Continuous measurements of atmospheric CO concentration at Syowa station and interpretation of its variations by using a Chem-AGCM

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Continuous measurements of the atmospheric CO concentration have been made at Syowa Station, Antarctica (69S, 40E) since March 2000. In this study, we present the observed variations and results of comparison with simulated CO concentration using a 3-dimentional chemical-transport model.

At Syowa station, the air samples were collected from the intake 30 m away from the laboratory building and directly introduced into a gas-chromatograph (GC) analytical system. Two working standard gases with CO concentration values of about 100 and 50 ppbv were analyzed to calibrate the GC response and the CO concentration of the sample air was determined against these working standard gases. By a series of observation sequence, the atmospheric CO concentration is determined twice every 40 min. The obtained daily mean CO concentrations show the standard deviations ranging between 0.1 and 4.5 ppbv, with an average of 0.5 ppbv. We compared our observational results with those from model simulation with the Chemical AGCM for Study of atmospheric Environment and Radiative forcing (CHASER). For the inventory of inputted CO emission from anthropogenic source and biomass burning, EDGAR3.2 (partly replaced to REAS2.1) and GFED2.0 were used, respectively. To estimate contributions of CO emitted in the respective regions or produced chemically in and above the boundary layer of the atmosphere, a tagged CO tracer experiment was also executed.

This study shows that the average CO concentration at Syowa Station for the period from 2001 to 2005 is 53.6 (0.8) ppbv. The seasonal variations reach the maximum between September and October and the minimum between February and March. The peak-to-peak amplitude of the seasonal cycle observed at Syowa is 23.8 ppbv. CHASER model results reproduce the observed CO concentration variations fairly well. The result of tagged tracer experiment CO emitted in South America and the southern part of Africa increases in September and October, reflecting biomass burning enhanced in dry season, which plays an important role in the appearance of the seasonal maximum at Syowa. The CO concentration increase found in March 2003 is produced by CO emitted in Australia in association with a big forest fire. In austral summer, the observed CO concentration shows short-term variations with periods of a few weeks, primary attributable to air mass exchange in association with synoptic scale disturbances. The model result also reproduces these short-term variations well. The tagged tracer experiment suggests that CO produced by oxidation of biogenic NMHCs such as isoprene and terpenes from remote areas, especially in South America, mainly contributes to these variations. The model simulation indicates that CO is destroyed more efficiently over the Antarctic Continent than over the Antarctic Ocean, reflecting the fact that the OH concentration levels are high due to photo-dissociation of O3 enhanced on the snow surface. Considering this latitudinally-dependent CO concentration distribution, the summertime short-term CO variations observed at Syowa Station could be ascribed to the alternation of continental and maritime air masses.