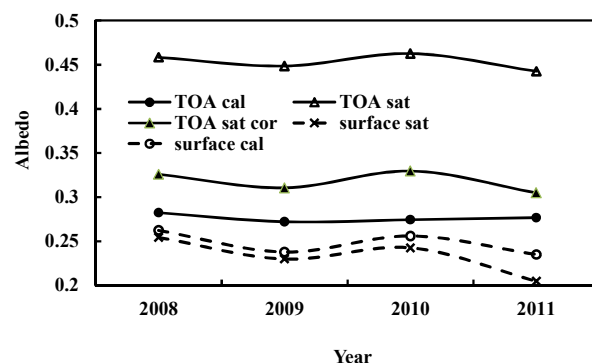
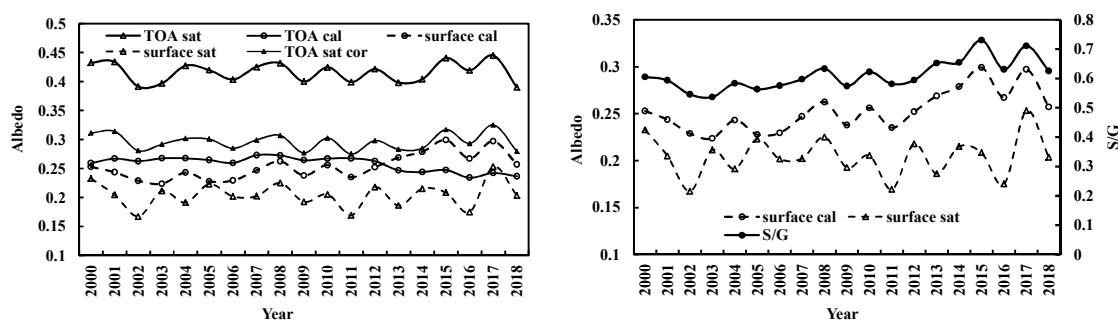


# Supplementary Materials:

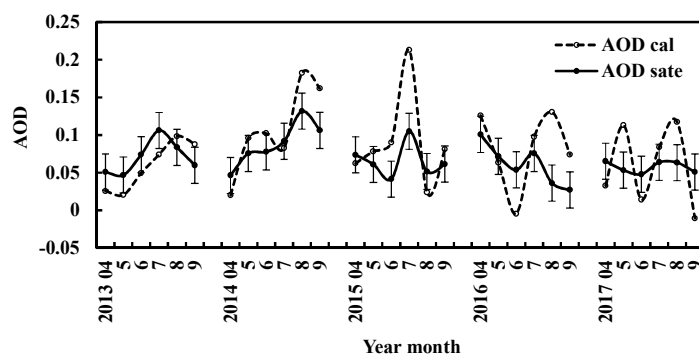
Jianhui Bai <sup>1,\*</sup>, Anu Heikkilä <sup>2</sup> and Xuemei Zong <sup>1</sup>



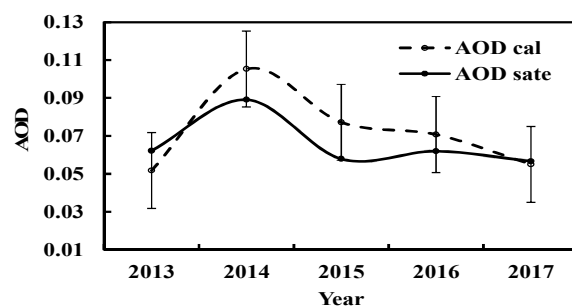
**Figure S1.** Annual mean albedos averaged from April to September in 2008-2011 calculated and satellite retrieved under all sky conditions at Sodankylä station. TOA cal, TOA sat and TOA sat cor denote the calculated, satellite retrieved and corrected satellite retrieved albedos at the TOA, surface cal and surface sat denote the calculated and satellite retrieved albedos at the surface.



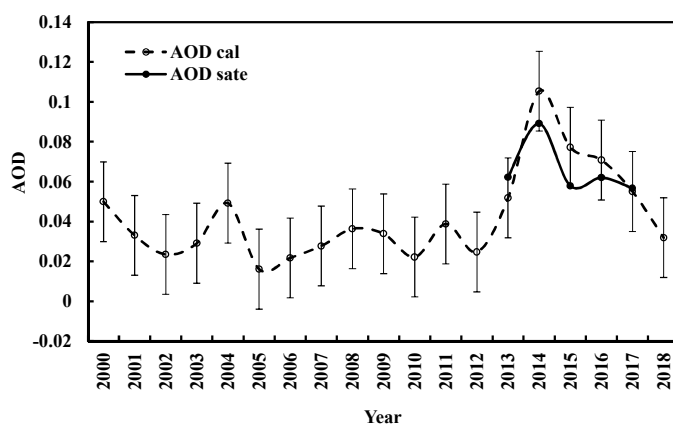
**Figure S2.** Annual mean albedos averaged from April to September in 2000-2018 calculated and satellite retrieved under all sky conditions at Sodankylä station.



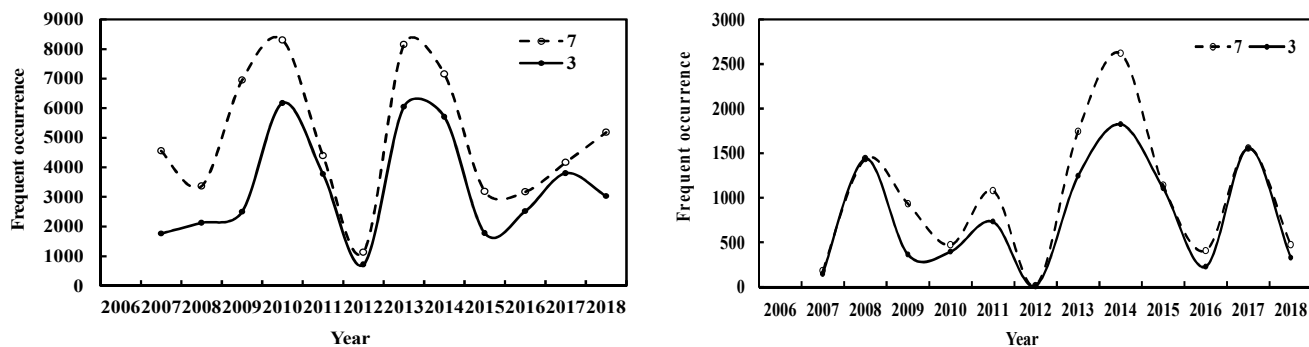
**Figure S3.** Monthly AOD calculated versus satellite retrieved (AOD cal and AOD sate) with error bars indicating standard deviation of satellite retrieved AOD at Sodankylä station.



**Figure S4.** Annual mean AOD calculated versus satellite retrieved with error bars indicating standard deviation of calculated AOD at Sodankylä station.



**Figure S5.** Annual mean AOD calculated versus satellite retrieved with error bars indicating standard deviation of calculated AOD at Sodankylä station.



**Figure S6.** Total frequent occurrence of 7 and 3 types of aerosols during April-September (left) in August (right).

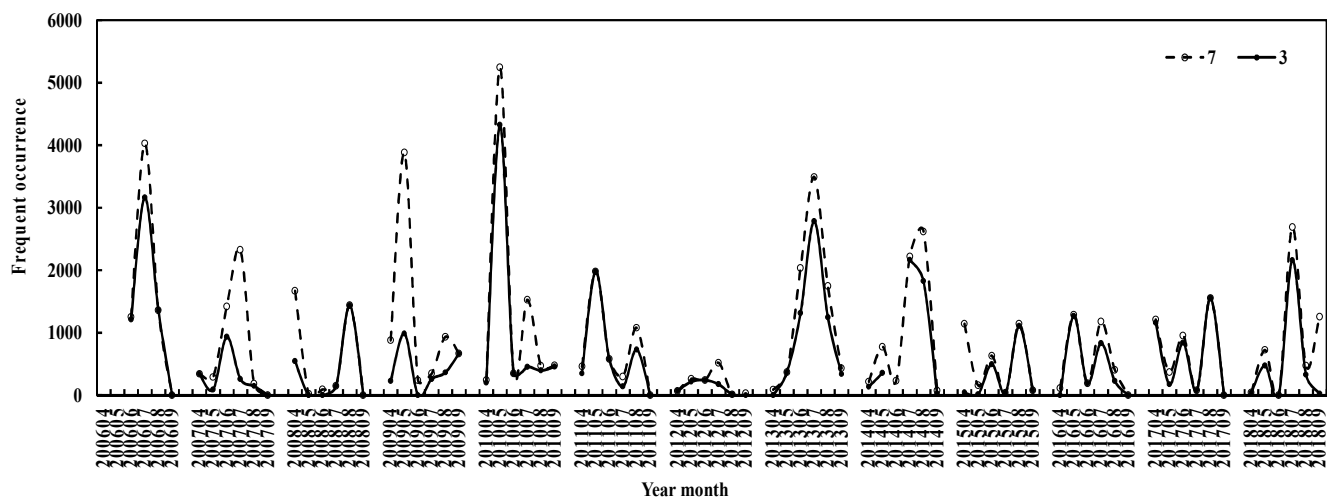


Figure S7. Monthly sums of frequent occurrence of 7 and 3 types of aerosols during April-September.

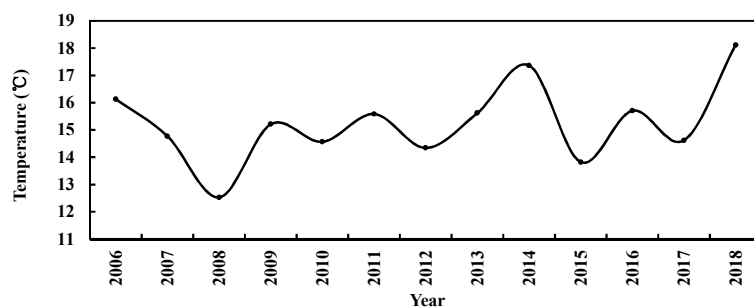


Figure S8. Averaged air temperatures during July-August at Sodankylä.

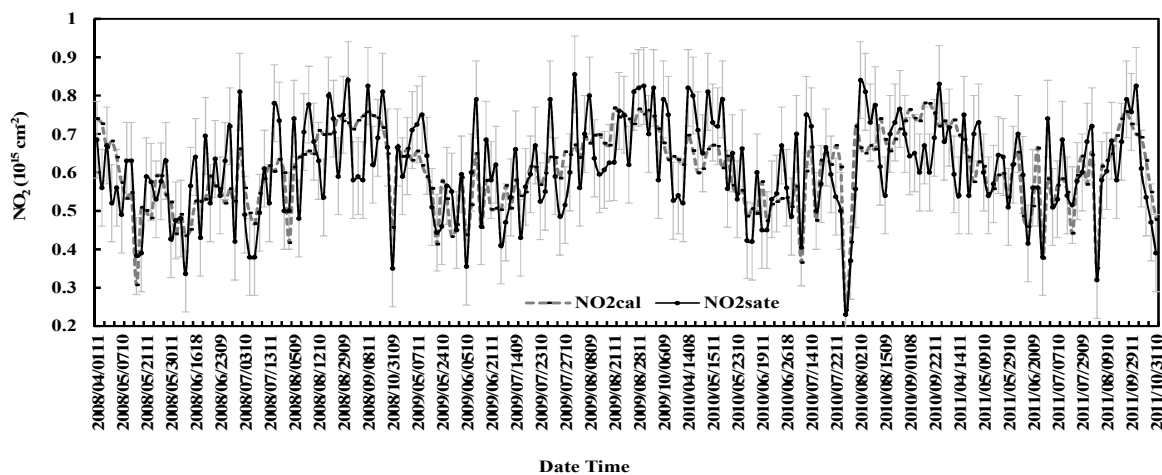
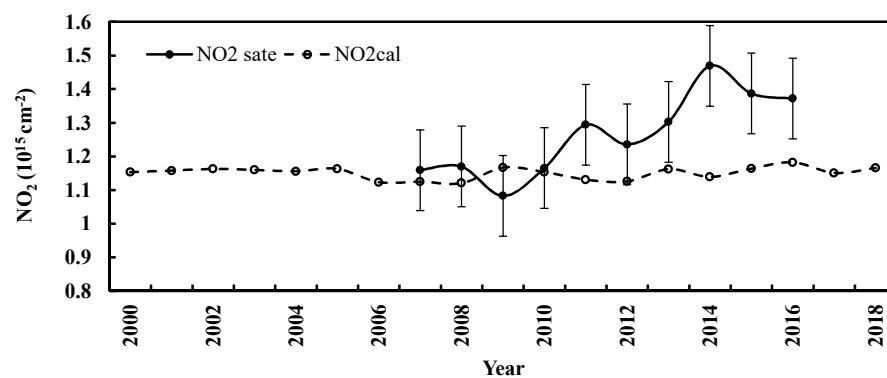
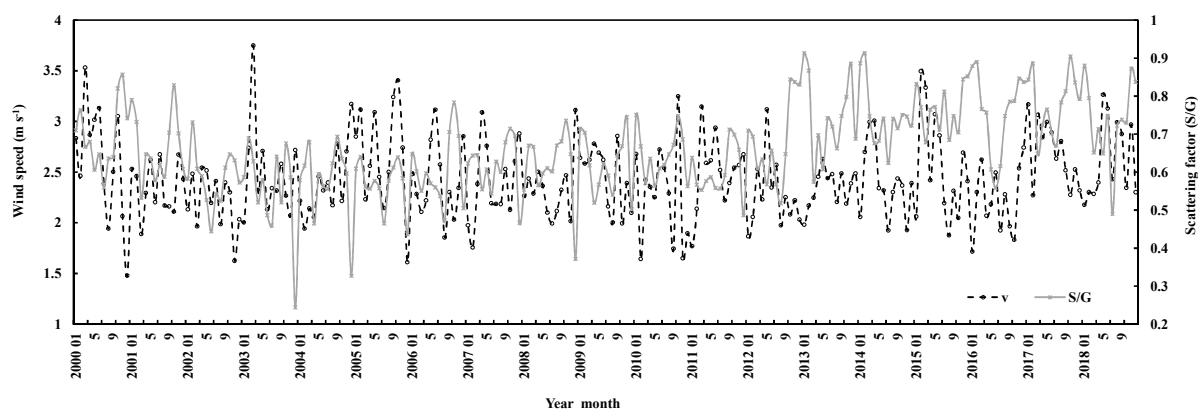


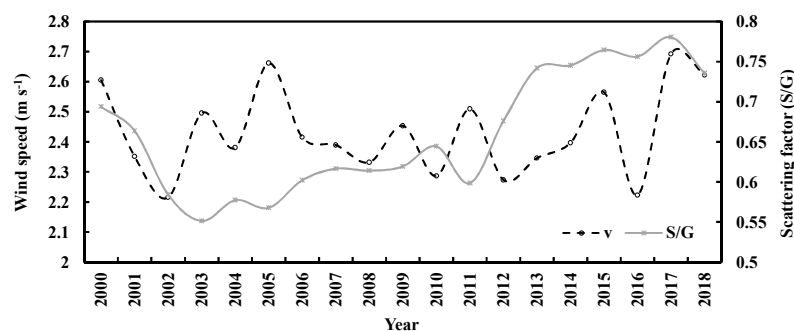
Figure S9. NO<sub>2</sub> VCDs calculated versus satellite retrieved (NO<sub>2</sub>cal and NO<sub>2</sub>sate) with error bars indicating standard deviation of satellite retrieved NO<sub>2</sub> VCD at Sodankylä station.



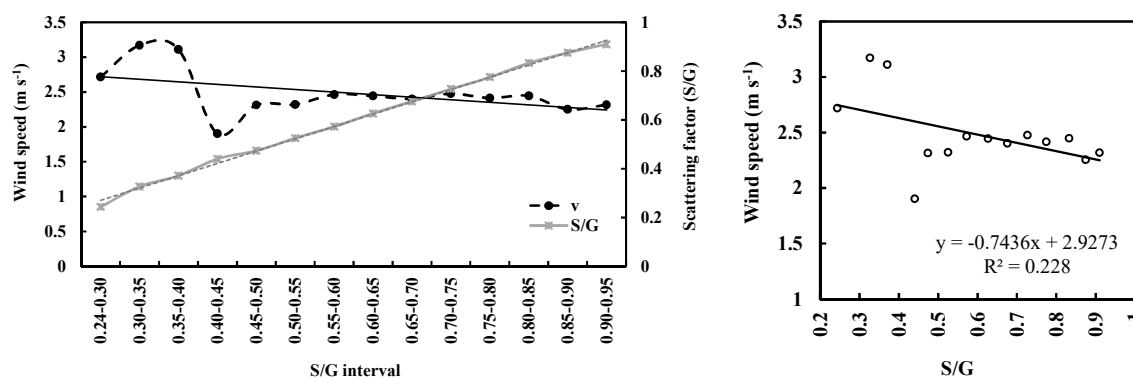
**Figure S10.** Annual NO<sub>2</sub> VCDs calculated versus satellite retrieved with error bars indicating standard deviation of satellite NO<sub>2</sub> VCDs during 2000 to 2018.



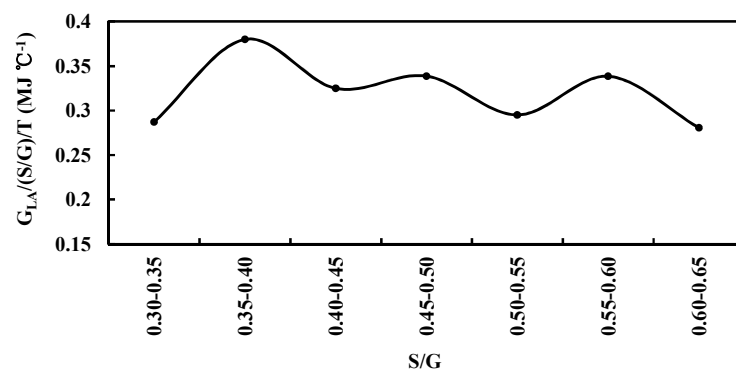
**Figure S11.** Monthly wind speed and monthly atmospheric substance over Sodankylä during January 2000-December 2018.



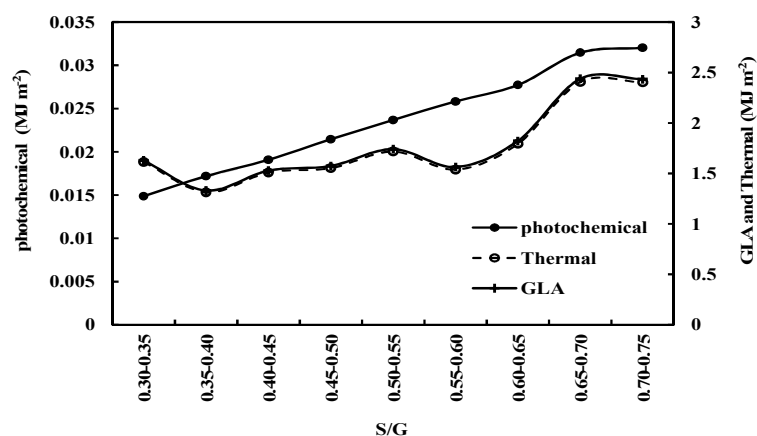
**Figure S12.** Annual wind speed (v) and monthly atmospheric substance over Sodankylä during 2000-2018.



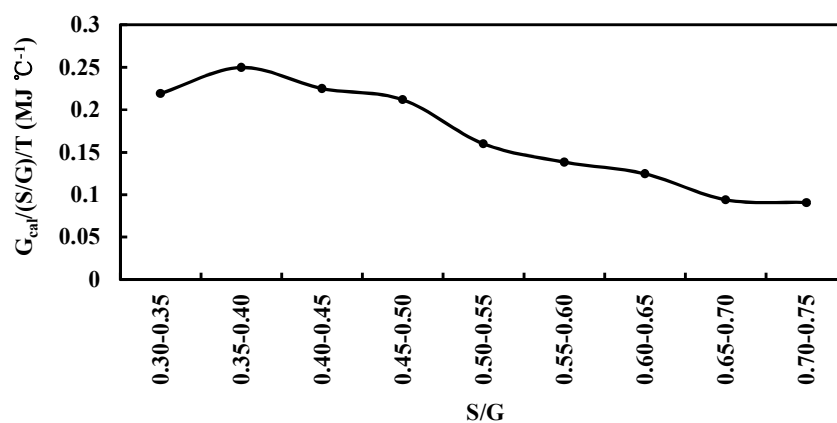
**Figure S13.** Monthly wind speed (v) and monthly atmospheric substance (S/G) for x-axis using S/G interval at 0.05 (left) and their scatter plot (right) during January 2000-December 2018.



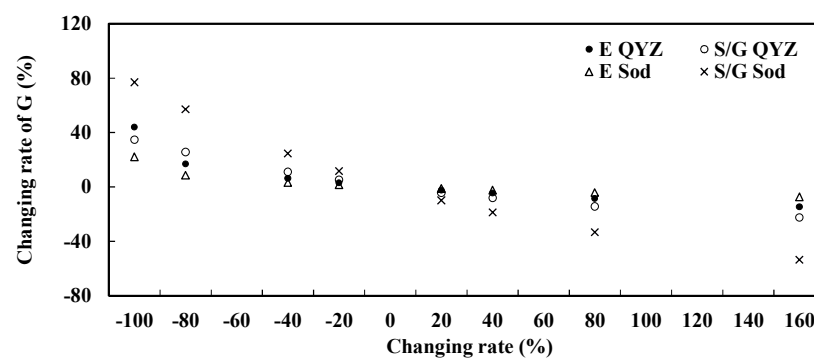
**Figure S14.** Ratio of solar absorbing loss to S/G and then to air temperature (T) at different S/G intervals.



**Figure S15.** The absorbing solar energy, thermal and photochemical energy ( $G_{LA}$ , thermal and photochemical) at different S/G intervals.



**Figure S16.** Ratio of calculated global solar irradiance to S/G and then to air temperature (T) at different S/G intervals.



**Figure S17.** Changing rates of global solar irradiance (%) caused by the changes of one factor (%), while other factors are kept at their original levels for QYZ and Sodankylä.