Geophysical Research Abstracts
Vol. 13, EGU2011-5314, 2011
EGU General Assembly 2011

Ship-plume sulfur chemistry in the ITCT 2K2 experiment

Yonghoon Kim, Hyun Soo Kim, and Chul Han Song

Gwangju Institute of Science and Technology, School of Environmental Science and Engineering, Gwangju, Korea (yhkim82@gist.ac.kr, +82-62-715-3404)

Estimation of the lifetime is a conventional way of examining the atmospheric evolution of pollutants. In this study, the ship-plume lifetimes of SO_2 were estimated for ITCT 2K2 (Intercontinental Transport and Chemical Transformation 2002) ship-plume case using a ship-plume photochemical/dynamic model. The magnitude of ship-plume SO_2 lifetimes is mainly affected by two main factors: (i) the levels of in-plume hydroxyl radicals (OH) and (ii) pH of sea-salt particles (pH_{ss}). The former is governed by stability condition of marine boundary layer (MBL) when the ship-emitted NO_x flux is fixed. The latter determines magnitude of aqueous-phase oxidation coefficients. SO_2 is oxidized inside deliquescent sea-salt particles via two main reactions: (1) bisulfite (HSO_3^-) + dissolved H_2O_2 at pH_{ss} <6.5 and (2) sulfite (SO_3^{2-}) + dissolved O_3 at pH_{ss} >6.5. According to the multiple ship-plume photochemical/dynamic model simulations, the estimated SO_2 lifetimes over the entire ship plumes ranged from 8.7 to 17.9 hrs under the neutral (D) to stable (F) MBL conditions, when pH_{ss} was assumed to be $\leq$ 7. These values are clearly shorter than the background SO_2 lifetime of 23.2 hrs. Moreover, dependence of SO_2loss budget on pH_{ss} was investigated. The changes of the SO_2 loss budget with pH_{ss} clearly show a shift in the dominant SO_2 loss processes, e.g., when pH_{ss} <6.5, approximately 60% of the SO_2 is lost by the gas-phase oxidation by OH radicals, whereas 96% of SO_2 is destroyed by the massive heterogeneous conversion of $SO_2$when pH_{ss}=8.