

Simulation	Emission perturbations	Applied to source regions	Scope
P0	No perturbations	Master zoom regions with $1^\circ \times 1^\circ$ resolution: AFR, AUS, EAS, EUR, MAM, MEA, NAM, RSA, RUS, SAM, SAS, SEA, and PAC ( $3^\circ \times 2^\circ$ )	Base simulation
P1	SO <sub>2</sub> , NO <sub>x</sub> , BC, POM	All 56 continental regions* + international shipping + aviation	SR matrices for BC and POM and first-order approximation for SO <sub>2</sub> and NO <sub>x</sub> , assuming negligible chemical interaction
P2	SO <sub>2</sub>	All 56 source regions* + shipping	Independent SR for SO <sub>2</sub> , to be compared to P1 to quantify potential interference between SO <sub>2</sub> and NO <sub>x</sub> in the formation of sulfate and ozone
P3	NO <sub>x</sub>	Representative source regions* (China, Europe, Japan, India, Germany, South Africa, USA)	Independent SR for NO <sub>x</sub> , to verify the additivity of $P1 = P2 + P3$ and justify the use of (P1–P2) as a proxy for NO <sub>x</sub> perturbation for all other regions
P4	NH <sub>3</sub> , NMVOCs	All 56 continental source* regions + international shipping	SR matrices for NH <sub>3</sub> and NMVOCs emissions, assuming little chemical interaction among the selected precursors in the formation of NH <sub>4</sub> and O <sub>3</sub>
P5	NMVOCs, NO <sub>x</sub>	Representative source regions* (Europe, China, India, USA)	Quantify chemical feedbacks in O <sub>3</sub> formation between NO <sub>x</sub> and NMVOCs ( $P5 = P3 + P4$ ) additivity