Effects of hydrogen on limits of radiative emission from a planet with a saturated-water-vapor atmosphere

MIKI NAKAJIMA[1], MASAHIRO IKOMA[1], HIDENORI GENDA[2] AND SHIGERU IDA[1]

[1]Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Tokyo, Japan (mnakajima@geo.titech.ac.jp)

[2]Research Center for the Evolving Earth and Planets, Tokyo Institute of Technology, Tokyo, Japan

It is known that there are upper limits of radiative emission from a planet covered with sufficient water (i.e., an ocean). If incoming thermal flux exceeds the limits, extra thermal energy is used to evaporate the ocean, which means that an ocean is unable to exist under such a circumstance.

These limits have close relationships with the early evolution and habitability of planets. Since the energy flux from the planet's surface decreases with time because of cooling of the planetary interior, the limits constrain the timing of ocean formation. Moreover, because the stellar radiative flux decreases with distance from the star, this limits constrain the inner edge of the habitable zone in a planetary system.

Several studies investigated these limits (Komabayashi 1967; Ingersoll 1969; Abe and Matsui 1988; Kasting *et al*. 1988; Nakajima *et al*. 1992). However, no study has evaluated the effects of hydrogen on these limits. According to recent studies of the accumulation of the Earth's atmosphere, the initial Earth is likely to have been rich in hydrogen (e.g., Ikoma and Genda 2006). Furthermore, in extrasolar planetary systems, there might exist hydrogen-rich terrestrial planets.

In this research, we have investigated the effects of hydrogen (e.g., changes in mean molecular weight and opacity) and gravity on the limits by simulating the structure of the atmosphere in the radiative-convective equilibrium. Then we discuss the early evolution of the Earth and the location of the habitable zone in extrasolar planetary system.

References

Abe Y., and Matsui T., (1988) *J. Atmos. Sci*., **45**, 3081-3101.

Ikoma M. and Genda H., (2006), *ApJ.* **648**, 696-706.

Ingersoll A.P., (1969), *J. Atmos. Sci*., **26**, 1191-1198.

Kasting J. F., (1988). *Icarus*, **74**, 472-494.

Komabayashi M., (1967), *J. Meteor. Soc. Japan*, **45**, 137-139.

Chemical composition and behavior of atmospheric aerosols in the mountainous and plain regions of Toyama, Central Japan

T. NAKAMURA, T. YAMAZAKI AND K. KAWASAKI

Toyama Prefectural Environmental Science Research Center, Toyama, Japan (tokuhiro.nakamura@pref.toyama.lg.jp)

Introduction

East Asia is one of the most troubled regions in terms of atmospheric environment due to its huge population and industrial development. The emission of anthropogenic substances in East Asia has been on the rise due to the use of fossil fuels, industrialization and due to the lack of waste control practices. In particular, it is predicted that NO_x emission will increase approximately 5-fold from 1990 to 2020 (Akimoto,2003). The excessive N loading may have several adverse effects on both ecosystem health and water quality.

The western North Pacific recieves a large influx of mineral dust and pollutants from East Asia through atmospheric long-range transport. The Japan Sea is a marginal sea of the western Pacific Ocean and located in a transit zone for the continental air masses traveling to the open North Pacific. The coastal area of Japan Sea is an important area to study the transport mechanisms and modifications to chemical properties of aerosols.

Method

Chemical composition of aerosols and suspendes particle matter (SPM) measurements were conducted at Mt. Tateyama (2450 m a.s.l.) and Imizu (10 m a.s.l.) in Toyama, central Japan, simultaneously from 18 May to 8 June 2006.

The sampling period was about 24 hours and the sampled air volume was from 27.7 to 39.1 m^3.

Results

During the observation period, anthropogenic plume were observed. One of these episodes were almost equal nss-SO_4^{2-} levels to the urban atmosphere, even in Tateyama.

The mean concentrations of nss-SO_4^{2-} and NO_3^- in Tateyama were 5.37 and 0.59 μg m^{-3}, respectively. The concentration of nss-SO_4^{2-} was relatively lower than that of Imizu 8.68 μg m^{-3}. However, the concentration of NO_3^- was much lower than that of Imizu (2.93 μg m^{-3}). The NO_3^-/nss-SO_4^{2-} ratio in Tateyama (0.11) was lower than that of in Imizu (0.34). This is probably because NO_3^- combined with nss-Ca^{2+} removed from the atmosphere faster than that of nss-SO_4^{2-}. New particulate nss-SO_4^{2-} is expected to form by gas to particle conversation with time.

These pollutants will influence air quality and radiative forcing. To understand the effect of nitrogen deposition to the ecosystems, both wet and dry including gaseous matter measurements are required.

Reference

Akimoto, H. (2003) *Science* **302**, 1716-1719.