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Atmospheric chemical response to the changes in biological and solar activities

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The temporal and spatial distributions of atmospheric constituents, especially trace species, are related to air quality and climate system. The distribution of trace species in the atmosphere is controlled by the chemical processes, the emission and deposition and the transport from one region to another. Vegetation is the largest sources of reactive volatile organic compounds (VOCs) which are the precursors of photochemical ozone and organic aerosol in the troposphere. The increase in ozone and aerosol concentrations at the surface level would affect agricultural productivity, biogenic activities, and local/regional climate. On the other hand, ozone and aerosol budgets would be strongly influenced by human activities, e.g., agricultural and industrial activities. Furthermore, climate change affects vegetation and the emission rates of biogenic VOCs and emission which leads to change in the type and strength of biogenic volatile organic compounds' emission. It is therefore important to accelerate the joint-studies between biological and atmospheric science communities in order to improve the knowledge of the interrelation among biogenic activity, chemistry in the atmosphere, human activity, and climate.

Solar radiation, the heat source of Earth, is an important external factor to control and trigger chemical reactions in the atmosphere. For example, the production rates of stratospheric ozone are basically given as a function of the flux of solar radiation shorter than 240nm, which is much more sensitive to solar activity than the radiation in visible and IR region. Solar activity may also perturb the circulation field in the middle atmosphere. Therefore, the distribution of ozone in the middle atmosphere would be given as a complex function against the variation of solar activity. Solar activity change also influences on the amount of energetic charged particles which penetrate into the Earth's atmosphere. Solar energetic particle event is one of the examples and triggers many neutral and ionic reactions which results in the large changes in trace atmospheric species, e.g., total reactive nitrogen (NOy) and ozone concentrations in the middle atmosphere. The enhanced NOy and/or depleted ozone could be used as a tracer of the atmospheric motion. Not only transient phenomena but also long term variability of solar activity has an influence on Earth's environment. For example, one of the ideas concerning the interrelation between solar activity and climate is that the changes in the production rates of fine particles in response to the variation of solar activity would affect the solar energy reaching at the Earth's surface. However, in order to estimate the impact of solar activity changes on aerosol concentration, atmospheric chemical feedback should be considered because both the emissions of VOCs and chemical processes would also be influenced by the change in the solar flux and temperature. Environmental changes induced by solar/cosmic transient phenomena and/or long term variation of solar activity would be mediated through atmospheric processes and their information might be recorded into the ice core, soil, and biosphere. Information on interaction among sun-atmosphere-biosphere should be shared in order to understand the mechanisms how the atmospheric chemical processes response the change in solar activities and cosmic events.