Supplement of
Global source attribution of sulfate concentration, direct and indirect radiative forcing

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Table S1. Relative contributions (%) from the sixteen tagged source regions/sectors (S, column) to regional mean surface concentrations of sulfate over the fourteen receptor regions and all globe (R, row) in December-January-February (DJF), March-April-May (MAM), June-July-August (JJA), September-October-November (SON), and annual mean (ANN).

DJF

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	74.9	7.1	0.0	0.5	0.6	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.0	2.0	2.6
CAM	5.8	45.3	1.2	0.1	0.3	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	2.0	1.8
SAM	0.0	0.2	42.3	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.8	1.1
EUR	0.4	0.4	0.4	59.7	16.1	3.2	8.2	0.1	6.8	0.8	0.5	11.2	0.0	1.9	3.5
NAF	0.1	0.5	0.8	2.4	15.3	4.6	2.8	0.0	0.6	0.4	0.1	0.3	0.0	0.7	1.3
SAF	0.0	1.4	4.5	0.1	1.1	35.1	0.4	0.1	0.1	0.2	0.0	0.0	2.8	1.9	2.9
MDE	0.7	0.7	1.9	5.2	18.7	23.6	62.6	0.8	15.9	9.4	1.7	2.4	0.0	4.1	7.7
SEA	0.0	0.1	0.1	0.0	0.0	0.1	0.0	12.2	0.0	0.8	1.2	0.0	0.6	1.7	1.7
CAS	0.3	0.0	0.0	0.4	0.1	0.2	0.8	0.1	41.2	1.0	2.2	12.8	0.0	0.4	1.5
SAS	1.4	0.8	0.3	0.3	0.7	3.5	1.1	11.3	2.4	74.4	8.2	0.3	0.1	12.4	13.1
EAS	4.9	1.7	0.1	0.8	1.2	0.5	0.4	57.0	3.6	4.2	77.1	5.5	0.2	16.3	20.4
RBU	0.6	0.0	0.0	7.7	0.6	0.2	1.0	0.1	20.8	0.1	2.8	54.7	0.0	1.2	3.0
PAN	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.1	0.5	0.5
ROW	6.3	17.0	13.4	12.0	14.6	14.6	16.1	11.7	4.9	6.7	4.8	10.0	17.3	13.9	12.2
VOL	2.2	16.4	12.6	9.2	28.7	7.8	5.9	4.9	3.2	1.4	1.0	2.3	10.6	11.2	9.0
DMS	2.4	8.4	22.3	1.6	1.8	6.1	0.5	1.5	0.3	0.6	0.2	0.4	29.6	29.0	17.7

MAM

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	55.6	4.0	0.0	1.0	1.3	0.2	0.5	0.0	0.6	0.3	0.2	0.5	0.0	2.2	2.8
CAM	7.1	39.3	0.3	0.2	0.7	0.2	0.3	0.1	0.2	0.2	0.1	0.1	0.0	2.0	1.9
SAM	0.0	0.8	58.2	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.8	2.3
EUR	1.0	0.5	0.2	49.8	18.4	2.6	10.9	0.3	11.8	2.2	1.2	13.0	0.0	2.8	4.9
NAF	0.2	0.5	0.2	2.2	12.8	2.8	3.0	0.1	1.2	0.9	0.2	0.5	0.0	0.7	1.4
SAF	0.0	0.7	1.5	0.0	1.2	51.2	0.2	0.1	0.1	0.1	0.0	0.0	2.5	2.8	3.8
MDE	2.2	1.3	0.3	2.2	5.8	7.7	47.9	2.7	15.0	19.2	3.2	3.2	0.0	4.3	6.8
SEA	0.1	0.1	0.1	0.0	0.1	0.1	0.1	24.3	0.0	0.4	1.9	0.0	0.3	1.5	1.7
CAS	0.8	0.2	0.0	0.4	0.2	0.1	1.1	0.2	26.1	2.6	2.3	7.8	0.0	0.5	1.4
SAS	2.2	1.9	0.1	0.5	1.6	7.4	4.4	23.6	1.4	52.5	8.1	0.5	0.1	8.2	9.5
EAS	11.1	4.0	0.1	1.6	2.2	0.6	1.0	20.0	2.8	1.2	68.6	8.5	0.1	12.2	15.6
RBU	1.4	0.1	0.0	8.0	2.0	0.2	1.9	0.1	25.5	0.6	3.5	45.7	0.0	1.7	3.7
PAN	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	47.7	0.7	0.7
ROW	10.3	18.3	10.7	11.6	12.9	10.5	16.0	15.5	6.7	15.4	7.4	12.1	16.5	17.4	14.8
VOL	4.0	19.9	16.0	17.6	37.2	8.1	12.0	9.8	7.3	3.1	2.8	5.6	7.5	13.5	12.0
DMS	3.9	8.3	12.3	4.8	3.7	7.8	0.8	2.9	1.3	1.4	0.5	2.5	24.6	27.7	16.7

JJA

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT

NAM	67.9	4.3	0.1	2.1	1.7	0.3	1.1	0.1	1.8	0.4	0.4	1.3	0.0	3.2	4.5
CAM	6.4	40.3	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.0	0.1	0.1	1.6	1.6
SAM	0.0	5.5	60.5	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.8	4.7	4.0
EUR	0.7	1.2	0.2	52.8	19.5	2.5	16.7	0.7	10.4	2.3	1.0	11.4	0.1	3.6	6.4
NAF	0.2	0.8	0.1	1.6	8.7	1.2	3.1	0.2	0.5	0.5	0.1	0.3	0.0	1.0	1.5
SAF	0.0	1.1	0.8	0.0	1.3	65.1	0.5	0.2	0.0	0.5	0.0	0.0	2.8	7.2	7.6
MDE	0.5	1.1	0.6	1.8	3.8	7.7	41.2	4.1	6.0	10.2	1.3	2.0	0.3	3.0	5.2
SEA	0.0	0.1	0.1	0.0	0.0	0.1	0.0	35.5	0.0	0.1	1.4	0.0	0.4	1.3	1.4
CAS	0.4	0.2	0.0	0.7	0.3	0.3	2.8	0.6	25.5	5.7	2.6	4.3	0.0	0.4	1.5
SAS	0.4	0.5	0.3	0.2	0.4	0.6	0.6	8.8	0.4	62.0	1.9	0.2	0.3	1.6	4.4
EAS	5.6	2.3	0.7	1.3	1.4	0.6	1.1	4.8	2.4	1.2	75.5	15.0	0.7	6.5	12.9
RBU	1.4	0.3	0.0	10.9	2.8	0.5	6.6	0.3	42.2	2.0	3.4	47.0	0.0	1.8	4.6
PAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	51.5	1.1	0.9
ROW	9.8	17.2	10.8	12.0	10.4	7.3	16.7	19.0	5.8	9.8	7.8	12.2	16.6	20.1	15.0
VOL	3.1	18.4	17.5	10.4	47.4	7.9	8.8	19.4	3.5	1.6	3.9	3.6	10.4	14.9	13.9
DMS	3.5	6.5	8.0	5.9	2.3	5.3	0.7	4.9	1.4	3.6	0.7	2.5	16.0	28.1	14.7

SON

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	69.9	9.6	0.0	1.2	0.9	0.2	0.5	0.0	0.8	0.2	0.2	0.7	0.0	3.0	3.3
CAM	5.0	42.5	0.3	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.2	1.6	1.5
SAM	0.0	1.7	54.3	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	1.3	2.4	2.6
EUR	0.7	0.7	0.2	53.1	16.3	3.6	9.4	0.1	10.0	1.2	0.9	15.1	0.1	3.1	5.2
NAF	0.1	0.4	0.1	2.3	11.6	3.4	1.8	0.0	0.7	0.3	0.1	0.4	0.0	0.9	1.6
SAF	0.0	3.0	7.2	0.0	0.4	38.6	0.1	0.1	0.0	0.1	0.0	0.0	7.0	4.5	4.6
MDE	0.9	1.2	0.7	5.3	15.1	18.1	56.1	0.6	14.9	8.2	2.3	2.8	0.2	4.4	8.5
SEA	0.0	0.0	0.1	0.0	0.0	0.1	0.0	17.7	0.0	0.9	0.7	0.0	0.6	1.5	1.4
CAS	0.6	0.2	0.0	0.3	0.3	0.6	2.8	0.2	31.1	3.5	3.0	8.2	0.0	0.8	1.8
SAS	0.9	0.7	0.3	0.3	0.8	4.9	3.0	4.1	1.0	71.9	3.3	0.2	0.3	8.5	10.7
EAS	7.0	2.2	0.4	1.1	1.1	0.7	0.7	47.2	2.3	4.7	77.0	8.0	0.6	10.7	15.6
RBU	0.9	0.2	0.0	9.7	1.9	0.5	2.4	0.1	28.4	0.5	2.6	48.7	0.0	1.6	3.3
PAN	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	43.3	0.9	0.8
ROW	7.4	17.1	13.4	11.5	13.3	12.9	16.9	15.4	5.9	6.6	7.1	11.0	15.6	17.6	14.1
VOL	2.0	13.8	12.2	12.8	37.1	9.7	5.8	11.3	4.1	1.0	2.3	3.6	12.9	12.6	11.2
DMS	4.6	6.8	10.5	2.3	1.2	5.8	0.5	2.5	0.8	1.0	0.4	1.2	17.8	26.0	13.7

ANN

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	66.5	6.2	0.0	1.3	1.2	0.2	0.6	0.0	0.8	0.2	0.2	0.7	0.0	2.5	3.2
CAM	6.2	42.0	0.5	0.2	0.3	0.2	0.1	0.0	0.1	0.1	0.0	0.1	0.1	1.8	1.7
SAM	0.0	2.0	55.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.2	2.5
EUR	0.7	0.7	0.2	53.4	17.7	3.0	11.3	0.2	9.8	1.5	0.9	12.6	0.0	2.8	5.0
NAF	0.2	0.6	0.2	2.1	11.4	3.0	2.6	0.1	0.8	0.5	0.1	0.4	0.0	0.8	1.5
SAF	0.0	1.5	3.5	0.0	1.0	47.7	0.3	0.1	0.0	0.2	0.0	0.0	3.9	3.8	4.6
MDE	1.0	1.1	0.8	3.5	10.0	14.5	51.9	1.6	13.2	11.3	2.1	2.6	0.1	4.0	7.1
SEA	0.1	0.1	0.1	0.0	0.0	0.1	0.0	19.3	0.0	0.6	1.3	0.0	0.5	1.5	1.5

CAS	0.5	0.1	0.0	0.4	0.2	0.3	2.0	0.2	31.0	3.1	2.5	8.1	0.0	0.5	1.6
SAS	1.2	1.0	0.3	0.3	0.8	3.9	2.3	11.9	1.3	66.3	5.4	0.3	0.2	8.1	9.6
EAS	7.2	2.6	0.4	1.3	1.4	0.6	0.8	39.6	2.8	3.1	74.5	9.5	0.4	11.8	16.2
RBU	1.1	0.2	0.0	9.1	2.0	0.4	3.0	0.1	28.8	0.7	3.1	48.8	0.0	1.6	3.6
PAN	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	44.7	0.8	0.7
ROW	8.7	17.5	12.0	11.8	12.4	11.3	16.5	14.4	5.8	9.2	6.7	11.3	16.5	17.0	14.0
VOL	2.9	17.1	14.7	12.8	39.3	8.4	8.0	9.6	4.6	1.7	2.5	3.9	10.5	12.9	11.5
DMS	3.7	7.5	12.3	3.8	2.1	6.1	0.6	2.5	0.9	1.5	0.4	1.7	22.2	27.8	15.7

Table S2. Relative contributions (%) from the sixteen tagged source regions/sectors (S, column) to regional mean column burden of sulfate over the fourteen receptor regions and all globe (R, row) in December-January-February (DJF), March-April-May (MAM), June-July-August (JJA), September-October-November (SON), and annual mean (ANN).

DJF

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	25.2	3.5	0.0	1.6	1.0	0.1	0.3	0.0	0.7	0.2	0.2	1.0	0.0	1.3	1.5
CAM	5.0	27.5	0.8	0.8	1.3	0.3	0.5	0.1	0.4	0.3	0.2	0.5	0.1	1.8	1.7
SAM	0.3	1.1	27.2	0.2	1.0	1.3	0.3	0.1	0.1	0.2	0.1	0.1	2.6	2.2	2.2
EUR	1.4	0.4	0.3	36.0	10.0	2.5	7.4	0.1	12.6	1.0	1.6	14.6	0.0	1.6	2.8
NAF	0.4	0.5	0.5	2.7	9.3	4.0	3.1	0.1	2.0	0.6	0.4	1.2	0.0	0.7	1.2
SAF	0.5	1.9	4.5	0.4	5.5	34.5	1.5	0.4	0.4	0.7	0.2	0.2	11.3	5.4	5.9
MDE	3.2	1.0	1.5	4.5	17.3	22.4	53.3	1.2	22.7	11.4	4.9	6.6	0.1	4.0	7.2
SEA	1.1	0.7	0.6	0.6	0.7	0.4	0.3	11.9	0.4	0.9	1.6	0.5	2.1	2.1	1.9
CAS	0.5	0.0	0.0	0.3	0.1	0.2	0.5	0.1	12.8	0.6	2.0	6.3	0.0	0.4	0.8
SAS	16.3	2.9	1.0	7.1	3.6	3.8	2.6	14.5	7.0	66.6	16.1	9.3	1.0	11.9	13.1
EAS	22.9	3.8	1.1	7.5	3.8	0.9	1.9	46.7	6.2	4.4	60.2	16.6	1.3	16.3	17.7
RBU	0.6	0.0	0.0	4.0	0.4	0.1	0.8	0.1	9.7	0.1	1.9	18.4	0.0	0.8	1.4
PAN	0.0	0.1	0.3	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	28.4	0.8	0.8
ROW	8.3	12.8	8.5	13.0	13.8	13.3	16.0	12.3	9.5	8.1	5.7	9.9	14.2	11.0	10.8
VOL	7.9	32.0	37.5	17.0	25.1	9.3	8.9	8.7	13.3	3.0	3.6	11.8	14.4	17.3	15.2
DMS	6.3	11.9	16.1	4.4	7.1	7.0	2.6	3.5	2.3	1.9	1.3	3.0	24.4	22.2	15.9

MAM

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	23.2	2.6	0.0	2.9	2.3	0.4	1.0	0.1	1.6	0.5	0.5	1.6	0.0	2.1	2.4
CAM	5.4	26.1	0.6	1.0	2.0	0.6	0.7	0.2	0.7	0.4	0.3	0.5	0.1	2.1	1.9
SAM	0.2	1.0	38.9	0.1	0.3	1.2	0.1	0.1	0.1	0.1	0.1	0.1	2.6	1.9	2.1
EUR	2.2	0.6	0.2	34.8	13.3	3.5	9.4	0.4	14.2	2.6	2.6	14.3	0.0	2.6	4.4
NAF	0.5	0.5	0.3	2.7	10.2	4.0	3.5	0.3	2.2	1.1	0.6	1.3	0.1	0.8	1.5
SAF	0.3	0.9	2.3	0.2	1.8	35.6	0.5	0.3	0.2	0.3	0.1	0.2	9.7	4.1	4.1
MDE	7.0	2.5	0.4	3.8	7.7	11.0	44.4	4.7	22.9	22.9	8.7	8.2	0.2	6.2	8.8
SEA	0.7	0.7	0.7	0.3	0.4	0.4	0.2	18.9	0.3	0.4	2.1	0.3	2.4	2.0	1.9
CAS	1.8	0.4	0.0	0.6	0.2	0.1	1.0	0.3	11.8	2.5	3.3	5.4	0.0	1.0	1.5
SAS	10.4	6.4	0.9	4.3	4.5	8.1	5.7	30.4	3.9	46.8	15.4	4.1	1.0	12.4	12.8
EAS	27.0	9.0	0.9	6.6	4.9	1.3	2.4	14.0	4.7	1.7	50.3	17.6	1.0	17.4	16.9
RBU	1.8	0.2	0.0	6.0	1.4	0.3	1.5	0.1	13.8	0.7	3.6	23.4	0.0	1.7	2.8
PAN	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	28.1	0.6	0.5
ROW	8.1	13.0	8.5	10.3	12.0	10.7	14.5	14.5	8.5	13.8	6.9	8.9	13.5	11.2	10.9
VOL	7.4	27.0	32.4	21.4	33.6	14.4	13.3	11.6	13.2	4.5	4.5	11.0	17.8	16.7	15.4
DMS	4.1	9.1	13.7	5.0	5.2	8.2	1.8	3.9	2.0	1.7	1.1	3.1	23.4	17.3	12.1

JJA

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT

NAM	44.3	8.7	0.4	6.9	2.7	0.7	1.5	0.2	4.3	0.8	0.9	3.9	0.2	4.7	5.0
CAM	6.6	28.7	2.0	0.7	0.4	0.4	0.2	0.1	0.5	0.1	0.1	0.4	1.0	2.2	1.9
SAM	0.1	3.8	37.7	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2.6	2.3
EUR	1.5	1.6	0.7	37.1	15.7	5.8	12.9	0.7	13.7	2.9	2.1	13.5	0.5	3.8	6.2
NAF	0.2	1.0	0.3	2.2	7.0	2.6	2.4	0.2	0.8	0.5	0.2	0.6	0.2	1.2	1.6
SAF	0.1	1.1	1.2	0.1	0.6	33.4	0.2	0.2	0.1	0.3	0.0	0.1	3.9	5.0	4.7
MDE	1.2	2.0	2.3	2.6	9.6	19.4	39.9	4.0	12.0	11.5	2.7	3.6	2.3	6.3	8.5
SEA	0.4	0.3	0.9	0.2	0.2	0.5	0.2	18.9	0.2	0.4	1.2	0.3	3.2	1.6	1.3
CAS	1.3	0.4	0.2	0.9	0.6	1.0	3.5	0.8	13.9	7.7	4.2	5.0	0.3	1.3	2.1
SAS	4.2	2.9	2.7	3.5	3.8	3.5	7.4	15.0	5.4	52.7	8.5	3.4	5.5	6.3	7.7
EAS	21.8	8.0	5.4	8.7	4.7	4.3	5.2	22.0	8.2	8.0	65.2	20.8	13.6	20.0	19.2
RBU	3.1	0.5	0.2	9.6	2.6	1.4	5.4	0.4	28.2	2.5	4.7	32.5	0.2	2.6	4.5
PAN	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	18.6	0.5	0.4
ROW	7.9	14.0	9.6	9.4	9.4	9.5	13.6	14.1	5.9	8.0	6.0	8.3	12.6	11.3	10.3
VOL	4.1	20.4	27.1	13.6	41.0	12.7	6.6	17.6	5.2	1.9	3.1	5.4	22.9	18.0	16.3
DMS	3.3	6.6	9.1	4.4	1.9	4.3	0.9	5.2	1.7	2.5	0.9	2.2	13.4	12.9	8.1

SON

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	31.5	7.5	0.2	3.7	1.3	0.3	0.8	0.1	2.7	0.3	0.7	2.8	0.2	2.6	2.8
CAM	4.7	29.0	1.3	0.8	0.5	0.4	0.3	0.1	0.6	0.2	0.2	0.6	0.7	2.0	1.7
SAM	0.1	2.1	39.6	0.0	0.1	1.3	0.0	0.1	0.0	0.0	0.0	0.1	3.2	3.0	2.9
EUR	1.7	1.0	0.3	33.4	12.3	4.1	8.6	0.2	12.7	1.6	2.1	13.7	0.2	2.6	4.3
NAF	0.3	0.5	0.2	2.8	8.7	3.4	2.1	0.1	1.4	0.5	0.3	0.8	0.1	0.9	1.5
SAF	0.1	3.1	6.1	0.1	0.6	29.2	0.2	0.2	0.1	0.1	0.1	0.1	12.5	6.9	5.9
MDE	2.8	1.9	1.2	5.1	21.3	21.5	51.2	1.0	20.7	11.1	5.1	5.1	0.8	5.4	9.7
SEA	0.6	0.4	0.7	0.3	0.2	0.5	0.2	14.3	0.3	1.1	1.0	0.4	2.7	1.9	1.6
CAS	1.3	0.2	0.1	0.5	0.4	0.8	2.5	0.3	13.1	4.0	3.7	5.8	0.1	1.0	1.6
SAS	14.2	4.3	1.9	7.5	3.4	5.8	6.1	9.9	7.8	63.9	10.8	10.5	3.1	11.8	12.6
EAS	25.1	5.8	2.9	9.1	3.1	2.4	2.6	40.3	8.4	6.3	62.1	20.5	5.4	16.5	16.7
RBU	1.3	0.2	0.1	5.9	1.5	0.7	2.0	0.1	14.9	0.7	2.5	22.1	0.1	1.3	2.1
PAN	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	26.1	0.9	0.8
ROW	7.2	14.3	9.8	10.7	12.5	12.3	16.1	14.8	7.9	7.3	7.2	8.3	12.2	11.6	11.1
VOL	4.2	21.4	25.6	16.7	32.4	12.2	6.2	14.2	7.5	1.6	3.2	6.9	18.9	16.8	14.9
DMS	4.9	8.4	9.8	3.3	1.9	5.0	1.1	3.9	1.9	1.4	1.0	2.5	13.7	15.0	9.7

ANN

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	32.6	5.6	0.2	4.2	2.0	0.4	1.0	0.1	2.5	0.4	0.6	2.5	0.1	2.7	3.0
CAM	5.6	27.9	1.2	0.8	0.8	0.4	0.4	0.1	0.6	0.2	0.2	0.5	0.5	2.0	1.8
SAM	0.1	2.0	36.5	0.1	0.2	1.0	0.1	0.1	0.1	0.1	0.0	0.1	2.6	2.4	2.4
EUR	1.7	0.9	0.4	35.3	13.6	4.2	10.2	0.3	13.4	2.1	2.1	13.9	0.2	2.7	4.6
NAF	0.3	0.7	0.3	2.6	8.3	3.4	2.6	0.1	1.5	0.7	0.4	0.9	0.1	0.9	1.5
SAF	0.2	1.7	3.6	0.2	1.3	32.9	0.4	0.3	0.2	0.3	0.1	0.1	9.6	5.3	5.1
MDE	3.5	1.9	1.4	3.9	13.7	19.1	46.0	2.5	19.0	14.3	5.3	5.8	0.9	5.5	8.6
SEA	0.6	0.5	0.7	0.3	0.3	0.5	0.2	15.6	0.3	0.7	1.5	0.4	2.6	1.9	1.6

CAS	1.3	0.3	0.1	0.6	0.4	0.6	2.2	0.3	12.9	3.9	3.4	5.5	0.1	0.9	1.6
SAS	10.1	4.2	1.7	5.3	3.7	5.1	6.0	17.5	5.8	57.2	12.5	6.1	2.7	10.5	11.4
EAS	24.2	6.8	2.8	8.1	4.1	2.5	3.4	31.9	6.9	5.2	59.4	19.1	5.4	17.6	17.7
RBU	1.9	0.2	0.1	6.8	1.8	0.7	3.0	0.2	17.8	1.0	3.3	25.2	0.1	1.6	2.8
PAN	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	25.2	0.7	0.6
ROW	7.8	13.6	9.2	10.5	11.3	11.4	14.9	13.8	7.7	9.3	6.4	8.7	13.1	11.2	10.7
VOL	5.6	24.9	29.9	17.1	35.5	12.1	8.2	12.7	9.5	2.7	3.6	8.4	18.6	17.2	15.5
DMS	4.4	8.8	11.8	4.3	2.9	5.8	1.4	4.0	1.9	1.9	1.1	2.7	18.3	16.7	11.1

Table S3. Seasonal and annual regional concentration efficiency of sulfate (unit: μg m^{-3} (Tg S yr^{-1})$^{-1}$) of the sixteen tagged source regions/sectors. The efficiency is defined as the local near-surface sulfate concentration divided by the corresponding sulfur emissions from that region (seasonal emissions multiplied by 4). The receptor region of ROW is used to calculate efficiency of VOL and DMS.

	DJF	MAM	JJA	SON	ANN
NAM	1.375E-01	1.633E-01	2.261E-01	1.911E-01	1.798E-01
CAM	4.734E-01	3.909E-01	3.750E-01	4.128E-01	4.119E-01
SAM	1.968E-01	3.265E-01	3.142E-01	3.157E-01	2.943E-01
EUR	2.311E-01	3.409E-01	4.641E-01	3.656E-01	3.343E-01
NAF	4.062E-01	4.395E-01	5.183E-01	6.584E-01	5.091E-01
SAF	2.228E-01	2.912E-01	3.705E-01	2.523E-01	2.892E-01
MDE	8.592E-01	6.589E-01	6.410E-01	1.019E+00	7.956E-01
SEA	4.393E-01	5.008E-01	4.084E-01	4.276E-01	4.429E-01
CAS	6.683E-01	5.279E-01	5.034E-01	5.725E-01	5.749E-01
SAS	7.929E-01	4.776E-01	5.040E-01	9.765E-01	6.868E-01
EAS	2.091E-01	2.103E-01	2.461E-01	2.366E-01	2.237E-01
RBU	1.810E-01	2.166E-01	2.534E-01	1.984E-01	2.094E-01
PAN	4.016E-01	4.558E-01	3.519E-01	3.750E-01	3.922E-01
ROW	1.094E-02	1.275E-02	1.177E-02	1.112E-02	1.163E-02
VOL	8.075E-03	8.591E-03	7.508E-03	7.139E-03	7.832E-03
DMS	1.082E-02	1.179E-02	1.274E-02	1.182E-02	1.166E-02

Table S4. Contributions (mW m^{-2}) from tagged source regions/sectors (S, column) to regional mean direct radiative forcing of sulfate over the fourteen receptor regions and all globe (R, row).

DJF

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	-42.9	-17.7	-0.5	-2.0	-2.5	-0.5	-1.3	-1.2	-0.5	-1.3	-0.3	-0.8	1.5	-4.7	-5.3
CAM	-8.2	-150.4	-2.7	-0.4	-3.9	-1.4	-2.6	-1.6	0.0	-3.0	-0.5	-0.3	1.3	-9.4	-9.2
SAM	0.0	-5.1	-84.7	0.9	-3.3	-7.2	-1.6	-2.0	0.8	-2.5	0.2	0.0	-4.9	-8.4	-9.3
EUR	-0.9	-3.0	-1.2	-80.2	-24.8	-11.6	-50.7	-2.1	-26.5	-11.5	-11.1	-13.8	1.6	-4.4	-6.8
NAF	0.1	-3.7	-1.9	-4.2	-22.3	-17.5	-19.0	-1.5	-3.4	-6.1	-1.9	-1.0	1.6	-3.0	-3.8
SAF	-0.2	-10.0	-13.4	0.5	-16.3	-198.2	-10.3	-4.5	0.2	-9.5	-0.9	-0.1	-26.2	-20.8	-24.3
MDE	-3.4	-5.9	-4.5	-8.6	-46.8	-122.8	-326.0	-11.0	-48.8	-132.9	-35.9	-6.3	1.3	-14.7	-23.0
SEA	-0.9	-3.8	-2.0	0.2	-2.1	-2.0	-1.4	-106.4	0.1	-13.5	-10.1	-0.4	-3.2	-8.3	-8.0
CAS	0.0	-1.3	-0.4	0.6	0.1	-0.9	-2.5	-1.9	-28.5	-6.5	-13.1	-7.3	1.6	-1.0	-1.6
SAS	-19.2	-14.2	-2.9	-12.1	-11.9	-22.9	-19.3	-118.0	-14.1	-754.6	-98.9	-9.5	-0.6	-42.3	-45.7
EAS	-28.0	-19.0	-2.8	-13.0	-11.9	-4.8	-14.2	-333.5	-11.9	-63.2	-382.8	-15.1	-1.1	-45.4	-49.3
RBU	-0.2	-1.3	-0.4	-7.4	-0.6	-0.5	-5.0	-1.6	-19.5	-0.8	-13.6	-22.4	1.6	-1.3	-2.3
PAN	0.5	-1.4	-1.3	1.3	0.2	-0.2	1.2	-2.3	1.1	0.7	1.2	0.2	-72.4	-3.8	-4.0
ROW	-10.6	-71.7	-27.1	-25.9	-39.1	-76.1	-103.7	-105.2	-20.1	-108.6	-36.5	-10.2	-35.0	-44.3	-44.2
VOL	-8.2	-114.5	-65.2	-31.7	-61.4	-27.5	-58.7	-77.3	-27.2	-30.5	-23.9	-11.1	-8.4	-10.1	-16.7
DMS	-7.8	-57.1	-51.8	-8.0	-22.9	-42.0	-20.6	-35.4	-4.4	-29.0	-9.5	-2.9	-62.3	-118.6	-95.9

MAM

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	-110.8	-16.7	0.1	-22.1	-8.4	-0.9	-8.3	-2.1	-11.9	-7.1	-2.6	-8.5	1.9	-10.1	-12.4
CAM	-21.5	-161.7	-1.4	-5.2	-7.4	-1.9	-5.8	-2.6	-2.4	-7.1	0.2	-0.7	1.6	-11.5	-11.6
SAM	0.9	-5.5	-137.8	2.0	0.2	-5.4	1.0	-2.4	3.2	-1.1	2.9	1.8	-3.6	-9.2	-11.1
EUR	-7.5	-4.0	-0.3	-275.9	-47.6	-11.4	-91.3	-4.4	-131.2	-41.1	-32.0	-86.9	1.9	-10.7	-18.4
NAF	-0.6	-3.6	-0.5	-16.8	-33.4	-12.4	-28.5	-3.3	-14.4	-17.6	-3.9	-4.5	1.8	-3.7	-5.0
SAF	0.4	-5.4	-6.7	1.3	-6.0	-194.9	-3.0	-4.1	2.3	-5.1	2.1	1.4	-18.5	-17.3	-20.6
MDE	-26.1	-14.5	-1.0	-24.3	-29.1	-43.3	-346.8	-34.4	-169.7	-354.5	-94.3	-38.7	1.6	-21.7	-31.8
SEA	-1.4	-4.5	-1.5	0.4	-0.2	-1.5	-0.2	-174.0	1.6	-7.6	-16.0	0.6	-3.1	-8.9	-9.1
CAS	-6.5	-3.0	0.2	-2.7	0.9	0.1	-7.3	-3.5	-92.8	-38.2	-39.8	-27.2	1.9	-3.3	-5.6
SAS	-39.2	-35.7	-2.0	-28.4	-19.6	-36.4	-50.7	-228.9	-30.0	-758.8	-126.2	-18.6	-0.1	-47.3	-53.6
EAS	-108.2	-51.1	-1.9	-48.4	-21.0	-4.8	-24.4	-105.8	-39.7	-30.2	-446.0	-70.1	0.0	-58.4	-63.3
RBU	-6.6	-1.7	0.2	-48.9	-3.3	-0.6	-13.3	-2.5	-135.2	-10.4	-48.7	-142.3	1.9	-5.4	-11.3
PAN	1.5	-0.9	-0.3	2.7	1.8	0.3	2.4	-3.6	3.9	0.7	3.6	2.3	-61.8	-3.1	-3.0
ROW	-34.2	-83.0	-28.6	-80.5	-45.0	-46.3	-119.0	-130.5	-67.8	-237.0	-66.2	-53.3	-28.0	-53.4	-55.5
VOL	-22.7	-119.6	-74.1	-138.9	-105.9	-38.0	-116.9	-96.2	-109.0	-61.6	-47.6	-53.9	-15.7	-27.3	-36.6
DMS	-15.5	-50.1	-42.8	-40.9	-21.7	-40.5	-16.9	-39.5	-14.2	-31.6	-8.9	-16.4	-49.6	-92.6	-76.8

JJA

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	-301.1	-53.1	-0.4	-81.8	-30.0	-2.7	-25.4	-3.2	-53.4	-13.1	-15.4	-38.1	1.1	-20.9	-30.2
CAM	-42.1	-173.0	-7.1	-6.6	-2.2	-1.8	-2.1	-2.9	-4.1	-2.2	-1.3	-2.0	-0.5	-10.1	-11.4

SAM	0.7	-25.3	-166.8	1.0	2.4	-1.5	1.5	-2.4	1.6	-0.1	0.8	1.4	-1.7	-10.2	-12.8
EUR	-8.8	-10.4	-1.8	-433.3	-145.7	-32.8	-182.3	-6.1	-168.0	-43.1	-33.9	-134.7	0.4	-16.4	-30.3
NAF	-0.4	-7.0	-0.2	-22.2	-63.6	-12.4	-28.8	-3.4	-7.4	-7.3	-1.5	-4.0	1.1	-5.0	-6.6
SAF	0.4	-8.4	-4.6	0.5	-3.6	-220.3	-1.1	-3.2	1.2	-4.3	0.5	1.1	-6.3	-17.6	-21.5
MDE	-7.2	-12.3	-8.4	-26.6	-112.1	-112.7	-507.0	-23.6	-126.5	-155.3	-39.8	-31.3	-3.4	-21.3	-33.3
SEA	-1.1	-2.9	-2.5	-1.3	0.3	-2.1	-2.1	-124.5	-1.2	-6.3	-18.4	-0.6	-5.3	-7.0	-7.4
CAS	-7.6	-3.5	0.4	-9.0	-4.5	-5.0	-55.0	-5.8	-153.9	-112.7	-67.4	-43.6	1.0	-5.3	-10.3
SAS	-24.9	-15.0	-10.2	-38.7	-46.7	-20.4	-156.2	-65.7	-65.0	-730.1	-109.8	-26.8	-10.5	-22.2	-33.8
EAS	-144.4	-44.8	-21.2	-98.5	-56.8	-25.7	-108.2	-92.5	-102.6	-111.7	-910.8	-150.3	-28.6	-73.6	-93.8
RBU	-19.7	-4.2	0.4	-108.0	-23.2	-7.4	-84.7	-4.1	-344.2	-38.1	-84.5	-306.7	1.2	-10.8	-25.2
PAN	1.1	-1.4	1.1	1.3	2.6	1.5	1.6	-9.1	2.0	0.1	1.0	1.8	-39.8	-3.0	-2.7
ROW	-52.4	-85.8	-42.8	-111.0	-93.4	-57.8	-169.8	-91.2	-70.1	-115.4	-99.0	-83.5	-26.1	-52.9	-58.5
VOL	-17.4	-91.7	-95.4	-120.3	-375.9	-64.1	-85.1	-118.8	-53.1	-7.4	-50.6	-39.8	-34.4	-36.2	-49.4
DMS	-21.3	-39.4	-38.6	-54.4	-17.7	-27.5	-13.7	-35.4	-19.5	-38.2	-14.7	-20.8	-27.3	-68.4	-58.1

SON

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	-132.6	-43.4	-0.2	-25.3	-11.1	-1.2	-10.2	-2.8	-20.1	-7.9	-8.4	-10.8	1.7	-11.2	-14.7
CAM	-18.8	-153.4	-4.5	-3.9	-3.5	-1.6	-3.2	-3.0	-2.7	-4.8	-1.7	-0.8	0.2	-8.8	-9.3
SAM	0.8	-9.7	-176.8	0.8	0.4	-9.0	0.5	-2.8	1.8	-1.9	1.2	1.2	-7.1	-10.3	-13.4
EUR	-5.1	-5.3	-0.8	-211.7	-93.9	-24.1	-112.0	-3.7	-91.5	-32.6	-26.7	-48.4	1.6	-9.7	-17.1
NAF	-0.1	-3.3	-0.2	-15.4	-63.9	-18.2	-27.8	-2.7	-7.5	-10.4	-3.0	-1.5	1.9	-3.5	-5.5
SAF	0.6	-15.7	-28.6	0.5	-4.3	-205.3	-1.5	-4.2	1.6	-3.9	0.9	1.0	-34.5	-23.4	-26.6
MDE	-8.8	-9.5	-4.7	-25.4	-185.3	-141.3	-609.1	-10.0	-127.7	-212.0	-59.4	-16.3	-0.2	-18.8	-35.5
SEA	-1.1	-2.3	-2.3	-0.7	-0.8	-2.4	-2.8	-132.0	-0.1	-24.2	-9.6	0.1	-5.7	-7.9	-8.1
CAS	-4.0	-1.9	0.2	-1.9	-2.5	-4.7	-30.3	-4.4	-81.4	-75.5	-44.2	-19.3	1.8	-3.4	-6.2
SAS	-48.2	-19.6	-7.1	-39.8	-35.3	-40.8	-95.8	-68.5	-54.9	-1187.2	-109.3	-31.1	-6.8	-40.2	-52.7
EAS	-93.9	-28.3	-11.2	-52.7	-29.9	-14.8	-44.6	-327.8	-62.8	-132.9	-569.4	-61.6	-13.4	-54.7	-67.1
RBU	-4.2	-1.8	0.2	-39.8	-10.3	-3.4	-26.3	-3.3	-107.9	-14.0	-32.6	-84.3	1.9	-4.2	-8.4
PAN	1.0	-0.7	-0.5	1.0	1.4	0.7	1.2	-7.7	2.0	-1.3	1.5	1.3	-79.2	-4.3	-4.4
ROW	-27.0	-74.8	-45.2	-63.5	-105.5	-84.2	-192.2	-135.8	-51.9	-152.6	-79.4	-29.4	-36.3	-50.7	-55.8
VOL	-9.3	-70.0	-81.0	-91.7	-242.9	-59.1	-80.0	-133.1	-47.6	-20.8	-36.0	-18.2	-36.7	-25.5	-36.1
DMS	-17.8	-40.7	-44.5	-19.5	-17.8	-35.3	-16.5	-40.5	-11.7	-31.3	-11.2	-7.1	-42.0	-78.4	-65.3

ANN

S \ R	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA	CAS	SAS	EAS	RBU	PAN	ROW	TOT
NAM	-146.6	-32.6	-0.2	-32.8	-13.0	-1.3	-11.3	-2.3	-21.5	-7.3	-6.6	-14.5	1.6	-11.7	-15.6
CAM	-22.8	-159.4	-3.9	-4.0	-4.2	-1.7	-3.4	-2.5	-2.3	-4.3	-0.8	-0.9	0.7	-9.9	-10.4
SAM	0.6	-11.4	-142.0	1.2	0.0	-5.8	0.4	-2.4	1.9	-1.4	1.3	1.1	-4.4	-9.5	-11.7
EUR	-5.6	-5.6	-1.0	-250.0	-78.1	-20.0	-109.2	-4.1	-104.5	-32.1	-25.9	-70.9	1.4	-10.3	-18.1
NAF	-0.2	-4.3	-0.7	-14.7	-46.0	-15.2	-25.9	-2.7	-8.1	-10.4	-2.6	-2.7	1.6	-3.8	-5.3
SAF	0.3	-9.7	-13.2	0.7	-7.7	-205.6	-4.0	-4.0	1.3	-5.7	0.7	0.8	-21.4	-19.8	-23.3
MDE	-11.4	-10.5	-4.6	-21.3	-93.8	-105.6	-447.2	-19.7	-118.2	-213.4	-57.3	-23.2	-0.2	-19.1	-30.9
SEA	-1.1	-3.4	-2.1	-0.4	-0.7	-2.0	-1.7	-133.9	0.1	-12.9	-13.5	-0.1	-4.4	-8.0	-8.2
CAS	-4.5	-2.4	0.1	-3.2	-1.5	-2.6	-23.8	-3.9	-89.1	-58.3	-41.2	-24.4	1.6	-3.3	-5.9
SAS	-32.9	-21.2	-5.6	-29.8	-28.5	-30.2	-80.6	-119.6	-41.1	-857.8	-111.3	-21.5	-4.5	-38.1	-46.5

EAS	-93.7	-35.8	-9.3	-53.2	-30.0	-12.6	-47.9	-213.6	-54.4	-84.9	-577.5	-74.3	-10.9	-57.8	-68.2
RBU	-7.7	-2.2	0.1	-50.9	-9.4	-3.0	-32.3	-2.8	-151.8	-15.8	-44.9	-138.9	1.7	-5.4	-11.8
PAN	1.0	-1.1	-0.3	1.6	1.5	0.6	1.6	-5.6	2.2	0.0	1.8	1.4	-63.1	-3.5	-3.5
ROW	-31.0	-78.7	-36.0	-70.2	-71.0	-66.4	-146.4	-115.1	-52.5	-153.3	-70.1	-44.0	-31.5	-50.3	-53.5
VOL	-14.5	-98.0	-78.8	-95.8	-196.9	-47.4	-84.8	-107.6	-59.2	-30.1	-39.5	-30.8	-24.1	-24.9	-34.8
DMS	-15.6	-46.5	-44.5	-30.7	-20.0	-36.3	-17.0	-37.7	-12.5	-32.5	-11.1	-11.8	-45.4	-89.5	-74.1

Table S5. Direct and indirect radiative forcing of sulfate (mW m^{-2}) averaged over land and ocean of the Northern and Southern Hemisphere from emissions in the sixteen tagged regions/sectors.

	Direct radiative forcing (mW m^{-2})			
S \ R	Land-NH	Ocean-NH	Land-SH	Ocean-SH
NAM	-35.5	-28.4	0.0	-0.7
CAM	-10.2	-22.6	-1.7	-2.1
SAM	-0.4	-3.0	-47.9	-16.5
EUR	-50.2	-28.2	-0.7	-1.2
NAF	-12.2	-8.3	-0.5	-1.0
SAF	-9.5	-9.5	-72.0	-30.8
MDE	-82.9	-44.8	-6.1	-4.8
SEA	-6.0	-12.4	-2.7	-6.5
CAS	-20.3	-7.2	0.1	-0.6
SAS	-89.7	-83.0	-5.7	-8.4
EAS	-122.1	-128.5	-8.1	-10.3
RBU	-44.0	-13.4	0.1	-0.6
PAN	1.1	-0.4	-10.0	-6.6
ROW	-62.6	-91.3	-23.0	-25.0
VOL	-57.0	-59.2	-40.8	-5.7
DMS	-17.6	-88.0	-29.6	-91.8
	Indirect radiative forcing (mW m^{-2})			
S \ R	Land-NH	Ocean-NH	Land-SH	Ocean-SH
NAM	-33.3	-25.9	0.0	-0.1
CAM	-3.3	-13.6	-0.3	-1.2
SAM	0.1	-4.3	-39.2	-27.6
EUR	-4.0	-10.6	-0.1	-0.3
NAF	0.8	-2.4	-0.1	-0.1
SAF	-1.5	-2.4	-15.7	-31.3
MDE	7.0	-4.1	-0.8	-1.8
SEA	0.2	-5.5	-0.3	-5.1
CAS	-4.7	-3.2	0.0	-0.1
SAS	0.4	-8.5	-0.4	-4.4
EAS	-15.2	-70.7	-0.6	-3.2
RBU	-18.4	-12.0	0.0	-0.1
PAN	0.0	-0.1	-24.0	-16.9
ROW	-6.7	-61.9	-15.9	-42.7
VOL	-1.3	-65.0	-20.9	-76.7
DMS	-2.4	-113.7	-26.5	-445.2

Table S6. Seasonal and annual sulfate direct and indirect radiative forcing efficiency (mW m^{-2} (Tg S yr^{-1})$^{-1}$) for the sixteen tagged source regions/sectors in this study and from Stjern et al. (2016). The radiative efficiency is defined as the sulfate radiative forcing divided by the corresponding scaled annual sulfur emission (seasonal emission multiplied by 4).

Direct radiative forcing efficiency						
	DJF	MAM	JJA	SON	ANN	Stjern et al. (2016)
NAM	-1.596E+00	-4.423E+00	-8.607E+00	-5.203E+00	-5.014E+00	-4.500E+00
CAM	-6.639E+00	-7.896E+00	-7.614E+00	-6.559E+00	-7.205E+00	
SAM	-7.090E+00	-7.568E+00	-6.759E+00	-7.702E+00	-7.287E+00	
EUR	-1.578E+00	-5.576E+00	-1.173E+01	-5.455E+00	-5.448E+00	-5.600E+00
NAF	-6.330E+00	-8.222E+00	-1.076E+01	-9.086E+00	-8.614E+00	
SAF	-9.320E+00	-8.754E+00	-6.636E+00	-1.000E+01	-8.577E+00	
MDE	-6.852E+00	-9.455E+00	-9.900E+00	-1.062E+01	-9.212E+00	-1.030E+01
SEA	-5.650E+00	-6.117E+00	-5.234E+00	-5.784E+00	-5.699E+00	
CAS	-1.290E+00	-5.143E+00	-1.120E+01	-5.937E+00	-5.503E+00	
SAS	-7.167E+00	-8.241E+00	-5.271E+00	-8.261E+00	-7.251E+00	-7.900E+00
EAS	-2.445E+00	-3.589E+00	-5.743E+00	-3.904E+00	-3.826E+00	-4.400E+00
RBU	-6.330E-01	-3.793E+00	-9.750E+00	-3.034E+00	-3.962E+00	-3.600E+00
PAN	-7.974E+00	-5.600E+00	-4.226E+00	-6.795E+00	-6.039E+00	
ROW	-3.895E+00	-5.004E+00	-5.337E+00	-4.957E+00	-4.790E+00	
VOL	-3.556E+00	-4.372E+00	-4.604E+00	-4.440E+00	-2.759E+00	
DMS	-1.844E+00	-2.910E+00	-4.133E+00	-3.559E+00	-4.065E+00	
Indirect radiative forcing efficiency						
	DJF	MAM	JJA	SON	ANN	
NAM	-3.556E+00	-2.946E+01	-3.971E+01	-1.843E+01	-2.276E+01	
CAM	-1.573E+01	-2.137E+01	-2.196E+01	-1.837E+01	-1.978E+01	
SAM	-5.435E+01	-4.943E+01	-1.540E+01	-5.763E+01	-5.027E+01	
EUR	1.380E+00	-1.167E+01	-1.446E+01	-2.496E+00	-6.587E+00	
NAF	-2.094E+00	-9.185E+00	-5.883E+00	-3.237E+00	-6.233E+00	
SAF	-1.924E+01	-1.928E+01	-1.540E+01	-4.440E+01	-2.866E+01	
MDE	-2.049E+00	-5.580E+00	-2.128E+00	3.821E+00	-1.689E+00	
SEA	-8.144E+00	-1.266E+01	-1.973E+01	-1.556E+01	-1.415E+01	
CAS	2.357E+00	-9.993E+00	-1.281E+01	-4.329E+00	-8.724E+00	
SAS	-3.351E+00	-6.880E+00	-3.670E+00	6.634E-02	-3.688E+00	
EAS	-1.542E+00	-8.715E+00	-1.303E+01	-4.603E+00	-7.842E+00	
RBU	4.934E+00	-1.204E+01	-3.876E+01	-3.135E+00	-1.181E+01	
PAN	-9.605E+01	-6.219E+01	-6.330E+01	-7.505E+01	-7.725E+01	
ROW	-1.209E+01	-1.957E+01	-2.711E+01	-1.586E+01	-1.860E+01	
VOL	-2.349E+01	-1.851E+01	-2.141E+01	-2.244E+01	-2.246E+01	
DMS	-9.346E+01	-4.747E+01	-4.006E+01	-7.307E+01	-6.317E+01	

Table S7. Seasonal and annual global burden efficiency of sulfate (unit: mg m^{-3} (Tg S yr^{-1})$^{-1}$) of the sixteen tagged source regions/sectors. The efficiency of a source region is defined as the source region's global column burden of sulfate divided by the corresponding sulfur emissions from that region (seasonal emissions multiplied by 4).

	DJF	MAM	JJA	SON	ANN
NAM	1.580E-02	3.497E-02	6.675E-02	4.154E-02	4.016E-02
CAM	4.198E-02	5.527E-02	5.873E-02	5.039E-02	5.190E-02
SAM	5.665E-02	5.814E-02	5.652E-02	6.983E-02	6.071E-02
EUR	2.260E-02	5.558E-02	1.121E-01	5.829E-02	5.651E-02
NAF	6.690E-02	9.899E-02	1.250E-01	1.076E-01	9.982E-02
SAF	7.737E-02	7.360E-02	6.845E-02	9.397E-02	7.805E-02
MDE	7.338E-02	1.093E-01	1.191E-01	1.228E-01	1.062E-01
SEA	4.661E-02	5.195E-02	4.290E-02	4.773E-02	4.736E-02
CAS	2.132E-02	5.776E-02	1.082E-01	6.499E-02	5.965E-02
SAS	7.003E-02	8.190E-02	5.644E-02	8.355E-02	7.317E-02
EAS	2.997E-02	4.004E-02	5.510E-02	4.094E-02	4.085E-02
RBU	1.324E-02	3.899E-02	8.126E-02	3.210E-02	3.882E-02
PAN	5.377E-02	4.213E-02	2.894E-02	4.985E-02	4.300E-02
ROW	3.241E-02	4.091E-02	4.395E-02	4.172E-02	3.969E-02
VOL	2.959E-02	3.575E-02	3.791E-02	3.737E-02	3.517E-02
DMS	2.260E-02	2.635E-02	2.704E-02	2.608E-02	2.520E-02

Table S8. Annual sulfate incremental indirect radiative forcing calculated based on simulations with and without 20%reduction in sulfur emissions globally and sulfate indirect radiative forcing (W m^{-2}) calculated based on simulation between present-day and preindustrial conditions, as well as these forcing efficiencies (mW m^{-2} (Tg S yr^{-1})$^{-1}$) for the sixteen tagged source regions/sectors.

	Forcing							
	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA
Incremental IRF	-0.01	-0.01	-0.02	-0.01	0.00	-0.02	0.00	0.00
IRF (PD–PI)	-0.08	-0.04	-0.07	-0.03	-0.01	-0.06	0.01	-0.02
	CAS	SAS	EAS	RBU	PAN	ROW	VOL	DMS
Incremental IRF	0.00	0.00	-0.03	-0.01	-0.01	-0.04	-0.06	-0.23
IRF (PD–PI)	-0.01	0.00	-0.12	-0.06	-0.05	-0.20		
	Efficiency							
	NAM	CAM	SAM	EUR	NAF	SAF	MDE	SEA
Incremental IRF efficiency	-22.8	-19.8	-50.3	-6.6	-6.2	-28.7	-1.7	-14.1
IRF efficiency	-26.3	-25.0	-44.7	-9.5	-7.9	-22.4	3.5	-11.9
	CAS	SAS	EAS	RBU	PAN	ROW	VOL	DMS
Incremental IRF efficiency	-8.7	-3.7	-7.8	-11.8	-77.3	-18.6	-22.5	-63.2
IRF efficiency	-11.5	-0.3	-6.6	-18.7	-86.6	-18.1		

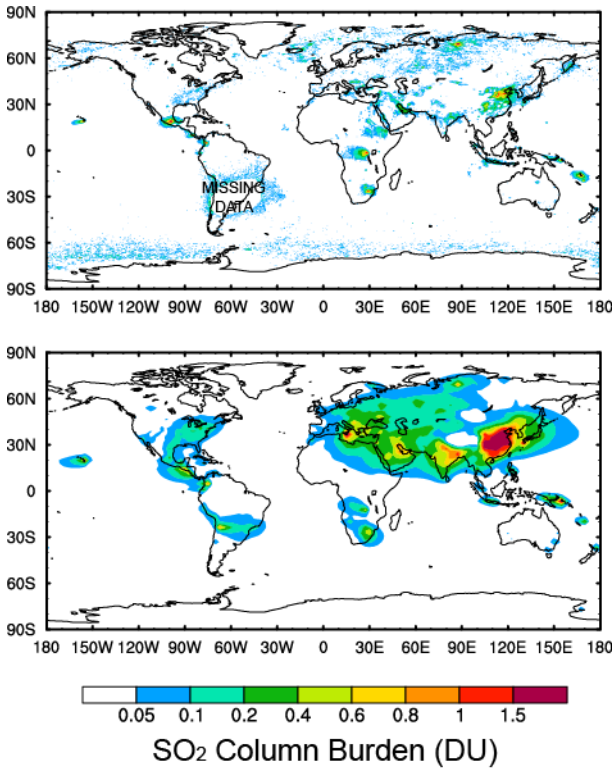

Figure S1. Spatial distribution of annual mean column burden of SO_2 (units: DU) derived from Ozone Monitoring Instrument (OMI) measurements (top panel) and model (bottom panel) over years of 2010–2014.

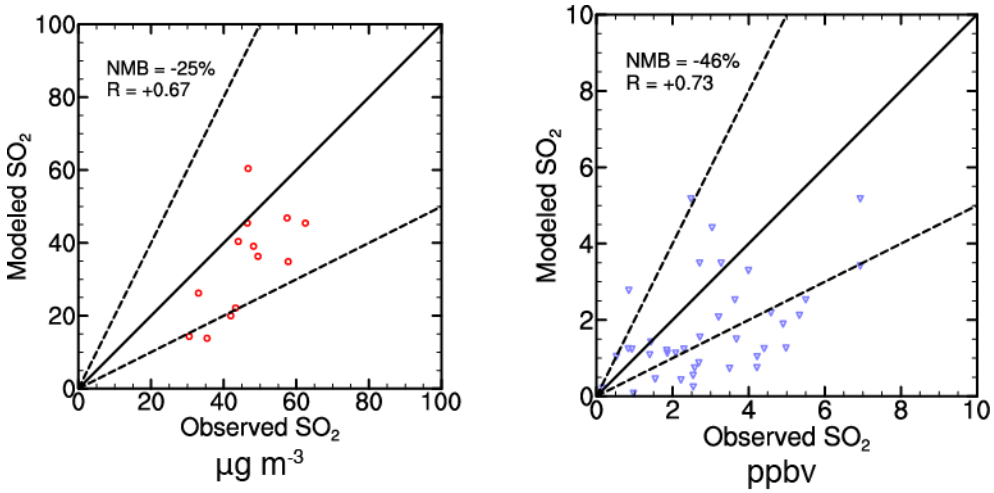

Figure S2. Scatter plot between the simulated and observed annual mean near-surface SO_2 concentrations over (a) China and (b) part of East Asia and Southeast Asia (EANET sites). Observed SO_2 surface Concentrations are over years 2000–2012 in China and 2010–2014 for EANET sites, and simulated values are over years 2010–2014.

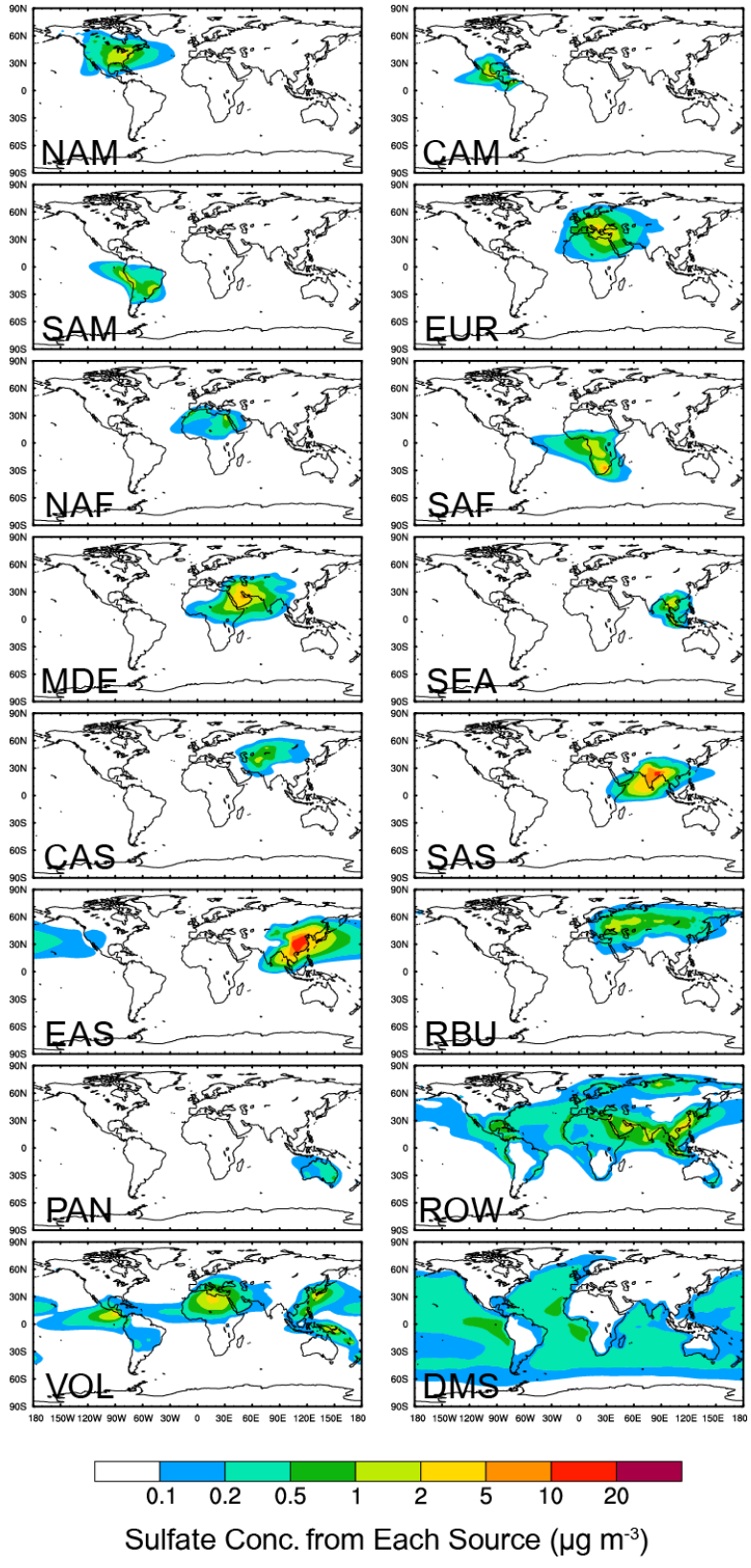

Figure S3. Spatial distribution of contributions to annual mean near-surface sulfate concentrations (unit: μg m^{-3}) from each of the tagged source region/sector.

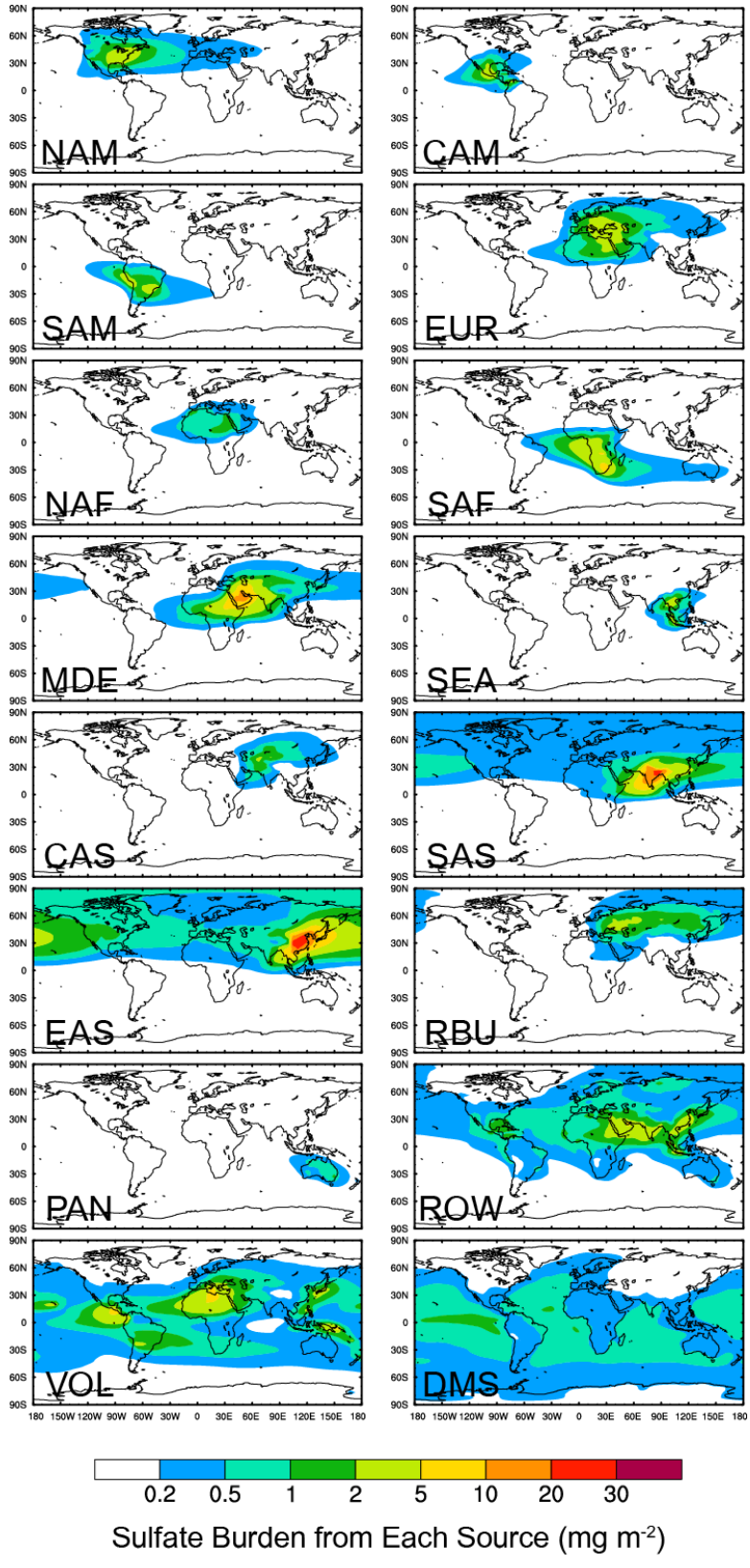

Figure S4. Spatial distribution of contributions to annual mean column burden of sulfate (unit: mg m^{-2}) from each of the tagged source region/sector.

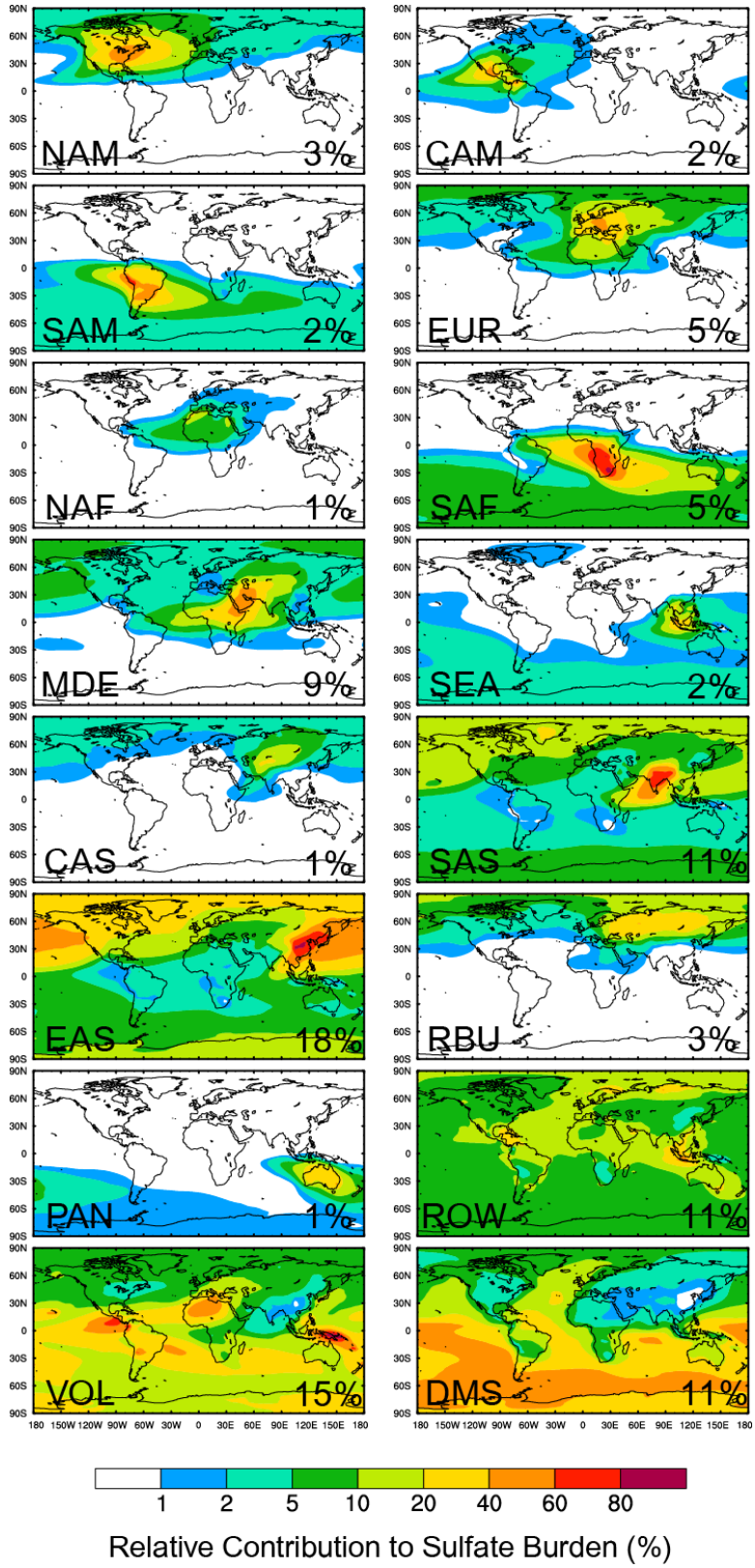

Figure S5. Spatial distribution of relative contributions (%) to annual mean column burden of sulfate from each of the tagged source region/sector. Relative contributions to global averaged sulfate from individual source regions/sectors is shown at the bottom right of each panel.

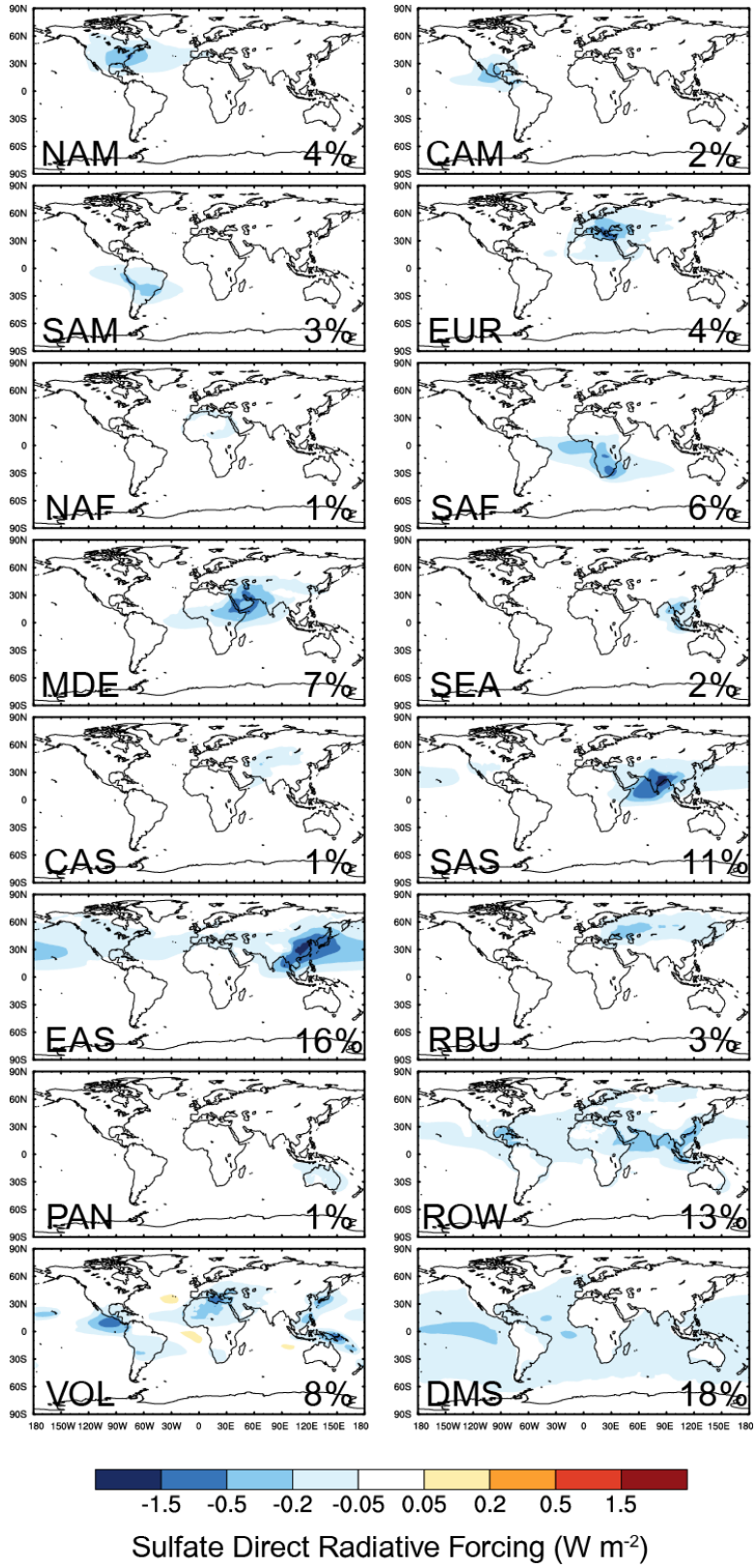

Figure S6. Spatial distribution of contributions to annual mean direct radiative forcing of sulfate (unit: W m^{-2}) from each of the tagged source region/sector. Relative contributions to global averaged direct radiative forcing of sulfate from individual source regions/sectors is shown at the bottom right of each panel.

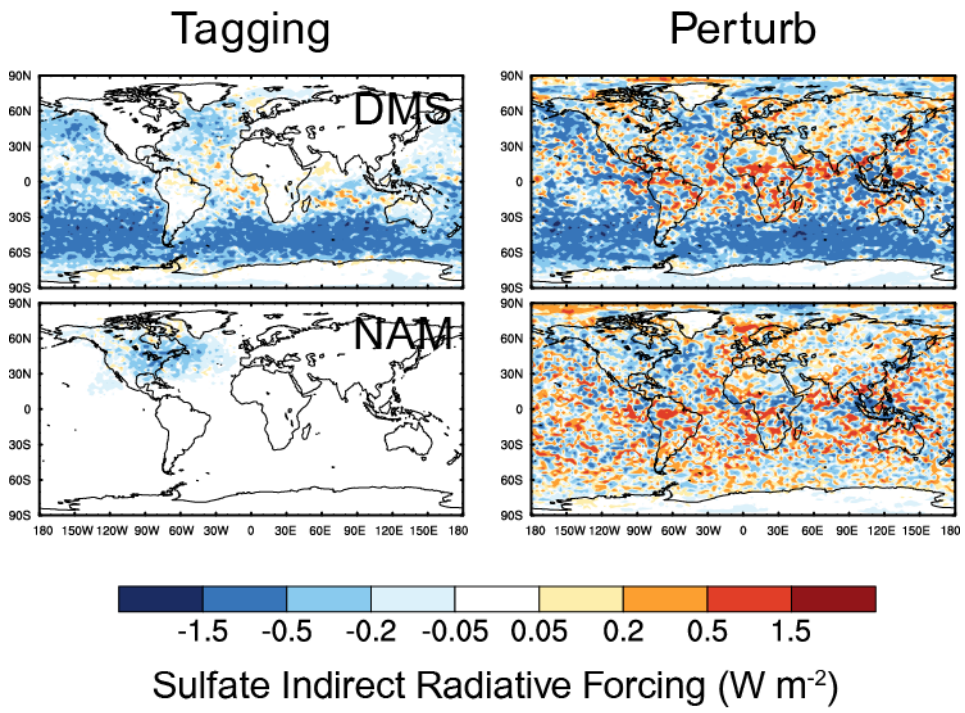

Figure S7. Spatial distribution of responses of annual mean IRF of sulfate (W m^{-2}) to a 20% reduction in sulfur emissions from the decomposition using sulfur tagging method (left panels) and simple 20% regional/source perturbation (right) for source from DMS (top panels) and North America (bottom panels).

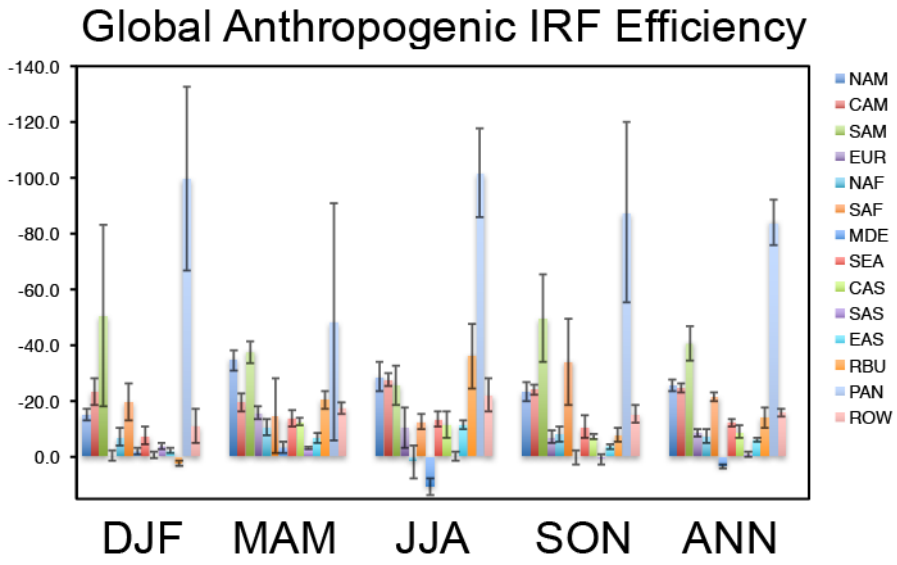

Figure S8. Seasonal and annual mean global anthropogenic sulfate indirect radiative forcing efficiency (mW m^{-2} (Tg S yr^{-1})$^{-1}$) of the fourteen tagged source regions calculated based on present-day and preindustrial condition simulations.