Soil microbes degrade carbonyl sulfide -precursor of aerosol-

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For accurate prediction of future climate, IPCC pointed out insufficient data about the dynamics of aerosol comparing to green house gases. Carbonyl sulfide (COS) is a major source of stratospheric aerosol, and many efforts have been made to understand dynamics of atmospheric COS, including determination of sources and sinks of COS. Microbial activity in soil environments play an important role for the sink, but mechanisms of COS degradation by soil microbes are still unknown. In this study, we aimed to (1) quantify microorganisms that can degrade COS in the soil environment, (2) isolate COS-degrading bacteria from soil and characterized their activity, and (3) detect influence of the soil microbes on vertical profiles of atmospheric COS.

(1) Quantifying COS-degrading microbes

Little information is available on the quantification of microorganisms responsible for the COS degradation. Therefore, we constructed a counting method for heterotrophic COS-degrading microbes, based on the Most Probable Number method. The results of soil samples obtained from Mt. Fuji, Miyake-jima Island and Mt. Karasawa revealed that in forest soils COS-degrading microbes ranged from 10^6 to 10^8 MPN / g dry soil, and these cell densities were correlated to the rate of COS degradation by soil. Furthermore, high proportion of COS degraders versus heterotrophic microbes were observed in most soil samples tested, indicating that large part of heterotrophs have the ability to degrade COS. These results support the notion that biomass in soil is correlated to COS-degrading activity of soil.

(2) COS-degrading bacteria

Bacterial strains were isolated from the soil samples, tested for ability to degrade 30 ppmv of COS, and phylogenetically identified based on the analysis of 16S rRNA gene sequences. We obtained 33 isolates of COS-degrading bacteria that decreased more than 40% of initial COS in 24 hours, and eight isolates of non COS-degrading bacteria. Phylogenetical analysis revealed that most of COS-degrading bacteria were related to *Bacillus* and *Actinobacteria*, while non COS-degrading bacteria were related to *Proteobacteria*. Bacterial groups of *Bacillus* and *Actinobacteria* are known to widely spread among soil environments.

Considering natural COS flux between soil and the atmosphere, bacterial COS degradation was tested at the ambient level of 500 pptv, using a sterilized soil to cultivate the bacterium. Autoclave-sterilization of soil resulted in small amount of COS emission, while *Mycobacterium* sp. THI401 degraded COS faster than the rate of COS emission from soil and reduced COS mixing ratio to lower than the ambient level. Flux of COS degradation by the isolate was 0.52 pmol m^{-2} s^{-1}, and comparable to the values obtained from soil experiments. Previous studies concerning bacterial degradation of COS were mainly performed on chemolithoautotrophic bacteria, but the results indicate that heterotrophic bacteria share a role in microbial degradation of COS in soil environment.

(3) Vertical distribution of atmospheric COS

Using Mt. Fuji as an observation tower, air samples were collected at the summit (3776 m asl, above sea level) and the foot (1300 m asl). The summit of Mt. Fuji is mostly located at free troposphere where local impacts by urban activity and forest ecosystem are considered to be relatively low. Measurements in summer from 2003 to 2007 revealed that COS mixing ratios at the foot were lower than those at the summit through experiment period of 24 hours, indicating that COS degradation by soil and vegetation at the foot affects mixing ratio of COS. To know effect of soil to atmospheric COS, vertical profiles of COS at near the ground level (0.05, 0.5, 1, and 2 m) were measured in forest ecosystems. COS mixing ratio in the air decreased toward the ground, and this means existence of sink of COS in soil.