Supplementary Material for

Sources and sinks driving sulphuric acid concentrations in contrasting environments: implications on proxy calculations

by Lubna Dada *et al.*

Table S 1 Summary of measurement locations and instrumentation used.

Location	Type	Measurement Period	Particle size distribution instrument	Trace Gases	Radiation
Hyytiälä, Finland	Boreal	August 18, 2016 to April 16, 2017 and March 8, 2018 to February 28, 2019	Twin - DMPS	SO_2 and O_3 are monitored using two Thermo Environmental Instruments (models 43i-TLE, 49i, respectively).	UVB radiation was measured with Solar SL 501A pyranometer (280 - 320 nm). Global radiation was measured with Middleton solar SK08 pyranometer until August 24, 2017 and after that with Middleton solar EQ08-S pyranometer.
Agia Marina, Cyprus	Rural background	February 22 and March 3, 2018	2-20 nm using Airel NAIS and 20-800 nm using TSI SMPS	SO_2 and O_3 are monitored using Ecotech Instruments (9850 and 9810, respectively)	Campbell Scientific weather station
Budapest, Hungary	Urban	March 21 and May 1, 2018	6-1000 nm using TSI SMPS	UV fluorescence (Ysselbach 43C)	Global radiation was measured by an SMP3 pyranometer (Kipp and Zonnen, The Netherlands)
Beijing, China	MegaCity	December 1, 2018 – January 31, 2019	3 – 800 nm PSD system	SO_2 and O_3 are monitored using two Thermo Environmental Instruments (models 43i-TLE, 49i, respectively).	The UVB (280–315 nm) radiation intensity was measured at the rooftop of the 5-floor building (UV-SB-T, KIPP&ZONEN, Netherlands)

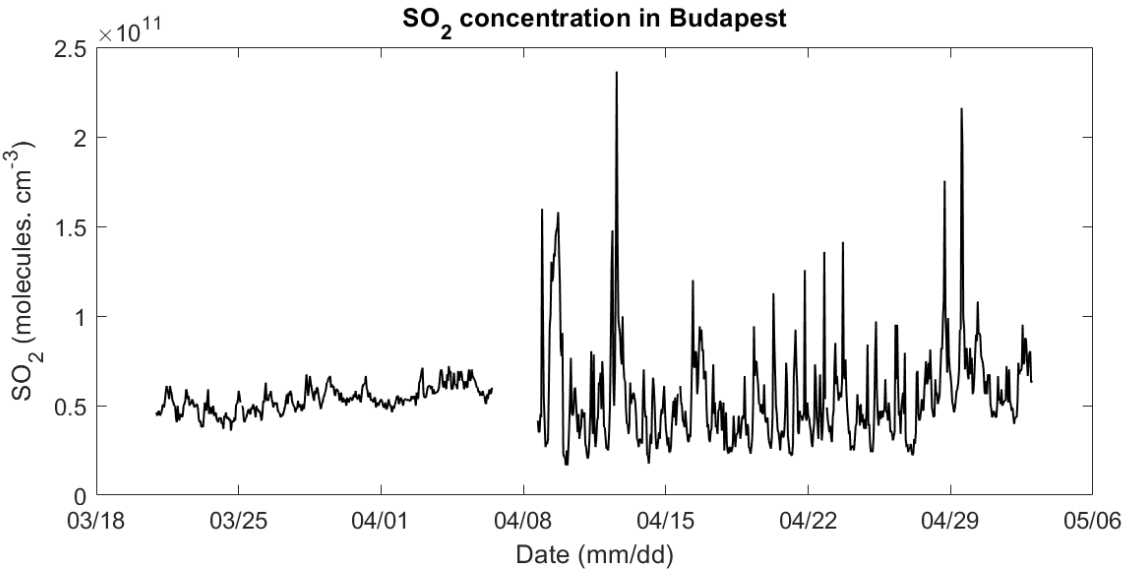

Figure S 1 SO_2 concentration in Budapest showing the change in concentration due to changes in meteorology mid-campaign.

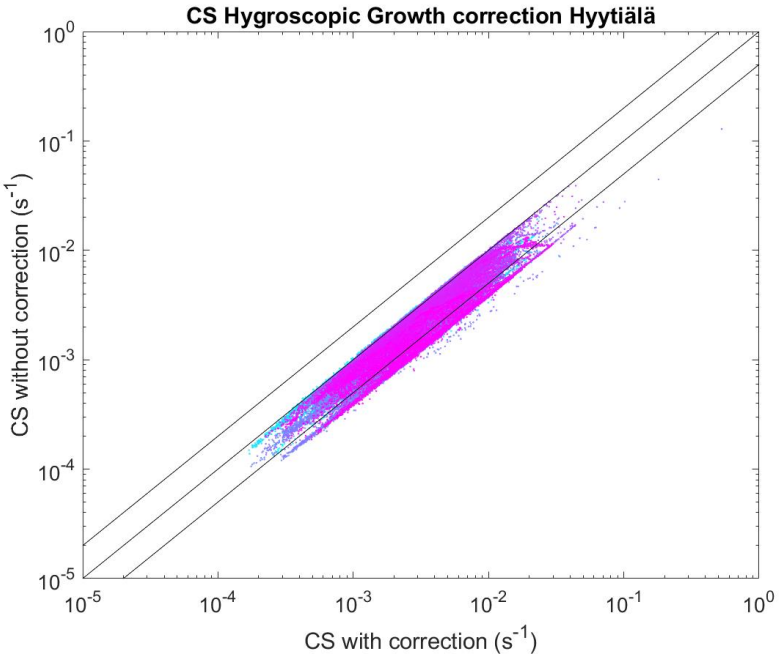

Figure S 2 Effect of hygroscopic growth correction on condensation sink calculation in the boreal forest.

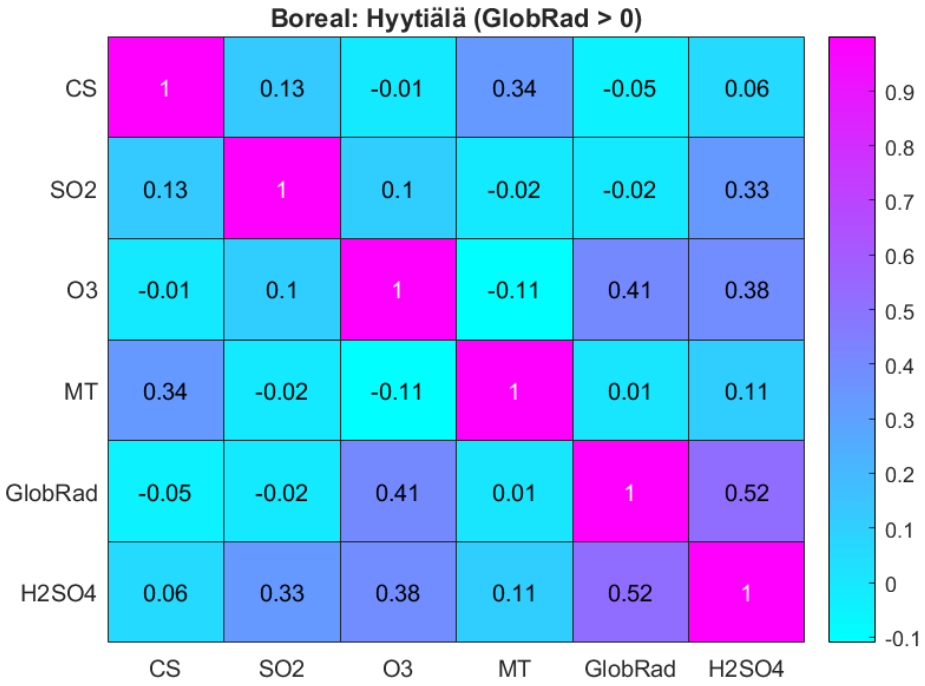

Figure S 3 Pearson's correlation coefficients matrix between variables involved in H_2SO_4 formation and loss at the Hyytiälä station (Global Radiation > 0 W/m^2). CS represents condensation sink in s^{-1}. SO_2, O_3 and MT (monoterpenes) in molecules/cm^{-3}. GlobRad is global radiation in W/m^2. H_2SO_4 is measured sulphuric acid in molecules/cm^{-3}.

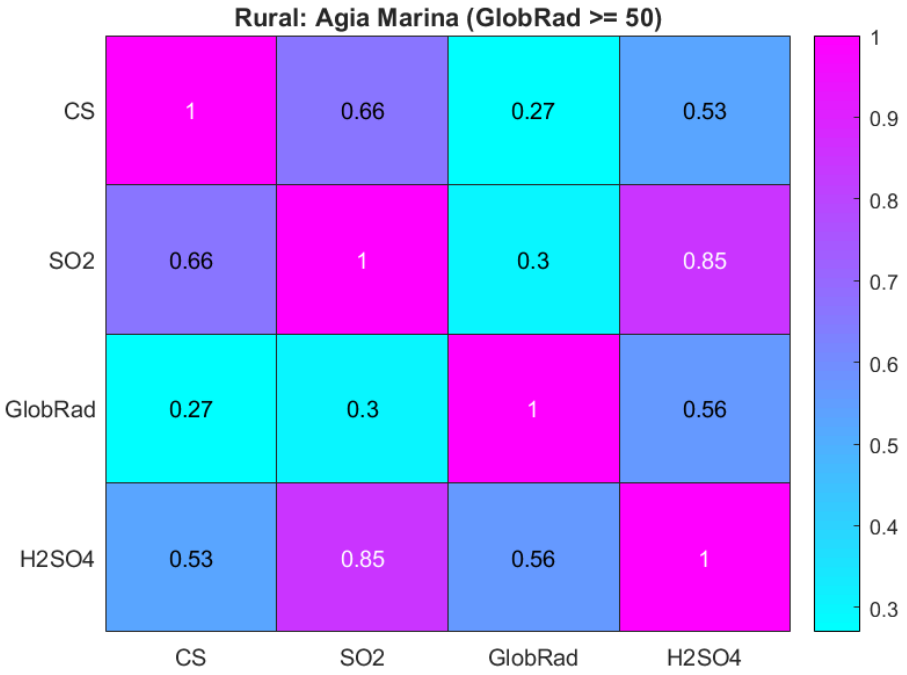

Figure S 4 Pearson's correlation coefficients matrix of variables involved in H_2SO_4 formation and loss at the Agia Marina station (Global Radiation > 50 W/m^2). CS represents condensation sink in s^{-1}. SO_2 is in molecules/cm^{-3}. GlobRad is global radiation in W/m^2. H_2SO_4 is measured sulphuric acid in molecules/cm^{-3}.

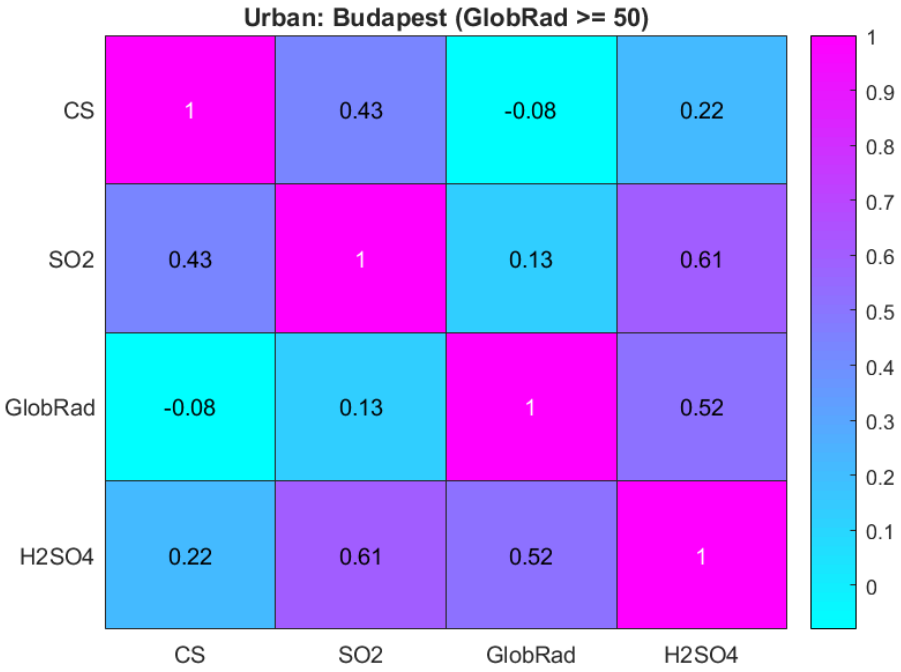

Figure S 5 Pearson's correlation coefficients matrix of variables involved in H_2SO_4 formation and loss at the Budapest station (Global Radiation > 50 W/m^2). CS represents condensation sink in s^{-1}. SO_2 in molecules/cm^{-3}. GlobRad is global radiation in W/m^2. H_2SO_4 is measured sulphuric acid in molecules/cm^{-3}.

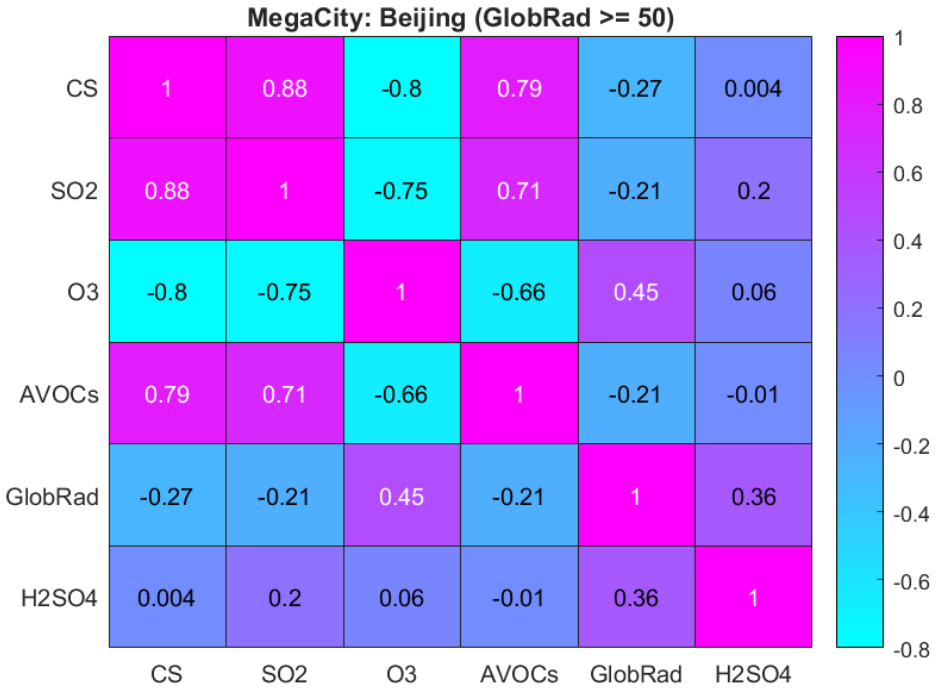

Figure S 6 Pearson's correlation coefficients matrix between variables involved in H_2SO_4 formation and loss at the Beijing station during daytime (Global Radiation > 50 W/m^2). CS represents condensation sink in s^{-1}. SO_2, O_3 and AVOCs (Anthropogenic volatile organic compounds) in molecules/cm^{-3}. GlobRad is global radiation in W/m^2. H_2SO_4 is measured sulphuric acid in molecules/cm^{-3}.

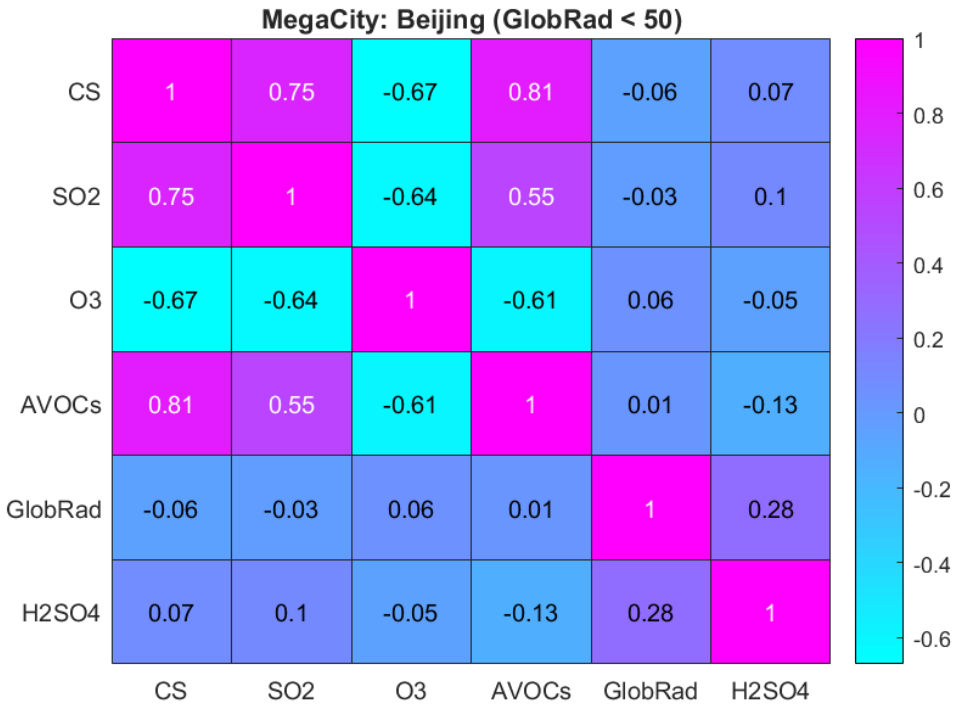

Figure S 7 Pearson's correlation coefficients matrix between variables involved in H_2SO_4 formation and loss at the Beijing station during nighttime (Global Radiation < 50 W/m^2). CS represents condensation sink in s^{-1}. SO_2, O_3 and AVOCs (Anthropogenic volatile organic compounds) in molecules/cm^{-3}. GlobRad is global radiation in W/m^2. H_2SO_4 is measured sulphuric acid in molecules/cm^{-3}.

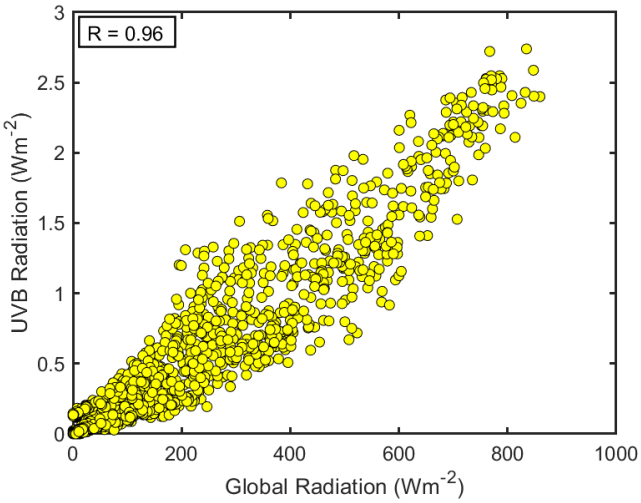

Figure S 8 Comparison between Global radiation and UVB in Hyytiälä. Hourly medians are shown. The total number of data points in the plot is 2306.

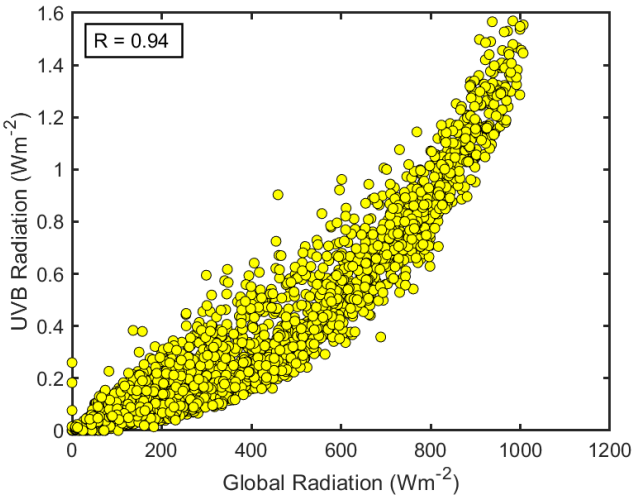

Figure S 9 Comparison between Global radiation and UVB in Beijing. Hourly medians are shown. The total number of data points in the plot is 7106.

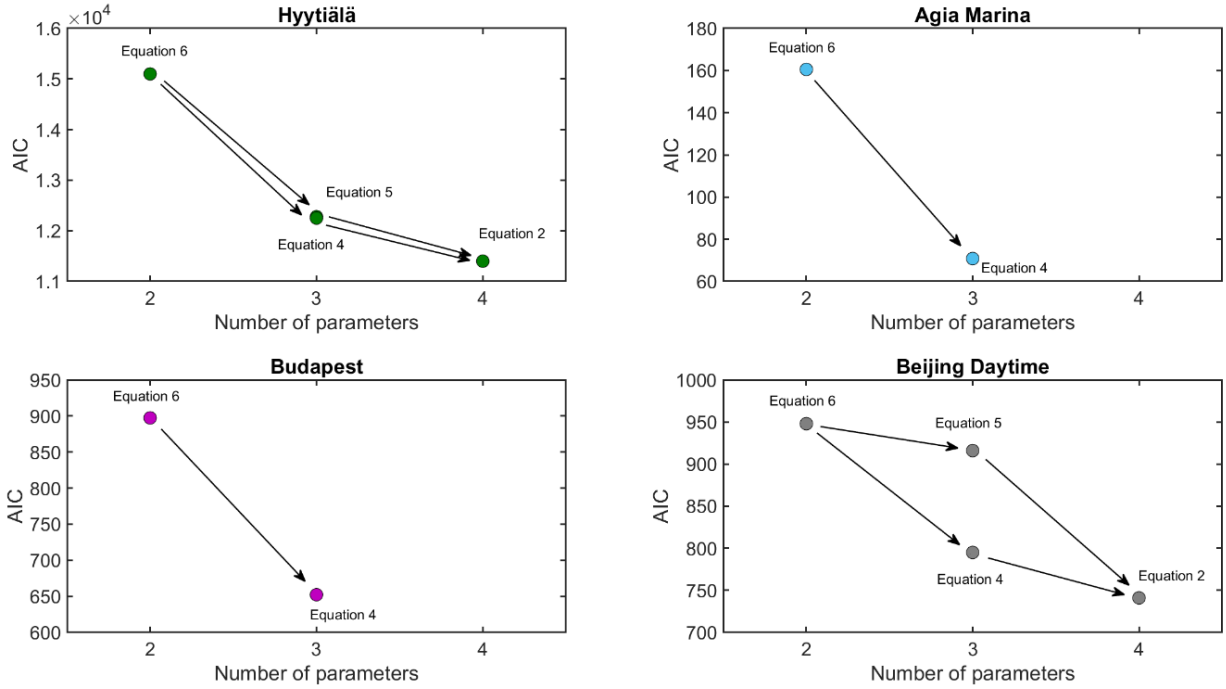

Figure S 10 Evaluation of the goodness of the fit using the Akaike information criterion (AIC) (McElreath, 2018). Number of parameters refers to the number of variables in each equation used. For example, Equation 2 uses four parameters which are the two sources (Radiation and sCI) and the two sinks (CS and cluster formation).

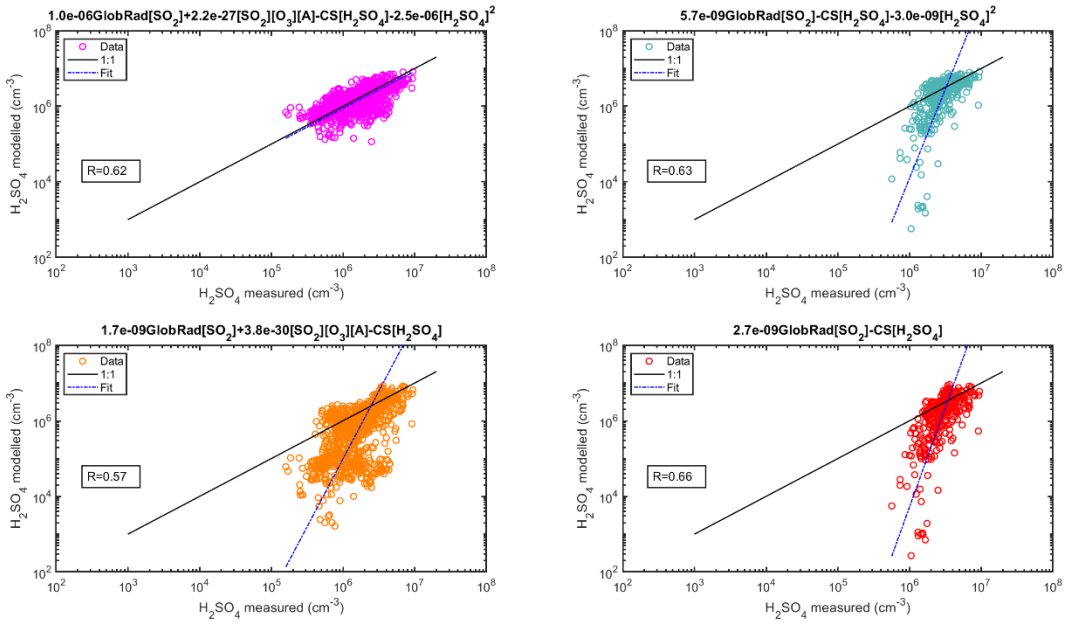

Figure S 11 Sulphuric acid proxy concentration as a function of measured sulphuric acid. observation at BUCT station, Beijing, China for day and nighttime combined. The observed concentrations are measured 2018-2019 using CI-APi-ToF and are 1-hour medians resulting in a total of 902 data points. In (A), the full Equation 2 is used, in (B) the equation without the Stabilized Criegee Intermediates source (Equation 4), in (C) the equation without the cluster sink term (Equation 5) and in (D) the equation without both the Crigee Intermediates source and the cluster sink term (Equation 6).

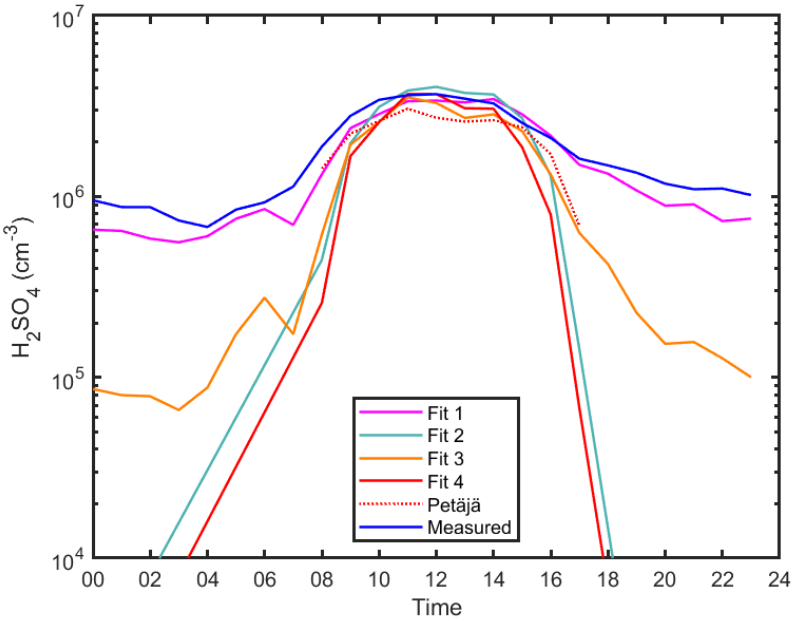

Figure S 12 The diurnal variation of sulphuric acid proxy concentrations using different fits and observed concentrations at Beijing China. Median values are shown. Fits 1,2, 3 and 4 corresponds to the Equations 2, 4, 5, and 6, respectively. Petäjä fit shown is applied using the coefficients reported in Petäjä et al. 2009.

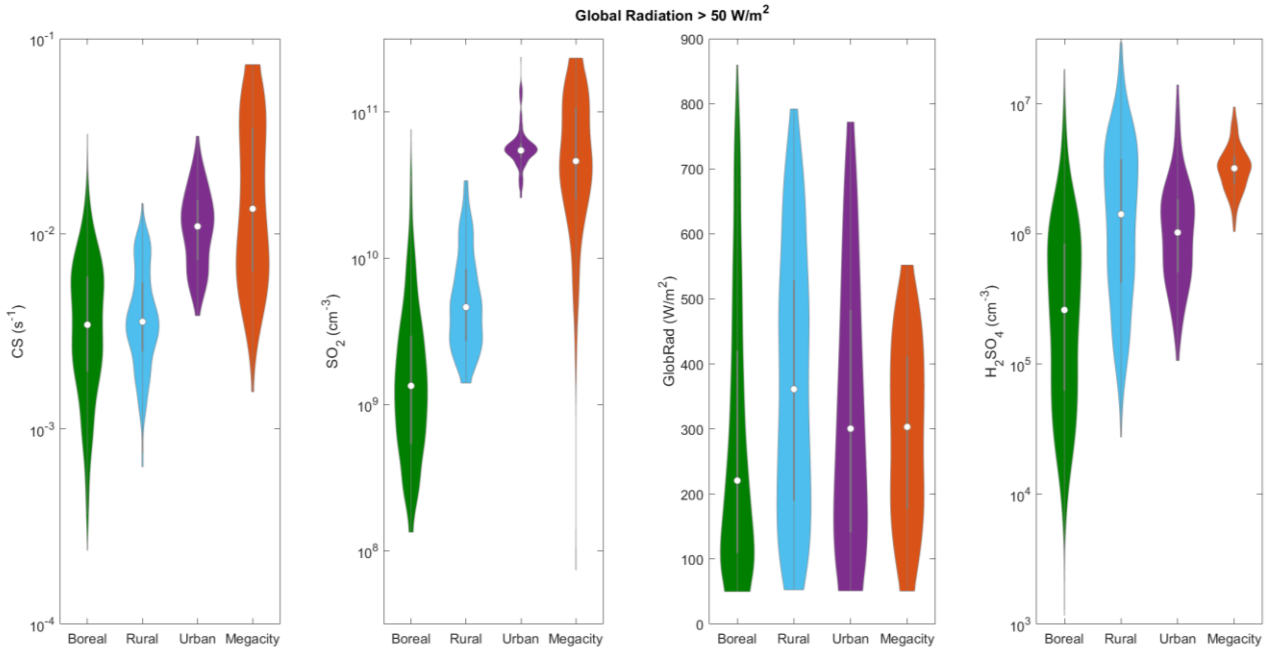

Figure S 13 Daytime data (GlobRad > 50 W/m^2) condensation sink, SO_2,GlobRad and H_2SO_4 concentrations in diffrerent environements. The concentrations are displayed as violin plots which are a combination of boxplot and a kernel distribution function on each side of the boxplots. The white circles define the median of the distribution and the edges on the inner grey boxes refer to the 25th and 75th percentiles respectively.