Supplementary Materials: Changes in the aerosol direct radiative forcing from 2001 to 2015: observational constraints and regional mechanisms

F. Paulot, D. Paynter, P. Ginoux, V. Naik, L. W. Horowitz

Table S1: Observation-based and and simulated estimates of the decadal trend in SDRECS ($\mathrm{W\,m^{-2}\,dec^{-1}}$) in selected region from 2001 to 2015[a]

	-Rsutcs		$SRECS_{CS}$		$SRECS_{CE}$		$SRECS_{M}$		$SRECS_{AM3}$	
Eastern US	*	*	1.8	[1.2 2.1]	1.4	[1.0 1.7]	0.9	[0.6 1.4]	0.8	[0.6 0.9]
Western Europe	*	*	1.4	[1.2 1.6]	1.0	[0.7 1.1]	0.7	[0.4 0.8]	0.6	[0.3 0.8]
India	0.5	[0.2 0.7]	-1.9	[-2.2 -1.2]	-1.5	[-1.9 -1.2]	-1.0	[-1.3 -0.6]	-2.4	[-2.7 -2.2]
Eastern China	-0.8	[-1.4 -0.4]	*	*	*	*	*	*	-1.3	[-1.7 -0.9]

[a] The trend is estimated using the Theil-Sen method. Bootstrap estimates of the 95% confidence interval are indicated in bracket. * denote non significant monotonous change at p=0.05

Table S2: Observation-based estimates and simulated decadal trends in surface broadband albedo for selected regions and seasons from 2002 to 2015 over India[a]

	DJF	MAM
CS	-9.6(-3)[0.129]	-8.7(-3)[0.128]
CE	-1.3(-2)[0.135]	-9.9(-3)[0.131]
MODIS	-6.1(-3)[0.158]	-7.5(-3)[0.163]
AM3	-2.6(-3)[0.166]	* [0.151]

[a]The average over the period 2002–2015 is shown in bracket (2003-2015 for AQUA). Trend is estimated using the Theil-Sen method. * denotes non significant monotonous change at p=0.05. CS, CE, and M refer to CERES-SYN, CERES-EBAF, and MODIS based estimates, respectively

Table S3: Aerosol radiative forcing under all-sky and clear-sky conditions for 2001 relative to 1850 [a]

	All-Sky		Clear-Sky	
Anthropogenic dust	-0.01	[-0.05[c]]	-0.09	[-0.07[c]]
Organic Carbon	-0.06	[-0.09[b],-0.06[c]]	-0.10	[-0.08[c]]
Sulfate	-0.43	[-0.32± 0.15[b],-0.28[c]]	-0.73	[-0.38[c]]
Nitrate	-0.05	[-0.08±0.04[b],-0.071[c]]	-0.08	[-0.10[c]]
Black Carbon	0.45	[0.18±0.07[b],0.08[c]]	0.36	[0.06[c]]
Total	-0.09	[-0.27±0.15[b],-0.36[c]]	-0.64	[-0.67±0.18[b],-0.57[c]]

[a] in $\mathrm{W\,m^{-2}}$

[b] Brackets denote estimates from the AEROCOM project for year 2000 (Myhre et al., 2013)

[c] Heald et al. (2014) for 2010

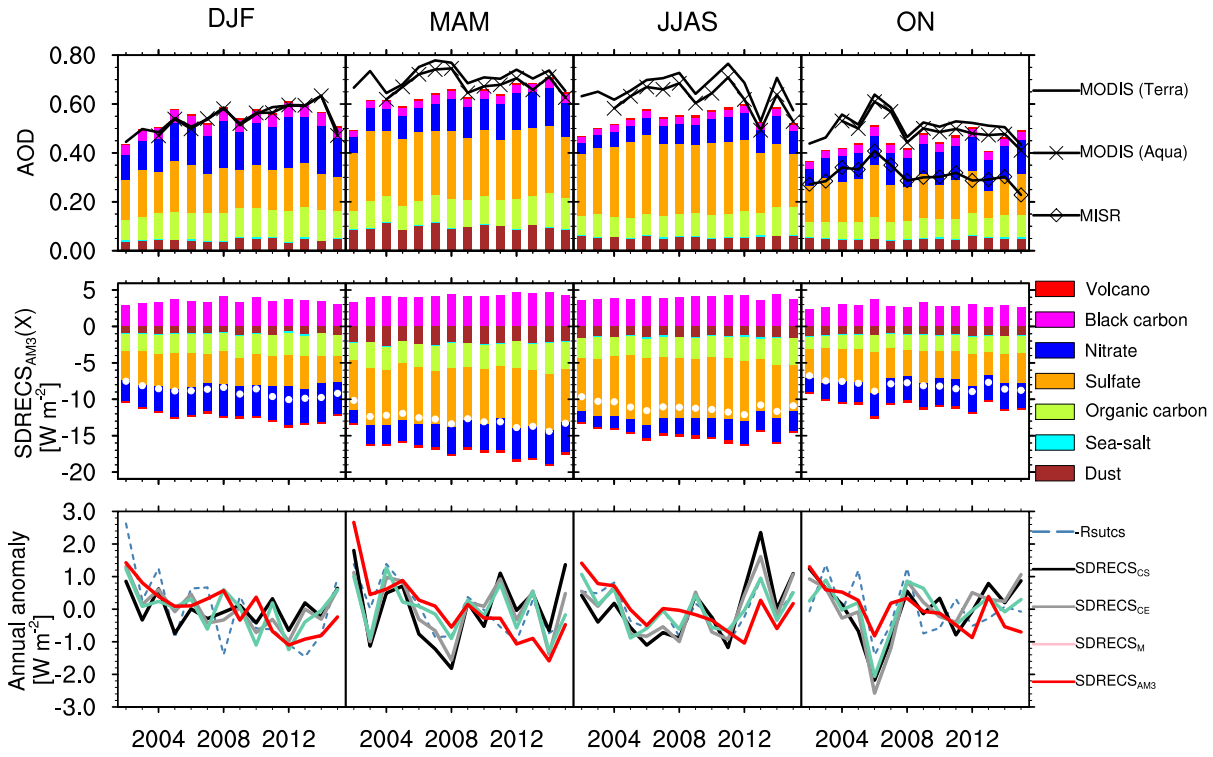

Figure S1: same as Fig. 8 but for China with revised anthropogenic emissions (see text)

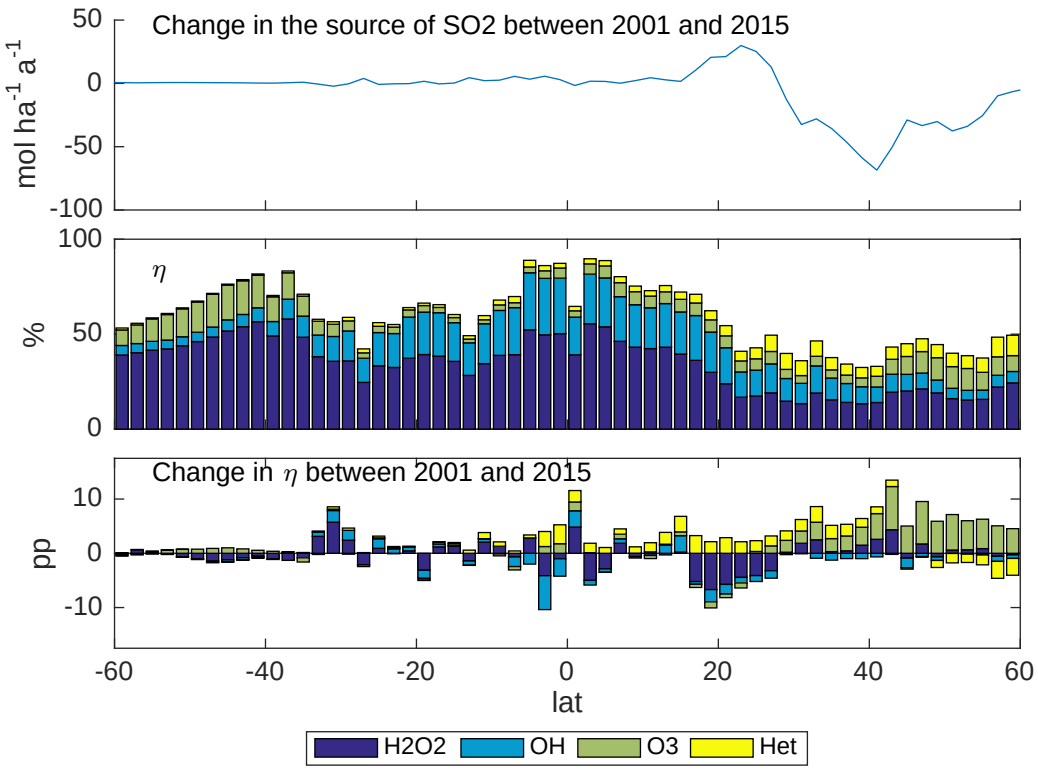

Figure S2: Meridional change in the source of SO_2 (top), conversion efficiency (η) between SO_2 and SO_4^{2-}, and change in η from 2001 to 2015

References

Heald, C. L., Ridley, D. A., Kroll, J. H., Barrett, S. R. H., Cady-Pereira, K. E., Alvarado, M. J., and Holmes, C. D.: Contrasting the direct radiative effect and direct radiative forcing of aerosols, Atmos. Chem. Phys., 14, 5513–5527, doi:10.5194/acp-14-5513-2014, URL http://www.atmos-chem-phys.net/14/5513/2014/, 2014.

Myhre, G., Samset, B. H., Schulz, M., Balkanski, Y., Bauer, S., Berntsen, T. K., Bian, H., Bellouin, N., Chin, M., Diehl, T., Easter, R. C., Feichter, J., Ghan, S. J., Hauglustaine, D., Iversen, T., Kinne, S., Kirkevåg, A., Lamarque, J.-F., Lin, G., Liu, X., Lund, M. T., Luo, G., Ma, X., van Noije, T., Penner, J. E., Rasch, P. J., Ruiz, A., Seland, Ø., Skeie, R. B., Stier, P., Takemura, T., Tsigaridis, K., Wang, P., Wang, Z., Xu, L., Yu, H., Yu, F., Yoon, J.-H., Zhang, K., Zhang, H., and Zhou, C.: Radiative forcing of the direct aerosol effect from AeroCom Phase II simulations, Atmos. Chem. Phys., 13, 1853–1877, 2013.