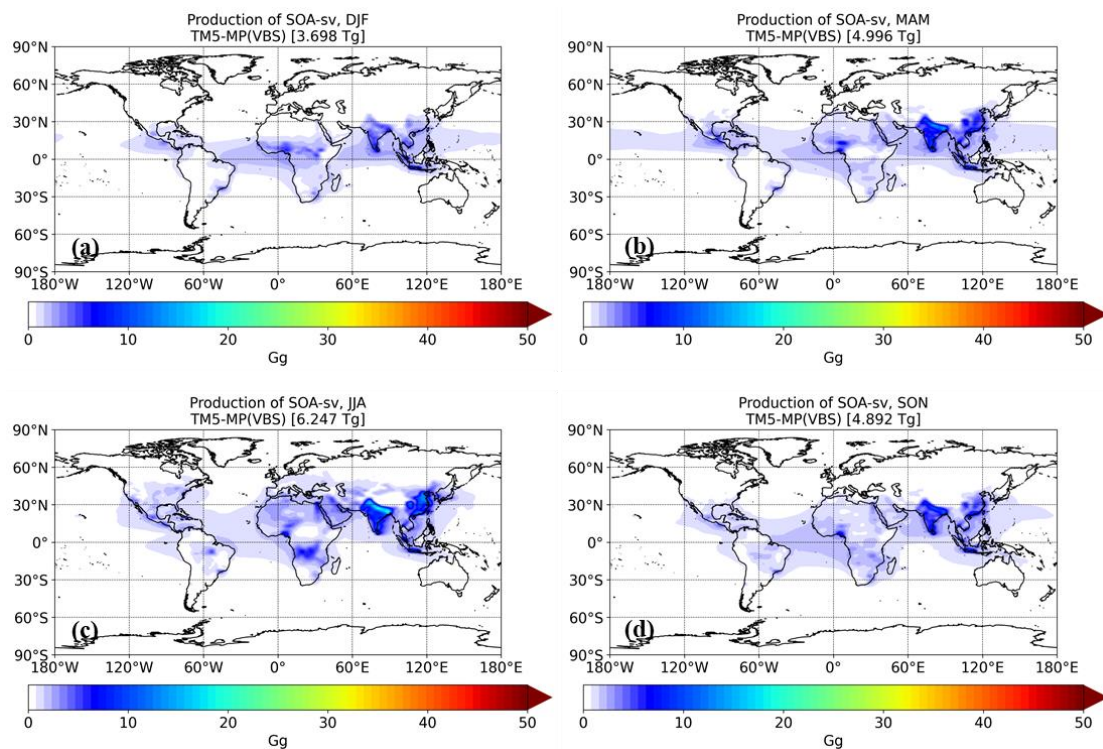


Figure S2. Production of SOA-sv as simulated using the VBS configuration in TM5-MP during 2005 (in Gg) for: (a) DJF, (b) MAM, (c) JJA, and (d) SON.

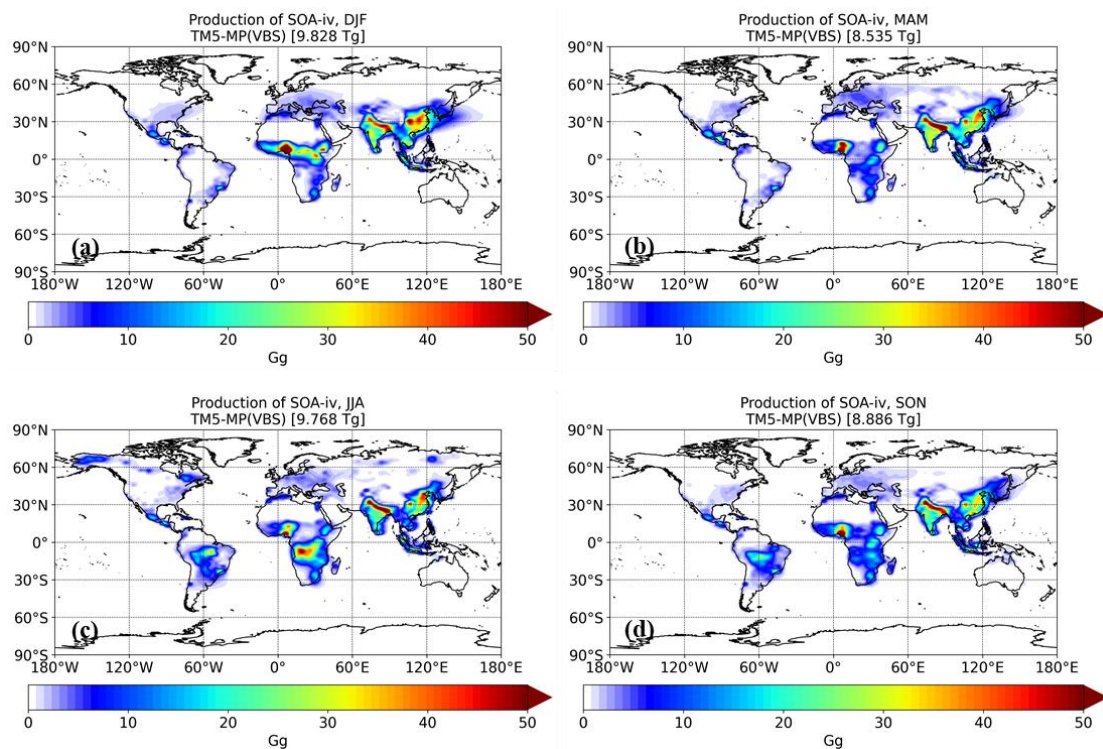


Figure S3. Production of SOA-iv as simulated using the VBS configuration in TM5-MP during 2005 (in Gg) for: **(a)** DJF, **(b)** MAM, **(c)** JJA, and **(d)** SON.

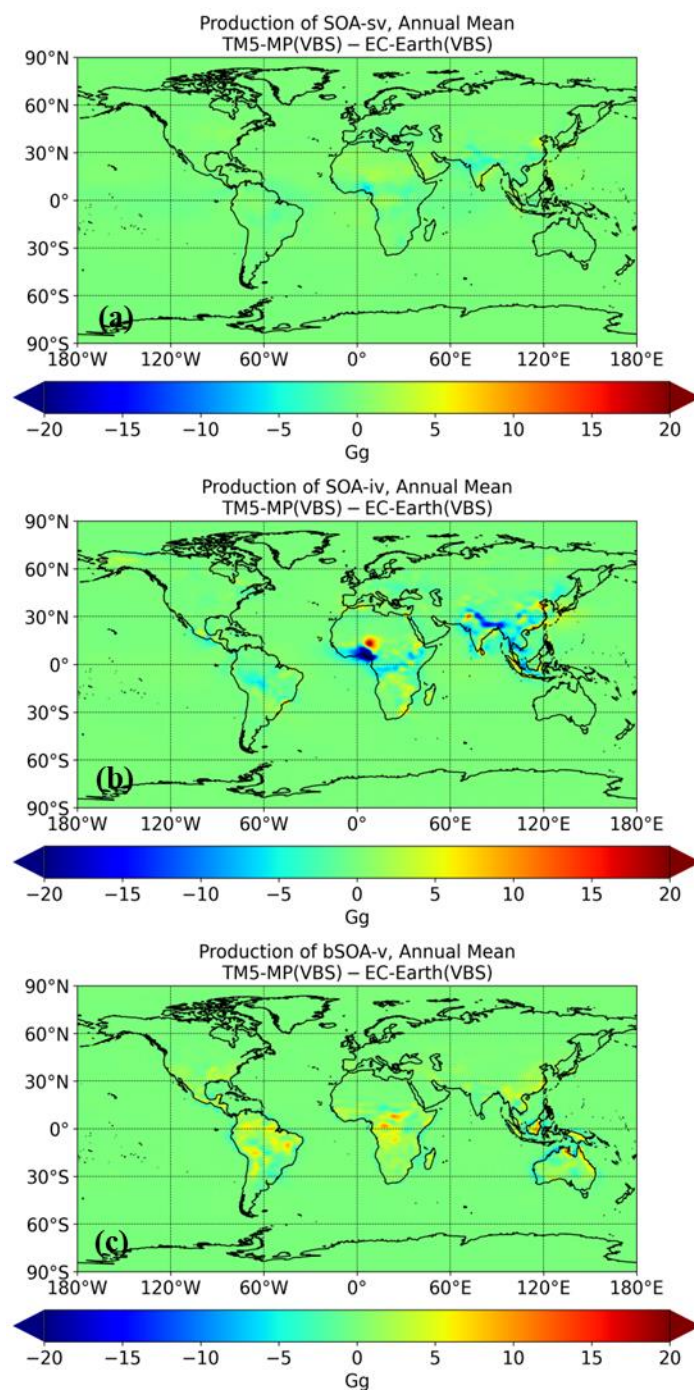


Figure S4. Annual mean differences in SOA production between TM5-MP and EC-Earth simulations during 2005 using the VBS configuration (in Gg) for: **(a)** SOA-sv, and **(b)** SOA-iv. For completeness, the difference in annual SOA production from biogenic VOCs (bSOA-v) in panel **(c)** is also shown. A positive change indicates that the standalone TM5-MP simulation predicts higher production than the EC-Earth.

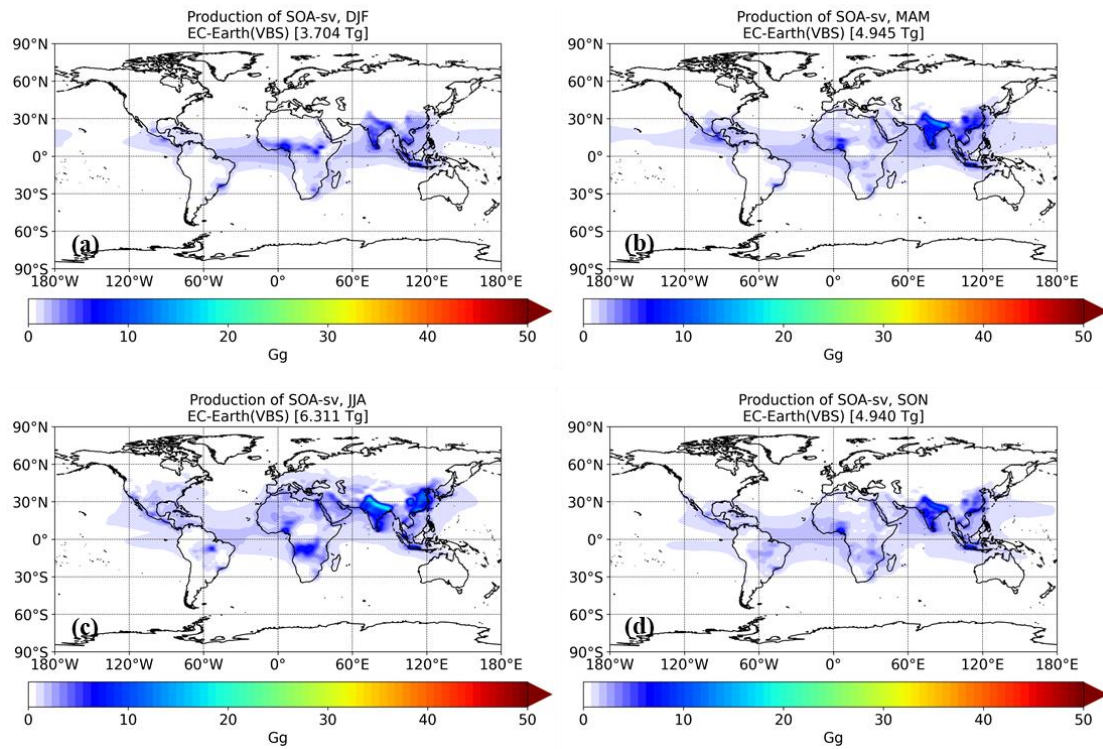


Figure S5. Production of SOA-sv as simulated using the VBS configuration of EC-Earth during 2005 (in Gg) for: (a) DJF, (b) MAM, (c) JJA, and (d) SON.

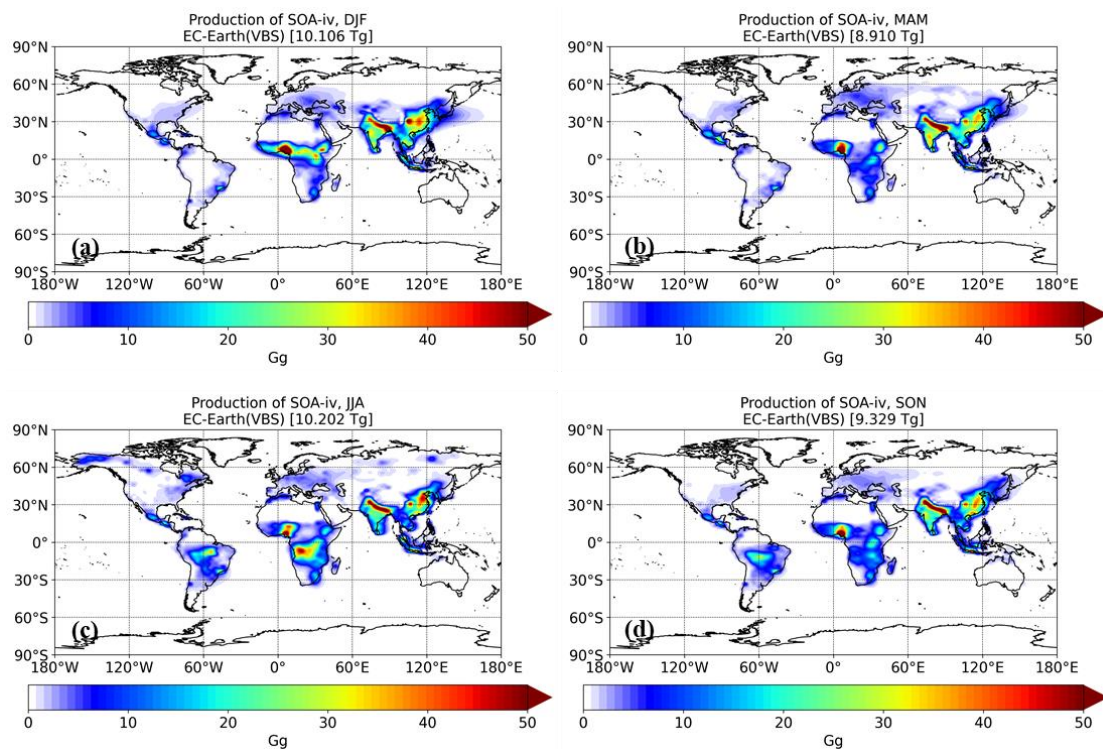


Figure S6. Production of SOA-iv as simulated using the VBS configuration of EC-Earth during 2005 (in Gg) for: (a) DJF, (b) MAM, (c) JJA, and (d) SON.

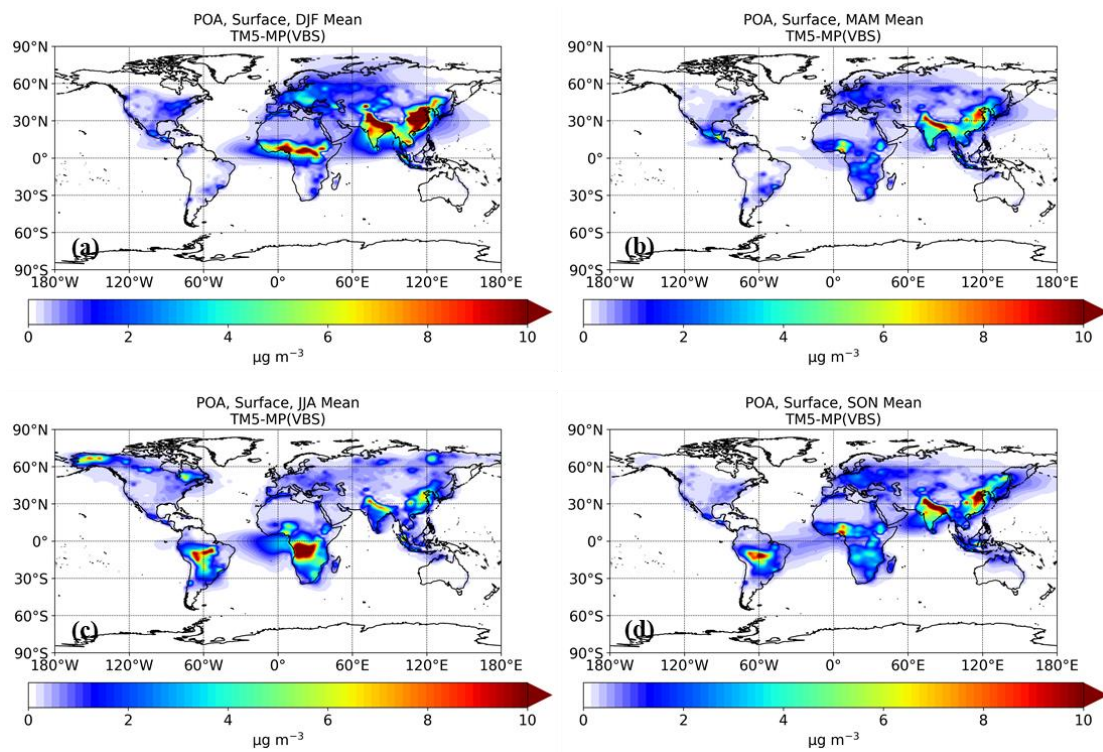


Figure S7. Mean surface concentrations of POA (in $\mu\text{g m}^{-3}$) during: (a) DJF, (b) MAM, (c) JJA, and (d) SON simulated using the VBS configuration in TM5-MP.

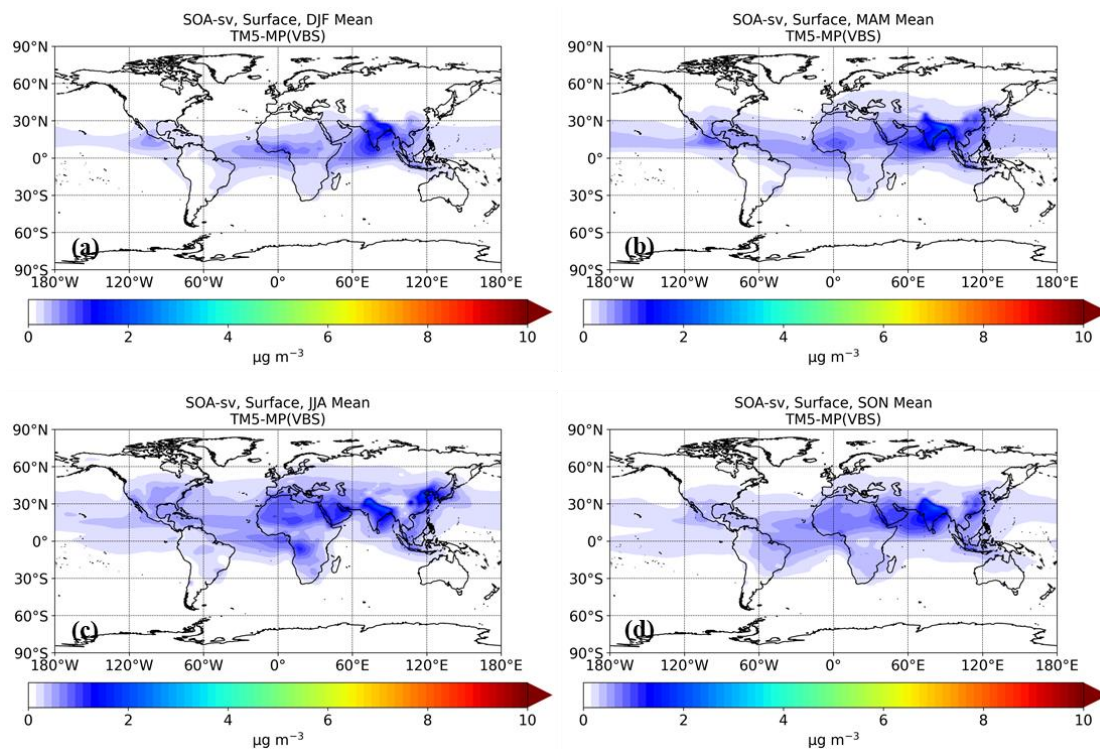


Figure S8. Mean surface concentrations of SOA-sv (in $\mu\text{g m}^{-3}$) during: (a) DJF, (b) MAM, (c) JJA, and (d) SON simulated using the VBS configuration in TM5-MP.

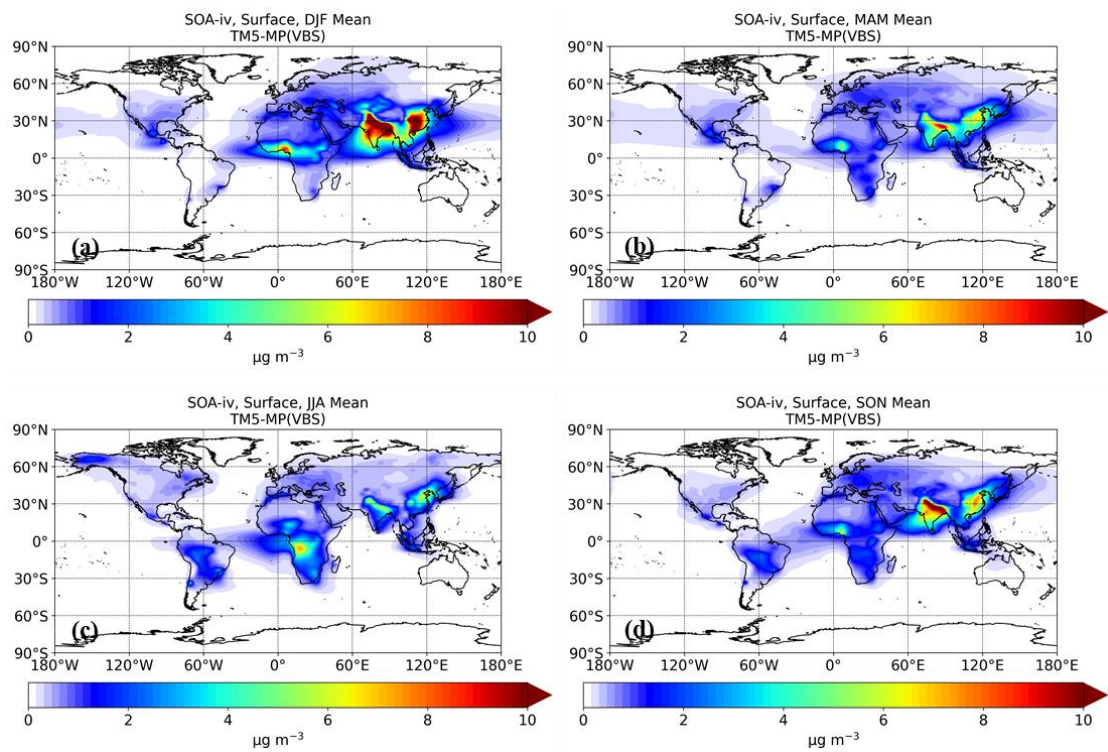


Figure S9. Mean surface concentrations of SOA-iv (in $\mu\text{g m}^{-3}$) during: (a) DJF, (b) MAM, (c) JJA, and (d) SON simulated using the VBS configuration in TM5-MP.

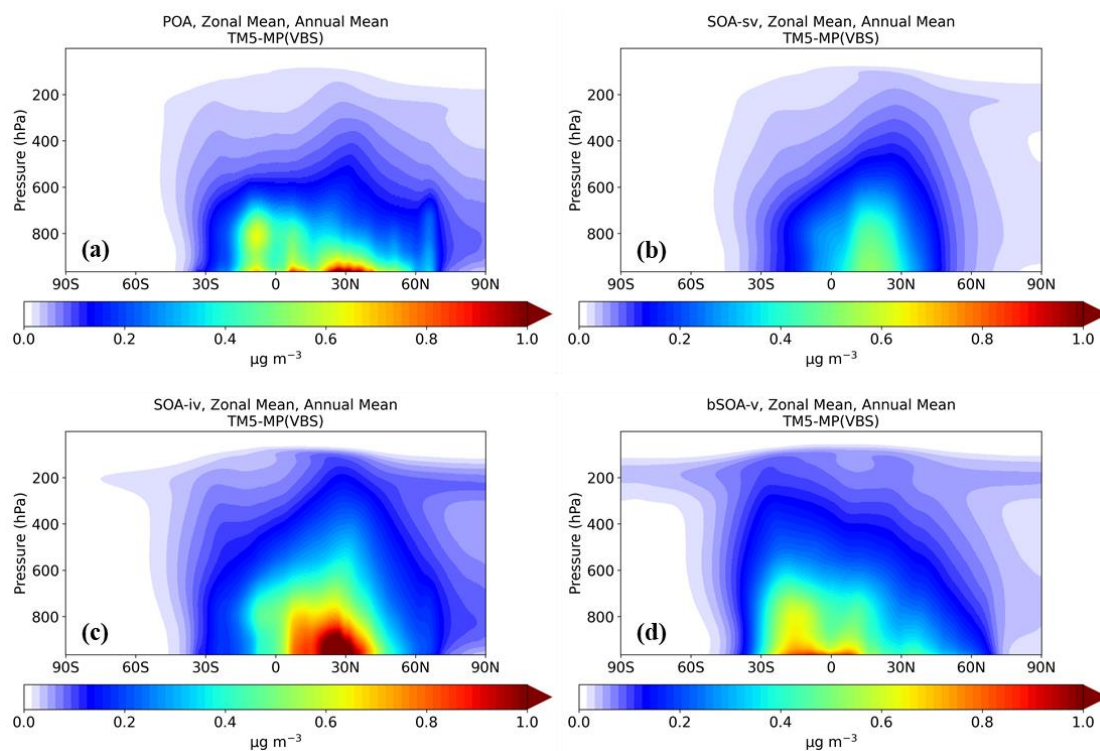


Figure S10. Annual mean zonal concentrations (in $\mu\text{g m}^{-3}$) of: **(a)** POA, **(b)** SOA-sv, and **(c)** SOA-iv simulated using the VBS configuration in TM5-MP. For completeness, bSOA-v in panel **(d)** is also shown.

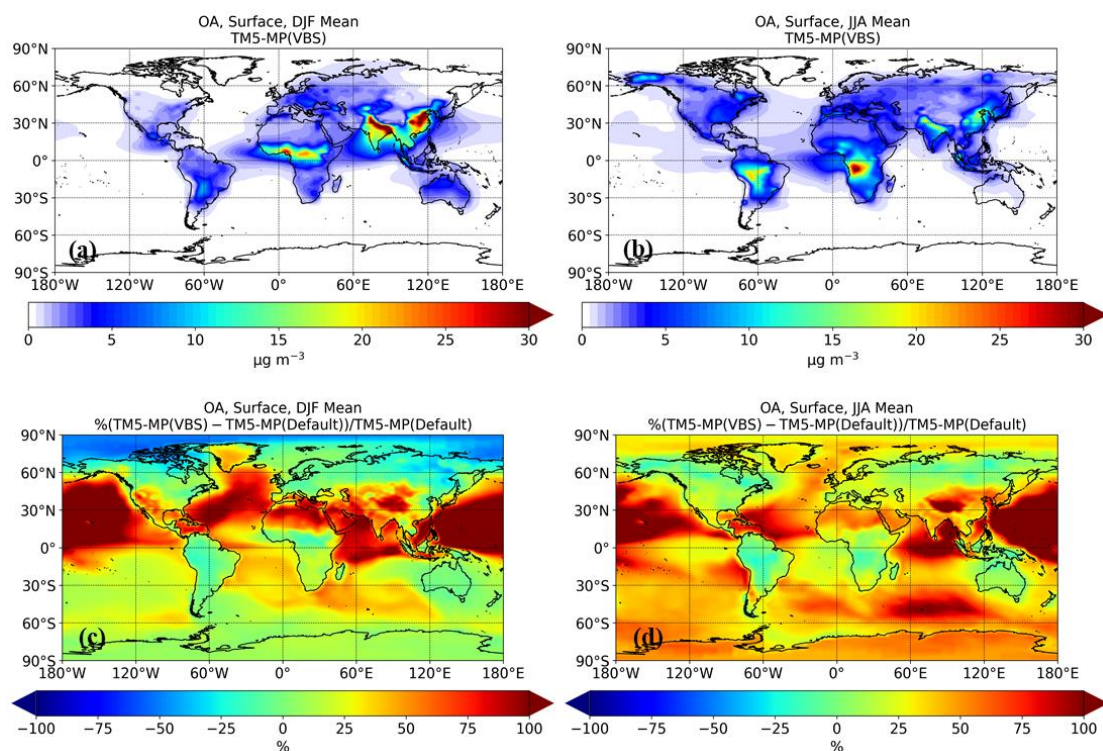


Figure S11. Mean concentrations of total organic aerosol (in $\mu\text{g m}^{-3}$) during: **(a)** DJF, and **(b)** JJA, simulated using the VBS configuration in TM5-MP. Panels **(c)** and **(d)** show the corresponding relative differences (in %) compared to the previous (default) model configuration. A positive change indicates that the VBS configuration predicts more than the default one.

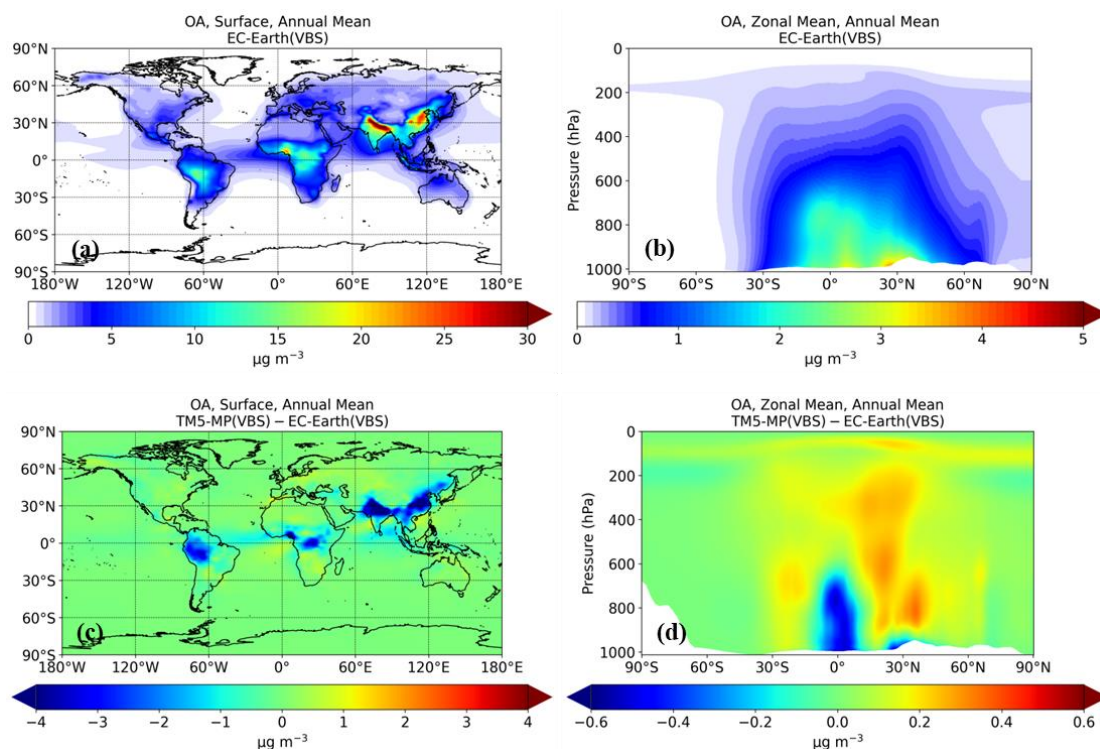


Figure S12. Annual mean concentrations of total organic aerosol (in $\mu\text{g m}^{-3}$): **(a)** surface concentrations, and **(b)** zonal values as simulated using the VBS configuration of EC-Earth during 2005. Panels **(c)** and **(d)** show the corresponding differences (in $\mu\text{g m}^{-3}$) compared to the TM5-MP predictions using the VBS configuration. A positive change indicates that the standalone TM5-MP simulation predicts higher concentrations than the EC-Earth.

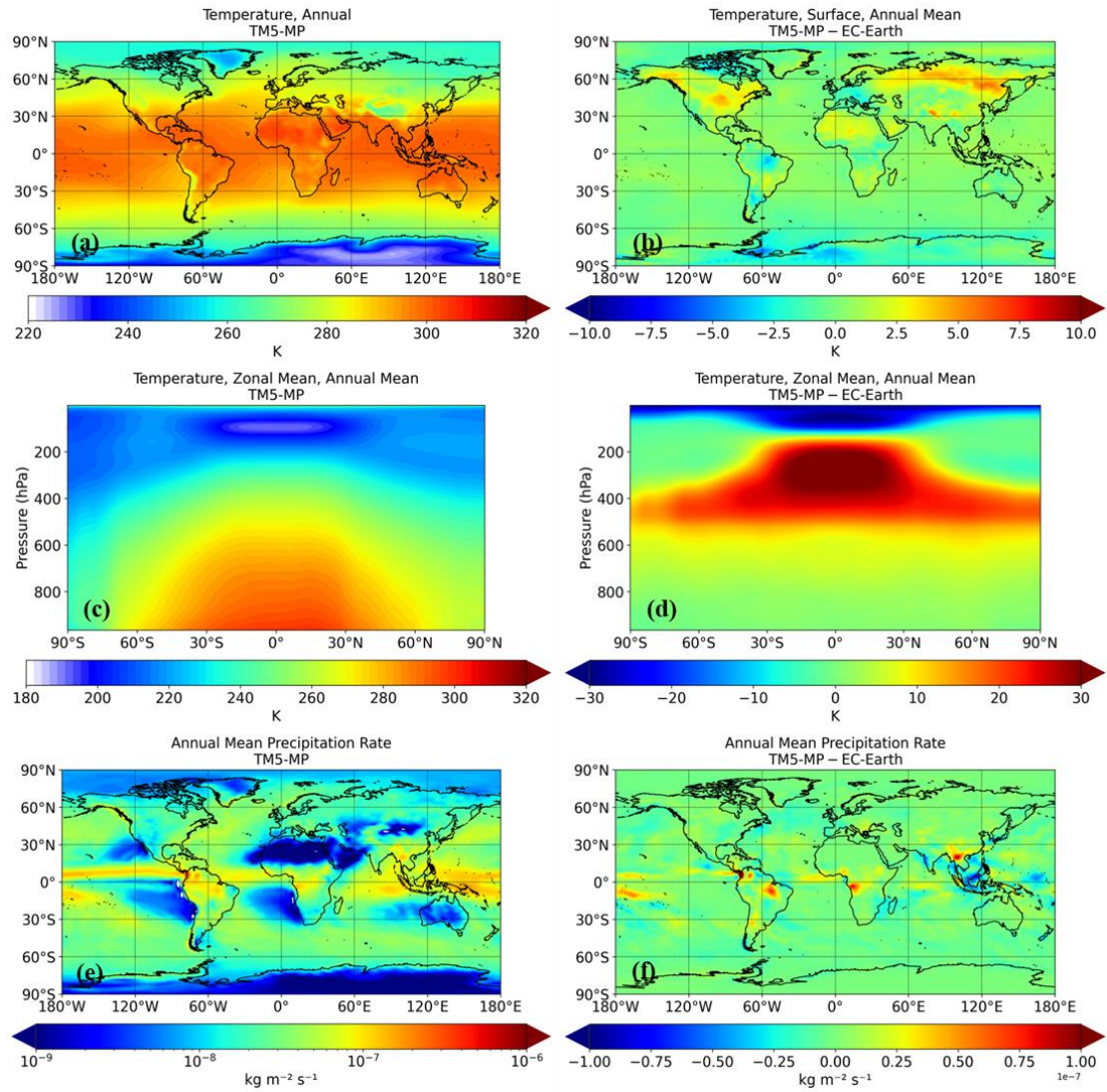


Figure S13. Meteorological fields from TM5-MP and their differences with EC-Earth for: (a), (b) annual mean surface temperature (in K), (c), (d) annual zonal-mean temperature (in K), and (e), (f) annual mean precipitation rate ($\text{kg m}^{-2} \text{s}^{-1}$) for 2005. A positive change indicates that the standalone TM5-MP model accounts for higher values than the simulated of EC-Earth.