A test observation of stratospheric and mesospheric water vapor with a mm-wave superconductive radiometer in Atacama, Chile

Akira Mizuno[1]; Tomoo Nagahama[1]; Hiroyuki Maezawa[2]; Toshihisa Kuwahara[3]; Makoto Matsuura[3]; Satoshi Murayama[3]; Tomoyo Sugimoto[3]; Yasuo Fukui[4]; Norikazu Mizuno[5]; Toshikazu Onishi[6]; Hideo Ogawa[7]; Atsushi Morihira[8]

[1] STEL, Nagoya U.; [2] STEL; [3] none; [4] Department of Physics, Nagoya Univ; [5] Department of Physics Sci., Nagoya Univ; [6] Dept. Astrophysics, Nagoya Univ.; [7] Department of Earth and Life Sci., Osaka Precture Univ; [8] Fujitsu VLSI Corporation

Water vapor is radiatively active gas affecting the stratospheric temperature as well as the surface climate, and plays an important role in catalytic destruction of upper-stratospheric and mesospheric ozone as a source of HOx radicals. Observations suggest that stratospheric water vapor has increased roughly at a rate of ~1%/yr over ~50years (e.g., SPARC Report, 2000). Recent satellites and ground based microwave observations revealed more rapid increase of stratospheric and mesospheric water vapor in the early 1990s, but the increase seems to have stopped about 1996 (e.g., Nedoluha, et al. 1999; Nedoluha et al. 2003). However, currently available data sets of water vapor are limited either in spatial coverage or duration to understand the mechanism of the long-term variations of water vapor in the middle atmosphere.

In order to investigate the causes of the long-term variations, we planed to observe millimeter-wave spectral lines of water vapor (H2O) and its isotopomers (H2-18O, HDO) at 180GHz-250GHz simultaneously, and started the development of a new observational station in Atacama highland, Chile (67W, 23S, 4800m Alt.) in September, 2004. Since a large part of the millimeter-wave signal at a frequency of H2O line, 183GHz is absorbed by the abundant tropospheric water vapor, the altitude of the observational site is essentially important for good observational condition.

We made some test observations at Atacama and obtained the following results. (1) We confirmed the good atmospheric condition for steady and frequent observations of stratospheric and mesospheric H2O spectra at 183GHz. (2)Various observation or switching methods were tested, and we have found that the cold-load switching method is most suitable for H2O observation. (3)High degree of side-band separation of the superconductive receiver is demanded for accurate retrieval of water vapor mixing ratio.

In this paper, we will present the results of the test observations in the Atacama highland and the laboratory development of the dual-frequency superconductive radiometer for the simultaneous observation of water vapor isotopomers. In addition, we will mention the development of a low-frequency 22GHz room-temperature receiver which is suitable to construct a global observation network since the tropospheric absorption at 22GHz is smaller than that at 183GHz and the 22GHz line is observable at low altitude sites.